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# Polar Continental Shelf Project

Titles and Abstracts of Scientific Papers  
Supported by PCSP

No. **4**

compiled by  
G.D. Hobson and J. Voyce



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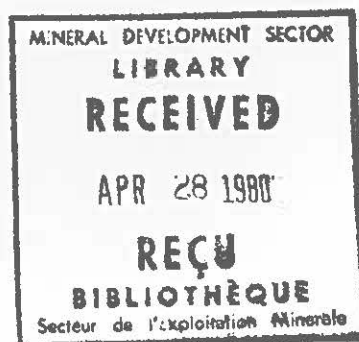
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## PREFACE

This is volume 4 of the Polar Shelf Bibliography and contains 421 new items covering recent scientific investigations in the Canadian Arctic. Interest in this bibliography continues at a high level amongst libraries in North America - we continue to add new addresses to our mailing list. It evidently serves a role in keeping certain individuals informed about scientific activity in the Arctic. So long as there is a reasonable demand for this type of information, we shall continue to publish it.

Thanks to the authors who send in the contributions to make this bibliography possible.

January 31, 1980

Ce volume 4 de la Bibliographie de l'Étude du Plateau Continental Polaire contient 421 nouveaux items couvrant de récentes investigations scientifiques dans l'Arctique canadien. Cette bibliographie continue à susciter un très grand intérêt dans les bibliothèques de l'Amérique du Nord. De nouvelles adresses s'ajoutent à la liste d'abonnés. Il est évident qu'elle sert à tenir certaines personnes au courant des recherches scientifiques dans l'Arctique. Tant qu'il y aura suffisamment de demandes pour ce genre d'information, nous continuerons à publier cette bibliographie.

Nous voulons remercier les auteurs, qui par leur collaboration, ont permis de réaliser cette bibliographie.

1e 31 janvier, 1980

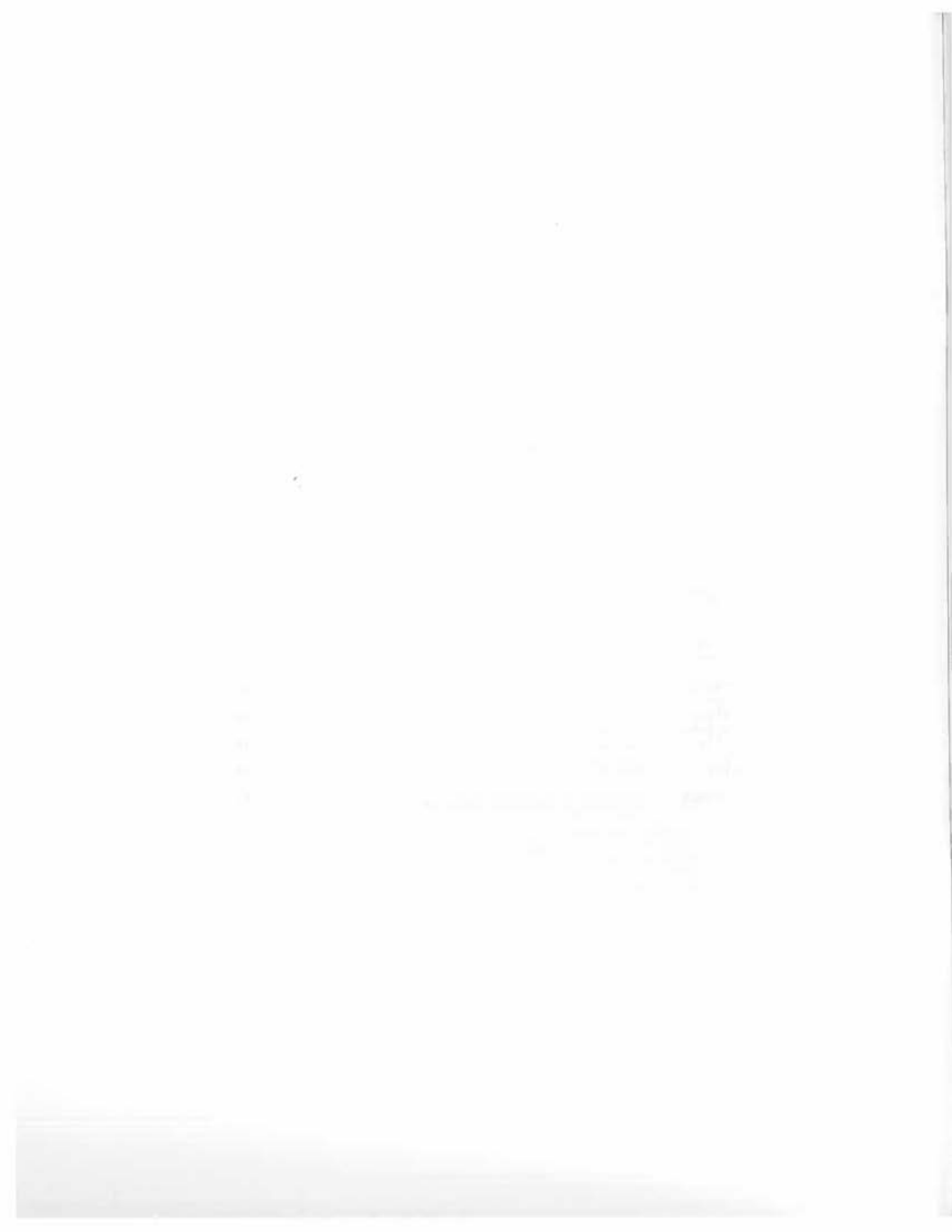
1. The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that this is crucial for ensuring the integrity of the financial statements and for providing a clear audit trail. The text also mentions the need for regular reconciliations and the use of appropriate accounting methods.

### 2. Accounting Principles

The second part of the document outlines the key accounting principles that should be followed. These include the principle of objectivity, which requires that transactions be recorded based on verifiable evidence. Other principles mentioned include the principle of consistency, which requires that the same accounting methods be used from period to period, and the principle of prudence, which requires that assets and liabilities be measured at their fair value.

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## ARCHEOLOGY

1393 ARNOLD, C.D. - 1977  
Excavations at the Lagoon Site (OjR1-3),  
Banks Island, N.W.T., 1977; *Polar Cont. Shelf  
Proj.*, internal report, 38 p.

This report constitutes a preliminary analysis of the results of a second season of archaeological investigations at the Lagoon Site (OjR1-3), a Paleoeskimo campsite situated near the mouth of the Masik River on the southwest coast of Banks Island, N.W.T. The site was discovered and initially tested during the course of an archaeological reconnaissance the previous year, yielding data of a nature which warranted more detailed investigations. Accordingly, a crew of five spent seven weeks at the site during the summer of 1977, testing new areas and extending the excavations of the previous year. The data thus obtained is seen to have a bearing upon our interpretation of the nature of the prehistoric cultural interactions between the western and eastern regions of the North American Arctic.

1394 BIELAWSKI, E. - 1978  
Aston Bay Archaeological Survey, Report of  
Field Work 1978; *Polar Cont. Shelf Proj.*, internal report, 55 p.

The Aston Bay Archaeological Survey is a regional study focusing on the prehistoric locational behavior of Arctic coastal inhabitants. The theoretical framework assumed views locational behavior as one aspect of cultural ecology. The coastal site distribution provides archaeological evidence from one part of the seasonal round probably followed by Arctic inhabitants. The field work methodology involved intensive site survey and stratified random site sampling. 76 sites were recorded and 7 sampled. The sites represent occupation of the Aston Bay area by at least four prehistoric groups, including early Arctic Small Tool Tradition people, Dorset Culture, Thule Culture and Post-Thule occupations. The information collected in the Aston Bay Survey is to be utilised for the spatial analysis of an Arctic coastal site distribution.

1395 CAIRNS, R. - 1978  
A slice of life in Kellet' storehouse; *Northern  
News Report*, vol. 7, no. 18, pp. 18-19.

1396 COWAN, C. - 1979  
Arctic gives up its past; *GEOS*, EM&R Winter  
vol., pp. 6-7.

1397 HAHN, J. - 1976  
Ein Eskimo-Werkzeug-Cache von Banks Island,  
N.W.T., Kanada; *Polarforschung*, vol. 46, no.  
2, pp. 95-105.

In northern Banks Island, one of the numerous historic Copper Eskimo sites yielded three tool caches, in addition to the usual tent rings and meat caches. The one discussed here contained a nearly complete land-hunting tool kit with a bow, arrows, trident, hunting and whittling knives, and bow drills. It is assumed that these implements were originally deposited in two tool bags and a quiver then placed under

stone slabs for protection. The familiar motives for caching winter equipment are not applicable here because this site was probably occupied during the end of spring and beginning of summer. The seasonal dating and the location of the site in central Banks Island, the placement of the caches apart from the settled area of the site, and the composition of the tool kit suggest that they were burial sites. There are several indicators that the human skeletons were probably scattered by wolves and foxes. It remains to be explained why such caches occurred at the Isachsen Sands site only and nowhere else.

1398 HELMER, J.W. - 1978  
Report of the 1978 Karluk Island Archaeology  
Project; *Polar Cont. Shelf Proj.*, internal report, 43 p.

During the 1977 field season, seven sites considered to be of early Dorset affiliation (ca. 800 - 400 B.C.) were discovered on the south and west coasts of Karluk Island in the Canadian High Arctic. All were situated on fossil beach terraces ranging in elevation from 8 metres to 13 metres above sea level. The identity of these sites was determined by the recovery of a number of diagnostic artifacts from several localities which were tested and/or surface collected. In 1978 a programme of archaeological excavations was initiated on Karluk Island. The purpose of this project was to continue the investigation of the early Dorset occupation begun the previous year. The following report summarizes the results of the 1978 field season.

1399 McCARTNEY, A.P. - 1977  
1976 excavations on Somerset Island; *Polar Cont.  
Shelf Proj.*, internal report, 30 p.

A field party returned to Somerset Island in 1976 to sample Thule house sites containing large amounts of whale bone. The 1975 surveys indicated the relative abundance of whale bone at several Somerset Island sites compared to those on Baffin Island. Clarke reported that Spence Bay carvers had collected heavily at Fort Ross and Cape Garry but had not yet reached the Creswell Bay sites by 1975. By sampling this south-to-north gradient of affected sites, we can compare degrees of recent site alteration. The Cape Garry site (PcJq-5) was chosen as a heavily altered site, while PeJr-1 on the north shore of Creswell Bay, 37 km north of PeJq-5, is a large but less recently collected site. These two sites on Creswell Bay represent 25 percent of the large Thule winter sites on southeastern Somerset (N=8). Cultural samples from these sites, therefore, should provide insights about similar adaptations to the local southeastern Somerset environment.

1400 McGHEE, R. - 1977  
Archaeological excavations at Port Refuge and  
Porden Point, Devon Island, N.W.T. (Summer  
1977); *Archaeological Surv. Can.*, internal  
report, 20 p.

1401 McGHEE, R. - 1978  
Canadian Arctic Prehistory; Can. distribution  
by Van Nostrand Reinhold Ltd., Scarborough,  
Ont., 128 p.

Thus, Inuit mythology tells of the creation of the earth and of mankind. After the creation came a mythical age, similar to the "once-upon-a-time" of European storytellers, when the world was inhabited by strange races of giants and dwarfs, and men could turn into animals or spirits. During this age, the sun evolved from a girl who fled to the sky, chased by her incestuous brother, who was to become the moon. The mammals of the sea grew from the fingers of a girl who was thrown out of a boat during a storm. Her father chopped off her fingers as she clung to the boat, and she sank to the bottom of the sea to become the most powerful spirit of all, the ruler of the sea beasts. During this mythical age, the various races of mankind originated from a girl who married a dog and set her more-or-less-human offspring adrift in a boat to populate the world with Inuit, Indian and European peoples. Legends that apparently relate to a more recent time tell of the Tunit, a gentle race that occupied arctic Canada when the ancestors of the Inuit arrived in the area. The legends of the distant past fade gradually into stories of events that occurred only a few generations ago, or within the memories of living people.

1402 MÜLLER-BECK, H. - 1977

Excavations at Umingmak on Banks Island, N.W.T., 1970 and 1973 Preliminary Report; Ed. H. Muller-Beck, Verlag Archaeologica Venatoria, Institut für Urgeschichte der Universität Tübingen, West Germany, 162 p.

The following is a preliminary report on the work conducted at "Umingmak", Banks Island, N.W.T. in 1970 and 1973 by the Institut für Urgeschichte (Institute of Prehistory) University of Tübingen.

A discussion of the sediment deposition is followed by a description of some of the sample stone and bone tools.

Radiocarbon dating placed the site in the Pre-Dorset period at 3,600 B.P. The term "Proto-Dorset" might deserve some consideration at this point as an alternative phraseology. This was a period just prior to a climatic decline and an increase in the rate of sedimentation.

About 80% of the animal remains preserved in the refuse of the excavated areas were from musk-oxen. These rests revealed a uniformity of hunting and butchering techniques during the repeated summer occupations of the site. The charcoal analysis proved that the wood had been gathered during the summer months. It is completely feasible, then, that the site was occupied by men and women busy with drying musk-oxen meat for the long winter ahead. Caribou and other species occurred rather infrequently among the hunted animal remains.

A detailed account of the sediment and plant life community in the Northern Sector of the site supplements the general geomorphological remarks on the Shoran Lake region.

Some additional comments, mainly concerning musk-oxen, have been added at the end.

1403 MUSTARD, L. - 1978

Souvenir hunters ruining Canada's Arctic his-

toric sites; *Recreation Canada*, December, pp. 12-14.

1404 PHILLIPS PARMENTER, C., BURNIP, M., FERGUSON, R., LANE, P., and SCISCENTI, J. - 1977

Preliminary Report of the 1976 Archaeological Investigations in the Queen Elizabeth Islands and the Eastern Arctic Region, Northwest Territories; *Parks Can.*, Ind. and Northern Affairs, Nat. Historic Parks and Sites Branch, 315 p. UNPUBLISHED MANUSCRIPT.

In the summer of 1976, a four-member crew from the National Historic Parks and Sites Branch of the Department of Indian and Northern Affairs began the first year of investigations into historic sites in the Queen Elizabeth Islands of the Northwest Territories. Aided by the Polar Continental Shelf Project, Department of Energy, Mines and Resources, twelve sites were visited both by helicopter and fixed-wing aircraft. The types of sites included a depot, wintering camps, marker and message cairns, and caches.

1405 PHILLIPS-PARMENTER, C., BURNIP, M., and FERGUSON, R. - 1978

Report on the Second Season of Archaeological Investigations of Historical Sites in the Canadian Arctic Archipelago; *Parks Can.*, Ind. and Northern Affairs, Nat. Historic Parks and Sites Branch Res. Bull. No. 81, January 1978, 26 p.

In 1976, a programme of historical site investigations in the Canadian Arctic archipelago was initiated by the Historical Resources Impact Assessment Unit of the Archaeological Research Section, National Historic Parks and Sites Branch. Increased industrial and scientific activity in the Arctic has left many of the above-surface sites vulnerable to the effects of development and particularly to souvenir hunting.

Twelve sites in the Arctic archipelago had been visited in 1976. Information gained during the 1976 field season on site type and condition and the problems of transportation and accommodation of the field crew enabled the planning of a slightly longer season in 1977 to include not only initial surveys but also some excavation.

1406 PHILLIPS PARMENTER, C., BURNIP, M., and FERGUSON, R. - 1978

Archaeological Investigations of Historical Sites in the Canadian High Arctic; *The Ottawa Archaeologist*, vol. 8, no. 1, pp. 2-11.

At the majority of historical sites in the Canadian High Arctic, the artifact remains lie scattered on the barren gravel surface. While environmental conditions are generally good for preservation with a cold, dry climate, exposure to wind, snow, animals and man is more severe than normal due to lack of soil protection. All archaeological sites in the Northwest Territories are protected by law, but, it is impossible to police the activities of the souvenir hunter in such a vast area.

1407 SCHLEDERMANN, P. - 1977  
The Ellesmere Island Research Project, Report on the 1977 field reconnaissance; *Arctic Inst. N. Amer.*, internal report, 37 p.

1408 SCHLEDERMANN, P. - 1978  
Preliminary results of archaeological investigations in the Bache Peninsula region, Ellesmere Island, N.W.T.; *Arctic*, vol. 31, no. 4, pp. 459-474.

1409 YORGA, B. - 1978  
Final Report, Archaeological Reconnaissance of the Yukon Coast; *Archaeological Surv. Can.*, internal report, 28 p.

#### BATHYMETRY

1410 THOMPSON, E.F. - 1978  
Final Field Report, P.C.S.P., Survey Viscount Melville Sound, Proj. File No. 5452-7230, February-April 1978; *Dept. Env.*, Canadian Hydrographic Serv., Central Region, internal report, 51 p.

#### BIOLOGY

1411 ADDISON, J.A. - 1977  
Population dynamics and biology of Collembola on Truelove Lowland; *in* Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem, ed. L.C. Bliss, Univ. Alberta Press, pp. 363-382.

Collembola are amongst the most abundant and widespread of soil arthropods. Species lists for several areas of the Canadian Arctic Islands are now available, but there has been little attempt to measure the seasonal variation in abundance of different species, and even less to investigate the biological significance of collembolan populations.

The objectives of this study were: (1) to investigate the population dynamics, life histories, and feeding biology of certain arctic collembolan species, and (2) to attempt to define the impact of the biological activities of these animals on the environment. Field work was carried out during the summer months of 1972, 1973, and 1974, with most of the work taking place during the latter two years. As *Hypogastrura tullbergi* and *Folsomia regularis* were the most widely distributed and abundant Collembola at the Devon Island site, much of the research centred on these two species.

1412 ALLEN, D.L., and HOGG, T.H. - 1979  
Bird Studies in the Keewatin District; *Can. Wildlife Service*, Report to Arctic Islands Pipeline Program, Environmental-Social Pro., Northern Pipelines, Ind. and Northern Affairs Pub. No. QS-8160-027-EE-A1, ESCOM Report No. A1-27, 129 p.

Aerial surveys were conducted between the end of May and mid September in 1976 and 1977 to determine the distribution of migrating, nesting, brood-rearing and moulting birds in the vicinity of the proposed Polar Gas pipeline route in the District of Keewatin.

South of the Thelon River the birds were generally evenly distributed, although waterfowl showed preference for the rivers, two lowland areas and two areas containing many small lakes. Thousands of staging Snow Geese were observed along the proposed route between the Thlewiazia River and Kogtok River during late August and early September. North of the Thelon River much of the terrain was rocky, poorly vegetated and uninhabited by birds. Two exceptions were the lower Back River area and the Rasmussen Lowlands. The former harboured large numbers of migrating waterfowl, cranes and loons in the spring and moulting geese during the summer. The latter was an extremely important breeding and moulting ground for Whistling Swans, White-fronted Geese, other waterfowl and shorebirds.

We recommended the following to minimize the impact of the Polar Gas pipeline on birds. Move the pipeline right-of-way out of the Rasmussen Lowlands into the highlands to the east. Move all support facilities at least 3.2 kilometres (2 miles) away from major waterways and from active Peregrine Falcon and Gyrfalcon nests. Reduce, and in two instances prohibit, construction and maintenance activities to avoid disturbing the birds during crucial phases of their life cycle. Control aircraft traffic over areas being used extensively by birds. Install mufflers on the machinery at the gas compressor stations. Devise and enforce stringent land-use regulations to minimize damage to the terrain.

We believe if our recommendations are implemented, the Polar Gas pipeline will have a minor effect on bird populations in the District of Keewatin.

1413 APRIL, J. - 1978  
tomorrow will be too late ...; *North*, July/August 1978, pp. 41-43.

There are areas of biological, geological and historical importance in the north that urgently require special protection. Because of the vastness of the Canadian North, this may not always be readily apparent. However, here, as elsewhere, man's expanding activities threaten an increasing number of unique areas and species. Future benefits from the North's renewable resources cannot necessarily be expressed in monetary terms, but their value in terms of space, the existence of many species, and even the preservation of scenic resources may be worth more to the people of Canada, over the longer term, than the quickly used non-renewable resources now being developed.

1414 BLISS, L.C. - 1977  
Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem; ed. L.C. Bliss, Univ. Alberta Press, 714 p.

The International Biological Programme was initiated in the late 1950s to study biological



## BIOLOGY

production in relation to human welfare, to advance scientific knowledge, and to promote international scientific cooperation. Approximately 50 countries participated in detailed planning and preparation from 1964 to 1967, research from 1967 to 1972, and syntheses from 1972 to 1975.

The Canadian Committee for the International Biological Programme (C.C.I.B.P.) sponsored two terrestrial productivity projects including this one. Planning for this study took place from 1969 to 1970, field research from 1970 to 1974, and synthesis in 1974 and 1975. Due to the late initiation of this project and the previous full commitment of C.C.I.B.P. funds, special approval by the committee was obtained to have the National Research Council of Canada provide basic core funding. Additional funds were obtained from Canadian government departments (Environment, Indian and Northern Affairs, Energy, Mines and Resources) and from 24 petroleum companies and consortia.

The Devon Island Project was one of 14 major studies within the I.B.P.-P.T. Tundra Biome Programme, a programme that included four arctic tundra sites. This one was the most northern.

This book contains summary papers of all of the field and laboratory studies conducted over the five year period.

1415 BLISS, L.C. - 1977

General summary Truelove Lowland ecosystem; *in* Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem, ed. L.C. Bliss, Univ. Alberta Press, pp. 657-675.

The chapters of this book have discussed in detail various components of this high arctic ecosystem. Many aspects of the study have been synthesized in the chapters on nutrient cycling, and on energy budgets and ecological efficiencies. General summaries of the study have been included in the synthesis volume of the Tundra Biome I.B.P. projects and the synthesis volume of the Canadian Contribution to the I.B.P.

It is the purpose of this final chapter to highlight some of the major integrative findings of this study, to relate these findings to general ecosystem function in the High Arctic, and to discuss their implications for land use management.

1416 BLOOD, D.A. - 1977

Birds and Marine Mammals; Beaufort Sea Project Overview Report Series, The Beaufort Sea and the Search for Oil, 124 p.

Several hundred papers and reports, as well as Beaufort Sea Project technical studies, were used in preparing this overview. They have not been cited in the text, but a selection of relevant literature is given in Appendix 3. Migratory Bird Sanctuaries, and proposed Ecological Reserves in the southeastern Beaufort Sea-Amundsen Gulf area, are listed in Appendices 4 and 5 respectively.

1417 BOOTH, T. - 1977

Muskox dung; its turnover rate and possible

role on Truelove Lowland; *in* Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem, ed. L.C. Bliss, Univ. Alberta Press, pp. 531-545.

One feature of the Truelove Lowland ecosystem is the presence of herbivore, particularly muskox, fecal material. Since there have been few studies on abiotic and biotic factor effects on vertebrate dung decomposition processes, determination of thermal and moisture regimes and turnover times was undertaken. Also, determination of dung contributions of minerals and organic substances to so-called "nutrient poor" tundra ecosystems was considered important.

Several microhabitats occur on the Lowland and, in order to account for variations in decomposition, it was decided to study the Beach Ridge Crest and Backslope, the Hummocky Sedge-moss Meadow, and Wet Sedge-moss Meadow sites.

1418 BRUEMMER, F. - 1978

Mystery Whales; *Ottawa Journal Weekend Magazine*, Saturday, July 22, 1978, pp. 16-18.

Every July beluga whales gather in Cunningham Inlet in Canada's High Arctic. No one knows why.

1419 EDDY, S.B., and LANKESTER, M.W. - 1978

Feeding and Migratory Habits of Arctic Char, *Salvelinus alpinus*, Indicated by the Presence of the Swimbladder Nematode *Cystidicola cristivomeri* White; *J. Fish. Res. Board Can.*, vol. 35, no. 11, pp. 1488-1491.

The presence of *Cystidicola cristivomeri* White 1941 in the swim bladder of char indicates the fish have fed on infected, freshwater *Mysis relicta* which is the essential intermediate host of this parasite. Char younger than 5 yr occur in shallow waters in Stanwell-Fletcher Lake and apparently feed rarely on *Mysis* as indicated by infrequent infection with *C. cristivomeri*. Older fish that adopt a migratory habit and go to sea for the summer appear to feed little on *Mysis* when they return to overwinter in the lake. Small, slow-growing char present in the lake during summer were commonly infected with *C. cristivomeri* indicating they feed heavily on *Mysis*. These small fish, which are as old as many migrants, may not participate regularly in the seaward migration.

1420 ENGELHARDT, F.R., GERACI, J.R., and SMITH, T.G. - 1977

Uptake and Clearance of Petroleum Hydrocarbons in the Ringed Seal, *Phoca hispida*; *J. Fish. Res. Board Can.*, vol. 34, no. 8, pp. 1143-1147.

Ringed seals, *Phoca hispida*, showed rapid absorption of hydrocarbons from Norman Wells crude oil into body tissues and fluids when exposed by both immersion and ingestion. Relatively low but significant levels were found in tissue, blood, and plasma. Levels in bile and urine were high, indicating these to be routes of excretion.

1421 FOY, M.G., and HSIAO, S.I.C. - 1976

Phytoplankton data from the Beaufort Sea, 1973 to 1975; *Fish. Mar. Serv., Res. Dev. Tech. Rep.* 617, 44 p.



The phytoplankton from collections made in the southern Beaufort Sea during the summers of 1973, 1974 and 1975 is tabulated quantitatively. Organisms of 51 genera and 72 species were identified; diatoms formed the largest group with 39 genera and 64 species.

1422 FRAKER, M.A., SERGEANT, D.E., and HOEK, W. - 1978

Bowhead and White Whales in the Southern Beaufort Sea; Beaufort Sea Technical Report No. 4, May 1978, 114 p.

The purpose of this report is to describe the biology of bowhead and white whales of the southeast Beaufort Sea and to assess the possible effects of oil and gas exploration on the whales.

1423 FRISCH, T., and MORGAN, W.C. - 1979  
Ivory Gull Colonies in Southeastern Ellesmere Island, Arctic Canada; *Can. Field-Naturalist*, vol. 93, no. 2, pp. 173-174.

Five Ivory Gull colonies, ranging in population from about 12 to 60 birds, have been discovered in the upland icefields of southeastern Ellesmere Island. The colonies occur on cliff-faces of precipitous nunataks as much as 26 km from the nearest sea coast. One colony is established as a nesting site; the others are probable breeding places.

1424 FULLER, W.A., MARTELL, A.M., SMITH, R.F.C. and SPELLER, S.W. - 1977

Biology and secondary production of *Dicrostonyx groenlandicus* on Truelove Lowland, in Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem, ed. L.C. Bliss, Univ. Alberta Press, pp. 437-459.

Many authors have recognized the pivotal role of lemmings in tundra ecosystems, not only as primary consumers and a major energy source for higher order consumers, but also as physical agents of change through their burrowing and other activities. Lemming populations are notoriously variable with peaks of abundance apparently occurring on the average every 3 to 4 years. The riddle of lemming cycles provides a second reason for studying the biology of a high arctic population because, in spite of numerous studies conducted in the Low Arctic of both hemispheres, there is no agreement about what factors control or regulate lemming numbers. This paper is based on research on *Dicrostonyx groenlandicus* over parts of four consecutive summers (1970-73). The major objectives were to determine the role they play in energy transfer within this ecosystem and to investigate their population cycles.

1425 GERACI, J.R., and SMITH, T.G. - 1977  
Consequences of oil fouling on marine mammals; in *Effects of Petroleum on Arctic and Subarctic Marine Environments and Organisms*, Vol. II Biological Effects, ed. Donald C. Malins, Academic Press Inc. New York, pp. 399-410.

Two oil immersion studies were carried out, one in natural seawater pens in the arctic, the other in a southern laboratory.

1426 GILL, D., and STRANDTMANN, R.W. - 1977  
Ectoparasites of the collared lemming (*Dicrostonyx torquatus*) on Bathurst Island, N.W.T., Canada; *J. Med. Entomol.*, vol. 14, no. 1, pp. 101-106.

The following ectoparasites were obtained from 52 specimens of the Collared Lemming (*Dicrostonyx torquatus*) on Bathurst Island, N.W.T., Canada. Anoplura: *Hoplopleura acanthopus* (Burmeister) (on 21 hosts); Acarina: *Laelaps alaskensis* Grant (27 hosts), *Hirstionyssus isabellinus* (Oudemans) (15 hosts), *Haemogamasus ambulans* (Thorell) (13 hosts), *Radfordia macdonaldi*, n. sp. (4 hosts), and *Myocoptes japonensis canadensis* Radford (3 hosts). In addition, about 20 hypopi of the scavenger mite *Dermacarus hypudaei* (Koch) were found on 1 host. The new myobiid, *Radfordia macdonaldi*, is described and illustrated.

1427 GRAY, D.R. - 1979

Nature Conservation in the North: the Contribution of the National Museums of Canada; *Can. Museums Assoc. gazette*, winter issue 1979, vol. 12, no. 1, pp. 35-42.

In Canada's North, museum research projects show how closely nature conservation and the traditional roles of natural history museums are linked. Though natural history has often been neglected by northern museums, recent conservation concerns and increased co-operative ventures are helping to improve the situation.

1428 GRAY, D.R. - 1977

The Status of the Muskox and Peary Caribou on Canada's Arctic Islands; in *Proc. Sym. on Canada's Threatened Species and Habitats*, eds. T. Mosquin and C. Suchal, Can. Nature Fed., Ottawa, pp. 57-62.

In the proceedings of several recent international conferences on the arctic and in the writings of Canadian biologists as far back as the early 1900s, concern has been expressed for the survival of significant populations of Canada's arctic wildlife. Recent concerns have included the inadequacy of funding for arctic research, the unanswered need for long-term studies, lack of biological reserves and the overwhelming speed of industrial development in the north. Specific concerns have been expressed regarding the state of research on particular species, including the muskox and Peary caribou.

The purpose of this paper is to review the situation of the muskox, *Ovibos moschatus*, and the Peary caribou, *Rangifer tarandus pearyi*, of Canada's arctic islands particularly to see how recent developments relate to the concern already expressed for the future.

1429 HSIAO, S.I.C., FOY, M.G., and KITTLE, D.W., - 1977

Standing stock, community structure, species composition, distribution, and primary production of natural populations of phytoplankton in the southern Beaufort Sea; *Can. J. Bot.*, vol. 55, no. 6, pp. 685-694.

Standing stock and *in situ* primary production of the southern Beaufort Sea phytoplankton were

determined during the summers of 1973, 1974, and 1975. They decreased with increasing distance from shore and the Mackenzie river mouths. The phytoplankton community was composed largely of diatoms and flagellates with diatoms dominating in the coastal waters and flagellates being more abundant in the waters farther off shore. Dinoflagellates and chrysophytes occurred in relatively low numbers except in a few cases when blooms were observed. Blue-green algae were found occasionally in very low numbers. Seventy-two species of phytoplankton were identified, most of these being diatoms.

1430 HSIAO, S.I.C., KITTLE, D.W., and FOY, M.G. - 1978

Effects of crude oils and the oil dispersant corexit on primary production of arctic marine phytoplankton and seaweed; *Environ. Pollut.*, vol. 15, pp. 209-221.

Effects of crude oil and Corexit on primary production of arctic marine phytoplankton were studied *in situ*. The production rate varied with types and concentrations of crude oil, method of preparation of oil-seawater mixtures, environmental conditions and species composition of each sample tested. In samples with the same species composition, inhibition of production generally increased with increasing oil concentration. The crude oil - Corexit mixtures were more toxic than crude oil or Corexit alone.

*In situ* primary production of the seaweeds, *Laminaria saccharina* (L.) Lamouroux and *Phyllophora truncata* (P.) Newroth et Taylor was significantly inhibited by all types and concentrations of oil tested.

1431 HUBERT, B.A. - 1977

Estimated productivity of muskox on Truelove Lowland; *in* Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem, ed. L.C. Bliss, Univ. Alberta Press, pp. 467-491.

The muskox (*Ovibos moschatus*) is native to the tundra of North America and Greenland and is the largest herbivore in those parts. Unlike the caribou, the muskox is not migratory or nomadic, but is sedentary. The muskox is the only ruminant species whose natural distribution is restricted to tundra regions. Many features of muskox anatomy seem to be specialized adaptations for energy conservation in a cold tundra environment. The same object may be served by the behavioral characteristic of muskox first taking a defensive position rather than fleeing when threatened.

1432 KILIAAN, H.P.L., and STIRLING, I. - 1978  
Observations on overwintering walrus in the eastern Canadian High Arctic; *J. Mammalogy*, vol. 59, no. 1, pp. 197-200.

The walrus (*Odobenus rosmarus*) is an abundant pinniped in the eastern Canadian High Arctic. For most of the year, walrus are associated with pack ice although during the open water season they may haul out on land in large numbers at certain traditional sites. During the winter, they congregate to feed in shallow water areas which are either relatively ice free or in

which they can maintain breathing holes in the leads, thereby assuring access to the molluscs upon which they feed. Walrus are apparently capable of breaking ice up to 15 cm thick in such areas. The availability of such habitat is probably the limiting factor to walrus distribution. In areas where access to the water may be reduced because of heavy ice, walrus may become vulnerable to predation from polar bears (*Ursus maritimus*), although few such encounters have been documented.

1433 KILIAAN, H.P.L., STIRLING, I., and JONKEL, C.J. - 1978

Polar bears in the area of Jones Sound and Norwegian Bay; *Fisheries and Env. Can.*, Can. Wildl. Serv. Progress Notes No. 88, August 1978, 21 p.

Studies of polar bears in the area of Jones Sound and Norwegian Bay were initiated by the Canadian Wildlife Service (CWS) in 1971 as part of a general study of polar bear population ecology in the eastern High Arctic. The objective here is to summarize all research knowledge and hunter kill data for the area of Jones Sound and Norwegian Bay.

1434 KINOSITA, S. - 1978

An Outline of Research Project; *in* Joint Studies on Physical and Biological Environments in the Permafrost, Alaska and North Canada, July to August, 1977, Inst. Low Temp. Sci., Hokkaido Univ., Japan, pp. 1-15.

Permafrost, distributing in such cold regions as Siberia, Alaska, Northern Canada and North-western China, covers more than 14% of the total land area of the earth or an area 55 times the total land area of Japan. Its thickness averages about 100m, reaching to 500m or more in some places. The very surface layer of permafrost, which melts in summer and refreezes in winter, is called "active layer", which holds meltwater and rainwater in summer because the underlying frozen layer is not permeable to water. Thus, a permafrost region allows a number of lives to support themselves, when this layer abounds in water, while cyclic melting and refreezing processes cause special landforms to be seen in this region.

This expedition carried out in the summer of 1977 in tundra areas in Barrow, Alaska, as well as Tuktoyaktuk, Mackenzie Delta, Canada, turned its chief attention both to the behavior of water in the active layer and the natural environment for a joint study from the geophysical, geographical and ecological (flora and fauna) viewpoint. Subjected to prior expeditions to this one using the same approach were a forest area in Yakutsk, Siberia, in the summer of 1972, and forest and tundra areas in Alaska and Northern Canada in the summer of 1974, both with emphasis of the physical and biological environment especially in the forest areas of permafrost. The present expedition was aimed at the tundra environment, whereby the results are presented in this book.

1435 MARTELL, A.M., and PEARSON, A.M. - 1978

The Small Mammals of the Mackenzie Delta Region, Northwest Territories, Canada; *Arctic*, vol. 31, no. 4, pp. 475-488.

The paper reports on 3800 small mammals taken in taiga and tundra east of the Mackenzie River Delta between 1971 and 1974. Local distributions are given for all 10 species of small mammals recorded in the region, plus two accidentals. In addition, abundance, body and cranial measurements, and reproductive information is presented for the 8 species collected during the study. The taxonomic status of *Clethrionomys rutilus platycephalus* is discussed.

1436 MILLER, F.L., RUSSELL, R.H., and GUNN, A. - 1977

Interisland movements of Peary Caribou (*Rangifer tarandus pearyi*) on western Queen Elizabeth Islands, Arctic Canada; *Can. J. Zool.*, vol. 55, no. 6, pp. 1029-1037.

To verify that Peary caribou were making seasonal interisland movements, we used an aerial dye-spray method. In April 1974, about 230 caribou were dye-marked green, and about 200 were marked red on Prince Patrick and Eglinton islands respectively. Aerial searches in June and July 1974 located 41 sightings of dye-marked animals. Of animals marked on Prince Patrick Island 4 were seen on Melville Island, 3 on Eglinton Island, and 16 on Prince Patrick. Of sightings of animals marked on Eglinton Island, there were 6 on Prince Patrick Island and 12 on Eglinton. Maximum distance travelled (vector sum on horizontal plane) by marked caribou was 450 km, from Prince Patrick Island to eastern Melville Island. The study indicates that high proportions of the caribou population seasonally range over two or more islands of the western Queen Elizabeth Group. Therefore, complete evaluation of annual range requirements on an island basis should take into consideration seasonal changes in numbers of caribou that are due to interisland movements.

1437 MILLER, F.L., and RUSSELL, R.H. - 1977  
Unreliability of Strip Aerial Surveys for Estimating Numbers of Wolves on Western Queen Elizabeth Islands, Northwest Territories; *Can. Field-Naturalist*, vol. 91, pp. 77-81.

Numbers of wolves (*Canis lupus arctos*) were obtained by aerial survey and by ground observation on western Queen Elizabeth Islands, Northwest Territories. Six transect-strip "census" aerial surveys were flown in March-April and July-August of each year from March 1972 to August 1974. The estimates based on aerial surveys were usually misleading. The behavior of observed wolves and their associations with other animals or objects that helped attract the observers attention to the wolves greatly influenced the number of observations. These reported shortcomings of aerial surveys must be considered during any future attempts at determining numbers of wolves.

1438 MILLER, F.L. - 1978  
Interactions between men, dogs and wolves on western Queen Elizabeth Islands, Northwest Territories, Canada; *Musk-ox*, vol. 22, pp. 70-72.

Both Peary caribou (*Rangifer tarandus pearyi*)

and muskoxen (*Ovibos moschatus*) experienced high mortality in winter 1973-74 and now occur in low numbers throughout the western Queen Elizabeth Islands. It is likely that wolves (*Canis lupus arctos*) have resultantly entered a period of declining numbers and redistributions as alternative sources of food are often unavailable or scarce. If only a small population of wolves exists, their future in the High Arctic in the face of ever increasing exploration and exploitation of non-renewable resources may be precarious.

1439 MILLER, F.L., and GUNN, A. - 1978  
Responses of Peary Caribou and Muskoxen to helicopter harassment, Prince of Wales Island, Northwest Territories, 1976-77; Vols. I and II; *Fisheries and Env. Can.*, Can. Wildl. Serv. Completion Report to Arctic Islands Pipeline Program; 588 p.

This report provides information on overt behavioural responses of Peary caribou (*Rangifer tarandus pearyi*) and muskoxen (*Ovibos moschatus*) to simulations of three likely categories of helicopter activities that would be associated with construction of a gas pipeline in Arctic Canada. The study was carried out on Prince of Wales and Russell islands, Northwest Territories, in summers 1976 and 1977. One, three-man team and a Bell 206B turbo-helicopter were used in July and August 1976 and four, two-man teams and a Bell 206B were used in June through August 1977. All helicopter harassment overflights were flown at less than 400 metres above ground level (m agl): mostly below and above 200 m agl in 1976 and 1977, respectively. The maximum response of an animal during an overflight was taken as a measure of harassment. In total, 3,939 individual maximum response samples (IRS) of Peary caribou were obtained during 671 harassment overflights and 4,011 IRS of muskoxen during 315 overflights: 64.0% of the Peary caribou samples and 43.6% of the muskox samples responded overtly to the helicopter overflights. It was judged that the 12.1% (477) of the Peary caribou samples and the 21.0% (841) of the muskox samples that were still responding at the extreme level after completion of the overflights represented the animals most seriously affected by the helicopter harassment. Helicopter landings were made on 116 occasions nearby 736 Peary caribou samples and 69 touchdowns near 1,192 muskox samples. In total, 31.9% (211) of the Peary caribou and 12.3% (147) of IRS from landings nearby muskoxen responded at the extreme level to the harassment. Our results indicated that (1) the responsiveness of cows and calves of both species and solitary bull muskoxen, (2) group size and type, (3) number of calves in a group, (4) the position of the sun and direction of the wind relative to the helicopter flight, (5) previous activity of the animals and (6) the terrain where the animals were sampled are all factors contributing to the levels of responses exhibited by harassed animals. There was an inverse relationship between response levels and the altitude of the helicopter overflights or the distance away for a helicopter landing and our recommendations were based on that relationship. Evidence for habituation was detected within but not between sets of passes simulating cargo



slinging. The levels of harassment did not cause any visible pathological conditions or lead to group splintering and/or calf desertion. It is not known, however, what the actual short-term costs of harassment to the individuals were in energy, or what are the potential long-term effects to the populations. If we are to advise wisely on the conservation of Peary caribou and muskoxen there is a vital need for additional baseline data, especially on affinities for and locations of critical areas such as calving grounds, post-calving areas, rutting areas and migrational routes.

1440 MILLER, F.L., and GUNN, A. - 1979 Responses of Peary caribou and muskoxen to turbo-helicopter harassment, Prince of Wales Island, Northwest Territories, 1976-77; *Env. Can.*, Wildlife Service Occasional Paper No. 40, 90 p.

1441 MILNE, A.R. - 1977 Floating Ice - Beaufort Sea; *Ice*, no. 53, pp. 7-8.

1442 MILNE, A. - 1977 Oil, Ice and Climate Change; Beaufort Sea Project Overview Report Series, The Beaufort Sea and the Search for Oil, 103 p.

Included in the Project were studies on Wildlife, Marine Life, Oceanography, Meteorology, Sea Ice and Oilspill Countermeasures. These studies provided ecological baselines, a better understanding of the physical environment, knowledge related to the consequences of a possible oilspill, and methods of oil cleanup in ice-infested waters. Reports on these studies - now 46 in number - were published as The Beaufort Sea Project Technical Report Series. They are available to the public, on request and by title, but were written for a specialized audience of consultant engineers, industry and government officials.

1443 MILNE, A.R., and SMILEY, B.D. - 1978 Offshore Drilling in Lancaster Sound: Possible Environmental Hazards; *Fisheries and Env.*, Inst. Ocean Sci., Patricia Bay, 95 p.

Petroleum exploration in eastern Lancaster Sound has been proposed by Norlands Petroleum Limited for the open water season in 770 m of water with a dynamically-positioned drillship located near 74°05'N 81°10'W. The frequency of iceberg encounters would undoubtedly present the major environmental hazard to such a drilling program, while an uncontrolled oilwell blowout would constitute the main threat to the marine life of the Lancaster Sound region. Accordingly, scenarios have been developed to consider exploratory drilling hazards in the Lancaster Sound area in light of the world-wide experience in offshore drilling vis-a-vis the specific environmental risks and sensitivities that are peculiar to this section of the Arctic archipelago. Based on world-wide offshore drilling experience, blowout probabilities range from 1 in 1,000 to 1 in 10,000; and in the Lancaster Sound area, the projected blowout would have a 10% probability of attain-

ing a flow rate of 950 m<sup>3</sup> (6,000 bbls) of oil per day.

At the well-site, oilspill countermeasures are expected to be, on average, less than 50% effective during open water months of July, August and September, assuming optimum use of available technology; for the remaining nine months, the effectiveness reduces to zero in sea-ice. Depending on distance from the blowout, up to 55% of the oil evaporates and more progressively disperses into wind whipped seas. Much of the oil drifts with surface currents and sea ice south-eastward into Baffin Bay, leaving on a yearly average, 6% to invade coastlines.

Oil drifting ashore can be stranded on coasts for about 4 months during the open water season. Drift directions predict heaviest oil deposition for the north shores of Bylot Island and the northern mouth on Navy Board Inlet. Less oil pollution is predicted for the coasts of east Bylot Island, Eclipse Sound and south Devon Island.

Unless the blowout stops itself, it could flow for a full year before being stopped by the drilling of a relief well. There is insufficient time in the open-water season, of median duration 109 days, to drill a deep exploratory well and a relief well, should the latter be needed.

Lancaster Sound, a highly productive maritime region within Canada's High Arctic, is judged to be sensitive to oil pollution from a blowout. The Sound's rich waters host, seasonally, over 50% of Eastern Arctic marine birds, one-third of North America's White Whales and, possibly, 85% of North America's Narwhals. These, and their supporting food-web, are at threat from oil in offshore and coastal waters, in sea ice, at ice edges and on shores. The degree of threat to Narwhals, White Whales, Harp Seals, Ringed Seals, Walrus and Polar Bears is unknown. At best, they will avoid oiled areas by shifting feeding and breeding patterns. This may not be possible in restricted high-use regions, such as Navy Board Inlet, Croker Bay, Dundas Harbour and other coastal waters. The long-term consequences of their immersion in oil or ingestion of oil-tainted prey is unknown.

With more certainty, we can predict the impact of oil from the blowout on seabirds. The diving alcids are highly vulnerable, due to their feeding, moulting and migratory habits. The major impact of an oilwell blowout will be on the four largest Thick-billed Murre colonies in Canada's High Arctic. The Murre colony at Cape Hay will probably be destroyed. Populations at Prince Leopold Island, Coburg Island and Cape Graham Moore will be reduced in numbers, possibly to below those necessary for survival. Birds such as Northern Fulmars, Black-legged Kittiwakes, Eiders, Snow Geese and, particularly, the alcids - Dovekies and Black Guillemots - will also die in large numbers. The long-term significance of abrupt population declines is unknown.

The hunting success of Pond Inlet's Inuit may be affected for one or more years by a blowout in Lancaster Sound. Narwhal hunting at ice-edges, Polar Bear and Ringed Seal hunting on sea ice, Snow Geese hunting on Bylot Island and egg-



gathering at Cape Graham Moore are at greatest risk.

1402 MÜLLER-BECK, H. - 1977  
Excavations at Umingak on Banks Island, N.W.T., 1970 and 1973 Preliminary Report; Ed. H. Müller-Beck, Verlag Archaeologica Venatoria, Institut für Urgeschichte der Universität Tübingen, West Germany, 162 p.

1444 MUNTHE, K., and HUTCHISON, J.H. - 1978  
A wolf-human encounter on Ellesmere Island, Canada; *J. Mammalogy*, vol. 59, no. 4, pp. 876-878.

The purpose of this note is to report a wolf-human encounter in which wolves were the aggressors. Only one other substantiated report has appeared in the scientific literature, and the wolf involved in that case was probably rabid.

1445 NELSON, L. - 1977  
Growth and survival characteristics of three arctic bacteria on Truelove Lowland; *in* Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem, ed. L.C. Bliss, Univ. Alberta Press, pp. 547-565.

The arctic region is a unique habitat characterized by low temperatures, low precipitation, and the presence of permafrost. As a result of these factors, many tundra soils tend to be poorly drained and retarded in development. The microbial populations of these soils play an important role in soil formation, as the primary decomposers. Considerable emphasis in bacteriological studies of tundra soils has been placed on biomass, species lists, and physiological groupings. Very little is known of how environmental factors can affect individuals or groups within the microbial populations. Boyd (1967) has stated that such factors as temperature, moisture, pH and low oxygen levels may be limiting microbial growth in polar regions. The concentrations of readily available nutrients are believed to be low in most soils, thus acting to limit microbial activity. It was felt that a more intensive study of several arctic bacterial isolates from soil under controlled conditions in the laboratory might provide valuable information for the estimation of potential activity levels in nature as well as some insight into bacterial adaptation to the arctic environment.

The material presented in this chapter represents the preliminary results of laboratory studies performed on three bacterial isolates (*Pseudomonas* sp., *Bacillus* sp., *Arthrobacter* sp.) from the Intensive Hummocky Sedge-moss Meadow Site. The effects of temperature, limiting nutrients, freeze-thawing, and starvation on growth and survival of these three isolates were assessed. Data on the effects of spring thaw on quantitative and qualitative changes in the soil microbial populations in the field are presented.

1446 NELSON, L.M., and VISSER, S. - 1978  
Effect of spring thaw on microorganisms in an arctic meadow site; *Arctic and Alpine Res.*,

vol. 10, no. 4, pp. 679-688.

Quantitative changes in bacterial, fungal and algal populations in the surface peat (0 to 5 cm depth) were studied during the spring thaw period at a tundra hummocky sedge-moss meadow (Devon Island, N.W.T., Canada). A significant peak in numbers of aerobic heterotrophic bacteria and in amounts of filamentous algae was observed during the thaw period. No significant maximum in fungal standing crop was evident during this period but an increase in the hyphae containing protoplasm after thaw was indicative of increased fungal activity. Data obtained at each sampling time were highly variable. This was probably due to the topographic heterogeneity of the site which gave rise to variation in soil moisture content and microenvironment.

Qualitative changes in bacterial populations were studied before and after thaw. Gram-negative psychrotrophic types predominated and *Bacillus* spp. were rarely isolated. Certain Gram-negative groups, the fluorescent pseudomonads and the *Cytophaga/Flexibacter* types, were isolated less frequently after thaw while Gram-negative orange pigmented rods, *Arthrobacter* spp. and other coryneforms occurred more frequently after thaw.

0966 NETTLESHIP, D.N. - 1977  
Seabird Resources of Eastern Canada: Status, Problems and Prospects; *in* Proc. Sym. on Canada's Threatened Species and Habitats, eds. T. Mosquin and C. Suchal, Can. Nature Fed., Ottawa, pp. 96-108.

This paper has three goals:  
to provide a brief review of the distribution, status, problems and prospects of the major seabird species breeding in eastern Canada;  
to identify the general nature and source of some of the main threats to seabirds;  
to define the task and to summarize the minimum requirements for management of this unique migratory bird resource.

1447 NETTLESHIP, D.N., and GASTON, A.J. - 1978  
Patterns of pelagic distribution of seabirds in western Lancaster Sound and Barrow Strait, N.W.T.; *Env. Can.*, Can. Wildl. Serv. Occasional Paper No. 39, 40 p.

Features of the distribution, use of water habitats, and foraging range were studied for the four major species of seabirds (Northern Fulmar, *Fulmarus glacialis*; Black-legged Kittiwake, *Rissa tridactyla*; Thick-billed Murre, *Uria lomvia*; and Black Guillemot, *Cephus grylle*) found in a 24 000 km<sup>2</sup> area of Barrow Strait and western Lancaster Sound during the 1976 summer season. A large proportion of the more than one-half million seabirds that reproduce in the survey area each summer nest at one location, Prince Leopold Island: 100% of murrelets, 95% of kittiwakes, at least 40% of guillemots, and 40% of fulmars. Five sets of aerial sample surveys were conducted over marine waters between latitudes 73°30' and 75°05'N and longitudes 87°00' and 95°10'W in August and September to determine the distribution of seabirds and to identify areas which were important to them for feeding during the crucial period when chicks were being reared.

We recorded a total of 18 616 birds of 13 species in 6455 km of transects. Ninety-eight percent of all birds observed belonged to the four major breeding species. The distributions of all species were far from random, all occurring at higher density in coastal than in offshore waters. In coastal waters, major concentrations most often occurred in bays or waters with land-fast ice or where streams or rivers flowed into the sea. The concentration of Arctic Cod (*Boreogadus saida*) in these estuarine water habitats during the summer is believed responsible for the high numbers of feeding birds associated with such sites, as this fish forms a major portion of the summer diet of most seabirds in the region.

Northern Fulmar was the most numerous species, comprising 55% of all birds seen, and they foraged over much greater distances than other species. Black-legged Kittiwakes were more frequent on coastal than offshore transects, usually foraging within 48 km of Prince Leopold Island, though large numbers were seen as far as 96 km from the colony. Thick-billed Murres showed a relatively dispersed feeding pattern on the open sea with a foraging range up to 112 km from the breeding colony. They made an abrupt shift in preferred feeding area between 2 and 6 August, probably due to heavy accumulations of pack-ice along the north coast of Somerset Island where they had previously concentrated. Some Black Guillemots were restricted to coastal waters adjacent to where they were breeding, but birds from the large population at Prince Leopold Island foraged at least as far along the northeast coast of Somerset Island as Garnier Bay, 55 km to the west.

On the basis of these aerial surveys and observations made on Prince Leopold Island in 1975 and 1976, we conclude that the most important aspect of the conservation and management of the seabird fauna and its habitats is the protection of critical feeding areas and breeding sites. The concentrations of birds near the mouths of only a small number of bays, estuaries, and ice-edges suggest that available food is very limited and is a major determinant of the way that sea-bird populations selectively use habitats. Such feeding areas are extremely vulnerable to industrial activities and should be carefully protected. Any environmental changes in these bays and inlets, man-made or natural, could cause severe reductions in the abundance and accessibility of Arctic Cod, which undoubtedly would lower seabird productivity in the Barrow Strait area.

The site most immediately threatened by the proposed route for a gas pipeline is Cunningham Inlet, Somerset Island. The construction, operation, and associated pollution and disturbance would adversely affect seabird populations and their food resources, as would any man-made alteration in patterns of water flow and runoff from adjacent lowlands.

Further studies are required to determine patterns of habitat usage and nutritional requirements of seabirds throughout the breeding season. Detailed information on changes and shifts of preferred feeding areas, both within a single season and from year to year, is necessary if effective protection of this seabird resource is to be achieved.

1448 PARMELEE, D.F., and MacDONALD, S.D. - 1960

The birds of west-central Ellesmere Island and adjacent areas; *Nat. Mus. Can.*, Bulletin No. 169, 103 p.

The purpose of this investigation was to obtain information on the breeding cycle of birds in the far north. Ellesmere Island, in the Canadian Arctic Archipelago, was attractive because of its high latitude - the more so since weather-stations on its north and west coasts were regularly serviced by military airlift. The west coast, close to Axel Heiberg Island, promised to be the most productive. Particular attention was given to previous records for Ellesmere and Axel Heiberg islands and also to Greenland records.

1449 PATTIE, D.L. - 1977

Population levels and bioenergetics of arctic birds on Truelove Lowland; *in* Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem, ed. L.C. Bliss, Univ. Alberta Press, pp. 413-436.

Information about populations of Canadian high arctic avifauna is largely limited to either intensive studies of one or two species over an extended period or seasonal studies of discrete sites or assemblages of birds. This study was designed primarily to determine densities and population fluctuations of all bird species of a reasonably large area (43 km<sup>2</sup>) over four subsequent summer seasons. A secondary goal was the acquisition of bioenergetic and reproductive data from snow buntings (*Plectrophenax nivalis*). Population levels of all species breeding or summering on this high arctic tundra were needed as a basis for calculating energy flow through the ecosystem. Bioenergetic studies of snow buntings similar to those conducted on ptarmigan were carried out to make energy flow estimates more precise. Most of the study was restricted to Truelove Lowland.

1450 PERCY, J.A. - 1978

Effects of Chronic Exposure to Petroleum Upon the Growth and Molting of Juveniles of the Arctic Marine Isopod Crustacean *Mesidotea entomon*; *J. Fish. Res. Board Can.*, vol. 35, no. 5, pp. 650-656.

Juveniles of the benthic marine isopod *Mesidotea entomon* were chronically exposed to different concentrations of water-soluble fractions of fresh and weathered Norman Wells crude oil and of fresh Pembina crude for 160 d. The 100% extracts contained 1.72, 1.12, and 0.56 ppm of oil (determined fluorimetrically), respectively. Most of the animals completed five or six molts before the end of the experiment. Long-term mortality was high in the 100% extracts of the oils (LT50 = 17, 17, and 41 d, for Norman Wells, Pembina, and weathered Norman Wells, respectively), but most of the animals molted at least once before dying. None of the deaths occurred in conjunction with the molt. Stimulation of the onset of the subsequent molt occurred in some exposure groups. A significant increase in the duration of the inter-molt period only occurred at the highest oil concentrations. Effects on growth were slight

at concentrations lower than that which is lethal during chronic exposure. Exposure to fresh Norman Wells crude depressed growth slightly, while Pembina crude slightly stimulated growth. Weathered Norman Wells severely inhibited growth at the highest concentration but stimulated growth slightly at lower concentrations.

1451 PERCY, J.A., and WALBRIDGE, J. - 1978  
Seasonal changes in organic composition and caloric value of an arctic marine amphipod, *Onisimus* (= *Boeckosimus*) *affinis*; *Fish. Mar. Serv.*, Data Rep. No. 46, 28 p.

This report contains data on seasonal changes in gross biochemical composition and caloric value of the benthic marine amphipod *Onisimus affinis*. The samples were collected in the Eskimo Lakes, adjacent to the Mackenzie Delta in the Northwest Territories. Changes in ash, protein, lipid, carbohydrate and chitin content were examined. Results are expressed both in terms of percent dry tissue weight and as dry weight per "standard" 10 mm animal. Regression equations relating head length to body length and body length to dry weight and ash-free dry weight are also presented.

1452 PERCY, J.A., VERMETTE, P., BOUCHARD, P., and FIFE, J. - 1978  
Osmoregulation and water permeability of arctic marine isopods, *Mesidotea entomon*, *M. sibirica*, and *M. sabini*; *Fish. Mar. Serv.*, Data Rep. No. 76, 163 p.

This report serves as a repository for tabular data relating to the osmoregulatory physiology of the Arctic marine isopods, *Mesidotea entomon*, *M. sibirica* and *M. sabini* from the southern Beaufort Sea. A freshwater form of *M. entomon* occurring in a lake in the Mackenzie Delta was also studied. This report contains data on temperature tolerance, salinity tolerance, osmoregulatory capabilities and water permeability characteristics of the three species.

1453 PROCTER, D.L.C. - 1977  
Nematode densities and production on Truelove Lowland; in Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem, ed. L.C. Bliss, Univ. Alberta Press, pp. 347-361.

The role of free-living soil nematodes in energy flow through high arctic ecosystems is poorly known. This paper is part of a study of the role of nematodes in energy flow in the Truelove Lowland terrestrial ecosystem. The primary purposes of this research were to measure the energy passing through the nematodes, and to determine the relative importance of nematodes in total invertebrate energy flow.

This paper gives nematode densities for July and August 1972, and for June to September 1973, and presents estimates of standing crop, respiration, turnover time, and production for the 1972 and 1973 growing seasons. Data are given for several habitats in the ecosystem. The dominant genera are also listed, and their trophic relations indicated. Apart from the density estimates, this information is pre-

liminary and more refined estimates are being prepared.

1454 PROCTER, D.L.C. - 1977  
Invertebrate respiration on Truelove Lowland; in Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem, ed. L.C. Bliss, Univ. Alberta Press, pp. 383-393.

This paper presents metabolic rates for representatives of most of the important terrestrial and aquatic invertebrate groups found on Truelove Lowland. Species of Enchytraeidae, Crustacea, Acarina, Collembola, Lepidoptera, Muscidae, and Chironomidae were studied. Field research was carried out during July and August 1972, and from June to September 1973.

These studies are part of a wider investigation to determine the role of invertebrates in energy flow in this high arctic terrestrial ecosystem.

1455 RIEWE, R.R. - 1977  
Mammalian carnivores utilizing Truelove Lowland; in Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem, ed. L.C. Bliss, Univ. Alberta Press, pp. 493-501.

Mammalian carnivores utilizing Truelove Lowland include short-tailed weasel (*Mustela erminea*), arctic fox (*Alopex lagopus*), arctic wolf (*Canis lupus*), and polar bear (*Ursus maritimus*). Due to the infrequent use of the Lowland by wolves and bears, negligible data were collected on these carnivores in relation to it.

1456 RIEWE, R.R. - 1977  
The utilization of wildlife in the Jones Sound region by the Grise Fiord Inuit; in Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem, ed. L.C. Bliss, Univ. Alberta Press, pp. 623-644.

Since Europeans first began to explore the North American Arctic, the region has held an aura of challenge and mystery which has created an endless demand for both popular and scientific information about it. This demand for arctic literature was filled at first by an ever-expanding number of arctic explorers and later by scientists and journalists. Since man usually possesses a keen curiosity about members of his own species, much arctic literature has centred around indigenous northern inhabitants, the Inuit.

Most anthropological studies dealing with the Inuit and their subsistence strategies have been qualitative and/or theoretical in nature. However, there has been a trend developing among a few northern researchers to quantify the Inuit's dependence upon the land.

In following this trend, the objectives of this study were to quantify the dependence of Grise Fiord Inuit upon the land and their utilization of wildlife and to examine their role in arctic ecosystems, both terrestrial and aquatic.

1457 RUSSELL, R.H., EDMONDS, E.J., and ROLAND, J. - 1978  
Caribou (*Rangifer tarandus*) and muskoxen (*Ovibos moschatus*) habitat studies on Prince of



Wales and Somerset Islands, Boothia Peninsula and northern district of Keewatin, Northwest Territories; Env. Can., Can. Wildl. Serv. Completion Report, Arctic Islands Pipeline Program, March 1978, 142 p.

Field studies of caribou (*Rangifer tarandus*) and muskoxen (*Ovibos moschatus*) habitat use were carried out in 1975, 1976, and 1977 along a 1200 km (780 mi.) segment of proposed Polar Gas pipeline routes on Prince of Wales and Somerset Islands, Boothia Peninsula and the northeast mainland in the District of Keewatin. Data to suggest areas of preferred ungulate summer and winter habitats were obtained. The relative seasonal use of certain habitats or regions by ungulates were estimated from pellet group counts. Seasonal patterns of animal movements were also inferred. Caribou on Prince of Wales Island, Somerset Island and Boothia Peninsula show a preference for xeric to mesic and moderately to poorly vegetated habitats in both winter and summer. Major caribou wintering grounds are found on Somerset Island and eastern Boothia Peninsula while Prince of Wales Island and western and central Boothia appear to be mainly used as summer range. The seasonal distribution implies east-west-migrations of these caribou populations; inter-island (across Peel Sound) and insular (across the interior highlands of Boothia Peninsula). Caribou in southern regions of the study area tend to select upland barrens for winter use and more productive lowlands in summer. There was little direct evidence of caribou within a 100 km radius of the settlement of Spence Bay. Moderate use was found from the Hayes River south to the Meadowbank River.

Competition for range by caribou and muskoxen was found to be minimal. In the study area muskoxen were found in substantial numbers on Prince of Wales Island. Their preferred habitats are well vegetated lowlands. Seasonal movements by muskoxen appear to be localized. A small herd of muskoxen recently established themselves on Somerset Island but none were observed on Boothia or northern Keewatin where good muskoxen habitat was found to be extensive. Implications of pipeline construction are presented and recommendations provided in the report.

1458 RYAN, J.K. - 1977

Synthesis of energy flows and population dynamics of Truelove Lowland invertebrates; in Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem, ed. L.C. Bliss, Univ. Alberta Press, pp. 325-346.

The quantity of energy released and transformed by invertebrates is presently being investigated in ecosystems throughout the world. Studies of single species provide the most detailed and accurate information on energy flow. Studies of groups of invertebrate species give a clearer perspective on energy flow through parts of ecosystems. A sophisticated trophic level perspective has been achieved with phytophagous insects. There are few published studies evaluating energy flow through all the invertebrates in an ecosystem.

While energy flow through invertebrates may never be accurately measured, the Arctic is

the best climatic zone where approximations of it can be made. The main obstacle to assessing invertebrate energy flow is the tremendous diversity of species and habits. The population size and structure must be determined for each species, for a year, to construct a summary annual energy budget. In an arctic ecosystem the invertebrate, and total organismic, species diversities are reduced. Primary production, the limiting variable for secondary production, is drastically less than that in other ecosystems. Seasons are short and decisively limited by below 0°C temperature.

This communication investigates which invertebrate taxa are dominant and what trophic levels are most significant in this ecosystem, and estimates the combined invertebrate annual energy flow.

1459 RYAN, J.K., and HERGERT, C.R. - 1977  
Energy budget for *Gynaephora groenlandica* (Homeyer) and *G. rossii* (Curtis) (Lepidoptera: Lymantriidae) on Truelove Lowland; in Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem, ed. L.C. Bliss, Univ. Alberta Press, pp. 395-409.

Two similar moth species, *Gynaephora groenlandica* (Homeyer) and *G. rossii* (Curtis), are the largest invertebrates at Truelove. They are conspicuous as woolly larvae and silken cocoons, but are actually rather uncommon. They are more abundant elsewhere in the Arctic. These two species are distinctive in that they are among the approximately two dozen Lepidoptera species found in extreme cold-dominated climates. Their arctic and alpine distributions in North America are evident in Fig. 1, which was compiled from 19 published papers and museum records.

The purpose of this study is to determine energy flow through the *Gynaephora* population of Truelove Lowland. Energy flow means calories assimilated  $m^{-2} yr^{-1}$ , and is partitioned into respired energy and tissue available for consumption by the next trophic level (= production). Because the larvae are large, consume distinct bites of leaves in measurable amounts, and have discrete, solid excreta, they can be handled and observed with accuracy. Their size and habits make them convenient to study under limiting field conditions. They were intensively studied as model insects to find essential factors governing energy flow within their populations. The energy budget constructed here is the prime example of the methodology used in energy budgets for other invertebrates.

1460 ST. AUBIN, D.J., GERACI, J.R., SMITH, T.G., and SMITH, V.I. - 1978  
Blood volume determination in the ringed seal, *Phoca hispida*; *Can. J. Zool.*, vol. 56, no. 8, pp. 1885-1887.

Red cell, plasma, and total blood volumes were determined in three ringed seals, *Phoca hispida*, through simultaneous labelling of both red cells and plasma. Total blood volumes were 139, 140, and 158 ml/kg of whole body weight ( $\bar{x}$  = 142 ml/kg). Lean body weight was determined in one seal; blood volume was calculated as 226 ml/kg lean body weight.



1461 SHIMADA, K. - 1978

Zooplankton Surveys in Arctic Temporary Ponds at Barrow, Alaska, and Tuktoyaktuk, Mackenzie Delta; *in* Joint studies on Physical and Biological Environments in the Permafrost, Alaska and North Canada, July to August 1977, Inst. Low Temp. Sci., Hokkaido Univ., Japan, pp. 93-102.

The coastal plains of northern Alaska and northern Canada are characterized by continuous permafrost. Repetition of seasonal melting and freezing is limited only to the upper layer of the frozen ground. In summer, numerous lakes and ponds appear on the melting ground, in some regions occupying as much as 90% of the surface areas. While various kinds of distinctive topographical features, such as pingo, ice wedge, massive ice body and patterned ground, exhibit characteristics of the continuous permafrost regions, many temporary ponds are found in troughs on patterned grounds, in craters of pingos and on hills of massive ice bodies.

In the present joint studies on physical and biological environments in permafrost regions, I mainly collected crustacean zooplankton in temporary ponds at Barrow and Tuktoyaktuk between 12 July and 2 August 1977. Surveys of zooplankton in Arctic Alaska and Canada have been made by several investigators in the taxonomic and ecological interest. Their surveys provide a mass of interesting and valuable information about the life history and community structure of microcrustaceans living in arctic lakes and ponds, but more comprehensive surveys of zooplankton are called for in various types of aquatic environments for better understanding of fresh-water ecology in the permafrost regions. In this connection, temporary ponds in the permafrost regions offer a unique field for arctic biology. Their environmental conditions are looked on as unfavorable for the growth of zooplankton because of low water temperature, drop of water level during the short summer and complete freezing of ponds during the lasting winter. Nevertheless, it is of considerable interest that zooplankton populations in these ponds are stably maintained.

The primary purpose of the present surveys was to examine the distribution of species of crustacean zooplankton among various types of temporary ponds in continuous permafrost regions.

1462 SINIFF, D.B., STIRLING, I., and EBERHARDT, L.L. - 1978

Problems in the Conservation of Polar Marine Mammals; *in* Polar Research, To the Present, And the Future, AAAS Selected Sym., Ed. Mary A. McWhinnie, Amer. Assoc. Advancement Science, pp. 161-174.

Within the last decade, marine mammals have become both subjects of great popular interest, and objects of widespread concern. This paper is concerned with problems in research and management of marine mammals in polar regions. Few people have the knowledge and experience necessary to consider this group as a whole and we do not claim any such status. We have,

however, been involved in research on several species of marine mammals in both polar regions and have struggled with their associated management problems. We have tried to focus on ideas and problems basic to the whole ensemble using particular species to illustrate points. We have attempted to consider four general areas: specific management problems: population research; the role and value of modeling; and aesthetics and recreational considerations in management.

1463 SLENO, G.A., and MANSFIELD, A.W. - 1978  
Aerial photography of marine mammals using a radio-controlled model aircraft; *Fish Mar. Serv.*, Manuscript Report No. 1457, 7 p.

This report is a summary of an experimental project using a radio-controlled model aircraft to obtain aerial photographs of a herd of beluga whales in the Canadian Arctic. Results, problems and possible future use are described.

1464 SMITH, R.F.C., and WANG, L.C.H. - 1977  
Arctic hares on Truelove Lowland; *in* Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem, ed. L.C. Bliss, Univ. Alberta Press, pp. 461-466.

Arctic hares (*Lepus arcticus*) are confined to the tundra zone of North America. The most northerly subspecies (*L.a. monstrabilis*) occurs throughout the Queen Elizabeth Islands with the exception of Prince Patrick Island.

No scientific studies have been made of population levels of arctic hares in the Canadian arctic. Population sizes are variable spatially and temporally and anecdotal reports suggest that parts of Ellesmere Island and part of Axel Heiberg Island support relatively high populations in some years while hares are generally rare elsewhere.

This study measured the energy metabolism of *L. a. monstrabilis* under various thermal environments both by conventional feeding experiments and by continuous recording of oxygen consumption in the laboratory. Based on the information obtained, the impact of this species on the production and energy flow on Truelove Lowland is evaluated.

1465 SMITH, T.G. - 1976

The icy birthplace of the ringed seal; *Can. Geographical J.*, October/November 1976; pp. 58-63.

1466 SMITH, T.G. - 1977

The Wolffish, cf. *Anarhichas denticulatus*, New to the Amundsen Gulf Area, Northwest Territories, and a Probable Prey of the Ringed Seal; *Can. Field-Naturalist*, vol. 91, no. 3, p. 288.

1467 SMITH, T.G. - 1977

The Occurrence of a Narwhal (*Monodon monoceros*) in Prince Albert Sound, Western Victoria Island, Northwest Territories; *Can. Field-Naturalist*, vol. 91, no. 3, p. 299.

## BIOLOGY

1468 SMITH, T.G., and MEMOGANA, J. - 1977  
Disorientation in Ringed and Bearded Seals; *Can. Field-Naturalist*, vol. 91, pp. 181-182.

The phenomenon of seals lost on land or unable to find access to the water through the frozen ice cover is well documented for some antarctic localities. Although it is common knowledge among the Inuit that seals get lost, few reports exist of such occurrences for the Arctic. This note documents several instances where both live or dead ringed seals and bearded seals (*Erignathus barbatus*) have been found on the land or away from access to water. Data were collected over an 8-year period in the Home Bay region, east Baffin Island, and in the Holman region on the west coast of Victoria Island, Northwest Territories.

1469 SMITH, T.G., and TAYLOR, D. - 1977  
Notes on marine mammal, fox and polar bear harvests in the Northwest Territories; *Fish. Mar. Serv.*, Tech. Rep. No. 694, 37 p.

Marine mammal, fox and polar bear catch statistics are summarised from R.C.M.P. game reports from 1961 to 1972 and from Hudson Bay Company records. For many marine mammal species other factors such as sinking loss, unidentified sources of trade and socio-economic factors cause simple harvest figures to be poor indicators of total harvest and local stock size. At present no regular reporting or analyses of annual harvests are done by the responsible management agencies. Recommendations are made to improve this situation.

1470 SMITH, T.G., BECK, B., and MEMOGANA, J. - 1978

Ringed Seal Breeding Habitat in Viscount, Melville Sound, Barrow Strait and Peel Sound; *Fisheries and Env. Can.*, Arctic Bio. Station Preliminary Report 1977 to Arctic Islands Pipeline Program, INA Pub. No. QS-8160-014-EE-A1, ESCOM Report No. A1-14, 19 p.

Subnivean lair densities found in 1976 are generally comparable to those of the 1975 survey. The areas of Peel Sound, and the ice of northern Prince of Wales Island to Lowther Island contained the highest number of birth lairs. Aston Bay on northwestern Somerset Island was again shown to be an important winter area for breeding seals. We are, as yet, unable to make firmer statements about the importance of the vast areas of pressured first year ice in the offshore regions, but it appears that there are few breeding seals there. The heavily pressured nearshore ice is heavily utilized as a hunting area by polar bears, but present methods have not revealed the density or age structure of seals found there. More information is needed on the age structure and ecological requirements of ringed and bearded seals occupying the open water of Lancaster Sound during the winter months. We also have no information about the feeding conditions existing in the Barrow Strait region in the summer.

1471 SMITH, T.G., and ARMSTRONG, F.A.J. - 1978

Mercury and Selenium in Ringed and Bearded Seal Tissues From Arctic Canada; *Arctic*, vol. 31, no. 2, pp. 75-84.

Analyses for total mercury, methyl Schreber mercury and selenium, with age determinations for 390 ringed seals (*Phoca hispida* Schreber) and 64 bearded seals (*Erignathus barbatus* (Erxleben)) from 7 localities across the Canadian Arctic confirm (with up to 420 ppm) earlier reports of very high values for total mercury in liver. Concentrations in muscle were higher than 0.5 ppm in mature animals. There were no significant differences between localities.

Mercury and age show a strong positive correlation, and so do selenium and age; the concomitant correlation between mercury and selenium is striking, the elements occurring together in a ratio by atoms of close to 1:1. Rates of accumulation appear to be somewhat higher in bearded seals.

Methyl mercury in liver amounts to less than 5 percent of the total in ringed seals and to less than 1 percent in bearded seals. There appears to be a small increase with age of the fraction present as methyl mercury. This low proportion of methyl mercury in liver, together with some 75% in muscle is in contrast to reports of 89% methyl mercury in the blood of Inuit in Arctic Bay and remains to be explained.

1472 SMITH, T.G., and STIRLING, I. - 1978  
Variation in the density of ringed seal (*Phoca hispida*) birth lairs in the Amundsen Gulf, Northwest Territories; *Can. J. Zool.*, vol. 56, pp. 1066-1070.

Identical helicopter-supported surveys indicated a large decrease in the density of ringed seal birth lairs in Amundsen Gulf, N.W.T., between 1974 and 1975. A similar decrease was shown by ground surveys in the Prince Albert Sound area south of Holman. The factors stimulating the change in productivity in the area are not clear but the responses of the seals appear to have included lowered reproductive rates and movement of a significant portion of the population out of the area.

1473 STIRLING, I. - 1977

Adaptations of Weddell and Ringed Seals to Exploit the Polar Fast Ice Habitat in the Absence or Presence of Surface Predators; in *Adaptations Within Antarctic Ecosystems*, A Select Reprint from the Proc. Third SCAR Sym. Antarctic Biology, Smithsonian Inst., Dist. Gulf Pub. Co., Houston, Texas, pp. 741-748.

The Weddell seal (*Leptonychotes weddelli*) has evolved into its niche in the antarctic fast ice habitat in the absence of surface predators. The ringed seal (*Phoca hispida*) has evolved into the same niche in the Arctic while being subjected to steady pressure from predation by polar bears (*Ursus maritimus*), Arctic foxes (*Alopex lagopus*), wolves (*Canis lupus*), and, more recently, indigenous man. This paper examines the ecological, behavioral, and morphological adaptations evolved by each species to exploit the polar fast ice habitat in the presence or absence of land predators.

Similarities between the species are noted with respect to the self-maintenance of breathing holes, differential distribution of age and sex classes at different seasons of the year, feeding, diurnal rhythm of hauling out, and weaning times of pups. Differences between the two species, apparently in response to the presence or absence of land predators, are noted with respect to underwater communication, use of breathing holes, behavior at breathing holes, site of birth of their single pups, color of the pups at birth, size of the adults, behavior when basking on the ice, and the use of land for basking or parturition.

1474 STIRLING, I. - 1977

Polar Bear conservation in Canada; *in* Proc. Sym. Canada's Threatened Species and Habitats, sponsored by Can. Nature Federation, Eds. T. Mosquin and C. Suchal, May 20-24, 1976, Ottawa, pp. 41-45.

Research on polar bears in Canada today is directed towards developing a dynamic management program which can respond to a variety of circumstances and habitats in which polar bears may be encountered. Polar bears represent an important part of the cultural and economic base of Inuit and Indian communities throughout the arctic and subarctic and, at present, about 600 polar bears are killed in Canada each year. Furthermore, in some areas, polar bears are competing with man for space. As such, a policy of total protection of polar bears would fall far short of the management needs for the species. In any case, our data indicate that in most areas the populations appear to be maintaining their numbers. Thus, in Canada, the polar bear is not regarded as an endangered species although it is clearly vulnerable to overharvesting or major ecological changes because of a slow reproductive rate and almost total dependence on a single food source - seals.

The last overview of polar bear research and conservation programs in Canada was published four years ago in *Nature Canada's* special issue on the arctic. That summary reflected fairly accurately the state of the art and the major concerns of the time. Essentially, most of the technical problems had been resolved and a certain amount of basic data collected so that we knew enough to be able to make our studies more specific and responsive to particular issues and problems. Considerable progress has been made since then and current research falls into three main categories: management research, environmental impact assessment programs and basic research. In this paper, I will describe what has been accomplished in these three areas since 1972 and the work that is being undertaken today.

1475 STIRLING, I., JONKEL, C., SMITH, P., ROBERTSON, R., and CROSS, D. - 1977

The ecology of the polar bear (*Ursus maritimus*) along the western coast of Hudson Bay; *Fisheries and Env. Can.*, Can. Wildl. Serv. Occasional Paper No. 33, 64 p.

This report on the ecology of the polar bear (*Ursus maritimus*) along the western coast of

Hudson Bay summarizes 10 years of data (fall 1966 to spring 1976) collected mainly by the Canadian Wildlife Service and the Manitoba Department of Renewable Resources and Transportation Services.

A summary of the historical records of polar bears in the Manitoba area, the development of polar bear management in Manitoba, and a documentation of the bear-man problems in the Churchill area are presented. At present, in Manitoba, only Indians can legally hunt polar bears but few are taken. To the north, hunting by NWT Inuit is allowed but is restricted by quotas.

Two hundred and twenty-seven polar bears were ear-tagged in Manitoba, 176 of which were in the Churchill area. Twenty-three bears were also tagged with radio-collars. The recorded movements of the tagged animals suggested the existence of a single sub-population in the western Hudson Bay area, extending from the Ontario-Manitoba border north to between Rankin Inlet and Chesterfield Inlet (Zone A).

The seasonal distribution and movement of polar bears is greatly influenced by the seasonal variation in the ice conditions of Hudson Bay. From radio-tracking data, a limited aerial survey, and tag returns from Inuit-killed polar bears, it appears that the bears move on to the newly formed ice in early November and spend the winter on the ice to the north and east of the Cape Churchill area. The bears return to the southern Manitoba coast in late July-August, when the final ice remnants dissipate in that area. A gradual northward movement to the Churchill - Cape Churchill area has been documented, and is possibly related to the freeze-up which begins to the north of Cape Churchill. From aerial surveys, some spatial segregation, of family groups into inland areas and groups of large adult males along coastal areas, has been recorded. Land areas are vacated as soon as the ice begins to form.

The influx of bears into the Churchill area each fall was dangerous for the human population. Bears showed a high degree of fidelity to the area over a span of several years and one bear first tagged as a cub with her mother was twice recorded in subsequent years with separate litters of her own cubs. Bears that were judged to be dangerous were either chased away from the settlements, captured and immobilized in culvert traps and then driven east to Bird Cove or Twin Lakes or airlifted to Kaska, 300 km southeast of Churchill, and released. Thirteen of 40 bears that were moved to Kaska returned, some in 14 to 24 days and others in later years. Persistent problem bears were sent to zoos or shot.

From aerial surveys (1970-76), it was estimated that 80 females and 150 newborn cubs leave maternity dens in Manitoba each spring. Denning is concentrated in the Owl River denning area, which is 30-60 km inland in the Fletcher - Sutton lakes - Rupert Creek area, south of the Churchill area. There is another denning area in the vicinity of Cape Tatnam, but the density of dens appears to be much lower. In both areas, mean litter size was high (2.0). The use of earth dens as maternity dens was recorded.

The average ages of male and female polar bears captured, recaptured (after 6 months), or kil-



led, from which teeth were aged, were mainly within the sub-adult range (2 to 4 years inclusive). There were significant differences between the average ages of bears captured or killed in Zone A compared to the James Bay - Belcher Islands area to the south, but the result was biased by the unrepresentative sample of adult age classes in the total captured sample of the former area. However, the average age of adults alone was still significantly higher in the James Bay - Belcher Islands area compared to Zone A which suggests the difference is real.

The accuracy of the cattle weight tape in estimating the actual weights of polar bears in Manitoba from heart girth measurements was within 92% of the scale weight. Age-specific mean weights and straight-line body measurements of male and female bears in the fall in Manitoba are presented.

A crude estimate of the population size for the Churchill area in 1975, based on a Lincoln Index, was 308 bears. With the data available, it was not possible to estimate the population size for Zone A.

The polar bear problem in the Churchill area should be reduced once the garbage problem is resolved. Additional management options for polar bears in Manitoba include the establishment of an annual harvest and the utilization of polar bears as a tourist attraction.

1476 STIRLING, I., and LATOUR, P.B. - 1978 Comparative hunting abilities of polar bear cubs of different ages; *Can. J. Zool.*, vol. 56, pp. 1768-1772.

In most areas of the Canadian Arctic polar bear (*Ursus maritimus*) cubs apparently remain with their mothers until they are 2.5 years of age. The degree to which cubs of each age-class participate in the hunting of seals while with their mothers is examined in this paper in order to evaluate the degree to which they might be capable of independent hunting, should they be orphaned prior to the completion of the normal weaning period. Cubs of all age-classes did almost no hunting during the spring. The proportions of time spent hunting by yearling and 2-year-old cubs and the durations of their lying 'still hunts' were not significantly different from each other but they were significantly shorter than their mothers' and than adult males' during the summer. However, the frequency of the lying 'still hunts' of 2-year-old cubs was double that of yearling cubs and the kill rate of 2-year-old cubs was comparable with that of adult age-classes, despite the fact they hunted for a significantly lesser proportion of their time. These results suggest that cubs which remain with their mothers until they are weaned have a higher probability of survival than those that do not and this interpretation lends support to the management concept of total protection of family groups and the harvesting of independent bears only.

1477 STIRLING, I., SCHWEINSBURG, R.E., CALVERT, W., and KILIAAN, H.P.L. - 1978 Population Ecology of the Polar Bear Along the

Proposed Arctic Islands Gas Pipeline Route; *Fisheries and Env. Can.*, Can. Wildl. Serv. Preliminary Report 1977 to Arctic Islands Pipeline Program, INA Pub. No. QS-8160-015-EE-A1, ESCOM Report No. A1-15, 71 p.

The objective of this report is to provide baseline information on polar bears as part of the overall ecological background required by the federal government to assess the environmental consequences of the proposed gas pipeline. Two aspects are of particular importance. The first is to provide baseline information on the population ecology, distribution, abundance, seasonal movements, number of discrete subpopulations affected, and the location of important denning, feeding, and summer retreat areas. The second is to try to identify important areas or times in the annual cycle of the polar bear that might warrant protection from, or modification of, construction or operational activities.

From 1970 through 1976, 611 polar bears were captured for the first time, 74 were recaptured and 30 were shot by Inuit hunters. Air and ground surveys of maternity denning areas were conducted and unpublished observations were gathered whenever possible.

Polar bears in the Central and High Arctic showed a high degree of fidelity to winter and summer feeding areas. Observations of individually tagged polar bears, recaptured over a series of two or more years, also tended to suggest a strong degree of fidelity for specific areas. Some long distance movements within, as well as out of the study area, were recorded, indicating that a limited amount of exchange between more widely separated subpopulations occurs. Within the study area, the polar bears of Barrow Strait, NE Victoria Island, and SE Victoria Island appeared to be discrete subpopulations. No evidence was found of northward or southward seasonal movements of polar bears. The summer feeding and retreat areas are of particular ecological importance because the period during which bears can continue to feed is significantly longer there than elsewhere.

Maternity denning in the study area appeared to occur over a widespread area, apparently at lower densities than have been reported for more localized denning areas on the Manitoba coast of Hudson Bay and on Wrangel Island, USSR. It is possible that maternity denning occurs at comparably high densities at some locations within the study area but, to date we have not found them in our surveys. The relative importance of maternity denning sites within the study area was evaluated within the limitations of the data available and then plotted on a map.

The mean litter size of cubs of the year that were captured or observed was  $1.64 \pm 0.51$ , which was comparable to data recorded in other areas of similar latitude. The age-specific mean litter size for adult female polar bears was lower, 1.51, but was still within one standard deviation of the first value given. The proportion of females 5 years and older accompanied by cubs of any age (54.5%, 85/156), and their age-specific conception and natal rates (0.210 and 0.159 respectively) were lower than were recorded in the Western Arctic from 1971-73. The full significance of these values in

relation to the present status of the population is not yet clear.

The sex-specific mean age of polar bears one year of age and over, killed by Inuit hunters did not differ significantly from the sex-specific mean ages of captured polar bears from the same age classes. This suggests that the age structure of the kill sample is representative of the total population. The sex-specific mortality rates of the capture samples were higher than those of the kill samples, probably because of biases as discussed in the text. Thus, the sex-specific mortality rates (males 16.6%, females 12.3%) of the killed bears are probably more representative of the natural population. There was no evidence that the polar bear population in the study area was currently being overharvested.

The main Inuit polar bear hunting areas tend to overlap with the locations of important maternity denning areas. Polar bear hunting is still of significant economic value to the Inuit communities.

However, it should be noted that this is an interim report and our conclusions are not yet final. As was noted in the report, several aspects of the data still require more refined analyses and additional research to fill gaps.

We recommend that staging or construction activities not be permitted in the most important summer feeding and retreat areas of Graham Moore Bay, the bays of SW Devon Island, Brentford Bay and Creswell Bay. With care, some activities in known maternity denning areas during the winter, on a localized basis, could probably be permitted.

Further investigation was recommended in three areas to fill gaps in the present knowledge: 1) survey of potential denning areas adjacent to the projected pipeline route that have not yet been examined; 2) mark and recapture studies in specific areas which have thus far been undersampled to complete the studies of movements, discreteness of populations, and fidelity to winter and summer feeding areas; and 3) more detailed analyses of mortality and reproductive data already collected, and to be collected in 1977, to refine the reliability of those vital baseline parameters.

The authors advised against the wider distribution of this interim report at this late date because of its inadequacy in the face of a completed final report. However, it was decided to print it anyway because of possible delays in distributing the final report. Because this is only an interim report it should not be quoted and only the final report should be relied upon for any conclusions.

1478 STIRLING, I., SCHWEINSBURG, R.E., CALVERT, W., and KILIAAN, H.P.L. - 1978  
Population Ecology of the Polar Bear Along the Proposed Arctic Islands Gas Pipeline Route; *Fisheries and Env. Can.*, Can. Wildl. Serv. Final Report to Environmental Management Service, 93 p.

This report provides baseline information on polar bears as part of the overall ecological background required by the Federal Government

to assess the environmental consequences of the proposed gas pipeline. Two aspects are of particular importance: 1) baseline information on the population ecology, distribution, abundance, seasonal movements, number of discrete subpopulations affected, and the location of important denning, feeding, and summer retreat areas; and 2) to identify important areas or times in the annual cycle of the polar bear that might warrant protection from, or modification of, construction or operational activities.

From 1970 through 1977, 914 polar bears were captured, 140 recaptures were made on 124 individual bears, and 48 were shot by Inuit hunters in the study area. Air and ground surveys of maternity denning areas were conducted and unpublished observations were gathered whenever possible.

The polar bears of Barrow Strait, NE Victoria Island, and the southern portion of the study area appeared to be discrete from each other. The summer feeding and retreat areas are of particular ecological importance because bears can continue to feed there for significantly longer than elsewhere. The data suggested that the average distance over which any activity may have an effect on polar bears is probably in the order of 150 to 200 km from the area under the influence of that activity.

Maternity denning in the study area appeared to occur over a widespread area, apparently at low densities. The relative importance of maternity denning sites within the study area was evaluated on a map, within the limitations of the data available.

Polar bear hunting still represents a significant part of the economic and cultural base in Inuit settlements throughout the Central and High Arctic.

In our judgement, it appears that the major potential impacts on polar bears of the proposed gas pipeline will occur during the construction phase and that once in operation, impacts will be of a lesser and probably more local nature.

All of the proposed channel crossings go under important winter and spring feeding areas. The laying of pipe will involve extensive activity of men and machinery on the sea ice and in the air as well as year-round or almost year-round, use of large icebreakers to supply the operation. Any significant changes in distribution or numbers of polar bears in the Barrow Strait area in particular could cause a moderate impact on the hunting success of Inuit from the Resolute area.

If a gas pipeline is constructed, a widespread high level of disturbance to maternity denning areas would probably occur on the Sabine Peninsula, Byam Martin Island, Bathurst Island north of Graham Moore Bay and around Bellot Strait.

Because of their importance as summer feeding areas, we recommend that Brentford Bay, Graham Moore Bay, and Radstock Bay on Devon Island, receive the maximum amount of protection possible.

We forecast that a substantial number of conflicts between men and bears will occur and that a large but unpredictable number of polar bears, and possibly some men may be killed.

1479 STUTZ, R.C. - 1977

Biological nitrogen fixation in High Arctic soils, Truelove Lowland; *in* Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem, ed. L.C.Bliss, Univ Alberta Press, pp. 301-314.

Studies of nitrogen fixation in remote natural systems were made feasible by the development of acetylene reduction assays. These assays are based on the observation that acetylene is a competitive inhibitor of nitrogen on the nitrogen fixing enzyme. The assay involves incubating biological material in the presence of acetylene and measuring the rate of ethylene evolution. Ethylene can be detected in minute quantities by gas chromatography. Ethylene production can be related to nitrogen fixation by comparing acetylene reduction with  $N^{15}$  assays or changes in total nitrogen content. Generally the ratio between acetylene reduction and nitrogen fixation is between 1.5:1 and 25:1. For soil systems the ratio is generally between 3 and 6:1.

1480 TANNO, K., and SHIMADA, K. - 1978

Diversity in Collembola and Topographic Features of Tundra; *in* Joint studies on Physical and Biological Environments in the Permafrost, Alaska and North Canada, July to August, 1977, Inst. Low Temp. Sci., Hokkaido Univ., Japan, pp. 85-92.

There is no other group soil invertebrates to be found that has so general a distribution of species as Collembola throughout the arctic and alpine tundra. This study represents an investigation of diversity in Collembola in relation to gradient areas such as pingos and polygons which constitute a topography of characteristic permafrost regions.

1481 THOMAS, D.C., RUSSELL, R.H., BROUGHTON, E., EDMONDS, E.J., and GUNN, A. - 1977

Further studies of two populations of Peary caribou in the Canadian Arctic; *Fisheries and Env. Can.*, Can. Wildl. Serv., Progress Notes No. 80, November 1977, 12 p.

In the third year of an ecological study emphasizing relationships among forage availability, condition and productivity we collected 88 caribou (*Rangifer tarandus*) on four Canadian Arctic islands and on Boothia Peninsula in March - April 1976. Only 1 of 18 adult females collected on Melville and Prince Patrick was pregnant compared with 19 of 26 from Somerset and Prince of Wales. Mean percentage fat in the femur marrows of adults from Melville and Prince Patrick islands was 21 and 51% compared with 79 and 73% for adults from Somerset and Prince of Wales respectively. Average age of the caribou obtained on Melville and Prince Patrick was 8.2 years compared with 4.4 years for the collection from Somerset and Prince of Wales.

Diet of the caribou, as inferred from rumen contents, was highly variable among islands and Boothia Peninsula. *Luzula* spp., mosses, *Saxifraga oppositifolia*, *Dryas integrifolia*, *Carex* spp., *Salix* spp. and foliose and fruticose lichens comprised 94% of the rumen contents of pooled samples.

The five caribou obtained on Boothia Peninsula exhibited physical characteristics ranging from the typical Peary (*R. t. pearyi*) phenotype to the typical barren-ground (*R. t. groenlandicus*) phenotype. Fetuses in three females collected on Boothia Peninsula on April 5 were significantly larger and further developed, by about 14 days, than fetuses in 11 females collected on Somerset.

Condition and fertility of caribou on Somerset and Prince of Wales were moderately high in March - April 1976 but considerably lower than a year earlier. Condition and fertility of caribou on Melville and Prince Patrick have remained low in samples collected each March - April since 1974. Those data substantiated conclusions reached previously: that fertility in Peary caribou was closely linked to physical condition, and that recovery from a malnourished state was slow.

1482 THOMAS, D.C., and BROUGHTON, E. - 1978

Status of three Canadian caribou populations north of 70° in winter 1977; *Fisheries and Env. Can.*, Can. Wildl. Serv. Progress Notes No. 85, July 1978, 12 p.

In March - April 1977, the fourth and concluding year of an ecological study of caribou (*Rangifer tarandus*), we collected 53 animals from three populations on Boothia Peninsula, Somerset - Prince of Wales and Melville - Prince Patrick.

The pregnancy rate in 17 adult females obtained on Melville and Prince Patrick was up sharply to 88% from 6% the previous year, and mean percentage fat in the femur marrows increased from 43 to 79%.

The pregnancy rate in the nine adult females collected on Somerset and Prince of Wales was 100%, up from 73% in 1976, and mean fat in the femur marrows increased from 76% to 88%. Fat reserves were intermediate in seven adult females obtained on Boothia Peninsula. All females older than one year were pregnant.

These data confirmed the close relationship between fat reserves and pregnancy rate and indicated that partial recovery of fat reserves and fertility in the Melville - Prince Patrick population after starvation conditions in winter 1973-74 took more than 2 years.

Caribou on Boothia Peninsula were significantly larger than the insular population but some interchange with caribou of Somerset or Prince of Wales was probable.

1483 VAN BREE, P.J.H., SERGEANT, D.E., and HOEK, W. - 1977

A Harbour Porpoise, *Phocoena phocoena* (Linnaeus, 1758), from the Mackenzie River delta, Northwest Territories, Canada (Notes on Cetacea, Delphinoidea VIII); *Beaufortia* vol. 26, no. 333, pp. 99-105.

A Harbour Porpoise, *Phocoena phocoena* taken from near Shallow Bay, Mackenzie River Delta, Northwest Territories (68°48' N 136°35' W) in July 1973 represents a range extension 800 km eastwards from the previous extreme northeastern record on the north Alaskan coast.



All 12 Harbour Porpoises so far examined from either the extreme north of the range of the species in the eastern North Pacific Ocean, or from the extreme south of the range in the eastern North Pacific and eastern North Atlantic Oceans, are large animals.

1484 VILKS, G. - 1977

Trends in the marine environment of the Canadian Arctic Archipelago during the Holocene; in Proc. Polar Oceans Conf., ed. M.J. Dunbar, McGill Univ., May 1974, pp. 643-653.

Changes in marine paleoenvironment in the Canadian Arctic Archipelago are discussed on the basis of foraminiferal assemblages in bottom sediments. In Lancaster Sound during glacial recession (18,000 - 6,000 years BP), bottom waters were less mobile than at present. In the Northwest Passage the present circulation was established at 6,000 BP. In Prince of Wales Strait during the marine maximum the circulation was in the opposite direction to what it is now. In the northwestern Queen Elizabeth Islands the channels have become shallower during the Holocene, while the extent of summer ice has remained close to that found at present.

1485 WAGNER, F.J.E. - 1977

Recent mollusc distribution patterns and palaeobathymetry, southeastern Beaufort Sea; *Can. J. Earth Sci.*, vol. 14, no. 9, pp. 2013-2028.

Molluscs were obtained from 515 of the 657 grab samples collected 1970-1972 inclusive from southeastern Beaufort Sea, from 29 of the 46 cores taken in the area, and from raised marine deposits at Kay Point and on Herschel Island, Yukon Territory. One hundred and one species have been identified. Water depth was apparently the major factor controlling species distribution. Holocene sea levels, determined by comparing core faunas with the established depth ranges for living specimens, are considered to be reasonably accurate for near-shore sites, but yield excessively shallow water depth figures for deep stations (outer shelf and slope). The anomalous results are probably related to offshore transport of shallow water species.

1486 WHITFIELD, D.W.A. - 1977

Energy budgets and ecological efficiencies on Truelove Lowland; in Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem, ed. L.C. Bliss, Univ. Alberta Press, pp. 607-620.

The broad approach and detailed integration of the Devon Island Project have permitted an analysis of the energy budget of a high arctic terrestrial ecosystem and comparisons with other terrestrial systems.

The exercise of determining energy budgets for the ecosystem and its subsystems was undertaken initially as an integrating measure within the project, and as such served the valuable function of helping to identify components which needed examination in greater depth. This initial aim was later supplanted by the intention of making as accurate and detailed an energy budget as possible as a con-

tribution toward the understanding of ecosystem structures from diverse biomes.

The level of detail attempted is quite fine, particularly within the decomposer complex. In this sort of study there is an inverse relationship between level of resolution and firmness of results; the more pathways which are studied, the more assumptions and extrapolations must be made. We have gone so far that much of what follows must be regarded as hypothesis. At the same time, the results are more interesting and provocative than they would have been at a higher level of aggregation.

The next section sets out the definitions with which I have worked and this is followed by details of the procedures, data, and assumptions necessary to derive the energy budgets. Then there is a discussion of the energetic pattern, computation of ecological efficiencies, and comparison with other ecosystems.

1487 WIDDEN, P. - 1977

Microbiology and decomposition on Truelove Lowland; in Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem, ed. L.C. Bliss, Univ. Alberta Press, pp. 505-530.

Although there are a number of reports in the literature on the occurrence of microorganisms in tundra soils, there have been few attempts to gain a complete picture of the microbial populations, their variation, and their functioning in the ecosystem. This report represents an attempt to gain a more complete understanding of the nature and functioning of the microbial community within a tundra ecosystem.

In order to understand the role of the microbial community within an ecosystem, it is first of all necessary to describe the populations within that community. This requires data on the types of organisms present, their numbers and biomass, and their temporal and spatial variation. As the major role of microorganisms is the decomposition of organic matter and the solubilization of mineral nutrients, an understanding of the substrates that the organisms can utilize and of the effects of a changing environment on their ability to degrade these substrates is necessary. It is therefore essential to conduct laboratory studies on the growth responses of representatives of the microbial community under controlled conditions on varied substrates. These data can then be integrated with field data on primary production and decomposition rates in order to gain clearer insight into the functioning of the decomposer system.

The present paper deals primarily with the description of microbial populations as they occur in the field, and lays particular stress on the nature of the fungal populations and the response of individual isolates to varied environmental parameters. Some laboratory studies on bacteria are reported on here, but the responses of specific bacterial isolates have been studied in more depth by Nelson.

During the present study an attempt was also made to obtain field data on the weight loss rates of natural plant remains (*Carex stans* litter and *Dryas integrifolia* litter). In order

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to gain some "index" of decomposition which could be compared directly with other I.B.P. study sites, weight loss of cellulose in the soil was also studied. Due to technical problems, no data on *Dryas* decomposition are available.

## BOTANY

1488 ADDISON, P.A. - 1977  
Studies on evapotranspiration and energy budgets on Truelove Lowland; *in* Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem, ed. L.C. Bliss, Univ. Alberta Press, pp. 281-300.

The measurement of evapotranspiration and the determination of energy budgets under various environmental conditions may help to explain how a plant is adapted to maintain itself in a harsh environment.

In the past only a limited amount of work has been done characterizing the physical and physiological responses of arctic plants to their environment with respect to partitioning of absorbed radiation and retention of water in xeric sites.

It is important that energy budget studies accompany those of water balance, since plant adaptations for water conservation may have far reaching effects on the overall energy regime of a plant community.

The aims of this study were: (1) to determine the energy budgets of the two dominant plant communities in this high arctic ecosystem; (2) to study the plant-soil-water relations of plant communities at the ends of a soil moisture gradient; and (3) to explore the ecological implications of presumed adaptations to environmental conditions.

1489 BABB, T.A. - 1977  
High Arctic disturbance studies associated with the Devon Island Project; *in* Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem, ed. L.C. Bliss, Univ. Alberta Press, pp. 647-654.

Much of the impetus toward a comprehensive study of a high arctic ecosystem was based on the concern that industrial development, particularly gas and oil exploration, was likely to trigger irreversible environmental damage. Low productivity and low species diversity in arctic ecosystems are assumed to result in much more pronounced interdependence of heterotrophic populations than is evident in milder climates. The high arctic landscape with its sparse plant cover, infrequent rainfall, and underlying permafrost is subject to different sorts of physical degradation than are landscapes under low arctic or temperate conditions. The concept of the Arctic as an "extreme" environment, imposing stress at all but the best of times, leads to the notion that very little additional stress is needed to surpass the tolerance limits of organisms. Sensi-

tivity must therefore be anticipated if damage is to be avoided.

Direct examination of some of the effects of human encroachment was thus incorporated as a part of the Devon Island Study. It is the purpose of this chapter to discuss in general terms some of the aspects of industrial activity likely to contribute to habitat degradation.

1490 BABB, T.A., and WHITFIELD, D.W.A. - 1977  
Mineral nutrient cycling and limitation of plant growth in the Truelove Lowland ecosystem; *in* Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem, ed. L.C. Bliss, Univ. Alberta Press, pp. 589-606.

The conceptual emphasis of the Devon Island Study has been on energy cycling, oxidizable carbon compounds being the biological "common denominator" for comparison of taxonomically remote organisms. This focus has been maintained throughout, and research has been directed accordingly. A detailed study of nutrient cycling was therefore not incorporated in the project design. Throughout the course of the project, however, a number of data and biological insights has been gained secondarily which lend themselves to interpretation of nutrient cycling within this high arctic ecosystem. As might be expected, inorganic nutrients, mainly nitrogen and phosphorus, seem to play an important controlling role in the function of the system. Further *a posteriori* analyses therefore appeared warranted.

The data upon which the following discussions are based include a range of soil, plant, and water analyses supplemental to other aspects of the project. These and concepts developed through the work of other researchers have been incorporated in a framework which, it is hoped, will elucidate the function of nutrient availability within the Truelove Lowland and other high arctic ecosystems. Included in this chapter are: (1) a discussion of the postulated role of landform and hydrology on mineral nutrition in the Lowland; (2) nitrogen and phosphorus flow schema for the two habitats studied most intensively (the hummocky sedge-moss meadow, "HSM," and the cushion plant-lichen, "CPL," communities); and (3) discussion of possible adaptations and functions of vascular plants and mosses within this system, and general trends in the role of nutrients in the ecosystem's functioning.

1414 BLISS, L.C. - 1977  
Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem; ed. L.C. Bliss, Univ. Alberta Press, 714 p.

1415 BLISS, L.C. - 1977  
General summary Truelove Lowland ecosystem; *in* Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem; ed. L.C. Bliss, Univ. Alberta Press, pp. 657-675.

1491 BLISS, L.C., KERIK, J., and PETERSON, W. - 1977  
Primary production of Dwarf Shrub Heath communities, Truelove Lowland; *in* Truelove Lowland,

Devon Island, Canada: A High Arctic Ecosystem; ed. L.C. Bliss, Univ. Alberta Press, pp. 217-224.

Plant communities dominated or co-dominated by species within the Ericaceae or closely related families are a common feature of the Low Arctic across mainland Canada and Alaska. This is exemplified by dwarf shrub heath in relatively dry sites of raised centre polygons and ridge tops; cottongrass tussock-heath on imperfectly drained slopes; and low shrub communities of *Salix* and *Betula* with a heath shrub understory on medium drained slopes.

Within the High Arctic, dwarf shrub heath with two or more heath species are largely restricted to the southern islands, North of 74°N, *Cassiope tetragona* is the only heath species that provides much cover or production although *Vaccinium uliginosum* may be present in small amounts. In general, this community type is highly restricted to snowbank sites, and within a landscape they seldom occupy more than 1% to 3% of the area.

Within Truelove Lowland, because of granitic rock outcrops with snowbanks that do not melt until early July, this community was better represented.

The objectives of this study were: (1) to describe the plant communities present; (2) to determine alive standing crop and net annual production within the heath communities; and (3) to gather data on the plant phenology and plant growth of *Cassiope tetragona*.

1492 FREEDMAN, W., and HUTCHINSON, T.C. - 1976

Physical and biological effects of experimental crude oil spills on Low Arctic tundra in the vicinity of Tuktoyaktuk, N.W.T., Canada; *Can. J. Bot.*, vol. 54, no. 19, pp. 2219-2230.

Data are presented on the effects of simulated crude oil spills on two Low Arctic terrestrial tundra plant communities near Tuktoyaktuk, Northwest Territories. Spills of fresh, unweathered crude oil had a general herbicidal effect, resulting in rapid damage to, and subsequent death of, all aboveground actively growing foliage coming in contact with the oil. Most species were defoliated. Mosses and lichens were especially susceptible and killed. However, within several weeks of the summer oil spillages, a limited number of relatively tolerant vascular plant species began to develop regrowth shoots.

Summer spills were markedly more damaging than were equivalent spills made in winter. No increases were seen in active layer depth from spills made in summer. However, winter spills on one of the two sites did show consistent and statistically significant ( $P > 0.01$ ) increases in depth of thaw. Examination of several key energy budget parameters at these field sites indicated consistently lower albedos and evapotranspiration and consistently higher soil surface temperatures and soil heat flux at all oil spill sites, relative to their controls. However, except for a winter spill on one site, the recorded differences were not sufficiently large in magnitude to produce significant increases in active layer thaw depths.

1430 HSIAO, S.I.C., KITTLE, D.W., and FOY, M.G. - 1978

Effects of crude oils and the oil dispersant corexit on primary production of arctic marine phytoplankton and seaweed; *Environ. Pollut.*, vol. 15, pp. 209-221.

1493 HUTCHINSON, T.C., GIZYN, W., HAVAS, M., and ZOBENS, V. - 1978

The Effect of Long-Term Lignite Burns on Arctic Ecosystems at the Smoking Hills, N.W.T.; in Proc. Sym. Trace Substances in Environmental Health; ed. D.D. Hemphill, Univ. Missouri, Columbia, vol. 12, pp. 317-332.

Spontaneous burning of bituminous shales along 30 km of sea-cliffs at Cape Bathurst, N.W.T. (70°14'N, 127°10'W) releases dense sulphur fumigations over the adjacent tundra. The burns have been ongoing for several hundred years, causing extreme acidities to tundra soils and ponds. pH levels as low as 2.0 occur in the soil and 1.8 in the ponds, compared with controls  $>7.0$ . The  $SO_2$  levels are in the ppm range. The worst fumigated areas have a much depleted fauna and flora, but some plant species have survived. In ponds at pH 1.8 some phytoplankton such as *Euglena mutabilis* occur. Mosses and liverworts dominate the pond bottom, the red chironomid *Chironomus anthracinus* grp. is common and the rotifer *Brachionus urceolaris* is plentiful. On land, despite intense fumigations of  $SO_2$  and sulphuric acid aerosol the lichens *Ochrolecia* and *Cladonia bellidiflora* occur, the moss *Pohlia nutans* is common and the flowering plants *Arctagrostis latifolia* and *Hierochloa alpina*, *Artemisia tilesii* and *Carex bigelowii* occur, in areas where other species have been killed. Volatile elements are emitted from the plume and have been determined by dustfall - rainfall collections, Hi-Vol samplers and by moss-bag techniques. Arsenic, selenium, antimony and bromine are important air contaminants. The extreme acidity of the soils has caused leaching of bases, as well as mobilisation of aluminum, manganese, iron and zinc. Vanadium and uranium levels are also elevated in pond sediments. The predictive value of the study site is emphasized in relation to a) coal burning power plants and b) the impact of acid precipitation on ecosystems.

1494 ITO, K. - 1978

Plant Communities of Permafrost; in Joint studies on Physical and Biological Environments in the Permafrost, Alaska and North Canada, July to August, 1977, Inst. Low Temp. Sci., Hokkaido Univ., Japan, pp. 105-146.

The present paper dealt with the tundra vegetation of Barrow and Tuktoyaktuk, Mackenzie Delta, Canada from a syntaxonomical viewpoint. The vegetation research party had the major purpose of conducting researches on distribution patterns of individual plants, succession processes, and limiting factors that govern lives of individual plants in the permafrost areas. Syntaxonomy of vegetation provides the very first step to develop understanding and pursue investigation of the foregoing. In fact, the data were collected along syntaxonomical work in cooperation with the members of other parties devoted to studies of zoology, cryopedology, etc. while



any one of line transect-, line-quadrat-, line-point quadrat-, point quadrat-, or quadrat methods was adopted in field work, depending upon aims of the cooperators or habitat conditions.

1495 JANKOVSKA, V., and BLISS, L.C. - 1977 Palynological analysis of a peat from Truelove Lowland; in Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem; ed. L.C. Bliss, Univ. Alberta Press, pp. 139-142.

Because of logistic difficulties, the generally shallow nature of peats, and the problems of interpreting the meager pollen profiles, the recent history of vegetation in the High Arctic is little known. Peat depths in most sedge-moss lowlands are only 10 to 50 cm and in uplands seldom more than 1 to 3 cm. Peats more than 1 to 2 m in depth seldom occur, thus greatly reducing potential areas that can be analyzed for past vegetation-climatic conditions.

The age of basal peats was determined at three sites in the Lowlands. They ranged in age from 6,900 ± 115 years B.P. in the Truelove Valley, 4,300 ± 95 years B.P. for peats along Bescheil Creek, and 2,450 ± 90 years B.P. in ice-centre polygons 1 km SW of Base Camp. The latter site was cored for samples.

The objective of the study was to determine pollen and plant material content throughout the limited depth of the profile and to compare these results with those of other high arctic areas.

1496 KINOSITA, S. - 1978 Joint studies on Physical and Biological Environments in the Permafrost, Alaska and North Canada, July to August, 1977; ed. S. Kinoshita, Inst. Low Temp. Sci., Hokkaido Univ., Japan, 149 p.

Northern parts underlain by permafrost form tundra, that is, treeless plains of the arctic region. The tundra area develops many typical landforms including pingo, polygon, ice wedge and exposed massive ice. These features are closely connected with surface conditions such as vegetation, soil type, water content, etc. An expedition was carried out at tundra areas in and around Barrow, Alaska, U.S.A., and Tuktoyaktuk, Mackenzie Delta, Canada, from July to August 1977 in pursuance of joint studies of the physical and biological environments by observing the uppermost layer from the viewpoints of geophysics, geography, geochemistry and biology.

1497 LICHTI-FEDEROVICH, S. - 1979 Contributions to the diatom flora of Arctic Canada: Report I. Scanning electron micrographs of some freshwater species from Ellesmere Island; in Current Research, Part B; Geol. Surv. Can., Paper 79-1B, pp. 71-82.

Scanning electron micrographs of the diatoms *Achnanthes flexella*, *Amphora veneta*, *Ceratoneis arcus*, *Cyclotella antiqua*, and *Navicula tuscula* are presented, together with a description of their respective ecological and environmental

characteristics. This report represents the first contribution to a comprehensive illustrated floristic account of the diatoms of the Canadian Arctic.

1498 MAYO, J.M., HARTGERINK, A.P., DESPAIN, D.G., THOMPSON, R.G., VAN ZINDEREN BAKKER Jr., E.M., and NELSON, S.D. - 1977 Gas exchange studies of *Carex* and *Dryas*, Truelove Lowland; in Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem; ed. L.C. Bliss, Univ. Alberta Press, pp. 265-280.

Field studies of photosynthesis were undertaken during the 1971 and 1972 field seasons with the following objectives in mind: (1) to determine the photosynthetic activity of some of the major plants under the environmental conditions prevailing in the islands of the High Arctic, particularly with respect to continuous light and low temperatures. These studies centered upon *Dryas integrifolia*, a major component of raised beach ridge communities, and *Carex stans* a dominant in meadows; (2) to determine seasonal changes in photosynthetic activity as the plants initiated growth, flowered, and formed seed; (3) to provide CO<sub>2</sub> assimilation data for use in modelling of production processes by other participants in the project; (4) to compare photosynthetic activity of Canadian high arctic species with information from other polar regions; and (5) to gain sufficient information about the conditions under which the plants are photosynthetically active so that studies could be carried out in the Controlled Environment Facility in Edmonton, Alberta, under near natural conditions.

1499 MILLER, N.G., and IRELAND, R.R. - 1978 A floristic account of the bryophytes of Bathurst Island, Arctic Canada; in Occasional papers of the Farlow Herbarium of Harvard Univ., No. 13, pp. 1-38.

Based primarily on collections made by the authors in 1973 and 1974, the bryophyte flora of the central part of Bathurst Island (ca. 75° 43'N, 98°25'W), Northwest Territories, Canada, is reported to consist of 21 species of Hepaticae (including 4 represented by varieties) and 112 species of Musci (11 of which are represented by one or more varieties). The flora of the entire island is known to consist of 131 species of Musci. This is the first report of liverworts for Bathurst Island, and 55 moss taxa are here reported as new to the flora. *Bryum algovicum* var. *rutheanum* (Warnst.) Crundw. is new to North America and *Bryum aeneum* Blytt ex B.S.G., *Cephaloziella uncinata* Schust. in Schust. & Dams., *Drepanocladus sendtneri* (Schimp.) Warnst., *Metacalypsoeia schusterana* Hatt. & Mizut., *Orthothecium chryseum* var. *cochlearifolium* (Lindb.) Limpr., *Orthotrichum jamesianum* Suil. ex James, *Pterygoneurum ovatum* (Hedw.) Dix., and *Seligeria campylopoda* Kindb. ex Mac. & Kindb. are reported as new to the Queen Elizabeth Islands. Because geological evidence indicates that the study area was freed of ice or marine waters only relatively recently, the two mainly temperate zone mosses found in the area, viz. *Pterygoneurum ovatum* and *Seligeria campylopoda*, are viewed as postglacial immigrants rather than indicating the presence of iceless areas on the island during the Pleistocene.



1500 MUC, M. - 1977

Ecology and primary production of Sedge-moss Meadow communities, Truelove Lowland; *in* Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem; ed. L.C. Bliss, Univ. Alberta Press, pp. 157-184.

Although lowlands with sedge and grass dominated meadows cover less than 2% of the landscape in the Queen Elizabeth Islands, they constitute the most productive landscape unit in the High Arctic. Nutrient deficiencies, low temperatures, and a relatively short growing season all contribute to a relatively low standing crop and annual production in this vegetation type, compared with more temperate communities. A distinctive feature of the meadow communities is their retention of the majority of vascular biomass belowground and maintenance of a relatively uniform growth rate over the growing season.

The objectives of this study were to determine plant communities, to determine aboveground and belowground net primary production within the three meadow community types present, to determine aboveground plant growth rates, and to relate carbohydrate, nutrient, and chlorophyll content to net production.

1501 MUC, M., and BLISS, L.C. - 1977

Plant communities of Truelove Lowland; *in* Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem; ed. L.C. Bliss, Univ. Alberta Press, pp. 143-154.

One of the most distinctive features of this Lowland is its richness of plant species and mosaic pattern of plant communities. Most vascular plant and cryptogam species recorded for the Queen Elizabeth Islands have been found here. Plant cover and plant production are also much greater than usual at this latitude.

The objectives of this study were to: (1) map the major habitats with associated plant communities onto air photos (1:5000) and transcribe this information onto a metrically corrected stereo-orthophoto map (plant community and soil map in folder); and (2) describe in general terms the structure (physiognomy) and floristic composition of the plant communities.

1502 MÜLLER, H. - 1977

Über Pflanzen und Klima auf Coburg Island, N.W.T., Kanada; *Geographica Helvetica*, vol. 4, pp. 213-218.

1402 MÜLLER-BECK, H. - 1977

Excavations at Umingmak on Banks Island, N.W.T., 1970 and 1973 Preliminary Report; Ed. H. Müller-Beck, Verlag Archaeologica Venatoria, Institut für Urgeschichte der Universität Tübingen, West Germany, 162 p.

1445 NELSON, L. - 1977

Growth and survival characteristics of three arctic bacteria on Truelove Lowland; *in* Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem; ed. L.C. Bliss, Univ. Alberta Press, pp. 547-565.

1503 RICHARDSON, D.H.S., and FINEGAN, E.J. - 1977

Studies on the Lichens of Truelove Lowland; *in* Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem; ed. L.C. Bliss, Univ. Alberta Press, pp. 245-262.

On Truelove Lowland lichens are found on the raised beaches and in the rock outcrop areas where they colonize the granite outcrops and form part of the heath vegetation between the boulders. Three areas, a rock outcrop and two raised beaches, were studied in detail. The Intensive Raised Beach site was typical of the older granite raised beaches while the younger dolomite-based Phalarope raised beach is representative of the younger coastal beaches where weathering is less advanced, as indicated by the much coarser rock material and more poorly developed soils.

Many reports concerning the growth and production of arctic lichens deal with *Cladonia* species which form mats over the ground in low arctic and sub-arctic habitats. Very little work has so far been reported on lichens from high arctic locations, where *Alectoria* and *Cetraria* species with a variety of crustose species form an important component of the ground flora.

The objectives of the study were to obtain data on the species composition, standing crop and, if possible, production of the lichens of this high arctic ecosystem.

1504 SVOBODA, J. - 1977

Ecology and primary production of Raised Beach communities, Truelove Lowland; *in* Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem, ed. L.C. Bliss, Univ. Alberta Press, pp. 185-216.

Raised beaches have a special ecological significance for Truelove Lowland and can be classified as a part of the Polar Semi-desert. In terms of species diversity and plant production the plant communities are depauperate, yet they are richer than the true Polar Desert. Although this vegetation type, dominated by cushion plants, is of rather limited extent in the Queen Elizabeth Islands, it covers vast areas of the southern arctic islands.

The objectives of this study were: (1) to describe the plant communities and estimate standing crop and net plant production; and (2) to contribute to the understanding of primary production processes and survival strategy in cushion - ants by studying phenology, growth, chemical components, and plant structure.

The field study was conducted during the summers of 1970 through 1973.

1505 SVOBODA, J., and TAYLOR, H.W. - 1979

Persistence of cesium-137 in arctic lichens, *Dryas integrifolia*, and lake sediments; *Arctic and Alpine Res.*, vol. 11, no. 1, pp. 95-108.

Samples of soils and plants collected at various locations in the Canadian Arctic for biomass and primary production study were also tested for radioactive contamination arising from nuclear weapons testing. Measurements with a gamma ray spectrometer showed that all the or-

ganic samples were contaminated with cesium-137 whereas the soils were relatively free of this isotope. A surprisingly high level of cesium-137 was observed in the fine organic sediments taken from a high-arctic oligotrophic lake. The radial distribution of cesium-137 in an arctic cushion plant, *Dryas integrifolia*, was determined and used to confirm a dating procedure for this type of plant. Samples collected in 1977 show radioactive contamination due to the Chinese nuclear explosion of September 1976.

1506 VINCENT, J-S., and EDLUND, S.A. - 1978 Surficial geology of Banks Island, District of Franklin, N.W.T.; *Geol. Surv. Can.*, Open File No. 577.

Preliminary drafts of seven surficial geology maps, at a scale of 1:125 000, show the distribution of surficial materials and landforms and are accompanied by a legend indicating the origin and texture of the deposits. The map units are based on the genesis of the materials and are shown in such a way as to indicate the stratigraphic relationship of units in a given area. The material is based on airphoto interpretation and field work in 1974, 1975 and 1977.

1507 VINCENT, J-S., and EDLUND, S.A. - 1978 Extended legend to accompany preliminary surficial geology maps of Banks Island; *Geol. Surv. Can.*, Open File No. 577.

For each surficial unit an extended legend by geology and geomorphology and vegetation gives information concerning the genesis, texture, distribution, morphology and drainage of the deposits, as well as comments on the vegetation cover and composition, climatic zonation as reflected by vegetation, the processes affecting the units and observations on ground ice. Sensitivity to disturbance and trafficability ratings are provided.

1508 VITT, D.H., and PAKARINEN, P. - 1977 The bryophyte vegetation, production, and organic components of Truelove Lowland; in Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem, ed. L.C. Bliss, Univ. Alberta Press, pp. 225-244.

Bryophytes are an important part of tundra ecosystems and in terms of production, phytomass, and species diversity are sometimes the dominant plant group. Bryophyte dominated communities occur in both the Arctic and Antarctic. On Truelove Lowland, where 41% of the Lowland is composed of *Carex stans* dominated meadow, bryophytes, particularly mosses, form an almost continuous cover. The water budget, nutrient status, soil formation, depth of active layer, and growth of other plants are strongly influenced by this bryophyte layer. In the drier habitats, mosses and hepatics usually play a minor role, with lichens and various vascular plants often forming a large part of the phytomass.

In July and August, 1971 and 1972, field studies were undertaken to: (1) accurately des-

cribe the bryophyte vegetation; (2) determine the species diversity and composition of the Lowland areas; (3) analyze the amounts of bryophyte phytomass and production in the major vegetation types of the Lowland; and (4) relate production to differences of chlorophyll, inorganic and organic components, caloric content, microhabitat, and growth of bryophyte species.

1509 WHITFIELD, D.W.A., and GOODWIN, C.R. - 1977 Comparison of the estimates of annual vascular plant production on Truelove Lowland made by harvesting and by gas exchange; in Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem, ed. L.C. Bliss, Univ. Alberta Press, pp. 315-321.

Annual above and belowground vascular plant production was measured by harvesting methods, for *Dryas integrifolia* and for hummocky sedge-moss meadow gramineae. On the same sites, Mayo et al. measured whole plant net CO<sub>2</sub> exchange by *Dryas* and by *Carex stans* using differential IRGA techniques. The latter measurements were made over 24 hr periods at irregular intervals during the growing season. This paper is an effort to compare these two sets of measurements using a simple curve-fit modelling approach. The procedure used is very similar to that of Scott and Billings. This is not a self-consistent model of plant production and was not intended as such. It is a check of consistency between two very different measurement methods which should, within measurement error, give the same answer.

#### CLIMATOLOGY

1510 ALBRIGHT, M. - 1978 Construction of atmospheric surface pressure maps from the AIDJEX data set; *AIDJEX Bull.*, Univ. Wash., Seattle, No. 39, pp. 111-120.

Atmospheric surface pressure measurements were taken at all four manned camps and at most data buoys deployed during the AIDJEX main experiment in 1975-76. At most locations we achieved a measurement accuracy of + 0.3 mb. Pressure maps constructed from the AIDJEX pressure measurements served as the basis for modeling the air stress field acting on the sea ice of the Beaufort Sea. An initial effort to use the Cressman successive correction method for producing pressure maps was terminated due to the poor first-guess fields which were available for us to use. The pressure analysis method finally chosen fits the pressure observations with a two-dimensional polynomial by the method of weighted least squares. The pressure maps we made with AIDJEX data are significantly better than the NWS maps without AIDJEX data for the Beaufort Sea region.

1511 ALT, B.T. - 1978 Synoptic climate controls of mass-balance variations on Devon Island Ice Cap; *Arctic and Alpine Res.*, vol. 10, no. 1, pp. 61-80.

Fourteen years (1961 through 1974) of synoptic weather charts for June through August were examined along with available meteorological and glaciological data from the northwest region of Devon Island ice cap, N.W.T., Canada. Use of a simple synoptic classification system facilitated investigation of the manner in which summer synoptic conditions control mass-balance fluctuations on the ice cap. Dominance of the Baffin Bay Cyclone suppresses melt and often results in solid precipitation. Cyclonic systems tracking into the region from elsewhere may also contribute to summer snow accumulation on the ice cap, but when the warm sector of such a system intrudes north of Devon Island substantial melt occurs on the ice cap and outlet glaciers. Sporadic anticyclonic periods produce proportionally more melt on the valley glaciers than over the ice cap but prolonged periods of anticyclonic blocking and warm air advection result in highly negative mass-balance conditions. A season dominated by anticyclonic conditions and the accompanying northward shift of the Arctic Front is capable of erasing the positive mass balance of five seasons dominated by the Baffin Bay Cyclone.

1512 BRADLEY, R.S., and ENGLAND, J. - 1978  
Influence of volcanic dust on glacier mass balance at high latitudes; *Nature*, vol. 271, no. 5647, pp. 736-738.

EXPLOSIVE eruptions, which inject large quantities of volcanic dust into the Earth's upper atmosphere, are believed to be important factors in climatic change. Theoretical considerations suggest that the greatest climatic effect of a stratospheric dust veil would be at high latitudes during summer months, when solar radiation passes through the greatest depth of atmosphere and the surface is illuminated continuously. Furthermore, the residence time of volcanic dust is greatest at high latitudes, where it may remain in the upper atmosphere for a decade or more, depending on particle size and initial injection height. Here we present evidence that the eruption of Mount Agung (8°S, 115°E) in March 1963, was responsible for a marked change in the climate of the North American High Arctic and that this change has had a significant impact on glacier mass balance in the region.

1513 BRADLEY, R.S., and ENGLAND, J. - 1978  
Recent climatic fluctuations of the Canadian High Arctic and their significance for glaciology; *Arctic and Alpine Res.*, vol. 10, no. 4, pp. 715-731.

Various measures of the character of ablation season conditions in the Canadian High Arctic (north of 74°N) are discussed based on an analysis of daily climatic data from Alert, Eureka, Isachsen, Resolute and Thule. Melting degree day totals appear to be the most useful index of "summer warmth". An abrupt change in the summer climate of the region occurred around 1963/64. Various indices indicate a marked decrease in summer temperature after 1963. During the same period, annual precipi-

tation in the north and northwest has increased.

Glacier mass balance is strongly controlled by summer climate; in particular, annual melting degree day totals are highly correlated with long-term mass-balance records. This enabled mass balance on the northwest sector of the Devon Island ice cap to be reconstructed back to 1947/48. Cumulative mass losses on the Devon Island ice cap from 1947/48 to 1962/63 are estimated to be ~3500 kg m<sup>-2</sup>. However from 1963/64 to 1973/74 a total of < 350 kg m<sup>-2</sup> have been lost. Significant ice-cap growth is presently limited by low precipitation even when mean summer temperatures are very low; an occasional warm summer may therefore obliterate cumulative mass gains over many years.

The post-1963 change in summer climate appears to be related to the massive increase of volcanic dust in the upper atmosphere, primarily due to the eruption of Mt. Agung (March 1963). Subsequent eruptions may have caused the cooler conditions to persist. Volcanic dust affects solar radiation receipts and perhaps also influences the general circulation. If the high volcanic dust levels of the 1960s are responsible for reduced mass losses on High Arctic glaciers and ice caps, it is probable that other periods with high atmospheric dust levels (e.g., 1750 to 1880) had summer temperatures at least as cold as the mid to late 1960s. Conversely, the period of very negative balance on the Devon Island ice cap from 1947 to 1963 was probably typical of the period back to 1920 when the atmosphere was relatively free of volcanic dust.

1514 CLASSEN, H.G. - 1978  
Ice caps: climatic records of ages past; *Can. Geographic*, August/September 1978, pp. 50-55.

1515 COURTIN, G.M., and LABINE, C.L. - 1977  
Microclimatological studies on Truelove Lowland; in *Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem*; ed. L.C. Bliss, Univ. Alberta Press, pp. 73-106.

In spite of recent interest in polar regions there remains a paucity of literature on arctic microclimates.

With the onset of the I.B.P. more intense work was initiated with attempts at much longer time spans of data gathering. The Canadian program, initiated in 1970, included the first attempt at long range microclimatic measurement in the Canadian High Arctic. Furthermore, the studies on the Truelove Lowland were undertaken with the biota in mind and most data gathering was concentrated in the biologically active snow-free period and the months that immediately preceded and followed it. The program had one complete over-winter period of data collection.

1516 COURTIN, G.M., and LABINE, C.L. - 1978  
High Arctic microclimatological data analysis study; *Fisheries and Env. Can.*, DSS Contract Report No. OSU77-00309, April 1978, 66 p.

This is the final report of the climatological and meteorological investigations undertaken



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at the Truelove Lowland, Devon Island, N.W.T.

This report consists of three sections; the first one deals with the föhn phenomenon, the second one with the surface energy processes and microclimatic characteristics of some of the major tundra types, and the third one is a brief report on our ongoing research with a self-aspirating radiation shield for temperature sensors.

1517 FISHER, D.A. - 1977

Ice crystals,  $\delta(0^{18}O)$  and dust in Devon Island ice cap cores; *Polar Cont. Shelf Proj.*, internal report, 19 p.

1518 FISHER, D.A. - 1979

Comparison of  $10^5$  Years of Oxygen Isotope and Insoluble Impurity Profiles from the Devon Island and Camp Century Ice Cores; *Quaternary Res.*, vol. 11, no. 3, pp. 299-305.

Oxygen-isotope profiles for the Devon Island ice cap and Camp Century Greenland are affected by a number of variables, some of which must have been the same for both sites. The two  $\delta(0^{18}O)$  records spanning about 120,000 years are brought into relative alignment by comparison of major  $\delta$  features, and subsequent verification that the insoluble particulate concentration records were also in phase for this alignment. The difference between the  $\delta$  profiles is shown to be mainly a function of the altitude of the accumulation area for Camp Century. This altitude seems to have been higher than present for the last 100,000 years, suggesting the present flow line through the site has never been shorter. The maximum altitude for the Camp Century accumulation area is 1500 m above the present site and is almost synchronous with the maximum in particulate concentration that occurs at 16,000 yr B.P. The synchronism is likely due to the maximum sea-level lowering that exposed vast areas of continental shelf to wind erosion.

1519 KOERNER, R.M. - 1977

Ice thickness measurements and their implications with respect to past and present ice volumes in the Canadian High Arctic ice caps; *Can. J. Earth Sci.*, vol. 14, pp. 2697-2705.

The main ice caps on Devon Island, central and northeast Ellesmere Island, and Axel Heiberg Island were sounded using a 620 MHz radar. Ice depths were found to be generally between 300 and 800 m. The bedrock topography is everywhere very irregular. There is a pronounced difference between the thickness, and hence volume, of ice on the east and west sides of the Central Ellesmere and Devon ice caps. The greater thickness on the east sides is attributed to much higher snow accumulation rates there and it is calculated that the asymmetry between the east and west sides began to develop some 8000 years ago. The greater thickness of ice on the ice caps facing Baffin Bay must be considered in any derivation of the dimensions of the Wisconsin ice sheet from maps of isostatic rebound in the Queen Eliza-

beth Islands. Some of the northwest-southeast tilt of strandlines on Devon and Southern Ellesmere islands can be attributed to the suppression of rebound by these thick ice masses. It is inferred, from the greater symmetry of ice caps in Northern Ellesmere and to a lesser extent Axel Heiberg Island, that the Arctic Ocean is a much less effective moisture source than Baffin Bay.

1520 MACKAY, J.R. - 1978

Freshwater shelled invertebrate indicators of paleoclimate in northwestern Canada during late glacial times; Discussion; *Can. J. Earth Sci.*, vol. 15, no. 3, pp. 461-462.

The purpose of this discussion is to present permafrost field evidence that suggests that mean annual air temperatures have remained several degrees below  $0^{\circ}C$ , in the coastal area of northwestern Canada, throughout postglacial time.

1521 MacKINNON, P.K. - 1977

An astronomical and geophysical model for long term climatic change, a research proposal; *Polar Cont. Shelf Proj.*, internal report, 54 p.

The astronomical motions of the earth are examined. Based on these motions evidence of climatic change is presented from a series of recent papers. A model of climatic change is introduced that accounts for the astronomical motions and astrophysical processes related to the sun and encounters with cosmic clouds. In addition, the model considers geophysical processes that are suspect to affecting global climate. It is suggested that the model can account for the development of ice centres in continental ice sheets as a result of magnetic field interaction with climate. Furthermore, the hemispheric and interhemispheric asymmetry in ice distribution is accounted for by the model.

1442 MILNE, A. - 1977

Oil, Ice and Climate Change; Beaufort Sea Project Overview Report Series, The Beaufort Sea and the Search for Oil, 103 p.

1522 MÜLLER, F., OHMURA, A., and BRAITHWAITE, R. - 1973

Das North Water-Projekt (kanadisch-grönländische Hocharktis); *Geographica Helvetica*, 28, Jahrg. Nr. 2, pp. 111-117.

Die North Water Polynia, ein semi-permanent eisfreier Meeresraum in der nördlichen Baffin-Bay (Fig. 1) von der Fläche der Schweiz (!) wird zurzeit von einer internationalen, interdisziplinären Arbeitsgruppe untersucht. Kanadische, amerikanische, dänische und schweizerische Meteorologen, Klimatologen, Glaziologen, Ozeanographen und Biologen versuchen Ursache und Auswirkungen dieser auch im Winter offenen Wasserfläche quantitativ zu erfassen.



1523 MÜLLER, F., OHMURA, A., BRAITHWAITE, R., and SCHROFF, K. - 1976

Das North Water Projekt: Die Probleme, das Feldexperiment und einige Ergebnisse; Paper presented at German Society of Polar Research, 10th Intern. Polartagung, Zurich, April 6-8, 1976.

1524 MÜLLER, F. - 1977

Glacier Studies - Arctic, Automatic Weather Stations, North Water; *Ice*, no. 53, p. 2.

1525 MÜLLER, F., BERGER, P., BRAITHWAITE, R., ITO, H., MÜLLER, H., OHMURA, A., SCHROFF, K., and STEFFEN, K. - 1978

Glaciological and Climatological investigation of the North Water Polynya in Northern Baffin Bay; A Report on North Water Project Activities, October 1, 1976 to April 30, 1978, internal report, 152 p.

The objectives of the North Water Project, as defined in the Canadian Government Contracts, are the following: (1) To measure the energy and mass exchanges and wind stress at the North Water Polynya and its surroundings; (2) To assess the amount and position of open water, melting and refreezing zones, pressure ridges and different sea ice forms and their movement in the areas; (3) To assess on a meso-scale the air mass modification induced by the open water and the areas of reduced ice coverage; and (4) To identify the origin of the air moisture in the area as cyclonic or local, mainly by means of isotope studies carried out at three all-year round manned stations (Coburg, Herschel, and Carey) and in firn pits on the surrounding ice caps.

1526 MÜLLER, F. - 1979

Floating Ice-Sea, Regional Studies - North Water; *Ice*, no. 59, p. 9.

1502 MÜLLER, H. - 1977

Über Pflanzen und Klima auf Coburg Island, N.W.T., Kanada; *Geographica Helvetica*, vol. 4, pp. 213-218.

1527 OHMURA, A., and MÜLLER, F. - 1976

Heat Balance Measurement on Arctic Tundra (Axel Heiberg Island, Canadian Arctic Archipelago); in Proc. XXIII Inter. Geographical Congress, Moscow, Vol. 2, Climatology, Hydrology and Glaciology, pp. 80-84.

The field measurement of the relevant components in the equation of the surface heat balance was carried out on the upland tundra on Axel Heiberg Island, NWT, Canada, for the periods of April to August between 1969 and 1972. The current location of the experimental site is 79°20'45" N, 90°30' W and 200 m a.m.s.l. The present article reports on the measuring techniques and the mechanisms of the heat balance of the tundra surface, with special emphasis on the process of snow melt and the development of an active layer which were observed in 1970.

1528 OHMURA, A., and MULLER, F. - 1976

A Review of Heat Balance Studies on Arctic Tundra and a Proposal for the Future; Paper presented at German Society of Polar Research, 10th Intern. Polartagung, Zurich, April 6-8, 1976

The study of heat balance at the surface of the Arctic tundra has been developed along with that of planetary heat balance, in which the role of the earth's surface is particularly important.

The origin of the concept of heat balance is the product of nineteenth century thermodynamics: IPY 1 was the first attempt to measure global radiation at many locations in the Arctic, though with little success: a good progress was made with respect to radiometry in the late 19th and early 20th centuries. In 1930 a reasonable description of the surface boundary layer was achieved, which made the gradient method practical: during IPY 2 the first successful attempt was made to determine all the involved components separately: IGY produced the most outstanding works: IBP is becoming a new stimulation for extending the field measurements of heat balance on the tundra surface. The key works during these periods will be reviewed.

There have been two traditionally used methods to investigate surface heat balance. One is a direct measurement with suitable instruments and the other is an attempt to estimate the heat balance components using either empirical laws or the laws of physics and the appropriate atmospheric information.

The most serious shortcoming of the current field studies is the fact that there is no single work continued long enough to be climatological. This is a serious obstacle in evaluating the role of tundra within the global system of climate. The second problematic point is that most of the works are either microscale studies with great detailness or extensive investigations with doubtful technique. The first point concerns the problem of sampling and the second point the accuracy. The third problem is that little progress was made so far for relating the surface fluxes to the large scale atmosphere. For this problem Kraus proposed a bulk-treatment of the planetary boundary layer and Ohmura presented a coupled model of the constant flux layer and the spiral layer.

The survey of the previous works shows that a new form of organization for field experiments is necessary to overcome these main problems.

#### EQUIPMENT

1529 ANONYMOUS - 1962

Hi-fix in Canada; *Decca navigator news*, July 1962, pp. 18-19.

Canada has always played an important part in the development of Decca Navigation systems. The permanent coverage of the four Decca Navigator chains in Canada forms an important part of

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our world coverage for shipping, whilst the Lambda equipment operating in the northern latitudes has been particularly satisfactory.

1530 BROWN, W.P. - 1978  
Arctic Environmental Buoy System; *AIDJEX Bull.* Univ. Wash., Seattle, No. 40, pp. 15-20.

The AEB is a remote unattended data acquisition and telemetry system designed for deployment on ice covered seas. The total system as presently configured consists of up to 12 AEBs and a Central Control Station (CCS). The Central Control Station under computer control collects the data from the AEBs, processes the data and formats the data on a digital tape for future analysis. The CCS is also capable of controlling the majority of the AEB functions via a command link. The AEB is configured to sample sensor data and acquire position data at three hour intervals automatically. The present sensor configuration allows 6 primary sensors with 10 bit resolution and 16 auxiliary sensors with 5 bit resolution. The auxiliary sensors are sampled only once per day. The sensor data and position data are stored in a digital memory which is transmitted via an H.F. link once per day to the Central Control Station. A unique dual memory concept is utilized to prevent data loss due to propagation vagaries and polar cap absorption events. The position measurements are accomplished by an on-board NAVSAT receiver.

1531 BURKE, S.P., and BUCK, B.M. - 1978  
The Synrams Ice Station; *in Proc. IEEE Ocean '75*, pp. 29-33.

A low power, unattended, ice station for collecting data has been developed to collect synoptic environmental data in polar regions for a period of two years. An array of 10 of these ice stations was installed 250-550 nautical miles north of the Alaskan coast during the spring of 1975. In each station, 24 hours worth of the most recent data, made up of eight 32-bit words, are retained in memory for burst transmission to the RAMS (Random Access Measurement System) receiver in the polar orbiting NIMBUS-F satellite. Surface platform location to a CPE of about 5 km is obtained through doppler measurement of the transmitted signal. This program is part of a continuing Arctic Research in Environmental Acoustics (AREA) project sponsored by the Office of Naval Research, and was performed in cooperation with the Arctic Ice Dynamics Joint Experiment (AIDJEX) to study sea ice dynamics and underwater acoustics ambient noise.

1532 DEYS, F.W. - 1978  
Arctic CTD Data Processing System; *Fisheries and Env. Can.*, Tech. Note Series 78-2, 30 p. UNPUBLISHED MANUSCRIPT.

This report deals with the data-handling software used to process conductivity, temperature, and depth (CTD) data in the Arctic. The data is processed using a number of programs which provide a means of reducing, editing, and dis-

playing data collected using the Guildline Mark IV probe. It is hoped that this data processing system will be the basis for even more useful and versatile systems to be used in future surveys carried out by the Research & Development Division of Central Region, Ocean & Aquatic Sciences.

1533 MARINAV CORP. - 1978  
The Polar Continental Shelf Decca Lambda System; *Marinav Corp.*, Ottawa, 27 p.

This publication is prepared by Marinav Corporation to introduce new users to the Decca Lambda System used by the Polar Continental Shelf Project for navigation and positioning requirements.

1534 MARTIN, P. - 1978  
Summary of technical developments in AIDJEX; *AIDJEX Bull.*, Univ. Wash., Seattle, No. 40, pp. 1-5.

Early in the planning for AIDJEX it was recognized that the success of the program depended on the availability of reliable automatic data acquisition and transmission systems (data buoys) and accurate positioning systems. These systems would involve an extension of existing technologies, including adaptation to arctic operating conditions. Since these development tasks were of central importance to the experiment, and were not within the scope of any single research component, responsibility for them was assigned to the project office. The approach adopted was to contract for the system's engineering development and production, with the project office staff being responsible for stating system requirements, monitoring contractor performance, and deploying and operating the systems. About ten person-years of effort were devoted to these tasks under the AIDJEX office contract with the National Science Foundation.

Development efforts for the two systems commenced in 1971 for the 1972 pilot study. The primary positioning system chosen for the pilot study was the Navy Navigation Satellite System, Transit. The necessary equipment was available commercially and was leased because of the short duration of the 1972 program. The problems encountered generally resulted from the use of relatively new equipment in an unusual environment without sufficient redundancy. An acoustic positioning system also was acquired in 1972 to resolve small amplitude (meters), high frequency (hours) ice motion. This system, while built to the specifications of the project, was well within the state of the art and performed as expected. Oscillations of ice motion with a 12-hour period observed by Hunkins on T-3 were found to be inertial rather than tidal with this acoustic positioning system. The other major finding was that there is little "power" at frequencies of ice velocity greater than 2 day<sup>-1</sup>.

1535 MARTIN, P., and GILLESPIE, C.R. - 1978  
Arctic odyssey - five years of data buoys in AIDJEX; *AIDJEX Bull.*, Univ. Wash., Seattle, 40, pp. 7-14.

The objective of the Arctic Ice Dynamics Joint Experiment (AIDJEX) is to reach a better understanding of the interaction of sea ice with the environment. The main field experiment ended in May 1976 after one year of data collection on the Arctic Ocean. Data buoys were used to define the motion of ice on the perimeter of the area of interest and to measure the surface barometric pressure over the same area.

1536 McPHEE, M.G., MANGUM, L., and MARTIN, P. - 1978

Performance of met/ocean buoys in AIDJEX; *AIDJEX Bull.*, Univ. Wash., Seattle, No. 40, pp. 35-59.

Four data buoys equipped with air pressure and temperature sensors and ocean current meters were deployed in the Beaufort Sea in November 1975 in an attempt to study air-ice-ocean interaction while testing a new type of data buoy. Difficulties with the hardware point to many areas where improvements could be made in the future. Two buoys produced usable floe rotation and ocean current data for 145 and 332 days. These data contain evidence of inertial oscillations, propagating mesoscale disturbances, and persistent westward currents which are consistent with similar observations taken from manned research camps on floes in the Arctic.

1537 PELLETIER, B.R. - 1977

The Unmanned Submersible; *Energy, Mines & Res. geogram*, no. 8, November 1977, pp. 9-11.

1463 SLENO, G.A., and MANSFIELD, A.W. - 1978

Aerial photography of marine mammals using a radio-controlled model aircraft; *Fish. Mar. Serv.*, Manuscript Report No. 1457, 7 p.

#### GENERAL

1538 BEARDMORE, R. - 1978

Regional analysis of natural region 37: the Eastern Arctic Lowlands; *Parks Can.*, Dept. Ind. & Northern Affairs, internal report, 125 p.

A prime objective of Parks Canada is to foster protection of those places which are significant examples of Canada's natural heritage and to encourage public understanding and enjoyment of this heritage, now and in the future. In order to achieve this objective, Canada's National Park system should include representative and unique areas and sites from each of the natural regions of Canada; that is, areas and sites which are of Canadian significance.

In order to facilitate the identification of such areas and sites, Canada has been divided into a number of natural regions based on physiographical, biological, geographical and

oceanographical features (natural themes) which make a natural region distinct from all others. At present, Parks Canada recognizes 39 terrestrial and 9 marine natural regions.

This report is the first step in the process of identifying Natural Areas and Sites of Canadian Significance in Natural Region 37: The Eastern Arctic Lowlands. Herein are described the geological themes, physiographic themes, landform themes, vegetation themes, wildlife themes and cultural history of this natural region. An analysis of these themes is provided and areas and sites are recommended for status as Natural Areas and Sites of Canadian Significance.

1539 CLERK, N. - 1977

Maurice Hall Haycock: painter of the Arctic; *The Arctic Circular*, vol. XXV, no. 3, p. 45.

1540 DYSON, J. - 1978

Our Scientific Assault on the High Arctic; *Reader's Digest*, June 1978, pp. 98-104.

1541 FRENCH, H.M. - 1978

Sump Studies: I Terrain Disturbances; *Ind. & Northern Affairs Can.*, Environmental Studies No. 6, to the Arctic Land Use Research Pro., INA Pub. No. QS-8195-000-EE-A1, Catalogue No. R71-19/6-1978, ISBN 0-662-10182-0, 52 p.

Forty-seven abandoned wellsites in the Mackenzie Delta and Arctic Islands are analysed with respect to terrain and land use problems encountered. Approximately 30% of the sites visited experienced problems related either directly or indirectly to sumps and/or the containment of waste drilling fluids. These problems are classified as follows: (1) Type A - non-containment during drilling, (2) Type B - melt-out problems during summer operations, and (3) Type C - restoration problems. Type C problems are the most common and include sump subsidence and collapse, non-containment of fluids during sump infill, subsurface leakage of fluids, and excessive terrain disturbance adjacent to the sump. The least problems appear associated with one-season winter drilling operations. Two-season winter drilling, in which the sump is left open during the summer, and one-season summer drilling operations usually present more problems.

A number of possible alternate sump fluid disposal methods are mentioned. These include the direct disposal of fluids upon tundra in certain instances, notably polar desert environments, dilution into water bodies in certain flood plain and coastal locations, and the trucking of fluids to central containment sites.

1542 FRENCH, H.M. - 1978

Terrain and Environmental Problems of Canadian Arctic Oil and Gas Exploration; *Musk-ox*, no. 21, pp. 11-17.

Following the discovery of oil and gas at Prudhoe Bay in 1968, Northern Canada has experienced a dramatic increase in exploration activity. Potential for the greatest environmental pro-



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blems is associated with the drilling operation itself, particularly in deep exploratory drilling. The disposal of toxic waste drilling fluids is a problem. Also, as more drilling extends through into the summer months terrain damage will inevitably occur since, at many High Arctic localities, there is a lack of gravel to form pads upon which such operations are conducted. Other environmental and terrain problems, associated with seismic operations and transportational aspects (e.g. roads, airstrips, borrow pits, etc.) have ameliorated in recent years as the result of the strict application of federal government land use regulations and the co-operation of industry. The problems of Canadian oil and gas exploration activity appear more critical than those currently being experienced on the Alaskan North Slope.

1543 FRENCH, H. - 1978  
Why Arctic oil is harder to get than Alaska's; *Can. Geographical J.*, vol. 94, no. 3, June/July 1978, pp. 46-51.

1544 FRENCH, H.M. - 1979  
Oil and Gas Exploration in the High Arctic Islands: problems and prospects; *in Proc. Kanada Naturraum und Entwicklungspotential, Marburger Geographische Schriften*, eds. C. Schott and A. Pletsch, Univ. Marburg, Germany, pp. 13-26.

1545 MacINNIS, J.B. - 1975  
The underwater Arctic: earth's most hostile frontier; *in Proc. The Working Diver Sym.*, Marine Tech. Society, U.S. Navy, Batelle Laboratories, Columbus, Ohio, pp. 196-213.

A review of 715 Arctic ocean dives made during nine expeditions have led the author to conclude that the underwater Arctic represents the planet's most inhospitable environment. Manned dives conducted during the four seasons of the year, from such diverse northern regions as Alaska, the Canadian Archipelago and the North Pole, have confirmed that work beneath the polar ice cap is far more difficult than the same task carried out in temperate waters. In addition to the problems of ice, magnetic variability, cold and winter darkness, considerable personal energy must be expended to overcome well known surface stressors.

1546 MACKAY, J.R. - 1978  
The use of snow fences to reduce ice-wedge cracking, Garry Island, Northwest Territories; *in Current Research, Part A; Geol. Surv. Can.*, Paper 78-1A, pp. 523-524.

1547 MINNS, C.K. - 1977  
Limnology of some lakes on Truelove Lowland; *in Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem*, ed. L.C. Bliss, Univ. Alberta Press, pp. 569-585.

Three lakes were investigated, Immerk, Fish, and Loon Lakes, accounting for 22.75% of the surface water in the Lowland. A broad spec-

trum of measurements was taken from mid-May to mid-August 1973, to obtain at least a qualitative measure of productivity. Most of the work was carried out on Immerk Lake. Comparisons are drawn primarily with data collected in the Canadian I.B.P. project on Char Lake, Cornwallis Island, a moderately deep arctic lake.

1548 PEISTER, K. - 1977  
Snatched from the sky; *Canadian Flight*, May-June 1977, pp. 10-11.

1549 PEISTER, K. - 1978  
the high arctic - land of contrasts; *Canadian Flight*, September-October 1978, pp. 10-11.

1556 RIEWE, R.R. - 1977  
The utilization of wildlife in the Jones Sound region by the Grise Fiord Inuit; *in Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem*, ed. L.C. Bliss, Univ. Alberta Press, pp. 623-644.

1550 UEMURA, N. - 1978  
Solo to the North Pole; *National Geographic*, vol. 154, no. 3, September 1978, pp. 298-325.

1551 WHITE, C. - 1978  
The construction and maintenance of ice airstrips; internal report, Faculty of Engineering, Univ. Waterloo, 29 p.

Factors affecting the usability of ice airstrips are examined for application in future ice airstrips of the Government of the Northwest Territories. The maximum allowable load on an ice strip is estimated from the ice thickness, and then other factors such as ice temperature, cracks, tides and fatigue are taken into account. Removing snow cover is the easiest method to increase load bearing capacity, but surface flooding, flooding snow, compacting snow and ice reinforcement are also possible. An airstrip should be oriented in the direction of the prevailing wind. Usually the dimensions should be 1800 by 45m with a 100 by 100m apron. A 5 to 8cm snow cover, and outline and lead-in barrels should be used. Ice condition and aircraft loading records should be kept. The present MOT standards for ice airstrips appear to be adequate. Data for the ice and sea level climate at Pond Inlet for the last three years is used to investigate the applicability of Stefan's equation to predict ice growth. The strength and composition of sea ice in Pond Inlet is determined.

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1552 BALKWILL, H.R., and ROY, K.J. - 1977  
Geology of King Christian Island, District of Franklin; *Geol. Surv. Can.*, Memoir 386, 28 p.



King Christian Island is in the central part of Sverdrup Basin, Canadian Arctic Archipelago. The island is low, has little relief, and is underlain by slightly folded and faulted Mesozoic sedimentary rocks. A rolling and scarped lowland in the central part of the island has formed on shale and poorly indurated sandstone; this is flanked on the north and south by a lowland plain developed on soft recessive shale.

Rocks exposed on King Christian Island consist of a conformable succession of Mesozoic terrigenous clastic strata, about 1875 m (4175 ft.) thick. Thick sequences of nonmarine and marine sandstone alternate with marine siltstone and shale. In ascending order, the outcrop succession is composed of: (1) the upper 180 m (600 ft.) of the Deer Bay Formation (Upper Jurassic(?) and Lower Cretaceous), which consists of dark grey, silty, marine shale with very thin sandstone beds and lenses near the top; (2) the Isachsen Formation (Lower Cretaceous), which is about 790 m (2600 ft.) thick and consists of fining-upward, cyclic repetitions of fluvially deposited sandstone, siltstone and shale with very minor amounts of coal; (3) marine, silty shale of the Christopher Formation (Lower Cretaceous), which may be separated informally into a thick lower member (365 m (1200 ft.)), that is greenish grey and contains large, buff mudstone nodules, abundant silt, and an interval of glauconitic sandstone at the top, and an upper member of dark grey shale, about 320 m (1050 ft.) thick, containing small red-brown concretions; and (4) the Hassel Formation (Lower and (?) Upper Cretaceous), consisting of fining-upward, fluvially deposited, cyclic repetitions of sandstone, siltstone and shale with minor amounts of coal. The uppermost beds of the Hassel Formation and succeeding Mesozoic formations have been removed by erosion.

Five wells have been drilled on the island, including one relief well. Natural gas was reported in all of the wells. Subsurface formations penetrated in the 11 020-foot (3360 m) deep Panarctic Tenneco et al. King Christian N-06 well are as follows, from the top downward: the lower part of the Deer Bay Formation (Upper Jurassic and? Lower Cretaceous); silty, calcareous shale, assigned to the Ringnes Formation (Upper Jurassic); the Savik Formation (Middle and Lower Jurassic), consisting of the Upper Shale Member, a thin interval of glauconitic sandstone and siltstone assigned to the Jaeger Member, and the Lower Shale Member; undivided sandstone of the Borden Island Formation and the Upper Member of the Heiberg Formation (Lower Jurassic and Upper Triassic); intercalated sandstone and shale of the Heiberg Formation Lower Member (Upper Triassic); and the deepest rocks penetrated, which comprise silty shale of the Blaa Mountain Formation (Middle and Upper Triassic) and, possibly, the upper part of the Blind Fiord Formation (Lower Triassic). The reservoir interval for natural gas is in the upper part of the Borden Island/Upper Heiberg interval.

The geological structure is simple: a broad, ovate, northwestward-trending structural de-

pression is flanked by a closed anticline on the eastern coast, and by eastward-dipping beds along the western coast, which may be part of a similar anticline. Regional evidence indicates that the latest phase of tectonism and uplift probably was in Late Cretaceous and early Tertiary. Development of deep fold roots as a result of mobilization of deeply buried evaporites may have preceded this.

King Christian Island is the site of major discoveries of natural gas, which is trapped structurally in ovate anticlines. Possibilities of significant coal or sedimentary uranium deposits are considered poor.

1553 BALKWILL, H.R. - 1978  
Geology, Borden Island, District of Franklin;  
*Geol. Surv. Can.*, Open File No. 544.

The map depicts an internal subdivision of Jurassic rocks, applicable to subsurface correlation of gas reservoirs in western Sverdrup Basin.

1554 BLAKE, Jr., W. - 1977  
Glacial sculpture along the east-central coast of Ellesmere Island, Arctic Archipelago; *in* Report of Activities, Part C; *Geol. Surv. Can.*, Paper 77-1C, pp. 107-115.

Part of the 1977 field season was devoted to investigating glacial features in the vicinity of Cape Herschel and Pim Island, on the east-central coast of Ellesmere Island.

The most striking feature of Cape Herschel and Pim Island is that they have been overridden and deeply sculptured by glacier ice flowing from north to south. Roches moutonnées abound, their polished, striated, and grooved north sides and plucked south sides showing clearly the direction in which the ice moved.

1555 BLAKE, Jr., W. - 1978  
Coring of Holocene pond sediments at Cape Herschel, Ellesmere Island, Arctic Archipelago; *in* Current Research, Part C; *Geol. Surv. Can.*, Paper 78-1C, pp. 119-122.

Studies in the area, during July 1977 showed that several ponds contained organic-rich sediments, despite the general sparseness of vegetation on the surrounding-granitic terrane. The majority of ponds are at relatively low elevations, below the level of raised beaches and marine shells in undisturbed shallow-water deposits. Thus it was thought that if cores of the bottom sediments could be recovered, a study of diatoms might reveal the point at which the transition from marine to freshwater conditions had occurred. Then, assuming that the age of the organic sediments above this transition could be determined by radiocarbon dating, it might be possible to document the passage of the shoreline and to construct an emergence curve for the Cape Herschel area.

1556 BLAKE, Jr., W. - 1978  
Aspects of glacial history, southeastern Ellesmere Island, District of Franklin; *in* Current

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Research, Part A; Geol. Surv. Can., Paper 78-1A, pp. 175-182.

Field work around Makinson Inlet, Ellesmere Island, has revealed that erratics, striated rock surfaces, and marginal drainage channels are widespread. These features, plus the glacial sculpture on Bowman Island, show that a major outlet glacier formerly flowed eastward in Makinson Inlet, draining a significant mass of ice that lay to the west of the present-day ice caps. A fossil peat deposit indicates an ice-free interval >44 000 years ago with a climate more favourable than that of today. During Holocene time the sea penetrated to the head of the west arm of Makinson Inlet by 8930 ± 100 years B.P. and to the head of the north arm by 7330 ± 80 years B.P.

1557 BLAKE, Jr. W. - 1978

Rock weathering forms above Cory Glacier, Ellesmere Island, District of Franklin; in Current Research, Part B; Geol. Surv. Can., Paper 78-1B, pp. 207-211.

1558 BLAKE, Jr. W., and MATTHEWS, Jr. J.V. - 1979

New data on an interglacial peat deposit near Makinson Inlet, Ellesmere Island, District of Franklin; in Current Research, Part A; Geol. Surv. Can., Paper 79-1A, pp. 157-164.

Examination of peat samples collected in 1977 near Makinson Inlet has revealed the presence of fossils of *Andromeda polifolia* and *Merry-anthes trifoliata*, plants which do not live in the Arctic Islands today. Likewise, fragments of the ground beetle *Amara alpina* and the ladybird beetle *Nephus georgei*, neither of which occurs as far north today, are present. The occurrence of these fossils beyond their present limits, coupled with the fact that the uppermost layer of peat in the deposit is > 52 000 years old, suggests that the peat is an interglacial deposit.

1559 BRAND, U. - 1979

Geochemistry of paleozoic corals, crinoids and carbonate rocks from Arctic Canada, Iowa and Missouri; unpub. Ph.D. Thesis, Univ. Ottawa.

Theoretical consideration of diagenetic stabilization by meteoric waters suggests that it leads to a decrease in  $\delta^{18}\text{O}$ ,  $\delta^{13}\text{C}$ , Sr, Na and possibly Mg and increase in Mn and Fe in progressively altered carbonates.

The combination of elemental patterns and textural trends shows that the Burlington Limestone (Mississippian, Iowa and Missouri) was completely equilibrated with meteoric waters, while the Read Bay Formation (Silurian, Arctic Canada) was less affected.

As a consequence, in the Burlington Limestone the rock matrix (ie. biosparite), the enclosed crinoids (composed originally of high-magnesium calcite) and to some degree the rugose corals (composed originally of low-magnesium calcite) are chemically identical. The crinoid ossicles have an average Sr content of

160 ppm, rugose corals 180 ppm and the enclosing biosparite 120 ppm.

In contrast in the Read Bay Formation all the above mentioned internal components have specific chemistry, with 210 ppm Sr for the crinoids, 780 ppm for rugose corals and 360 ppm for their enclosing micritic matrix.

The rate at which a particular internal component approaches the open system equilibrium is dictated by its respective mineralogical stability. The path of this equilibration for each fossil group can be traced across facies on Sr-Mn covariance diagrams.

Oxygen and carbon isotopic distributions in the separated fossil and matrix components of the Burlington Limestone and the Read Bay Formation can be reconciled with textured and trace element observations, only if it is accepted that the  $^{18}\text{O}$  content of ancient oceans differed from that of the present day. Accepting these secular variations, the postulated  $\delta^{18}\text{O}$  of Mississippian seawater was about 1 ‰ and of the Upper Silurian about 5 ‰ lighter than at present.

The estimated average diagenetic shift in  $\delta^{18}\text{O}$  of the Burlington Limestone constituents is about -3 ‰ and for the Read Bay Formation constituents about -1 ‰ (PDB). Correcting for the magnitude of secular variation, the probable paleotemperature for the Mississippian sea of Iowa and Missouri was 31 ± 4°C and for the Upper Silurian sea of Arctic Canada 21 ± 2°C.

Calculations suggest that the Paleozoic rugose corals and crinoids were not enriched in  $^{12}\text{C}$  and  $^{16}\text{O}$ , rather they are in line with expected results for the studied brachiopods. The apparent "vital effect" of Recent scleractinian corals and crinoids may not be applicable to their Paleozoic counterparts.

The  $\delta^{13}\text{C}$  of the studied samples is bimodally distributed, with +0.5 ± 0.4 and +3.0 ± 0.7 ‰ as modes of the groups. The light- $^{13}\text{C}$  group is characteristic of inorganically derived aragonite mud matrix and/or cement precipitated in equilibrium with ambient seawater. The heavy- $^{13}\text{C}$  group is associated with samples from organic build-ups or from areas of high concentrations of skeletal debris. The cement of this group is organically derived high-Mg calcite and aragonite cement precipitated in carbon isotopic disequilibrium with ambient seawater.

Cementation of the Read Bay Formation sediments, which, in general, fall into the light- $^{13}\text{C}$  group, preceded in the submarine environment. On the other hand, most of the Burlington Limestone samples fall into the heavy- $^{13}\text{C}$  group, and were initially cemented in the submarine environment, followed by subsequent cementation in the meteoric phreatic environment.

While the results show that the carbonate assemblage may act as a completely open diagenetic system (eg. Burlington Limestone), available data for the majority of studied sequences suggest that diagenetic equilibration ceases while some internal differences in chemical composition only are still preserved. This supports the concept of diagenetic stabilization in a partly closed reaction zone, which is not in

equilibrium with the bulk aquifer water (eg. Read Bay Formation). If so, such chemical criteria could serve as a potential tool for evaluating the degree of diagenesis and for estimating the original composition of the different stabilized carbonate phases.

Also diagenetic dolomites from the Read Bay Formation were examined in this study. These late diagenetic dolostones form as a replacement of stabilized low-Mg calcite limestones with average Sr values of about 450 ppm. This replacement takes place in the "Dorag" fresh-seawater mixing zone.

This transformation is selective for the matrix (30 to 300 microns), while the allochems are usually replaced by larger crystals, but only after the original matrix has been dolomitized.

Any possible original isotopic or chemical differences within or between precursor limestones are eradicated during "Dorag" dolomitization, since this diagenetic transformation proceeds in a more or less open system with respect to the bulk aquifer (pore) water.

This precludes the use of trace elements and stable isotopes as facies, paleoenvironmental or paleoflow indicators for "Dorag" dolostones, while at the same time differentiating this group of dolostones from the "early diagenetic" varieties described by other authors.

1560 BROWN, R.J.E. - 1977

Permafrost investigations on Truelove Lowland; in Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem, ed. L.C. Bliss, Univ. Alberta Press, pp. 15-30.

Permafrost, or perennially frozen ground, occurs everywhere beneath the land surface of Truelove Lowland, which is situated in the northern part of the continuous zone. The presence of thick continuous permafrost throughout the Canadian Arctic Archipelago has been known for a long time, but until recently investigations have been limited to a few scattered locations. During the past few years, observations have increased considerably, especially in the Queen Elizabeth Islands, with the onset of petroleum explorations. The Canadian Tundra Biome Study of the I.B.P. provided an opportunity to obtain information on permafrost conditions in the major terrain types at Truelove Lowland. No permafrost investigations had been carried out previously on Devon Island. A preliminary indication of permafrost conditions was available from observations at Resolute, N.W.T., 320 km to the southwest on adjacent Cornwallis Island.

1561 CAMPBELL, F.H.A. - 1979

Stratigraphy and sedimentation in the Helikian Elu Basin and Hiukitak Platform, Bathurst Inlet-Melville Sound, Northwest Territories; *Geol. Surv. Can.*, Paper 79-8, 18 p.

Helikian sedimentation in the Melville Sound area commenced with deposition of the Tinney Cove Formation conglomerate on remnant outliers of the Aphebian fluviatile Burnside

River Formation and underlying Archean basement. With uplift and erosion, a hematitic, anomalously radioactive regolith formed on the Tinney Cove and Archean rocks.

Sedimentation in the Elu Basin and adjacent Hiukitak Platform commenced with the deposition of fluvial trough crossbedded quartzite, grit, and conglomerate between and eventually across the pre-Ellice hills of Archean and Aphebian rocks. Distal braided fluvial sediments are transitional into a quartz-sand dominated deltaic complex. Thin stromatolitic units, locally interstratified with oolites and aeolian-transported quartz grains, were deposited in ephemeral lagoons and embayments on the northwestern part of the deltaic complex. Seaward of the coarse clastics, red mudstone, shale, and dolomite accumulated in the more distal parts of intermittently-exposed deltaic complex.

Beyond the limits of significant terrigenous clastic sedimentation, clastic and biogenic carbonate rocks accumulated on a shallow shelf. Gypsum interbedded with the carbonate formed in significant quantities in quiescent parts of the carbonate shelf facies. The evaporites later dissolved and formed a chaotic solution breccia in the Parry Bay Formation. With transgression and decreasing supply of terrigenous clastics, clastic carbonate, accompanied by thin sheets of low-amplitude, elongate, laterally-linked domal stromatolites, was deposited over the evaporite-bearing facies. With stability in the basin, extensive tabular bioherms of this same type of stromatolite accumulated at the platform-basin margin on the same low-angle paleoslope established during deposition of the Ellice Formation. Coarse grained dolarenite and intraformational carbonate-pebble conglomerate were deposited following formation of the tabular bioherm complex. A thin continuous unit of conical stromatolites formed during a lull in coarse clastic sedimentation, and the southern limit of this unit delineates the northern margin of the Hiukitak Platform south of Daniel Moore Bay.

Reefoid stromatolite bioherms, with inter-reef distributary channels spread southwestward across the basin during renewed subsidence. These were in turn buried beneath algal-bound fine grained carbonate in the east and coarser grained carbonate in the west, terminating deposition in the Elu Basin.

1562 DiLABIO, R.N.W., SHILTS, W.W., and KLASSEN, R.A. - 1978

Glacier Studies - Arctic, Bylot Island; *Ice*. No. 56 and 57, p. 3

1563 DiLABIO, R.N.W., and SHILTS, W.W. - 1978

Compositional variation of debris in glaciers, Bylot Island, District of Franklin; in *Current Research, Part B; Geol. Surv. Can.*, Paper 78-1B, pp. 91-94.

A pilot study to define variations in composition of glacial debris was carried out on outlet glaciers that flow from high-grade metamorphic terrane onto sedimentary terrane on the southwest side of Bylot Island. Preliminary observations indicate that 1) debris in lateral moraines of four of the five glaciers sampled



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has differing and distinct trace element geochemistry; 2) there are significant vertical compositional changes in debris bands in the glaciers; and 3) more than 99 per cent of the sand and coarser debris in the ice and moraines is derived from the metamorphic terrane.

1564 DiLABIO, R.N.W., and SHILTS, W.W. - 1979  
Glacier Studies - Arctic, Bylot Island; *Ice*, No. 59, p. 4.

1565 DIXON, O.A., and JONES, B. - 1978  
Upper Silurian Leopold Formation in the Somerset-Prince Leopold Islands type area, Arctic Canada; *Bull. Can. Petroleum Geol.*, vol. 26, no. 4, pp. 411-423.

Substantially arenaceous and dolomitic rocks of the Leopold Formation are exposed through a composite type section 405 m thick near Port Leopold and on Prince Leopold Island. The formation is highly varied lithologically, contains a sparse, restricted marine fauna and is predominantly intertidal in origin.

The Leopold Formation is herein divided into 3 members. The Cape Seppings Member (28 m thick at the base) is largely dolostone with minor gypsum pods and laminae, transitional between underlying supratidal evaporites of the Cape Crauford Formation and the overlying Cape Clarence Member. This middle member (275 m thick) contains a large proportion of sandstones and dolostones and numerous stromatolitic units. The overlying Prince Leopold Member (102 m thick) is mainly sandstone and limestone, and is transitional into the subtidal fossiliferous limestones of the succeeding Read Bay Formation.

1566 DIXON, O.A. - 1979  
Late Silurian plasmopodid and stelliporellid corals (Heliolitidae) from the Canadian Arctic; *J. Paleontology*, vol. 53, no. 3, pp. 642-656.

*Squameolites dissitus* n. sp., *Stelliporella* cf. *s. podolica* Bondarenko and other *Stelliporella*-like corals occur sparsely in biohermal and bioherm flank rocks of the Read Bay Formation on Somerset Island. Heliolitids referable to these genera, although more common in Europe and Asia, have rarely been reported in North America. Two of the stelliporellid specimens possess characters that suggest a further assessment is necessary of the status and relationships of the genera *Stelliporella* Wentzel, *Derivatolites* Bondarenko and *Podollites* Bondarenko. The morphological variability in these species strongly confirms the need to base new taxa on assemblages rather than single specimens.

1567 DYKE, A.S. - 1978  
Indications of neoglaciation on Somerset Island, District of Franklin; *in Current Research, Part B; Geol. Surv. Can.*, Paper 78-1B, pp. 215-217.

Lichen-kill areas, as well as miniature eskers and meltwater channels, indicate neoglaciation

of parts of Somerset Island. These are the subject of this note.

1568 DYKE, A.S. - 1978  
Glacial history of and marine limits on southern Somerset Island, District of Franklin; *in Current Research, Part B; Geol. Surv. Can.*, Paper 78-1B, pp. 218-223.

Two distinct terrains, one of glacial and one of nonglacial character, are recognized. Within the glacial terrain two sets of marine limit features are mapped and dated. The older marine limit was formed upon deglaciation, and the younger apparently by a transgression in a ice-free area.

1569 DYKE, A.S. - 1979  
Radiocarbon-dated Holocene emergence of Somerset Island, Central Canadian Arctic; *in Current Research, Part B; Geol. Surv. Can.*, Paper 79-1B, pp. 307-318.

Thirty-six radiocarbon dates on marine shells, whale and walrus bones, and driftwood are used to reconstruct the Holocene emergence of Somerset Island. Nine dates, all around 9200 ± 100 years, pertain to the marine limit. The 9200 ± 100 year old shoreline has a parabolic profile that rises and steepens west-southwestward; its maximum gradient is in the area of the late Wisconsin Laurentide Ice Sheet limit. The shoreline lies at 76 m a.s.l. in the northeast and 157 m a.s.l. in the southwest part of the island. Emergence curves are drawn for Cape Anne, Cunningham Inlet, Rodd Bay, and the Creswell River lowland. Early emergence rates were 8 to 11 m/100 years, and 56 per cent of total emergence was accomplished in the first 1000 years. Emergence has proceeded at a constant rate at each site during the last 5000 to 6000 years but has varied spatially from 46 cm/100 years in the west to 28 cm/100 years in the east. The 5000 year old shoreline declines from 22 m a.s.l. in the west to 14 m a.s.l. in the east with an average gradient of 6.2 cm·km<sup>-1</sup>.

1570 DYKE, A.S. - 1979  
Glacial geology of Northern Boothia Peninsula, District of Franklin; *in Current Research, Part B; Geol. Surv. Can.*, Paper 79-1B, pp. 385-394.

Mapping of glacial and marine features and radiocarbon dating of fossil marine molluscs have provided much new information on the glacial geology of northern Boothia Peninsula. At the late Wisconsin maximum ice flowed eastward to northeastward over the area. This flow is recorded by large fields of rock drumlins and other ice moulded bedrock forms. During recession, lateral meltwater channels, ice dammed lakes, and moraines were formed. These features document westward recession of the ice mass, whose margins and last flow pattern were topographically controlled. The marine limit near the east coast lies at 215 m a.s.l. and was formed 9230 ± 130 years B.P. The marine limit declines westward in the direction of ice recession to 155 m a.s.l. and less in Wrottesley Valley, where it was formed about 9040 ± 100

years ago. The ice margin retreated about 300 m/year, and the ice surface lowered about 5.5 m/year between 9230 and 9040 years B.P. The initial coastal emergence rate was more than 30 m/100 years. Shells dated at >23 300 years, from deltaic sediment at 195 m a.s.l. on the northeast coast, probably represent a pre-late Wisconsin marine incursion caused by ice recession. Organics, dated at >30 000 years, from sands below the Holocene marine limit in Wrottesley Valley, are probably detritus in Holocene marine sediments.

1571 DYKE, L. - 1979

Bedrock heave in the central Canadian Arctic; in *Current Research, Part A; Geol. Surv. Can., Paper 79-1A*, pp. 241-246.

Sites for detailed study of bedrock heave motions and rates were established in gneisses of District of Keewatin and sedimentary rocks of the central Arctic Islands. Observations of heave suggest that freezing of standing water in otherwise vacant bedrock cracks may result in relatively large and rapid vertical displacements where the active layer is deep. The confinement of water by a downward-advancing freezing front through water-filled cracks may lead to the development of excess pore water pressure. Where free water is not present, water retained in soil infillings may be capable of causing smaller, more gradual displacements in bedrock masses by the development of segregated ice.

1572 DYKE, L. - 1979

Permafrost and ground ice, frost heave; *Ice*, No. 59, p. 13.

1573 ENGLAND, J. - 1978

The glacial geology of northeastern Ellesmere Island, N.W.T., Canada; *Can. J. Earth Sci.*, vol. 15, no. 4, pp. 603-617.

Thirty-five radiocarbon dates associated with former ice sheet margins and raised marine deposits are presented from northeastern Ellesmere Island. Along the southern margin of Hazen Plateau, and in inner Archer Fiord, a prominent morpho-stratigraphic boundary is marked by the Hazen Moraines. These moraines represent a restricted ice advance during the last glaciation and date ca. 8130 ± 200 B.P. On the immediate distal side of the Hazen Moraines, eastward for 100 km towards northwestern Greenland, the majority of dates on marine limits show synchronous emergence beginning ca. 7500 BP. This zone of synchronous emergence is considered to represent an ice-free corridor isostatically unloaded between the margins of the receding Greenland and Ellesmere Island ice sheets.

A more widespread till, above and beyond the Hazen Moraines, extends out of Archer Fiord - Lady Franklin Bay to Robeson and Kennedy channels. This maximum ice advance is considered to predate the last glaciation on the basis of <sup>14</sup>C and amino acid dates from ice-marginal deposits; however, alternative interpretations

of the data are presented. Previous evidence suggesting an older advance of the Greenland Ice Sheet onto this coastline is confirmed. Several glaciers in the area are presently at their maximum postglacial positions.

1574 ENGLAND, J., BRADLEY, R.S., and MILLER, G.H. - 1978

Former ice shelves in the Canadian High Arctic; *J. Glaciology*, vol. 20, no. 83, pp. 393-404.

Moraines deposited by the outermost ice advance across Judge Daly Promontory, northeastern Ellesmere Island, reflect thin, topographically controlled ice lobes extending to sea-level. The termini of two ice lobes were investigated and both produced ice shelves where they flowed into isostatically depressed embayments along western Kennedy Channel. Morphological evidence for these ice shelves occurs at the entrance to these valleys where steeply descending lateral moraines become abruptly horizontal for 2 km. In addition, both the horizontal moraines and associated pro-glacial terraces are fossiliferous down-valley from the apparent grounding line. Based on the differences in elevation between the horizontal moraines and the valley bottoms, the two ice shelves had estimated thicknesses of c. 110 and 150 m. A proglacial outwash terrace at 175 m a.s.l. is considered to represent the approximate relative sea-level during the formation and break-up of the ice shelves. This relative sea-level is consistent with the water depths required to float the calculated ice thicknesses in both valleys. Associated with these ice margins are finite <sup>14</sup>C dates of 28 000-30 000 B.P. and amino-acid age estimates of >35 000 B.P. The importance and likelihood of additional past ice shelves in the Canadian High Arctic is discussed.

1542 FRENCH, H.M. - 1978

Terrain and Environmental Problems of Canadian Arctic Oil and Gas Exploration; *Musk-ox*, no. 21, pp. 11-17.

1575 FRISCH, T. - 1977

Northernmost part of Precambrian Shield undergoes reconnaissance geology mapping; *The Northern Miner*, November 24, 1977, p. C20.

1576 FRISCH, T., and THORSTEINSSON, R. - 1978

Haughton Astrobleme: A Mid-Cenozoic Impact Crater Devon Island, Canadian Arctic Archipelago; *Arctic*, vol. 31, no. 2, pp. 108-124.

Haughton Astrobleme is a nearly circular impact crater with a diameter of about 16 km and a central uplift in Devon Island. Bedrock exposed in the crater comprised the following mainly carbonate Lower Ordovician to Upper Silurian formations in order upward: Eleanor River, Bay Fiord, Thumb Mountain, Irene Bay and Allen Bay. The Eleanor River Formation in the centre of the crater is raised about 480 m above its normal stratigraphic position outside the crater. The much shattered and faulted lower Paleozoic rocks within the crater contrast markedly with

the subhorizontal surrounding strata. The Allen Bay Formation constitutes surface exposure around all but the easternmost part of the crater's border where the Thumb Mountain and Irene Bay Formations are exposed. Also exposed in the crater are two newly recognized, and as yet unnamed, formations: a polymict impact breccia that overlies the lower Paleozoic rocks, with marked angular unconformity and crops out over about a quarter of the area of the crater; and a unit of lake sediments near the western border of the crater that lies disconformably on the impact breccia and with angular unconformity on the lower Paleozoic rocks.

The impact breccia is composed chiefly of carbonate rocks, but locally contains clasts of Precambrian crystalline basement from a depth estimated to be at least 1700 m. The basement clasts show varying degrees of shock metamorphism, the highest being that displayed by rocks with vesicular, flow-banded feldspar or quartz glass. Coesite has been identified in a sample of gneiss.

The lake sediments are interpreted as an infilling of the crater that occurred shortly after impact. On the basis of fossils, these sediments are dated as Miocene or, possibly, Pliocene. From this and other evidence, it is concluded that the impact took place in the Miocene or Pliocene.

1577 FRISCH, T., MORGAN, W.C., and DUNNING, G.R. - 1978

Reconnaissance geology of the Precambrian Shield on Ellesmere and Coburg Islands, Canadian Arctic Archipelago; *in* Current Research, Part A; Geol. Surv. Can., Paper 78-1A, pp. 135-138.

Reconnaissance geological mapping of the Precambrian Shield on Ellesmere and Coburg Islands has been completed. The Shield area was metamorphosed entirely in the granulite facies. Detailed work on the unmetamorphosed Proterozoic sedimentary and igneous rocks of the Thule Basin has enabled correlations to be made both between the three main areas of outcrop and with the lower part of the Wolstenholme Formation on Greenland. Minor occurrences of Cu-Fe sulphides and malachite are common in meta-sedimentary basement rocks; malachite is also found in Thule Basin igneous rocks.

1578 FRISCH, T. - 1979

Reconnaissance studies of the Precambrian Crystalline basement on Devon Island, District of Franklin; *in* Current Research, Part A, Geol. Surv. Can., Paper 79-1A, pp. 113-114.

The metamorphic rocks on the south coast and part of the north coast of eastern Devon Island were mapped. Massive to gneissic biotite granulite is the predominant rock type. Retrogression of granulite to granitoid gneiss of amphibolite facies is common and in many places severe. Metasedimentary garnet + sillimanite gneiss underlies large areas of the south coast and is commonly interlayered with granulite, suggesting that the latter is also of meta-

sedimentary origin. Deformation has generally been intense and affected all units of the basement except the diabase dykes.

1579 GELL, W.A. - 1978

Ice-wedge ice, Mackenzie Delta-Tuktoyaktuk Peninsula Area, N.W.T., Canada; *J. Glaciology*, vol. 20, no. 84, pp. 555-562.

Petrologic analysis was performed on ice-wedge ice in order to investigate changes in fabric across wedges in relation to the growth mechanism. Crystal size increased from the centre outward and strongly preferred dimensional orientations developed parallel to the sides of wedges. *c*-axis orientations changed from a horizontal girdle at the wedge centre to a point maximum normal to the foliation at the boundary. These changes are related to recrystallization and grain growth associated with the horizontal stress field. In massive ice penetrated by an ice-wedge, crystal size and complexity of crystal shape decreased toward the wedge, dimensional orientations tended to become parallel to the wedge, and *c*-axes formed a point maximum normal to the wedge boundary.

1580 GELL, W.A. - 1978

Fabrics of icing-mound and pingo ice in permafrost; *J. Glaciology*, vol. 20, no. 84, pp. 563-569.

Crystallization histories of some ice layers in permafrost are inferred from crystal size, shape, dimensional and lattice orientation, and inclusion patterns. In an icing mound, formed by injection of water beneath frozen active-layer soil, early growth was rapid, indicated by copious small crystals and bubbles, followed by slower growth giving rise to crystals and bubbles elongate parallel to the freezing direction. *c*-axes were normal to crystal long axes. In a small pingo, bulk water existed temporarily at the freezing interface and freezing was unidirectional. In a larger pingo, variations in freezing rate were inferred. Later flow of ice modifies growth fabrics.

1581 GELL, W.A. - 1978

Thermal contraction cracks in massive segregated ice, Tuktoyaktuk Peninsula, N.W.T., Canada; *in* Proc. Third Intern. Conf. Permafrost, July 10-13, 1978, Edmonton, Alta., sponsored by Nat. Res. Council of Can., Vol. 1, pp. 278-281.

Petrological analysis was performed on massive ground ice transected by thermal contraction cracks, in order to investigate mode of fracture, infill of cracks and interrelationships among fracture paths. Cracks propagated transgranularly through large crystals of massive ice. Sub-boundaries and other dislocation groups may have aided in micro-crack nucleation, and bubbles probably acted as stress concentrators. Fractures were infilled by freezing of bulk water rather than hoar. *C*-axes of infill crystals formed a vertical girdle normal to the crack plane, in contrast to the vertical point maximum in massive ice. Some infill growth occurred in lattice continuity with massive ice crystals but frequently small new co-



lummar crystals grew. Subsequent fractures did not follow the paths of earlier cracks. Massive ice can still be recognized between fractures; repeated cracking may eventually produce an ice wedge.

1582 GIBBINS, W.A., SEATON, J.B., LAPORTE, P.J., MURPHY, J.D., HURDLE, E.J., and PADGHAM, W.A. - 1977

Mineral Industry Report, 1974, Northwest Territories, EGS 1977-5; *Ind. & Northern Affairs*, North of 60, Cat. No. R71-9/1974-2, QS-8143-000-EE-A1, ISBN 0660-01161-1, 267 p.

Mining and mineral exploration in the Northwest Territories (N.W.T.), in 1974 is described in this report.

1583 GIBLING, M.R., and NARBONNE, G.M. - 1977

Siluro-Devonian sedimentation on Somerset and Cornwallis Islands, Arctic Canada; *Bull. Can. Petroleum Geol.*, vol. 25, no. 6, pp. 1145-1156.

Stratigraphic sequences of Upper Silurian-Lower Devonian cratonic sediments on Somerset Island and near the craton margin on Cornwallis Island to the north show strong lithological and faunal similarity. The predominantly intertidal Cape Storm Formation is overlain by subtidal rocks of the Read Bay Formation (Member A) on both islands; a regressive succession of intertidal and fluvial clastics is common to the upper parts of both sections. However, the thick subtidal and intertidal sequence of Members B and C in the middle of the section on Cornwallis Island has no lithological equivalent on Somerset Island. Members B and C appear instead to be equivalent in age to the continental sediments on Somerset Island. Paleocurrents indicate that the Boothia Uplift was the source of the coarse clastics on both islands. Extension of the locus of uplift led to a northward advance of continental sedimentation with time.

1584 GIBLING, M.R. - 1978

Sedimentation of the Siluro-Devonian Clastic Wedge of Somerset Island, Arctic Canada; unpub. Ph.D. Thesis, Univ. Ottawa, (xxi and 334 p.)

The Siluro-Devonian clastic wedge of Somerset Island comprises two formations. The Somerset Island Formation is divided into a lower member of grey laminated dolosiltite and minor limestone, up to 130 m thick, and an upper member of red massive and grey laminated dolosiltite, up to 300 m thick. The overlying Peel Sound Formation, up to 600 m thick, and divided into four members, consists mainly of red sandstone and conglomerate.

Cycles in the Somerset Island Formation were shown by Markov analysis to contain the sequence: grey thin-bedded limestone, grey laminated dolosiltite, red massive dolosiltite. Structures representing algal mat types comparable to those of modern tidal flats indicate a repeated progression from shallow subtidal to terrestrial conditions during deposition of the cycles. The cyclicity reflects transgres-

sive-regressive events, probably related to tectonism in the adjacent Boothia Uplift.

Peel Sound member 1 consists of red sandstone with less than 20% of siltstone and mudstone. Laterally extensive fining-upward cycles (3.9 m average thickness) were shown by Markov analysis to contain the sequence: erosion surface, large-scale trough and planar cross-stratified sandstone, small-scale cross-stratified or laminated sandstone, massive siltstone. The cycles represent accretion in braided river systems, with bars and shallow (2 m) channels on low-gradient, distal plains. Rare non-cyclic sequences comprise laminated and trough cross-stratified sandstones, with current lineation and abundant cross-cutting erosion surfaces; deposition occurred in very shallow (less than 1 m) channels migrating rapidly on high-gradient, proximal surfaces.

Peel Sound members 2 and 4 consist of horizontally stratified framework conglomerate with minor sandstone. Current-parallel and -transverse orientation of clast A-axes indicates both suspension and bedload transport. Deposition took place on longitudinal bars in proximal braided rivers. Rare cross-stratified conglomerate and sandstone successions containing channels indicate deposition on foreset bars and large-scale bedforms in more distal braided rivers. Proximal-type conglomerates pass eastward into distal-type sandstones in the Cape Anne syncline, and these sediments constitute the bulk of the clastic wedge.

Peel Sound member 3 contains units of bright red, giant cross-stratified sandstone, intercalated with erosionally based units of grey pebbly sandstone with flute casts and current lineation. The strata represent eolian dune and flash flood deposits, respectively.

The succession of clast lithotypes in the Peel Sound conglomerates matches in reverse order the rock sequence presently exposed in the Boothia Uplift. Lateral facies changes and paleocurrent data indicate mainly easterly transport, confirming that the Uplift was the main source of the detrital sediment. The clastic wedge contains abundant detrital dolomite of rudite to siltite grade, with some *in situ* penecontemporaneous and secondary dolomite. Petrography and analysis for Sr and Na suggests that the detrital dolomite was probably derived initially from erosion of contemporaneously formed dolomite and later from erosion of older dolostone formations. Comparable Siluro-Devonian regressive sequences on Prince of Wales and Cornwallis Islands were also derived from the Boothia Uplift. The Somerset Island succession coarsens upward gradually while the Prince of Wales Island succession contains abundant intercalated units of conglomerate, a result of local differences in tectonic style during uplift. The basal clastic units are upper Ludlovian or Pridolian in age on Somerset Island, but Gedinnian in age on Cornwallis Island, indicating that uplift advanced northward with time. The climate was semi-arid, probably with higher rainfall on the Uplift.

Analysis of size, shape and roundness of 558 clasts from the Peel Sound conglomerates sug-

gests that internal texture exerted more influence on morphology than the rock type *per se*. Parameters of morphology and fabric generally show weak correlation, a reflection of short transport distance, intense flow and rapid deposition. Analysis of clast projection area indicates that these contact fabrics fulfill the criteria proposed for hydrodynamic stability of isolate fabrics.

1585 HEGINBOTTOM, J.A. - 1978  
An active retrogressive thaw flow slide on Eastern Melville Island, District of Franklin; *in* Current Research, Part A; *Geol. Surv. Can.*, Paper 78-1A, pp. 525-526.

1586 HODGSON, D.A., and EDLUND, S.A. - 1978  
Surficial materials and biophysical regions, Eastern Queen Elizabeth Islands: Part II; *Geol. Surv. Can.*, Open File No. 501.

This file consists of preliminary drafts of maps and explanatory legends for Fosheim Peninsula and eastern Axel Heiberg Island (N.T.S. 49 G and H, 340 B south) based on airphoto interpretation and field data collected in 1972-74 at a scale of 1:125 000.

1587 HODGSON, D.A. - 1979  
Surficial material, south-central Ellesmere Island, N.W.T.; *Geol. Surv. Can.*, Open File No. 635.

This file consists of preliminary unedited drafts of two maps (scale 1:125 000) and separate explanatory legend describing surficial materials of the Vendom Fiord (49D) and Strathcona Fiord (49E) map-areas. The maps are based on airphoto interpretation and on field data collected in 1972, 1973, 1974 and 1978. An extended legend provides additional information for each unit in terms of material, topography, drainage, processes, thermal regime and vegetation and provides ratings on sensitivity, hazardousness and trafficability.

1588 IANNELLI, T.R. - 1979  
Stratigraphy and depositional history of some upper Proterozoic sedimentary rocks on northwestern Baffin Island, District of Franklin; *in* Current Research, Part A; *Geol. Surv. Can.*, Paper 79-1A, pp. 45-56.

Neohelikian strata outcropping on southwest Borden Peninsula and southeast into the Paquet Bay area (northwestern Baffin Island) include about 4500 m of shales, quartzarenites, subarkoses, stromatolitic dolostones and conglomerates. These beds were deposited in environments that ranged from fluvial braided stream, delta fan complex, to marine basin supratidal, intertidal and subtidal. Paleocurrent dispersal patterns indicate that the dominant depositional trends were from the east and southeast.

The pattern of sediment deposition was influenced by faulting, which occurred within northwest trending zones.

1589 JACKSON, G.D., IANNELLI, T.R., NARBONNE, G.M., and WALLACE, P.J. - 1978  
Upper Proterozoic sedimentary and volcanic rocks of Northwestern Baffin Island; *Geol. Surv. Can.*, Paper 78-14, 15 p.

About 15 000-20 000 feet (4600-6100 m) of Neohelikian strata consisting of quartzarenites, shales, carbonate strata commonly containing stromatolites and/or bioherms, greywackes, arkoses and conglomerates outcrop east of Admiralty Inlet, Baffin Island. These strata were deposited in environments that ranged from fluvial to subtidal and may include a submarine channel-fan complex in the upper part. Paleocurrent trends for all but the uppermost formation indicate westerly transport, whereas easterly transport is indicated for the uppermost formation. About 300-500 feet (90-150 m) of tholeiitic plateau basalts occur near the base of the sequence.

Faulting was active during deposition that took place in a rift zone which (according to Olson) may be an aulacogen related to early development of the Franklinian Geosyncline.

1590 JONASSON, I.R., and DUNSMORE, H.E. - 1979  
Low grade uranium mineralization in carbonate rocks from some salt domes in the Queen Elizabeth Islands, District of Franklin; *in* Current Research, Part A; *Geol. Surv. Can.*, Paper 79-1A, pp. 61-70.

A reconnaissance survey was made of parts of the Queen Elizabeth Islands to determine suitable geological settings in which U mineralization might be located. The geological studies were integrated with, and supported by, detailed geochemical studies of stream sediments, waters and rocks.

Two main target types were selected: Paleozoic and Mesozoic continental sandstones on Melville and Ellef Ringnes Islands, and Pennsylvanian anhydrite-halite diapirs intruding these sediments at the same locations.

Sandstone did not yield any U occurrences although its potential remains undiminished. However significant signs of radioactivity were encountered within the Dumbbells Dome, Ellef Ringnes Island. These led ultimately to the discovery of extensive, low grade U mineralization hosted by Pennsylvanian limestone breccias. Stream waters analyzed for uranium proved particularly useful in outlining favourable zones, especially when used in detailed studies. Sediments, leached by sulphate-bearing waters, were less effective. However all geochemical and radiochemical methods were found to be restricted by the nature of the generally wet and deeply weathered arctic terrain.

1591 JONES, B. - 1976  
The use of primary growth indices for the identification of brachiopod species; *Abstract in Paleontology and Biostratigraphy Seminar, Univ. Windsor, October 22-23, 1976*, p. 7.

The relative ontogenetic development of any two size parameters of a brachiopod can be re-

lated by a reduced major axis, herein referred to as a growth axis. A study of 41 assemblages of *Atrypella* Kozłowski and 17 assemblages of *Protathyris* Kozłowski from the upper Silurian of Arctic Canada, shows that there is considerable inter-assemblage variation in the attitude of the growth axes. If attention is focused on one bivariate graph, for example, length versus height, then the variation in the attitude of the axes from the different assemblages can be depicted by constructing another bivariate graph with the Y axis representing the constant and the X axis representing the gradient of the axes, respectively. Such a graph for all the *Protathyris* assemblages shows that the gradients and constants have an inverse linear relationship, such that the constant decreases as the gradient increases. This relationship can only exist if all the axes on the original length/height graph passed through or close to a common point. Similar relationships also exist if the axes being compared relate length to width or width to height.

Similar graphical studies of the 41 assemblages of *Atrypella* show that 3 main groups of assemblages exist: the groupings being consistent from one graph to another. Each group, which displays the inverse relationship between axis gradient and constant, probably represents a distinct species or subspecies.

The co-ordinates of the intersection point of the growth axes, which can be calculated from the graph relating the gradients and constants of a particular set of growth axes, are taken to be the primary growth indices of the two parameters being considered. These indices differ significantly from one group to another.

This biometrical method is useful since it allows the division of a brachiopod genus into various groups on the basis of the brachiopod's growth characteristics.

1592 JONES, D.L., and FAHRIG, W.F. - 1978  
Paleomagnetism and age of the Aston dykes and Savage Point sills of the Boothia Uplift, Canada; *Can. J. Earth Sci.*, vol. 15, no. 10, pp. 1605-1612.

Oriented samples (107) have been drilled for paleomagnetic studies from diabase sills and dykes on either side of the Boothia Uplift, Canada. Six sites at Savage Point are in sills which intrude the Aston Formation; three, at Whitehead Point, north of Savage Point on the east coast of Prince of Wales Island, are in sills which also intrude these strata. Six sites in the Aston Bay area of Somerset Island are in dykes and a sill which cut the Aston Formation; the former also intrude the Hunting Formation. No meaningful results were obtained from the Whitehead Point samples. Paleomagnetic measurements on the Savage Point samples, together with new K-Ar data, strongly suggest these sills belong to the Mackenzie igneous episode (ca. 1240 Ma). The sill in the Aston Bay area apparently belongs to this episode too, whereas most of the dykes are Franklin dykes (ca. 675 Ma). One large dyke was possibly emplaced in Tertiary times. Thus the Aston Formation is older than 1240 Ma and

the Hunting Formation is bracketed between 1240 and 675 Ma.

1593 KEMPER, E. - 1976  
Biostratigraphy of the Valanginian in Sverdrup Basin, District of Franklin; *Geol. Surv. Can.*, Paper 76-32, 6 p.

A sequence of Valanginian rocks was studied in the part of the depocentre of the Sverdrup Basin, now occupied by Amund Ringnes and Ellef Ringnes islands. The about 500 m thick Valanginian sequence is represented mostly by the upper part of the Deer Bay Formation.

Bed by bed collecting of fossils resulted in an improvement of our knowledge of the succession of ammonite species in the report area. Only high-boreal to arctic species occur in the lower part of the particularly thick (about 300 m) lower Valanginian. The upward faunal sequence is: *Temnoptychites*, *Thorsteinssonoceras*, *Polyptychites* (*Siberiptychites* n. subgenus) ex gr. *stubendorffi*. In the younger lower Valanginian these faunas are replaced by those consisting of true *Polyptychites*. The latter faunas originating in the more temperate regions of the Boreal Realm consist of *P. keyserlingi* fauna below and *P. spheroidalis* fauna at the top. These beds also contain new, very large *Polyptychites* species. The lower part of overlying lower upper Valanginian beds contains a new *Prodichotomites* species which is then replaced by representatives of *Homolsomites*. No ammonites have been found in the topmost beds of Deer Bay Formation which only yielded a late Valanginian *Buchia* fauna.

1594 KERR, J.W. - 1977  
Four mineralization controls established for Arctic's Cornwallis lead-zinc district; *The Northern Miner*, November 24, 1977, pp. B16-B17.

A newly named lead-zinc district in the Canadian High Arctic includes the Polaris orebody. All deposits in the district are carbonate hosted and occur in Paleozoic rocks of the Cornwallis Fold Belt. Four controls on mineralization are indicated. Using these controls may lead the way to future discoveries.

1595 KERR, J.W. - 1977  
Frost and glacially deformed bedrock on Somerset Island, Northwest Territories; in Report of Activities, Part C; *Geol. Surv. Can.*, Paper 77-1C, pp. 75-77.

1496 KINOSITA, S. - 1978  
Joint studies on Physical and Biological Environments in the Permafrost, Alaska and North Canada, July to August, 1977; ed. S. Kinoshita, Inst. Low Temp. Sci., Hokkaido Univ., Japan, 149 p.

1596 KINOSITA, S., FUJINO, K., HORIGUCHI, K., FUKUDA, M., and INOUE, M. - 1978  
Core Samplings of the Uppermost Layer in a Tundra Area; in Joint studies on Physical and



Biological Environments in the Permafrost, Alaska and North Canada, July to August, 1977; ed. S. Kinoshita, Inst. Low Temp. Sci., Hokkaido Univ., Japan, pp. 17-42.

The permafrost expedition in the tundra area of Alaska and North Canada was conducted from July to August 1977 under the financial support of the Japanese Ministry of Education. It had the main purpose of studying the relation of soil water behavior in the uppermost layer to the physical and biological environment in the tundra area. The authors were in charge of geotechnical surveys of the uppermost layer in this expedition. This paper reports the results of core samplings as part of their studies. The results of the other parts are presented in this book individually under the titles: Thermal regime of the uppermost layer in a tundra area in summertime, Acidity of the uppermost layer of permafrost - Its relationship to the thickness of the active layer, Water-permeability inside the uppermost layer of a tundra area, Determination of oxygen isotopic concentration in the ground ice of a tundra area.

Core samples of 5 cm in diameter were collected from the surface to the depth of 100-150 cm in the fields, using a hand driving auger for unfrozen soil and a portable boring machine for frozen soil. Analyses were made of their layer structures, soil types, soil colors and densities. After they were dried in an oven, measurements were made of water contents, densities and size distributions of soil particles contained. When ice cores or ice lumps were obtained, they were sliced to have their crystal structures examined under a polarized light.

1597 KRUPICKA, J. - 1977

Bedrock geology of the Truelove River area; in Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem, ed. L.C. Bliss, Univ. Alberta Press, pp. 63-72.

The Truelove River area on the northeastern coast of Devon Island is underlain by two geological units: 1) the Canadian Shield, and 2) the Arctic Platform. The crystalline rocks of the Shield outcrop in the Lowland, in the steep fault zone of the cliff south of the Truelove River, and in the lower part of the slope of the eastern plateau. The platform sediments build the eastern plateau and the Rocky Point, and form a shallow cover upon the basement rocks of the southern block.

1598 KURFURST, P.J. - 1977

Geotechnical study of rock heave, Central Arctic Canada; in Report of Activities, Part C; Geol. Surv. Can., Paper 77-1C, p. 33.

This project was initiated in spring 1977 as a part of a detailed study of the proposed route of the Polar Gas pipeline. The main objective was to study and to describe the process of rock heave in massive rocks in the central Arctic along the proposed pipeline route and its effect on the pipeline.

1599 LENZ, A.C. - 1978

Llandoveryan and Wenlockian *Cyrtograptus*, and some other Wenlockian graptolites from northern and Arctic Canada; *Géobios*, vol. 11, no. 5, pp. 625-653.

Llandoveryan and Wenlockian graptolite zones in northern and Arctic Canada comprise the *Sakmaricus-Laqueus* Zone of latest Llandoveryan age, *Centrifugus* Zone of earliest Wenlockian age, *Rigidus* Zone of about mid-Wenlockian age, possibly the *Pernerii* Zone of late Wenlockian age, and the *Testis Lundgreni* Zone of very late Wenlockian age.

Species of *Cyrtograptus* described and illustrated in this study are *C. centrifugus*, *C. cf. insectus*, *C. aff. lapworthi*, *C. laqueus*, *C. lundgreni*, *C. sp. (aff. C. lundgreni)*, *C. mancki*, *C. radians*, *C. rigidus*, *C. sakmaricus*, *C. solaris* n. subsp.?, and *C. sp. (similar to C. murchisoni bohemicus)*. Other taxa comprise *Mono-graptus cf. capillaceus*, *M.? aff. deubeli*, *Gothograptus nassa*, *Plectograptus praemacilentus*, *Spinograptus cf. spinosus* and *Retiolites nevadensis*.

1600 LEWKOWICZ, A.G., DAY, T.J., and FRENCH, H.M. - 1978

Observations on sloopwash processes in an Arctic tundra environment, Banks Island, District of Franklin; in Current Research, Part A; Geol. Surv. Can., Paper 78-1A, pp. 516-520.

A reconnaissance study, aimed at an understanding of the hydrologic and geomorphic importance of sloopwash processes in an arctic permafrost region, was undertaken at Thomsen fly camp, north-central Banks Island (73°14'N; 119°32'W), between May 25 and July 28, 1977.

1601 LOEFFLER, E.J., and JONES, B. - 1977

Additional late Silurian ostracoderms from the Leopold Formation of Somerset Island, North West Territories, Canada; *Palaeontology*, vol. 20, part 3, pp. 661-674.

An ostracoderm fauna which includes *Tolypelepis leopoldensis* sp. nov., *Corvaspis* cf. *C. arctica* Loeffler and Dinely, and ? *Kallostrakon* sp. indet. occurs 30 m above the base of the Leopold Formation on Somerset Island in the Canadian Arctic Archipelago. Associated ostracods and conodonts indicate a Late Ludlovian or Pridolian age for the ostracoderm horizon. Although the lithology of the enclosing sediment suggests that it accumulated in intertidal conditions, the ostracoderms were not necessarily inhabitants of such an environment; some post-mortem transportation of the bony plates may have taken place.

1602 MACKAY, J.R. - 1978

Contemporary pingos: a discussion; *Bull. Peryglacjalny*, no. 27, pp. 133-154.

The principal difference between open and closed system pingos is believed to be in the water source and growth site, rather than in the type of ice. There appears to be a continuum from tabular sheets of injection ice, which are, of

course, not pingos, through pingos of intrusive to segregated ice, to flat areas underlain by segregated ice. Thus it is the mound form, rather than ice type, which characterizes a pingo. The growth of open and closed system pingos can be explained by the capillary model which accounts for both the growth of ice and also for pore water expulsion which is associated with closed system pingos. When the capillary model of ice lensing is applied to pingos, the bending resistance of the superincumbent material must be taken into consideration in computing the total uplift resistance.

1603 MACKAY, J.R. - 1978

The surface temperature of an ice-rich melting permafrost exposure, Garry Island, Northwest Territories; *in* Current Research, Part A; Geol. Surv. Can., Paper 78-1A, pp. 521-522.

The purpose of this note is to discuss results of radiometer surface temperature measurements of a thawing headwall developed in ice-rich permafrost as measured on a typical sunny day at Garry Island, Northwest Territories. Although data for only one day are given, other measurements have shown similar results.

1604 MACKAY, J.R. - 1979

An equilibrium model for hummocks (nonsorted circles), Garry Island, Northwest Territories; *in* Current Research, Part A; Geol. Surv. Can., Paper 79-1A, pp. 165-167.

Hummocks (nonsorted circles) are a widely distributed type of patterned ground in the boreal forest of lower Mackenzie Valley and the tundra of the Western Arctic coast. An equilibrium model for hummocks in fine grained soils with high liquid limits is suggested, based upon summer and winter field studies during 1963 to 1978 at Garry Island, Northwest Territories. At the top of a hummock the surface of winter heave and summer subsidence is concave down, whereas at the bottom of the hummock it is concave up. In consequence, an upward cell circulation develops, because movement near the top of the hummock is down and radially outward and movement at the bottom is up and radially inward.

1605 MACKAY, J.R., OSTRICK, J., LEWIS, C.P., and MACKAY, D.K. - 1979

Frost heave at ground temperatures below 0°C, Inuvik, Northwest Territories; *in* Current Research, Part A; Geol. Surv. Can., Paper 79-1A, pp. 403-406.

It is well known from numerous laboratory studies that volume changes can occur in many fine grained soils when temperatures are lowered below 0°C. In 1975 a field program was started at Inuvik, Northwest Territories to determine if volume changes could be measured in the active layer after the entire active layer had cooled to below 0°C and had frozen through to permafrost. The purpose of this report is to show that ground surface heave of at least 2 cm had been measured at Inuvik in the January to May period after the active layer had frozen through to permafrost. The Inuvik results

are of potential importance to the assessment of long-term heave in frozen ground at temperatures below 0°C such as might occur when permafrost aggrades around a cold buried gas pipeline over a period measured in years.

1606 MATTHEWS, Jr., J.V. - 1977

Coleoptera fossils: their potential value for dating and correlation of late Cenozoic sediments; *Can. J. Earth Sci.*, vol. 14, no. 9, pp. 2339-2347.

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

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

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

1607 MCGREGOR, D.C., and NARBONNE, G.M. - 1978

Upper Silurian trilete spores and other microfossils from the Read Bay Formation, Cornwallis Island, Canadian Arctic; *Can. J. Earth Sci.*, vol. 15, pp. 1292-1303.

A diverse palynomorph assemblage of trilete spores, tetrads, acritarchs, chitinozoans, scolecodonts, and fragments of arthropods, ?hydrozoans, ?graptolites, and possibly nematophytalean and vascular plants occurs 20 m above the base of member B of the Read Bay Formation at the type section on eastern Cornwallis Island, District of Franklin. This assemblage, here described briefly, is late Ludlow according to faunas above and below. The palyno-

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morphs, other fossils, and stratigraphic framework indicate that the shales of member B were deposited in a sheltered near-shore marine environment. One new species of trilete spores, *Retusotriletes chartulatus* McGregor, is erected.

1608 McLAREN, P. - 1978

Cruise Report, M.V. Gulf Star; EM&R, internal report, Atlantic Geosci. Centre, Bed. Inst. Oceanography, 15 p.

The M.V. Gulf Star was chartered by Petro-Canada in a joint GSC-Petro-Canada research program. The purpose was to survey the coastal environments of eastern Lancaster Sound and eastern Baffin Island with respect to geomorphology, sedimentology and processes as well as biological habitats.

1609 McLAREN, P., and BARNETT, D.M. - 1978  
Holocene Emergence of the South and East Coasts of Melville Island, Queen Elizabeth Islands, Northwest Territories, Canada; *Arctic*, vol. 31, no. 4, pp. 415-427.

Twenty-five radiocarbon dates from the coast of Melville Island show that there has been up to 100 m of Holocene emergence. This evidence of post-glacial rebound suggests there was significant late-Wisconsin glacier cover on or near the island. The Winter Harbour moraine on the south coast is thought to mark the maximum northward advance of the Laurentide Ice. However, emergence for this area appears to be essentially complete, whereas the northeast coast is still recovering at a rate of approximately 0.35 cm/yr. Ice cover in the region to the northeast must, therefore, have been thicker and/or lasted longer than in the peripheral areas of the Laurentide Ice, lending support to the concept of an Innuitian Ice Sheet, rather than local ice masses over the central Queen Elizabeth Islands. Unfortunately, there is an absence of fresh glacial landforms and stratigraphy that can be attributed to the Innuitian Ice Sheet. We suggest that this ice sheet may have had a thermal regime below the pressure melting point, thus depriving the ice of much of its erosive and depositional capabilities, but with a sufficient mass to account for the observed pattern of emergence.

1610 MIALI, A.D. - 1976

Palaeocurrent and palaeohydrologic analysis of some vertical profiles through a Cretaceous braided stream deposit, Banks Island, Arctic Canada; *Sedimentology*, vol. 23, pp. 459-483.

A study of directional variability has been carried out on five vertical profiles containing a total of approximately 195 superimposed planar crossbed sets. The latter are interpreted as the deposits of braid bars. Detailed measurements on one set revealed within-set variance of 93. Within river tract, between-bar variance was obtained by calculating a ten-point moving average for each profile, and subtracting the actual azimuth at each point from the moving average value. Variance

at this level is 980, which compares closely with data obtained from modern braided streams. Variability in the moving average azimuth is interpreted as the result of meander migration in the entire channel system. Sinuosity can be estimated from this variability, using a geometrical approximation. It ranges from 1.03 to 1.13.

Changes in stream competency with time are indicated by vertical changes in directional variance and set thickness. When accompanied by changes in mean azimuth, as in one of the present five profiles, the data suggest successive deposition by two distinct stream systems.

A Markov chain analysis of the data sequence indicates a weak memory effect. Short sequences of bar deposits were formed by streams which varied little in orientation, and these are separated from one another by sequences showing random directional fluctuation.

The hydrology of the Isachsen rivers was investigated using Schumm's (1968a, b, 1969, 1972) empirical relationships for modern rivers. Owing to inherent uncertainties in these relationships and a wide margin of error in the input data (principally associated with estimates of depth and width of the Isachsen streams), the results have a validity only at the order-of-magnitude level. Individual Isachsen rivers are estimated to have had drainage areas of between 5000 and 30,000 km<sup>2</sup>; this information is of use in reconstructions of palaeogeography and tectonic history.

1611 MIALI, A.D. - 1978

Permian stratigraphy at Piper Pass, Northern Ellesmere Island, District of Franklin; in *Current Research, Part A; Geol. Surv. Can., Paper 78-1A*, pp. 541-544.

1612 MIALI, A.D., KERR, J.W., and GIBLING, M.R. - 1978

The Somerset Island Formation: an upper Silurian to ?Lower Devonian intertidal/supratidal succession, Boothia Uplift region, Arctic Canada; *Can. J. Earth Sci.*, vol. 15, no. 2, pp. 181-189.

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

The regressive sequence reflects a major pulse of the Cornwallis Disturbance of Boothia Uplift. A similar sequence occurs in Prince of Wales



Island, although the lower part of the succession there contains conglomerate and sandstone, rock types that are absent in Somerset Island. These rocks are formally assigned to the Lower Peel Sound Formation but are of similar age to the Somerset Island Formation of the type area.

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

#### 1613 MIALL, A.D. - 1978

Tectonic setting and syndepositional deformation of molasse and other nonmarine-paralic sedimentary basins; *Can. J. Earth Sci.*, vol. 15, no. 10, pp. 1613-1632.

Molasse is a distinctive sedimentary facies consisting of alluvial and shallow marine deposits derived from source areas undergoing rapid uplift and erosion. The characteristic setting of molasse is within or adjacent to fold belts, and most molasse basins can be classified as foreland basin (external) or intermontane (internal) in type. Thick alluvial and shallow marine sequences in cratonic settings (e.g. taphrogenic troughs) have been classified as molasse by some workers, but this is not generally accepted.

Most molasse is synorogenic, and the interdependence of sedimentation and tectonism results in structural and stratigraphic complexity. Intermontane basins generally are tensional in origin and are bounded by high angle (commonly normal) faults. Facies distributions adjacent to each fault depend on relative rates of differential movement, erosion, and sedimentation; accelerated source area uplift causes segmentation and progradation of alluvial fans and generates coarsening-upward sedimentary cycles. Complications are introduced if tectonism occurs in discrete pulses and if basins enlarge themselves along systems of stepped faults.

Basins of compressional origin, such as those in a foreland setting, show a greater variety of internal complexity. Facies belts and trends of maximum thickness move progressively out from the core of the fold belt in response to a migration of the zone of active deformation. Conversely, broad structural warps may develop in response to a locally increased sedimentary load, such as a major delta. Folds or thrust faults growing within the basin cause local thinning or unconformable relationships, and may breach the surface so as to isolate parts of the alluvial plain as a synorogenic intermontane basin. Uplift of the fold belt may be discontinuous, causing the generation of stacked sedimentary megacycles. Basin margins commonly are characterized by intraformational angular unconformities and syndepositional folds.

Rates of alluvial sedimentation and tectonic movement measured in modern environments are

one to two orders of magnitude higher than rates deduced from ancient nonmarine sequences. This lends support to the idea that much sedimentation may be very episodic in nature, but it could also imply that alluvial sequences are deposited much more rapidly than current interpretations of the ancient record would imply, based as they are on relatively crude dating techniques. Only in some wrench-fault basins do calculated sedimentation rates compare with those measured in modern environments.

#### 1614 MIALL, A.D. - 1979

Tertiary fluvial sediments in the Lake Hazen intermontane basin, Ellesmere Island, Arctic Canada; *Geol. Surv. Can.*, Paper 79-9, 25 p.

Tertiary sediments at Lake Hazen have been divided into two units, a lower sandstone-mudstone member, up to 450 m thick, consisting of very fine to very coarse, weakly consolidated sandstone, siltstone, mudstone, with minor coal and conglomerate, and an upper conglomerate member, 450 m thick, comprising cobble and boulder conglomerate with subordinate sandstone. The name Eureka Sound Formation is retained for the entire succession, which is Eocene to ?Oligocene in age. The contact between the members probably is conformable and gradational, and an earlier assignment of the conglomerate member to the Beaufort Formation (Miocene) is now judged to be incorrect.

Sediments of the sandstone-mudstone member were deposited mainly by small, high sinuosity, single channel ('meandering'), mixed load streams, although coarse deposits within the member may reflect temporary establishment of more competent, multiple channel ("braided") bedload streams as a result of minor climatic fluctuations or tectonic pulses. Sand petrography and paleocurrent evidence indicate derivation from lower Paleozoic rocks of Hazen Plateau, south of the basin.

The conglomerate member was formed as a result of thrust movement and uplift along Hazen Fault Zone. Beds of the sandstone-mudstone member grade up into cobble and boulder conglomerates deposited on an alluvial fan zone bordering the fault. Petrographic and paleocurrent evidence indicates a shift in source area and transport direction, the conglomerates being derived from Lower Paleozoic and Carboniferous to Mesozoic sediments and diabase sills of Grantland Uplift, north of Lake Hazen.

Absence of Paleocene strata suggests initiation of basin subsidence as much as 20 Ma later at Lake Hazen than in many other parts of the Arctic Islands. The tentative correlation of the conglomerate beds at Boulder Hills implies that there is now no positive evidence in the report area of the final episode of the Eureka Orogeny, which involved renewed faulting and sedimentation during the Miocene elsewhere in the Arctic Islands.

#### 1615 MORISON, S.R., and TAYLOR, R.B. - 1978

Physical characteristics and seasonal changes in an Arctic estuarine environment; *in* Current

Research, Part B; Geol. Surv. Can., Paper 78-1B, pp. 101-106.

Cunningham Inlet exhibits distinct seasonal changes in water mass, primarily because of variable fluvial discharge resulting from limited source water, i.e. snowmelt. In summer there is a pronounced halocline at a depth of 1 to 3 m, with freshwater flowing over the more dense saline water. Suspended sediment from rivers is the main source of clayey silt covering much of the inlet bottom. Bedrock outcrops along the shallow entrance to the inlet and unconsolidated sediments along the shores are the other major sources of sediment found on the inlet bottom.

1616 MORRIS, W.A., and VINCENT, J-S. - 1979 Magnetostatigraphy of Pleistocene sediments of Banks Island, Northwest Territories: a feasibility study; *in* Current Research, Part B; Geol. Surv. Can., Paper 79-1B, pp. 301-306.

Stratigraphic sections on Banks Island in the Canadian Arctic record successive Quaternary glacial and nonglacial episodes. A feasibility study was undertaken in order to establish if paleomagnetism could be used to improve a chronostratigraphic framework for these episodes. It is demonstrated that the sediments collected fulfil the necessary criteria for the application of paleomagnetism. Even though the study was not aimed at defining magnetostatigraphic time zones, one of the suite of samples revealed upon alternating field cleaning a shallowly, negatively inclined magnetic vector which could relate to a geomagnetic excursion. The samples indicating this possible excursion are from marine sediments belonging to an interglaciation that precedes the Sangamonian interglaciation and therefore is at least older than ca. 225 Ka. If this excursion can be validated during intensive paleomagnetic investigation, it means that a chronostratigraphic marker horizon has been found which possibly could be used for correlation purposes in the Arctic.

1617 NAGEL, G. - 1977 Vergleichende Beobachtungen zur periglazialen Hangabtragung in Spitzbergen und Axel Heiberg Island - N.W.T. Kanada; *Z. Geomorph. N.F.*, Suppl.-Bd. 28, pp. 200-212.

The denudation and erosion on slopes with angles of up to 25° degrees in presently non-glaciated regions in West-Spitzbergen and Axel Heiberg N.W.T. Canada Island is similar but differentiated in the intensity. In general the intensity of slope denudation in Axel Heiberg is less than in West-Spitzbergen. Here the highest intensity is reached in active gullies, whereas on other parts of the slopes only indications of minor denudation are recognizable. In middle and upper parts of the slopes the active layer usually reaches the bedrock. This is not the case in Axel Heiberg Island. Here, the upper part of the permafrost down to 160 cm also consists of transported material. Under the recent climatic conditions in Axel Heiberg only minor or no acti-

vity in slope denudation can be observed.

1618 NARBONNE, G.M. - 1977 Stratigraphic setting of the type specimen of *Carpocrinus arcticus* Frest and Strimple from the Late Silurian of Somerset Island, Arctic Canada; *Can. J. Earth Sci.*, vol. 14, p. 2168

The type specimen of *Carpocrinus arcticus* Frest and Strimple was collected approximately 65 m below the upper boundary of the Read Bay Formation (Member A) at Fury Point, Somerset Island. Associated brachiopods, trilobites, and bryozoans suggest a Ludlovian age for this specimen.

1619 NEAVE, K.G., JUDGE, A.S., HUNTER, J.A., and MacAULAY, H.A. - 1978 Offshore permafrost distribution in the Beaufort Sea as determined from temperature and seismic observations; *in* Current Research, Part C; Geol. Surv. Can., Paper 78-1C, pp. 13-18.

Ice-bonded sediments are found over much of the Beaufort Sea continental shelf but are absent from most parts of Mackenzie Bay. They reflect Pleistocene climatic conditions which resulted in the growth of permafrost to depths of 600 m or more. The study made use of oil industry reflection records to determine the distribution of these sediments.

1620 PACKARD, J.J., and DIXON, O.A. - 1979 Upper Silurian carbonate buildups from the east coast of Cornwallis Island, Arctic Canada; *Abstract of paper presented MAC Mtg.*, Quebec, May 23-25, 1979, 71 p.

Three general types of stratigraphic reefs occur within Member C of the Read Bay Formation, a 1300m thick shallowing upward sequence of Ludlovian to late Pridolian shelf-edge carbonates: 1) Irregular lenticular bodies up to 3m thick contain halysitid corals and crinozoan holdfasts as sediment baffles (~30) in a lime mudstone matrix (~70). These buildups rest on crinoidal packstones and are enclosed by thinly-bedded, poorly fossiliferous mudstones; 2) Dormal to bulbous buildups 5-40m thick contain a framework of hemispherical and lamellar stromatoporoids and tabulate corals (40-75%) in a matrix varying from calcirudite packstone to dolomitized crinoidal grainstone. Severe dolomitization has obscured internal structures and any faunal zonation that may have been present; and 3) Laterally extensive, undifferentiated buildups up to 60m thick are composed mainly of lime mudstone with minor skeletal debris (<30) and with no consistent development of framework components. Associated fore-reef breccias, crinoidal flank beds, interstratal deformation structures and considerable draping of flank beds suggest that these buildups had original topographic relief, grew above wave base and may be considered true ecologic reefs.

1621 PELLETIER, B.R. - 1977 Bottom samples as taken by the hydrographer and the geologist; *International Hydrographic Review*,

Monaco, LIV 2, pp. 103-124.

Bottom-sampling is the subject of this paper. It is prepared for the hydrographer unfamiliar with sedimentological principles. Some background on sedimentary sizes, principles of sedimentation, terminology and laboratory practices is given. Illustrative material has been selected to demonstrate and illuminate these concepts, and arguments and case histories are presented throughout the text as additional support for the recommendations.

1622 PERRY, D.G. - 1978

A new fossil occurrence from the Vendom Fiord Formation (type area), Ellesmere Island; *Can. J. Earth Sci.*, vol. 15, no. 10, pp. 1675-1679.

Probable reworked Lochkovian (early Early Devonian) brachiopods and conodonts were recovered from the basal clastic beds of the Vendom Fiord Formation in the type area on central Ellesmere Island. Although most of the fossils are reworked from underlying strata, none appear to be younger than Lochkovian. Data obtained by other workers from more northerly exposures of the Vendom Fiord Formation show that the lower part of the formation is no older than late Pragian (middle Early Devonian). Elsewhere, the North American Early Devonian eustatic sea-level minimum occurs in the Pragian and is followed by transgressive deposits of late Early Devonian age of which the Vendom Fiord Formation possibly represents the basal transgressive unit in the Arctic Archipelago.

1623 PISSART, A. - 1975

Glace de segregation, soulèvement du sol et phénomènes thermokarstiques dans les régions a pergélisol; *Bull. de la Société géographique de Liege*, no. 11, pp. 89-96.

Une fente de gel observée sur l'île de Banks (Arctique canadien) montre que des lentilles de glace de ségrégation peuvent apparaître à la partie supérieure du pergélisol lorsque se produit en surface une accumulation éolienne. Une faible élévation du niveau du pergélisol peut entraîner l'apparition de masses importantes de glace de ségrégation. Ce phénomène est inverse mais comparable à celui qui, par un léger abaissement de la surface du pergélisol, provoque l'apparition d'affaissements thermokarstiques.

1624 PISSART, A. - 1976

Sols à buttes, cercles non triés et sols striés non triés de l'île de Banks (Canada, NWT); *Bull. Peryglacjalny*, no. 26, pp. 275-285.

Frost hummocks, unsorted circles and unsorted soil stripes have been studied on Banks Island. Sections cut through these features show direction of mass movement which produced them. Genetic hypotheses are suggested for their formation. It is hoped that the description will help in the recognition of these structures in fossil periglacial context.

1625 PISSART, A., VINCENT, J-S, and EDLUND, S.A. - 1977

Dépôts et phénomènes éoliens sur l'île de Banks, Territoires du Nord-Ouest, Canada; *Can. J. Earth Sci.*, vol. 14, no. 11, pp. 2462-2480.

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

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

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

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

1626 PISSART, A., and FRENCH, H.M. - 1977

The origin of pingos in regions of thick permafrost, Western Canadian Arctic; *Quaestiones Geographicae*, vol. 4, pp. 149-160.

The presence of pingos in regions of thick and continuous permafrost is often explained by the freezing of a talik previously developed beneath a standing water body, usually a lake. These pingos are generally referred to as "MacKenzie Delta" or closed system type pingos. A number of pingos studied in the islands of the Western Canadian Arctic indicate that the conditions for favourable closed system pingo growth are much more varied. For example, pingos situated on low terraces of the Thomsen River in north central Banks Island (73°N) probably developed following the lateral migration of the river and the freezing of a talik which had formed beneath the channel. Two near parallel pingo-like ridges developed on the lower part of the gentler slope of an asymmetrical valley in southern Banks Island (71°N) are thought also to have formed by the freezing of sub-channel taliks at times when the stream migrated laterally to produce the valley asymmetry. On



Prince Patrick Island, elongated pingos located near the coast at Satellite Bay (77°N), formed following fluctuations of sea level and the inundation of river valleys. Other pingos, located in the central parts of Prince Patrick Island (76°N), appear related to the presence of deep faults in the underlying bedrock at a time when permafrost was aggrading. Those pingos thought related to the evolution of streams often exhibit an elongate, ridge-like form.

1627 POULTON, T.P. - 1978

Internal correlations and thickness trends, Jurassic Bug Creek Formation, Northwestern Yukon and adjacent Northwest Territories; *in* Current Research, Part B, Geol. Surv. Can., Paper 78-1B, pp. 27-30.

The Jurassic Bug Creek Formation and equivalent parts of the Kingak Formation to the northwest, considered together, form a clastic package that thickens more or less regularly, and becomes more argillaceous, northwestward from the contemporaneous Aklavik Arch. A small uplift was present in the vicinity of White Mountains in Early or early Middle Jurassic time. It was overstepped by Middle Jurassic sandstones, which also transgressed southward beyond the limits of Lower Jurassic sediments. Except for the basal sandstone member which occurs only locally, the five members of the Bug Creek Formation at its type section, together with two others not present there, can be recognized throughout most of the northern Richardson Mountains.

1628 POULTON, T.P. - 1978

Correlation of the Jurassic Bug Creek Formation in the subsurface of the Mackenzie Delta, District of Mackenzie; *in* Current Research, Part C, Geol. Surv. Can., Paper 78-1C, pp. 39-42.

The Jurassic Bug Creek Formation in the subsurface of Mackenzie Delta between 68°N and 68°30'N exhibits the same northwestward-thickening trend observed in the northern Richardson Mountains immediately to the west. The same members are present, the same southeastward loss of section below an unconformity within the formation and the same increased amount of sandstone relative to argillaceous rocks. Correlation of lower parts of the formation north of 68°30'N is tenuous. This is due in part to an apparent change of facies of a glauconitic sandstone unit that serves as an important marker in the southern wells. Subsurface thinning of the entire formation approaching 69°N does not have equivalent expression at the surface because exposures do not extend that far north.

1629 POULTON, T.P. - 1978

Pre-Late Oxfordian Jurassic biostratigraphy of Northern Yukon and adjacent Northwest Territories; *in* Western and Arctic Can. Biostratigraphy, eds. C.R. Stelck and B.D.E. Chatterton, Geol. Assoc. Can. Special Paper 18, pp. 445-471.

The pre-Upper Oxfordian Jurassic rocks of northern Yukon and adjacent Northwest Territories are a natural biostratigraphic package, overlying Triassic and older rocks with regional unconformity and underlying rocks that characteristically contain species of the bivalve *Buchia*. Every stage of the Lower and Middle Jurassic Epochs, as well as the Lower Oxfordian Substage, is present in marine facies containing ammonites. The Lower Jurassic ammonites have cosmopolitan affinities and permit ready correlation with the zones of northwestern Europe. Middle Jurassic ammonite faunas are dominated by boreal forms which are closely similar in morphology and zonal succession with those of east Greenland. Certain other fossils, particularly certain bivalve genera such as *Inoceramus* and belemnites also permit interprovincial correlation.

The Bug Creek Formation represents the Lower and Middle Jurassic Epochs in northwesternmost Northwest Territories and northeastern Yukon. It is dominantly sandstone and shale. The basal part of the overlying Husky Formation in the same area is Early Oxfordian in age. The argillaceous succession in north-central and northwestern Yukon is referred to the Kingak Formation. Hettangian through Early Oxfordian ammonite faunas have been found within it, below *Buchia* faunas.

1630 RAHMANI, R.A., and TAN, J.T. - 1978

The type section of the Lower Jurassic Borden Island Formation, Borden Island, Arctic Archipelago, Canada; *in* Current Research, Part A; Geol. Surv. Can., Paper 78-1A, pp. 538-540.

1631 REINSON, G.E. - 1978

Carbonate-evaporite cycles in the Silurian rocks of Somerset Island, Arctic Canada; *Geol. Surv. Can.*, Paper 76-10, 13 p.

The east coast of Somerset Island is characterized by spectacular cliffs, as much as 365 m high, consisting of Silurian strata which are nearly horizontal or dip westerly at a low angle. A cyclic sequence of carbonate-evaporite rocks forms the lower exposures, but the upper two thirds of the cliff are composed primarily of carbonate rocks. The upper carbonate succession has been studied in detail and designated as the Leopold Formation. The lower cyclic carbonate-evaporite sequence is described in this paper.

The carbonate-evaporite sequence is considered to be Wenlockian in age, and correlative with the upper Cape Crauford Formation on northwestern Baffin Island and the lower Cape Storm Formation on Devon Island. It crops out only in the vertical cliffs of northeastern Somerset Island and, thus, cannot be mapped on a regional scale. This cyclic carbonate-evaporite succession has a maximum exposure of 125 m in the coastal cliffs 18 km south of Elwyn Bay, and it is there that a detailed section was measured. The lower boundary of the sequence lies below sea level, and the upper boundary was placed at the top of the last continuous evaporite bed, which marks the base of the Leopold Formation.

Twenty-three carbonate-evaporite cycles were recognized in the measured section. Each cycle is considered to represent deposition during progradation of a lagoonal-sabkha shoreline. Three lithofacies make up the complete cycles; subtidal, intertidal, and supratidal. Three rock types constitute the subtidal or lagoonal lithofacies; pelletal wackestone, finely laminated mudstone, and massive to laminated mudstone. Rocks interpreted to be algal stromatolites constitute the intertidal lithofacies. Two stromatolite forms are recognized - digitate stromatolites and cryptogalaminite. The supratidal lithofacies is characterized by birds-eye laminated mudstone, interlaminated gypsum and carbonate mudstone, and by bedded gypsum deposits.

Not all the cycles contain all three lithofacies; in some, the subtidal lithofacies is absent, and in others the supratidal lithofacies is absent. The middle of the measured section commonly contains subtidal-intertidal cycles, whereas in the upper and lower parts, intertidal-supratidal cycles are prevalent. Where the lagoonal or subtidal facies of the cycles is absent, the carbonate is dolomite but, where subtidal rocks are present in the cycles, calcitic carbonate prevails. This dolomite distribution is consistent with that observed in the modern sabkha of the Trucial Coast, Persian Gulf, in that the dolomitization occurs as a diagenetic front which progresses seaward in the prograding supratidal zone.

The Silurian stratigraphic succession of north-eastern Somerset Island, from the basal carbonate-evaporite sequence, through the Leopold Formation to the overlying Read Bay Formation, records a sequence of deposition in a shoreline-shelf environment that was subsiding continually. During the evaporite depositional phase, conditions were restricted and hypersaline; these conditions changed gradually to a shallow, more open marine environment during deposition of the subtidal fossiliferous carbonates of the Read Bay Formation.

1632 RIGBY, J.K., and LENZ, A.C. - 1978  
A new Silurian Astylospongid sponge from Baillie-Hamilton Island, Canadian Arctic Archipelago; *Can. J. Earth Sci.*, vol. 15, no. 1, pp. 157-162.

The new sponge, *Astylospongiella megale*, is described from rocks of the Ludlovian *Neodiversograptus nilssoni* Zone of the Cape Phillips Formation from southern Baillie-Hamilton Island, Arctic Canada. The genus is included in Astylospongiidae because its skeletal net is composed of sphaeroclones, which in this species, are of relatively uniform size throughout the sponge. The new sponge also has irregularly placed radiating canals which are subparallel to the upper surface, and which are cross-connected by upward fanning canals that are approximately normal to the sponge surface and the radiating canals.

1633 RIGBY, J.K., and DIXON, O.A. - 1979  
Sponge fauna of the Upper Silurian Read Bay Formation, Somerset Island, District of Franklin, Arctic Canada; *J. Paleontology*, vol. 53, no. 3, pp. 587-627.

An unusually diverse and well preserved sponge fauna occurs in the Upper Silurian Read Bay Formation on Somerset Island in the Canadian Arctic. New demosponges described and figured include: *Haplistion cylindricum* n. sp., *H. minutum* n. sp., *H. creswelli* n. sp., *Eochaunactis radiata* n. gen., n. sp., *Haplistionella garnieri* n. gen., n. sp., *H. minittraba* n. sp., *Somersetella conicula* n. gen., n. sp., *S. digitata* n. sp., *Finksella turbinata* n. gen., n. sp. *Eochaunactis* and *Haplistionella* are included with *Saccospongia* Ulrich, 1889, in the new family, Saccospongiidae. In addition a coarsely silicified *Hindia* (?) sp. occurs in the collection. The brachiospongioid *Peliaspongia perforata* n. sp. is the single hexactinellid species in the collection. Calcareous heteractinid sponges are represented in the collection only by a single polyactine and three octactine spicules. The sponge fauna occurs in bioherms and in the intermound beds of the formation.

1634 TAN, J.T., and HILLS, L.V. - 1978  
Oxfordian-Kimmeridgian dinoflagellate assemblage, Ringnes Formation, Arctic Canada; in *Current Research, Part C, Geol. Surv. Can.*, Paper 78-1C, pp. 63-73.

Dinoflagellates can be utilized to distinguish the Ringnes Formation from underlying and overlying formations in the Sverdrup Basin and to correlate it with its equivalents in the subsurface. *Psaligonyaulax dualis*, *Horologinella spinosigibberosa*, *Pareodinia borealis*, *Sirmiodinium grossii*, *Lanterna saturnalis* and *Pareodinia capillosa* are characteristic of the Ringnes Formation and are indicative of a late Oxfordian to Kimmeridgian age. The latter two species occur only in the upper part of the formation and extend into the overlying formation.

1635 TARNOCAI, C., and ZOLTAI, S.C. - 1978  
Earth hummocks of the Canadian Arctic and Sub-Arctic; *Arctic and Alpine Res.*, vol. 10, no.3, pp. 581-594.

Studies in the western Arctic and Subarctic and in the central Arctic indicate that earth hummocks have an average diameter of 80 to 160 cm and an average height of 40 to 60 cm. They have developed on materials having 58 to 99% total clay and silt content and either high ice content or pure ice layers in the near-surface permafrost. Earth hummocks are cryogenic in origin with their development being controlled by three major factors: soil texture, soil moisture, and soil temperature. Most of the earth hummocks have developed during the last 5000 yr, when the climate became colder.

1636 TAYLOR, R.B. - 1977  
Floating Ice - Grounded ice ridges, Somerset Island, N.W.T.; *Ice*, no. 53, p. 8.

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1637 TAYLOR, R.B. - 1977

Ground Ice and Permafrost - Seasonal ground temperatures across a beach, Somerset Island, N.W.T.; *Ice*, no. 53, p. 10.

1638 TAYLOR, R.B. - 1978

Beach changes, northern Somerset Island; in Proc. 4th Intern. Conf. on Port and Ocean Engineering under Arctic Conditions (POAC), Memorial Univ., Nfld., pp. 904-914.

Quantitative studies of shoreline change are severely lacking along coasts of the Canadian Arctic Islands. Beach processes and the effects of storms on beaches of Radstock Bay, Devon Island, have been discussed by McCann (1972) but shoreline changes have not been monitored elsewhere along Barrow Strait. It is generally acknowledged that arctic beaches are low energy wave environments, but with the possible construction of pipelines and marine facilities across the coastal zone, knowledge of sediment transport rates and the magnitude of beach changes becomes important.

Investigations of coastal morphology and processes were begun along northern Somerset Island in 1972 and were continued until 1976. Observations in 1972 and 1973 were restricted to 'Staples' beach, but in 1974, several beaches, representative of the coastline from Aston Bay to Garnier Bay, were selected for detailed study. Beach changes at three of these beaches - 'Staples', 'Rennell' and 'Cunningham' - are presented in this paper. Surveys at varying frequencies at each of the beaches illustrate changes experienced over the short term, e.g., a storm, and over the longer term of three to five years. Effects on the beach of higher energy waves from different directions are examined together with the volumetric changes in beach sediment.

1639 TAYLOR, R.B. - 1978

The Occurrence of Grounded Ice Ridges and Shore Ice Piling Along The Northern Coast Of Somerset Island, N.W.T.; *Arctic*, vol. 31, no. 2, pp. 133-149.

Massive shore ice piles and grounded ice ridges up to 30 m high were examined along the northern coast of Somerset Island between 1973 and 1976. The ice ridges, composed of 1 to 2 m thick ice blocks and occasionally thicker multi-year ice blocks, occurred most frequently along the north and west shores of capes and headlands. 'Cape Fisher' was the site of shore ice piling during each of the four years and one set of ice piles, built 15-60 m inland existed three years. Effects of grounded ice ridges on nearshore morphology were minimal but ice-push features were observed as much as 185 m inland across the beach.

1640 THOMAS, R.D., and DYKE, A.S. - 1977

Ground Ice and Permafrost - Ground ice in north-central Keewatin, N.W.T.; *Ice*, no. 53, p. 10.

1641 THOMAS, R.D., DYKE, A.S., and EDLUND, S.A. - 1979

Surficial geology and geomorphology, north-central Keewatin, N.W.T. (Part II); *Geol. Surv. Can.*, Open File 642.

Preliminary drafts of four surficial geology maps at a scale of 1:125 000 show the distribution of surficial materials and landforms. Each map is accompanied by a legend indicating the material, genesis and morphology of the units. The map units are based on the genesis of the materials with stratigraphic relationships being shown. The material is based on airphoto interpretation and field work in 1976 and 1977.

An extended legend gives information concerning the genesis, texture, permafrost conditions, drainage, distribution, and vegetation cover and composition of each surficial unit.

1642 TIPNIS, R.S. - 1978

Early Middle Ordovician conodonts of North Atlantic Province from northeastern Ellesmere Island, Arctic Canada; in Current Research, Part C, *Geol. Surv. Can.*, Paper 78-1C, pp. 75-78.

An early Middle Ordovician North Atlantic conodont fauna from the Franklinian Miogeocline includes the first record of *Pygodus* from Arctic Canada. The finding is consistent with the previously noted restriction of conodonts of the North Atlantic faunal Province to strata marginal to the North American craton.

1643 TRETIN, H.P., BARNES, C.R., KERR, J.W., NORFORD, B.S., PEDDER, A.E.H., RIVA, J., TIPNIS, R.S., and UYENO, T.T. - 1979

Progress in Lower Paleozoic stratigraphy, northern Ellesmere Island, District of Franklin; in Current Research, Part B, *Geol. Surv. Can.*, Paper 79-1B, pp. 269-279.

Three major depositional phases have previously been distinguished in the Hazen Plateau and southern Grantland Mountains region of northern Ellesmere Island: a phase of nonmarine to shallow marine clastic deposition (Grant Land Formation) and the starved basin and flysch phases of the deep but ensialic Hazen Trough. New fossil identifications indicate that the Grant Land-Hazen contact is middle to late Early Cambrian at Ella Bay, Archer Fiord, but no older than Late Cambrian east of the head of Tanquary Fiord. Most of the Grant Land Formation now appears to be Early Cambrian in age and correlative with the clastic Ellesmere Group of central Ellesmere Island. The Grant Land Formation probably was derived from the ancient Pearya Mountains to the north, and the Ellesmere Group both from the Pearya Mountains and the Canadian Shield. The Hazen-Imina contact is close to the Ordovician-Silurian boundary at some localities and of different Llandoveryan ages at others. A thick volcanic unit at Yelverton Inlet, separated from the underlying Grant Land Formation by a tongue of the lower Hazen Formation, extends in age upward to the early or middle Llandoveryan. It is overlain by three shallow marine, predominantly sedimentary units the middle of which contains conodonts and corals of middle to late Llandoveryan



age. The sediments are overlain by the Imina Formation, here divided into three members with a combined age range from late Llandoveryan(?) to early Ludlovian. A comparable volcanic-sedimentary succession had earlier been reported from the McClinton Inlet region, but the top of the volcanic unit there is early Ashgillian in age and that of the shallow marine sedimentary unit middle or late Ashgillian. The stratigraphic framework of that area has been extended downward into the early(?) Ordovician, but fossils of pre-late middle Ordovician age are lacking. New fossil finds indicate that on Judge Daly Promontory the Imina Formation overlies not the Cornwallis Group but a limestone of Ashgillian age correlative with the lower Allen Bay Formation.

1644 VEIZER, J., LEMIEUX, J., JONES, B., GIBLING, M.R., and SAVELLE, J. - 1978 Paleosalinity and dolomitization of a Lower Paleozoic carbonate sequence, Somerset and Prince of Wales Islands, Arctic Canada; *Can. J. Earth Sci.*, vol. 15, no. 9, pp. 1448-1461.

Trace element study of Lower Paleozoic carbonate formations on Somerset and Prince of Wales Islands (Arctic Canada) suggests the following interpretation: (1) Na contents of the formations studied reflect the paleosalinities of their depositional and (or) early diagenetic environments; (2) K is not suitable as a paleosalinity indicator; (3) the post-Allen Bay limestones studied were probably originally (bio)chemical aragonitic muds associated with environments having hypersaline tendencies; (4) Sr distribution of penecontemporaneous - early diagenetic dolostones (Cape Storm, Somerset Island, Peel Sound Formations) suggests that they are replacements of aragonitic muds, frequently in hypersaline settings; (5) the late diagenetic dolostones (Lang River and Allen Bay Formations) are probably hyposaline replacements of CaCO<sub>3</sub> precursors deficient in high-Sr aragonite; aragonite may have undergone diagenetic transformation into calcite prior to dolomitization.

1506 VINCENT, J-S., and EDLUND, S.A. - 1978 Surficial geology of Banks Island, District of Franklin, N.W.T., *Geol. Surv. Can.*, Open File No. 577.

1507 VINCENT, J-S, and EDLUND, S.A. - 1978 Extended legend to accompany preliminary surficial geology maps of Banks Island; *Geol. Surv. Can.*, Open File No. 577.

1645 VINCENT, J-S - 1978 Lithostratigraphy of the quaternary sediments east of Jesse Bay, Banks Island, District of Franklin; *in Current Research, Part A, Geol. Surv. Can.*, Paper 78-1A, pp. 189-193.

The detailed study of sediments in coastal sections east of Jesse Bay on Banks Island has revealed the existence of three or possibly four separate glacial events. Associated with each of these events, both before and after

ice advance, are sequences of marine and terrestrial bone, peat, shell, and wood bearing sediments. The lithostratigraphic correlation of the sequences is presented and a brief description of the units is given.

1646 VINCENT, J-S - 1978 Limits of ice advance, Glacial lakes, and marine transgressions on Banks Island, District of Franklin: a preliminary interpretation; *in Current Research, Part C, Geol. Surv. Can.*, Paper 78-1C, pp. 53-62.

Three glaciations with associated marine and glaciolacustrine phases on Banks Island are recognized for the first time. The oldest (Banks Glaciation) affected all but the northwest part of the island; glacial lakes Egina and Storkerson were formed during deglaciation. Ice of the Thomsen Glaciation of pre-Sangamonian age covered the south and east and flowed down Thomsen River valley. Associated with it are glacial lakes Parker and Dissection in the northeast and a marine transgression, the Big Sea, which followed the ice during deglaciation and inundated much of western, central, and eastern Banks Island. The youngest, or Amundsen Glaciation, of probable Early or Middle Wisconsinian age involved two icelobes that impinged on the east and southwest coasts creating glacial lakes Raddi, Masik, Rufus, de Salis, Cardwell, and Sarfarssuk at their limit. Ice of the Viscount Melville Glaciation, possibly equivalent to the Amundsen Glaciation and probably also of Wisconsinian age, impinged on the north coast and created glacial lakes Ballast and Ivitaruk. The East Coast Submergence, which inundated the east coast up to 120 m, may be equivalent to the Meek Point Sea that covered the west up to 20 m; both possibly relate to Early or Middle Wisconsinian deglaciation. The Schuyter Point Sea of Late Wisconsinian - Holocene age drowned the east coast up to 25 m and is possibly a transgression that occurred in an icefree area. Sand Hills Readvance in Thesiger Bay and Russell Readvance on the northeast coast are possibly late readvances of Amundsen and Viscount Melville ice, respectively.

1647 WALKER, B.D., and PETERS, T.W. - 1977 Soils of Truelove Lowland and Plateau; *in Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem*; ed. L.C. Bliss, Univ. Alberta Press, pp. 31-62.

Much information concerning the soils of Soviet and North American Arctic regions have been collected since 1950. So-called genetic soil types (Great Soil Groups) have been recognized and qualitative pedogenic processes contemplated. Pedologists now discuss genetic soil types and pedogenic gradients in terms of biogeographic or pedogenic zones that have been imposed upon the Arctic.

Yet until recently pedologists have not constructed relatively detailed soil maps, partly because of landscape phenomena produced by frost disturbance and manifest in the disruption of soil profiles and horizons. Terrain systematic approaches to mapping of soils have

resulted in the use of extremely complex map units or generalized map units where groups of patterned ground types were recognized in delineating terrain (map) units but not in classifying the soils. Holowaychuk et al. were probably the first pedologists to recognize the single taxonomic class or pedon concept (Soil Survey Staff 1960) as applied to mapping of soils in patterned ground.

The prime objective of this paper is to depict local distribution of soils within Truelove Lowland. Mapping problems, alluded to above, were overcome through: (1) recognition of frost disturbance as a pedogenic factor; (2) adherence to the pedon concept (Soil Survey Staff 1960) as specified for northern soils (Canada Soil Survey Committee 1973); and (3) use of a tentative classification system for northern soils - the Cryosolic Order (C.S.S.C. 1973). Consequently mapping difficulties have been reduced to dependence upon complexities in parent material types and vegetation and drainage patterns. Such is the case on the Truelove Lowland sector of the study area.

Soil map units relate, via legend format, soil subgroup classes (C.S.S.C. 1973) with parent materials, drainage patterns, periglacial features, and plant community types. It is hoped that the mapped distribution of these units (based on soil series or complexes) will provide a land base interpretation or extrapolation of other ecological data gathered within the framework of the Devon Island I.B.P. program.

1648 WEST, R.M., and DAWSON, M.R. - 1977  
Mammals from the Palaeogene of the Eureka Sound Formation: Ellesmere Island, Arctic Canada; *Géobios*, Mem. special 1, pp. 107-124.

The Eureka Sound Formation on Ellesmere Island, Canadian High Arctic at about 79° north latitude, has yielded mammalian assemblages of early to middle Eocene aspect. Preliminary examination has shown the presence of the orders *Proteutheria*, *Dermoptera*, *Primates*, *Rodentia*, *Pantodonta*, carnivores, and *Perissodactyla*. Associated with these mammals are a variety of lower vertebrates, including numerous fish, salamander, alligator, several kinds of turtle, lizard, snake, and several kinds of birds. The assemblages provide the first paleontological evidence of high latitude Paleogene terrestrial faunas in the Holarctic, and raise new questions about Arctic environment during the Eocene.

1649 WILSON, M.V.H. - 1978  
Upper Cretaceous marine Teleostei from the basal Kanguk Formation, Banks Island, Northwest Territories; *Can. J. Earth Sci.*, vol. 15, no. 11, pp. 1799-1807.

A marine teleostean assemblage, from within 2 m of the base of the Upper Cretaceous Kanguk Formation on Banks Island, is dominated by scales of *Osmeroides? transversus* and *Ichthyodectes otenodon*, as well as bones of a primitive teleost tentatively referred to the salmoniforms. The fish indicate a shallow, calm

paleoenvironment. Possible mechanisms of deposition include aerobic flotation decay, scale loss by living fish, and deposition of carnivore feces. The assemblage indicates a Cenomanian or Turonian age for the basal Kanguk, with an Early Turonian age preferred by correlation with the late Early Turonian fishes of Lac des Bois, Northwest Territories.

1650 YOUNG, F.G. - 1977

The mid-Cretaceous flysch and phosphatic ironstone sequence, northern Richardson Mountains, Yukon Territory; in Report of Activities, Part C; *Geol. Surv. Can.*, Paper 77-1C, pp. 67-74.

Upper Lower Cretaceous (Aptian and Albian Stages) and possibly lowest Upper Cretaceous (Cenomanian Stage) rocks in northern Yukon Territory comprise a very thick flysch sequence which thins rapidly eastward and changes facies to bedded ironstone and shale in northwestern District of Mackenzie. Field studies of these rocks by the writer have been carried out sporadically for the last eight field seasons, and have been concentrated in the northern Richardson Mountains. Sufficient data have been gathered to define stratigraphic units in this sequence and to construct a sedimentological model. This paper summarizes knowledge of the stratigraphy and sedimentology of the sequence to date.

1651 YOUNG, G.M. - 1977

Stratigraphic correlation of upper Proterozoic rocks of northwestern Canada; *Can. J. Earth Sci.*, vol. 14, no. 8, pp. 1771-1787.

In the northwestern part of the Canadian Shield upper Proterozoic rocks of Banks Island, Brock Inlier, Coppermine area (Rae Group), Minto Arch of Victoria Island, and some small inliers have all been considered as parts of the Amundsen Basin. Formational correlation among these areas has been hindered because different stratigraphic subdivisions have been used by geologists working in different regions and because no individual has previously studied the rocks of the basin as a whole. In general, the Proterozoic rocks of the mainland coastal region have been more finely subdivided than those of Victoria Island. Most of the upper Proterozoic rocks of the mainland regions and all of those at the southern tip of Banks Island are considered to be correlative with the Glenelg Formation of Victoria Island. The Glenelg Formation is divisible into at least four widespread mappable units, each of which has diagnostic rock types, sedimentary structures, and in some cases, stromatolites corresponding closely to those of the mainland areas.

The stratigraphic succession in the Shaler Group of the Minto Arch area is remarkably similar to that of the sub-Rapitan Proterozoic sequence of the Mackenzie Mountain region about 500 km to the southwest. Approximate time equivalence is proposed. If this correlation is correct then the 'older' Proterozoic sequence in the northern Cordillera is between 1200 Ma and 700 Ma in age and is therefore Neohelikian or Hadrynian in age (or both). Other corollaries of the proposed correlation are that the

Rapitan and younger Proterozoic rocks of the Cordilleran region are not represented in the northwestern part of the Canadian Shield and that the older Proterozoic rocks of the Mackenzie Mountains region are probably younger than at least part of the Belt-Purcell sequence of the Canada-U.S.A. border region.

New paleocurrent measurements from sandstones in the western part of the Brock Inlier indicate that dominant sediment transport was to the north-northwest. Limited data from the older Proterozoic sequence in the northern part of the Canadian Cordillera suggest transport to the west. These data are consistent with the existence of a weak positive area to the south and east of the two depocentres with possible continuity of a shallow marine shelf sea around its northern margin.

1652 YOUNG, G.M., and LONG, D.G.F. - 1977 A tide-influenced delta complex in the upper Proterozoic Shaler Group, Victoria Island, Canada; *Can. J. Earth Sci.*, vol. 14, no. 10, pp. 2246-2261.

The Reynolds Point Formation is the second formation of the Shaler Group of Victoria Island. It has a maximum known thickness of about 1100 m. It comprises four members as follows: basal terrigenous clastics, a thick carbonate-dominated unit, a second terrigenous clastic member, and a mixed carbonate-clastic sequence. The lower clastic member is the subject of this report. Its greatest known thickness is about 215 m. The basal part consists of dark green and purple shaly mudstones, interpreted as prodelta and distal delta slope deposits. These fine grained sediments were spread out westward across an extensive, strongly current-influenced shelf sea that contained abundant stromatolites. These stromatolites comprise the orange-weathering stromatolitic biostrome of the topmost unit of the underlying Glenelg Formation. The abrupt contact between the two formations and the strongly contrasted nature of the rock types involved suggest that the platform underwent rapid subsidence. Sandstones, siltstones, and minor mudstones of the overlying (main) part of the lower clastic member are interpreted as platform deposits of a prograding marine delta complex. These include deposits of tidal channels and associated tidal flats, commonly forming fining-upward sequences, beach deposits, and mudstones and siltstones that may be lagoonal or intertributary bay deposits. These fine grained rocks contain casts of salt crystals. Subsidence of the delta platform is recorded by the overlying suite of deeper water grey shales and shaly carbonates that constitute the lower part of the carbonate member of the Reynolds Point Formation. Gradual filling and shallowing is indicated by upward transition from shaly beds to a thick, current-influenced stromatolitic biostrome. This pattern of pulsatory subsidence, followed by gradual sedimentary filling is shown by both the basal clastic member and the overlying beds.

1653 YOUNG, G.M., and LONG, D.G.F. - 1977 Carbonate sedimentation in a Late Precambrian shelf sea, Victoria Island, Canadian Arctic Archipelago; *J. Sedimentary Petrology*, vol. 47, no. 3, pp. 943-955.

The Reynolds Point Formation is the second lowest unit in the Late Precambrian Shaler Group of Victoria Island in the western part of the Canadian Arctic Archipelago. It has a maximum known thickness of about 1,100 m. The formation may be divided into four members. The lowest member is made up of shale followed by a sandstone-dominated sequence. The overlying lower carbonate member is thicker than the others. It is overlain by a second terrigenous sandstone unit (mainly tidalites) that is succeeded by the topmost, carbonate-dominated member. The lower carbonate member may be considered as three units. Unit 1 (the lowest) is about 100 m of fine-grained shaly carbonate with sole, and ball and pillow structures, together with some thick and extensive stromatolitic banks. Unit 1 is interpreted as representing minor subsidence of the depositional basin, followed by gradual infilling and stabilization. Unit 2 is about 100 m of shaly nodular dolostone and limestone that was probably deposited below wave base in a lagoonal system protected by a barrier complex. A thin purple shale in this unit is an excellent stratigraphic marker. Unit 3 (450 m) consists mainly of interbedded oolites (commonly associated with stromatolites) and shaly carbonates. This unit was deposited under a warm(dry)? climatic regime, adjacent to a continental area of low relief in a depositional setting comparable in some ways to that of the Persian Gulf. The oolites probably formed on tidal bars or in tidal deltas from which they were spread into topographic lows that normally received fine-grained muddy carbonate sediment. The upper part of Unit 3 includes some thin cross-bedded fine-grained quartzarenites which were mainly deposited as subtidal sand sheets.

Hematitic oolites in the northern part of central Victoria Island are interpreted as an early diagenetic replacement phenomenon. Molar-tooth structure is common in shaly carbonates interbedded with oolites of Unit 3. The molar-tooth is interpreted as being due to early dewatering of muddy carbonate sediment, controlled in part by interbedding of very permeable sediment (oolite) with water-saturated mud.

Carbonate sedimentation was interrupted by the influx of fine silt and sand (upper clastic member; 130 m thick) that spread over the depositional area (from the east?) and was deposited mainly from tidal currents. A return to carbonate deposition (upper carbonate member; 200 m thick) was followed by the evaporitic-red bed sequence of the Minto Inlet Formation.



GEOPHYSICS

1654 ANNAN, A.P., and DAVIS, J.L. - 1977  
Ground Ice and Permafrost, Ground probing radar and time-domain reflectometry experiments in permafrost terrain; *Ice*, no. 53, p. 11.

1655 ANNAN, A.P., and DAVIS, J.L. - 1978  
Ground Frost and Permafrost, Mapping techniques; *Ice*, nos. 56 & 57, p. 10.

1656 ANONYMOUS - 1979  
Arctic expedition studies underwater mountain range; *the northern news report*, vol. 8, no. 4, p. 9.

Members of the largest Canadian scientific expedition ever mounted in the Arctic performed their first experiments from a floating ice island this week and are well on schedule for their planned two months' of work.

The 32 scientists are studying the Lomonosov Ridge, the underwater mountain ridge that divides the Arctic Ocean into the European and American basins, in hopes of learning more about the movement of continents in the Arctic area.

1657 BLASCO, S.M. - 1978  
Probing with TROV; *Arctic Digest*, vol. X, no. 1 (53), January/February, pp. 4, 6, 17.

The Departments of Energy, Mines and Resources, Fisheries and Environment and Panarctic Oils Limited, were engaged in a joint project to assess the feasibility of an unmanned, tethered submersible for geological investigations in the high Arctic channels. The submersible's capacity to operate in the severe Arctic environment, accommodate geological instrumentation, and conduct a systematic survey of the seabed under the polar ice were in question.

1658 BLASCO, S.M. - 1978  
Preliminary Cruise Reports, Beaufort Sea - Amundsen Gulf, *Geol. Surv. Can.*, Atlantic Geoscience Centre Project 700092, 6 p.

1659 BORNHOLD, B.D., BLASCO, S.M., and McLAREN, P. - 1977  
Glacier Studies - Arctic, submarine observations of calving glacier fronts, S. Devon Island; *Ice*, no. 53, p. 3.

1660 BOWER, D.R., and WEBER, J.R. - 1978  
Estimation of the ocean tide from ice-surface gravity observations; *AIDJEX Bull.*, no. 38, pp. 151-157.

During the AIDJEX experiment a recording gravimeter was operated at the main station. Examination of the gravity data recorded at Caribou (lat. 73°N, long 144°W) during quiet periods with little drift in February and March 1976 showed that gravity changes were mainly due to tidal effects. Using a standard tidal analysis technique the following amplitude and Greenwich phase lags of the local ocean tide for the two main semi-diurnal ( $M_2$  and  $S_2$ ) and for the

two main diurnal ( $O_1$  and  $K_1$ ) constituents were obtained:

$M_2$  : 5.6 cm  $\pm$  0.5; 280°  $\pm$  7  
 $O_1$  : 1.6 cm  $\pm$  2.5; 329°  $\pm$  58  
 $S_2$  : 2.0 cm  $\pm$  1.4; 303°  $\pm$  25  
 $K_1$  : 6.0 cm  $\pm$  2.8; 100°  $\pm$  28

It is concluded that over the abyssal plain, during the winter, relatively quiet periods are sufficiently frequent to allow the determination of the local ocean tide from gravity observations.

1661 BROOKS, R.L., CAMPBELL, W.J., RAMSEIER, R.O., STANLEY, H.R., and ZWALLY, H.J. - 1978

Ice sheet topography by satellite altimetry; *Nature*, vol. 274, pp. 539-543.

The surface elevation of the southern Greenland ice sheet and surface features of the ice flow are obtained from the radar altimeter on the GEOS 3 satellite. The achieved accuracy in surface elevation is ~2 m. As changes in surface elevation are indicative of changes in ice volume, the mass balance of the present ice sheets could be determined by repetitive mapping of the surface elevation and the surface could be monitored to detect surging or significant changes in ice flow.

1662 BRYAN, L., FARR, T., LEBERL, F., and ELACHI, C. - 1977

Synthetic aperture radar imagery of the AIDJEX triangle; *AIDJEX Bull.*, no. 37, pp. 161-187.

Imaging radar mosaics of the AIDJEX triangle are presented together with a brief discussion of the radar sensor used in the data collection.

1663 BURGESS, M., and JUDGE, A.S. - 1977

Thermal observations conducted as part of Beaufort Delta Oil Project Limited's sampling cruise on the M.S. Norweta, Beaufort Sea, September 1976; *Energy, Mines & Res. Canada*, Geothermal Service of Canada, Earth Phys. Br., Internal Report No. 77-1, 32 p.

In September 1976 the Geothermal Studies section of the Earth Physics Branch participated in a survey conducted by Beaufort Delta Oil Project Limited (B.D.O.P.L.) in the Southern Beaufort Sea. This report presents and comments on the thermal measurements recorded during this field programme on board the M.S. Norweta.

1664 CAMPBELL, W.J., WAYENBERG, J., RAMSEIER, J.B., RAMSEIER, R.O., VANT, M.R., WEAVER, R., REDMOND, A., ARSENAULT, L., GLOERSEN, P., ZWALLY, H.J., WILHEIT, T.T., CHANG, T.C., HALL, D., GRAY, L., MEEKS, D.C., BRYAN, M.L., BARATH, F.T., ELACHI, C., LEBERL, F., and FARR, T. - 1978

Microwave remote sensing of sea ice in the AIDJEX main experiment; *Boundary-Layer Meteorology*, vol. 13, pp. 309-337.

During the AIDJEX Main Experiment, April 1975 through May 1976, a comprehensive microwave

sensing program was performed on the sea ice of the Beaufort Sea. Surface and aircraft measurements were obtained during all seasons using a wide variety of active and passive microwave sensors. The surface program obtained passive microwave measurements of various ice types using four antennas mounted on a tracked vehicle. In three test regions, each with an area of approximately  $1.5 \times 10^4 \text{ m}^2$ , detailed ice crystallographic, dielectric properties, and brightness temperatures of first-year, multiyear, and first-year/multiyear mixtures were measured. A NASA aircraft obtained passive microwave measurements of the entire area of the AIDJEX manned station array (triangle) during each of 18 flights. This verified the earlier reported ability to distinguish first-year and multiyear ice types and concentration and gave new information on ways to observe ice mixtures and thin ice types. The active microwave measurements from aircraft included those from an X- and L-band radar and from a scatterometer. The former is used to study a wide variety of ice features and to estimate deformations, while both are equally usable to observe ice types. With the present data, only the scatterometer can be used to distinguish positively multiyear from first-year and various types of thin ice. This is best done using coupled active and passive microwave sensing.

1665 DZEGUZE, K. - 1979  
The Lomonosov Factor; *The Canadian Magazine*, July 7th Weekend Citizen, pp. 6-9.

1666 HOBSON, G. - 1979  
Canadian Research at the North Pole - The Lomonosov Ridge Experiment (LOREX); *A.P.O.A. Review*, vol. 2, no. 2, p. 14.

1667 JACKSON, H.R., KEEN, C.E., and BARRETT, D.L. - 1977  
Geophysical studies on the eastern continental margin of Baffin Bay and in Lancaster Sound; *Can. J. Earth Sci.*, vol. 14, no. 9, pp. 1991-2001.

The results of three crustal refraction lines on the western margin of Baffin Bay and one in Lancaster Sound are described. The refraction measurements in Baffin Bay along with earlier refraction, gravity, magnetic, and seismic reflection data are used to define the boundary between continental and oceanic crust. The results suggest that the transition from continental to oceanic material takes place in about 30 km. The seismic refraction data also suggest a sedimentary basin on the continental shelf with at least 6 km thickness of sediment which, however, thins rapidly near Baffin Island. This basin is truncated under the slope by either a basement high or carbonate rocks. Lancaster Sound is filled by about 10 km of sediments that could be either of Mesozoic or Paleozoic age based on comparisons with velocities in nearby wells. The sedimentary and structural characteristics of Lancaster Sound are discussed and related to

the concepts of sea-floor spreading and continental drift.

1592 JONES, D.L., and FAHRIG, W.F. - 1978  
Paleomagnetism and age of the Aston dykes and Savage Point sills of the Boothia Uplift, Canada; *Can. J. Earth Sci.*, vol. 15, no. 10, pp. 1605-1612.

1668 JUDGE, A., TAYLOR, A., COLYER, J., BURGESS, M., and RAJ, P.P. - 1977  
Ground Ice and Permafrost, Geothermal studies in Northern Canada; *Ice*, no. 53, pp. 9-10.

1669 JUDGE, A.S. - 1977  
Permafrost, hydrates and offshore thermal regime; *in Proc. Sym. Permafrost Geophys.*, NRC Assoc. Comm. Geotech. Res., Tech. Memo No. 119, pp. 99-113.

1670 JUDGE, A. - 1978  
Ground Frost and Permafrost, general; *Ice*, no. 56 & 57, p. 8.

1671 JUDGE, A.S. - 1979  
Permafrost and Ground Ice - Distribution - General; *Ice*, no. 59, pp. 11-12.

1672 JUDGE, A. - 1979  
Permafrost and Ground Ice; Beaufort Sea; *Ice*, no. 59, p. 12.

1673 KOERNER, R.M. - 1977  
Glacier Studies - Arctic, Devon Island; *Ice*, no. 53, p. 3.

1674 KOZIAR, A., and STRANGWAY, D.W. - 1978  
Permafrost mapping by audiofrequency magnetotellurics; *Can. J. Earth Sci.*, vol. 15, no. 10, pp. 1539-1546.

The audiofrequency magnetotelluric (AMT) method has been used to study permafrost thickness near Tuktoyaktuk, N.W.T. in the Mackenzie Delta. In the frequency range of 10 Hz - 10kHz the permafrost behaves as a simple resistive layer over a conductive layer. This simple two-layer model can be inverted by asymptotic models to give a unique value for the thickness of the highly resistive frozen layer. In areas of simple layering, these results correlate well with drilling. In areas of sharp lateral variations in resistivity, depths tend to be underestimated. Unlike other electrical methods, AMT is not hampered by the presence of a surface melt layer in the summer if the conductivity-thickness product of this 'active layer' is less than about 0.03 mho (0.03 S).

1675 LEWIS, C.F.M. - 1978  
Drift Ice Scratches the Seafloor; *GEOS*, pp. 18-20.

GEOPHYSICS

1676 MacAULAY, H.A., JUDGE, A.S., HUNTER, J.A., BURGESS, M., GAGNE, R.M., ALLEN, V.S., and BURNS, R.A. - 1979

A study of sub-seabottom permafrost in the Beaufort Sea, Mackenzie Delta, by hydraulic drilling methods, spring 1978; *Energy, Mines & Resources Canada*, GSC Open File 624, EPB Open File 79-11, 41 p.

During the two-week period of March 21 to April 3, 1978, 12 holes were drilled from sea ice to maximum depths of 60 m beneath the seabottom of the Beaufort Sea. Each of the holes, drilled with a novel low-cost hydraulic drilling technique, was instrumented with several temperature sensors which were subsequently monitored as the thermal disturbance due to the jetting dissipated. The file comprises drilling logs, temperature and water salinity measurements taken at the 12 drill sites.

This report is a sequel to GSC Open File 472 (June 1977). It is a joint publication with the Earth Physics Branch, Department of Energy, Mines and Resources. This open file may be viewed at all Geological Survey libraries; and the Resident Geologist's Office, Department of Indian and Northern Affairs, Bellanca Building, Box 1500, Yellowknife, Northwest Territories, X1A 2R3. Copies are available at the user's expense from Campbell Reproductions, 880 Wellington Street, Ottawa, Ontario K1R 6K7.

1677 MACKAY, J.R., JUDGE, A.S., HUNTER, J.A., SCOTT, W.J., and RITCHIE, J.C. - 1979  
Permafrost and Ground Ice, Mackenzie Delta, N.W.T.; *Ice*, no. 59, p. 12.

1441 MILNE, A.R. - 1977  
Beaufort Sea Project; *Ice*, no. 53, pp. 7-8.

1678 MÜLLER, F. - 1977  
Floating Ice, Remote sensing of the North Water; *Ice*, no. 53, p. 7.

1619 NEAVE, K.G., JUDGE, A.S., HUNTER, J.A., and MacAULAY, H.A. - 1978  
Offshore permafrost distribution in the Beaufort Sea as determined from temperature and seismic observations; in *Current Research, Part C; Geol. Surv. Can.*, Paper 78-1C, pp. 13-18.

1679 O'CONNOR, A.D. - 1977  
Final Field Report, Amundsen Gulf, Western Arctic, M.V. Pandora II, June 30 to September 27, 1977; *Can. Hydro. Serv.*, Inst. Ocean Sci., Patricia Bay, internal report, 34 p.

1680 O'CONNOR, A.D. - 1978  
Final Field Report, Amundsen Gulf, Western Arctic, M.V. Pandora II, June 30 to September 23, 1978; *Can. Hydro. Serv.*, Inst. Ocean Sci., Patricia Bay, internal report, 33 p.

1681 PATERSON, W.S.B., and CLARKE, G.K.C. - 1978

Comparison of theoretical and observed temperature profiles in Devon Island ice cap, Canada; *Geophys. J.R. astr. Soc.*, vol. 55, pp. 615-632.

A non-steady-state theoretical model is used to predict the present variation of temperature with depth in two boreholes in the Devon Island ice cap, Arctic Canada. The boreholes are 300 m apart and one of them reaches bedrock. The heat transfer equation is solved numerically with the record of past temperatures obtained from measurements of the variations of oxygen-isotope ratio with depth in the cores as surface boundary condition. The effects of ice advection, refreezing of meltwater percolating from the surface (the amount of which is recorded in the cores), heating due to firn compaction and ice deformation, and heat flow in the bedrock below the ice sheet are all included in the model. The free parameters are geothermal heat flux, present surface temperature and heat loss at the surface which depends on the depth of meltwater penetration and other factors. Agreement between observed and predicted temperature-depth profiles is very close. Latent heat released by percolating meltwater is the predominant factor in determining the temperature distribution in the upper half of each borehole. The temperature distribution is insensitive to the value of the factor used to convert oxygen-isotope ratio to temperature.

1682 PAUTZKE, C.G., and HORNOF, G.F. - 1978  
Radiation program during AIDJEX: a data report; *AIDJEX Bull.*, no. 39, pp. 165-185.

Components of the radiation regime were measured from May 1975 through April 1976 in the Arctic Ocean during AIDJEX. Numerical data and field notes from the experiment were used to construct a time series of short-wave incoming and outgoing radiation.

1683 RAJ, P.P., and JUDGE, A.S. - 1977  
Coupled two-dimensional heat-mass flow model for the prediction of sub-seabottom permafrost; *Abstract in EOS*, vol. 58, no. 12, p. 1130.

A coupled two-dimensional heat-mass flow model for the prediction of the temperature and distribution of sub-seabottom permafrost is proposed. Both two-dimensional heat flow including latent heat and two-dimensional mass flow as a phenomenon of soil-water redistribution due to a moisture gradient are considered. The numerical solution is obtained by employing an implicit (alternate direction) finite difference scheme for the main time steps in combination with an explicit finite difference for 'phase-change nodes'. The effect of salt concentration and freezing point shift as proposed by Banin and Anderson is also incorporated in the model. A generalised computer model has been developed to include various soil geometries and boundary conditions, viz., homogeneous, heterogeneous or layered, different soil and rock types, transgression or regression of sea, and different flow conditions viz., heat flow



(with or without latent heat and depressed freezing points of the pore fluids), heat and mass flow (with or without salt concentration gradients). At the end of each time step thermal and hydraulic properties and phase change temperatures are recalculated. Woodside and Messmer's geometric model is used for thermal conductivity calculation. The model was verified using Lachenbruch's solution for two-dimensional heat conduction equation with reference to sub-seabottom permafrost. The results from the recent sub-seabottom permafrost studies made at Shallow Bay by the second author were used for further testing the model. With the aid of this numerical model the sub-seabottom permafrost and its temperature distribution in homogeneous and layered media of different lithologies are discussed.

1684 RICHARDSON, R.J. - 1978  
Observations on the paleomagnetism of some sediments from Ellesmere and Devon Islands, District of Franklin; *in* Current Research, Part C, Geol. Surv. Can., Paper 78-1C, pp. 105-107.

Three short lake sediment cores and twelve sediment plugs from a river section were collected from southern Ellesmere Island during the summer of 1977 as part of the project entitled "Quaternary Geochronology, Arctic Islands". These samples were taken to study the paleomagnetic characteristics of some Holocene arctic sediments. Sampling of the lake sediments also served to test a light-weight (25 kg) gravity corer and tripod.

1685 ROSSITER, J.R. - 1977  
Interpretation of radio interferometry depth sounding, with emphasis on random scattering from temperate glaciers and the lunar surface; unpub. Ph.D. Thesis, Univ. Toronto, 223 p.

Radio interferometry sounding data have now been collected, at frequencies from 1 to 32 MHz, from two temperate glacial regions, the Taurus-Littrow valley of the Moon (Apollo 17 site), a permafrost region, and a frozen lake. In order to interpret these data, studies were made in a laboratory-size analogue scale model, operating at 5.9 GHz. Automated interpretation procedures were developed using the scale model results as a guide, and were applied to field data.

The dielectric constant, loss tangent, and thickness of a two-layer, low-loss earth can be determined from the envelopes of the interference curves and maximum entropy spectral analyses. The tilt of a sub-surface reflector can also be obtained if up- and down-dip traverses are available. The two-layer interpretations presented are consistent with previous estimates.

The level of random scattering was obtained at each site. Inhomogeneities are ineffective scatterers unless they are larger than 0.3 wavelengths in size. Larger objects are slightly more effective scatterers, but the overall scattering level increases primarily with

scatterer density. The result is that for radio frequencies above the scattering threshold, scattering is essentially frequency-independent.

1686 ROSSITER, J.R., STRANGWAY, D.W., KOZIAR, A., WONG, J., and OLHOEFT, G.R. - 1978  
Electromagnetic sounding of permafrost, N.W.T., Canada, in summer and winter; *in* Proc. Third Int. Conf. Permafrost, July 10-13, 1978, Edmonton, Alta., Vol. 1, pp. 567-579.

Three separate electromagnetic methods were used both in summer and in winter to determine the electrical properties and layering of permafrost near Tuktoyaktuk, N.W.T. Audio-frequency magnetotellurics was able to delineate permafrost layering. The method was insensitive to the active layer, whether melted or frozen, implying a conductivity-thickness ( $\sigma t$ )  $\leq 0.03$  mho. The permafrost had a conductivity of  $\leq 10^{-4}$  mho/m, and overlay material at least 100 times more conductive. Radio-frequency interferometry was also insensitive to a melted active layer, indicating  $\sigma t < 0.1$  mho. Permafrost layering was not detected, but a dielectric constant of about 6, and a conductivity of about  $5 \times 10^{-4}$  mho/m were estimated for the permafrost. An *in situ* probe measurement gave conductivities for the melted active layer in summer of  $< 0.12$  mho/m, and a thickness of 50 cm ( $\sigma t < 0.06$  mho). In winter, the dielectric constant of the frozen active layer was about 7, and the conductivity  $\leq 3 \times 10^{-4}$  mho/m.

1687 ROSSITER, J.R., and BUTT, K.A. - 1979  
Remote estimation of the properties of sea ice, Beaufort Sea field trip report - March, 1979; C-CORE, Mem. Univ. Nfld., Pub. no. 79-9, DSS Contract no. 1SU78-00347, 35 p.

As more work is carried out in the Canadian Arctic during winter, there exists a greater need for the ability to make remote estimates of the physical properties of sea ice. The critical properties are the thickness and strength of ice, whether it be for operations on the ice surface, or movement of ice-breaking vessels. Although progress has been made in recent years in the observation and classification of sea ice using remote sensors, little success has been achieved in remote measurement of ice thickness and strength. This ability is particularly important because of the high variability and dynamic nature of sea ice and the increased industrial activity in Canada's North.

In spite of this lack of success, there is promise of being able to sound sea ice using radio waves in or near the VHF band.

1688 ROSSITER, J.R. - 1979  
airborne sea ice sounding comes "of age"; C-CORE news, vol. 4, no. 2, pp. 2-4.

1689 SINHA, A.K. - 1978  
Mapping techniques; *Ice*, no. 56 and 57, p. 10.

GEOPHYSICS

1690 SINHA, A.K. - 1977

Dipole electromagnetic mapping of permafrost terrains: theoretical developments and computer programs; *Geol. Surv. Can.*, Paper 77-13, 31 p.

Multifrequency electromagnetic mapping using dipolar sources may be useful for detecting and delineating permafrost in high latitude areas such as the arctic regions of Canada. A theoretical study has been made on the relative suitability of five coil arrangement systems for mapping permafrost where it occurs as the top layer of a two-layer medium, underlain by unfrozen sediments. The computer modeling study has indicated that the horizontal coplanar system would be the best from the viewpoint of the anomaly magnitude, while the perpendicular system might offer the highest resolution. The null-coupled, inclined, parallel system comes close in performance to the horizontal coplanar system.

The generalized computer program for obtaining the response of an n-layer lossy dielectric medium excited by harmonic dipolar sources has been included in the Appendix. The program is completely general and valid for any frequency, coil separation and electrical constants of the media. Hence, it may be used to generate theoretical response of any layered model necessary for the interpretation of multifrequency field data.

1691 SWEENEY, J.F. - 1979

Arctic seafloor: past and present; *GEOS*, winter, pp. 2-5.

In April and May of 1979 about 30 scientists, chiefly from EMR, will conduct a series of geophysical surveys across the Lomonosov Ridge, a major submarine feature of the Arctic seafloor. They will work from three camps on drifting pack ice close to the North Pole, and their research will cast light on one of the key unknowns in our understanding of Arctic Basin development.

1692 TAYLOR, A.E., and JUDGE, A.S. - 1977

Canadian Geothermal Data Collection - Northern Wells 1976-77; *Energy, Mines & Res. Canada*, Geothermal Service of Canada, Earth Phys. Br., Geothermal Series No. 10, 194 p.

The assessment and solution of many problems which may occur in the development of northern regions require a knowledge of subsurface temperatures. This volume supplements three earlier volumes in this series, and it reports new measurements at 37 of the sites listed in the previous volumes and observations from 8 new sites. A total of 86 determinations of permafrost thickness have been reported in the collection to date. Determined thicknesses in the Arctic Islands range from 144 m to 728 m, in the Mackenzie Delta from 0 m to 700 m and in the remainder of the Northern Mainland from 0 m to in excess of 700 m.

1693 VANT, M.R., RAMSEIER, R.O., and MAKIOS, V. - 1978

The complex-dielectric constant of sea ice at frequencies in the range 0.1 - 40 GHz; *J. Appl. Phys.*, vol. 49, no. 3, pp. 1264-1280.

A comprehensive and unique set of measurements of the complex-dielectric constant of sea ice, performed at several frequencies in the range 0.1 - 7.5 GHz, is described. In addition, a brief survey of previously published results is given and a set of dielectric models describing the complex-dielectric behavior of sea ice, over the frequency range 0.1 - 40 GHz, is discussed.

1694 VILKS, G., HALL, J.M., and PIPER, D.J.W. - 1977

The natural remanent magnetization of sediment cores from the Beaufort Sea; *Can. J. Earth Sci.* vol. 14, no. 9, pp. 2007-2012.

Two sediment cores collected from the continental slope of the southeastern Beaufort Sea show zones of stable shallow geomagnetic inclination at close to 0° in contrast with the dipole value of 80°. Although the cores were taken 60 km apart, the shallow inclination sections are sufficiently similar in form to be useful as potential correlation horizons, on the reasonable assumption that the same geomagnetic excursion is recorded in both cores.

The cores consist of silt and clay, showing fine silt-clay laminae or structureless mud on X-radiographs. Except for the surface 2.5 m of core 810, foraminifera are sparse everywhere.

The <sup>14</sup>C dates for total organic carbon place the recorded paleomagnetic event at between 10 000 and 40 000 years BP. According to paleontologic evidence, the event took place between 6 000 and 16 000 years BP. The later dating method is considered to be more reliable. Sediment cores from other high deposition rate areas need to be examined paleomagnetically to determine the areal extent of this Beaufort Sea geomagnetic excursion.

1695 WALFORD, M.E.R., HOLDORF, P.C., and OAKBERG, R.G. - 1977

Phase-sensitive radio-echo sounding at the Devon Island ice cap, Canada; *J. Glaciology*, vol. 18, no. 79, pp. 217-229.

A radio-echo sounder has been built with which both the amplitude and phase of radio echoes can be measured. In experiments with this instrument at the Devon Island ice cap, in the Canadian Northern Territories, precise amplitude and phase measurements have been made upon radio echoes from the bed of the ice cap. If these measurements are repeated after a number of years, the results, considered in conjunction with snow accumulation and compaction data, will be interpretable as a long-term change in the thickness of the ice cap. Wave dislocations and bend points have been observed in radio echoes reflected from the bed. It is suggested that amplitude and phase measurements from a network of sites may be synthesized in order to explore the geometry of the reflecting surface on a fine scale.

1696 WEBER, J.R. - 1977

Tilt-meter measurements during collision of two floes, 1972 AIDJEX Pilot Study; *AIDJEX Bull.*, no. 37, pp. 153-160.

An event recorded by a biaxial tilt-meter during a storm at the camp of the 1972 AIDJEX pilot study located on the Beaufort Sea pack ice is interpreted as an acceleration caused by the collision of a faster drifting floe with the station floe. It is estimated that the acceleration lasted between 20 and 40 seconds and resulted in a velocity increase of between 84 and 120 m hr<sup>-1</sup>. The energy imparted per square kilometer to the station floe during collision is estimated to be between 5.7 and 8.1 x 10<sup>6</sup> joules.

The station was equipped with an acoustic bottom reference (ABR) system with a sampling rate of one minute. However, the positional scatter is too large and the sample rate too low to be able to identify the collision event reliably from the ABR data alone.

1697 WEBER, J.R. - 1978

Ice floes in collision; *J. Glaciology*, vol. 20, no. 82, pp. 135-139.

#### GLACIOLOGY

1698 ARNOLD, K.C., and TERROUX, A.C.D. - 1977  
Glacier Studies - Arctic, Aerial photography; *Ice*, vol. 53, p. 2.

1699 ARNOLD, K.C., SHERSTONE, D.A., and TERROUX, A.C.D. - 1978  
Glacier Studies - Arctic, Aerial photography; *Ice*, nos. 56 and 57, p. 2.

1554 BLAKE, Jr., W. - 1977

Glacial sculpture along the east-central coast of Ellesmere Island, Arctic Archipelago; in Report of Activities, Part C; Geol. Surv. Can. Paper 77-1C, pp. 107-115.

1556 BLAKE, Jr., W. - 1978

Aspects of glacial history, southeastern Ellesmere Island, District of Franklin; in Current Research, Part A; Geol. Surv. Can., Paper 78-1A, pp. 175-182.

1558 BLAKE, Jr., W., and MATTHEWS, Jr., J.V. - 1979

New data on an interglacial peat deposit near Makinson Inlet, Ellesmere Island, District of Franklin; in Current Research, Part A; Geol. Surv. Can., Paper 79-1A, pp. 157-164.

1700 BRADLEY, R.S., and ENGLAND, J. - 1977  
Past glacial activity in the High Arctic;

Final Report to National Science Foundation, Climate Dynamics Program (Grant OCD75-00975), Univ. Mass. Contr. no. 31, 184 p.

Northeastern Ellesmere Island and northwestern Greenland are separated by only 20-40 km along the lengths of Kennedy and Robeson Channels. In this area the present day United States Range and Agassiz ice caps on Ellesmere Island are but 150 km from the margin of the Greenland Ice Sheet. The intervening landscape along both coastlines is characterized by dissected plateaus and mountains of low to moderate elevation (300 - 1200 m a.s.l.). The proximity of Ellesmere Island to Greenland, combined with their moderate topographies, provides an ideal location for investigating the past interactions of their respective ice sheets. Recent fieldwork between these ice sheets has provided new information on past glacial activity in the region which is directly relevant to both paleoclimatic and chronological interpretations of high latitude ice cores.

Early physiographic analysis of northern Ellesmere Island led to the hypothesis that the Greenland Ice Sheet had once overridden this landmass. Subsequent field investigations in the United States Range showed that Ellesmere Island erratics extended near to these summits, therefore, the complete inundation of this area by the Greenland Ice Sheet was rejected. More substantive evidence for a limited Greenland ice advance onto northeastern Ellesmere Island was later indicated by the presence of granite and gneiss erratics along the eastern edge of the Hazen Plateau and Judge Daly Promontory. However, the advance of the Greenland Ice Sheet onto this area, as suggested by the presence of these granite and gneiss erratics, was considered uncertain since both the provenance and complete distribution of these erratics was not firmly established. As a result, it was suggested that a northern Ellesmere Island source be considered as a possible alternative to their deposition by the Greenland Ice Sheet. It was concluded, however, that if the granite and gneiss erratics did originate on Greenland then the ice advance responsible for their deposition must predate the formation of the outermost Ellesmere Island moraines along western Kennedy Channel. These glacial features have not been disturbed by any subsequent ice advance and they are associated with an ice marginal terrace dated 27,950 ± 5400 B.P.

1512 BRADLEY, R.S., and ENGLAND, J. - 1978  
Influence of volcanic dust on glacier mass balance at high latitudes; *Nature*, vol. 271, no. 5647, pp. 736-738.

1513 BRADLEY, R.S., and ENGLAND, J. - 1978  
Recent climatic fluctuations of the Canadian High Arctic and their significance for glaciology; *Arctic and Alpine Res.*, vol. 10, no. 4, pp. 715-731.

1701 BRAITHWAITE, R. - 1976

On the relation between ablation and air temperature; in Proc. 10th Intern. Meeting German



Soc. of Polar Research, Zurich, April 6-8, 1976.

Many energy balance studies carried out on glaciers have shown that net radiation is the main energy source in the ablation process. However many workers have found high correlations between runoff from glacierized areas and air temperature and precipitation. These facts are not contradictory. It can be shown theoretically that the correlations between ablation and individual energy balance components are governed by the variances of the components during the period of record rather than by their mean values or sums.

Statistical analysis of energy balance data from White Glacier (Axel Heiberg Island) and Sverdrup Glacier (Devon Island) confirm this theoretical expectation. In three cases the sensible heat flux has highest variance and correlates most highly with ablation whilst net radiation has highest variance and correlates most highly in one case. In all cases the air temperature is correlated with the sensible heat flux and with ablation. A model of daily ablation rate in terms of positive daily mean temperature is proposed on the basis of the various regression equations. The model can be used to compute cumulative ablation from positive degree-day totals over periods longer than a day.

Compilation of ablation and temperature data from published literature suggests the model has general validity as a first approximation for many glacier situations.

1702 BRAITHWAITE, R., and MÜLLER, F. - 1976  
On the simulation of glacier melt using temperature data from remote weather stations; *in* Proc. XXIII Inter. Geographical Congress, Moscow, vol. 2, Climatology, Hydrology, and Glaciology, pp. 274-276.

An investigation has been made of the modelling of daily mean air temperature at weather stations on and around the White Glacier, a medium sized sub-polar valley glacier. The independent variable used was temperature interpolated from surrounding remote weather stations. Computation of daily ablation at a site on the glacier using air temperature measured at the site was also investigated. Combining the results of these studies suggests the hypothesis that long period (i.e. summer) glacier ablation can be computed from temperature data at distant weather stations. This paper describes the development and preliminary testing of the hypothesis.

1661 BROOKS, R.L., CAMPBELL, W.J., RAMSEIER, R.O., STANLEY, H.R., and ZWALLY, H.J. - 1978  
Ice sheet topography by satellite altimetry; *Nature*, vol. 274, pp. 539-543.

1703 CLARKE, G.K.C., KOERNER, R.M., ROGERSON, R.J., MATHEWS, W.H., and OMMANNEY, C.S.L. - 1979  
Symposium on Glacier Beds: The Ice-Rock Interface; *Geoscience Canada*, vol. 6, no. 1, pp. 22-24.

Construction of a realistic theory of glacier sliding is still one of the major pieces of unfinished business in glacier research. A significant component of the flow of wet-based glaciers and ice sheets is due to bottom sliding, and until a satisfactory description is found it will be difficult to develop realistic models to describe glacier flow and the growth and decay of ice-age ice sheets. In addition a complete theory of sliding would also lead to a better understanding of erosion and deposition processes at the glacier bed. The "Symposium on Glacier Beds: The Ice-Rock Interface" held in Ottawa, August 15 to 19, 1978, was aimed at bringing together glaciologists and glacial geologists to discuss the intimately connected problems of glacier sliding and erosion.

1514 CLASSEN, H.G. - 1978  
Ice caps: climatic records of ages past; *Can. Geographia*, August/September 1978, pp. 50-55.

1563 DiLABIO, R.N.W., and SHILTS, W.W. - 1978  
Compositional variation of debris in glaciers, Bylot Island, District of Franklin; *in* Current Research, Part B; *Geol. Surv. Can.*, Paper 78-1B, pp. 91-94.

1567 DYKE, A.S. - 1978  
Indications of neoglaciation on Somerset Island, District of Franklin; *in* Current Research, Part B; *Geol. Surv. Can.*, Paper 78-1B, pp. 215-217.

1570 DYKE, A.S. - 1979  
Glacial geology of Northern Boothia Peninsula, District of Franklin; *in* Current Research, Part B; *Geol. Surv. Can.*, Paper 79-1B, pp. 385-394.

1573 ENGLAND, J. - 1978  
The glacial geology of northeastern Ellesmere Island, N.W.T., Canada; *Can. J. Earth Sci.*, vol. 15, no. 4, pp. 603-617.

1574 ENGLAND, J., BRADLEY, R.S., and MILLER, G.H. - 1978  
Former ice shelves in the Canadian High Arctic; *J. Glaciology*, vol. 20, no. 83, pp. 393-404.

1704 ENGLAND, J., and BRADLEY, R.S. - 1978  
Past Glacial Activity in the Canadian High Arctic; *Science*, vol. 200, no. 4339, pp. 265-270.

For at least 30,000 years ice-free areas have existed between Greenland and Ellesmere Island ice sheets.

1517 FISHER, D.A. - 1977  
Ice crystals,  $\delta^{18}O$  and dust in Devon Island ice cap cores; *Polar Cont. Shelf Proj.*, internal report, 19 p.

1518 FISHER, D.A. - 1979

Comparison of  $10^5$  Years of Oxygen Isotope and Insoluble Impurity Profiles from the Devon Island and Camp Century Ice Cores; *Quaternary Res.*, vol. 11, pp. 299-305.

1705 HAMBREY, M.J., and MÜLLER, F. - 1978

Structures and ice deformation in the White Glacier, Axel Heiberg Island, Northwest Territories, Canada; *J. Glaciology*, vol. 20, no. 82, pp. 41-66.

The major structures in the long, narrow tongue of a sub-polar valley glacier are described: namely, longitudinal foliation, crevasses, clear-ice layers related to crevasses, debris-rich layers (frequently referred to as thrust or shear planes in the past), and folds. The foliation is vertical, is as well-developed in the centre of the glacier as at the margins, and does not, apparently, form perpendicular to the principal compressive strain-rate axis, nor exactly parallel to a line of maximum shearing strain-rate, although it sometimes approximately coincides with the latter. The intensity of foliation development is not related to the magnitude of the strain-rates, but the structure consistently lies parallel to flow lines through the glacier. There is no critical extending strain-rate, as such, associated with the development of new crevasses. Some crevasses have formed where the principal extending strain-rate is as low as  $0.004 \text{ a}^{-1}$  while, in other areas, extending strain-rates of  $0.163 \text{ a}^{-1}$  have not always resulted in fracturing. Prominent clear-ice layers, referred to as crevasse traces as displayed at the glacier surface, have formed in crevasse belts parallel to the main fracture directions. These are interpreted either as tensional veins or as the result of the freezing of water in crevasses. Extension parallel to the layering occurs during flow and, near the snout, the surface dip decreases rapidly. The fact that the crevasse traces can be followed to the snout implies that fracture occurs almost to the bottom of the glacier in the source area of the traces. Near the snout, debris-rich layers have developed parallel to the crevasse traces; frequently these are marked by prominent ridge-like ice-cored moraines. It is suggested that these structures are formed by a combination of basal freezing and thrusting. Isoclinal and tight similar folds on all scales are present. Some may be formed by the passive deformation of clear-ice layers as a result of differential flow; others may arise from the lateral compression of the original stratification in areas where ice flow becomes constricted by the narrowing of the valley. An axial plane foliation sometimes is associated with these folds.

1706 KAPPENBERGER, G., MÜLLER, F., and BLATTER, H. - 1976

Massenhaushalt, bewegung und wärmehaushalt des laika - gletschers, Coburg Island, NWT, Canada; Paper presented at 10th Intern. Meeting German Soc. of Polar Research, Zurich, April 6-8, 1976.

1673 KOERNER, R.M. - 1977

Glacier Studies - Arctic, Devon Island; *Ice*, no. 53, p. 3.

1707 KOERNER, R.M. - 1977

Glacier Studies - Arctic, Mass balance; *Ice*, no. 53, p. 2.

1708 KOERNER, R.M. - 1977

Glacier Studies - Arctic, Radio echo sounding; *Ice*, no. 53, p. 2.

1519 KOERNER, R.M. - 1977

Ice thickness measurements and their implications with respect to past and present ice volumes in the Canadian High Arctic ice caps; *Can. J. Earth Sci.*, vol. 14, pp. 2697-2705.

1709 KOERNER, R.M. - 1978

Glacier Studies - Arctic, Devon Island ice cap; *Ice*, nos. 56 and 57, p. 2.

1710 KOERNER, R.M. - 1978

Glacier Studies - Arctic, Meighen Island Ice Cap; *Ice*, nos. 56 and 57, p. 2.

1711 KOERNER, R.M. - 1978

Glacier Studies - Arctic, Mer de Glace Agassiz, Ellesmere Island; *Ice*, nos. 56 and 57, p. 2.

1712 KOERNER, R.M. - 1979

Glacier Studies - Arctic, Queen Elizabeth Islands; *Ice*, no. 59, p. 3.

1713 KOERNER, R.M. - 1979

Glacier Studies - Laboratory; *Ice*, no. 59, pp. 5-6.

1714 KOERNER, R.M. - 1979

Accumulation, ablation, and oxygen isotope variations on the Queen Elizabeth Islands ice caps, Canada; *J. Glaciology*, vol. 22, no. 86, pp. 25-41.

Measurements made on traverses over ice caps in the Queen Elizabeth Islands show that there is a region of very high accumulation ( $>40 \text{ g cm}^{-2} \text{ year}^{-1}$ ) on the slopes facing Baffin Bay and one of low accumulation ( $<15 \text{ g cm}^{-2} \text{ year}^{-1}$ ) in the interior parts of northern Ellesmere Island. Ablation rates in summer show much less regional variation over the same ice caps except for lower rates along the north-west edge of the islands and possibly on the Baffin Bay slopes as well. However, there is a stronger relationship between ablation and elevation which is exponential below the firn line. From the fractional  $^{18}\text{O}$  content of the snow it is shown that Baffin Bay contributes significant amounts of moisture ( $>20\%$  of the total) to the Baffin Bay slopes. In addition the Arctic Ocean is seen as another, but much less significant moisture source. The  $\delta^{18}\text{O}$  data show two effects on the

condensation processes - an orographic one (i.e. adiabatic cooling) and a distance-from-source effect (isobaric cooling) where the source is somewhere to the south-east of the islands.

1715 KOERNER, R.M. - 1979  
Dynamics of Large Ice Masses; *Geoscience Canada*, vol. 6, no. 2, pp. 97-98.

1716 KOERNER, R., and RUSSELL, R.D. - 1979  
 $\delta^{18}O$  variations in snow on the Devon Island ice cap, Northwest Territories, Canada; *Can. J. Earth Sci.*, vol. 16, pp. 1419-1427.

A study of  $\delta^{18}O$  variations of snow samples taken on traverses across the Devon Island ice cap in June 1971, 1972, and 1973 has shown a difference between the accumulation conditions on the southeast and northwest sides of the ice cap. On the southeast side there is an increasing depletion of  $^{18}O$  in the snow with increasing elevation. This pattern is attributed to the effect of orographic uplift of air masses moving over the ice cap from the southeast, which promotes condensation and precipitation due to adiabatic cooling. On the northwest side of the ice cap there is no evidence of any further depletion of  $^{18}O$  in snow, neither with increasing distance from the possible moisture source in Baffin Bay to the southeast nor with increasing elevation if the air mass comes from the northwest. In this case condensation is due to isobaric cooling so that precipitation is generally from level cloud bases. The changes inferred for the isotopic composition of the water vapour as it rises up the southeast slope are found to be consistent with its depletion through precipitation under near-equilibrium conditions. It is calculated that approximately 30% of the moisture at sea level on the southeast side of the ice cap and 8% at the top of the ice cap are of local origin. Lower temporal and aerial variability of the  $\delta$  values on the southeast side of the ice cap is attributed to dominance of the Baffin Bay low on that side effecting consistency of storm conditions there.

The  $\delta$  values of ice in the ablation zone on the Sverdrup Glacier show the combined effect of ice movement from the accumulation to the ablation zone and climatic change during the period of movement from cold to warm and back to cold conditions again.

1717 MacKINNON, P.K. - 1977  
A Report on Aspects of the Logistic and Scientific Activities on Mer de Glace Agassiz, Northern Ellesmere Island; *Polar Cont. Shelf Proj.* internal report, 59 p.

The following report is a summary of activities associated with the Polar Continental Shelf Project glaciology drilling and field survey program on Mer de Glace Agassiz during the 1977 field season.

A generalized flow chart of the operation de-

picts the various phases of the program. The report emphasizes the aspects of the flow chart that were within the responsibilities of the author.

1609 McLAREN, P., and BARNETT, D.M. - 1978  
Holocene Emergence of the South and East Coasts of Melville Island, Queen Elizabeth Islands, Northwest Territories, Canada; *Arctic*, vol. 31, no. 4, pp. 415-427.

1718 MÜLLER, F., and IKEN, A. - 1973  
Velocity fluctuations and water regime of Arctic Valley Glaciers; in Proc. Sym. Hydrology of Glaciers, Cambridge, Sept. 7-13, 1969, Inter. Assoc. Scientific Hydrology, Pub. no. 95, pp. 165-182.

Over a period of 10 years, 1959-69, surface movement, ablation and, to some extent, run-off were measured in the ablation area of cold valley glaciers, particularly White Glacier on Axel Heiberg Island (lat.  $80^{\circ}N$ ) in the Canadian Arctic Archipelago. The annual, seasonal and short-period velocity fluctuations were found to be most strongly linked to the discharge capacity of the intra and subglacial drainage system. However, changes in glacier thickness, ice temperature near the bed and longitudinal stress gradient are also influential. Intra-glacial, water-activated glide planes were observed.

1719 MÜLLER, F. - 1977  
Glacier Studies - Arctic, Baby Glacier, Axel Heiberg Island; *Ice*, vol. 53, p. 3.

1720 MÜLLER, F. - 1977  
Glacier Studies - Arctic, Coburg Island; *Ice*, no. 53, p. 2.

1721 MÜLLER, F. - 1977  
Glacier Studies - Arctic, Isotopic analysis of accumulation rates; *Ice*, no. 53, p. 2.

1722 MÜLLER, F. - 1977  
Glacier Studies - Arctic, White Glacier, Axel Heiberg Island; *Ice*, no. 53, p. 3.

1723 MÜLLER, F. - 1977  
Snow Studies, Snow cover, Axel Heiberg Island; *Ice*, no. 53, p. 5.

1724 MÜLLER, F. - 1977  
Fluctuations of Glaciers 1970-1975 (Vol. III); Pub. jointly by Inter. Assoc. Hydrological Sci. and UNESCO, Paris, UNESCO: ISBN 92-3-101462-5, Printed by Vontobel Druck AG, Feldmeilen, Switzerland, 269 p.

Population growth and industrial and agricultural development are leading to constantly increasing demands for water, hence all countries are endeavouring to improve the evaluation of their water resources and to make more rational



use of them. The International Hydrological Decade (IHD) 1965-74 was instrumental in promoting this general effort, and UNESCO has now launched a new long-term intergovernmental programme, the International Hydrological Programme (IHP), to follow the Decade. The basic objectives of the IHP are defined as follows: (a) to provide a scientific framework for the general development of hydrological activities; (b) to improve the study of the hydrological cycle and the scientific methodology for the assessment of water resources throughout the world, thus contributing to their rational use; (c) to evaluate the influence of man's activities on the water cycle in relation to environmental conditions as a whole; (d) to promote the exchange of information on hydrological research and on new developments in hydrology; (e) to promote education and training in hydrology; (f) to assist Member States of UNESCO in the organization and development of their national hydrological activities.

In many countries, glaciers play a significant rôle in the hydrological cycle, and an improved knowledge of their distribution and fluctuation is necessary for long-term planning and rational water use. Their study is, therefore, an important scientific contribution to the IHP programme of snow and ice investigations. The continuity of these essential observations and their extension to all regions of the world which possess perennial ice masses are fostered by the UNESCO-UNEP Temporary Technical Secretariat for a World Glacier Inventory and the Permanent Service on the Fluctuations of Glaciers (PSFG) of the IUGG.

1725 MÜLLER, F. - 1978  
Glacier Studies - Arctic, Axel Heiberg Island; *Ice*, nos. 56 and 57, p. 2.

1726 MÜLLER, F. - 1978  
Glacier Studies - Arctic, North Water; *Ice*, nos. 56 and 57, pp. 2-3.

1727 MÜLLER, F. - 1979  
Glacier Studies - Arctic, Axel Heiberg Island; *Ice*, no. 59, pp. 3-4.

1728 MÜLLER, F. - 1979  
Glacier Studies - Arctic, North Water; *Ice*, no. 59, p. 4.

1681 PATERSON, W.S.B., and CLARKE, G.K.C. - 1978  
Comparison of theoretical and observed temperature profiles in Devon Island ice cap, Canada; *Geophys. J.R. astr. Soc.*, vol. 55, pp. 615-632.

1729 TERROUX, A.C.D. - 1979  
Glacier Studies - Arctic, Aerial photography; *Ice*, no. 59, p. 3.

1695 WALFORD, M.E.R., HOLDORF, P.C., and OAKBERG, R.G. - 1977  
Phase-sensitive radio-echo sounding at the Devon Island ice cap, Canada; *J. Glaciology*, vol. 18, no. 79, pp. 217-229.

#### HISTORY

1395 CAIRNS, R. - 1978  
A slice of life in Kellet's storehouse; *Northern News Report*, vol. 7, no. 18, pp. 18-19.

1730 WONDERS, W.C. - 1978  
The Joint Arctic Weather Stations (JAWS) in the Queen Elizabeth Islands; in *Essays on Meteorology and Climatology in honour of Richmond W. Longley*, eds. K.D. Hage and E.R. Reinelt, pp. 399-418.

Thirty years have passed since the first permanent weather station came into operation in the Queen Elizabeth Islands of Canada's High Arctic. Eureka was established on the west coast of Ellesmere Island, by airlift from Thule, Greenland, in April 1947. Four others in the Joint Arctic Weather Station programme were to follow, providing not only a reliable flow of meteorological data from this most remote part of Canada, but also the basis for the much-altered High Arctic of today. Though the physical environment remains essentially the same, knowledge of the area in many fields has been immensely expanded and man's presence is felt everywhere.

Despite the critical role which the JAWS programme has played in this transformation surprisingly little note has been taken of it following the initial interest in the venture. Even at the time of the twenty-fifth anniversary of the programme only brief recognition was made of the event. In view of the stations' contributions and significance in the Canadian North some fuller recognition is overdue.

#### HYDROGRAPHY

1731 MacPHEE, S.B., CRUTCHLOW, M., and KNUDSEN, D. - 1978  
Arctic Hydrography - Past, Present and Future; *Lighthouse*, no. 18, pp. 3-5.

The Arctic Archipelago has long represented a major challenge to the Canadian Hydrographic Service. Short summers, capricious weather, unpredictable ice conditions, and the very remoteness of the area present formidable obstacles to a hydrographic survey operation. Despite this, major surveys have regularly been mounted. Because of the difficulties encountered by conventional shipborne surveys, development efforts over the years have centered on

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devising less conventional techniques which turn to advantage the Arctic's most intimidating feature: the ever-present ice. Winter surveys are now carried out using the ice cover as a platform for helicopters and tracked vehicles.

However, many Arctic charts still show areas which are sparsely sounded, if at all. Until recently, this was of little practical concern; however, the last decade has seen the prospect of extensive year-round shipping in the Arctic grow from a remote possibility into a virtual certainty as traditional reserves of fossil fuel have dwindled. The production of high quality bathymetric charts of the Arctic has taken on a new importance, and the development of the necessary survey techniques and systems has assumed a high priority.

1679 O'CONNOR, A.D. - 1977  
Final Field Report, Amundsen Gulf, Western Arctic, M.V. Pandora II, June 30 to September 27, 1977; *Can. Hydro. Serv.*, Inst. Ocean Sci., Patricia Bay, internal report, 34 p.

1680 O'CONNOR, A.D. - 1978  
Final Field Report, Amundsen Gulf, Western Arctic, M.V. Pandora II, June 30 to September 23, 1978; *Can. Hydro. Serv.*, Inst. Ocean Sci., Patricia Bay, internal report, 33 p.

1621 PELLETIER, B.R. - 1977  
Bottom samples as taken by the hydrographer and the geologist; *International Hydrographic Review*, Monaco, LIV 2, pp. 103-124.

1732 STEPHENSON, F. - 1977  
An Assessment of the Permanent Water Level Stations in the Canadian Arctic; *Lighthouse*, no. 16, pp. 21-25.

To monitor sea level fluctuations in the Canadian Arctic a number of permanent water level stations were constructed in the early 1960's. In 1962 there were five permanent stations in operation. This network has grown slowly since then and presently there are thirteen permanent stations, being operated by Water Survey of Canada on behalf of the Canadian Hydrographic Service.

It requires a large expenditure of manpower and money to maintain these sensitive instruments on a continuous basis. Subzero air temperatures and sea ice present problems which must be battled almost year round. Most of the stations are in isolated locations which can only be visited by trained technicians once every few months. Because of this, gauge malfunctions often go undetected for long periods and much valuable data is lost.

The average data return from the Arctic stations between 1962 and 1974 was 78%. This is remarkably high considering the recording instruments being used and the conditions under which they are required to operate. But is it high enough? The technology now exists for a complete renovation of the Arctic gauging

network. The form this renovation should take depends on what we see as the major requirements for an Arctic gauging network - now and in the future.

1733 STEPHENSON, F.E. - 1979  
Aerial photography of artificial islands in the Beaufort Sea, July 6, 1977 and September 28, 1977; *Can. Hydro. Serv.*, Pacific Region, Final Field Report, Inst. Ocean Sci., Patricia Bay, 25 p.

In 1976 the Canadian Hydrographic Service initiated, as part of its responsibility for the safety of navigation in Canadian waters, a continuing program to monitor the status of all artificial islands in the Beaufort Sea. This report covers the aerial photographic flights of July 6, 1977 and September 28, 1977, compares the results of the July 1977 flight with the September 1976 flight and the September 1977 flight with the July 1977 flight.

1734 STEPHENSON, F.E. - 1979  
Aerial photography of artificial islands in the Beaufort Sea, July 17, 1978 and August 29, 1978; *Can. Hydro. Serv.*, Pacific Region, Final Field Report, Inst. Ocean Sci., Patricia Bay, 26 p.

In 1976 the Canadian Hydrographic Service initiated, as part of its responsibility for the safety of navigation in Canadian waters, a continuing program to monitor the status of all artificial islands in the Beaufort Sea. This report covers the aerial photographic flights of July 17, 1978 and August 29, 1978. It summarizes the condition of the islands at the time of each photographic flight, identifies any recent erosion, and notes its severity and rate. Where islands have been abandoned and man-made objects remain which may be a hazard to navigation, these objects have been noted. An attempt has been made to provide information which will be of use not only to the hydrographer, but also to geologists interested in the erosion of these islands and the resulting sediment transport.

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1735 ANDERSON, J.C., and GREY, B.J. - 1978  
Hydrologic studies in the Mackenzie Delta Region, N.W.T., 1977, a progress report; in Northern Highways Hydrology Studies, Mackenzie River Basin, 1977, Report for Northern Roads Env. Working Group, DIAND, 39 p.

Hydrologic investigations were continued during the 1977 open water season at a number of small watersheds along the route of the Mackenzie Highway in the east Mackenzie Delta region, N.W.T. 1977 was a year of hydrologic extremes in several respects. Winter season icings within culverts were relatively large, and two complete culvert blockages occurred between Inuvik

and Km 1512.4. Snowmelt floods were of generally high magnitude, particularly in the tundra where, in the case of Ryan Creek, a peak unit area discharge of  $0.85 \text{ m}^3/\text{s}/\text{km}^2$  was estimated. In contrast, extremely low discharge was observed at most sites by late summer, in spite of heavy precipitation in late June, owing to the warm, dry weather which prevailed for most of the open water period. Seasonal runoff ratios were high because of the intensity of the snowmelt flood. Suspended sediment concentration levels were similar to those recorded in previous years.

Flood maxima for the study basins in 1977 were compared with 50-year design flood estimates proposed for the region. The design floods were not exceeded in the taiga zone.

1736 ANDERSON, J.C. - 1979

Hydrologic studies in the Mackenzie Delta Region, N.W.T., 1978; a progress report; *in* Northern Highways, Hydrology Studies, Mackenzie River Basin, 1978, Report for Northern Roads Env. Working Group, DIAND, 62 p.

Hydrologic investigations continued during the 1978 open water season at eight watersheds in the taiga and tundra zones of the eastern Mackenzie Delta region, N.W.T. Data were gathered on snowpack water equivalent, river channel and culvert icings, precipitation, air temperature, river discharge, suspended sediment and water temperature. In the taiga zone, late winter snowpack water equivalent and culvert ice accumulations were of intermediate magnitude in comparison with past years' observations. Snowmelt produced the largest flood event of the year in most cases, but peak discharge was only moderate when compared with that of former years and well below 50-year design curve values. Two noteworthy extremes were the lateness of snowmelt in the taiga zone, and the very low discharge of most rivers by mid- or late summer as a result of a month-long drought in July. A reconnaissance of stream crossings along the entire route of the proposed Inuvik-Tuktoyaktuk highway was done during the snowmelt flood period in order to gain a better appreciation of the alignment as a whole, and some preliminary comments are offered. A more intensive study of a major recurrent river icing on Hans Creek was initiated and some observations on the structure and formation of that feature are presented.

1737 ANDERSON, J.C. - 1979

Permafrost and Ground Ice, Mackenzie Delta, N.W.T.; *Ioe*, no. 59, p. 12.

1738 COGLEY, J.G. - 1977

Ground Ice and Permafrost, Sub-channel permafrost, Cornwallis Island; *Ioe*, no. 53, p. 9.

1739 DAY, T.J. - 1978

Spatial asymmetry of a dispersing tracer mass; *in* Current Research, Part A, Geol. Surv. Can., Paper 78-1A, pp. 453-458.

During the course of a longitudinal dispersion experiment in a meandering gravel channel (Banks Island, Northwest Territories), twelve partial or complete descriptions of a distance-concentration distribution were determined. These data indicate that for large times, the distance-concentration curve is distinctly asymmetric, with a tail of tracer concentration extending upstream. This asymmetry is considered to be consistent with the theory that tracer material is retained in, then subsequently slowly released from, fluid traps distributed along the flow boundary.

1572 DYKE, L. - 1979

Permafrost and ground ice, frost heave; *Ioe*, no. 59, p. 13.

1740 FUJINO, K., and KATO, K. - 1978

Determination of Oxygen Isotopic Concentration in the Ground Ice of a Tundra Area; *in* Joint Studies on Physical and Biological Environments in the Permafrost, Alaska and North Canada, July to August, 1977, Inst. Low Temp. Sci., Hokkaido Univ., Japan, pp. 77-82.

While water in nature has a fairly uniform isotopic composition, its application to glaciological studies provides the most interesting results in terms of  $\text{H}_2\text{O}^{18}$  and  $\text{HDO}^{16}$ , because recent investigations of such heavy isotope contents as Deuterium and  $\text{O}^{18}$  have such remarkable progress that the following have become clear: The composition of these heavy isotopes in snow flakes becomes a kind of measure of condensation temperature and has a simple correlation with annual mean values of surface temperature. These results have contributed to successful stratigraphic analyses of the arctic continental ice shed.

In case of ground ice which are kept within the distinctive ground features such as polygons, pingos and massive ices, it is supposed that ice bodies underlying these ground features are kept within the ground and do not have any considerable abrasion taking place by evaporation, melting or drifting; then, stratigraphic application of isotopes may make it possible to find the key to the mechanisms and characteristics of such ground ice.

From these points of view, the isotopic concentration ratio of  $\text{O}^{18}$  was determined for ground ice samples collected from polygons, pingos and massive ices during the joint research expedition in the summer of 1977 at Barrow, Alaska and Tuktoyaktuk, Mackenzie Delta.

1741 FUJINO, K. - 1978

Water-Permeability Inside the Uppermost Layer of a Tundra Area; *in* Joint Studies on Physical and Biological Environments in the Permafrost, Alaska and North Canada, July to August, 1977, Inst. Low Temp. Sci., Hokkaido Univ., Japan, pp. 71-76.

Distinctive ground features are formed by frost action due to climatic conditions in high latitudes, especially, in the Arctic region, like the Arctic seacoast.



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Typical among such ground features are polygons (patterned ground) and pingos, which are commonly observed in Arctic regions of Alaska and Canada.

Their origins and formation processes remain arguable, but, the fact that large ice bodies such as ice wedges and massive ices are usually found underneath them suggests that the freeze-thaw cycle of an underlying ice body as well as water supply from various sources, play an important role in their forming processes. That is, water from a precipitation on the surface and from the active layer of permafrost percolates through a soil and feeds the underlying ice body. The growth and decay of the underlying ice body cause an overlying soil layer to heave and bring about cracks, resulting in the development of characteristic ground features.

From this view point, the movement of the retained water in the surface soil layer was extensively investigated in and around such ground during the joint research expedition in the summer of 1977 at Barrow, Alaska and Tuktoyaktuk, Mackenzie Delta.

1579 GELL, W.A. - 1978  
Ice-wedge ice, Mackenzie Delta-Tuktoyaktuk Peninsula Area, N.W.T., Canada; *J. Glaciology*, vol. 20, no. 84, pp. 555-562.

1742 GREY, B.J., and JASPER, J.N. - 1978  
Hydrologic studies along the Liard Highway, Spring and Summer, 1977, a progress report; in Northern Highways Hydrology Studies, Mackenzie River Basin, 1978, Report for Northern Roads Env. Working Group, DIAND, 27 p.

In a reconnaissance hydrologic program in 1977, streamflow and precipitation were measured at five study sites along the route of the Liard Highway. Analyses of the meteorologic records revealed that precipitation was below normal during the winter of 1976/1977, and generally above normal during the summer, and some months had extreme amounts. Also, this summer rainfall was spatially very variable. Snowmelt runoff was very low, and all study basins had peak flow in response to the same summer rainstorm. The discussion of design flows and the design curves currently in use suggests that some changes are required and that a modified UNIES curve best represents the streams crossed by the Liard Highway. Only one of the measured flows exceeded the design curve presented, but did so by a considerable amount. Suspended sediment and culvert icings are also discussed.

1743 HERON, J.R. - 1978  
Computation of Snowmelt at a High Arctic Site; unpub. M.Sc. thesis, McMaster Univ., 89 p.

In 1977, snowmelt was studied at a site near Resolute Bay, N.W.T., with additional data obtained in 1978. Using measured net radiation and computed fluxes of sensible and latent heat, the surface energy balance over snow was calculated. Field measurements of snow ablation compared favourably with the computed

values, indicating that the energy balance approach is adequate for the computation of snowmelt at a High Arctic site.

The surface energy balance was also extended to a number of slopes using data from the horizontal site. On individual clear or partly cloudy days, the difference in the surface energy balance between slopes was small and on overcast days, such differences were further minimized. Over the entire study period, computations show that there was little difference in the amount of energy received by various slopes up to 10°.

1744 HERON, R., and WOO, M-K. - 1978  
Snowmelt computations for a High Arctic Site; in Proc. 35th Eastern Snow Conf., Ed. B.E. Goodison, Hanover, N.H., February 1978, pp. 162-172.

The energy balance approach was used to calculate the snowmelt at a site near Resolute Bay, Northwest Territories (75°N, 95°W). Snowmelt energy was partitioned into net radiation, sensible heat, latent heat and rain melt components. Net radiation and sensible heat fluxes accounted for approximately 60 and 40 percent of the incoming energy while snowmelt and evaporation consumed 80 and 20 percent of the energy respectively. This study demonstrates that unless the snow cover is extremely patchy, the energy balance approach adequately estimates the rate of snowmelt at a High Arctic site.

1745 HORIGUCHI, K. - 1978  
Acidity of the Uppermost Layer of Permafrost - Its Relationship to the Thickness of the Active Layer; in Joint Studies on Physical and Biological Environments in the Permafrost, Alaska and North Canada, July to August, 1977, Inst. Low Temp. Sci., Hokkaido Univ., Japan, pp. 57-68.

Rocks exposed to weathering at the earth's surface are destroyed as a result of physical and chemical weathering. Physical disintegration and chemical decomposition transform a massive rock into elastic, colloidal and soluble states, while organic matter in soil is decomposed into components of soil in various stages of decomposition. Weathering processes of all kinds require the presence of water. Naturally, whatever is dissolved in the water will effect the chemical reactions that occur.

Soluble elements in soil, such as alkaline and alkaline earth ions, are removed from insitu to other places with soil water. We can find traces of the dissolution and accumulation of soluble elements in a soil profile, from which most of soils are classified into several types. The soils at Barrow, Alaska, and Tuktoyaktuk, Mackenzie Delta, N.W.T., Canada usually belong to the tundra type. In these areas the active layer, which lies above the permafrost ground, freezes in winter and thaws in summer. The depth of the layer depends on environmental factors including local climate, thickness of a snow cover, presence of flora, and amount of soil water.

The acidity pH of soil is one of its typical physico-chemical properties, whereby useful information is provided as to the degree of weathering, the activity of micro-organisms in it, and so on. The pH of soil is also important from an engineering view-point, because it affects the durability of foundation of an artificial construction thereon. While it is known that arctic tundra soil is usually acid as a result of organic acids, many agronomists have measured the pH in the active layer as a characteristic of the soil horizon. It reflects the degree of chemical weathering, the degree depending on the water content as well as a thawing period during the brief polar summer.

The presented paper is devoted to the measurement of vertical distribution of the pH of soil in the active layer and, drawing on it, to the estimation of a maximum depth of thaw extending over a long period of time. The measurements of pH reported here were made during summer of 1977 at Barrow, Alaska and Tuktoyaktuk, Mackenzie Delta.

1746 INOUE, M., and KINOSITA, S. - 1978  
Thermal Regime of the Uppermost Layer in a Tundra Area in Summertime; *in* Joint Studies on Physical and Biological Environments in the Permafrost, Alaska and North Canada, July to August, 1977, Inst. Low Temp. Sci., Hokkaido Univ., Japan, pp. 45-55.

The permafrost expedition in the tundra area of Alaska and North Canada was conducted from July to August 1977, under the financial support of the Japanese Ministry of Education. It had the main purpose of studying the relation of soil water behavior in the uppermost layer to the physical and biological environment in the tundra area. The soil water is retained in the uppermost layer owing to thawing in summertime of the upper frozen layer which was frozen in the previous winter. The study of the soil water behavior calls for the clarification of the thermal regime of the uppermost layer in summertime, especially the maximum thawing depth. With this aim in mind measurements were conducted of thawing depths and temperature profiles in the fields of Barrow, Alaska and Tuktoyaktuk, Mackenzie Delta. They depended greatly on surface conditions such as vegetation and soil type. Discussions were made on the relations of thawing depth to vegetation, soil type, water content, thermal conductivity and thawing index (accumulation of daily mean air temperatures above 0°C). Based on the discussions, the maximum thawing depth was estimated on each field site.

1434 KINOSITA, S. - 1978  
An Outline of Research Project; *in* Joint Studies on Physical and Biological Environments in the Permafrost, Alaska and North Canada, July to August, 1977, Inst. Low Temp. Sci., Hokkaido Univ., Japan, pp. 1-15.

1496 KINOSITA, S. - 1978  
Joint Studies on Physical and Biological En-

vironments in the Permafrost, Alaska and North Canada, July to August, 1977; ed. S. Kinoshita, Inst. Low Temp. Sci., Hokkaido Univ., Japan, 149 p.

1596 KINOSITA, S., FUJINO, K., HORIGUCHI, K., FUKUDA, M., and INOUE, M. - 1978  
Core Samplings of the Uppermost Layer in a Tundra Area; *in* Joint Studies on Physical and Biological Environments in the Permafrost, Alaska and North Canada, July to August, 1977; ed. S. Kinoshita, Inst. Low Temp. Sci., Hokkaido Univ., Japan, pp. 17-42.

1600 LEWKOWICZ, A.G., DAY, T.J., and FRENCH, H.M. - 1978  
Observations on slopewash processes in an Arctic tundra environment, Banks Island, District of Franklin; *in* Current Research, Part A; Geol. Surv. Can., Paper 78-1A, pp. 516-520.

1747 MACKAY, D.K., and ANDERSON, J.C. - 1978  
Floating Ice - River & Lake, Mackenzie Valley, N.W.T.; *Ice*, nos. 56 & 57, p. 7.

1602 MACKAY, J.R. - 1978  
Contemporary pingos: a discussion; *Bull. Peryglacjalny*, no. 27, pp. 133-154.

1603 MACKAY, J.R. - 1978  
The surface temperature of an ice-rich melting permafrost exposure, Garry Island, Northwest Territories; *in* Current Research, Part A; Geol. Surv. Can., Paper 78-1A, pp. 521-522.

1748 MACKAY, J.R. - 1978  
Sub-pingo water lenses, Tuktoyaktuk Peninsula, Northwest Territories; *Can. J. Earth Sci.*, vol. 15, no. 8, pp. 1219-1227.

In 1976 and 1977 three growing pingos were drilled for the purpose of measuring sub-pingo water pressures beneath aggrading permafrost. All holes drilled through permafrost in the pingos and adjacent lake flats produced artesian flow. The flow from the pingos was clear and as the gushers rose to a maximum height of 3 m above ground level, large sub-pingo water lenses under pressure seemed evident. The existence of the lenses was confirmed by sounding their depths once permafrost was penetrated.

One pingo had a 2.2 m deep water lens beneath the top. Pressure transducers, installed in the sub-pingo water lenses or in the unfrozen sands beneath, all indicated pressure heads above the tops of the pingos. Precise levelling of bench marks showed that the top of one pingo subsided 60 cm from drill hole water loss. Calculations for one pingo show that the water lens has likely been present since the birth of the pingo. Recharge from a distant source cannot account for the high pressures because the hydrostatic heads are above the pingo tops and as the pingo tops are usually the highest features in Tuktoyaktuk Peninsula, there can be no available higher source area; even if there were

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distant sources, the countless intervening lakes would quickly release any artesian pressures; and numerous pingos have grown up in drained lakes which are either too small or too young to have through-going taliks beneath them. Therefore, the observed water lenses and high sub-pingo pore water pressures cannot be attributed to recharge but provide strong field evidence for pressure generated by pore water expulsion.

1677 MACKAY, J.R., JUDGE, A.S., HUNTER, J.A., SCOTT, W.J., and RITCHIE, J.C. - 1979  
Permafrost and Ground Ice, Mackenzie Delta, N.W.T., *Ice*, no. 59, p. 12.

1749 MARSH, P., and WOO, M.K. - 1977  
The Water Balance of a Small Pond in the High Arctic; *Arctic*, vol. 30, no. 2, pp. 109-117.

Tundra ponds are ubiquitous features in the High Arctic. The water balance of one such pond situated on Ellesmere Island was found to be dependent upon the groundwater supplies from the internally-drained basin in which it was located. For the basin as a whole, evaporation constituted an important component of the water balance, accounting for over 90 per cent of the rainfall over a summer period of less than six weeks. Changes occurring in the quantity of water in the pond in response to rainfall were found to depend upon the degree of saturation of the active layer of the underlying permafrost.

1750 MARSH, P. - 1978  
Water balance of a small High Arctic Basin; unpub. M.Sc. thesis, McMaster Univ., 108 p.

A small drainage basin (area 33 km<sup>2</sup>) near Resolute Bay, N.W.T., and three sub-basins with areas of 21, 10 and 0.65 km<sup>2</sup> were studied during the summer of 1976. All components of the water balance were measured or calculated, including basin snow storage, rainfall, streamflow and evaporation. A snow survey indicated that Atmospheric Environment Service data underestimated basin snow storage by 50% but weather station rainfall was representative of the study basin. Water balance studies showed that for the three larger basins, streamflow consistently accounted for 80% of the total incoming precipitation and evaporation 20%. The smallest basin was found to discharge only 67% of precipitation, leaving 33% available for evaporation. This difference was attributed to a larger percentage of wet areas in the small basin. The spatial variability of the water balance components was also demonstrated by calculating the values of all components for individual terrain units. It was found that the percentage of total precipitation which was discharged as streamflow varied from 53% for crests to 98% for gullies. Findings from this study agree with other studies in a similar environment. In general, streamflow as a component of the water balance is more important in the high Arctic than in the sub-Arctic regions.

1751 MARSH, P., and WOO, M.K. - 1979  
Annual water balance of small High Arctic Basins; Presented at 10th Canadian Hydrology Sym., Cold Climate Hydrology, May 10-11, 1979, Vancouver, B.C., 10 p.

A comprehensive water balance study was carried out in small basins near Resolute, Cornwallis Island, N.W.T. Snowfall measurements by the Resolute weather station were found to underestimate basin snow storage by at least one half, while point estimates of evaporation overestimated basin evaporation because of a variable snow cover which partially inhibited evaporation. To improve upon point measurements, data were obtained from four basins ranging in size from 0.5 to 33 km<sup>2</sup>. Due to a large boggy area in the smallest basin annual streamflow and evaporation were not characteristic of the surrounding area. When basin size increases, however, localized hydrometeorological conditions become less prominent and data from these basins are more representative of the region. In these basins snowfall contributed 80 to 85 percent of total precipitation and rainfall made up the remainder. Eighty to 90 percent of precipitation was removed by streamflow, and the rest was lost to evaporation.

1623 PISSART, A. - 1975  
Glace de ségrégation, soulèvement du sol et phénomènes thermokarstiques dans les régions à pergélisol; *Bull. de la Société géographique de Liege*, no. 11, pp. 89-96.

1626 PISSART, A., and FRENCH, H.M. - 1977  
The origin of pingos in regions of thick permafrost, Western Canadian Arctic; *Quaestiones Geographicae*, vol. 4, pp. 149-160.

1752 RYDÉN, B.E. - 1977  
Hydrology of Truelove Lowland; in Truelove Lowland, Devon Island, Canada: A High Arctic Ecosystem, ed. L.C. Bliss, Univ. Alberta Press, pp. 107-136.

The water budget of high arctic and many high mountain areas is characteristic of extremely cold hydrological environments. They have the shortest season with liquid precipitation, accounting for less than 30% of the annual total. They receive high values of global solar radiation which allows rapid snowmelt, but the summer solstice is often past before the land is snow-free. Melt water movement downward is prevented by permafrost. The occurrence of glaciers in some areas increases dramatically the supply of water to downstream parts of basins during summer. After snowmelt, most streams carry a limited amount of water that comes from thawing of the active layer and from ground water storage.

Most small catchments within the High Arctic yield 80% to 90% of the annual runoff (predominantly snowmelt) over a period of 2-3 weeks in late June and early July. Spring is very short and is characterized by a rapid decrease in snow cover; air temperature at the vegetation level rises rapidly. Lakes and ponds occur in



great numbers on flat coastal plains in the Arctic; their detention storage often modifies runoff on lowlands.

The objectives of this study were to determine: (1) the water budget of the Intensive Study Sites and the Truelove Lowland; (2) the hydrological regime of rivers and streams connected to the Lowland, in particular the dynamics of their discharge during snowmelt, and (3) the pattern of evaporation from meadows and lakes.

1753 SAURIOL, J. - 1978

Channel development and fluvial processes in snow-filled valleys, Resolute Bay, N.W.T.; unpub. M.Sc. Thesis, McMaster Univ., 132 p.

In 1977, this study was carried out in a small drainage basin (33 km<sup>2</sup>) near Resolute (74°55' N, 94°50' W), Northwest Territories (1) to examine the manner in which meltwater runoff carves channels in the valley snowpack before the channels become stabilised on their clastic beds, and (2) to assess the role played by valley snowpacks on fluvial processes.

Major factors controlling channel development in the snowpack include the distribution and the characteristics of the snow, which in turn are related to the local topography and the prevailing directions of winter snowdrift. Based on this relationship, an attempt was made to predict the sequences of channel development in terms of several processes including ponding, tunnelling, lateral and vertical shifting, and stream capturing.

Availability of water controls the rate of channel development sequences and hence the magnitude of fluvial processes over a flow season. In the case of substantial runoff, the rate of snowpack depletion is rapid. However, since the bulk of annual water discharge occurs while the snow is interposed between the running water and the bed material, little geomorphic work is performed during the early part of the flow season. For four selected sites, calculations suggest a protective effect of the snow in reducing the potential bed material transport.

1754 STEER, P.J. - 1979

Water balance of a small lake in the High Arctic; unpub. Res. Paper, B.A., McMaster Univ., 94 p.

In 1978, the water balance of a small lake near Resolute, N.W.T., was studied. Using measured water inputs and water outputs, the change in storage term was calculated. A positive net change in storage was partitioned between storage in the active layer and storage in the lake.

A comparison of the magnitudes of the various components of the water balance equation shows that i) for the snow-dammed lake, outflow is most important for the few days following the breakup of the channel, ii) evaporation is an important process, removing almost as much water as summer precipitation received by the basin, and iii) depending on the condition of the active layer during freeze-up, considerable

amounts of water may be held in storage at the end of summer.

1640 THOMAS, R.D., and DYKE, A.S. - 1977  
Ground Ice and Permafrost - Ground ice in north-central Keewatin, N.W.T.; *Ice*, no. 53, p. 10.

1755 WANKIEWICZ, A.C. - 1979

Temperature Measurements Under Arctic Rivers; *in* Nat. Res. Council Assoc. Com. Tech. Memo No. 124, pp. 191-206.

The thermal regime and ground water conditions have been investigated under rivers which freeze to their bed in areas of continuous permafrost. This information is expected to help in finding solutions to engineering structure and water supply problems in the Far North. Ground water temperatures have been measured at four Arctic sites, two on Melville Island and two in the Inuvik area. The King River on Melville Island is a flashy stream which is frozen to the river bed for seven months of the year. In May, 1976 a Nodwell mounted air rotary drill was used to drill a line of 18 metre deep boreholes across the river valley. Thermistor cables were installed through the ice into the boreholes drilled in the river bed. Dry-land holes were also instrumented for comparison. The mean dry land temperature equaled the mean air temperature at Resolute Bay. The snow cover on the exposed dry-land site was only a few tens of mm thick. The temperatures beneath the river bed were similar. The river bed in winter was covered by 0.7 m of ice and a dusting of snow. The temperature contrast was largest in October 1976, just when the river froze to its bed.

1756 WOO, M-K., HERON, R., MARSH, P., and SAURIOL, J. - 1977

Hydrology of nival-regime basins in the vicinity of Resolute, Cornwallis Island, N.W.T.; *Polar Cont. Shelf Proj.*, internal report, 41 p.

Between May 1st and September 3rd 1977, fieldwork was carried out in an area approximately 5 km north of Resolute, Cornwallis Island, Northwest Territories. The overall objective is to study the hydrologic behaviour of several small nival-regime basins. This project began in 1976 and has since been broadened to encompass several research topics. More specifically, the minor objectives are (1) to study the precipitation distribution in small High Arctic basins to enable an accurate assessment of precipitation input for water balance studies, and to enable an areal evaluation of snow accumulation distribution with regard to basin topography; (2) to apply an energy balance approach to study snowmelt in an High Arctic environment; (3) to assess the role of evaporation in the High Arctic, using both a water balance approach and computations based on a Penman-type combination model; (4) to understand the processes of stream development in snowfilled channels from the period of initial snowmelt runoff to the stage when the streams stabilize their flow in the snowfree channels; (5) to document the hydrologic behaviour of small Arctic lakes dur-

## HYDROLOGY

ing the breakup and the ice-free periods.

1757 WOO, M-K., and MARSH, P. - 1978  
Error analysis in the determination of snow storage for a small High Arctic Basin; *in* Proc. 2nd Conf. Hydrometeorology, October 25-27, 1977, Toronto, Ont., Pub. Amer. Meteorological Soc., Boston, Mass., pp. 239-244.

Water balance studies of small basins require precipitation data. In the Canadian Arctic, however, weather station records are often inadequate for determining basin precipitation input. One major problem is the inability of the stations to provide snowfall data representative of their nearby basins. This difficulty can be overcome by conducting extensive basin snow surveys, but time and costs usually make this impractical. Instead, attempts have been made to reduce regional variability by identifying land use or terrain units and then obtaining snow depth and density information for each unit. In the sub-Arctic, vegetation is considered to be an important factor determining snow distribution. In a forest-tundra environment, characteristic snow depths are associated with various topographic features. Granberg's finding suggests the feasibility of determining basin snow coverage from a knowledge of terrain types.

In the High Arctic, snowfall constitutes a large proportion of total precipitation. For water balance studies, it is essential to obtain accurate information on basin snow storage prior to the melt season. The objective of the present paper is therefore to assess the possibility of determining basin snow storage using a late-winter snow survey, and to evaluate the error associated with the basin snow storage thus determined.

1758 WOO, M-K., and HERON, R. - 1978  
Hydrology of two small basins in the vicinity of Resolute, Cornwallis Island, N.W.T.; *Polar Cont. Shelf Proj.*, internal report, 49 p.

Field work was carried out between June and October 15, 1978 in two small basins 5 km north of Resolute, Cornwallis Island, N.W.T. The overall objective is to study the hydrologic behaviour of these two basins. The project is a continuation and an extension of the study started in 1976. Specifically, the minor objectives of the 1978 field season are: (1) to further examine the water balance of a small basin by accurately determining the basin snow storage, summer rainfall and streamflow; (2) to complete the snowmelt study which was started in 1977. This involves a better definition of the boundary layer and detailed measurement of snow and ground temperatures during the snowmelt season; (3) to study the break-up and freeze-up events of a small lake; (4) to devise a means of measuring trace rainfall.

1759 WOO, M-K., and MARSH, P. - 1978  
Analysis of Error in the Determination of Snow Storage for Small High Arctic Basins; *J. Applied Meteorology*, vol. 17, no. 10, pp. 1537-1541.

Water balance studies in tundra regions require accurate snowfall data but weather station records often underestimate basin snow storage. However, snow storage can be determined by snow surveys conducted prior to the melt period because Arctic snowpacks do not melt during winter. Topography strongly controls snow distribution. A basin can be subdivided into various terrain types and the snow survey then establishes the snow characteristics of each terrain type so that basin snow storage is obtained as their areally weighted mean.

Such a survey was carried out in small basins near Resolute, Northwest Territories, traversing different types of terrain. The results confirmed that weather station snowfall grossly underestimated basin snow storage. Since it is also desirable to simplify future snow surveys by reducing the number of transects, an error analysis was performed to determine the error resulting from a grouping of terrain types. It was found that both maximum and mean error increased as the number of terrain types was reduced, but the increase was not substantial when certain terrain types were combined. A mean error of 15% is expected when only four types of terrain (hilltops, flats, gullies-valleys and slopes) are recognized in the survey, but the error quickly increases when further simplification of the terrain is introduced.

1760 WOO, M-K. - 1979  
Floating Ice - River & Lake, Cornwallis Island; *Ice*, no. 59, p. 7.

1761 WOO, M-K., and HERON, R. - 1979  
Modelling basin snow storage in a High Arctic environment; Presented at 10th Canadian Hydrology Sym., Cold Climate Hydrology, May 10-11, 1979, Vancouver, B.C., 10 p.

A physically-based model was developed to simulate snow storage in a small High Arctic basin. This model incorporates spatial variations of snow distribution according to terrain characteristics. An extension of snowfall and snowmelt events from a base station to the entire basin makes use of an indexing method and an energy balance approach.

The model was applied to a small drainage basin which was first sub-divided into terrain units. For each unit, daily changes in snow storage was budgeted. A comparison of the observed and the computed snow-covered areas in the basin during the snowmelt period indicates that the model was able to simulate spatial variations of snow distribution.

## METEOROLOGY

1762 BROWN, R.A. - 1978

A summary of the planetary boundary layer model for AIDJEX; *AIDJEX Bull.*, Univ. Wash., Seattle, No. 38, pp. 95-116.

A two-layer, first order closure model for the planetary boundary layer (PBL) was developed with the objective of parameterizing the surface stress on a synoptic scale. The model includes stability effects by considering stratification-dependent secondary flow in the outer layer and empirical corrections to the surface layer flow. It shows the compatibility of simple eddy viscosity closure solutions with similarity theory by producing the Rossby similarity equations. It allows further insight into the Rossby similarity parameters by relating them to a single similarity parameter which is the ratio of the characteristic scale of the PBL to that of the surface layer.

The measured and derived values of the similarity parameters  $A$  and  $B$  are compared with the AIDJEX data and other published values. The variation in these values in stably stratified conditions is predicted by the theory, and two alternate similarity parameters are calculated, one a constant and the other with a small variation and a decreasing influence on the drag coefficient in stable stratification. The result is an empirical resistance law for a geostrophic drag coefficient variation which parameterizes an observed order of magnitude change in surface stress with changes in roughness or PBL stratification. This variation is related to similarity parameters characteristic of the pack ice region and to measurable changes in the geostrophic departure angle.

1763 CARSEY, F., SHORT, D., ANDERSEN, R., BELL, D., BROWN, R., CLARKE, M., JOHNSON, A., LEAVITT, E., and PAULSON, C. - 1978

Analysis of AIDJEX data from a boundary layer profiler, spring 1976; *AIDJEX Bull.*, Univ. Wash., Seattle, No. 38, pp. 117-131.

A boundary layer profiler carried aloft by a tethered balloon was used to collect data at AIDJEX camp Caribou in February 1976. In general, the balloon was not reliable at probing the entire boundary layer height, but sufficient height was reached to permit close approximation to most of the parameters of interest: geostrophic wind speed ( $G$ ), drag coefficient ( $u_*^2/G$ ), total wind turning ( $\alpha$ ), and bulk Richardson number ( $Ri_b$ ). Results show that  $\alpha$  increases with increasing  $Ri_b$  and decreases with increasing  $G$ , while  $u_*^2/G$  increases with both  $G$  and  $Ri_b$ . In the limit as  $Ri_b \rightarrow 0$ ,  $\alpha \rightarrow 230^\circ + 5$  and  $u_*^2/G \rightarrow 0.017 + 0.005$ .

1764 CARSEY, F.D. - 1978

Character of Arctic PBL structure as determined by acoustic radar; *AIDJEX Bull.*, Univ. Wash., Seattle, No. 38, pp. 132-150.

Acoustic radar and surface meteorological data are analyzed for descriptive and quantitative information about the structure of the planetary boundary layer (PBL) over arctic pack ice.

The data span most of the year from mid-April 1975 to mid-April 1976. Specific topics discussed are seasonal, diurnal, and synoptic variations in the inversion height  $Z_i$ ; events in the PBL including multiple layer structure, plumes, stratus, and storms; and the baroclinic impact of variations in  $Z_i$  and surface heat flux. In the Arctic most of the measured variations in  $Z_i$  are synoptic in origin. The data contain several types of multiple-echo structures, at least two of which indicate regimes of complex PBL flow. As the PBL becomes neutral in high wind or solar insolation the data for all seasons indicate  $fZ_i/u_* = 0.13$ , where  $u_*$  is the stress velocity and  $f$  the Coriolis parameter.

1765 HILL, S.H., FISSEL, D.B., and SERSON, H. - 1978

A study of wind and atmospheric pressure in eastern Parry Channel, N.W.T. - summer, 1977; *Env. Can.*, internal report, Inst. of Ocean Sciences, Pacific Marine Science Report 78-21, 59 p. *UNPUBLISHED MANUSCRIPT.*

Wind and air pressure data collected in eastern Parry Channel during the summer of 1977 are presented. Winds, as measured at the AES station at Resolute are found to differ significantly from simultaneous speed and direction measurements at other stations in the region, although correlation coefficients increase as the distance from Resolute decreases. Easterly wind components throughout the region show a better correlation with Resolute than do northerly wind components. A good correlation ( $r^2 = 0.76$  - with limited data of 9 days duration) is found between calculated geostrophic winds and measured winds at two stations in Barrow Strait.

1766 JAYAWEEERA, K.O.L.F. - 1977

Characteristics of Arctic stratus clouds over the Beaufort Sea during AIDJEX; *AIDJEX Bull.*, Univ. Wash., Seattle, No. 37, pp. 135-151.

The stratus cloud cover over Barrow, AIDJEX camp Big Bear, and the Beaufort Sea from May to September 1975 was studied by means of surface and satellite observations. Contrary to previous reports of consistently high long-term summer mean cloudiness, the values for 1975 showed a period of considerably low cloudiness. Comparison with the wind field suggests that a southerly component in the 700 mb winds corresponds to an increase in cloudiness and a northerly component corresponds to a decrease. The unusual northerly 700 mb flow during this year may explain both the low summer cloudiness and the severe ice conditions in the Beaufort Sea.

The temperature and emissivity profiles measured from an instrumented aircraft in May 1976 indicate that within a few days of formation of stratus cloud overcast the emissivity at the top part of a cloud becomes low and the temperature inversion drops down to the middle part of the cloud. Continuous solar heating and the effect of long-wave scattering may be responsible for these changes.



METEOROLOGY

1767 LEAVITT, E., ALBRIGHT, M., and CARSEY, F. - 1978  
Report on the AIDJEX meteorological experiment; *AIDJEX Bull.*, Univ. Wash., Seattle, No. 39, pp. 121-147.

A one-year series of meteorological data was collected during the AIDJEX experiment. This report summarizes the data set and describes the data reduction process and the final form of the data products. Representative mean parameters (wind speed, temperature, dew point, inversion height, and sensible and latent heat fluxes) are listed at six-hour intervals for the duration of the experiment.

1768 LEAVITT, E., ALBRIGHT, M., and BAUMANN, R. - 1978

Variations in planetary boundary layer parameters observed during AIDJEX; *AIDJEX Bull.*, Univ. Wash., Seattle, No. 39, pp. 149-163.

During the 1975-76 AIDJEX field study an extensive set of atmospheric boundary layer data was collected from the manned camps and data buoys. Using a surface drag coefficient  $C_{10} = 2.5 \times 10^{-3}$ , a time series of surface air stress and heat fluxes was computed. These data have been used in a study of variations in boundary layer wind turning, geostrophic drag coefficient, and Rossby similarity parameters (A and B) with stability. The AIDJEX data show excellent agreement with empirical functions derived by Arya from Wangara, Australia, data. Neutral values of A and B also agree very closely with values derived from recent PBL models. The ratio height scale  $u_* / f$  is 0.125 for this arctic boundary layer.

1536 McPHEE, M.G., MANGUM, L., and MARTIN, P. - 1978

Performance of met/ocean buoys in AIDJEX; *AIDJEX Bull.*, Univ. Wash., Seattle, No. 40, pp. 35-59.

1442 MILNE, A. - 1977

Oil, Ice and Climate Change; Beaufort Sea Project Overview Report Series, The Beaufort Sea and the Search for Oil, 103 p.

1522 MÜLLER, F., OHMURA, A., and BRAITHWAITE, R. - 1973

Das North Water-Projekt (kanadisch-grönlandische Hocharktis); *Geographica Helvetica*, 28, Jahrg. Nr. 2, pp. 111-117.

1525 MÜLLER, F., BERGER, P., BRAITHWAITE, R., ITO, H., MÜLLER, H., OHMURA, A., SCHROFF, K., and STEFFEN, K. - 1978

Glaciological and Climatological investigation of the North Water Polynya in Northern Baffin Bay; A Report on North Water Project Activities, October 1, 1976 to April 30, 1978, internal report, 152 p.

1682 PAUTZKE, C.G., and HORNOF, G.F. - 1978  
Radiation program during AIDJEX: a data report; *AIDJEX Bull.*, no. 39, pp. 165-185.

1769 STATEMAN, M. - 1978

Final disposition of AIDJEX data bank files; *AIDJEX Bull.*, Univ. Wash., Seattle, No. 40, pp. 190-201.

The termination of the AIDJEX project also signals the end of the AIDJEX data bank. All validated source data have been submitted to national data banks for permanent retention, together with pertinent documentation. Copies will be distributed from those facilities upon the request of interested scientists. The following information may be useful to them.

The data acquired during the AIDJEX main experiment have been validated, for the most part, by the principal investigators and analysts. Copies of finished data sets had been supplied to the data bank in several forms, such as unformatted binary using Fortran or Extended Fortran and in formatted SCOPE Internal Display code. Each set is in the format preferred by the analysts that created it. The units of common variables also vary with the analysts' preference--for example, time in minutes of the day, dates as year-days or AIDJEX days (starting 1 January 1975), latitude and longitude in decimal degrees, and position in rectangular coordinates originating at the North Pole.

Data presented to national data banks whose computer centers are not compatible with the CDC 6400 have been prepared in fixed block record size, external BCD, or even parity. Documentation is included as part of the headers and data records. Narrative descriptions of the data may be included as part of the header.

Appendix 1 is a description of the data sets developed and used by the AIDJEX analysts. It had been published in preliminary form in AIDJEX Bulletin No. 36 (May 1977), pp. 203-210.

Appendix 2 is a computerized list of the data transferred to the Environmental Data Service, which maintains the data banks at the National Oceanographic Data Center in Washington, D.C., and the National Climatic Center in Asheville, North Carolina.

1770 TAYLOR, R.B. - 1977

The summer climate of Cunningham Inlet, Somerset Island, District of Franklin; in Report of Activities, Part C; Geol. Surv. Can., Paper 77-1C, pp. 39-48.

The meteorological data presented in this report were collected during the summer months of 1974-76 in support of a research project which examined coastal processes along northern Somerset Island. The only source of continuous yearly meteorological data along Barrow Strait is from the Resolute Bay meteorological station located on southwestern Cornwallis Island. Because climatic conditions were thought to vary with geographic position and local topography along Barrow Strait, a program to measure meteorological parameters was carried out at the field base camp at Cunningham Inlet, Somerset Island.

1730 WONDERS, W.C. - 1978

The Joint Arctic Weather Stations (JAWS) in

the Queen Elizabeth Islands; *in* Essays on Meteorology and Climatology in honour of Richmond Longley, eds. K.D. Hage and E.R. Reinelt, pp. 399-418.

### OCEANOGRAPHY

1656 ANONYMOUS - 1979

Arctic expedition studies underwater mountain range; *the northern news report*, vol. 8, no. 4, p. 9.

1660 BOWER, D.R., and WEBER, J.R. - 1978

Estimation of the ocean tide from ice-surface gravity observations; *AIDJEX Bull.*, no. 38, pp. 151-157.

1532 DEYS, F.W. - 1978

Arctic CTD Data Processing System; *Fisheries and Env. Can.*, Tech. Note Series 78-2, 30 p. UNPUBLISHED MANUSCRIPT.

1665 DZEGUZE, K. - 1979

The Lomonosov Factor; *The Canadian Magazine*, July 7th Weekend Citizen, pp. 6-9.

1771 FISSEL, D.B., and MARKO, J.R. - 1978

A surface current study of eastern Parry Channel, N.W.T. - Summer 1977; *Env. Can.*, Inst. of Ocean Sciences, Patricia Bay, Contractor Report Series 78-4, 66 p.

Near-surface current measurements were obtained from nine drogued satellite-tracked buoys in eastern Parry Channel, from July to November, 1977. Persistent, and at times intense, coastal currents were observed on either side of eastern Parry Channel with eastward movements on the southern side and weaker and more variable westward flow on the opposite side. In the centre of the Sound, gyral motions appeared to dominate the flow pattern except off Wellington Channel and McDougall Sound where a southward current was measured. In Prince Regent Inlet and Peel Sound, a counter clockwise intrusion from Parry Channel was observed.

1772 HUNKINS, K. - 1977

Oceanographic aspects of the Arctic Ice Dynamics Joint Experiment (AIDJEX); *in* Proc. Polar Oceans Conf., ed. M.J. Dunbar, McGill Univ. May 1974, pub. Arctic Inst. North America, pp. 209-218.

AIDJEX is a large-scale study of interactions between the atmosphere, sea ice and the Arctic Ocean. The primary objective of the study is establishment of laws for sea ice behaviour. Oceanographic observations contribute to this aim by measuring water drag and pressure-gradient force on the ice. The results furnish input for theoretical ice drift models and

also provide constraints on such models. A secondary goal of AIDJEX is fundamental experiments on boundary layer processes in ocean and atmosphere. The three pilot programs completed in the Arctic Ocean north of Alaska have already identified new phenomena in the upper water layers. Under-ice boundary currents and subsurface eddies have been detected and studied during the pilot experiments; these currents and eddies will be investigated further and water drag and ocean tilt will be monitored continuously during the main experiment in 1975-1976.

1773 LANGLEBEN, M.P. - 1977

Water drag coefficient at AIDJEX, Station Caribou; *in* Proc. AIDJEX Review Meeting, Seattle, September 1977, pp. 233-239.

Measurements of current in the frictional boundary layer under the pack ice were made at AIDJEX, station Caribou for a period of one week between 15 and 21 November 1975. The observations were obtained with a rapid-response three-component ultrasonic current meter in which the measuring probe was immersed to a depth of 1m below the ice bottom. Time series analyses were performed on forty data runs, each of one-half-hour duration during which the mean current was reasonably steady. Water stress was calculated from the correlation between the downstream and vertical components of the deviation between instantaneous and mean current. Mean currents fell in the range of about  $1 \text{ cm s}^{-1}$  to  $14 \text{ cm s}^{-1}$  and values of water stress were between  $0.035 \text{ dyn cm}^{-2}$  and  $0.986 \text{ dyn cm}^{-2}$ . A 1-m water drag coefficient of  $4.1 \times 10^{-3}$ , corresponding to a roughness length of 1.9 mm, was calculated from a least-squares parabolic fit of stress against mean current.

1774 LEWIS, E.L., and PERKIN, R.G. - 1978

Salinity: Its Definition and Calculation; *J. Geophys. Res.*, vol. 83, no. C1, pp. 466-478.

Salinity data used to trace water movement or compute density are normally derived from measurements of chlorinity or electrical conductivity, temperature, and pressure. The latter technique has a precision about 1 order of magnitude greater than that of a typical chlorinity titration, but both are sensitive, in different ways, to variations in the ionic ratios of seawater. Present definitions of salinity are also ion dependent, causing significant variations in the salinity-density relationship which cannot be simply expressed. In order to obtain density to an accuracy commensurate with the available precision it is best to define salinity in relation to a water mass of known ionic content so that a density correction to be applied to other water masses may be expressed as variations from a fixed standard. These corrections then appear in the form of simple additive constants for most waters, and where density difference is the important parameter, no correction is necessary within a specific water mass. The new salinity definition is based on dilution by weight of a conductivity ratio labeled standard seawater. It would be variant under compositional variations and in accord with the proposed new equation of state.

It is conservative within acceptable limits, would provide a 'practical salinity scale' for use by oceanographers of all levels of sophistication, and would greatly facilitate data comparisons between institutions. The present variety of computational procedures for insitu data reduction would be replaced by one set of definitive equations that would not be subject to change as the precision of physical or chemical measurement improved. A great part of the data base necessary to write these equations exists, and the remainder should be available by 1978.

1536 McPHEE, M.G., MANGUM, L., and MARTIN, P. - 1978

Performance of met/ocean buoys in AIDJEX; *AIDJEX Bull.*, Univ. Wash., Seattle, No. 40, pp. 35-59.

1775 McPHEE, M.G. - 1978

The effect of the oceanic boundary layer on the mean drift of pack ice: application of a simple model; *AIDJEX Bull.*, Univ. Wash., Seattle, No. 39, pp. 1-31.

Smoothed records of ice drift, surface wind, and upper ocean currents at four manned stations of the 1975-1976 AIDJEX experiment in the central Arctic have been analyzed to provide a statistical relationship between stress at the ice-ocean interface and ice-drift velocity during a 60-day period when the ice was too weak to support internal forces. Using interfacial stress calculated from a balance with air stress and Coriolis force on the ice column for times longer than the inertial period, logarithmic linear regression of the stress-velocity samples provided the relation

$$\tau = 0.010V^{1.78}$$

where  $\tau$  is the magnitude of interfacial stress and  $V$  is the ice speed relative to the geostrophic current in the ocean. This result is statistically indistinguishable from predictions of a numerical model adapted from Businger and Arya with surface roughness,  $z_0 = 10$  cm. Essential features of the model are dynamic scaling by  $u_*$ ,  $u_*^2$ , and  $u_*/f$  for velocity, kinematic stress, and length, with exponential attenuation of a linear dimensionless eddy viscosity, viz.

$$K_* = -k\xi \exp(c_1\xi)$$

where  $\xi = fz/u_*$  and  $k$  is von Karman's constant. Currents measured 2 m below the ice confirmed the shape of the  $\tau$  vs.  $V$  curve and provided an estimate of the angle between surface stress and velocity. The model was used to estimate qualitatively the effect of a pycnocline at 25 m on surface characteristics. The observed behavior when stratification at that level was most pronounced tended toward slightly higher drag at higher speeds, which is qualitatively consistent with the model results.

1776 McPHEE, M.G. - 1978

AIDJEX oceanographic data report; *AIDJEX Bull.* Univ. Wash., Seattle, No. 39, pp. 33-77.

Results are presented which were obtained from fixed current meters, profiling current meters (PCM), and STDs during the 1975-1976 AIDJEX field experiment. Data include smoothed records of currents at 2 m and 30 m relative to the drifting ice from day 121 (1 May 1975) to day 481 (25 April 1976), a few PCM casts from summer 1975, some selected STD casts at station Blue Fox, mixed-layer characteristics from all available casts on days 121-481, and pycnocline  $\sigma_t$  contours from all available casts. Errors in current measurement are discussed, as is the impact of the oceanographic program on the ice modeling effort.

1441 MILNE, A.R. - 1977

Floating Ice - Beaufort Sea Project; *Ice*, no. 53, pp. 7-8.

1442 MILNE, A. - 1977

Oil, Ice and Climate Change: Beaufort Sea Project Overview Report Series, The Beaufort Sea and the Search for Oil, 103 p.

1777 MILNE, A.R. - 1979

Floating Ice - Sea, Beaufort Sea; *Ice*, no. 59, p. 9.

1522 MULLER, F., OHMURA, A., and BRAITHWAITE, R. - 1973

Das North Water-Projekt (kanadisch-grönlandische Hocharktis); *Geographica Helvetica*, 28, Jahrg. Nr. 2, pp. 111-117.

1778 MULLER, F., OHMURA, A., and BRAITHWAITE, R. - 1977

The North Water Project (Canadian-Greenland Arctic); *Polar Geography*, vol. 1, no. 1, pp. 75-85.

North Water is the name given to an unusually large polynya, or semi-permanent ice-free water area, at the northern end of Baffin Bay between Greenland and Ellesmere Island. It has been the subject of an international study program aimed at establishing the causes and quantitative impact of this open water area. The following report is by the Swiss team, which has been concerned mainly with the climatic and glaciological impact of North Water. Both a numerical model and a black-box model are proposed for air-mass transformation resulting from interaction between water and atmosphere in the North Water area.

1779 PECK, G.S. - 1977

Arctic Oceanographic Data Report 1976 - Penny Strait; *Fisheries Env. Can.*, internal report, Ocean and Aquatic Sci., Central Region Data Report Series No. 77-2, 153 p. UNPUBLISHED MANUSCRIPT.

This report contains CTD, current, and tidal data collected during a three-week reconnaissance survey in Penny Strait and Belcher Channel, N.W.T., in April, 1976. Beginning in 1977, a separate series of field reports has been instituted. Because there is no formal



field report for the survey, certain details, in relation to how the data were collected, are included in this report.

1780 PECK, G.S. - 1977

Arctic Oceanographic Survey - 1977, Field Report; *Fisheries & Env. Can.*, internal report, Ocean and Aquatic Sci., Central Region Field Report Series No. 77-2, 39 p.

The 1977 Arctic Oceanographic Survey investigated vertical salinity and temperature structure along three transects across M'Clure Strait, Prince of Wales Strait, and Viscount Melville Sound. Six current meter records were obtained from 4 stations at depths of approximately 6 and 30 m. Record lengths varied from 5 to 9 weeks.

This area was chosen for study because of the availability of the CHS-Polar Shelf base camp at Cape Bounty (Dundas Peninsula) as a base for our work. As an extension of our reconnaissance study in Penny Strait last year, the data collected in 1977 will be used to compute geostrophic flow obtained from averaged density transects and compare to the mean flow obtained by direct current meter measurements. The time series data will be subjected to constituent (harmonic) and power spectral analyses to derive the levels of motion and their causes. The data will also be useful for input into a general circulation model of the high Arctic and of Parry Channel specifically.

1781 PECK, G.S. - 1978

Arctic Oceanographic Data Report 1977, Western Viscount Melville Sound; *Fisheries & Env. Can.* internal report, Ocean and Aquatic Sci., Central Region Data Report Series No. 78-3, 150 p. UNPUBLISHED MANUSCRIPT.

This report contains current, tidal and CTD data collected during a short Arctic field program in March and April, 1977. Current meters were moored across M'Clure and Prince of Wales Straits and CTD measurements were taken along these two transects and a third in Viscount Melville Sound. Tide gauges were deployed by the Canadian Hydrographic Service to enable sounding reductions to be made, with an additional instrument being specifically deployed for our program. Details of the field program are available in a separate report.

1782 PERKIN, R.G., and LEWIS, E.L. - 1978

Mixing in an Arctic Fjord; *J. Physical Oceanography*, vol. 8, no. 5, pp. 873-880.

Measurements made in Cambridge Bay, N.W.T., during the winter show that the breaking of internal waves on the shore influences downward salt transport from the homogeneous surface layer produced by saline convection beneath sea ice during growth. Denser water from the shallows, where the depth of this convective layer is limited by the sea bed, flows down the slope to the layer interface contour where the breaking waves introduce turbulence aiding mixing of the convecting water into the lower layer.

Away from the boundaries entrainment of salt from the lower to the upper mixed layer is aided by the internal waves on the interface. These two salt transports, downward at the boundaries upward over the basin, produce horizontal salinity gradients which overall make water in the shallows less saline than the surface layer of the basin. The energies available for these mixing processes are estimated.

1783 POUNDER, E.R., and LeBLANC, A. - 1977

Ice-water stress at Station Snow Bird, AIDJEX; in Proc. AIDJEX Review Meeting, Seattle, September 1977, pp. 251-259.

A programme of synoptic oceanographical observations was carried out nearly continuously from Drifting Station Snow Bird in the Beaufort Sea during the period May 1975 to April 1976. There are a few brief breaks in the records because of malfunctions of one or other of the instruments and, towards the end, because cracking of the floe on which the station was sited required relocation of the instrument huts and the drilling of new hydroholes. The programme consisted of (at least) once-daily observations of the STD profile to a depth of 750m below the lower ice surface and twice-daily of the current profile to a depth of 200m. In addition currents were recorded continuously by two current meters supported 2m and 30m below the lower ice surface.

The STD records show that a mixed layer of constant temperature and salinity extended to a depth  $H$  below the ice surface during the winter season. The depth  $H$  varied seasonally, the layer forming in late August and reaching a maximum thickness of about 60m in May. Below this mixed layer there was a very sharp, thin halocline and thermocline. The water column of depth  $H$  consisted of a thin boundary layer adjacent to the ice surface and of the Ekman layer. From a study of current hodographs it was clear that frictional coupling between ice and water stopped at a level  $L < H$ . The level  $L$  was selected from the current hodograph as the centre of the first loop in the Ekman spiral.

On selected days throughout the year, chosen mainly when currents were relatively large, the water stress (drag) on the lower ice surface was calculated by integrating numerically the water and momentum transport from the depth  $-L$  to the ice surface. To investigate seasonal variation of water stress and the effect of water speed, drag coefficients were calculated from the usual equation

$$\tau_w = \rho_w C_D(z) V_z^2$$

where  $\tau_w$  is the water stress,  $\rho_w$  the water density,  $V(z)$  the current speed at depth  $-z$ , and  $C_D(z)$  is the drag coefficient calculated for the referenced depth. Two values of  $z$  were used:  $z = -2m$ , which is approximately the depth of the constant-stress boundary layer, and  $z = -5m$  which is in the top of the Ekman layer. In each case the  $\sigma_T$  plot of the water column (to  $z = -H$ ) was used to classify conditions as unstable, neutrally buoyant, or stable. Conclusions were drawn principally from

the neutrally buoyant situations.

It is difficult to determine the relative contributions to the water stress of skin friction and viscosity and of form drag. No underwater profiling of the lower ice surface was attempted so that no "correction" for form drag was possible, current measurements being made from a single point on the floe. The floe itself, which was over 2 km in length and breadth, was quite smooth with no surface indications of pressure ridging in its interior. However, shortly after the station was established a lead developed about 200m SW of the current meter hut. From time to time this lead was active, opening and closing to form a small pressure ridge (< 2m high). It seems reasonable to assume that the water stress resulted almost entirely from skin friction when the floe velocity was in the sector NW through N to SE.

Water stress values found were somewhat larger than found at other locations in the Beaufort Sea. They are analysed in terms of variation of drag coefficient with current direction, current speed and date.

1784 PRINSENBERG, S.J., and BROOKS, D.J. - 1978

Arctic Oceanographic Survey - 1978; *Fisheries and Env. Can.*, internal report, Ocean and Aquatic Sci., Central Region Field Report Series No. 78-1, 52 p. *UNPUBLISHED MANUSCRIPT*.

The 1978 Arctic Oceanographic Survey investigated the vertical and horizontal salinity and temperature distribution of the area surrounding the Barrow Sill. The CTD Survey covered that part of the North West Passage between the eastern side of Melville Island (105°W longitude) and the center of Cornwallis Island (94°W longitude). The main emphasis was placed on the four channels of the Barrow Sill area where repeated CTD transects were obtained. The centers of the four channels were also the locations at which 13-hour CTD data and surface (2m) and mid-depth (50m) current meter data were obtained. In addition, surface current meter data were obtained from each side of Keene Bank (south end of Austin Channel), and surface and mid-depth data were obtained from upstream of Keene Bank in support of the ARCTEC project. The current meter length varied from 4 to 5 weeks.

The CTD data will be used to compute the relative vertical geostrophic currents of the four channels and to investigate the exchange properties of the Arctic and Atlantic surface waters. The time-series data will be subjected to harmonic and power spectral analysis in order to study the decomposition and causes of the total currents. The mean currents will be used in conjunction with the relative geostrophic currents obtained from the CTD data. The final analyzed data will be used in a general circulation model of the high Arctic as well as in the M.O.T.-sponsored studies relating to the shipping of fossil fuels from the Arctic by means of tankers.

1785 PRINSENBERG, S.J. - 1978  
Arctic Oceanographic Data Report - 1978, Vol. I; *Fisheries and Env. Can.*, internal report, Ocean and Aquatic Sci., Central Region Data Report Series No. 78-4, 212 p. *UNPUBLISHED MANUSCRIPT*.

This report contains the profile data collected by Central Region, Ocean and Aquatic Sciences, in the center section of the North West Passage during the months of March and April, 1978. The conductivity and temperature data were obtained with a Guildline Mark IV CTD probe deployed from the ice surface using a small portable Arctic profiling winch. A helicopter (Bell 206B Jet Ranger), based at the Polar Continental Shelf Project camp at Resolute Bay, N.W.T., was used as the means of transportation and contained the recording electronics of the CTD system. The time-series current meter data and 13-hour station CTD data collected during this survey will be published separately.

1769 STATEMAN, M. - 1978  
Final disposition of AIDJEX data bank files; *AIDJEX Bull.*, Univ. Wash., Seattle, No. 40, pp. 190-201.

1786 STELTNER, H.A.R. - 1979  
Open-water and ice-covered sea-surface conditions on the eastern approaches to the Parry Channel, a Progress Report; Paper presented at EAMES Management Committee Meeting, Feb. 28 - March 1, 1979, Dartmouth, N.S., 35 p.

ERTS images from March and April 1973, SLAR images from August and September 1978, radar iceberg tracks from June and July 1978, ice reconnaissance flight December 1978, tide measurements from June and July 1978, and other observations and measurements are presented graphically and form the data base for the delineation of sea-surface shear lines, sources, sinks and gyres in the area north of Borden Peninsula and Bylot Island, N.W.T.

Ridging and rafting areas are identified, iceberg movements are related to tide and wind, the southward drain of surface water from the Lancaster Sound through the Navy Board Inlet is explained with the tide characteristics of the region, and the influence of Devon and Bylot icecaps on the water surface conditions is emphasized with the barometric gradients in the near-shore regions.

The results of this study can be applied in the planning of marine operations and are currently applied in the interpretation of satellite and remote-sensed images and planning of further specific location surveys and measurements in the continuous year-round efforts from Pond Inlet.

1733 STEPHENSON, F.E. - 1979  
Aerial photography of artificial islands in the Beaufort Sea, July 6, 1977 and September 28, 1977; *Can. Hydro. Serv.*, Pacific Region, Final Field Report, Inst. Ocean Sci., Patricia Bay, 25 p.

1734 STEPHENSON, F.E. - 1979  
Aerial photography of artificial islands in the Beaufort Sea, July 17, 1978 and August 29, 1978; *Can. Hydro. Serv.*, Pacific Region, Final Field Report, Inst. Ocean Sci., Patricia Bay, 26 p.

1787 WALKER, E.R. - 1977  
Aspects of oceanography in the Archipelago; *Env. Can.*, internal report, Inst. Ocean Sci., Patricia Bay, IOS Note - 3, 186 p. *UNPUBLISHED MANUSCRIPT*.

This note began as background material for studies of the Institute of Ocean Sciences, Patricia Bay, Canada, in the Queen Elizabeth Islands. However, like Topsy, it just grew, resulting in the present heterogenous form. However, it has a plan. Chapter 2 gives a brief description of the Arctic Ocean whence most water in channels of the archipelago comes. Next is a brief description of the geography of the archipelago followed in Chapter 4 by a discussion of those aspects of meteorology most relevant to oceanography, temperature, precipitation, and the most important components of the surface heat budget, the radiation terms. In Chapter 5 aspects of freshwater runoff affecting water characteristics and locally, movement are noted. The tidal and water level material in Chapter 6 stresses longer period fluctuations, daily tide data being widely available. In Chapters 7 and 8 sea ice statistics and water currents are briefly noted. Water structure as characterized by temperature and salinity profiles is discussed in Chapter 9 while results of studies in three fiords or bays are outlined in Chapter 10. Budgets and principles of pollutant dispersion are next noted. Brief appendices outline equations governing water motion, give common conversion factors, and include a short gazetteer.

#### OIL SPILLS

1492 FREEDMAN, W., and HUTCHINSON, T.C. - 1976  
Physical and biological effects of experimental crude oil spills on Low Arctic tundra in the vicinity of Tuktoyaktuk, N.W.T., Canada; *Can. J. Bot.*, vol. 54, no. 19, pp. 2219-2230.

1425 GERACI, J.R., and SMITH, T.G. - 1977  
Consequences of oil fouling on marine mammals; in *Effects of Petroleum on Arctic and Subarctic Marine Environments and Organisms*, Vol. II Biological Effects, ed. Donald C. Malins, Academic Press Inc., New York, pp. 399-410.

1788 LEWIS, E.L. - 1977  
Floating Ice - Frozen Sea Research Group; *Ice*, no. 53, p. 8.

1789 MILNE, A.R., HERLINVEAUX, R.H., and WILTON, G. - 1977  
A field study on the permeability of multiyear ice to sea water with implications on its permeability to oil; Report to Env. Emergency Br., Env. Protec. Serv., Fisheries & the Env., EPS 4-EC-77-11, 33 p.

Four multiyear ice floes of opportunity, in the vicinity of Resolute Bay, N.W.T., were investigated for their permeability with respect to sea water. Experiments took place between 24th August and 19th September, 1976, when the ice floes were expected to be warmest and hence most porous to brine drainage. The main technique was to measure the flow-rate of water which filled blind holes drilled to various depths in the ice. All holes flooded but at varying rates, depending on the particular floe examined, and the hole depth. A simple, analytical model for hole-flooding, where applicable, enabled the porosity with respect to interconnected pores and capillaries to be determined. Although no oil was used, results indicate that most, if not all oil trapped in and under multiyear ice should surface before mid-September if it was spilled under the ice during the previous winter and spring.

1450 PERCY, J.A. - 1978  
Effects of Chronic Exposure to Petroleum Upon the Growth and Molting of Juveniles of the Arctic Marine Isopod Crustacean *Mesidotea entomon*; *J. Fish. Res. Board Can.*, vol. 35, no. 5, pp. 650-656.

1790 ROSS, S.L., LOGAN, W.J., and ROWLAND, W. - 1977  
Oil Spill Countermeasures, The Beaufort Sea and the Search for Oil; *Fisheries & Env.*, Inst. Ocean Sci., Patricia Bay, ed. A.R. Milne, 67 p.

#### SEA ICE RESEARCH

1791 ADAMS, W.A. - 1977  
Floating Ice - Environmental Consequences of Light Penetration through Snow and Ice; *Ice*, no. 53, p. 7.

1792 ADAMS, W.A. - 1978  
Effects of ice cover on the solar radiation regime in Canadian lakes; *Verh. Internat. Verein Limnol.*, vol. 20, pp. 141-149.

The intensity and spectral distribution of solar radiation penetrating an ice covered lake depends on its optical properties -- the reflectance, scattering and absorption of the ice sheet and water column. In addition, the geographic location of the lake controls the radiation regime within the lake by influencing factors such as solar elevation and hours of daylight experienced during different seasons. Climatic factors interacting with the peculiar features of individual lakes determine the characteristics of the ice cover such as its



## SEA ICE RESEARCH

stratigraphy and duration. Although the thermal behaviour of lakes has long been studied and used as a classification parameter, little attention has been given to the winter (ice cover) radiation regime and optical properties of the ice cover in this regard.

This paper describes the measurement systems developed for use under extreme winter conditions to characterize the optical properties of floating ice, presents some of the results, and gives three areas of application: in primary productivity, oil pollution and remote sensing research.

1793 ADAMS, W.A., and FLAVELLE, P.A. - 1978  
Low Temperature Adapted Submersible Spectrophotometers for Use in Floating Ice Research; *Env. Can.*, Inland Waters Directorate Scientific Series No. 82, 15 p.

The calibration and operation of underwater spectrometers in the visible region (400 nm to 750 nm) are described. The application of the spectrometers for the measurement of the penetration of solar radiation through floating ice is presented with examples of systems used for a variety of ice conditions. The methods used for handling the data, both analog and digital, are given. Also discussed is the role of these spectroscopic techniques in glaciological and limnological studies.

1794 AIDJEX STAFF - 1977  
A Preliminary AIDJEX Model Simulation with 1972 Data; *AIDJEX Bull.*, Univ. Wash., Seattle, no. 37, pp. 1-23.

The ice cover in a portion of the Beaufort Sea was simulated with the AIDJEX sea ice model for the period 11 to 16 April 1972. The motion was driven by air stress fields derived from surface pressure data. The boundary of the region was determined by a ring of imaginary buoys whose initial positions were arbitrarily chosen to encircle a manned station and whose subsequent positions during the 6-day simulation were assumed to be wind driven. The initial conditions on stress and thickness distribution were homogeneous. The initial velocities were the local wind-driven velocities.

As the integration proceeded, stress, velocity and thickness distribution were calculated in the interior of the region from the momentum equation, the constitutive laws, and the thickness distribution equation, as described below. The calculated velocities were generally directed to the northwest and reached 20 cm sec<sup>-1</sup> at times. Toward the end of the run spatial gradients became marked, the velocity varying through 180° across the solution region. At no time was the divergence of internal ice stress large enough to affect the momentum balance.

This run was designed primarily as an exercise to test our capability to set the inputs in an acceptable form and perform the numerical integration, and in this objective we have succeeded.

1795 ARNOLD, K.C., SHERSTONE, D.A., and TERROUX, A.C.D. - 1977  
Floating Ice - Aerial Photography; *Ice*, no. 53, p. 7.

1796 ARNOLD, K.C., SHERSTONE, D.A., and TERROUX, A.C.D. - 1978  
Floating Ice - River & Lake, Mackenzie Valley, N.W.T.; *Ice*, nos. 56 & 57, p. 7.

1530 BROWN, W.P. - 1978  
Arctic Environmental Buoy Systems; *AIDJEX Bull.* Univ. Wash., Seattle, No. 40, pp. 15-20.

1662 BRYAN, L., FARR, T., LEBERL, F., and ELACHI, C. - 1977  
Synthetic aperture radar imagery of the AIDJEX triangle; *AIDJEX Bull.*, no. 37, pp. 161-187.

1664 CAMPBELL, W.J., WAYENBERG, J., RAMSEYER, J.B., RAMSEIER, R.O., VANT, M.R., WEAVER, R., REDMOND, A., ARSENAULT, L., GLOERSEN, P., ZWALLY, H.J., WILHEIT, T.T., CHANG, T.C., HALL, D., GRAY, L., MEEKS, D.C., BRYAN, M.L., BARATH, F.T., ELACHI, C., LEBERL, F., and FARR, T. - 1978  
Microwave remote sensing of sea ice in the AIDJEX main experiment; *Boundary-Layer Meteorology*, vol. 13, pp. 309-337.

1797 COLONY, R. - 1978  
Daily rate of strain of the AIDJEX manned triangle; *AIDJEX Bull.*, Univ. Wash., Seattle, no. 39, pp. 85-110.

The daily changes in position of three manned camps during the AIDJEX experiment have been used to estimate the large-scale strain rate of sea ice. A definition of mean strain for a large area of sea ice is proposed. Estimates of the daily rate of mean strain are given in tabular form. It is emphasized that the strain rates are for the deformation of the triangle connecting the camps; this is only an estimate of the "true" deformation of a differential element of sea ice containing the three camps. A spectral analysis of the time series of stretching rate provides evidence that the daily rate of strain is a good measure of the instantaneous strain rate.

1798 GLOERSEN, P., ZWALLY, H.J., CHANG, A.T.C., HALL, D.K., CAMPBELL, W.J., and RAMSEIER, R.O. - 1978  
Time-dependence of sea-ice concentration and multiyear ice fraction in the Arctic Basin; *Boundary-Layer Meteorology*, vol. 13, pp. 339-359.

The time variation of the sea-ice concentration and multiyear ice fraction within the pack ice in the Arctic Basin is examined, using microwave images of sea ice recently acquired by the Nimbus-5 spacecraft and the NASA CV-990 airborne laboratory. The images used for these studies were constructed from data acquired

from the Electrically Scanned Microwave Radiometer (ESMR) which records radiation from earth and its atmosphere at a wavelength of 1.55 cm. Data are analyzed for four seasons during 1973-1975 to illustrate some basic differences in the properties of the sea ice during those times. Spacecraft data are compared with corresponding NASA CV-990 airborne laboratory data obtained over wide areas in the Arctic Basin during the Main Arctic Ice Dynamics Joint Experiment (1975) to illustrate the applicability of passive-microwave remote sensing for monitoring the time dependence of sea-ice concentration (divergence). These observations indicate significant variations in the sea-ice concentration in the spring, late fall and early winter. In addition, deep in the interior of the Arctic polar sea-ice pack, heretofore unobserved large areas, several hundred kilometers in extent, of sea-ice concentrations as low as 50% are indicated.

1799 HIBLER, W.D. III, and TUCKER, W.B. III  
- 1977

An examination of the viscous wind-driven circulation of the Arctic ice cover over a two year period; *AIDJEX Bull.*, Univ. Wash., Seattle, no. 37, pp. 95-133.

To demonstrate that many alleged shortcomings of viscous models are more apparent than intrinsic, a detailed re-examination of the viscous approach is made by comparing predicted with observed ice drift in the Arctic basin over a two-year period employing a viscous constitutive law having both bulk and shear viscosities. Using available atmospheric and oceanic input data in 8-day averaged form and seasonally varying viscosity parameters without spatial variations, numerical drift calculations for the Arctic Basin are carried out at 4-day intervals over a two-year period employing periodic boundary conditions. Drift predictions are compared with the observed drift of three contemporaneous drifting stations with reasonable agreement. The largest errors are found to occur in late summer, and may be due to nonsteady current effects. Numerical finite-difference boundary value calculations are also made using seasonal averaged input data. These boundary value calculations show that reduction of the shear viscosity (while still maintaining a large bulk viscosity) reduces the excessive stiffening often found in viscous models while still maintaining substantial changes in drift direction due to boundaries. Sensitivity studies show steady current effects to be small for drift rates over tens of days but not negligible for cumulative drift over years.

1772 HUNKINS, K. - 1977

Oceanographic aspects of the Arctic Ice Dynamics Joint Experiment (AIDJEX); *in Proc. Polar Oceans Conf.*, ed. M.J. Dunbar, McGill Univ. May 1974, pub. Arctic Inst. North America, pp. 209-218.

1800 ITO, H., and MÜLLER, F. - 1975  
Measurement of Sea Ice Force by Strain Rosette in the North Water Area; *in Proc. Third Inter. Conf. Port and Ocean Engineering under Arctic Conditions*, Univ. Alaska, Fairbanks, August 11-15, 1975, Vol. 1, pp. 269-284.

Pim Island (approx. 12 km by 6 km) in Kane Basin, between Ellesmere Island and Greenland, and a hypothetical dam across the southern end of Kane Basin are treated as models of large structures suffering sea ice force. Field data for the study was collected as part of the North Water project during spring 1974 and in 1975.

Strain rosettes of three different sizes were set in the sea ice 5 to 12 km north-east of Pim Island: four of 50 m, two of 2 km and one of 10 km. The 50 m rosettes were measured by steel tape whilst the others were measured by optical theodolite and an Electronic Distance Measurer (EDM). The strain at each point was computed and then the stress calculated, assuming several constitutive laws: elastic, Newton's, and Glen's laws. Forces parallel and perpendicular to the coast of Pim Island were integrated along three sides of an imaginary 10 km square with one side resting on the coast. The reacting force from the structure, Pim Island, was computed for equilibrium of forces. The sea ice force on the hypothetical dam was computed in a similar way.

From the analysis it appears that the 50 m rosette size is the most suitable one and that Glen's law serves best for the computations required for this study. The greatest difficulties arose from the uncertainties in the specifications of the constitutive laws.

1379 ITO, H., and MÜLLER, F. - 1977

Horizontal movement of fast ice in the North Water area; *J. Glaciology*, vol. 19, no. 81, pp. 547-554.

1801 KOERNER, R.M. - 1979

Floating Ice - Sea, Monitoring and Modelling; *Ice*, no. 59, p. 9.

1773 LANGLEBEN, M.P. - 1977

Water drag coefficient at AIDJEX, Station Caribou; *in Proc. AIDJEX Review Meeting*, Seattle, September 1977, pp. 233-239.

1675 LEWIS, C.F.M. - 1978

Drift Ice Scratches the Seafloor; *GEOS* pp. 18-20.

1788 LEWIS, E.L. - 1977

Floating Ice - Frozen Sea Research Group; *Ice*, no. 53, p. 8.

1802 LINDSAY, D.G. - 1978

Floating Ice - Sea, Remote Sensing; *Ice*, nos. 56 & 57, p. 5.

1803 MARKO, J.R. - 1977

A satellite-based study of sea ice dynamics in the central Canadian Arctic Archipelago; *Fisheries & the Env.*, Inst. Ocean Sci., Patricia Bay, Contractor Report Series 77-4, 106 p.

NOAA and LANDSAT satellite imagery, as well as historical ice chart data, have been used to establish the characteristic distributions and movements of sea ice in the central Arctic Archipelago. The dominant features of the ice circulation were the strong easterly and southerly movements, after break-up, of the Parry and McClintock Channels, respectively. In the eastern Parry Channel (Lancaster Sound), the easterly trend of motion continued throughout the year. The cited movement tendencies combined with the observed, extremely sluggish behaviour of the western Sverdrup Basin to produce characteristic late summer open water areas extending along the northern edge of Viscount Melville Sound and reaching as far north as the multiyear ice edge in Byam Martin Channel.

Ice floe displacement data indicate that large-scale ice motion first ceased in the north-south oriented side channels of Parry Channel. The directions of ice-drift in these side channels, e.g. Byam and Austin Channels, were largely determined by surface winds. Ice speeds were significantly larger when the wind and prevailing water-current velocities were, more or less, parallel. In Parry Channel, on the other hand, evidence indicated that macroscopic ice motion was dominated by surface current and possible internal icepack forces.

Qualitative and quantitative ice data were used to construct scenarios whereby oil spilled in the Sverdrup Basin may work its way downstream into the biologically-critical areas of Barrow Strait and Lancaster Sound.

1535 MARTIN, P., and GILLESPIE, C.R. - 1978  

Arctic odyssey - five years of data buoys in AIDJEX; *AIDJEX Bull.*, Univ. Wash., Seattle, no. 40, pp. 7-14.

1775 McPHEE, M.G. - 1978

The effect of the oceanic boundary layer on the mean drift of pack ice; application of a simple model; *AIDJEX Bull.*, Univ. Wash., Seattle, no. 39, pp. 1-31.

1804 McPHEE, M.G. - 1978

The free-drift velocity field across the AIDJEX manned camp array; *AIDJEX Bull.*, Univ. Wash., Seattle, no. 38, pp. 158-169.

The observed velocity field across the AIDJEX triangle of manned stations is compared with the free-drift velocity field the ice would have under conditions of no internal stress as driven by surface winds observed at the camps. Calculations were made for the entire 1975-76 field project, with plots presented of velocity components at each camp and of velocity gradient characteristics (vorticity, principal strain rates, principal angle). The

report is intended to indicate times when internal ice forces are important in the momentum balance.

1442 MILNE, A. - 1977

Oil, Ice and Climate Change; Beaufort Sea Project Overview Report Series, The Beaufort Sea and the Search for Oil, 103 p.

1789 MILNE, A.R., HERLINVEAUX, R.H., and WILTON, G. - 1977

A field study on the permeability of multiyear ice to sea water with implications on its permeability to oil; Report to Env. Emergency Br., Env. Protec. Serv., Fisheries & the Env., EPS 4-EC-77-11, 33 p.

1525 MÜLLER, F., BERGER, P., BRAITHWAITE, R., ITO, H., MÜLLER, H., OHMURA, A., SCHROFF, K., and STEFFEN, K. - 1978

Glaciological and Climatological investigation of the North Water Polynya in Northern Baffin Bay; A report on North Water Project Activities, October 1, 1976 to April 30, 1978, internal report, 152 p.

1805 MULLER, F. - 1977

Floating Ice - Sea Ice Dynamics, North Water; *Ice*, no. 53, p. 7.

1806 MÜLLER, F. - 1978

Floating Ice - Sea, Remote Sensing; *Ice*, nos. 56 & 57, p. 5.

1807 PRITCHARD, R.S., COON, M.D., McPHEE, M.G. and LEAVITT, E. - 1977

Winter ice dynamics in the nearshore Beaufort Sea; *AIDJEX Bull.*, Univ. Wash., Seattle, no. 37, pp. 37-93.

Ice conditions and motion in the nearshore Beaufort Sea from 27 January to 3 February 1976 were strongly affected by ice stresses. We chose to simulate this response using the AIDJEX model. There is no motion during the first two days. When motions begin, they are westward. There is a time lag with ice in the eastern portion responding later. In the nearshore area a fast ice region exists that is separated from the moving pack by a discontinuity. These conditions are verified by NOAA satellite images and data from drifting buoys and AIDJEX manned camps. The model is shown to simulate these features accurately, including the velocity discontinuity. This test of the AIDJEX model shows that we understand how ice responds on the large scale to driving forces and are able to describe this relationship at times when the ice stress exerts a dominant influence on the response. This model allows us to use winds (including the large set of historical winds) to determine ice velocity (and trajectories) and to estimate the large-scale average forces that pack ice may exert.



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1808 SHERSTONE, D.A., and TERROUX, A.C.D. -  
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Floating Ice - River & Lake, Mackenzie and  
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tions on the eastern approaches to the Parry  
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March 1, 1979, Dartmouth, N.S. 35 p.

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MAE, J. - 1973  
EOS Routing Study 1972, Pond Inlet, N.W.T.,  
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tigations Analytical Efforts and Reports;  
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94 p.

The Routing Study efforts in 1972 generated  
from the EOS Project of the A.G. Weser, a lead-  
ing shipyard in Bremen, Germany, under a joint  
program with the Ministry of Science and Edu-  
cation of the Federal Republic of Germany.  
This program expressed the F.R.G.'s government  
policy to participate with up to 50 percent of  
the cost of developing new technologies with  
an inherent high financial risk whilst the in-  
dustrial partner was entirely responsible for  
the management of all ensuing R & D efforts.

As a substantial effort was projected, assist-  
ance and guidance was solicited in Canada. From  
this time on, to trace the origin of the many  
contributory thoughts is an almost impossible  
task as the proposed undertaking became a team  
effort in which, foremost, members of the De-  
partment of Geological Sciences of Brock Uni-  
versity, the Polar Continental Shelf Project  
of the Department of Energy, Mines and Resour-  
ces, and many individuals in various capacities  
contributed to the refinements of the concept  
of the first phase of the Routing Study.

1810 THORNDIKE, A.S., and COLONY, R. - 1977  
Estimating the deformation of sea ice; *AIDJEX  
Bull.*, Univ. Wash., Seattle, no. 37, pp. 25-  
36.

In current treatments of the large-scale inter-  
action between sea ice and its environment, an

important role is assigned to the deformation  
of the ice pack. Deformation occurs by the  
three mechanisms of pressure ridging, the for-  
mation of open leads, and shearing along exist-  
ing leads.

Pressure ridges are important, from a dynamical  
point of view, primarily because of the work  
required to form them. For a given deformation,  
the work done in ridging can be used to estim-  
ate the state of stress in the ice pack. Ridges  
are also important because of the large propor-  
tion of mass tied up in them. They affect the  
roughness characteristics of the top and bottom  
surfaces of the ice, and are thought to have  
anomalous rates of ice growth and melting.

The presence of leads has two consequences. The  
strength of the ice pack decreases as the area  
of leads increases. If the fractional area of  
leads is as large as 10% - 20%, it is thought  
that the pack offers no resistance to applied  
forces. From a thermodynamic view, a vigorous  
exchange of heat and moisture occurs over leads,  
and the ice grows rapidly as a lead begins to  
freeze over.

Some shearing displacement along a wide lead  
can occur with no effect, but as the displace-  
ment increases, the irregular lead edges will  
come into contact and locally large stresses  
will cause the ice to break. Long, narrow re-  
gions in which floes appear pulverized are  
thought to be regions of concentrated shear de-  
formation.

Having defined a probability density function  
to describe the relative abundance of ice of  
different thicknesses, Thorndike et al. (1975)  
developed a model which parameterizes the three  
deformation mechanisms in terms of a given  
strain rate tensor. This model has been coupled  
with a mechanical constitutive law to calculate  
the state of stress in a differential element  
of sea ice. The input data for these calcula-  
tions are estimates of strain rate components.  
In what follows we discuss one measurement set  
from which strain rate estimates can be made,  
the procedure for making the estimates, and how  
the estimated quantities should be interpreted.

The deformation mechanisms are active at the  
boundaries separating nearly rigid floes which  
have length scales of up to tens of kilometers.  
The motion on such a scale is piecewise rigid  
with discontinuities between the floes. Along  
the lines argued by Maykut et al. (1972), an  
element of sea ice with a length scale of 100  
km can be expected to contain many floe-to-floe  
discontinuities and therefore to have a well-  
defined average deformation. Such an element  
is still small compared with the wave length  
of the Nye and Thomas curve.

1811 UNTERSTEINER, N. - 1979  
A review of the AIDJEX Project, 1970-77; *Polar  
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The basic nature of the ice dynamics problem  
has been understood for many decades; irregu-  
larly shaped, interlocking pieces of ice are  
driven by air and water currents, influenced  
by internal stresses, deflected by the earth's  
rotation, and subject to melting and freezing

## SURVEYING

as dictated by the regional climate. An increased understanding of these processes has shown that synoptic data are needed if further progress is to be made. Thus the idea for a scientific programme such as the Arctic Ice Dynamics Joint Experiment (AIDJEX) was conceived.

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1697 WEBER, J.R. - 1978  
Ice floes in collision; *J. Glaciology*, vol. 20, no. 82, pp. 135-139.

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Floating ice - River & Lake, Mackenzie Valley, N.W.T.; *Ice*, nos. 56 & 57, p. 7.

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Seasonal photo mosaics of the AIDJEX triangle; *AIDJEX Bull.*, Univ. Wash., Seattle, no. 39, pp. 79-84.

This note presents and briefly describes four airphoto mosaics of the AIDJEX triangle which were constructed at the AIDJEX office from data collected during the NASA Arctic Experiment Program. This program consisted, in part, of series of flights by the fully instrumented NASA CV-990 over the site of the AIDJEX triangle in April, August, and October 1975 and in April 1976. One mosaic from each period is presented.

The photos were taken with an RC-9 or, in the case of the April 1975 mosaic, an RC-8 Wild/Heirbrugg aerial mapping camera using Kodak black and white Pan 3410 film. Both cameras have a film format of 9 inches square. The RC-9 is fitted with a 3.5-inch lens, whereas the RC-8 lens has a focal length of 6 inches. The photographs in both the October 1975 and

the April 1976 mosaic were acquired from an altitude of 29,000 feet, in April 1975 from 33,000 feet, and in August 1975 from 35,000 feet. The flying time from start to finish of a mosaic was about two hours close to local noon.

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Summary of technical developments in AIDJEX; *AIDJEX Bull.*, Univ. Wash., Seattle, no. 40, pp. 1-5.

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1813 MARTIN, P., GILLESPIE, C.G., THORNDIKE, A., and WELLS, D. - 1978  
Position measurements of AIDJEX manned camps using the navy navigation satellite system; *AIDJEX Bull.*, Univ. Wash., Seattle, no. 40, pp. 83-101.

The Navy Navigation Satellite System was used during AIDJEX to make precise measurements of the positions of the four manned camps. Satellite signals were acquired under computer control to standardize and maximize data collection. Single-channel (400 MHz) translocation (relative positioning) was used to measure changes in distance between camps and a reference azimuth at each camp. Special attention was given to the frequency and time references for Doppler counting, and an efficient editing algorithm was used to ensure that translocation Doppler data matched. Statistical filtering after the experiment produced smoothed and evenly spaced estimates of position, velocity, acceleration, and azimuth.

An ensemble of 500 fixes from a period of virtually no ice motion was examined for position errors. Of these, 68% from a single station had errors of less than 75 m. For translocation between two stations separated by 100 km, 68% of the errors were less than 20 m, and between two receivers separated by 100 m at the same station 68% of the errors were less than 5 m.

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1677

Seaton, J.B.  
1582

Sergeant, D.E.  
1422, 1483

Serson, H.  
1765

Sherstone, D.A.  
1699, 1795, 1796, 1808

Shilts, W.W.  
1562, 1563, 1564

Shimada, K.  
1461, 1480

Short, D.  
1763

Sinha, A.K.  
1689, 1690

Siniff, D.B.  
1462

Sleno, G.A.  
1463

Smiley, B.D.  
1443

Smith, P.  
1475

Smith, R.F.C.  
1424, 1464

Smith, T.G.  
1420, 1425, 1460, 1465, 1466, 1467, 1468,  
1469, 1470, 1471, 1472



Smith, V.I.  
1460

Speller, S.W.  
1424

Stanley, H.R.  
1661

Stateman, M.J.  
1769

Steer, P.J.  
1754

Steffen, K.  
1525

Steltner, H.A.R.  
1786, 1809

Stephenson, F.E.  
1732, 1733, 1734

Stirling, I.  
1432, 1433, 1462, 1472, 1473, 1474, 1475,  
1476, 1477, 1478

Strandtmann, R.W.  
1426

Strangway, D.W.  
1674, 1686

Stutz, R.C.  
1479

Svoboda, J.  
1504, 1505

Sweeney, J.F.  
1691

Tan, J.T.  
1630, 1634

Tanno, K.  
1480

Tarnocai, C.  
1635

Taylor, A.E.  
1668, 1692

Taylor, D.  
1469

Taylor, H.W.  
1505

Taylor, R.B.  
1615, 1636, 1637, 1638, 1639, 1770

Terasmae, J.  
1809

Terroux, A.C.D.  
1698, 1699, 1729, 1795, 1796, 1808

Thomas, D.C.  
1481, 1482

Thomas, R.D.  
1640, 1641

Thompson, E.F.  
1410

Thompson, R.G.  
1498

Thorndike, A.  
1810, 1813

Thorsteinsson, R.  
1576

Tipnis, R.S.  
1642, 1643

Trettin, H.P.  
1643

Tucker, III, W.B.  
1799

Uemura, N.  
1550

Untersteiner, N.  
1811

Uyeno, T.T.  
1643

Van Bree, P.J.H.  
1483

Vant, M.R.  
1664, 1693

Van Zinderen Bakker Jr., E.M.  
1498

Veizer, J.  
1644

Vermette, P.  
1452

Vilks, G.  
1484, 1694

Vincent, J-S.  
1506, 1507, 1616, 1625, 1645, 1646

Visser, S.  
1446

Vitt, D.H.  
1508

Wagner, F.J.E.  
1485

Walbridge, J.  
1451

Walford, M.E.R.  
1695

Walker, B.D.  
1647

Zwally, H.J.  
1661, 1664, 1798

Walker, E.R.  
1787

Wallace, P.J.  
1589

Wang, L.C.H.  
1464

Wankiewicz, A.C.  
1755

Wayenberg, J.  
1664

Weaver, R.  
1664

Weber, J.R.  
1660, 1696, 1697

Wells, D.E.  
1813

West, R.M.  
1648

White, C.  
1551

Whitfield, D.W.A.  
1486, 1490, 1509

Widden, P.  
1487

Wilheit, T.T.  
1664

Wilson, M.V.H.  
1649

Wilton, G.R.  
1789

Wonders, W.C.  
1730

Wong, J.  
1686

Woo, M-K  
1744, 1749, 1756, 1757, 1758, 1759, 1760,  
1761

Yorga, B.  
1409

Young, F.G.  
1650

Young, G.M.  
1651, 1652, 1653

Zobens, V.  
1493

Zoltai, S.C.  
1635