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ICE SCOUR BIBLIOGRAPHY

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INTRODUCTION

Background

This bibliography is the first in a series of bibliographies to be prepared by the ESRF/ASTIS Project on the priority subjects of the Environmental Studies Revolving Funds. The purpose of the ESRF/ASTIS Project, in addition to providing the printed bibliographies themselves, is to enhance the ASTIS database in each of the ESRF priority subjects in order to provide a central source of environmental and social information relating to Canada Lands.

ESRF research in the ice scour priority subject is coordinated by the Ice Scour Program Study Committee, chaired by Bill Livingstone of Gulf Canada Resources. Studies currently in progress include:

- Evaluation of Sea Bottom Ice Scour Models
- Beaufort Sea Ice Scour Data Base
- Regional Ice Scour Update Studies: Grand Banks, Labrador Shelf, Baffin Bay, Davis Strait, Lancaster Sound
- Documentation of Iceberg Groundings: Grand Banks, Labrador Shelf, Baffin Shelf
- 1984 Beaufort Sea Repetitive Ice Scour Mapping
- Regional Ice Scour Update, Phase II
- Design of an Ice Scour Repetitive Mapping Network, East Coast
- Upslope and Downslope Iceberg Scouring

Scope of the Bibliography

Ice scour is defined as the disturbance of the bottom sediments of a water-body by floating ice. Ice scour therefore does not include the effects of non-floating ice such as glaciers, grounded ice shelves, ice rises, or ice ride-up. Synonyms for ice scour that are often used in the literature include: ice scoring, ice gouging, iceberg scouring, iceberg grounding, iceberg ploughing, iceberg furrowing, iceberg harrowing, plough marks, scour marks, or furrows.

Although it is ice scour in oceans that is of immediate ESRF concern, ice scour in lakes is relevant to ocean ice scour because it occurs through a

similar mechanism, and lake ice scour has therefore been included in this bibliography. Ice scour in rivers was deemed much less relevant, and has not been included. Ocean and lake ice scour on land that was formerly submerged but which is now above water has been included.

This bibliography only includes works on ice scour itself, and not on related subjects such as the properties and distribution of sea ice and icebergs, characteristics of bottom sediments, terramechanics, or current scour. The bibliography includes a small number of works on ice scour in the intertidal zone and the biological effects of ice scour. Works that describe iceberg or sea ice groundings are included even if the scour marks themselves are not investigated or mentioned. Works that contain a significant amount of information on ice scour are included even if the scope of the work is quite broad and ice scour is a relatively small part of it. Proprietary works, such as wellsite surveys, are not included.

No geographic restrictions were made in selecting works for the bibliography, although the fact that mostly English-language literature was examined means that information from Scandinavia and the Soviet Union is probably under-represented.

Comprehensiveness of the Bibliography

This bibliography contains 379 citations. It is as comprehensive as its relatively short preparation time would allow. Whenever possible the actual documents were obtained and examined for relevance before preparing citations and abstracts. Some documents could not be obtained in time to do this, and so, provided they were clearly relevant and an unambiguous citation was available, were indexed sight-unseen. Such citations contain the note "Document not seen by ASTIS" and, of course, have no abstract or location code.

There are undoubtedly some works which should be in this bibliography but which have been missed. We would ask the reader's help in locating them. The bibliography should eventually find its way into the hands of most of the world's ice scour researchers. We would ask you to check to see if everything that you and your organization have published on ice scour is included. Please inform us of any missing items, and, if convenient, please send us a copy.

ESRF/ASTIS will continue to work to include items overlooked, to locate cited items not yet examined, and to report newly published material. A continually updated online version of the bibliography is available in the ASTIS database under the subject term "Ice scouring".

Organization of the Bibliography

The citations in this bibliography have been grouped in a series of categories as shown in the Table of Contents. Those works that describe ice scour conditions in specific locations have been grouped geographically. Note that "Canadian East Coast Waters" includes all waters from Baffin Bay south to the Scotian Shelf. "Other Canadian Waters" includes the arctic island waters, Hudson Bay, and the West Coast. Works that refer to many different locations have been put in the "General" category. Works on the theory or modelling (both mathematical and physical) of ice scour are relevant to all geographic areas, and are therefore placed in the separate category "Theory and Modelling". Similarly, works on protection of facilities from ice scour have been placed in the separate category "Protection". Because a work can only be assigned to a single category, this assignment is sometimes somewhat arbitrary. Please check alternate categories.

Within each category citations are sorted by first author. Citations with no author appear at the beginning of the category. An author's works are sorted by title. The bibliography contains five indexes which refer back to the main section of the bibliography by citation number. Terms in the Subject and Geographic Indexes are taken from the ASTIS Subject and Geographic Thesauri. All authors of a citation are traced in the Author Index. Leading articles (A, The, Le, etc.) are removed in the Title Index. The Serial Index allows documents to be found under the title of the serial or other larger work in which they appeared.

Availability of Documents

The last line of most citations (i.e. the line preceding the abstract) contains a location code indicating where the document may be obtained on interlibrary loan. The standard Canadian interlibrary loan codes are used. Most documents which have location codes have either or both of:

ACU — Interlibrary Loan Office, Room 218, Library Tower, University of Calgary, Calgary, Alberta, Canada T2N 1N4. Telephone (403) 220-5967.

NFSMO — Ocean Engineering Information Centre, Memorial University of Newfoundland, St. John's, Newfoundland, Canada A1B 3X5. Telephone (709) 737-8377.

Please give the ASTIS document number and full citation when ordering.

Documents, with or without location codes, may also be available from their publishers.

INTRODUCTION

Présentation

Cette bibliographie est la première d'une série de bibliographies prévues par le project FRÉE/ASTIS sur les sujets prioritaires des Fonds renouvelables pour l'étude de l'environnement. En plus d'assurer la publication de ces bibliographies, le project FRÉE/ASTIS vise à augmenter la base de données ASTIS dans chacun des sujets prioritaires des FRÉE afin de former une source centrale de renseignements environnementaux et sociaux portant sur les terres du Canada.

La recherche des FRÉE sur le sujet prioritaire de l'affouillement par les glaces est coordonnée par le Comité de programme d'étude de l'affouillement par les glaces, présidé par Bill Livingstone de Gulf Canada Resources. Les études en cours comprennent:

- Evaluation de l'action des glaces sur les fonds marins
- Compilation des données sur l'affouillement par les glaces dans la mer de Beaufort
- Mise à jour des études régionales d'affouillement par les glaces: Grands Bancs, plateau du Labrador, détroits de Baffin et de Davis, détroit de Lancaster
- Echouement des icebergs: Grands Bancs, plateau du Labrador, plateau de Baffin
- Cartographie répétitive de l'affouillement du fond de la mer de Beaufort par la glace, en 1984
- Mise à jour régionale des données sur l'affouillement par la glace, phase II
- Conception d'un réseau aux fins de la cartographie répétitive de l'affouillement par la glace - Côte Est
- Affouillement par les icebergs, au fil de la pente et à contre-pente

Portée de la bibliographie

L'affouillement par les glaces comporte le dérangement des sédiments du fond d'une masse d'eau par de la glace flottante. L'affouillement par les glaces ne comprend donc pas les effets de la glace non flottante tels les glaciers, les plateaux de glace échoués, les falaises de glace et le chevauchement de la glace sur les rivages. Quelques synonymes employés dans la littérature scientifique comprennent: l'érosion par iceberg, le raclage (des fonds) par iceberg, le creusage par iceberg, l'échouement d'icebergs, le developpement de rayures, rainures, cannelures et sillons par l'action des glaces.

Bien que ce soit l'affouillement des fonds marins par les glaces qui intéresse en tout premier lieu les FRÊE, l'affouillement par les glaces dans les lacs se produit selon un mécanisme similaire et, par conséquent, il a été jugé pertinent d'en tenir compte dans la présente bibliographie. De même, les cas d'affouillement des terres autrefois recouvertes par les oceans ou les lacs mais qui sont aujourd'hui émergées ont été inclus dans cette bibliographie. Par contre il n'a pas été tenu compte de l'affouillement par les glaces dans les rivières.

La bibliographie ne comprend que les écrits traitant de l'affouillement par les glaces en particulier, et non les sujets connexes tels les propriétés et la distribution de la glace maritime et des icebergs, les caractéristiques des sédiments de fond, l'étude de l'outillage de labourage (terramechanics) et l'érosion en cours. Elle comprend aussi quelques ouvrages sur l'affouillement par les glaces dans la zone intertidale et sur les effets biologiques de l'affouillement par les glaces. Les travaux qui décrivent l'échouement d'icebergs ou de glace maritime sont inclus même si l'effet érosif de ces derniers n'est pas examiné ou mentionné. Les études qui contiennent une quantité importante de renseignements sur l'affouillement par les glaces sont incluses même si leur portée est vaste et si l'affouillement par les glaces n'en forme qu'une petite partie. Les travaux de droit de propriété tels les levées de sites de forage ne sont pas inclus.

La sélection des travaux qui ont donné naissance à cette bibliographie n'a pas été limitée par des restrictions géographiques. Cependant le fait que la plupart des études examinées étaient de langue anglaise suggère que l'information générée en Scandinavie et en Union Soviétique est probablement sous-représentée.

Textes manquant dans la bibliographie

Cette bibliographie contient 379 entrées. Elle est aussi complète que sa période de compilation relativement courte l'a permise. Lorsque ce fut possible, les documents furent examinés quant à leur pertinence avant la

préparation des entrées et résumés. Certains documents ne purent être obtenus à temps et furent donc indexés sans être examinés, pourvu qu'ils étaient clairement pertinents et si une entrée non-équivoque était disponible. De telles entrées ont reçu la notation «Document not seen by ASTIS» et ne contiennent aucun résumé ou code d'accès.

Il existe sûrement des travaux qui devraient être compris dans cette bibliographie mais que nous n'avons pu localiser. Nous prions nos lecteurs de nous aider à les localiser. La bibliographie sera, avant longtemps, examinée par la plupart des chercheurs s'intéressant à l'affouillement par les glaces. Nous vous prions donc de vérifier si tout ce que vous et votre groupe de recherche avez publié à ce sujet s'y trouve inclus. Veuillez nous aviser de tout texte manquant et, si possible, nous en faire parvenir un exemplaire.

FRÉE/ASTIS continuera à rechercher les textes manquants, à localiser les ouvrages cités non-examinés et à signaler le nouveau matériel publié. Une version automatisée et continuellement mise à jour de la bibliographie peut être obtenue de la base de données ASTIS sous la rubrique «Ice Scouring».

Organisation de la bibliographie

Les entrées dans cette bibliographie sont rassemblées dans une série de catégories tel qu'indiqué à la table des matières. Les travaux qui décrivent l'affouillement par les glaces en des sites particuliers sont groupés par catégorie géographique. La catégorie «Canadian East Coast Waters» comprend toutes les eaux de la baie de Baffin jusqu'au plateau continental néo-écossais au sud. «Other Canadian Waters» comprend les eaux des îles arctiques, de la baie d'Hudson et de la côte ouest. Les travaux qui traitent de plusieurs sites différents ont été regroupés dans la catégorie «General». Les travaux sur la théorie et la construction de modèles (mathématiques et physiques) sur l'affouillement par les glaces relèvent de toutes les régions géographiques et sont donc groupés dans une catégorie distincte, «Theory and Modelling». De même, les travaux portant sur la protection d'installations contre l'affouillement par les glaces paraissent dans une seule catégorie, «Protection». Puisqu'un ouvrage ne peut être assigné qu'à une seule catégorie, le choix est parfois quelque peu arbitraire. Veuillez donc consulter les catégories connexes.

Les entrées dans chaque catégorie sont classées sous le nom du premier auteur. Les citations sans auteur paraissent au début de la catégorie. Les travaux d'un même auteur sont classés par titre. La bibliographie contient cinq index qui rapportent le lecteur au corps de la bibliographie par indicatif d'entrée. Les termes dans les index de sujets et de sites géographiques proviennent du dictionnaire de sujets et de sites géographiques de l'ASTIS. Tous les auteurs des entrées sont énumérés à l'index des auteurs. Les articles en début de titre (A, The, Le, etc.) ne paraissent pas à l'index des titres.

L'index des périodiques permet de trouver un document sous le titre du périodique ou de l'ouvrage dans lequel il fut publié.

Accès aux documents

La dernière ligne de la plupart des entrées (c'est-à-dire la ligne précédant le résumé) contient un code d'accès signalant l'endroit où le document peut être obtenu par prêt entre bibliothèques. Les codes standards canadiens de prêts entre bibliothèques sont utilisés. La majorité des documents dotés d'un code ont l'un des deux codes suivants ou les deux:

ACU — Interlibrary Loan Office, Room 218, Library Tower, University of Calgary, Calgary, Alberta, Canada T2N 1N4. Téléphone (403) 220-5967.

NFSMO — Ocean Engineering Information Centre, Memorial University of Newfoundland, St. John's, Newfoundland, Canada A1B 3X5. Téléphone (709) 737-8377.

Veuillez donner le numéro de document ASTIS et l'entrée complète lorsque vous faites une demande de prêt.

Les documents avec ou sans codes d'accès peuvent éventuellement aussi être obtenus chez leurs éditeurs.

CANADIAN EAST COAST WATERS

1
DIGS '85 will study iceberg scouring
(Offshore resources, v. 3, no. 2&3, May/June 1985, p. 10)
ASTIS document number 167495.
ACU, NFSMO

A major field program is to be undertaken off the coast of Labrador this summer. This program, to be called DIGS-85, is to document the dynamics and processes of iceberg grounding and scouring through the study of about four actual groundings. Data to be collected include: forces exerted on the seabed by icebergs, the character and depth of the resultant sediment response, and data for the validation of ice scour models. ... The following work plan is proposed. About four grounded icebergs will be tracked and monitored. This will be carried out from a research vessel using ship radar and side-scan sonar to measure iceberg shape and draft. A sensor package will be deployed by helicopter to measure iceberg motion. The sedimentary backfill and current scour during the iceberg scouring event will be monitored from an unmanned submersible and towed camera. After the scouring event, a manned submersible will be used to examine the scour in detail and to retrieve seabed samples. Other ocean and climatic measurements will be made during the scouring event. ... The cost of performing and supporting the DIGS-85 geotechnical program is expected to range up to $250,000, while the logistics and support costs an additional $500,000. A final report on this study is expected by March 1986. (Au)

2
Dynamic Iceberg Grounding and Scouring Experiment (DIGS)
(C-CORE news, v. 10, no. 1, Mar. 1985, p. 5)
ASTIS document number 167070.
ACU, NFSMO

C-CORE and the Geological Survey of Canada, Bedford Institute of Oceanography, are planning a major field program off eastern Canada for the summer of 1985 with support from Environmental Studies Revolving Fund (ESRF). The experiment will correlate iceberg movement and seabed disruption in the Grand Banks and Labrador Sea regions through the examination of up to six case histories of iceberg/seabed interaction. During the experiment measurments will be made of the following: (1) iceberg forces on the seabed; (2) effects of the seabed on iceberg motion; (3) hydrodynamic sediment redistribution during actual scouring events; and (4) scour degradation with time. The program's objectives are: (1) to predict ice scour depth and sediment disruption so that more effective protection may be designed for pipelines and wellheads; and (2) to understand processes of ice/seabed interaction and to integrate the information into an improved model of seabed penetration by icebergs. ... (Au)

3
Iceberg scour studies in Davis Strait
(C-CORE news, v. 8, no. 2, July 1983, p. 4-5)
ASTIS document number 148237.
ACU

A joint C-CORE-AGC-Canterra Energy Ltd. iceberg scouring/seabed study of the continental shelf off southeast Baffin Island was initiated in July 1981. Results from this 1981 pilot study formed the basis of a report to Canterra Energy and will be published as a C-CORE Technical Report. Salient features of the report are summarized. (Au)

4
Towing icebergs as part of arctic offshore feasibility study
(Hydrospace, v. 3, no. 5, Oct. 1970, p. 42-43, ill.)
ASTIS document number 162981.
NFSMO

As part of a feasibility study on offshore operations in Arctic regions, Marine Exploration Ltd. (MAREX) of Cowes, Isle of Wight, participated in a reconnaissance during April 1970 of Southwest Greenland by Compagnie Francaise des Petroles (CFP). ... The reconnaissance was part of a continuing study of offshore operations in Arctic Regions implemented by CFP, in which MAREX have been acting as chief consultants, the object being to test theories and carry out practical experiments in a region where many types of sea ice were to be found. ... Icebergs were seen which were aground in depths of over 150 m and having displacements of five million tons, but these would be dwarfed by the largest ones recorded. MAREX carried out a dive near a grounded iceberg in order to study its shape and discover whether it had deformed the sea bed when it ran aground. This was successful and was aided by the excellent underwater visibility .... Another experiment was that of taking bottom samples in different locations. This was accomplished with the aid of a simple dredge sampler designed and constructed by MAREX. ... Samples were taken over a wide area and were taken back to CFP's laboratories for analysis. It was at once evident, however, that the composition of the sea bed was not as had been expected. A clear pattern of the distribution of bottom material emerged as a result of this operation. One possible way of preventing an iceberg approaching an offshore drilling site is to tow it away and allow it to drift past the site at a safe distance. ... A floating iceberg was selected for the experiment and a towline attached to it with the aid of a small outboard motor boat. The survey ship was used to provide the towing force, this being measured. ... The experiment was a success and the results agreed well with those obtained by calculation. ... (Au)

ALLEN, J.H.

5
An analysis of the effect of bottom scouring icebergs / Allen, J.H.
(Proceedings of the Canadian Seminar on Icebergs held at the Canadian Forces Maritime Warfare School, CFB Halifax, Halifax, Nova Scotia, Canada, December 6-7, 1971. – [Halifax, N.S. : Maritime Command Headquarters, 1971?], p. 110-111, figure)
ASTIS document number 148784.
ACU, NFSMO

Dr. Allen initially discussed several aspects of iceberg investigation carried out during the "Dawson" cruise in May, 1971, including their movement, detailed shape and changes in surface topography, geological effects, marine life in, on, and around the bergs, and effects on the adjacent water and bottom. Current meters and cameras were placed at various depths from the surface to the bottom near the path of a moving iceberg and measurements and photographs were taken as the berg moved past. Local currents around the berg were noted. These photographs and others taken by scuba divers showed progressive rounding off of submerged portions of the icebergs and local erosion to give a pitted effect. Several slides illustrated the topography of the submerged surfaces. It was noted that small bubbles were given off continuously from the underwater ice surfaces and that this could explain the nature of sonar echoes obtained. ... Results on grounding of bergs and their tracks or bottom scouring were inconclusive. One berg was observed to be definitely grounded but it was caught between two shoals and no track was discernible. ... (Au)

6
Cruise report, C.S.S. Dawson, June 2-June 12, 1971 / Allen, J.H.
St. John's, Nfld. : Memorial University, Faculty of

Engineering, 1971.
37 leaves : ill. ; 28 cm.
ASTIS document number 149152.
NFSMO

[The purpose of the cruise off the north east coast of Newfoundland and in Conception Bay was] to study various parameters of icebergs, especially iceberg motion and iceberg grounding and to carry out other data-gathering operations including geological and biological sampling. (Au)

7
Iceberg study, Saglek, Labrador including cruise report C.S.S. Dawson, August 7-August 26, 1972 : initial report / Allen, J.H.
St. John's, Nfld. : Memorial University of Newfoundland, Faculty of Engineering and Applied Science, 1972.
ix, 92 leaves : ill. ; 28 cm.
Initial report.
ASTIS document number 149446.
NFSMO

The 1972 iceberg research programme was carried out along a coastal strip off Saglek Bay in northern Labrador, 30 miles in North/South direction and 60 miles East/West .... The study was conducted from land, sea, and air. ... The physical parameters measured were evaluated in conjunction with observed iceberg movement in the study area. A definite relationship between the parameters and the berg tracks was recognized. (Au)

AMOS, C.L.

8
The frequency of ice scouring on the northeastern Grand Banks of Newfoundland using the interrelationship of scours and bedform migration / Amos, C.L. Barrie, J.V.
(National Research Council of Canada Associate Committee on Geotechnical Research Workshop on Ice Scouring, 15-19 February 1982 / Edited by G.R. Pilkington. Technical memorandum - Canada. National Research Council. Associate Committee on Geotechnical Research, no. 136, p. 220-221)
Abstract only.
References.
ASTIS document number 148466.
NFSMO

There are several lines of evidence to suggest that the seabed in the vicinity of the Hibernia discovery is mobile under certain conditions. High resolution sidescan records have revealed sand ribbons, sand ridges, sand waves and two and three dimensional megaripples (Lewis and Barrie, 1981). These features can only be generated by unidirectional flows at velocities of between 60-120 cm/sec. Sequential photography reveal asymmetrical, wave-formed oscillatory ripple marks after severe storms, above 110 m, which are subsequently degraded by browsing echinoderms and bivalves. The inferrence is that the smaller bedforms observed on the sidescan records are modern and migrate periodically across the shelf, presumably during periods of intense storms. The migration of these bedforms tend to cover older features, such as ice scours, with the result that an area may appear free of scouring. This same approach can be used in relating iceberg scours and the otter board trawl marks. (Au)

9
Hibernia and Ben Nevis seabed study : Polaris V cruise report / Amos, C.L. Barrie, J.V.
St. John's, Nfld. : Memorial University of Newfoundland, Centre for Cold Ocean Resources Engineering, 1980.
vi, 40 p. : figures, tables ; 28 cm.
(C-CORE publication, no. 80- 17)
(Data report - Memorial University of Newfoundland. Centre for Cold Ocean Resources Engineering)
ISBN 0-88901-060-9.
Appendices.
References.
ASTIS document number 133086.
ACU, NFSMO

The stability of the surficial sedimentary cover over the Grand Banks is a topic of considerable speculation and some dispute. The source of the dispute lies in the interpretation of what features on the seabed are relict and which are modern. The purpose of the cruise, then, was to examine in some detail an area of the Grand Banks 65 km by 30 km covering the Hibernia and Ben Nevis blocks in order to determine the genesis and mobility of the surficial cover and its composition and thickness. ... The stability of the surficial sediments has a direct bearing on the preservation of ice scours and on the current scour or infill of seabed oil-related facilities. (Au)

BARRIE, J.V.

10
Data report of the Hekja wellsite marine survey undertaken during CSS Hudson cruise no.HU81-045 October, 1981 / Barrie, J.V. Woodworth-Lynas, C.M.T. Pereira, C.P.G.
St. John's : Centre for Cold Ocean Resources Engineering, 1982.
vi, 50 p. : figures, tables ; 28 cm.
(C-CORE publication, no. 82- 2)
(Data report - Memorial University of Newfoundland. Centre for Cold Ocean Resources Engineering)
ISBN 0-88901-081-1.
Appendices.
References.
ASTIS document number 105074.
ACU, NFSMO

This report concerns the acquisition and some initial interpretation of raw data during a marine survey in the vicinity of the Hekja wellsite off Loks Land, southwest Baffin Island on the CSS Hudson. ... Raw data collected included bottom sediment grabs, gravity and piston core samples, camera transects, shallow and deep tow sidescan transects, bathymetry, HUNTEC DTS high resolution seismic reflection transects, air-gun seismics and an iceberg log. Also presented are some preliminary observations made while the data was being collected. (Au)

11
Down on the Labrador Shelf : visual examination of iceberg scouring / Barrie, J.V.
(C-CORE news, v. 7, no. 2, June 1982, p. 2-3, ill.)
ASTIS document number 148245.
ACU

This article describes a descent in the untethered self-propelled submersible Pisces IV, operating from the research vessel Pandora II. Main objectives were to investigate seafloor actively disrupted by grounding keels of icebergs and to note degradation of scour marks by superimposed current regime and benthic biological activity, to provide ground truth for acoustic geophysical data, to note sedimentary environments and describe a sample section of bedrock outcrop. (ASTIS)

12
Grand Banks pits : description and postulated origin / Barrie, J.V.

[6] leaves ; 28 cm.
Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.
Indexed from a preliminary draft, July 1985.
Proceedings to be published as an ESRF Report in late 1985.
ASTIS document number 166570.

In the summer of 1984 C-CORE had the use of the SDL 1 submersible of the Canadian Navy primarily to set up a sediment transport study site and to extend our regional knowledge of the area. A secondary goal was to investigate some of the interesting features that had been observed on the seafloor during earlier geophysical surveys. These features, which have been called amongst other things pits, depressions and pockmarks are located on the outer shelf of the Grand Banks in the Hibernia area. They were first discovered in the area in 1980 and many more features have been observed since during wellsite surveys. The pit selected for this study was originally discovered in 1980 in 90 metres of water. (Au)

13

Iceberg grounding review from wellsite observations / Barrie, J.V. Lynas, C.M.T. Gidney, G. Canada. Geological Survey [Sponsor].
St. John's, Nfld. : Memorial University of Newfoundland, Centre for Cold Ocean Resources Engineering, 1982.
ii, 38 p. : ill. ; 28 cm.
(Open file – Canada. Geological Survey, no. 880)
(C-CORE publication, no. 82- 7)
(Contract report – Memorial University of Newfoundland. Centre for Cold Ocean Resources Engineering)
Appendices.
References.
ASTIS document number 133264.
ACU, NFSMO

This study was carried out to analyze and assess the behaviour of grounding icebergs on the Labrador Continental Shelf. Iceberg observation data collected by MAREX are analyzed using a special computer program, BRGPRT. BRGPRT was designed by C-CORE based on an earlier program, IMCVIE, developed by Ball et al (1980). Preliminary interpretation shows that at two well sites icebergs ground preferentially on bank edges but elsewhere grounding appears to be random. (Au)

14

Iceberg grounding studies / Barrie, J.V. Lewis, C.F.M.
(C-CORE news, v. 5, no. 1, Jan. 1980, p. 7-8, ill.)
ASTIS document number 148105.
ACU

A research program to study iceberg scouring on the Labrador Shelf has been ongoing since 1976 .... The most recent field activity for this joint program of the Geological Survey of Canada, through its Atlantic Geoscience Centre (AGC), and C-CORE was carried out as part of Cruise 79-019 of the CSS Hudson of the Bedford Institute of Oceanography. ... The objectives of our participation in this cruise were to investigate the present situation at two previously surveyed locations on the Shelf, and to seek out icebergs in the process of scouring and investigate the nature of the resulting seabed disruption. This second objective would be a matter of opportunity. One of the areas to be resurveyed was on Makkovik Bank, in the region of the Total Eastcan Exploration Ltd. Bjarni well. ... The other area, on Saglek Bank, was investigated in 1976 for Total, and in 1977 and 1978 by BIO and C-CORE. We were to resurvey these two areas with overlapping side scan sonar and high resolution seismic profiling systems, and to collect cores, sediment samples, photographs and bottom current meterings along the survey lines. ... (Au)

15

Iceberg-seabed interaction (northern Labrador Sea) / Barrie, J.V.
(Proceedings of the Conference on Use of Icebergs : Scientific and Practical Feasibility, Cambridge, U.K., 1-3 April, 1980. Annals of glaciology, v. 1, 1980, p. 71-76, figures)
(C-CORE publication, no. 80- 3)
References.
ASTIS document number 61107.
ACU, NFSMO

... Side-scan sonograph mosaics from the northern Labrador Shelf were constructed for two bathymetric interbank areas. They reveal that both relict ice bottom gouging and modern iceberg scouring have taken place at water depths greater than 180 m. ... The dominant scour trend is north-south, reflecting the Labrador Current. Impedance of icebergs by bottom interaction is primarily a function of the gross iceberg size and shape, sediment encountered by the keel, and prevailing current. For modern scouring, frequencies of detectable impact decrease exponentially with increasing scour depth, and scour depth is inversely proportional to the sediment shear and compressive strengths. (Au)

16

Sediment transport and iceberg scour preservation and degradation, eastern Canadian shelf / Barrie, J.V.
[4] leaves ; 28 cm.
Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.
Indexed from a preliminary draft, July 1985.
Proceedings to be published as an ESRF Report in late 1985.
ASTIS document number 166529.

In this short presentation I am going to discuss the problem of the actual preservation and degradation of scours. This process is critical in many of the analyses we shall be discussing at this workshop. I hope to suggest methods of how the degradation process can be monitored both during and immediately after scouring takes place and in the long term. (Au)

17

Sedimentary processes and the preservation of iceberg scours on the eastern Canadian continental shelf / Barrie, J.V.
Espoo, Finland : Technical Research Centre of Finland, 1983.
(Seventh International Conference on Port and Ocean Engineering Under Arctic Conditions. – Espoo, Finland : Technical Research Centre of Finland, 1983, v. 4, p. 635-653, figures)
(C-CORE publication, no. 83- 6)
References.
ASTIS document number 133272.
ACU, NFSMO

Iceberg scours, the physical evidence of grounding icebergs, are observed over much of the eastern Canadian continental shelf. The degree of preservation or degradation of these scours (which can define scour age) depends on the type of sediments, their physical and geotechnical properties and the hydrodynamic regime that the sediments are exposed to. Evidence drawn from sediment textures, mineralogical analyses, submersible observations, acoustic geophysical surveys and from the hydrodynamic environment demonstrate that the rate of scour degradation is determined primarily by wave-induced oscillatory motion and to a lesser extent, by unidirectional currents at the seabed and the sediment available for deposition. Assuming that the hydrodynamic processes can be quantified, then scour frequencies and rates of scour degradation can be determined more accurately; these quantitative parameters are based on scour morphology as interpreted from the existing scour data base. Three defined scoured environments are compared,

including examples from the Davis Strait, the Labrador Shelf and the Grand Banks of Newfoundland. (Au)

BASS, D.W.

18
Iceberg crater chains and scour up and down slope / Bass, D.W. Woodworth-Lynas, C.M.T.
[10] leaves : ill. ; 28 cm.
Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.
Indexed from a preliminary draft, July 1985.
Proceedings to be published as an ESRF Report in late 1985.
ASTIS document number 166588.

An iceberg crater chain is the term given to a scour feature which occurs randomly on the seafloor in areas affected by iceberg scouring. They have been observed on several sidescan mosaics that have been produced for the Labrador Shelf. As yet this type of feature has not been observed on the Grand Banks. Crater chains occur in linear or curvilinear groups with crater diameter decreasing along the length .... Each chain consists of usually no more than six craters and may be linked together or spaced apart. Outlines of the crater on the seafloor may clearly indicate that the keel shape of the scouring berg plays a very important part in determining crater morphology. Both linked and unlinked crater chains may be associated with one or both ends of a normal scour. (Au)

BLAKE, W.

19
Iceberg concentrations as an indicator of submarine moraines, eastern Queen Elizabeth Islands, District of Franklin / Blake, W.
(Paper – Canada. Geological Survey, 77- 1B, p. 281-286, ill.)
References.
ASTIS document number 150711.
NFSMO

At a number of localities in southeastern Ellesmere Island and on Coburg Island ... submarine moraines are delineated by concentrations of stranded icebergs or, in shallower water, by rafted floes of sea ice. Although the situation varies from year to year, in a general way photographs taken in late spring or early summer, before breakup, are the most useful. ... In areas where detailed soundings have been carried out and hydrographic charts are available (cf. Liestol, 1972), submarine moraine ridges can be discerned without recourse to indirect methods; but in more remote and less-studied Arctic regions, mapping of moraines by the stranded icebergs aligned along them is a useful tool, as Loken (1973) has demonstrated already off the northeastern coast of Baffin Island. Investigations of the submarine moraines in the northern part of the Canadian Arctic Archipelago are just commencing as part of a long-term project of deciphering the glacial history and geochronology of this vast region. The purpose of this report is to illustrate a few examples of the type of occurrence described above. (Au)

BOLTON, J.J.

20
Effects of short-term ice scouring on a Newfoundland rocky shore community / Bolton, J.J.
(Astarte, v. 12, no. 2, 1983, p. 39-43, figures, table)
References.
ASTIS document number 139262.
ACU

A previous study revealed a three-zone community structure to be present on a sub-arctic shore which had not been subject to ice action for five years. Following a relatively minor ice scour the shore has been re-examined, and the effects of ice action on the community structure and species composition discussed. The ice action produced: (1) very little effect on the littoral fringe, the main impact being concentrated in the mid and lower eulittoral zone; (2) The removal of Fucus cover, the degree dependent on the severity of ice action; and (3) a large reduction in fragile filamentous species, especially epiphytes, in the eulittoral zone and sublittoral fringe. It is suggested that without further ice action the shore will return to its previous state in one to two years, whereas with regular winter scouring the zonation patterns will largely break down. (Au)

BRETT, C.P.

21
Project Westmar : a shallow marine geophysical survey on the west Greenland continental shelf / Brett, C.P. Zarduski, E.F.K.
[Kobenhavn] : Gronlands Geologiske Undersogelse, 1979.
27p. : ill., figures, maps ; 24cm.
(Rapport – Gronlands Geologiske Undersogelse, nr. 87)
References.
ASTIS document number 37354.
ACU

An extensive shallow geophysical survey has been carried out on the West Greenland continental shelf between 64 deg. and 69 deg. 30 sec. N. Preliminary interpretation of the data reveals that between 64 deg. and 67 deg. 30 sec. N at least, the entire shelf was glaciated to its western margin during the Pleistocene, the glaciation processes leaving a variable (<20-200 m thick) cover on the Tertiary sedimentary wedge underlying the shelf. A morphological relationship exists between the degree of sea floor roughness and the types of glaciation forms. The distribution and contacts of the three main shallow bedrock units in the area (Precambrian gneisses, Lower Tertiary volcanics and Tertiary sediments) are delineated. Widespread prograding is observed in sediments along the shelf margin. Extensive iceberg scouring of the sea floor is observed north of 67 deg. 30 sec. N reaching a maximum water depth of 340 m. (Au)

CHARI, T.R.

22
Iceberg scour factors on eastcoast production / Chari, T.R.
(Drilling Canada, v. 2, no. 4, July/Aug. 1981, p. 55-56, ill.)
ASTIS document number 149527.
NFSMO

The article briefly describes the problems of scouring icebergs in an area of potential hydrocarbon development, the approaches used for examining and evaluating the scour problem, and future reseach projects. (NFSMO)

COLLINS, W.T.

23
Iceberg scouring and sediment dynamics on the Labrador Shelf / Collins, W.T. Barrie, J.V. Woodworth-Lynas, C.M.T.
(Program with abstracts – Geological Association of Canada, v. 9, 1984, p. 54)
Abstract only of paper presented at the Joint Annual Meeting of the GAC and MAC.
ASTIS document number 149543.
NFSMO, ACU

The use of manned submersibles allows for an opportunity to view directly seabed features which have only been detected by acoustic

mapping. Since 1980 two submersible investigations have been carried out in areas over the Labrador Continental Shelf. A video tape of preliminary results is presented together with a review of past work. Emphasis is placed on the phenomenon of iceberg scouring and the effect of local hydrodynamic activity on the surficial sediments. (Au)

24

Icebergs and sediment transport as hazards related to the production of oil and gas off the east coast of Canada / Collins, W.T.

(Newfoundland journal of geological education, v. 7, no. 3, Dec. 1983, p. 19-26, figures)

(C-CORE publication, no. 83- D)

References.

ASTIS document number 141690.

ACU, NFSMO

Commercial recovery of oil and gas from the sediments off the east coast of Canada is drawing near .... Before this can happen, however, specific problems related to the emplacement of any fixed structure on or just below the seabed must be dealt with. Icebergs, evident along most of the Labrador and Newfoundland coastline today, present a serious hazard to shipping. When the forces moving these bergs drive them into shallower water, such as the Grand Banks, their keels may come into contact with the seabed and engineering systems therein. An ancillary problem facing producers of offshore hydrocarbons is the stability of the surficial sediment. What is the likelihood of the top few metres of sediment being eroded and transported under the influence of near-bottom currents, waves and unstable slopes? (Au)

25

Norploy '82 cruise report August, 1982 / Collins, W.T. Diemand, D.

St. John's, Nfld. : Centre for Cold Ocean Resources Engineering, Memorial University, 1983.

vi, 31 p. : figures, tables ; 28 cm.

(C-CORE publication, no. 83- 4)

(Cruise report – Memorial University of Newfoundland. Centre for Cold Ocean Resources Engineering)

ISBN 0-88901-094-3.

Appendices.

References.

ASTIS document number 115479.

ACU, NFSMO

Sediment stability under the influence of both iceberg interaction and wave and current hydrodynamics is a topic of considerable interest to offshore operators. It must be taken into consideration in the design and emplacement of engineering systems in the waters off Eastern Canada. The purpose of the Norploy '82 cruise was to make direct observations, from the Canadian Armed Forces manned submersible SDL-1, of seafloor features, paying particular attention to iceberg scours and sediment stability. Sidescan sonar survey lines and bottom samples were taken to determine and investigate dive sites. The internal temperatures of icebergs are also of considerable interest as they relate to both the age of the bergs and to their mechanical properties. ... it was hoped that Norploy '82 would provide us with an opportunity to obtain this information as well as data on the size distribution of the bergs. (Au)

D'APOLLONIA, S.J.

26

Ice scour database user's manual / d'Apollonia, S.J. Lewis, C.F.M.

Dartmouth, N.S. : Bedford Institute of Oceanography, 1981.

45 leaves : ill. ; 28 cm.

Appendices.

Unpublished document dated March 31, 1981.

ASTIS document number 149144.

NFSMO

An ice scour database has been developed at the Atlantic Geoscience Centre, Geol. Survey of Canada, to provide information on regional trends of (a) ice scour features on the seabed, (b) acoustic reflectivity of the surficial seafloor cover, and (c) geological and geomorphological characteristics of the seabed. Each section in the manual explains a particular aspect of the design, development and maintenance of the system 2000 database. By following the procedures described in this manual, persons having little or no programming experience can access and retrieve information from the database from any remote terminal with a link to the CYBER 171 computer at the Bedford Institute of Oceanography. (Au)

27

Iceberg scour data maps for the Grand Banks of Newfoundland between 46 degrees N and 48 degrees N / d'Apollonia, S.J. Lewis, C.F.M.

Dartmouth, N.S. : Atlantic Geoscience Centre, G.S.C., Bedford Institute of Oceanography, 1981.

12 p. : ill., maps ; 28 cm.

(Open file – Canada. Geological Survey, no. 819)

References.

Scale: 1:25,000.

ASTIS document number 150665.

... [A] computerized data base has been developed under contract at the Atlantic Geoscience Centre, Geological Survey of Canada, to facilitate the organization and analysis of measured iceberg scour parameters. Because of the high level of interest in the ice scouring problem regarding planning and development of the Hibernia oil discovery on the northeast Grand Bank of Newfoundland, these measurements are being released now in advance. The maps in this open file show posted values from the ice scour data base for the northern Grand Banks region between 46 degrees N and 48 degrees N, and 46 degrees W to 54 degrees W at a scale of 1:250,000. Four maps of the northeast Grand Banks ... between 46 degrees N and 48 degrees N and 46 degrees W and 50 degrees W are compiled showing values of maximum scour depth, maximum scour width, per cent seabed disturbance and scour occurrences Km-2 respectively. The same parameters are shown in a similar set of four maps for the northwest Grand Banks ... between 46 degrees N and 48 degrees N and 50 degrees W and 54 degrees W. It is expected that future editions of these maps will incorporate additional data currently under analysis. (Au)

DIONNE, J.-C.

28

L'action geologique des glaces dans l'estuaire du Saint-Laurent = The geological action of ice in the St. Lawrence estuary / Dionne, J.-C.

(First Symposium on the Geological Action of Drift Ice, Quebec, Canada, April 20-24, 1974 [sic]. Maritime sediments, v. 9, no. 3, Dec. 1973, p. 107)

Abstract only.

ASTIS document number 149748.

ACU

... Drift ice is an important agent of erosion, transportation, sedimentation, and protection in the St. Lawrence Estuary. Millions of tons of sediments are displaced annually by ice while shores and bottoms are eroded. Ice has minor effects on beaches; local ice-push and minor features related to the melting of buried ice are observed; however beaches are a zone where large amounts of coarse sediments are incorporated into the ice before being carried elsewhere at breakup. The intertidal zones are more severely affected by ice which scours or scratches soft bottoms, and brings large quantities of sediments of various sizes and lithologies. Tidal flats and marshes are probably the more severely disturbed zones

along the St. Lawrence Estuary. Marshes are characterized by a large amount of erratics up to boulders 2-3 m in diameter, and by ice-made pans, while various ice-made features occur in mud tidal flats such as grooves up to 2 km long, striations, hummocky micro-reliefs, mud ridges, polygonal patterns, ribbed grooves, ice-rafted debris, and other minor features. Rocky shores are only slightly modified by ice which scratches soft rocks and aids levelling the surface of shore platforms. A photographic documentation on the geological action of drift ice in the St. Lawrence Estuary is provided. (Au)

29
Tidal flat erosion by ice at La Pocatiere, St. Lawrence estuary / Dionne, J.-C.
(Journal of sedimentary petrology, v. 39, no. 3, Sept. 1969, p.1174-1181, figures)
References.
ASTIS document number 148660.
ACU

The tidal flat areas of the Middle St. Lawrence Estuary are severely eroded by shore ice. Grooves parallel or perpendicular to the shoreline, measuring 30 to 80 cm wide, 20 to 35 cm deep, and 1400 to 2000 m long and circular or subcircular basins up to 2 m in diameter and 20 to 40 cm deep are produced every spring by ice blocks that plough the surface and greatly disturb the sediments. (Au)

EL-TAHAN, M.S.S.

30
Documentation of iceberg groundings / El-Tahan, M.S.S. Moran, K.
[4] leaves ; 28 cm.
Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.
Indexed from a preliminary draft, July 1985.
Proceedings to be published as an ESRF Report in late 1985.
ASTIS document number 166545.

The objective of this ESRF supported study was to compile all the iceberg grounding information pertaining to the East Coast of Canada, Grand Banks, Labrador Shelf and Baffin Bay regions in an attempt to understand where icebergs ground, and why they ground? In this presentation I will describe several of the data sets produced by this study and discuss the criteria that was established to identify groundings. This will be followed by a review of some very preliminary data analyses that have been conducted. (Au)

FADER, G.B.

31
A reconnaissance study of the surficial geology of the Grand Banks of Newfoundland / Fader, G.B. King, L.H.
(Paper – Canada. Geological Survey, 81- 1A, p. 45-81, figures)
References.
ASTIS document number 148644.
ACU

The results of a reconnaissance study of the surficial and near-surface bedrock marine geology of the Grand Banks of Newfoundland are presented. On the basis of high-resolution seismic reflection profiles, sidescan sonograms, and bottom samples, the position of a Late Wisconsin low sea level stand is tentatively identified at 110-120 m. Above these depths, glacial sediments were eroded and redistributed during the Holocene transgression. Stable areas of lag gravel and large patches of sand have been deposited. Iceberg furrows occur at the seabed and are up to 5 m deep. On the basis of the distribution and stratigraphic relationships of the surficial sediments, it is suggested that above a 110 m depth the iceberg furrows were formed during the last 10,000-12,000 years and that these furrows may represent the total number developed during this time interval. (Au)

32
Surficial geology of the Laurentian Channel and the western Grand Banks of Newfoundland; / Fader, G.B. King, L.H. Josenhans, H.W.
Ottawa : Geological Survey of Canada, 1982.
v, 37 p. : ill., maps ; 28 cm.
(Paper – Canada. Geological Survey, 81- 22)
(Marine sciences paper, 21)
ISBN 0-660-11110-1.
References.
One map folded in pocket, scale 1:350,000.
ASTIS document number 149861.
ACU

Five surficial formations are identified on the basis of high resolution seismic reflection profiles, side-scan sonograms, echo sounder data, seabed grab samples, piston cores, and bottom photographs: Scotian Shelf-Newfoundland Shelf Drift, Emerald Silt, Sambro Sand, LaHave Clay, and Sable Island Sand and Gravel. Scotian Shelf-Newfoundland Shelf Drift is a poorly sorted till occurring at the base of the surficial succession, and has been deposited beneath a grounded ice sheet that advanced across the cont ental shelf. An end moraine complex occurs south of Cape Island on the Scotian Shelf and south of the Burin Peninsula, on the western Grand Banks of Newfoundland. It is the easternmost extension of a submarine end moraine system on the Scotian Shelf. Emerald Silt is a proglacial muddy sediment deposited from floating ice and is interbedded with the till at the distal side of the moraines. Sambaro Sand is a sublittoral muddy sand developed below a Late Pleistocene sea-level terrace at 115 m. It is formed by reworking of the till and proglacial sediments. LaHavre Clay is a homogeneous marine mud deposited in the basins and depressions on the shelf. The material was derived from reworking the sediment on the bank and inner shelf areas during the Late Pleistoce-Holocene transgression. Sable Island Sand and Gravel is a transgressive deposit formed by erosion of till and proglacial sediment in depths less than the 115-m depths of the Late Pleistocene terrace. The distribution and stratigraphic relationships of the surficial formations were controlled by an advance of the continental ice sheet across the shelf together with late and postglacial isostatic and eustatic fluctuations. The sediment distributions are mostly relict except in the shallow areas where some reworking of Sable Island Sand and Gravel occurs in response to the modern hydrodynamic regime. All surficial formations have been scoured by grounded icebergs unlike the Scotian Shelf where iceberg furrows are confined to till surfaces. (Au)

FILLON, R.H.

33
High-resolution subbottom profiles across the northern Labrador Shelf : do they provide evidence of glaciation? / Fillon, R.H.
(Program with abstracts – Geological Association of Canada, v. 5, 1980, p. A53)
Abstract only.
ASTIS document number 148741.
ACU

Huntec deep-tow records, 3.5 kHz and 12 kHz echo sounder profiles backed by air-gun reflection and cores delineate 7 mapable acoustic/morphologic units between 57 degrees and 61 degrees N. These include: I- section composed of numerous horizontal reflectors with minimal scattering and smooth microrelief; II- acoustically transparent section with numerous sub-parallel, draped reflectors at its base- it underlies unit I in basin centers; III- section marked by intense scattering, point reflectors and a rough microrelief; IV-

section exhibiting strong scattering as in III but with smooth microrelief and obvious terraces; V- out-cropping portions of II variably dissected; VI- outcrops of II exhibiting warping, acutely intersecting reflectors and undulating mesorelief; VII- areas of strong macrorelief of hummocks and ridges with wedge or lens-shaped reflectors and strong scattering. Of the 7 units, only the upper meter or less of unit I, 14C dated at <6,000BP, is unambiguously postglacial. The remainder of units I and II date between 8,400 and 26,000BP. Sedimentation rates for the intervals 8,400-6,000BP and 26,000-22,00BP of 200cm/kyr compare with <20cm/kyr compare with <20cm/kyr for post 6,000BP – the high rates possibly related to turbid glacial melt-water. Glacigenic interpretations for units III and V – VII also seem plausible, eg. III- ground moraine; V- iceberg furrowing or subglacial melt-water erosion; VI- deformation till; VII- end or lateral moraines. If as a working hypothesis, deposits on the shelf are considered ice-sheet related and if the 14C dates reflect time of deposition, rapid melting is inferred from 26,000 to 21,000BP and after 12,000BP until final deglaciation sometime between 8,400 and 6,000BP. Concentrations of units I and II suggest principal melt-water sources on the outer shelf rather than inshore. (Au)

GILBERT, G.R.

34

Provenance and sedimentary processes of ice scoured surficial sediments, Labrador Shelf / Gilbert, G.R. Barrie, J.V.

(Program with abstracts – Geological Association of Canada, v. 8, 1983, p. A75)

Abstract only.

ASTIS document number 148750.

ACU

Iceberg scour marks are evident over much of the Labrador Continental Shelf. The preservation/degradation potential of these features depends on the nature of surrounding sediments and the intensity of the hydrodynamic forces they are exposed to. Mineralogical and textural analysis of grab samples from southern Saglek and Makkovik Bank reveal information concerning sediment provenance and post-glacial sedimentary processes affecting these ice scoured surficial sediments. Heavy mineral and lithic fragment analysis indicate sediment origin from Precambrian terrains of Labrador, evidenced by igneous and high grade metamorphic rock assemblages. Clastic sedimentary and low grade metamorphic rocks are notably absent. Fossiliferous carbonate fragments identify a secondary sediment derivation from northern Greenland and/or the Canadian Arctic Islands through iceberg rafting. The sedimentary environments of Saglek and Makkovik Bank differ based on hydraulic equivalence relationships, texture, acoustic geophysical data and submersible observations. Southern Saglek represents a low energy environment with little evidence of sediment reworking except towards the seaward Bank margin. The well defined dense distribution of linear and curvilinear iceberg scours are well preserved. Conversely, the areally smaller and shallower Makkovik Bank is intensely disturbed by short linear and pit scours. Degradation of the scour marks by hydrodynamic reworking is evident and can be predicted from hydraulic equivalence relationship of the surficial fine sand sediment. (Au)

GORDON, D.C.

35

Dynamics and environmental effects of ice in the Cumberland Basin of the Bay of Fundy / Gordon, D.C. Desplanque, C.

(Canadian journal of fisheries and aquatic sciences, v. 40, no. 9, Sept. 1983, p.1331-1342, figures)

References.

ASTIS document number 124532.

ACU

Ice occurs in the upper reaches of the Bay of Fundy from December to April and conditions are influenced by the macrotides characteristic of the area. Drift ice forms on the seawater surface and because of almost constant movement in tidal currents is composed of small, rounded pieces. Shorefast ice develops from the stranding of drift ice between the neap and spring high water levels. Drift ice can also strand during ebb tide on intertidal salt marshes and mudflats which together comprise two-thirds of the Cumberland Basin area. Intertidal sediments can freeze to form a frozen crust, and sheet ice can form where salinity and tidal energy are low. Shorefast ice can significantly reduce the cross-sectional area of tidal rivers and encourage flooding. Stranded drift ice can import sediment and export plant debris from salt marshes. Mudflats are heavily scoured by ice all winter which causes erosion and mortality of benthic organisms. Construction of a tidal power project would change ice properties considerably. (Au)

GUIGNE, J.Y.

36

Review of deep water scours in the Davis Strait and its relevance to present day activity / Guigne, J.Y. Ross, D.I. Westergard, H.

(National Research Council of Canada Associate Committee on Geotechnical Research Workshop on Ice Scouring, 15-19 February 1982 / Edited by G.R. Pilkington. Technical memorandum – Canada. National Research Council. Associate Committee on Geotechnical Research, no. 136, p. 155-167, ill.)

References.

ASTIS document number 148415.

NFSMO

... A major objective of the study was to evaluate the extent and nature of iceberg scouring in the area. The deep water and strong currents required a careful assessment of each line to evaluate layback and side movement corrections for the towed fish. The high illustrative quality of the sonograms provided an excellent record of the nature of scouring around the Hekja Wellsite. Of the 281 scours interpreted 48.4 percent were longer than 500 metres, 63.0 percent were deeper than 1.5 metres and 59.5 percent had widths in the range of 20 to 30 metres. The dominant orientation was NE – SW, concordant to the currents. The sonograms provided a surprisingly wide catalogue of distinct iceberg scour marks which suggested at least initially, a range of ages from relict to recent time. However, the absence of observed icebergs with keel depths capable of scouring in these water depths raises serious questions on the relevance of using the physical characteristics of iceberg scours in assessing the question of age. This also questions the reliability of interpreting the relative age of scours found in the shallower areas of the Eastern Canadian seaboard based solely on scour characteristics as interpreted off Sidescan Sonar data. (Au)

GUSTAJTIS, K.A.

37

Iceberg scour survey, Labrador Shelf / Gustajtis, K.A.

(C-CORE news, v. 2, no. 4, Nov. 1977, p. 7-8, ill.)

ASTIS document number 148180.

ACU

This article describes the iceberg scouring work commenced during a four-month study of the marine environment of the Canadian Eastern Arctic and the Labrador Sea, aboard the Canadian oceanographic vessel CSS Hudson (July 1977). To assess the threat of present iceberg scouring to prospective sea-bottom installations it is necessary to determine the present rate of scouring since scours reported may be relic features formed during the last ice age. To conduct seismic surveys over areas which could be re-surveyed in subsequent years, it was decided to use acoustic transponders as markers anchored on the seabed, to facilitate accurate repositioning

in the subsequent year. Three parallel lines 1.0-1.5 km apart and 150 km long were run across Saglek Bank at the northern extreme of the continental shelf off Labrador. The actual mapping of scours was carried out using the HUNTEC Deep Tow Sub-bottom (DTS) Profiler. (ASTIS)

38
Iceberg scouring on the Labrador Shelf, Saglek Bank / Gustajtis, K.A.
St. John's, Nfld. : C-CORE, 1979.
xiv, 89p. : ill., maps, photos. ; 28cm.
(C-CORE publication, no. 79- 13)
(Technical report – Memorial University of Newfoundland. Centre for Cold Ocean Resources Engineering)
ISBN 088901-024-2.
References.
ASTIS document number 38172.
ACU, NFSMO

... Using available draft to height ratios for icebergs in the Labrador Sea, a theoretical scour rate curve as a function of water depth was developed. A study area on Saglek Bank, off northern Labrador was taken as a representative example of the Labrador Continental Margin and a detailed surficial seismic survey was carried out in 1977. All iceberg scours were mapped in three essentially adjacent areas, each about 2x5 kilometres in extent. ... A comparison of high resolution seismic data from 1976 proved inconclusive in the detection of any new or previously undetected scours in the study area. (Au)

HARRIS, I.M.

39
Iceberg furrow marks on the continental shelf northeast of Belle Isle, Newfoundland / Harris, I.M. Jollymore, P.G.
(Canadian journal of earth sciences, v. 11, no. 1, Jan. 1974, p. 43-52, figures)
References.
ASTIS document number 148288.
ACU, NFSMO

Side-scan sonar imagery indicates the presence of numerous large-scale furrows on the continental shelf northeast of Belle Isle, Newfoundland. The furrows are attributed to the ploughing action of bottom-dragging icebergs. They are typically linear troughs bordered by raised shoulders with an average width of about 30 m, a maximum observed depths of 6.5 m, and a maximum length of at least 3 km. Considered collectively, the furrows have a pronounced north-south trend, which probably reflects the general southerly drift of icebergs in the Labrador Current. (Au)

40
Iceberg marks on the Labrador Shelf / Harris, I.M.
(Offshore geology of eastern Canada. Volume 1. – Concepts and applications of environmental marine geology / Edited by B.R. Pelletier. Paper – Canada. Geological Survey, 74- 30, p. 97-101, figures)
References.
ASTIS document number 143421.
ACU, NFSMO

Sonar depth-sounding and side-scanning results indicate that marks formed by the dragging of icebergs over the sea bottom are widespread but not uniformly distributed on the continental shelf and upper continental slope off Labrador and northeastern Newfoundland. Typically, the marks are linear furrows (troughs bordered by raised shoulders). Their distribution and preservation on the sea bottom are determined by the drift behaviour of the icebergs, the bottom topography, and the extent to which the marks are buried beneath sediments or eroded by bottom currents. (Au)

41
Under-water diamond drill trial and support survey northeast of Belle Isle, Newfoundland / Harris, I.M.
(Paper – Canada. Geological Survey, 73- 1A, p. 109-110, ill.)
References.
ASTIS document number 148679.
ACU

A two-day program (Oct. 1-2, 1972, on board CSS DAWSON) of diamond-drilling, seismic reflection profiling and sonar side-scanning was carried out northeast of Belle Isle, Newfoundland .... The seismic profiling was used to distinguish the structure and seismic characteristics of the bedrock and the approximate depth of overburden along the survey lines. The seismics and sonar side-scanning together allowed inferences regarding the general nature of the substrate and provide a basis for selecting drill sites. The side-scan sonar records revealed numerous linear features on the sea floor, commonly several miles in length and apparently caused by the grounding of icebergs. ... (Au)

HODGSON, G.

42
Design of an ice scour repetitive mapping network / Hodgson, G.
[6] leaves ; 28 cm.
Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.
Indexed from a preliminary draft, July 1985.
Proceedings to be published as an ESRF Report in late 1985.
ASTIS document number 163554.

Geonautics Limited is presently evaluating conditions pertinent to the design of a repetitive seafloor mapping network for the east coast. The initial work has been directed at compilation of data to forecast the occurrence of iceberg groundings. Data on bathymetry, iceberg flux and density distribution, iceberg draft distribution and currents have been input to the Atlantic Geoscience Centre modelling program and predicted groundings derived. The model studies are being carried out for the northeast Grand Banks and for the Labrador Shelf. ... (Au)

ICE ENGINEERING LTD.

43
Arctic Iceberg Dimension Project : final report / ICE Engineering Ltd. Petro-Canada [Sponsor].
[St. John's, Nfld. : Ice Engineering Ltd.], 1978.
66 p. : ill. ; 22 x 28 cm.
References.
ASTIS document number 164062.
NFSMO

The Arctic Iceberg Dimension (AID) Project was ... a comprehensive survey of the High Arctic offshore environment prior to proposed drilling operations. The AID project involved a dimensional study of a sample of bergs [including grounded bergs] in the vicinity of Cape Sherard, Devon Island. The survey was carried out in August, 1978, from a base at Cape Sherard with a twin engine helicopter fitted for offshore reconnaisance and sonar deployments. The report contains the dimensional data recovered on a sample of 35 icebergs surveyed and includes a discussion of their implications for iceberg management. (Au)

JOSENHANS, H.W.

44

DIGS : regional geology and seabed dynamics at the proposed iceberg scour impact study site / Josenhans, H.W.

[4] leaves ; 28 cm.

Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.

Indexed from a preliminary draft, July 1985.

Proceedings to be published as an ESRF Report in late 1985.

ASTIS document number 163651.

[This paper] ... describes the geology of the Makkovik setting and [shows] why this site was selected for the DIGS (Dynamics of Iceberg Grounding and Scouring) experiment. ... [A scour mark and its degradation is also described.] ... (Au)

45

Pockmarks on the Labrador Shelf triggered or caused by iceberg scouring / Josenhans, H.W. Zevenhuizen, J.

[S.l. : s.n., 1983].

[6] leaves : ill., map ; 28 cm.

Paper presented at the Geotechnical Practice in Offshore Engineering Conference, 27-29 Apr., 1983, Austin, Tex.

ASTIS document number 159662.

Pockmarks are cone shaped depressions on the seafloor that are thought to be formed by venting gas or water. These features have been found worldwide occurring in unconsolidated fine sediments frequently in association with areas of hydrocarbon potential. Within the study area pockmarks range in size up to 100 m wide and 7 m deep and some occur in a unique association with iceberg scour marks. Extensive sidescan sonar and high resolution seismic reflection profile data shows pockmarks immediately adjacent to the lateral embankments (rims) of iceberg scour marks. High resolution profile data indicates that gas charged sediments frequently occur close to and in one example directly beneath a pockmark. A repeated association of pockmarks adjacent to iceberg scour marks suggests a causal relationship in which the grounded iceberg triggers release of the interstitial gas to form a pockmark. Alternatively, a moving grounded iceberg may compact and over pressure the unconsolidated sediment to force interstitial pore water out along areas of greater permeability or weakness within the sediment to form a pockmark-like feature adjacent to the scour mark. The association of pockmarks with seabed morphology sediment type, shallow gas occurance, and local stratigraphy is described. (Au)

46

Preliminary results of submersible observations on the Labrador Shelf / Josenhans, H.W. Barrie, J.V.

[Ottawa : Geological Survey of Canada, 1982].

(Paper – Canada. Geological Survey, 82- 1B, p. 269-276, figures)

(C-CORE publication, no. 82- 1)

(National Research Council of Canada Associate Committee on Geotechnical Research Workshop on Ice Scouring, 15-19 February 1982 / Edited by G.R. Pilkington. Technical memorandum – Canada. National Research Council. Associate Committee on Geotechnical Research, no. 136, p. 100, ill.)

References.

ASTIS document number 133230.

ACU, NFSMO

... Side-scan sonar and high resolution Huntec profiles suggest a relationship between iceberg scour mark morphology and sediment properties that warrants more detailed investigation by submersible. Also submersible observations of the local seabed dynamics are necessary to determine the degradation rate of scour marks in order to ultimately establish their recurrence interval. In October 1981 the use of the Pisces IV manned submersible provided visual and photographic documentation of the seabed within the Bjarni area ... and provided a vehicle for precise surficial sampling in iceberg-scoured terrain and over areas of bedrock outcrop. Our three main objectives were to: (1) investigate areas of the seafloor that have been actively disrupted by the grounding keels of icebergs and to note the degradation of these scour marks by the superimposed current regime and benthic biological activity; (2) provide ground truth for the acoustic data and note the modern sedimentary environment in terms of erosion or deposition: and (3) describe and sample a section of Tertiary (?) outcrop. ... (Au)

47

Seafloor dynamics on the Labrador Shelf / Josenhans, H.W. Zevenhuizen, J.

[S.l. : s.n., 1984?].

1 leaf ; 28 cm.

Abstract only.

Photocopy.

Paper presented at Sedimentology of Shelf Sands and Sandstones, Calgary, Alberta, June 1984.

ASTIS document number 159670.

Recent geological-geophysical studies on the Labrador Shelf demonstrates very dynamic bottom conditions over 70% of the shelf area and extending to depths of 230 m. A variety of sediment reworking processes which affect the seafloor are described but the most important agent – iceberg scouring – is emphasized. A series of oriented bottom photographs (colour) taken every 14 metres along a 6 km transect show a clearly defined "fresh" keel mark cut through a lag gravel and into the underlying gravelly silty clay substrate of Makkovik Bank. Transects taken from Saglek and Nain Banks in similar water depths ranging between 140 and 160 m also showed one "fresh" keel-mark per 6 km of seafloor photographed. On Saglek Bank a detailed synthesis of high resolution acoustic data, sidescan sonar and age determinations from piston core samples suggests complete iceberg reworking of all shelf areas shallower than 152 m within the last 10,000 years. Another important dynamic process on the shallow (<165 m) areas of the shelf is winnowing by bottom currents. ... The evidence for strong current winnowing and the very clearly defined keel marks suggest that "fresh" may represent days or months. The recurrence interval of modern iceberg scouring on the Labrador Shelf could be determined by measuring the rate of scour degradation by current winnowing for a given area and relating the number of partially degraded scours of a known age to the number of fresh scours with the same area. ... Contemporary deposition is mainly limited to water depths > 300 m in the transverse saddles, the marginal trough and shelf edge. Additional, but relatively minor, processes affecting the sea bottom are: ice rafting, reworking by macrobenthos and slumping. (Au)

KING, E.L.

48

Regional iceberg scour distribution and variability, eastern Canadian continental shelf / King, E.L. Gillespie, R.T.

[4] leaves : ill. ; 28 cm.

Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.

Indexed from a preliminary draft, July 1985.

Proceedings to be published as an ESRF Report in late 1985.

ASTIS document number 166510.

The Ice Scour Data Base that presently exists at Bedford Institute was initially established in 198? by Mike Lewis and Steve d'Apollonia using PERD funding. This presentation describes an update of that data base which was contracted to Geonautics Limited and funded out of the ESRF. The original data base involved an analysis of regional sidescan and Huntec DTS profiler records for the entire Canadian seaboard from Lancaster Sound to

the Grand Banks of Newfoundland and included the Baffin Island and Labrador Sea regions. The contract awarded to Geonautics to update this data base involved an analysis of any remaining regional data from both Government Institutions and Industry. (Au)

KING, L.H.

49

Relict iceberg furrows on the Laurentian Channel and western Grand Banks / King, L.H.

(Canadian journal of earth sciences, v. 13, no. 8, Aug. 1976, p.1082-1092, figures)

References.

ASTIS document number 148520.

ACU, NFSMO

A side-scan sonar survey along the western bank of the Laurentian Channel and on the western Grand Banks revealed the occurrence of iceberg furrows that are probably of Late Pleistocene age. The occurrence of furrows in the Gulf of St. Lawrence is significant in that it helps to date iceberg furrows along the northeast Newfoundland-Labrador margin of the northwest Atlantic, provides data on the history of deglaciation of the offshore area of the Atlantic Provinces, provides a means of evaluating sea level curves, and provides additional evidence for the broad regional extent of the Late Pleistocene shoreline at 115 to 120 m. (Au)

LEWIS, C.F.M.

50

DIGS : Dynamics of Iceberg Grounding and Scouring Experiment / Lewis, C.F.M.

[4] leaves ; 28 cm.

Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.

Indexed from a preliminary draft, July 1985.

Proceedings to be published as an ESRF Report in late 1985.

ASTIS document number 163643.

[This paper outlines the objectives of DIGS (the Dynamics of Iceberg Grounding and Scouring Experiment).] ... One important objective will be to determine the iceberg forces on the seabed and secondly to determine the seabed response to those forces. A third objective is to determine the effects of the seabed on iceberg motion and trajectory. Fourthly, to observe the possible hydrodynamic/sediment redistribution effects during the scouring event and finally to provide the opportunity to study a scour mark of known age and to determine its degradation with time. ... (Au)

51

Geological evidence of iceberg groundings and related seafloor processes in the Hibernia discovery area of Grand Bank, Newfoundland / Lewis, C.F.M. Barrie, J.V.

St. John's, Nfld. : Memorial University of Newfoundland, 1982.

ii, 32p. : figures ; 28cm.

(C-CORE publication, no. 81- 8)

(Proceedings of the Symposium Production and Transportation Systems for the Hibernia Discovery, St. John's, Newfoundland, Canada, February 16-18, 1981 / Edited by W.E. Russell and D.B. Muggeridge. – St. John's, Nfld. : Petroleum Directorate, Government of Newfoundland and Labrador, 1981, p. 146-177, ill.)

References.

ASTIS document number 86908.

ACU, NFSMO

Interpretation of the northeastern area of Grand Bank seabed based on high resolution seismic reflection profiles; side scan sonar imagery; bottom photography, sample and current metering; and engineering boreholes generally supports the surficial geology model of Fader and King (1981) and shows further evidence that the Hibernia area seabed is subject to iceberg scouring and intermittent sediment transport. ... A sparse population of relatively fresh looking ice scours comprising linear and curvilinear furrows and circular pits occurs throughout the region and is believed to represent the cumulative record of iceberg impacts within the past 10,000 years (Holocene) when late Wisconsin low sea level had risen sufficiently to allow icebergs to drift onto the Bank. ... Between 140 and 70 metres water depth on the margin of the Bank there is an upslope decrease in scour depths, widths, abundance and seabed disturbance. This is thought to arise as a result of a decrease in iceberg size and flux toward the Grand Bank margin away from the major iceberg source – the main branch of the Labrador current flowing around the northeast corner of Grand Bank. Scour depths may also be limited in shoaler water by the occurrence of the over-consolidated Tertiary unconformity near the seabed surface and by intermittent sedimentary infilling. (Au)

52

Ice scour studies on the Labrador Shelf / Lewis, C.F.M. Barrie, J.V.

(Proceedings – Workshop on Research in the Labrador Coastal and Offshore Region, Goose Bay, Labrador, September 4-6, 1980 / Newfoundland Institute for Cold Ocean Science. [St. John's, Nfld.] : Memorial University of Newfoundland, 1980, p. 264-265)

(C-CORE publication, no. 80- 13)

ASTIS document number 73598.

ACU, NFSMO

Numerous furrows in unconsolidated surficial deposits have been revealed by side scan sonar transects during geological reconnaissance of the Labrador Shelf by the Atlantic Geoscience Centre over the last decade. The furrows, tens of metres wide, are generally attributed to sediment gouging by bottom-dragging icebergs and represent a menace to potential offshore wellheads and pipelines. Three types of study are currently in progress to clarify the nature of this scouring process. 1. Regional Distribution of Ice-Scour Features ... 2. Site Investigation and Time Series Mapping [and] 3. Modern Iceberg Grounding Dynamics ... (Au)

53

Iceberg scour abundance in Labrador Sea and Baffin Bay, a reconnaissance of regional variability / Lewis, C.F.M. MacLean, B. Falconer, R.K.H.

(Proceedings : First Canadian Conference on Marine Geotechnical Engineering = Comptes rendus : Premiere Conference Canadienne sur le Genie Geotechnique Marin / Edited by W.J. Eden. – Montreal, Quebec : The Canadian Geotechnical Society, 1980, p. 79-94, ill.)

References.

ASTIS document number 149578.

NFSMO

This preliminary reconnaissance of the shelves of Baffin Bay and Labrador Sea, using a medium range side-scanning sonar, has revealed the diversity in regional abundance of iceberg scours. In general the number of iceberg impacts and scour marks tend to decrease with increasing water depth. This is expected because deep draft icebergs are scarcer than shallow draft icebergs. However, deeper draft icebergs appear to scour more deeply and longer with each impact. ... On a regional scale, iceberg scours are most abundant and best developed on the Canadian shelves of Baffin Bay and Labrador Sea where icebergs are naturally concentrated from West Greenland glaciers by a cyclonic gyral circulation. ... Iceberg scour is scarce on the southwestern Greenland shelf where the north-flowing West Greenland current carries relatively few icebergs (Murray, 1969). Scour is common farther north where numerous icebergs, fed from West Greenland glaciers, are drifting north and west. In general, the ice scour distribution correlates with major

ocean currents and iceberg drift routes. On a local scale the variability in scour abundance, form and orientation is high. ... (Au)

54
Reconnaissance of iceberg scour on the shelves of Labrador Sea and Baffin Bay / Lewis, C.F.M. Blasco, S.M. Falconer, R.K.H.
(Program with abstracts – Geological Association of Canada, v. 2, 1977, p. 32)
Abstract only.
ASTIS document number 149349.
ACU, NFSMO

Side-scan sonar transects, totalling 1000 km approximately, were obtained in 1976 across the continental shelves of northern Labrador Sea and northern Baffin Bay including Lancaster Sound. Iceberg scour tracks, where present, are the dominant feature of the seafloor micro relief. They occur as long, persistent, curvilinear single tracks, with younger tracks often superimposed on older tracks, where scour is abundant, or as short, crater-like marks. The former are characteristic of the northern Labrador and northern Baffin Is. shelves and may be favoured by a continuous cover of unconsolidated shelf sediment and by flat banks or slopes whose contours parallel the general direction of iceberg drift. The latter type are noted on the Greenland side of northern Baffin Bay and are believed to reflect a hard or sloping seafloor, possibly with little unconsolidated sediment cover. Minor bathymetric features control scour abundance; scour is virtually absent in shallow closed depressions on bank tops and is highly concentrated on the northern flanks of cross-shelf ridges. Scour abundance diminishes with increasing water depth with approximate limits of at least 100 m in Lancaster Sound and at least 275 m on Baffin and Labrador shelves. The general distribution of ice scour occurrences correlates with known ocean currents and iceberg drift routes. Scour is scarce on the southwestern Greenland shelf where the north-flowing West Greenland current carries relatively few icebergs. Scour is common farther north where icebergs, fed from Greenland glaciers, are drifting north and west. Scour is most abundant on the Canadian shelves where icebergs are concentrated and swept southwards by the persistent Baffin Bay and Labrador currents. (Au)

55
Report on cruise BIO no. 81-012, CSS Baffin, May 22-28, 1981 / Lewis, C.F.M.
Dartmouth, N.S. : Bedford Institute of Oceanography, 1981.
1 v. (various pagings) : ill. ; 28 cm.
Appendices by J.A.M. Hunter, C. Waboso, R. Burns, R. Good, T.R. Chari, W.G. Smith, J.V. Barrie, C. Lynas, K. Asprey.
ASTIS document number 149560.
NFSMO

The specific objectives of the cruise were: (1) measurement of seismic velocities and layer thicknesses in representative sediment facies of northeast Grand Bank; (2) trials of Memorial University free-fall penetrometer in northeast Grand Bank sediments; (3) collection of seabed samples, photographs and sidescan imagery for study of surficial sediment distribution, bedforms and sediment mobility, and resistance to iceberg scouring; (4) acquisition of sidescan imagery to assess iceberg scouring activity near Hibernia and across central Grand Bank (a potential southern pipeline route). ... (Au)

56
Submersible observations of iceberg furrows in glacial till, northeast Newfoundland Shelf : and in sand and gravel, Grand Banks of Newfoundland / Lewis, C.F.M. Fader, G.B.
(National Research Council of Canada Associate Committee on Geotechnical Research Workshop on Ice Scouring, 15-19 February 1982 / Edited by G.R. Pilkington. Technical memorandum – Canada. National Research Council. Associate Committee on Geotechnical Research, no. 136, p. 101)
Abstract only.
ASTIS document number 148377.
NFSMO

Observations from the research submersible PISCES IV of relic iceberg furrows in glacial till on the Northeast Newfoundland Shelf in water depths of 180 m, show that the troughs of the furrows are very flat and consist of well-sorted, angular, cobble-sized clasts. Large boulders are compressed into the substrate. Furrows are abundant, virtually saturating the seabed surface. Most furrows are less than 100 m in width, their shoulders or berms marked by linear ridges of exposed boulders projecting one to five metres above the adjacent furrow troughs. The berms slope more steeply inward toward the troughs than outward. A conspicuous paucity of sediment in the troughs of the furrows indicates that little deposition of sediment by ice rafting or other mechanisms has taken place since the furrows were formed. Observations of iceberg furrows in water depths of 80 m on the Grand Banks of Newfoundland in the Hibernia discovery area across a sand and gravel seabed show that the furrows are less numerous and much less well defined, even though they are inferred to be younger. The icebergs appear to have broken through a gravel lag exposing underlying pebbly sand which has subsequently been developed into small sand waves, or mega ripples. The berms of the furrows are approximately 0.5 m or less in height. A furrow was observed which continued for 50 m and terminated in a circular depression "iceberg pit", formed as the iceberg ceased to move in a linear direction. These observations are documented with video recordings. (Au)

LEWIS, J.K.C.

57
Icebergs on the Grand Banks : oil and gas considerations / Lewis, J.K.C. Benedict, C.P.
(World oil, v.192, no. 1, Jan. 1981, p. 109-114, figures, tables)
References.
ASTIS document number 149322.
ACU

As hydrocarbon production on the Grand Banks comes nearer, demands for ice technology are moving into a new era. Ice prediction and management capabilities, almost static over the nine year exploration phase, will have to become highly cost effective and mature rapidly for the production phase. This article is an introduction to current knowledge of iceberg movements, mechanical properties relevant to structural design, and the four components of iceberg management – detection, track prediction, pre-tow surveying and towing – as they affect offshore drilling and production operations. (Au)

LOKEN, O.H.

58
Bathymetric observations along the east coast of Baffin Island : submarine moraines and iceberg distribution / Loken, O.H.
(Earth Science Symposium on Offshore Eastern Canada, Ottawa, February 1971 / Edited by P.J. Hood. Paper – Canada. Geological Survey, 71- 23, p. 509-519, figures)
Cover title.
References.
ASTIS document number 148300.
ACU, NFSMO

Detailed studies of the submarine trough which extends across the

continental shelf off Clyde Inlet show that a terminal moraine lies across the outer part of the trough and that there is further evidence of four (4) other ice marginal positions, all seaward of the present shoreline. The oldest submarine feature is correlated with a supramarine moraine. The irregular topography of the trough differs sharply from the very smooth bottom topography on either side. The submarine moraine along the northwest side of the Clyde trough forms a barrier to the southward flowing icebergs which become stranded, thus accounting for the well-known field of icebergs characteristic of the Cape Christian area; which has an important stabilizing influence on the ice cover in the area. Studies of this naturally stabilized ice cover will be relevant to plans for artificially constructed ice islands in other areas. (Au)

MACLEAN, B.

59

Bedford Institute of Oceanography cruise report : CSS Hudson - 84-035 phase II, September 11 - September 28, 1984 / MacLean, B.

[S.l. : s.n., 1984].

[9] leaves : maps ; 28 cm.

Unpublished BIO Cruise Report.

ASTIS document number 159654.

... Principal objectives of the program were as follows: 1) investigate with Sea Marc sediment features associated with Western Boundary Undercurrent along SE-NW transect on continental slope east of Saglek Bank to outer edge of shelf off Hudson Strait. 2-a) with Sea Marc, examine ridge features (morainal or giant ice scours) on the outer part of the shelf off Hudson Strait; b) carry out brief (few hours) Huntec survey in inner part of area (a) and; c) obtain six cores of the sediments. 3) Carry out brief Huntec transect and core stratified sediments northeast of Resolution Island. 4) Conduct Sea Marc transect seaward from Loksland through Hekja and Raleigh exploratory well localitites on outer part of shelf into 2500-300 m of water to examine variations in iceberg scour characteristics and topography with changing seabed material and depth, maximum seaward depth limits of iceberg scour features, possible slump features, and Western Boundary Undercurrent sediments. 5) investigate with Sea Marc probable morainal sediments, 200 m terrace feature, iceberg scour characteristics and paleochannels (?) at north side of Saglek Bank. 6) investigate with Sea Marc glacial and bedrock features in Cartwright Saddle area including possible slump feature along SE ridge of Harrison Bank. ... Line 2 indicated the presence of subparallel iceberg scours or glacial ice sole marks that trend east-west on the outer part of the shelf off Hudson Strait. ... Line 3 east of Loksland showed that many scours on the central part of the intensely ice-scoured southeast Baffin Shelf seabed display a pronounced east-west orientation. ... Line 4 revealed parallel iceberg scours or icesheet sole marks in 275 m of water on the northeast edge of Saglek Bank that locally display a preferred orientation which is subparallel to bathymetric contours. Orientation of scours on the eastern part of the bank is more random. ... (Au)

60

Geology of the Baffin Island shelf / MacLean, B.

(Quaternary environments, eastern Canadian Arctic, Baffin Bay and west Greenland / Edited by J.T. Andrews. - London : George Allen and Unwin Ltd., [17] leaves, ill.)

Monograph in press.

Photocopy.

References.

ASTIS document number 159557.

Iceberg scour marks are observable on sidescan sonar records and high resolution seismic profiles across the sediment covered areas of the Baffin shelf down to depths of some 500 m or greater (e.g., Lewis et al., 1980). Some of these features are believed to be relict, other are the product of present day iceberg groundings. Although depth of water, iceberg size, seabed gradient, current regime, etc. are factors in the frequency of grounding and iceberg ploughing capability, various acoustic data and follow-up observations from the submersible Pisces IV indicate that depth of scouring into the seabed is also very much related to the hardness and resistance of the various seabed sediment types. ... (Au)

61

Investigations of Baffin Island shelf from surface ship and research submersible in 1981 / MacLean, B.

(Paper - Canada. Geological Survey, 82- 1A, p. 445-447, figures)

References.

ASTIS document number 81744.

ACU

Between September 9 and October 13, 1981, Atlantic Geoscience Centre (AGC) and Atlantic Oceanographic Laboratory (AOL), Bedford Institute of Oceanography, carried out a geological/chemical cruise (81-055) on the Baffin Island shelf using the surface ship M.V. Pandora II and the research submersible Pisces IV. This cruise was a follow-up to previous AGC bedrock and reconnaissance surficial geological investigations and to AGC and AOL oil seep studies in this area .... This report outlines the nature of the investigations and the preliminary results. (Au)

MARINE ENVIRONMENTAL SERVICES LIMITED

62

Environmental conditions in Baffin Bay and Davis Strait including presentation of data collected during summer 1972 / Marine Environmental Services Limited.

[Calgary : Distributed by APOA, 1972].

2 microfiches : tables ; 11 x 16 cm.

(APOA project no. 35 : Environmental study of the Baffin Bay-Davis Strait region. Report, no. 2)

Appendices.

References.

ASTIS document number 24503.

ACU, NFSMO

To present existing environmental data of the Canadian portion of the Baffin Bay - Davis Strait Region in a format suitable for use in planning exploration and development activities in this frontier region. All existing environmental data was studied by Marex and summarized in useful charts and diagrams. In addition, an observer was placed aboard a seismic vessel working in the area in the summer of 1972. This data added significantly to the limited amount of quantitative data available and forms an important part of the report. [Includes information on iceberg densities and percent of icebergs that are grounded.] (Au)

MARKO, J.R.

63

A study of long-term satellite-tracked iceberg drifts in the Baffin Bay and Davis Strait / Marko, J.R. Birch, J.R. Wilson, M.A.

(Eastern Arctic Marine Environmental Studies Program / Edited by N. Sutterlin. Arctic, v. 35, no. 1, Mar. 1982, p. 234-240, figures)

References.

ASTIS document number 83240.

ACU, NFSMO

Long-term, satellite-tracked iceberg trajectories were analyzed relative to the larger spatial and temporal scales of iceberg drift in Baffin Bay and Davis Strait. Berg movements were concentrated in the core of the Baffin Current which flows along the continental slope in a primarily southerly direction. The net rate of southward movements was found to be governed by a combination of

grounding and landfast ice entrapment which tended to be of particular significance in areas of the coastal shelf adjacent to major submarine canyon systems. (Au)

MCINTYRE, N.F.

64
The ability of floating platforms and tankers to operate in the Hibernia environment / McIntyre, N.F.
(Proceedings of the Symposium Production and Transportation Systems for the Hibernia Discovery, St. John's, Newfoundland, Canada, February 16-18, 1981 / Edited by W.E. Russell and D.B. Muggeridge. – St. John's, Nfld. : Petroleum Directorate, Government of Newfoundland and Labrador, 1981, p. 134-144, ill.)
ASTIS document number 149462.
NFSMO

Floating production systems being considered for Hibernia basically involve ship shape vessels, conventional semi-submersibles and some form of floating storage and loading facility. The first system evaluated by Mobil was the ship shape vessel .... It is a completely self-contained, self-propelled vessel with 1 MM bbl storage capacity. It would be over 1000 feet long and 160 feet wide. This vessel would be equipped for direct offloading to shuttle tankers, and includes a flare tower, 2 main processing areas, living accomodations for 125 people and a helideck. ... [The second concept is being considered primarily because it exhibits better motion and mooring characteristics. Associated with it is a cluster of subsea wells directly located beneath the semisubmersibles. This reduces the need for intrafield flowlines and thus reduces iceberg scour potential.] (Au)

MORAN, K.

65
DIGS : geotechnical aspects / Moran, K.
[6] leaves ; 28 cm.
Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.
Indexed from a preliminary draft, July 1985.
Proceedings to be published as an ESRF Report in late 1985.
ASTIS document number 163660.

This paper describes the equipment to be used in measuring the geotechnical aspects of the DIGS (Dynamics of Iceberg Grounding and Scouring) experiment. Equipment and instruments will include a Pisces submersible, a cone penetrometer, possibly a Nordco core drill and an offshore positioning system, acclerometers and temperature sensors, and possibly an acoustic sonobuoy. (ASTIS)

MUDIE, P.J.

66
Palynology as a method for dating ice scours / Mudie, P.J. Piper, D.J.W. Petro-Canada [Sponsor].
[S.l.] : Petro-Canada, [1982].
9, [14] leaves : 8 ill., 1 leaf of plates ; 28 cm.
References.
ASTIS document number 151386.

This report describes studies carried out to evaluate the use of palynology for dating ice scours on the continental shelves of Eastern Canada. This work included: (1) obtaining and analysing samples to establish a regional palynostratigraphy for Late Quaternary marine sediments; (2) obtaining and analysing samples from ice scours, and (3) attempting to determine the time of scour formation by correlation of palynological assemblages in the scour sediments with the regional palynofacies. ... The preliminary studies described here indicate that palynology can be applied to dating of postglacial ice scours to a precision of about ± 1,000 years. However, its application requires that two conditions first be met: (i) the scour must contain muddy sediment which can be sampled by coring, and (ii) a regional palynostratigraphy must be established for both onshore and marine sediments. ... (Au)

67
Palynology as a method for dating ice scours / Mudie, P.J.
[8] leaves : ill., map ; 28 cm.
Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.
Indexed from a preliminary draft, July 1985.
Proceedings to be published as an ESRF Report in late 1985.
ASTIS document number 167460.

Preliminary studies sponsored by PetroCanada indicate that palynology can be applied to dating of ice scours to a precision of about ±1,000 years. However, its application requires that two conditions be met: (1) The scour must contain progressively accumulated muds that can be cored; (2) A regional palynostratigraphy must first be established for both onshore and marine sediments. In the Northeast Newfoundland Shelf region, the palynological method indicates a period of possible disruption between 8,000 and 3,400 years B.P. (before present) with an interpreted age of 3,400 years B.P. for a furrow scour at 183 m water depth off Conception Bay. The method shows another period of possible disruption between 12,000 and 9,500 years B.P. with an interpreted age of 9,500 to 10,000 years B.P. for a crater-like scour feature at 260 m water depth in Notre Dame Bay. (Au)

PELLETIER, B.R.

68
Ice scour marks on the sea bottom off northern and eastern Canada / Pelletier, B.R. Harris, I.M.
(First Symposium on the Geological Action of Drift Ice, Quebec, Canada, April 20-24, 1974 [sic]. Maritime sediments, v. 9, no. 3, Dec. 1973, p. 111)
Abstract only.
ASTIS document number 149772.
ACU

Sidescan sonar and conventional depth-sounding provide imaginary imagery which indicates the widespread occurrence of marks on the sea bottom (formed by icebergs and pack ice running aground) off northern and eastern Canada. The marks typically have the form of linear furrows (troughs bordered by raised shoulders). Those that occur in the Arctic range in relief up to 10 m, in width from a few metres to several tens of metres, and in length up to 8 km. Those that occur in the eastern Canada offshore tend to be larger, as shown by their maximum observed dimensions (relief 10 m, width 250 m, and length 17 km). ... [Frequency of iceberg occurrence varies in the Arctic and eastern Canada offshore.] The Arctic occurrences are formed for the most part by the ploughing action of pressure-related structures in pack ice, whereas those off eastern Canada are formed primarily by bottom-dragging icebergs. (Au)

PEREIRA, C.P.G.

69
Davis Strait iceberg scouring study / Pereira, C.P.G. Woodworth-Lynas, C.M.T. Barrie, J.V.
St. John's, Nfld. : Centre for Cold Ocean Resources Engineering, 1984.
x, 78 p. : ill., maps ; 28 cm.
(C-CORE publication, no. 84- 4)
(Technical report – Memorial University of Newfoundland. Centre for Cold Ocean Resources Engineering)
ISBN 0-88901-122-2.

References.
ASTIS document number 167045.
ACU, NFSMO

... Two iceberg scour mosaics were compiled from sidescan sonar records of the Hekja Wellsite and Hekja North areas. Iceberg cross-cutting relationships (as defined from the mosaics) were then examined to determine the relative ages and scour depths of the individual scours. Eight relative age groups of scours have been identified from both the Hekja Wellsite and the Hekja North mosaic areas. ... The HUNTEC DTS and airgun seismic profiles along with the sidescan sonograms identified a seabed feature at 320 m located above and adjacent to a well-defined, major geological contact zone. Its similarities to other worldwide occurrences led Woodworth-Lynas (1983a) to identify the feature tentatively as a mud volcano. Farther south on line A, at the same contact, a not dissimilar conical feature is recorded which is interpreted as an eroded, relict feature, not directly a consequence of any form of tectonism. ... Sediment analysis of the surface grab samples indicates coarser and predominantly biogenic sediment toward the shore with the proportion of fine-grained siliciclastic sediment increasing with water depth. Micropalaeontological and sediment analyses of two cores suggest a number of possible causes to explain geological events recorded in the cores. The results suggest that core #44 was probably cored from either the trough, the berm, or from an area immediately adjacent to a scour. Based on the data collected, the age of the scouring event recorded in the core is not older than 5000 years BP, and not younger than 2000 years BP. ... (Au)

70
Determination of iceberg scoured sediment surfaces using quantitative microfaunal analysis / Pereira, C.P.G.
(Proceedings of the 1st Semi-Annual SEPM Meeting, San Jose, Calif., Aug. 1984, p. 66, ill.)
Abstract only.
ASTIS document number 159549.

During multiparameter surveys of the southeastern Baffin Island continental shelf, iceberg scours (=plough marks) down to a water depth of 700 m (2100 ft) were clearly identified on the geophysical records. Icebergs are a hazard to drilling and icebergs with such deep draughts could have a very detrimental effect on the industry's offshore drilling program. Buried iceberg scour features have been determined by quantitative microfaunal analysis using the technique illustrated in the accompanying figure. Analysis to date indicates several occurrences of distinct microfaunal and sedimentological breaks in a number of cores examined. With reference to these deep sea scours an idea put forward suggests that these scours were in fact made by smaller icebergs when sea levels were considerably lower indicating that these features are relict. Radiocarbon data determinations for these breaks is currently underway and correlations with cores from other earlier sampled sites within the southeastern Baffin Island Shelf suggests that the breaks identified immediately predate the Hall ice age. (Au)

71
Iceberg scouring in Davis Strait / Pereira, C.P.G.
(C-CORE news, v. 7, no. 2, June 1982, p. 3-4, ill.)
ASTIS document number 148253.
ACU

This article outlines Pereira's and Woodworth-Lynas' work on the CSS Hudson from Resolute Bay to St. John's in the final stages of her circum-navigation of North America. Their objective was a marine geological survey off the southeast coast of Baffin Island. Canterra's earlier work indicated extensive iceberg scour features at a depth of 350 m. A C-CORE data report on the marine geological survey will be published. It is hoped to eventually define a sea-level curve for the area and possibly infer probable ages of iceberg scours. (Au)

72
Iceberg scouring off the southeast Baffin Island continental shelf, eastern Canada, abstract results / Pereira, C.P.G.
(Iceberg research, no. 3, Feb. 1983, p. 5-11, figures, table)
(C-CORE publication, no. 83- 1)
References.
ASTIS document number 125040.
NFSMO, ACU

... This study aims to determine the age of individual scours and/or the scoured seabed surface, both in relative and in absolute terms. Relative dating techniques used in the analysis are iceberg cross-cutting relationships and frequency distribution patterns (vide Woodworth-Lynas, a, in prep.). Determining the 'absolute' age (date) of a scour, made prior to the commencement of the present research interests in these seabed features is perhaps an impossibility, but nevertheless radiometric dating of biogenic material from a core collected from within the scour should generate a working date .... However, too many varying factors, eg. strong cross currents, inaccurate navigation, ships' drift, etc., make the collection of a core from a scour (from a surface vessel), that had earlier been identified from sidescan mosaic, a very difficult task, especially at the water depths found at the Hekja Wellsite. ... (Au)

73
Marine geology of southeast Baffin Island : results from a 1981 and 1982 survey / Pereira, C.P.G.
(AAPG bulletin, v. 67, no. 3, Mar. 1983, p. 531)
(C-CORE publication, no. 83- 7)
Abstract only.
ASTIS document number 133299.
ACU, NFSMO

... The seabed sampling program was conducted off southeast Baffin Island during October, 1981 and in the summer of 1982. The samples were collected on exploration leases in water depths down to 450 m using both a piston and a gravity corer. Core recovery was variable and cores ranged from 15 cm to 100 cm. Additional samples and data also collected included surface sediment grabs, bottom photographs, sidescan, bathymetry, HUNTEC DTS and airgun geophysical data. ... Full results of the core analysis, sediment distribution, geotechnical properties and sea level changes and a comparison with earlier studies are presented in the paper. (Au)

PRAEG, D.B.

74
Quaternary geology of the southeast Baffin Island continental shelf, N.W.T. / Praeg, D.B. MacLean, B. Hardy, I.A. Mudie, P.J.
[S.l. : s.n., 1985].
ii, 65, [34] leaves : ill., maps ; 28 cm.
(Paper – Canada. Geological Survey, 85- 14)
GSC paper in press.
Photocopy.
References.
ASTIS document number 159735.
ACU

The Quaternary sediments of the southeast Baffin Island continental shelf have been investigated using acoustic data (Huntec DTS and 665 cubic cm air gun seismic profiles, sidescan sonograms, echograms) supplemented by sample control (grabs and cores). Four acoustic units have been defined and informally named: map-unit 1: Baffin Shelf Drift - unstratified diamictons generally <100 m thick but up to 300 m off Hudson Strait, which were deposited from grounded glacial ice, and which reach to the shelf edge in some areas; these sediments record repeated advances of galcial ice, of varied extent, of early late Foxe and older age; map-unit 2: Davis

Strait Silt – sediments generally <10 m but up to 70 m thick, which are stratified where unscoured by grounding icebergs (Subunit A) and acoustically unstratified where scoured by grounding icebergs (Subunit B); these sediments record depostion from mid Foxe to Holocene time and contain microfossil evidence of ice-proximal to ice-distal glacial marine environments; map-unit 3: Tiniktartuq Silt and Clay – stratified basin-fill sediments up to 10 m thick which directly overlie the stratified sediments of Davis Strait Silt Subunit A; these sediments indicate a change in depositional style in the late Foxe to Holocene; map-unit 4: Resolution Island Lag- subangular gravels and sands which occur in areas that appear largely devoid of cover to the limit of acoustic resolution (30-50 cm), and which may include areas of exposed bedrock; these sediments record current winnowing of areas of thin to discontinuous Baffin Shelf Drift or Davis Strait Silt. There in no evidence for a transgressive zone marking a relative sea level lowstand in the depths represented by the data (mainly >150 m). (Au)

ROBE, R.Q.

75

Long-term drift of icebergs in Baffin Bay and the Labrador Sea / Robe, R.Q. Maier, D.C. Russell, W.E.

(Iceberg Dynamics Symposium, June 4 and 5, 1979, St. John's, Nfld., Canada / Edited by W.E. Russell. Cold regions science and technology, v. 1, no. 3 and 4, Feb. 1980, p. 183-193, illl., maps)

References.

ASTIS document number 164089.

ACU, NFSMO

During January and February 1978, six ADRAMS (Air Deployable Random Access Measurement System) ice buoys were dropped by parachute onto five icebergs, four in the vicinity of Cape Dyer, Baffin Island, and one northwest of Disko Island on the west coast of Greenland. These ice buoys transmitted a signal to the NIMBUS-6 satellite which could be used to compute position and local temperature. The ice buoys were tracked for periods which ranged from 138 days up to 202 days. The four icebergs along the Baffin Island coast were aground from 8% to 88% of the time observed. Maximum daily average speeds ranged as high as 0.60 m/s while modal speeds were generally less than 0.15 m/s. The drifts were generally coastwise in a southerly direction. The iceberg near Disko Island was aground 25% of the time observed and had a maximum daily average speed of up to 0.20 m/s with a modal value of between 0.05 to 0.10 m/s. The drift of this iceberg began erratically with the final 40 days strongly offshore toward the west. (Au)

76

Long-term tracking of arctic icebergs / Robe, R.Q. Maier, D.C.

[Groton, Conn.?] : U.S. Coast Guard Research and Development Center, 1979.

41p.

(Final report – U.S. Coast Guard. Office of Research and Development, CGRT/DC-8/79)

(U.S. Coast Guard, USCG-D-36-79)

Also available on microfiche from NTIS.

References.

Document not seen by ASTIS. Citation from MRIS.

ASTIS document number 40460.

NFSMO

Seven Greenland icebergs were tracked, two in 1977 and five in 1978, using ADRAMS (Air-Deployable Random Access Measurement System) ice buoys. The ice buoys transmit a signal to the NIMBUS-6 satellite which is used in computing the buoy's position. ... two icebergs began near Disko Island, Greenland ... five began on the Baffin Island side of Baffin Bay near Davis Strait. The icebergs initially located near Disko Island did not appear to be influenced by any well-defined current system, the drift track of each was erratic and the drift speeds generally less than 0.20 m/s. The icebergs initially located along the coast of Baffin Island followed the prevailing currents southward. These icebergs drifted at speeds as high as 0.8 m/s with model speeds generally falling between 0.10 m/s and 0.20 m/s. Groundings occurred frequently, occupying 40 percent of the observed time. Data processing methods, accuracy of the ice buoy system, and a detailed analysis of each iceberg's drift is presented. It was estimated ... approximately 190 days are needed for an average size iceberg to travel the 1100 nautical miles from Cape Dyer, Baffin Island, to the outer limits of the Grand Banks of Newfoundland. (Au)

SCHOENTHALER, L.

77

Grand Banks ice scour catalogue / Schoenthaler, L.

[3] leaves ; 28 cm.

Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.

Indexed from a preliminary draft, July 1985.

Proceedings to be published as an ESRF Report in late 1985.

ASTIS document number 166553.

On behalf of the Hibernia joint venture participants, (Chevron, Gulf Canada, Petro-Canada, Columbia Gas and Mobil (operator)) Mobil has compiled a Grand Banks ice scour catalogue using information from wellsite surveys, pipeline surveys, Bedford Institute regional reconnaissance survey data and C-CORE survey data. This presentation will briefly describe the ice scour catalogue. ... Objectives of our cataloguing efforts were: (1) Determine the areas where surveys exist (2) Catalogue scours to be used as base for statistical calculations. Over the last six years Mobil has conducted many wellsite surveys on the Grand Banks, in and around the Hibernia field. The wellsite surveys are conducted over relatively small areas around prospective drillsites, and consist of survey lines laid out in a grid pattern with spacing between 250 and 1000 metres. As a result, large quantities of bathymetric, sub-bottom profiler and sidescan data have been gathered. This data, used as the starting point for establishing our computer based ice scour catalogue, was augmented with pipeline surveys, and regional survey data. (Au)

SYVITSKI, J.P.M.

78

SAFE : HU82-031 sidescan sonar and sounder profiles / Syvitski, J.P.M. Blakeney, C.P. Hay, A.E.

(Sedimentology of Arctic Fjords Experiment : HU 82-031 data report, volume 1 / Compiled by J.P.M. Syvitski and C.P. Blakeney. Canadian data report of hydrography and ocean sciences, no. 12, p. 16.1-16.49, ill., maps)

ASTIS document number 159450.

ACU

[This data report presents sonar and sounder information from cruises of several Baffin Island fiords. The cruise objectives were to:] (A) Ascertain the shallowness of sills and depth of basins: important parameters for fjord circulation studies. (B) Identify sea floor markings such as bedforms (for sediment dynamics), ice scours and dropstones (indicative of ice activity), submarine channels (indicative of sediment gravity flows), and slide scars (mass movement activity). (Au)

79

Seabed investigations of the Canadian east coast and Arctic using Pisces IV / Syvitski, J.P.M. Fader, G.B. Josenhans, H.W. MacLean, B. Piper, D.J.W.

(Geoscience Canada, v. 10, no. 2, June 1983, p. 59-68,

figures)
References.
ASTIS document number 120090.
ACU

Our aim is to provide the reader with information on the Canadian submersible Pisces IV and its effectiveness in reaching a wide range of scientific objectives during a program carried out in the Eastern Canadian offshore in 1981 ... we address a cross-section of objectives [which] include the investigation or characterization of ... iceberg scour processes ... Labrador, Baffin and Grand Banks Shelves ... submarine hydrocarbon seepage (Scott Trough, Baffin Shelf) .... (Au)

TODD, B.J.

80
Iceberg scouring on Saglek Bank, northern Labrador Shelf / Todd, B.J.
Halifax, N.S. : Dalhousie University, 1984.
xvi, 162 p. : ill. ; 28 cm.
Thesis (M.Sc.) – Dalhousie University, Halifax, N.S., 1984.
Bibliography: p. 149-162.
ASTIS document number 150037.
NFSMO

High-resolution seismic and sidescan sonar surveys on Saglek Bank indicate extensive areas of iceberg-scoured seabottom. The scour trends and abundance are compared with iceberg trajectories and oceanic current information. Saglek Bank shows heavy scouring (50 to 100% of the seabed shows clearly defined scour marks) on its north-facing bank edge (175 to 250 m water depth) where the iceberg-carrying Labrador Current impinges. The remaining bank edges show moderate to heavy scouring (25 to 75%) while the bank top at water depths less than about 150 m is heavily scoured. The differences in the amount of scouring are interpreted as resulting from variations in iceberg flux, iceberg draft and bathymetry, combined with differing rates of scour obliteration. The orientation of the scours generally parallel the bank edges i.e. northwest-southeast. ... Iceberg scour trends generally reflect the direction of oceanic flow and modern iceberg movements. These movements are primarily controlled by currents which in turn are influenced by the shelf bathymetry. Local direct bathymetric control of iceberg movement has been recognized in shelf areas of low translatory current strength. (Au)

81
Iceberg scouring on Saglek Bank, northern Labrador Shelf / Todd, B.J.
[33] leaves : ill., maps ; 28 cm.
Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.
Indexed from a preliminary draft, July 1985.
Proceedings to be published as an ESRF Report in late 1985.
ASTIS document number 166537.

This presentation describes the first use of the Bedford Institute of Oceanography Ice Scour Data Base in a regional geological setting. It reviews the combined efforts of Dr. C.F.M. Lewis, Steve d'Appollonia and the author and supplements similar studies described earlier in this workshop. The papers presented at this workshop so far have indicated that the continental shelves adjacent to the glaciated continents show extensive scouring which is attributable to icebergs. However, most of the published data assumes that scours are aligned with the prominent currents. This assumption, we thought, needed verification. We know that about 85% of the icebergs that reach the Labrador Shelf are calved in the tidewater glaciers of Greenland and flow from the northwest in a southeast direction, along the shelf, under the influence of the Labrador Current. Saglek Bank, which is located on the northern end of the Labrador Shelf was chosen as the study area for a number of reasons. Primarily this area has been the subject of a regional surficial geological study at BIO for several years and significant amounts of geological, iceberg and ocean current data are available. Our objectives were to describe the iceberg scour record and attempt to interpret some of the features that relate the iceberg scours to the known ocean currents. (Au)

VAN DER LINDEN, W.J.

82
Hamilton Bank, Labrador margin : origin and evolution of a glaciated shelf / Van der Linden, W.J. Fillon, R.H. Monahan, D.
Ottawa : Canadian Hydrographic Service and the Geological Survey of Canada, [c1976].
1 portfolio : ill., maps (part. fold.) ; 29cm.
(Paper – Canada. Geological Survey, 75- 40)
(Marine sciences paper, 14)
ISBN 0-660-00482-5.
References.
ASTIS document number 6572.
ACU, NFSMO

Hamilton Bank consists of a thick wedge of Mesozoic and Cenozoic sediments that was built out over a block-faulted, subsiding Precambrian crystalline basement. Subsidence was in response to the same forces that caused the opening of the Labrador Sea and the separation of Greenland and North America. The gross final relief was formed through alternating phases of valley erosion and of deposition corresponding to periods of glacio-eustatic lowered and raised sea level. ... Postglacial sediment dynamics has been largely a matter of winnowing and local redeposition of glacial deposits. The bulk of the fine clays that accumulated in the deepest parts of the marginal trough in early postglacial time seems to have been derived from the inner shelf while the Labrador Current was confined to the outer edge of the shelf. In the past 6000 years or so, however, the Labrador Current adopted a course closer to shore, through Cartwright Saddle and the marginal trough. Icebergs calved from the Greenland Icecap are carried southward across Hamilton Bank by the Labrador Current. Where they touch bottom furrows are gouged up to several meters deep and several kilometers long. (Au)

WOODWORTH-LYNAS, C.M.T.

83
Grounding and scouring icebergs on the Labrador Shelf / Woodworth-Lynas, C.M.T. Simms, A. Rendell, C.M.
[12] leaves, figures, table ; 28 cm.
(C-CORE publication, no. 84- 8)
(Iceberg research, no. 7, Mar. 1984, p. 13-20, ill.)
References.
ASTIS document number 148202.
ACU, NFSMO

... Whilst most offshore operators agree that scours and scouring are problems to the safe exploration and development of hydrocarbon resources, very little effort has been directed at determining modern day grounding frequencies in exploration areas. ... Because there is a large gap in our knowledge of modern grounding frequencies, we have analyzed a complete set of iceberg radar observation data from the Labrador and northeast Newfoundland Shelf collected between 1973 and 1981. We have currently analyzed more than 1500 iceberg tracks observed at these wellsites in order to establish criteria for identifying grounded and scouring icebergs. So far we have identified over fifty groundings from eleven areas but we feel that this number is conservative and that several other groundings will be identified as our criteria are refined. We present here, for the first time, some preliminary results of this study from six wellsites on Makkovik Bank. (Au)

84
Iceberg grounding and scouring / Woodworth-Lynas, C.M.T.
(C-CORE news, v. 9, no. 1, Mar. 1984, p. 5, ill.)
ASTIS document number 148229.
ACU

This article reports on the analysis by the author and by A. Simms and C. Rendell of tracks of over 1,500 icebergs collected from 40 wellsites between 1973 and 1981. The study is concentrated on the Saglek and Makkovik Banks, the best documented areas on the Labrador Shelf. Results will be published in C-CORE's Technical Report "Iceberg Grounding and Scouring on the Labrador Continental Shelf." (ASTIS)

85
Iceberg grounding and scouring frequency, Labrador Sea / Woodworth-Lynas, C.M.T. Simms, A. Rendell, C.M.
(Oceans 84, conference record : industry, government, education ... design for the future. – [New York : Institute of Electrical and Electronics Engineers], 1984, v. 1, p. 259-262, ill.)
(C-CORE publication, no. 84- 16)
References.
ASTIS document number 150762.
NFSMO, ACU

Iceberg scouring presents a major problem in the placement of pipelines and other seabed installations at producing wells in the iceberg-rich waters of the eastern Canadian continental shelf. Over fifty grounded and scouring icebergs have been identified from iceberg observations made at twelve exploratory wellsites on the Labrador and northeast Newfoundland shelf areas. From these data sets, icebergs which remained stationary for twelve hours or more, were considered to be grounded. Bergs which moved into shallower water from the grounding sites were interpreted to be scouring. We found that icebergs can scour both up and downslope; one berg scoured over a vertical interval of 45 m. Many scour tracks exceeded lengths of 20 km and some exceeded 50 km. The grounding frequency varied greatly between years and wellsites; the average, however, ranges between 5 groundings per 100 bergs at 59 degrees N and 3.4 per 100 at 56 degrees N. ... (Au)

86
Iceberg grounding and scouring from Labrador / Woodworth-Lynas, C.M.T. Simms, A.
[20] leaves : ill., maps ; 28 cm.
Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.
Indexed from a preliminary draft, July 1985.
Proceedings to be published as an ESRF Report in late 1985.
ASTIS document number 163520.

[This paper outlines a study on iceberg groundings using radar data.] Observations of over 2000 icebergs have been used to delineate areas of active grounding and scouring on the Labrador Shelf. ... [The] study shows that many scouring icebergs can move over very large (220 km) distances and may traverse significant (up to 45 m) ranges in bathymetry. ... On Saglek Bank, [it was estimated] ... that approximately 112,000,000 cubic m of seabed material may be reworked each year by scouring icebergs, clearly indicating that although grounding frequencies are low, iceberg scouring is a dynamic and geologically important process capable of generating significant areas of iceberg turbate facies. (Au)

87
Iceberg grounding and scouring on the Labrador continental shelf / Woodworth-Lynas, C.M.T. Simms, A. Rendell, C.M.
(Cold regions science and technology, v. 10, no. 2, Feb. 1985, p. 163-186, ill.)
References.
ASTIS document number 160547.
ACU

Icebergs drifting in seas of the eastern Canadian Continental Shelf present serious hazards to offshore drilling operations. Damage to offshore structures may be caused by direct collisions with a floating or gravity-based structure. Icebergs whose keels touch and plough through or scour the soft sediments of the seabed may crush and rupture seabed installations such as wellheads, anchoring/mooring systems, pipelines and telecommunication cables. Observations made at exploration wells on the Labrador Shelf from 1973 to 1981 are used to delineate areas of active iceberg scouring and to quantify the incidence of grounding and scouring icebergs. The term grounded is used to describe icebergs whose keels have contacted the seabed and which have thus been halted. Scouring icebergs are those whose keels have contacted the seafloor, but which continue to move forward. Observations of more than 1500 icebergs from twenty-two well sites have been analyzed and criteria for identifying grounded and scouring bergs have been established. Over fifty icebergs have been observed to ground and scour in eleven areas. Over the observation periods, the average grounding frequency for Makkovik and Saglek Banks were 3.3% (data collected in seven years) and 4.3% (data collected in six years), respectively. It appears likely, however, that these frequencies are an underestimate and that many more "possible" grounding and scouring icebergs will eventually be included in the data set. We show that many scouring icebergs can move over large (60 km) distances and are able to traverse significant (up to 45 m) ranges in bathymetry. We suggest that they may accomplish this through increases and decreases in draft by continual gradual rotation about a horizontal axis normal to the movement direction. (Au)

88
The relative age of ice scours using cross-cutting relationships / Woodworth-Lynas, C.M.T.
St. John's, Nfld. : Centre for Cold Ocean Resources Engineering, Memorial University, 1983.
viii, 54 p. : figures, tables ; 28 cm.
(C-CORE publication, no. 83- 3)
(Technical report – Memorial University of Newfoundland. Centre for Cold Ocean Resources Engineering)
ISBN 0-88901-089-7.
References.
ASTIS document number 115460.
ACU, NFSMO

Iceberg scour marks are straight or curvilinear troughs on the seabed which have been formed by grounding iceberg keels as they are carried forward by ocean currents. A new method for dating the relative ages of ice scour utilizes cross-cutting relationships. The method allows delineation of relative age groups and identification of oldest and youngest end member scours from sidescan sonar mosaics. Selective coring of two or more end member scour troughs from a scour population in which undisturbed sediments have accumulated and use of conventional absolute age dating techniques should establish the age of the population from which a scouring rate can be extrapolated. A decrease in scour width with decreasing scour age shows positive correlation and has been used to show a possible net decrease in iceberg size with time. (Au)

89
The relative age of ice scours using cross-cutting relationships / Woodworth-Lynas, C.M.T.
(Program with abstracts – Geological Association of Canada, v. 8, 1983, p. A75)
Abstract only.
ASTIS document number 148725.
ACU

Iceberg scour marks are ubiquitous on the seabed of the continental

shelves of southeastern Baffin Island and Labrador and are made by grounding icebergs which plough linear furrows in the seafloor sediments. When a scouring iceberg traverses a pre-existing scour mark the resulting characteristic cross-cutting relationship that is made can be easily detected from sidescan sonograms. Using the cross-cutting principle a method for defining the relative ages of scour populations from three areas in this shelf region has been developed. The method allows the delineation of oldest and youngest "end member" scours which can be radiometrically dated to define the absolute age of the scour population. A decrease in scour width with decreasing scour age can be shown and this may be used to infer a net decrease in iceberg size since deglaciation. (Au)

CANADIAN BEAUFORT SEA

90

Introduction to ice scouring in the southern Beaufort Sea
(APOA review, v. 3, no. 1, Mar. 1980, p. 15-16, ill.)
ASTIS document number 148091.
ACU

Expeditions undertaken by the United States Navy in the early 1950s produced echo-sounding traces (fathograms) revealing the presence of a complicated sea bottom microrelief (small landform features) present in both the Chukchi and Beaufort Sea. The existence of pits, mounds, ridges and troughs was not readily explained, owing to the possibility of various processes acting upon the sea floor, the haphazard arrangement of the features, and the similarity in bottom type in those areas with and those without the microrelief. Five possible explanations of the origin of the features were forwarded: glacial deposition, sea-ice melt deposits, permafrost activity, mass movement, and the grounding of sea-ice and icebergs (Carsola, 1954). ... [Several prossesses were explored as possible explanations for these features. The most likely] mechanism for the formation of the microrelief was the grounding of sea ice and icebergs. The microrelief formations had been observed at depths greater than the keels of present day ice, but this could be explained by historically lower sea levels, or from previously thicker glacial ice. The grounding of the keels of pack ice, ice islands and pressure ridges may have been responsible for these patterns observed on the sea floor. (Au)

91

Sea-bed scouring by ice (projects 19, 32 and 69)
(APOA review, v. 3, no. 1, Mar. 1980, p. 17-18)
References.
ASTIS document number 148083.
ACU

[This paper reviews three APOA projects, #19, 32, and 69, which explore the subject of sea-bed ice scouring in the Beaufort Sea.] Sonar records obtained in 1970 by the Canadian Geological Survey and the Bedford Institute of Oceanography revealed linear depressions on the seafloor. These were believed to be the result of the grounding of ice masses. Mounds on the sea-bed were also found and could have been pingos or the raised banks of scour trenches. In addition to the sonar records, seismic profiling, grab samples and cores were obtained. These records were studied in APOA project #19 to determine the cause, location, frequency and magnitude of ice scouring of the sea floor. ... Additional records obtained by the GSC in 1971 and a contractor in 1972 led to phase II of the APOA study on ice scouring. Project 32 reviewed both the new records along with the 1970 data and were analyzed in a similar manner as in project 19. ... The primary objective of project 69 was to develop mathematical models describing the interaction of ice with seabed soils in order to predict scour depths and forces that may be produced by a grounding ice feature of given geometry. The ice mass may be an ice island, a multi-year floe, or an iceberg. General observations pertinent to scouring were made: the nature of sea-bottom sediments, ice formations and environmental forces, as well as the formation of several preliminary, idealized mathematical models describing ice scour actions. ... (Au)

ARCTIC LABORATORIES LIMITED

92

A benthic survey of a potential gravel deposit near Banks Island, N.W.T. / Arctic Laboratories Limited. Heath, W.A. Thomas, D.J. Koleba, J.M. Perry, B.M. Ethier, A.G. Maclauchlan, L. Dome Petroleum Limited [Sponsor].
Inuvik, N.W.T. : Arctic Laboratories Ltd., 1982.
2 microfiches : figures, tables ; 11 X 15 cm.
(Beaufort E.I.S. reference work, no. RWE19)
Appendix.
References.
ASTIS document number 108111.
ACU

Near the southwest coast of Banks Island ... a survey of the benthos was conducted by diving biologists on a potential gravel deposit. The purpose of the survey was to describe the types and distributions of benthos, and their community associations in the gravel area prior to a proposed dredging program. Sampling stations ranged from 3.3 to 18.2 m in depth. ... Shallow trenches which had been ploughed in the bottom by grounding ice were evident at four stations. ... The benthos from bottom samples were identified only to the family level .... A total of 96 families were distinguished. Diversity, in terms of families present, ranged from 17 per sample at the shallowest, sandy station to 68 per sample at a deep station with heterogeneous sediments. The benthic biomass varied from 14.43 to 109.70 g/square m per sample. ... it does not appear that the study area would be a significant feeding area for the seals. ... Despite the periodic disturbance due to ice scouring, the benthos in samples from the "deep, heterogeneous" stations exhibited high levels of diversity and biomass. However the within station sampling variance in this group was also high, indicating a patchy or clumped distribution of the infauna. If dredging was performed in the study area, the patterns of recolonization and faunal distribution would likely be similar to those associated with ice scouring. (Au)

CANADIAN MARINE DRILLING LIMITED

93

Ice scour survey 1979, Beaufort Sea report / Canadian Marine Drilling Limited. Hoare, R.D. Gulf Canada Resources Inc. [Sponsor]. Dome Petroleum Limited [Sponsor].
[S.l. : Canadian Marine Drilling, 1979?].
[19] leaves : ill. (some folded), maps ; 28 cm.
(APOA project no. 158 : Beaufort Sea repetitive scour mapping analysis – 1979 and comparison with 1972, 1974 and 1977 mosaics. Report)
Two maps and 5 illustrations folded in pocket.
Background information related to APOA project no. 158.
ASTIS document number 149420.

A joint Dome/Gulf project to survey selected sub-sea areas in the Beaufort Sea in 1979 was conducted over a period of 20 days in August of that year. The reasons for doing the job may be summarized as follows: (1) To determine the extent of ice scour at the selected sites. (2) To compare the scours with previously surveyed ones in the same areas, and hence determine return rates. (3) To lay the foundations for an on-going program using magnetic tape records which could be computer processed and improve our overall resolution and confidence level of sea-bed scours. ... (Au)

CREARE, INC.

94
Sea ice pressure ridges and ice islands / CREARE, Inc. Kovacs, A. Mellor, M.
[Calgary : Distributed by APOA], 1971.
3 microfiches : ill., figures, tables ; 11x16cm.
(APOA project no. 17 : Beaufort Sea pressure ridge and ice island scouring. Report, no. 1)
(Technical note – CREARE, Inc., no. 122)
Appendices.
References.
ASTIS document number 25500.
ACU, NFSMO

The environmental conditions of ice-covered polar seas are described, with special emphasis on the pressure ridges and ice islands encountered in Mackenzie Bay and the Beaufort Sea. Techniques for determining the geometric configurations and the physical and mechanical properties of sea ice structures and ice islands are described. Profiles of pressure ridges were determined by surface surveys, drill hole probes, and side-looking sonar scanning; results are given for several multi-year ridges and one first-year ridge. Supplementary information obtained from dives under the ice is also given. Corresponding data are given for ice islands, with particular attention being given to contact between the ice and the sea bed. Measurements of temperature, salinity, tensile strength and compressive strength are given for ice taken from old pressure ridges, and factors influencing the interpretation of test data are discussed. The main report closes with a brief discussion of some of the findings. The appendices give complete diving reports, and a full report on the performance of the SR.N6 Hovercraft. (Au)

FENCO CONSULTANTS LIMITED

95
An analytical study of ice scour on the sea bottom / Fenco Consultants Limited.
[Calgary : Distributed by APOA], 1975.
5 microfiches : figures, tables ; 11x16cm.
(APOA project no. 69 : An analytical study of ice scour. Report)
Appendices.
References.
ASTIS document number 26697.
ACU, NFSMO

... The study covers all aspects of scouring: a review of literature; environmental factors required for study; types of ice formations; marine sediments; plus several idealistic mathematical models to predict scour for different situations. In particular, a dynamical model has been developed (by solving the basic equations of motion of a body being driven into a sloping sea bed) and the solutions compared with other simpler model solutions which use either energy conservation or static equilibrium conditions. Finally, suggestions for model tests are given which could be used to verify the mathematical solutions presented here. ... (Au)

GEOMARINE ASSOCIATES LTD.

96
Compilation of the thickness of Recent soft sediment and ice-related features in the Beaufort Sea, Northwest Territories, Canada / Geomarine Associates Ltd. Meagher, L.J. Canada. Geological Survey. Terrain Sciences Division [Sponsor].
[Ottawa : Geological Survey of Canada, Terrain Sciences Division], 1978.
Document not seen by ASTIS.
ASTIS document number 149934.

GEOTERREX LIMITED

97
Marine bottom and sub-bottom survey regional lines, Beaufort Sea / Geoterrex Limited. Musellec, P. Soon, A. Quinn, R. Gulf Canada Resources Inc. [Sponsor].
Calgary, Alta. : Geoterrex Ltd., 1980.
1 v. (loose-leaf) : ill. (some folded), map ; 30 cm.
Three illustrations folded in pockets.
References.
ASTIS document number 149390.

Two regional lines were completed in an area located approximately 100 kilometres northwest of Tuktoyaktuk, N.W.T. ... During the detailed site survey the following equipment was utilized: (a) Precision echo sounder – ELAC LAZ 17: to accurately measure and record the water depths; (b) Side scan sonar – KLEIN: to delineate the seafloor topographic features between grid lines; (c) Sub-bottom profiler – RTT 1000 and Boomer with single hydrophone, NSRF: to investigate the soft surficial sediments. (d) Boomer with surface tow streamer array, NSRF: to provide deeper penetration of the surficial sediments and provide details of potential shallow ice bonding; (e) Miniflexichoc high resolution seismic source and 12 channel streamer: to investigate the geology, including the occurrence of acoustic permafrost and possible gas hydrates to a depth of approximately 1 km. ... (Au)

GILBERT, G.R.

98
Beaufort Sea ice scour analysis using a computerized data base / Gilbert, G.R. Blasco, S.M. Stirbys, A.F. Lewis, C.F.M.
(OTC paper, 4969)
Abstract only.
Paper presented at 17th Annual Offshore Technology Conference, 1985.
ASTIS document number 159980.

To facilitate the assessment of seabottom ice scouring on pipeline design, a computerized ice scour data base has been established for the Canadian Beaufort Sea. Side scan sonar, bathymetric and subbotom profile data are digitized, computer processed, and incorporated into a location referenced data file. The digitization process includes outlining the discrete scour events on sonographs and tracing the seabed profiles on echographs. Individual scours are defined in a twenty-seven column data file and characterized by location, orientation, length, width, form, smoothness, sediment infilling, associated sediment type and other features. Scour depths are derived by automatic measurement from computer normalized echo sounder profiles. Scour parameter distributions and inter-relationships can be statistically analyzed and graphically illustrated. In addition, the relationships between scour parameters and environmental conditions such as bathymetry, can be examined for the entire data set or selected subset. This scour analysis technique allows for a full range of conditions to be tested for potential impact on Arctic marine pipeline design. (Au)

99
Ocean-bottom sea-ice scour : a computer based data management system / Gilbert, G.R. Stirbys, A.F. Blasco, S.M.
[15] leaves : ill. ; 28 cm.
Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.
Indexed from a preliminary draft, July 1985.

Proceedings to be published as an ESRF Report in late 1985.
ASTIS document number 163511.

To facilitate the assessment of seabottom scouring by ice keels on pipeline design, a computerized ice scour data management and analysis system has been established for the Canadian Beaufort Sea. With the aid of a microcomputer and related peripherals, side scan sonar, bathymetric and sub-bottom profile data were directly digitized and incorporated into a large regional compilation. ... Individual scours were defined in a 27 column data file and characterized by location, orientation, apparent depth, width, form smoothness, infilling, associated sediment type and other features. In excess of 5000 km (60,000 scours) of industry/government acoustic data have been incorporated into the data base. Seabed acoustic profiles were selected to accommodate the full range of physical conditions anticipated on the Beaufort Continental shelf including bottom morphology, sediment type, water depth, sea-ice zonation, etc. ... (Au)

HNATIUK, J.

100
Sea bottom scouring in the Canadian Beaufort Sea / Hnatiuk, J. Wright, B.D.
(Fifteenth Annual Offshore Technology Conference 1983, proceedings. – Dallas, Tex. : Offshore Technology Conference, 1983, v. 3, p. 35-40, figures)
(OTC paper, 4584)
(National Research Council of Canada Associate Committee on Geotechnical Research Workshop on Ice Scouring, 15-19 February 1982 / Edited by G.R. Pilkington. Technical memorandum – Canada. National Research Council. Associate Committee on Geotechnical Research, no. 136, p. 222, abstract only)
References.
ASTIS document number 127418.
NFSMO

Echo sounding, side scan sonar and seismic profiling records have shown that the continental shelf of the Canadian Beaufort Sea has been subjected to extensive scouring by ice features. The scouring phenomena is extremely important in the design and protection of offshore wells and future pipelines. Analyses of records collected by industry and government in the early 1970's and reported by Hnatiuk and Brown in 1977 have been refined with the inclusion of additional data collected by industry and government in 1975 and 1976. Here, the results of the information synthesis are presented in terms of regional maps showing relevant scouring parameters and their variation with location and water depth. A quantitative evaluation of scour return period is also presented on the basis of sedimentation assumptions. This information is compared with a recent analysis of sidescan scour mosaics collected repetitively over four areas ranging in water depths from 45 to 150 feet and with time intervals ranging from 2 to 7 years between the repetitive seafloor maps. The rate of addition of new scours determined from the repetitive mosaic approach supports the regional assessment of Beaufort Sea scour but suggests more episodic and areally frequent scour events along with more active scouring in water depths approaching 150 feet. This information is discussed in terms of the Beaufort Sea ice regime. (Au)

101
Sea bottom scouring in the Canadian Beaufort Sea / Hnatiuk, J. Brown, K.D.
(Ninth Annual Offshore Technology Conference 1977, proceedings. – Dallas, Tex. : Offshore Technology Conference, 1977, v. 3, p. 519-527, figures)
(OTC paper, 2946)
References.
ASTIS document number 148512.
ACU

... Records obtained over a three year period by government and industry were analyzed with particular regard to frequency of scouring and scour azimuth, depth and width. Approximately 1100 n. miles of echo sounding records and 1900 n. miles of side scan sonar records obtained in 1970, 1971 and 1972 were examined in detail during the study. ... Speculative discussion regarding causes of scouring, scour rates and sedimentation within scours is also presented. Two areas were selected where parallel side scan sonar tracks were run to prepare mozaics of the sea bottom. These areas were later resurveyed to determine the number of scours added over several years. ... The tendency is for scours to become deeper in deeper water. The depth of scouring is particularly important in design of protection for offshore wells and future pipelines. The most important parameters in this regard are the depth of scours and the rate of new scouring. (Au)

HUNTING GEOLOGY AND GEOPHYSICS LTD.

102
Investigation of sea-bed scouring in the Beaufort Sea / Hunting Geology and Geophysics Ltd.
[Calgary : Distributed by APOA], 1971.
1 microfiche : tables ; 11x16cm.
(APOA project no. 19 : Analysis of sea bottom iceberg scouring records. Report)
Appendices.
References.
ASTIS document number 25542.
ACU, NFSMO

Side-scan sonar, echo-sounder and seismic profiler records from the Beaufort Sea show conclusive evidence of scouring on the sea-bed. This is generally believed to be due to the passage of ice-masses. Every third nautical mile of selected records has been analysed by visual and statistical means to determine the origin and rate of scouring. A number of spatial relationships have been established which have a bearing on these problems. These relationships include scour frequency, depth and azimuth. Recommendations are made for further sonar, echo-sounder, sampling, oceanographic, meteorological and radiocarbon work. (Au)

103
Investigation of sea-bed scouring in the Beaufort Sea (Phase II) / Hunting Geology and Geophysics Ltd.
[Calgary : Distributed by APOA], 1973.
1 microfiche : figures, tables ; 11x16cm.
(APOA project no. 32 : Beaufort Sea scour records – Phase II. Report)
Appendices.
References.
ASTIS document number 24473.
ACU, NFSMO

Purpose: To study all aspects of sea bottom scouring in selected areas of the Beaufort Sea. A mosaic of a control area surveyed by the Canadian Government in 1971 was constructed from Side Scan Sonar Records. An attempt was made to resurvey this area in 1972 using Side Scan and Echo Sounders and one additional area was similarly surveyed. Mosaics of these areas were constructed. During future projects they will be analyzed to determine the number of new scours added. All data recorded after 1970 was incorporated into a revised analysis to replace that done during APOA Project 19. (Au)

KENTING EXPLORATION SERVICES LIMITED

104

Ice scour age-dating Beaufort Sea 1975 / Kenting Exploration Services Limited. Canadian Marine Drilling Limited [Sponsor].
Calgary, Alta. : Kenting Exploration Services Limited, 1975.
[29] leaves : ill. ; 28 cm.
Appendices.
References.
ASTIS document number 149284.

Eight piston cores were obtained from the central portion of ice scours in the Beaufort Sea during the month of August 1975. Four cores were taken from Tingmiark drill site and four from Nektoralik drill site. The cores were to be analyzed in an attempt to determine the approximate year of scour occurrence. Several standard age dating techniques were used. This describes the analytical procedures followed and subsequent results of each technique. A previous report entitled "Ice Scour Coring in the Beaufort Sea, Summer 1975" provides a description of the field method used for coring scours. (Au)

LERAND, M.M.

105

Micropaleontologic – mineralogic analysis of recent mud samples from ice-scoured surface of Beaufort shelf / Lerand, M.M.
[Calgary : Distributed by APOA], 1971.
1 microfiche : figure, table ; 11x16cm.
(APOA project no. 17 : Beaufort Sea pressure ridge and ice island scouring. Report, no. 3)
ASTIS document number 25526.
ACU, NFSMO

Five samples of unconsolidated mud from the Beaufort Sea shelf were analyzed for microfaunal content and clay mineralogy in hopes of discovering some criteria by which the age of ice-scoured trenches could be dated. One sample was recovered from the sediment-water interface in the bottom of a trench, and four samples came from a shallow (48 cm) core adjacent to the trench. ... Although there is some slight similarity of the trench sample (#55) to the two samples from the upper part of the sediment column (0-12, 12-24 cm) adjacent to the trench, the five samples do not represent a statistically valid sample and definite conclusions based on this data are not justified. The samples are all so similar that they may all be assumed to have been taken from a single population of Recent age. The clay mineralogy analysis suggests a similar relationship to that hinted by the micropaleontology. ... (Au)

LEWIS, C.F.M.

106

Bottom scour by sea ice in the southern Beaufort Sea / Lewis, C.F.M.
Victoria, B.C. : Beaufort Sea Project, Dept. of Fisheries and the Environment, 1977.
88 p. ; 28 cm.
(Technical report – Canada. Beaufort Sea Project, no. 23)
Draft only.
Report B374s.
Document not seen by ASTIS.
ASTIS document number 149926.

107

Drift ice scratches the sea floor / Lewis, C.F.M.
(Geos, 1978 [2] Summer, p. 18-20, ill.)
ASTIS document number 7447.
ACU, NFSMO

Brief discussion of sea ice pressures and the unseen damage done to the sea floor by the scoring and gouging. (ASTIS)

108

The frequency and magnitude of drift-ice groundings from ice-scour tracks in the Canadian Beaufort Sea / Lewis, C.F.M.
(POAC 77 : proceedings / Edited by D.B. Muggeridge. – St. John's, Nfld. : Ocean Engineering Information Centre, Memorial University of Newfoundland, 1977, v. 1, p. 568-579, ill.)
References.
ASTIS document number 149411.
ACU, NFSMO

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

109

Ice scour on the Canadian Beaufort Sea continental shelf / Lewis, C.F.M. Blasco, S.M. McLaren, P. Pelletier, B.R.
(Program with abstracts – Geological Association of Canada, v. 1, 1976, p. 83)
Abstract only.
ASTIS document number 148733.
ACU

Long curvilinear grooves or scours formed by the impingement of drifting continental shelf. The phenomenon is reviewed, based on existing and new investigations using side scan sonar, profiling, coring, SCUBA and submersible diving. Scours are best preserved in the cohesive silt and clay sediments that blanket the Mackenzie canyon and Beaufort shelf from Herschel to Baillie Islands. ... The seafloor is virtually saturated with scour from 3 to 50 m water depth. Scour frequency diminishes rapidly in deeper water and reaches zero by 80 m. The direction and depth of scour is influenced by topographic irregularities such as embayments and depressions. A den subbottom sand rising close to the seabottom may limit scour depth. Scour widths range from a few metres to hundreds of metres; the widest are multiple (parallel) scours. Scour depths on the average range 1.0 to 1.5 m but maximum depths commonly range up to 6 m below the sea floor. Present results on the rate of scour addition from rate of burial considerations are preliminary and speculative. On the other hand comparison of selected areas from 1971 to 1975 by means of seabed mosaics constructed from side scan sonar imagery have been highly successful and show for the first time that, (a) much scour is preserved from year to year, and (b) new scours are being added. In the 15 to 20 m depth zone north of Pullen Island approximately 0.2 to 2.0% of the seabed is disturbed (scoured) each year. (Au)

110

Scouring of the Beaufort shelf by sea ice / Lewis, C.F.M.
(Program with abstracts – Geological Association of Canada, v. 2, 1977, p. 32)
Abstract only.
ASTIS document number 149063.

ACU

Deep keels of sea-ice pressure ridges and ice islands run aground and rake the sea floor, pushed along by wind/current stress on the ice form and its contiguous pack ice. Annual sea floor mapping shows that scour forms are retained in the mud substrate for long periods of time .... Consideration of the Holocene history suggests that most deep scours remain visible for thousands of years, being slowly infilled and oscured by mud sedimentation or by new scours. To a first approximation scouring is a geographically random impact process, controlled by shelf bathymetry such that deeper scours occur in deeper water. Scour depths occur in distinctive exponential frequency distributions whose parameters can be derived from echogram study. With this data extreme scour depths based on unit sea-floor distance can be predicted for given probability levels. The seaward limit of contemporary scouring is at the 50 m isobath where extreme scour depths begin to decrease with increasing water depth. Scour in deeper water is believed to be relict dating from periods of lower sea level. This limit is supported by the deepest occurrence of Arctic Ocean pressure ridge keels, by predicted keel depths from observed maximum pressure ridge heights, and by the limits imposed on the vertical growth of pressure ridges and keels by the finite strength of sea ice. A theory for the prediction of long-term scouring rates that agrees with annual mapping data is based on the observed distribution of scour depth, the probability of scour superimposition and the sedimentation rate. (Au)

MACLAREN ATLANTIC LIMITED

111

Investigation of sea-bed scouring in the Beaufort Sea (Phase III) / MacLaren Atlantic Limited. Gulf Oil Canada [Sponsor].

[Calgary : Distributed by APOA], 1977.

3 microfiches : ill., tables ; 11 x 13cm.

(APOA project no. 133 : Investigation of sea-bed scouring in the Beaufort Sea (Phase III). Report)

Appendix.

ASTIS document number 87785.

ACU, NFSMO

Echo sounding records obtained in the Beaufort Sea during 1975 and 1976 have been analyzed and the resulting ice scour data has been combined with the results of APOA projects 19 and 32 which included 1970 and 1972 data. Scouring was found to be common in depths of water from 50 to 150 ft. and deeper water. In an attempt to relate these scours to current processes, return periods were calculated using sedimentation assumptions. This indicates the number of years between scouring in a given nautical mile and was found to vary mainly between 10 and 100 years. (Au)

MCGONIGAL, D.

112

A study of grounded ice features and their associated scours in the Beaufort Sea / McGonigal, D. Stirbys, A.F. Lussenberg, J.L.

[13] leaves : ill., maps ; 28 cm.

Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.

Indexed from a preliminary draft, July 1985.

Proceedings to be published as an ESRF Report in late 1985.

ASTIS document number 163589.

This [paper describes] ... a study of grounded ice features undertaken by Gulf Canada Resources in April 1984. It was a short project investigating some unusual ice features which had invaded the Beaufort Sea during the previous summer. (Au)

NORCOR ENGINEERING AND RESEARCH LIMITED

113

An investigation of multi-year pressure ridges and shore pile-ups / NORCOR Engineering and Research Limited. Kovacs, A. Dickins, D.F. Wright, B.D.

[Calgary : Distributed by APOA], 1975.

1 microfiche : ill., photos. ; 11x16cm.

(APOA project no. 89 : Study of the thickness of multi-year pressure ridges. Report)

References.

ASTIS document number 29190.

ACU, NFSMO

This report presents the findings of a field study designed to generate fundamental data on multi-year pressure ridges and floes in the near shore zone of the Beaufort Sea. The programme investigated the geometry of 11 floating multi-year ridges or ridge fragments, the sail height and keel depth of four multi-year ridge fragments, and the cross sections of two large shore ice pile-ups. Most of the ridges were situated within a 20 mile radius of Sachs Harbour, N.W.T. Measurements were made during the period from May 4 to May 18, 1975. ... (Au)

O'CONNOR, M.J.

114

Gas seeps, permafrost and acoustic voids in the southern Beaufort Sea / O'Connor, M.J.

(Proceedings – Symposium on Permafrost Field Methods, 3 October 1977, and Permafrost Geophysics, 4 October 1977, Saskatoon, Canada / Prepared by W.J. Scott and R.J.E. Brown. Technical memorandum – Canada. National Research Council. Associate Committee on Geotechnical Research, no. 124, 1979, p. 73-100, figures)

References.

ASTIS document number 61379.

ACU

... The Beaufort-Delta survey was intended as a preliminary step to assess the performance, reliability and applicability of various investigative procedures, to provide additional correlation among existing data, and to identify conditions which might require more detailed examination during subsequent investigations. ... This paper deals with some anomalous features encountered along two ... lines – north of Richards Island – along the Pullen Corridor, and north of Tuktoyaktuk, along the Kugmallit Corridor. (Au)

PALLISTER, A.E.

115

Ice covered waters – a new offshore petroleum environment / Pallister, A.E. Pallister, J.M.

(APOA review, v. 1, no. 2, May 1978, p. 12-15, ill., photos.)

References.

ASTIS document number 62987.

ACU, NFSMO

The article presents a description of the various types of sea ice encountered in Arctic waters, with particular reference to the Beaufort Sea region. This is followed by a description of APOA Project no. 17, "Pressure ridge and ice island scouring" the most significant findings of which were "the large thicknesses of ice ridges, the relatively small depths of bottom scours, and the absence of cavities in multi-year ridges." The article points out that this project, and others since conducted, have greatly increased the knowledge required for oil and gas exploration and for transportation in these ice infested waters. (ASTIS)

PELLETIER, B.R.

116

Bottom studies of the Beaufort Sea / Pelletier, B.R.
(Paper – Canada. Geological Survey, 73- 1A, p. 115-116, ill.)
References.
ASTIS document number 148687.
ACU

Sediment sampling of the continental shelf underlying the Beaufort Sea ... continued in two phases during the field season of 1972. In the first phase, a helicopter was required for the operations over the ice and this was supported by the Polar Continental Shelf Project during the months of April and May. The western portion of the area was completed on a 5-km sampling grid. In the second phase, sampling was undertaken from the CSS PARIZEAU with the support of the Canadian Hydrographic Service, Marine Sciences Directorate, Victoria, British Columbia. This work was carried out in the eastern portion of the Beaufort Sea, and brought to completion approximately 85 per cent of the contemplated sampling program for the area. Only the northeastern portion remains and this is expected to be completed during the spring of 1973 with the use of a helicopter. Side-scan sonar records of the sea floor were further studied and a compilation is being made of the ice-scour features shown on the records. The general east-southeast trend of the scours persists throughout the area .... Echo-sounding records obtained by the Canadian Hydrographic Service are also being examined in order to determine the depth and frequency of scouring, and to examine the frequency of ancient scours some of which are partially or completely infilled by subsequent sedimentation. (Au)

117

Discussion of papers on geological action of sea ice, sedimentation, and sea floor morphology / Pelletier, B.R.
(The coast and shelf of the Beaufort Sea / Edited by J.C. Reed and J.E. Sater. – Arlington, Va. : Arctic Institute of North America, 1974, p. 541-542)
ASTIS document number 148075.
ACU

The formation of long linear grooves, some in parallel arrangement and many in crisscross arrangement, are the most dominant aspects of ice movement over the seabed. Mostly, ice scouring is caused by the action of the keels of pressure ridges of ice which are dragged along the bottom under the impetus of wind chiefly, but also by currents. Ice grounding may occur without the action of scour, such as in the case of bergy bits and pieces of shelf ice which are lowered to the sea floor by the sea in the shallow waters of the inshore areas. Sediments may be moved by ice, or be mixed by means of the plowing action of ice. Faunal zones and sedimentary dispersal areas may be difficult to map because of this action. [A short discussion on the subject of determining the frequency of ice scouring follows.] ... (Au)

118

Sea bottom scouring in the Beaufort Sea of the Arctic Ocean / Pelletier, B.R. Shearer, J.M.
(Proceedings of the 24th International Geological Congress, Montreal, Quebec, 1972, Section 8, p. 251-265)
References.
ASTIS document number 148709.
ACU

Marine geological investigations undertaken during the summers of 1970 and 1971 in the Beaufort Sea with echo-sounding and side-scan sonar equipment have shown the sea bottom to be composed mainly of linear scratches of varying width, depth and length. Churning and scouring by ice islands and pressure ridges as they scrape the bottom are thought to be the origin of these features. In many areas, generally in depths of water between 10 and 30 m, the bottom is marked by systems of parallel scours. This is thought to be a result of one or more pressure ridges moving as a solid unit with the Arctic pack ice. ... Depending upon the rate of sedimentation at any given point, deep scours (maximum observed relief about 10 m) which may be the result of scouring in earlier post-glacial times (lower sea level) may still possess some topographic expression. Unless these relict scours are recognized, anomalously high results would be obtained for the present amount of scouring at various depths. (Au)

119

Side scan sonar surveys and ice scouring in the Beaufort Sea / Pelletier, B.R.
(Proceedings of the Canadian Seminar on Icebergs held at the Canadian Forces Maritime Warfare School, CFB Halifax, Halifax, Nova Scotia, Canada, December 6-7, 1971. – [Halifax, N.S. : Maritime Command Headquarters, 1971?], p. 48-49)
ASTIS document number 148776.
ACU, NFSMO

Dr. Pelletier indicated that he would present other aspects of the bottom scouring phenomenon including physiographic aspects. The investigation of scouring shape and extent, and bottom morphology and surface composition was carried out using side scan sonar from a towed "fish". This instrumentation was capable of distinguishing three main bottom types – rock, unconsolidated sediments and sand waves, the latter about 6 feet across. The work described was done during the summers of 1970 and 1971. Much of the bottom surface in the areas of the Beaufort Sea investigated consisted of fairly flat stretches separated by ridges and bottom scouring. Some of the bottom scouring is thought to have been caused by the keels of large pressure ridges in the ice, the remainder by iceberg scraping. At 40 to 80 foot depths much of the bottom was covered with several series of parallel grooves and ridges thought to be due to ice scouring. The incidence of scouring (15 to 20 km) seemed to be the same between bottom depths of 30 to 150 feet, then decreased rapidly with increasing depth. The greatest bottom depth at which scouring was found was 240 feet. It was difficult to date the scouring, different methods giving estimates between 750 and 12,000. Estimates based on sedimentation rates can vary widely with time and these, therefore, did not give a reliable indication of age. ... (Au)

SHEARER, J.M.

120

Analysis of side scan sonar sea bed imagery from repeated surveys off Pullen Island – Beaufort Sea / Shearer, J.M. Gulf Oil Canada [Sponsor].
[Calgary, Alta. : Distributed by APOA], 1979.
2 microfiches : figures, tables ; 11 x 15 cm.
(APOA project no. 151 : Analysis of 1978 Beaufort Sea side scan sonar records for sea bottom scouring. Report)
Appendix.
Mosaic maps, scale 1:10,000.
ASTIS document number 148547.

... Pressure ridges and ice islands which have become frozen into the polar pack are moved around with the movement of the pack and have virtually the momentum of the pack behind them when they encounter the bottom. With respect to future petroleum activity and production from the offshore in the area, the frequency of scouring and maximum depth of scouring into the bottom for given areas and water depths are the most important factors to be considered involving ice action. The one to be treated in detail in this study is the frequency of scouring or rate of rescouring. This can be dealt with in two principal ways: (1) A formula using some general data ... can be calculated on the basis that scours will be present or visible for different lengths of time depending upon the scour infilling rate (Lewis, Beaufort Sea Project report #23). (2) The other method of calculating the amount of rescouring occurring in a given area, is to observe the changes in the bottom on a

sequential basis. This has been attempted at a number of localities in the Beaufort Sea, off Canada and the United States. The area with the greatest number of successful side scan resurveys is one some 10-12 n.m. north of Pullen Island in the Canadian Beaufort Sea with surveys having been run in 1971, 1972, 1974, 1975 and 1978. ... It is method 2 which will be applied in this study. (Au)

121

Beaufort Sea ice scour correlations with environmental factors / Shearer, J.M. Blasco, S.M.
[4] leaves : map ; 28 cm.
Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.
Indexed from a preliminary draft, July 1985.
Proceedings to be published as an ESRF Report in late 1985.
ASTIS document number 166502.

This study ... is an attempt to correlate ice scour parameters and environmental factors from certain areas of the Beaufort Sea. A second part of the project is an assessment of the terminology used in dating scours .... As both these projects are ongoing no final results are presently available but as far as the correlation of ice scour and environmental factors are concerned, a large portion of the available data has been plotted on work sheets. Maps of bathymetry, sedimentation rates etc. have been compiled and preliminary results can be discussed in this presentation. (Au)

122

Further observations of the scouring phenomena in the Beaufort Sea / Shearer, J.M. Blasco, S.M.
(Paper – Canada. Geological Survey, 75- 1A, p. 483-493, figures)
References.
ASTIS document number 148636.
ACU

... The summer of 1974 ... The edge of the polar pack was not much more than 15 miles offshore, except in Mackenzie Bay where the indentation southwards off the Mackenzie River delta gave, on occasion, up to 40 miles of open water. ... It is proposed that all scouring by ice on the bottom is done when the ice is frozen into the polar pack and its effective momentum is orders of magnitude greater than when drifting alone. Many of the scours observed are in fact a network of parallel scours caused by the movement of one or more pressure ridge and ice island keels frozen into the polar pack and thus all moving as part of a rigid system .... Echo sounding profiles with a 200 khz sounder have shown that the properties of the bottom scours in profile seem to vary considerably from shallow to deep water and from area to area. ... it appears that the age of scour in general cannot be related to width or peakedness alone, but that relative ages can be assigned to scours whatever the size, depending upon the amount of infilling. ... (Au)

123

Ice scour mosaic comparison study, 1980 / Shearer, J.M. Gulf Canada Resources Inc. [Sponsor].
Ottawa : [s.n.], 1980.
17 leaves : 18 figures (folded), map ; 36 cm.
(APOA project no. 158 : Beaufort Sea repetitive scour mapping analysis – 1979 and comparison with 1972, 1974 and 1977 mosaics. Report)
Four figures folded in pocket.
Photo mosaics scale 1:5,000 and 1:10,000.
ASTIS document number 148539.

Detailed side scan surveys were carried out during the summer of 1979 in a number of areas in the Canadian sector of the Beaufort Sea. Three major surveys were carried out in areas where other side scan surveys had been run in previous years. The previous surveys run were in the Kaglulik A – 75 area in 1977 covering 12 sq km, in the Tingmiark area in 1972 covering about 6 sq km and in the East Mackenzie area in 1974 covering about 100 sq km. In 1979 these three areas were resurveyed with the East Mackenzie area survey being cut to about 80 sq km and the Tinkmiark area being increased to one 6 km by 6 km .... As well as these areas, surveys were initiated along 3 corridors about 1 km wide and 50 or so kilometers in length. These corridors were orientated in a N-S direction to cover as wide a depth range as possible, generally from 25 meters of water to over 50 meters. This report will not deal with these corridors, as this was the first year that they were surveyed. (Au)

124

Pipeline corridor East Amauligak to North Point to Tarsuit [sic] / Shearer, J.M. Gulf Canada Resources Inc. [Sponsor].
Ottawa : [s.n.], 1984.
11 leaves : figures (folded) ; 36 cm.
ASTIS document number 149071.

This corridor runs in a roughly ENE-WSW direction starting in 30 m of water at East Amauligak and moves quickly into about 10 meters of water north of Pullen Island. At around longitude 136 degrees (10 miles NW of Pelly Is.), the corridor moves to the NNW towards Tarsuit A-25. ... There are two main points of interest with respect to this area being a pipeline corridor. One is the bottom sediment type present along the corridor and its thickness or continuity with depth. This is an important factor when burial depths are considered. The other point to be considered is that of the effect of ice scouring – frequency and depth which in turn will define the degree of burial necessary. (Au)

125

Preliminary interpretation of shallow seismic reflection profiles from the west side of Mackenzie Bay, Beaufort Sea / Shearer, J.M.
(Paper – Canada. Geological Survey, 71- 1B, 1971, p. 131-138, figures)
References.
ASTIS document number 148598.
ACU

About 250 nautical miles of shallow reflection profiling using a Huntec 2A sparker unit were obtained during the month of August, 1970 in the Mackenzie Bay area of the Beaufort Sea from the C.H.S. Richardson .... A few short lines using a side scan sonar unit were also run. Throughout most of the area traversed, except in depths of less than 20 to 30 feet, considerable thicknesses of recent (postglacial) muds were observed .... Wave action is apparently strong enough to prevent deposition of clay in the summertime and to erode what fine sediments were deposited during the winter at these shallow depths (<30 feet). In depths of less than 150 to 200 feet this mud unit has a very irregular surface, which is attributed to cumulative scouring by the bottoms of ice islands and pressure ridges .... Work using the side scan sonar ... demonstrated that these observed features were, in fact, continuous (usually quite linear) thus supporting the ice scouring hypothesis. ... (Au)

126

Repetitive mapping study, Beaufort Sea / Shearer, J.M.
[9] leaves : ill., map ; 28 cm.
Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.
Indexed from a preliminary draft, July 1985.
Proceedings to be published as an ESRF Report in late 1985.
ASTIS document number 163619.

This [paper] ... describes an ESRF repetitive mapping program in the Beaufort Sea. It commenced in the summer of 1984 with Geoterrex as contractors. ... As the primary objective of the mapping program was to increase our data base on new scours, the

first field program was aimed at collecting high quality baseline data that could be referred to in later years. ...In 1979 a rather crude corridor system was set up in the Beaufort Sea ... some large pieces of ice had been observed during the winter of 1983 at the transition zone between the shore pack ice and the polar pack ice. As these pieces of ice were grounded they offered an opportunity to examine their effect on the seabed. The next objective was to compare the most recent data with data collected in 1982 and from the corridors mentioned above in order to determine the impact rate of new scours. Finally we hoped to determine the depth distribution of the new scours. (Au)

127

Scour depth distribution Tarsuit [sic] 1980 : rescour corridor study, Tarsuit [sic] - Nektoralik / Shearer, J.M. Gulf Canada Resources Inc. [Sponsor].
Ottawa : [s.n.], 1983.
19 leaves : ill. (some folded) ; 28 cm.
Partial contents: Tingmiark - Nerlerk rescour lines.
ASTIS document number 148270.

In 1980 side scan sonar and RTT-1000 subbottom units were run on a number of lines as part of a detailed site investigation of TARSUIT A-25 and TARSUIT N-44. As well, a number of lines were run to the south of this area as part of a granular resources search (SOUTH TARSUIT). ... (Au)

WAHLGREN, R.V.

128

Ice-scour tracks in eastern Mackenzie Bay and north of Pullen Island, Beaufort Sea / Wahlgren, R.V.
(Paper - Canada. Geological Survey, 79- 1B, p. 51-62, figures, tables)
References.
ASTIS document number 148130.
ACU

Ice-scour tracks are created by ice pressure-ridge keels and ice islands scraping the seabed. Tracks visible on echosounding and side-scan sonar records obtained in water depths of 25 to 50 m are analyzed quantitatively in order to understand the relationship between track form and the processes that created the tracks. A system of classification and methods for analyzing data on ice-scour tracks are presented. Seabed morphology affects the length of ice-sonar tracks that can be left by a grounding keel but does not deflect the keel. In water depths less than 45 m, ice keels that are being driven upslope usually do not penetrate deeper into the seabed sediment (silty clay or clay) but rise along the seabed slope. (Au)

129

Ice-scour tracks on the Beaufort Sea continental shelf / Wahlgren, R.V.
Ottawa : National Library of Canada, 1979.
2 v. : ill., figures (folded in case), tables ; 29 cm.
(Canadian theses on microfiche, no. 41683)
Thesis (M.A.) - Carleton University, Ottawa, 1979. - xxi, 183p.
Appendices.
References.
Also available in microfiche.
ASTIS document number 65226.
ACU, NFSMO

Quantitative geomorphological analyses are made of ice-scour tracks created by drift ice scraping the seabed of the southeastern Beaufort Sea. The data consists of measurements from echograms and sonograph mosaics. ... The results ... include: grounding ice having less than 45 m draft usually does not dig further into the sediment as the ice keel proceeds upslope; keels approaching normal to the slope leave shorter tracks than keels which travel along the slope; ice floe interaction processes can explain the various planimetric forms of tracks; deep ice keel drafts and tracks are fairly rare events; and excess pore water pressure beneath a moving, grounded ice keel evidently can support negative buoyancy of the keel. The ice-scouring process is analysed using an energy flow model which is adaptable to computer simulation. (Au)

OTHER CANADIAN WATERS

130

The Polar Gas Project : marine research studies undertaken by Polar Gas with particular reference to sea ice
[S.l. : s.n.], 1982.
48 leaves : figures ; 28 cm.
Appendix.
ASTIS document number 135720.
NFSMO

... A large amount of research work has been undertaken by Polar Gas devoted to conditions in the Arctic channels that could affect the designs of pipelaying systems - from the depths, currents and channel bottom composition and profiles - to the thickness, strength and stability of the ice surface - to the potential for iceberg and ice island "scour". ... Since 1972 Polar Gas has carried out a large number of studies related to marine pipelaying using consultants experienced in specific tasks and also with its own staff. The publication describes these studies with the reports. ... Contents of this publication include the following: sea ice thickness profiling in selected areas of the Arctic, 1973; ice scour in the Canadian Arctic Islands, 1975; load bearing capacity of sea ice, 1975; operations report of on-ice survey of channels in the Arctic Islands, 1977; model testing of a laybarge in synthetic ice, 1977; ocean current measurement program 1980; sea ice and navigation studies, 1981. A listing of the marine studies undertaken since 1973 which may be of interest to C-Core is given in the appendix. (Au)

DIONNE, J.-C.

131

Le glaciel de la region du Chissibi, Baie-de-James, Quebec subarctique = Drift ice features in the Chissibi River area, James Bay, subarctic Quebec / Dionne, J.-C.
(First Symposium on the Geological Action of Drift Ice, Quebec, Canada, April 20-24, 1974 [sic]. Maritime sediments, v. 9, no. 3, Dec. 1973, p. 108)
Abstract only.
ASTIS document number 149756.
ACU

... Ice-made features in the marine environment include erosional features in the tidal flats such as grooves, shallow depressions, mud ridges and other drag marks; boulder-strewn mud and clay flats; boulder-strewn marshes with ice-made pans; boulder ridges; large and shallow ice-melted depressions locating sites of buried ice cakes or ice cores; marine clay injected upward under pressures exerted by the load of ice cakes; miniature mud volcanoes, and polygonal patterns of mud ridges. Ice-made features in the fluvial environment include ice-push boulder and gravel ridges up to 5 m high .... Ice-made features in the lacustrine environment include ice-push boulder ridges, 2-3 m high, resulting from ice thermal expansion; long and wide grooves on lake bottoms made by boulders pushed shoreward by ice; and scattered boulders on sand beaches overlying clay. Drift ice processes are particularly active in the tidal flats of James Bay, although a small tidal range (maximum 2 m), and

along the shores of the lower Chissibi River. Most ice-made features are not destroyed during the summer. Drift ice is considered an important agent of erosion, transport and sedimentation in the Chissibi River area, subarctic Quebec. ... (Au)

LEWIS, C.F.M.

132
Marine geological and geophysical activities in Lancaster Sound and adjacent fiords / Lewis, C.F.M. Blasco, S.M. Bornhold, B.D. Hunter, J.A.M. Judge, A.S. Kerr, J.W. McLaren, P. Pelletier, B.R.
(Paper – Canada. Geological Survey, 77- 1A, p. 495-506, figures)
References.
ASTIS document number 148580.
ACU

An analysis of surficial sediments was made by combining the results of high resolution seismic work with sediment coring .... Representative nearshore sediment facies were examined by scuba divers with particular reference to bottom scouring by drifting icebergs and sea ice .... Determinations were made of seabottom temperatures, sediment and water thermal gradients, and sediment thermophysical properties primarily for assessment of the potential for ice-bonded subsea permafrost .... Surficial sediment distribution and offshore bedrock structures were delineated by seismic, magnetic, and gravity profiling. (ASTIS)

LUTERNAUER, J.L.

133
Late Quaternary morphologic development and sedimentation, central British Columbia continental shelf / Luternauer, J.L. Murray, J.W.
Ottawa : Geological Survey of Canada, 1983.
38 p. : ill. ; 28 cm.
(Paper – Canada. Geological Survey, 83- 21)
ISBN 0-660-11453-4.
Appendix: Primary characteristics of samples.
References.
ASTIS document number 149870.
ACU

The physiography of Queen Charlotte Sound is dominated by banks capped with sand and gravel and troughs floored with gravel, sand and mud. Grounded ice, probably including that of the Fraser Glaciation, sculpted most morphologic features and strongly influenced the present sediment distribution. The oceanographic regime which prevailed when sea level was lower contributed to the formation of valleys at bank margins and the concentration of heavy minerals on banks and probably determined the depth of the present shelf break. Inlets on the southern mainland coast of the shelf are the principal sources of sediment presently supplied to the shelf. This material, composed of olive green organic- and smectite-rich muds, is accumulating on the shelf almost exclusively in a section of trough adjacent to the mouths of these inlets. Probably the most mobile terrigenous sediment on banks, fine to very fine sand, is being reworked from glacigene deposits and swept onto bank margins. Although foraminifers and molluscan skeletal carbonate in places are dominant components of bank sediments, their concentration across the shelf is highly variable because of differences in wave and current climate, dilution by terrigenous detritus and, possibly, proximity to upwelling, nutrient-rich, slope waters. The best sorted, nonencrusted finer gravels and clean sands best suited for construction materials are most concentrated on the eastern, shallower part of Goose Island Bank. The most extensive skeletal carbonate beds, a potential source of lime for use in the manufacture of cement, extend for several tens of kilometres in a 10-15 km wide band adjacent to northern Vancouver Island and the Scott Island chain. The highest concentration of heavy mineral rich "black sands" are found at or near the 100 m depth on northern Cook Bank. (Au)

134
The relict surface of the central British Columbia continental shelf / Luternauer, J.L.
(Abstracts of papers – International Congress on Sedimentology, 11th, McMaster University, Hamilton, Ont., 22-27 Aug., 1982, p. 93)
Abstract only of paper presented at Eleventh International Congress on Sedimentology, 1982.
ASTIS document number 148717.
ACU

Queen Charlotte Sound extends approximately 125 km from the mainland coast and encompasses an area of approximately 20,000 sq. km. between Vancouver Island and the Queen Charlotte Islands. Since the retreat of Pleistocene ice it has become a sediment starved basin because most land derived detritus is trapped in adjacent deep fjords. Regular mobilization of sediments on the open shelf by waves and currents occurs mainly in water depths shallower than 140 m but much of the shelf lies below this depth. Because of the shelf's size and depth and the low sediment supply the morphology and sediment character of this part of the continental margin still reflect the widespread effects of glaciation much of which was by grounded ice: broad troughs which cross the shelf contain ice-contact deposits including morainal ridges and an esker. Sharply defined iceberg furrows also are evident over a large area. The oceanographic climate which prevailed when sea level was lower probably determined the depth of the present shelf break and contributed to the concentration of heavy minerals on banks and to the formation of canyons which crease bank margins. The little terrigenous material that has been supplied to the shelf during the Holocene is accumulating near the mainland coast. Elsewhere on the shelf the principal post glacial deposits are foraminiferal and molluscan skeletal detritus which can be a dominant component of bank sediments. (Au)

MARTINI, I.P.

135
Ice effect on erosion and sedimentation on the Ontario shores of James Bay, Canada / Martini, I.P.
(Zeitschrift fur Geomorphologie, N.F., Bd. 25, Heft 1, Mar. 1981, p. 1-16, ill., figures, photos.)
References.
ASTIS document number 70394.
ACU

James Bay is a cold, brackish, inland sea covered for approximately six months of the year by sea ice. Although occasional storm surges occur, it is normally a low energy, shallow ... tidal coast. ... Several types of beach ridges are common along this coast, and they are scoured by ice, and receive considerable amounts of ice rafted material. This material is reworked by storm waves, and the legacy of ice action is seldom recognizable, except for rare basal cut and fills. The freezing of ice blocks to the ground is another significant sea ice process. ... This, plus semi-circular depositional features formed around melting ice blocks, generates a pattern of highs and lows which is rapidly stabilized by vegetation on this fast emerging coast, and is preserved as a slightly modified form in the patterns of pools of upper marshes and fens. ... (Au)

MCLAREN, P.

136
The coastal geomorphology, sedimentology and processes of eastern Melville and western Byam Martin islands, Canadian Arctic Archipelago / McLaren, P.
Ottawa : Geological Survey of Canada, 1982.

39 p. : figures, tables ; 28 cm.
(Bulletin – Geological Survey of Canada, 333)
ISBN 0-660-11178-0.
References.
ASTIS document number 124788.
ACU

The coasts of eastern Melville and western Byam Martin Islands have emerged approximately 100 m during the Holocene and are still undergoing isostatic recovery at the rate of approximately 0.35 cm/year. During deglaciation, glacial-marine sediments consisting of 33% sand, 45% silt and 22% clay with variable amounts of gravel and larger sized material reflecting local lithologies were deposited in Byam Channel. SCUBA observations show that there is little present sedimentation on the sand-silt-clay facies but grounding ice blocks result in considerable sediment reworking. ... During emergence, three principal coastal types were formed: deltas, sandflats and raised beaches. The deltas are of the "Gilbert" type consisting of steeply dipping (>10 degrees) foreset beds composed predominantly of sand. Nearshore under-ice tidal currents transport this sand to adjacent coastal areas and it accumulates at the sandflat coast. The mobile sand forms a shallow sandy facies overlying the glacial-marine sand-silt-clay facies and extends from the shoreline to approximately the 7 m isobath. Where the shallow sandy facies is thin (<3 m), ice scouring can be sufficiently deep to excavate the underlying sand-silt-clay facies and the resultant ice push deposits containing gravel and larger sized clasts can be added to the beach. ... (Au)

137

The coasts of eastern Melville and western Byam Martin islands : coastal processes and related geology of a High Arctic environment / McLaren, P.

Ann Arbor, Mich. : University Microfilms International, 1977.
1 microfilm reel : figures, tables ; 3.4 in., 35 mm.
Appendices: I. Sequence of breakup and freezeup events, Byam Channel, 1973 and 1974. – II. Summary of diving observations in Byam Channel June to August, 1974. – III. Grain size data for all sub-environments.
Thesis (Ph.D) – University of South Carolina, 1977.
ASTIS document number 148571.
ACU

The coasts of eastern Melville and Western Byam Martin Islands have emerged approximately 100 m during the Holocene and are still undergoing isostatic recovery at the rate of approx. 0.35 cm/yr. ... During emergence, three principal coastal types were formed: deltas, sandflats and raised beaches. ... SCUBA observations showed that moving ice blocks impinging on the substrate leave long linear scour tracks approximately 2 m deep which are flanked on either side by embankments 1 m high .... [The effects of ice scouring where the shallow sandy facies is thin (<3 m) are contrasted with the effects where it is thick and the sand acts as a buffer.] Suspended sediment analysis and SCUBA observations indicate little or no present day sedimentation is occurring beyond the 7 m isobath on the sand-silt-clay facies. The latter is believed to be "palimpsest", primarily relict sediments reworked and modified by recent ice scour. Electrical resistivity and shallow seismic techniques, borehole information and coastal observations suggest that ice-bonded permafrost may be rare or absent in Byam Channel .... (Au)

138

Under-ice diving observations in the coastal environments of southeast Melville and western Byam Martin islands / McLaren, P.

(Paper – Canada. Geological Survey, 75- 1A, p. 475-477, figures)
References.
ASTIS document number 148601.
ACU

The 1974 field season completed a two-year coastal process study (McLaren, 1974a). In addition to re-examining formerly established profiles and zonals, the near-shore environments (to 100 feet depth) were extensively observed by the use of SCUBA diving (McLaren, 1974b). ... Four different bottom environments were recognized: [rocky bottom, poorly sorted sand-silt bottom, shallow sand facies and delta front.] ... Scour levees and scour moraines show abundant rocks of the same bedrock lithology found on the adjacent coast. ... It is suggested that an area of bottom would not be immune from scour for very many years at a time. ... no sedimentation appeared to be taking place as evidenced by the lack of deposition on the rocks and on dead fauna and flora. It is suggested, therefore, that this facies is a till of which the top 5 to 10 feet continually is being disturbed by ice scour, and that present deposition, if it is occurring at all, becomes incorporated into the sediment. (Au)

SADLER, H.E.

139

A survey of some arctic beach zones in southwest Cornwallis Island, N.W.T. / Sadler, H.E. Serson, H.V.

Victoria, B.C. : Research and Development Branch, Department of National Defense, 1981.
xiii, [95] p. : figures, tables ; 28 cm.
(Report – Canada. Defence Research Establishment Pacific, 81- 1)
Appendices.
References.
ASTIS document number 110035.
ACU, NFSMO

This was a preliminary investigation into the physical processes in the beach zone along an arctic coast with emphasis on the possible damage to scientific equipment by ice action on gravel beaches. Detailed profiles are given of the spring ice on a number of beaches in the area and of the bathymetry and ice morphology at three stations where test cable arrays were laid. The results indicate that a comparatively shallow trench into the frost table below the beach will provide good protection for cables laid across gravel beaches, and that most of the breaks to be expected are probably due to the freezing of the cable onto the bottom surface of the sea ice during tidal changes in level. Additional investigations were made into methods of accelerating the melting of sea ice, on a simple method of obtaining stereophotographs and on the properties of a belt of fresh-water anchor ice which was found along the beaches. (Au)

TAYLOR, R.B.

140

Nearshore marine geological reconnaissance at Cunningham Inlet, Somerset Island, N.W.T. / Taylor, R.B. Lewis, C.F.M.

(Paper – Canada. Geological Survey, 75- 1A, p. 505-507, figure)
ASTIS document number 148628.
ACU

A geological reconnaissance of the sea bed at the mouth of Cunningham Inlet ... was carried out from August 16 to 27 using the 'Hudson Barge' which had been transported to Cunningham Inlet by the C.S.S. Hudson. ...Sediment grab samples, gravity cores, echo sounding, and side scan sonar records were collected in support of the beach and nearshore studies (Project 730021) which also were being carried out along the north shore of Somerset Island. ... Shallow seismic refraction profiles were run ... to provide estimates of thickness of unconsolidated marine deposits and to test for the presence of frozen ground. ... Bathymetric information at the mouth of Cunningham Inlet is very sparse. ... Visual observations of the sea bed to 10 m depth plus the collection of side scan sonar records have led to the conclusion that although well developed ice-scoured

grooves are present on and to the west of the above mentioned shoal ... much of the scour observed from the air is merely the removal of kelp from the hard sea bed by sea-ice movement. ... The effects of grounded drift-ice were clearly visible off Cunningham Inlet headland .... In order of increasing severity, grounding ice may simply remove bottom-fast plant growth with little or no disturbance of bottom materials or it may contact the bottom with greater force and pressure where it rolls cobbles and boulders over the sea bottom floor and presses them into the substrate to produce a cobble 'pavement'. With greater grounding pressures the moving sea ice actually displaces the cobble veneer and scours into the grey silt subbottom material. (Au)

141

Nearshore observations along the east coast of Melville Island, District of Franklin / Taylor, R.B.

(Paper – Canada. Geological Survey, 76- 1B, p. 43-58, figures)

References.

Appendix: Instruments: advantages and disadvantages.

ASTIS document number 148610.

ACU

In 1973 P. McLaren, Terrain Services Division, began a study of the coastal characteristics and processes along the eastern coast of Melville Island and western coast of Byam Martin Island (McLaren, 1974). The nearshore observations presented in this paper were collected in support of the above coastal project (Project 730020). Apart from collecting information on nearshore bottom topography, the research involved experimentation with and testing of commonly used oceanographic instruments in a shallow nearshore arctic environment. [The paper summarizes bathymetry, morphology, sediment characteristics, salinity and temperature, storm coastal processes, and sea ice scours]. (ASTIS)

VILKS, G.

142

Foraminifera of an ice-scoured nearshore zone in the Canadian Arctic / Vilks, G.

(First International Symposium on Benthic Foraminifera of Continental Margins : Part A. Ecology and biology / Edited by C.T. Schafer and B.R. Pelletier. Maritime sediments, special publication, no. 1, 1976, p. 267-277, ill.)

References.

ASTIS document number 149705.

ACU

Benthonic foraminifera were studied in 19 cores collected by SCUBA divers in Byam Channel in the Canadian Arctic Archipelago. The divers observed that the nearshore Byam Channel sea floor was considerably modified by ice scouring. The three most dominant species in the first 10 cm of core were identified as Spiroplectammina biformis, Textularia torquata, and Trochammina nana, which are typical of the nearshore waters surrounding the Queen Elizabeth Islands. In the first 2 cm of core the ratio of calcareous to arenaceous species increases at localities closer to the Viscount Melville Sound. In the subsurface layers (2 to 5 cm) calcareous species occur in significantly greater numbers than in the surface layer throughout the study area. A distinctive subsurface layer in most of the cores may indicate that ice scouring normally does not overturn the sediment. The increasing abundance of calcareous species with depth in the cores suggests that Byam Channel once had longer open-water seasons than it does today. (Au)

U.S. BEAUFORT SEA

BARNES, P.W.

143

Break in gouge character related to ice ridges / Barnes, P.W. Ross, C.R. Reimnitz, E.

(Environmental assessment of the Alaskan continental shelf : Annual reports of principal investigators for the year ending March 1980. Vol. IV : Hazards, p. 333-343, ill.)

References.

Attachment E of report entitled: Geologic processes and hazards of the Beaufort Sea shelf and coastal regions, by P. Barnes and E. Reimnitz, 1980, reporting period April 1979-March 1980.

ASTIS document number 149187.

ACU

During the summer of 1979 a series of three precisely navigated side-scan sonar and bathymetry lines were run along well-located ice ridges observed in the spring of the same year. No obvious set of gouges lead up to the location of the ridge nor were gouges associated with the existing remnants of the ice ridges observed in summer. However, the innermost ice ridge of the stamukhi zone appears to correlate with a marked change in gouge character and to an abrupt change in bottom slope. The gouge orientation is essentially similar on both sides of the change. Diver observations coupled with vibracore sample data indicate that there is a decrease in the compactness of the surficial gravelly mud sediments on the seaward side of the slope and gouge change. Although the sediment textures are similar, there is a significant change in seabed character associated with the stamukhi zone. The cause and effect relationship between the ice zonation and the seabed character is well established; however the mechanisms for the abrupt nature of the break are unsure. (Au)

144

Core descriptions and preliminary observations of vibracores from the Alaskan Beaufort Sea shelf / Barnes, P.W. Reimnitz, E. Toimil, L.J. Maurer, D.K. McDowell, D.

Menlo Park, Ca. : U.S.G.S., 1979.

17 leaves : ill., map ; 28 cm.

(Open-file report – U.S. Geological Survey, 79- 351)

Appendix.

References.

ASTIS document number 149900.

Interpretation of modern sedimentary environments requires an understanding of sub-seafloor sedimentary character. This is especially true on the arctic shelves where ice gouging actively influences sediments to depths of a meter or more on an annual basis such that surficial sedimentary parameters do not entirely reflect ongoing geologic processes. Knowledge of substrate character is also an important parameter for safe and efficient offshore development activities. Samples for analysis for analysis of substrate character were obtained in 1976 and 1977 using a vibratory coring device to obtain cores up to 180 cm in length at 60 locations on the inner Beaufort Sea shelf. Locations were chosen from several different geologic environments. Three of these environments: (1) delta front platform, (2) areas extensively reworked by ice, and (3) barrier islands, could be characterized on sedimentologic data. ... In the first section of this report we describe the coring procedures and methodology used in processing the cores. This section is followed by preliminary discussion of the sedimentary environments based on analysis of the cores. The data, in the form of core descriptions, is

contained in the appendix. (Au)

145

Correlation between an ice ridge and sea bed geologic boundary / Barnes, P.W. Ross, C.R. Reimnitz, E.

(National Research Council of Canada Associate Committee on Geotechnical Research Workshop on Ice Scouring, 15-19 February 1982 / Edited by G.R. Pilkington. Technical memorandum - Canada. National Research Council. Associate Committee on Geotechnical Research, no. 136, p. 169-184, ill.)

References.

ASTIS document number 148440.

NFSMO

During the summer of 1979 a series of three precisely navigated side-scan sonar and bathymetry lines were run along well-located ice ridges observed in the spring of the same year. No obvious set of gouges lead up to the location of the ridge nor were gouges associated with the existing remnants of the ice ridges observed in summer. However, the innermost ice ridge of the stamukhi zone appears to correlate with a break in bottom slope and a marked change in gouge character. Gouging is more intense seaward in the stamukhi zone although gouge orientations are essentially the same. The bottom profile is marked by a 1 to 2 m high bench. Diver observations coupled with vibracore sample data indicate that there is a decrease in the compactness of the surficial gravelly mud sediments on the seaward side of the bench. The cause and effect relationship between the ice zonation and the seabed character is well established; however the mechanisms for the abrupt nature of the break are unsure. (Au)

146

Geologic processes and hazards of the Beaufort Sea shelf and coastal regions / Barnes, P.W. Reimnitz, E.

(Environmental assessment of the Alaskan continental shelf : Quarterly reports of principal investigators April-December 1979. Vol. II, p. 189-192, ill.)

References.

Reporting period: July 1-Sept. 30, 1979.

ASTIS document number 149225.

ACU

This report outlines field studies on the R.V. Karluk during July, August and September 1979 in the area from Harrison Bay to Camden Bay, Alaska. From the following studies and observations they hoped to gain insights into the processes responsible for some unusual bottom features of the Arctic nearshore zone: mud cover probably caused by formation of slush ice; study of outcrops of current-polished silty clay; criss-crossing tracks of seismic profiles run on 20 bore holes drilled by U.S.G.S.; study of ice gouge and strudel scour; observations of Dinkum Sands; ice gouge test lines re-run for determining rates of scour, boulder patches discovered; survival rate of sessile animals and plants investigated on cobbles and boulders in an ice-gouge environment. (ASTIS)

147

Geologic processes and hazards of the Beaufort Sea shelf and coastal regions / Barnes, P.W. Reimnitz, E. Drake, D.

(Environmental assessment of the Alaskan continental shelf : Quarterly reports of principal investigators April-June 1977. Vol. II, p. 449-569, ill.)

References.

ASTIS document number 149306.

ACU

... The primary goal of this project is to study the nature, distribution, stability and thickness of Holocene and older sediments, and their relationship to sources, dispersal mechanisms and bottom processes. Emphasis is placed on processes that are unique to the arctic environment where ice plays a dominant role. ... Previous high resolution seismic profile surveys off major river distributaries on the inner shelf of the southern Beaufort Sea have revealed an apparent lack of Holocene sediment deposition. Off the Colville River, arctic Alaska's largest river system, almost no expression of a prograding delta system can be seen beyond the 2-m isobath. Recently we have speculated that this condition is likely related to under-ice processes which may play a significant role in the lithologic character, distribution, and removal of modern sediments. The objective of this study is to define such processes. The nature of the contact between the bottom fast ice and the sea bed was examined at 19 stations established between the 0.25 and 2.0-m isobath. ... Eleven stations were occupied on the floating fast ice out to the 5-m isobath along with two established on the floating ice within the Colville and Kupigruak Channels. At these stations, water temperature and salinity were measured using a Beckman salinometer. Here also the general character and thickness of the ice were recorded. On May 8th two ice-level recorders were placed on the ice to record vertical fluctuations of the ice canopy. ... (Au)

148

Ice gouge characteristics and their relation to ice zonation, Beaufort Sea, Alaska / Barnes, P.W. Rearic, D.M. Reimnitz, E.

(Abstracts of papers - International Congress on Sedimentology, 11th, McMaster University, Hamilton, Ont., 22-27 Aug., 1982, p. 75)

Abstract only of paper presented at Eleventh International Congress on Sedimentology, 1982.

ASTIS document number 149683.

ACU

Ice gouging is a major mechanism for disruption, reworking, and transport of sediment on the gently sloping shelf of the Beaufort Sea off northern Alaska. Eight years of fathometer and side-scan sonar records form the basis for a statistical analysis of numerous parameters of 100,000 gouges in water as deep as 50 m. The average gouge from this data base is 7.5 m wide and 0.5 m deep, with flanking ridges 0.4 m high and is oriented east-west. The maximum values for these parameters are a width of 62 m, an incision depth of 5.5 m, and a ridge height of 2.7 m. Gouges are largest and most abundant in water 15 to 35 m deep. Inshore and offshore from these depths both gouge density and size decrease. Intensity of gouging should be related to the distribution and size of ice ridges and ice keels, which are responsible for much of the seabed gouging. Other factors influencing gouge intensity are sediment type and accumulation rate, and rate of reworking by waves and currents. Because of these additional factors, the relation between gouge intensity and ridge-keel distribution is complex. Nevertheless, study of the past 8 years of satellite imagery for the shelf shows an ice zonation, with an abrupt offshore increase in ridge density and height in water 15 to 20 m deep, and frequent occurrence of major stable, grounded ridge systems where gouging is most intense. (Au)

149

Ice gouge characteristics related to sea-ice zonation, Beaufort Sea, Alaska / Barnes, P.W. Reimnitz, E. Rearic, D.M.

Menlo Park, Calif. : Geological Survey, Pacific - Arctic Branch of Marine Geology, 1982.

32 leaves : figures ; 28 cm.

(National Research Council of Canada Associate Committee on Geotechnical Research Workshop on Ice Scouring, 15-19 February 1982 / Edited by G.R. Pilkington. Technical memorandum - Canada. National Research Council. Associate Committee on Geotechnical Research, no. 136, p. 185-219, ill.)

Appendix.
References.
ASTIS document number 136727.
NFSMO

... In this report we summarize 8 years of bathymetric and side-scan sonar data regarding the character and variability of ice gouging on the shelf of the Beaufort Sea off northern Alaska. A description of the character of ice gouging is presented to describe the regional character of gouging on the shelf without regard to yearly variability. Regional and process-related variability are then discussed to show general ice, seabed-sediment relationships in a reassessment and updating of our earlier work (Reimnitz and Barnes, 1974). (Au)

150

Ice gouge obliteration and sediment redistribution event, 1977-1978, Beaufort Sea, Alaska / Barnes, P.W. Reimnitz, E.
22 p. : ill., map ; 28 cm.
(Open-file report – U.S. Geological Survey, 79- 848)
References.
ASTIS document number 149888.
ACU

In 1978 major changes in shelf morphology were observed during a routine re-survey of part of the inner shelf region of the central Beaufort Sea. Regional observations are coupled with a detailed diving and side-scan study of a single ice gouge of known age to develop a detailed description of the altered seabed conditions. Hydrodynamic activity has caused extensive sediment reworking, obliterating ice gouges to water depths of at least 13 m and has caused ponding of sediment in ice gouge terrain in deeper waters. Ponded sediment is characterized as a soft, sometimes very poorly consolidated, mud unit underlain by a stiffer, more consolidated, silty clay. In places, stiff silty clay is exposed in windows in the sediment pond and displays a fine-textured ice gouge morphology. Rates of sediment reworking and redisposition from apparently episodic events are an order of magnitude greater than the average sediment accumulation rates on the Beaufort Sea shelf. Reported maximum ice gouge incision depths are not representative of maximum ice keel penetrations into the seabed because these sedimentation events preferentially infill gouges. Furthermore, because these sedimentation events concentrate sediments in gouge troughs, a series of overlapping and interfingering "shoestring" deposits is developed which should characterize the ice gouge stratigraphy. The specific hydraulic mechanisms for sediment redistribution and sediment compaction observed in this study are only poorly understood.

151

Ice gouge studies, Alaskan Beaufort Sea / Barnes, P.W.
[19] leaves : ill., maps ; 28 cm.
Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.
Indexed from a preliminary draft, July 1985.
Proceedings to be published as an ESRF Report in late 1985.
ASTIS document number 163449.

... the USGS ice scouring studies have covered many areas of interest, three of which will be briefly discussed in this presentation. The first area will describe the characterisation of ice gouge population data from the statistics derived from the total gouge population. The second topic will involve the characterisation of datable gouges: gouges that we have dated in order to determine the rate of seabed reworking. This will include a discussion on the seaward limit of present day gouging on the Alaskan Beaufort Shelf. Finally, the methods involved in ascertaining the effect of scouring on the shelf morphology within the sediment will be mentioned. (Au)

152

Ice gouging characteristics : their changing patterns from 1975-1977, Beaufort Sea, Alaska / Barnes, P.W. McDowell, D. Reimnitz, E.
(Environmental assessment of the Alaskan continental shelf : Annual reports of principal investigators for the year ending March 1978. Vol. XI : Hazards, p. 193-229, figures, tables)
(Open-file report – U.S. Geological Survey, 78- 730)
References.
This is attachment B to the report entitled: Marine environmental problems in the ice covered Beaufort Sea shelf and coastal regions / P. Barnes and E. Reimnitz.
ASTIS document number 148989.
ACU

... The rates of sediment reworking by ice can be estimated using ice gouge recurrence intervals coupled with the incision depth of ice keels. Similarly the demise of gouge features in time gives information on the rates of sediment reworking by benthic communities and by currents. Seasonal or annual changes in patterns of ice gouge events and their orientation are a reflection of the ice motion during gouge formation. Furthermore, the orientations and intensities of all gouges are an integration of ice motions dating back many years to the time of complete seabed reworking by ice. ... In the area of this study ... sea ice can generally be divided into three zones based on bathymetry and ice character (Reimnitz and others, 1977b): (1) a bottom fast ice zone inside the 2-m isobath, where ice at the end of the season of ice growth rests on the sea floor; (2) the zone of floating fast ice; and (3) the stamukhi zone which forms the seaward edge of the floating fast ice; and (3) the stamukhi zone which forms the seaward edge of the floating fast ice, as a series of major grounded ice ridges. The stamukhi zone occurs in 15-20 m water depths, marks the boundary between the quasi-stable fast ice and the moving polar pack. It is an area of shear and pressure ridge formation and an area of intense ridge grounding during the winter. ... (Au)

153

Ice gouging characteristics and processes / Barnes, P.W. Rearic, D.M. Reimnitz, E.
(The Alaskan Beaufort Sea : ecosystems and environments / Edited by P.W. Barnes, D.M. Schell, and E. Reimnitz. – Orlando, Okla. ; Toronto : Academic Press, 1984, p. 185-212, ill.)
References.
ASTIS document number 164658.
ACU

... Since 1972, we have recorded morphologic data of the ice-scoured continental shelf of the Alaskan Beaufort Sea using side-scan sonar and fathometers. The primary objective has been to assemble quantitative data on ice-gouge characteristics and processess and to analyze these data for trends. Initial comparison of seabed morphology and shelf-ice zonation suggested a relationship between ice gouging and sea ice ridges on the inner Beaufort Sea shelf (Reimnitz and Barnes, 1974). In this report we update earlier work, summarize new data regarding the character and variability of ice gouges on the Beaufort Sea Shelf ... and discuss the gouging process, suggesting relationships to seabed morphology, sediments, and ice dynamics. (Au)

154

Marine environmental problems in the ice covered Beaufort Sea shelf and coastal regions / Barnes, P.W. Reimnitz, E.
(Environmental assessment of the Alaskan continental shelf : Annual reports of principal investigators for the year ending March 1978. Vol. XI : Hazards, p. 148-299, figures, tables)

Appendix.
References.
ASTIS document number 148822.
ACU

The present investigation is an intensification of our earlier studies on the marine geology and modern sedimentary environment off arctic Alaska with emphasis on rates and processes. In particular we have concentrated on phenomena involving ice and its unique influence on the shelf and inshore environment. The marine environment of the arctic shelf poses special problems to offshore development. Faulting, tectonic activity and sea floor instability are environmentally of lower concern in the Beaufort Sea, when compared to processes involving sea ice and low temperatures. Seven years of study have provided a basic understanding of this unique marine geologic environment. However, many important aspects have yet to be addressed. For example, the major processes involved in ice gouging of the sea floor are reasonably understood, including distribution, densities, gouge trends, rates of gouging, depths of reworking and the variability of gouge formation from year to year. Critical questions regarding the interaction of the stamukhi with the continental margin, the distribution and character of gouging in this zone, the time of formation and the year to year stability of the stamukhi zone. Neither are the effects of the stamukhi zone on oceanographic circulation, sediment disruption and dispersal, and the shelf profile understood. ... (Au)

155

Marine environmental problems in the ice covered Beaufort Sea shelf and coastal regions / Barnes, P.W. Reimnitz, E. Drake, D.
(Environmental assessment of the Alaskan continental shelf : Annual reports of principal investigators for the year ending March 1977. Vol. XVII : Hazards, p. 1-229, ill., maps)
References.
ASTIS document number 148954.
ACU

Many questions have been raised on the basis of our past investigations, and apparently hold the key to an understanding of the seasonal cycle in the marine environment. It is these tasks that we address in our current research. (1) Processes of ice gouging – in particular the repetitive rates of gouging and the extent to which it occurs outside the area of our past investigations. Repetitive side-scan sonar surveys with precise navigational control and direct diving observations will be used. For the outer shelf studies a manned submersible must be chartered. (2) Shelf sediment transport regime – including ice rafting, river effluents and reworking and resuspension of bottom materials by ice and benthos. (3) The fast-ice zone, and its influence on nearshore current circulation, bedforms, sediment transport, permafrost, and on river discharge. (4) The stamukhi between the coastal ice and the offshore pack ice, and its influence and/or relationship to (a) bathymetry, (b) thermal effects on the sea floor, (c) ice gouging, (d) winter current regime, (e) tides, and (f) sediment transport. (5) An estimation of coastal erosion and its relationship to the formation of offshore islands and the stability of the coastal marine environment. (6) Inner shelf oceanography, and its relationship to the sedimentary environment. ... (7) A study of the apparent lack of deltaic sedimentation near river mouths in the Arctic, and the unique marine aspects of arctic rivers in general. (8) Outlining the Pleistocene stratigraphy and geologic history of the shelf, from a combined analysis of available sediment and seismic data, drill hole data, and 2-m long vibrocorer samples. (9) Delineation of offshore sand and gravel resources on the inner shelf from a correlation of available seismic reflection records with permafrost drill hole data. ... (Au)

156

Marine environmental problems in the ice covered Beaufort Sea shelf and coastal regions / Barnes, P.W. Reimnitz, E. Drake, D.
(Environmental assessment of the Alaskan continental shelf : Annual reports of principal investigators for the year ending March 1976. Vol. XII : Geology, p. 512-566)
References.
Includes preliminary cruise report of the Karluk.
ASTIS document number 149250.
ACU

... Investigation of the marine geology and sedimentary processes of the continental shelf and shores of the Chukchi and Beaufort Seas in northern Alaska were initiated in 1970. Many aspects have been cooperative efforts with federal and state agencies and universities. The primary goal of the program has been to understand the processes that are unique to Arctic shelves and their sedimentary environment, where sea ice plays an important role. Our specific objectives have included: (1) a definition of the character of the bottom materials, including permafrost; (2) a study of the present sediment transport and depositional mechanisms; and (3) studies of the Holocene and Pleistocene geologic record. ... (Au)

157

Nearshore surficial sediment textures – Beaufort Sea, Alaska / Barnes, P.W. Reimnitz, E. Ross, C.R.
41 leaves : maps ; 28 cm.
(Open-file report – U.S. Geological Survey, 80- 196)
Appendix: p. 9-41: Field and laboratory notes.
References.
Two maps on 2 folded leaves.
ASTIS document number 159859.
ACU

The surficial sediment character of inner shelf sediments is a commonly used parameter in the interpretation of sedimentary processes and sedimentary environments. We have collected a large number of samples and have made observations on the surficial sediments from the inner shelf of the Beaufort Sea. These data are compiled to aid other geological and non-geological researchers. ... (Au)

158

New insights into the influence of ice on the coastal marine environment of the Beaufort Sea, Alaska / Barnes, P.W. Reimnitz, E.
(Symposium on significant results obtained from the earth resources technology satellite. – [New Carrollton, Md.?] : NASA, 1973, v. 1, p.1307-1314, ill.)
References.
ASTIS document number 149853.

Areal patterns from field data and ERTS-1 imagery have shown a close relationship between geologic processes and the influence of sea ice along Alaska's northern coast, perhaps the nation's least known continental margin. Ice acts as (1) a bottom-gouging agent, (2) an influence on water circulation, (3) a carrier of sediments, and (4) an influence on water types. (Au)

159

Observations of arctic shelf processes from marine geologic studies conducted off the northern coast of Alaska / Barnes, P.W. Reimnitz, E. Arctic Institute of North America [Sponsor].
[S.l. : s.n., 1974?].
54p. : ill., figures, maps ; 28cm.
Bibliography: p.49-54.
ASTIS document number 24619.

ACU

... The purpose of our study has been an attempt to examine as many aspects of the sedimentation processes prevalent on arctic shelves and to assess their importance at different times during the year. Considering the effort that is and has gone into understanding the processes of lower latitude shelves, depth of study of the more complex and inhospitable arctic shelf has been inadequate. As a result our comprehension of these processes is just beginning to surface. ... (Au)

160

Rates of ice gouging, 1975 to 1976, Beaufort Sea, Alaska / Barnes, P.W. McDowell, D. Reimnitz, E.

(Environmental assessment of the Alaskan continental shelf : Annual reports of principal investigators for the year ending March 1977. Vol. XVII : Hazards, p. 89-100, ill.)

(Open-file report – U.S. Geological Survey, 77- 477, p. E1-12)

This is attachement G to the report entitled: Marine environmental problems in the ice covered Beaufort Sea shelf and coastal regions / P. Barnes, E. Reimnitz and D. Drake.

References.

ASTIS document number 148962.

ACU

Sea ice on the continental shelves of arctic Alaska impinges on the sea bottom at varying intervals of space and time. Knowledge of the recurrence interval at which ice is likely to interact with the sea floor, or the rate of ice gouging, is important from several standpoints. Using gouge recurrence and depths, the rates of sediment reworking can be estimated, and the effect on benthic communities evaluated. Furthermore it is of utmost importance in the planning and design of offshore installations, such as pipelines and subsea well heads to know the rate and depth to which ice is likely to penetrate into the sea floor. In the area of this study ... sea ice zonation falls into three general categories (Reimnitz and others, 1976): (1) a bottom fast ice zone inside the two meter isobath, where ice at the end of the season of ice growth rests on the sea floor; (2) the zone of floating fast ice, with varying quantities of thicker, older ice, seaward of the bottom fast ice; and (3) at the seaward edge of the floating fast ice, a zone of grounded ice ridges forming the stamukhi zone. The two fast ice zones remain essentially stable during the winter. The stamukhi zone, commonly occurring in 15-20 m depths, marks the boundary between the stable fast ice and the moving polar pack, and is an area of shear and pressure ridge formation and ridge grounding during the winter. During the summer open water season, drifting ice of various drafts is commonly present at all water depths on the inner shelf. Solidly grounded stamukhi may remain grounded throughout one or several seasons of melting. The study area of this study ... is located north of Oliktok Point in water depths of 6 to 12 m, the zone of floating fast ice .... (Au)

161

Sedimentary processes on arctic shelves off the northern coast of Alaska / Barnes, P.W. Reimnitz, E.

(The coast and shelf of the Beaufort Sea / Edited by J.C. Reed and J.E. Sater. – Arlington, Va. : Arctic Institute of North America, 1974, p. 439-476, ill.)

References.

ASTIS document number 148849.

ACU

... The nearshore zone of the Beaufort Sea to a depth of about 4 m is dominated by waves during the summer and by ice push and adfreezing during the winter. The inner shelf seaward to the boundary between the shorefast ice and the polar pack ice, at about 20 m, is influenced more by waves and currents than by grounding ice. However, the surficial sediments of this zone may reflect dominance of ice effects, depending on the history of events influencing the bottom just prior to the time of observation. In the depth range between about 20 m and the shelf break at 50 to 70 m, ice gouging jumbles the older sediments and homogenizes the gravelly mud that characterizes this zone. Interaction between the ice and the sea bottom decreases seaward across the shelf, because the number of ice ridges with keels long enough to reach the bottom decreases with depth. Along the shelf edge, surficial gravels overlying laminated clay-silt suggest that ice rafting, most probably relict, is responsible for sediment character. The current directions, ice motion, and wind regime in each of the environments indicate that the bulk of sediments, whether bulldozed, ice-rafted, or in suspension, is transported westward on the Alaskan shelf. The implications of this study suggest that a careful look at the significance of winter processes on subarctic shelves is needed in order to evaluate the transition between arctic and low-latitude shelf processes. ... (Au)

162

Sedimentary structures related to the influence of drift ice as seen on the shelf off northern Alaska / Barnes, P.W. Reimnitz, E.

(First Symposium on the Geological Action of Drift Ice, Quebec, Canada, April 20-24, 1974 [sic]. Maritime sediments, v. 9, no. 3, Dec. 1973, p. 104)

Abstract only.

ASTIS document number 149721.

ACU

... It has been rediscovered that ice gouging is a significant agent influencing arctic sedimentation. Obviously, gouging should leave a record in the sediments. To date, no reports are known relating to the sedimentary structures that would result from the intense action of ice on arctic shelves. Drifting ice interacts with the surface sediments and currents of the Beaufort Sea shelf to form a series of morphologies and sedimentary structures that are related to water depth, ice type and distribution, and season of the year. Four shelf facies are defined. No analog for these structures is reported from the geologic record, however, several glacial-marine sections in the Pleistocene are prime candidates for investigation. ... (Au)

163

Shoal migration under the influence of ice : a comparison study 1950-1975 / Barnes, P.W. Reimnitz, E. Drake, D.

(Environmental assessment of the Alaskan continental shelf : Annual reports of principal investigators for the year ending March 1976. Vol. XII : Geology, p. 583-590, ill.)

ASTIS document number 149241.

ACU

During the course of our summer operations with small boats, which began in 1970, we have commonly noted the existence of grounded ice on offshore shoals. This grounded ice generally appears to be of pressure ridge origin, with a sail 5 to 8 m high, a keel of at least 10 m, and plain view much longer (the order of kms), parallel to depth contours than wide. Pack ice fragments and floes frequently accumulate along the seaward side of these grounded ridges, which act as fences. In many cases the grounded ridges mark a distinct boundary between the scattered ice on the inner shelf and tightly packed ice on the central shelf. ... The areal distribution of such grounded ridge systems was determined for the area between Cross Island and Cape Halkett from ERTS-1 satellite imagery of early July, 1973. ... A striking correlation between the areal distribution of linear ridge systems and charted shoal, can be seen .... This winter relationship along with summer observations led us to suspect an interaction between ice dynamics and shoals found along the inner Arctic. ... All available evidence leads to the conclusion that the shoals under discussion are not hydraulic bedforms related to open-water conditions, but that they were formed, and presently are migrating, under influence of ice-related processes .... The findings presented here are the first solid evidence for a relationship between anomalies in the overall profile of an

Arctic shelf and boundary processes of the Beaufort Gyre pack ice. These findings have extremely important implications for offshore development in the Arctic especially concerning the construction of artificial islands. (Au)

164
A study of the repetitive rate of ice gouging in Harrison Bay, Beaufort Sea / Barnes, P.W. Reimnitz, E. Drake, D.
(Environmental assessment of the Alaskan continental shelf : Annual reports of principal investigators for the year ending March 1976. Vol. XII : Geology, p. 576-582, ill.)
This is Attachment E of the report entitled : Marine environmental problems in the ice covered Beaufort Sea shelf and coastal regions.
ASTIS document number 149268.
ACU

... In 1973 a precise range-range navigation system was available for the first time for our Beaufort Sea studies. Using this navigation system, we surveyed three particular tracks between Prudhoe Bay and Harrison Bay, which we plan to resurvey occasionally with side-scan sonar, in order to determine the repetitive rates of ice gouging on the shelf. The three track lines of 1973 were resurveyed in 1975. Unfortunately, ice during these two years has prevented us from extending these survey lines from the coast far enough offshore to study the entire zone of predominantly grounded ice (stamukhi zone). Also, the quality of the sonar records obtained during the two surveys is not equal, making a comparison of bottom features difficult. However, the results from the comparison of one of these three transects, Harrison Bay, are significant, and are reported below. (Au)

BRESLAU, L.R.

165
The underwater shape of a grounded ice island off Prudhoe Bay, Alaska / Breslau, L.R. James, J.E. Trammell, M.D. Behlke, C.E.
(Proceedings : the First International Conference on Port and Ocean Engineering under Arctic Conditions. – Trondheim, Norway : Technical University of Norway, 1971, vol. 1, p. 119-139, figures)
References.
ASTIS document number 148806.
ACU

The underwater geometry of an ice island grounded off Prudhoe Bay, Alaska was mapped using a narrow beam sonar. Vertical section profiles of the submerged portion of the ice island were obtained by lowering a sonar transducer through the pack ice at eleven sites surrounding the ice island. The ice island studied had previously been ballasted by freezing sea water on its upper surface in an attempt to ground it more firmly. This was part of a research effort to investigate the feasibility of using grounded ice islands as offshore platforms. The results of the sonar investigation showed that the ice island was sharply undercut in some places. At a later date, the ice island broke into a few fragments and was partially abandoned. (Au)

166
The underwater shape of a grounded ice island off Prudhoe Bay, Alaska / Breslau, L.R. James, J.E. Trammell, M.D.
(Second Annual Offshore Technology Conference, April 22-24, 1970, Houston, Texas, preprints. – Dallas, Tex. : Offshore Technology Conference, 1970, v. 2, p. 753-766, ill.)
(OTC paper, 1305)
References.
ASTIS document number 149101.
ACU

The underwater geometry of an ice island grounded off Prudhoe Bay, Alaska was mapped using a narrow beam sonar. Vertical section profiles of the submerged portion of the ice island were obtained by lowering a sonar transducer through the pack ice at eleven sites surrounding the ice island. The ice island studied had previously been ballasted by freezing sea water on its upper surface in an attempt to ground it more firmly. This was part of a research effort to investigate the feasibility of using grounded ice islands as offshore platforms. The results of the sonar investigation showed that the ice island was sharply under-cut in some places. At a later date, the ice island broke into a few fragments and was partially abandoned. (Au)

BROOKS, L.D.

167
Ice scour on northern continental shelf of Alaska / Brooks, L.D.
(The coast and shelf of the Beaufort Sea / Edited by J.C. Reed and J.E. Sater. – Arlington, Va. : Arctic Institute of North America, 1974, p. 355-366, figures)
References.
ASTIS document number 148067.
ACU

There appears to be considerably less ice scouring inside the 18-m curve than outside. The decrease is in frequency, width, and length; however, there is little decrease in relief of scour. The 18-m curve acts as a barrier sill to the relatively constant draft ice islands. Although ice islands are grounded during heavy storms (with considerable scour), they are generally not permanently grounded. The design of any offshore facility on the North Slope must take ice scour into account. (Au)

168
Ice scour on the northern continental shelf of Alaska / Brooks, L.D.
(1973 Offshore Technology Conference, April 30-May 2 – Houston, Texas : preprints. – Dallas, Tex. : Offshore Technology Conference, 1973, v. 1, p.I- 764-I- 766, ill.)
(OTC paper, 1813)
References.
ASTIS document number 150053.
NFSMO

The intent of this investigation was two-fold: first, to provide an operational, research platform in the Arctic for first class cadets (seniors) of the U.S. Coast Guard ... and second, to insure that the research be pertinent to the role of the USCG in the Arctic. ... the Coast Guard Academy has been involved in the Arctic every summer since 1969 in the following areas: (1) West Greenland glacier survey, (2) air cushion vehicle evaluation, (3) oil spill effects on ice, (4) ice thickness by shear wave techniques, (5) ice scour on the northern continental shelf of Alaska and (6) icebreaker instrumentation and ramming tests. [The CGA studied a number of ice islands in the Arctic. Their findings were as follows:] ... 1. Ice scouring is considerably less severe inside the 10-fathom curve. 2. The 10-fathom curve acts as a barrier sill to the relatively constant draft ice islands. No ice islands were observed inside the 10-fathom curve. 3. The bottom scour inside the 10-fathom curve can be attributed to ice island remnants and pressure ridge keels. Keels have been reported deeper than 75 ft. 4. The row of grounded ice islands acts as a barrier to sea ice from the north. Outside the row there was 7 to 8 oktas coverage, while inside there was only 1 to 3 oktas coverage (once broken up by the summer season). 5. The ice islands must become grounded during storms with high winds and maximum meteorological tide and likewise refloated and carried away or broken up. (Au)

CARSOLA, A.J.

169
Microrelief on arctic sea floor / Carsola, A.J.
(AAPG bulletin, v. 38, no. 7, July 1954, p.1587-1601, ill.)
References.
ASTIS document number 149128.
ACU

The upper continental slope in the Arctic Ocean off Alaska and northwestern Canada is characterized by a series of low mounds and troughs. These features are found only between the edge of the shelf and the 200-fathom isobath on the slope, and on the sides of two shelf valleys. The origin of this microrelief is not clear, but the evidence available suggests that it is best explained as formed by mass movement on low slopes in regions where tides are small and tidal currents are weak. (Au)

GENERAL DYNAMICS

170
Ice scouring on the Alaskan continental shelf, II / General Dynamics. McDonald, M.F. Amoco Production Company [Sponsor]. Atlantic Richfield Company [Sponsor]. BP Alaska Exploration, Inc. [Sponsor]. Gulf Oil Canada [Sponsor]. Humble Oil and Refining Company [Sponsor]. Mobil Oil Canada Ltd. [Sponsor]. Shell Oil Company [Sponsor].
Groton, Conn, : General Dynamics, 1973.
1 v. (loose-leaf) : ill. (some folded) ; 28 cm.
Appendix.
References.
ASTIS document number 149403.

Scouring conditions on the inner shelf (inside the 60-foot curve) have been studied for the shelf area between Harrison Bay and Prudhoe Bay, and can now be compared with scouring conditions on the outer shelf. On the inner shelf the frequency of scours on the sea bottom averages 10 scours per nautical mile, and depth of scouring averages 1.0 foot with the deepest scour located being 4.0 feet deep. Scour widths are typically 10 to 50 feet with the wide multiple scour tracks previously observed on the outer shelf being a rarity on the inner shelf zone. In general, scouring conditions on the inner shelf are less severe than on the outer shelf. ... (Au)

GRANTZ, A.

171
Constraints of geologic processes on western Beaufort Sea oil developments / Grantz, A. Dinter, D.A.
(Oil and gas journal, v. 78, no. 18, May 5, 1980, p. 304-319, maps)
ASTIS document number 44920.
ACU, NFSMO

This article details geologic, bathymetric, geomorphic, and sea ice and permafrost characteristics in the western Beaufort Sea which present considerable problems to offshore exploration and pipeline construction between Point Barrow and the International boundary. (ASTIS)

HARPER, J.R.

172
Shore-zone ice scour statistics : implications to coastal development / Harper, J.R.
(National Research Council of Canada Associate Committee on Geotechnical Research Workshop on Ice Scouring, 15-19 February 1982 / Edited by G.R. Pilkington. Technical memorandum - Canada. National Research Council. Associate Committee on Geotechnical Research, no. 136, p. 223-230, ill.)
References.
ASTIS document number 148458.
NFSMO

Shore-zone ice-scour statistics are available for some sections of the arctic coast, and these statistics provide some preliminary design constraints for coastal development in areas of ice infested waters. The statistics suggest that ice over-ride and associated ice scour may be a process occurring frequently enough to dictate minimum set back distances of coastal structures; the risk of damage by scouring to buried structures, such as pipelines or cables, appears to be of comparable magnitude to other hazards such as coastal erosion, thaw settlement, storm surge, strudel scour and ice "wallowing". These hazards may pose more serious design problems. (Au)

KOVACS, A.

173
Grounded ice in the fast ice zone along the Beaufort Sea coast of Alaska / Kovacs, A.
Hanover, N.H. : U.S. Army. Cold Regions Research and Engineering Laboratory, 1976.
iv, 21 p. : ill. ; 28 cm.
(CRREL report, 76- 32)
References.
ASTIS document number 159816.
ACU

Four large grounded multi-year shear ridge formations were found in the grounded ice subzone of the fast ice zone near the Harrison Bay/Prudhoe Bay area of Alaska. A 166-m-long cross section of one of these formations was obtained by leveling and sonar measurements. These measurements revealed that the maximum ridge height was 12.6 m and that the formation was grounded in 17-18 m of water. The salinity, temperature , brine volume and density of the ice were determined on samples obtained by coring. The physical characteristics of the formations as observed in satellite, SLAR and aerial imagery indicate that these formations have not moved between the time of their formation in the fall of 1974 and August of 1976. Evidence of significant aeolian debris discoloring the ice is discussed. (Au)

174
An ice island fragment in Stefansson Sound, Alaska / Kovacs, A.
Hanover, N.H. : Cold Regions Research and Engineering Laboratory, [1985].
[15] leaves : ill., map ; 28 cm.
Reprint: 8th Int. Con. on Port and Oceans Eng. Under Arctic Conditions, 8th, Narssarssuak, Greenland, Sept. 1985.
References.
ASTIS document number 159760.
ACU

A small ice island fragment was found in a unique location southwest of Cross Island, Alaska, in April 1983. Investigations were made to determine the thickness, salinity, density, internal temperature, and strength of the ice island ice. Measurements were also made which revealed that the ice island was grounded. Side scan sonar, depth profiles and direct sounding measurements of the sea bottom revealed that the ice island had gouged into the seabed when it was driven into shallower waters. Implications of this ice feature to offshore petroleum development are discussed. (Au)

175
Ice scoring marks floor of the arctic shelf / Kovacs, A.
(Oil and gas journal, v. 70, no. 43, Oct. 23, 1972, p. 92, 97-106, figures)
References.
ASTIS document number 148296.
ACU

... from the information available, it would appear that ice scoring on the Beaufort Sea shelf can be divided into three zones: (1) A coastal shelf zone where the waters are less than 20 ft deep. Although scoring may be very frequent the resulting microrelief is shallow (less than 2 ft) and is soon smoothed by wave action and local currents. (2) A mid-shelf zone with water between 20 and 100 ft deep. Considerable contemporary scoring occurs, which mixes the surface sediments to a depth of perhaps 5 ft, depending upon local sediments, destroying stratification, and oxygenating the sediments. The frequency of scores is on the order of 20 to 25/mile and the depth of a score tends to be less than 5 ft but on occasion reaches 10 to 15 ft. (3) An outer shelf zone between the 100 and 250-ft depth. Scoring to 30 ft has occured but the frequency of scores decreases very quickly beyond the 150-ft depth. I believe that, while considerable overlapping of scores exists between the 100 and 150-ft depth range, many of these scores are not of recent origin. This is predicted upon the observation that many of the scores are partially filled with sediment and upon recent estimates of ice keel depth distributions in the Beaufort Sea. Resulting calculations indicate that the possibility of encountering an ice keel 110 ft deep at a given location is less than once every 100 years. Probability of encountering keels less than 100 ft deep increases exponentially with decreasing depth, e.g., tens of keels 60 ft deep can be expected to pass a given location during the course of a single year. (Au)

176
Recent ice observations in the Alaskan Beaufort Sea federal-state lease area / Kovacs, A.
(The Cold Regions Research and Engineering Laboratory : recent work by CRREL staff. The northern engineer, v. 10, no. 3, Fall 1978, p. 7-12, ill.)
Reference.
ASTIS document number 164313.
ACU, NFSMO

There is a paucity of information on ice movement and deformation events in the Alaskan Beaufort Sea federal-state lease area. ... However, the observed location of the "fresh-water ice floes" from the nearest river delta clearly indicates that fall storms can break up and displace ice for great distances inside the barrier islands. The importance of this finding is that structures placed in these waters not only must be designed to resist the forces associated with fast ice movement inside the barrier islands but also to withstand potential ice pile-up and override. In addition, the surprisingly large pressure ridges found inside the barrier islands, with their potential for gouging the sea bed or impinging against a bottom-founded structure, must now be considered in the design of these installations. The observations reported here show that fast ice over 1.6 m thick located seaward of the barrier islands can be suddenly displaced in excess of 100 m, that the seaward extent of the "stable" land-fast ice in the Alaskan Beaufort Sea federal-state lease area borders on the 13-m bathometric depth contour in years when there is a small amount of grounded ice in the grounded ice zone, and that major displacements of thick first-year ice and related pressure ridging can occur well within the proposed lease area. As a result of our findings, we have recommended that the seaward extent of the proposed 1979 lease area be moved southward inside the shore-fast ice area. Here ice movements are less severe, and the possibility of ice pile-up or ride-up and the forces exerted by the pack ice on a manmade drilling structure would be greatly reduced. We feel that this recommendation should remain a condition of the lease until such time as a test structure has been built and evaluated for resistance to the dynamic ice conditions that exist in the seasonal pack ice zone. (Au)

177
Sea ice morphology and ice as a geologic agent in the southern Beaufort Sea / Kovacs, A. Mellor, M.
(The coast and shelf of the Beaufort Sea / Edited by J.C. Reed and J.E. Sater. – Arlington, Va. : Arctic Institute of North America, 1974, p. 113-161, figures)
(Miscellaneous publications – U.S. Army. CRREL, 801, 1974)
References.
Reviewed by document number 148040.
ASTIS document number 148032.
ACU

The paper gives a general account of ice conditions in the southern Beaufort Sea and makes a preliminary exploration of one of the important engineering problems created by ice over the continental shelf. Notes on the oceanic environment mention surface winds, currents, waves, temperature, salinity, bed relief, bottom sediments, and extent of ice cover. Three characteristic ice zones are defined (fast ice, seasonal pack ice, and polar pack ice), and for each zone the genesis, morphology, activity, and distribution of constituent ice types are discussed, with special reference to ice ridges and the configuration of pressured ice. The occurrence, movement, and size distribution of ice islands are considered, and ice scoring of bed sediments is described. The bed-scoring problem is examined in terms of: (1) forces required for gouging typical bed sediments, (2) the structural integrity of ice keels, (3) the potential role of momentum in gouging, (4) the thrust limitation of first-year ice, and (5) forces developed by wind shear. The authors conclude that most keels have ample strength for gouging, that necessary sustained forces can be developed by wind shear over reasonable areas, and that first-year ice can transmit the needed thrust to ice islands or pressure ridges. The momentum of isolated ice masses was determined to be insufficient to cause significant gouging. (Au)

178
Some characteristics of grounded floebergs near Prudhoe Bay, Alaska / Kovacs, A. Gow, A.J.
(Arctic, v. 29, no. 3, Sept. 1976, p. 169-173, ill., figures)
ASTIS document number 103403.
ACU

During the winter of 1974-75, a large number of floebergs (fragments of multi-year pressure ridges) were found incorporated in the fast ice northwest of Prudhoe Bay, Alaska. Many of them had been driven up onto the sea floor and become stranded, as was indicated by their high free-board. ... In order to gather information on the shape and structure of floebergs, and their effect upon the sea bed during groundings, studies were undertaken in April 1975 in the area located approximately 35 km northwest of Prudhoe Bay (70 35 N, 148 50 W). These studies included the determination of the surface relief of two floebergs (henceforward designated A and B) by means of standard surveying techniques; snow thickness measurements; the profiling of the floeberg keels by a sonar technique developed by Kovacs, and an examination of the internal structures of the floebergs, including voids and impurities, as observed in fracture faces on their sails and the portions of their keels uplifted upon grounding. The fast ice surface in the immediate area of the floebergs was highly irregular, due largely to the incorporation of ice fragments into the ice sheet. The surface was covered with a layer of snow that varied in thickness from 10 to 40 cm, depending on the relief of ice. (Au)

179
Some characteristics of grounded floebergs near Prudhoe Bay, Alaska / Kovacs, A. Gow, A.J.
Hanover, N.H. : Cold Regions Research and Engineering Laboratory, 1976.
13 p. : ill. ; 28 cm.
(CRREL report, 76- 34)
ASTIS document number 160237.

ACU, NFSMO

Some physical characteristics of two grounded floebergs near Prudhoe Bay, Alaska, are described. Cross-sectional profiles of the sails and keels of both floebergs were obtained. Additional studies included investigations of the internal structure of the floebergs, surveys of the sea floor for evidence of scouring induced during grounding of the floebergs, and a brief examination of the organic and sedimentary debris found entrained within the floebergs. (Au)

LOKEN, O.H.

180

Discussion of paper by Mr. Kovacs and Mr. Mellor / Loken, O.H.

(The coast and shelf of the Beaufort Sea / Edited by J.C. Reed and J.E. Sater. – Arlington, Va. : Arctic Institute of North America, 1974, p. 163-164)

References.

Review of document number 148032, Sea ice morphology and ice as a geologic agent in the southern Beaufort Sea / A. Kovacs and M. Mellor.

ASTIS document number 148040.

ACU

The authors have given a comprehensive and excellent review of ice morphology as it pertains to the Beaufort Sea. However, the most original part of the paper is their discussion of sea ice as a geologic agent. This latter section focusses on the plowing resistance of the bottom sediments, on the structural integrity of ice keels, and on the forces which are pushing the scouring ice body. The authors should be highly commended for their contribution. ... Clearly the ice scouring problem requires further studies, and I urge that a test area be selected for detailed surveys (with sidelooking sonar, core studies, etc.) over a period of years. ... These bottom studies should be carried out along with oceanographic, meteorological, and glaciological studies from the same area to verify the scouring model developed by the authors. ... (Au)

NEAVE, K.G.

181

Hyperbolic reflections on Beaufort Sea seismic records / Neave, K.G. Sellmann, P.V. Delaney, A.J.

Hanover, New Hampshire : Cold Regions Research and Engineering Laboratory, 1981.

iv, 16p. : figures ; 28cm.

(CRREL report, 81- 2)

Appendix.

References.

ASTIS document number 66133.

ACU, NFSMO

Many hyperbolic reflections have been observed on marine seismic records obtained during oil exploration in the Beaufort Sea, and on USGS seismic sub-bottom profiles from the Prudhoe Bay vicinity. ... The velocities observed were approximately the velocity of sound in water. The hyperbolic signals also showed dispersion properties similar to acoustic normal modes in shallow water. These observations indicate that the signals responsible for the hyperbolic reflections propagate as normal modes within the water layer, with very limited penetration of the seabed. Determinations of the dominant frequency of these signals indicate that the penetration into the seabed has a characteristic attenuation depth (skin depth) of about 1.5m for the sub-bottom profiles and 12m for the marine records. It therefore appears that some hyperbolic reflections may be generated by variations in materials that occur near the seabed. There is some evidence of linearity of the anomalies, possibly related to sediment-filled or open ice gouges, or other changes in material properties at shallow depths. (Au)

REARIC, D.M.

182

Character and implications of new ice gouges in eastern Harrison Bay, Beaufort Sea / Rearic, D.M.

(United States Geological Survey in Alaska : accomplishments during 1983 / Edited by S. Bartsch-Winkler and K.M. Reed. – Washington, D.C. : U.S.G.S., 1985. Circular – U.S. Geological Survey, 945, p. 99-100)

References.

ASTIS document number 164712.

ACU

... Two tracklines covering different seafloor morphologies in eastern Harrison Bay, 50 km west of Prudhoe Bay, were surveyed each summer between 1977 and 1982; one covers a relatively smooth, non-shoaled bottom, and the other covers an area containing three successive 2-3 m high shoals which trend east-west and are subparallel to the isobaths. Repetitive studies using side-scan sonar and fathometer indicate that ice gouging occurs over 3.5-3.9 percent of the sea floor each year and that the sea floor is gouged to an average depth of 18 cm. These values represent a slight change in the values reported by Reimnitz and others (1977) and Barnes and others (1978) of 2 percent and 20 cm. The differences are attributed to an increase in record quality from the previous studies, leading to better definition of the smaller gouge events. Measurements made over the 5 years of the study indicated that 75 percent of the gouges formed were less than 20 cm deep. One gouge more than 1 m deep was measured in each area during the study, both occurring in water depths greater than 10 m; gouges this deep account for only 0.1 percent of all gouges formed in these water depths. When the present results are combined with those of the previous studies, the data suggest that in water 10-18 m deep, the recurrence interval for gouges more than 1 m deep is 6+ years. By extrapolation, an area 250 m wide lying between 10 and 16 m water depth would be gouged 12,500 times in 100 years, and of these gouges, 17 would be more than 1 m deep. Yearly sediment disruption volume in a swath 250 m wide was used to compare shoaled and non-shoaled tracklines. ... (Au)

183

Ice gouge data sets from the Alaskan Beaufort Sea : magnetic tape and documentation for computer assisted analyses and correlation / Rearic, D.M. McHendrie, A.G.

(Open-file report – U.S. Geological Survey, 83- 706, [10] p., ill., map)

References.

Document not seen by ASTIS.

ASTIS document number 149896.

184

Ice-gouge data, Beaufort Sea, Alaska, 1972-1980 / Rearic, D.M. Barnes, P.W. Reimnitz, E.

[Menlo Park, Calif.] : U.S.G.S., 1981.

22 leaves : figures ; 28 cm.

(Open-file report – U.S. Geological Survey, 81- 950)

Bibliography: leaves 18-22.

ASTIS document number 136360.

NFSMO

The report outlines the field and office techniques, the terminology, and the results of an effort to enumerate ice gouge characteristics from existing sonographic and bathymetric records to form a comprehensive set of data on ice gouge characteristics of the Alaskan Beaufort Sea Shelf. (NFSMO)

185
Reassessment of ice gouging on the inner shelf of the Beaufort Sea, Alaska : a progress report / Rearic, D.M. Barnes, P.W.
(Environmental assessment of the Alaskan continental shelf : Annual reports of principal investigators for the year ending March 1980. Vol. IV : Hazards, p. 318-332, ill.)
References.
Attachment D of report entitled Geologic processes and hazards of the Beaufort Sea shelf and coastal regions, by P. Barnes and E. Reimnitz, 1980, reporting period April 1979-March 1980.
ASTIS document number 149195.
ACU

... Initial compilation of seabed and ice zonation data suggests a causal relationship exists between the character and intensity of ice gouging and the formation of pressure ridges on the inner Beaufort Sea shelf (Reimnitz and others, 1978). Data gathered since earlier studies suggests that ice gouge zonation can be better defined when compilations of the new data are included. Since 1972 we have been recording morphologic data on the ice-gouged continental shelf of the Beaufort Sea using side-scan sonar and bathymetric profiling. Seven years of data from the R/V Loon, R/V Karluk, and USOG Ice Breaker Glacier have produced many records of the inner and central shelf ice-gouge features. In January, 1979 we began a correlation and analysis of these records to redefine and reassess ice gouging in the north slope lease area. The primary objective has been to assemble quantitative data on ice-gouge characteristics and processes and to analyze this data for characteristic trends in ice-gouge processes. We present here a summary of the work that has been completed, some preliminary results, and projected plans. (Au)

REIMNITZ, E.

186
Arctic continental shelf morphology related to sea-ice zonation, Beaufort Sea, Alaska / Reimnitz, E. Toimil, L.J. Barnes, P.W.
(Marine geology, v. 28, no. 3/4, Oct. 1978, p. 179-210, ill. (1 folded))
References.
ASTIS document number 148865.
ACU

Landsat-1 and NOAA satellite imagery for the winter 1972-1973, and a variety of ice and sea-floor data were used to study sea-ice zonation and dynamics and their relation to bottom morphology and geology on the Beaufort Sea continental shelf of arctic Alaska. In early winter the location of the boundary between undeformed fast ice and westward-drifting pack ice of the Pacific Gyre is controlled by major coastal promontories. Pronounced linear pressure- and shear-ridges, as well as hummock fields, form along this boundary and are stabilized by grounding, generally between the 10- and 20-m isobaths. Slippage along this boundary occurs intermittently at or seaward of the grounded ridges, forming new grounded ridges in a widening zone, the stamukhi zone, which by late winter extends out to the 40-m isobath. Between intermittent events along the stamukhi zone, pack-ice drift and slippage is continuous along the shelf edge, at average rates of 3 – 10 km/day. Whether slippage occurs along the stamukhi zone or along the shelf edge, it is restricted to a zone several hundred meters wide, and ice seaward of the slip face moves at uniform rates without discernible drag effects. A causal relationship is seen between the spatial distribution of major ice-ridge systems and offshore shoals downdrift of major coastal promontories. The shoals appear to have migrated shoreward under the influence of ice up to 400 m in the last 25 years. The sea floor seaward of these shoals within the stamukhi zone shows high ice-gouge density, large incision depths, and a high degree of disruption of internal sedimentary structures. ... (Au)

187
Arctic continental shelf processes and morphology related to sea ice zonation, Beaufort Sea, Alaska / Reimnitz, E. Toimil, L.J. Barnes, P.W.
(AIDJEX bulletin, no. 36, May 1977, p. 15-65, ill., maps, photos.)
References.
ASTIS document number 47635.
ACU, NFSMO

Landsat-1 and NOAA satellite images for winter 1972-73 and ice seafloor data from several sources were used to study sea ice zonation and dynamics and their relation to bottom morphology and geology on the Beaufort Sea continental shelf of arctic Alaska. ... A casual relation is seen between the spatial distribution of major ice ridge systems and offshore shoals downdrift of major coastal promontories. ... There is evidence that anomalies in the overall arctic shelf profile are related to sea ice zonation, ice dynamics, and bottom processes. The ice zonation proposed – (a) bottom-fast ice, (b) floating fast ice, (c) stamukhi, and (d) seasonal pack ice – emphasizes ice interaction with the shelf surface and differs from previous zonation. Certain aspects of the results reported here are directly applicable to planned offshore developments in the Prudhoe Bay oil field. ... (Au)

188
Bottom features and processes related to drifting ice on the arctic shelf, Alaska / Reimnitz, E. Barnes, P.W. Alpha, T.R.
[Reston, Va. : U.S.G.S.], 1973.
1 sheet (folded) ; 112 x 86 cm.
(Miscellaneous field studies – U.S. Geological Survey, map MF- 532)
ASTIS document number 150690.
NFSMO

... It has become apparent that drifting ice is an important agent influencing the sedimentary structures and the sediment transport regime of Arctic shelves today and has been in the past. The diagrams presented here, with supporting evidence in the form of side-scan sonar records, and ice and bottom photos, demonstrate the most prevalent processes and types of bottom features observed on the continental shelf off northern Alaska. As the map shows, most of the shelf is affected by these processes today. The map shows ice-gouge density, and side scan sonar records with ice scours represented graphically are shown. (Au)

189
Depositional complexities in sea-ice environment of arctic shelves : example from Harrison Bay, Alaska / Reimnitz, E. Barnes, P.W.
(AAPG bulletin, v. 65, no. 5, May 1981, p. 978)
Abstract only.
ASTIS document number 149110.
ACU

Harrison Bay, a gently sloping, shallow embayment on the continental shelf of northern Alaska near the Colville delta, is ice covered 9 months of the year. The 3 to 5-m Holocene marine sediment blanketing the shelf commonly is gouged into jagged relief forms by ice, and periodically winnowed or shaped into 1-m high sand waves by waves and currents. Yearly fathometer and sidescan sonar surveys, many diving observations, and numerous cores collected along a 14-km long test line show a complex sedimentation pattern, apparently typical for much of the shallow circum-Arctic shelves. Ice-plowed sediments piled 20 to 80 cm above the shelf surface form a rough topography composed of soft cohesive mud. Locally the excavation products border gouges as continuous ridges; elsewhere they form isolated massive extrusion mounds with fissured crests. In some years a transient layer, as thick as 50 cm of flocculated silt and clay, blankets the surface, and only the crests of excavation products protrude. This transient

layer remains trapped only in narrow gouges, where as much as 60 cm of mud may accumulate yearly. Original gouge floors commonly consist of smoothly striated compacted mud, as distinguished from the soft fill. The sea floor between recent gouges has subdued relief, is very firm, and is characterized by sediment-texture variations from clean sand to silty clay over distances of 10 m or less .... The addition of gouge fill – sinuous, crisscrossing shoestring-like deposits of mud – appears to be the primary accretional process on shallow arctic shelves. (Au)

190

Geological evidence for 60 meter deep pressure-ridge keels in the Arctic Ocean / Reimnitz, E. Barnes, P.W. Phillips, R.L.

18 leaves : ill. ; 28 cm.

References.

Paper presented at IAHR Symposium 1984, Hamburg.

ASTIS document number 159913.

... Several lines of evidence suggest, however, that these deep-water gouges are modern features. Continuous, 380-day current records at 60 m depth near the shelf edge show that the environment is dynamic, with long-period current pulses up to 70 cm/sec capable of transporting medium to coarse sand as bedload and fine sand in intermittent suspension. A rich benthic fauna also reworks the upper 20 cm of sediment and provides sedimentary particles for current transport. The water depth along the seaward limit of the ice gouged shelf surface, if of relict origin, should shoal eastward in the region where isostatic rebound after deglaciation occurred. The deep limit of gouges instead varies irregularly between 49 and 64 m water depth along the shelf edge, as one would expect from an interaction of sporadic ice reworking to 64 m depth during the last 200 years and continuous reworking by currents and organisms. For offshore petroleum development, this interpretation has the important implications that bottom-founded structures at >47 m water depth may not be safe from ice impact. ... Attempts to interpret the history of deep keels from the geologic record therefore are presently restricted to studies of surficial gouges and are limited by our understanding of processes that erase shelf relief. This report is an attempt to interpret the age of deep-water gouges seen on the Alaskan Arctic shelf in light of these processes. (Au)

191

Ice gouge recurrence and rates of sediment reworking, Beaufort Sea, Alaska / Reimnitz, E. Barnes, P.W. Toimil, L.J. Melchior, J.

(Geology, v. 5, no. 7, July 1977, p. 405-408, ill.)

References.

ASTIS document number 148873.

ACU

Certain shelf areas have been resurveyed with side-scanning sonar, fathometer, and accurate navigational control for studies of the rate of ice gouging and sediment reworking by ice in the Beaufort Sea, Alaska. Analysis of one such survey, initially done in 1973 and rerun in 1975 along 14 km of trackline in 6 to 14 m of water depth, suggests complete reworking of the bottom to an average depth of 20 cm in 50 yr. Only 3 cm of sediment accumulated during this time interval, making the rate of reworking much higher than rate of deposition. (Au)

192

Influence of grounding ice on the arctic shelf of Alaska / Reimnitz, E. Barnes, P.W. Forgatsch, T. Rodeick, C.

(Marine geology, v. 13, no. 5, 1972, p. 323-334)

References.

ASTIS document number 148695.

ACU

Alaska's Beaufort Sea shelf is characterized by small-scale relief with an average amplitude of 1-2 m and wavelength of 50-100 m. Diving observations confirm that much of the bottom roughness reflects the action of grounded ice. Except for areas in the shadow of islands, bars, and offshore bathymetric highs, the entire shelf surface from the beach to at least the 75-m contour is now or has been modified by ice gouging. Ice contact with the bottom is more common, and rates of sedimentation higher on the inner shelf than on the outer shelf; the density of gouge features is about equal in both areas. Therefore, the chances are that an area of gouging on the inner shelf contains younger gouges than a similar area on the outer shelf. When ice grounds, it becomes an important agent in the sedimentary and morphologic environment of the Arctic shelf, directly by deforming bottom deposits and secondarily by affecting the current regime near the sediment/ice contact. While bulldozing action and rafting do not seem to contribute significantly to the direct transport of sediment, re-suspension of bottom material during bulldozing, which makes sediment available for transport, may be significant. (Au)

193

Influence of sea ice on sedimentary processes off northern Alaska / Reimnitz, E. Barnes, P.W.

(ERTS-1 : a new window on our planet / Edited by R.S. Williams and W.D. Carter. – Professional paper – U.S. Geological Survey, 929, p. 360-362, ill.)

References.

ASTIS document number 160970.

The ice cover of the Beaufort Sea has a critical influence on the sedimentary environment of the Continental Shelf north of Alaska. ... Comprehension of this type of environment can be directly applied during future offshore development of the Prudhoe Bay oilfield. ... an ERTS MSS color composite image [was] taken on June 14, 1973, about 2 weeks after the river flooding of the fast ice (sea ice anchored to the coast or bottom) but 3 weeks before the breakup of the ice. ... Surveys of the sea-floor bottom made after the sea-ice breakup show sea-floor gouges produced by ice in this zone of major pressure ridges and a remarkably smooth bottom in the area landward of the shear line .... The keels of pressure ridges in the shear zone, where they are in contact with the bottom, may affect water circulation on the Continental Shelf. Obviously the shear zone will be the most hazardous region for any offshore construction. (Au)

194

Marine geological investigations in the Beaufort Sea in 1981 and preliminary interpretations for regions from the Canning River to the Canadian border / Reimnitz, E. Barnes, P.W. Rearic, D.M. Minkler, P.W. Kempema, E.W. Reiss, T.E.

Menlo Park, Calif. : U.S.G.S., 1982.

[60] leaves ; 28 cm.

(Open-file report – U.S. Geological Survey, 82- 974)

Appendix.

References.

ASTIS document number 136395.

NFSMO

The paper describes the marine geology of the coastal area in the Alaskan Beaufort Sea from the Canning River to the Canadian Border. Data analysed includes sediment samples, seismic and ice gouging records. (NFSMO)

195

Sea ice as a geologic agent on the Beaufort Sea shelf of Alaska / Reimnitz, E. Barnes, P.W.

(The coast and shelf of the Beaufort Sea / Edited by J.C. Reed and J.E. Sater. – Arlington, Va. : Arctic Institute of North America, 1974, p. 301-353, figures)

References.

Partial contents: Diving observation diagram of Reindeer Island / T.R. Alpha, E. Reimnitz, C. Rodeick, and A.D. Oesterle.
ASTIS document number 148059.
ACU

A study of the processes and effects of sea ice as a geologic agent on the Beaufort Sea shelf north of Alaska has been conducted during 4 years of data collecting under both summer and winter conditions. A variety of techniques was used, including bathymetric, high-resolution seismic, and sidescan sonar surveys; surface and diving observations; bottom photography; sediment sampling; oceanographic measurements; and remote sensing. During the winter season, which lasts about 9 months, the ice cover is nearly complete. During the summer season, drifting ice occurs in concentrations up to 100 percent. A dominant movement of ice from east to west is evident at all seasons. ... (Au)

196
Stamukhi shoals of the Arctic – some observations from the Beaufort Sea / Reimnitz, E. Maurer, D.K.
(Environmental assessment of the Alaskan continental shelf : Annual reports of principal investigators for the year ending March 1978. Vol. XI : Hazards, p. 277-299, figures)
(Open-file report – U.S. Geological Survey, 78- 666, [17] p., ill.)
This is attachment D to the report entitled: Marine environmental problems in the ice covered Beaufort Sea shelf and coastal regions / P. Barnes and E. Reimnitz.
References.
ASTIS document number 148997.
ACU

A number of linear shoals, standing out as pronounced topographic anomalies on the surface of the Arctic shelf, have been studied in the Prudhoe Bay area. ... Large chunks of grounded ice commonly have been seen on the linear shoals of the inner shelf forming barriers parallel to shore .... They speculate that the shoals may have formed in response to ice-bottom interaction within the stamukhi zone. Based on the observations that the shoals migrate rather slowly, retain their shapes over periods of 25 years, and control the location of the outer edge of the floating fast ice zone providing shelter for the inner shelf and coast, Reimnitz, et al. (1977b) surmised that similar artificial structures might be used to modify the ice environment on the arctic shelf. ... An understanding of the nature and behavior of the shoals, and of their interaction with the ice regime, will be fundamental to an understanding of ice zonation on the Beaufort Sea shelf. ... (Au)

197
Stamukhi zone processes : implications for developing the Arctic offshore area / Reimnitz, E. Toimil, L.J. Barnes, P.W.
(Journal of petroleum technology, v. 30, no. 7, July 1978, p. 982-986, figures, photos.)
(OTC paper, 2945)
(Paper – Society of Petroleum Engineers of AIME, SPE 6945)
Paper presented at the Ninth Annual Offshore Technology Conference, Houston, May 2-5, 1977.
References.
ASTIS document number 54860.
ACU, NFSMO

Offshore islands and shoals in the Beaufort Sea interact with the westward pack-ice drift, causing the formation of major grounded-ridge systems of the Stamukhi zone. These systems resist the forces of pack ice and protect the inner shelf. Fully exposed islands and shoals show little modification for the past 25 years, suggesting that similar artificial structures, properly placed, should also survive and might modify sea-ice zonation. (Au)

198
A word of caution on the age of deep water ice gouges in the Beaufort Sea / Reimnitz, E. Barnes, P.W. Toimil, L.J. Maurer, D.K.
(Environmental assessment of the Alaskan continental shelf : Quarterly reports of principal investigators April-June 1977. Vol. II, p. 452-455, ill.)
References.
This is attachment A of the quarterly report entitled: Geologic processes and hazards of the Beaufort Sea shelf and coastal regions, by P. Barnes, E. Reimnitz and D. Drake.
ASTIS document number 149292.
ACU

... In the annual report, one of us (Toimil) gave a brief discussion on ice gouging in the Chukchi Sea. In that sea, ice gouges occur in much more patchy pattern than in the Beaufort Sea, often being found associated with hydraulic bedforms due to strong currents. This is especially true for deep-water (30 to 60 m) regions, suggesting both ice and water were active geologic agents. If there were no active processes besides the ice reworking the sea floor, the 3000-5000 years since sealevel has been near its present position should have been sufficient to establish an equilibrium between process and result. In which case, numbers of gouges being added should equal those eliminated by sediment infilling and reworking by benthic organisms. Therefore, for a particular area and environment, the distribution and number of gouges should be rather uniform. We feel that the patchy gouge pattern together with the presence of ripple marks or sand waves indicates that even at 50 m depth in the Chukchi Sea gouging and reworking by currents is an ongoing process, while statistical calculations on the depth distribution of ice keels suggest these gouges to be hundreds of years old. ... (Au)

SANGREY, D.A.

199
Geotechnical engineering problems of the Arctic Ocean bottom / Sangrey, D.A.
(Proceedings of the Twelfth Annual Engineering Geology and Soils Engineering Symposium / Edited by I.F. Erickson. – [Idaho] : Idaho Transportation Dept., 1974, p. 149-161, figures)
References.
ASTIS document number 149608.
NFSMO

... In this paper, a general description of the soils and their engineering properties is developed from the standpoint of the geology of the area and limited sampling. ... When trying to define and evaluate the scope of geotechnical engineering problems in the marine arctic, it is important to appreciate the almost total lack of information about the soils of this area. Near shore, particularly around Prudhoe Bay and the MacKenzie River delta, some boring and sampling has been done; however, most of this information is proprietary. The other main sources of geotechnical information about the Arctic Ocean are research studies done by the United States and Canadian Governments. In spite of this limited information, a general description of the soils and geotechnical engineering problems is possible, particularly if attention is focused on several situations unique to the Arctic. Focusing on these, this paper is presented in three sections – the distribution and characteristics of sea bottom sediments, the occurrence of permafrost in these sediments and ice scour of the sea bottom. (Au)

SKINNER, B.C.

200
Investigation of ice island scouring of the northern continental shelf of Alaska / Skinner, B.C.
New London, Conn. : U.S. Coast Guard Academy, 1971.
iii, 24 p. : ill. ; 28 cm.
(Report – U.S. Coast Guard Academy, RDCGA- 23)
References.
ASTIS document number 149985.
NFSMO

Ice Islands (Tabular Ice Bergs) which break off the Ice Shelf of Ellesmere Island have been known to ground on the northern coast of Alaska. This survey was conducted to investigate the bottom deformation (scour) occurring when such islands ground. The detailed survey utilized Side Scanning Sonar, Sub Bottom Profiling, and detailed bathymetry from a Coast Guard Icebreaker in water depths of 50' – 200' on the northern continental shelf of Alaska between 29 July and 3 August 1971. Approximately 120 miles of detailed tracks between Harrison Bay and Barter Island were surveyed. The Side Scan Sonar records complemented by the bathymetry and sub-bottom records revealed areas of extensive bottom scouring, believed to be due to grounded ice features; either ice islands or deep pressure ridges. (Au)

STRINGER, W.J.

201
Morphology of the Beaufort Sea shorefast ice / Stringer, W.J.
(The coast and shelf of the Beaufort Sea / Edited by J.C. Reed and J.E. Sater. – Arlington, Va. : Arctic Institute of North America, 1974, p. 165-172, figures)
References.
ASTIS document number 148555.
ACU

The results of a preliminary morphological analysis of ERTS-1 Beaufort Sea shorefast ice are presented. The sheet of ice, stationary with respect to the shore in the vicinity of Harrison Bay, has been delineated for successive satellite coverage dates. It has been found that while the boundary of grounded shorefast ice can be generally related to the location of the 18-m contour, there are significant deviations from this generalization. In outer Harrison Bay, grounded ice was located in 27-m-deep water, resulting in a large seaward bulge of shorefast ice. To the east of Harrison Bay there is evidence that grounded ice occurs within the 18-m contour. The spring 1973 data showed two regimes of ice motion in the Beaufort Sea: one involving south and west motions of ice spiraling clockwise off the gyre past Point Barrow toward Bering Strait, and the other involving ice motions parallel to the north coast of Alaska from the extreme western edge of Harrison Bay to the mouth of the Mackenzie River. Off Harrison Bay between these two regimes of ice motion, there was a large sheet of stationary floating ice attached to grounded pressure ridges near the shore. Portions of this attached ice sheet remained in place until late May. (Au)

WEEKS, W.F.

202
Statistical aspects of ice gouging on the Alaskan Shelf of the Beaufort Sea / Weeks, W.F. Barnes, P.W. Rearic, D.M. Reimnitz, E.
Hanover, N.H. : Cold Regions Research and Engineering Laboratory, 1983.
v, 34 p. : figures, 1 map (folded), tables ; 28 cm.
(CRREL report, 83- 21)
Appendix.
References.
ASTIS document number 130486.
ACU, NFSMO

The statistical characteristics of ice-produced gouges in the sea floor along a 190-km stretch of the Alaskan coast of the Beaufort Sea between Smith Bay and Camden Bay are studied, based on 1500 km of precision fathometry and side-looking sonar records that were obtained between 1972 and 1979 in water depths to 38 m. The probability density function of the gouge depths into the sediment is represented by a simple negative exponential over four decades of gouge frequency. ... The deepest gouge observed was 3.6 m, from a sample of 20,354 gouges that have depths greater than or equal to 0.2 m. The dominant gouge orientations are usually unimodal and reasonably clustered, with the most frequent alignments roughly parallel to the general trend of the coastline. ... As a Poisson distribution gives a reasonable fit to the N1 [mean number of gouges] distributions for all water depths, it is suggested that gouging can be taken as approximating a Poisson process in both space and time. The distributions of the largest values per kilometer of gouge depths, gouge widths, and the heights of the lateral embankments of sediments plowed from the gouges are also investigated. Limited data on gouging rates give an average of 5 gouges per kilometer per year. Examples are given of the application of the data set to hypothetical design problems associated with the production of oil from areas in the Alaskan portion of the Beaufort Sea. (Au)

203
Statistics of ice gouging on the Alaskan shelf of the Beaufort Sea / Weeks, W.F. Barnes, P.W. Rearic, D.M. Reimnitz, E.
([Papers] – American Geophysical Union, Fall Meeting, San Francisco, California, 7-11 December, 1981. EOS, v. 62, no. 45, Nov. 10, 1981, p. 902)
Abstract only.
ASTIS document number 85871.
ACU

The statistical characteristics of the ice produced gouges that occur on the sea floor along a 190 km stretch of the Alaskan coast of the Beaufort Sea between Smith Bay and Camden Bay are studied. The data set is based on 1500 km of precision fathometry and side-looking sonar records that were obtained between 1972 and 1979 in water depths to 38 m. The probability density function of the gouge depths into the sediment can be represented by a simple negative exponential over 4 decades of frequency. ... The mean number of gouges per kilometer of sample track varied from 12 for the lagoons and sounds to 139 offshore from Lonely. The form of the distribution was exponential for the lagoons and sounds, positively skewed for the near-shore off the barrier islands and near-normal for deeper water. The spacings between gouges also show an exponential distribution and are independent. ... A study was also completed of the distributions of the largest values per kilometer of gouge depths, gouge widths and the heights of the lateral embankments of sediments plowed from the gouges. Limited data on gouging rates give an average value of 5 gouges per kilometer per year. Pipeline burial depths that would on the average allow 1 encounter with an ice keel every 100 years are 1.0 m for shallow water and 3.2 m for deep (25-35) water. (Au)

WELLER, G.

204
The role of sea ice in the arctic coastal environment / Weller, G.
(Science in Alaska 1976 : proceedings of the Twenty-seventh Alaska Science Conference, Fairbanks, Alaska, August 4-7, 1976. – Fairbanks, Alaska : Alaska Division, American Association for the Advancement of Science, 1976, vol. II, p. 133-149, figures, tables)
References.
Results drawn from studies presented in synthesis report of

OCSEAP 1977.
ASTIS document number 149330.
ACU

... Sea ice in the coastal environment thus affects a multitude of biological and physical processes and requires close scrutiny and study in any environmental assessment program. The BLM/NOAA-sponsored Outer Continental Shelf Environmental Assessment Program (OCSEAP) recognizes this clearly and a major portion of its efforts in the Arctic is directed towards the study of sea ice. Some results and conclusions of these studies are presented here. They are, for the most part, taken from a synthesis report of OCSEAP and other investigators (OCSEAP, 1977). (Au)

BERING AND CHUKCHI SEAS

DOBSON, B.M.

205
Overview of soil and engineering geologic conditions in the Beaufort, Chukchi, and Bering seas / Dobson, B.M. Wickham, J.T.
(Civil engineering in the arctic offshore : proceedings of the Conference Arctic '85 / Edited by F.L. Bennett and J.L. Machemehl. – New York : American Society of Civil Engineers, 1985, p. 812-819, maps)
References.
ASTIS document number 159611.

This paper discusses general soil and engineering geologic conditions that are likely to affect exploratory drilling and development activities in six Alaska OCS lease sale areas. ... Important soil and geologic conditions affecting development activities in the Beaufort Shelf and Chukchi areas include 1) weak soils, 2) submarine permafrost, 3) effects of ice gouging on seafloor topography and soil conditions, and 4) the availability of granular borrow resources. Important conditions affecting Norton Basin include the abundance of silts and the potential for seafloor erosion and ice gouging. A primary consideration affecting development of the Navarin Basin area is the possible lack of competent soils. Weak soils may, in some areas, preclude the use of massive gravity structures proposed by some for use in Navarin Basin. Seismicity is one of the most important conditions affecting the St. George and North Aleutian Basin areas. Both areas are bounded on the south by one of the most seismically active areas in the world. (Au)

HESS, G.R.

206
Summary of 1980 cruise results, geohazard program, Norton Basin-Chirikov Basin, and summary of surface sediment characteristics, Norton Basin / Hess, G.R. Larsen, B.R. Nelson, C.H. Mango, P. Klingman, D.
(Environmental assessment of the Alaskan continental shelf : Annual reports of principal investigators for the year ending March 1981. Vol. VII : Hazards, p. 439-497, figures)
Published as the appendix to the annual report for RU 429.
Appendix.
References.
Preliminary report.
ASTIS document number 148148.
ACU

More than 2300 km of high-resolution and deep-penetration seismic reflection profiling records were collected in Norton and Chirikov Basins. In addition, over 2400 km of side-scan sonar records were collected along these same tracklines. These data, collected in 1980, combined with data collected in previous years, provide the data base for evaluation of potential hazards in the northern Bering Sea. ... This report in part presents a preliminary summary of the data collected in Chirikov Basin and in part augments reports previously prepared on Norton Basin. Potential geologic hazards discussed include gas-charged sediment, ice-gouging, areas of mobile bedforms, and zones of intense current scour. ... (Au)

HOOD, D.W.

207
The eastern Bering Sea shelf : oceanography and resources / Hood, D.W. [Editor]. Calder, J.A. [Editor]. United States. Office of Marine Pollution Assessment [Sponsor]. United States. Bureau of Land Management [Sponsor].
[Washington : Office of Marine Pollution Assessment, National Oceanic and Atmospheric Administration; Seattle : University of Washington Press [distributor], 1981].
2v. : ill., figures, tables ; 29cm.
References.
ASTIS document number 75809.
ACU, NFSMO

This publication consists of 73 chapters divided into 13 disciplinary and interdisciplinary sections to present what is now known about the natural science of the eastern Bering Sea continental shelf. The section headings are: physical oceanography, ice distribution and dynamics, geology and geophysics, chemical oceanography, fisheries oceanography, marine birds, interaction of ice and biota, mammals, microbiology, plankton ecology, fisheries biology, benthic biology, and, interaction of sedimentary and water-column regimes. (ASTIS)

KOVACS, A.

208
Dynamics of near-shore ice / Kovacs, A. Weeks, W.F.
(Environmental assessment of the Alaskan continental shelf : Annual reports of principal investigators for the year ending March 1981. Vol. VII : Hazards, p. 125-135)
ASTIS document number 136638.
NFSMO

R.U. [Research Unit] #88 investigates sea ice and ice induced gouges in the sea floor along the coasts of the Beaufort, Chukchi, and Bering Seas. New results reported during FY81 include further documentation of coastal ice pileup and over-ride events, studies of the block size distributions in first-year pressure ridges, investigations of additional laser profilometer observations on pressure ridges, radar studies of near-shore lakes on the North Slope that may serve as year-round sources of fresh water, and the preparation of a review paper on the physical environment of arctic Alaska as it relates to petroleum exploration and production. (Au)

209
Islands of grounded sea ice / Kovacs, A. Gow, A.J. Dehn, W.F.
Hanover, N.H. : U.S. Army. Cold Regions Research and Engineering Laboratory, 1976.
v, 24 p. : ill. ; 28 cm.
(CRREL report, 76- 4)
References.
ASTIS document number 159832.
ACU

Large areas of grounded sea ice have been reported by early arctic

explorers and more recently by the U.S. Coast Guard. The ESSA, ERTS, NOAA and DMSP satellites now provide multispectral imagery with sufficiently high resolution to allow detailed sequential observations to be made of the movement and spatial extent of arctic sea ice. This report discusses the location, formation and decay of five large (greater than 30 sq km) islands of grounded sea ice in the southern Chukchi Sea as oberved for an extended period of time using satellite imagery. Measurements of the bathymetry around one grounded sea ice feature are presented along with observations made and photos taken from the ice surface. The potential use of these sea ice islands as research stations is also discussed. (Au)

210

Sea ice rubble formation, in the Bering Sea and Norton Sound, Alaska / Kovacs, A.

Hanover, N.H. : Cold Regions Research and Engineering Laboratory, 1981.

iii, 23 p. : ill., photos. ; 28 cm.

(Special report - U.S. Army. CRREL, 81- 34)

References.

ASTIS document number 88927.

ACU, NFSMO

The occurrence of large, compact, grounded pressure ridge formations up to 15 m high in the coastal waters of Norton Sound and the Bering Sea is discussed. These formations periodically float free and drift about, gouging the seabed. Their mass makes them a severe threat to both floating and bottom-founded structures in these waters. (Au)

LARSEN, M.C.

211

Geologic implications and potential hazards of scour depressions on Bering shelf, Alaska / Larsen, M.C. Nelson, C.H. Thor, D.R.

(Environmental geology, v. 3, 1979, p. 39-47, ill.)

References.

ASTIS document number 150010.

NFSMO

Flat-bottomed depression 50-150 m in diameter and 60-80 cm deep occur in the floor of Norton Sound, Bering Sea. These large erosional bedforms and associated current ripples are found in areas where sediment grain size is 0.063-0.044 mm (4-4.5), speeds of bottom currents are greatest (20-30 cm/s mean speeds under nonstorm conditions, 70 cm/s during typical storms), circulation of water is constricted by major topographic shoals (kilometers in scale), and small-scale topographic disruptions, such as ice gouges, occur locally on slopes of shoals. These local obstructions on shoals appear to disrupt currents, causing separation of flow and generating eddies that produce large-scale scour. Offshore artificial structures also may disrupt bottom currents in these same areas and have the potential to generate turbulence and induce extensive scour in the area of disrupted flow. The size and character of natural scour depressions in areas of ice gouging suggest that large-scale regions of scour may develop from enlargement of local scour sites around pilings, platforms, or pipelines. Consequently, loss of substrate support for pipelines and gravity structures is possible during frequent autumn storms. (Au)

NELSON, C.H.

212

Faulting, sediment instability, erosion, and deposition hazards of the Norton Basin seafloor / Nelson, C.H.

(Environmental assessment of the Alaskan continental shelf : Annual reports of principal investigators for the year ending March 1978. Vol. XII : Hazards, p. 189-195, ill.)

References.

Summary of report by Hans Nelson of same title.

ASTIS document number 149209.

ACU

... In conclusion, present knowledge suggests that the offshore region surrounding the Yukon Delta and eastern Bering Strait areas have the combination of the most severe geologic hazards .... Faulting and current scour are most intense near Bering Strait, but similar less severe conditions exist near Anadyr and Shpanberg Strait. Ice gouge, bottom-current scour and storm surge activity are all intense over a wide area around the shallow prodelta area. Apparent gas cratering occurs throughout north central Norton Sound. Dynamics of mobile bedforms, scour depressions, storm surge deposits, and gas craters must be ascertained before extent of these hazards can be fully assessed. Our confirmation of a thermogenic hydrocarbon seep 40 km south of Nome is likely to cause a quantum jump in interest and development in Norton Basin. This points to the urgent need for a continued strong program of environmental research in this outer continental shelf area. (Au)

213

Ice gouging and other environmental geologic problems of northern Bering Sea / Nelson, C.H.

(The United States Geological Survey in Alaska : accomplishments during 1977 / Edited by K.M. Blean. - Washington, D.C. : U.S.G.S., 1977. Circular - U.S. Geological Survey, 751-B, p. B98)

ASTIS document number 149837.

ACU

... The following preliminary results have been noted from the Sept.-Oct. 1976 cruise to Norton Sound. Ice gouging has been found in all areas less than 20 m deep, but intensity of gouging is highly variable. Gouging is very intense where southward moving bergs first intersect the 18- to 20-m isobaths trending across the mouth of Norton Sound. Intense gouging also occurs around the shallow margin of the modern Yukon subdelta, where the outer edge of shorefast ice coincides with the counter-clockwise current gyre entering the southern side of Norton Sound. The state of preservation of ice gouges delimits regions of nondeposition and sites of rapid deposition, particularly around the modern Yukon subdelta. In some areas, both new and old gouges are well preserved, indicating nondeposition during recent time. In others, recent gouges are truncated by superposed sediment smoothing, showing recent rapid deposition. Fresh ice gouges in the nearshore parts of the sand wave fields near Pt. Clarence suggest that movement of the bedforms is intermittent and may be due mainly to periodic forcing by storm-related barotropic currents. ... (Au)

O'CLAIR, C.E.

214

Disturbance and diversity in a boreal marine community : the role of intertidal scouring by sea ice / O'Clair, C.E.

(The eastern Bering Sea shelf : oceanography and resources / Edited by D.W. Hood and J.A. Calder. - Washington, D.C. : Office of Marine Pollution Assessment, NOAA [publisher] ; Seattle, Wash. : Univ. of Washington Pr. [distributor], 1981, v. 2, p.1105-1130, ill.)

References.

ASTIS document number 149080.

ACU

The intertidal region of most shores in the eastern Bering Sea north of 56 degrees N is subject to scouring by sea ice in late winter and spring of most years. Using data collected with systematically sampled belt transects and arrays of randomly placed quadrats, intertidal communities on rocky shores in the Pribilof Islands, frequently scoured by ice, were compared with intertidal communities on rocky shores of islands in the southeastern Bering

Sea [Amak and Akun islands] that are rarely scoured by ice. Species richness (number of species in a community) tended to increase with time from the last scouring episode. ... Intertidal organisms find refuge from ice scour primarily in crevices in bedrock and spaces beneath and between boulders. The effect of perturbations on the intertidal community structure will depend largely upon the degree to which the refuge is altered in such a way as to exclude marine organisms. (Au)

OLSEN, H.W.

215
Geotechnical characteristics of bottom sediment in the northern Bering Sea / Olsen, H.W.
(Environmental assessment of the Alaskan continental shelf : Annual reports of principal investigators for the year ending March 1981. Vol. VIII : Hazards and Data management, p. 79-244, ill., figures, tables)
References.
ASTIS document number 136620.
NFSMO

This report presents the results of the reconnaissance geotechnical studies in the Northern Bering Sea and describes the work in progress on cores taken from gas-charged areas in central Norton Sound. (NFSMO)

REX, R.W.

216
Microrelief produced by sea ice grounding in the Chukchi Sea near Barrow, Alaska / Rex, R.W.
(Arctic, v. 8, no. 3, 1955, p. 177-186, ill., figures)
(Contributions – California. University. Scripps Institution of Oceanography, La Jolla, n.s. no. 845)
References.
ASTIS document number 97772.
ACU

In the summer of 1954 the writer studied the microrelief off Barrow, Alaska, to determine the effective range of grounding of the polar pack ice. ... The microrelief studied here is not the same as that described by Carsola (1954) for deeper waters of the outer continental shelf to the northwest of the Barrow area. ... The traverses generally showed irregular depth fluctuations of 8 feet or less over distances of 25 to 50 feet, superimposed on a very gently sloping bottom. ... Microrelief is best developed between depths of 20 to 80 feet, where it is often 6 feet, and in one case reached 12 feet. Moderate microrelief usually extends to a depth of 100 feet ... Before accepting the hypothesis of pack ice grounding to explain the microrelief a number of alternate hypotheses were considered. These were: residual features of thawed permafrost, slump topography, current scouring, and sand waves. ... Pack ice grounding could cause the development of microrelief in a way that explains all the observed features. ... The sharpness of the microrelief and the scale are what one would expect if an average ice floe (4-6 feet thick and 20-100 feet in diameter) were up-ended by the pressure of other floes and driven into the bottom. The abrupt end of microrelief at 100 feet can be explained as the maximum depth at which pack ice grounds. ... It is suggested that, on the basis of the sharpness of the microrelief, grounding is most frequent between 20 and 80 feet. Grounding below this depth is probably less frequent and occurs with less bottom gouging than grounding within this depth range. ... Subsequent to the completion of this paper MacGinite (1955) has made a number of comments on sea ice grounding. His observations agree with those of this writer, but are of a more general nature. MacGinitie's winter observations are of special interest .... (Au)

SHAPIRO, L.H.

217
Mechanics of origin of pressure ridges, shear ridges and hummock fields in landfast ice / Shapiro, L.H. Harrison, W.D.
(Environmental assessment of the Alaskan continental shelf : Quarterly reports of principal investigators October-December 1976. Vol. III, p. 473-476, ill.)
Volume published 1977.
ASTIS document number 149179.
ACU

... As noted in the last quarterly report, a bathymetric survey was conducted within the field of view of the University of Alaska radar system at Barrow. A bathymetric map of the area has been prepared to aid in interpretation of ridging patterns. In addition, E. Riemnitz of the U.S. Geological Survey had the opportunity to examine the records acquired during the survey (which was done with a continuously recording fathometer), and pointed out that numerous gouges in the sea floor were visible on the data. Accordingly, we attempted to determine the distribution of gouges with water depth in the survey area. ... A total of 32.7 nautical miles of track was covered during the survey, and most legs were run at a high angle to the coast. Thus, the counts are probably biased toward gouges which are oriented parallel to the coast. ... During the past quarter we began a study of the vibration of ice sheets as an indicator of increasing stress. ... We are examining the role of wave motion of the sea ice-water system as an energy sink in the process of formation of pressure ridges. (Au)

THOR, D.R.

218
Environmental geologic studies of the northern Bering Sea / Thor, D.R. Nelson, C.H.
(The United States Geological Survey in Alaska : accomplishments during 1979 / Edited by N.R.D. Albert and T. Hudson. – [Washington, D.C.] : U.S.G.S., 1981, p. 121-122, ill.)
(Circular – U.S. Geological Survey, 823-B)
References.
ASTIS document number 156213.
ACU

Seismic studies conducted during 1976-1978 aboard the R/V Sea Sounder in the northern Bering Sea indicate a dynamic environment of moderate tectonism, sediment instability, and active erosional and depositional processes on the shallow sea floor, which create several potential geologic hazards. ... Processes active in the area include faulting, thermogenic gas seeps, sea-floor gas cratering, sediment liquefaction, ice gouging, scour-depression formation, storm-sand deposition, and large-scale bedform movement. Seeps of thermogenic hydrocarbon and carbon dioxide gas result from near-surface faulting south of Nome. ... Interaction between the processes ... may cause sediment instability problems. (Au)

219
Ice gouging on the subarctic Bering shelf / Thor, D.R. Nelson, C.H.
(Environmental assessment of the Alaskan continental shelf : Annual reports of principal investigators for the year ending March 1980. Vol. V : Hazards, p. 286-314, ill.)
References.
ASTIS document number 148946.
ACU

Ice impacting the sea floor gouges surficial sediment of the shallow, Bering epicontinental shelf, Alaska. Two types of ice gouge have been recognized: the single gouge, a single gouge furrow, and multiple gouges or raking, a wide zone of numerous, subparallel

gouge furrows. Single gouges, the most common type, are cut by single-keeled pieces of thick ice, whereas multiple gouges are formed by multikeeled, thick, pressure-ridge ice. Gouges occur in water depths of 30 m or less, but are most dense in water 10 to 20 m deep. Although some gouge incisions are as deep as 1 m, most gouges are 0.5 m or less. Ice gouges trend parallel to pack ice movement, which in turn generally moves parallel to isobaths and coastline configuration. Mean gouge trend in Norton Sound is west-east, in northeastern Bering Sea north-south. ... (Au)

220

Ice gouging on the subarctic Bering shelf / Thor, D.R. Nelson, C.H.

(The eastern Bering Sea shelf : oceanography and resources / Edited by D.W. Hood and J.A. Calder. – Washington, D.C. : Office of Marine Pollution Assessment, NOAA [publisher] ; Seattle, Wash. : Univ. of Washington Pr. [distributor], 1981, v. 1, p. 279-291, ill.)

References.

ASTIS document number 149098.

ACU

Ice striking the sea floor gouges surficial sediment of the shallow Bering epicontinental shelf of Alaska. Two types of ice gouge have been recognized: the single gouge, a single furrow, and multiple gouges or raking, a wide zone of numerous, subparallel furrows. Single gouges, the most common type, are cut by single-keeled pieces of thick ice, whereas multiple gouges are formed by multikeeled, thick, pressure-ridge ice. Gouges occur in water depths of 30 m or less, but are most dense in water 10 to 20 m deep. Although some gouge incisions are as deep as 1 m, most are 0.5 m or less. Ice gouges trend parallel to pack-ice movement, which in turn is generally parallel to isobaths and coastline configuration. Mean gouge trend in Norton Sound is west-east, in the northeastern Bering Sea north-south. ... (Au)

221

Potential hazards of ice gouging over the Norton Basin sea floor / Thor, D.R. Nelson, C.H. Williams, R.O.

(Environmental assessment of the Alaskan continental shelf : Annual reports of principal investigators for the year ending March 1978. Vol. XII : Hazards, p. 262-278, ill.)

Report is Part E of Faulting, sediment instability, erosion, and deposition hazards of the Norton Basin seafloor, by Hans Nelson.

ASTIS document number 149217.

ACU

The study of ice-related hazards is part of the geo-environmental evaluation of Norton Basin, Alaska, by the U.S. Geological Survey .... Extensive previous research has been accomplished on the affects of ice on shelf sediment in arctic regions such as the Beaufort Sea (Reed and Sater, 1974), but not in subarctic regions such as the Bering Sea. It is apparent from our studies that a variety of gouging features occurs throughout the northeastern Bering Sea, even though ice conditions are not as severe as in arctic regions. This study assesses the distribution, density, and intensity of ice gouging in the northeastern Bering Sea. Water depths in northeastern Bering Sea range from 30 – 50 m in Chirikov Basin to 10 – 25 m in Norton Sound .... Important geomorphologic features in the study area include the series of ridges and swales that parallel the shoreline off Port Clarence, and the extensive shoals (less than 10 m water depth to 30 km from shore) of the Yukon prodelta .... (Au)

222

Preliminary assessment of ice gouging in Norton Sound, Alaska / Thor, D.R. Nelson, C.H. Evans, J.E.

(Environmental assessment of the Alaskan continental shelf : Annual reports of principal investigators for the year ending March 1977. Vol. XVIII : Hazards, Data management, p. 93-110, ill.)

References.

ASTIS document number 149233.

ACU

... In our new studies it is apparent that a variety of gouging features occur throughout Norton Sound. Because of the potential effects on bottom facilities, it is important to map intensity and direction of the gouges and relate them to distribution and movement patterns of the different types of pack, pressure ridge, and shore fast ice. ... during October 1976, aboard R/V Sea Sounder, operated by the U.S. Geological Survey ... an E.G.I.G. side scan sonar was employed to study bottom features. [Gouge data were collected from the side scan records by counting the number, measuring the compass trend, and noting the time occurrence of all gouges seen on the record. This information was then normalized to 10 km intervals by (1) graphing the measured trends at 10 degree increments on a rose diagram and noting the average dominant and subordinate trend or trends, and (2) noting the number of gouges per 10 km interval. Each average trend per interval was then plotted on the map to facilitate defining areas of similar trend and distribution of gouge intensity.] (Au)

223

A summary of interacting, surficial geologic processes and potential geologic hazards in the Norton Basin, northern Bering Sea / Thor, D.R. Nelson, C.H.

(Journal of petroleum technology, v. 32, no. 3, Mar. 1980, p. 355-362, maps)

(Paper – Society of Petroleum Engineers of AIME, SPE 8615)

(OTC paper, 3400)

Paper presented at 11th Offshore Technology Conference, Houston, April 30-May 3, 1979.

References.

ASTIS document number 40037.

ACU, NFSMO

Future developers of the Bering Sea epicontinental shelf will have to cope with a variety of interacting or synergistic surficial geologic processes and potential hazards. These include moderate tectonism and resultant faulting, thermogenic gas seepage, seafloor gas cratering, sediment liquefaction, ice gouging, scour depression formation, storm-sand deposition, and large-scale bedform migration. (Au)

TOIMIL, L.J.

224

Ice gouge characteristics in the Alaskan Chukchi Sea / Toimil, L.J.

(Proceedings of the Specialty Conference Civil Engineering in the Oceans, IV. – New York : American Society of Civil Engineers, 1979, vol. II, p. 863-876, ill.)

References.

ASTIS document number 148881.

ACU

The Chukchi Sea continental shelf has long been considered to have a potential for major oil and gas accumulations. The presence of ice gouges on the seabed has direct implications for design of future offshore exploration and engineering structures placed on the shelf. Side-scan sonar and bathymetric records, obtained from the eastern Chukchi Sea, between water depths of 20 and 70 m, show that the furrow-like linear depressions produced by ice keels gouging the seabed features are not uniformly distributed. Analysis of some 10,000 individual gouges shows that their number increases with increasing latitude, increasing slope gradient, and decreasing water depth. Furthermore, maximum gouge incision depths are greatest in water 36 to 50 m deep within areas where slope gradients are

extremely gentle, less than 3 m/km. A maximum incision depth of 4.5 m occurs in the 35 to 40 m depth interval. Current-produced bedforms appear within individual ice gouges and ice gouges are found cutting across bedforms. Because these bedforms seem to be in equilibrium with existing flow regimes, it is believed that ice gouges are presently being formed to water depths of at least 43 meters. (Au)

225

Ice-gouged microrelief on the floor of the eastern Chukchi Sea, Alaska : a reconnaissance survey / Toimil, L.J.

(Environmental assessment of the Alaskan continental shelf : Annual reports of principal investigators for the year ending March 1978. Vol. XI : Hazards, p. 230-276, ill.)

(Open-file report – U.S. Geological Survey, 78- 693 [48] p., ill.)

This is attachment C to the report entitled: Marine environmental problems in the ice covered Beaufort Sea shelf and coastal regions / P. Barnes and E. Reimnitz.

Appendix.

References.

ASTIS document number 148830.

ACU

... An analysis of some 10,200 individual gouges shows that the density of ice gouges increases with increasing latitude, increasing slope gradients, and decreasing water depth. Across the northern half of the shelf few trackline segments were free of ice gouges; in the southern portion numerous segments contained no ice gouges. However, ice gouges do extend at least as far south as Cape Prince of Wales. Densities of over 200 gouges per kilometer of trackline are not uncommon in water depths less than 30 m, but no values higher than 50/km were encountered in water deeper than 50 m. No ice gouges were observed in water depths exceeding 58 m. Saturation ice gouge densities (greater than 300/km) occur along the eastern side of Barrow Sea Valley and the northeast flank of Hanna Shoal. ... The character of ice-gouged microrelief in the Chukchi Sea differs from that in the adjacent Beaufort Sea in that: (a) ice gouge densities are highly variable or patchy under otherwise uniform conditions; (b) preferred orientations of the trend of gouges are poorly developed, (c) the process of ice gouging in many instances is associated with and modified by strong current action; and (d) the maximum water depth of ice gouge occurrence appears to be shallower in the Chukchi Sea than in the Beaufort Sea. The two areas have similar maximum values of ice gouge densities, ice gouge widths, and incision depths. (Au)

226

Origin of a bergfield in the northeastern Chukchi Sea and its influence on the sedimentary environment / Toimil, L.J. Grantz, A.

(AIDJEX bulletin, no. 34, Dec. 1976, p. 1-42, ill., maps, photos.)

References.

ASTIS document number 47546.

ACU, NFSMO

... collections of grounded deep-draft floebergs (>25 m keel depths) and ice-island fragments ... ground on eastern Hanna Shoal, a structurally controlled bathymetric high that rises to within 25 m of sea level near 72 deg. N, 162 deg. W. A reconnaissance of the Hanna Shoal bergfield and adjacent seafloor during August 1974 and interpretation of available Landsat images suggest that the bergfields grow by recurrent groundings of floebergs of progressively deeper draft. ... The more stable parts of the bergfield shield the seafloor in their lee from gouging by deep-draft ice that churns and winnows the seafloor under the bergfield and elsewhere on Hanna Shoal. ... (Au)

227

Some characteristics of ice gouged microrelief on the floor of the eastern Chukchi Sea / Toimil, L.J.

(Environmental assessment of the Alaskan continental shelf : Annual reports of principal investigators for the year ending March 1977. Vol. XVII : Hazards, p. 101-113, ill.)

This is attachment H of the report entitled: Marine environmental problems in the ice covered Beaufort Sea shelf and coastal regions / P. Barnes, E. Reimnitz and D. Drake.

ASTIS document number 148970.

ACU

The effects of ice gouging on the morphology and microrelief of the eastern Chukchi Sea continental shelf, and on the texture and structure of it's surficial sediments have been recognized by Rex (1955), the U.S. Department of Commerce, Coast Pilot (No. 9, 1964), Barnes and Reimnitz (1974), and Toimil and Grantz (1976). Sonographs (side scan sonar records) and bathymetric profiles from well separated transects of the shelf reveal the occurrence of ice gouged microrelief to be wide-spread regionally. The records, obtained over 1,800 trackline kilometers of the shelf between water depths of 20 and 70 m ... provide a data base from which some general characteristics of ice gouged microrelief of the shelf may be analyzed with respect to bathymetry and geographic location. Such an analysis has been completed, the results of which are summarized here. ... (Au)

UNITED STATES. NORTHWEST AND ALASKA FISHERIES CENTER

228

Reconnaissance of intertidal communities in the eastern Bering Sea and the effects of ice-scour on community structure / United States. Northwest and Alaska Fisheries Center. O'Clair, C.E. Hanson, J.L. Myren, R.T. Gharrett, J.A. Merrell, T.R. MacKinnon, J.S. United States. Bureau of Land Management [Sponsor].

(Environmental assessment of the Alaskan continental shelf : Final reports of principal investigators. Vol. 10 : Biological studies, 1981, p. 109-415, ill., figures, maps, tables)

Partial contents: Appendix III : Some benthic marine algae from the Pribilof Islands, Bering Sea : a preliminary annotated list / N.I. Calvin.

Appendices.

References.

ASTIS document number 148156.

ACU

Our specific objectives have been to determine the composition of intertidal communities and to describe the distributions and abundances of species in them at as many representative sites as possible near the proposed oil and gas lease areas. In addition we have examined possible mechanisms of community organization at our sites and how they might determine the response of a community to oil spills. In this report, we describe the intertidal communities at our study sites in the Bering Sea (those in the Gulf of Alaska have been described elsewhere [O'Clair et al. 1978 and Zimmerman et al. 1978]), and examine the role of scouring by sea ice in structuring intertidal communities in the Bering Sea. (Au)

WEEKS, W.F.

229
Pressure ridge characteristics in the arctic coastal environment / Weeks, W.F. Kovacs, A. Hibler, W.D.
(Proceedings : the First International Conference on Port and Ocean Engineering under Arctic Conditions. – Trondheim, Norway : Technical University of Norway, 1971, vol. 1, p. 152-183, figures, tables)
References.
ASTIS document number 148814.
ACU

... Between 1969 and the present a number of both free-floating and grounded ridges have been examined by the authors in the Bering, Chukchi and Beaufort Seas. Profiles of the upper and lower surfaces of the ridges were determined by leveling and by drilling and sonar, respectively, and the internal structure of the ridges was investigated by coring. Ice temperatures, salinities, and densities were obtained and brine volumes were computed from the temperatures and salinities. Representative profiles are presented. The present results of this program are [given]. ... Current data bearing on the general distribution of deformation features in time and space over the Arctic Ocean are also summarized. ... (Au)

OTHER OCEANS AND SEAS

BELDERSON, R.H.

230
Iceberg plough marks in the northeast Atlantic / Belderson, R.H. Kenyon, N.H. Wilson, J.B.
(Palaeogeography, palaeoclimatology, palaeoecology, v. 13, no. 3, June 1973, p. 215-224, figures)
References.
ASTIS document number 148261.
ACU, NFSMO

A criss-cross pattern of large furrows on the sea floor has been observed on sonographs (side-scan sonar records) west of the British Isles, from the Faeroe Islands to Porcupine Bank. By analogy with present-day examples from the Canadian Arctic, this is attributed to the ploughing action of drifting icebergs. The "iceberg plough marks" occur in the sediments of the outer shelf and upper continental slope and around shoal areas of the deep sea at depths mainly between 140 and 500 m. The implications of these limits are discussed. The plough marks should also be found in many other areas previously traversed by Glacial and Late Glacial icebergs, as suggested by the widespread distribution of glacial erratics in the oceans. (Au)

231
Iceberg plough marks in the vicinity of the Norwegian Trough / Belderson, R.H. Wilson, J.B.
(Norsk geologisk tidsskrift, v. 53, no. 4, 1973, p. 323-328, ill.)
References.
ASTIS document number 149004.
ACU, NFSMO

Side-scan sonar pictures (sonographs) obtained from the southern Norwegian shelf and the Norwegian Trough show the presence of large furrows which are attributed to the action of icebergs ploughing into the sediment as they touch bottom. These iceberg plough marks are similar to others recently described from the continental margin west of the British Isles. Plough marks are best developed on the north side of the Trough. Parallelism of plough marks is observed on the sides and low rises on the floor of the Trough not covered by mud. (Au)

BROCHWICZLEWINSKI, W.

232
The action of ice and frost in the development of moderate climate Baltic beaches / Brochwiczlewinski, W. Rudowski, S.
(First Symposium on the Geological Action of Drift Ice, Quebec, Canada, April 20-24, 1974 [sic]. Maritime sediments, v. 9, no. 3, Dec. 1973, p. 104)
Abstract only.
ASTIS document number 149730.
ACU

...Ice occurs in the nearshore of the southern Baltic Sea for a period of 4 to 74 days per year. It remains longer on beaches than elsewhere, usually for 2 to 3 months a year, and beaches are frozen for about the same period, although numerous freeze-thaw cycles do occur. Such conditions favor the development of various structures related to ice and frost action, the most common being ice-pushed and ice-deposited ridges or mounds up to 2 m high, ice-rafted debris including boulders, ice cemented blocks, frost cracks, beaches resting on ice or snow patches, buried ice lenses, solifluction features, and various features related to the melting of ice including shore-ice kettles. ... Ice floes under wave and current motion commonly truncate the top of the underwater bars and build ridges when pushed on the shore. Subsequently abrasion of the beach results from this action of ice over submerged bars. Ice also influences the development of the beaches in stopping or impeding the action of normal shore processes (waves and currents), and in shifting the shoreline seawards. In the southern Baltic region shore ice often shifts the shoreline 400 to 500 m seawards. ... (Au)

EISMA, D.

233
Sea-floor morphology and recent sediment movement in the North Sea / Eisma, D. Jansen, J.H.F. van Weering, Tj.C.E.
(Acta Universitatis Upsaliensis. Symposia Universitatis Upsaliensis Annum Quingentesimum Celebrantis : 2. The Quaternary history of the North Sea / Edited by E. Oele, R.T.E. Schuttenhelm and A.J. Wiggers., p. 217-231.)
ASTIS document number 164321.

The morphology of the North Sea floor is dominated by relict features except in the Southern Bight and adjacent areas. The oldest are the glacially eroded Norwegian Channel and Skagerrak, the still unexplained Dogger Bank, and the channels and gravel deposits in the southern North Sea. Others originated during the last Weichselian glaciation: gravel banks bordering the Norwegian Channel, which are considered as terminal moraines and glacial outwash deposits, iceberg grooves and subglacial tunnel valleys. The tunnel valleys in the southern North Sea probably were reshaped later by tidal scour. ... Pockmarks in the northern North Sea are attributed to escaping gas. (Au)

FAIRBRIDGE, R.W.

234
Pleistocene marine shore platforms eroded by drift ice / Fairbridge, R.W.
(First Symposium on the Geological Action of Drift Ice, Quebec, Canada, April 20-24, 1974 [sic]. Maritime

sediments, v. 9, no. 3, Dec. 1973, p. 109)
Abstract only.
ASTIS document number 149764.
ACU

... Large erratic boulders believed to have been transported by sea ice are widespread along the mid-Pleistocene emerged shore platforms of northwestern Europe. Late Pleistocene boulder accumulations are commonly found near the margin of the continental shelf. The anomalous, higher elevation of the earlier deposits is attributed to secular lowering of sea level due to plate tectonics. The erratics are associated with so-called "wave-cut" marine abrasion platforms that are often carved in hard rock such as would require excessive periods of time for erosion by normal wave action. Dionne's invaluable research into drift-ice erosion provides an effective mechanism for explaining this intertidal abrasion. A similar drift-ice explanation is offered to account also for flat-floored stream beds cut into bedrock in mid- to high-latitude areas. Finally, iceberg scours mark the Continental Shelf both of today and of the Ordovician Saharan glaciation; they are compared with the shore platforms scours, and found to be quite distinctive. (Au)

HANSOM, J.D.

235
Ice-formed intertidal boulder pavements in the sub-antarctic / Hansom, J.D.
(Journal of sedimentary petrology, v. 53, no. 1, Mar. 1983, p. 135-145, ill.)
References.
ASTIS document number 148920.
ACU

Boulder pavements are flat, tightly packed mosaics of ice-smoothed and striated boulders that occur in low gradient intertidal and lacustrine areas in polar regions. In the sub-Antarctic, intertidal boulder pavements are located in three morphogenetic environments spanning 10 degrees of latitude. Some boulder pavements are composed of ice-pushed or ice-rafted boulders which have been forced into the substrate by the pressure of grounding ice blocks. Other pavements may result from wave-winnowing of glacial till at sea level which has been subsequently modified by grounding ice. Shallow depressions in the pavement surface may correspond to the loci of large grounded ice blocks, and this interpretation is supported by striation and boulder orientations on the ridges between the depressions. The occurrence of the pavement appears to depend on the following factors: (a) a boulder supply; (b) frequent onshore movement of floating ice; and (c) a low-gradient intertidal zone. Given such conditions, the degree of development of the pavement seems to be controlled by the frequency of onshore ice movement because the best formed pavements occur in areas subject to the highest frequencies of freely moving floating ice. The occurrence of raised pavements in the South Shetland Islands suggests that little morphogenetic change has occurred in the area since 9,000 years ago. Radiocarbon dating indicates that where the frequency of ice grounding is relatively low, periods in excess of 200 years are necessary for pavement development, whereas at locations where the ice-grounding frequency is high, pavements are well formed within 300 years. (Au)

KOSHECHKIN, B.I.

236
Traces of ice floe actions on the seabed in shallow waters of the northern Caspian Sea / Koshechkin, B.I.
(Trudy – Akademiia Nauk SSR. Laboratoriia Astrometodov, v. 6, 1958, p. 227-234, ill.)
This is a translation from the Russian original obtained from Chris Woodworth-Lynas of C-CORE, Memorial University of Newfoundland, St. John's.
References.
ASTIS document number 150002.

A specific pattern on the seabed of the Caspian Sea was observed from aerial photographs. These furrows and scars are connected with the ploughing action of ice floes during their movement in spring. The paper describes the deposits found within them. The majority of the scars extend in an east west direction, relating to the predominant wind direction, and to currents created by these winds. The study of aerial photographs enable the investigator to determine the density of scars per unit area. (NFSMO)

LIEN, R.L.

237
Ice age plough marks a hazard to pipelines in northern seas / Lien, R.L.
(Offshore engineer, 1982 [5] May, p. 79, ill.)
ASTIS document number 136662.
NFSMO, ACU

Plough marks left by drifting icebergs have been found at water depths of 100-240 m on the Norwegian continental shelf .... IKU's [Continental Shelf Institute's] surveys have shown that future pipeline projects on the shelf off central and northern Norway will meet problems with the local sea floor topography and foundation conditions caused by iceberg plough marks. The Institute is continuing the surveys of the continental shelf and the investigations into the geotechnical implications of plough marks. ... (Au)

238
Iceberg scouring and its influence on seabed conditions : investigation results and formation model / Lien, R.L.
[19] leaves : ill., maps ; 28 cm.
Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.
Indexed from a preliminary draft, July 1985.
Proceedings to be published as an ESRF Report in late 1985.
ASTIS document number 163562.

This contribution is based on an investigation performed in an area outside the TROMS-I area off North-Norway. The investigation encompasses shallow seismic surveying with positioned deep towed sensors, ROV-profiling using video, pinger, side scan sonar and precision bathymetry device, use of positioned sampler and sampling/testing from [the] drill ship. Based on results from this study a model for the influence of grounding icebergs on seabed conditions is presented. ... (Au)

239
Iceberg scouring on the Norwegian continental shelf / Lien, R.L.
(1983 Offshore Technology Conference, May 2-5, 1983, Astrodomain, Houston, Texas : proceedings. – [S.l. : Offshore Technology Conference, 1983], v. 3, p. 41-48, ill.)
(OTC paper, 4585)
References.
ASTIS document number 150045.
NFSMO

... The first part of the paper deals with the regional distribution of iceberg scouring on the Norwegian continental shelf, and some general aspects related to it. The second part deals with iceberg scouring as a local phenomenon and its relation to the sea floor topography, sediment distribution, and geological and geotechnical properties of the sediments. (Au)

240
Istiden skaper vansker for oljen i nord [The ice age creates problems for oil exploration on the northern Norwegian shelves] / Lien, R.L.
(Teknisk Ukeblad, nr. 6, 1982)
Photocopy.
Text in Norwegian.
ASTIS document number 159697.

This paper addresses the impact of relict plough marks on the ocean bottom as they pertain to the design and construction of underwater pipelines and production platforms. (ASTIS)

241
Ployemerker etter grunnstotte isfjell pa Tromsoyflaket [Plough marks from grounded icebergs offshore northern Norway] / Lien, R.L.
(Geolognytt, nr. 13, 1979)
Abstract only.
Paper presented at the 14th Nordic Geological Winter Meeting, Bergen, Norway, 1980.
Text in Norwegian.
ASTIS document number 159638.

Sidescan sonar surveys in a mosaic pattern have been undertaken at Tromsogflaket. The interpretation deals with three main objectives: 1. Distribution of sea bottom sediments, 2. Frequency of plough marks, 3. Depth of plough marks. The bathymetry and the sediment distribution are found to have a strong influence on plough mark frequency and depth. (ASTIS)

242
Ployemerker etter isfjell pa norsk kontinentalsokkel = Iceberg scouring on the Norwegian continental shelf / Lien, R.L.
Trondheim, Norway : Institutt for kontinentalsokkelundersokelser, 1893.
147 leaves : ill. ; 36 cm.
(Publikasjon - Institutt for Kontinentalsokkelundersokelser, nr.109)
Photocopy.
References.
Summary in English.
Text in Norwegian.
ASTIS document number 159778.
ACU

When the ice cap covering northern Europe retreated towards the end of the last ice age, large areas on the Norwegian continental shelf were exposed to drifting icebergs. A great number of these were grounded and made scour marks in to the sea floor. This publication deals with the regional distribution of such scouring in the area between 60 N and 71 30 N, where more than 50% of the area shallower than 500 m is scoured. The distribution shows that water depths, regional topography, and current directions have been decisive of where the scouring took place. Further it gives indications of which factors have been crucial as to the directions, shapes, and numbers of the scars. The second part of the publication concenstrates on the local conditions in an iceberg scoured area, with special emphasis on how the scouring has influenced the local topography of the sea floor, the soil conditions, the soil distribution, and the near-botton currents. Finally it is given some comments on what consequences the scouring process may have for developments in such areas, and for investigation methods and interpretation of data. (Au)

243
Sea bed features in the Blaaenga area, Weddell Sea, Antarctica / Lien, R.L.
(POAC 81 : the Sixth International Conference on Port and Ocean Engineering under Arctic Conditions, Quebec, Canada, July 27-31, 1981, proceedings. - Quebec City, Quebec : Universite Laval, 1981, v. 2, p. 706-716, ill.)
References.
ASTIS document number 150681.
NFSMO

Data for this contribution were gathered during two expeditions in the summer seasons 1967/77 and 1978/79, and consist of records with echo sounder and side-scan sonar. From these data we have constructed a tentative bathymetric map of the area, and the sea floor has been classified into four groups of sea bed features. Two of these are well known and widely described in the literature: plough marks from grounded icebergs, and conventional undisturbed sea bed. The other two, in spite of a comprehensive study, are not found in the literature. These features consist of a washboard pattern, and a hummocky, mosaiclike, sea bed pattern. The different features are described and shown on record sections. Further some record sections with special phenomena such as tracks of wobbling icebergs, arresting icebergs, multi-keeled icebergs etc. are shown. Finally the different patterns and phenomena will be discussed with reference to their process of formation. (Au)

244
Undersokelser av overflatelaget pa kontinentalsokkelen utenfor Troms og Vest-Finnmark = Investigations of the sea bed cover on the continental shelf offshore Troms and western Finnmark / Lien, R.L. Myhre, L.A.
Trondheim, Norway : Institutt for kontinentalsokkelundersokelser, 1977.
33 leaves : ill., maps ; 36 cm.
(Publikasjon - Institutt for Kontinentalsokkelundersokelser, nr. 92)
Photocopy.
References.
Summary in English.
Text in Norwegian.
ASTIS document number 159530.
ACU

Based mainly on a study of bottom photographs, bottom samples, and profiling with side-scan sonar, the sea bed offshore Troms and Western Finnmark has been investigated. The sea bed cover consists mainly of coarse material, cobbles and stones, on the shallow banks, and of silt, sand up to gravel size on the deeper banks, while the troughs and sheltered areas have a sea bed cover of clay and silt. The erosion is greatest in shallow water, while sedimentation is greatest in the deep or sheltered areas. Today, however, both processes apparently are relatively small. The mapped area has been highly influenced by stranding icebergs, which have torn up the sea bed. The present depth of the stranding areas is between 120 and 300 m. (Au)

245
Utstyr og metoder for kartlegging av ployemerker [Equipment and methods for plough mark mapping] / Lien, R.L.
[Oslo : Norske Sivilingenioers Forening, 1983].
22 leaves : ill. ; 36 cm.
Paper presented at the Erfaringer Med Offshore Instrumentering Seminar, Geilo, 31 Jan.-2 Feb., 1983.
Photocopy.
Text in Norwegian.
ASTIS document number 159786.
ACU

This paper addresses the need for detailed positioning systems and accurate instrumentation for ice plough surveys. As previous surveys did not meet these requirements, the data so far collected is only useful for regional compilations. This paper discusses, in detail, the instruments and methods for mapping plough marks offshore northern Norway. (ASTIS)

MOIGN, A.

246

L'action des glaces flottantes sur le littoral et les fonds marins du Spitsberg central et nord-occidental = Drift ice action on the shores and bottoms of central and northwestern Spitsbergen / Moign, A.

(Le glaciel / Edited by J.-C. Dionne. La revue de geographie de Montreal, v. 30, no. 1-2, 1976, p. 51-64, ill.)

References.

English abstract.

Text in French.

ASTIS document number 150673.

NFSMO

... In NW Spitsbergen the effects of drift ice is of minor importance in the evolution of shores and in the formation of strandflats. ... Icebergs play a role in the erosion of soft bottoms and in sedimentation. They plough grooves and circular depressions. No direct erosion of rocky bottoms has been observed. ... Small icebergs stranded on the beaches leave patches of glacial debris or circular depressions. ... drift ice may scratch soft bottoms in shallow waters and transport away small amounts of sediments. ... Icefoot action differs from rocky shores and beaches. Cliff icefoots play a role in the formation of a notch at the base of cliffs. Icefoots developed on gently sloping beaches protect the beach against normal shore processes. A micro-relief of mounds and kettles result from melting of icefoot over pebble beaches; however, waves reworking the beach sediments during the summer, ice-made features are destroyed. (Au)

REINECK, H.-E.

247

Drift ice action on tidal flats, North Sea / Reineck, H.-E.

(La revue de geographie de Montreal, v. 30, no. 1-2, 1976, p. 197-200, ill.)

ASTIS document number 150657.

NFSMO

Almost every year, ice is formed on the surface of tidal flats of the North Sea. The effect of drift ice and of ice floes are the following: erosion of ocean bottom by currents or tossing of waves; other scouring marks due to ice floes dragged along the bottom by ocean currents or tossed by waves; deformation of sediments under and around the ice floes stranded in the muddy zones; sediment transport, notably of islets of mud, by the ice floes which abandon their load on the flats and the sand beaches; these islets of mud are cracked both by the action of the needles of ice and by dessication: the transport of both living and dead molluscs such as Cardium edule, Scrobicularia plana and Mytilus edulis from the intertidal zone to deeper zones. [Translation]. (Au)

ROKOENGEN, K.

248

Shallow geology of the continental shelf off north Norway / Rokoengen, K. Bugge, T. Dekko, T. Gunleiksrud, T. Lien, R.L. Lofaldli, M.

(POAC 79 : the Fifth International Conference on Port and Ocean Engineering under Arctic Conditions, at the Norwegian Institute of Technology, August 13-18, 1979, proceedings, v. 2, p. 859-875, maps)

References.

ASTIS document number 55832.

ACU, NFSMO

As a part of IKU's [Continental Shelf Institute, Trondheim] regional mapping program 6,200 km sparker profiling and sampling from 50 localities off North Norway have been carried out. ... Possible submerged and tilted beach levels have been observed down to more than 150 m water depth. Areas with water depths between about 100 and 300 m have extensive iceberg plough marks. Many of the relict glacial features have considerable engineering implications. (Au)

SOLHEIM, A.

249

Marin-geologiske og -geofysiske undersokelser i Barentshavet 1983 : Toktrapport [Marine geology and geophysical investigations in the Barents Sea 1983 - Cruise report] / Solheim, A.

Oslo : Norsk Polarinstitut, 1983.

116 p. : ill. ; 28 cm.

(Rapportserie - Norsk Polarinstitut, nr, 14)

References.

English summary.

Text in Norwegian.

ASTIS document number 165328.

ACU

Shallow rock core drilling was the main purpose of the 1983-survey with M/S LANCE in the northern and northwestern Barents Sea. The survey, a joint operation by the Norwegian Polar Research Institute and Norwegian Petroleum Directorate, also included participation from Woods Hole Oceanographic Institution, USA, by professor John Milliman. The survey started in Longyearbyen 5.8 (loaded in Tromso 8.-9.8) and ended in Longyearbyen 1.9. ... The sediment thickness was generally in the range of 5-10 m and successful drilling into bedrock was obtained at 5 stations. Twenty-two stations were planned. ... The site survey [by penetration echo sounder and side scan sonar] provided for the first time data for detailed studies of the sea floor morphology. A pock-mark field was observed south of Hopen, and commonly the sea bottom showed extensive ice ploughing. Recent icebergs probably plough down to a water depth of 80-90 m. ... (Au)

250

A pockmark field in the central Barents Sea : gas from a petrogenic source? / Solheim, A. Elverhoi, A.

(Polar research, v. 3 n.s., no. 1, p. 11-19, ill., maps)

References.

ASTIS document number 163678.

ACU

A pockmark field has been encountered in the northwestern Barents Sea, 50 km southeast of Hopen Island. High resolution seismic records and side scan sonographs show that the features are small (10-20 m diameter), shallow (less than 1 m deep) structures that may cover up to 25% of the sea floor in local areas. Pockmark existence seems to be dependent on the presence of soft, Holocene mud. In more firm sea-floor they seem to concentrate in the partly infilled troughs of iceberg plough marks. The pockmark distribution, characteristics of the underlying sedimentary bedrock and thin cover of glacigenic sediments in the area, indicate they are formed by ascending gas from a deeper, probably petrogenic source. It is inferred that pockmarks may be found in larger parts of the Barents Sea. (Au)

251

Sea-floor morphology outside a grounded, surging glacier; Brasvellbreen, Svalbard / Solheim, A. Pfirman, S.L.

(Marine geology, v. 65, no. 1/2, May 1985, p. 127-143, ill., maps)

References.

ASTIS document number 160083.

ACU

Acoustical profiling and bottom photography reveal several different

sea floor morphological features adjacent to the grounded Brasvellbreen glacier on Svalbard, northwestern Barents Sea. Some of the features and their distribution may be closely related to a major glacial surge in 1936-38, and as such are valuable in identifying former surges in other locations. A continuous, wide ridge with a characteristic asymmetrical cross-section, running subparallel to the glacier, defines the maximum extent of the surge. A large part of this ridge is most likely rapidly deposited from meltwater during the surge. A rhombohedral pattern of smaller mounds inside the ridge is probably an expression of sub ice relief during the surge. Discontinuous ridges define local, minor readvances during retreat of the ice. Iceberg ploughmarks are most frequent seaward of the continuous ridge, their orientation is controlled by the combination of a coastal current, offshore katabatic winds and topography. Superimposed on ploughmarks are some secondary features such as "washboard pattern" and striae, most likely caused by push-up of overconsolidated material during gouging and multi-keel icebergs, respectively. ... (Au)

STOKER, M.S.

252

A relict ice-scoured erosion surface in the central North Sea / Stoker, M.S. Long, D.

(Marine geology, v. 61, no. 1, Oct. 1984, p. 85-93, ill.)

References.

ASTIS document number 148903.

ACU

The interpretation of shallow seismic records from the central North Sea has revealed the existence of an irregular erosion surface within late Pleistocene sediments. A morphological study of this surface has identified two main types of relief: (1) an irregular, rough topography with depressions varying in depth from 1 to 6 m, and in width from 25 to 300 m; and (2) a much smoother topography with relatively few depressions. On a palaeobathymetric map the rough topography extends from ca. 110 to 160 m below sea level (OD), while the smoother topography extends beyond the 160 m below OD contour. This surface is interpreted as an ice-scoured erosional feature formed by the grounding of sea ice in a shallow shelf environment. The stratigraphic position of the ice-scoured surface shows it to be a relict late Weichselian feature formed at ca. 17,000-18,000 B.P. (Au)

VINJE, T.

253

A grounded iceberg in Fram Strait / Vinje, T.

(Polar record, v. 21, no.131, May 1982, p. 174-175, figures)

Reference.

ASTIS document number 149055.

ACU

At the beginning of October 1980 an iceberg became stranded at 81 degrees N, 10 degrees W on the Ob' Bank, south-east of Nordostrundingen, north-east Greenland. The iceberg was triangular in shape, about 50 km in length and had a maximum breadth of about 25 km. The minimum water depth in the area is 37 m (Faleyev and others, 1980), so the thickness of the berg must have been in excess of 40. ... The berg and its associated fast ice produced a large artificial bight on the sheltered south side .... A polynya in this position has often been observed in winter, but the 1980-81 polynya was the largest and most persistent winter-time opening in this area since the advent of satellite pictures in 1966. Observations also show that the grounded iceberg influenced the general ice drift in Fram Strait. ... (Au)

VORREN, T.O.

254

Glacigenic sediments and sedimentary environments on continental shelves : General principles with a case study from the Norwegian shelf / Vorren, T.O. Hald, M. Edvardsen, M. Lind-Hansen, O.-W.

(Glacial deposits in north-west Europe / Edited by J. Ehlers. – Rotterdam, Netherlands : A.A. Balkema, 1983, p. 61-73, ill., map)

ASTIS document number 159719.

The purpose of this article is: 1) To give a general survey of glacigenic sedimentation and sedimentary environments related to shelf areas. 2) To discuss briefly glacigenic sediments and stratigraphy from a representative area of the Norwegian Shelf. 3) To present a reconstruction of the changes in the sedimentary environment on this shelf area from the time that the ice sheet stood at the shelf edge up to the present. 4) To discuss briefly diagnostic parameters used to differentiate between various types of glacigenic diamictons found on this shelf area. (Au)

255

Quaternary sediments and environments on the continental shelf off northern Norway / Vorren, T.O. Hald, M. Thomsen, E.

(Sedimentation on high-latitude continental shelves / Edited by B.D. Bornhold and A. Guilcher. Marine geology, v. 57, no. 1/4, May 1984, p. 229-257, ill., maps)

References.

ASTIS document number 159700.

ACU

Based on lithologic, palaeontologic and chronostratigraphic investigations of close to 200 gravity cores from troughs, deep banks and shallow banks the following late Quaternary environment can be outlined: In the Weichselian, deposition of basal tills was followed by deposition of laminated clay in a sea-ice environment. Later a pebbly pelite was deposited in the troughs at the same time as the banks were iceberg ploughed. Then (13,000 yrs B.P.) a period with incipient winnowing occurred on the deep banks and depostion of sandy pelite took place in the troughs. The Holocene commenced with a marked environmental change due to intrusion of Atlantic water, the fauna changed from arctic to boreal, high-energy winnowing forming a lag deposit took place on the banks, and high accumulation rates in the troughs occurred due to the winnowing and sediment influx from the downwasting continental icesheet. During the later part of the Holocene the winnowing diminished on the deeper banks, on the shallow banks and on the shelf break it still prevails, and in the troughs calcareous sandy mud is being deposited. The surface sediments comprise three main facies, bouldery and pebbly sand, sand, and sandy mud, whose distribution mainly depends on the prevailing bottom current regime. The composition of the older Quaternary sediments is demonstrated by some selected seismic profiles. (Au)

LAKES

BERKSON, J.M.

256

Microphysiography and possible iceberg grooves on the floor of western Lake Superior / Berkson, J.M. Clay, C.S.

(Geological Society of America bulletin, v. 84, no. 4, Apr. 1973, p.1315-1328, figures)

References.
ASTIS document number 148563.
ACU

The floor of Lake Superior northwest of the Keweenaw Peninsula has three zones of small-scale relief based on echogram character. The zones are roughly depth dependent. Zone A, located between the shore to about a 54-m depth is generally smooth on the echogram and consists mainly of sand and boulder gravel deposits. Zone B, between about 54 and 165 m, has microroughness features with a 2- to 5-m relief and a 90- to 300-m spacing; the bottom consists of glacial till and lacustrine clay. Zone C, below depths of about 165 m, has narrow troughs with depths to 12 m and separation of 60 to 600 m; the bottom consists of lacusstrine clay. The microrelief of Zone B consists of an intersecting network of grooves having widths of 5 to 75 m and lengths of as much as 1,950 m. Regular parallel features 15 to 30 m apart are also found in scattered areas of Zone B and the deepest parts of Zone A. Sand and boulder gravel deposits of Zone A may be beach and dune material of lower glacial-lake stages, and the border with Zone B may mark the lowest shoreline during the sequence of glacial lakes in the Superior basin. The grooves of Zone B were probably formed by scouring by icebergs during an earlier lake stage. Relief in Zone C probably was formed by a lacustrine process. (Au)

GRASS, J.D.

257
Ice scour and ice ridging studies in Lake Erie / Grass, J.D.
Abstract only of paper presented at IAHR symposium, 1984, Hamburg.
ASTIS document number 159956.

In 1980, Ontario Hydro proposed construction of a high voltage transmission cable system across the eastern basin of Lake Erie to connect the Nanticoke generating station in Ontario, Canada to the presently undeveloped Coho site in Pennsylvania, USA. During marine geophysical surveys of the lake bottom, ice scours were discovered in soft sediments in 13 to 25 m water depth on both the Canadian and American sides of the lake. The ice scours were approximately 4.5 to 6 km long, 60 to 100 m wide and up to 2 m deep. Correlation of survey observations, gas pipeline damage and diver observations of ice scours on the Canadian side confirmed their recent age. Fresh scours found on the American side were formed during the winters of 1980/81 and 1981/82. Scours on the Canadian side were preserved while scours on the American side were obliterated from year to year. A helicopter supported ice observation program was carried out during the winters of 1980/81 and 1981/82 to map ice ridges and measure ice thicknesses. The ice ridging process was observed and filmed during February, 1982. The location of scours is related to the occurrence of major ice ridges which form at the edge of fast ice masses. It was recommended that the proposed power cables be buried in shallow trenches, excavated into the lake bottom materials to various depths to protect the cables against damage from ice keels. (Au)

258
Ice scour and ice ridging studies in Lake Erie / Grass, J.D.
[3] leaves ; 28 cm.
Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.
Indexed from a preliminary draft, July 1985.
Proceedings to be published as an ESRF Report in late 1985.
ASTIS document number 163546.

In 1980 Ontario Hydro proposed the construction of a high voltage transmission cable system across the eastern basin of Lake Erie from the Nanticoke Generating Station to a site near Girard, Pennsylvania. Unfortunately, the project was cancelled .... However, a tremendous volume of bottom and sub-bottom data was collected during the geotechnical investigations which included barge drilling, sediment sampling and marine geophysics. The geophysical surveys provided a clear picture of the lake bottom and sub-bottom characteristics particularly the occurrence of long, wide and shallow ice scours in the soft sediments on the Canadian and American sides of the cable corridor. ... Ice damage has occurred to gas pipelines during the winter on the Canadian side while new scours were found on the American side when geophysical records from resurveyed areas were compared. ... (Au)

259
Lake Erie cable crossing – ice scour study / Grass, J.D.
(National Research Council of Canada Associate Committee on Geotechnical Research Workshop on Ice Scouring, 15-19 February 1982 / Edited by G.R. Pilkington. Technical memorandum – Canada. National Research Council. Associate Committee on Geotechnical Research, no. 136, p. 1-10, ill.)
Reference.
ASTIS document number 148334.
NFSMO

Ontario Hydro and General Public Utilities of New Jersey are proposing the construction of 5 high voltage transmission cables across the eastern part of Lake Erie. The cable will run from the Nanticoke generating station in Ontario to the Coho Site in Pennsylvania, USA. Geotechnical investigations along the cable corridor predominantly by barge drilling and gravity sampling techniques have been carried out to determine soil and bedrock characteristics and distributions. Marine geophysical surveys using side-scan sonar, bottom and subbottom profiling echo sounders have been used to study the lake bottom and subbottom conditions. The geophysical surveys revealed the existence of ice scour on the Canadian and American sides of the corridor in about 13 to 25 m of water. The scours are generally less than 1 m deep up to a maximum of 1.7 m, up to 6 km long and up to 100 m wide. To protect the cables from ice damage, they are to be buried in trenches up to 3 m deep on the Canadian side and up to 2 m deep on the American side. (Au)

260
Ontario Hydro-General Public Utilities interconnection Lake Erie cable crossing ice scour evaluation / Grass, J.D. Johnston, O.A.
[Toronto, Ont.?] : Ontario Hydro, 1982.
1 v. (various pagings) ; 28 cm.
(Report – Ontario Hydro. Geotechnical Engineering Dept., no. 82032)
Appendices: A. Ontario Hydro-GPU interconnection, Lake Erie submarine cable crossing, ice scour study, report no. 80463 / J.D. Grass. – B. Ontario Hydro-GPU interconnection, Lake Erie submarine cable crossing, ice scour study, report no. 80463 / J.D. Grass. – C. Lake Erie ice scour investigation, report no. 81555 (section 4.1 Conclusions) / R. Abdelnour. – D. Ice scour depth analysis on the Canadian side, a probabilistic approach.
References.
Glossary of terms.
ASTIS document number 159867.

Investigative geophysical work carried out during 1980 in the study area for the proposed DC cable link from Nanticoke GS to the Coho site west of Erie, Pennsylvania disclosed scouring impressions on the lake bed offshore Nanticoke and the Soho site. The presence of such ice damage was unexpected since it was not thought that ice masses of sufficient size to cause such damage at the depths involved could form in the Lake Erie environment. These markings were found in water depths of 12 m to 25 m, had overall disturbance widths of a few metres to 100 metres and penetrated as much as 2 m. Such penetration due to ice scour would have considerable impact to the interconnection project. Subsequent to the initial findings more detailed examination and searches were carried out in 1980 and 1981. This report is intended to set in

perspective the significance of the ice scouring phenomenon on Lake Erie relative to this proposed interconnection project. An overall engineering appraisal of likely scour penetration is made with the intention of determining a realistic depth of conductor burial to provide the necessary protection and security. (Au)

261
Ontario Hydro-GPU interconnection Lake Erie submarine cable crossing ice scour study / Grass, J.D.
[Toronto, Ont.?] : Ontario Hydro, 1981.
1 v. (various pagings) : ill. ; 28 cm.
(Report - Ontario Hydro. Geotechnical Engineering Dept., no. 81317)
Supplementary to report no. 80463.
ASTIS document number 159891.

Initial geophysical surveys carried out in the Nanticoke approach area and environs during the period July to October, 1980 using side scan sonar and echo sounding equipment showed significant ice scour in the southern part of the approach area. The scours occur in soft clayey silt and are up to 2 m in depth. They extend for up to 3 km into water depths of 13 to 19 m. On the American side north of the Coho approach area only a few sand-filled scours were found in 16 m and 20 m of water. The 1981 investigations included an ice ridge monitoring program and a geophysical marine survey. ... This report is supplementary to Report No. 80463. It provides more information on ice ridging conditions on the lake and further details about ice scour on both the Canadian and American sides. (Au)

262
Ontario Hydro-GPU interconnection Lake Erie submarine cable crossing ice scour study / Grass, J.D.
[Toronto, Ont.?] : Ontario Hydro, 1981.
1 v. (various pagings) : figures ; 28 cm.
(Report - Ontario Hydro. Geotechnical Engineering Dept., no. 80463)
Appenidix A: Photographs of ice scour.
ASTIS document number 159905.

Ontario Hydro and General Public Utilities (GPU) (USA), in a joint venture, have proposed the construction of a high voltage transmission cable across the eastern basin of Lake Erie. The proposed cable connects Nanticoke GS to the Coho site located near Girard, Pennsylvania. A geotechnical investigation was carried out by the Geotechnical Engineering Department along the proposed cable corridor which is about 100 km long and 4 km wide. ... During the course of the investigations, several ice scours were encountered in the soft sediments of the Nanticoke approach area. It became evident that the grounding of 'icebergs' and the resulting scour of the lake bottom sediments to varying depths was a significant process relative to the continued security of the power cables. ... This study is a preliminary overview of ice conditions and ice scour in eastern Lake Erie. The purpose of the ice scour study was to determine: (a) areas of active and potentially active ice scour in the study area and particularly within the proposed cable corridor area; (b) the location, extent and maximum depth of ice scour; (c) maximum depth of water in which ice can affect the lake bottom. (Au)

STANLEY, G.M.

263
Origin of playa stone tracks, Racetrack Playa, Inyo County, California / Stanley, G.M.
(Geological Society of America bulletin, v. 66, no. 11, Nov. 1955, p.1329-1350, ill., figures, map, tables)
References.
ASTIS document number 148857.
ACU

Curious tracks on playas, obviously made by moving stones, have been interpreted as caused by wind blowing stones over wet level clay. The stones weigh from ounces to several hundred pounds. Among hundreds of tracks on Racetrack Playa, Inyo County, California, certain ones exhibit near parallelism which implies unit movement; precise measurements and plots confirm this. Certain bends and cusps in these irregular tracks are comparable in all tracks of the same "signature". A transparency plot of analogous points (one for each track in same signature group), when moved along plotted tracks, matches repeatedly at other analogous points. Rotation precluded true parallelism of tracks and identity of lengths and shapes. Distance of unit movement exceeded 300 feet, and maximum spread of stones in unit is 480 feet. Unit movement over so great a span scarcely allows any reasonable conclusion as to cause other than wind-blown ice floes dragging protruding stones. Ice ramparts and other evidence indicate longshore shearing motion, feasible for ice floes but impossible for ice shove by thermal expansion. The writer finds no evidence that stones, freely wind blown, have made tracks. Though not disproved, this idea meets serious objections in many other small object tracks than those surveyed and is unfeasible for tracks inscribed by 300 pound stones. (Au)

WEBER, J.N.

264
Recent grooving in lake bottom sediments at Great Slave Lake, Northwest Territories / Weber, J.N.
(Journal of sedimentary petrology, v. 28, no. 3, Sept. 1958, p. 333-341, figures)
References.
ASTIS document number 148652.
ACU

Large grooves up to 33 m wide and 4,760 m long have been inscribed in soft unconsolidated lake bottom sediments at Great Slave Lake, NWT. The grooves are probably formed by wind-driven ice floe gouging during each spring breakup. Smaller grooves having a boulder at one end were formed by boulders pushed by floating lake ice. Study of the hydraulics of fluid flow upon spheroidal solids indicates that wind is quite incapable of transporting large rocks like those suggested to have formed the grooves on Racetrack Playa, California. (Au)

FORMERLY SUBMERGED LAND

CLAYTON, L.

265
Intersecting minor lineations on Lake Agassiz plain / Clayton, L. Laird, W.M. Klassen, R.W. Kupsch, W.O.
(The journal of geology, v. 73, no. 4, July 1965, p. 652-656, ill.)
References.
ASTIS document number 148911.
ACU

Intersecting minor ridges on the plain of glacial Agassiz were probably pushed up by floating lake ice and apparently are not primarily the result of permafrost, wave action and running water, or a fracture pattern in the underlying bedrock, as previously suggested. Associated intersecting minor grooves were also formed by dragging lake ice. They are essentially identical to grooves forming in Great Slave Lake in recent times. (Au)

DIONNE, J.-C.

266
Relict iceberg furrows on the floor of glacial lake Ojibwa, Quebec and Ontario / Dionne, J.-C.
(Maritime sediments, v. 13, no. 2, Aug. 1977, p. 79-81, map)
References.
ASTIS document number 149780.
ACU

To the author's knowledge, relict iceberg furrows on the floor of former glacial lakes in Canada have not yet been reported. Many examples of recent and relict iceberg features on sea floors are known in the Arctic Ocean ... and in the North Atlantic Ocean .... In addition Berkson and Clay (1973) have reported iceberg furrows on the floor of Lake Superior, and Clayton et al (1965) have interpreted the intersecting minor lineations on Lake Agassiz plain as grooves made by drifting ice floes. Examples of modern grooving by drift-ice in lake bottom sediments are given by Koshechkin (1958) for the north Caspian Sea, by Weber (1958) for the Great Slave Lake, and by Mollard (1973) for the Great Slave Lake, and lakes Manitoba and Montreal (Saskatchewan). Ice-made grooves in the tidal flats of the Lower St. Lawrence Estuary have been fully described by Dionne (1968, 1969, 1971). This paper reports furrows observed on air photos and in the field of a clay plain in northwestern Quebec and adjacent Ontario. (Au)

DREDGE, L.A.

267
Relict ice-scour marks and late phases of Lake Agassiz in northernmost Manitoba / Dredge, L.A.
(Canadian journal of earth sciences, v. 19, no. 5, May 1982, p.1079-1087, ill.)
References.
ASTIS document number 149314.
ACU

In Northern Manitoba, intersecting grooves 300-1800 m long are ice-scour marks created by dragging of iceberg keels along rises in the bed of a glacial lake whose water plane was at about 305 m asl. The lake was bounded by glacial ice on its northern and eastern margins. The occurrence of scours on topographic divides indicates that a single extensive lake, thought to be a northern extremity of Lake Agassiz, occupied the area as far north as Seal River at the time the ice scours were formed. The lake extended as far west as Sprott Lake and eastwards into the Hudson Bay Lowlands into an area later occupied by Tyrrell Sea. The preservation of the scour marks suggests that the lake drained suddenly. Ice-scour marks are easily recognized on air photographs and provide a means of identifying areas that have been inundated by glacial lakes. Scours in emerged marine sediment are generally obliterated by littoral processes. (Au)

HELIE, R.G.

268
Relict iceberg scours, King William Island, Northwest Territories / Helie, R.G.
(Paper – Canada. Geological Survey, 83- 1B, p. 415-418, figures)
References.
ASTIS document number 122904.
ACU, NFSMO

Emerged relict iceberg scours occur on King William Island, Northwest Territories. These long, shallow troughs are similar to those found in the Lake Agassiz basin, and they represent the presence of a body of water adjacent to a calving ice front. (Au)

HORBERG, L.

269
Intersecting minor ridges and periglacial features in the Lake Agassiz basin, North Dakota / Horberg, L.
(The journal of geology, v. 59, no. 1, Jan. 1951, p. 1-18, ill. (1 folded))
Reviewed by document number 149012.
References.
ASTIS document number 148938.
ACU

Low, intersecting ridges, 3-10 feet high and 75-500 feet wide, with intervening depressions form a fracture pattern which is strikingly revealed on airplane photos of the flat Lake Agassiz plain. The ridges occupy the axial part of the old lake basin and are known to extend from Fargo, North Dakota, northward to well beyond the Canadian boundary. Because the ridges are composed entirely of the underlying lake clays and surface soils, they cannot be explained by ordinary agents, such as wind, waves and currents, or glaciers. It is proposed that the ridges represent frozen-ground structures formed during retreat of the late Wisconsin ice. This is supported by the occurrence of periglacial involutions, fossil ice wedges, and polygonal and network soil patterns in the lake sediments. (Au)

LAVERDIERE, C.

270
Marques d'abrasion glacielles en milieu littoral Hudsonien, Quebec subarctique = Drift ice abrasion marks, littoral zone of Hudson Bay, subarctic Quebec / Laverdiere, C. Guimont, P. Dionne, J.-C.
(Geographie physique et Quaternaire, v. 35, no. 2, 1981, p. 269-275, figures)
References.
English abstract.
Text in French.
ASTIS document number 120448.
ACU

... Coastal rock-platforms, in any area once covered by glaciers, necessarily bear the marks of both glacial ice and drift ice. In the James Bay and Hudson Bay areas, Quebec, drift ice marks are often found superimposed on glacial forms, intersecting them in various manners as well as running parallel to them, and become a real puzzle to the unexperienced observer, especially when the former face different directions, as is most often the case. These marks due to drift ice occur in great number on the basaltic shores of the Manitounouc Islands and of Long Island, in Hudson Bay, where we surveyed them. They are exceptional by their size as well as by their quantity and their direction. They are particularly remarkable on ancient shores, now emerged, especially those of the Tyrrell Sea and even those of glacial lake Barlow-Ojibway. (Au)

LONGVA, O.

271
Plogjespor og mjele pa Romerike [Plough marks and silt at Romerike, Norway] / Longva, O.
(Geolognytt, nr. 17, 1982)
Abstract only.
Paper presented at the 7th National Meeting of the Norwegian Geological Society, Stavanger, Norway, 1981.
Text in Norwegian.
ASTIS document number 159620.

At Romerike, Norway (map sheet number 1915 II – Ullensaker, north of Oslo) plough marks and pits from grounded icebergs are identified. The characteristic white coloured Romerriksmjelen [silt]

was deposited contemporaneously with the ice ploughing, as a blanket of a thickness of 1 meter. This talk will present ideas on formation, depositional environments and time frame [Translation]. (Au)

MOLLARD, J.D.

272

Subaerial expressions of relict ice scour signatures in different environments on mainland Canada / Mollard, J.D.

(National Research Council of Canada Associate Committee on Geotechnical Research Workshop on Ice Scouring, 15-19 February 1982 / Edited by G.R. Pilkington. Technical memorandum - Canada. National Research Council. Associate Committee on Geotechnical Research, no. 136, p. 11-31, ill.)

References.

ASTIS document number 148342.

NFSMO

My main objective in preparing this paper was to bring to the attention of investigators of ice scour signatures and processes those localities in mainland Canada where detailed field studies can be made in order to better understand the relation of ice scour occurrence, intensity and maximum depth of scours, and ice scour formation processes to the differing shearing resistance of bottom materials, to differences in bottom topography, and changes in water depth, among other factors. ... (Au)

NIKIFOROFF, C.C.

273

Origin of microrelief in the Lake Agassiz basin [discussion] / Nikiforoff, C.C.

(The journal of geology, v. 60, no. 1, Jan. 1952, p. 99-103)

Discussion of document number 148938: Intersecting minor ridges and periglacial features in the Lake Agassiz basin, North Dakota / L. Horberg.

References.

ASTIS document number 149012.

ACU

... In a recent and very interesting and thought-provoking paper on presumed periglacial features in the Lake Agassiz Basin, Horberg (1951) describes some of these features and suggests an explanation of their origin. Some of the assumptions on which the interpretation of the field data are based, however, appear to be open to criticism. ... [Here the author, Nikiforoff, discusses several aspects of Horberg's work and outlines those areas he feels are open to dispute. His objections include: the use of the term periglacial] with reference to the area in question after the draining of the lake, which was accomplished well after the withdrawal of the glacier; ... whether it was possible for the sediments of Lake Agassiz to become perennially frozen subsequent to the draining of the lake .... [And finally, he discusses Horberg's proposed origin of the minor ridges which are on the average about 150 feet wide and range from 75 to 500 feet in width and from 3 to 10 feet in elevation. Holberg favors the hypothesis that they might "represent tundra ridges" due to ground-ice wedges. Nikiforoff argues that ice wedges could not be the cause, and favors the simpler conclusion that strong wave action is the most probable cause for the microrelief of Lake Agassiz.] (Au)

WOODWORTH-LYNAS, C.M.T.

274

Ancient iceberg scours / Woodworth-Lynas, C.M.T. Christian, D.

(C-CORE news, v. 9, no. 3, Nov. 1984, p. 2-3, ill.)

ASTIS document number 150789.

ACU, NFSMO

Some fascinating results of a pilot study on iceberg scours on King William Island, N.W.T., have been found following a short ten-day field trip in late August .... Relict iceberg scours, now raised above sea level, were recently discovered by R. Helie of the Geological Survey of Canada during a season of geological mapping. The scours, about 8,000 years old, are thought to have been incised into what was then the seafloor by large icebergs which had calved and drifted northwards from part of the Laurentide Ice Sheet during its final disintegration at the end of the Ice Age. Water depths at that time stood at about 120 m; since then the scours have emerged, largely due to isostatic rebound of the earth's crust as the great weight of the Laurentide Ice Sheet was removed, and are presently at about 10-20 m above modern sea level. ... Detailed analysis of our findings hopefully will shed new light on the scouring process in sandy and bouldery soils, and may provide corollaries to the scouring process on the Grand Banks in particular where large areas of the scoured seabed also consist of sand with gravel and cobbles. (Au)

275

Iceberg scours : what do they really look like? / Woodworth-Lynas, C.M.T. Day, T. Christian, D. Seidel, M.

(Iceberg research, no. 9, Jan. 1985, p. 10-14, ill.)

References.

ASTIS document number 166782.

ACU, NFSMO

... Because of our present inability to study individual scours on the continental shelf areas, we elected in this study to make a detailed investigation of scours on King William Island, Northwest Territories, Arctic Canada .... We chose this perhaps unlikely location over the Lake Agassiz scours because the scours were generated by icebergs (which is relevant to our east coast seabed studies) rather than by sea or lake ice; the scours were made at about 8800-8600 years B.P. (Helie, 1983), which is a similar age for many of the scours on the eastern Canadian shelf; the water depth at the time was about 120 m (Helie, 1983), also similar to present depths on the Labrador shelf and Grand Banks; the scours are developed in bouldery silty sand, analagous to areas on parts of the modern east coast shelf. We anticipated that because they are now in soils subjected to permafrost (which was at about 1 m depth in the scour we studied in late August), primary structures associated with the scours would perhaps be better preserved than in scoured areas where there is no permafrost and where annual freeze/thaw might modify and destroy such structures. ... We reconnoitered seven scours and selected one for detailed study .... This scour is about 12 m above sea level and has an average width of 43 m and average apparent depth of 1.3 m. We surveyed the scour over a total distance of about 660 m, although the scour is about 1.8 km long. ... (Au)

276

Relict ice scour study, King William Island / Woodworth-Lynas, C.M.T.

[12] leaves : ill. ; 28 cm.

Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.

Indexed from a preliminary draft, July 1985.

Proceedings to be published as an ESRF Report in late 1985.

ASTIS document number 163627.

This paper describes a relict ice scour found on King William Island, N.W.T., studied in the expectation that its geophysical properties and regional geology will be analogous to those of offshore ice scours occurring today. (ASTIS)

GENERAL

ARCTIC OIL AND GAS RECOVERY RESEARCH PLANNING WORKSHOP, ALBUQUERQUE, N.M., 30 JUNE-2 JULY, 1980

277
Report of the Workshop on Arctic Oil and Gas Recovery held at Sandia National Laboratories, Albuquerque, N.M., 30 June-2 July, 1980 / Arctic Oil and Gas Recovery Research Planning Workshop, Albuquerque, N.M., 30 June-2 July, 1980. Sackinger, W.M. [Editor]. United States. Dept. of Energy [Sponsor].
Washington, D.C. : U.S. Dept. of Energy, Office of Oil [publisher] ; Springfield, Va. : National Technical Information Service [distributor], 1980.
1 microfiche ; 11 x 15 cm.
(NTIS DOE-ET-14317)
Submitted as Final Report for contract no. DE-ACOI-80ET14317.
ASTIS document number 149829.
NFSM

The overall objectives of the workshop were to answer the following questions: 1. What are the problems crucial for the production of oil and gas from the Arctic offshore? 2. What needs to be done to solve these problems? ... To accomplish these workshop objectives, workshop participants were divided into two working groups: ice and soils. The ice-related group evaluated ice and oceanographic considerations, and compiled a list of research topics without assigning priorities or discussing responsibility for conducting research. The soil working group first compiled a detailed outline of important problem areas relating to soil behaviour and then prepared, from the outline, a working text concentrating on crucial problem areas only. ... "Crucial" was taken to mean "critically needed within a specific time frame for a problem that has not been solved before and cannot be easily solved with current technology". ... An attempt to establish relative importance and a time frame was made after the workshop through the use of a survey form. The form and a summary of its results, and a discussion of its implications, are given. ... (Au)

BARRIE, J.V.

278
Ice scour : methods of analysis / Barrie, J.V. Woodworth-Lynas, C.M.T.
(A short course on the sediment stability of Canadian shelves, March 9-10, 1982 / Edited by J.V. Barrie. C-CORE publication, no. 82- 10, 1984, p. 83-96)
(Technical report – Memorial University of Newfoundland. Centre for Cold Ocean Resources Engineering)
ASTIS document number 149950.
NFSMO

The understanding of scour frequency and the mechanism of the ice/seabed interaction is critical to design criteria for seabed installations. The paper discusses a number of methods for analyzing iceberg scours. (NFSMO)

BENOIT, J.

279
Iceberg scours I / Benoit, J. Chari, T.R. El-Tahan, M.S.S.
(Iceberg Management in Offshore Exploration, Production and Transportation. – [St. John's, Nfld. : Memorial University, Faculty of Engineering and Applied Science, 1982], p. 148-160, ill.)
References.
ASTIS document number 150746.
NFSMO

... This paper will review the present knowledge on the mechanics of iceberg scouring. Recent work has been performed in the Beaufort Sea and on the Canadian Eastern Seaboard and will be reviewed. Although very little data have been gathered to understand how the wind, currents and waves affect the scouring process, a review of existing knowledge will be presented. Furthermore, one of the most important parameters in estimating the effects of scouring is information on the draft of an iceberg. A method of estimating the draft will be presented. Finally, a review of the available mathematical and laboratory models for iceberg scour studies will be presented. The physics of each model and their limitations will be discussed. (Au)

BLASCO, S.M.

280
Ice scour terminology / Blasco, S.M.
[4] leaves ; 28 cm.
Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.
Indexed from a preliminary draft, July 1985.
Proceedings to be published as an ESRF Report in late 1985.
ASTIS document number 167762.

Geomorphologists, geologists, statisticians, and engineers are all studying ice scour from different perspectives, each needing their own terminology. This situation has resulted in ambiguities in the literature. The author makes the following recommendations to alleviate this problem: (1) recognize the need for a variety of terms, (2) define the terms used within reports, publications, etc., to avoid ambiguity. He has also prepared a short list of terms that require differentiation, and a list of database parameters. (ASTIS)

CAULFIELD ENGINEERING LTD.

281
Development of processing costs & specification for classifying ice scour from sidescan data via computer / Caulfield Engineering Ltd. Dome Petroleum Limited [Sponsor].
Sherwood Park, Alta. : Caulfield Engineering, 1980.
14, [5] leaves ; 28 cm.
Job no. 1013.
ASTIS document number 149276.

In order to develop realistic processing costs for automatically detecting changes in ice scour patterns from year to year some detailed specifications on the process must be developed along with a sample record to illustrate that the specifications are adequate. This work statement defines most of the problem areas and outlines procedures and cost for determining adequate specifications. Because of the research nature of the effort all of the specifications might not be defined in this work effort. However, the generation of a sample output comparing two adjacent lines should isolate all major problems and test the specifications. (Au)

DAY, T.

282
Paleomagnetic observations from core samples taken from an iceberg scour / Day, T.
[3] leaves ; 28 cm.
Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.
Indexed from a preliminary draft, July 1985.
Proceedings to be published as an ESRF Report in late 1985.
ASTIS document number 163490.

Paleomagnetism is usually used in the dating of sediments or in correlating the dates of sediments. The normal method on core samples is to measure the remnant magnetism inclination or declination at several locations along the core. ... [The author has] tried to extend this principle and use remnant magnetism as a strain marker. ... the remnance is used to determine the depth beneath the bottom of an iceberg scour that the deformation extends to. ... (Au)

GOODWIN, C.R.

283
The ESRF/ASTIS Ice Scour Bibliography / Goodwin, C.R.
[3] leaves ; 28 cm.
Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.
Indexed from a preliminary draft, July 1985.
Proceedings to be published as an ESRF Report in late 1985.
ASTIS document number 166367.

Describes the ESRF/ASTIS Project and the Ice Scour Bibliography that ESRF/ASTIS is preparing. (ASTIS)

INTERNATIONAL SYMPOSIUM ON THE GEOLOGICAL ACTION OF DRIFT ICE, 1ST, QUEBEC CITY, QUEBEC, 20-24 APR., 1973

284
First Symposium on the Geological Action of Drift Ice, Quebec, Canada, April 20-24, 1974 [sic] / International Symposium on the Geological Action of Drift Ice, 1st, Quebec City, Quebec, 20-24 Apr., 1973. Universite du Quebec [Sponsor]. Institut national de la recherche scientifique (Quebec) [Sponsor].
(Maritime sediments, v. 9, no. 3, Dec. 1973, p. 104-115)
Abstracts only.
Abstracts in French and English for some papers only.
ASTIS document number 149713.
ACU

This symposium was held at the Complexe Scientifique, under the auspices of the Universite du Quebec and the Institut National de la Recherche Scientifique. ... [Topics discussed at the symposium included: sedimentary structures and drift ice, ice action and frost and the development of beaches, glacio-marine deposits, coastal sedimentation drift ice features and effects, ice-made boulder fields, ice scouring, and ice rafting.] (Au)

LEVER, J.H.

285
DIGS : ice dynamics / Lever, J.H.
[6] leaves : ill. ; 28 cm.
Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.
Indexed from a preliminary draft, July 1985.
Proceedings to be published as an ESRF Report in late 1985.
ASTIS document number 163635.

[This paper outlines procedures developed during the DIGS (Dynamics of Iceberg Grounding and Scouring) experiment that are useful in monitoring iceberg motion during a scouring event.] ... A sensor package was developed for these measurements .... This unit is approximately one metre in diameter and includes a six degree of freedom sensor package with three linear accelerometers, two tilt sensors and a compass. The sensor outputs are recorded directly on an eight channel tape deck and the entire package is enclosed in a water tight sealed hemisphere. The package can be deployed by helicopter on to very small ice masses. This package was field tested off Labrador [in summer 1984] .... (Au)

LEWIS, C.F.M.

286
The distribution and shape variability of iceberg scour marks on Canadian continental shelves / Lewis, C.F.M. Josenhans, H.W. Fader, G.B. MacLean, B. d'Apollonia, S.J. Barrie, J.V.
(Joint Oceanographic Assembly, poster abstracts. – Halifax, N.S. : [s.n.], 1982, v. 2, p. 40)
Document not seen by ASTIS.
ASTIS document number 149942.

287
Methods to detect seabed ice scour and to estimate frequency of ice scouring / Lewis, C.F.M. Barrie, J.V.
(Iceberg Management in Offshore Exploration, Production and Transportation. – [St. John's, Nfld. : Memorial University, Faculty of Engineering and Applied Science, 1982], p. 146)
Abstract only.
ASTIS document number 150738.
NFSMO

The abstract lists methods of detecting ice scour, statistical distribution of scours, methods of estimating grounding frequency and factors influencing scouring. The need and applications of this research are directed toward the estimation of: "1. Risk of impact on seabed structures by ice keels, 2. Trenching depth requirements for seabed pipelines and cables." (NFSMO)

LIVINGSTONE, W.

288
Ice scour research : long term plan / Livingstone, W.
[11] leaves : ill. ; 28 cm.
Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.
Indexed from a preliminary draft, July 1985.
Proceedings to be published as an ESRF Report in late 1985.
ASTIS document number 163570.

[This paper outlines the ESRF Ice Scour Committee's long term research plan.] ... The sea bottom ice scour committee is unique in the sense that ice scour has been identified and perceived as a priority topic in both the Beaufort Sea and the east coast offshore regions. ... In presenting the plan the ice scour committee has taken a very simple approach. The plan is broken down into two components aimed at providing answers to basic questions with regard to ice scour. In other words, how deep are the scours, and how often do they occur? (Au)

NATIONAL RESEARCH COUNCIL (U.S.). MARINE BOARD. COMMISSION ON ENGINEERING AND TECHNICAL SYSTEMS

289
Understanding the arctic sea floor for engineering purposes / National Research Council (U.S.). Marine Board. Commission on Engineering and Technical Systems.
Washington, D.C. : National Academy Press, 1982.
141 p. : ill. ; 28 cm.
(Special report – U.S. Army. CRREL, 83- 25)
(NTIS AD-A-119 773)
References.
ASTIS document number 149977.
ACU

... This report identifies and assesses those arctic seafloor phenomena that influence the design and operation of facilities and platforms for exploring and producing oil, gas, and hard minerals both on and under the sea floor. It also identifies knowledge that is needed of seafloor phenomena and conditions, and, for several areas of major concern, recommends special research. These recommendations are intended to enhance the ability of the engineer and operator to anticipate and avoid problems that may be posed by seafloor and coastal phenomena, and guard against the effects of such events as thaw subsidence and erosion. (Au)

NATIONAL RESEARCH COUNCIL OF CANADA ASSOCIATE COMMITTEE ON GEOTECHNICAL RESEARCH WORKSHOP ON ICE SCOURING, MONTEBELLO, QUEBEC, 15-19 FEB., 1982

290
National Research Council of Canada Associate Committee on Geotechnical Research Workshop on Ice Scouring, 15-19 February 1982 / National Research Council of Canada Associate Committee on Geotechnical Research Workshop on Ice Scouring, Montebello, Quebec, 15-19 Feb., 1982. Pilkington, G.R. [Editor]. National Research Council Canada. Associate Committee on Geotechnical Research. Snow and Ice Subcommittee [Sponsor].
Ottawa : NRC, Snow and Ice Subcommittee, 1985.
251 p. : ill. ; 29 cm.
(Technical memorandum – Canada. National Research Council. Associate Committee on Geotechnical Research, no. 136)
Appendices.
References.
ASTIS document number 148326.
NFSMO, ACU

... One of the challenges for Canadians is to add to the normal scope of ocean engineering that knowledge, technology, techniques and know-how necessary to work effectively and safely in ice-affected waters. A major challenge in this regard is to determine the characteristics of large ice masses such as icebergs, ridges and ice islands, and their effects, particularly on the ocean floor, so that these can be taken into proper consideration in the design, construction and operation of offshore structures and in resource exploration and exploitation activity. [This workshop was organized to share the state-of-the-art information on ice scouring covering recent work being done in Canada and the U.S.; and to discuss complementary topics which are relevant to ice scour research.] ... (Au)

PILKINGTON, G.R.

291
Overview of methods of estimating ice scour frequency and risk / Pilkington, G.R.
[6] leaves ; 28 cm.
Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.
Indexed from a preliminary draft, July 1985.
Proceedings to be published as an ESRF Report in late 1985.
ASTIS document number 166561.

One of the most important factors in the burial of pipelines in arctic oceans is the estimation of the return period of ice ridges with keels sufficiantly deep to cause damage. Various physical models have been discussed at this workshop which seem ideal for understanding processes taking place. However, in risk assessment where the problem of estimating the return period of ice keels arises, these models may have certain limitations. For example, statistical information forms the parameters that are entered into the models and these may not be as well known as the results that are being predicted. In the Beaufort Sea for instance, the statistics of ice keel distributions, of ice keel shapes and of soil interactions are not as well known as the actual number of scours on the seafloor or the distribution of scours on the seafloor. This argument tends to suggest that statistical methods of obtaining return periods are preferable ... (Au)

TARR, R.S.

292
The arctic sea ice as a geological agent / Tarr, R.S.
(American journal of science. Fourth series, v. 3, no. 15, 1897, p. 223-229)
ASTIS document number 150029.
NFSMO

Floating in the Arctic waters there are two kinds of ice – the sea-made, and the glacier ice. The former develops in the autumn, first freezing over the protected fjords and bays, and later covering the greater part of the Arctic sea. As it freezes it encloses the glacier ice and consolidates the entire water surface into one mass of ice, which remains in this state until spring. The sea-made ice attains a depth of only a few feet, averaging perhaps fifteen or twenty feet. The wind, waves and currents move it about somewhat even in the winter, and by breaking it and piling the fragments on one another make the surface very irregular, greatly increasing the depth of some of the cakes. Moved by the tides and winds, it grinds against the shore and the shallow bottom, thus doing much work of erosion. ... Near the glaciers which end in the sea, the surface of the fjords is littered with ice that has been derived from the glacier front. ... After leaving the glacier front, in the course of its life history, the berg in all probability becomes stranded once or perhaps several times. Each time it touches the bottom it strikes a direct and heavy blow, and then, breaking slightly as the jar passes through it, and perhaps even falling into fragments, it rocks backward and forward in its effort to regain a stable position, thus striking the bottom again and again, and undoubtedly stirring up much mud by means of the disturbance of the water. ... (Au)

WRIGHT, B.D.

293
Joint Industry/Government Working Group on Ice Scour / Wright, B.D.
(APOA review, v. 3, no. 1, Mar. 1980, p. 7, ill.)
ASTIS document number 148318.
ACU

... The Working Group's mandate is to: (1) Identify the needs for ice scour knowledge in ice-infested waters, review current and

proposed research programs relevant to these needs, and report to the committee on the adequacy of Canadian activity in this field. (2) Identify the additional research programs that are required to obtain an adequate level of knowledge on which the design of safe production systems can be based. (3) Promote Canadian expertise in ice scour research by encouraging information exchange, cooperative program planning and operations, and by arranging for the coordination of these activities. Since the ice scouring concern is common to the geographically distinct Beaufort Sea, Arctic Islands and East Coast regions, the Working Group membership is quite diversified and represents complimentary expertise from different operators and various government agencies. ... In general terms, the following four complimentary research approaches to the scour problem have been identified by the Working Group: (1) Assessment of contemporary ice scouring by repetitive seafloor mapping and scour dating. (2) Statistical and theoretical analysis on the distribution and morphology of observed seafloor scours and related processes. (3) Statistical predictions of seafloor scouring based on the distribution and movement of extreme ice features. (4) Application of scour models describing ice/seafloor interactions. ... (Au)

THEORY AND MODELLING

294

APOA project review : project 150

(APOA review, v. 7, no. 2, Fall 1984, p. 25-26, ill.)

Project title: Laboratory model tests of sea floor scouring by ice features.

Report title: Model tests of sea bottom scouring.

Report by: ARCTEC Canada Limited.

Operator: Petro-Canada Exploration Inc.

ASTIS document number 148172.

ACU

The objectives of the test program were fourfold. First, to measure the force required for an ice mass to scour under different conditions; second, to measure the pressure on the scouring surface and in the surrounding soils; third to observe the behaviour of soils displaced by the moving ice mass models under various conditions; and lastly, to correlate laboratory results with other model testing and field measurements. The model tests were conducted at the ARCTEC hydraulic basin near Ottawa. The program was divided into three phases corresponding to three soil types (fine sand, sandy silt, and silty clay) simulating different sea-bed conditions. The tests were varied during the experiments in four different ways. These involved: two different ice keel models, a rectangular prismatic shape, and a pyramid shape, two different sizes of each model shape, three different cutting depths, and three different towing speeds. ... The principal measurements taken into account in the analysis included cut depth and trench characteristics; friction, resistance force and pressure measurements at various points; and stress transmission and soil strength. (Au)

295

Risk assessment & pipeline trench depths

(National Research Council of Canada Associate Committee on Geotechnical Research Workshop on Ice Scouring, 15-19 February 1982 / Edited by G.R. Pilkington. Technical memorandum - Canada. National Research Council. Associate Committee on Geotechnical Research, no. 136, p. 231-244)

References.

ASTIS document number 148474.

NFSMO

... [This paper reviews those papers presented at the Workshop on Ice Scouring which covered methods of calculating pipeline trench depths to avoid the ice scouring problem.] The methods can be divided into three general categories involving: (1) measurements or observations of the seabed soils (2) ice keels statistics (3) ice scour statistics. ... (Au)

ABDELNOUR, R.

296

Model tests of sea bottom scouring / Abdelnour, R. Lapp, D. Haider, S. Shinde, S.B. Wright, B.D.

(POAC 81 : the Sixth International Conference on Port and Ocean Engineering under Arctic Conditions, Quebec, Canada, July 27-31, 1981, proceedings. - Quebec City, Quebec : Universite Laval, 1981, v. 2, p. 688-705, figures, tables)

A discussion of this paper can be found on p. 1540 of POAC 81, volume 3.

References.

ASTIS document number 148113.

ACU

A series of model scale tests of ice sea bottom scouring were conducted as part of the Arctic Petroleum Operator's Association project to acquire experimental data on: (1) scouring resistance forces (2) pressure distribution in the soil (3) pressure distribution on the model front face (4) shape and characteristics of the scour profile. The test variables included two model scales of 1:25 and 1:50, two model shapes, an inverted pyramid and a prism; three soil materials, sand, sandy silt and silty clay. Each of these parameters were tested at three cut depths in a levelled soil bottom with three towing velocities. (Au)

ALLAN, D.

297

Iceberg scour damage risk assessment : Labrador Sea and Grand Banks / Allan, D.

[14] leaves : ill. ; 28 cm.

Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.

Indexed from a preliminary draft, July 1985.

Proceedings to be published as an ESRF Report in late 1985.

ASTIS document number 163422.

This presentation ... [reviews] some of the recent work done by Petro-Canada to assess the risk of iceberg scour damage to subsea installations and pipelines. The final objective of this work is to determine the burial depths or alternate protective measures required to provide an acceptable level of scour damage risk for subsea facilities required for development of Petro-Canada operated discoveries in the Labrador Sea and the Grand Banks. An overview of the risk assessment approach will be reviewed. Differences in risk assessment for intra-field subsea facilities and pipelines to shore will be discussed. Methodologies for determining the probability of iceberg scour damage will be outlined. ... (Au)

ARCTEC CANADA LIMITED

298

Model tests of sea bottom ice scouring / Arctec Canada Limited. Abdelnour, R. Lapp, D.

[Calgary, Alta. : Distributed by APOA], 1980.

5 microfiches : figures, tables ; 11 x 15 cm.

(APOA project no. 150 : Laboratory model tests of sea floor

scouring by ice features. Report)
References.
ASTIS document number 148199.
ACU

A series of small scale tests of ice sea bottom scouring were conducted to acquire experimental data on: scouring resistance force, pressure distribution in the soil, pressure distribution at the model front face, shape and characteristics of the scour profile. The work conducted included two model scales of 1:25 and 1:50; two model geometries, a pyramid and a prismatic; three soil materials, sand, sandy silt and silty clay. Each of these parameters were tested at three cut depths in a levelled soil bottom and with three towing velocities .... The following applications are envisioned from results of this study: (1) estimating for a given location, the maximum scour depth as well as recurrence intervals for a range of scour depths (2) predicting the effectiveness of natural and artificial underwater barriers ... in stopping the movement of deep draft ice features and consequently determining the depth of burial of a pipeline or establishing the depth of a glory hole for the installation of a sub-sea facility (3) verifying the theoretical model of APOA #69 ... (4) defining the parameters needed for scour prediction and incorporating these requirements into future offshore ice and geotechnical surveys (5) planning full scale field tests, if necessary. (Au)

BANKE, E.G.

299
Iceberg avoidance research is tricky / Banke, E.G.
(Offshore resources, v. 1, no. 4, Winter 1983, p. 14-15)
References.
ASTIS document number 139637.
ACU, NFSMO

... The dynamic iceberg drift model developed at the Bedford Institute of Oceanography, Dartmouth, Nova Scotia, by Dr. S.D. Smith has been applied to a number of selected iceberg drift tracks in order to reach conclusions on the following: (a) Suitability of operational data for hindcast modelling of iceberg drift tracks. (b) Quantity of data required to estimate drag coefficients from drift track. (c) Effect of rotating wind drag direction relative to wind direction. (d) Variability of drag coefficients of icebergs, as estimated by hindcast modelling. (e) Relative influence of winds and currents in causing iceberg drift. (f) Effectiveness of actual towing of icebergs, as opposed to modelled tracks with tow force deleted. (g) Estimates of bottom-scouring forces during an observed grounding event. ... Despite valiant efforts, (including Martec's adaption of the model to run on a mini computer) to make dynamic modelling of iceberg drift a useful tool on offshore drill rigs, general acceptance of modelling by the oil industry has been slow .... (Au)

BASS, D.W.

300
Hydrodynamic forces and iceberg stability / Bass, D.W.
Peters, G.R.
[5] leaves : ill. ; 28 cm.
Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.
Indexed from a preliminary draft, July 1985.
Proceedings to be published as an ESRF Report in late 1985.
Presentation summarised by Dr. T.R. Chari.
References.
ASTIS document number 163465.

... [This paper briefly covers a project involving] a computer simulation of a basic iceberg shape representing a stable berg. Portions of this basic shape are sliced off and the new stable position is computed. In the course of this work, some interesting results were obtained which indicate that the draft of an iceberg could be increased by as much as 50% through instability, rolling and rotation. ... (Au)

BENEDICT, C.P.

301
Iceberg incursion probabilities into subsea structures / Benedict, C.P. Lewis, J.K.C.
(The Seventh International Conference on Port and Ocean Engineering Under Arctic Conditions. – Espoo, Finland : Technical Research Centre of Finland, 1983, v. 1, p. 273-279, figures)
References.
ASTIS document number 129607.
NFSMO

This paper presents a method for describing analytically the distribution of iceberg drafts at a particular latitude and of combining this with site bathymetry and iceberg flux data to calculate incursion probabilities and mean times between incursions as a function of site design parameters. (Au)

CANADIAN MARINE ENGINEERING LTD.

302
Assessment of risk to seabed installations at Gulf drillsites / Canadian Marine Engineering Ltd. Gulf Canada Resources Inc. [Sponsor].
[S.l.] : Canadian Marine Engineering Ltd., 1983.
1 v. (loose-leaf) : ill ; 28 cm.
(Report – Canadian Marine Engineering Limited, no. 1022)
Appendices.
References.
ASTIS document number 149136.

This work comprises the initial phase of a larger study to investigate and update the estimates of risk to seabed structures from ice scouring in the Canadian Beaufort Sea. The scope for this initial phase was to review existing data and the different techniques for calculating the risk to seabed installations to update the estimates of risk for wellheads and to a somewhat lesser degree for pipelines in the Canadian Beaufort Sea. ... (Au)

CHARI, T.R.

303
An analytical model and laboratory tests on iceberg sediment interaction / Chari, T.R. Allen, J.H.
(Oceans '74 : IEEE International Conference on Engineering in the Ocean Environment. – New York : Institute of Electrical and Electronic Engineers, Inc., 1974, v. 1, p. 133-136, figures)
References.
ASTIS document number 148792.
ACU, NFSMO

... This paper describes a laboratory phase of the iceberg grounding studies currently in progress. (Au)

304
Environmental factors affecting iceberg scour estimates / Chari, T.R. Peters, G.R. Muthukrishnaiah, K.
(Proceedings – Symposium on Iceberg Dynamics, St. John's, Newfoundland, June 3-4, 1979. Cold regions science and technology, v. 1, no. 3-4, Feb. 1980, p. 223-229, figures)
References.
ASTIS document number 148210.

ACU, NFSMO

The mechanics of iceberg grounding can be modelled mathematically and scour sizes estimated. However, such estimates will not be realistic unless the various environmental parameters influencing the phenomenon are determined to a reasonable degree of accuracy. The scouring potential of an iceberg depends on its size, shape, drift velocity and the drag coefficient. Similarly, the scour size depends on the sediment type, its shear strength and the bathymetry. This paper describes the mathematical model and the influence of the different variables on the scour size estimates. A correlation is attempted between the model and reported scour observations. (Au)

305

Estimates of iceberg scour depths / Chari, T.R. Peters, G.R.

St. John's : Faculty of Engineering and Applied Science, Memorial University of Newfoundland, 1981.

11p. : ill., figures, tables ; 28cm.

(Proceedings of the Symposium Production and Transportation Systems for the Hibernia Discovery, St. John's, Newfoundland, Canada, February 16-18, 1981 / Edited by W.E. Russell and D.B. Muggeridge. – St. John's, Nfld. : Petroleum Directorate, Government of Newfoundland and Labrador, 1981, p. 178-188, ill.)

References.

ASTIS document number 69515.

NFSMO

The maximum depth of iceberg scour at any location can be estimated using the basic concepts of geotechnical engineering and the principle of energy balance. The water depth will, to a large extent, control the magnitude of the scour problem by limiting the size of the berg likely to ground. The shape of the iceberg keel, the type of the seabed sediment and the coefficient of hydrodynamic drag between the iceberg and ocean currents are the major factors influencing the scour size. (Au)

306

Geotechnical aspects of iceberg scours on ocean floors / Chari, T.R.

(Canadian geotechnical journal, v. 16, no. 2, May 1979, p. 379-390, ill., map, photos.)

Appendix.

References, p.386-387.

ASTIS document number 31860.

ACU, NFSMO

... This paper describes a simple analysis for iceberg grounding and scouring of ocean floors. Theoretical and laboratory results are presented and compared with the limited field data available at present. (Au)

307

Ice scour modelling / Chari, T.R.

[S.l. : s.n., 1985].

[4] leaves : ill. ; 28 cm.

Proceedings in press.

Paper presented at Workshop on Ice-Seabed-Structure Interaction, Second Canadian Conference on Marine Geotechnical Engineering, Halifax, N.S., Canada.

Photocopy.

ASTIS document number 159727.

Dr. Chari discusses certain aspects of modelling iceberg scours and testing the model in a laboratory tank, and how different types of models play a role in predicting iceberg scours. (ASTIS)

308

Iceberg grounding – a preliminary theory / Chari, T.R. Allen, J.H.

(Applications of solid mechanics : proceedings of the Symposium held at the University of Waterloo June 26 and 27, 1972 / Edited by R.G. Charlwood, D.S. Weaver and B. Tabbarok. – Waterloo, Ont. : University of Waterloo, Solid Mechanics Division, 1972, p. 81-95, ill.)

References.

ASTIS document number 149594.

NFSMO

...An understanding of the mechanics of grounding of icebergs is of considerable importance in planning the exploitation of resources from Canada's Eastern seaboard. The paper considers a regular prismatic shaped iceberg grounding on the fluvial marine sediments typical of Newfoundland waters. It is shown that the kinetic energy would be absorbed by horizontal shear into the sediments and a preliminary theory is presented. Some of the problems associated with analysis of iceberg grounding are discussed. ... It is possible to estimate the zone of gouging of an iceberg under idealized conditions, but further work on the value and influence of the various parameters is required before it can find practical application. (Au)

309

Iceberg grounding problems in the North Atlantic / Chari, T.R. Allen, J.H.

(Proceedings of the Second International Conference on Port and Ocean Engineering under Arctic Conditions / Edited by T. Karlsson. – Reykjavik, Iceland : University of Iceland, Dept. of Engineering and Science, 1973, p. 608-616, ill.)

References.

ASTIS document number 149586.

NFSMO

This paper outlines some aspects of grounding icebergs, and describes an analytical model for a simple, block-shaped idealized berg. Initial laboratory test results show that the assumptions in the analytical model of iceberg scouring are correct for the front face and bottom. Further tests are being undertaken. (NFSMO)

310

Iceberg scour studies in medium dense sands / Chari, T.R. Green, H.P.

(POAC 81 : the Sixth International Conference on Port and Ocean Engineering under Arctic Conditions, Quebec, Canada, July 27-31, 1981, proceedings. – Quebec City, Quebec : Universite Laval, 1981, v. 2, p.1012-1018, figures, table)

References.

ASTIS document number 148121.

ACU, NFSMO

The problem of iceberg scours on Canada's east coast is a major hazard in the extraction of the offshore hydrocarbon resources. Various production systems which take into account the severe environmental factors such as the heavy seas, ice and icebergs are under consideration for the Hibernia field on the Grand Banks. In any system, all seafloor structures are to be located below the zone of iceberg scours. However, the estimation of the maximum scour depths is still an aspect of the problem not fully understood. A model for iceberg scouring in clays has been suggested earlier and is now modified to include cohesionless soils. Laboratory tests were conducted with a 50 cm wide model, using medium dense sand as the representative seabed material. Results of these experiments are discussed. (Au)

311
Iceberg scours III / Chari, T.R.
(Iceberg Management in Offshore Exploration, Production and Transportation. – [St. John's, Nfld. : Memorial University, Faculty of Engineering and Applied Science, 1982], p. 161)
Abstract only.
ASTIS document number 150754.
NFSMO

The maximum depth to which a grounding iceberg scours the seafloor depends on factors such as the iceberg size, the type of the seabed, and other environmental factors such as the bathymetry and ocean currents. Mathematical analysis and physical model tests show that a grounding iceberg creates a zone of disturbance during the scouring process below the bottom of the scour trench. Soil pressure is developed during such a disturbance. This phenomenon has to be considered in the design of seabed structures and in the computation of the safe burial depths. The magnitude of the soil pressure below a scouring iceberg depends on the actual mechanics of ploughing. ... (Au)

312
Iceberg threat to ocean floor structures / Chari, T.R. Muthukrishnaiah, K.
(Proceedings : IAHR Symposium on Ice Problems, 5th, Lulea, Sweden, 7-9 August, 1978, pt. 1. – Lulea, Sweden : International Association for Hydraulic Research, 1978, p. 421-434, ill.)
References.
ASTIS document number 149810.
NFSMO

... This paper describes a model for the ocean floor scouring by icebergs. ... A schematic of the types of iceberg threat and possible preventive measures is presented .... A theoretical model and the laboratory verification of the scouring mechanics of an iceberg of idealized shape are described. Reported measurements of actual scours on the ocean bottom are as long as 3 km and 6 meters deep. Calculations using the proposed model compare very well with actual measurements reported. ... (Au)

313
Memorial University of Newfoundland engineering studies / Chari, T.R.
[16] leaves : ill. ; 28 cm.
Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.
Indexed from a preliminary draft, July 1985.
Proceedings to be published as an ESRF Report in late 1985.
References.
ASTIS document number 163473.

This presentation is a review of research on iceberg scour modelling that has been ongoing for several years in the Faculty of Engineering and Applied Science at Memorial University. The focus of this talk is the rolling of icebergs and the subsequent forms that are left on the seabed. [Research utilized mathematical and physical models to predict effects on bottom sediments and pipelines]. (Au)

314
Model studies of iceberg scouring / Chari, T.R.
(POAC 77 : proceedings / Edited by D.B. Muggeridge. – St. John's, Nfld. : Ocean Engineering Information Centre, Memorial University of Newfoundland, 1977, v. 2, p. 775-783, ill.)
References.
ASTIS document number 149551.
ACU, NFSMO

... Iceberg threat to an offshore operation could be in the form of a direct hit or scouring of the ocean floor in the process of grounding. Published observations as well as surveys conducted by exploration companies suggest the presence of definite scour marks on the surface sediments. Scours 3 km. long have been reported (Harris and Jollymore 1974) and attributed to icebergs. However, these scours may not be recent and could have been caused by large icebergs thousands of years ago. To establish the relevance of the measured scour sizes to the present day iceberg sizes, an understanding of the process and mechanics of scouring is necessary. Analytical and laboratory modelling of iceberg scouring is one of the current projects in Ocean Engineering research at Memorial University. Some of the results are presented in this paper. The possibility of occurrence of long scours for present day iceberg sizes is explained in the light of the proposed model. (Au)

315
Model studies of ocean floor scouring by icebergs / Chari, T.R. Muthukrishnaiah, K.
(Proceedings of the Conference on Applied Techniques for Cold Environments, Anchorage, Alaska, 17-19 May, 1978. – New York : American Society of Civil Engineers, 1979, v. 2, p. 828-839, figures)
References.
ASTIS document number 149020.
ACU, NFSMO

... On the Canadian east coast, where oil and gas finds are encouraging, these icebergs pose, not only a threat of a direct hit with the offshore rigs, but also scouring of the ocean bottom installations in the process of grounding. Instances where icebergs damaged B.O.P. stacks of exploration wells and transatlantic cables have been reported. Side-scan sonar observations indicate the possibility of scour lengths in the order of kilometers and as deep as 5 to 6 meters. To understand the mechanism of iceberg scouring, an idealized iceberg was assumed to gouge into a uniformly sloping ocean floor. The consequent length and depth of the scour was computed by equating the initial energy of the iceberg to the resistance of the ocean floor soil. The same model was tested in a laboratory tank. The model was instrumented and towed into an artificially formed soil slope. Soil pressure on the different faces of the model was continuously monitored. From the laboratory results, the analytical model was indirectly validated. Calculations using the proposed hypothesis for the ocean floor scouring by icebergs compare well with actual scour measurements, giving further credibility to the model, under assumed conditions. Details of the iceberg scour model and the laboratory results are presented in this paper. (Au)

316
A model study of iceberg scouring in North Atlantic / Chari, T.R. Guha, S.N.
(Tenth Annual Offshore Technology Conference 1978, proceedings. – Dallas, Tex. : Offshore Technology Conference, 1978, v. 4, p.2319-2326, ill.)
References.
ASTIS document number 149535.
ACU, NFSMO

... This paper describes an analytical model for the iceberg scouring in which an idealized berg ploughs into a gentle slope of soft ocean-floor soil. Theoretical equations were obtained for the scour size. An instrumented laboratory model was pushed into an artificial slope of soft sediment in a glass-sided tank, thus reproducing the scouring phenomenon. These experiments verified the assumptions of the analytical model. Results obtained for the above model compare well with the scour sizes reported for typical weak surficial sediments. It is hoped that prediction of maximum scour depths would help placing bottom installations well below the zone of possible damage. Description of the analytical model, the details of laboratory tests, as well as the correlation of the measured and

predicted values are given in this paper. Extension of this analysis for possible protection of production platforms from a direct iceberg hit also is indicated. (Au)

317
A model study of iceberg scouring in the North Atlantic / Chari, T.R.
(Journal of petroleum technology, v. 32, no. 12, Dec. 1980, p.2247-2252, figures)
References.
ASTIS document number 90921.
ACU, NFSMO

A model has been developed to predict the maximum depth of iceberg scour in the north Atlantic Ocean. A prior knowledge of the environmental parameters – such as the bathymetry, seabed properties, iceberg dimensions, and ocean current data – would be required to compute safe burial depth for blowout preventer stacks and pipelines. (Au)

318
Resistance of sediments to iceberg scouring / Chari, T.R. Allen, J.H.
(New frontiers in geotechnical engineering : preprints of papers, Twenty-seventh Canadian Geotechnical Conference, Edmonton, 1974. – [S.l. : s.n.], 1974, p. 1-12, figures, table)
References.
ASTIS document number 149616.
NFSMO

Operators on the Canadian Atlantic Offshore face an additional marine problem in the form of icebergs. ... Side scan sonar images reveal long marks on the sea floor believed caused by bottom dragging bergs. Some of these marks have been reported to be as deep as 6.5 m and 3 km long. This paper describes the laboratory experiments conducted to understand the soil failure pattern during iceberg grounding. (Au)

319
Some geotechnical aspects of iceberg furrows / Chari, T.R. Green, H.P. Reddy, A.S.
[S.l. : s.n., 1985?].
[4] leaves : ill. ; 28 cm.
Proceedings in press.
Paper presented at the Second Canadian Conference on Marine Geotechnical Engineering, Halifax, N.S., 7-11 June 1982.
References.
ASTIS document number 159689.
NFSMO

The maximum depth of iceberg scour is an important parameter to be evaluated in the design of any production scheme for the Hibernia oil field on the Grand Banks. Such an evaluation is complicated because of the multitude of variables such as the iceberg size, hydrodynamic effects, hydrostatic stability factors and the geotechnical properties of the seabed all of which influence the scouring phenomenon. Apart from the sediment properties like the shear strength, density and seabed slope, an additional geotechnical phenomenon of importance during the gouging of the seafloor is the mass disturbance of the soil below the scour. This factor is important in the design of burial depths for sea bottom installations. Two different techniques of analyses of a geotechnical model for iceberg furrows are given in this paper. The results are compared with laboratory data. Tests with instrumented model pipelines buried below simulated iceberg scours are described and their implication for actual field conditions discussed. (Au)

320
Some geotechnical aspects of iceberg grounding / Chari, T.R.
[St. John's, Nfld.] : Memorial University of Newfoundland, 1975.
xvi, 181 leaves : ill., figures, tables ; 28 cm.
Appendices.
Bibliography: p. 162-169.
Thesis (Ph.D.) – Memorial University of Newfoundland, 1975.
ASTIS document number 148504.
NFSMO

... An understanding of the interaction of an iceberg with the continental shelf surface sediment during the process of grounding is needed to establish safe design standards for bottom structures in offshore drilling operations. Knowledge of icebergs, their size, shape and drift, is still very limited and so is the engineering behaviour of the surface sediment of the oceans. In this thesis, the behaviour of an iceberg of idealized shape is analyzed while it grounds in a uniform slope of very weak and compressible sediment. An expression was derived for the theoretical size of the scour that could be caused and this was substantiated by laboratory experiments. A tiltable towing tank was fabricated in which a 9 inch wide plexiglas model of the idealized iceberg was tested. Forces and pressures on the model were measured during the process of its scouring into an artificially sedimented slope. The frontal soil resistance was found to be the predominating force confirming the assumptions made. ... Scour sizes, computed and compared with reported side-scan observations off the Newfoundland coast showed that the predictions made by the analytical model are realistic. (Au)

COMFORT, G.

321
Lake Erie ice scour investigation / Comfort, G. Abdelnour, R. Trak, B. Menon, B. Graham, B.
(National Research Council of Canada Associate Committee on Geotechnical Research Workshop on Ice Scouring, 15-19 February 1982 / Edited by G.R. Pilkington. Technical memorandum – Canada. National Research Council. Associate Committee on Geotechnical Research, no. 136, p. 55-99, ill.)
References.
ASTIS document number 148431.
NFSMO

... This paper describes analytical work which was undertaken to estimate the maximum probable scour depth. Two analytical approaches were used to determine a safe burial depth in an attempt to verify conclusions drawn from the available field measurements of ice scour: (1) Analytical models based on considerations of kinetic energy and work done in soil deformation were exercised for a range of input parameters to provide a comparison with the available field ice scour measurements. (2) The limiting scour depth, (based on consideration of the limited flexural strength of the ridge), was predicted. The objective of this work was to determine a safe burial depth for the submarine cable. (Au)

322
Review of ice scour models / Comfort, G. Graham, B.
[6] leaves ; 28 cm.
Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.
Indexed from a preliminary draft, July 1985.
Proceedings to be published as an ESRF Report in late 1985.
ASTIS document number 163481.

... [This paper reviews] the results of a recently completed ESRF [Environmental Studies Revolving Funds] study in which ... [the

authors] evaluated several deterministic ice scour models. The scope of this project included: (1) a review of all the available models, (2) the compilation of available ground truth data and (3) a calibration type study in which ... [the models were exercised] by the introduction of ground truth data. ... (Au)

D'APOLLONIA, S.J.

323

A numerical model for calculating long term frequency and spatial distribution of iceberg grounding events / d'Apollonia, S.J. Lewis, C.F.M.

[17] leaves : ill. ; 28 cm.

Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.

Indexed from a preliminary draft, July 1985.

Proceedings to be published as an ESRF Report in late 1985.

References.

ASTIS document number 163430.

This model simulates mean long term iceberg grounding events in terms of given iceberg flux, iceberg keel draft and bathymetry. ... The range of water depth plus an allowance for scouring depth and iceberg draft changes due to tilt and roll is applied to the given frequency distribution of iceberg drafts to determine the proportion of bergs that interact with the seabed as grounding events in each cell. Options in the model simulate decline of berg population and decrease in berg draft due to iceberg loss and ablation processes. ... This model was applied to the northeastern Grand Banks of Newfoundland between 46 degrees and 48 degrees N and 47 degrees and 50 degrees W, an area which encompasses the main route of iceberg drift in the Labrador Current around Grand Banks. Good agreement was found between patterns of the predicted spatial distribution of groundings and the density of ice scour occurrences mapped from acoustic survey data. ... (Au)

DARWIN, C.R.

324

On the power of icebergs to make rectilinear, uniformly-directed grooves across a submarine undulatory surface / Darwin, C.R.

(The collected papers of Charles Darwin / Edited by P.H. Barrett. – Chicago [Ill.] : University of Chicago Press, 1977, v. 1, p. 252-255)

Originally printed in: London, Edinburgh, and Dublin philosophical magazine and journal of science, v. 10, 1855, p. 96-98.

References.

ASTIS document number 149640.

ACU, NFSM

Having been induced to believe, with many geologists, that certain continuously scored and polished surfaces of rock were due to icebergs, and not to glaciers, I have nevertheless always felt much difficulty in understanding how long, rectilinear scratches, running in one given direction across an undulatory surface, could have been thus formed. Others have felt this same difficulty, and it has been advanced as an insuperable difficulty by the opponents of iceberg action. The following considerations, though possessing little or no novelty, have in my own case removed the difficulty. ... may we not feel almost certain, that, moulding itself like a glacier (of which it originally was a portion), but owing to its water-logged state and little downward pressure moulding itself more perfectly than a glacier, it would slide straight onwards over considerable inequalities, scratching and grooving the undulatory surface in long, straight lines? In short, if in our mind's eye we look at an iceberg, not as a rigid body (as has hitherto been always my case) which would be deflected or broken up when driven against any submarine obstacle, but as a huge semi-viscid, or at least flexible mass floating on the water, I believe much of the difficulty will be removed which some have experienced in understanding how rectilinear grooves could be formed continuously running, as if regardless of the outline of the surface, up and down moderately steep inequalities, now existing as hills on the land. ... (Au)

DUNWOODY, A.B.

325

Ice/berm interactions / Dunwoody, A.B. Losch, J.A. Been, K.

(Sixteenth Annual Offshore Technology Conference 1984, proceedings. – Dallas, Tex. : Offshore Technology Conference, 1984, v.1, p. 223-228, ill.)

(OTC paper, 4672)

References.

ASTIS document number 149438.

NFSMO

A physical model study was undertaken to develop a better understanding of ice-berm interactions. After reviewing the important considerations in the problem, a simple apparatus was constructed to model the main physical phenomena involved. Thirty-four tests were run over a range of floe face geometries and vertical stiffnesses of the leading edge of the floe. The main conclusions from the model tests were that the horizontal load is proportional to the stiffness for low values of stiffness and that the floe face geometry has minimal influence on the loads. (Au)

GASKILL, H.S.

326

A non-deterministic model of populations of iceberg scour depths / Gaskill, H.S. Nicks, L. Ross, D.I.

[3] leaves ; 28 cm.

Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.

Indexed from a preliminary draft, July 1985.

Proceedings to be published as an ESRF Report in late 1985.

Abstract only.

ASTIS document number 163503.

In this paper a non-deterministic model of iceberg scour depth distributions is developed. The model employs data on an initial distribution of scour depths, annual iceberg scour rates and annual sedimentation rates to generate populations of 'observable' iceberg scour depths, such as can be obtained from present day deep tow seismic data. ... As a test of the predictive capabilities of the model, iceberg scour data from three sites on the Grand Banks are analyzed and an annual scour rate determined. This rate is compared to an annual scour rate derived from iceberg arrival rates and size exceedence data for the region. Very good agreement is found. (Au)

GREEN, H.P.

327

Geotechnical modelling of iceberg-seabed interaction / Green, H.P.

[St. John's, Nfld.] : Memorial University of Newfoundland, 1984.

xv, 165 leaves : ill. ; 28 cm.

Appendices.

Bibliography.

Thesis (M.Eng.) – Memorial University of Newfoundland, St. John's, Nfld., 1984.

ASTIS document number 149160.

NFSMO

... In this thesis an experimental approach was taken to physically

model the iceberg scour process in a 14 m x 3 m x 1 m towing tank. Cohesionless soil at a uniform slope and with controlled properties was used as the representative seafloor material. Iceberg models 500 mm wide and a pipeline model 122 mm diameter were instrumented and used in a test programme aimed primarily at examining the interaction of the iceberg model and the soil and delineating the influence of the scour process below the incision depth. ... The tests indicate that the zone of soil disturbance extends below the keel of the scouring iceberg. This zone of influence should be accounted for in the design of all buried installations in the Newfoundland and Labrador offshore region. (Au)

328

Iceberg scouring and pipeline burial depth / Green, H.P. Reddy, A.S. Chari, T.R.

(The Seventh International Conference on Port and Ocean Engineering Under Arctic Conditions. – Espoo, Finland : Technical Research Centre of Finland, 1983, v. 1, p. 280-288, figures, table)

References.

ASTIS document number 129615.

NFSMO

Seabed disturbance due to ploughing by iceberg keels is a recognized phenomenon which threatens offshore operations along the Eastern Canadian Continental Shelf. This threat to seafloor installations such as well heads, pipelines and foundations is a factor to be taken into account in the design of production systems. Determining the maximum depth of scour is difficult due to the many variables including iceberg size, stability, driving forces and the geotechnical properties of the seabed. This paper considers the geotechnical aspects of the problem and the evaluation of the seabed resistance to displacement due to ice content. ... Two theoretical approaches to soil resistance, the method of trial wedges and the method of characteristics are compared with experimental results. Another phenomenon of importance during the scour process is the mass disturbance of the soil below the scour. Tests were conducted with an instrumented pipeline model to investigate the effect of iceberg model front face inclination on soil pressures generated below the scour zone. The implications of the result in determining the safe burial depths are discussed. (Au)

329

Sediment compaction below iceberg furrows / Green, H.P. Chari, T.R.

(Oceans 81, conference record, volume one : the ocean ... an international workplace, Boston, Massachusetts, September 16-18, 1981. – [New York : Institute of Electrical and Electronics Engineers, 1981], p. 223-227, ill.)

References.

ASTIS document number 150770.

NFSMO

Scouring of the seabed by icebergs and ice keels is a phenomenon unique to the cold oceans. The threat to buried offshore structures and installations from such a process is obvious. Laboratory experiments and field observations show that the sediment outside the actual scour is also subjected to some degree of movement, compression and compaction. This paper describes the experiments in the laboratory and the analysis of the pressures measured on a pipeline model buried at different depths below the gouge bottom. (Au)

JORDAAN, I.J.

330

Risk and safety assessment for arctic offshore projects / Jordaan, I.J.

(Arctic technology and policy : proceedings of the Second Annual MIT Sea Grant College Program Lecture and Seminar and the Third Annual Robert Bruce Wallace Lecture / Edited by I. Dyer and C. Chryssostomidis. – Washington, D.C. : Hemisphere Pub. Corp. [publisher]; Toronto, Ont. : McGraw-Hill International [distributor], 1984, p. 81-88, ill.)

References.

ASTIS document number 149624.

ACU

Risk is defined in terms of both the probability, generally small, and the undesirability of an event. Risk analysis is a systematic procedure requiring estimation of probabilities and an analysis of the consequences of the event. It can be seen as part of the decision-making procedure and is aimed at determining an optimal decision from a set of possible actions, in addition to delineating levels of risk. The methodology is most suitable for problems in frontier areas of technology such as are involved in Arctic projects. Some typical problems are discussed in a general way, such as the choice between fixed and mobile production systems in iceberg-infested waters. Environmental loading and the probabilistic analysis of pressure ridges as a Poisson process are discussed. An example of application to the risk of scour of a pipeline system is given. The use of utility theory for combining attributes is suggested as a fruitful area for further development. Practical guides for dealing with problems of risk are discussed. (Au)

KIVISILD, H.R.

331

Use of mathematical models to estimate ice scour / Kivisild, H.R.

(Conference on Canadian Offshore Drilling & Downhole Technology (CODD), September 14-16, 1981, Hotel MacDonald, Edmonton, Alberta. – Calgary, Alta. : CODD, 1981, [p. 68-76], figures)

ASTIS document number 132799.

NFSMO

Two basic methods are available to estimate ice scour on natural ocean-beds: (1) Statistics derived from scour records, and (2) Scour depths estimated from physics of ice/water/soil interaction. On natural oceanbeds, scour marks have shown to provide reasonable basis for the estimating of scour with a given frequency in a given location. ... A good mathematical model will give input for distribution functions in this type of analysis. ... It is of great interest to calculate the forces required by an ice keel to scour a given depth. If this is done, it is possible to relate environmental forces to scour depths and produce return periods for scours. From this we can: 1. Improve Probability Models. 2. Develop Physical Models Including Laboratory Models. 3. Estimate Ice Drag Forces on Structures on Oceanbed. 4. Design Protective Mounds, and Estimate Scour on Filled-in Trenches. 5. Estimate Scour Risk Behind Natural Barriers and in Protected Areas. This paper discusses several idealized mathematical models which will shed light on the above-described relationships. ... (Au)

LEWIS, J.K.C.

332

Burial parameters : an integrated approach to limit overdesign / Lewis, J.K.C. Benedict, C.P.

(Proceedings of the Symposium Production and Transportation Systems for the Hibernia Discovery, St. John's, Newfoundland, Canada, February 16-18, 1981 / Edited by W.E. Russell and D.B. Muggeridge. – St. John's, Nfld. : Petroleum Directorate, Government of Newfoundland and Labrador, 1981, p. 189-206, ill.)

References.

ASTIS document number 149993.

NFSMO

... This paper begins with a review of iceberg properties relevant to engineering design on the Grand Banks. Routine engineering calculation of scour depth and frequency, and burial parameters such as glory hole depth and trenching depth, will necessitate a computer simulation scheme which combines an iceberg shape and motion model with a tested geotechnical model. With a site-specific draft distribution and iceberg flux this can be run to generate scour depth distribution for 50 years of icebergs, or the 50 year overpressure at a stated depth below the seafloor. The four steps to be taken so that engineering calculations of burial parameters can eventually be made on routine basis are: measure iceberg drafts; instrument an iceberg seafloor impact sequence; simulate the impact with the seafloor on a computer; combine the above with shape and motion models, and draft and flux, in an overall iceberg motion/scour simulator. (Au)

333

Use of draft distribution for evaluating iceberg incursion probability / Lewis, J.K.C. Benedict, C.P.

(National Research Council of Canada Associate Committee on Geotechnical Research Workshop on Ice Scouring, 15-19 February 1982 / Edited by G.R. Pilkington. Technical memorandum - Canada. National Research Council. Associate Committee on Geotechnical Research, no. 136, p. 168)

Abstract only.

ASTIS document number 148423.

NFSMO

Before offshore hydrocarbon deposits can be developed commercially, the probability of iceberg scouring and incursion into subsea production facilities must be evaluated. Such information is an essential component in specifying the design parameters related to the platforms and/or subsea systems to be used in recovery of oil and gas. This paper presents a method for describing analytically the distribution of iceberg drafts at a particular latitude, and of combining this with site bathymetry and iceberg flux data to calculate iceberg incursion probabilities and mean times between incursions as a function of site design parameters. (Au)

LOPEZ, R.J.

334

Hydrodynamic effects on iceberg gouging / Lopez, R.J. Chari, T.R. Moore, E. Peters, G.R. Zielinski, A.

(Cold regions science and technology, v. 4, no. 1, Jan. 1981, p. 55-61, figures)

Appendix.

References.

ASTIS document number 59730.

ACU, NFSMO

A model of a grounding iceberg which takes into account the soil resistance and the hydrodynamic drag is formulated. Based on analytical investigations and numerical results, a simple and accurate estimator for gouge length is proposed. The calculations reveal that the hydrodynamic drag on grounding icebergs may have significant influence on the total gouge length. A numerical criterion which defines the range of iceberg parameters and ocean bottom characteristics for which drag effect cannot be neglected is established. (Au)

MARCELLUS, R.W.

335

Profiler resolution and ice scour depth distributions / Marcellus, R.W.

[11] leaves : ill. ; 28 cm.

Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.

Indexed from a preliminary draft, July 1985.

Proceedings to be published as an ESRF Report in late 1985.

ASTIS document number 166391.

A means of mathematically improving uncertain resolution of shallow, deep-water ice scours is described. The method uses probability distribution methods to increase sonar data effectiveness. (ASTIS)

PILKINGTON, G.R.

336

Determination of pipeline trench depths in the Beaufort Sea / Pilkington, G.R. Marcellus, R.W.

(Conference on Canadian Offshore Drilling & Downhole Technology (CODD), September 14-16, 1981, Hotel MacDonald, Edmonton, Alberta. - Calgary, Alta. : CODD, 1981, [p. 62-67], figures)

ASTIS document number 132780.

NFSMO

This paper discusses methods of determining pipeline trench depths for the South Eastern Beaufort Sea. For shallow water (less than 20 m) interpretation of shallow seismic records is recommended as these can indicate the deepest score that has occurred over the past few thousand years. In deeper water, a method of combining ice keel and score statistics is used. Pipeline depths of about 2 m in shallow water, 4 to 6 m in 20 to 40 m of water and no burial beyond 50 m depths are indicated by preliminary studies using these techniques. (Au)

337

Methods of determining pipeline trench depths in the Canadian Beaufort Sea / Pilkington, G.R. Marcellus, R.W.

[S.l. : s.n.], 1981.

1 microfiche : figures ; 11 x 15 cm.

(Beaufort E.I.S. reference work, no. RWT03)

(POAC 81 : the Sixth International Conference on Port and Ocean Engineering under Arctic Conditions, Quebec, Canada, July 27-31, 1981, proceedings. - Quebec City, Quebec : Universite Laval, 1981, v. 2, p. 674-687, figures)

References.

ASTIS document number 108405.

ACU, NFSMO

The problem of ice scouring on the sea floor in ice infested water is an important problem now that development schemes for these waters are seriously being considered. This paper describes the origin and subsequent disappearance of sea floor ice scores, then presents a discussion of the various methods that can be used to calculate the return period for ice scores and TOP (top of pipe) depth for sea bed installations; namely, TOP below the saturated score zone or deepest score, score dating, repetitive mapping, score equilibrium analysis, ice keel/score statistics, and TOP depth optimization method. Of the methods, the last two are felt to be most useful for the Beaufort Sea, and results indicating TOP at 5 m in 25 m water depths and no trenching in 55 m of water are presented. Many of the other methods are thought to be useful for comparative purposes only. ... The purpose of this work is to estimate the likelihood of disruption of a pipeline by an ice feature as a function of TOP depth, and thus rationally choose a TOP depth for the pipeline. Here we review all the methods known to the authors for determining TOP depth in the Beaufort Sea and present a new method of calculating TOP depth based on observed ice keel/ice score statistics. (Au)

PRASAD, K.S.R.

338
Some factors influencing iceberg scour estimates / Prasad, K.S.R. Chari, T.R.
[S.l. : s.n.], 1985.
[8] leaves : ill., map ; 28 cm.
Paper presented at 4th International Symposium on Offshore Mechanics and Arctic Engineering, Dallas, Texas, 17-22 February 1985.
Photocopy.
References.
ASTIS document number 159646.

The phenomenon of seabed scouring by icebergs is a major threat to buried structures on the Canadian East Coast and is of immediate concern to the petroleum operators. The design of a suitable production and transportation system for the development of the Hibernia field is very much influenced by the potential size of iceberg scours. Several factors influence the theoretical estimates of scour size and some of these have been discussed in the mathematical and laboratory models proposed earlier. In this paper, an appraisal is made of the potential error in iceberg scour predictions caused by assuming a linear velocity variation during scour. The influence of an initial penetration of the iceberg prior to scour is examined. Upper and lower bounds of initial penetration depths are shown to exist which influence the resulting scour type. (Au)

SCHOENTHALER, L.

339
Mobil Oil ice scour model studies / Schoenthaler, L.
[5] leaves : ill. ; 28 cm.
Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.
Indexed from a preliminary draft, July 1985.
Proceedings to be published as an ESRF Report in late 1985.
ASTIS document number 163597.

... [This paper describes] some of the work that Mobil has been doing in the last several years with regard to iceberg scour modelling. ... [The] ultimate objective is to develop, verify and define an analytical model capable of fully describing iceberg motion. ...[The first feature required was] the facility to input the shape of the iceberg, as a simple or complex form. The second key feature was that the iceberg motion should be modelled in the free floating mode as well as in the scouring mode. The last requirement for the model was that the environmental conditions and the soil resistance functions should be capable of being defined by the user. ... (Au)

STACY, R.A.

340
The nature of iceberg/seabed interaction / Stacy, R.A.
(Proceedings of the Symposium Production and Transportation Systems for the Hibernia Discovery, St. John's, Newfoundland, Canada, February 16-18, 1981 / Edited by W.E. Russell and D.B. Muggeridge. – St. John's, Nfld. : Petroleum Directorate, Government of Newfoundland and Labrador, 1981, p. 207-210)
ASTIS document number 149047.
NFSMO

The iceberg/seabed interaction is described. To understand the nature of iceberg scour, information on the character of the seafloor and the physical, dynamic and hydro-dynamic properties of the berg is required. (NFSMO)

THIEL, C.C.

341
Risk assessment of sea bottom scouring using fuzzy set theory / Thiel, C.C. Singh, J.P. Boissonnade, A.C.
(Civil engineering in the arctic offshore : proceedings of the Conference Arctic '85 / Edited by F.L. Bennett and J.L. Machemehl. – New York : American Society of Civil Engineers, 1985, p. 430-438, ill.)
References.
ASTIS document number 159590.

An approach to the assessment of risk to buried pipelines from ice gouging is developed using Fuzzy Set Theory. Statistical procedures currently used to analyze ice gouge data are inadequate in that they do not assess the site-specific risk, i.e., the influence of bottom soil types, water depths, or the degree of site protection, all of which are factors that influence the frequency with which gouges of different depths and widths occur. Evaluation of regional hazards using statistical procedures alone can over- or underestimate the site-specific hazards. Analyzing existing data with more sophisticated methods may allow ice gouging frequencies to be determined with more confidence. Based on observations of the gouges that cross different soil horizons and their modifications with time, it appears that Fuzzy Set Theory is well suited to process this type of data to develop site-specific ice gouge risk estimates. (Au)

UTT, M.E.

342
Coefficient of friction between submerged ice and soil / Utt, M.E. Clark, R.A.
New York : American Society of Mechanical Engineers, 1980.
4p. : ill., figures, table ; 28cm.
(Paper – American Society of Mechanical Engineers, 80-PET- 41)
Presented at the Energy Technology Conference & Exhibition, New Orleans, La., February 3-7, 1980.
ASTIS document number 68250.
NFSMO

Laboratory scale experiments were conducted at conditions of ice salinity, brine salinity, and temperature corresponding to those measured at a grounded ice island. Measurements were made of the coefficient of static friction over a range of contact pressures from 29 to 96 lb/square ft (1.4 to 4.6 kPa). A total of nine tests were run, including three soil types at each of three contact pressures. Coefficients of friction ranged from 0.85 to 1.47. (Au)

WADHAMS, P.

343
The prediction of extreme keel depths from sea ice profiles / Wadhams, P.
(Cold regions science and technology, v. 6, no. 3, Feb. 1983, p. 257-266, figures, tables)
References.
ASTIS document number 116661.
ACU, NFSMO

The prediction of return periods of extremely deep pressure ridge keels is discussed, using as data a 1400 km submarine profile obtained by U.S.S. "Gurnard" in the Beaufort Sea. Three techniques of predicting return periods at a point are examined: the use of the negative exponential distribution; a depth crossing technique; and a probability plotting technique. The problem of predicting return periods along a line is then examined with reference to ice scouring across seabed pipeline routes. A technique which combines keel statistics and scour depth statistics is used to

compute the pipeline burial depth necessary to avoid disturbance by ice for a specified period. (Au)

344
Predictions of extreme keel depths from submarine sonar data / Wadhams, P.
(National Research Council of Canada Associate Committee on Geotechnical Research Workshop on Ice Scouring, 15-19 February 1982 / Edited by G.R. Pilkington. Technical memorandum – Canada. National Research Council. Associate Committee on Geotechnical Research, no. 136, p. 32-47, ill.)
References.
ASTIS document number 148350.
NFSMO

A fundamental problem in the estimation of return periods for deep keels at a point is that of predicting extreme values from a time series or spatial profile of limited extent. In this paper we examine three techniques of prediction, and compare their performances using a data set in the public domain. We then examine the problem of predicting extreme keel depths along a line, i.e. the probability that a pipeline route will suffer scoring by a keel during a given interval. We propose two ways of attacking this problem, and consider an example of how to predict pipeline burial depths using these statistics. (Au)

WEEKS, W.F.

345
A numerical simulation of ice gouge formation and infilling on the shelf of the Beaufort Sea / Weeks, W.F. Tucker, W.B. Niedoroda, A.W.
[15] leaves : ill. ; 28 cm.
References.
Paper presented at POAC 85.
ASTIS document number 159930.

A simulation model for sea ice-induced gouges on the shelf of the Beaufort Sea is developed by assuming that annual occurrence of new gouges is given by a Poisson distribution, locations of the gouges are random, and distribution of gouge depths is specified by an exponential distribution. Once a gouge is formed it is subject to infilling by transport of sediment into the region and by local movement of sediment along the sea floor. These processes are modeled by assuming a sediment input based on stratigraphic considerations and by calculating bedload transport using methods from sediment transport theory. It is found that if currents are sufficient to transport sediment, rapid infilling of gouges occurs. In that these threshold currents are small for typical grain sizes on the Beaufort Shelf, this suggests that the gouging record commonly represents only a few tens of years. (Au)

346
A preliminary simulation study of sea ice induced gouges in the sea floor / Weeks, W.F. Tucker, W.B. Niedoroda, A.W.
[10] p. ill. ; 28 cm.
References.
Paper presented at Arctic Energy Technologies Workshop, 1985.
ASTIS document number 159964.

A simulation model for sea ice-induced gouges on the shelf of the Beaufort Sea is developed by assuming that the annual occurrence of new gouges is given by a Poisson distribution, the locations of the gouges are random, and the distribution of gouge depths is specified by an exponential distribution. Once a gouge is formed it is subject to infilling by transport of sediment into the region and by local movement of sediment along the sea floor. These processes are modeled by assuming a sediment input based on stratigraphic considerations and by calculating bed-load transport using methods from sediment transport theory. It is found that if currents are sufficient to transport sediment, rapid infilling of gouges occurs. In that these threshold currents are small for typical grain sizes on the Beaufort Shelf, this suggests that the gouging record commonly represents only a few tens of years. (Au)

347
A preliminary simulation study of sea ice induced gouges in the sea floor / Weeks, W.F. Tucker, W.B. Niedoroda, A.W.
[16] leaves : ill. ; 28 cm.
Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.
Indexed from a preliminary draft, July 1985.
Proceedings to be published as an ESRF Report in late 1985.
ASTIS document number 163538.

A simulation model for sea ice-induced gouges on the shelf of the Beaufort Sea is developed by assuming that the annual occurrence of new gouges is given by a Poisson distribution, the locations of the gouges are random, and the distribution of gouge depths is specified by an exponential distribution. Once a gouge is formed, it is subject to infilling by transport of sediment into the region and by local movement of sediment along the sea floor. These processes are modeled by assuming a sediment input based on stratigraphic consideration and by calculating bed-load transport using methods from sediment transport theory. It is found that if currents are sufficient to transport sediment, rapid infilling of gouges occurs. In that these threshold currents are small for typical grain sizes on the Beaufort Shelf, this suggests that the gouging record commonly represents only a few tens of years. (Au)

PROTECTION

348
Offshore pipeline transportation in the southern Beaufort Sea
(APOA review, v. 6, no. 3, Winter 1983/84, p. 31-32, ill.)
ASTIS document number 137740.
ACU, NFSMO

This article traces the history of pipeline research and pipeline construction. The significant design considerations are the effects of ice scour and permafrost zones. (ASTIS)

349
Pipeline to cross icy waters
(Offshore, v. 40, no. 5, May 1980, p. 215-216, ill.)
ASTIS document number 149667.
NFSM

The proposed $17 billion Polar Gas pipeline route to tap discoveries in the Arctic Island and the Mackenzie-Beaufort Sea areas will utilize an improved bottom-pull technique to cross the frozen 76-mile wide M'Clure Strait .... Polar Gas will augment an earlier developed bottom pull method of installing pipeline, suitable for short distances, by cutting rectangular ice holes for pulling equipment all along the crossing route. Thus a pipe string can be passed from one pulling unit to another under the ice. ... Because of the scouring by deep-draft ice, protection of the pipeline out to a water depth of 150 ft is required. Polar Gas plans to route the pipeline through a tunnel under the seabed and use a subsea riser to connect the pipe installed in the tunnel to the pipeline laid on

the seabed. ... (Au)

350
Research will uncover pipe problems
(Offshore, v. 40, no. 5, May 1980, p. 217-218)
ASTIS document number 149675.
NFSM

Pipeline design in the Arctic will require careful consideration of the ice scouring of the seabed, the effect of pipe temperatures on the surrounding environment, and the connection of pipelines to producing structures offshore. ... Much of higher-than-average expected costs of laying pipelines in the Arctic will be reflected in the modification of existing equipment to contend with the cold environment. ... (Au)

351
Seabed silos protect arctic wells
(Offshore, v. 40, no. 5, May 1980, p. 204-205, ill.)
ASTIS document number 149659.
NFSM

Blowout preventer stacks and wellhead assemblies used for Arctic exploration and production must be protected from the keels of ice ridges which frequently scour the sea floor. Some scour marks, not of recent origin, have been found at depths of 140 ft. ... Dome Petroleum has drilled a number of wells inside the 150-ft contour and generally recesses the BOP stack below the mud line by dredging the site to a minimum depth of 35 ft. ... Two methods are used to provide proper recess for the BOP stack or wellhead assembly. One is the dredging of the seafloor to a wide conical shape and placement of the assembly on the bottom in an open mode. The second is the drilling or jetting out of a cylindrical hole and the installation of a silo to protect the assembly. Dome Petroleum has chosen to use the former in what has been termed a "Glory Hole." ... A Global Marine Development engineer has designed and patented a system of installing an Arctic seabed silo (also caisson or cofferdam) for the protection of the BOP stack by arming the silo with a jetting and eduction system. ... (Au)

352
The tunnel alternative
(Arctic and northern development digest, v. 9, no. 47, Feb./Mar. 1977, p. 8-10, ill.)
ASTIS document number 148890.
ACU

The mandate for Polar Gas Project researchers was to develop a viable means of economically moving trillions of cubic feet of Arctic Islands natural gas over 2000 miles to the South, without seriously damaging social or biophysical environments. [Towards this end, the tunnel alternative is presented.] (Au)

ABRAMOVICH, D.

353
Performance of Salm/shuttle-tanker production/transportation systems in a hostile environment / Abramovich, D.
(Proceedings of the Symposium Production and Transportation Systems for the Hibernia Discovery, St. John's, Newfoundland, Canada, February 16-18, 1981 / Edited by W.E. Russell and D.B. Muggeridge. – St. John's, Nfld. : Petroleum Directorate, Government of Newfoundland and Labrador, 1981, p. 110-121, ill.)
References.
ASTIS document number 149454.
NFSMO

Development of the Hibernia field oil production/transportation system presents design challenges and economic considerations that closely resemble experiences encountered in developing the Thistle field in the U.K. Sector of the North Sea. The principal similarities between these two development plans lie in the environmental conditions that prevail in the Hibernia field and the North Sea and in the economic benefits realizable by bringing in oil production at the earliest possible point in the oilfield development program. The design concept, installation procedure, and transport operation used for initially handling the Thistle field production may be valuable guidelines for implementing oil production and transportation systems in the Hibernia field. (Au)

BEA, R.G.

354
Engineering aspects of ice gouging / Bea, R.G.
[7] leaves ; 28 cm.
Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.
Indexed from a preliminary draft, July 1985.
Proceedings to be published as an ESRF Report in late 1985.
References.
ASTIS document number 163457.

... [This paper discusses the following] four principle engineering aspects: 1. Influence of ice gouging on the engineering characteristics and properties of Arctic sediments. 2. Ice gouging effects on base mat contact pressures and capacity efficiencies of Arctic gravity structures. 3. Ice gouging effects on buried and armored pipelines. 4. The role of ice gouging in reducing the global ice forces on Arctic structures. ... (Au)

355
The role of ice gouging in determining global forces on arctic structures / Bea, R.G. Puskar, F.J. Barnes, P.W. Reimnitz, E.
(Civil engineering in the arctic offshore : proceedings of the Conference Arctic '85 / Edited by F.L. Bennett and J.L. Machemehl. – New York : American Society of Civil Engineers, 1985, p. 251-266, ill.)
Appendix.
References.
ASTIS document number 159581.

Seafloor gouging by ice keels on the arctic shelf results in potentially significant reductions in the environmental driving forces transmitted to fixed structures located in water depths to 150 ft (45 m). Data on seafloor gouging processes are reviewed and estimates made of the potential forces developed by these processes. (Au)

BROWN (R.J.) AND ASSOCIATES

356
Pipeline installation protection and repair feasibility study, Beaufort Sea – Mackenzie Delta / Brown (R.J.) and Associates. Dome Petroleum Limited [Sponsor]. Esso Resources Canada [Sponsor]. Gulf Canada Resources Inc. [Sponsor].
[Calgary : Dome Petroleum Limited], 1981.
1 v. (various pagings) : ill., figures (some folded), tables ; 28 cm.
(Beaufort E.I.S. support document, no. BEISSD22)
References.
ASTIS document number 87599.
ACU

Hydrocarbon discoveries in the southern Beaufort Sea have prompted the petroleum industry to seek approval for offshore pipeline development within the Mackenzie Delta Region. The

objective of this study is to review the representative offshore development scenario ... and to demonstrate the feasibility of pipeline design and installation in this area. ... The development scenario which has been selected for evaluation consists of trunklines and inter-island gathering lines (flowlines) which represent typical development of the fields at Tarsiut, Kopanoar and Issungnak. ... (Au)

DUVAL, J.

357
Production system is planned for iceberg infested waters / Duval, J. Mercier, G. Morin, P.
(World oil, v.190, no. 4, Mar. 1980, p. 81-84, 86, figures)
ASTIS document number 149039.
ACU, NFSMO

Off the east coast of North America, drifting icebergs are a hazard to conventional production facilities and thus, new techniques will be required. As described here, it will be necessary to use a highly mobile, floating platform and excavations to protect subsea equipment from scour by grounded icebergs. (Au)

358
A seasonal oil production scheme for ice-infested waters [Part 2] / Duval, J. Mercier, G. Morin, P.
(Ocean industry, v. 15, no. 1, Jan. 1980, p. 19-20, 25-26, ill.)
ASTIS document number 149691.
NFSMO

Deepwater production systems currently used in conventional seas generally consist of floating supports and subsea wellheads. They are not adapted to production in Arctic seas. A new design has been considered. ... The production Christmas tree is installed in an excavation and is designed to have its top located 5 m below the mudline beyond the range of scouring icebergs in the morainic soils. The tubing hangers are located in a 1-m dia. casing approximately 17 m below the bottom of the silo. (Au)

FJELD, S.

359
Pipeline construction in arctic seas / Fjeld, S. Babala, D.J. Devik, O.
(The Seventh International Conference on Port and Ocean Engineering Under Arctic Conditions. – Espoo, Finland : Technical Research Centre of Finland, 1983, v. 1, p. 254-272, figures, tables)
References.
ASTIS document number 129593.
NFSMO

The paper provides a general overview of present thinking about arctic marine pipelines considering – influence of present and ancient ice conditions, – feasible protection methods, – installation procedures taking benefit of ice conditions. ... (Au)

GIBSON, C.E.

360
Underwater trench production systems / Gibson, C.E.
(Proceedings of the Symposium Production and Transportation Systems for the Hibernia Discovery, St. John's, Newfoundland, Canada, February 16-18, 1981 / Edited by W.E. Russell and D.B. Muggeridge. – St. John's, Nfld. : Petroleum Directorate, Government of Newfoundland and Labrador, 1981, p. 223-237, ill.)
ASTIS document number 149470.
NFSMO

Protection of submarine cables and pipelines by embedment in the sea bed has long been a recognised method of reducing the probability of their being damaged by such manmade and natural hazards as ships anchors, fishing gear, sabotage, wave and current action, ice crushing and bed gouging by ice keels. Many varied systems have been developed or proposed for such embedment and this paper briefly discusses the merits of two systems which have been developed and used by Land and Marine Engineering on pipeline and cable embedment contracts; and then considers further development possibilities. (Au)

MARCELLUS, R.W.

361
Interactions between first-year grounded ridge keels and trenched pipelines / Marcellus, R.W.
(Proceedings of Workshop on Sea Ice Ridging and Pile-up, 22-24 October, 1980, Calgary, Alberta. Technical memorandum – Canada. National Research Council. Associate Committee on Geotechnical Research, no. 134, p. 285-295, figures, table)
References.
ASTIS document number 122491.
ACU, NFSMO

As the oil and gas industry investigates various production scenarios for offshore discoveries in ice infested waters, specific design questions must be considered. This paper addresses the problem of contact between first-year grounded ridge keels and trenched pipelines and comments on the possible force levels which could be exerted on a pipeline in an open trench. (Au)

362
Shore crossing techniques for offshore pipelines in arctic regions / Marcellus, R.W. Palmer, A.C.
(POAC 79 : the Fifth International Conference on Port and Ocean Engineering under Arctic Conditions, at the Norwegian Institute of Technology, August 13-18, 1979, proceedings, v. 3, p. 201-215, ill., photos.)
References.
ASTIS document number 56090.
ACU, NFSMO

... the zone where an offshore pipeline meets the shoreline presents unique design problems. ... This paper discusses the state-of-the-art and future developments for pipeline shore crossing techniques in Arctic regions. ... This paper reviews the environmental factors that govern the design of a pipeline shore crossing, and goes on to consider design concepts and alternative construction techniques. It also describes the design of the shore crossing for the gas flowlines from the Drake F-76 well to Melville Island, a project successfully completed in 1978. (Au)

MCKEEHAN, D.

363
Marine pipeline design in ice environments / McKeehan, D.
[13] leaves : ill. ; 28 cm.
Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.
Indexed from a preliminary draft, July 1985.
Proceedings to be published as an ESRF Report in late 1985.
ASTIS document number 163600.

The objective of this [paper is] ... to present the planning aspects that we need to develop for offshore pipelines, particularly in respect to ice scour. ... three ... are felt to represent the most inextricable inter-related aspects and these are: the aspect of the

trenching mechanism itself, the scouring mechanism and the repair of a damaged offshore pipeline. All of these must be considered together when deriving a requirement for protection, or in estimating trench depth. (Au)

MELLOR, M.

364
Subsea trenching in the Arctic / Mellor, M.
Hanover, New Hampshire : Cold Regions Research and Engineering Laboratory, 1981.
iv, 38p. : ill., figures, tables ; 28cm.
(CRREL report, 81- 17)
References.
ASTIS document number 82287.
ACU, NFSMO

Environmental conditions are described for the continental shelf of the western Arctic, and for the shelf of Labrador and Newfoundland. Special emphasis is given to the gouging of bottom sediments by ice pressure ridges and icebergs, and an approach to systematic risk analysis is outlined. Protection of subsea pipelines and cables by trenching and direct embedment is discussed, touching on burial depth, degree of protection, and environmental impact. Conventional land techniques can be adapted for trenching across the beach and through the shallows, but in deeper water special equipment is required. The devices discussed include hydraulic dredges, submarine dredges, plows, rippers, water jets, disc saws and wheel ditchers, ladder trenchers and chain saws, routers and slot millers, ladder dredges, vibratory and percussive machines, and blasting systems. Consideration is given to the relative merits of working with seabed vehicles, or alternatively with direct surface support from vessels or from the sea ice. (Au)

365
Undersea pipelines and cables in polar waters / Mellor, M.
Hanover, New Hampshire : U.S. Army, CRREL, 1978.
v, 34p. : figures ; 27cm.
(CRREL report, 78- 22)
References.
ASTIS document number 15563.
ACU, NFSMO

Special environmental factors that influence the design, laying and maintenance of undersea pipelines and cables in polar waters are described. Various approaches to the protection of submarine pipes and cables are considered, and prime emphasis is given to burial techniques for shallow water. A wide range of methods for trenching and burying are discussed, and technical data are given. (Au)

MORGENSTERN, N.R.

366
Soil stabilization for protection of sea-bed structures from ice scour / Morgenstern, N.R. Sterne, K.
Edmonton : Boreal Institute for Northern Studies, 1980.
1v. (various paging) : ill. ; 28cm.
References.
ASTIS document number 68225.
NFSMO

One of the major problems to be considered in the design of pipelines and drilling platforms in the Beaufort Sea is the damage that can result from ice scouring. ... It was thus decided to conduct a laboratory investigation to determine whether the sea bed in the vicinity of such structures could be stabilized by in-situ mixing of the sea bed sediments with cement to a degree sufficient to offer substantial resistance to ice forces. ... The preliminary laboratory work that was carried out is described in this report. In addition, problems of ice scouring and the formation of pressure ridges were reviewed from the available literature. Finally, the results of the laboratory work are discussed and proposals for further research outlined. ... (Au)

NASSAM, M.

367
Risk analysis and pipe burial depths / Nassam, M.
[2] leaves ; 28 cm.
Paper presented at: Ice Scour Workshop, Calgary, Alta., 5-6 Feb., 1985.
Indexed from a preliminary draft, July 1985.
Proceedings to be published as an ESRF Report in late 1985.
ASTIS document number 166383.

This paper describes risk analysis modelling performed by Det Norske Veritas with respect to protecting submarine petroleum pipelines from the effects of ice scour. Strategies examined include trenching, valve segmentation and pipeline twinning; risks considered include oil spill costs. (ASTIS)

NOBLE, P.G.

368
Damage to an underwater pipeline by ice ridges / Noble, P.G. Comfort, G.
(Proceedings of Workshop on Sea Ice Ridging and Pile-up, 22-24 October, 1980, Calgary, Alberta. Technical memorandum – Canada. National Research Council. Associate Committee on Geotechnical Research, no. 134, p. 248-284, figures, table)
References.
ASTIS document number 122483.
ACU, NFSMO

... A 24-inch diameter water intake pipeline approximately 5 miles long was installed in Great Slave Lake in 1977/78 to meet the increased water requirements of the Town of Hay River. The line, with its associated intake structure and pumphouse, was put into service in January 1979. By late spring it became apparent that the line had failed and that water was being drawn into the system from nearshore. After ice breakup, divers examined the line and found that the pipe was broken at a point 7100 ft from shore. This paper describes work which was carried out to ascertain the possible mechanisms causing failure of the pipe, and to suggest improvements in the intake system which might minimize future damage from ice ridges. ... (Au)

O'DONNELL, J.P.

369
Polar gas tunnels designed to protect arctic pipelines from ice scour / O'Donnell, J.P.
(Offshore, v. 36, no. 8, July 1976, p. 72-75, ill.)
ASTIS document number 4995.
ACU, NFSMO

Polar Gas proposes to protect the pipeline from ice scour by enclosing the pipeline in tunnels at all approaches to channel crossings. The article describes how the tunnels are going to be designed and built. (ASTIS)

PALMER, A.C.

370
Design and installation of an offshore flowline for the Canadian Arctic Islands / Palmer, A.C. Baudais, D.J. Masterson, D.M.
(Proceedings - Offshore Technology Conference, 11th, Houston, Texas, April 30-May 3, 1979. Dallas, Tex. : Offshore Technology Conference, 1979, v. 2, p. 765-772, ill.)
(OTC paper, 3446)
References.
ASTIS document number 150703.
ACU

In April 1978, the world's first Arctic subsea production gas well was connected to production facilities onshore, through a 1200 m flowline bundle connected to the wellhead by a diverless subsea flowline connector. This paper describes the design, installation and connection of the flowline bundle, and the shore crossing protection system. ... The well is in the Drake gas field, on the east side of the Sabine Peninsula. ... It was originally intended to place the flowlines in a trench 4 m deep, below the expected multi-year ice scour level, and to backfill the trench with rock. The surveys showed that the bottom soil is too weak for it to be possible to excavate such a deep trench, because it would collapse under its own weight whatever construction technique was used. After extensive study of alternative protection techniques it was decided to place the pipeline in a shallower trench, 1.5 m deep, to back fill the trench with gravel (the best material locally available), and to freeze the soil around the carrier pipe, thus forming a strong cylinder of artificial permafrost. The original concept for such a system came from the artificially-frozen core of a dam on the Irelyakh river in Siberia, seen on a field trip during the Second International Conference on Permafrost. In the present project the freezing was carried out by circulating a methanol-water mixture cooled to -30 degrees C out through the annular space between the 18-inch carrier and an outer 24-inch casing, and back through a 3-inch return line, ... It was hoped to use the Arctic air as the only source of "cold" for this system, but that proved not to be practicable. ... (Au)

PILKINGTON, G.R.

371
Canadian patent : passive seabed protection against ice scour / Pilkington, G.R. [Inventor]. Dome Petroleum Limited [Assignee].
Ottawa : Patent Office, 1979.
8 leaves : figures ; 28 cm.
(Canadian patent documents, no.1064272, Oct. 16, 1979)
ASTIS document number 132985.
NFSMO

This invention relates to method and means for protecting permanent structures and pipelines on the sea floor against scour by ice or dragging anchors. ... Accordingly, it is an object of one aspect of this invention to provide a method for providing for protection for any permanent structure at or near the sea floor against scour. An object of another aspect of this invention is the provision of a pipeline bed on the sea floor which is protected against scour. ... (Au)

ROCHELLE, W.R.

372
Methods for protecting subsea pipelines and installations / Rochelle, W.R. Simpson, D.M.
(Proceedings of the Symposium Production and Transportation Systems for the Hibernia Discovery, St. John's, Newfoundland, Canada, February 16-18, 1981 / Edited by W.E. Russell and D.B. Muggeridge. - St. John's, Nfld. : Petroleum Directorate, Government of Newfoundland and Labrador, 1981, p. 253-269, ill.)
ASTIS document number 149497.
NFSMO

The hazards for subsea pipelines and installations are described. Methods currently being used to protect subsea pipelines and installations are discussed with the emphasis on various trenching methods and equipment. Technical data on progress rates for trenching and feasible depths of trench are given. Possible methods for protection against icebergs are discussed. A case for more comprehensive data on icebergs is presented. Should a pipeline become damaged, repair methods are noted. (Au)

SHINDLER, K.

373
The other pipeline / Shindler, K.
(North/Nord, v. 24, no. 6, Nov./Dec. 1977, p. 26-31, col. ill.)
ASTIS document number 149632.
ACU

[This paper reviews the proposed Polar Gas pipeline route which runs] ... from the Drake and Hecla fields on northern Melville Island, as well as a spur from Ellef Ringnes Island further north, the Polar Gas pipeline would angle south and east, crossing to the mainland via Somerset Island and the Boothia Peninsula. From there it would skirt the west coast of Hudson Bay, tying into the TransCanada Pipeline, probably at Longlac, Ontario. ... The major problem to be solved is how to build a pipeline across the 90 miles of water crossing to the mainland. There are three major problems: 1. The lack of a suitable open-water season. ... 2. In the beginning relatively little was known about the bathymetric conditions in the channels the pipeline would cross. It was necessary to establish an encyclopaedia of knowledge on the currents, bottom profiles, soils, and other factors which are to be critical in marine pipeline design. 3. It was feared that icebergs moved through these channels ... icebergs large enough to gouge or "scour" the bottom and to rip out a pipeline. Research in this area, however, has established that to the extent that scour is a problem, means were found to cope with it. ... (Au)

TIMMERMANS, W.J.

374
Design of offshore pipelines for ice environments / Timmermans, W.J.
(Design for ice forces / Edited by S.R. Caldwell and R.D. Crissman. - New York : American Society of Civil Engineers, 1983, p. 69-98, ill.)
References.
ASTIS document number 149969.
NFSMO

Design and installation of offshore pipelines in cold regions requires special care. Low ambient temperatures may cause increased friction losses in oil and gas lines due to wax crystallization or hydrate formation. Environmental conditions in these areas are described. Installation methods in cold regions are different from those normally used, to take into account presence of surface ice during most of the year. Protection of pipe against bottom gouging ice masses is essential; several methods are outlined. (Au)

375
Design, installation and operation of gathering and transmission pipelines for the Hibernia field / Timmermans, W.J.

(Proceedings of the Symposium Production and Transportation Systems for the Hibernia Discovery, St. John's, Newfoundland, Canada, February 16-18, 1981 / Edited by W.E. Russell and D.B. Muggeridge. – St. John's, Nfld. : Petroleum Directorate, Government of Newfoundland and Labrador, 1981, p. 238-252, ill.)
References.
ASTIS document number 149489.
NFSMO

Development of the oil reserve discovered in the Grand Banks area will require a network of gathering lines to bring together production from various locations to a point where the crude oil is loaded into tankers for further transport. This includes flowlines and loading lines. ... Of special concern was the possible damage that grounding icebergs may do to such a system. Several feasible configurations were identified for these lines. It was concluded that the risk of iceberg damage cannot be eliminated, but will be reduced by trenching to the maximum depth presently feasible. Presently available techniques will allow a speedy repair of any such damage, should it occur. RJBA was also requested to investigate the feasibility of laying a transmission line to the Newfoundland shore. Since this line would cross the paths of icebergs along its entire 200 mile length, the risk of damage is high. Therefore, although it is technically possible to install such a line, its successful operation is considered unfeasible. (Au)

VAN IEPEREN, M.

376
Ice scour protection Drake F-76 flowline bundle / Van Ieperen, M.
(National Research Council of Canada Associate Committee on Geotechnical Research Workshop on Ice Scouring, 15-19 February 1982 / Edited by G.R. Pilkington. Technical memorandum – Canada. National Research Council. Associate Committee on Geotechnical Research, no. 136, p. 48-54, ill.)
References.
ASTIS document number 148369.
NFSMO

Drake F-76 is the first producing subsea gas well in the High Arctic. Jointly undertaken by Panarctic Oils Ltd., Petro-Canada and Nova (An Alberta Corporation), the project was successfully completed on April 23, 1978. It involved the design of a rig to drill from an artificial ice platform; the design and installation of a flowline bundle and its connection with a subsea Christmas tree; and finally the design of an ice scour protection system. ... my paper will concentrate on aspects of the ice scour protection system of the pipeline only. ... (Au)

WEIDLER, J.B.

377
Technical considerations for Beaufort Sea pipelines / Weidler, J.B. Healey, A.J. Hazlegrove, B.M.
(Civil engineering in the arctic offshore : proceedings of the Conference Arctic '85 / Edited by F.L. Bennett and J.L. Machemehl. – New York : American Society of Civil Engineers, 1985, p. 774-782, ill.)
ASTIS document number 159603.

This paper addresses technical considerations associated with the construction of marine pipelines in the Arctic Beaufort Sea. The development of Beaufort Sea fields will require construction methods and equipment for pipeline installation and trenching providing a balance between safety, reliability, and economy. Pipeline design factors relating to the need for thermal insulation and the economic trade-offs of different materials are discussed in this paper. In addition, requirements of burial depth in the transition zone and the methods of obtaining them are discussed. The paper also includes both winter and summer offshore construction methods, and concludes that, because of short operating seasons, methods that combine installation and trenching will be attractive. [Environmental criteria such as ice gouging are also discussed as they pertain to pipeline trenching depth.] (Au)

WEIR, F.V.

378
The ability to protect oil/gas pipelines and subsea installations from icebergs in the Hibernia area / Weir, F.V.
(Proceedings of the Symposium Production and Transportation Systems for the Hibernia Discovery, St. John's, Newfoundland, Canada, February 16-18, 1981 / Edited by W.E. Russell and D.B. Muggeridge. – St. John's, Nfld. : Petroleum Directorate, Government of Newfoundland and Labrador, 1981, p. 279-290, ill.)
ASTIS document number 149500.
NFSMO

The paper discusses two pipeline routes from the Hibernia field to Newfoundland and the associated problems. Methods for protecting subsea installations and pipelines were evaluated in light of current technology. (NFSMO)

379
The comparative environmental risks associated with fixed platforms and floating platforms and with tankers and pipelines / Weir, F.V.
(Proceedings of the Symposium Production and Transportation Systems for the Hibernia Discovery, St. John's, Newfoundland, Canada, February 16-18, 1981 / Edited by W.E. Russell and D.B. Muggeridge. – St. John's, Nfld. : Petroleum Directorate, Government of Newfoundland and Labrador, 1981, p. 337-355, ill.)
ASTIS document number 149519.
NFSMO

The environmental risks associated with fixed or floating production systems are discussed. Mobil Oil Canada is confident that systems which can be moved in the face of iceberg and floe ice occurrence will be environmentally safe. A fixed, in-place gravity platform can be designed. (NFSMO)

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