ARCTIC INDUSTRIAL ACTIVITIES COMPILATION – VOLUME 4
Historical Drilling Chemicals Data Associated with Offshore Hydrocarbon Exploration in the Canadian Beaufort Sea, Arctic Islands and Davis Strait Regions (1973 to 1987)

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ARCTIC INDUSTRIAL ACTIVITIES COMPILATION

VOLUME 4

COMPILATION OF HISTORICAL DRILLING CHEMICALS DATA ASSOCIATED WITH OFFSHORE HYDROCARBON EXPLORATION IN THE CANADIAN BEAUFORT SEA, ARCTIC ISLANDS AND DAVIS STRAIT REGIONS (1973 TO 1987)

by

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TABLE OF CONTENTS

TABLE OF CONTENTS, cont'd

TABLE OF CONTENTS, cont'd

TABLE OF CONTENTS, cont'd

TABLE OF CONTENTS, cont'd

LIST OF TABLES

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This report represents the cumulative contributions and co-operation of many people during the past several years. Portions of previous reports prepared by L. Turney, and P. Wainwright and J. McDonald have been used freely. The dedication of A. Blyth (ESL), R. Jacox, S. Ament and F. Noone are also greatly appreciated.

The scientific authority for this study was Mr. Brian Smiley of the Ocean Information Division, Institute of Ocean Sciences, Sidney, B.C. He in conjunction with Mr. Glen Packman (EPS, Yellowknife), Mr. Richard Nancarrow (COGLA, Yellowknife) and Mr. Paul Chenard (COGLA, Ottawa) comprised a technical steering committee that worked with ESL to confirm the overall project objectives, determine the final database structure and design an access/search program to meet each of their respective agency's requirements.

Mr. Richard Nancarrow (COGLA) also spent many additional hours with study team members in Yellowknife reviewing, explaining and interpreting the language "quirks" and typical practices described in the "Tour" Sheets (offshore drilling records). Thanks also to Ms. Irene Morris (COGLA) for her tireless efforts in accessing requested "Tour" Sheets and other information from the Yellowknife library files, and to Ms. Colleen Bryden (ESL) for her assistance in the computer entry of the drilling data. Mr. Paul Mudroch (EPS) arranged the necessary microcomputer facilities for study team members to use in Yellowknife. Mr. Mike Foreman of the Institute of Ocean Sciences provided assistance in copying the computerized map base for the three regions of interest from DFO computer files.

SERIES ABSTRACT

ESL Environmental Sciences Limited. 1991. Arctic Industrial Activities Compilation: Volume 4. Compilation of Historical Drilling Chemicals Data Associated with Offshore Hydrocarbon Exploration in the Canadian Beaufort Sea, Arctic Islands and Davis Strait Regions (1973 to 1987). Can. Data Rep. Hydrog. Ocean Sci. 32: (Vol. 4) 22 pp + appendices.

This volume is one of a group of catalogues designed to compile and summarize important descriptive details of selected industrial activities carried out in the offshore Canadian Arctic during the past two or three decades. For user convenience, the Arctic has been arbitrarily divided into seven geographical areas, incorporating where possible, major oceanographic regions. These seven areas coincide with those of a companion series, namely, the Arctic Data Compilation and Appraisal catalogues which describe historic oceanographic data (currents, hydrocarbons, whales -- to mention a few). The approach and format within and between these catalogues and series are intended to facilitate comparison among subjects and regions.

With such a large undertaking, it is not possible to provide all catalogues at once. Therefore, publications which are presently available in the series are indicated on the inside back cover of each volume.

Marine industrial development is ongoing, and further updates of these catalogue descriptions are planned. Readers are requested to submit corrections and additions by writing to the issuing establishment. Such revision will be incorporated into an interactive computer graphics and listing system, and custom reports and maps will be available on request.

Key words: Canadian Arctic, marine industrial activities, catalogue, database.

SÉRIES RÉSUMÉ

ESL Environmental Sciences Limited. 1991. Arctic Industrial Activities Compilation: Volume 4. Compilation of Historical Drilling chemicals Data Associated with Offshore Hydrocarbon Exploration in the Canadian Beaufort Sea, Arctic Islands and Davis Strait Regions (1973 to 1987). Can. Data Rep. Hydrog. Ocean Sci. 32: (Vol. 4) 22 pp + appendices.

Le présent volume fait partie d'une série de répertoires conçus pour la compilation et le résumé des importants détails descriptifs d'activités industrielles choisies effectuées dans les eaux hauturières canadiennes de l'Arctique au cours des deux ou trois dernières décennies. Pour faciliter l'utilisation de l'ouvrage, les auteurs ont divisé arbitrairement l'Arctique en sept zones géographiques incorporant, si possible, de grandes régions océanographiques. Ces sept zones coincident avec celles d'une série associée, océanographiques historiques (courants, hydrocarbures, baleines, etc.). L'approche et la présentation de ces répertoires et séries visent une comparaison facile entre les sujets et les régions.

RÉSUMÉ
cont.

Il n'est pas possible de fournir tous les répertoires in même temps dans un travail de telle envergure. Les ouvrages de la série actuellement disponsibles sont donc indiqués au plat du verso de chaque volume.

Le développement industriel du milieu marin est une activité permanente; on prévoit donc des mises à jour des répertoires. On demande aux lecteurs de faire parvenir leurs corrections et ajouts à l'éstablissement d'ou provient la publication. De telles révisions seront ajoutées à un système interactif de listage et de traitement des données graphiques, des cartes et des rapports spéciaux seront disponibles sur demande.

Mots-clés: Arctique canadien, activités industrielles en milieu marin, répertoire, base de données.

VOLUME 4 ABSTRACT

This inventory contains a summary of chemical usage at 119 offshore drilling locations in the Beaufort Sea, Arctic Islands and Davis Strait areas of the Canadian Arctic between 1973 and 1987. Information was obtained both from Tour Sheets and Well History Records. The data extracted were standardized into consistent units and entered into an IBM PC microcomputer database using the Ashton-Tate dBase III Plus management system. A menu-driven access/search program, using the PASCAL programming language, was developed to enable various user-friendly search options for the database. Data are graphically displayed for evaluating patterns of drill waste discharges in the three offshore drilling areas of the Canadian Arctic. These displays include: (1) comparison of data obtained from Tour Sheets and Well History Records; (2) summaries of drilling mud chemicals used by year, by well and by oil company; (3) the frequency of wells drilled as a function of water depth; (4) offshore drilling activity for each year between 1973 and 1987; (5) offshore drilling activity for the period 1973 to 1987 by each oil company active in Arctic drilling; and (6) number of wells drilled between 1973 and 1987 in the offshore Canadian Arctic from various drilling platforms. An overall quality of the available data is assessed.

1. INTRODUCTION

This report is a synthesis of two previous projects related to the waste discharges from exploratory wells in Canadian arctic marine waters north of 60° N Latitude. The first study (Turney *et al.* 1986) involved the development of a microcomputer database containing weekly drilling chemical records from offshore hydrocarbon exploration drilling activities in Canadian Arctic waters. The objectives of the second study (Wainwright and McDonald 1987) were to assemble information on drilling activity prior to 1976 and from mid-1985 onwards, which was not included in the earlier version of the database (i.e., Turney *et al.* 1986); to upgrade the database access software, and to compile additional information to facilitate interpretation of the data. The objectives of this follow-on to the previous two studies were (1) to incorporate additional drilling waste details from the Well History Reports obtained from DIAND Water Resources into the database (in the previous study, daily Tour Sheets provided by COGLA were the primary source of drilling waste records); and (2) to use the database to highlight, wherever possible, major trends and patterns in drill waste discharges in the Arctic seas.

DISCLAIMER AND CAUTIONARY NOTE

The data included in the database were assembled from original source documents which were of varying quality and degrees of completeness. **These data include records of chemicals which were not discharged to marine waters**; records of chemicals mixed on site or bulked into hoppers, but not circulated down the well; records of chemicals not used as drilling mud constituents (e.g., rigwash); and records pertaining to special circumstances such as shallow water flow events, diesel and low-toxicity oil base muds, and muds utilized prior to suspension of wells at the end of the open-water season.

The software for accessing the database contains routines for outputting data which facilitate use of the data by statistical and related software. These routines may encourage misuse of the data because they do not incorporate the requirement to exclude data of low quality from a search. **It is incumbent on the user to verify that data extracted from the database are suitable for statistical analyses or other intended uses.** Potential users are encouraged to examine any data extracted critically and to consult an expert statistician regarding the significance of results obtained.

2. SCOPE

2.1 The Study Area

The study area comprises the Canadian marine waters of the Beaufort Sea, the Arctic Archipelago and the northern portion of the Davis Strait. The study area includes only those wells lying within DIAND's administration as defined by the Administrative Line of Convenience between the Department of Energy, Mines and Resources and the Department of Indian Affairs and Northern Development (COGLA 1985). Mr. Richard Nancarrow (formerly of COGLA, Yellowknife) identified the wells in the Davis Strait region that were within the study area.

2.2 Information Compiled

Well history information was compiled for 119 wells in the study area. Wherever possible, weekly drilling chemical records were compiled from 'Tour Sheets' (pronounced: tower sheets) on file with COGLA. Information was also compiled from Well History Reports submitted by industry as required by Environmental Operating Conditions (EOCs) or from secondary information sources. The types of information compiled were determined in consultation with the Scientific Authority and are listed in Table 2.1.

Compilation of the well information included the following activities:

1. Meetings with the Scientific Authority at the Institute of Ocean Sciences, Sidney and with the Steering Committee in Yellowknife to determine which specific waste information should be extracted from the subcontractor reports on daily drilling activities ("Tour" sheets); how the extracted information should be stored on the microcomputer database; and, which general search options would be built into a "user-friendly" access/search program for the database.

2. Search of all of the available "Tour" Sheets and Well History Reports archived at COGLA's regional office in Yellowknife for pertinent drill wastes information for weekly and total spud-release volumes. A list of 80 offshore wells (1976 to 1985) was provided by COGLA from a cursory review of their files. DIAND produced a list of an additional 24 offshore wells (with no drilling fluids information) for the period 1973 to 1985.

3. Entry of extracted drilling waste summaries including well name, drilling authority number, operator, contractor, rig type, spud date, release date, well depth, water depth, cuttings volume and all drilling wastes constituents and quantities (weekly and total) onto an IBM microcomputer database using the PASCAL programming language and dBASE-III, the Ashton-Tate database management system.

4. Production of a simple-to-use computer program to permit searching and sorting of the extracted drill waste records by geographic area, time period, waste type, total spud-release volumes, etc. with easy capability for updating and outputting the search results to printer, plotter or monitor. The manual for this software package is given in Appendix D.

Table 2.1
Information Included in the Microcomputer Database

Well History Parameters

Drilling Authority Number
Well Name
Well Status
Well I.D.
Latitude (degrees, minutes and seconds to .001 second if available)
Longitude (degrees, minutes and seconds to .001 second if available)
Area Code (Beaufort Sea, Arctic Islands or Davis Strait)
Operator
Contractor
Spud and Release Dates
Water Depth (m)
Total Well Depth (m)
Hole Sizes (mm) and Depths (m) of Casing Sections
Hole Volume (m^3)
Rig Type (drillship, artificial island, ice platform, etc.)
Rig Name
Comments

Chemical Parameters

Date (daily records were summarized at the weekly level)
Product Name
Quantity
Units
Hours Drilling or Reaming Hole

2.2.1 Standardization of Nomenclature and Units

The extraction of information from the Tour Sheets was often difficult. The Tour Sheet records (1) were either nearly illegible; (2) did not report units or reported ambiguous units such as sacks, pallets, seacans and cans; (3) reported ambiguous product names or only the supplier's name; or (4) reported chemicals in an unusual form (such as fluid units where the product is normally supplied as a solid). In such cases, assumptions were made after careful scrutiny of the available information and, if possible, clarification was sought by telephone with the well operator, contractor or potential suppliers of the product. A comprehensive audit trail was maintained of all nomenclature changes, unit conversions and other assumptions which relates the records in the database (approximately 11,000 entries) to the original source documentation. A discussion of the quality and utility of the information compiled is given in Section 4.

Considerable effort was also required to convert the quantities reported to standard units (kilograms) and to standardize fluid nomenclature. The International Union of Pure and Applied Chemistry (IUPAC) nomenclature has been used where possible (e.g., "caustic soda" was entered as "sodium hydroxide"). However, for some proprietary formulations (e.g., Dual Spacer - Halliburton Services Ltd.) information could not be obtained to standardize chemical names. Information on container sizes, specific gravity, composition and sales to companies operating in the Canadian Arctic was obtained from the various suppliers. Additional specific gravity information was obtained from the COGLA (Ottawa) database: "COGLAMUD" through the assistance of Mr. Paul Chénard.

A complete listing of the drilling products identified in this study together with common names and equivalent product names (where applicable), contains sizes, specific gravity, form (solid/liquid), primary/secondary uses and supplier is given in Appendix A.

2.2.2 Toxicology Data Compiled

The previous version of the microcomputer database contained toxicology information obtained from DIAND and COGLA files for some drilling mud constituents. These data are LC50 values, which are defined as the concentration of contaminant in the environment that can be expected to result in 50% mortality of the test organisms over a specified time interval and under specific test conditions. No information describing test conditions, duration (time interval), test organisms, concurrent measurements or information source was available for any of these data.

The objective for this component of the study was to assemble data in a format that would allow consideration of patterns of use of the chemicals in relation to their toxicity. However, intercomparison of toxicology data is not practical where the data are not standardized in some manner (Wainwright and Humphrey 1986; Dillon 1984; Klapow and Lewis 1979). The data provided and currently on file with COGLA and DIAND could not be standardized. In consultation with the Scientific Authority, it was agreed to delete these data from the database, because they would be unsuitable for the intended use.

The version of the database produced for this study contains no toxicology information, but includes an entry-editor-access module that will allow data to be included at a later time.

3. AN OVERVIEW OF TYPICAL DRILLING FLUID CHEMICALS

It is easier to understand the usage rates, quantities and potential fate/affects of drilling chemicals when their chemical formulation and function are understood. The purpose of this section is to provide an overview of the types of chemicals that have been or are being used in typical drilling operations in the Arctic.

3.1 Drilling Discharges

In normal offshore exploration drilling, the major waste discharges are drilling fluids and cuttings. Minor discharges include sand, deck drainage, completion fluids, cement, BOP 'fluid', sanitary and domestic wastes and slop oil.

Drilling fluids are prepared from a variety of commodity and specialty chemicals. The choice of drilling fluid is primarily dependent upon the characteristics of the foreseen geological strata which will be drilled. As differing geological conditions are almost certainly encountered, the chosen drilling mud must be a flexible compromise to deal with a range of possible problems. Consequently, the drilling fluid at each well is somewhat unique in composition although a very small number of major constituents (i.e., barite, bentonite or other clay) lignosulphonate, lignite, caustic soda and sodium carbonate/bicarbonate) often account for over 90% of the total weight of drilling products used. In drilling conducted in the Arctic Canada in offshore areas, chemical additives are chosen from a list approved by Indian and Northern Affairs (INAC 1989; Appendix B).

3.2 Drilling Muds

Drilling muds are classified according to the nature of the base-liquid. The major classification is as follows:

- Water based (e.g., freshwater, seawater, brine or mixed salts)
- Oil based (e.g., diesel oil, "low-toxic" oil, or invert oil emulsion)
- Other (e.g., air, gas, mist or foam systems)

In worldwide usage, approximately 99.5% of wells are drilled with water-based mud systems, 0.4% with oil based mud systems and 0.1% with other systems. In offshore Arctic Canada all but a few wells (Nipterk L-19A, Adgo G-24, Minuk I-53 and Kaubvik I-43) have been drilled with water-based systems. "Low-tox" oil based muds were used at the remaining wells.

A description of the typical types of chemicals used with water-based and oil-based muds are given below.

3.2.1 Water-based Mud Systems

i) Weighting Agents

Materials with high specific gravity used to provide the required density of the drilling fluid. Iron oxides (haematite, ilmenite), calcium carbonate are also used. The most commonly used weighting agent is barite ($BaSO_4$).

ii) Viscosifiers

Materials used mainly to build fluid viscosity. Bentonite clay is the most commonly used product, together with lesser amounts of other clays e.g., attapulgite. Polymers are also now being increasingly used e.g., partially hydrolysed polyacrylamides, cellulose ethers, copolymers of vinyl acetate and maleic anhydride.

iii) Dispersants

Materials which disperse solid particles in the drilling fluid. Examples are ferrochrome lignosulphonates, chrome-free lignosulphonates, sodium polyacrylates, phosphates.

iv) Fluid loss additives

Materials which prevent the loss of fluid from the mud to permeable and porous rock formations. Examples are carboxymethyl cellulose, xantham gum, guar gum, polyacrylates, pre-gelatinised starch and lignite.

(v) Commodity chemicals

Appreciable quantities of lime and sodium hydroxide are for pH adjustment. Also other chemicals are used to provide correct ionic balance in the fluid e.g., sodium chloride, potassium chloride, lime and calcium chloride.

(vi) Biocides

Biocides are added to drilling fluids to eliminate or control the growth of sulphate reducing bacteria. These bacteria, in anaerobic conditions, generate hydrogen sulphide by reduction of sulphate ions. The hydrogen sulphide produced in the reaction is toxic and corrosive as it reacts with iron to produce iron sulphide. The chemical formulation of biocides has included the following categories:

- chlorine and chlorine releasing chemicals
- phenolics (dichloroxyphenol, benzyl cresol)
- organometallics (compounds of tin, mercury and copper)
- oxidants (hydrogen peroxide)
- aldehydes (formaldehyde, gluteraldehyde)
- quaternary ammonium compounds (trimethylalkylammonium chloride)

All biocides are toxic. The biocide of choice is usually the one which has selective toxicity to sulphate reducing bacteria without causing long-term storage, handling or toxicity problems for humans and marine life. Thus, quaternary ammonium compounds are often selected. Biocides are generally soluble in water. Their biocidal action is usually a function of concentration; once diluted they lose their biocidal action.

(vii) Corrosion Inhibitors:

These chemicals protect metals against corrosion. Inhibitors are chosen to suit the corrosion problem. A variety of chemical additives are possible including:

- primary monoamines (as salts, ethoxylates or unmodified forms)
- polysubstituted monoamines (secondary or tertiary form)
- diamines/polyamines/imidazolines, (either unmodified or as derivatives)
- quaternary ammonium compounds.

The corrosion inhibitors are usually added continuously to the mud system as an alcohol-inhibitor solution (20-70% inhibitor) such that final concentrations of inhibitor in the mud range from 5-25 ppm, the actual concentration depending upon water temperature, pH, salinity and flow velocity.

(viii) Surfactants:

Emulsifiers, demulsifiers and flocculants reduce the relationship between viscosity and solids concentration, vary gel strength and reduce plastic viscosity (includes ethyl hexanol, sulphonates, non-toxic compounds and quaternary ammonium compounds).

(ix) Defoamers:

Most of the many commercial defoamers contain phosphate esters, metallic soaps of fatty acids or organic silicone compounds.

3.2.2 Oil-based Mud Systems

i) Primary emulsifiers

These materials emulsify water into the base oil to provide a stable invert oil emulsion mud. Typical chemicals are polymerised/oxidised tall oil soaps; animal fatty acids plus alkanol amides; oleyl amide + oleic acid + dimerised oleic acid; magnesium soaps of fatty acids + tall oil resin + fatty amides; fatty imidazoline derivatives.

ii) Wetting agents/secondary emulsifiers

These materials preferentially oil-wet solids introduced in the mud and provide additional stability to the system. Examples are amide derivatives of tall oil; long chain fatty amides; oleyl amide lignosulphonate; fatty diamine; imidazolines and ethoxylated alkyl phenols.

iii) Viscosifiers

These materials impart viscosity to the system. The main product used is an organophilic bentonite.

iv) Fluid loss additives

These materials which prevent the loss of the continuous phase of the mud (i.e., oil) to permeable and porous rock formation. Examples are oxidised asphalt; organophillic lignite or mixture of polyphenols.

(v) Other specialty chemicals

To a limited extent, thinners such as petroleum sulphonates or napthenic acids are used.

In the Canadian Arctic, potassium chloride (KCl or potash) mud formulations are used to drill through permafrost which may extend to over 600 m depth, because KCl acts as a freezing point depressant (Friesen 1980) Below this depth, use of KCl is reduced. KCl muds have also been used for drilling through sensitive formations such as swelling or sloughing shales. Canadian and U.S. companies are considering use of KCl mud systems instead of oil-based muds for development drilling. Concentrations of KCl used in Canadian Arctic surface wells range from 29 to 58 kg/m^3 (Neff 1982 citing Bryant 1976). The use of KCl in whole mud ranges from 15 to 140 kg/m^3 when used in sensitive deeper formations instead of in permafrost drilling.

There is a change in mud characteristics with mud weight (density). The light-weight muds which are used in the upper portions (0-3 000 m) of a well have low solids content and a relatively low density. The high-weight muds which are used in the lower portions (3 000-6 000 m) of a well have a higher solids content and a high density due to a higher portion of barite in the formulation.

Chemical usage generally increases with well depth. Barite dominates the total drilling muds and drilling fluid discharges in the deeper wells. The nature of the additives also changes, with near-surface mud consisting mostly of caustic soda and bentonite. Deeper-well muds contain increasing amounts of barite, lignosulphonate and lignin (Neff 1982).

Discharged water-based drill cuttings are composed of: (1) formation cuttings which have been circulated through the well to the platform; (2) wash water which is used to separate drilling fluid from the cuttings; and (3) residual drilling fluid which is not removed from the cuttings (Ray and Meek 1980). Before discharge of cuttings overboard, the drill cuttings and fluid mixture which has returned from the well are passed through a series of separator devices, known as solids control equipment, which removes the larger cuttings particles from the system and allows the fluid to be recirculated. The final cuttings discharge comprises coarse particles (rock chips), sand and clay particles.

Oil-based muds are not discharged to the sea for environmental and cost reasons. Cuttings from oil-base mud system used are discharged following appropriate cleaning to removal oil. Overall oil retention on cuttings from, for example, the Minuk I-53 and Kaubvik I-43 wells in the Beaufort Sea was 13.6 and 15.0 g per 100 g dry solids respectively (Erickson *et al.* 1988)

4. DATA QUALITY AND COMPLETENESS

4.1 Completeness of Information

A summary of wells for which information was compiled is given in Table 4.1. A total of 119 Drilling Authorities were identified and included in the database. These Drilling Authorities typically correspond to unique wells. Of these wells, no data could be located for 4 stratigraphic wells in 1973; only well history reports could be located for 3 wells; well history reports were required to fill in data for specific years for 3 wells; and specific tour sheets could not be located or were not legible for an additional 7 wells.

4.2 Quality of Information

The quality of the information included in the database must be considered in relation to specific intended uses. By way of example, the database provides a rapidly accessible copy of well information from the tour sheet and well history records currently maintained in various forms in government files. However, some past studies have recommended that statistical analyses of the tour sheet data (fluid use records) be performed with the objective of examining the factors influencing the quantity and nature of drilling muds discharged to the marine environment (Schneider 1983; Evans and Milburn 1985; and Milburn and Evans 1986).

Several factors influence the quality of these data for statistical analyses: (1) the completeness of the data coverage; (2) the nature of the information compiled; (3) errors associated with lack of units, inconsistent nomenclature, illegible entries and arithmetic errors in the source documents; (4) compilation and data entry errors; and (5) artificial distinctions where proprietary products may be similar or identical but cannot be so identified. The first two factors are considered to be the most significant limits to use of the data. However, it is apparent that the data are not of uniform quality and that some data are clearly in error. An obvious example of this is Drilling Authority number 821, Netserk F-40.

For this well, 36 million kilograms of barite are reported for the 1976 drilling season. This value is an order of magnitude greater than the quantity of barite reported for any other well. Scrutiny of the information compiled from the tour sheets reveals a mixture of units including: no units, "bulk", bags, sacks and pounds. It does not seem possible that a mistake in units could result in an error of this magnitude. The values for bentonite at this well are also in error by approximately the same factor. All other reported quantities of fluids appear reasonable. One can only assume that the information on the

TABLE 4.1

SUMMARY OF WELL INFORMATION COMPILED

DA No.	WELL NAME	Completeness and other comments
618	SUN GULF GLOBAL LINCKENS ISLAND P-46	Totals only
669	PANARCTIC KRISTOFFER STRAT L-45	No data
670	PANARCTIC KRISTOFFER STRAT C-36	No data
671	PANARCTIC ELVE PT. STRAT K-50	No data
694	IMPERIAL IMMERK B-48	No hours
703	PANARCTIC JACKSON BAY STRAT B-16	No data
706	ESSO ADGO F-28	
738	PANARCTIC TENNECO ET AL W. HECLA N-52	From well history
755	IMPERIAL PULLEN E-17	
767	IMPERIAL NETSERK B-44	Main chart of mud and tour sheets do not agree (offset by one day)
768	SUN BVX ET AL UNARK L-24	5 sheets illegible*
770	SUN BVX ET AL PELLY B-35	
791	ESSO ADGO P-25	
805	PANARCTIC GULF ET AL E. DRAKE I-55	3 sheets illegible
809	IMPERIAL ADGO C-15	
818	PANARCTIC TENNECO CS N.W. HECLA M-25	
820	IMPERIAL DELTA 5 IKATTOK J-17	
821	ESSO NETSERK F-40	Data not correct
822	PANARCTIC W. HECLA P-62	
828	PANARCTIC ET AL JACKSON G-16	

* Indicates a product name for which no supplier could be identified or the report of a product in dubious form

TABLE 4.1, cont'd

SUMMARY OF WELL INFORMATION COMPILED

DA No.	WELL NAME	Completeness and other comments
834	HUNT DOME KOPANOAR D-14	Appears incomplete Still pumping mud after 26/09/76
835	DOME ET AL TINGMIARK K-91	
838	IMPERIAL SARPIK B-35	
841	PANARCTIC ET AL JACKSON G-16A	*
843	PANARCTIC TENNECO ET AL W. HECLA C-05	
846	SUN BVX ET AL UNARK L-24A	
848	PANARCTIC NORCEN AIEG ET AL GRASSY I-34	
850	IMPERIAL ARNAK L-30	
851	IMPERIAL KUGMALLIT H-59	
854	DOME HUNT NEKTORALIK K-59	
858	PANARCTIC SW HECLA C-58	
859	PANARCTIC AIEG NE DRAKE P-40	
869	HUNT DOME KOPANOAR M-13	2 sheets missing*
870	IMPERIAL IOE KANNERK G-42	
879	DOME ET AL UKALERK C-50	
882	DOME KAGLULIK A-75	
885	DOME NERLERK M-98	
890	PANARCTIC DRAKE F-76	
892	PANARCTIC ET AL ROCHE PT O-43	
893	ESSO IOE ET AL ISSERK E-27	
905	DOME PACIFIC ET AL PEX NATSEK E-56	

* Indicates a product name for which no supplier could be identified or the report of a product in dubious form

TABLE 4.1, cont'd

SUMMARY OF WELL INFORMATION COMPILED

DA No.	WELL NAME	Completeness and other comments
906	DOME GULF ET ALL UKALERK 2C-50	
909	DOME HUNT KENALOOAK J-94	22/09/81 - 25/09/81 from well history
910	DOME GULF TARSIUT A-25	
911	PANARCTIC AIEG WHITEFISH H-63	
912	PHILLIPS AQUIT ET AL HAZEN F-54	
914	DOME KAGLULIK M-64	includes chemicals pre-mixed
919	PANARCTIC AIEG DESBARATS B-73	
928	ESSO ADGO J-27	
936	ESSO ET AL GJOA G-37	
937	AQUITAINE ET AL HEJKA O-71	
943	DOME HUNT GULF KOPANOAR L-34	
945	ESSO ET AL ISSUNGNAK O-61	
946	DOME HUNT GULF KOAKOAK O-22	
947	PANARCTIC AIEG WHITEFISH 2H-63	
950	DOME GULF HUNT KOPANOAR 2L-34	
952	PANARCTIC ET AL CHAR G-07	
953	PANARCTIC AIEG DOME PPC BALAENA D-58	from well history no sheets legible
962	DOME SUPERIOR ORVILRUK O-03	1980 and 1981 from well history
964	DOME GULF HUNT KOPANOAR I-44	
966	DOME ET AL KILANNAK A-77	*

* indicates a product name for which no supplier could be identified or the report of a product in dubious form

TABLE 4.1, cont'd

SUMMARY OF WELL INFORMATION COMPILED

DA No.	WELL NAME	Completeness and other comments
967	DOME GULF HUNT KOPANOAR 2I-44	No hours, 1981 from well history
968	ESSO GULF ET AL ISSUNGNAK 2O-61	
972	PANARCTIC AIEG PRC PPC CISCO B-66	Tour sheets omit 3622 L diesel reported in well history*
973	PANARCTIC AIEG PPC DOME SKATE B-80	*
974	PANARCTIC AIEG PPC DOME MACLEAN I-72	1 sheet illegible*
978	GULF ET AL NORTH ISSUNGNAK L-86	*
981	ESSO PEX ALERK P-23	*
984	DOME HUNT IRKALUK B-35	
985	DOME ET AL SIULIK I-05	
986	PANARCTIC ET AL SCULPIN K-08	*
987	PANARCTIC ET AL CAPE MAMEN F-24	*
988	PANARCTIC ET AL WHITEFISH A-26	*
989	PANARCTIC ET AL CISCO C-42	
991	GULF ET AL EAST TARSIUT N-44	05/07/82 - 25/07/82 missing
992	ESSO PEX WEST ATKINSON L-17	
1001	GULF ET AL KIGGAVIK A-43	
1005	ESSO PEX HOME ET AL ITIYOK I-27	
1015	PANARCTIC ET AL CISCO K-58	Includes inventory adjustments
1029	DOME ET AL NATIAK O-44	

* indicates a product name for which no supplier could be identified or the report of a product in dubious form

TABLE 4.1, cont'd

SUMMARY OF WELL INFORMATION COMPILED

DA No.	WELL NAME	Completeness and other comments
1030	DOME AIVERK I-45	
1031	PANARCTIC ET AL GRENADIER A-26	
1032	PANARCTIC ET AL CAPE MACMILLAN K-15	
1039	DOME TEXACO ET AL UVILUK P-66	
1040	DOME ET AL AIVERK 21-45	28/08/84 - 25/09/84 missing, includes chemicals pre-mixed
1058	PANARCTIC ET AL CAPE MACMILLAN 2K-15	
1073	DOME ET AL ARLUK E-90	
1078	GULF ET AL AMAULIGAK J-44	22/11/83 fluids disposed by burning
1080	GULF ET AL PITSIULAK A-05	
1081	DOME ET AL HAVIK B-41	
1098	ESSO HOME ET AL KADLUK O-07	Includes inventory adjustments
1118	GULF ET AL KOGYUK N-67	
1126	DOME NERLERK J-67	*
1131	PANARCTIC ET AL SKATE C-59	
1132	PANARCTIC ET AL CISCO M-22	Fluids disposed on land
1133	PANARCTIC ET AL BUCKINGHAM O-68	
1194	ESSO HOME PCI ET AL AMERK O-09	Includes inventory adjustments and bulking chemicals after rig release

* indicates a product name for which no supplier could be identified or the report of a product in dubious form

TABLE 4.1, cont'd

SUMMARY OF WELL INFORMATION COMPILED

DA No.	WELL NAME	Completeness and other comments
1195	ESSO TRILLIUM ADGO H-29	Includes inventory adjustments and bulking chemicals, 2 sheets illegible
1198	ESSO HOME PCI ET AL NIPTERK L-19	
1199	GULF ET AL TARSIUT P-45	Includes pre-mixed chemicals prior to spudding
1201	GULF ET AL AKPAK P-35	
1216	PANARCTIC ET AL CAPE ALLISON C-47	
1217	PANARCTIC ET AL EAST DRAKE L-06	
1243	ESSO HOME PCI ET AL NIPTERK L-19A	Well used same bore as DA 1198 for 0 to 701 m
1249	GULF ET AL AKPAK 2P-35	
1250	ADLARTOK P-09	
1251	DOME ET AL EDLOK N-56	
1262	GULF ET AL AMAULIGAK I-65	
1265	ESSO PCI HOME ET AL MINUK I-53	Includes inventory adjustments*
1266	ESSO PCI HOME ET AL ARNAK K-06	
1267	ESSO TRILLIUM ET AL ADGO G-24	Includes inventory adjustments*
1271	CHEVRON TRILLIUM NORTH ELLICE L-39	
1272	AAGNERK E-56	
1287	PANARCTIC ET AL NORTH BUCKINGHAM L-71	
1294	PANARCTIC ET AL WEST CORNWALL N-49	
1297	GULF ET AL AMAULIGAK I-65A	
1317	GULF ET AL AMAULIGAK I-65B	
1321	ESSO HOME ET AL KAUBVIK I-43	
1350	TRILLIUM ESSO CHEVRON ANGASAK L-03	

* Indicates a product name for which no supplier could be identified or the report of a product in dubious form

tour sheet was misunderstood or incorrectly recorded. Compilation records indicate that these tour sheets were considered 99% legible. Poor legibility, therefore is not an adequate explanation for the problems with this well's records. Examination of the Well History Records, however, helps to resolve the discrepancy. In these Records, barite usage is reported as 2.5 million kg. While this is consistent with expectation, it too may be in error because of the lack of rigour often present in the keeping of these records.

As a consequence of the shortcomings of the database, the data included should be considered reliable only to within an order of magnitude. Data prior to 1980 are not considered reliable even to within an order of magnitude. These shortcomings must be fully taken into account when using statistical methods to test the significance and results. A discussion of the possible uses and limitations of statistical methods on the drill waste data is provided in Appendix C.

5. DISCUSSION

5.1 Patterns of Drill Waste Discharges

5.1.1 Comparison of Data Obtained from Tour Sheets and Well History Records

The drilling fluid usage for various fluid categories as obtained from Tour Sheets and Well Histories is given in Figures 1.1 to 1.6 for drilling operations in the Beaufort Sea and Arctic Islands offshore. In general, agreement is not good between data obtained from Tour Sheets and Well Histories, particularly for chemicals used in large quantities. In some cases, the discrepancies can be as high as 1500%. This provides graphic evidence of the uncertainties in the database and the unsuitability of the data in their current form for rigorous statistical analysis.

5.1.2 Summary of Chemical Usage

Summaries of mud chemicals used by year, by well and by company are provided in a series of reports such as INAC 1985, 1986 a,b. Generally, the most heavily used additives are weighting agents followed by solids control inhibitors, viscosifiers and filtrate reducers for drilling in the Beaufort Sea (Figures 1.1, 1.2, 1.3) and pH control chemicals, lubricants, and lost circulation material for drilling in the Arctic Islands offshore (Figures 1.4, 1.5 and 1.6). Histograms of chemical usage from 1973 to 1987 are provided for a series of fluid categories for drilling in the Arctic Islands offshore, Davis Strait and the Beaufort (Figures 2.1 to 2.15). These yearly summaries combine to produce the histograms of Figure 1. A summary of weighting material usage between 1973 and 1987 for the three drilling areas is given in Figure 2.16.

5.1.3 Depositional Environments

Figure 3.1 shows the frequency of wells drilled as a function of water depth. This is an approximate surrogate for the amount of waste discharge as a function of water depth. Of 119 wells drilled, 15 (13%), 33(28%), 61(51%) and 87(73%) occurred in depths shallower than 5 m, 20 m, 50 m and 100 m, respectively. Thirty-two wells (27%) were drilled in water depths greater than 100 metres. Most of the wells drilled in the Beaufort have been in shallow water (<50 m) whereas most of the wells drilled offshore in the Arctic Islands and Davis Strait have been drilled in deep water (>100 m). The water depth at the drilling location is an important factor influencing the fate of the drilling waste and its potential effects. Generally, the deeper the water, the greater the dilution of wastes during their descent to the seabed and the less the possible effects on the water column and benthic environments.

5.1.4 Yearly Activity by Region

A histogram showing the drilling activity for each year between 1973 and 1987 in the Beaufort Sea, Arctic Islands offshore and Davis Strait (Figure 4.1) indicates that the number of wells drilled in Arctic Canada ranged from one in 1987 to twenty in 1979. Most wells were drilled in the Beaufort (72%), followed by the Arctic Islands (26%) and Davis Strait (2%). There has been some drilling occurring in the Beaufort each of the years from 1973 through 1987 time period.

5.1.5 Activity by Company

Figures 5.1 to 5.4 show the drilling activity for the period 1973 to 1987 by each company active in arctic drilling. The most active operators have been DOME, PANARCTIC and ESSO/GULF/IMPERIAL OIL. Locations of where each operator has drilled are summarized in Figures 5.5, 5.6 and 5.7. Annual breakdown of all the locations in Figures 5.5, 5.6 and 5.7 are provided in Figures 5.8 to 5.37.

5.1.6 Activity by Rig Type

Figures 6.1 to 6.4 show the number of wells drilled from various rigs between 1973 and 1987 in the offshore Canadian Arctic. Most wells have been drilled from drillships (42%), followed by ice platforms (28%) and artificial islands (26%). Locations of rig types are shown on Figures 6.5 to 6.33. Rig type has implications for the fate of drill wastes. Discharge from drillships and ice platforms is usually into the water column wherein dispersion and settling are aided in all three dimensions. Discharge from artificial islands tends to confine the wastes on one side of the island, usually on its flank. Ultimately the wastes will become incorporated in the island material as the island erodes.

6. RECOMMENDATIONS

The following recommendations address: (1) problems identified with the data; (2) revisions of the database structure required to ensure data integrity; (3) assignment of data quality ratings; (4) identification of information sources; and (5) identification of appropriate uses of the information in the database. Recommendations 1, 2 and 3 are considered to have the highest priority. Recommendations are not otherwise presented in any specific order of importance.

1. No statistical analyses and specifically no regulatory decisions should be based upon the fluid use data until the suitability of Tour Sheet data for such purposes has been investigated and satisfactorily addressed.

   The operators should be consulted to clarify exactly what the Tour Sheet chemical records represent. With respect to drilling chemicals, the original requirement to provide copies of Tour Sheet records to the government appears to have been to provide verification that only approved products are in use. It appears that the Tour Sheets meet this objective by providing a record of all handling of drilling chemical at the well site. Additional information such as site chemical inventory, bulking into hoppers and pre-mixing of fluids is recorded as well, and hence included in the database (see Table 3.1). The major difficulty with this is that once in the database, this additional information cannot be differentiated from the information on chemical discharge to the ocean.

2. No significant effort should be expended on the development of a predictive statistical model until additional data are obtained either from new drilling activity or expansion of the scope of the study to other regions.

   Scrutiny of the information in the database suggests that pre-1980 data are not reliable and should not be used for statistical analyses. On this basis, only five years of data would be available for the development of a predictive model. Further, some of the remaining data represent special cases (see Recommendation 7) and should also be excluded. As discussed below (Recommendation 4), several factors are expected to influence drilling chemical use. As a consequence, it is expected that the available Arctic data of acceptable quality represent too small a sample size for the development of a predictive model.

3. The merits of deterministic models should be investigated as a predictive method of drilling chemical useage. Deterministic models are not based on probability or the concerns regarding use of statistical methods.

   Further, the use of drilling chemicals at a well is not random, but is determined largely by the results of stratigraphic information, previous experience in similar formations and the objectives of the drilling. As a consequence, a deterministic model is inherently more feasible. Nonparametric inferential statistics may be of benefit in defining the relationships and parameters to include in such a model.

4. The database structure should be modified to a relational structure between data.

   Factors such as time spent drilling, depth in the well, hole diameter, the specific operator and stratigraphy are related to the nature and quantities of chemicals used in the well. At present the database structure does not relate these data to quantities of chemicals used. Instead, the relation between these data is hierarchical.

5. Annual totals, i.e., totals for fluids reported in all drilling sessions (spud-to-release) commencing in that calendar year, should be calculated from the fluid use records and not be discrete records.

   With the existing database structure, if any specific record is edited, appended or deleted, it is necessary to update the corresponding annual total. This is undesirable because (a) updating is more difficult, requiring tedious calculations, and it is possible that annual totals could be in error - because the totals must be updated as well, and the user must be aware that specific totals require updating; (b) it is not possible to distinguish whether an annual total was entered from a Well History (39 records in the current version) or calculated from the Tour Sheet data without printing out all records from the database applicable to that session; and (c) the annual totals represent 2 426 additional records which contribute significantly to the size of the database without contributing additional information.

6. The database structure should be modified to include a a means of identifying where a particular datum came from (source identifier).

   Information has not always been compiled from Tour Sheets; Well History Reports and other sources have also been used. It is important for verification and updating that this information be available, particularly when units and nomenclature have been standardized, and assumptions or adjustments have been made. This will also be important when toxicology data are entered.

7. The database structure should be modified to incorporate a data quality rating, perhaps similar to the Arctic Data Compilation and Appraisal Program (ADCAP) rating scheme.

   These ratings could facilitate sorting and retrieval by allowing the user to limit any output or activity to a specific data quality range. Similarly the database structure should allow identification of well information which is incomplete or represents a 'special case' such as: shallow water flows at Tingmiark K-91, Kopanoar D-14 and Kaglulik A-75; land disposal of diesel base muds at Cisco M- 22; disposal by flaring of approx. 34 metric tons of diesel used at Amauligak J-44; use of low-toxicity oil base muds at Nipterk L-19A and Minuk I-53; and questionable records for Netserk F-40 reporting quantities of barite and bentonite which are obviously overstated by two orders of magnitude. Such atypical wells should not be retrieved in response to a routine database query.

8. The database structure should be modified to include an additional field categorizing the mud system; i.e., Polymer, sea water CLS, spud mud, etc.

   The change-over from one mud system to another is normally associated with both a change in chemical use and the need to dispose of the previous mud. In addition, toxicity data for whole mud systems are available and are probably more useful than data for the individual chemicals. This factor should be considered when examining the pattern of mud discharges and incorporated into the development of any inferences or models.

9. The database should be expanded to include product information for all chemicals included in the database; e.g., density, container sizes, suppliers, common and equivalent trade names, description, water solubility, and hazardous materials data such as information on safety and health and safe disposal.

   This information was required by the study team to standardize units, validate specific data and to interpret the database information (and has been delivered as separate dBase III+ files). It is assumed that such information will also be required by database users, but cannot be included in the existing database structure. Such information could also be of benefit to interpret dilution and dispersion characteristics of contaminants and their environmental effects.

10. The database should not rely on a specific standard measurement (such as LC50) to relate specific chemicals to their effects in the environment, but rather utilize a 'concern rating' (i.e., very high, high, moderate, low, or negligible).

    Such ratings could be assigned after careful review of information on fate, persistence, bioaccumulation and biological effects, and would inherently have a low potential for misapplication when accessing information from the database (see Section 5.1).

    LC50 values are a specific determination which identifies a concentration which is expected to be lethal to 50% of the test organisms within a specific time and under specific conditions. Such information does not address potential bioaccumulation or persistence in the environment, or potential mutagenic, carcinogenic and teratogenic effects. Alternative methods of assessing toxicity include LC25, LD50, NOEC, EC50 and TLm50, each with its own specific definition and associated values. It is somewhat problematical which values to use. It is important, however, that care be exercised to ensure that toxicology information is appropriate.

    For example, sodium carbonate (soda ash) is moderately toxic to amphipods in terms of 96h LC50 value - 67 mg/L (Bond *et al.* 1973). This value, however, was determined for lake water and is inappropriate for marine waters. Also, it is important to consider the concentration in sea water to which biota will be exposed. In the case of sodium carbonate it is unlikely that toxic concentrations could be achieved except under conditions of limited circulation.

7. LITERATURE CITED

Bond, W.A. and T.D. Turnbull. 1973. Fishery investigations at Great Slave Lake, NWT, 1972. Can. Fish. Mar. Serv. Tech. Rep. Serv. CENT/T-73-7:78 pp.

Canada Oil and Gas Lands Administration (COGLA). 1985. The Canada Oil and Gas Lands Administration Annual Report 1984. Submitted to the Parliament of Canada in accordance with Section 73 of the Canada Oil and Gas Act, SSC Cat. No. M 97- 1984E, 41 pp.

Dillon, T.M. 1984. Biological Consequences of Bioaccumulation in Aquatic Animals: An Assessment of the Current Literature. U.S. Department of the Army, U.S. Army Corps of Engineers, Technical Report D-84-2, 35 pp. + Tables.

Erickson, P., B. Fowler and D. Thomas. 1988. Oil-Based Drilling Muds: Off Structure Monitoring - Beaufort Sea. Environmental Studies Research Funds Report No. 101. Ottawa. 192 pp.

Evans, T.B., and D. Milburn. 1985. Drilling Mud Usage and Discharge in Arctic Marine Waters North of 60° for the Period 1978-1982. Water Resources Division, Northern Affairs Program, Indian and Northern Affairs Canada, Yellowknife, N.W.T., (Unpublished manuscript) 46 pp.

Friesen, G. 1980. Drilling fluids and disposal methods employed by Esso Resources Canada Ltd. to drill in the Canadian arctic. Pages 53-69. (In) Research on Environmental Fate and Effects of Drilling Fluids and Cuttings, Symposium Proceedings, 21-24 January, 1980, Lake Buena Vista, Florida.

INAC. 1986a. Summary report: Drilling fluid use and waste discharged in arctic marine waters of 60° for 1983. Arctic Waters Section. Water Resources Division. Indian and Northern Affairs (Canada). Yellowknife. 38 pp.

INAC. 1986b. Summary Report: Drilling fluid use and waste discharge in arctic marine waters north of 60° for 1984. Arctic Waters Section. Water Resources Division. Indian and Northern Affairs Canada. Yellowknife. 47 pp.

INAC. 1985. Drilling mud usage and discharge in arctic marine waters north of 60° for the period 1978-1982. Arctic Waters Section. Water Resources Division. Indian and Northern Affairs Canada, Yellowknife. 6 pp. + Appendices.

INAC. 1989. List of approved drilling fluid additives. Canadian Arctic Offshore November 1989 Edition. Indian and Northern Affairs Canada, Ottawa. 6 pp.

Klapow, L.A., and R.H. Lewis. 1979. Analysis of Toxicity Data for California Marine Water Quality Standards, J. Water Pollut. Control Fed. 51:2054-69.

Mendenhall, W. 1979. Introduction to Probability and Statistics 5th Edition. Duxbury Press. Belmont California U.S.A. 594 pp.

Milburn, D., and D.L.S. Evans. 1986. Summary Report: Drilling Fluid Use and Wastes Discharge in Arctic Marine Waters North of 60° for 1983. Arctic Waters Section, Water Resources Division, Northern Affairs program, Indian and Northern Affairs Canada, Yellowknife, N.W.T., (Unpublished manuscript) 44 pp.

NAS. 1983. Drilling Discharge in the Marine Environment. National Academy of Sciences. National Academy Press. Washington, D.C., U.S.A. 180 pp.

Neff, J.M. 1982. Fate and effect of oil well drilling fluids in the marine environment: a literature review. Prep. by Battelle New England Research Laboratory for Environmental Research Laboratory, office of Research and Development, U.S. Environmental Protection Agency, Gulf Breeze, Florida. 62 pp.

Ray, J.P. and R. P. Meek. 1980. Water column characterization of drilling fluids dispersion from an offshore exploratory well on Tanner Bank. pages 223-258. (In) Proceedings of Symposium Research on Environmental Fate and Effects of Drilling Fluids and Cuttings. Lake Buena Vista, Florida.

Schneider, F. 1983. A Report on the Feasibility of Forecasting Rig Waste Effluent. A report for Canada Oil and Gas Lands Administration by University of Waterloo, Biology Department, Co-op Program (Unpublished manuscript) 67 pp. + appendices.

Thomas, D.J., G.D. Greene, W.S. Duval, K.C. Milne and M.S.Hutcheson. 1983. Offshore Oil and Gas Production Waste Characteristics, Treatment Methods, Biological Effects and Their Applications to Canadian Regions. A report for Environment Canada by Arctic Laboratories Limited, ESL Environmental Sciences Limited, SKM Consulting Limited and Atlantic Oceanics Company Ltd. (Unpublished manuscript).

Turney, L., J.W. McDonald, T. Sackmann and E. Svendsen. 1986. Compilation of Historical Drill Waste Data Associated with Exploratory Drilling in the Canadian Beaufort Sea, Arctic Islands and Davis Strait Regions (1976-1985). A report by ESL Environmental Sciences Limited for Department of Fisheries and Oceans, Department of Indian Affairs and Northern Development, Department of Environment and Canada Oil and Gas Lands Administration, (Unpublished manuscript) 146 pp. + appendices.

Wainwright, P.F. and J.W. McDonald. 1987. Compilation of Historical Drilling Chemicals Data Associated With Offshore Hydrocarbon Exploration in the Canadian Beaufort Sea, Arctic Islands and Davis Strait (1973 to 1987). A report by ESL Environmental Sciences Limited for Department of Fisheries and Oceans, Department of Indian Affairs and Northern Development, Department of Environment and Canada Oil and Gas Lands Administration, (Unpublished manuscript) 38 pp. + appendices.

Wainwright, P.F. and B. Humphrey. 1986. Literature Review of Selected Organic Compounds of Concern to Ocean Dumping of Dredged Sediments. A report by Seakem Oceanography Ltd. for the Ocean Dumping Programme, Environmental Protection, Environment Canada, (Unpublished Manuscript)

8. FIGURES

Figure 1.1 Tour Sheet vs. Well History Summary of drilling fluid usage in Beaufort Sea Drilling, 1973 - 1979

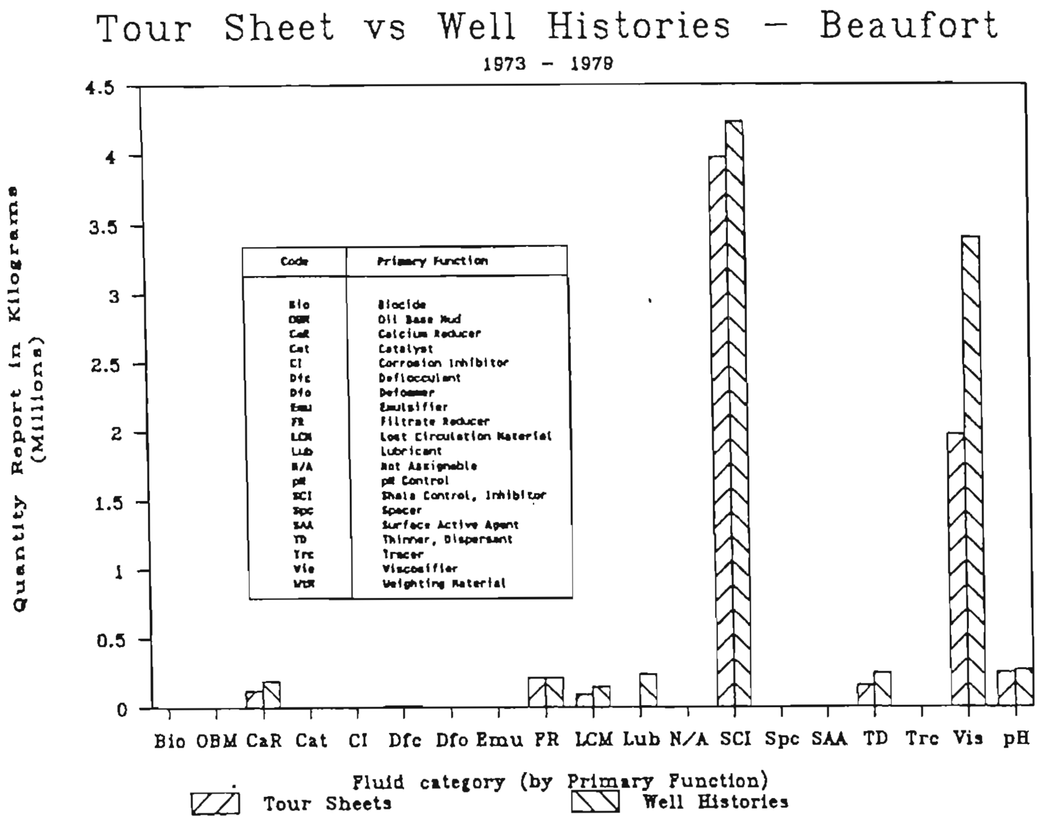


Figure 1.2 Tour Sheet vs. Well History Summary of drilling fluid usage in Beaufort Sea Drilling, 1980 - 1982

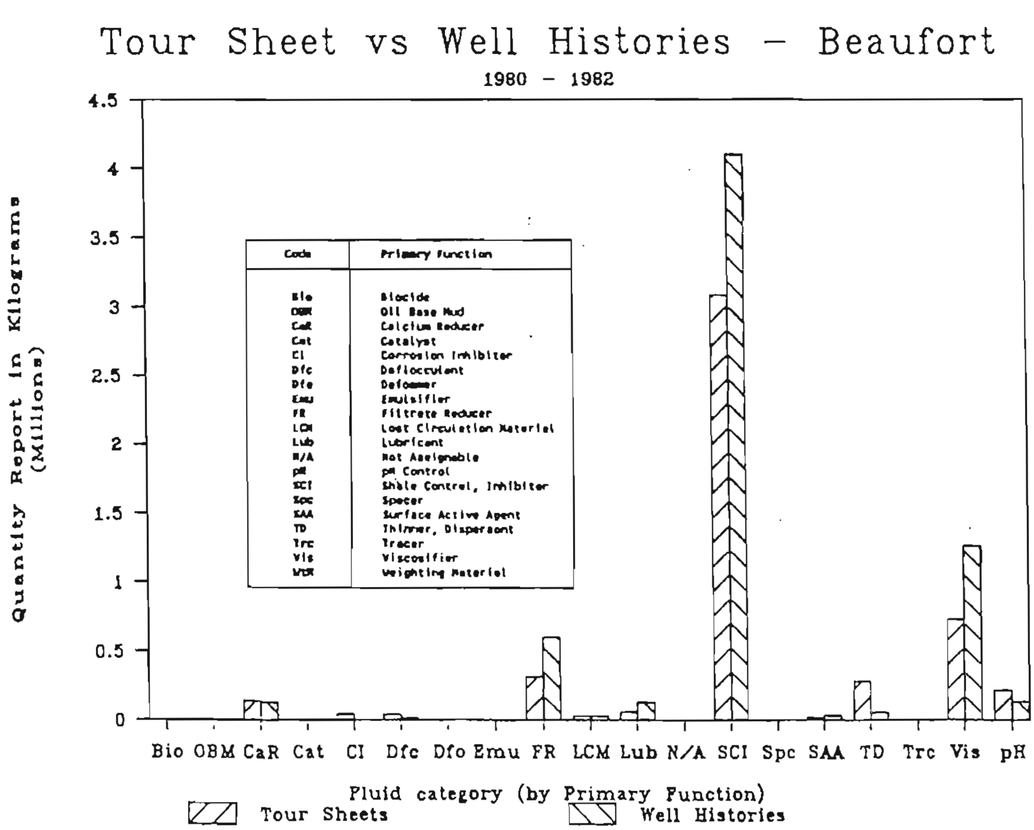


Figure 1.3 Tour Sheet vs. Well History Summary of drilling fluid usage in Beaufort Sea Drilling, 1983 - 1985

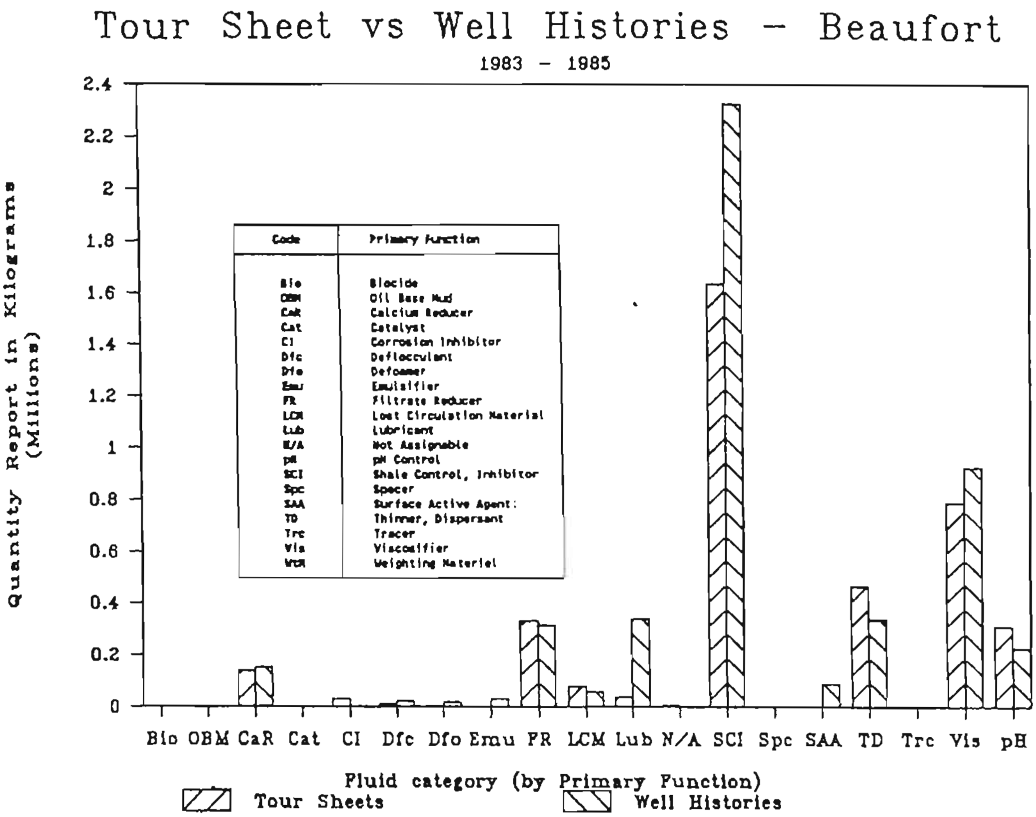


Figure 1.4 Tour Sheet vs. Well History Summary of drilling fluid usage in Arctic Islands Drilling, 1973 - 1979

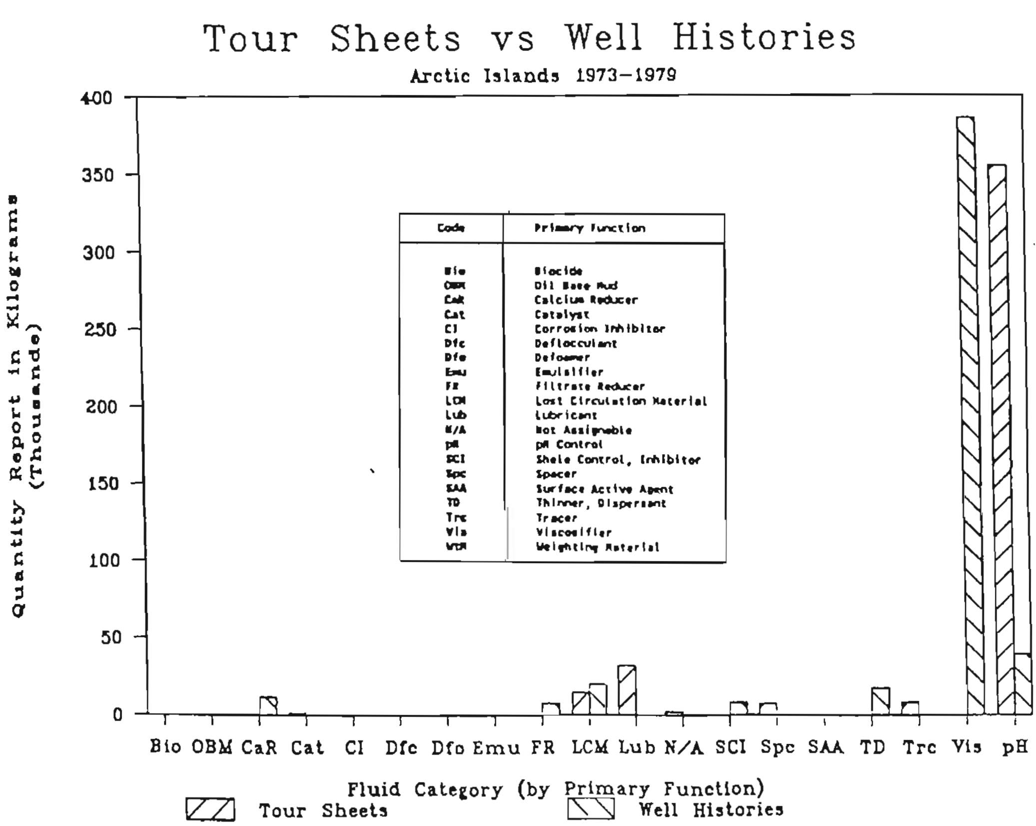


Figure 1.5 Tour Sheet vs. Well History Summary of drilling fluid usage in Arctic Islands Drilling, 1980 - 1982

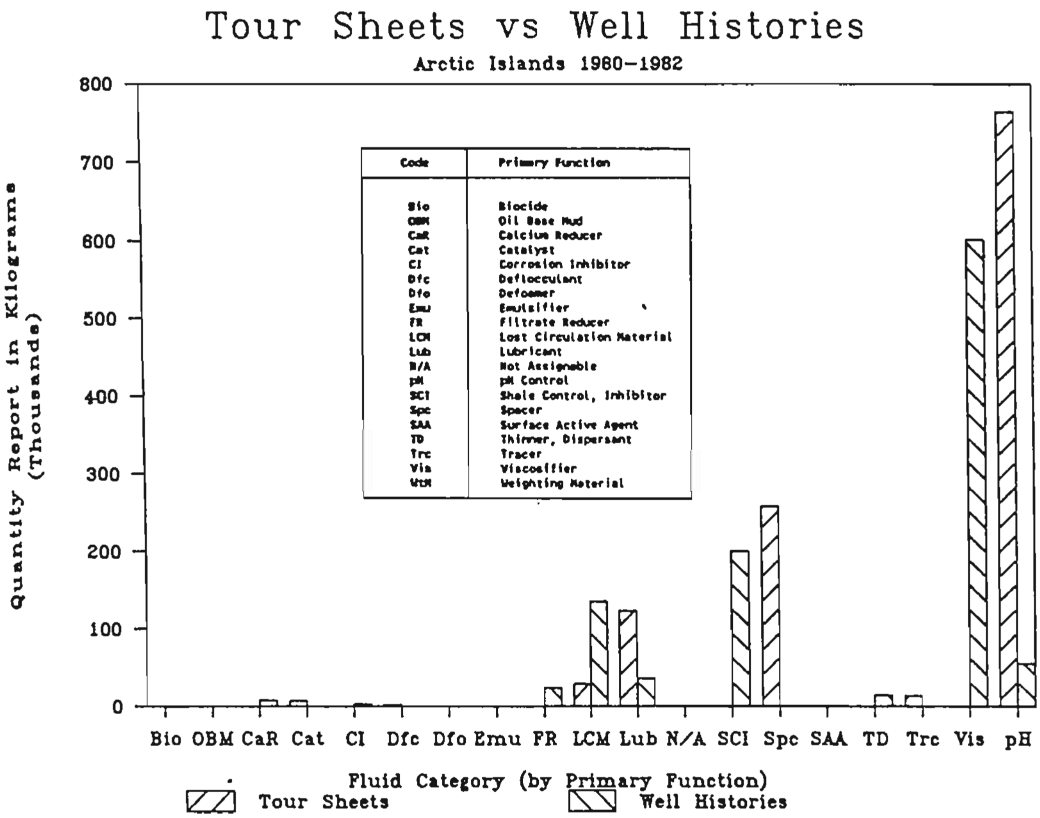


Figure 1.6 Tour Sheet vs. Well History Summary of drilling fluid usage in Arctic Islands Drilling, 1983 - 1985

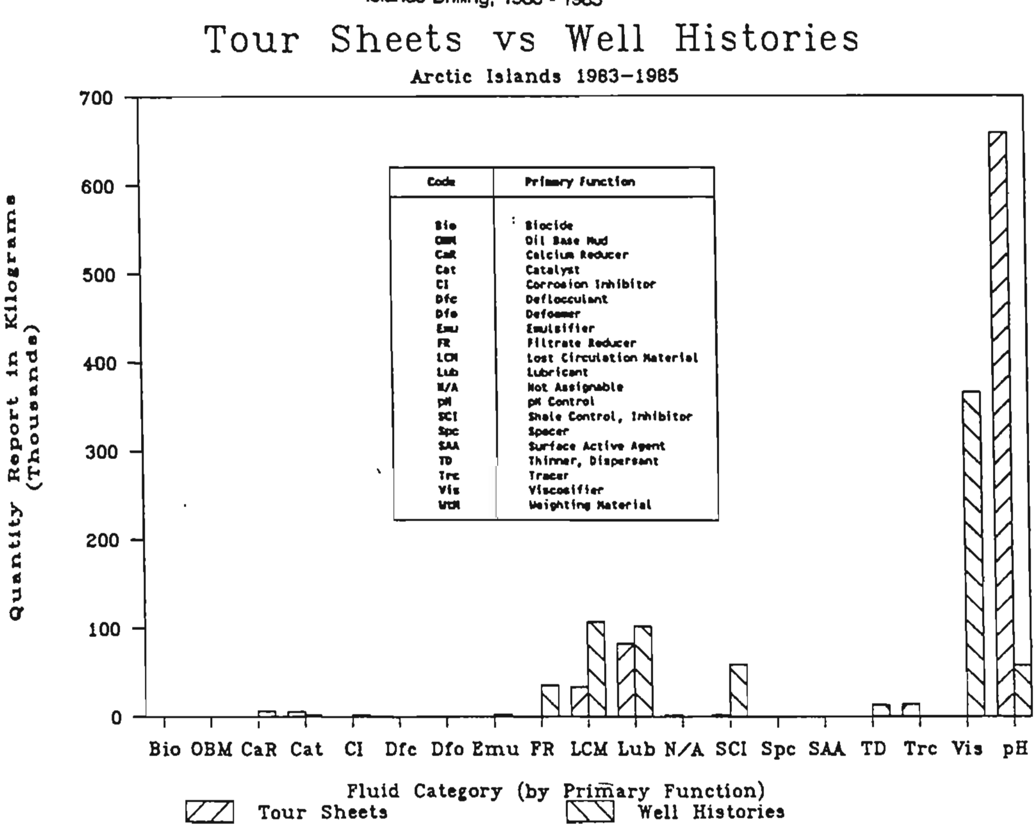


Figure 2.1 Summary of chemical usage for drilling in the Arctic Islands, Davis Strait and the Beaufort Sea, 1973

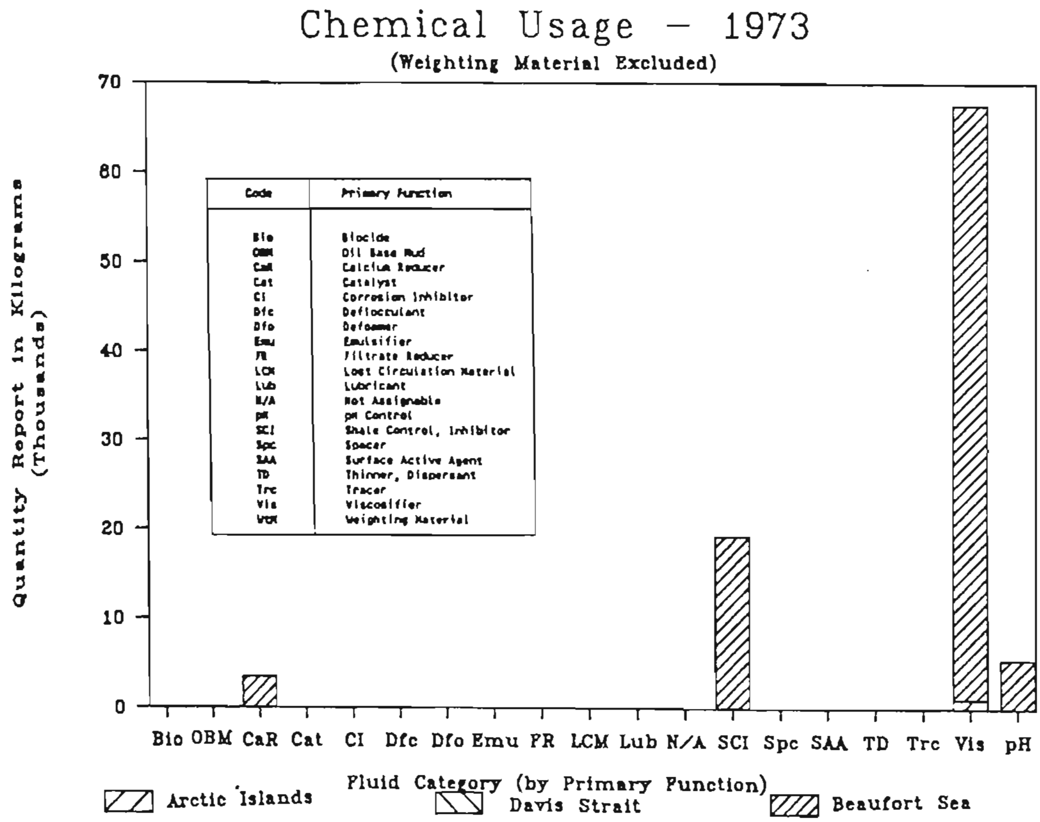


Figure 2.2 Summary of chemical usage for drilling in the Arctic Islands, Davis Strait and the Beaufort Sea, 1974

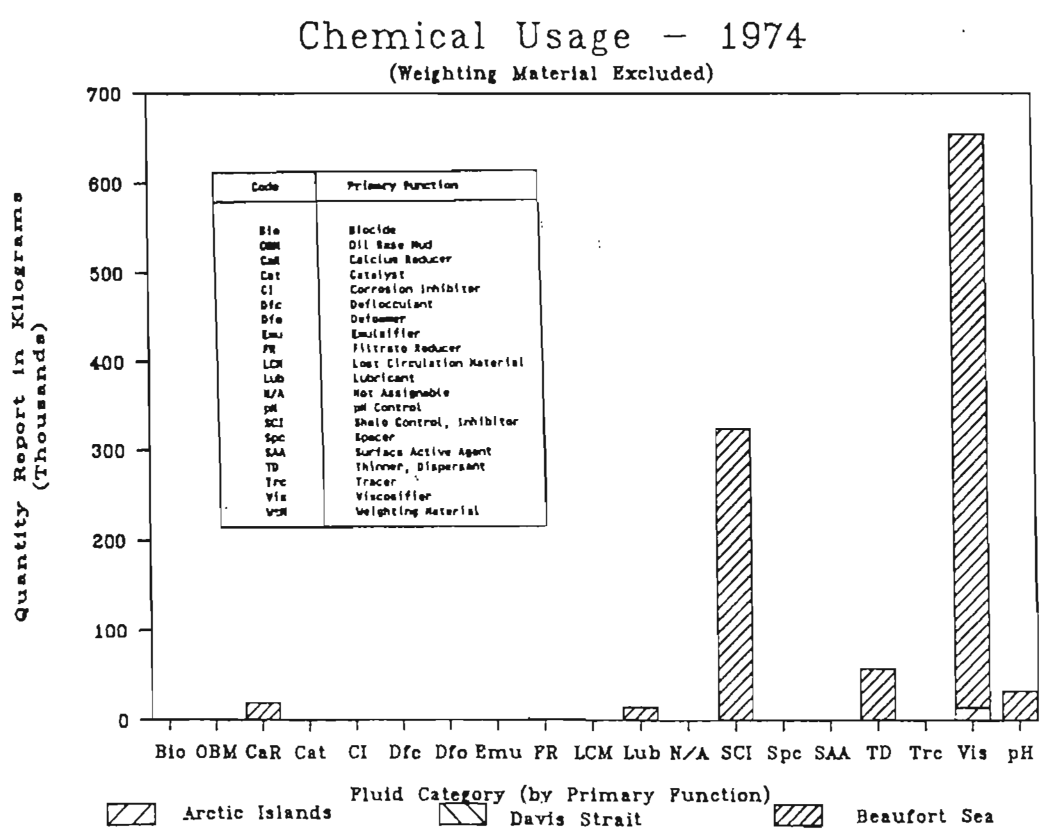


Figure 2.3 Summary of chemical usage for drilling in the Arctic Islands, Davis Strait and the Beaufort Sea, 1975

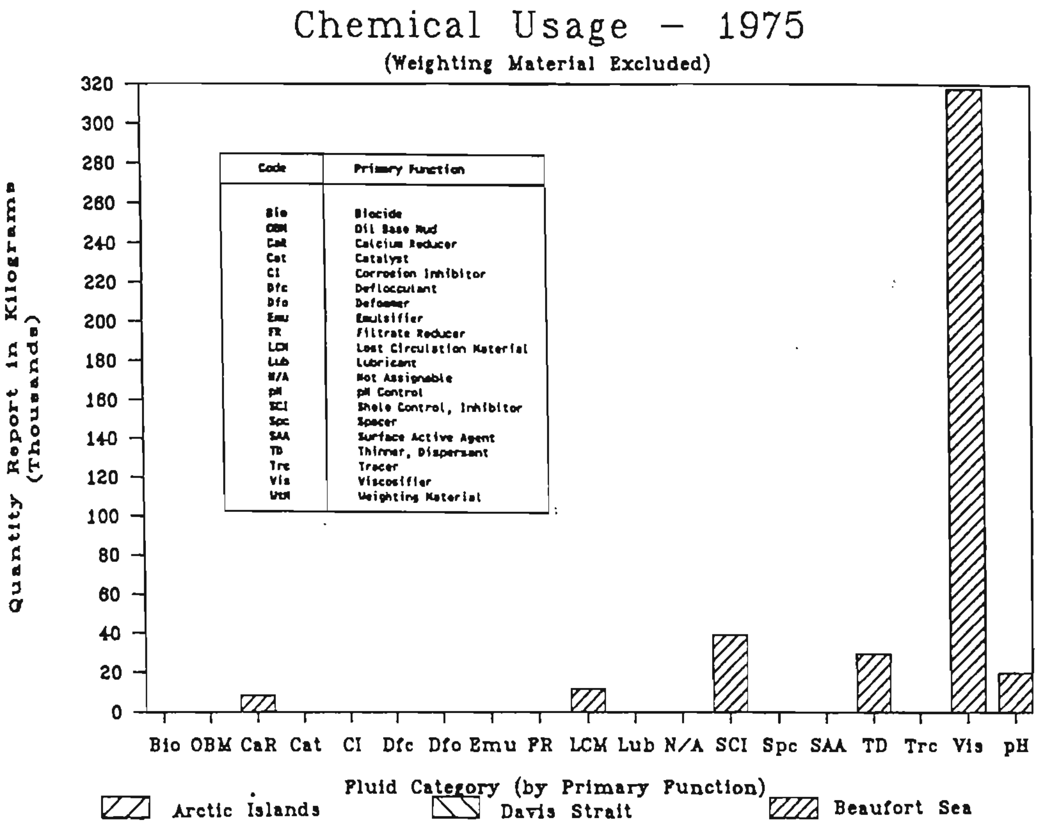


Figure 2.4 Summary of chemical usage for drilling in the Arctic Islands, Davis Strait and the Beaufort Sea, 1976

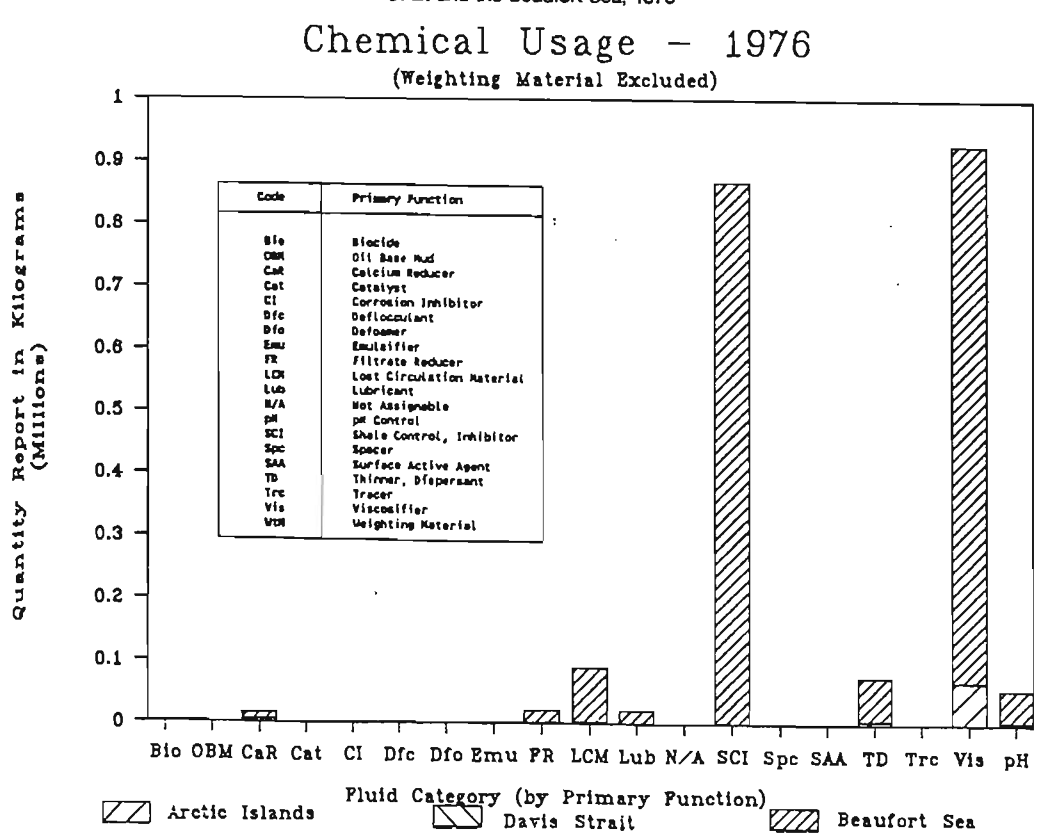


Figure 2.5 Summary of chemical usage for drilling in the Arctic Islands, Davis Strait and the Beaufort Sea, 1977

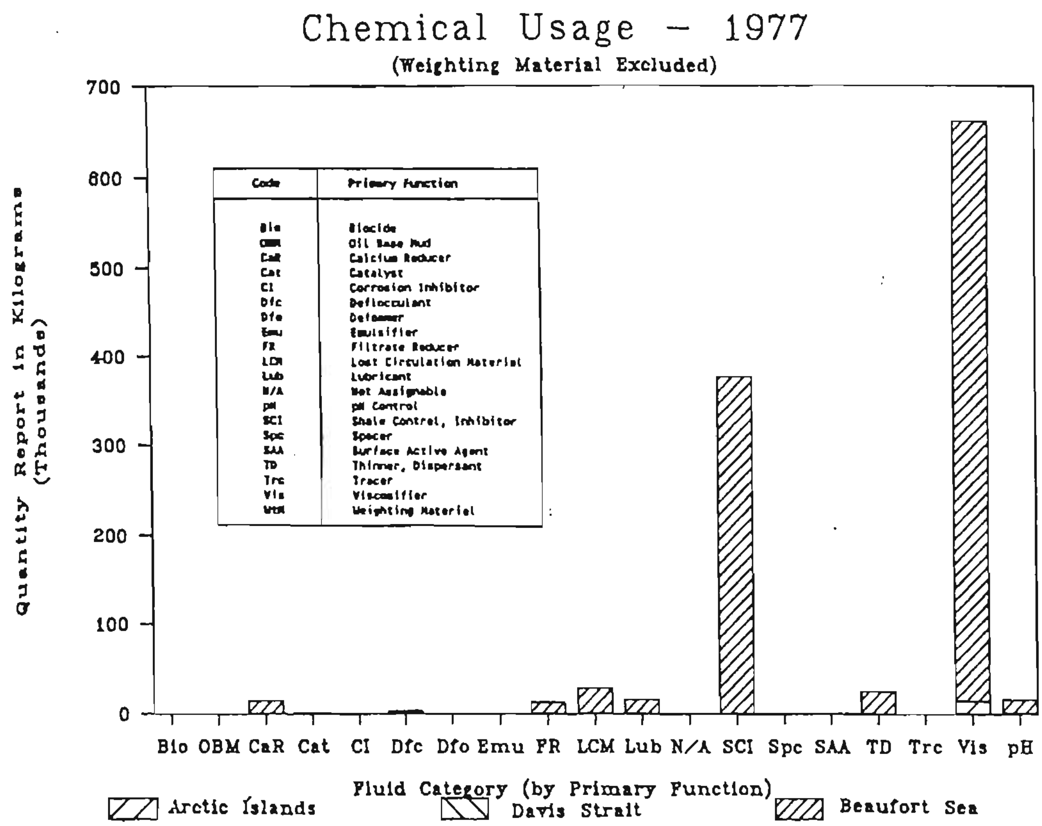


Figure 2.6 Summary of chemical usage for drilling in the Arctic Islands, Davis Strait and the Beaufort Sea, 1978

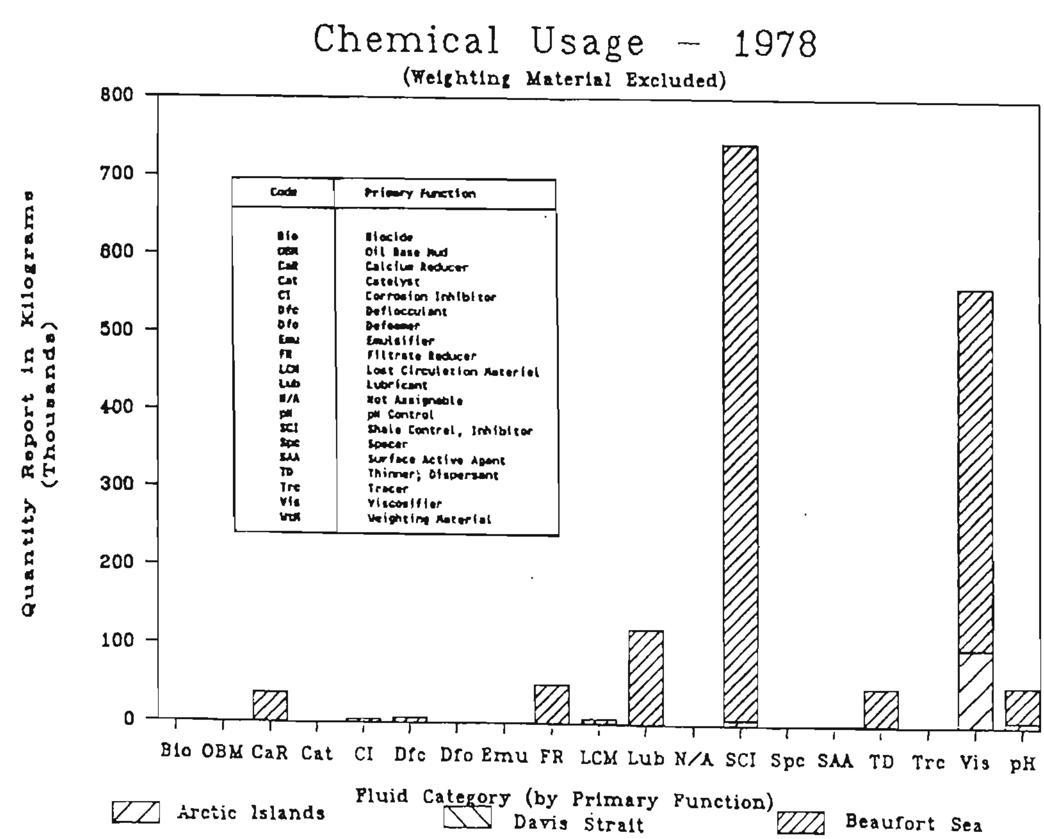


Figure 2.7 Summary of chemical usage for drilling in the Arctic Islands, Davis Strait and the Beaufort Sea, 1979

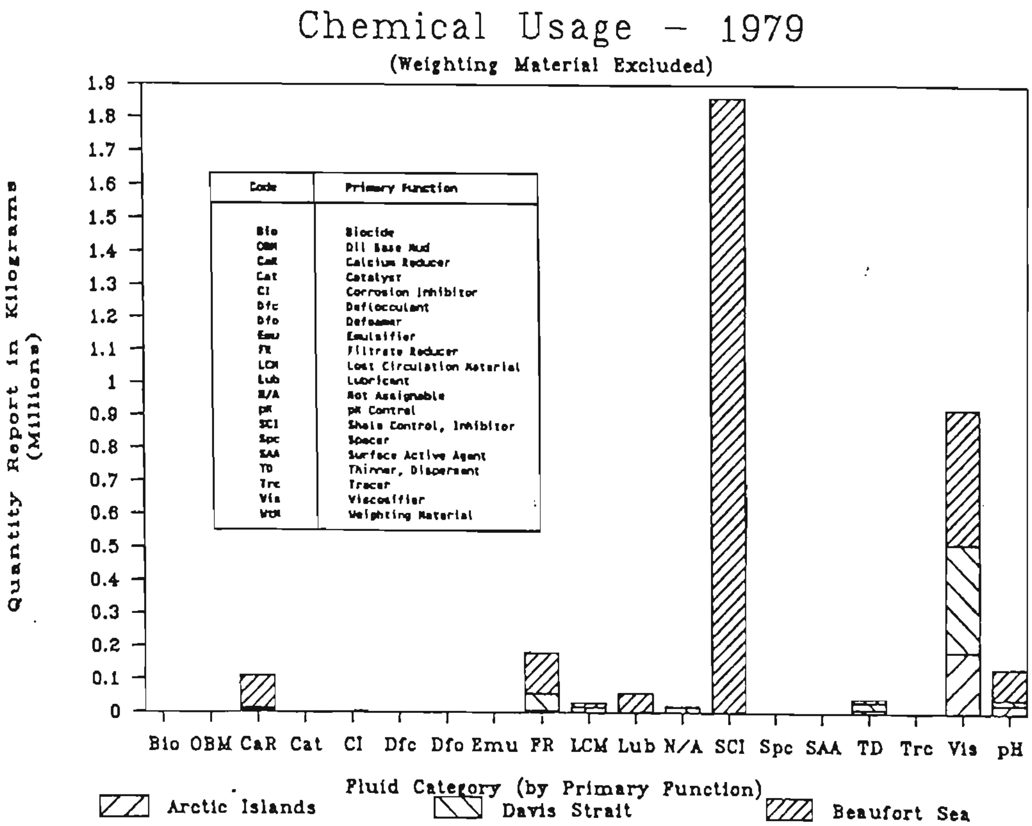


Figure 2.8 Summary of chemical usage for drilling in the Arctic Islands, Davis Strait and the Beaufort Sea, 1980

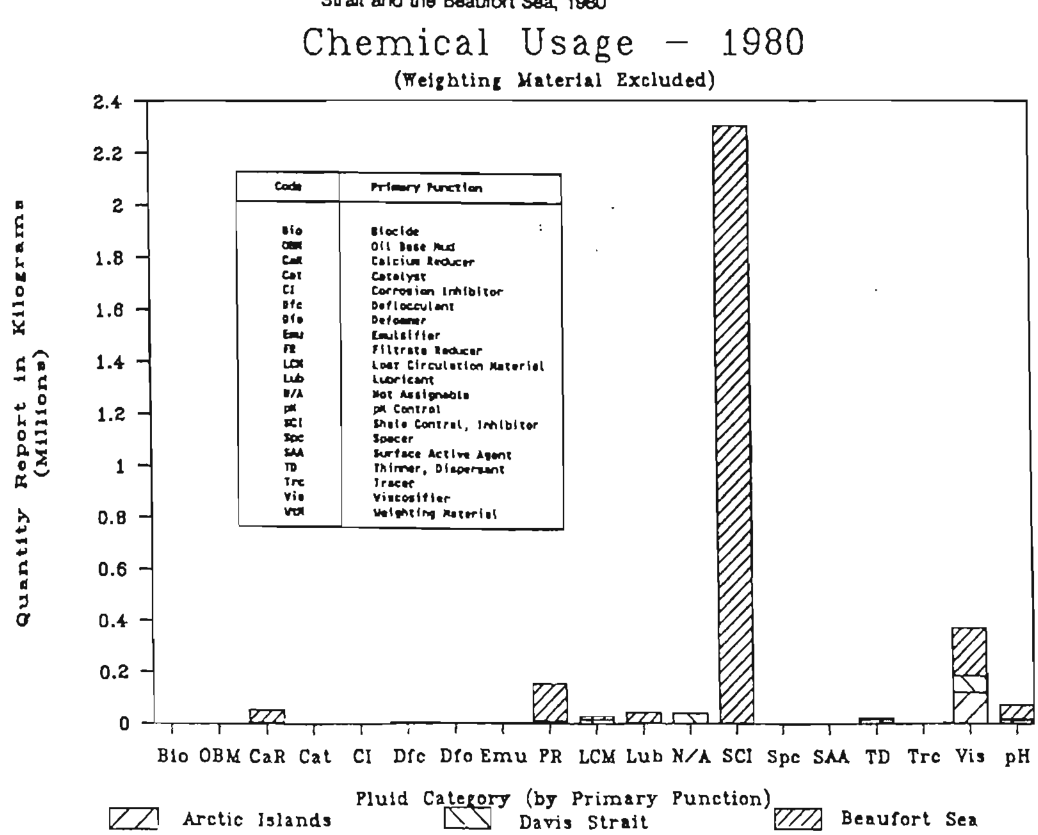


Figure 2.9 Summary of chemical usage for drilling in the Arctic Islands, Davis Strait and the Beaufort Sea, 1981

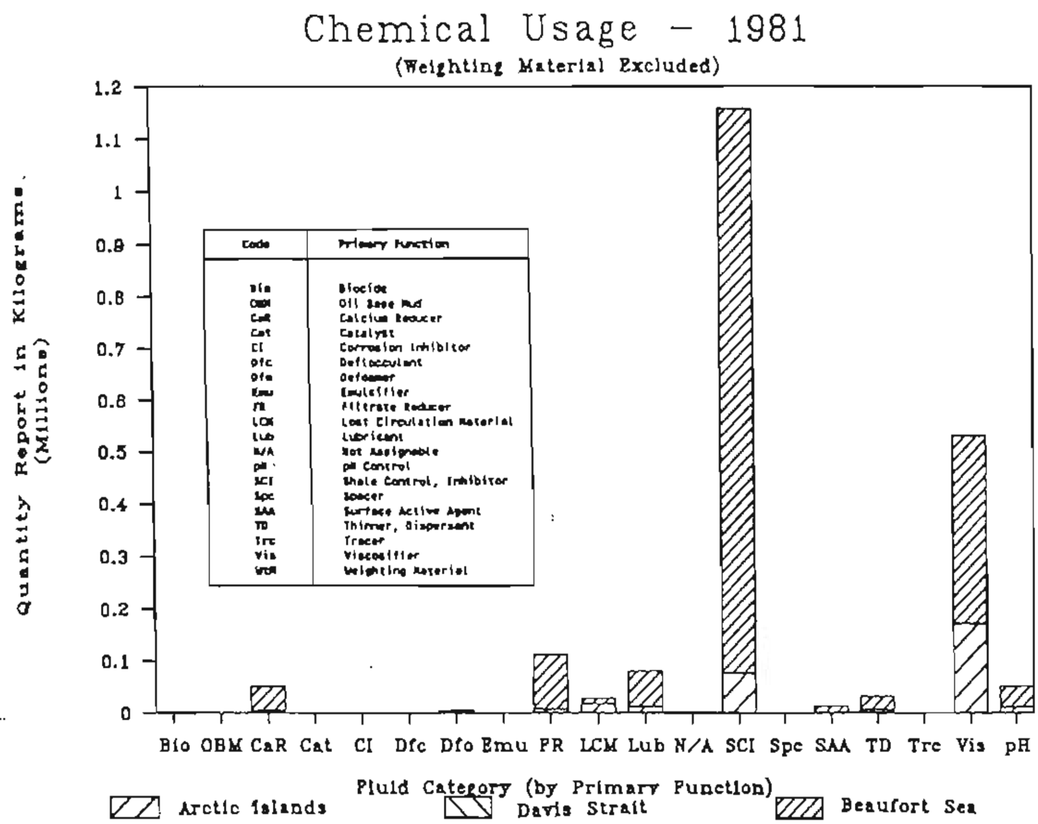


Figure 2.10 Summary of chemical usage for drilling in the Arctic Islands, Davis Strait and the Beaufort Sea, 1982

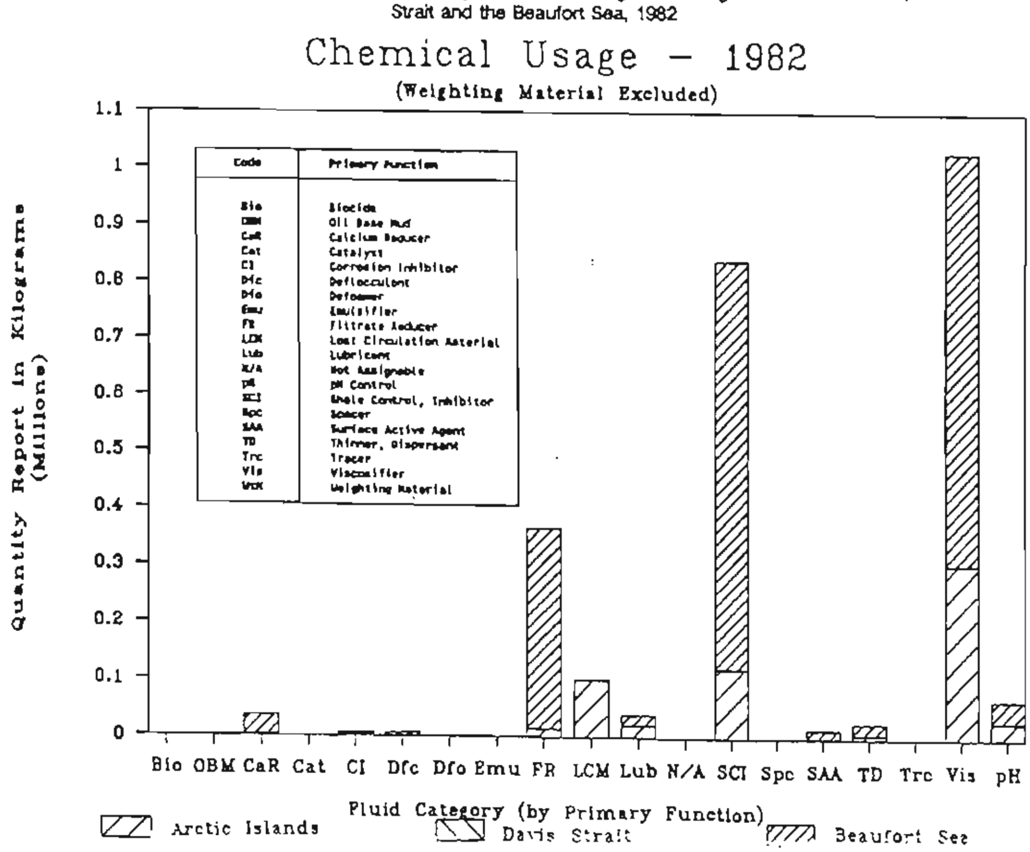


Figure 2.11 Summary of chemical usage for drilling in the Arctic Islands, Davis Strait and the Beaufort Sea, 1983

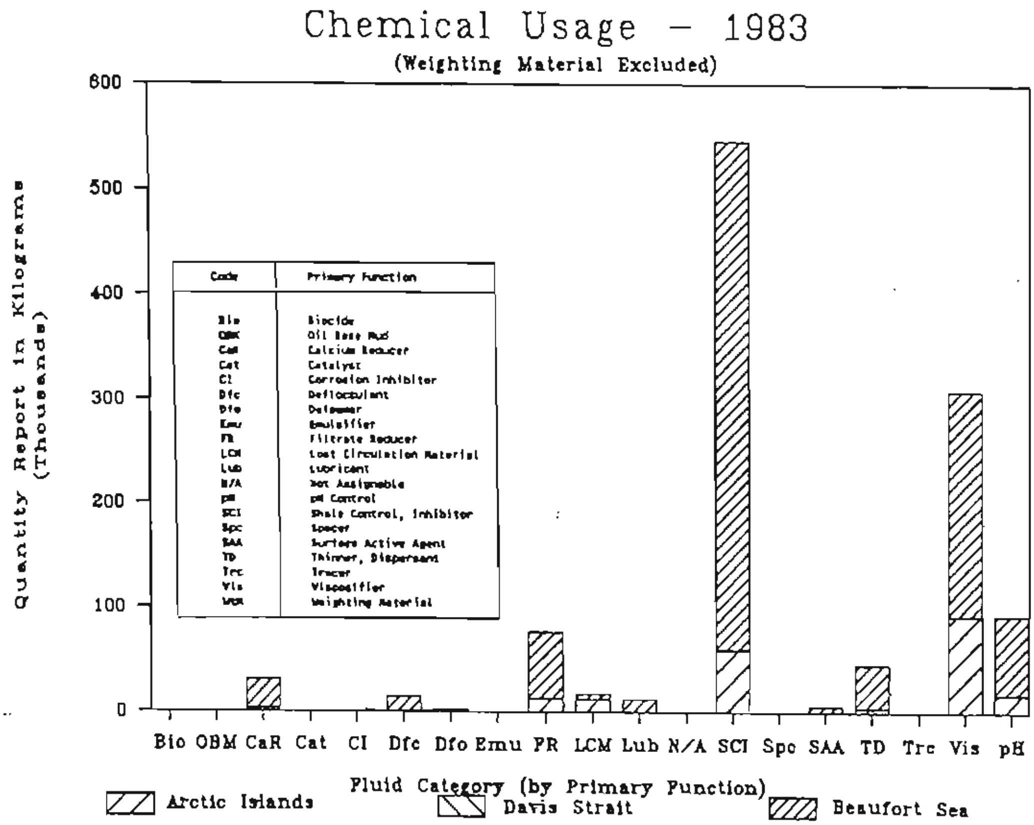


Figure 2.12 Summary of chemical usage for drilling in the Arctic Islands, Davis Strait and the Beaufort Sea, 1984

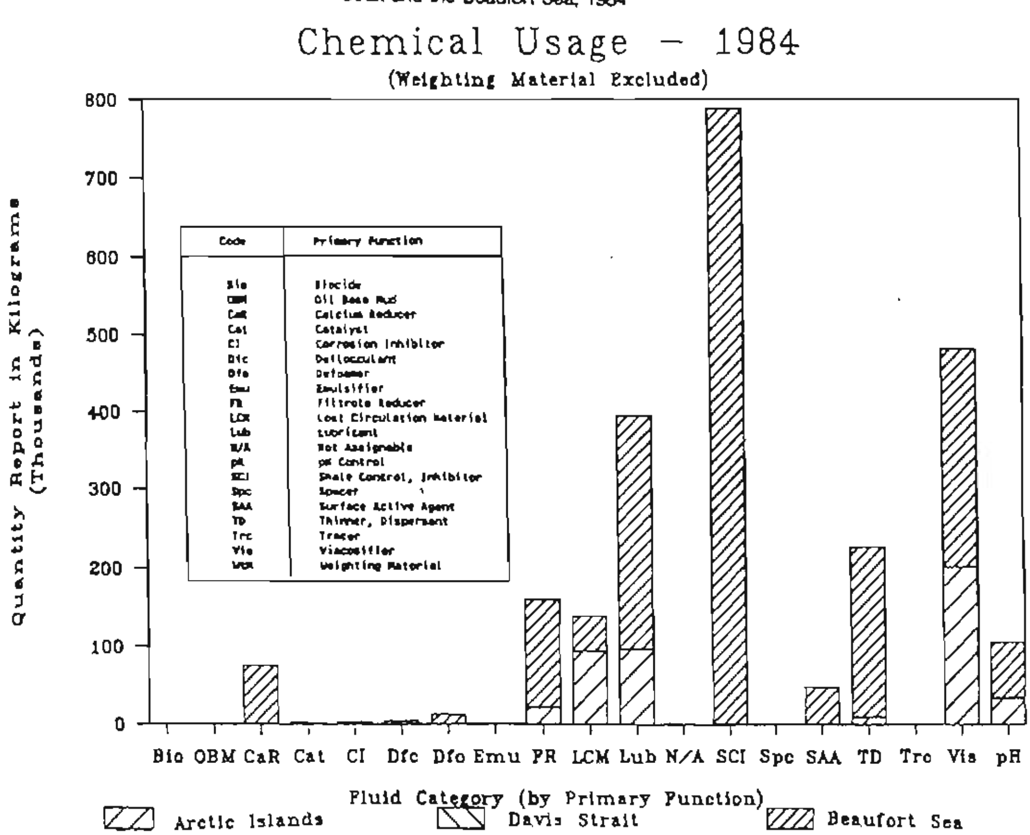


Figure 2.13 Summary of chemical usage for drilling in the Arctic Islands, Davis Strait and the Beaufort Sea, 1985

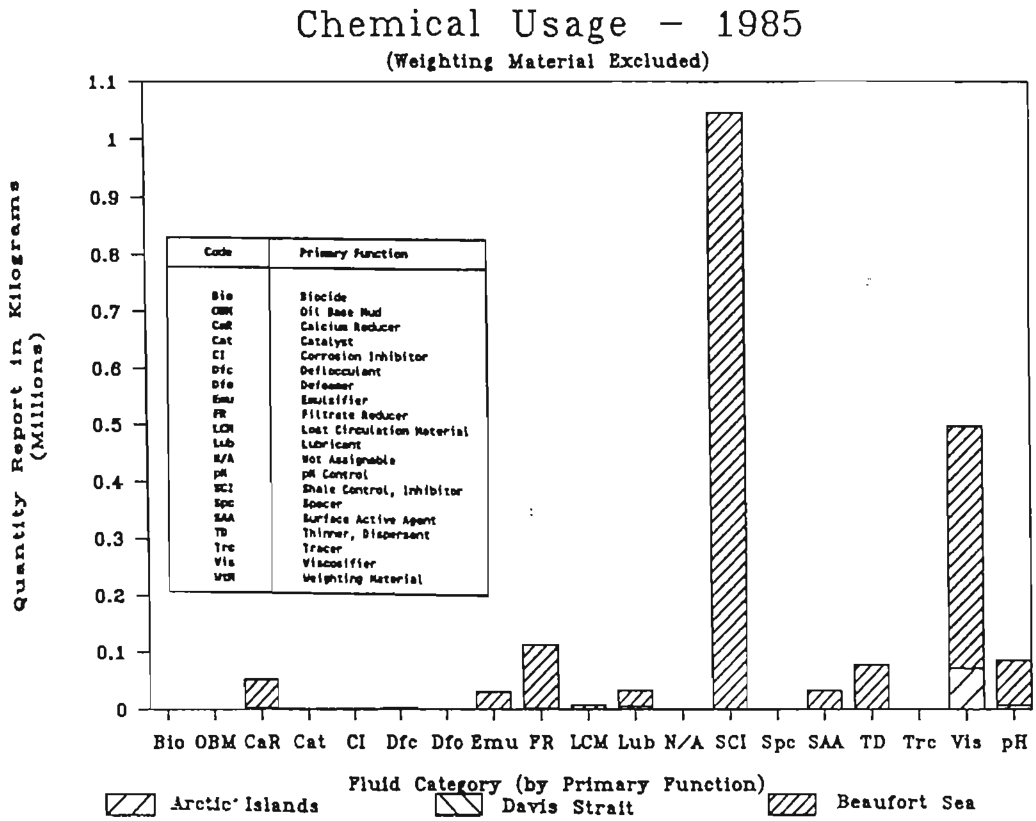


Figure 2.14 Summary of chemical usage for drilling in the Arctic Islands, Davis Strait and the Beaufort Sea, 1986

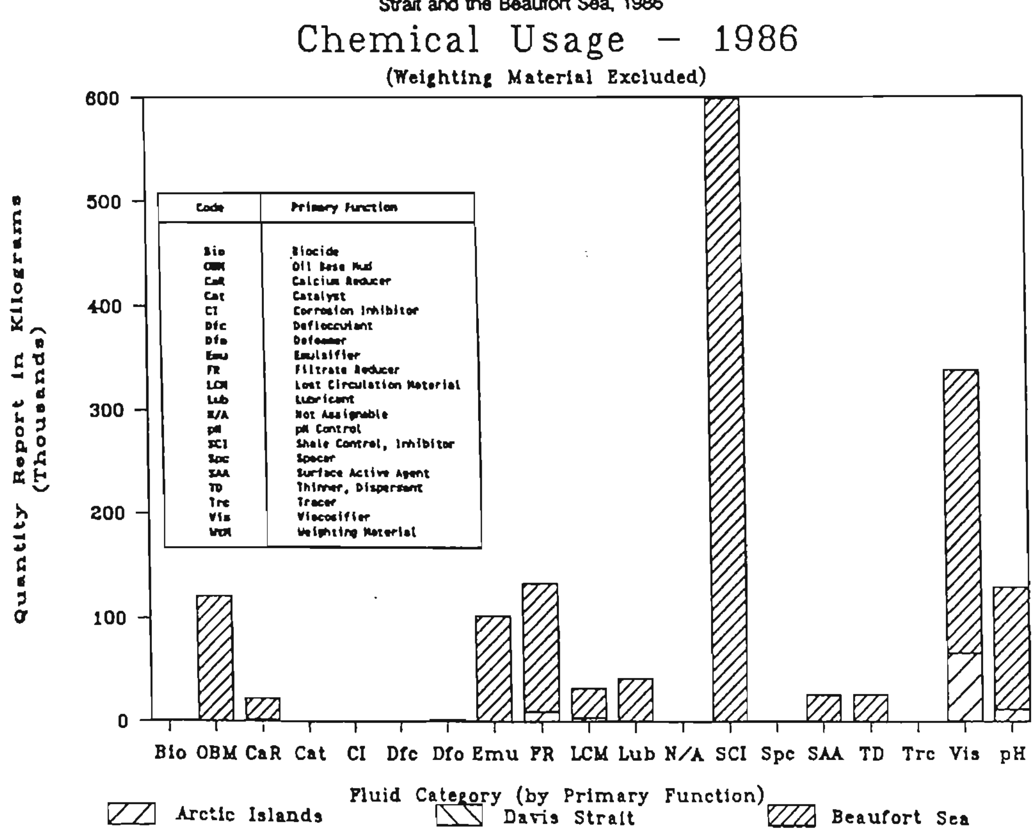


Figure 2.15 Summary of chemical usage for drilling in the Arctic Islands, Davis Strait and the Beaufort Sea, 1987

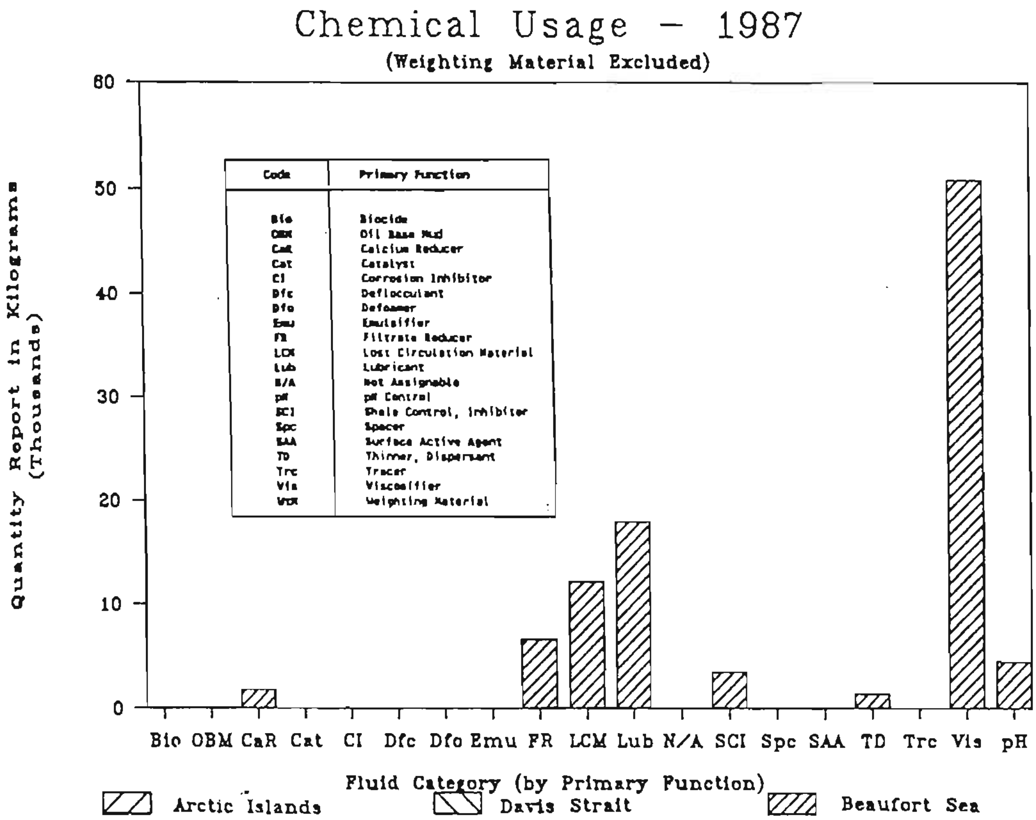


Figure 2.16 Summary of weighting material usage for drilling in the Arctic Islands, Davis Strait and the Beaufort Sea, 1973 - 1987

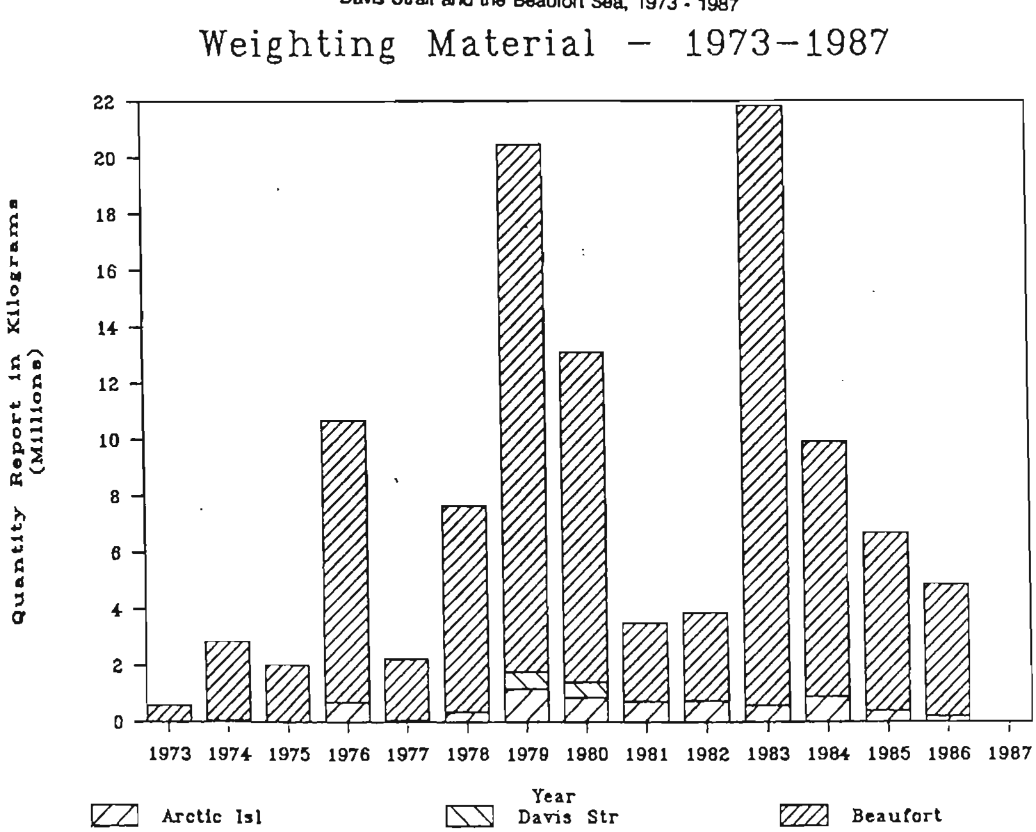


Figure 3.1 Number of wells drilled as a function of water depth for locations in the Beaufort Sea, Arctic Islands and Davis Strait, 1973 - 1987

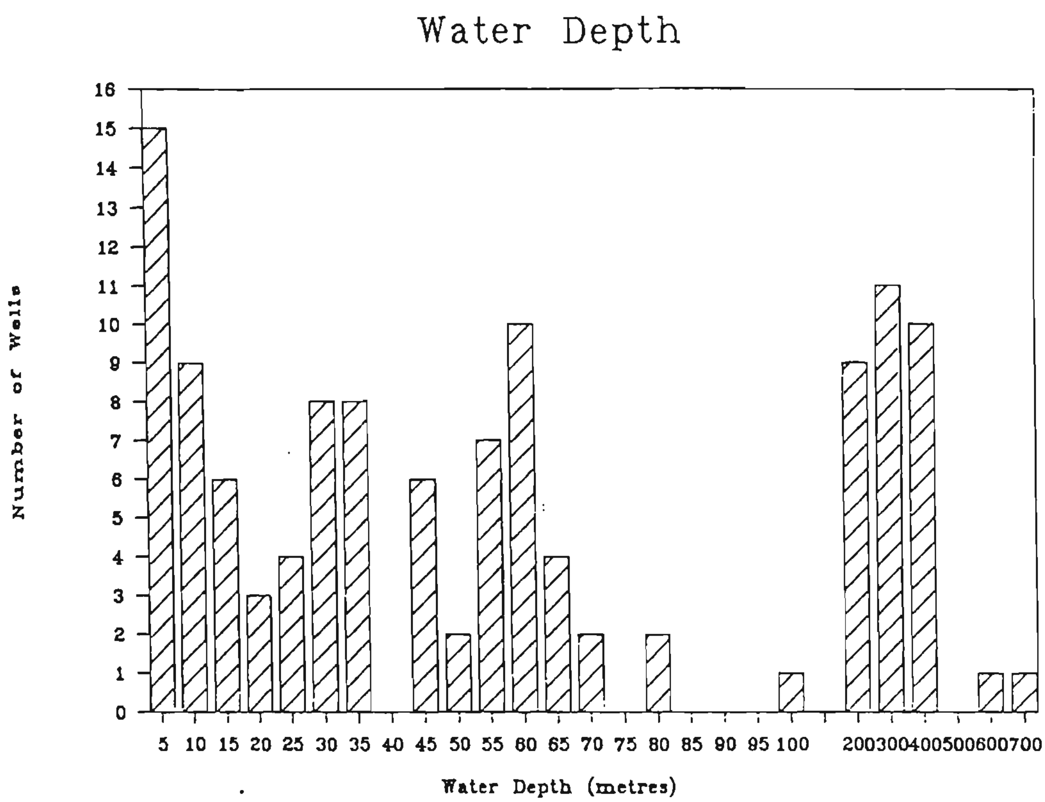


Figure 4.1 Yearly drilling activity in the Beaufort Sea, Arctic Islands and Davis Strait, 1973 - 1987

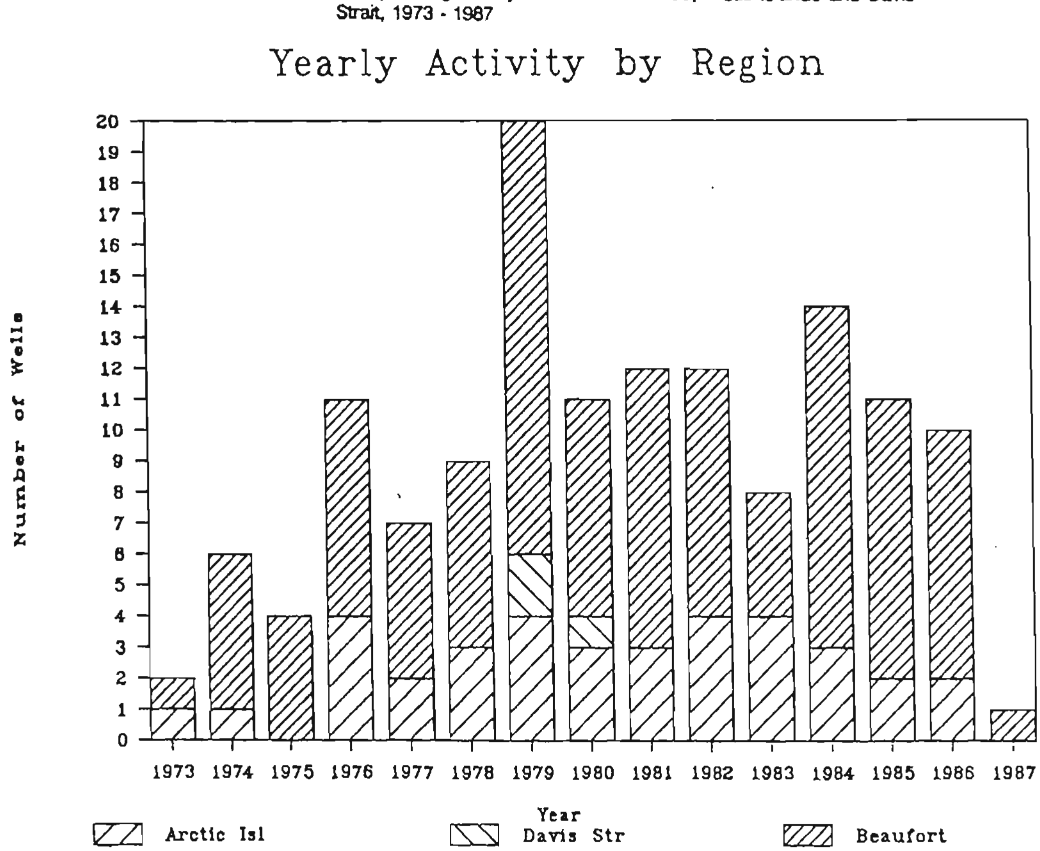


Figure 5.1 Number of wells drilled by each oil company in the Beaufort Sea, Arctic Islands and Davis Strait, 1973 - 1987

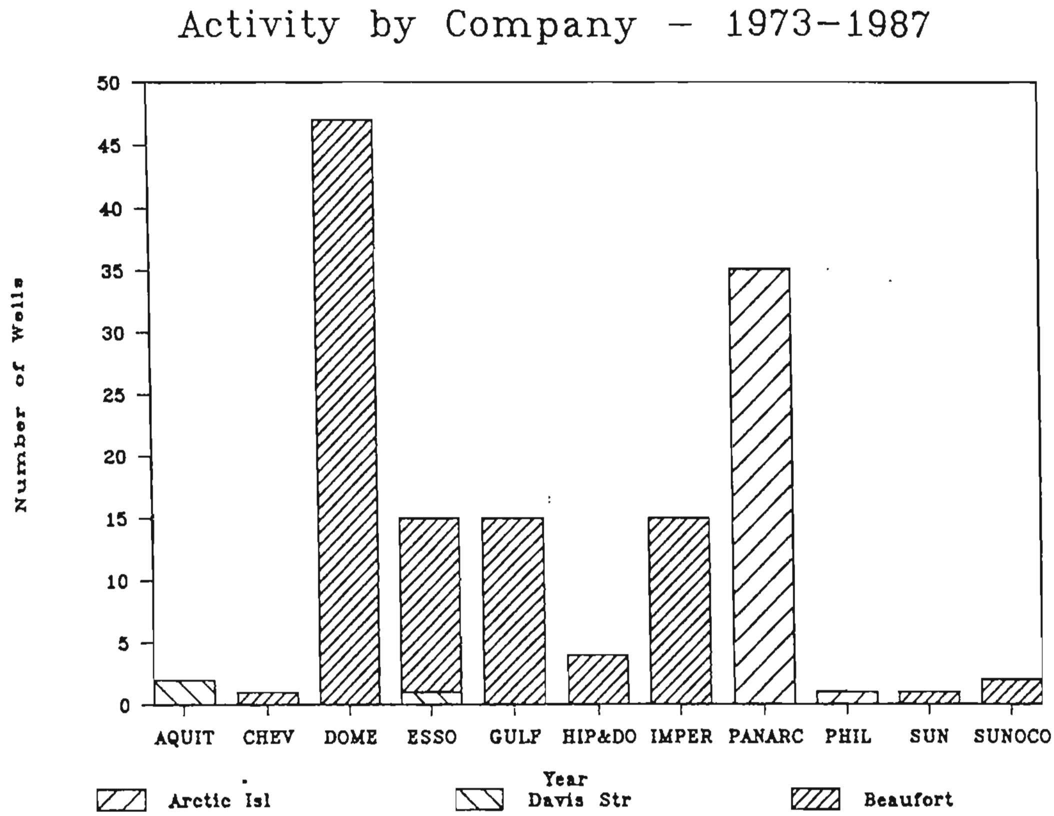


Figure 5.2 Number of wells drilled by each oil company in the Beaufort Sea, Arctic Islands and Davis Strait, 1973 - 1979

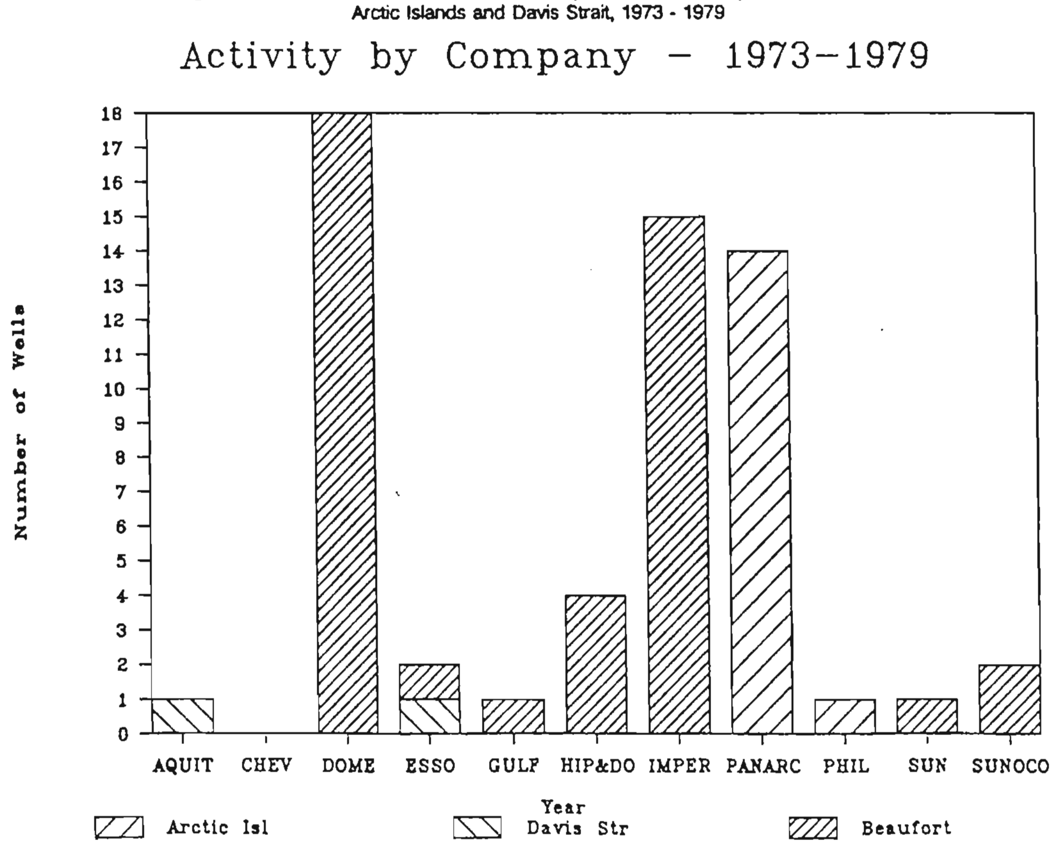


Figure 5.3 Number of wells drilled by each oil company in the Beaufort Sea, Arctic Islands and Davis Strait, 1980 - 1982

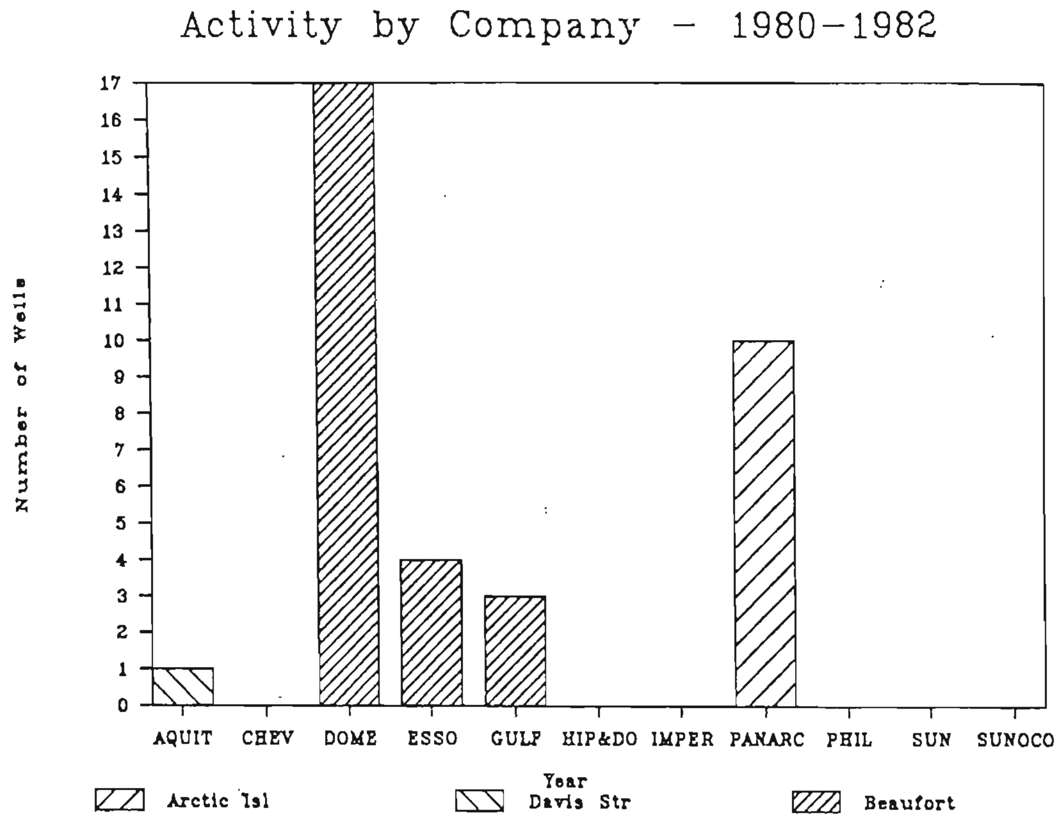


Figure 5.4 Number of wells drilled by each oil company in the Beaufort Sea, Arctic Islands and Davis Strait, 1983 - 1987

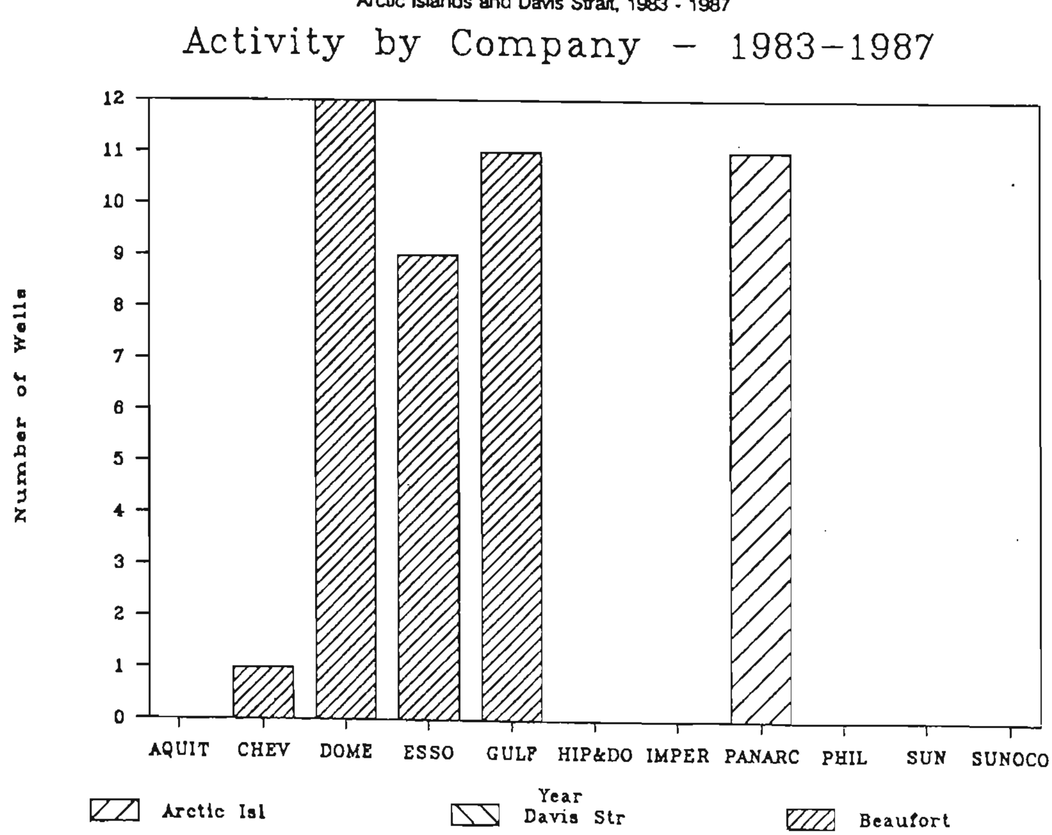


Figure 5.5 Locations of offshore wells drilled in the Beaufort Sea, 1973 - 1987

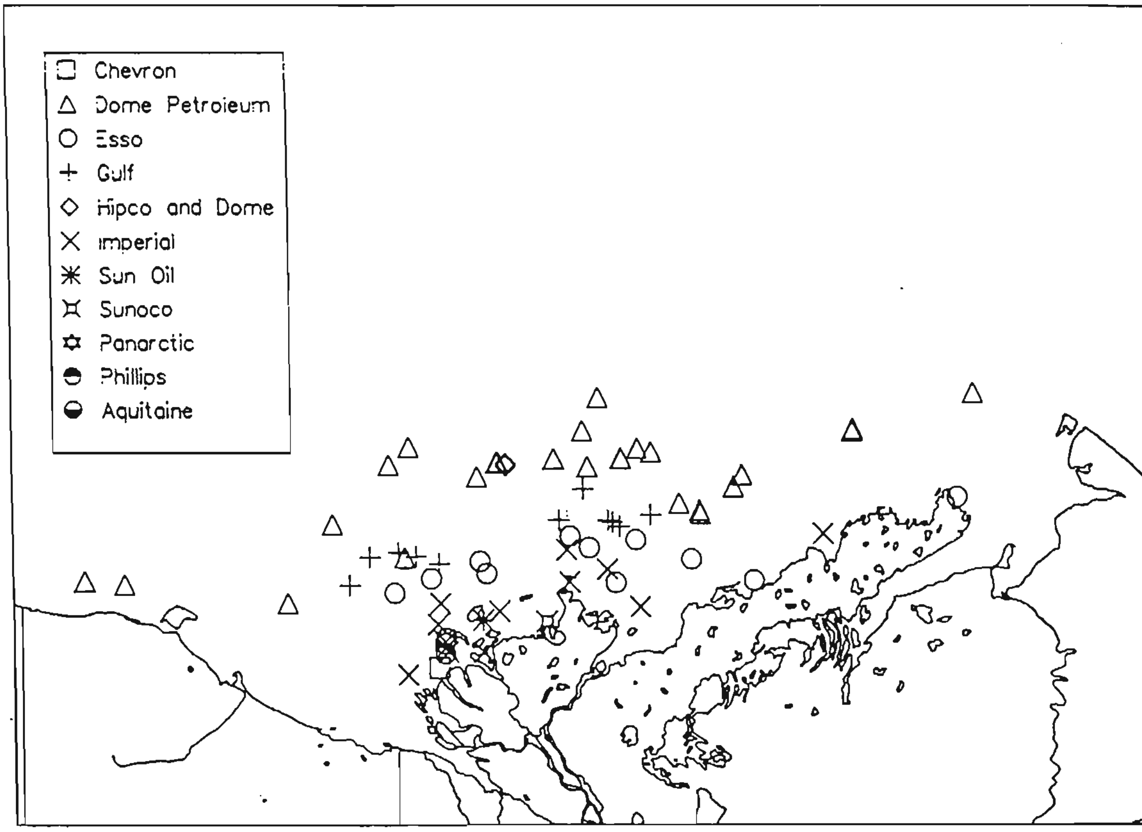


Figure 5.6 Locations of offshore wells drilled in Davis Strait, 1973 - 1987

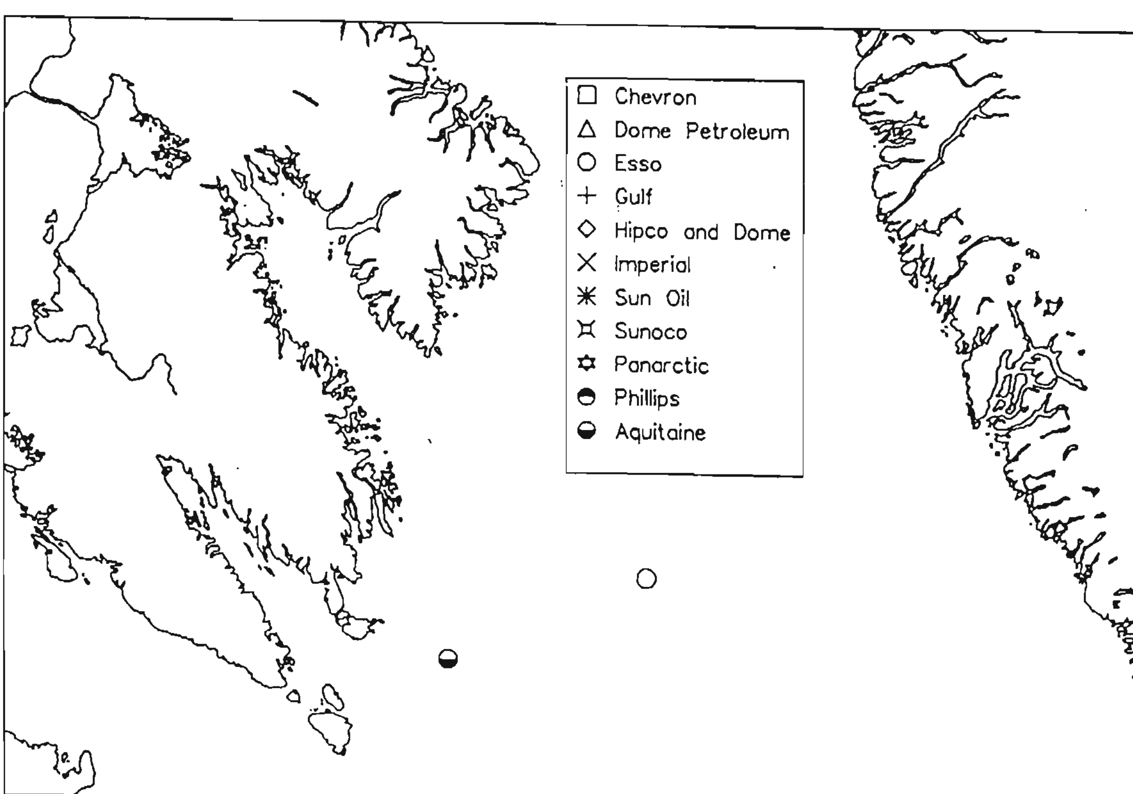


Figure 5.7 Locations of offshore wells drilled in the Arctic Islands, 1973 - 1987

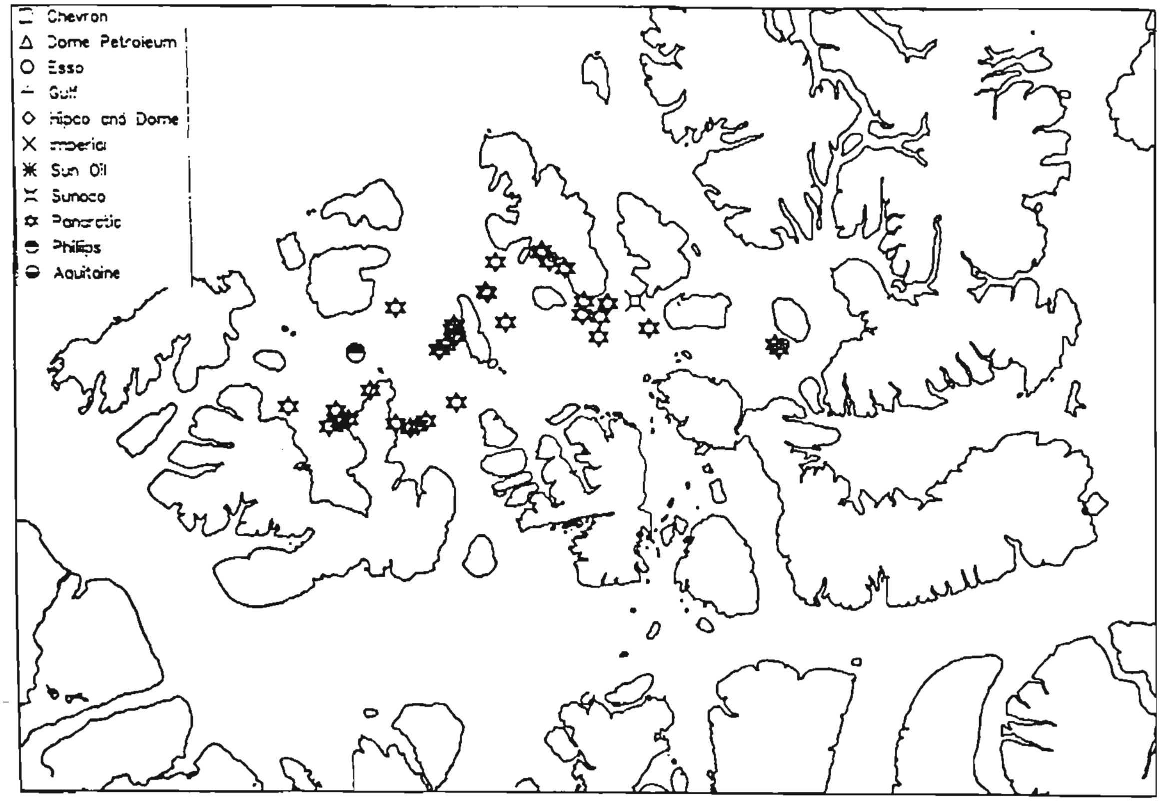


Figure 5.8 Locations of offshore wells drilled in the Beaufort Sea, 1973

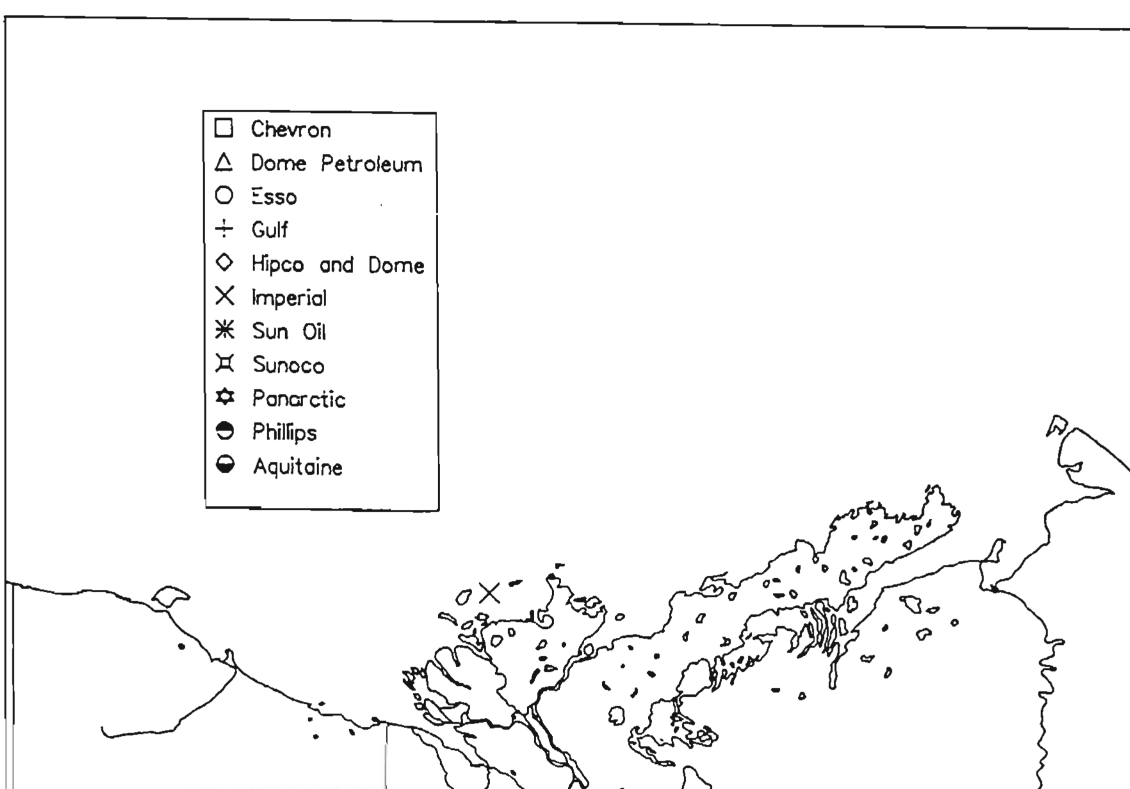


Figure 5.9 Locations of offshore wells drilled in the Beaufort Sea, 1974

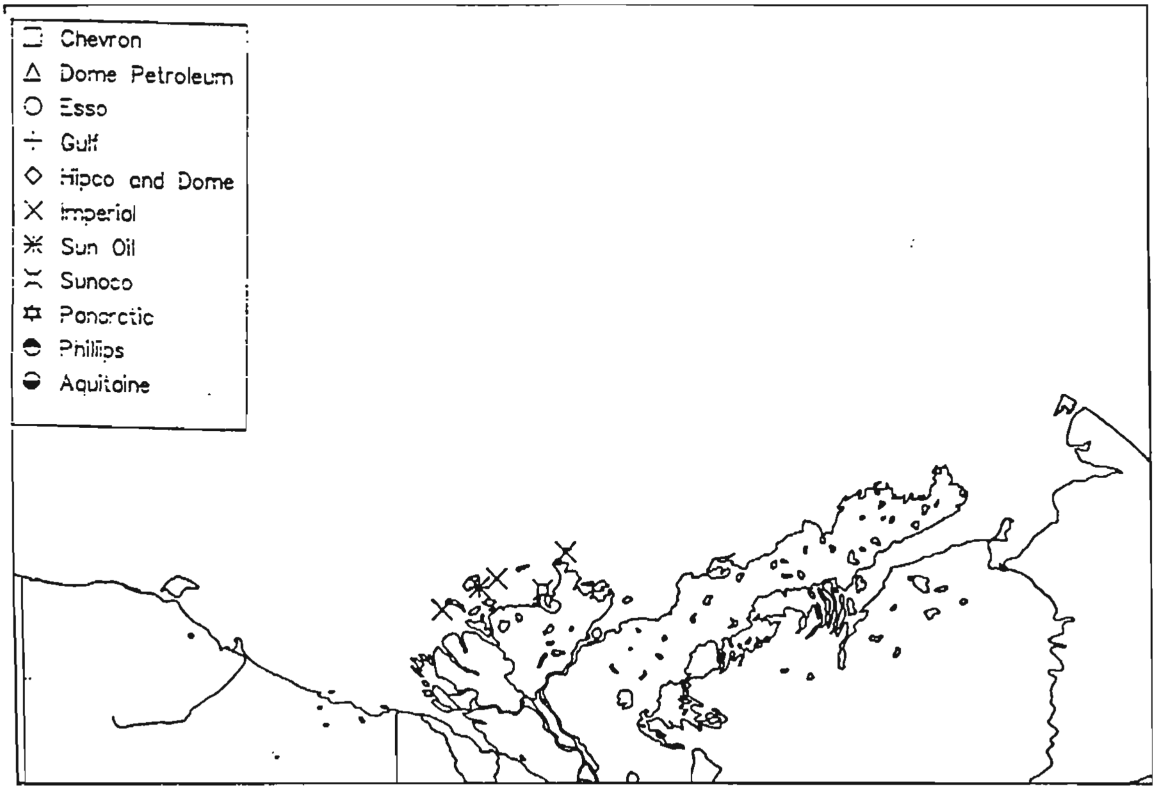


Figure 5.10 Locations of offshore wells drilled in the Beaufort Sea, 1975

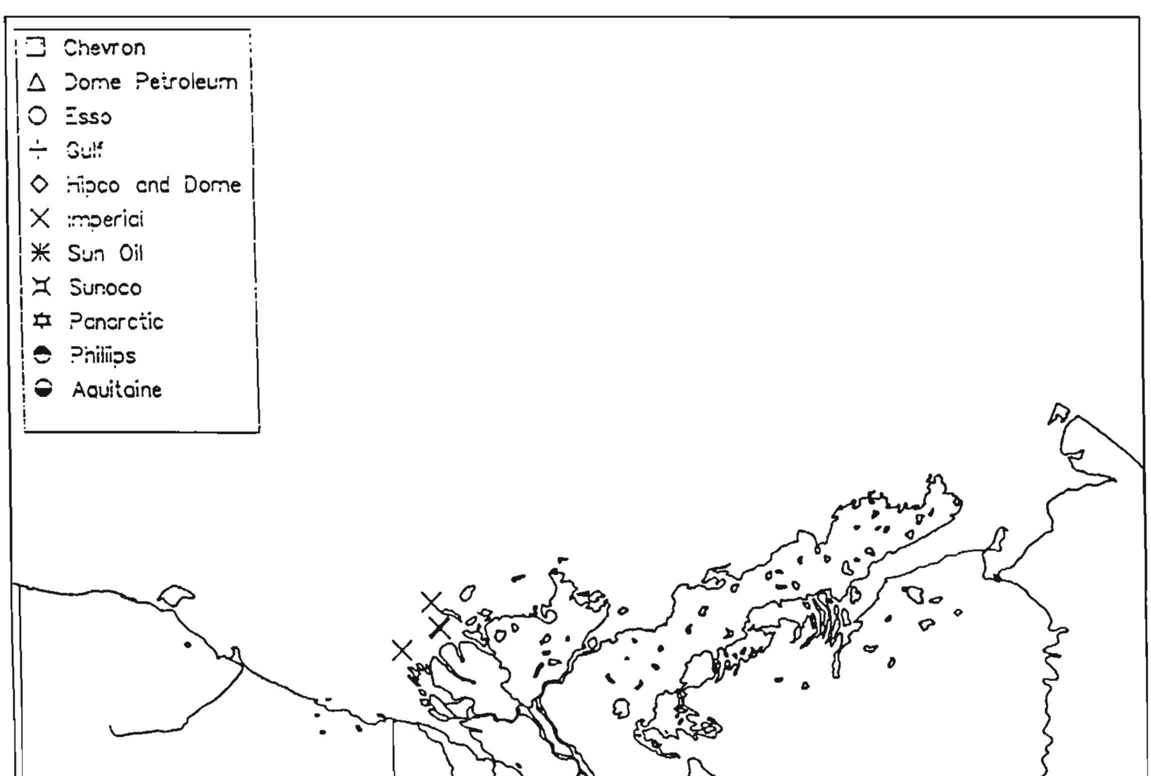


Figure 5.11 Locations of offshore wells drilled in the Beaufort Sea, 1976

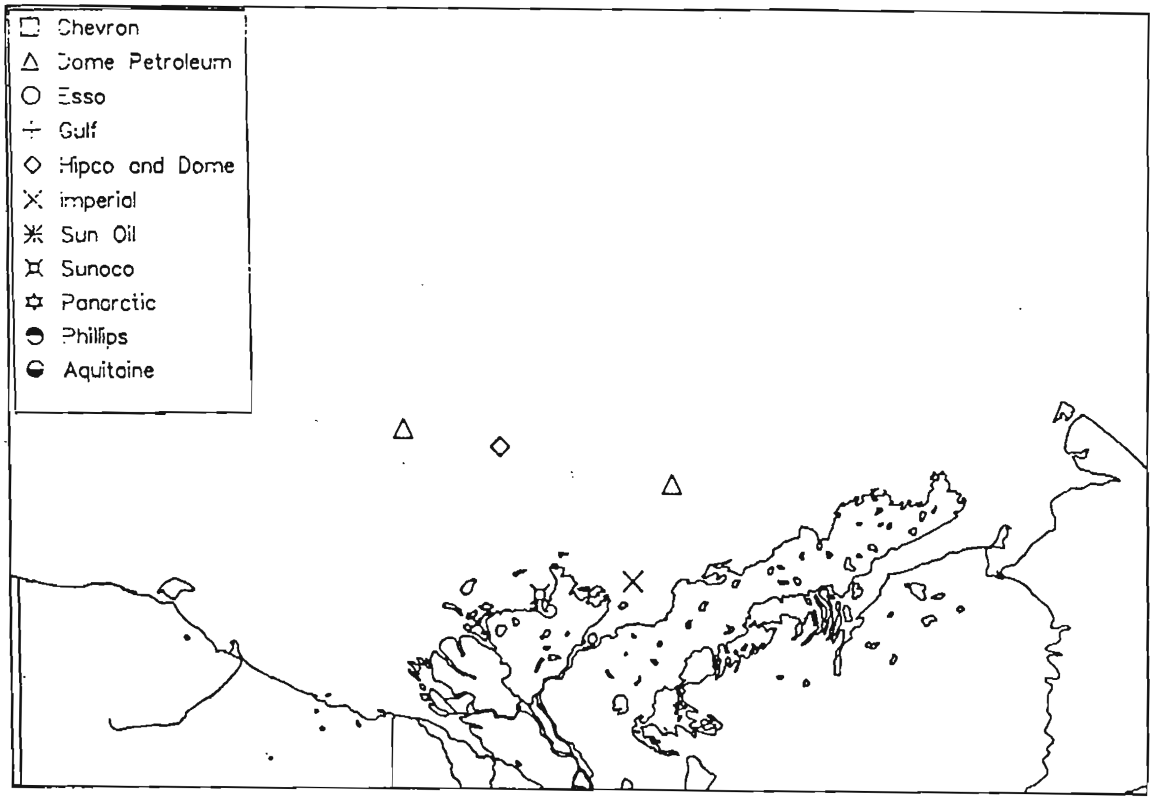


Figure 5.12 Locations of offshore wells drilled in the Beaufort Sea, 1977

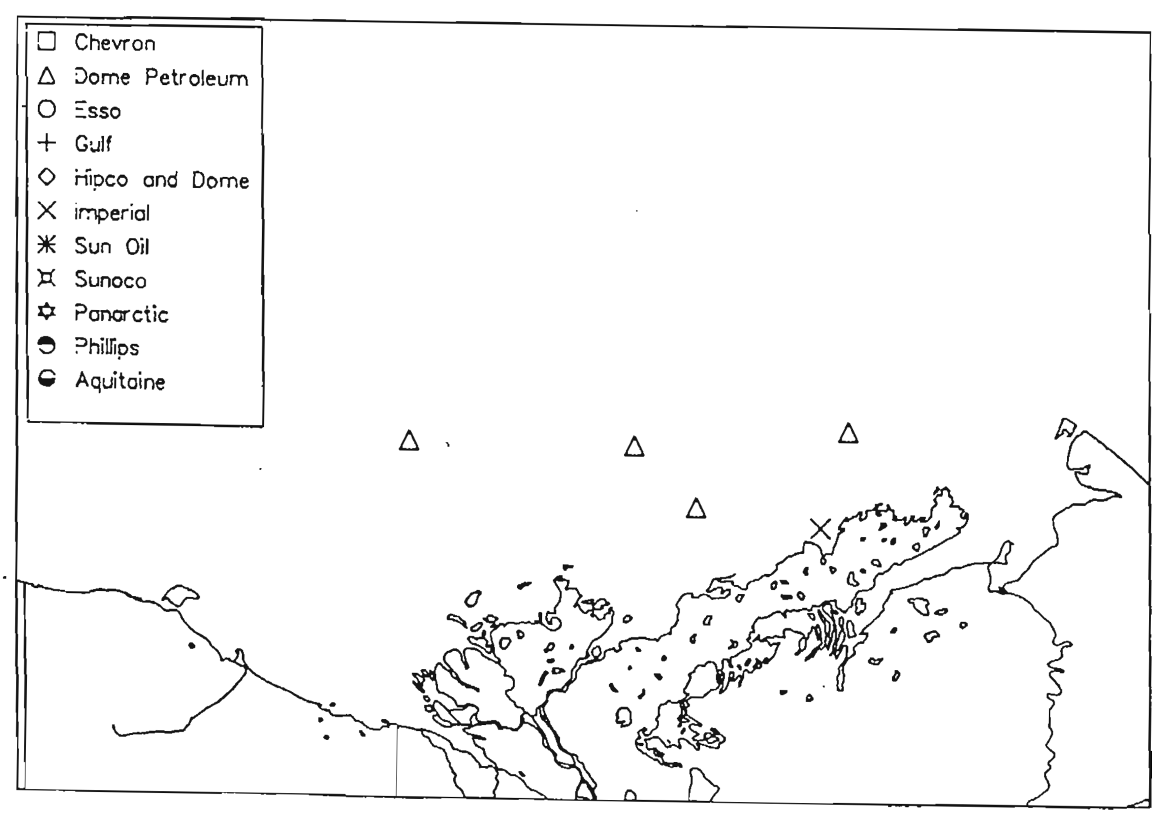


Figure 5.13 Locations of offshore wells drilled in the Beaufort Sea, 1978

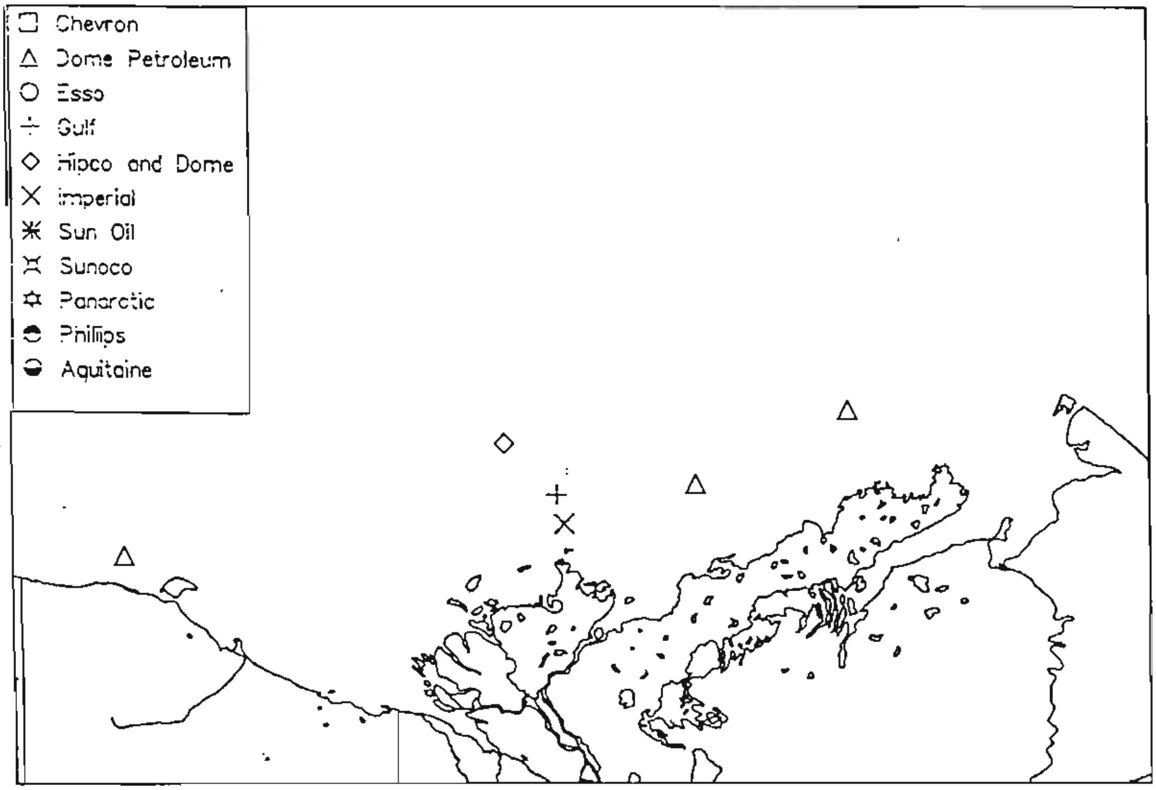


Figure 5.14 Locations of offshore wells drilled in the Beaufort Sea, 1979

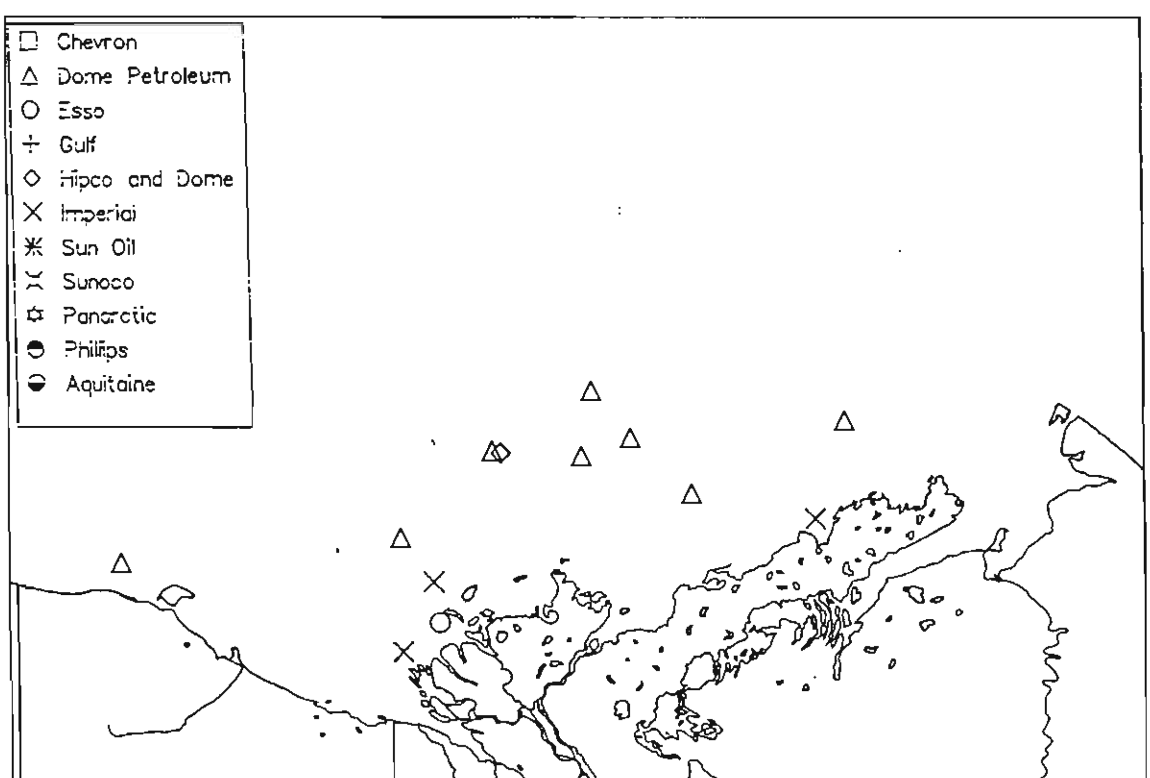


Figure 5.15 Locations of offshore wells drilled in the Beaufort Sea, 1980

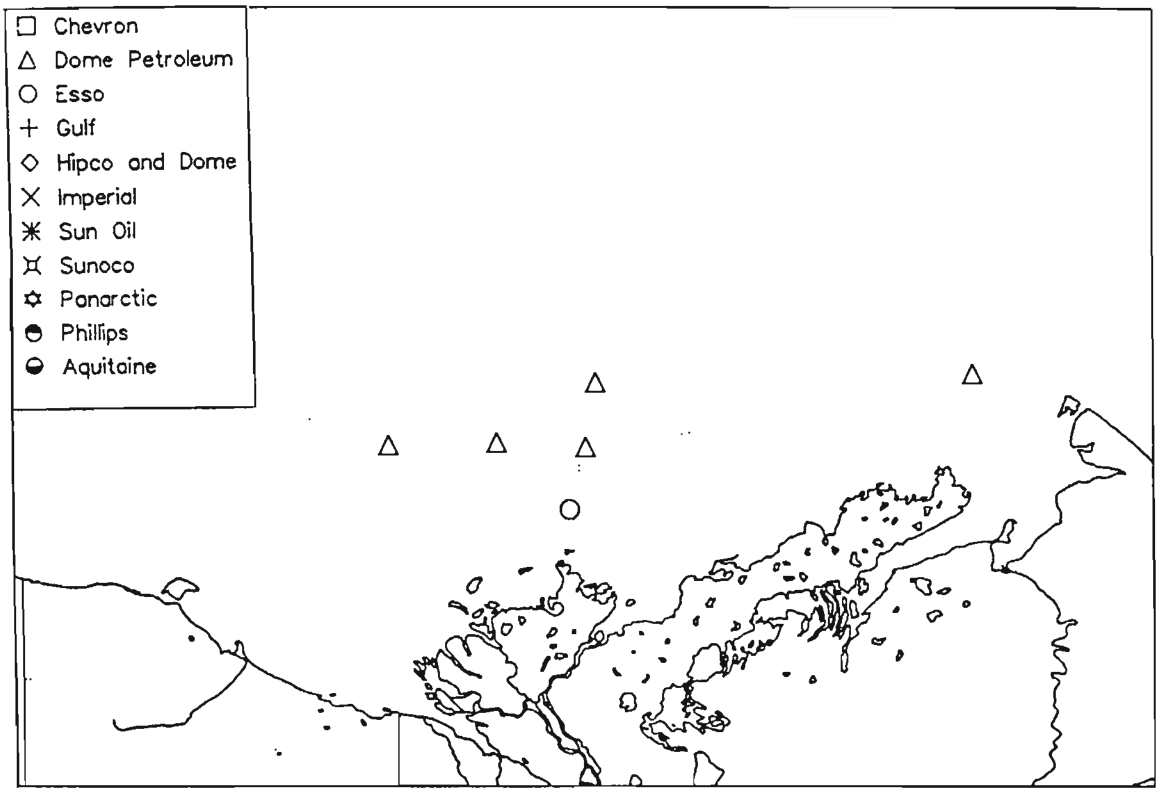


Figure 5.16 Locations of offshore wells drilled in the Beaufort Sea, 1981

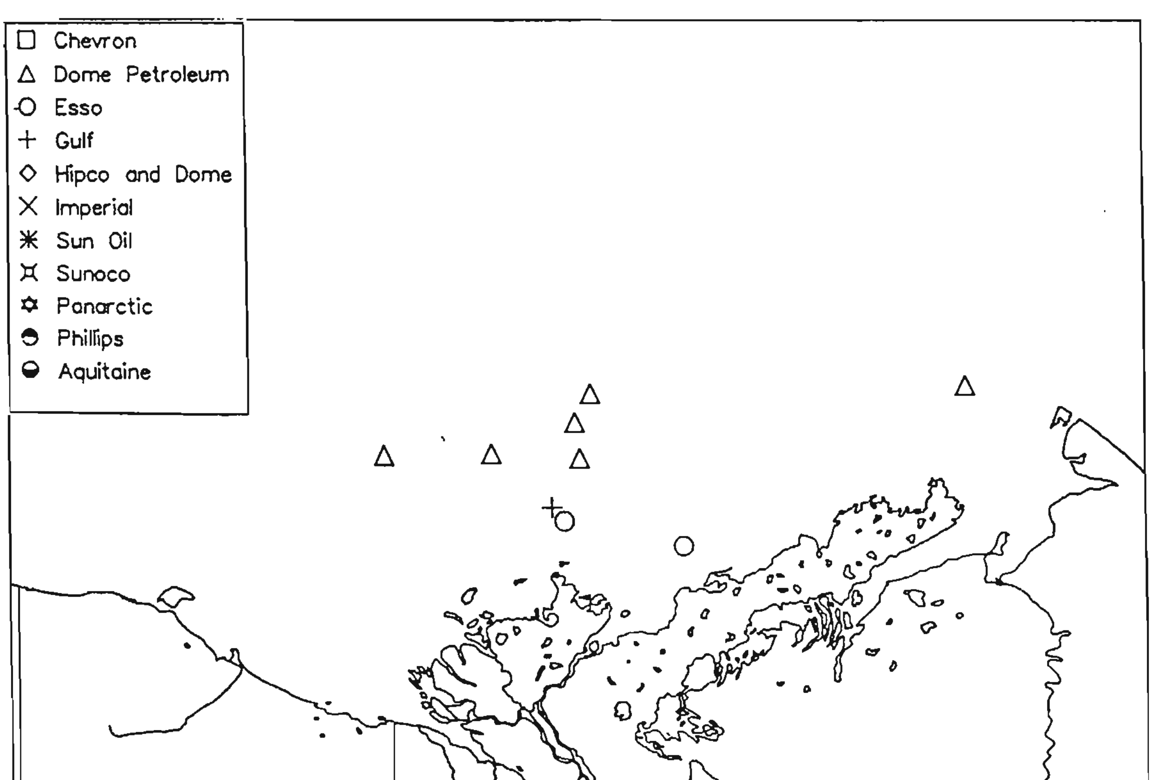
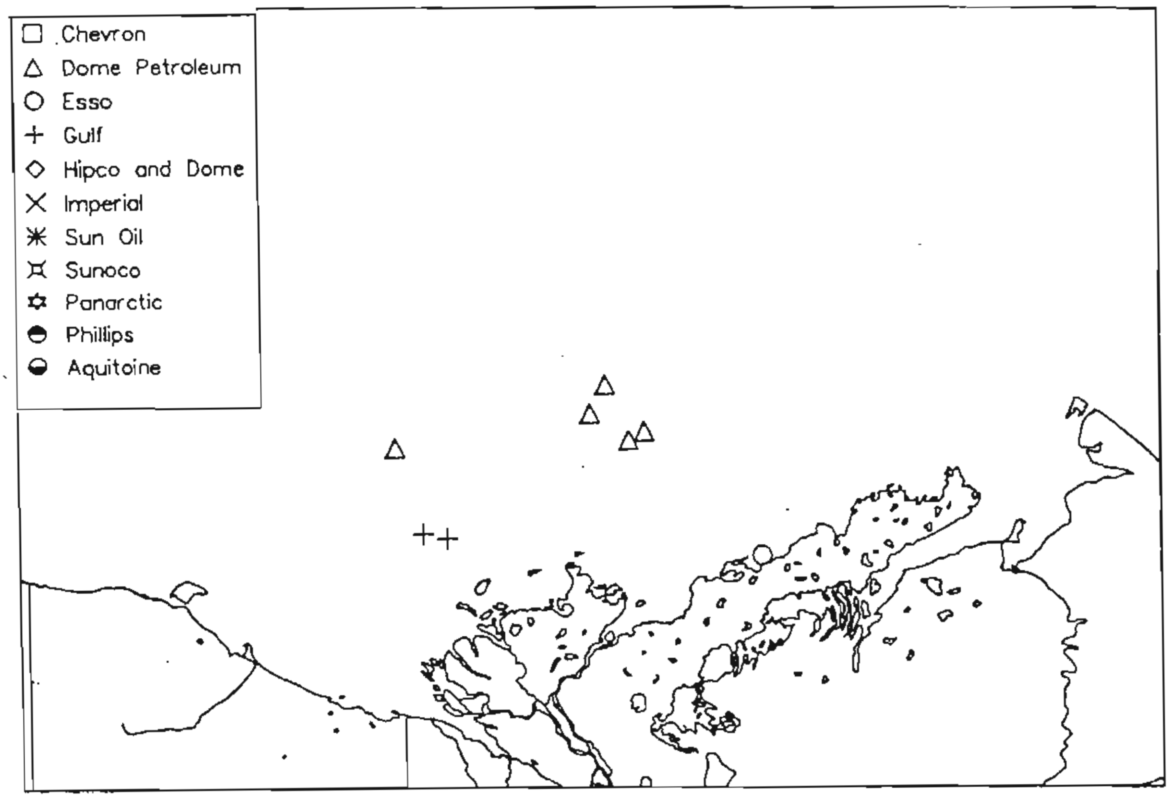


Figure 5.17 Locations of offshore wells drilled in the Beaufort Sea, 1982



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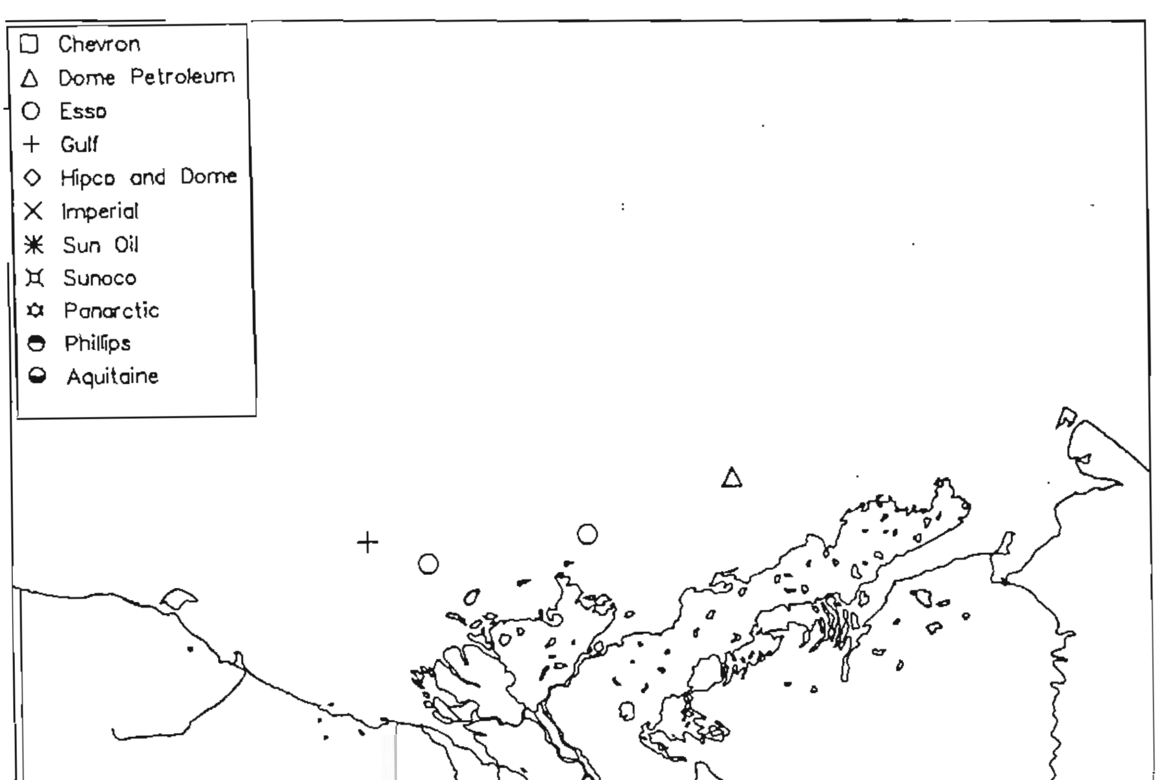
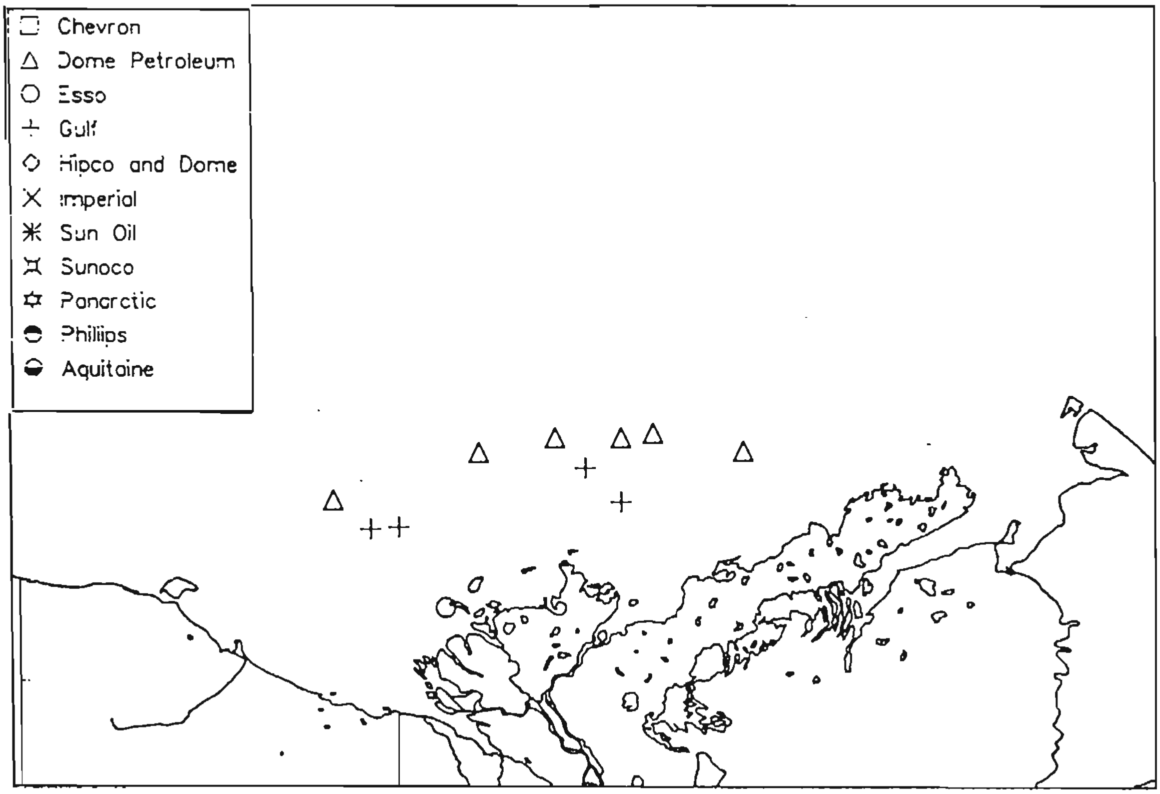


Figure 5.19 Locations of offshore wells drilled in the Beaufort Sea, 1984



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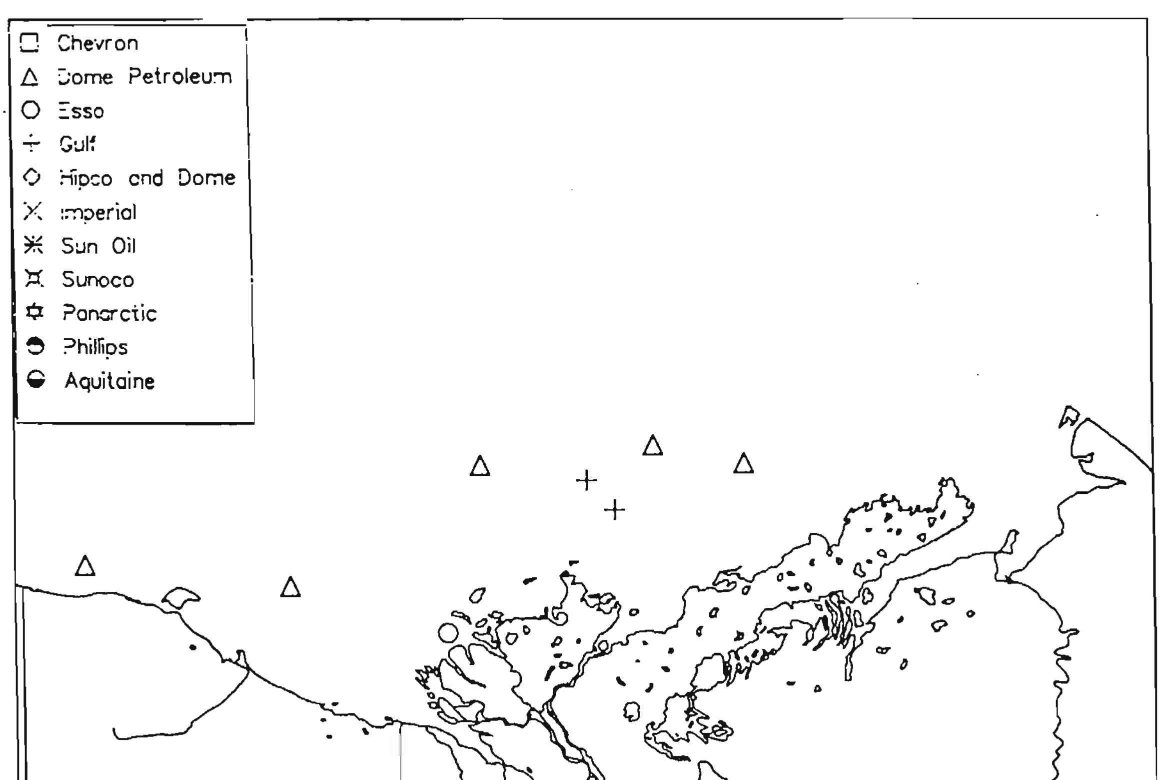

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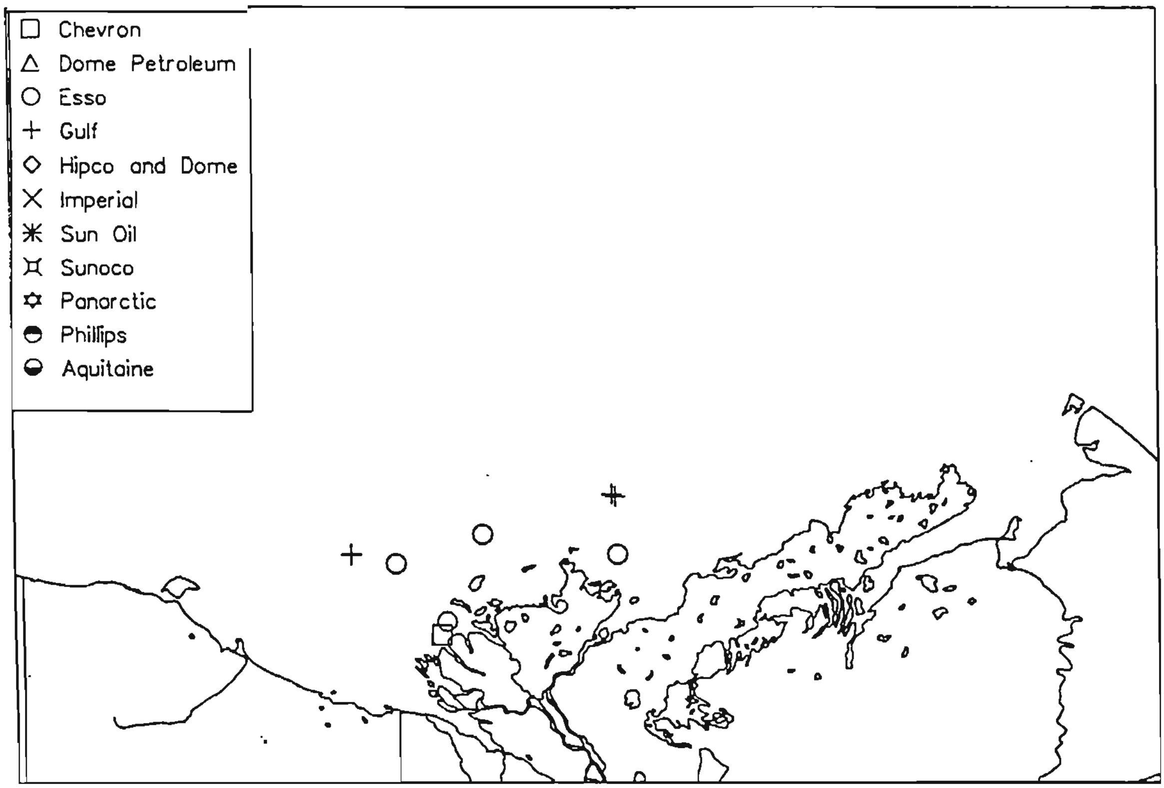


Figure 5.22 Locations of offshore wells drilled in the Beaufort Sea, 1987

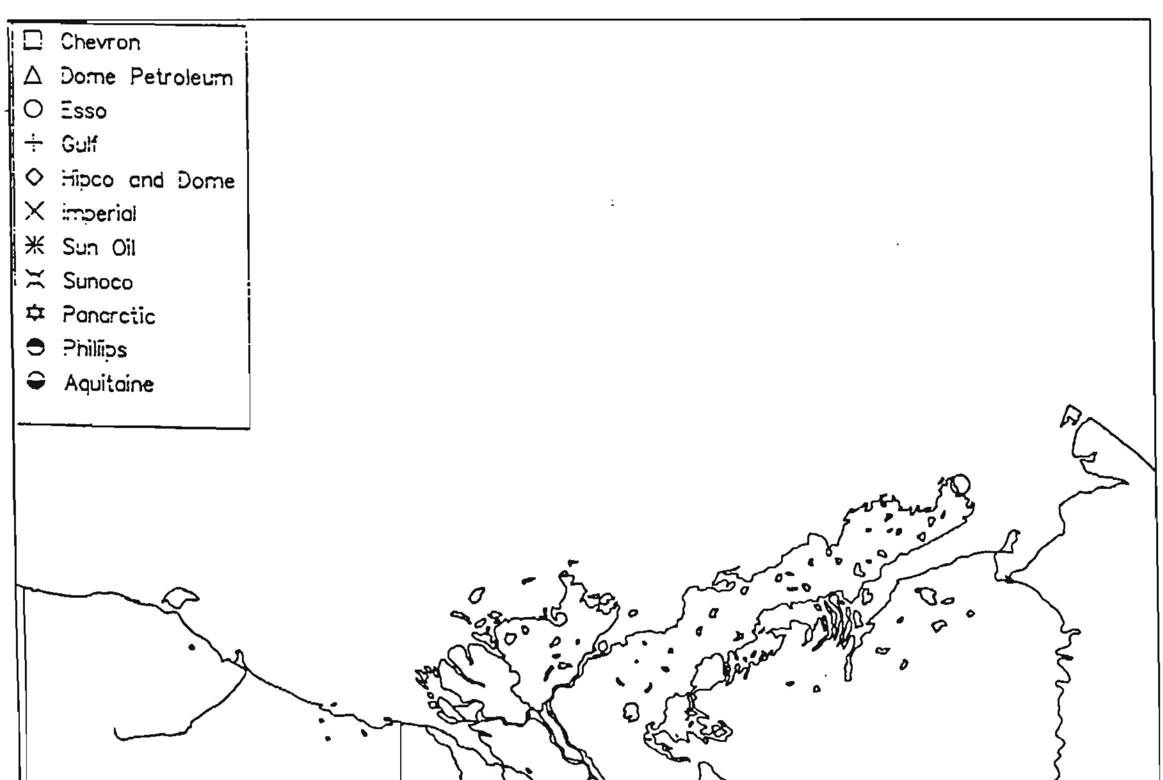
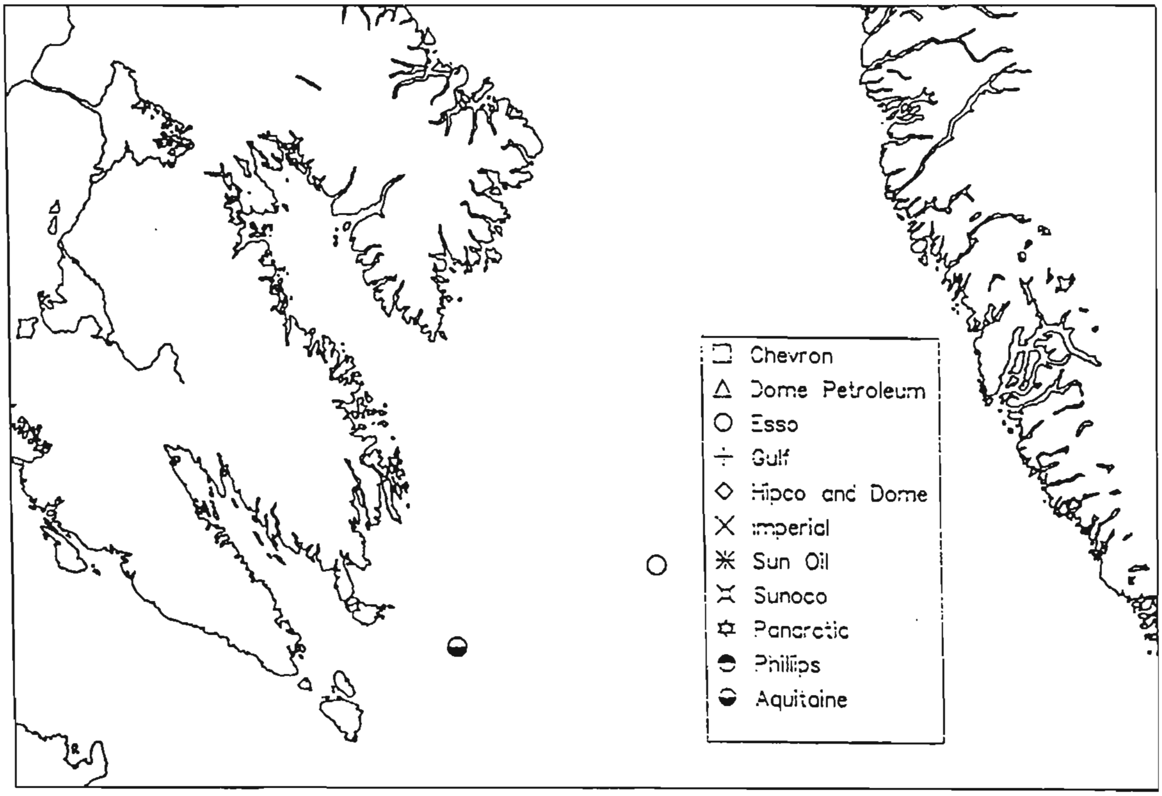


Figure 5.23 Locations of offshore wells drilled in the Davis Strait, 1979



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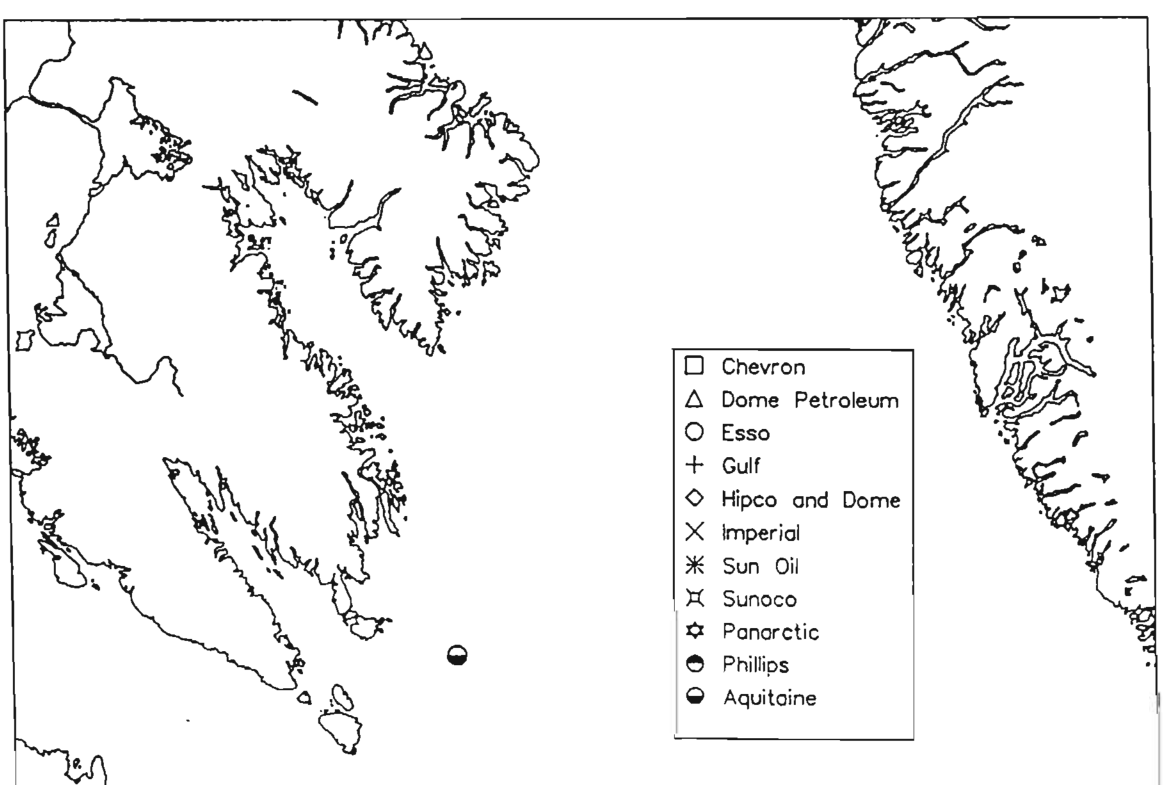


Figure 5.25 Locations of offshore wells drilled in the Arctic Islands, 1973

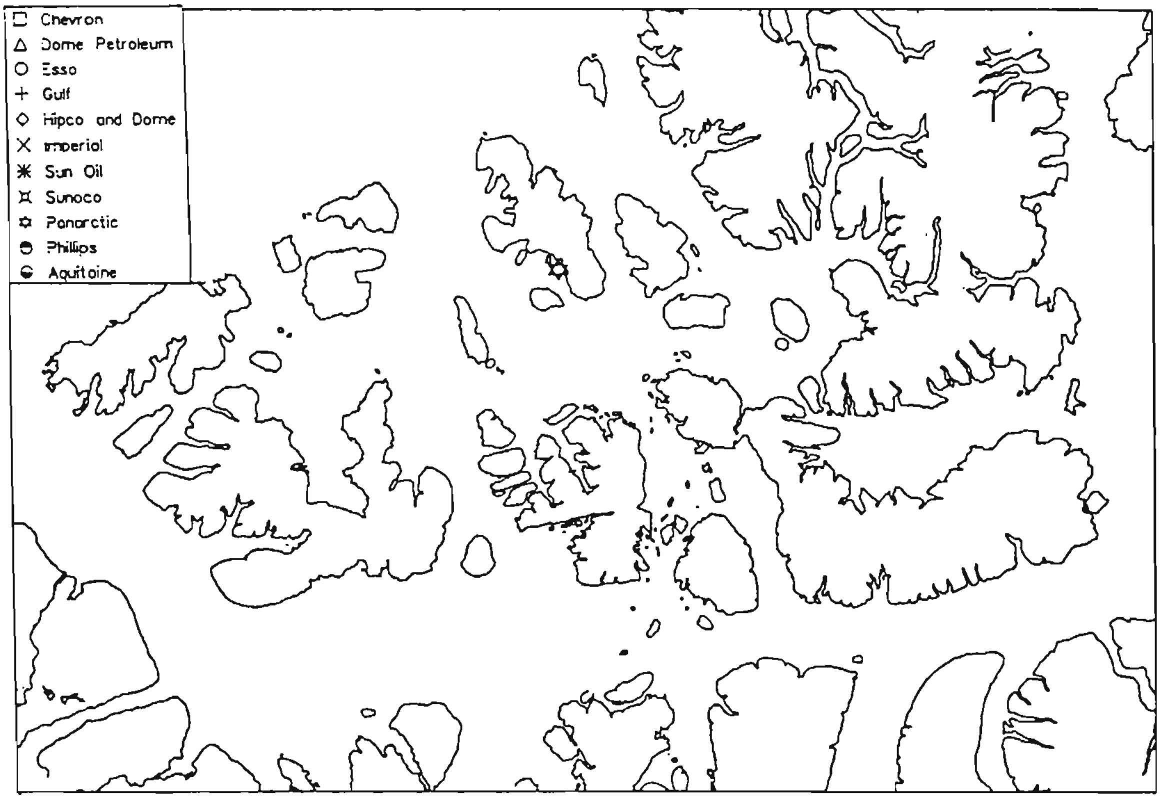
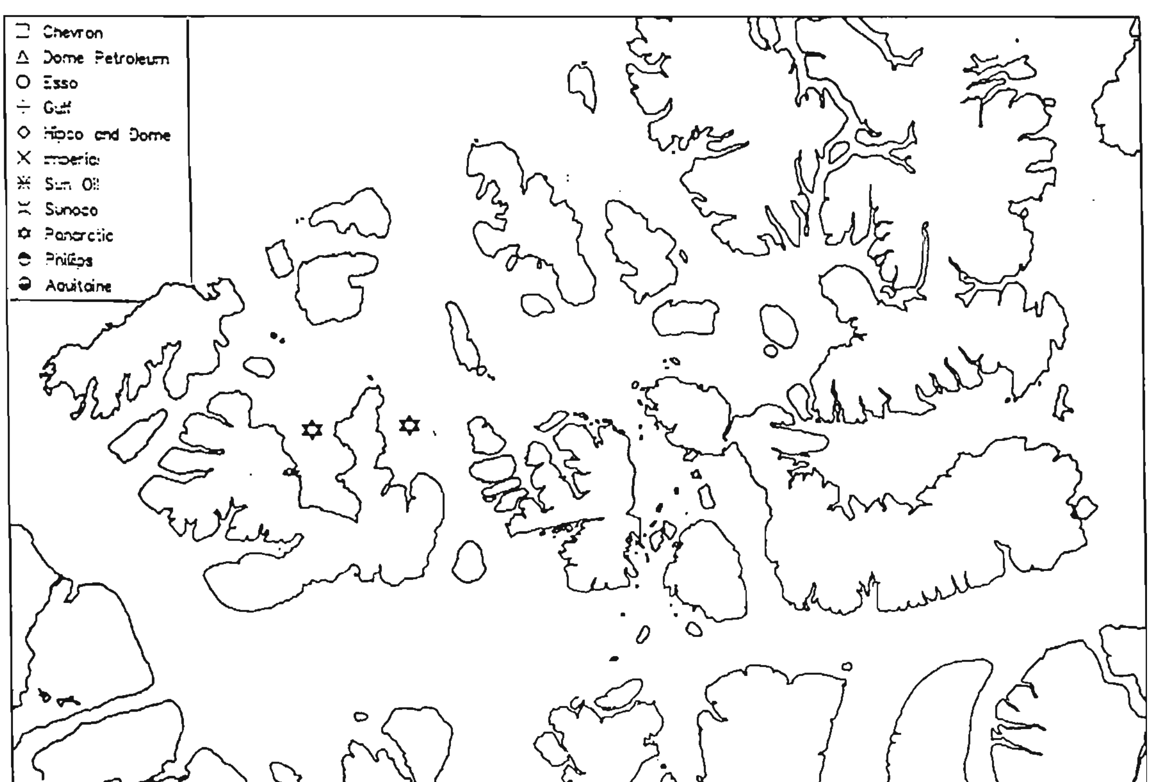


Figure 5.26 Locations of offshore wells drilled in the Arctic Islands, 1974

Figure 5.27 Locations of offshore wells drilled in the Arctic Islands, 1976

Figure 5.28 Locations of offshore wells drilled in the Arctic Islands, 1977



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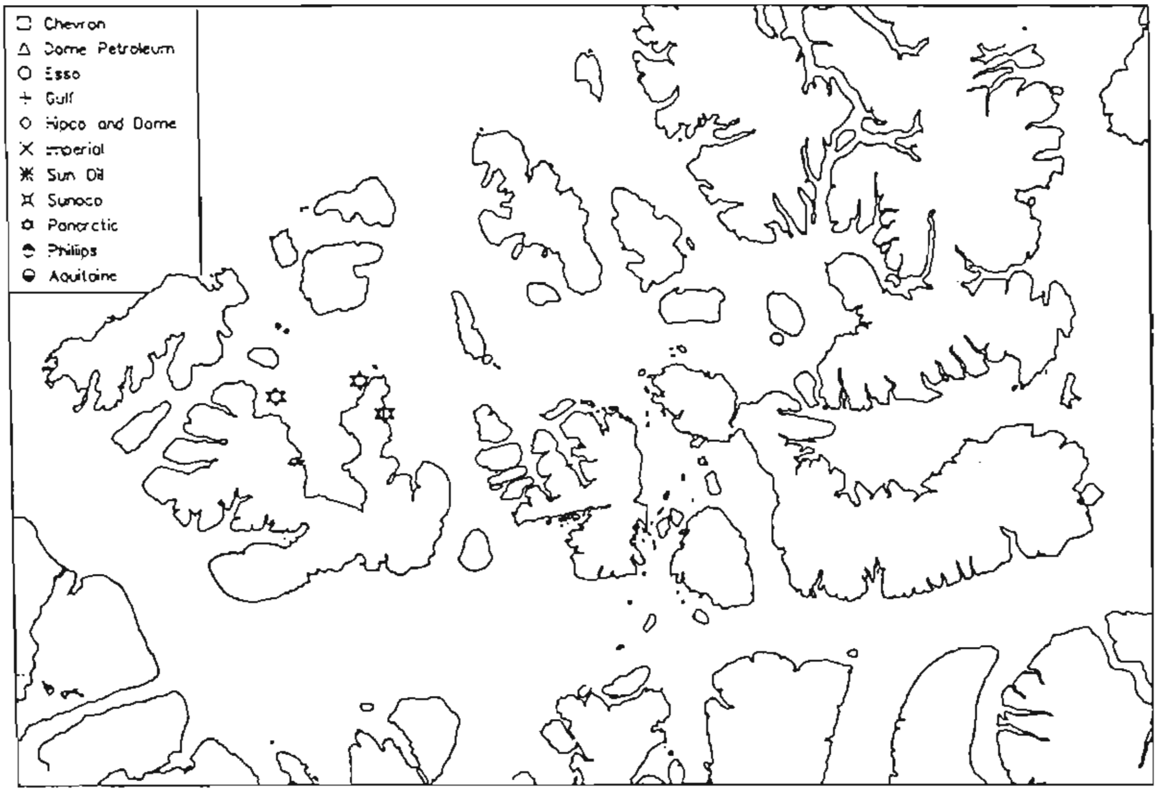


Figure 5.30 Locations of offshore wells drilled in the Arctic Islands, 1979

Figure 5.31 Locations of offshore wells drilled in the Arctic Islands, 1980

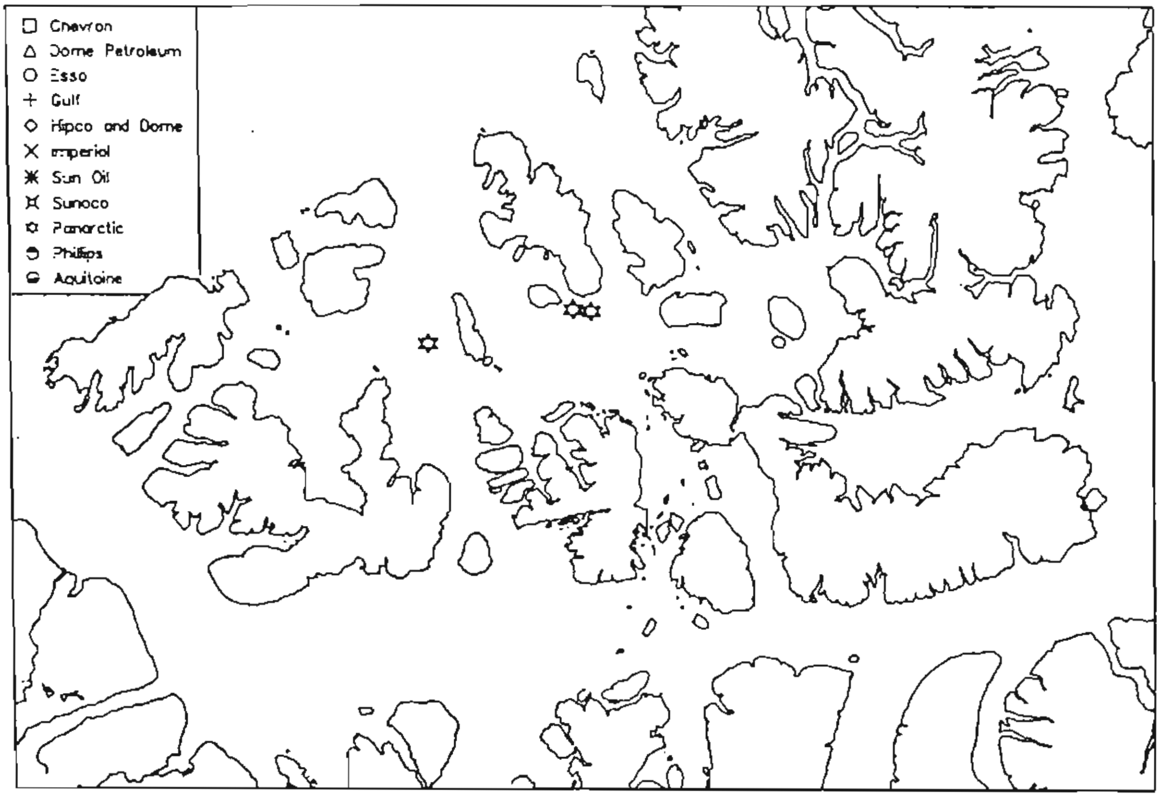
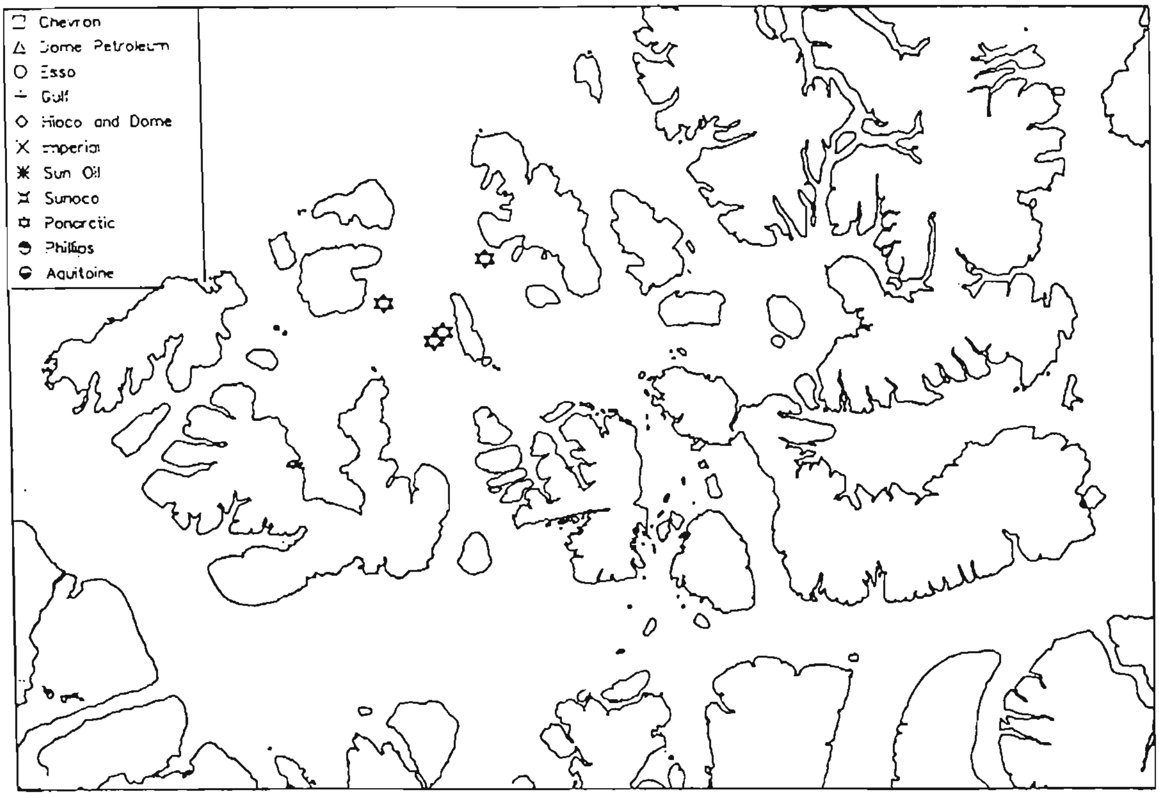


Figure 5.32 Locations of offshore wells drilled in the Arctic Islands, 1981

Figure 5.33 Locations of offshore wells drilled in the Arctic Islands, 1982



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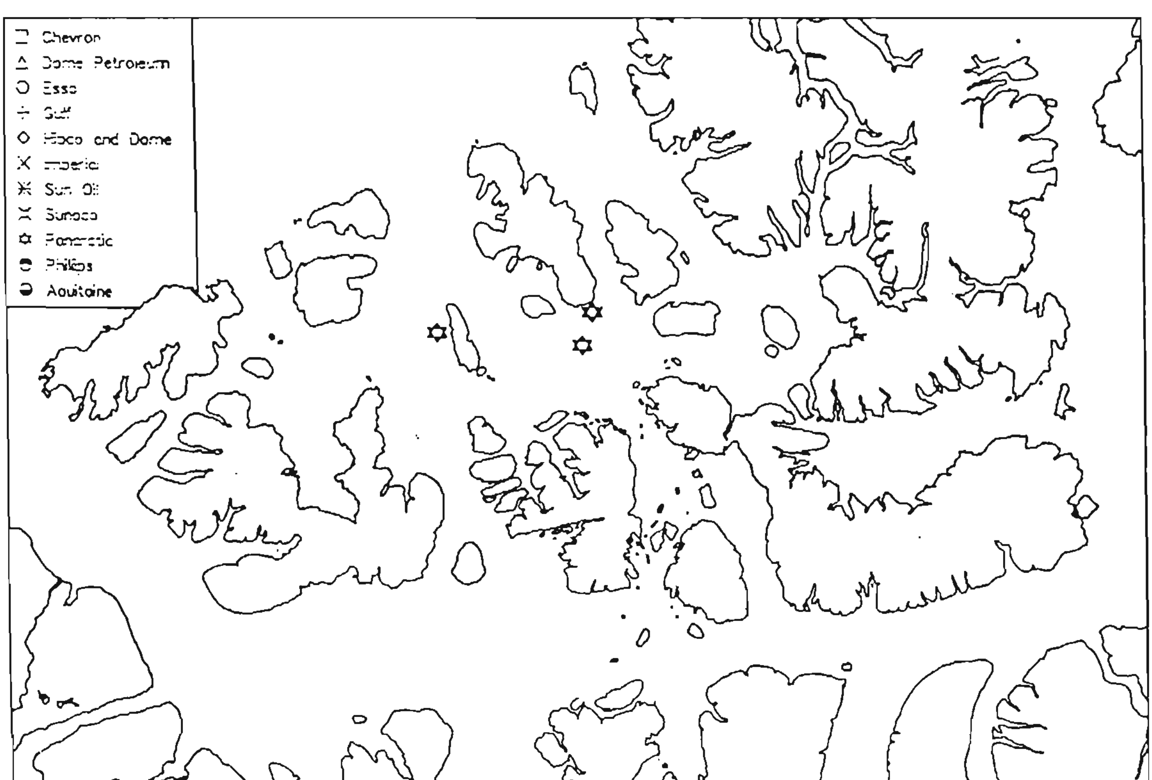


Figure 5.35 Locations of offshore wells drilled in the Arctic Islands, 1984

Figure 5.36 Locations of offshore wells drilled in the Arctic Islands, 1985

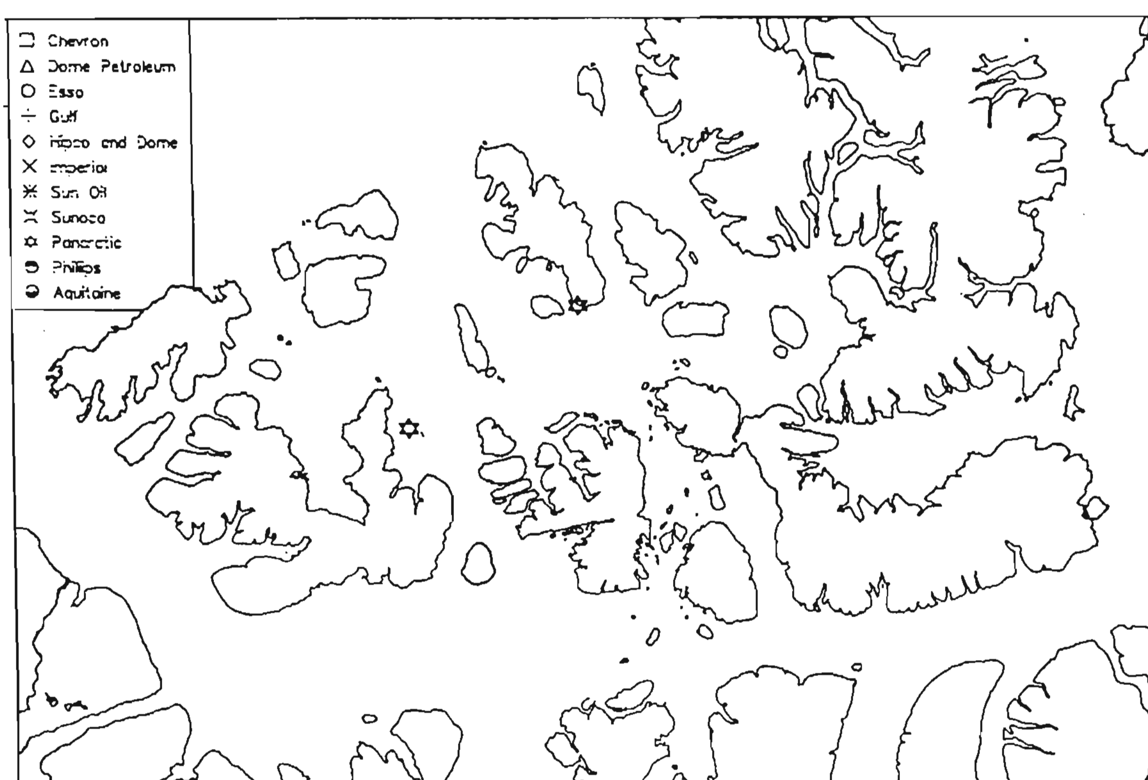


Figure 5.37 Locations of offshore wells drilled in the Arctic Islands, 1986

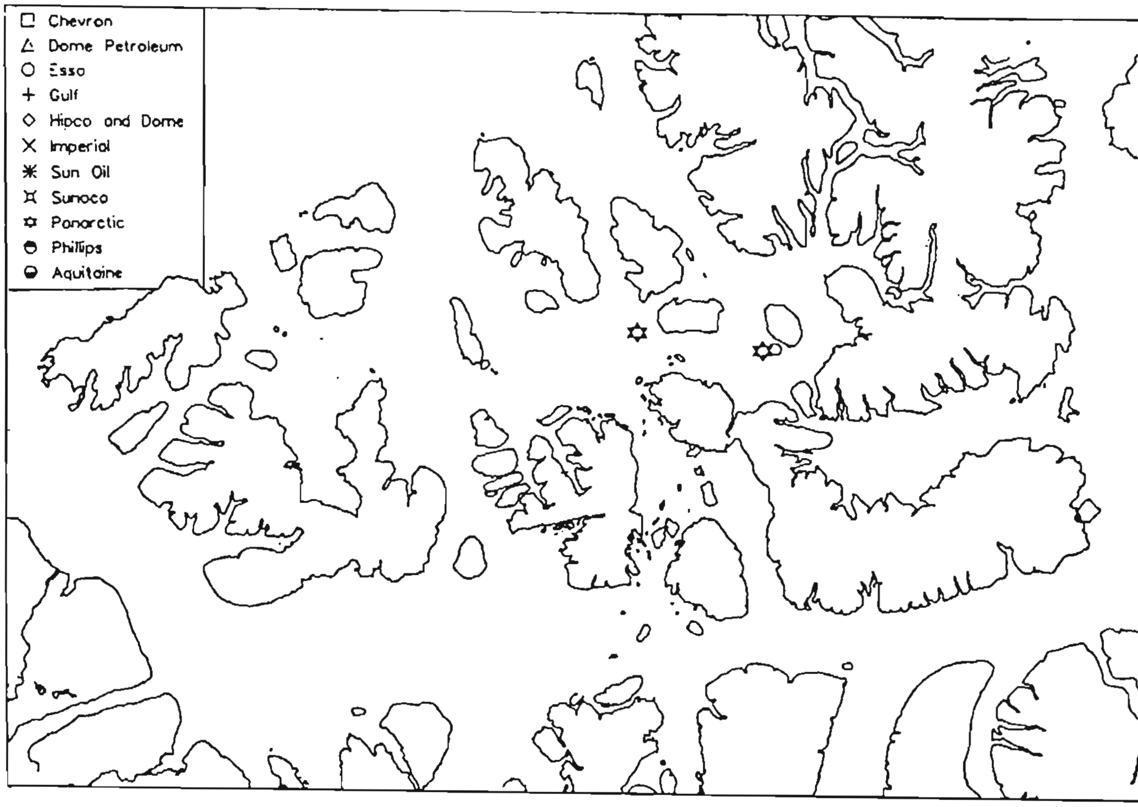


Figure 6.1 Number of wells drilled from various rig types in the Beaufort Sea, Davis Strait and Arctic Islands, 1973 - 1987

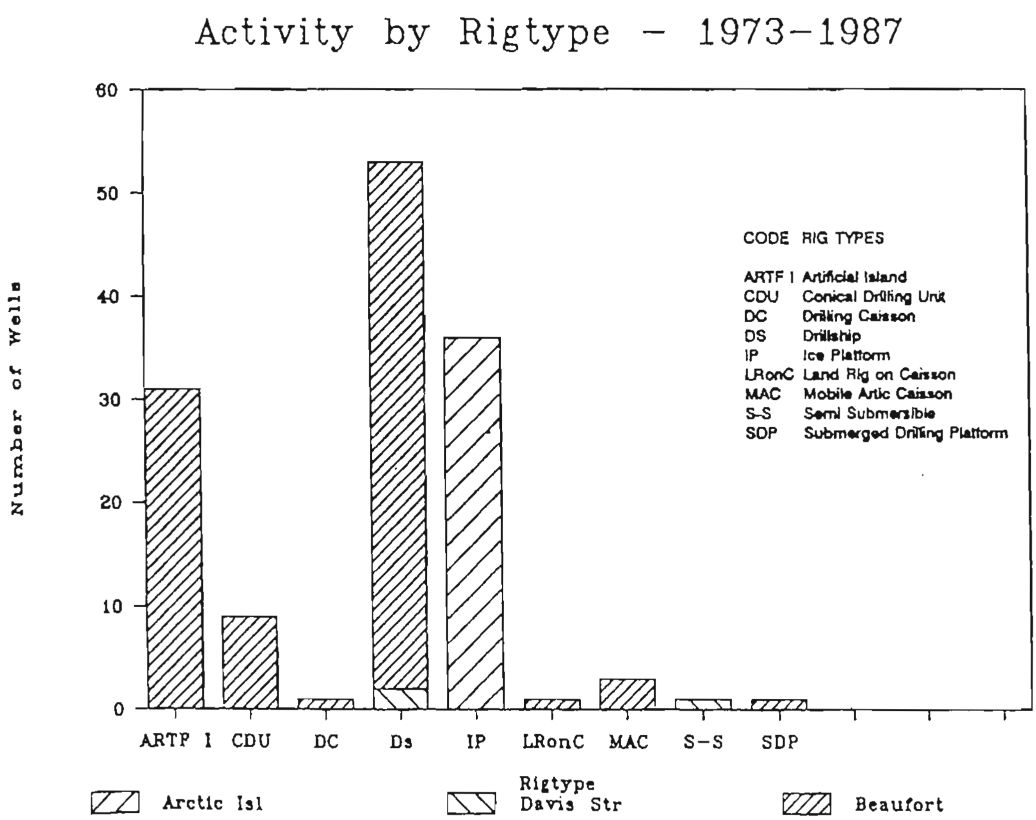


Figure 6.2 Number of wells drilled from various rig types in the Beaufort Sea, Davis Strait and Arctic Islands, 1973 - 1979

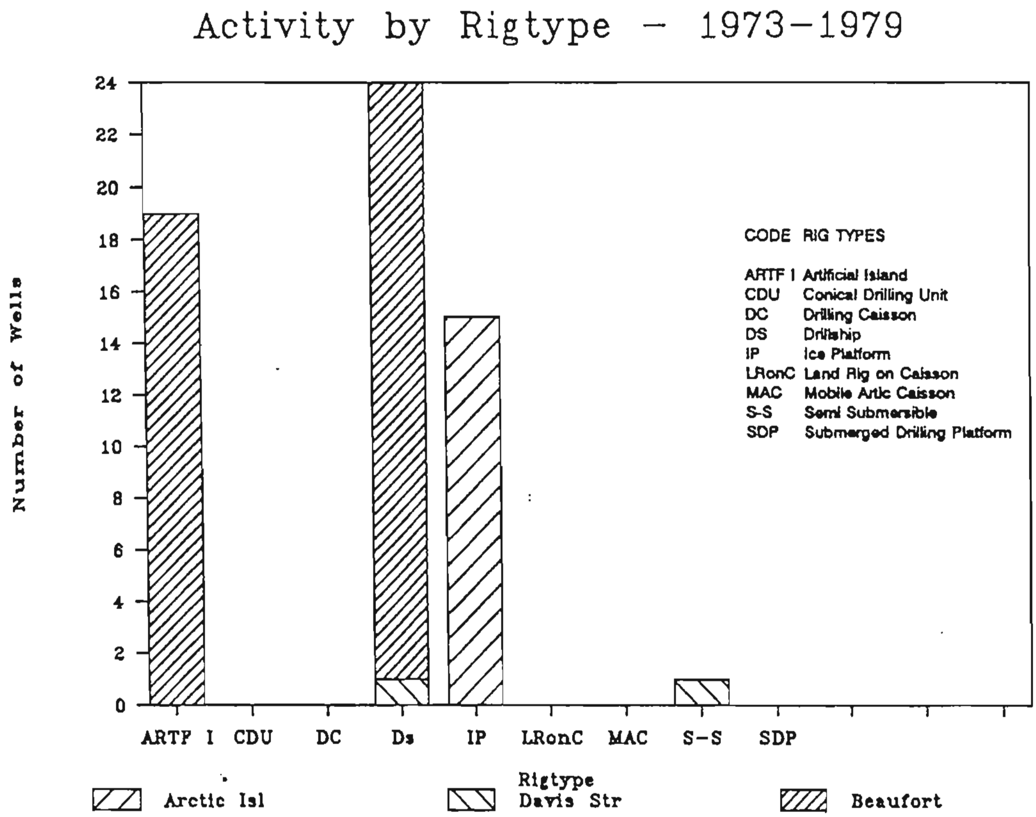


Figure 6.3 Number of wells drilled from various rig types in the Beaufort Sea, Davis Strait and Arctic Islands, 1980 - 1982

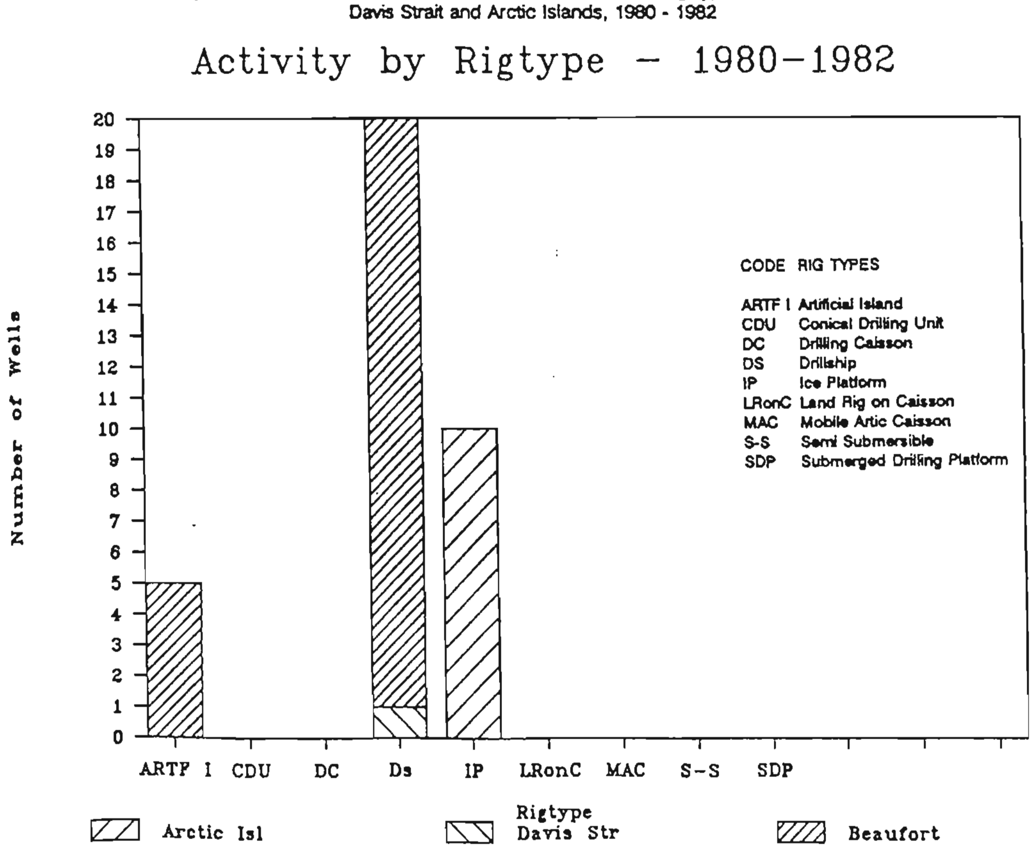


Figure 6.4 Number of wells drilled from various rig types in the Beaufort Sea, Davis Strait and Arctic Islands, 1983 - 1987

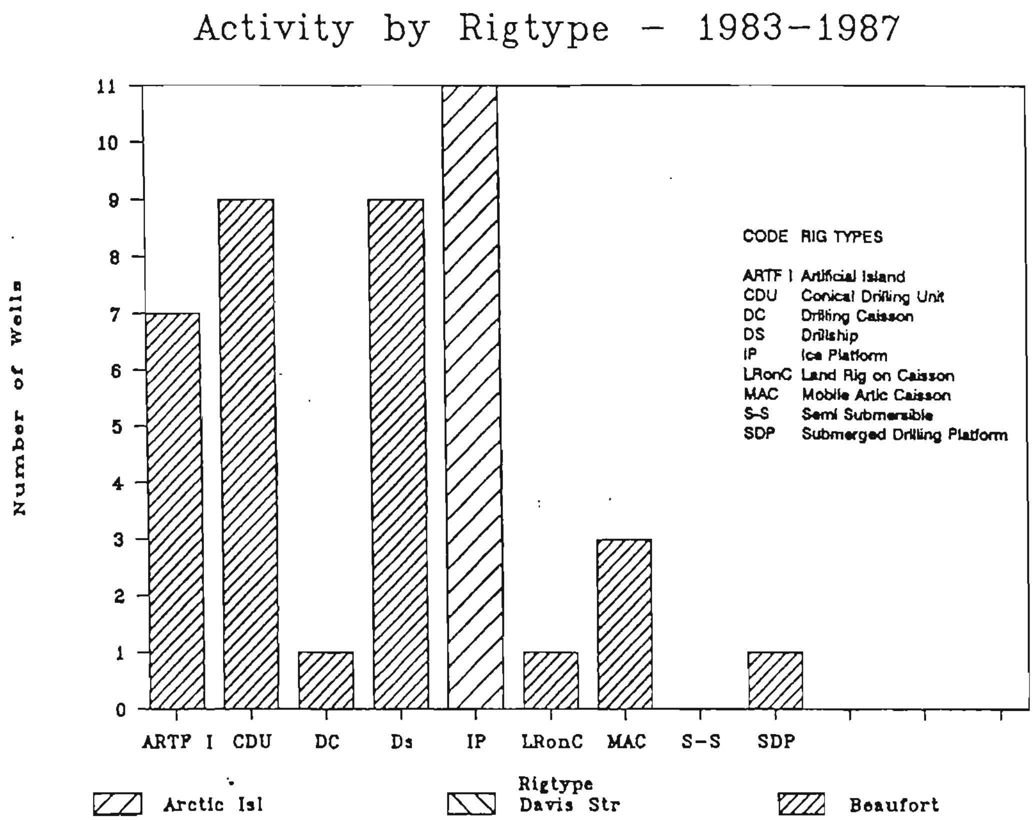
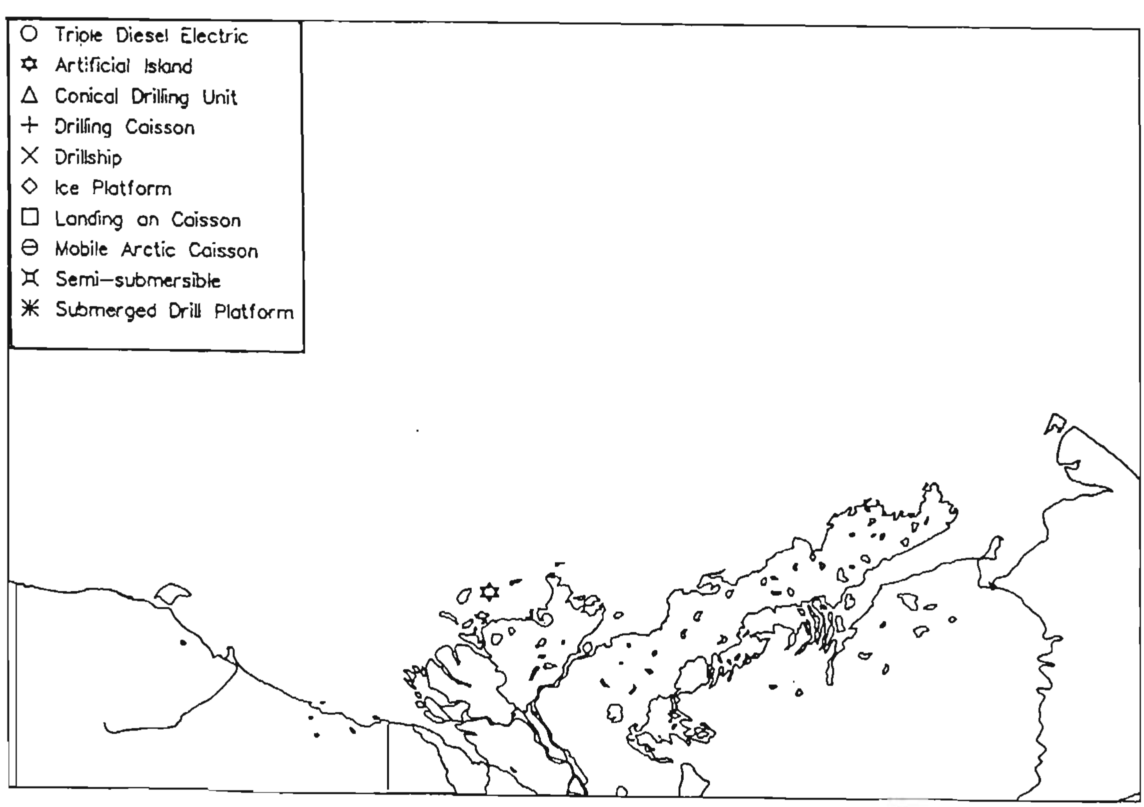


Figure 6.5 Locations of wells drilled from various rig types in the Beaufort Sea, 1973



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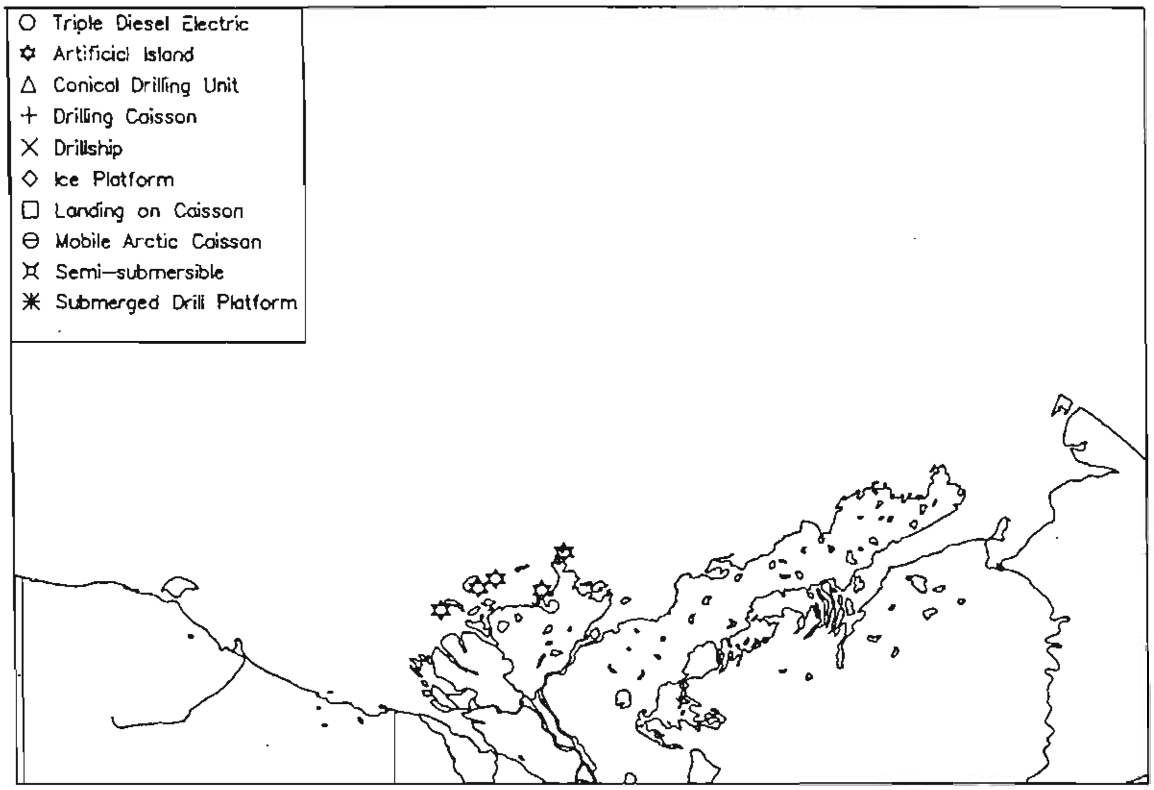


Figure 6.7 Locations of wells drilled from various rig types in the Beaufort Sea, 1975

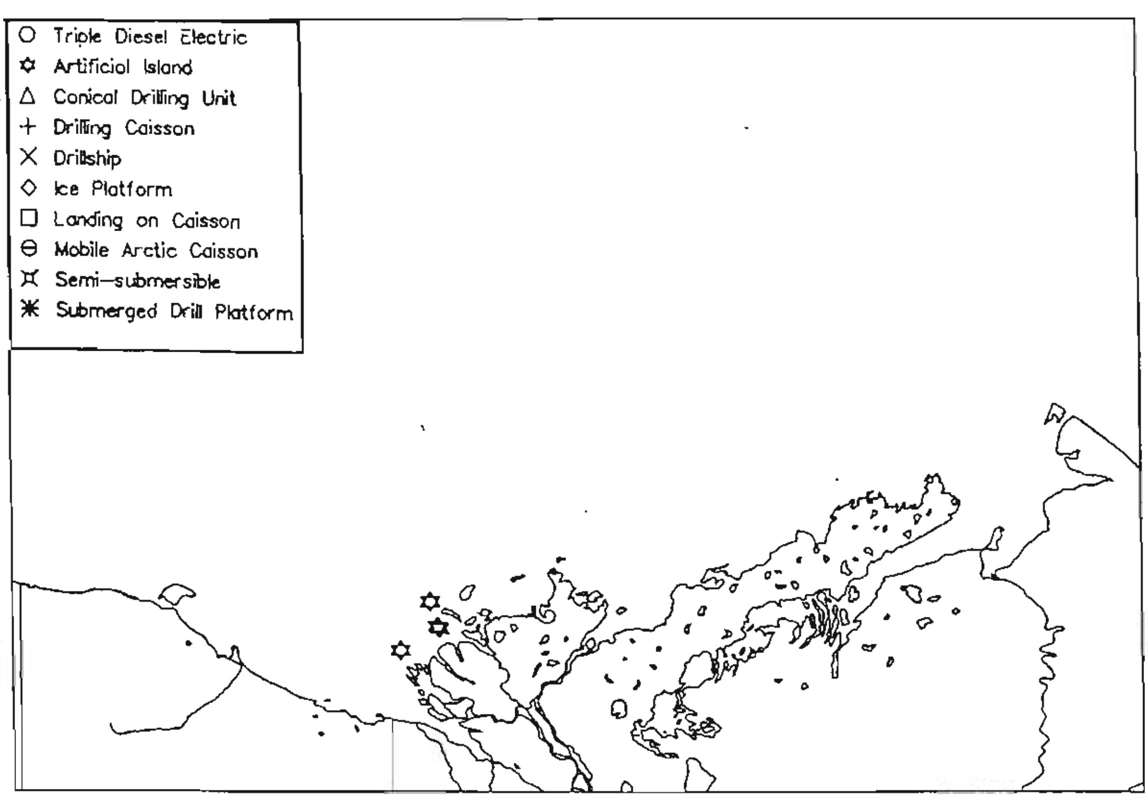


Figure 6.8 Locations of wells drilled from various rig types in the Beaufort Sea, 1976

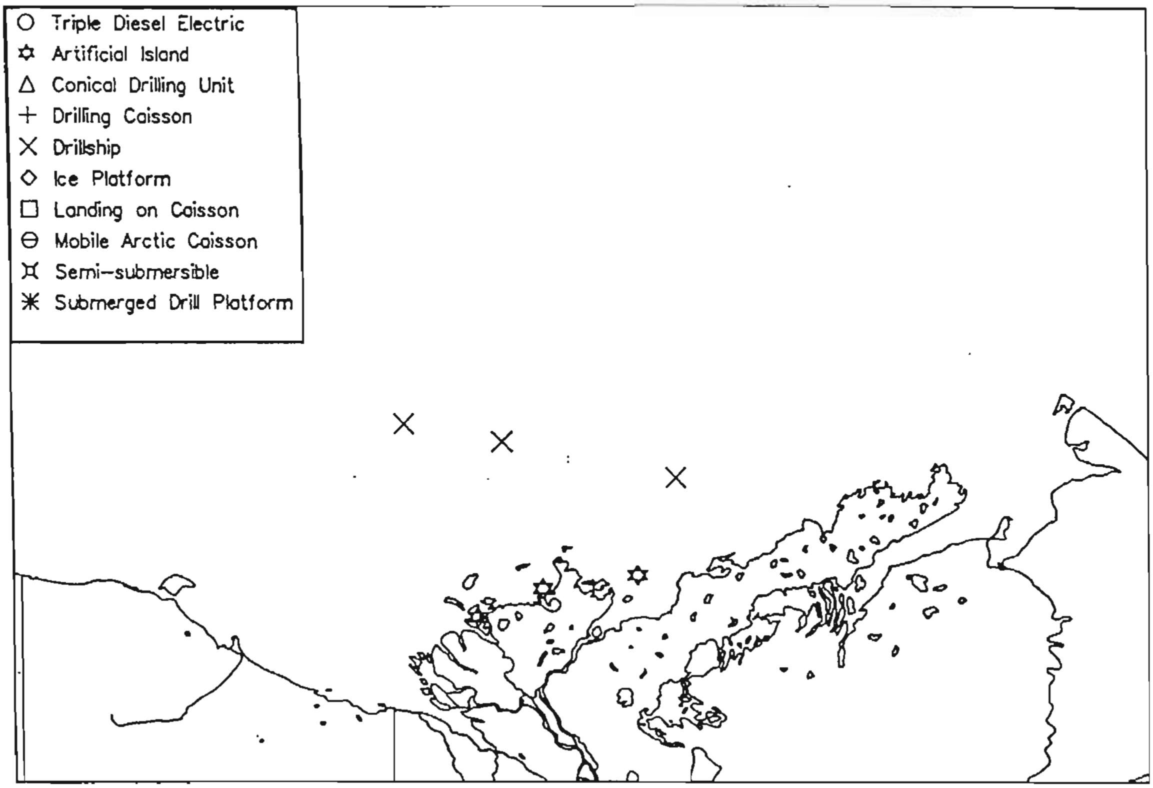


Figure 6.9 Locations of wells drilled from various rig types in the Beaufort Sea, 1977

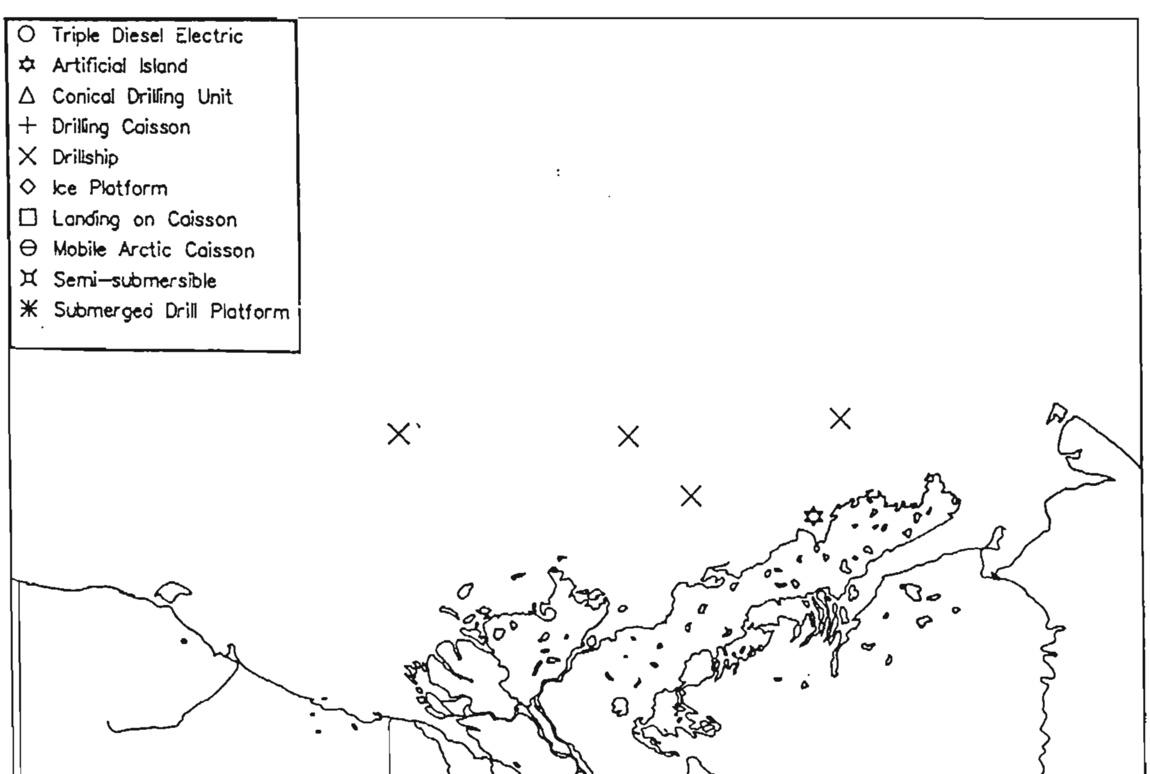
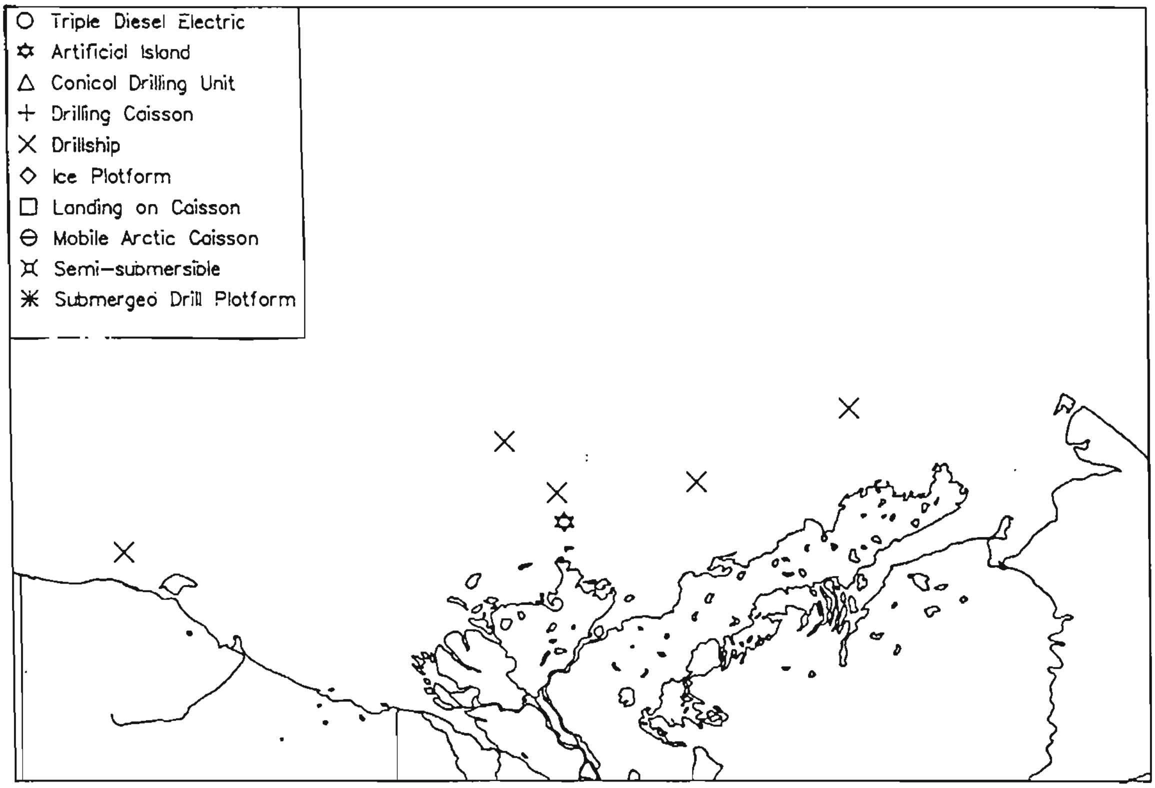


Figure 6.10 Locations of wells drilled from various rig types in the Beaufort Sea, 1978



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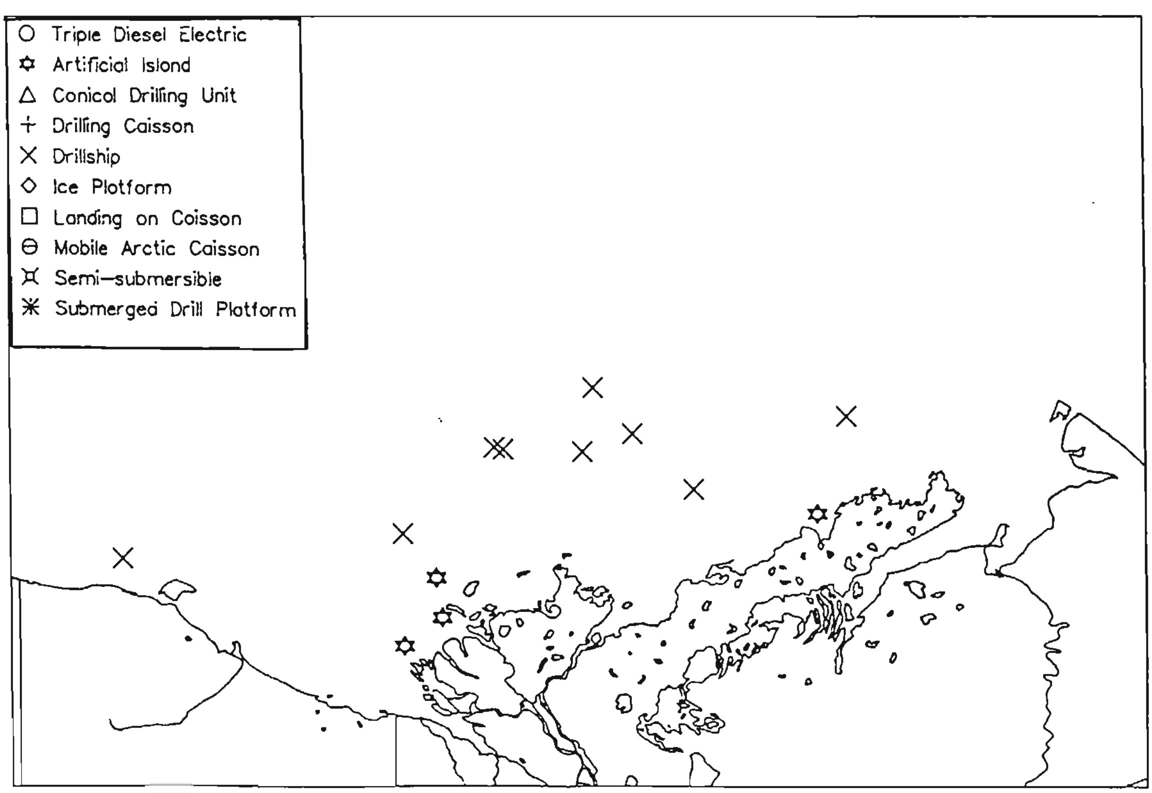

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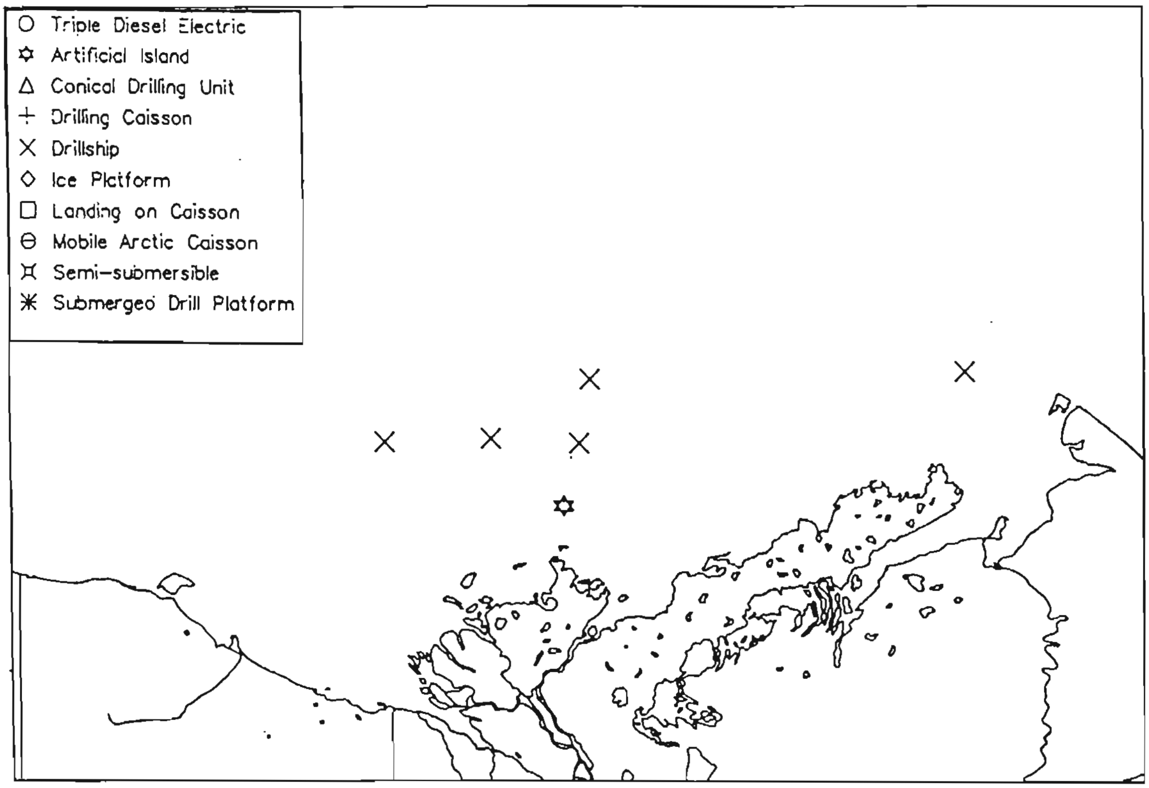

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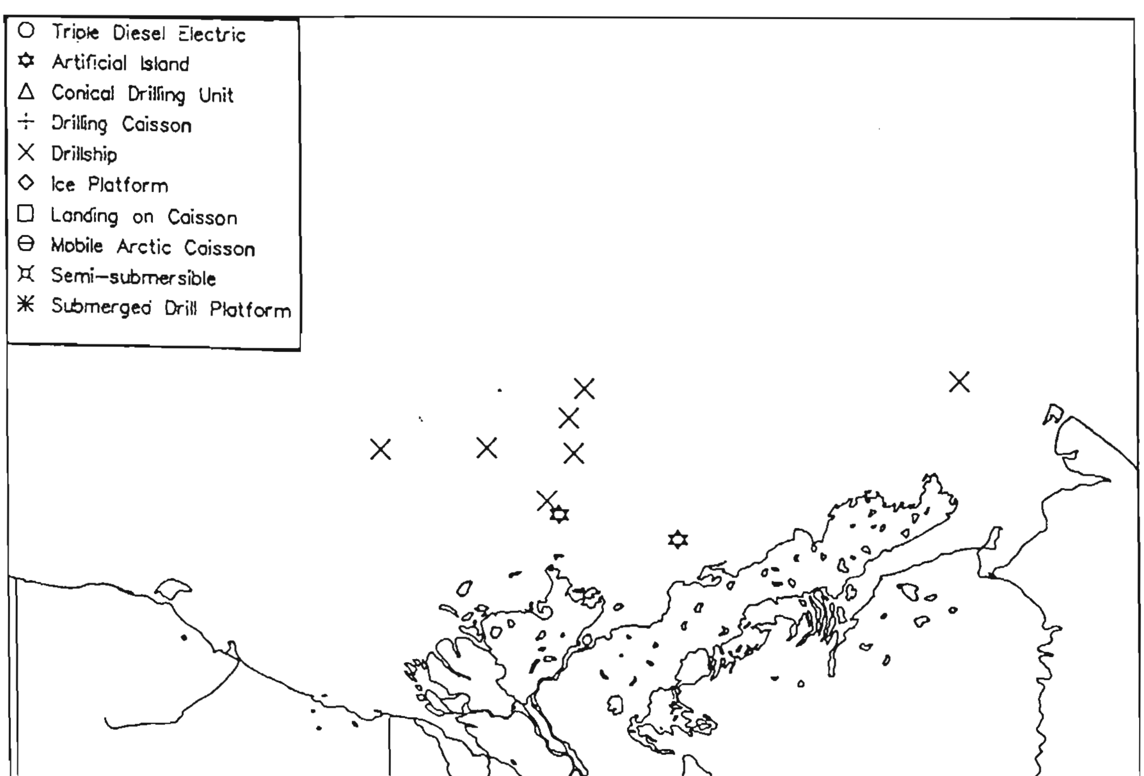

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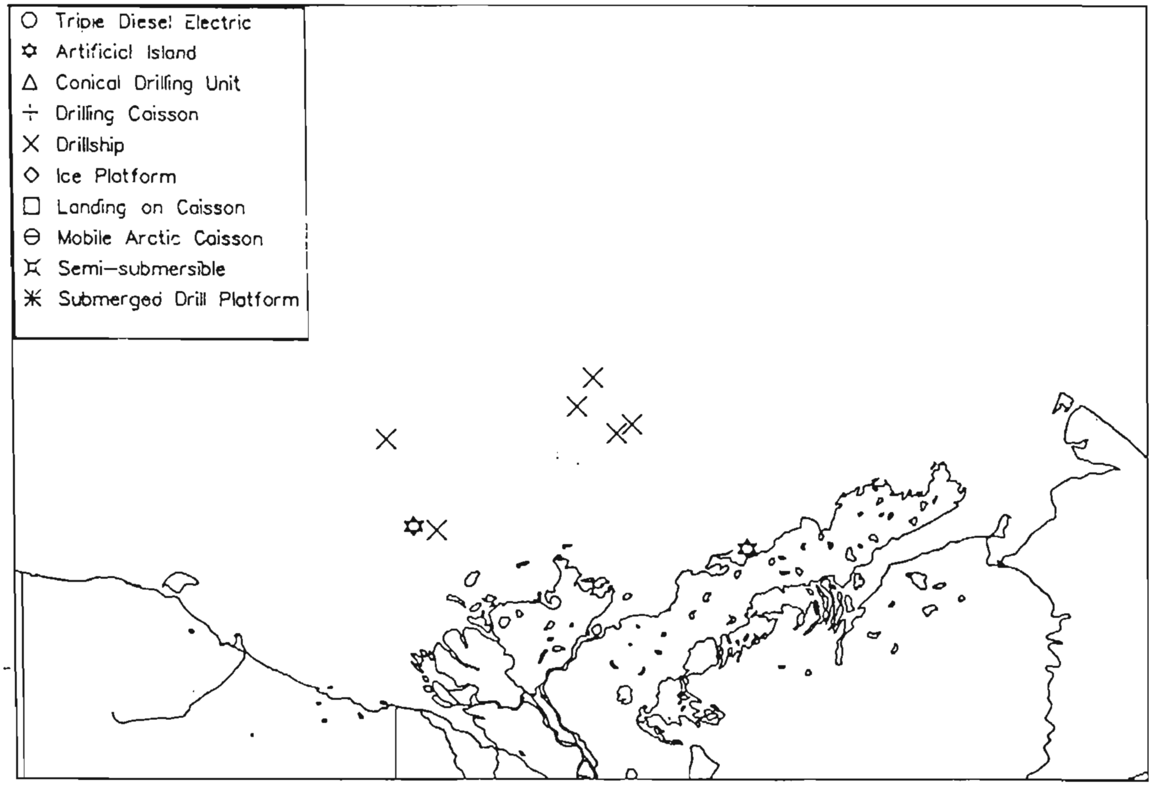

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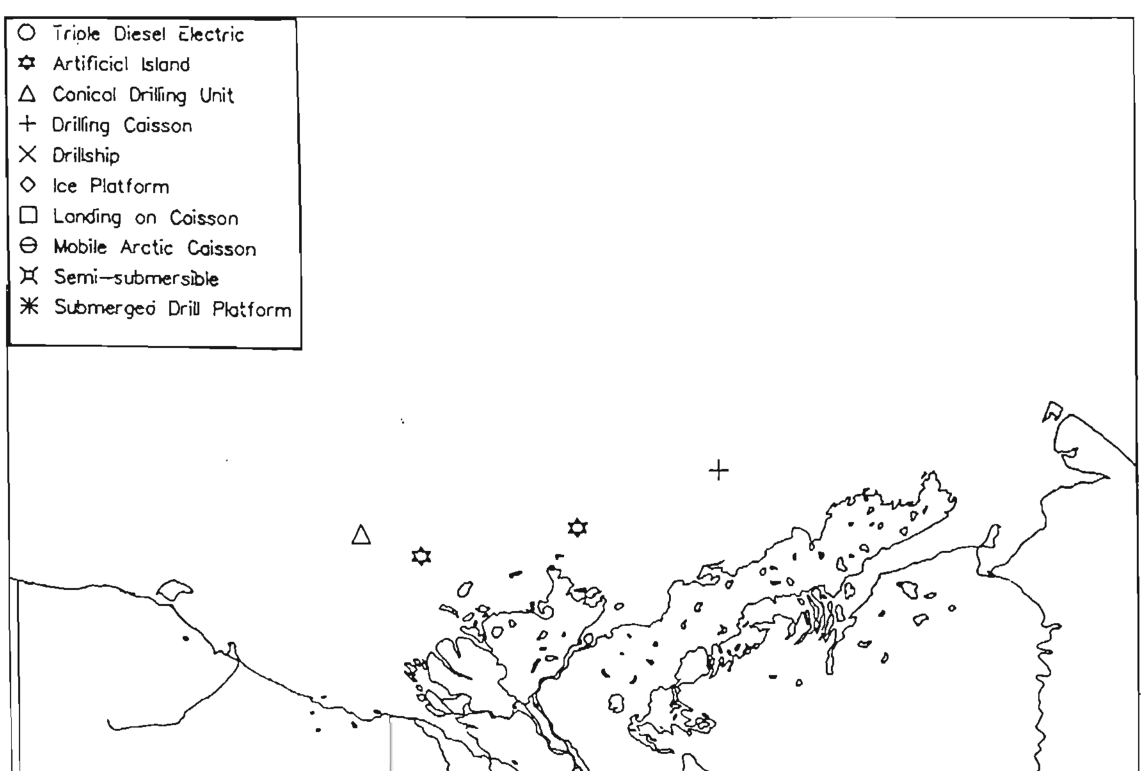


Figure 6.16 Locations of wells drilled from various rig types in the Beaufort Sea, 1984

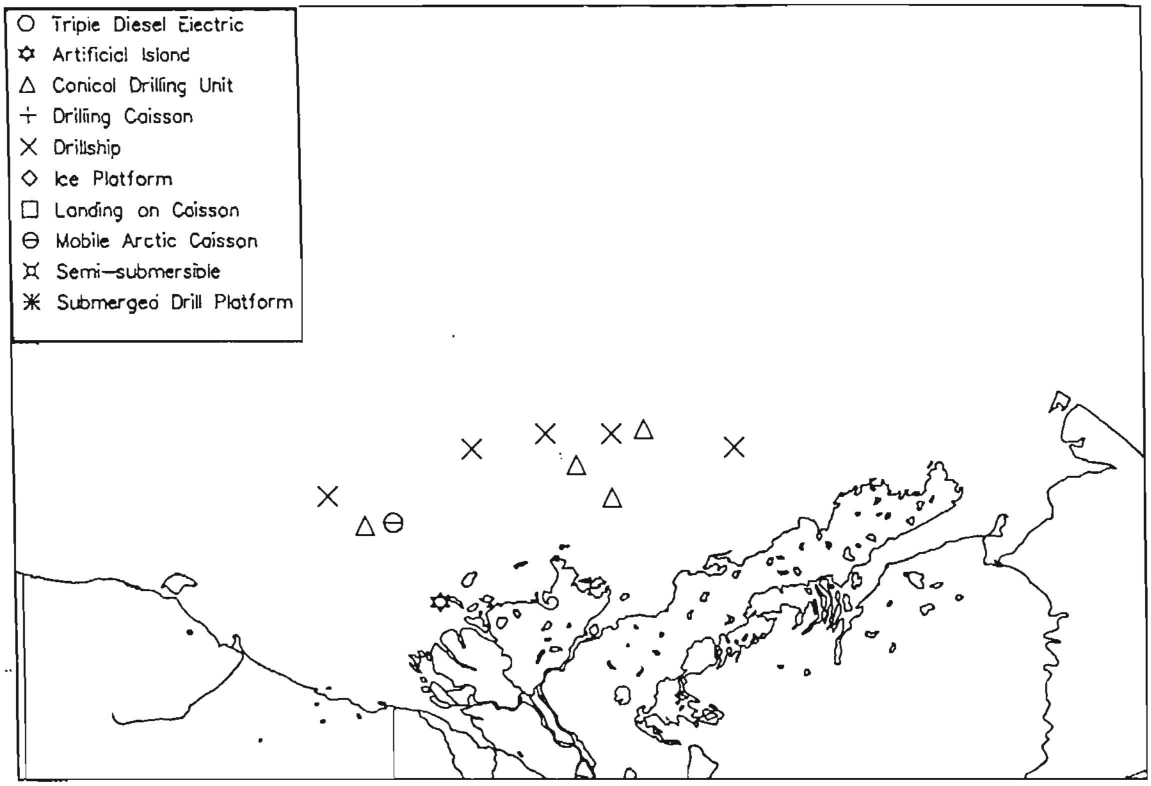
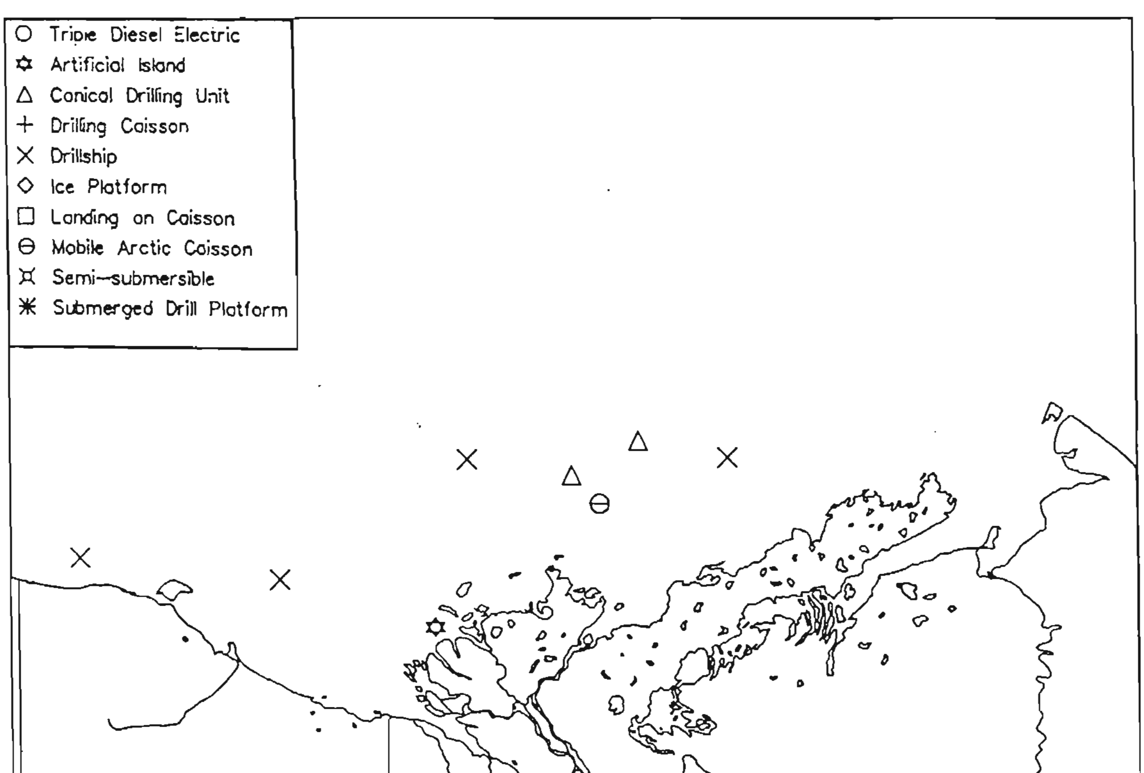


Figure 6.17 Locations of wells drilled from various rig types in the Beaufort Sea, 1985



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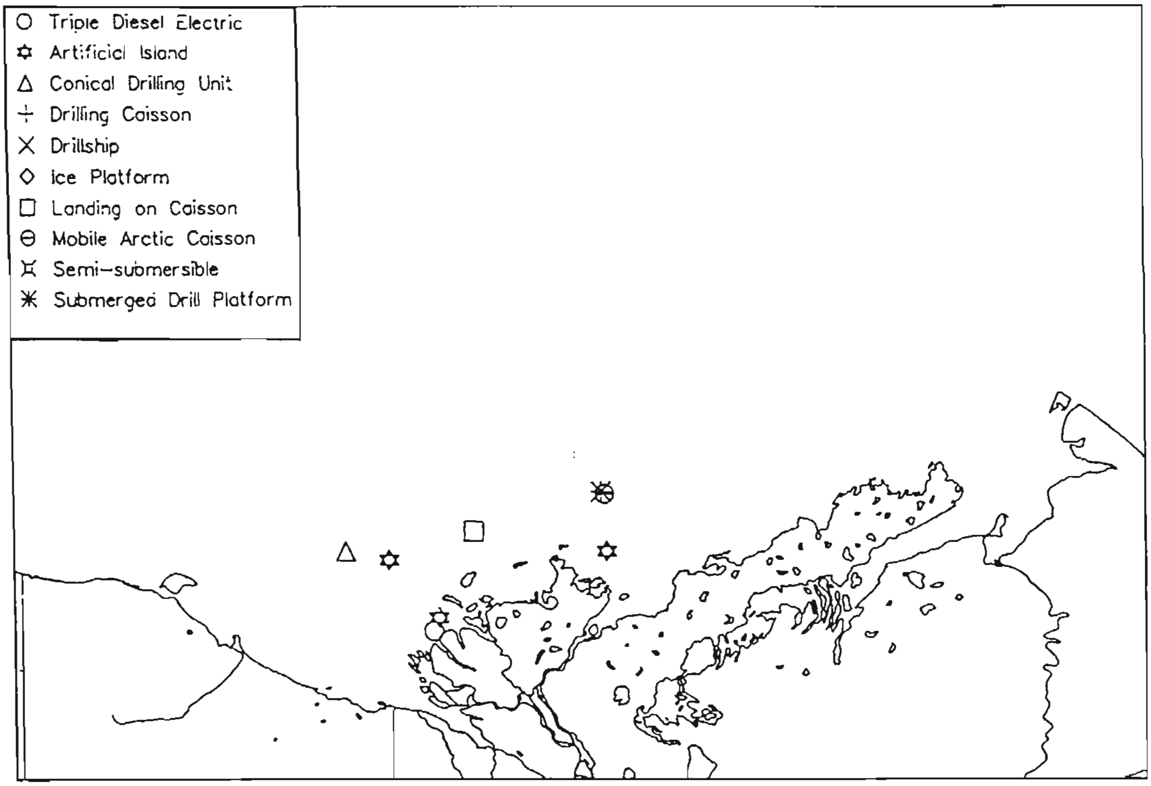


Figure 6.19 Locations of wells drilled from various rig types in the Beaufort Sea, 1987

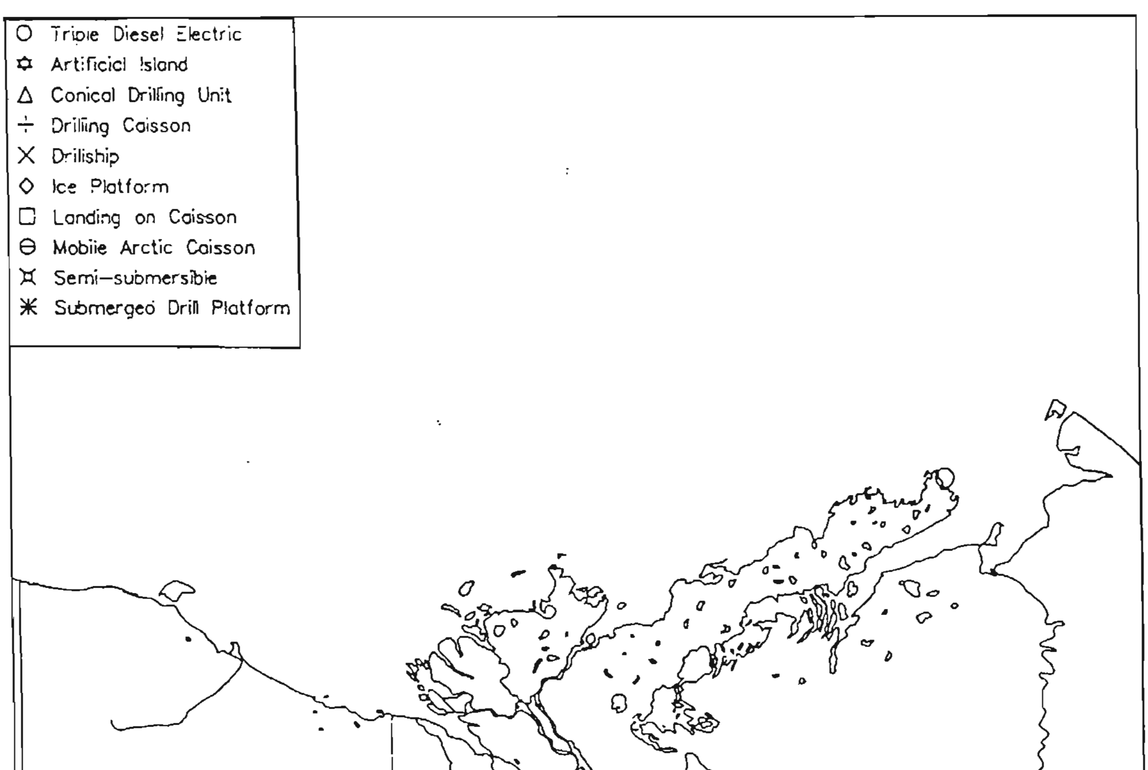


Figure 6.20 Locations of wells drilled from various rig types in the Davis Strait, 1979

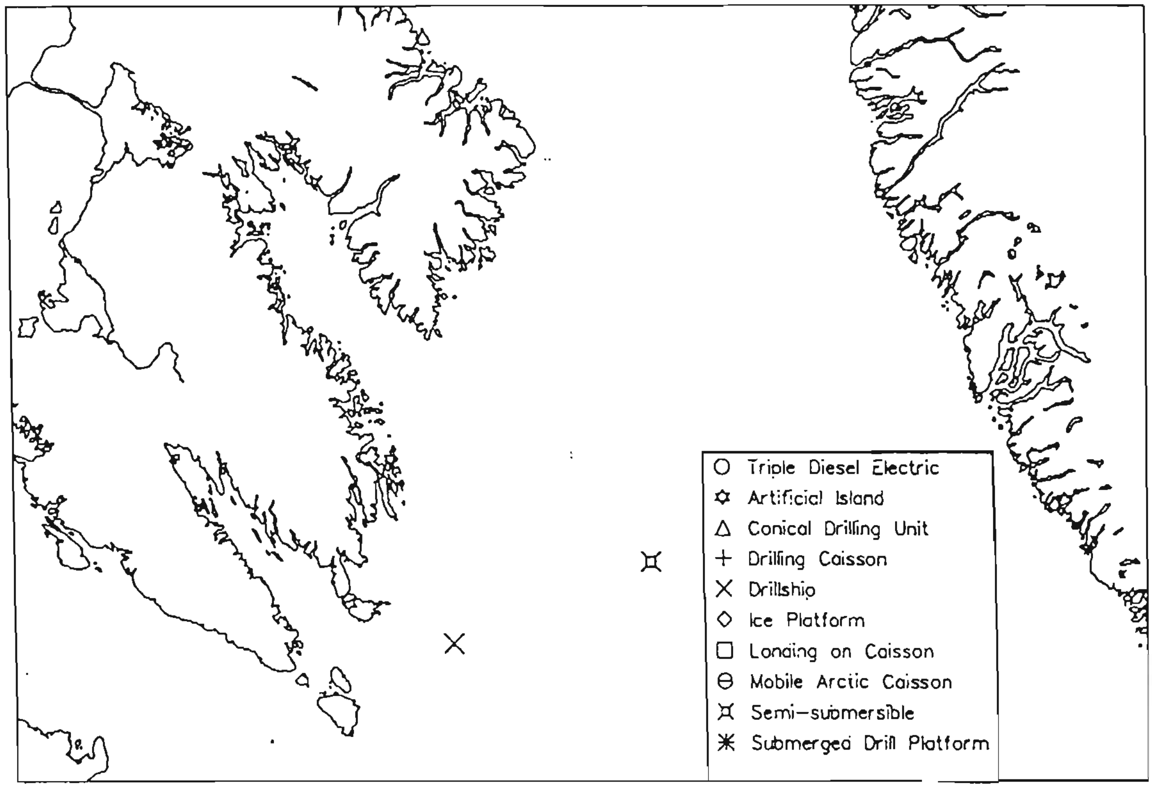


Figure 6.21 Location of wells drilled from various rig types in the Davis Strait, 1980

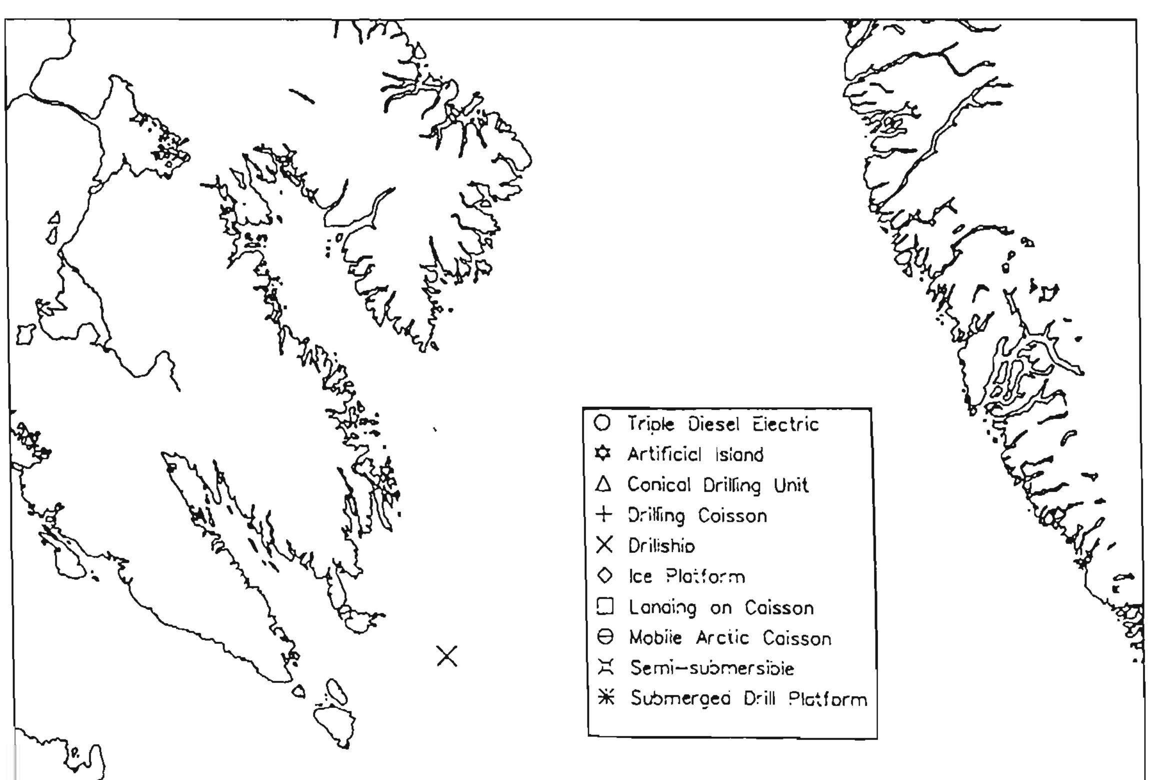


Figure 6.22 Locations of wells drilled from various rig types in the Arctic Islands, 1973

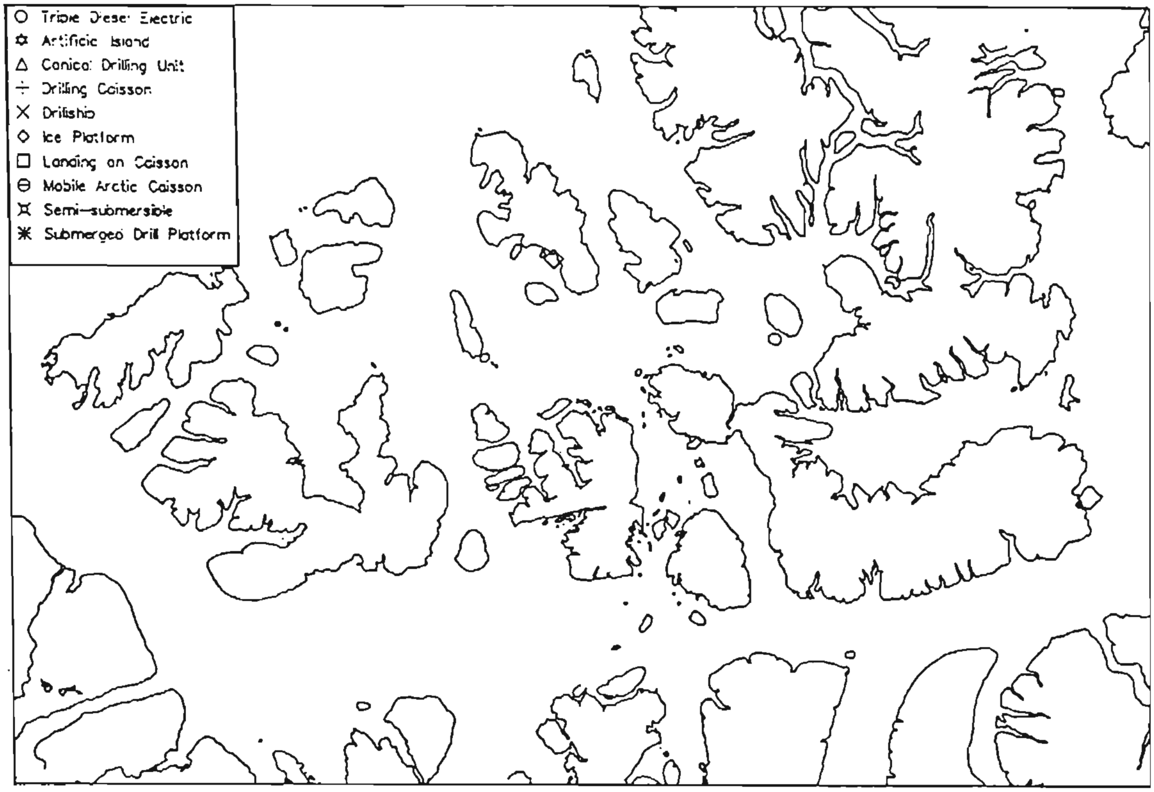
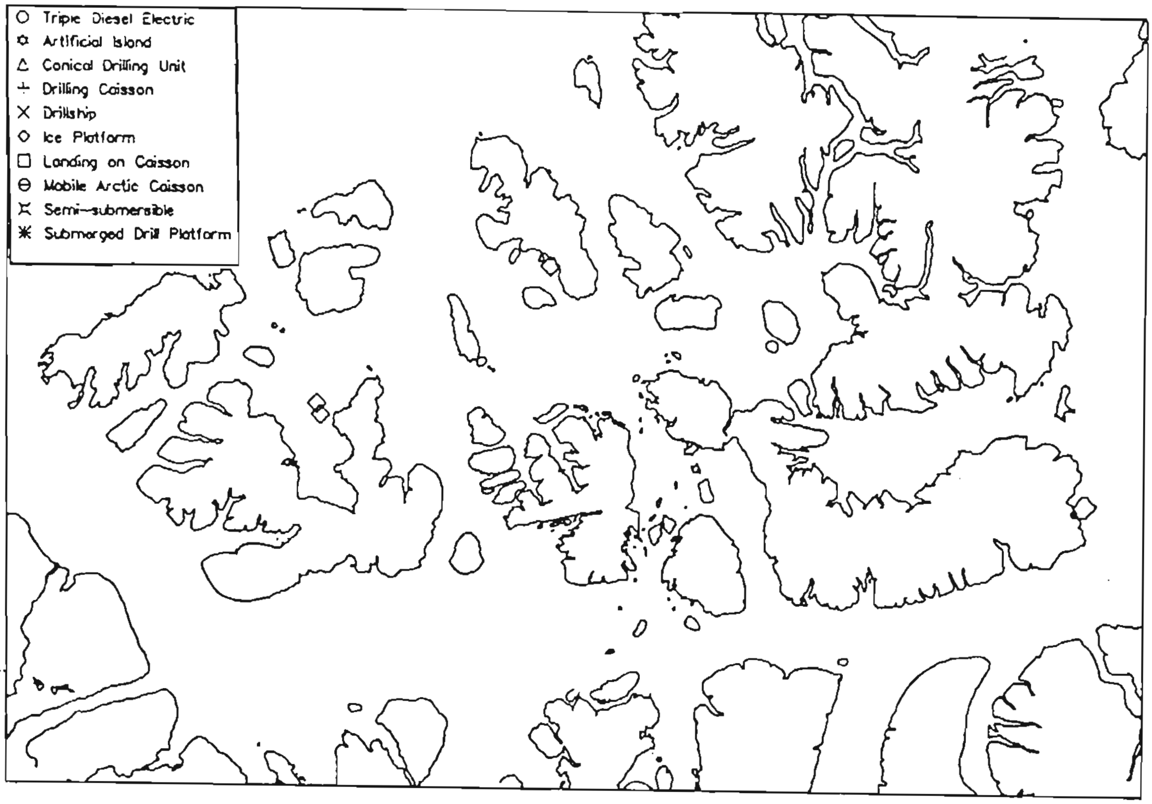


Figure 6.23 Locations of wells drilled from various rig types in the Arctic Islands, 1974

Figure 6.24 Locations of wells drilled from various rig types in the Arctic Islands, 1976



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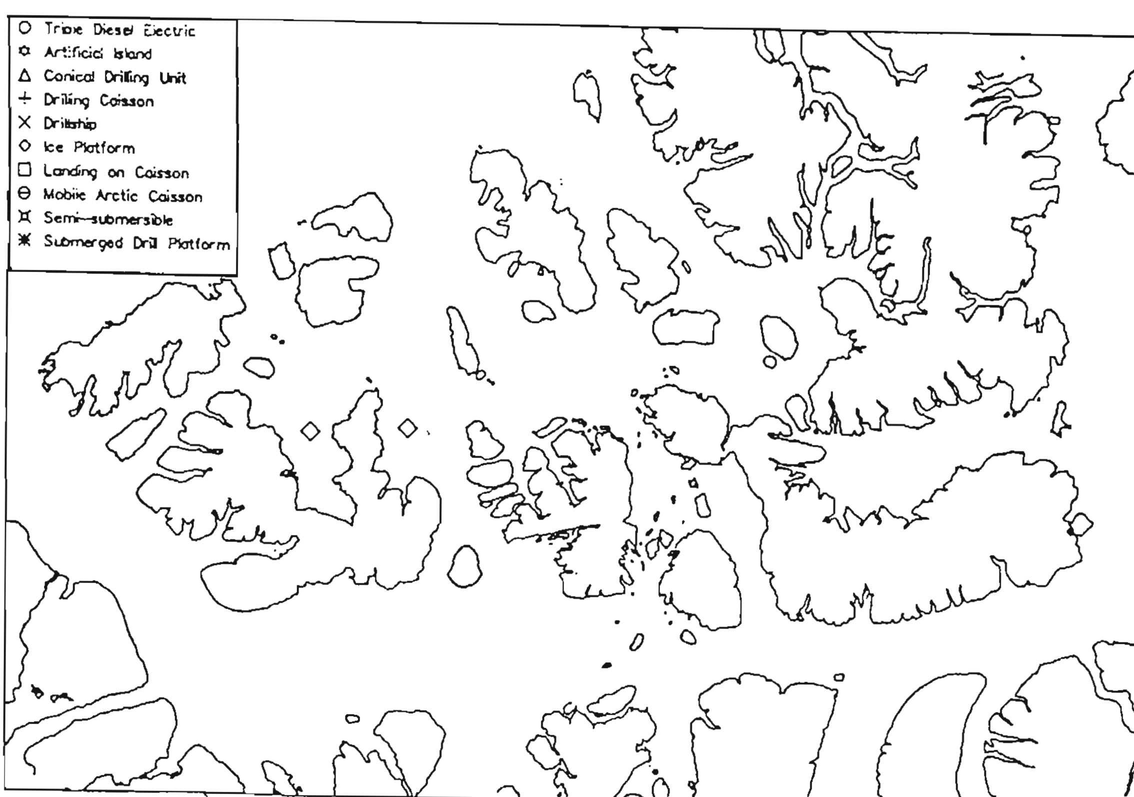

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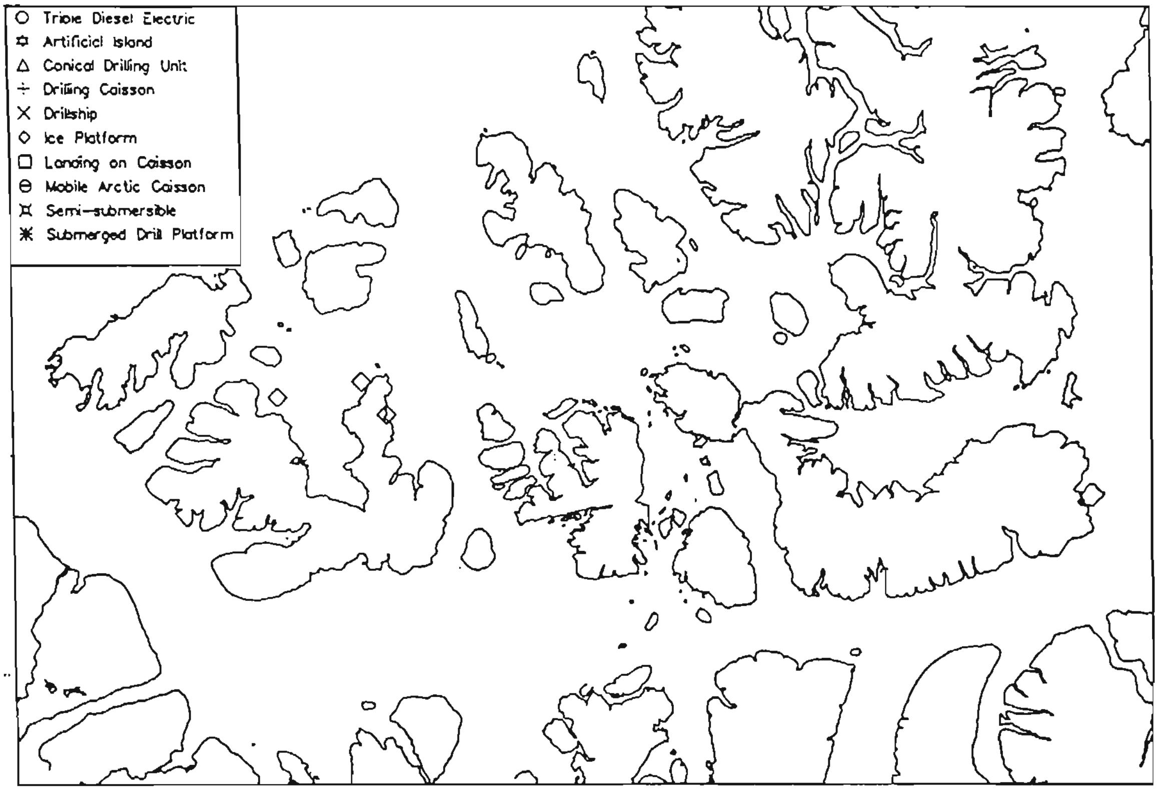


Figure 6.27 Locations of wells drilled from various rig types in the Arctic Islands, 1979

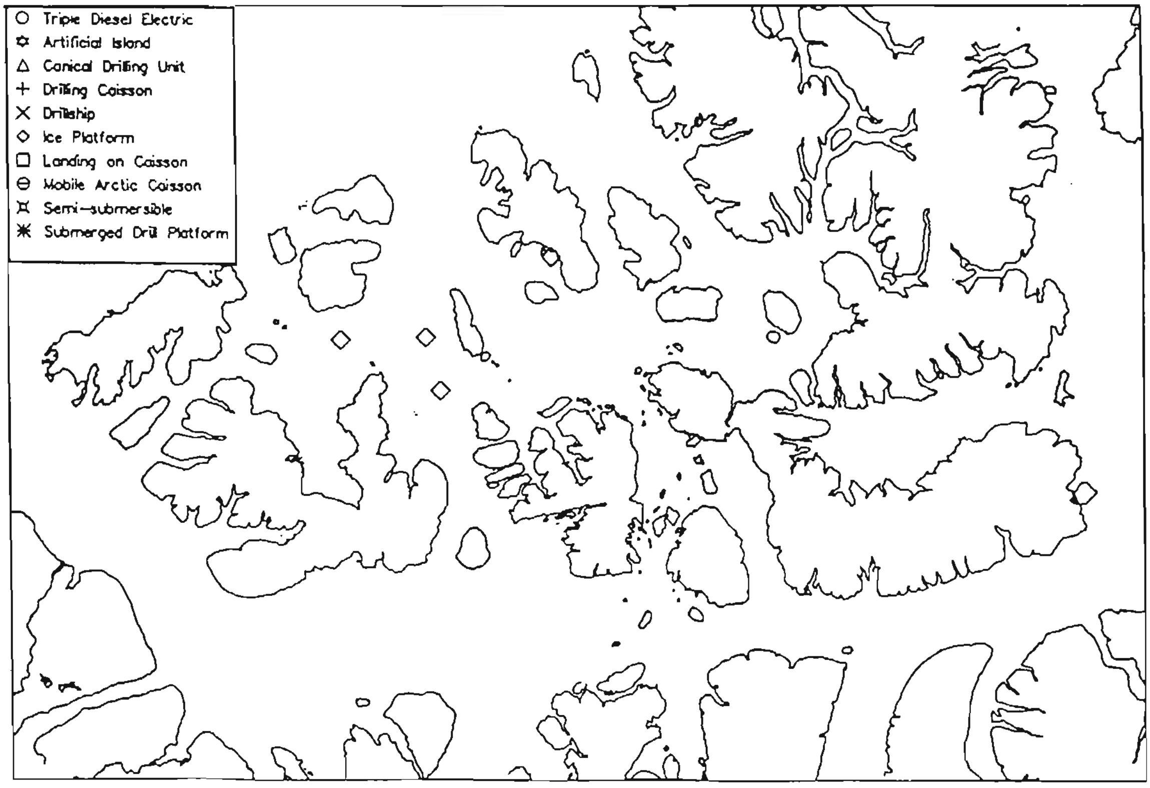


Figure 6.30 Locations of wells drilled from various rig types in the Arctic Islands, 1982

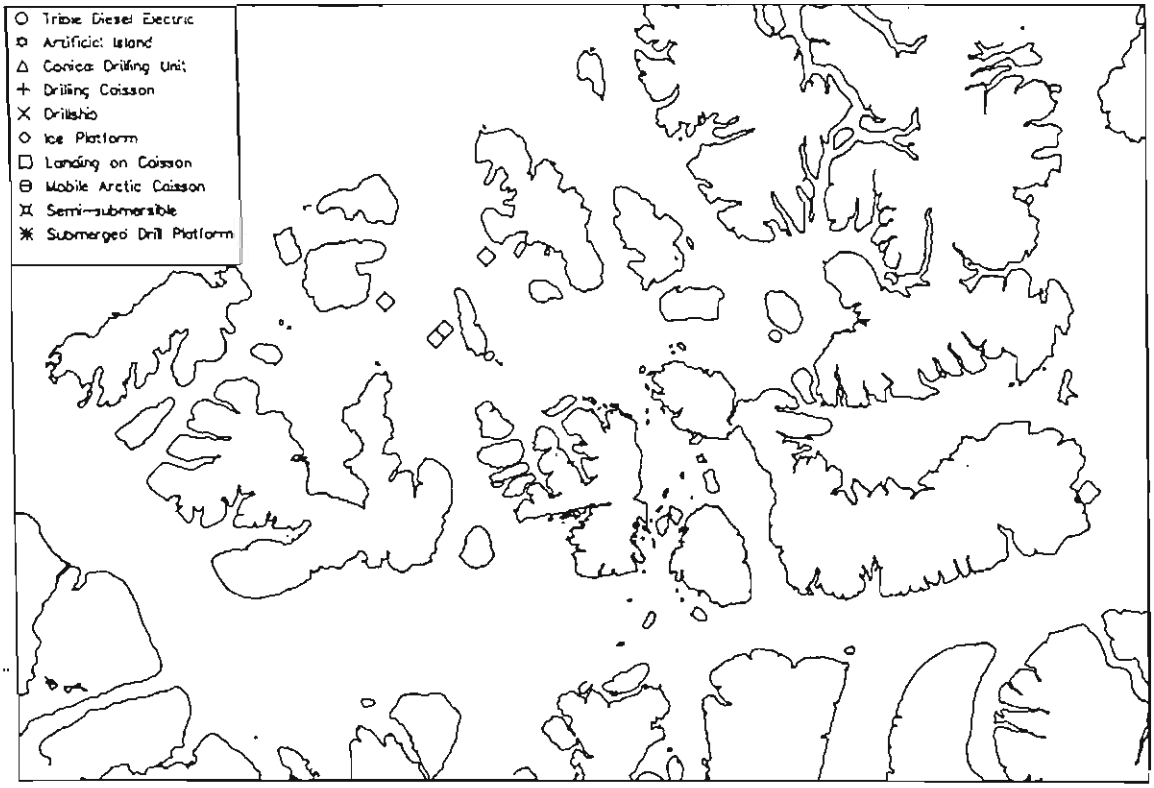


Figure 6.31 Locations of wells drilled from various rig types in the Arctic Islands, 1983

Figure 6.28 Locations of wells drilled from various rig types in the Arctic Islands, 1980

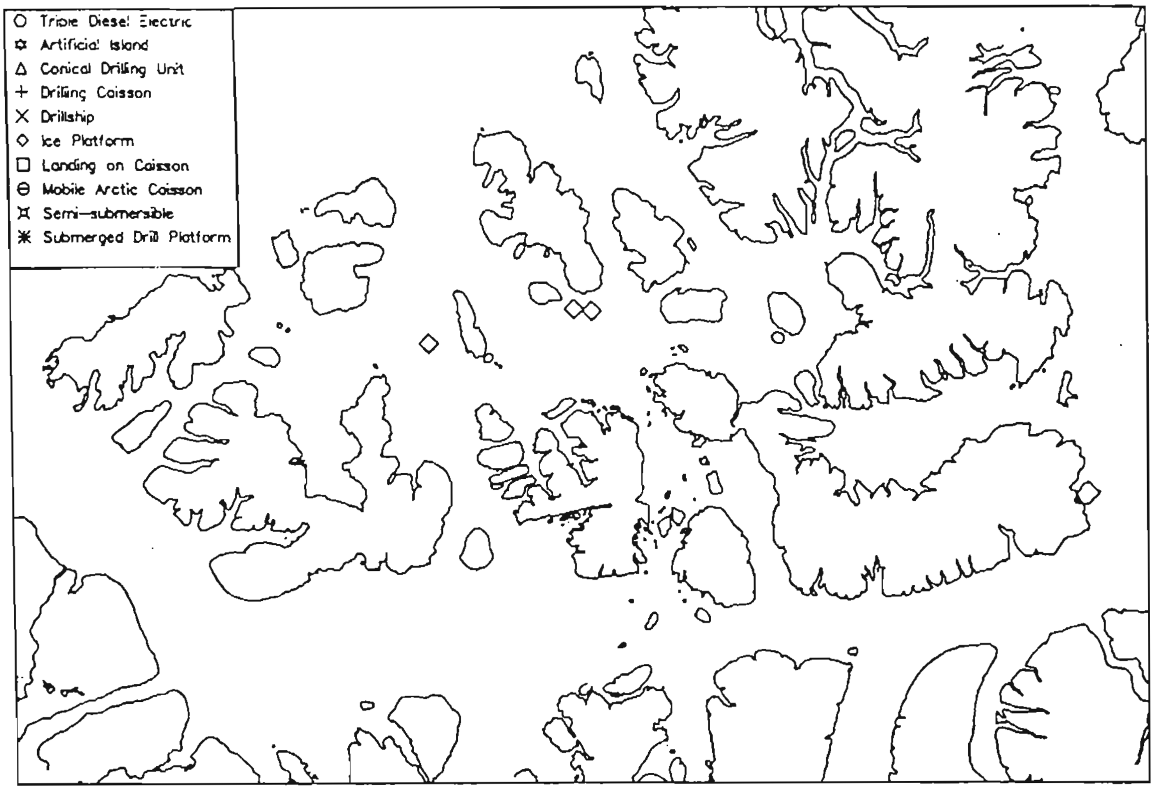


Figure 6.29 Locations of wells drilled from various rig types in the Arctic Islands, 1981

Figure 6.32 Locations of wells drilled from various rig types in the Arctic Islands, 1984

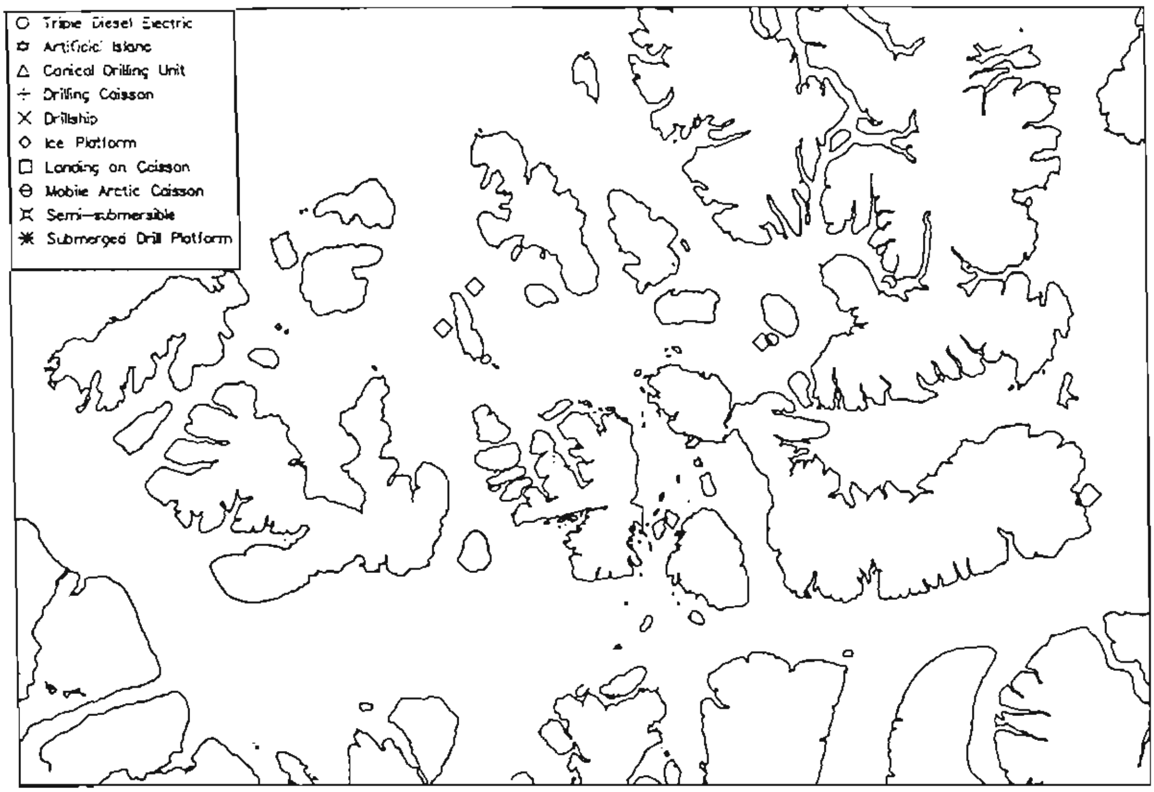
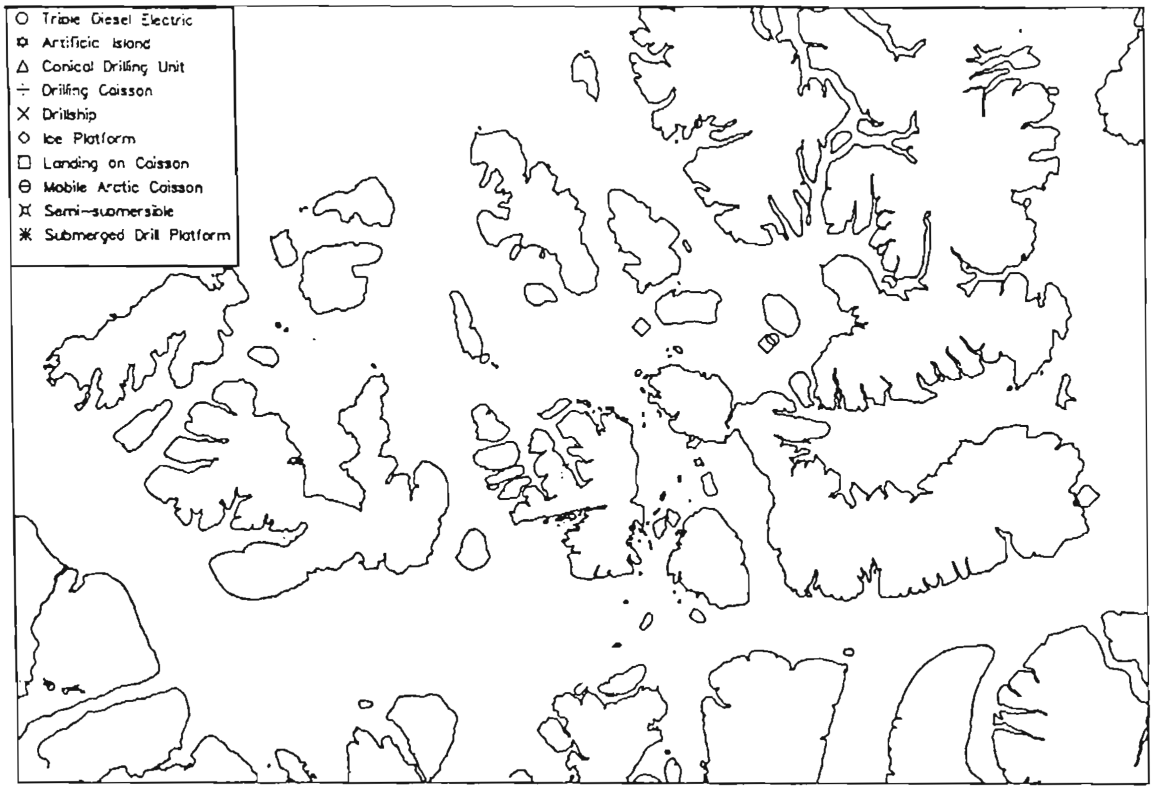


Figure 6.33 Locations of wells drilled from various rig types in the Arctic Islands, 1985

Figure 6.34 Locations of wells drilled from various rig types in the Arctic Islands, 1986



APPENDIX A.

CHEMICALS REPORTED IN ARCTIC DRILLING RECORDS 1973 - 1986

(alphabetical order by trade-name)

CHEMICALS REPORTED IN ARCTIC DRILLING RECORDS 1973 - 1986

FLUID	DENSITY (g/mL)	FORM	SUPPLIER	CONTAINER SIZE	DESCRIPTION	PRIMARY USE, SECONDARY USE
ALPHLOUSE	-	NA	NA	Qty = 48 no units reported 1982 week 3	NA - Panarctic Mamen F-24, DA 987)	NA
ALUMINUM STEARATE	-	Solid	Various	11.4 kg	Aluminum stearate powder	Defoamer
ALWATE	-	Solid	Messina	100 lb sack	High specific gravity granular powder	Weighting Material
AMI-TEC	0.900	Liquid	Milchem	55 US gal	Oil soluble amine compound	Corrosion Inhibitor
AMMONIUM NITRATE	-	Solid	Hughes/Imco	NA		Tracer Oxidizer
ANTI-FOAM	0.890	Liquid	Exxon (Carney)	5 US gal or 55 US	Silicon oil	Defoamer
AP-21	1.300	Both	Technifluids	25 kg sack or 20 L pail	Non-viscosifying polymeric fluid	Thinner, Dispersant Emulsifier
B FREE HEAVY WATE	0.972	Liquid	Technifluids	55 US gal drum	Spotting fluid for stuck pipe with viscosifier	Lubricant Emulsifier, etc
BARABUF	-	Solid	Baroid	50 lb bag	Magnesium oxide - marine origin	pH Control
BARAVIS	-	Solid	Baroid	25 kg or 50 lb probably metric	Pure hydroxyethyl cellulose	Viscosifier
BARAZAN	-	Solid	Baroid	25 kg or 50 lb probably pounds	High molecular weight polysaccharide	Viscosifier Emulsifier
BARDAC 2250	0.927	Liquid	Technifluids	20 L or 55 US gal probably pounds	Isopropyl and didecyldimethyl ammonium chloride	Bactericide
BARITE	-	Solid	Various	100 lb bag, 1500 kg sea-can, 1500 kg palet	processed barites ($BaSO_4$)	Weighting Material
BENTONITE	-	Solid	Various	45.4 kg bag	Aquagel, Hydrogel, Macogel, etc.	Viscosifier Filtrate Reducer

CHEMICALS REPORTED IN ARCTIC DRILLING RECORDS 1973 - 1986, cont'd

FLUID	DENSITY (g/mL)	FORM	SUPPLIER	CONTAINER SIZE	DESCRIPTION	PRIMARY USE, SECONDARY USE
BIGALO	-	NA	NA	NA		NA
CALCIUM CHLORIDE	-	Solid	Various	45.4 kg	Calcium Chloride	Weighting Material pH Control, etc.
CALCIUM HYDROXIDE	-	Solid	Various	25 kg or 50 lb bag	Lime	pH Control Bactericide, etc.
CALCIUM SULPHATE	-	Solid	Various	NA	Plaster of Paris	Surface Active Agent Filtrate Reducer
CALLITE	-	NA	NA	NA		NA
CARBONOX	-	Solid	Baroid	50 lb bag	Lignitic humic acid powder	Thinner, Dispersant Emulsifier, etc.
CELLEX	-	Solid	Baroid	50 lb bag	Sodium carboxymethyl cellulose	Filtrate Reducer Viscosifier
CHROME ALUM	-	Solid	Magcobar	22.7 kg bag	Chromium aluminum silicate?	Viscosifier
CLF	-	NA	NA	Qty = 7 sacks reported 1981 week 15	NA - Panarctic (Cisco B-66, DA 972)	NA
CMC	-	Solid	Various	25 kg or 50 lb bag	Carboxymethyl cellulose	Filtrate Reducer Viscosifier
COAT 129	1.400	Liquid	Baroid	50 lb pail	Oxygen scavenger and scale inhibitor	Corrosion Inhibitor
COAT 415	0.910	Liquid	Baroid	5 US gal or 55 US gal	Filming amine	Corrosion Inhibitor
COAT 888	1.330	Solid	Baroid	50 lb bag	Oxygen scavenger	Corrosion Inhibitor
CS-2	-	Solid	Halliburton	100 lb keg	Proprietary powder	Spacer
D-115	2.150	Solid	Dowell	50 lb bag	Viscosifier	Viscosifier
D-47	0.996	Liquid	Dowell	55 US gal or 1 US gal can	Organic polymer	Defoamer

CHEMICALS REPORTED IN ARCTIC DRILLING RECORDS 1973 - 1986, cont'd

FLUID	DENSITY (g/mL)	FORM	SUPPLIER	CONTAINER SIZE	DESCRIPTION	PRIMARY USE, SECONDARY USE
D-65	1.580	Solid	Dowell	50 lb bag	Thinner, dispersant	Thinner, Dispersant
D-AIR-1	-	Solid	Haliburton	22.7 kg	Powdered antifoam agent	Defoamer
DEFOAM	1.000	Liquid	Brine-Add Fluids	20 L pail	Acetylinic diol & ethylene glycol in water	Defoamer Surface Active Agent
DEFOAMER	0.895	Liquid	Technifluids	55 US gal drum	Long chain alcohol	Defoamer
DENSIMIX	5.100	Solid	Densimix	100 lb sacks	Micaceous hematite	Weighting Material Corrosion Inhibitor
DESCO	-	Solid	Drilling Specialties	25 lb bag	Organic mud thinner	Deflocculant Thinner, Dispersant
DF-VIS	-	Solid	Technifluids	NA	Organic viscosifier	Viscosifier
DF-VIS HT	-	NA	Technifluids	NA		Viscosifier
DFE-506	-	NA	NA	NA		NA
DIASEAL M	-	Solid	Drilling Specialties	50 lb bag (now 40 lb as 07/86)	Blended lost circulation material	Lost Circulation Material
DIESEL/OIL	0.830	Liquid	Various	Various	Includes motor oil, turbo, and oil	Lubricant
DMO-75	0.859	Liquid	Esso	NA	Diesel mud oil	Base Oil
DRILL AID LC	-	NA	Amoco	NA		NA
DRISPAC	-	Solid	Drilling Specialties	50 lb bag	Polyanoniccellulose	Filtrate Reducer Shale Control, etc.
DRISPAC SL	-	Solid	Drilling Specialities	50 lb bag	Polyanioniccellulose - low viscosifying	Filtrate Reducer Shale Control, etc.
DUAL SPACER	-	Solid	Halliburton	50 lb bag	Proprietary powder blend	Spacer
DURATONE HT	-	Solid	Baroid	50 lb bag	Aminated lignite (organophillic colloid powder)	Filtrate Reducer
DX-10	0.968	Liquid	Technifluids	55 US gal	Drilling detergent	Surface Active Agent Emulsifier, etc.
E Z SPOT	0.950	Liquid	Baroid	15 and 55 US gal	Oil mud concentrate	Lubricant

CHEMICALS REPORTED IN ARCTIC DRILLING RECORDS 1973 - 1986, cont'd

FLUID	DENSITY (g/mL)	FORM	SUPPLIER	CONTAINER SIZE	DESCRIPTION	PRIMARY USE, SECONDARY USE
ENVIROSPOT	0.950	Liquid	Baroid	55 US gal	Oil mud concentrate - mineral base (like E Z SPOT)	Lubricant
ETHYLENE GLYCOL	1.127	Liquid	Various	Various	Recorded as 'Glycol'	NA
EZ MUL	0.900	Liquid	Baroid	55 US gal	Oil soluble sufactant liquid	Emulsifier Surface Active, etc.
FLE SPOT	-	NA	NA	NA		NA
FLR-100	1.590	Solid	Technifluids	25 kg bag	Polymeric fluid loss reducer	Filtrate Reducer Emulsifier, etc.
FLR-100E	-	NA	Technifluids	NA		Filtrate Reducer
FOAM KONTROL	0.837	Liquids	Technifluids	55 US gal	Alcohol blend	Defoamer
FRICTION EASE	1.066	Liquid	Technifluids	55 US gal	Water soluble surfactant - Frontier Res & Chem Co.	Lubricant
GELGUNT	-	NA	NA	NA		NA
GELTONE	-	Solid	Baroid	50 lb bag	Oil mud gelling agent	Viscosifier
GILSONITE	-	Solid	Various	25 kg or 50 lb bag	(SUPER LUBE FLOW, X-PEL-G)	Shale Control Inhibitor
HEMATITE	-	Solid	Various	NA	Iron carbonate	Weighting Material
HEXANOL	0.815	Liquid	Various	Various		NA
HIDENSE	-	Solid	Halliburton	Bulk	Ground hematite	Weighting Material
HIVIS HEC	0.550	Solid	Hercules (Aqualon)	50 lb bag	Hydroxyethylcellulose	Viscosifier Lubricant, etc.
IDFLO	1.400	Solid	IDF	50 lb bag	Starch based polysaccharide (TECHNIFLO)	Filtrate Reducer, Emulsifier
IMCO FYBRE	-	Solid	Imco	40 lb bags	Processed cane fibre	Lost Circulation Material

CHEMICALS REPORTED IN ARCTIC DRILLING RECORDS 1973 - 1986, cont'd

FLUID	DENSITY (g/mL)	FORM	SUPPLIER	CONTAINER SIZE	DESCRIPTION	PRIMARY USE, SECONDARY USE
INLAD 22	-	NA	NA	NA		NA
IVERMUL	0.970	Liquid	Baroid	55 US gal	Emulsifier for oil muds	Emulsifier
JKL	-	NA	NA	Qty = 453.59 kg reported 1975 week 11	NA - Panarctic (Drake I-55, DA 805)	NA
K-91	-	NA	NA	Qty = 4 sacks reported 1976 week 14	NA - Panarctic (Jackson G-16A, DA 841)	NA
KARB	-	NA	NA	Qty = 6 sacks reported 1981 week 12	NA - Panarctic (Skate B-80, DA 973)	NA
KAZ-20	-	NA	NA	Qty = 2 sacks reported 1982 week 12	NA - Panarctic (Whitefish A-26, DA 988)	NA
KELZAN	-	Solid	KelcoRotary	50 lb bag	Xanthum gum - biopolymer	Viscosifier Emulsifier
KELZAN XCD	-	Solid	KelcoRotary	50 lb bag	Water dispersible biopolymer	Viscosifier Emulsifier
KID-97	-	Solid	Technifluids	40 lb bag	Biopolymer - development product (now BIOZAN)	Viscosifier
KWIK-SEAL	-	Solid	Baroid	40 lb bag	Combination lost circulation material	Lost Circulation Material
LIGNITE	-	Solid	Various	25 kg or 50 lb bags	lignite	Thinner, Dispersant Filtrate Reducer, etc.
LO LOSS	1.300	Solid	Milchem, Magcobar	55 US gal or 50 lb bag	Guar gum	Filtrate Reducer
LUBRAGLIDE	1.130	Solid	Technifluids	50 lb bag	Thermo-plastic polymer	Lubricant
MAGCO DEFOAMER A-40	0.497	Liquid	Magcobar	NA	Magco Defoamer A-40	Defoamer
MAGCOCIDE		Solid	Magcobar	50 lb sack	Starch preservative	Bactericide Corrosion Inhibitor

CHEMICALS REPORTED IN ARCTIC DRILLING RECORDS 1973 - 1986, cont'd

FLUID	DENSITY (g/mL)	FORM	SUPPLIER	CONTAINER SIZE	DESCRIPTION	PRIMARY USE, SECONDARY USE
MAGCONOL	0.950	Liquid	Magcobar	18.9 L or 55 US gal	Octanol	Defoamer
METHANOL	0.810	Liquid	Various	Various	Methyl alcohol	NA
MICA	-	Solid	Various	22.7 kg bag	Sized potassium aluminum silicate flakes	Lost Circulation Material
MIL-SOS	1.050	Liquid	Milchem	20 L pail	Hydrolized polyacrylamide	Shale Control Inhibitor Flocculant
MOTOR OIL	0.800	Liquid	Various	Various	Included in 'DIESEL/OIL'	Lubricant
NF 1	0.983	Liquid	Imco	5 US gal pail	Tributylphosphate compound	Defoamer
NICKEL SULPHATE	-	Solid	Various	NA	Nickel sulphate - catalyst for oxygen scavengers	Catalyst
NORMUL	0.963	Liquid	Technifluids	55 US gal	Oil mud emulsifier	Emulsifier Filtrate Reducer
NOXYGEN	-	Solid	Milchem	50 lb bag	Catalyzed sodium sulphite powder	Corrosion Inhibitor
OCTANOL	0.827	Liquid	Various	Various	Capryl alcohol (MAGCONOL)	Defoamer
OIL	0.800	Liquid	Various	Various	Included with 'DIESEL/OIL'	Lubricant
OIL FAZE	-	Solid	Magcobar	50 lb sack	Oil mud basic package	Emulsifier Filtrate Reducer, etc.
PARAFORMALDE-HYDE	-	Solid	Various	50 lb bag	Starch preservative - CURRENTLY PROHIBITED	Bactericide
PELTEX	-	Solid	Various	25 kg or 50 lb bag	Ferrochrome lignosulphate	Thinner, Dispersant, Filtrate Reducer, etc.
PERMAFROST	-	NA	NA			NA
PIPE LAX	0.995	Liquid	Magcobar	55 US gal drum	Surfactant mixed with diesel to free pipe	Surface Active Agent
POLMAR	-	NA	NA	NA		NA

CHEMICALS REPORTED IN ARCTIC DRILLING RECORDS 1973 - 1986, cont'd

FLUID	DENSITY (g/mL)	FORM	SUPPLIER	CONTAINER SIZE	DESCRIPTION	PRIMARY USE, SECONDARY USE
POLY RX	-	Solid	Imco	50 lb bag	High temperture polymer	Filtrate Reducer Shale Control Inhibitor
POTASSIUM CHLORIDE	-	Solid	Various	25 kg or 50 lb bag	Potash - Potassium chloride	Shale Control Inhibitor Freezing Point Depressant
PRE-MIX	-	NA	Technifluids	NA		Viscosifier
PRIMUL	0.924	Liquid	Technifluids	55 US gal	Oil mud emulsifier	Emulsifier Filtrate Reducer
PROTECTO-MAGIC M	-	Solid	Hughes	50 lb sack	Water dispersible asphalt	Shale Control Inhibitor Filtrate Reducer
PULSEM	-	NA	NA	Qty = 14, no units reported 1982 week 13	NA - Panarctic (Whitefish A-26, DA 988)	NA
Q-BROXIN	-	Solid	Baroid	50 lb bag	Chrome free ferrochrome lignosulphonate	Thinner, Dispersant Filtrate Reducer, etc.
RESINEX	-	Solid	Magcobar	50 lb sack	Synthetic resin	Filtrate Reducer Shale Control Inhibitor
S FIL	-	NA	NA	Qty - 226.79 kg reported 1975 week 11	NA - Panarctic (Drake I-55, Da 805)	NA
SAFEGUARD	0.934	Liquid	Technifluids	NA	should be 5000 or 7000?	Corrosion Inhibitor
SALT FREE	-	NA	NA	NA		NA
SAPP	_	Solid	Various	40 kg or 100 lb bag	Sodium acid pyrophosphate	Thinner, Dispersant pH Control, etc.
SAWDUST	-	Solid	Various	25 kg or 50 lb bag	Wood sawdust	Lost Circulation Material
SCALE-BAN	1.100	Solid	Milchem	55 US gal drum	Scale inhibitor	Corrosion Inhibitor
SHALE KONTROL	-	Solid	Technifluids	25 kg bag	Shale stabilizer	Shale Control Inhibitor
SKOT FREE	0.880	Liquid	Baroid	15 US gal	Surfactant mixed with diesel to free pipe	Surface Active Agent

CHEMICALS REPORTED IN ARCTIC DRILLING RECORDS 1973 - 1986, cont'd

FLUID	DENSITY (g/mL)	FORM	SUPPLIER	CONTAINER SIZE	DESCRIPTION	PRIMARY USE, SECONDARY USE
SODIUM BICARBONATE	-	Solid	Various	100 lb bag	$NaHCO_3$ - Sodium Bicarbonate	Calcium Remover pH Control
SODIUM CARBONATE	-	Solid	Various	100 lb bag	Soda ash - $Na(CO_3)_2$	Calcium Remover pH Control
SODIUM CHLORIDE	-	Solid	Various	25 kg or 50 lb bags	Salt, NaCl	Weighting Material Shale Control, etc.
SODIUM CITRATE	-	Solid	Various	40 kg or 100 lb bags	Sodium citrate	NA
SODIUM HYDROXIDE	-	Solid	Various	50 lb	Sodium hydroxide - caustic soda	pH Control Bactericide
SOLTEX	-	Solid	Drilling Specialties	50 lb	Sodium asphalt sulphonate	Lubricant Emulsifier, etc.
SPERSENE	-	Solid	Magcobar	50 lb	Chrome lignosulphate	Thinner, Dispersant Filtrate Reducer
SPUD MUD R	-	Solid	Technifluids	25 kg	Polymeric viscosifier (SPUD MUD R)	Viscosifier
SRL	-	NA	NA	Qty = 1095.88 kg reported 1975 week 11	NA - Panarctic (Drake I-55, DA 805)	NA
SS-100	1.038	Liquid	Technifluids	20 L	Shale encapsulator	Shale Control Inhibitor
SST 202	-	Solid	Milchem	50 lb	Organoaluminum complex	Shale Control Inhibitor
STAFLO	-	NA	National Mud Control	NA		Filtrate Reducer
STAFLO X-LO	-	NA	National Mud Control	NA		Filtrate Reducer
SURFLO H35	1.350	Liquid	Baroid	5 and 55 US gal	Anionic phosphate liquid scale inhibitor	Surface Active Agent Corrosion Inhibitor
SURFLO W300	0.880	Liquid	Baroid	5 and 55 US gal	Surface active defoamer	Defoamer
TECHNIFLO	1.400	Solid	Technifluids	NA	See IDFLO	Filtrate Reducer

CHEMICALS REPORTED IN ARCTIC DRILLING RECORDS 1973 - 1986, cont'd

FLUID	DENSITY (g/mL)	FORM	SUPPLIER	CONTAINER SIZE	DESCRIPTION	PRIMARY USE, SECONDARY USE
TECHNIKOTE	0.832	Liquid	Technifluids	55 US gal	Technikote P? - Atmospheric Corrosion Inhibitor	Corrosion Inhibitor
TECHNIMUL	0.931	Liquid	Technifluids	55 US gal	Low toxicity oil mud emulsifier	Emulsifier Filtrate Reducer
TECHNIREG	-	NA	Technifluids	NA		NA
TECHNISPERSE	-	NA	Technifluids	NA		Thinner, Dispersant
TECHNISURF	0.930	Liquid	Technifluids	55 US gal	Oil mud wetting agent	Surface Active Agent Thinner, Dispersant
TECHNITROL	-	Solid	Technifluids	50 lb	Oil mud fluid loss reducer	Filtrate Reducer
TECHNIVIS	-	Solid	Technifluids	50 lb	Oil mud viscosifier	Viscosifier
TEXAMOL	-	NA	NA			NA
TORQ-TRIM	0.880	Liquid	Baroid	55 US gal	Biodegradable blend of triglycerides and alcohols	Lubricant
TORQUELESS	-	Solid	Various	Various	Glass beads - TORQUELESS GLASS BEADS	Lubricant
TUFLU	-	NA	NA	NA		NA
TURBO	0.800	Liquid	Various	55 US gal	Turbo JP1 fuel - included with 'DIESEL/OIL'	Lubricant
UNI-CAL	-	Solid	Milchem	50 lb bag	Chrom lignosulphate	Thinner, Dispersant Filtrate Reducer, etc.
VALUE 100	-	Liquid	NA	NA	Industrial detergent	Rig Wash
VIS 90	-	NA	NA	NA		NA
VISTA ODC	0.805	Liquid	Esso		Base oil for oil base mud	Oil Base Muds
WALNUT HULLS	-	Solid	Various	25 kg	Ground walnut hulls	Lost Circulation Material
X-38	-	Solid	Macgobar			Weighting Material
ZEOGEL	-	Solid	Baroid	50 lb	Attapulgite powder	Viscosifier Lost Circulation Material

APPENDIX B.

LIST OF DRILLING MUD ACTIVITIES APPROVED BY DIAND (1989) FOR USE IN THE CANADIAN ARCTIC OFFSHORE

LIST OF DRILLING MUD ADDITIVIES APPROVED BY DIAND (1989) FOR USE IN THE CANADIAN ARCTIC OFFSHORE

PRODUCT	SEE ALSO	DESCRIPTION	USE	LC_{50} (ppm)	SUPPLIER
Ada Foam BR-1	Alcohol ether sulphate	Alcohol ether sulphate	Air foaming agent	1 050	Walco
Alcohol ether sulphate	Ada Foam	Alcohol ether sulphate	Air foaming agent	1 050	Walco
Aluminum stearate		Aluminum stearate	Defoamer	1 100	All
Aluminum sulphate		Aluminum sulphate	Corrosion inhibitor	23 000	Most
AP-21		Sodium polyacrylate	Fluid loss, HT dispersant	3 100	Technifluids
AP-21 L	DFLC	Low molecular weight polycarboxylate	Fluid loss, HT dispersant	3 100	Technifluids
Aquatreat DN30	Surflo B466	Sodium/bithiocarbonate methanol	Biocide	22	Baroid
ASP 700	PHPA, SS-100	30% Hydrolized polyacrylamide	Encapsulator	425	Welco
Attapulgite	Zeogel	Salt water gel	Viscosifier	23 500	Baroid
Baravis		Hydroxyethyl Cellulose (MOD)	Viscosifier	2 900	Baroid
Bardac 2250		Ammonium Chloride (MOD)	Biocide	1	Technifluids
Barite		Mineral $BaSO_4$	Weighting agent	100 000	Most
Bentonite	Montmorillonite gel. clay	Sodium montmorillonite	Viscosifier, fluid loss	10 000	Most
Bicarbonate of Soda	Sodium bicarbonate	Sodium bicarbonate	Calcium treatment	7 500	All
Biotrol		Glutaraldehyde	Biocide	1.5	Magcobar
B-Free		Surfactant Blend	Lubricant	7	Technifluids
B-Free heavy wate		Non-ionic surfactant	Lubricant	6	Technifluids
Calcium bromide		Calcium bromite	Completion fluid	9 000	Most
Calcium carbonate	Technikal	Calcium carbonate	Completion fluid	46 000	All
Calcium chloride		Calcium chloride	Freeze depressant	8 000	Most
Capryl Alcohol		Alcohol	Defoamer	83	Most
Carbonox		Processed Lignite	Dispersant	7 500	Baroid

LIST OF DRILLING MUD ADDITIVIES APPROVED BY DIAND (1989) FOR USE IN THE CANADIAN ARCTIC OFFSHORE, cont'd

PRODUCT	SEE ALSO	DESCRIPTION	USE	LC_{50} (ppm)	SUPPLIER
Catalyzed sodium sulphite	Sodium sulphite	Sodium sulphite	Corrosion inhibitor	8 500	Most
Caustic soda		Sodium hydroxide	pH Control	105	All
Cellophane	Jelflake	Cellophane flakes	Prevents lost circulation		Baroid
Chrome alum		Chromic chloride ($CrCl_3$)	XC Polymer system	730	Magcobar additive
Chrome lignite		Ferrochrome lignosulphonate	Dispersant, fluid loss	1 750	Magcobar
Clay	Bentonite, montmorillonite gel	Sodium montmorillonite	Viscosity, fluid loss	10 000	Most
CMC		Sodium carboxymethyl cellulose	Fluid loss control	2 300	All
CMC lo-vis		Sodium carboxymethyl cellulose	Fluid loss control	5 500	All
Coat 110		Oil soluble/water insoluble	Corrosion inhibitor	175	Baroid
Coat 129			0_2 Scavenger	4 400	Baroid
Coat 415		Filming amine	Corrosion inhibitor	5	Baroid
Coat 888		Sodium Sulphide	0_2 Scavenger	7 000	Baroid
Dacolite	Tannithan	Lignite	Dispersant	6 500	Magcobar
Defoamer	IDF defoamer, D-foam	Long chain alcohol	Foam reduction	1 300	Techni-fluids
Densimix		Hematite Fe_20_3	Weighting agent	100 000	Densimix
Desco		Organic quebracho extract	Thinner	105	Most
DFLC	AP21L	Lo weight sodium polyacrylate	Polymer deflocculant	3 100	Welchem
Dowell U66	EGMBE	Ethyl glycol n-butyl ether	Completion fluid	913	DOW
Drillaid 405		Surfacant blend	Lubricant	41	Most
Drispac		Polyanionic cellulosic polymer	Fluid loss, viscosifier	2 750	Most
Drispac super-lo		Polyanionic cellulosic polymer	Fluid loss control	10 000	Most
DX-10		Detergent	Detergent	320	Technifluids

LIST OF DRILLING MUD ADDITIVIES APPROVED BY DIAND (1989) FOR USE IN THE CANADIAN ARCTIC OFFSHORE, cont'd

PRODUCT	SEE ALSO	DESCRIPTION	USE	LC_{50} (ppm)	SUPPLIER
D-foam	Defoamer, IDF defoamer	Long chain alcohol	Foam reduction	1 300	Technifluids
D.F. Vis		Polysaccharide	Viscosifier,fluid loss	1 000	Technifluids
EGMBE	Dowell U66	Ethyl glycol n-butyl ether	Completion fluid	913	Most
Escaid 90		Low aromatic oil	Pipe-freeing agent	100 000	Esso
Ethylene glycol		Ethylene glycol	Spotting pill	42 000	Most
EZ-spot		Fatty acids/sulphonate/ asphalt	Lubricant	900	Baroid
Fibre tex		Sugar cane fibres	Prevents lost circulation		Baroid
FLR-100		Carboxymethyl cellulose	Fluid loss control	3 200	Technifluids
Foam kontrol		Surface-active defoamer	Defoamer	550	Technifluids
Friction ease		Water soluble surfactant	Lubricant	42 000	Magcobar
Gilsonite	X-pel G	Gilsonite	Shale inhibitor	10 000	Most
ID Kontrol		Low molecular weight polyacrylate	Foam reduction	1 300	Technifluids
IDF Defoamer	D-foam, defoamer	Long chain alochol	Foam reduction	1 300	Technifluids
IDF Thin	Peltex, Technisperse	Modified lignosulphonate	Dispersant, fluid loss	1 750	Technfluids
IDFLO	Techniflo	Starch based poly-saccharide	Fluid loss control	35 000	Technifluids
IMCO Fybre		IMCO Fybre	Fluid loss control		Imco
Jelflake	Cellophane	Cellophane flakes	Lost circulation		Baroid
KID97		Biopolymer	Viscosifier	15 000	Technifluids
K_2CO_3 Shamrock	Potassium carbonate	Potassium carbonate	pH control	60	Diamond
KCl	Potash	Potassium chloride	Shale inhibitor	2 750	Most
Kelzan	XC polymer	Xanthum gum	Viscosifier, fluid loss	1 900	Most
Kelzan XCD	New spud mud	Organic polysaccharide	Viscosifier	10 000	Most
Kwik seal		Wood fibre/cellophane	Prevents lost circulation	21 000	Most
Kwikspot		Non-hydrocarbon additive	Lubricant	6 100	Imco

APPENDIX B, cont'd

LIST OF DRILLING MUD ADDITIVIES APPROVED BY DIAND (1989)
FOR USE IN THE CANADIAN ARCTIC OFFSHORE, cont'd

PRODUCT	SEE ALSO	DESCRIPTION	USE	LC_{50} (ppm)	SUPPLIER
LD-8		Surfactant blend	Non-hydrocarbon defoamer	670	Milchem
Lime		Calcium hydroxide	pH control	50	Most
Lubraglide		Teflon Beads	Lubricant	10 000	Technifluids
Magconol		2-ethyl hexanol	Foam reduction	30	Magcobar
Mica		Potassium aluminum silicate	Prevents lost circulation	100 000	Most
Montmorillonite	Bentonite, clay	Sodium montmorillonite	Viscosifier, fluid loss	10 000	Most
Mud acid		Acid	Completion fluid	3 230	Most
Mudmaster 289L		Non hydrocarbon prop. mix	Lubricant	1 260	Diamond Shamroc
Myacide AS		Bromo nitro propane diol	Biocide	20	
Na_2CrO_4-H_3O	Sodium bichromate	Sodium bichromate	Corrosion inhibitor	100	Baroid
New spud mud	Kelzan XCD	Organic polysaccharide	Viscosifier	10 000	Most
Nickel sulphate		Nickel sulphate	Catalyst for coat 888	800	Baroid
N'oxygen		Sodium sulphite	Corrosion inhibitor	13 000	Milchem
Nut plug	Walnut hulls	Walnut shells	Prevents lost circulation	800	Magcobar
Oil-faze		Fatty acid emilsifier	Lubricant	2 000	Magcobar
Paraformaldehyde		Paraformaldehyde	Biocide/Corrosion Inhibitor	60	All
Peltex	IDF Thin. Technisperse	Modified Lignosulphonate	Dispersant, Fluid Loss	1 700	Most
PHPA	SS-100.ASP 700	30% Hydrolized Polyacrylamide	Encapsulator	425	Nelco
Pipe Lax		Oxoline/Grease (Naptha Base)	Lubricant	1 700	Magcobar
Poly RX		Synergistic Polymer Blend	High Temp Dispersant	4 560	Imco
Potash	KCl	Potassium Chloride	Shale Inhibitor	2 750	Most
Potassium Carbonate	K_2CO_3	Potassium Carbonate	pH Control	60	Diamond Shamroc
Q-Broxin		Modified Lignosulphonate	Dispersant, Fluid Loss	8 800	Baroid
Resinex		Blended Product	High Temp Dispersant	3 700	Magcobar
Safeguard 5000		Amine Based Corrosion Inhibitor	Corrosion Inhibitor	120	Technifluids

**LIST OF DRILLING MUD ADDITIVIES APPROVED BY DIAND (1989)
FOR USE IN THE CANADIAN ARCTIC OFFSHORE, cont'd**

PRODUCT	SEE ALSO	DESCRIPTION	USE	LC_{50} (ppm)	SUPPLIER
Safeguard 6500	Techniguard 6500	Amine Based Corrosion Inhibitor	Corrosion Inhibitor	288	Technifluids
Safeguard 7000		Amine Based Corrosion Inhibitor	Corrosion Inhibitor	120	Technifluids
Salt	Sodium Chloride	Sodium Chloride	Freeze Depressant	11 250	Most
SAPP		Sodium Acid Pyrophosphate	Dispersant-cement Contam.	870	All
Sawdust		Wood Fibre	Prevents Lost Circulation		All
Scale-Ban		Scale Inhibitor	Corrosion Control	55 000	Milchem
Shale Kontrol		Organo-Aluminum Complex	Corrosion Control	10 000	Technifluids
Skot-Free		Surfactant Blend	Lubricant	14	Baroid
SMR	Spud Mud R	Hydroxyethyl Cellulose	Viscosifier	2 900	Technifluids
Soda Ash		Sodium Carbonate	Calcium Treatment	75	All
Sodium Bicarbonate	Bicarbonate of Soda	Sodium Bicarbonate	Calcium Treatment	7 500	All
Sodium Bichromate	$N_2CrO_4 \cdot H_2O$	Sodium Bichromate	Corrosion Inhibitor	100	Bariod
Sodium Chloride	Salt	Sodium Chloride	Freeze Depressant	11 250	Most
Sodium Nitrate		Sodium Nitrate	Tracer in Logging	7 600	Most
Sodium Sulphite	Catalyzed Sodium Sulphite	Sodium Sulphite	Corrosion Inhibitor	8 500	Most
Soltex		Sodium Asphalt Sulphonate	Mud Conditioner	230	Most
Spersene		Modified Lignosulphonate	Dispersant, Fluid Loss	3 750	Magcobar
Spud MUD-R	SMR	Hydroxyethyl Cellulose	Viscosifier	2 900	Technifluids
SST-202		Organo-Aluminum Complex	Shale Inhibition	12 857	Milchem
SS-100	PHPA, ASP 700	Hydrolized Polyacrylamide	Shale Inhibition	425	Technifluids
Staflo		Polyanionic Cellulosic Polymer	Fluid Loss Control	4 200	Most
Staflo Ex-lo		Polyanionic Cellulosic Polymer	Fluid Loss, Viscosifier	2 400	Most
Stratawool		Fiberous Wool	Fluid Loss Control	263 000	Rockwool
Surflo B466	Aquatreat DN-30	Sodium/Bithiocarbonate Methanol	Biocide	22	Baroid
Surflo H35		Anionic Phosponate Liquid	Scale Inhibition	1 200	Baroid

LIST OF DRILLING MUD ADDITIVIES APPROVED BY DIAND (1989) FOR USE IN THE CANADIAN ARCTIC OFFSHORE, cont'd

PRODUCT	SEE ALSO	DESCRIPTION	USE	LC_{50} (ppm)	SUPPLIER
Surflo W-300		Surface-Active Liquid Defoamer	Foam Reduction	50	Baroid
Tannithan	Dacolite	Lignite	Dispersant	6 500	Magcobar
Technibeads		Teflon Beads	Lubricant		Technifluids
Techniflo	Idflo	Starch Based Polysaccharide	Fluid Loss Control	35 000	Technifluids
Techniguard 6000		Surfactant/cationic Amine Blend	Corrosion Inhibitor	750	Technifluids
Techniguard 6500		Surfactant/cationic Amine Blend	Corrosion Inhibitor	288	Technifluids
Technikal	Calcium Carbonate	Calcium Carbonate	Completion Fluid	46 000	Technifluids
Technisperse	Peltex, IDF Thin	Modified Lignosulphonate	Dispersant, Fluid Loss	1 700	Technifluids
TEK MUD 1950		Non Hydrocarbon Additive	Lubricant	21 300	Exxon
Torq Trim	TOR-IDF, Torq-Kontrol	Vegetable oil, isoproponol	Lubricant	160	Baroid
Torq Trim II		Vegetable oil, isoproponol	Lubricant	1 000	Baroid
Torqueless Glass Beads		Glass	Lubricant		Milchem
Torq-Kontrol	Torq Trim, TOR-IDF	Vegetable oil, isoproponol	Lubricant	160	Baroid
TOR-IDF	Torq Trim-Torq-Kontrol	Vegetable oil, isoproponol	Lubricant	160	Baroid
Ultraglide 100		Glycol	B.O.P. Fluid	500	
Unical		Chrome Lignosulphonate	Dispersant	860	Milchem
Value-100		Industrial Cleaner	Rig Wash	860	Michem
--Nfibre		Cellulose Derivative	Prevents Lost Circulation	13 500	
Walnut Hulls	Nut Plug	Walnut Shells	Prevents Lost Circulation	800	Magcobar
Wellchem Spa		Sodium Polyacrylate	Fluid Loss Reducer	19 400	
XC Polymer	Kelzan	Xanthum Gum	Viscosifier, Fluid Loss	1 900	Most
X-Pel G	Gilsonite	Gilsonite	Shale Inhibitor	10 000	Most
Zeogel	Attapulgite	Salt Water Gel	Viscosifier	23 500	Baroid
Zinc Bromide/$CaBr_2$ Blend		Zinc Bromide/Calcium Bromide	Completion Fluid	1 200	Chromalloy
Zinc Carbonate		Zinc Carbonate	H_2S Scavenger	200	All

APPENDIX C.

USE OF WELL HISTORY DATA FOR STATISTICAL ANALYSES

USE OF WELL HISTORY DATA FOR STATISTICAL ANALYSES

(Note: References cited in this Appendix are listed in Reference Section of Report)

SUMMARY

Statistics may be employed either to describe data, as an aid to the interpretation of data or as a predictive tool. It has previously been suggested that statistical analyses be applied to historical drilling chemicals data as a predictive tool (c.f. prediction of the quantity of chemicals discharged -- Schneider 1983). In the following sections, we examine the nature of the compiled data and demonstrate that predictive statistical methods are not valid because of the nature of the Arctic drilling activity. Other concerns with respect to the data and data quality also limit the use of inferential statistics (hypothesis testing). It is recommended that nonparametric statistical methods be used in preference to standard methods. Standard methods should only be used for descriptive purposes (e.g., means and standard deviations). In preparing the following sections, a deliberate effort has been made to keep the discussion simple and suitable for readers with limited background in statistical methods. A thorough treatment of elementary statistics is beyond the scope of this report.

C.1 Data Potentially Suitable for Analysis

Fundamentally, the rationale for performing statistical analyses is to extract information from the reported drilling chemical data for use in making inferences about drilling activity in the Arctic offshore. An example of this would be estimation of the frequency of marine disposal of a contaminant from a proposed drilling activity. To achieve this objective, various inferential procedures must be examined to identify the best predictor or combination of procedures to apply to the data in hand. Even more important, information should be provided concerning the goodness of the inferential procedure. When we predict, we would like to know something about the error in our prediction. If we make a decision on the basis of our inferences, we want to know the chance that our decision is correct.

Confidence in our conclusions will be greater if we perceive a pattern in a large set of data. Therefore it is desireable to have a large number of observations to analyse statistically. However, it is important not to include observations which are not consistent with the rest of the data (i.e., are not representative, are incorrect or incomplete, or are influenced by factors which do not affect the most of the data). If such data are included in the analyses, then they will tend to obscure or distort the pattern we wish to examine and will reduce our confidence in any conclusions we formulate. It is therefore important to examine the data critically and to reject data that are unsuitable for analysis.

The data included in the database represent 151 drilling sessions (i.e., from spud to release) at 109 wells. Of these, 82 sessions occurred after 1979 (data prior to 1980 were judged to be not reliable). Three of these 82 sessions were reported for 1986 and are incomplete; 5 of the remaining 79 sessions were compiled from Well History Reports; 5 of the remaining 74 sessions included records of drilling chemical inventory adjustments which could not be reliably distinguished from other records; an additional 2 sessions were missing one or more Tour Sheets; 2 more included records of mixing of chemicals that were subsequently not used; and lastly, three sessions represent special cases such as oil-base muds, flaring and land disposal. Therefore, 20 of the 82 potentially reliable sessions should also be excluded from analysis, leaving 62 potentially useful well records.

C.2 Selection of Standard or Nonparametric Methods

At this point, we can now address the selection of the most suitable methods of statistical analysis (i.e., which methods are valid and also which of the valid methods are likely to yield the greatest confidence in the conclusions of the analysis). Specifically, we want to know if we can apply standard methods (parametric statistics) or whether we must apply nonparametric methods. Nonparametric methods do not require any assumptions concerning the probability distribution of the data. However, standard methods would be preferred because they are more powerful (defined as: providing a lower probability of failing to reject the null hypothesis when it is false) (Mendenhal, 1979). Standard methods are based on probabilistic mathematical models; that is, they contain one or more random elements with specified probability distributions. Use of standard methods requires that the data conform reasonably to (or can be transformed to approximate) these specified probability distributions. Some methods are more sensitive to data deviating from the required distribution. For example, the Student's t and z statistics are robust (insensitive) to moderate departures from a normal distribution; the chi-square and F statistics (which is employed in regression analysis and ANOVA) are sensitive to departures from normality. Standard methods can also require additional assumption; e.g., regression analysis requires that the independent variable(s) be measured without error and also that the expected value of the random error be equal to zero. It is critical to note that if the assumptions underlying the use of standard methods are violated then the error probabilities for our tests and the confidence estimates will not be meaningful. As a consequence, we would not be able to determine if our conclusions were correct.

In a practical situation, one can never truly know the probability distribution of the population (i.e., the data) under investigation and therefore, whether the assumptions underlying the use of standard methods have been satisfied. This difficulty can be circumvented by the use of nonparametric procedures.

With respect to the drilling chemicals data, it is apparent that the drilling chemical use in any year (i.e., the drilling activity) is influenced by the previous year's drilling activity. Data from different years, therefore, cannot be considered to be independent observations. Furthermore, we are aware that the tour sheet records do not accurately reflect the actual chemicals usage. We therefore conclude that the assumptions underlying regression analysis are not valid, and that regression analysis should not be performed on these data as a predictive method. As a descriptive tool, simple histograms are to be preferred because plots of regression lines might easily be misinterpreted as having predictive value.

Other concerns regarding the potentially suitable data are:

1. There are not enough data to examine the effect of the three regions on the pattern of chemicals reported. In the case of the Davis Strait region, there are only two observations in total, and only one potentially suitable observation, Hejka 0-71 (D.A. #937).

2. In the case of the Arctic Islands, there is only one operator (Panarctic) after 1979 and essentially only one operator if the scope were expanded to include all drilling in the region (one additional well by Sunoco in 1973). Therefore we would be unable to differentiate the influence of the operator from the influence of the region on the pattern of chemicals reported.

   Therefore, only the Beaufort Sea data should be used for inferential statistics. This leaves 41 of the 62 potentially suitable drilling sessions: 24 Dome/Canmar, 10 Gulf/Beaudril and 7 Esso.

3. The remaining potentially suitable drilling sessions are primarily records of Dome/Canmar wells. Therefore any analysis will be biased unless care is taken in dealing with the unequal number of observations for each operator. This inequality will also decrease the power of statistical analyses (i.e., there will be less confidence in the results).

4. The 41 potentially suitable Beaufort Sea wells are of different depths and status. Some wells are dry and abandoned, others are suspended. Of the 24 dome/Canmar wells, 14 are records of suspended wells, 10 are records of abandoned wells. It would be necessary to take these factors into consideration when testing hypotheses with the effect of further reduction in confidence in the results.

It is apparent that standard statistical methods are not valid for the historical drilling chemical data unless most of the data are excluded from analysis. There would then be limited confidence in the results of the analysis.

Nonparametric methods are therefore required. However, even if nonparametric methods are used, it is apparent that much of the data should still be excluded. The following section examines an alternative approach which is not based on statistical analysis of these data.

C.3 Deterministic Modelling

Deterministic models are mathematical models which make no allowance for error (e.g., random error). Deterministic models are useful when the error of prediction is negligible for practical purposes and may also be useful when statistical methods cannot produce reliable results. Deterministic models are based on an understanding of the factors influencing the parameter predicted. Statistical models are developed by inference from the available data. Deterministic models are currently used by industry to estimate chemical use at proposed wells.

In the case of drilling activity, the nature and quantities of chemicals used in any particular well are chosen on the basis of available seismic and stratigraphic data on the formation being drilled, previous experience drilling in similar formations and in the area, and the specific objectives of the well. Chemical use at a proposed well is always estimated by the operator prior to any drilling for planning purposes and particularly to estimate costs. The operators attempt to make these estimates as accurate as possible. However, deviations from the operators' estimates frequently occur.

Reasons for such deviations include: (1) the best available seismic and stratigraphic information may be inaccurate; (2) over-pressure zones may be encountered down hole; (3) the chemistry of the formation drilled may cause corrosion problems or foaming; (4) fluids may be lost down hole and require the use of lost circulation materials; (5) the bit, stem or casing may become stuck and require lubricants; and (6) ice may encroach on the site and force early release of the well.

Despite any deviations from estimated chemical use, it must be expected that the accuracy of the operators' estimates will improve as more and better seismic and stratigraphic information becomes available; as instrumentation used to sense conditions down hole and to control the drilling improves; and, as operators gain additional experience in the region.

This study has not examined the accuracy of industry predictions in detail. Milburn and Evans (1986) and Evans and Milburn (1985) present comparisons between chemical use reported in well histories and quantities of chemicals approved for use at the wells. While their data have not been standardised for nomenclature or units, it is nonetheless apparent that the operators' estimates are correct to order of magnitude and frequently much better than this. It is unlikely that a probabilistic model would provide predictions as good as the industry estimates.

Inferential (nonparametric) statistics may be used to aid in refinement of deterministic models by identifying factors which should be included in the model. Standard statistical methods may also be employed to evaluate the expected error in models used by operators. Both of the approaches have merit, but are beyond the scope of this study. It is recommended that the feasibility of these approaches be investigated.

APPENDIX D.

USER'S MANUAL FOR THE CANADIAN ARCTIC DRILL WASTES DATABASE

ESL-00394

USER'S MANUAL FOR THE CANADIAN ARCTIC DRILL WASTES DATABASE

Version 2.0

Prepared by:

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For:

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1.0 INTRODUCTION

Information on current and historical offshore drilling activity is required for environmental management, regulatory decision-making and interpreting monitoring and research results. To facilitate access to the required information relating to offshore hydrocarbon exploration drilling in the Canadian Arctic, a microcomputer database and access software was developed incorporating information on individual wells and the drilling chemicals associated with each well. Information was compiled from two sources - tour sheets and well history reports - both submitted by industry to regulatory agencies and entered into the database. Program software can be obtained by contacting the Department of Fisheries and Oceans, Institute of Ocean Sciences (Sidney) and Indian and Northern Affairs Canada (Yellowknife).

The tour sheet information summarizes daily records of handling of chemicals at each well site, including:

- records of chemicals which were not discharged to marine waters;
- records of chemicals mixed on site or bulked into hoppers but not circulated down the well;
- records of chemicals not used as drilling constituents (e.g., rigwash); and
- records pertaining to special circumstances such as shallow water flow events, use of diesel and low-toxicity oil-base muds, and special muds utilized prior to suspension of wells at the end of the open-water season.

The well history information compiles records from annual reports prepared by industry to detail quantities of drilling chemicals circulated down the well. To examine the quantities of drilling fluids used at a specific location, the well history information is more reliable than that of the tour sheets. A disclaimer appears on starting the program discussing limitations of use of the data.

A menu-driven search/output program (**Drilwast.Com**) was developed by ESL Environmental Sciences Limited to access the well and fluid information. The search utility provides search/retrieval capabilities, simple statistical summaries of fluid data, and output of information. The software will allow data to be displayed in four formats: on-screen, in printed reports, plotted maps of the data points, or in text files of fluid information suitable for importing by Statgraphics or other statistical or spreadsheet software.

A separate program (**Edit.Com**) allows new information to be appended to the database and existing information to be edited. In this way, copies of the data and the search utility can be distributed but the integrity of the data can be ensured by restricting the task of updating to one location.

The software creates separate files containing the results of each search. The results of two different searches can be compared or combined. This feature allows complex searches to be conducted for various types of information. Expected uses of the program include:

1. Information on a specific well can be obtained on the basis of the drilling authority (D.A.) number, well I.D. or by name.

2. Information on wells possessing common characteristics, such as, operator, contractor, rig type, well depth and volume, and well status can be examined.

3. Spatial and temporal patterns in fluid use, drilling activity, types of wells or other aspects of the data may be examined.

4. Statistical analyses can be performed on drilling fluid data by "exporting" search results for use with common statistical or spreadsheet software.

It is expected that users of the Drill Wastes software will have a general understanding of terms common to oil and gas drilling, such as, tour sheet, well history, drilling fluid, operator and rig.

The Drill Wastes software is designed to run on any IBM PC (or 100% compatible) personal computer equipped with a hard disk storage system, colour graphics adapter (CGA), an Epson (or compatible) printer and a Hewlett Packard (or compatible) plotter. Note that neither a plotter or printer is required to run the program.

2.0 INSTALLATION AND START-UP

2.1 Installing the Drill Wastes Software

1. Place the **Drill Wastes Installation Disk** into drive A:.

2. Type **A:Install C:<Return>** where C: is the name of the hard disk where the Drill Wastes software is to be installed.

Installing Drill Wastes software creates a **\Drilwast** directory with **\Tour** and **\Well** subdirectories "below" it on the hard drive. All of the necessary files are copied into their appropriate directories.

2.2 Installing Base Map Files

The Drill Wastes software produces maps either by plotting only the data points on top of prepared base maps or by plotting both the data points and coastline.

Plotting of both the data points and coastline requires that the Northern Canada map base is installed on the hard disk. The Northern Canada map base occupies 8 MB of hard disk memory. To install the Northern Canada map base:

1. Log onto the root directory of your hard disk by typing:

   C:<Return> (where "C" designates your hard drive)
   CD \<Return>

2. Place the Northern Canada Backup Disk 1 in floppy drive A:
   Then use DOS's RESTORE utility to place the map base on your hard drive by typing:

   RESTORE A: C: /S<Return>

   (It is assumed that the RESTORE utility is on the DOS PATH. Consult your DOS manual for additional instructions.)

3. Replace the Backup Disk in drive A: with subsequent Backup Disks when prompted to by the RESTORE utility.

   A subdirectory, **\Canada**, is created on the hard drive containing the map data files.

2.3 Starting the Drill Wastes Search Utility

1. After the Drill Wastes Software is installed on the hard drive, move into the Referrals directory by typing:

   C:<**Return**> (Where C: is the letter designating the hard drive where the Drill Wastes software is installed.)

   Then type **CD \Drilwast**<**Return**> to move into the \Drilwast subdirectory.

2. Type **Halortp4**<**Return**> to load the graphics device driver.

3. If you intend to use the plotter, you must use DOS's MODE utility to configure your system correctly to communicate with your plotter. Consult your DOS manual and the plotter manual for additional details.

4. Type **Drilwast**<**Return**> to start the program.

After starting the Drill Wastes Search Utility the Main Menu is displayed on the screen. Note: See Section 5.0 for information on starting the editor utility, **Edit.Com**.

3.0 THE DRILL WASTES SEARCH UTILITY

The Main Menu of the search utility presents the eight options detailed below. To select one of the options type the number listed beside the menu option, then press <Return>.

The Main Menu

```
Northern Drilling Wastes Search Utility
Tour Sheet Data

1. Search the Database
2. Compare Search Files
3. Display Search Files
4. Print Search Files
5. Plot Search Files
6. Output Statistical Files
7. Delete Old Search Files
8. Select Well History or Tour Data

Enter Choice -

Esc to quit
```

3.1 Select Well History or Tour Data

The Drill Wastes software accesses either of two sets of data:

Tour Sheet Information - Compiled from the tour sheets detailing the handling of chemicals at each well site. These data are required from industry by COGLA.

Well History Information - Compiled from the well history reports detailing the total quantities of fluids used at each well. Well history data are also required by COGLA from the well operators.

This option is a "toggle" feature that allows you to select either the Well History Information or the Tour Sheet Information. The software defaults to use of the Well History Information. When <**8**> is first selected the software accesses the Tour Sheet Information. Pressing <**8**> again returns to the Well History Information. The name of the current database appears under the title "Northern Drilling Wastes Search Utility".

3.2 Search the Database

To choose this option;

1. Type 1 and press <**Return**>.

2. Specify appropriate search criteria (as listed below in the Search Menu, and detailed in Section 4.0) (by typing the corresponding number and pressing <Return>) in response to the prompts on-screen.

3. Type a file name to store the search results (file names may be up to 8 characters long; may be any valid DOS file name; and must NOT include an extension - see your DOS manual for additional details).

It is recommended that you choose a file name that is associated with the search criteria. For example, if you are interested in D.A. number 1058, an appropriate file name would be DA1058. If an existing file name is entered, a prompt appears asking you if the file should be replaced. Care should be taken at this point because answering <**Y**>es overwrites all data in the previous file.

When a search is complete, the number of "matches" found during the search is displayed and the program returns to the Search Menu. To exit the Search Menu and to return to the Main Menu, press the <**Esc**> key.

The Search Menu

Northern Drilling Wastes Search Utility

1. LC-50s
2. D.A. Number
3. Well Name
4. Well ID
5. Well Status
6. Contractor
7. Operator
8. Years of Operation
9. Months of Operation
10. Rig Name
11. Rig Type
12. Area
13. Latitude/Longitude Box
14. Spud Dates
15. Release Dates
16. Hole Size
17. Hole Depth
18. Hole Volume
19. Water Depth
20. Total Depth
21. Fluids

Enter Choice -

Esc to quit

3.3 Compare Search Files

When "Compare Search Files" is selected, the screen lists the names of previously saved search result files. Select one of these search files as the first file to be compared. Then select the second file to be compared. By typing 2 and pressing <Return>, you can compare two files of search results.

Comparison searches are easy to understand and permit complex searches. There are only three types: "AND", "OR", and "NOT" comparisons. Each comparison creates a new search file containing the results of the comparison. The "AND" search selects all records which appear in **both** file one AND file two. The "OR" search selects all records in **either** file one OR file two (i.e., the two files are combined). The "NOT" search will select any records which appear in file one **but do not appear** in the file two.

A menu is then displayed presenting the three comparison options (AND, OR and NOT). Select one of the options by typing the corresponding menu number.

A third screen requests a new filename to store the results of the comparison search.

Comparison Search Screen 1

Enter first file name -

1001 1015

Esc to Quit

Comparison Search Screen 3

Enter Choice - 2
File One - 1- 1001
File Two - 1015

1. Search for what is in File One AND File Two
2. Search for what is in File One OR File Two
3. Search for what is in File One but NOT File Two

Enter Choice -

Esc to Quit

Comparison Search Screen 4

Enter Choice - 2

1020

1001 AND 1015

Records found - 3

Comparison Completed

Esc to quit

3.4 Display Search Files

This Main Menu option (type 3 and press <Return>) allows you to view information in the database. Note that to view information in the database, you must first execute a search. When this option is selected a list of the current search files is presented, from which you select the file to be viewed.

Each record (i.e., information for a single drilling authority number) consists of three or more "pages" (screens) of information (see below). The Drilling Authority (D.A.) number is displayed at the top of each page.

Page 1

Northern Drilling Wastes Search Utility

D.A. Number______1216
Well Name_______PANARCTIC ET AL CAPE ALLISON C-47
Well Status_______OIL WELL
Well ID__________300C477750100000
Latitude__________77x 46' 5.00"
Longitude_________100x 17' 20.00"
Area_____________AI
Operator_________PANARCTIC OILS LTD.
Contractor________PANARCTIC DRILLING LTD
Water Depth______232.00
Total Depth______2100.00
Hole Volume______168.80
Rig Type_________ICE PLATFORM
Rig Name________UNKNOWN
Comments_______

PgUp.PgDn__Toggle Pages ←,→ __See Records Ins__Next Year F1__Fluid Stats

Esc to Quit

Page 2

```
Northern Drilling Wastes Search Utility

1st Spud__19850131        1st Release__19850805
2nd Spud__                2nd Release__
3rd Spud__                3rd Release__
4th Spud__                4th Release__
5th Spud__                5th Release__
6th Spud__                6th Release__

1st Hole Size__660.00     1st Hole Depth__67.00
2nd Hole Size__444.00     2nd Hole Depth__336.00
3rd Hole Size__311.00     3rd Hole Depth__652.00
4th Hole Size__216.00     4th Hole Depth__790.00
5th Hole Size__ 0.00      5th Hole Depth__ 0.00
6th Hole Size__ 0.00      6th Hole Depth__ 0.00
7th Hole Size__ 0.00      7th Hole Depth__ 0.00
8th Hole Size__ 0.00      8th Hole Depth__ 0.00
9th Hole Size__ 0.00      9th Hole Depth__ 0.00


PgUp,PgDn__Toggle Pages  ←,→ __See Records Ins__Next Year
Esc to Quit
```

Page 3

Northern Drilling Wastes Search Utility

Year/Fluid	Value	Units	Year/Fluid	Value	Units
1985					
B FREE HEAVY WATE	524.88	KG	BARITE	229521.00	KG
BENTONITE	7989.00	KG	DF-VIS	2270.00	KG
DIESEL/OIL	4382.40	KG	DRISPAC	3175.00	KG
HRS_DRILL	595.25	H	KELZAN	6700.00	KG
SAWDUST	522.00	KG	SODIUM BICARBONATE	1499.00	KG
SODIUM CARBONATE	182.00	KG	SODIUM HYDROXIDE	4018.00	KG
ZEOGEL	19600.00	KG			

```
PgUp,PgDn__Toggle Pages  ←,→ __See Records Ins__Next Year
Esc to Quit
```

To move between pages within one record use the <**PgUp**> and <**PgDn**> keys. To advance to the next record use the <**Left**> arrow key. To display the previous record press the <**Right**> arrow key. To exit viewing press the <**Esc**> key. Simple descriptive statistics are available for a specific fluid by pressing <**F1**>. When <**F1**> is pressed you are prompted for the name of a fluid (e.g., see Table 7). Maximum and minimum quantities and the arithmetic mean for the fluid are then displayed calculated on all wells in the search file being viewed.

3.5 Print Search Files

This option (type 4 and press <Return>) allows the results of a search to be printed. A menu is presented that allows you to select different fields to be printed. To include a specific field in the print out, type the corresponding menu number and press **<Return>**. A field may be "unselected" by selecting it a second time. When a field is selected, the message "Added to Printout" appears beside the field. After the fields of interest are selected, enter **-1<Return>**. A screen is now presented with a list of all the search file names and shows the prompt "Enter search file to display - ". Enter the file name of concern. At this point, make sure the printer is connected and ready.

Print Out Field Selection Menu

```
                Northern Drilling Wastes Search Utility

        Drilling Authority Number, Well Name

   1.   Status____________________
   2.   Well ID___________________
   3.   Location__________________
   4.   Area______________________
   5.   Operator__________________
   6.   Contractor________________
   7.   Spud and Release Date_____
   8.   Water Depth_______________
   9.   Total Depth_______________
  10.   Hole Size and Depth_______
  11.   Hole Volume_______________
  12.   Rig Type__________________
  13.   Rig Name__________________
  14.   Comments__________________
  15.   Drilling Additives________
  16.   Page Eject After Each Well_

        Enter Number To Add Field To Printout; Enter Again To Remove It
        Enter -1 To Start Printing
        Enter Choice -

        Esc to Quit
```

3.6 Plot Search Files

When this option (type 5 and press <Return>) is selected a list of the search files is displayed. Enter the filenames to be plotted. You are then prompted to select display of the results either on-screen or on the plotter. Press **<P>** for plotter or **<S>** for screen. You must now select the base map on which to plot the search results.

N.B. It is critical to load the Halortp4 device driver before attempting to display a map on-screen or send to a plotter. If this is not done first, the system "hangs" and you must again reboot and start the Drill Wastes Search Utility (see page 3).

The Drill Wastes software includes the following three base maps (see the maps on pages 13-15 for details of area covered):

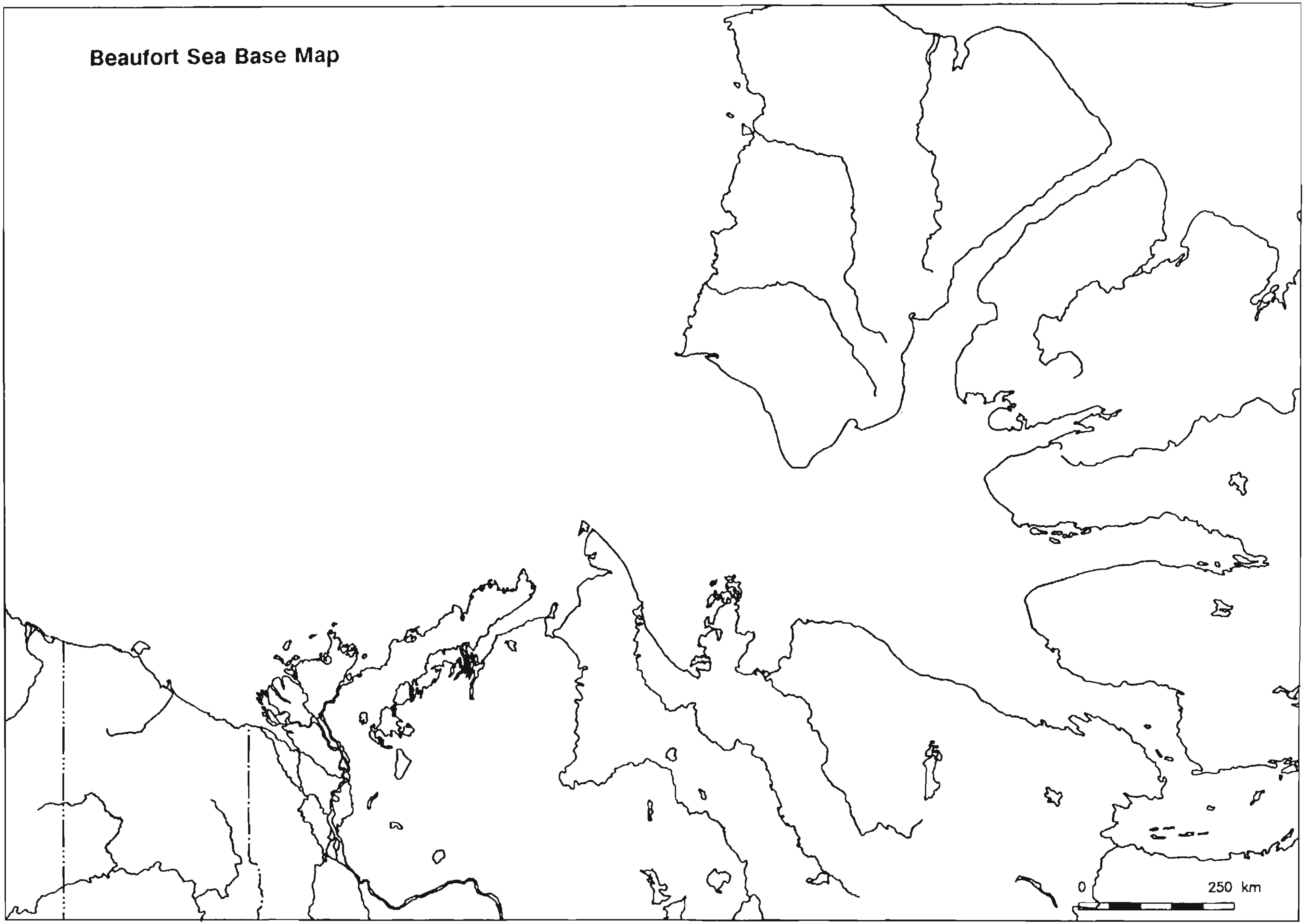
B - Beaufort Sea
A - Arctic Islands
D - Davis Strait

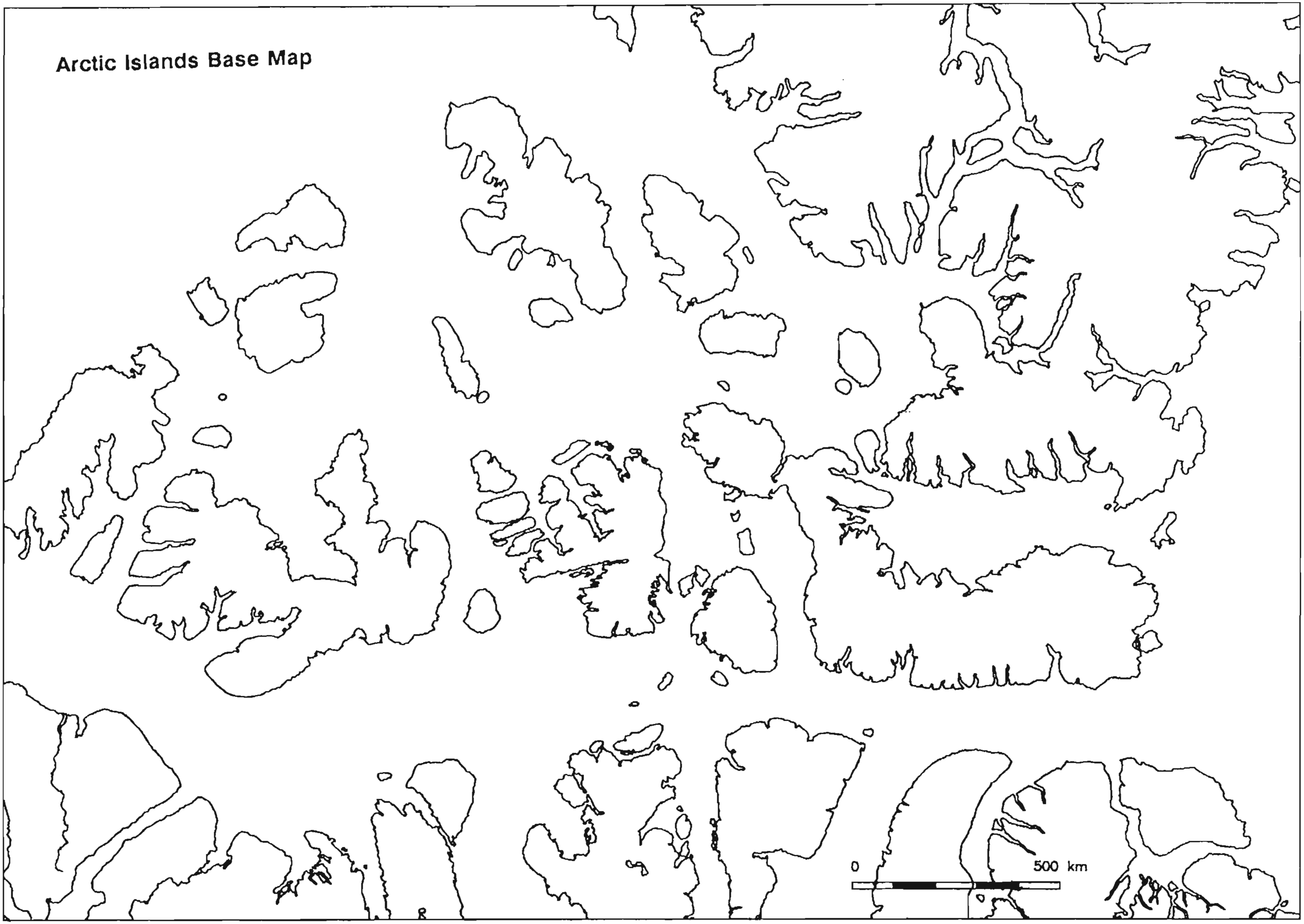
After the base map is selected, you are is prompted to select a plot of the entire map (i.e., including the coastline) or just the data points for your own prepared base map. Enter **<M>** to plot the map and data points or **<P>** to plot just the data points. If the option to plot to the screen is selected, the map appears immediately after the base map is selected. Remember that plotting the entire map on the plotter is a slow process and also requires that the Northern Canada map files be installed.

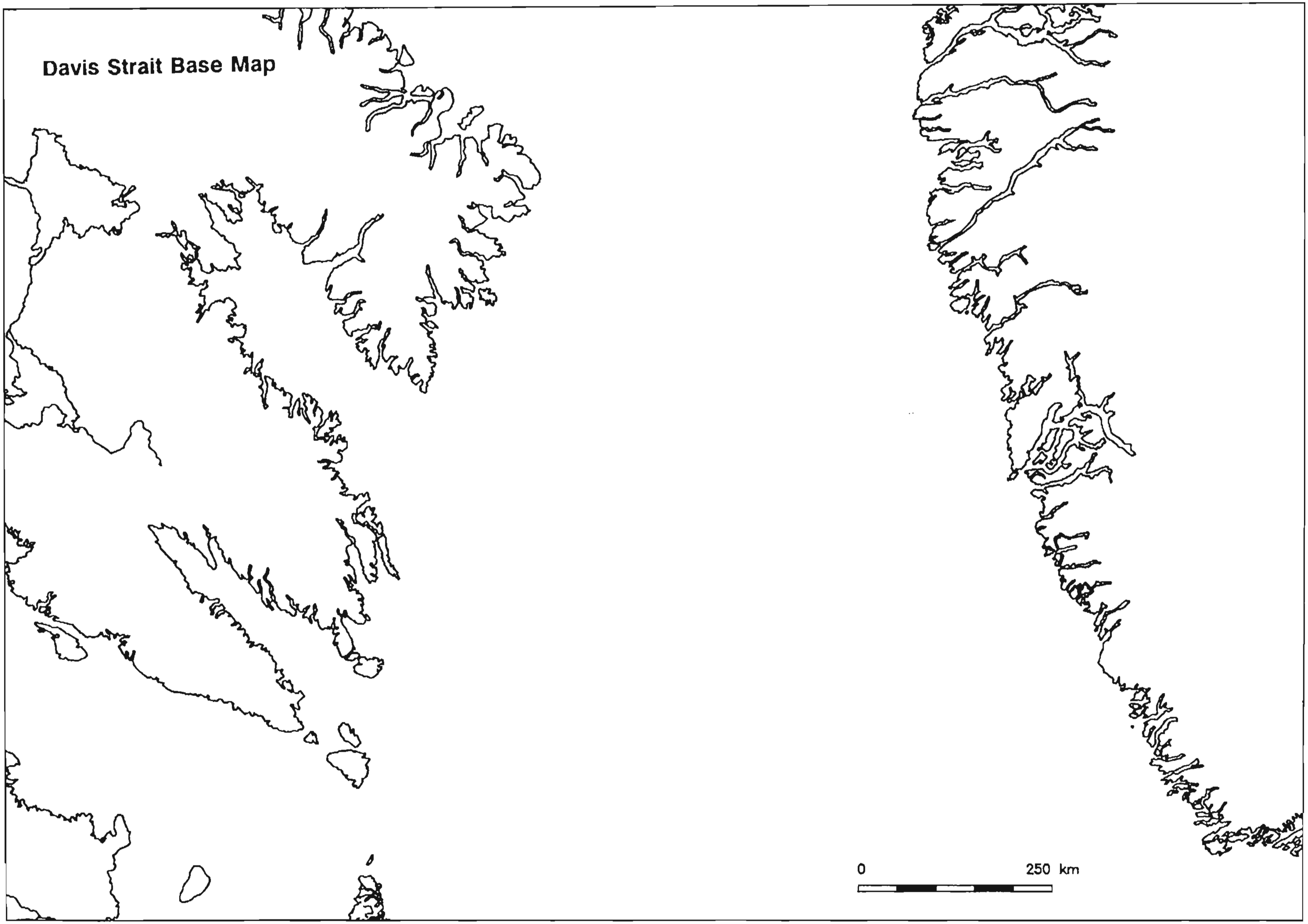
Plotting Menu

```
There are three maps available for use; the Beaufort Sea Map, covering a
        rectangular area from 74.6° Lat, 142° Lon to 67° Lat, 111° Lon;
        the Arctic  Islands Map, from 80° Lat, 120° Lon to 72° Lat, 80°
        Lon; the Davis Strait, from 68° Lat, 90° Lon to 60° Lat, 50° Lon


Canadian Beaufort Sea, Arctic Islands, or Davis Strait
Which map would you like to use (B/A/D) -
```


Beaufort Sea Base Map
0
250 km


Arctic Islands Base Map
0
500 km


Davis Strait Base Map
0
250 km

3.7 Output Statistical Files

The software writes the results of a search to a text file that may subsequently be imported by statistics or spreadsheet packages.

After selecting this option (type 6 and press <Return>), the screen displays a list of existing search files. Type one of the file names and press **<Return>**. You are then prompted to specify an output file name. Enter this and press **<Return>**. You then specify that data is output for all of the fluids (by typing **ALL** at the prompt) or a specific fluid by typing its name. The output file containing the fluid data is written to the root directory of the hard drive. An example output file is presented below. The file format is self-explanatory.

Table 1. Example of Fluid Data in the Drill Wastes Database

DANum	Year Wk	Fluid	Amount	Units
834	1976	BARITE	1236605.00	KG
834	1976	BENTONITE	11985.00	KG
834	1976	CALCIUM CHLORIDE	1271.00	KG
834	1976	DESCO	353.00	KG
834	1976	DIESEL/OIL	21580.00	KG
834	1976	DRISPAC	7037.00	KG

3.8 Delete Old Search Files

This option (type 7 and press <Return>) allows you to remove an unwanted search file from the hard drive. At the prompt enter the name of the file to be deleted and press **<Return>**. To return to the Main Menu, press **<Esc>**.

4.0 SEARCH CRITERIA

4.1 D.A. Number

The D.A. (Drilling Authority) Number is a unique identifier assigned to each Drilling Authority by Canada Oil and Gas Lands Administration (COGLA). Note that a single well may have more than one D.A. number (e.g., if more than one mud system was used). At the prompt, enter the D.A. number of the well to be retrieved.

4.2 Well Name

At the prompt, enter the name of the well (examples are listed in Table 2). When you specify the well name, it does not have to exactly match the complete well name. For example, entering **ADGO** will retrieve all wells with the phrase **ADGO** occurring in the well name field. Pressing <F1> (the help key) presents a list of the well names found in the database.

Table 2. Well Names in the Drill Wastes Database

AAGNERK E-56
ADLARTOK P-09
AQUITAINE ET AL HEJKA O-71
CHEVRON TRILLIUM NORTH ELLICE L-39
DOME AIVERK I-45
DOME ET AL AIVERK 2I-45
DOME ET AL ARLUK E-90
DOME ET AL EDLOK N-56
DOME ET AL HAVIK B-41
DOME ET AL KILANNAK A-77
DOME ET AL NATIAK O-44
DOME ET AL SIULIK I-05
DOME ET AL TINGMIARK K-91
DOME ET AL UKALERK C-50
DOME GULF ET AL UKALERK 2C-50
DOME GULF HUNT KOPANOAR 2L-34
DOME GULF HUNT KOPANOAR I-44
DOME GULF HUNT KOPONOAR 2I-44
DOME GULF TARSIUT A-25
DOME HUNT GULF KOAKOAK O-22
DOME HUNT GULF KOPANOAR L-34
DOME HUNT IRKALUK B-35
DOME HUNT KENALOOAK J-94
DOME HUNT NEKTORALIK K-59
GULF ET AL NORTH ISSUNGNAK L-86
GULF ET AL PITSIULAK A-05
GULF ET AL TARSIUT P-45
HUNT DOME KOPANOAR D-14
HUNT DOME KOPANOAR M-13
IMPERIAL ADGO C-15
IMPERIAL ARNAK L-30
IMPERIAL DELTA 5 IKATTOK J-17
IMPERIAL IMMERK B-48
IMPERIAL IOE KANNERK G-42
IMPERIAL KUGMALLIT H-59
IMPERIAL NESTERK B-44
IMPERIAL PULLEN E-17
IMPERIAL SARPIK B-35
PANARCTIC AIEG DESBARATS B-73
PANARCTIC AIEG DOME PPC BALAENA D-58
PANARCTIC AIEG NE DRAKE P-40
PANARCTIC AIEG PPC DOME MACLEAN I-72
PANARCTIC AIEG PPC DOME SKATE B-80
PANARCTIC AIEG PRC PPC CISCO B-66
PANARCTIC AIEG WHITEFISH 2H-63
PANARCTIC AIEG WHITEFISH H-63
PANARCTIC DRAKE F-76
PANARCTIC ELVE PT. STRAT K-50

Table 2. Well Names in the Drill Wastes Database (cont'd.)

DOME KAGLULIK A-75
DOME KAGLULIK M-64
DOME NERLERK J-67
DOME NERLERK M-98
DOME PACIFIC ET AL PEX NATSEK E-56
DOME SUPERIOR ORVILRUK O-03
DOME TEXACO ET AL UVILUK P-66
ESSO ADGO F-28
ESSO ADGO J-27
ESSO ADGO P-25
ESSO ET AL GJOA G-37
ESSO ET AL ISSUNGNAK O-61
ESSO GULF ET AL ISSUNGNAK 2O-61
ESSO HOME ET AL KADLUK O-07
ESSO HOME ET AL KAUBVIK I-43
ESSO HOME PCI ET AL AMERK O-09
ESSO HOME PCI ET AL NIPTERK L-19
ESSO HOME PCI ET AL NIPTERK L-19A
ESSO IOE ET AL ISSERK E-27
ESSO NETSERK F-40
ESSO PCI HOME ET AL ARNAK K-06
ESSO PCI HOME ET AL MINUK I-53
ESSO PEX ALERK P-23
ESSO PEX HOME ET AL ITIYOK I-27
ESSO PEX WEST ATKINSON L-17
ESSO TRILLIUM ADGO H-29
ESSO TRILLIUM ET AL ADGO G-24
GULF ET AL AKPAK 2P-35
GULF ET AL AKPAK P-35
GULF ET AL AMAULIGAK I-65
GULF ET AL AMAULIGAK I-65A
GULF ET AL AMAULIGAK I-65B
GULF ET AL AMAULIGAK J-44
GULF ET AL EAST TARSIUT N-44
GULF ET AL KIGGAVIK A-43
GULF ET AL KOGYUK N-67
PANARCTIC ET AL BUCKINGHAM O-68
PANARCTIC ET AL CAPE ALLISON C-47
PANARCTIC ET AL CAPE MACMILLAN 2K-15
PANARCTIC ET AL CAPE MACMILLAN K-15
PANARCTIC ET AL CAPE MAMEN F-24
PANARCTIC ET AL CHAR G-07
PANARCTIC ET AL CISCO C-42
PANARCTIC ET AL CISCO K-58
PANARCTIC ET AL CISCO M-22
PANARCTIC ET AL EAST DRAKE L-06
PANARCTIC ET AL GRENADIER A-26
PANARCTIC ET AL JACKSON G-16
PANARCTIC ET AL JACKSON G-16A
PANARCTIC ET AL N. BUCKINGHAM L-71
PANARCTIC ET AL ROCHE PT O-43
PANARCTIC ET AL SCULPIN K-08
PANARCTIC ET AL SKATE C-59
PANARCTIC ET AL WEST CORNWALL N-49
PANARCTIC ET AL WHITEFISH A-26
PANARCTIC GULF ET AL E. DRAKE I-55
PANARCTIC JACKSON BAY STRAT B-16
PANARCTIC KRISTOFFER STRAT C-36
PANARCTIC KRISTOFFER STRAT L-45
PANARCTIC NORCEN AIEG ET AL GRASSY I-34
PANARCTIC SW HECLA C-58
PANARCTIC TENNECO CS N.W. HECLA M-25
PANARCTIC TENNECO ET AL W. HECLA C-05
PANARCTIC TENNECO ET AL W. HECLA N-52
PANARCTIC W. HECLA P-62
PHILLIPS AQUIT ET AL HAZEN F-54
SUN BVX ET AL PELLY B-35
SUN BVX ET AL UNARK L-24
SUN BVX ET AL UNARK L-24A
SUN GULF GLOBAL LINCKENS ISLAND P-46
TRILLIUM ESSO CHEVRON ANGASAK L-03

4.3 Well I.D.

Each well is assigned a unique identifier by COGLA, distinct from the D.A. number. Using the "Well I.D." option, information can be retrieved for a specific well by its unique identifier. Pressing <F1> will present a list of the Well I.D.'s in the database.

4.4 Well Status

Only four different descriptions are recorded for the status of wells:

ABANDONED
DRY & ABAND(oned)
SUSPENDED
OIL WELL

Enter the desired status and then enter a file name to store the search results. A search will be performed on the phrase entered. An "exact match" is not required to retrieve records. For example, entering **ABAND** would retrieve all the records with status ABANDONED or DRY & ABAND.

4.5 Contractor

Information can be retrieved based on the contractor. Table 3 presents a listing of contractors recorded in the current database. This list may also be obtained by pressing the <**F1**> key.

Table 3. Contractors in the Drill Wastes Database

ADECO DRILLING AND ENGINEERING CO LTD
BEAUDRIL
CANADIAN MARINE DRILLING SYSTEMS LTD
COMMONWEALTH HI-TOWER
COMMONWEALTH HI-TOWER & ARCTIC DRILLING LTD
ESSO RESOURCES CANADA LTD
IMPERIAL OIL LTD
KENTING DRILLING CO LTD
MARINE DRILLING S.A.
OCEAN DRILLING LTD
PANARCTIC DRILLING LTD
PANARCTIC OILS LTD.
SPARTAN DRILLING LTD.
WESTBURNE HI-TOWER
WESTBURNE HI-TOWER & ARCTIC DRILLING LTD

You can only select one contractor at a time unless you search on a phrase common to one or more contractors. For example, a search on the word "DRILLING" would locate all contractors with the word "DRILLING" anywhere in the contractor name e.g., PANARCTIC DRILLING LTD and SPARTAN DRILLING LTD.

4.6 Operator

Table 4 presents a listing of operators in the current database. Information can be retrieved based on the operator. Pressing <F1> will present a list of the operators.

Table 4. Operators in the Drill Wastes Database

AQUITAINE COMPANY OF CANADA LTD
CHEVRON CANADA RESOURCES LTD.
DOME PETROLEUM LTD.
ESSO RESOURCES CANADA LTD.
GULF CANADA RESOURCES INC.
HIPCO LTD & DOME PETROLEUM LTD
IMPERIAL OIL LTD
PANARCTIC OILS LTD.
PHILLIPS PETROLEUM CANADA LTD
SUN OIL CO LTD
SUNOCO LTD

4.7 Years of Operation

By selecting "Years of Operation", you retrieve information for all wells with any fluid data recorded for the specified year. At the prompt "Enter Year to search for - ", enter the last two digits of the year to be searched for. For example, to locate those wells in operation in 1979, enter **79<Return>**. Information may only be selected for a single year. The selection of a range of years is not possible.

4.8 Months of Operation

Enter the month (01-12) to be searched for. The "Months of Operation" option retrieves information for all wells that were in operation during the given month. Fluid data may or may not be recorded for the specified month.

Information may only be selected for a single month. The selection of a range of months is not possible.

4.9 Rig Name

By selecting the "Rig Name" option, information is retrieved for all wells with a specific phrase occurring in the Rig Name field. Table 5 lists all rig names recorded in the current database. Pressing <F1> will present a list of the rig names.

Table 5. Rig Names in the Drill Wastes Database

32E
BEN OCEAN LANCER
BIG INDIAN #3
CBIR #1
CBIR #2
ESSO RIG 2E
ESSO RIG 3
EXPLORER I
EXPLORER I (1977 & 1979); III (1978 & 1982)
EXPLORER I (1978); II (1979)
EXPLORER II
EXPLORER II (1977), EXPLORER III (1978)
EXPLORER II (1978); III (1978); IV (1979)
EXPLORER II (1978); III (1979 & 1980)
EXPLORER II (1980 & 1981)
EXPLORER II (1983); I (1984)
EXPLORER II (79); III (79 & 80); IV (81 & 82)
EXPLORER III
EXPLORER III (1976 & 1979); II (1977); I (1978)
EXPLORER III (1980); IV (1981)
EXPLORER III (1983); II (1984)
EXPLORER IV
EXPLORER IV (1980 & 1981); III (1982)
EXPLORER IV (1981); II (1982)
KULLUK
MOLIKPAQ
PANARCTIC RIG A
PANARCTIC RIG C
RIG "A"
RIG "B"
RIG "C"
RIG #1
RIG #11
RIG #2
RIG #2E
RIG #32
RIG #3E
RIG #4
RIG #4E
RIG #5
RIG #7
RIG #8
RIG NO. 4
SEDCO 709
SPARTAN RIG 10E
UNKNOWN

4.10 Rig Type

It is possible to retrieve information for all wells containing a specific phrase in the Rig Type field. A listing of all rig types recorded in the current database is presented below:

Table 6. Rig Types in the Drill Wastes Database

ARTIFICIAL ISLAND	CONICAL DRILLING UNIT
DRILLING CAISSON	DRILLSHIP
ICE PLATFORM	LAND RIG ON CAISSON
MOBILE ARCTIC CAISSON	SEMI SUBMERSIBLE
SUBMERGED DRILLING PLATFORM	TRIPLE DIESEL ELECTRIC

4.11 Area

The "Area" search option allows information for all wells recorded within the specified area to be retrieved. Only three area codes have been used in the current database:

BS for Beaufort Sea
AI for Arctic Islands
DS for Davis Strait

You can search on only one geographical area at a time because the software can only map one area at a time.

4.12 Latitude/Longitude Box

The "Latitude/Longitude Box" search retrieves information for all wells occurring within a specified radius from a selected centre coordinate. Enter the coordinates of the centre point (latitude and longitude - North and West are assumed). Then specify the radius from the centre point in kilometres. This number must be entered with a decimal point; e.g., to enter 100 press **100.**

4.13 Spud and Release Dates

Using this option, it is possible to retrieve information for wells spudded or released either before or after a specified date. First enter the date in the format **DD/MM/YY**, e.g., April 24, 1980 would be entered as **24/04/80**. The software then prompts you to select records <**B**>efore or <**A**>fter the date specified.

4.14 Hole Sizes

Hole size refers to the diameter of casing sections.

At the prompt "Enter size to search for (in millimetres) - " specify a numeric value. The program then prompts you to select values <**G**>reater or <**L**>ess than the specified number.

4.15 Hole Depth

Hole depth in this context, refers to the length of individual casing sections in metres. This option is otherwise identical to "Hole Size", see Section 4.15 above.

4.16 Hole Volume

Hole volumes were calculated from the hole size (casing diameter) and hole depth (casing length). Specify the desired volume in cubic metres. This option is otherwise identical to "Hole Size", see Section 4.15 above.

4.17 Water Depth

Water depth refers to the depth of water in metres in which the well was drilled. This option is otherwise identical to "Hole Size", see Section 4.15 above.

4.18 Total Depth

Total depth refers to the total depth of the well measured in metres from the sea floor. This option is otherwise identical to "Hole Size", see Section 4.15 above.

4.19 Fluids

The "Fluids" option is one of the most useful search criteria in the Search Utility. On selecting this option, you are prompted to enter a fluid name (fluids are the drilling chemicals circulated down the well). A search will then retrieve information for all wells with the specified phrase occurring in the Fluid Name field of any record (a search may take up to 45 seconds). Note that the search will be executed on either the Tour Sheet Information or the Well History Information depending on which data source is selected (see Section 3.8).

Table 7 presents a listing of all fluid names in the current database (i.e., both Tour Sheet and Well History Information). This list may also be obtained by pressing <F1> (the generation of this list may take up to two minutes)

Table 7. Fluid Names

ADGO MUD
ADOFOAM BF-1
ALUMINUM STEARATE
AMMONIUM NITRATE
AP-21
B FREE HEAVY WATE
BARABUF
BARAVIS
BARDAC 2250
BARITE
BENTONITE
BIOTROL
CALCIUM BROMATE
CALCIUM CHLORIDE
CALCIUM HYDROXIDE
CALCIUM SULPHATE
CARBONOX
CELLOPHANE
CHROME ALUM
CHROME LIGNOSULPHONATE
CMC
COAT 129
COAT 888
D-47
DEFOAM
DEFOAMER
DENSIMIX
DESCO
DF-VIS
DFE-506
DIASEAL M
DIESEL/OIL
DMO-75
DRISPAC
DRISPAC SL
DURATONE HT
DX-10
bE Z SPOT
ENVIROSPOT
ETHYLENE GLYCOL
EXXSOL
EZ MUL
FLR-100
FOAM KONTROL
FRICTION EASE
GELTONE
GELTONE II
GILSONITE
IDF THIN
IDFLO
IMCO FYBRE
INVERMUL
IRON CARBONATE
K-91
KELZAN
KELZAN XCD
KID-97
KWIK-SEAL
LIGNITE
LIGNOSULPHONATE
LO LOSS
LUBRAGLIDE
MAGNESIUM OXIDE
MICA
MINUK MUD
MYACIDE
NICKEL SALT
NICKEL SULPHATE
NORMUL
NOXYGEN
OCTANOL
OIL FAZE
PARAFORMALDEHYDE
PELTEX
PIPE LAX
POLY RX
POTASSIUM CARBONATE
POTASSIUM CHLORIDE
PRIMUL
PROHIB 58
PROTECTOMAGIC
PROTECTOMAGIC M
Q-BROXIN
RESINEX
SAFEGUARD
SAPP
SAWDUST
SHALE KONTROL
SKOT FREE
SOD. SOL.
SODIUM BICARBONATE
SODIUM BICHROMATE
SODIUM CARBONATE
SODIUM CHLORIDE
SODIUM HYDROXIDE
SODIUM NITRATE
SODIUM SULPHATE
SODIUM SULPHITE
SOLTEX
SOS
SPOTTING FLUID
SPUD MUD R
SS-100
SST 202
STAFLO
STAFLO X-LO
STARCH
SURFLO B-466
SURFLO H35
SURFLO W300
TECHNIMUL
TECHNIREG
TECHNISPERSE
TECHNISURF
TECHNITROL
TECHNIVIS
TOR-IDF
TORQ-KONTROL
TORQ-TRIM
TORQUELESS
TURBO
ULTRAGLIDE
VALUE 100
VISTA ODC
WALNUT HULLS

5.0 EDITING AND APPENDING THE DRILL WASTES DATABASES

A separate program, **Edit.Com**, allows you to add new and edit existing data in both the Tour Sheet and Well History Information. **Note that if the "D.A. Record" information is to be updated, it is necessary to perform the updating in <u>both</u> the Tour Sheet Data and the Well History Information because the data is stored in separate files.**

In the \Drilwast directory, type **Edit<Return>** to start the editing program. A menu will be presented:

Main Menu - Edit Program

```
                 Northern Drilling Wastes Editor
                        Tour Sheet Data


    1. Enter a D.A. Record
    2. Edit an Old D.A. Record
    3. Enter a New Fluid Record
    4. Edit an Old Fluid Record
    5. Select Fluid Directory

    Enter Choice -

    Esc to Quit
```

To select an option, type the corresponding menu number. To quit the editor program, press <**Esc**> when at the Main Menu, and answer <**Y**>es to the prompt.

Note that all information should be entered in upper case.

5.1 Enter a D.A. Record

This option allows new records to be added to the database. Each record consists of two pages. When selected, a blank record with field headings is displayed on-screen for you to complete (see below).

To move to the next field (down) press either the <**Return**> key or the <**Down**> arrow. The <**Up**> arrow moves the cursor up a field. The <**Right**> and <**Left**> arrow keys move within a single field. To delete characters, use the <**Backspace**> key or the <**Del**> key. To add information to a field, position the cursor at the desired position and begin typing.

New D.A. Record - Page 1

```
                Northern Drilling Wastes Editor


D.A. Number______
Well Name________
Well Status______
Well ID__________
Latitude_________  0x  0'  0.00"
Longitude________  0x  0'  0.00"
Area_____________
Operator_________
Contractor_______
Water Depth______  0.00
Total Depth______  0.00
Hole Volume______  0.00
Rig Type_________
Rig Name_________
Comments_________


F10 - Save       PgDn, PgUp - Toggle Pages
Esc to Quit
```

When all information has been entered on the first page press <**PgDn**> to move to the second page. <**PgUp**> will return to the first page.

The spud and release dates must be entered numerically in the format **DD/MM/YY**.

Hole sizes and depths must be entered with a decimal point, e.g., to enter 1000, press **1000.**

When all the information has been entered, press <**F10**> to save the entry. To return to the Main Menu without saving, press the <**Esc**> key and answer <**Y**>es to confirm that the entry is to be abandoned.

New D.A. Record - Page 2

```
                    Northern Drilling Wastes Editor

1st     Spud__      1st  Release__
2nd     Spud__      2nd  Release__
3rd     Spud__      3rd  Release__
4th     Spud__      4th  Release__
5th     Spud__      5th  Release__
6th     Spud__      6th  Release__

1st     Hole Size__ 0.00   1st    Hole Depth__ 0.00
2nd     Hole Size__ 0.00   2nd    Hole Depth__ 0.00
3rd     Hole Size__ 0.00   3rd    Hole Depth__ 0.00
4th     Hole Size__ 0.00   4th    Hole Depth__ 0.00
5th     Hole Size__ 0.00   5th    Hole Depth__ 0.00
6th     Hole Size__ 0.00   6th    Hole Depth__ 0.00
7th     Hole Size__ 0.00   7th    Hole Depth__ 0.00
8th     Hole Size__ 0.00   8th    Hole Depth__ 0.00
9th     Hole Size__ 0.00   9th    Hole Depth__ 0.00

F10 - Save      PgDn, PgUp - Toggle Pages
Esc to Quit
```

5.2 Edit an Old D.A. Record

Option 2 presents a list of the Drilling Authority numbers for all wells in the database. Enter the D.A. number of the record to be edited. The screen will then display the first page of the record. Position the cursor on the field or character to be edited using the arrow keys then type any changes desired (as in 5.2 above). To save the changes that have been made, press <**F10**>. To return to the Main Menu without saving changes, press <**Esc**> and answer <**Y**>es at the prompt.

5.3 Select Fluid Directory

Option three selects the data being edited or added to. The Well History Information is selected by default. When 5 is first pressed the Tour Sheet Information becomes the current file. The <5> key allows you to "toggle" between the two data sources. The current data file is indicated below the title "Northern Drilling Wastes Editor" at the top of the screen display.

You should always check to ensure that the correct data file is being accessed.

5.4 Edit a New Fluid Record

Option four allows you to enter new fluid information: name, year, week, quantity and units. Make sure that you have selected the correct fluid data source (i.e., Tour Sheets or Well History Information) before making entries (see Section 5.5). When selected, the screen will display:

New Fluid Record - Page 1

```
                 Northern Drilling Wastes Editor


D.A. Number     :
Year            :
Week            :

Fluids                     Value              Units
~~~~~~~~~~~~~~~~~~~~~~     ~~~~~~~~~~~~~      ~~~~~~




F10 - Save
Esc to Quit
```

1. Enter the Drilling Authority Number

2. Enter the last two digits of the year; e.g., 1980 would be entered as **80**

3. Enter the week (01 to 52) or 00 if the entry represents a whole year (e.g., from a well history).

4. Enter the fluid name (for a list of fluids refer to Table 7) in upper case. Particular care has been taken to standardize fluid names. It is desirable to utilize names already in the database wherever practical.

5. Enter the quantity with a decimal point, under the "Value" heading, e.g., to enter 1000, press **1000.** Note that any entries with units other than kilograms will not be included in statistical calculations. Values should be converted to kilograms wherever possible.

6. Enter the fluid units, e.g., **KG** for kilograms.

Note: Information on the number of hours spent drilling is a special case and is also recorded as a "fluid" with the description: **HRS_DRILLED** and units: **H**.

To save the new information, press <**F10**>. Note that the D.A. record must be entered before the fluids because the fluid record is cross referenced to the D.A. record.

5.5 Edit an Old Fluid Record

In option five a list displays the Drilling Authority numbers for all wells in the database. Enter the D.A. number of the record to be edited at the prompt. The years of operation for that D.A. number is then displayed. Enter the year and week to be edited at the prompts. In the Well History Information, weeks are not required; press <**Return**> in response to the "Enter Week to Edit - " prompt.

A list of fluids and quantities used for the selected D.A. number and period is then displayed. See Section 5.1 for instructions on entering data and moving from field to field.

Old Fluid Record - Edit Screen

Northern Drilling Wastes Editor

D.A. Number :1001
Year :1982
Week :

Fluids	Value	Units
~~	~~~~~~~~	~~~~~
AP-21	4369.00	KG
BARITE	2255810.00	KG
BENTONITE	273.00	KG
DF-VIS	2656.00	KG
DRISPAC	18800.00	KG
DX-10	3385.09	KG
HRS_DRILL	552.75	H
IDFLO	2875.00	KG
KELZAN	5225.00	KG
LUBRAGLIDE	15512.64	KG
MAGCONOL	197.60	KG
NOXYGEN	3975.00	KG
POTASSIUM CHLORIDE	194950.00	KG

F10 - Save
Esc to Quit