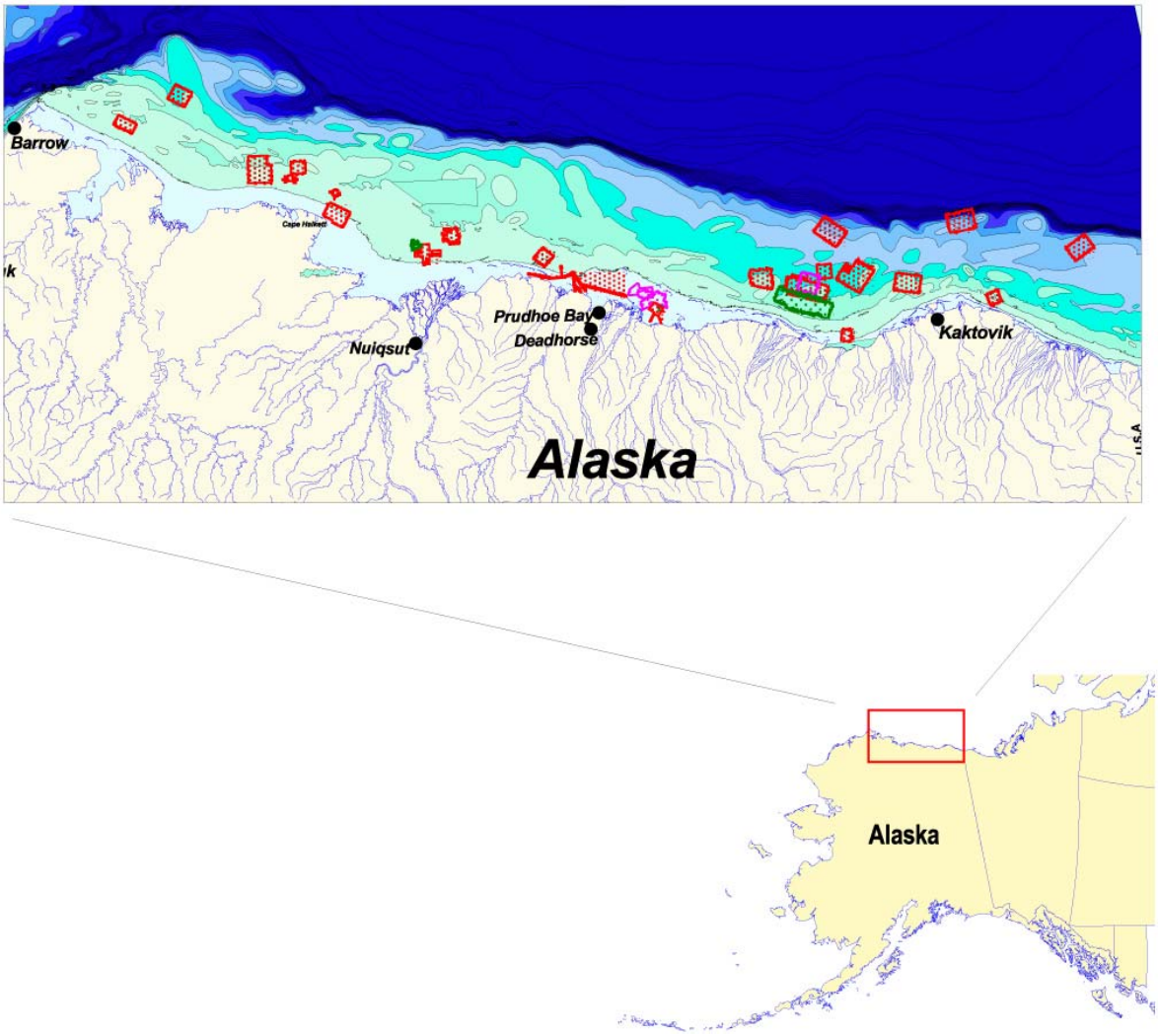
User Manual for Study Titled

OCS Study MMS 2002-017

Evaluation of Sub-Sea Physical Environmental Data for the Beaufort Sea OCS and Incorporation into a Geographic Information System (GIS) Database

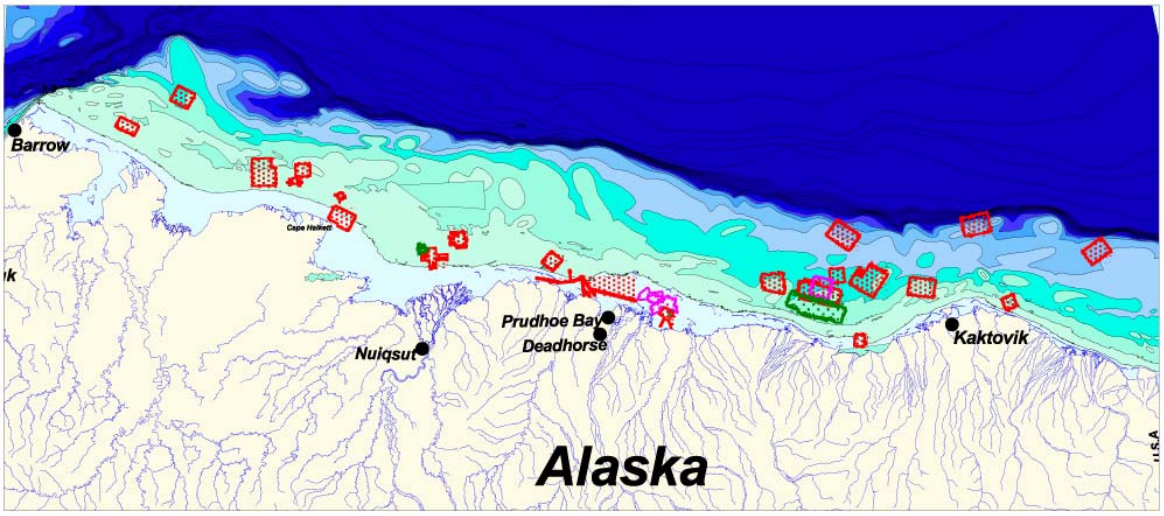


U.S. Department of the Interior
Minerals Management Service
Alaska Outer Continental Shelf Region

OCS Study MMS 2002-017

Evaluation of Sub-Sea Physical Environmental Data for the Beaufort Sea OCS and Incorporation into a Geographic Information System (GIS) Database

By Warren L. Horowitz, Oceanographer, MMS Alaska OCS Region



Locations of past Shallow Hazard Site Surveys and Pipeline Route Surveys for the Beaufort Sea Federal Outer Continental Shelf, Alaska

U.S. Department of the Interior
Minerals Management Service
Alaska Outer Continental Shelf Region

Anchorage, Alaska
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Abstract

Evaluation of Sub-Sea Physical Environmental Data for the Beaufort Sea OCS and Incorporation into a Geographic Information System (GIS) Database

This study, published on CD-ROM, presents a comprehensive database that synthesizes spatial and attribute information collected during shallow geological and geophysical surveys of the Federal Outer Continental Shelf in the Beaufort Sea, Alaska. The surveys were conducted on the Beaufort Sea Continental Shelf between Barrow, Alaska in the west and the Canadian border to the east (Figure 1). The Geohazards Database includes raw and interpretated data from the collection of high-resolution seismic data in the Beaufort Sea. The included survey data are from twenty eight (28) site-clearance surveys for proposed exploratory wells, four (4) years of repetitive pipeline-route surveys for the Northstar Development area; two (2) years repetitive pipeline-route surveys for the proposed Liberty Development, and three (3) surveys of the Boulder Patch. In addition, the database includes boring and grab-sample data from the surveys, regional bathymetry, and historical earthquake data. The database provides spatial and attribute information for surface features such as the "Boulder Patch", strudel scour, ice gouges, and bottom relief (bathymetry); spatial data on subsurface features such as shallow faults, shallow gas, and channels; and spatial data on other features such as shotpoint surveys, shallow borings, and earthquakes.

All the database and user documentation is provided on the CD-ROM. Programs needed to fully access the CD are Adobe Reader, ESRI's ArcView 3.2a, and Microsoft Access 97. Included on the CD are the Geohazards Database, the Geohazards Extension for the ArcView program, the User Manual, and the Database Documentation. The ArcView Geohazards Extension has a Graphical User Interface that allows the user to query and view information from the database in map form. The User Manual provides an overview of tasks performed in compiling the database; a description of the data set types; a summary of regional geology; a description of the data collected for each survey; and a tutorial that describes how to load the ArcView Geohazards Extension and query the database. The tutorial links to the Database Documentation, which contains the Entity Relationship Diagram (ERD), Data Dictionary, Relationships table, and Domain table. Questions may be addressed to MMS, Environmental Studies Section, at 907-271-6577, Attention: Warren Horowitz, Oceanographer (Warren.Horowitz@mms.gov).

Program Organization/Acknowledgements

PROJECT MANAGEMENT

MMS (Contracting Officer's Technical Representative (COTR): Warren Horowitz, Oceanographer wrote the User Manual and managed Resource Data Inc. efforts to incorporate additional data sets; reformat and merge data, modify the database, create a new tutorial, and update the database documentation.

CONTRACTORS:

Watson Company, Inc. / GeoNorth, LLC compiled most of the spatial and attribute data, produced the initial database design and provided the intial database documentation. Contract # 0199CT30985.

Resource Data Inc: Technical assistance as described above

MMS ASSISTANCE:
Jody Lindemann: (MMS Editor) Document edits
Richard Pomeroy: MMS Records Manager

MMS Disclaimer:

Any use of trade names is for description purposes only and does not constitute endorsements of these products by the Minerals Mangement Service. The use of the data and information from the following report and database shall be at the sole discretion of the user. The MMS cannot be held reponsible for the use of the data from the geohazards database for operational purposes. It will be the responsibiltiy of the user to review all reports and seismic records before using the data for operational purposes in the Beaufort Sea.

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Evaluation of Sub-Sea Physical Environmental Data for the Beaufort Sea, Alaska

Scope and Effort for the Beaufort Sub-Sea Program

The objective of this project was to create a Geographical Information System (GIS) database for all of the data contained within the reports from all the Alaskan Beaufort Sea Outer Continental Shelf well-site clearance surveys and the Liberty and Northstar pipeline-route surveys (Figure 1). Other data included: "Boulder Patch" surveys, regional and site-specific boring and seafloor grab-sample data, regional bathymetry between Barrow and the Canadian Border, and historical earthquake data. In the initial phase of the project, Watson Company Inc performed under MMS contract. The data was to be provided as SDE Layers, Oracle tables, and as ArcView shapefiles and DBF tables. A database structure was to be developed for SDE/Oracle along with a Graphical User Interface to query the data and data loaders to add new data sets. The database structure was to be compatible with the current MMS CORIS data structure. Complete metadata was to be provided for all data sets. In the final phase of the project, performed by MMS with the technical assistance of Resource Data Inc., the database was updated and converted into ArcView shapefiles and Access 97 tables. A Graphical User Interface (GUI) was built to access the data from the geohazards database. The User Manual was produced and the database documentation was updated. Finally, the User Manual and the integrated database documentation was made user friendly.

Task Summary

The project was organized into discrete tasks and data products, described in the following table. The first column of the table lists the tasks. The second column describes the data products provided to MMS by the contractor, Watson Company Inc. The third column describes the work that was completed by MMS with Resource Data Inc.'s technical assistance to update the database and documentation subsequent to the delivery of the preliminary information by the contractor in May 2001.

Task Summary Table

Task	Data provided to MMS by Contractor	Database Updates by MMS
Task 1A Inventory and Data Collection of Non-digital and Digital Data Sets:	Inventories including reports, maps and borehole information are included within this report. The contractor requested and obtained the required Liberty and Northstar pipeline survey data along with the borehole information. The contractor obtained all of the available site-specific survey reports from the MMS vault.	
Task 1B Compile Single Navigation File:	Shotpoint information was provided by the contractor in ArcView shapefile format with the exception of the following spatial, attribute, and metadata, which were completed by MMS.	Five site-specific surveys shotpoint maps from the Fireweed (ARCO), Karluk, Kuvlum, Eric, Galahad surveys were digitized and attributed. MMS digitized the hardcopy maps, attributed the shotpoints, provided metadata, and appended the new data to the ArcView shotpoint file. MMS attributed eight additional shotpoint surveys. MMS completed this task by scanning the hard copy post-plot maps, georeferencing them to the digital shotpoint files and assigning shotpoint numbers to the shotpoints. MMS also provided the metadata. MMS integrated all of the Northstar and Liberty shotpoint surveys. All shotpoint data has been digitized and attributed with the exception of Tract 42. These data are missing attributes for the shotpoints. A single ArcView shapefile holds all of the spatial information and an Access 97 table contains the related metadata.
Task 1C Geologic Core Data	Borehole information for 216 sampling locations including the site specific surveys, Liberty and Northstar development programs has been submitted to the MMS.	
Task 1D Integration of Core and Navigation	Provided core data and the geophysical navigation data in ArcView Shapefile format. Navigation data was completed by MMS as described in Task 1B.	See Task 1B
Task 2. Digitize all Interpreted Maps from all Final Reports	Most data was digitized and attributed by the contractor, with the exception of the approximately 25% of the shotpoint data and a few other sets of spatial features.	MMS digitized and attributed the missing shotpoint data. All of the data with some minor exceptions are located within the ArcView shapefiles and the Access 97 tables. Seismic Anomalies, Seismic Anomaly Annotation, Fault Line Annontation and metadata along with Ice features were digitized, attributed and added to the database.
Task 3. Interpretation of Seismic and Geologic Data	Most of the data within this study were derived from the digitizing of maps and attributing of spatial features found within the final reports for the site-specific and pipelines survey reports. Zones of ice gouging were identified for site-specific surveys. No discrete ice gouge analysis was provided.	MMS scanned the TIFF images of seismic sections from selected site-surveys and incorporated those data into a new table called “Interpreted Seismic Sections”. MMS provided software coding to retreive the images from the database.
Task 4. Inventory and Digitally Compile Sea Ice and Bathymetric Datasets	All bathymetry information has been provided to the MMS in two ArcView shapefiles (bathymetry contours & bathymetry spot points). These data contain the site-specific surveys, and the Northstar and Liberty pipeline route surveys. Regional bathymetry information was submitted as an ArcView shapefile as a third set of bathymetry data. MMS did not receive the sea ice component because MMS had	MMS reformated and merged the site survey and pipeline route bathymetry files into a single ArcView shapefile and updated the metadata.

Task	Data provided to MMS by Contractor	Database Updates by MMS
	already developed those data prior to the completion of the study.	
Task 5. Develop Database Design/Analysis Tool and Import Batch Utility	The contractor provided the initial database design and documentation. They provided the Entity Relationship Diagram (ERD), Data Dictionary, Relationships, and Domain tables. They populated the database with the digitized and attributed data from the reports. They expanded the CORIS database structure. They provided MMS with Oracle Exports of the spatial and attribute data.	MMS recreated the database as ArcView shapefiles and Access 97 tables. The MMS updated the database design and database documentation. MMS reformated the database documentation so that the ERD is linked to the Data Dictionary, Relationships, and Domains tables. MMS populated the newly designed database with updated spatial, attribute and metadata.
Task 6 Develop Spatial Analyst Application Tools	The contractor provided MMS with an ArcView Project File, which contained a View for each major feature group. Power Point screen shots of a proposed Graphical User interface (GUI) was submitted to the MMS for review.	MMS completed all of the programming for the Graphical User Interface (GUI). The GUI is built into the Geohazards Extension included on the CD.
Tasks 7 and 7A Users Manual and Reference Manual	A “Project Manual” was submitted that included the following: Entity Relationship Diagram (ERD), Data Dictionary, Relationship and Domain tables, survey and inventory information of what is contained in the Oracle/SDE database, and survey and inventory information of what *is not* contained in the Oracle/SDE database. In addition, full color figures of the Beaufort Sea database area, with respective features have been included for: _Site_identification, _ice_gouging, _bore_ hole,_boulder_patch,_faulting,_historic_earthquates,_etc. The manual was provided in .pdf format. In addition, the contractor provided data in ArcView shapefile format and as Oracle Exports.	The User Manual was written by MMS to include more comprehesive information for each site-specific and pipeline survey. The information pertaining to the discussion of data types was expanded to include additional data types not covered by the contract. MMS removed the information provided by the contractor on data and survey quality. MMS removed their notes on data intergration and replaced it with a detailed synoposis of the survey effort and results. MMS added a section on the regional geology of the Beaufort Sea including additional background information on the Boulder Patch. MMS produced a comprehensive tutorial that provides detailed instruction on how to load the database, ArcView Extension and use the Graphical User Interface to display the data.

Program Data Set Types in Database

The following data was captured from the site-specific, pipeline-route surveys and geotechnical reports. In addition, high-resolution seismic shotpoint data was taken from navigation tapes when available.

Listing of Data Set Types

Site Specific Bathymetric (spots and contours) Regional Bathymetry	Strudel Holes
Isopach Contours of Shallow Stratigraphy	Drain Cracks
Faults/Structure Contours	Strudel Scour
Sub-Seafloor Channels	Ice Overflood Limits
Shallow Gas	Ice Gouge
Boulder Patch	Magnetic Intensity Contours
Borings and Grab Samples	Images of Seismic Sections
Earthquakes	*Shipwrecks
Shotpoints for Surveys	Survey Polygons

**Information for these features were not found within the reports and therefore not included in database*

Discussion of Data Set Types

The Geohazards Database contains 28 site-specific surveys for proposed exploratory wells, 6 pipeline-route surveys for the Liberty and Northstar pipeline studies, 3 Boulder Patch surveys, boring and seafloor grab sample data from the surveys, regional bathymetry, and historical earthquake data. The following is a brief description of the main spatial data types in the database.

Shotpoint Surveys (Points) – The shotpoints for all of the surveys are included within the database. All of the shotpoints have been attributed with the shotpoint number and Line id's with the exception of Tract 42, Tern Island. The shotpoint information has been obtained from the maps in the back of the final reports and from available navigation tapes.

Survey Polygons – A survey polygon has been generated from each shotpoint survey. The survey polygons represent the geographic extent for each survey based upon the shotpoint data. The survey polygons appear on the opening screen after accessing the database for the first time.

Site-Specific-Bathymetry (contours) – Seafloor bathymetry was contoured for each survey. Data collection methods varied along with the resolution of the contour intervals. Typically the contours are generalized and don't represent the actual seafloor surface.

Spot Bathymetry – Most of the spot bathymetry was collected from the Northstar and Liberty Pipeline Route Surveys. These data are very detailed and provide a very good representation of the surface over a very limited geographic area.

Regional Bathymetric Data Set -This information is fairly coarse compared to the site specific survey bathymetry data. The regional bathymetry is a good representation of the Beaufort Sea shelf bathymetry over a large area. Some irregularities occur in the regional bathymetry data coverage.

Isopach Contours of Shallow Stratigraphy - The geophysical stratigraphic sequence information from the surveys has been compared against core data when available, to provide information regarding the geologic age of seafloor sediment conditions. The mapping of sediments is based on the stratigraphy codes: Holocene, Holocene over Pleistocene, Holocene and/or Pleistocene, Pleistocene, and unknown.

Ice Gouges (polygons) - Ice gouge polygons (zones of ice gouging) for the site-specific surveys are included in the database. The zones of ice gouging cover the site-specific areas and classify each as heavy, medium, light or none. The zones of ice gouging are generalized.

Discrete Ice Gouges (Lines) Discrete ice gouge lines were included if the original contractor included them within the report maps and tables. Discrete ice gouges for the site-specific surveys don't contain associated attributes of depth and width, although the Liberty and Northstar pipeline surveys contain width and depth attributes for many of the mapped ice gouges.

Strudel Scour, Drain Cracks (points) and Drain Cracks (Lines) – These features were spatially located and attributed based upon the report and map information contained with the reports for the Northstar Development Pipeline Route Surveys 1995-1998 and the Liberty Development Pipeline Route Surveys for 1997 and 1998.

Overflood Limits – Overflood limits were captured in the database during the Northstar and Liberty pipeline route surveys. In addition, historical overflood limits were also incorporated into the database. The historical line represents the outer most flood line from multiple survey years beginning in the 1970's.

Shallow Gas - This information is included as part of the seismic anomalies. Annotations for these features are included within the seismic anomaly annotation file. The annotation file contains information on the depth from the measured surface to the top and bottom of the anomaly when those information were available.

Boring - Boring and seafloor grab sample information for the site-specific surveys and the Northstar and Liberty Development Pipeline Route Surveys are contained within the database. The boring data was also interpreted lithologically (physical properties of the sediments) and is contained in the associated tables. The data dictionary should be consulted during review. The boring information was modeled after the Unified Soil Classification System (USCS).

Shallow Structure, Faults, Folds and Seismicity – The spatial locations of these features were digitized and attributes such as depth of feature, included in the database. The spatial locations of historic seismic events (earthquakes) are included in the database along with the attributes of depth and magnitude.

Seafloor Sediment Properties - The boring and seafloor grab sample information (including Northstar and Liberty) are located in the coring lithology table and the other associated boring tables.

Shipwrecks – No shipwrecks were located within the reports. This table is included within the E.R.D, but the table is empty.

Boulder Patch – Included in the database are rock habitat percent coverages from five surveys: (1) the Karluk survey by Harding Lawson Associates; (2) the Liberty site survey by Watson Company, Inc.; (3) the Liberty Boulder Patch Survey by Coastal Frontiers Corporation; (4) the Warthog survey by Fairweather E&P Services, Inc.; and (5) the USGS lag deposits survey. The first three surveys classified the Boulder Patch based upon the recommendations of the Joint Federal and State Biological Task Force. The Warthog and USGS classified their information differently.

TIFF Images of Seismic Sections - We have provided TIFF images of seismic records (side scan sonar, sub-bottom profiler, boomer etc..) to illustrate some of the features and conditions found within the offshore surveys. The TIFF images of the seismic sections can be viewed in greater detail by utilizing the zoom in tool on the ArcView Graphical User Interface.

Metadata – The ENVM_SOURCES table contains the names of the site-surveys, pipeline route surveys and geotechnical reports and associated maps used to compile the database. The spatial features in the database are linked to the report and map names in the ENVM_SOURCES table. In addition, the Database Documentation contains the Entity Relationship Diagram (ERD) which is linked to the Data Dictionary, Relationship and Domains tables.

Background Geology of the Beaufort Sea Continental Shelf

Physiography

The continental shelf is the submarine extension of the North Slope coastal plain. The continental shelf is between 45 and 75 miles wide and contains barrier islands and back barrier lagoons. The shoreline is composed of actively eroding coastal bluffs and river deltas. Some barrier islands and sub-sea shoals have migrated hundreds of feet landward over historic time. In shallow water (approximately up to 20 meters in depth) the sediments are redistributed by long-shore currents, wave action, and entrainment in bottom-fast ice. In deeper water (approximately 20-45 meters) ice gouging plays a major role in reworking the shallow shelf sediments. In still deeper water, ocean currents and internal waves may act as the predominant sediment transport mechanisms.

Regional Geology

The northern coast of Alaska is divided into two major geologic provinces: the Arctic Platform and the Brookian Basins. The Arctic Platform is the oldest, composed of southerly dipping Paleozoic and Mesozoic rocks. To the north the younger Brookian Basins consist of Cretaceous and Tertiary strata. These two geologic regions are separated by a crustal flexure composed of down-to-the-north basement faults called the Hinge Line.

Pre-Quaternary

Northern Alaska stratigraphy is divided into four main sequences—the *Franklinian*, *Ellesmerian*, *Rift*, and *Brookian* sequences, which are separated by major unconformities representing major periods of uplift or rifting. The *Franklinian* sequence is composed of metamorphosed sedimentary and volcanic rock defined as acoustic basement. The *Franklinian* sequence is characterized from seismic data by the absence of coherent internal reflections. The *Franklinian* sequence is truncated by the Ellesmerian unconformity, which represents the Middle to Late Devonian Ellesmerian Orogeny. This unconformity formed the top of the stable shelf of the Arctic Platform. The overlying *Ellesmerian* sequence is Late Devonian to Jurassic in age. The Ellesmerian sequence is overlain by the Jurassic to Cretaceous *Rift* sequence. The Colville Basin formed on the southward-tilted Arctic platform between the Barrow Arch to the north and the Brooks Range to the south. Shelf-margin basins formed north of the Barrow Arch. These basins are filled by the *Brookian* sequence that consists of thick northeast-prograding sediments deposited in basin, basin-slope, shallow marine, and nonmarine shelf environments. These sediments were derived from the ancestral Brooks Range orogenic belt to the south and southwest. The Brookian sequence, Early Cretaceous to Pliocene in age, is the thickest and most widespread sedimentary sequence with sediments as thick as 13,700 meters. The Brookian depositional cycle ended with the beginning of the Plio-Pleistocene glacial episodes of deposition.

Quaternary

Pleistocene strata of the North Slope include terrestrial and marine deposits of the Gubik Formation and cover most of the coastal plain to a depth of approximately 30 meters, thickening seaward to approximately 100 meters offshore. The Pleistocene sequence exhibits a number of regional internal unconformities. These may represent the base of the late Pleistocene and a shallower unconformity separating nonmarine from marine units. A prominent geophysical reflector marks the upper surface of the Pleistocene strata. This reflector is visible on seismic records collected offshore and has been interpreted to represent the exposed portion of the shelf during the latest Wisconsin glacial period. Although Holocene sediments thicken seaward, long-shore currents and ice gouge processes play a significant role in the distribution of the unit.

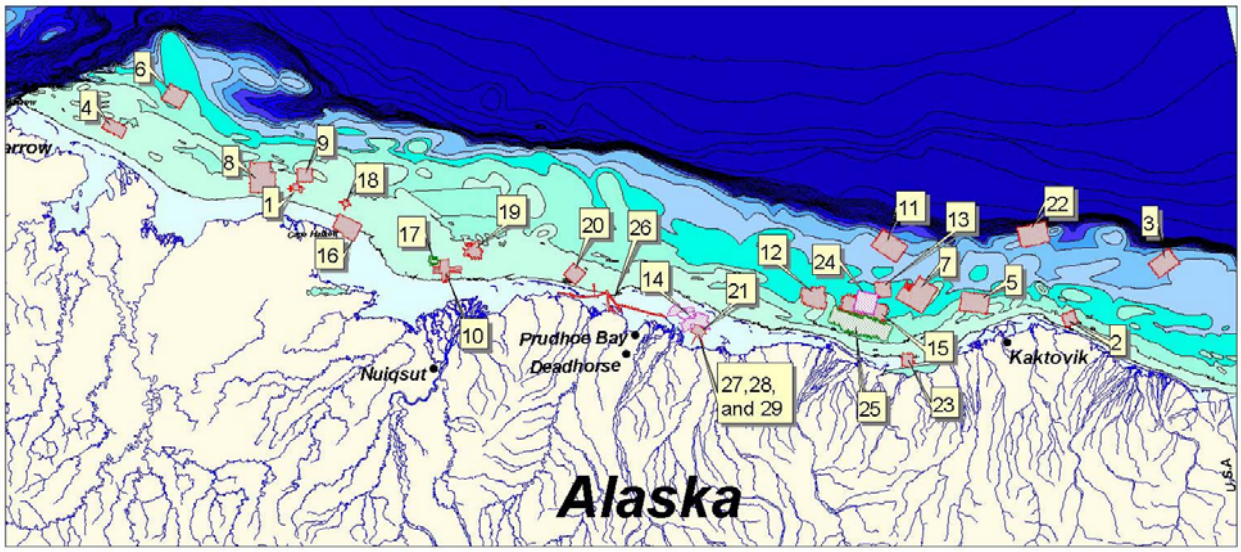
Boulder Patch

The Boulder Patch is found where the Flaxman Member of the Gubik Formation crops out on the sea floor. The Boulder Patch is an area of cobble and small boulder lag that provides a substratum for a diverse assortment of invertebrates and several species of kelp. Side Scan Sonar and Fathometer geophysical instruments were used in site-specific and pipeline surveys to collect data on the density and distribution of boulders in the Boulder Patch. Divers and Remotely Operated Vehicles (ROVs) were used

to verify the concentration of boulders and to collect additional data on associated kelp and invertebrate organisms. *Laminaria solidungula* is the predominate species of algae found in the Boulder Patch. Sub-Bottom Profiler seismic data indicate that boulders on the shelf are located where Holocene sediments are absent, so the area surrounding the Boulder Patch is considered to be a non-depositional environment. Ice gouges are scarce due to the islands and shoals, which restrict the passage of large ice keels (Dunton, K.H., Reimnitz, E., Schonberg, S., 1982, An arctic kelp community in the Alaskan Beaufort Sea. Arctic 35:465-484). Also, in water depths between about 2 and 15 meters, stable floating shore-fast ice protects the sea floor from the impinging pack ice and associated ice gouging.

Inventory and Summary of Data Collected from each Survey

The following section provides the reader with a summary of the data collected for the site-specifc and pipeline-route surveys. Almost all of the information in this section is taken from the final reports for each survey. The surveys are listed in alphabetical order by site name; locations are shown on the map below.



Click on site name in the table below to link to the portion of the document that describes the *summary*, *seafloor conditions*, and *sub-seafloor conditions* for each shallow hazard survey. Similary, click on the pipeline route surveys to link to a description of their survey operations.

Map Site #	Site Name	Map Site #	Site Name
1	Antares	16	Mars
2	Aurora	17	Mukluk Island
3	Belcher	18	Orion
4	Cabot	19	Phoenix
5	Eric	20	Sandpiper Island
6	Canvasback (Gemini)	21	Tern Island
7	Corona	22	Thorgisl
8	Fireweed (ARCO)	23	Warthog
9	Fireweed (Shell)	24	West Maktar
10	Fur Seal	25	Wild Weasel
11	Galahad	26	Northstar Pipeline Route Surveys*
12	Hammerhead (624 & 625)	27	Liberty Boulder Patch Suvey
13	Hammerhead (631)	28	Liberty Pipeline Route Surveys *
14	Karluk	29	Liberty Site Survey
15	Kuvlum		

* = multiple years of survey effort

Report Name	Antares 1 & 2 Geophysical and Geotechnical Site Evaluation of OCS Lease Y-0279 and Y-0280 Beaufort Sea	
Operator		**Name of Contractors and (Date of Final Report)**
Exxon Company USA		Harding Lawson Associates (July - 5 - 1983)
Site Name	**Data Type**	**Title of Map Digitized from Final Report**
Antares 1 & 2	Shotpoint	Trackline
Antares 1 & 2	Bathymetry	Bathymetry
Antares 1 & 2	Structure	Structure on Marker Horizon 1
Antares 1 & 2	Structure	Structure on Marker Horizon 2
Antares 1 & 2	Hazard	Acoustic Anomaly

SUMMARY

The shallow hazard survey area was conducted on the shallow Beaufort Sea continental shelf, approximately 15 miles northwest of Cape Halkett, Alaska (Figure 1). The survey was conducted between February 17 and March 22, 1983. Activities included: 1) multi-channel high-resolution geophysical survey; 2) A geotechnical boring sampling program; 3) A scuba diving program. This survey was conducted through ice.

SEAFLOOR CONDITIONS

Bathymetry and Seafloor Relief: Bathymetric data were obtained by lead-line soundings approximately every 300 feet along the survey lines. No meteorological tidal corrections were made on the data. Bottom topography appears to be best demonstrated within this survey as compared to the two adjacent fireweed surveys.

Divers identified ice gouging on the seabed. Ice gouging was encountered at every site. The report indicated that the Divers found fifty percent of the surveyed area covered with ice gouges. Measured gouges were between one and more than nine meters wide. The deepest gouges observed during the dives were approximately 1.5 meters deep. Orientations for all new ice gouges were north-south or northeast-southwest.

Dive Site Observations: The dive sites are spatially located in the database. The divers collected data on benthic communities and surficial seabed conditions. Occasional “dropstones” were observed throughout the dive sites.

SUB-SEAFLOOR CONDITIONS

Stratigraphy: Brookian sequence strata are found within the survey area. Brookian deposits thin to the north against the Barrow Arch. The Barrow Arch is located at approximately 2 seconds (two-way time) on the survey records. Tertiary sediments are absent in wells immediately south of the study area. Upper Cretaceous rocks are located near the surface. Shallow borings spudded and ended in fine-grained marine deposits (clayey silts). These fine-grained marine deposits and associated dropstones are thought to be part of the Flaxman Member of the Gubik Formation and interpreted as Pleistocene in age.

Structure: The zone of faulting is approximately 1300 meters wide. Faulting is normal and down to the north. There are two sets of faults. One set originates deep within the section and may be active since Cretaceous time. The other set is confined to within the upper one second of the reflection profile. All faults, with one exception terminate below 0.1 second reflection (two-way travel time).

Borings: Ten boreholes were drilled at three proposed sites. Borehole locations are not included within the database for this survey. The hardcopy reports only included the total depth, but did not include the geotechnical logs of the boreholes.

Report Name	Aurora Prospect Shallow Hazards Survey OCS Y-0943, Block 890 (NR 7-3)	
Operator		**Name of Contractors and (Date of Final Report)**
TENNECO OIL COMPANY		PELAGOS CORPORATION (September -1987)
Site Name	**Data Type**	**Title of Map Digitized from Final Report**
Aurora	Shotpoint	Navigation Postplot
Aurora	Bathymetry	Bathymetry
Aurora	Isopach	Sediment Isopach
Aurora	Structure	Shallow Structure
Aurora	Hazard	Geologic Hazards and Anomalies

SUMMARY:

The shallow hazard survey was conducted approximately 30 Kilometers northeast of the village of Kaktovik, Alaska (Figure 1). The high-resolution shallow hazards survey was performed by Western Geophysical for Tenneco Oil Company. The survey was conducted aboard the R/V Western Polaris between August 19-22, 1987. Pelagos Corporation interpreted the high-resolution seismic data.

SEAFLOOR CONDITIONS

Bathymetry and Seafloor Relief: Water depths values were plotted every twelfth shotpoint or every 150 meters. Tidal correction values for Flaxman Island were provided at 30-minute intervals. The tidal correction values ranged from 0.01 to 0.21 meters. Since the tidal correction values were so small, they were not applied to the bathymetric data. Ice has gouged and reworked the surficial sediments in water depths greater than 18 meters. Ice scour relief did not exceed one meter. Individual ice gouges ranged in width from one to a few meters. Gouge orientation was within 20 degrees of the shoreline. In water depths less than 16 meters, ice scour was nearly absent.

MMS interpretation of ice gouging: More specifically ice gouge intensity was very high in water depths greater than 20 meters, diminishing in intensity at water depths of 18 meters. In water depths less than 16 meters, ice gouge intensity diminished significantly.

SUB-SEAFLOOR CONDITIONS

Isopach: The isopach map shows two reflectors that define a general northeast thickening of shallow sediments. The isopach map displays laterally prominent seismic reflections that were not continuous throughout the survey. In a few areas, the acoustic return signal was poor and therefore not mappable. In these areas, the seismic horizons were extrapolated through the obscured data. Soil borings, not included in the report, describe over 20 meters of "dark-gray, clayey silt with some sparse laminae of sand, shell fragments and minor amounts of organic material disseminated though the core".

Structure: The shallow structure in the survey area was mapped based upon an unconformity between younger prograding sediments and underlying older flat lying strata. This structure is represented in the eastern portion of the study area. The western portion of the study area it is poorly discerned due to shallow reflectors that were difficult to interpret. Faulting was not identified within either area.

Seismic Anomalies: Shallow gas and permafrost were tentatively mapped within the shallow sediments.

Report Name	Belcher Prospect Geological Hazards Survey Outer Continental Shelf Beaufort Sea, Alaska, Covering all Portions of Blocks 681, 724, 725, 726, 728 and 769 UTM Zone 7	
Operator		**Name of Contractors and (Date of Final Report)**
AMOCO PRODUCTION COMPANY		COMAP GEOPHYSICAL SURVEYS (Nov-85)
Site Name	**Data Type**	**Title of Map Digitized from Final Report**
Belcher	Shotpoint	Survey Post-Plot
Belcher	Bathymetry	Bathymetry and Seafloor Features
Belcher	Structure	Structure
Belcher	Hazard	Drilling Constraints
Belcher	Isopach	Isopach and Shallow Geologic Features

SUMMARY

The shallow hazard survey was located approximately 64 Km. north-northwest of Demarcation Bay (Figure 1). This survey was conducted between August 11 and 28, 1985 from the survey vessel M/V/ Arctic Rose. Survey conditions were impeded by poor weather conditions, which at times consisted of 6 to 8 foot seas and mobile sea ice. Fresh water influx also caused some equipment problems.

SEAFLOOR CONDITIONS

Bathymetry and Seafloor Relief: The Echosounder geophysical instrument provided good water depth data. The data was not corrected for small tidal range of less than 1 foot since the survey is located on the outer shelf and upper continentel slope. The seafloor is very irregular over most of the survey with micro-relief up to 4 meters. This micro-relief is the result of ice gouging from large ice keels and deeper pressure ridges of pack ice. The individual gouges vary in width from 5 to 50 meters. The depth of the gouges range between 1 and 2 meters below the general seafloor, with adjacent parallel gouge ridges of 1 to 2 meters. The overall relief being up to 4 meters. The deepest gouge beneath the seafloor was approximately 4 meters. Individual ice gouges are laterally very extensive and can be traced between adjacent lines. The gouges are uniformly distributed over the survey area except for the area beyond the shelf break (> 60 meters) where fewer ice gouges were observed. The predominate orientation of the gouges are northwest and southeast. Some of the ice gouges are steep sided and appear to have been recently formed.

Surficial Sediments: Low to medium acoustic reflectivity from the side-scan sonar data may indicate surficial sediment cover of soft, fine-grained sediments.

SUB-SEAFLOOR CONDITIONS

Isopach and shallow Stratigraphy: The Sub-Bottom Profiler and the Boomer data systems were used to map three shallow near-surface sedimentary units, Units A, B, and C. Unit A is located in the northeastern quadrant of the survey area. This unit rests on a very irregular surface thickening to the northeast where it pinches out around a linear northwest-southeast trending subsurface mound. This unit was interpreted as being Holocene in age because of non-stratified acoustic signature. Unit A is underlain by a “complexly stratified” Unit B. Unit B’s complex stratigraphy is represented by “irregular hummocky mounds”, “apparent channeling”, “cut and fill structures”, “overlapping”, and “foreset bedding” typically representative of a deltaic and coastal environment. The southwestern edge of Unit B is interpreted as a paleo-shoreline where the unit outcrops at the surface. Unit C is west of Unit B and consists of well-bedded internal reflectors. This units overlies and infills a highly irregular surface. Unit C is interpreted as being Pleistocene in age.

Structure: A shallow and a deep anticlinal structure were identified on the seismic data. The shallow anticline trends southwest-northeast, whereas the deeper anticline, interpreted to be the eastern extension of the Camden Anticline trends northwest-southeast. Two linear zones of faulting are located in the southwest quadrant of this survey. The shallow depths of these faults indicated recent movement.

Seismic Anomalies: Several areas of possible gassy sediments were located within the southwest quadrant of the survey area.

Report Name	Cabot Prospect High Resolution Geophysical Survey and Assessment of Potential Shallow Drilling Hazards Dease Inlet (NR 5-1) Blocks 688/689 OCS-Y-0747/Y-0748 Beaufort Sea, Alaska	
Operator		**Name of Contractors and (Date of Final Report)**
EXXON COMPANY USA		FUGRO-MCCLELLAND MARINE GEOSCIENCES, INC. (March -1990)
Site Name	**Data Type**	**Title of Map Digitized from Final Report**
Cabot	Shotpoint	Shotpoint
Cabot	Bathymetry	Water-Depth
Cabot	Isopach	Isopach of Sediments above Horizon A
Cabot	Structure	Structure of Simpson Canyon
Cabot	Structure	Shallow Structure, Horizons B and C
Cabot	Hazard	Geologic Features
Operator		**Name of Contractors and (Date of Final Report)**
ARCO ALASKA, INC.		FUGRO-MCCLELLAND MARINE GEOSCIENCES, INC. (August-9-1991)
Site Name	**Data Type**	**Title of Map Digitized from Final Report**
Cabot No. 1	Bathymetry	Detailed Bathymetry
Cabot No. 1	Bathymetry	Detailed Bathymetry - 0.5 ft Contour Interval

SUMMARY

A shallow hazard survey was conducted for the proposed offshore well at the Cabot #1 Prospect, approximately 10 Kilometers north of Dease Inlet in the western Beaufort Sea (Figure 1). The field program was completed from the ice sheet during the period of April 15 to April 25, 1991. Sea ice conditions at the Cabot Site limited access across the proposed site. The ice was rafted producing deep keels, and mobile ice in the water column. Ice thickness varied from 5 to 42 feet.

SEAFLOOR CONDITIONS

Bathymetry and Seafloor Relief: Site bathymetry data was collected from CTD data points collected during the ROV survey and by Swath Bathymetry techniques. Swath Bathymetry was collected over the proposed drill site location. These detailed contours are in the database but only cover a very small area of the total survey. The seafloor is highly irregular at the drill site. The generalized contour map for this survey are contours displayed as mean water depth and do not illustrate the micro-relief caused by the extensive ice gouging.

Forward Looking Sonar was used to detect ice gouging beneath the surface ice canopy. The seafloor is covered with extensive ice gouging. According to the report, the site is located within an area of very heavy gouging called the Stamukhi Zone. The ROV verified the presence of a heavily gouged and disturbed sediment surface.

SUB-SEAFLOOR CONDITIONS

Stratigraphy: The site consists of a thin veneer of Holocene sediments over a thick section of Pleistocene strata. The report suggests that ice gouges may have reworked the upper portions of the Pleistocene sediments. The isopach map shows the approximate thickness, in meters of sediments of Holocene and upper Pleistocene age. ROV Visual Observations were taken but not included in the database.

Structure: Three horizons were mapped for this survey. The individual horizons can be separated in the database by selecting the field “struct-hor” and by “unique” value. Horizon A is mapped as the base of Simpson Canyon. Simpson Canyon truncates the sediments of Horizon B and C. Horizon B underlies the eastern side of the Simpson Canyon and Horizon C underlies the western side of Simpson Canyon. Both Horizons B and C are interpreted from the report to be Brookian events. Horizon B displays east-southeast striking faults that are predominately down to the North.

Seismic Anomalies: Areas of gassy sediments are interpreted to be present within the fill of Simpson Canyon and within other parts of the surveyed area outside the canyon fill.

Report Name	Canvasback (Gemini) Prospect OCS-Y 0729 Geological Hazard Assessment Beaufort Sea, Alaska OCS	
Operator		**Name of Contractors and (Date of Final Report)**
CHEVRON U.S.A. INC.		PELAGOS CORPORATION (March -1990)
Site Name	**Data Type**	**Title of Map Digitized from Final Report**
Canvasback (Gemini)	Shotpoint	Navigation Postplot
Canvasback (Gemini)	Bathymetry	Bathymetry
Canvasback (Gemini)	Isopach	Sediment Isopach
Canvasback (Gemini)	Structure	Shallow Structure
Canvasback (Gemini)	Hazard	Hazards and Anomalies

SUMMARY

The shallow hazard survey was conducted approximately 80 Kilometers northeast of Point Barrow on the Beaufort Sea Continental Shelf (Figure 1). The survey was conducted between August 5 and 10, 1989. Pelagos Corporation and Western Geophysical collected geophysical data and Harding Lawson Associates (HLA) collected geotechnical data for the Canvasback (Gemini) Prospect.

SEAFLOOR CONDITIONS

Bathymetry and Seafloor Relief: The seafloor within the survey area slopes gently to the northeast at a gradient ranging from approximately 0.5 to 20 meters per Kilometer. Water depths range from 32 meters in the southwest corner of the survey area to 43 meters in the northeast corner. Micro-relief has developed from active seasonal ice gouging which has reworked the surficial sediments. Heavy ice gouging was identified on side-scan records. Individual ice gouges range from 1 to few tens of meters across. The ice gouges were reported to be mostly five meters in depth and some as much as 8 meters deep.

SUB-SEAFLOOR CONDITIONS

Surficial Samples and Borings: Three Van Veen grab samples were taken at the site. All samples were clay. These samples are not in the database. The geotechnical report utilized borings 6 and 9 from a Harding Lawson and Associates (HLA) study done in 1982 called Harding Lawson Associates (HLA), 1982 Harrison Bay, Geotechnical Study, prepared for the Alaska Oil and Gas Association. Only the surface locations for these borings are in the database.

Isopach: Sub-Bottom Profiler and Geopulse instruments were used to interpret the near surface stratigraphy. Sediment thickness is between 10 and 18 meters. These sediments are interpreted to be Pleistocene in age, but may also include Holocene sediments. A buried channel was identified in the northeast corner of the survey.

Structure: The Canvasback Survey is located in the Nuwuk Basin, which contains over 12,000 meters of Cretaceous and Tertiary Brookian sequence clastic sediments. A fairly continuous high amplitude reflection was chosen to trace the shallow structure. The faults are restricted to the Brookian sequence, and do not displace pre-Brookian bedrock or the overlying Pleistocene/Holocene sediments.

Report Name	Corona Prospect Block NR-6-4-678 Vicinity, Geological Hazards and Constraints Camden Bay Area, Beaufort Sea, Alaska	
Operator		**Name of Contractors and (Date of Final Report)**
UNION-SHELL-AMOCO BIDDING GROUP		DAMES AND MOORE (April -1985)
Site Name	**Data Type**	**Title of Map Digitized from Final Report**
Corona	Shotpoint	Survey Post Plot
Corona	Bathymetry	Bathymetry
Corona	Isopach	Surficial Sediment Thickness
Corona	Structure	Structure (Time) Contour
Corona	Hazard	Composite Anomaly

SUMMARY:

The shallow hazard survey for the Corona exploration well was conducted approximately 30 Kilometers north-northeast of Camden Bay, Alaska (Figure 1). Northern Technical Servicies collected marine geohazard data for zone A, Block 678 during the period September 22-25, 1984. The Crowley Marine ocean-going tug " Point Thompson" conducted the survey operations. Weather conditions were very good on September 22 and 23 but deteriorated on the 25th with winds reaching 25 knots forcing sea ice to move into the area. Ice did not interfere with survey operations. McClelland Engineers used the M/V Frank Broderick to drill a soil boring during the month of September 1984.

SEAFLOOR CONDITIONS

Bathymetry and Seafloor Relief: Water depths range between 31 and 43 meters. The datum is MLLW, although these measurements were estimated based upon predicted tides in the area. These depths were smoothed through the irregular micro-relief caused by the extensive ice gouging. The northern part of the survey displays a smooth more regular sloping surface whereas the central and southern area is characterized by a highly irregular surface, with irregular depressions and low relief shoals. The shoals may be pre-Holocene relict beach ridges, or barrier islands that were drowned by the rising sea level. Alternatively, these features may have been the result of ice/seafloor interaction.

The Side-Scan Sonar and Sub-Bottom Profiler data imagery identified many ice gouges over the survey area. Ice gouging affect a large percentage of the survey area, with the orientations predominately east-west and WNW-ESE. The most notable gouges are 2 to 3 meters deep and 10 to 15 meters in width.

SUB-SEAFLOOR CONDITIONS

Isopach: The isopach was measured in milliseconds based upon a velocity of 1500 meters/sec. The single core taken in the survey area was interpreted to have a thin layer of Holocene silty clay overlying poorly graded sand of Pleistocene age. Ice-bonded soils were observed below the seabed at approximately 12.2 meters.

Structure: Extensive faulting was identified on seismic records. These faults trend east-west and are predominately normal faults. Most of the faulting is down to the north, except for the southeast corner of the survey block where localized uplift has caused down to the south faulting. The faults exhibit probable surface offset.

Seismic Anomalies: Water column anomalies, acoustic turbid zones, acoustic wipe-out zones and bright spots were identified on the seismic records.

Report Name	Eric OCS Y-0912 Potential Geologic Hazards and Constraints Block NR7-3-7O5/Vicinity Camden Bay Area, Beaufort Sea, Alaska	
Operator		**Name of Contractors and (Date of Final Report)**
UNION-SHELL-AMOCO BIDDING GROUP		DAMES AND MOORE (April -1985)
Site Name	**Data Type**	**Title of Map Digitized from Final Report**
Eric	Shotpoint	Survey Postplot
Eric	Bathymetry	Bathymetry
Eric	Isopach	Surficial Sediment Thickness
Eric	Structure	Structure (Time) Contour
Eric	Hazard	Composite Anomaly

SUMMARY

The shallow hazard survey for the Eric drilling prospect was conducted approximately 10 Kilometers northwest of Barter Island, Alaska (Figure 1). The marine geophysical survey was conducted between September 11 and 25, 1984. High-resolution seismic data was acquired by Marine Technical Services. Dames & Moore completed the data interpretation, mapping, and wrote the report.

SEAFLOOR CONDITIONS

Bathymetry and Seafloor Relief: The isobaths range between 21 and 38 meters. The bathymetric contours are in one-meter contour intervals which clearly illustrates the complex relief in this area of the shelf. An area of very complex relief occurs between 27 and 33 meters of water depth. This area of complex relief was formed in part by heavy ice gouging. A large elongate feature is found at the north central boundary of this complex area of seafloor relief. The feature is approximately 5 kilometers long and 1 kilometer in width. To the northwest and southeast of the area of complex relief is an area of the seafloor that exhibits very gentle relief. The ice gouge trend generally parallels to the overall bathymetric contour. Individual ice gouges observed in the seismic data records have an approximate maximum vertical height of 3 meters from the seafloor to the bottom of the trench.

Surficial Sediments: The Side-Scan Sonar seismic records displays different bottom reflectivity between the western and eastern portions of the survey. In the western section of the survey ice gouging is very distinct. According to the report less dense signal characteristics are interpreted as possible cohesive surficial sediments. In contrast, the eastern portion of the survey area displays a “very dense signal characteristic” which possibly might represent coarser grained surficial sediments.

SUB-SEAFLOOR CONDITIONS

Isopach: Three shallow horizons were mapped over the survey area. These are horizons A, B, and C. The user can define the horizons by defining a unique value under the field name “description” in the database. Based upon a review of the seismic records, the uppermost sedimentary unit of the eastern portion of the survey differs in its seismic signature from the uppermost unit found in the western portion of the surveyed area. The report states that the “eastern section may represent “relict” material from earlier fluvial glacial processes”.

Permafrost: Ice was encountered in sediments below 22 meters in the boring. The interpreters were unable to locate a horizon that followed the top of the ice-bonded sediment surface.

Structure: The major structural feature in the survey was found to be a broad anticlinal fold trending northeast southwest. East-west tensional faulting dominates the structural pattern. Many of the faults are shallow, coming close to the seafloor. This area is actively being uplifted as evident by the thin section of Holocene sediments and the faulting that approaches the surface. The prominent subsurface structural horizon included in the database is not traceable throughout the survey area.

Seismic Anomalies: The database can be queried under Seismic Anomalies by “Unique” and “Seis_Type” in order to differentiate the types of seismic anomalies identified within the seismic data. According to the report, indications of shallow gas were mainly identified from true amplitude processing of CDP data. Shallow gas was also tentatively identified with the Boomer data.

Report Name	Fireweed (Shell) Potential Geological Hazards and Constraints Block NR 5-2-883 Vicinity Near Cape Halkett, Beaufort Sea, Alaska	
Operator		**Name of Contractors and (Date of Final Report)**
Shell Oil Company		DAMES AND MOORE (January -1984)
Site Name	**Data Type**	**Title of Map Digitized from Final Report**
Fireweed (Shell)	Shotpoint	Survey Post Plot
Fireweed (Shell)	Bathymetry	Bathymetry
Fireweed (Shell)	Isopach	Surficial Sediment Thickness
Fireweed (Shell)	Structure	Structure (Time) Contour
Fireweed (Shell)	Hazard	Composite Anomaly

SUMMARY

The Fireweed shallow hazard survey was conducted on the Beaufort Sea inner shelf, about 30 kilometers northwest of Cape Halkett. This survey location was just north of the Antares shallow hazard survey (Figure 1).

SEAFLOOR CONDITIONS

Bathymetry and Seafloor Relief: The bathymetric contours are in 1- meter contour intervals. Water depths range between 15 and 21 meters. Ice keel gouges are found on all records. Crest to trough amplitudes ranged between 1 and 4 meters. The most recent gouge trend generally NW-SE. Some long and deep gouges trend E-W. This site is located on the inshore edge of the Stamuki Zone.

SUB-SEAFLOOR CONDITIONS

Structure: Two large faults cut across the survey area. They are north-northwest trending down to the north normal faults.

Seismic Anomalies: Large areas of shallow gas have been interpreted to exist within this survey area. Gas appears to be associated with faults.

Report Name	Fireweed (ARCO) Prospect Geological Hazards Survey Harrison Bay, Beaufort Sea, Alaska Covering Tracts 71-7, 71-11 and 71-12	
Operator		**Name of Contractors and (Date of Final Report)**
ARCO ALASKA, INC.		COMAP GEOPHYSICAL SURVEYS (January -1985)
Site Name	**Data Type**	**Title of Map Digitized from Final Report**
Fireweed (ARCO)	Shotpoint	Survey Post Plot Chart (Digital)
Fireweed (ARCO)	Bathymetry	Bathymetry and Seabed Features
Fireweed(ARCO)	Isopach	Isopach Chart
Fireweed (ARCO)	Structure	Deep Structure Chart
Fireweed (ARCO)	Hazard	Drilling Constraints Chart
Fireweed (ARCO)	Structure	Shallow Structure Chart

SUMMARY

The shallow hazard survey was located approximately 30 Kilometers northwest of Cape Halkett, Alaska (Figure 1). The geohazards survey was conducted between August 13 and September 21, 1984. Survey operations were hampered by large mobile ice flows. The geophysical systems utilized in the survey included: hydrographic Echosounder, Side-Scan Sonar, Sub-Bottom Profiler, Boomer Profiler and 24 Channel seismic data.

SEAFLOOR CONDITIONS

Bathymetry and Seafloor Relief: The bathymetry map in the database is generalized. A more realistic example of the type of microrelief in the area is shown with the Antares survey to the east. The contractor reported extremely irregular microrelief in part caused by ice gouging of the seafloor. Individual scours average 2 meters in depth, with widths from 1 to 20 meters. The predominate ice gouge direction is NW-SE. This survey probably provides a good representative sample of the type and trend of ice gouging found within the adjacent Antares and Fireweed (shell) surveys to the east.

SUB-SEAFLOOR CONDITIONS

Stratigraphy: A prominent erosion surface from 3 to 11 meters beneath the seafloor may mark the Holocene/Pleistocene boundary.

Structure: In the south, numerous east to west trending, high angle normal faults produce minor horst and graben structures. Faulting in the north of the survey is dominated by east-west trending, downthrown to the north, growth faults. The central zone between the two major areas of east to west trending faults is undisturbed except for three north to south and north-northwest-southeast trending faults.

Seismic Anomalies: Shallow gas is prevalent within the seismic sections.

Report Name	Fur Seal Island Site Potential Geological Hazards and Constraints Block NR 5-4-370, Lease OCS Y-0353, Tract 71-220 Harrison Bay, Alaska	
Operator		**Name of Contractors and (Date of Final Report)**
TEXACO USA		DAMES AND MOORE (November -1983)
Site Name	**Data Type**	**Title of Map Digitized from Final Report**
Fur Seal Island	Shotpoint	Shotpoint
Fur Seal Island	Bathymetry	Bathymetry
Fur Seal Island	Hazard	Composite Anomaly
Fur Seal Island	Structure	Structure (Time) Contour Late Cretaceous - Tertiary Reflector

SUMMARY:

The Fur Seal Island shallow hazard survey was conducted approximately 15 Kilometers north of the Colville River delta (Figure 1). The high-resolution survey was carried out between September 10 and 21, 1983.

SEAFLOOR CONDITIONS

Bathymetry and Seafloor Relief: Water depth data was provided by a 38 KHz Simrad EA Echosounder. Side-Scan Sonar was collected to interpret seafloor features. The seafloor is dominated by irregular shallow ice–keeled gouges and associated flanking ice ridges. Ice gouges were reported to cover 50% of the seafloor.

SUB-SEAFLOOR CONDITIONS

Stratigraphy: The boring in the database penetrated strata down to approximately 38 meters. The upper 8 meters of strata is mostly clayey silt, unbonded, interpreted as Holocene in age. The strata just below the Holocene section are Pleistocene strata, made up of fine sand and silty clay. These Pleistocene strata are ice-bonded. Three Cone Penetration Tests (CPT) were completed for the survey but not entered into the database.

Structure: The northeast corner of the survey contains northwest trending down to the north, normal faults. Displacement of the shallow Holocene/Pleistocene horizon is not readily evident.

Seismic Anomalies: The map shows numerous areas over the survey area that displays amplitude and possible water-column anomalies that might suggest the presence of shallow gas.

Report Name	Galahad Prospect OCS Y-1092, Block 412 (NR 6-4) Geological Hazard Assessment Beaufort Sea, Alaska OCS	
Operator		**Name of Contractors and (Date of Final Report)**
AMOCO PRODUCTION COMPANY		PELAGOS CORPORATION (February -1990)
Site Name	**Data Type**	**Title of Map Digitized from Final Report**
Galahad	Shotpoint	Navigation Postplot
Galahad	Bathymetry	Bathymetry
Galahad	Isopach	Sediment Isopach
Galahad	Structure	Shallow Structure
Galahad	Hazard	Hazards and Anomalies

SUMMARY

The shallow hazard survey for the Galahad exploratory well was located on the Beaufort Sea continental shelf and slope approximately 60 Kilometers northeast of Flaxman Island (Figure 1). Western Geophysical and Pelagos Corporation conducted a high-resolution seismic survey for Amoco Production Company between September 4 and 8, 1989. The vessel M/V Arctic Star utilized a suite of geophysical instruments to collect the pertinent data.

SEAFLOOR CONDITIONS

Bathymetry and Seafloor Relief: Tidal corrections were made to the data based upon the information collected at 30-minute intervals from the Flaxman Island Tidal Station. Tides ranged between 0.0 to 0.2 meters. Ice gouging has actively reworked the seafloor. Ice gouges were reported to be one to several meters across and less than two meters in depth. Ice gouges are generally oriented in an east-west direction.

SUB-SEAFLOOR CONDITIONS

Isopach and Near Surface Sediments: The Sub-Bottom-Profiler data and the GeoPulse data display an acoustically transparent geologic section in most areas of the survey except for the central and eastern sectors. These zones show horizontally bedded sediments. Holocene sediments are reported to be very thin within the survey area. The Holocene/Pleistocene boundary is unknown in the survey area. The upper 50 meters of near-surface strata consists of hummocky reflectors. The base of this hummocky unit is a set of more coherent reflections. The sediments above these coherent reflections were selected as the mapped isopach horizon.

Shallow Structure: A set of northwest-southeast and east-west faults offset the mapped structural horizon. Apparent offsets are approximately 20 milliseconds, although correlation across the faults was difficult because of the discontinuous nature of the reflectors. One fault identified on the seismic data offsets sediments interpreted to be as young as Pleistocene in age.

Seismic Anomalies: In the northeastern and southwestern portion of the survey area, acoustically amorphous zones on the Sub-Bottom Profiler data were interpreted as concentrations of near surface gas. These interpreted near surface gas concentration were not apparent in the deeper strata interpreted from the GeoPulse data.

Within the southern area of the survey, a large area of high-amplitude reflectors or “bright spots” were observed on the deep seismic data. The gas effect zone lies within the first 150 milliseconds of the Sub-Bottom Profiler data to at least 1.0 second of the deeper data. Velocity sags were also interpreted on deeper horizons underlying the bright spots, according to the report suggesting a “strong potential high gas concentrations and possible over-pressurization.

Several water column anomalies were observed on the Sub-Bottom Profiler data in the southwestern portion of the survey area.

Report Name	Hammerhead (624 & 625) Data Report NR 6-4 Federal OCS Lease Blocks Beaufort Sea, Alaska OCSY 0849 & 0850	
Operator		**Name of Contractors and (Date of Final Report)**
UNION OIL COMPANY OF CALIFORNIA		NORTHERN TECHNICAL SERVICES (February -1985)
Site Name	**Data Type**	**Title of Map Digitized from Final Report**
Hammerhead (624, 625)	Hazard	Potential Shallow Hazards
Hammerhead (624, 625)	Other	Shallow Channel Distribution
Hammerhead (624, 625)	Bathymetry	Bathymetry
Hammerhead (624, 625)	Shotpoint	Shiptrack and Shot Points
Hammerhead (624, 625)	Isopach	Surficial Sediment Isopach
Hammerhead (624, 625)	Structure	Shallow Structure

SUMMARY:

The shallow hazard survey was conducted approximately 16 Kilometers north of Flaxman Island (Figure 1). Union Oil Company of California conducted a high-resolution site-specific shallow hazards survey between September 8 and 20, 1984. Northern Technical Services (NORTEC) was contracted by Union Oil Company to conduct the survey.

During the 8-10 days of the survey weather conditions were excellent with nearly flat seas and low to zero wind conditions. On a couple of occasion's wind speeds forced the shutdown of equipment. Pack ice moved into the southern portion of the survey area, but did not interfere with the data collection efforts.

SEAFLOOR CONDITIONS

Bathymetry and Seafloor Relief: The bathymetry was contoured in three-meter contour intervals. This contour interval does not account for the irregular seafloor relief due to ice gouging at this water depth. Ice gouges are found throughout the survey area, ranging from a few meters to over 200 meters in width and from 1 to 5 meters in depth. An ice gouge trend analysis over a small area (6 square Kilometers, 5% of survey area) was conducted under this survey utilizing Side-Scan Sonar imagery. One third of the ice gouge trend east-northeast, one third trended east-southeast, and one third trended in directions scattered over the remaining 230 degrees of arc.

SUB-SEAFLOOR CONDITIONS

Sediments: Eight sediment samples were taken using Van Veen Grab sampler. In late September, McClelland-EBA drilled a hole and performed a cone penetrometer test. Bonded sediments were identified at approximately 24 meters below the seabed.

Isopach: The report identified a shallow acoustic reflector over the survey. This reflector coincides with the approximate depth of ice-bonded sediments

Structure: Two major parallel faults strike northwest-southeast. A dome like feature was detected between these two major faults. The depth of the dome like feature is at approximately 550 meters. Faults that cut the surfaces were not detected. The shallowest faults were detected at approximately 100 meters beneath the seafloor. These faults have very little relief.

Seismic Anomalies: Numerous seismic anomalies were identified in the geophysical data. Most are thought to represent shallow gas although this interpretation is uncertain. Seismic anomalies interpreted as "bright spots" (?) were associated with shallow faulting.

Report Name	Hammerhead (631) Data Report NR 6-4 Federal OCS Lease Blocks Beaufort Sea, Alaska OCS Y-0854	
Operator		**Name of Contractors and (Date of Final Report)**
UNION OIL COMPANY OF CALIFORNIA		NORTHERN TECHNICAL SERVICES (February - 1985)
Site Name	**Data Type**	**Title of Map Digitized from Final Report**
Hammerhead (631)	Hazard	Potential Shallow Hazards
Hammerhead (631)	Structure	Shallow Time Structure Contour
Hammerhead (631)	Bathymetry	Bathymetry
Hammerhead (631)	Shotpoint	Ships Tracks and Shot Points

SUMMARY

The shallow hazard survey was conducted approximtely 30 Kilometers northeast of Flaxman Island (Figure 1). Union Oil Company of California contracted to Northern Technical Services, Inc. (NORTEC) to conduct a shallow hazard survey for OCS Lease Block 631. Field data was collected between September 25 and 27, 1984. Weather conditions during the survey effort were excellent. Ice was present in the survey area, but not in sufficient concentration to impede the survey operations.

SEAFLOOR CONDITIONS

Bathymetry and Seafloor Relief: The bathymetric contour interval was contoured at 3- meter intervals. The bathymetry map at the three-meter contour interval does not account for the irregularity of the sea floor which is covered by ice gouges. Ice gouges range in width between 3 and 200 meters and 1 to 5 meters in vertical height. The largest and most recent gouges trended east-west.

Surface Sediments: A single Van Veen Grab sample was taken at the intersection of lines 720 and 800. The report identified the sample to be soft very fine mud, which was most likely reworked by ice gouging. This sample is not in the database.

SUB-SEAFLOOR CONDITIONS

Structure: According to the report, the strike for most of the faults in the study area was difficult to map.

Seismic Anomalies: The report indicated that “Bright” reflectors associated with faults might indicate the presence of gas-charged zones in the geologic section. The center of the survey area is a highly turbid zone where interpretation of the data was difficult.

Report Name	Karluk Prospect Geophysical And Geotechnical Site Evaluation Beaufort Sea, Alaska	
Operator		**Name of Contractors and (Date of Final Report)**
CHEVRON U.S.A. INC.		HARDING LAWSON ASSOCIATES (October - 11-1988)
Site Name	**Data Type**	**Title of Map Digitized from Final Report**
Karluk	Shotpoint	Trackline
Karluk	Bathymetry	Bathymetric
Karluk	Bathymetry	Bathymetry Central Area
Karluk	Isopach	Isopach of Holocene Sediments
Karluk	Isopach	Isopach of Marine Sediments (Holocene and Uppermost Pleistocene)
Karluk	Other	Rock Cover

SUMMARY

The Karluk shallow hazard survey was located northwest of Foggy Island Bay, just west of the Liberty surveys (Figure 1). A total of 240 Km of geophysical data and 12 Km of underwater video data were collected during survey operations in the month of August 1988. A geotechnical investigation was conducted concurrently with the geophysical survey.

SEAFLOOR CONDITIONS

Bathymetry and Seafloor Relief: A Raytheon 200 kHz Fathometer and a DESO-20 digital Fathometer were used to collect the bathymetry data. Mean Sea Level varied during the survey operations between –0.3 to 0.3 meters. Ice gouges were reported scattered throughout the site. All gouges were reported to be shallow, less than 0.3 meters with gouge widths from 5 to 50 meters. The predominate gouge trends were northeast-southwest and northwest-southeast. There wasn't any evidence of strudel scours.

Boulder Patch: Irregular seafloor expressions were present within the southwest corner of the survey area as a result of the sea-floor highs caused by the Boulder Patch. The Boulder Patch was identified with Side-Scan Sonar records and verified at specific dive locations.

SUB-SEAFLOOR CONDITIONS

Borings and Subsurface Sediments: Harding Lawson also collected geotechnical data for the project and utilized borehole information from previous studies in the area. Harding Lawson collected box-core and Clam-shell samples on the site. These results were tied to deeper boreholes collected by HLA during an earlier survey in 1979. These boreholes were tied to the survey using geophysical data. These three deep HLA borings (HLA11, HLA13, and HLA14) are not included as part of this database. The soils at the site consisted of approximately 1.5 meters of silty sand and sandy silt. These strata were interpreted to be Holocene in age. Fine grained sand and silt of Pleistocene age strata extends to an approximate depth of 14 meters. Below 14 meters, a very dense gravelly sand and sandy gravel are present.

Permafrost: Ice-bonded permafrost was not identified within the site-survey since none of the shallow sediment samples penetrated Pleistocene sediments. Pleistocene ice-bonded sediments were found in deeper borings outside of the site survey within Stefanson Sound.

Acoustic Anomalies: Areas of seismic amplitude anomalies were identified within the northern and eastern portions of the site survey. The anomalies along the eastern portion of the survey exhibit total signal attenuation and are nearly continuous along the entire seismic profile. The northern area shows only partial signal attenuation along the seismic profile.

Report Name	Kuvlum Prospect OCS-Y 0866, Shallow Hazards Report Beaufort Sea, Alaska	
Operator		**Name of Contractors and (Date of Final Report)**
ARC0 ALASKA, INC.		DEEPSEA DEVELOPMENT SERVICES DIV. OF SAIC (*1/18/1993)*
Site Name	**Data Type**	**Title of Map Digitized from Final Report**
Kuvlum	Shotpoint	Postplot
Kuvlum	Bathymetry	Bathymetry
Kuvlum	Isopach	Isopach of Horizon 1
Kuvium	Isopach	Isopach of Horizon 2
Kuvium	Structure	Shallow Structure
Kuvlum	Hazard	Geologic Features

SUMMARY

In October 1992, DEEPSEA Development Services, a division of SAIC performed a high-resolution geophysical survey over portions of the Kuvlum Prospect. The survey was located 15 Km. northwest of Camden Bay (Figure 1). The field effort was limited by extreme ice conditions. The survey equipment was mobilized on the M/V/Kigoriak, a class IV Ice-Breaker. Water column anomaly detectors did not function properly because of the surrounding ice and the ice scrapping along the ship's hull. Due to the heavy ice conditions, the geophysical instruments were located at the stern of the Ice-Breaker.

SEAFLOOR CONDITIONS

Bathymetry and Seafloor Relief: Water depth values were checked against the Blocks 673 and 674 Fugro-McClelland 1992 report. Depths were selected at 500 meter intervals along the survey line. No corrections were made for tides. The seafloor is heavily gouged. The ice gouges provide significant relief along the seafloor. The gouges display relief of up to 4 meters.

SUB-SEAFLOOR CONDITIONS

Isopach: Two separate horizons were mapped over the survey area. One horizon was the same horizon mapped under the Fugro-McClelland 1992 report for Blocks 673 and 674. Some parts of the survey were so heavily gouged that return signals from seismic were poor. Isopach Horizon 1, field name = iso_horiz # 23 in the database was mapped from the Sub-Bottom Profiler data. Thickness of this unit ranges between 2 and 10 meters. This horizon is mappable over the prospect. The isopach thins to the northeast. This horizon is considered to be the extent of the Holocene sediments in the survey.

Unit 2 is bounded by the two isopach horizons. The boundary between Units 1 and 2 probably represents the base of the Holocene(?). Isopach horizon two (2) represents the total thickness of units 1 and 2. Horizon 2 thins across the major northwest trending faults that cuts the survey. Filled channels are found stratigraphically within Unit 2. These channels may represent fluvial channels filled with coarser grained sediments cutting into older more finer-grained marine transgressive sediments. Unit 3 is considered to be Pleistocene in age, but was not observed in the survey area. Unit 4 is probably Tertiary fluvial-deltaic deposits.

Structure: A northwest trending growth fault system cuts the northern portion of the survey. The growth on the north side of the faults is related to basin subsidence. Offsets of up to 400 milliseconds, are evident across the north side of the fault. All near surface faulting within the survey are related to this major fault system, especifically at its southern edge. All of the mapped faults in the prospect are considered active. This is because of the offset of Horizon 1, and the recorded earthquakes in this area. Drilling operations should not be conducted in the vicinity of the faults in this area due to their active nature.

Seismic Anomalies: Three distinct types of amplitude anomalies were identified from seismic data records in the sub-seabed geologic section. The database can be differentiated by the "unique" value of "seis_type" to obtain the different seismic anomalies that were mapped. An extensive area of possible gassy sediments trends along the major growth fault system. Seismic anomalies indicative of gas were identified within the deep seismic data.

Report Name	Liberty Development 1997 and 1998 Boulder Patch Survey	
Operator		**Name of Contractors and (Date of Final Report)**
BP EXPLORATION (ALASKA), INC.		COASTAL FRONTIERS CORPORATION (CFC) (July -1998)
Site Name	**Data Type**	**Title of Map Digitized from Final Report**
Liberty Boulder Patch	Other	Liberty Development 1997-98 Boulder Patch
Liberty Boulder Patch	Shotpoint	Tracklines with Sonar and ROV data - area 1
Liberty Boulder Patch	Shotpoint	Tracklines with Sonar and ROV data - area 2
Liberty Boulder Patch	Shotpoint	Tracklines with Sonar and ROV data - area 3
Liberty Boulder Patch	Shotpoint	Tracklines with Sonar and ROV data - area 4
Liberty Boulder Patch	Shotpoint	Tracklines with Sonar and ROV data - area 5
Liberty Boulder Patch	Shotpoint	Tracklines with Sonar and ROV data - area 6

SUMMARY:

The survey was conducted in part for the proposed Liberty Development Project located in Foggy Island Bay, approximately 2.5 Kilometers southeast of the Endicott Satellite Drilling Island (SDI) (Figure 1).

The information contained within the database are the data from the sea bottom survey conducted during the 1997 open-water season and 1998 winter season in support of the proposed Liberty Development Project. The 1997 field program commenced on August 11 with an initial dive reconnaissance and then an extensive side scan and multi-beam sonar survey from August 17 to August 28. A Remotely Operated Underwater Vehicle (ROV) verification program was conducted from August 29 through 31 and from September 11 through 14. The poor visibility encountered during the 1997 ROV survey resulted in the addition of an over ice ROV survey in April, 1998. The winter 1998 ROV survey was conducted between April 2 through April 8, 1998.

The primary objective of the 1997-1998 survey was to characterize potential Boulder Patch habitat in areas that could be affected by the proposed Liberty Development. The report stated the following specific objectives for the collection of these data: (1) to document the absence or presence of the Boulder Patch communities at the planned site of the Liberty Production Island; (2) to document the absence or presence of Boulder Patch communities on the three candidate pipeline routes (West Pipeline Route, East Pipeline Route, and SDI Pipeline Route) (3) to estimate the distribution of Boulder Patch habitat along the fifteen North-South transects that encompass a large region in Stefansson Sound surrounding the project site.

The process used by the contractor to establish the percentage of Kelp attached to the rock substrate was the following: (1) The sea bottom beneath each track line was classified by target concentration on the basis of side scan and multi-beam sonar records; (2) Visual confirmation of the absence or presence of Boulder Patch habitat in critical areas by the ROV video tapes; (3) Findings from the two previous steps were utilized to estimate the locations and densities of the Boulder Patch habitat.

The database can be queried by adding the Boulder Patch shapefile via the ArcView Extension and classifying the Boulder Patch by Bpatch_desc or Bpatch_code. The Sea Floor Visual Observations shapefile, (points) provides additional information on the concentration of rock, bivalve shells, and kelp types attached to those surfaces. The SROV and WROV are the summer and winter ROV sites respectively, whereas the DS numbers are the dive sites

Report Name	Liberty Development 1997 and 1998 Pipeline Route Surveys	
Operator		**Name of Contractors and (Dates of Final Reports)**
BP EXPLORATION (ALASKA), INC.		COASTAL FRONTIERS CORPORATION (CFC) (May –1999 and December - 1999)
Site Name and Year	**Data Type**	**Title of Map Digitized from Final Report**
Liberty Pipeline 1997	Other	Strudel Hole and Overflood Limit Location
Liberty Pipeline 1997	Shotpoint	Track Lines, Ice Gouges, and Strudel Scours
Liberty Pipeline 1997	Shotpoint	Track Lines, Ice Gouges, and Strudel Scours
Liberty Pipeline 1997	Shotpoint	Track Lines, Ice Gouges, and Strudel Scours
Liberty Pipeline 1997	Shotpoint	Track Lines, Ice Gouges, and StrudeF Scours
Liberty Pipeline 1997	Shotpoint	Track Lines, Ice Gouges, and Strudel Scours
Liberty Pipeline 1997	Shotpoint	Track Lines, Ice Gouges, and Strudel Scours
Liberty Pipeline 1997	Shotpoint	Track Lines, Ice Gouges, and Strudel Scours
Liberty Pipeline 1997	Shotpoint	Track Lines, Ice Gouges, and Strudel Scours
Liberty Pipeline 1997	Shotpoint	Track Lines, Ice Gouges, and Strudel Scours
Liberty Pipeline 1997	Shotpoint	West Pipeline Corridor Bathymetry
Liberty Pipeline 1997	Bathymetry	West Pipeline Corridor Bathymetry
Liberty Pipeline 1998	Other	Strudel Hole and Overflood Limit Location
Liberty Pipeline 1998	Other	Strudel Hole and Strudel Scour Location
Liberty Pipeline 1998	Shotpoint	Track Lines, Ice Gouges, and Strudel Scours
Liberty Pipeline 1998	Shotpoint	Track Lines, Ice Gouges, and Strudel Scours
Liberty Pipeline 1998	Shotpoint	Track Lines, Ice Gouges, and StrudeF Scours
Liberty Pipeline 1998	Shotpoint	Track Lines, Ice Gouges, and Strudel Scours
Liberty Pipeline 1998	Shotpoint	West Pipeline Corridor Track Lines
Liberty Pipeline 1998	Shotpoint	West Pipeline Corridor Track Lines
Liberty Pipeline 1998	Shotpoint	West Pipeline Corridor Track Lines
Liberty Pipeline 1998	Bathymetry	West Pipeline Corridor Bathymetry
Liberty Pipeline 1998	Bathymetry	West Pipeline Corridor Bathymetry
Liberty Pipeline 1998	Bathymetry	West Pipeline Corridor Bathymetry

SUMMARY

Identical methods of data acquisition and analysis were conducted during the 1997 and 1998 Liberty Pipeline Route Surveys. Coastal Frontiers Corporation conducted a spring and summer survey phase. During the spring (May 30 and June 1, 1997; June 1 and 3, 1998), helicopter overflights were conducted to map the extent of maximum overflood limit within Foggy Island Bay, which included the limits of the Sagavanirktok(Sag), Kadleroshilik (Kad) and the Shaviovik (Shav) Rivers. It was estimated in the report that less than 10% of the drainage features escaped detection. The accuracy of the collection of these data was dependent upon (1) The 50-ft radius in which the helicopter was able to hover over the feature (2) The 328-ft (100 meter) radius inherent in the autonomous GPS positioning system.

The summer geophysical survey was conducted to acquire data on the surface relief (bathymetry) along the planned pipeline routes, in addition to strudel scour and ice gouge data. The 1997 program was conducted between August 17 and August 28 whereas the 1998 survey was conducted between July 28 and August 4, 1998. In 1997, survey data were acquired along three candidate pipeline routes. Subsequent to the 1997 survey, the “West Pipeline Route was the main focus of investigation.

SURVEY EQUIPMENT:

The survey equipment inlcuded the Seabat 9001 Multibeam Echo Sounder, Raytheon DE-719C Fathometer (single-beam bathymetric sonar), EdgeTech Dual Frequency Side Scan Sonar System, an ISIS side scan sonar digital data acquisition system, and a Trimble 4000 RS GPS Receiver.

Report Name	Liberty Cultural Assessment, Foggy Island in Stefansson Sound, Alaska	
Report Name	Liberty High Resolution Geophysical Survey, Foggy Island Bay in Stefansson Sound, Alaska	
Operator		Name of Contractors (Date of Final Report)
BP EXPLORATION (ALASKA), INC.		WATSON COMPANY, INC. (February -1998)
BP EXPLORATION (ALASKA), INC.		WATSON COMPANY, INC. (February -1998)
Site Name	Data Type	Title of Map Digitized from Final Report
Liberty	Bathymetry	Phase II Bathymetry Contour
Liberty	Structure	Phase I Structure Horizon C
Liberty	Structure	Phase I Structure Horizon D
Liberty	Isopach/other	Phase II Holocene And Distributary Channel Fragments
Liberty	Other	Site Clearance & Pipeline Route Survey Ice Gouge and Side Scan Sonar Interpretation

SUMMARY

The shallow hazards survey for the Liberty exploration well was located in Foggy Island Bay (Figure 1). Watson Company conducted their survey operations in two phases. The first phase collected multi-channel seismic data from the vessel M/V Toolik River. Phase II collected high-resolution Sub-Bottom Profiler, Mini-Sparker data, digital Side Scan Sonar, and Precision Fathometer data from the R/V Annika Marie. Navigation was from a Trimble DSM-PRO differential global positioning system.

SEAFLOOR CONDITIONS

Bathymetry and Seafloor Relief: Tidal corrections were made to the bathymetry data from the NOAA Data Collection Platform located at West Dock STP (Seawater Treatment Plant) facility. Water depths range between 4 and 7 meters over the surveyed area. Light ice gouging was observed from interpreted Side Scan Sonar data.

Boulder Patch: The survey found that the highest concentration of boulders (>25% boulders with cobbles) occurred in the west and northwest portion of the survey area.

SUB-SEAFLOOR CONDITIONS:

Isopach: Holocene marine sediments ranged in thickness between 0 and 2.6 meters. The thickest accumulation of Holocene sediments were interpreted to be at the eastern portion of the survey area. Holocene sediments thin to the west where they are absent at the western end of the survey. Here, Pleistocene strata are exposed at the surface. The exposed Pleistocene strata at the western end of the survey contain the Boulder Patch.

Structure: Horizons C and D were the two structural horizons mapped by the contractor for this report. Horizon D (str_horiz = 34) is the deep horizon which lies between 1575 and 1685 milliseconds (two-way travel time) below zero over the survey area whereas, the shallower structural Horizon C (str_horiz = 35) lies between 830 and 945 milliseconds (two-way travel time).

Seismic Anomalies: Acoustic wipeout zones were interpreted along the southwest perimeter of the survey area.

Report Name	OCS Mars Y-0302 Potential Geological Hazards and Constraints Block NR5-4-140/ Vicinity near Cape Halkett, Beaufort Sea, Alaska	
Operator		**Name of Contractors and (Date of Final Report)**
AMOCO PRODUCTION COMPANY		DAMES AND MOORE (October -1985)
Site Name	**Data Type**	**Title of Map Digitized from Final Report**
Mars	Shotpoint	Survey Postplot
Mars	Bathymetry	Bathymetry
Mars	Isopach	Surficial Sediment Thickness
Mars	Structure	Structure (Time) Contour
Mars	Hazard	Composite Anomaly

SUMMARY

The shallow hazard survey for the Mars exploratory well was located approximately 2 Kilometers northeast of Cape Halkett, Alaska (Figure 1). The marine geophysical survey was carried out during the months of August and September, 1984.

SEAFLOOR CONDITIONS

Bathymetry and Seafloor Relief: Water depths were computed from Echosounder records. Contours were smoothed to account for irregularities due to localized ice gouging and to sea-state. Gouges are primarily located at the greater water depths within the north and northeast sectors of the survey. Gouge orientations are west-northwest in the deeper areas. Gouge relief generally did not exceed 0.5 meters. Maximum gouge depth was less than 1.0 meter.

SUB-SEAFLOOR CONDITIONS

Isopach: Depth from seafloor to mapped reflector interpreted as the Holocene/Pleistocene contact. The four shallow boreholes show permafrost about 3 to 5 meters below the surface.

Structure: There is little evidence of fault displacement from the interpreted data.

Seismic Anomalies: Seismic anomalies were interpreted to be shallow gas.

Report Name	Mukluk Island Site OCS Y-0334 Potential Geological Hazards and Constraints Block NR5-4-280 Harrison Bay, Beaufort Sea Alaska	
Operator		**Name of Contractors and (Date of Final Report)**
SOHIO ALASKA PETROLEUM COMPANY		DAMES AND MOORE (April - 1983)
Site Name	**Data Type**	**Title of Map Digitized from Final Report**
Mukluk	Shotpoint	Survey Postplot
Mukluk	Bathymetry	Bathymetry
Mukluk	Structure	Structure (Time) Contour Late Cretaceous - Tertiary Reflector
Mukluk	Hazard	Composite Anomaly

SUMMARY

The over-ice geophysical survey was conducted between February 1 and March 4, 1983, in Harrison Bay, approximately 24 Kilometers north of the Colville River delta (Figure 1). The Mukluk survey is located just west of the Fur Seal Island survey. Selected mult-sensor USGS seismic data collected in 1980 was also utilized to evaluate the seafloor and sub-seafloor conditions.

SEAFLOOR CONDITIONS

Bathymetry and Seafloor Relief: Water depth measurements were taken through holes in the ice using conventional lead-line techniques. Water depths range between 13 and 16 meters. No corrections for tide were made on these data. No major bathymetric features were identified. A north-south oriented low-relief feature (0.3 meters) was identified in the survey.

Irregular shallow gouges are found on the seafloor. These gouges were reported to be less than 0.5 meters deep. The earlier USGS survey collected Side-Scan Sonar imagery that showed low flanking ridges associated with ice gouges. According to the report, Craig and Thrasher (1982) mapped a high density (>50%) of ice gouging within this area. **Craig, J.D. and Thrasher, G.P., 1982.Environmental Geology of Harrison Bay, Northern Alaska. USGS/MMS Open-File Report 82-35.**

SUB-SEAFLOOR CONDITIONS

Stratigraphy: Four shallow borings for this survey reveal a Holocene section that is approximately 4 to 6 meters deep. A change in the sampling method and sampler advancement was reported at approximately 7.5 meters. This is the approximate depth that the cores encountered ice bonded sediments.

Structure: According to the report, the northwest-southeast trending faults do not displace the shallow Holocene sediments.

Seismic Anamolies: Shallow gas has been tentatively identified within the seismic anomaly coverage. One of the test borings, Boring N, encountered a small pocket of gas within ice-bonded silty sand at a depth of 9 meters.

Report Name	Northstar Development Preliminary Pipeline Route Survey August 1995 - Final Report	
Operator		Name of Contractors and (Date of Final Report)
BP EXPLORATION (ALASKA), INC.		COASTAL FRONTIERS CORPORATION (CFC) (6/30/96)
Site Name	Data Type	Title of Map Digitized from Final Report
Northstar	Shotpoint	Stump Island Route Track Lines, Ice Gouges, Strudel Scours
Northstar	Shotpoint	Stump Island Route Track Lines, Ice Gouges, Strudel Scours
Northstar	Bathymetry	Stump Island Route Bathymetry Spot Depths
Northstar	Bathymetry	Stump Island Route Bathymetry Spot Depths
Northstar	Bathymetry	Bathymetric Contours On Stump Island Route
Northstar	Shotpoint	West Dock Route Track Lines, Ice Gouges, Strudel Scours
Northstar	Shotpoint	West Dock Route Track Lines
Northstar	Bathymetry	West Dock Route Bathymetry Spot Depths
Northstar	Bathymetry	West Dock Route Bathymetry Spot Depths
Northstar	Shotpoint	Endicott Route Track Lines
Northstar	Shotpoint	Endicott Route Track Lines, Strudel Scours
Northstar	Shotpoint	Endicott Route Track Lines
Northstar	Bathymetry	Endicott Route Bathymetry Spot Depths
Northstar	Bathymetry	Endicott Route Bathymetry Spot Depths
Northstar	Bathymetry	Endicott Route Bathymetry Spot Depths
Northstar	Shotpoint	Milne Point Route Track Lines
Northstar	Shotpoint	Milne Point Route Track Lines, Ice Gouges, Strudel Scours
Northstar	Shotpoint	Milne Point Route Track Lines, Ice Gouges
Northstar	Bathymetry	Milne Point Route Bathymetry Spot Depths
Northstar	Bathymetry	Milne Point Route Bathymetry Spot Depths
Northstar	Bathymetry	Milne Point Route Bathymetry Spot Depths
Northstar	Shotpoint	Seal Island Track Lines
Northstar	Bathymetry	Seal Island Bathymetry Spot Depths and Contours
Northstar	Bathymetry	Detailed Bathymetric Contours Northeast of Seal Island
Northstar	Shotpoint	Northstar Island Track Lines
Northstar	Bathymetry	Northstar Island Bathymetry Spot Depths and Contours

SUMMARY:

The Northstar development lies northwest of Prudhoe Bay in approximately 12 meters of water (Figure 1). The Northstar Production facility is currently producing oil from the Ivishak Formation. A sub-seabed pipeline is carrying the oil from the Northstar production facility to onshore pipeline facilities. It is the first sub-seabed Arctic pipeline to carry oil from any offshore production facility in North America.

Coastal Frontiers Corporation began a preliminary review of four candidate pipeline routes for the Northstar Development Project in 1995. The four candidate pipeline routes were the Point Storkersen, the "Stump Island Route", West Dock, the "West Dock Route", the "Endicott Route", and the "Milne Point Route". Ice Gouge, strudel scour and bathymetry data were collected over those routes. Sub-bottom Profiler data was collected for this survey, but the data results were not part of the report provided to MMS. Field data acquisition for the first year of the survey activity was conducted from August 7-August 12, 1995.

EQUIPMENT

Seabat 9001 Multibeam Echo Sounder, Raytheon DE-719C Fathometer (single-beam bathymetric sonar), EdgeTech Dual Frequency Side Scan Sonar System, Trimble 4000 RS GPS Receiver, and Datasonics Sub-Bottom-Profiler. Sub-bottom profiler records. (Similar systems used for all Northstar Development Pipeline Surveys 1995-1998.) Multi-beam sonar acquired data in water depths greater than 6 feet and single beam sonar were used to acquire data in water depths less than 6 feet. Please note that DUANE MILLER & ASSOCIATES collected extensive borehole data for Northstar. These data are in the database along with references to the reports.

Report Name	Northstar Development 1996 Pipeline Route Survey - Final Report	
Operator		**Name of Contractors and (Date of Final Report)**
BP EXPLORATION (ALASKA), INC.		COASTAL FRONTIERS CORPORATION (CFC) (6/30/96)
Site Name	**Data Type**	**Title of Map Digitized from Final Report**
Northstar	Other	Strudel Hole and Overflood Limit Location
Northstar	Shotpoint	Pt. Storkersen Route Track Lines, Ice Gouges, Strudel Scours
Northstar	Shotpoint	Pt. Storkersen Route Track Lines, Ice Gouges, Strudel Scours
Northstar	Shotpoint	Pt. Storkersen Route Track Lines
Northstar	Bathymetry	Pt. Storkersen Route Bathymetry Spot Depths and Contours
Northstar	Bathymetry	Pt. Storkersen Spot Depths and Contours
Northstar	Bathymetry	Pt. Storkersen Route Bathymetry Spot Depths and Contours
Northstar	Bathymetry	Pt. Storkersen Route Bathymetric Contours and Profile
Northstar	Other	Pt. Storkersen Route Deviations in Magnetic Intensity
Northstar	Other	Pt. Storkersen Route Deviations in Magnetic Intensity
Northstar	Shotpoint	Stump Island Route Track Line and Bathymetry Spot Depths
Northstar	Shotpoint	West Dock Route Track Lines, Ice Gouges
Northstar	Bathymetry	West Dock Route Bathymetry Spot Depths
Northstar	Shotpoint	Milne Point Route Tracklines and Bathymetry Spot Depths

SUMMARY:

This data represents the second year of the pipeline survey for the Northstar Development Project. The survey focused on the Point Storkersen Pipeline Route. Other survey activities included helicopter overflights on June 4, 1996 to collect strudel hole data (drain cracks on the ice sheet), and to map the seaward limit of the Kuparuk River overflood area. The summer survey occurred between July 26 and August 4, 1996. The survey collected data on ice gouge, strudel scour, and water depth. A magnetometer was used to detect magnetic intensity over the pipeline route in water depths greater than six feet.

Report Name	Northstar Development 1997 Pipeline Route Survey - Final Report	
Operator		**Name of Contractors and (Date of Final Report)**
BP EXPLORATION (ALASKA), INC.		COASTAL FRONTIERS CORPORATION (CFC) (Oct-98)
Site Name	**Data Type**	**Title of Map Digitized from Final Report**
Northstar	Other	1997 Strudel Hole and Overflood Limit Location
Northstar	Shotpoint	Pt. Storkersen Route Track Lines, Bathymetric Contours, Ice Gouge
Northstar	Shotpoint	Pt. Storkersen Route Track Lines, Bathymetric Contours, Ice Gouge

SUMMARY:

This was the third consecutive year of survey activities conducted for the Northstar Development Project conducted by Coastal Frontiers Corporation. The objective of this survey was to extend the database on strudel scour and ice gouges developed from the two previous surveys. The survey effort was focused on the Point Storkersen Route Pipeline Corridor. The aerial survey began in the late May and ended in early June, 1997 with helicopter based reconnaissance of strudel holes (drain cracks on the ice sheet) and the mapping of the overflood area for the Kuparuk River. A vessel-based survey was conducted on August 15 and 16, 1997 to map strudel scours, ice gouge, and to collect water depth data.

Report Name	Northstar Development 1998 Pipeline Route Survey- Final Report	
Operator		**Name of Contractors and (Date of Final Report)**
BP EXPLORATION (ALASKA), INC.		COASTAL FRONTIERS CORPORATION (CFC) - (June-1999)
Site Name	**Data Type**	**Title of Map Digitized from Final Report**
Northstar	Other	Strudel Drainage Feature and Overflood Limit Location
Northstar	Shotpoint	Pt. Storkersen Pipeline Corridor Track Lines
Northstar	Shotpoint	Pt. Storkersen Pipeline Corridor Track Lines
Northstar	Bathymetry	Bathymetric Contours and Profiles

SUMMARY:

This was the fourth year that the pipeline survey was conducted for the Northstar Development Project. The primary emphasis was placed on extending the database on ice gouges and strudel scours. A helicopter based survey was conducted in early June to map strudel holes (drain cracks on the ice sheet), and to map the extent of the Kuparuk River overflood. The vessel-based survey began in late July and mapped the extent of the strudel scours and ice gouges along the Point Storkersen Pipeline Route.

Report Name	Orion Prospect OCS Lease Y-0804, Geophysical and Geotechnical Site Evaluation, Beaufort Sea, Alaska	
Operator		**Name of Contractors and (Date of Final Report)**
EXXON COMPANY USA		HARDING LAWSON ASSOCIATES (July 15 -1985)
Site Name	**Data Type**	**Title of Map Digitized from Final Report**
Orion	Shotpoint	Trackline
Orion	Bathymetry	Bathymetry
Orion	Structure	Structural Horizon E

SUMMARY

The shallow drilling hazard survey lies 18 Kilometers north-northeast of Cape Halkett, Alaska (Figure 1). These data are the output from the shallow drilling hazard survey conducted at Exxon's Company Orion Prospect, OCS Lease Y-0804 in the Alaska Beaufort Sea. The survey was conducted between March 7 and March 31, 1985. Harding Lawson conducted a 1) Winter on-ice multichannel high-resolution geophysical survey 2) Winter geotechnical borehole sampling and scuba diving program. A Sub-Bottom Profiler transducer was used at each shothole along lines 49 and 50. The results were unsatisfactory and not used for the survey.

SEAFLOOR CONDITIONS

Bathymetry and Seafloor Relief: Water depths were measured with a Fathometer every 152 meters. The data are uncorrected for tides. Detailed bathymetry of the footprint of the Concrete Island Drilling System (CIDS) was measured by HLA during the winter 1984-85. Lead line soundings were made on a 152-152 meter grid along lines spaced 15.2 meters apart. Lead line sounding was made every 3 meters along those lines. Results were checked in situ by SCUBA divers. Acoustical imaging of the seafloor was attempted using a Mesotech Polar Scanning Sonar System through the ice canopy. Most of the data from these records were not useable. Good ice gouge data was not available from the report.

SUB-SEAFLOOR CONDITIONS

Structure: All deep faults were reported as high angle normal faults with north to northeast dips. Graben structures are common features. These structures are formed by the intersection of deep faults and shallow antithetic faults.

Boreholes: Eight boreholes were taken and are contained within the database. Ice bonded permafrost was found within boreholes B1 and B7.

Seismic Anomalies: Shallow gas was not identified within the geophysical records.

Report Name	Phoenix Prospect Harrison Bay (NR 5-4) Diapir Field OCS Lease Sales 71 and 87 Beaufort Sea, Alaska	
Operator		**Name of Contractors and (Date of Final Report)**
TENNECO OIL COMPANY		McClelland-EBA, Inc. (February - 1986)
Site Name	**Data Type**	**Title of Map Digitized from Final Report**
Phoenix	Bathymetry	Bathymetric
Phoenix	Hazard	Geologic Features
Phoenix	Isopach	Isopach of Upper Sediment Unit
Phoenix	Structure	Shallow Structure
Phoenix	Shotpoint	Post-Plot Navigation

SUMMARY

The shallow hazard survey was conducted approximately 22 Kilometers north of the of the Colville River delta (Figure 1). The geophysical data was acquired in two phases. Phase I occurred during the months of August and September, 1984. Phase II data acquisition occurred in September 1985. Side-Scan Sonar, bathymetric profiler, Sub-Bottom Profiler, Boomer, Water Gun, and Air-Gun arrays were used to investigate the surface and sub-surface geology.

SEAFLOOR CONDITIONS

Bathymetry and Seafloor Relief: The water depth data was interpreted from Simrad bathymetric profiler records (1984) and Atlas Deso 20 bathymetric profiler records (1985). No tidal corrections were made to the data.

The northern area of the survey contained a higher density of ice gouging than the southern area of the survey. The northern area also contained gouges that were deeper. Within the northern area, ice gouges that have 1 meter of relief are common. The maximum relief estimated to be around 2 meters. Ice gouges in the survey area were 10-20 meters wide. The gouge trend was typically east-northeast.

SUB-SEAFLOOR CONDITIONS

Shallow Sediments: The upper 3-10 meters of sediment was interpreted to be Holocene in age. The base of the Holocene section was interpreted to be the top of the frozen soils. A locally thick section of the upper Holocene unit occurs in the northeast and southeast quadrants of the survey as shown on the isopach coverage for this survey.

Structure: Most of the faults trend in a northerly to northeasterly direction. This is in contrast to the northwesterly fault trend found within the Mukluk and Fur Seal Island surveys to the southwest. Depths to the tops of most faults range from 300-600 meters below the seafloor and therefore do not displace Holocene sediments.

Seismic Anomalies: Shallow gas was observed over most of the survey area. Only one area of shallow gas was mapped and is contained within the database. This area of shallow gas is located in the southern part of the survey.

Report Name	Sandpiper Island Exploration Site Potential Geologic Hazards and Constraints Block NR 6-3-424, Lease OCS Y-370, TRACT 71-322	
Operator		**Name of Contractors and (Date of Final Report)**
SHELL OIL COMPANY		DAMES AND MOORE (December -1983)
Site Name	**Data Type**	**Title of Map Digitized from Final Report**
Sandpiper	Shotpoint	Survey Post Plot
Sandpiper	Bathymetry	Bathymetry
Sandpiper	Isopach	Isopach of surficial sediments
Sandpiper	Structure	Structure (Time) Contour
Sandpiper	Hazard	Composite Anomaly

SUMMARY:

The Sandpiper shallow hazard survey was conducted approximately 5 miles north of Cottle Island (Figure 1). The survey was conducted between September 11-13, 1983. Ocean conditions were good to moderately rough during the Fall survey. Harding Lawson Associates conducted a geotechnical investigation between April 22 and 24, 1982. Four borings collected under that investigation are included in the discussion below.

SEAFLOOR CONDITIONS

Bathymetry and Seafloor Relief: Water depth information was collected by a narrow beam Echosounder. Water depth ranged between 9 and 18 meters (27 to 63 feet). East-southeast trending shoals predominately found in the southwestern portion of the survey exhibit approximately 3 meters of relief with some slopes reaching 6 degrees. One of these larger shoals found in the center of the survey called "Loon Shoal" was previously mapped in a survey conducted by (Kempema and others, 1981). Kempema, E., Reimnitz, E., and Barnes., 1981. Marine Geologic Studies in the Beaufort Sea, Alaska, 1980; Location, DataType, and Records Obtained, USGS Open-File Report 81-241.

Occasional ice gouges were identified on the side-scan sonar records. These gouges are primarily located north of the northeastern most shoal previously identified as "Loon Shoal". They are less frequent or absent landward of Loon Shoal and in topographic lows. Ice gouges cover less than 10% of the survey site. Gouges were reported to trend east-southeast and rarely exceed 1 meter in depth.

Low-relief hydraulic bedforms including small patches of ripples were located just north of Loon Shoal. This seafloor feature was identified on the Side-Scan Sonar imagery and on underwater TV transects. The locations of these ripples are shown as part of the seafloor features (various) coverage under feature code 6 in the database. The majority of the ripples were oriented parallel to the bathymetric contours.

SUB-SEAFLOOR CONDITIONS:

Structure: The structure contour map was mapped along a prominent reflector interpreted to be within the upper Tertiary section. There doesn't appear to be any evidence of displacement of this surface. Over 4000 feet of Tertiary strata was reported in the Sandpiper exploratory well subsequent to the drilling of the well (MMS pers. Comm.).

Stratigraphy: Four soil borings were drilled and sampled to depths ranging from 13.4-30.5 meters below mudline. The boreholes penetrated a thin veneer of Holocene sand and silty sands and underlying Pleistocene silts, sands and gravels. The Holocene sediments around the well location site are less than 4 meters thick. The underlying fining-upwards sequence of Pleistocene gravels, sands, silts and clays were present in the borings. Possible sub crops of Pleistocene strata were interpreted on the Sub-Bottom Profiler records. Permafrost was not encountered in the four boreholes at the Sandpiper Island site.

Seismic Anomalies: The coverage displays amplitude anomalies in the northeast corner of the survey area. These areas have been interpreted as possible shallow accumulations of biogenic gas.

Report Name	Tern Island Marine Geophysical Survey Tract 42 Beaufort Sea, Alaska	
Operator		**Name of Contractors and (Date of Final Report)**
SHELL OIL COMPANY		HARDING LAWSON ASSOCIATES. (February - 1981)
Site Name	**Data Type**	**Title of Map Digitized from Final Report**
Tern Island - Tract 42	Shotpoint	Trackline
Tern Island - Tract 42	Bathymetry	Bathymetric
Tern Island - Tract 42	Isopach	Isopach of Holocene Sediments
Tern Island - Tract 42	Isopach	Isopach of Marine Sediments

SUMMARY:

The shallow hazard survey for the Tern Island exploratory well was conducted in Foggy Island Bay (Figure 1). Harding Lawson Associates (HLA) performed a shallow hazards geophysical survey within Tract 42 for Shell Oil Company in 1981 prior to drilling the Tern Island exploratory well.

SEAFLOOR CONDITIONS

Bathymetry and Seafloor Relief: There are two coverages that display the bathymetry (spot and contoured points). The seafloor is relatively flat with few ice gouges.

SUB-SEAFLOOR CONDITIONS:

Stratigraphy: Four test borings were conducted between September 5 through 8, 1980. Holocene and Pleistocene strata were encountered within all of the boreholes. There are two layers in the coverage for isopach contours. One layer depicts the approximate thickness of Holocene sediments and the other layer is the approximate thickness of Pleistocene age marine sediments. The stratigraphic sequence is typical for the shallow Beaufort Sea showing a thin unit of surficial Holocene sediments overlying late Pleistocene fine grained marine section and late to middle Pleistocene coarse-grained continental deposits. The upper Holocene deposits are typically less than 5 meters thick, but may locally be as much as 15 meters thick. Those areas of thick Holocene deposits are typically where paleo-river channels cut into the Pleistocene deposits during lowered sea level stands. Ice-bonded soils were encountered from 7.6-9.1 meters (25.0 – 30.0 feet) in boring # 3 and from 7.6-11 meters (25- 36 feet) in boring # 4.

Report Name	Thorgisl Prospect Geological Hazard Survey Outer Continental Shelf, Beaufort Sea, Alaska Covering Portions of Blocks 403, 404, 405 406, 447, 448, 449 450, 491, 492, 493 and 494 UTM Zone 7	
Operator		**Name of Contractors and (Date of Final Report)**
AMOCO PRODUCTION COMPANY		COMAP GEOPHYSICAL SURVEYS (December -1983)
Site Name	**Data Type**	**Title of Map Digitized from Final Report**
Thorgisl	Shotpoint	Survey Post-Plot
Thorgisl	Bathymetry	Bathymetry and Seafloor Features
Thorgisl	Isopach	Isopach and Shallow Geologic Features
Thorgisl	Structure	Structure
Thorgisl	Hazard	Drilling Constraints

SUMMARY

The shallow hazard survey was conducted approximately 60 Kilometers north-northeast of the village of Kaktovik (Figure 1). The survey was conducted by COMAP for AMOCO Production Company between August 28 and September 13, 1985 from the survey vessel M/V Arctic Rose. At times, survey operations were impeded by ice conditions and by other seismic activity in the area.

SEAFLOOR CONDITIONS

Bathymetry and Seafloor Relief: The survey area is located on the outer shelf and upper slope region of the Beaufort Sea Continental Shelf. Water depths ranged between 50 and 170 meters. A hydrographic Echosounder was used to acquire the bathymetric data. Tidal variation during the survey was found to be 0.23 meters. Tidal correction was not made against the collected data using tidal information from Flaxman Island since the survey area was far offshore.

The seafloor displays irregular relief. Ice gouging has formed microrelief of up to 3.5 meters on the seabed. Ice gouging is evident from the Side-Scan Sonar data. Ice gouging is extensive over the outer shelf (50-60 meters), but is nearly absent beyond the 70 meter contour (upper slope). The overall orientation of the ice gouging is predominately northwest-southeast. Most ice gouges are between 7 and 10 meters in width, but some gouges are as wide as 40 meters. Individual ridges may be up to 1.5 meters in height.

Other surface features identified from the Echosounder data include: A north-south trending bathymetric high located in the center of the survey, sediment slumps on the outer shelf and slope and shallow relief features on the outer shelf.

SUB-SEAFLOOR CONDITIONS

Isopach: Three distinct units were mapped based upon the Sub-Bottom Profiler data. All of these surfaces consist of sediments found within Unit A, the uppermost strata in the survey. A single surface within Unit A could not be mapped over the entire survey so individual sub-units of Unit A were identified and traced over portions of the survey. In the northern portion of the survey, a distinctive group of slumped sediments were mapped above a prominent reflector that extends from a shallow sub-surface depth at the shelf-slope edge and dips steeply to the north. Numerous large slumps align themselves with the southerly edge of the bedding plan feature.

A broad channel (?) was identified on the Sub-Bottom Profiler and Side-Scan Sonar data in the western portion of the survey. The thickness of the sediments that fill this channel were mapped as a second horizon. The last horizon was mapped along an unconformable surface, which could be traced from the southern end of the survey to the outer shelf edge.

Structure: The dominant structural trend in the survey area is an east-west trending system of faults. This major fault system according to the report "separates a complex irregularly-folded and faulted zone of strata in the southern portion from more uniform strata to the north". None of these faults extends to the seafloor. "Within the survey, the complex structure of the Camden Anticline is overlain by a least 100 meters of apparently undisturbed strata."

Seismic Anamolies: Shallow gas was interpreted from Boomer data at the southeast portion of the survey. Many of these anomalies are associated with the major east-west fault system.

Report Name	Warthog No. 1, OCS Y- 1663, Camden Bay, Beaufort Sea, Shallow Hazard Survey Results	
Operator		**Name of Contractors and (Date of Final Report)**
ARCO ALASKA, INC.		FAIRWEATHER E&P SERVICES, INC. (September -1997)
Site Name	**Data Type**	**Title of Map Digitized from Final Report**
Warthog	Shotpoint	Postplot of side scan sonar, bathy, and geopulse subbottom
Warthog	Isopach	Surficial features and shallow sediment
Warthog	Structure	Shallow structure of Horizon 1, Time Plot
Warthog	Structure	Shallow structure of Horizon 1, Depth Plot
Warthog	Structure	Shallow structure of Horizon 2, Time Plot
Warthog	Structure	Shallow structure of Horizon 3, Depth Plot

SUMMARY

The shallow hazard survey was conducted in Camden Bay, Alaska (Figure 1). Fairweather E&P Services, Inc of Anchorage, Alaska was contracted by ARCO Alaska Inc to conduct a shallow hazards survey over the proposed site for the Warthog # 1 Exploration Well. The survey was conducted during the month of August 1997. The geophysical survey was conducted from two different vessels, the M/V Sea Ducer owned and operated by Terra Surveys LLC of Palmer, Alaska and the M/V Stryker operated by I.C.E. Services of Deadhorse, Alaska. The high-resolution multi-channel program was conducted by Northern Geophysical, of Anchorage, Alaska. Geotechnical data was previously collected by Fairweather in 1995 and EBA in 1996.

SEAFLOOR CONDITIONS

Bathymetry and Seafloor Relief: The bathymetric contours range between 2 and 12 meters Water depth contours increase from southwest to northwest. Localized shoaling, with 1 to 2 meters of relief are oriented east-west. The Side-Scan Sonar shows only a lightly ice gouged surface. The widths of the ice gouges were reported to be less than several meters with vertical heights less than one meter.

Isopach: A surficial unconsolidated sedimentary unit was mapped over the study area. This unit varied in thickness from 1 to 20 meters. This unit consists of silt, sand and clay. This unit is absent near the center of the survey area. Coarse-grained sediment, cobbles and boulders (Boulder Patch) cover the center of the survey. Underwater video images identified areas with attached kelp. This coarse-grained unit extends to the northwest where it is buried beneath the surficial unit of fine-grained sand, silt, and clay.

SUB-SEAFLOOR CONDITIONS

Structure: Two structural horizons (Horizons I and II) were used to map the shallow structure between 800 and 2900 feet. These horizons were laterally continuous across the survey area. Horizon I is shallower than Horizon II. Both structural horizons dip to the northwest. The predominate direction of faulting trends northwest-southeast. These faults offset the structural horizons.

Seismic Anomalies: The zone of amplitude decrease, on the multi-channel data coincides with the zone of coarse-grained sediments (cobbles and boulders) mapped from the shallow seismic reflection Bubble-Pulse data. The multi-channel data also exhibited approximately 3 to 6 milliseconds of velocity pull-down over the same area. The area of amplitude increase appears to represents the finer grained sediments beneath the surface. Evidence of potential shallow gas was also identified in the survey.

Report Name	West Maktar, Prospect, OCS Y-0852, Geologic Hazard Assessment Beaufort Sea, Alaska OCS	
Operator		**Name of Contractors and (Date of Final Report)**
CHEVRON U.S.A. INC.		PELAGOS CORPORATION (June -1990)
Site Name	**Data Type**	**Title of Map Digitized from Final Report**
West Maktar	Shotpoint	Navigation Postplot
West Maktar	Bathymetry	Bathymetry
West Maktar	Isopach	Sediment Isopach
West Maktar	Structure	Shallow Structure
West Maktar	Hazard	Hazards and Anomalies

SUMMARY

The West Maktar shallow hazard survey was conducted in the east-central Beaufort Sea, approximately 40 Kilometers north-northwest of Camden Bay (Figure 1). The high-resolution shallow hazards survey and bottom sampling was conducted by Western Geophysical and Pelagos Corporation. Harding Lawson and Associates wrote the soil summary. The survey was conducted aboard the M/V Western Aleutian between September 5-8, 1989.

SEAFLOOR CONDITIONS

Bathymetry and Seafloor Relief: Water depth was contoured at a 2-meter interval. Water depths range between 30 and 38 meters. Tidal correction values from Flaxman Island, the nearest tidal station were utilized every thirty minutes. Tidal correction values ranged from 0.02 to 0.20 meters. Active ice gouging has reworked the seabed. Individual ice gouges range between one and ten meters in width and less than 4 meters in vertical height.

Sediments: Three Van Veen Grab samples were taken over the survey area. Site specific soil borings were not available over the survey area, therefore the composition and thickness of the deeper sediments are unknown.

SUB-SEAFLOOR CONDITIONS

Isopach: A continuous reflector was used to map the uppermost thickness of sediments from the continuous reflector to the surface. This reflector was interpreted in the report to be near the base of the Pleistocene or the upper Brookian section of strata. The mapped horizon is offset by several parallel faults striking northwest-southeast. A few faults offset near-surface sediments and may extend to the seafloor.

Structure: The mapped structural horizon was interpreted to be within the upper Brookian sequence. This structural horizon generally dips to the southwest, and is interpreted to be part of the southern flank of the Camden Anticline. The faulting in the survey area is part of the growth-fault system, which is parallel to, and north of the Hinge Line.

Seismic Anomalies: Acoustic amorphous zones were interpreted in the near surface sediments in the northern and western portion of the survey area. Zones of acoustically chaotic reflectors occur within the northern and eastern portions of the survey area. The report interpreted these zones to be caused by gas in shallow sediments although no evidence of water column anomalies was observed. Many of the faults located in these zones may act as conduits from deeper stratigraphic levels. No evidence of permafrost or gas hydrates was observed in the seismic records.

Report Name	(West Maktar) Blocks 673 AND 674, NR-6, Shallow Hazards Report, Beaufort Sea, Alaska	
Operator		**Name of Contractors and (Date of Final Report)**
BP EXPLORATION (ALASKA), INC.		FUGRO-McCLELLAND MARINE GEOSCIENCES (April - 1992)
Site Name	**Data Type**	**Title of Map Digitized from Final Report**
Blocks (673, 674)	Shotpoint	Navigation Postplot
Blocks (673, 674)	Bathymetry	Water Depth
Blocks (673, 674)	Isopach	Isopach
Blocks (673, 674)	Structure	Shallow Structure
Blocks (673, 674)	Hazard	Geologic Features

SUMMARY:

These data are a reinterpretation of West Maktar site survey data (previous page) collected between September 5 and 8, 1989.

SEAFLOOR CONDITIONS

Bathymetry and Seafloor Relief: The Side-Scan Sonar records shows that the entire seafloor has been gouged by ice. Ice gouges with up to 4 meters of vertical relief were identified on these records. The majority of the ice gouges trend east-west. The survey area is within the area defined by the "stamukhi zone", a coast-parallel zone of thick ice ridges between 10 and 30 meters water depth.

SUB-SEAFLOOR CONDITIONS

Isopach: The report subdivided the four acoustic units identified with the seismic sections. Units 1, 2 and 3 are within the top 50 meters of sediments. Unit 4 comprises the remainder of the sedimentary sequence below 50 meters. Unit 1 has an approximate thickness of 6 meters and is probably comprised of Holocene sediments. Unit 2 is mostly Pleistocene in age. The isopach maps show the cumulative thickness of units 1 and 2. The unit thickens significantly across the downthrown side of the fault that cuts through the center of the survey. Relict channels are located near the base of Unit 2. Unit 3 is considered to be Pleistocene in age and Unit 4 is probably Tertiary fluvial-deltaic deposits

Structure: The southwesterly dipping sediments are broken in several places by northwestward dipping growth faults and a few southeastward dipping antithetic faults. Structural dip is to the southwest away from the Camden Anticline. Two sets of faults occur within the survey area. Both sets trend northwest-southeast. Several faults within the survey area extend very close to the surface. The report indicates that the faults located near the surface are active.

Seismic Anomalies: Shallow gas is probably associated with faulting in the survey as identified from seismic data records.

Permafrost: The thickness of permafrost and the depth to bonded sediments cannot be substantiated beneath this survey since borings weren't drilled.

Report Name	Wild Weasel Prospect OCS Y-1597, Shallow Hazards Report, Beaufort Sea, Alaska	
Operator		**Name of Contractors and (Date of Final Report)**
ARC0 ALASKA, INC.		DEEPSEA DEVELOPMENT SERVICES DIV. OF SAIC (January 20 1994)
Site Name	**Data Type**	**Title of Map Digitized from Final Report**
Wild Weasel	Shotpoint	Post-Plot
Wild Weasel	Bathymetry	Bathymetry
Wild Weasel	Isopach	Isopach
Wild Weasel	Structure	Shallow Structure
Wild Weasel	Hazard	Geologic Features

SUMMARY

In July/August of 1983, DEEPSEA Development Services, a division of SAIC conducted a high-resolution geophysical survey in the eastern Beaufort Sea, north-northwest of Camden Bay (Figure 1). The survey was conducted for ARCO Alaska Inc. and managed by Western Geophysical, Inc. Ice conditions ranged from open water to 9/10 one-year ice coverage. Survey activity had to be interrupted at times due to heavy ice conditions. Vessel speed and direction varied with the thickness and extent of ice coverage.

SEAFLOOR CONDITIONS

Bathymetry and Seafloor Relief: The bathymetry map was generated from Echosounder data. Depths were selected at 100-meter intervals along the survey lines. No correction was made for tides, and the transducer offset was corrected in the field. The bathymetric contours display a northeasterly slope interrupted by several shoals. Part of the survey lies within an area of heavy ice gouging. Survey data from the report indicates that 100% of the seafloor has been reworked from ice gouging. Ice gouges display relief of up to 3 meters (berm to trough)

SUB-SEAFLOOR CONDITIONS

Isopach and Shallow Stratigraphy: The mapped horizon was identified as the same horizon mapped for the 1992 Kuvlum report. The horizon was picked based upon the sediment sound velocity of 1600m/sec.

References for Borings and Geotechnical Studies

		BORE HOLE INFORMATION IN DATABASE			
Site Name	# of Samples	Report Name	Report Date	Operator	Contractor
Cabot	9	ARCO Cabot No. 1 Prospect Geotechnical Site Investigation Volumes 1 Through 3	Jun-91	ARCO Alaska, Inc.	EBA Engineering Inc.
Canvasback (Gemini)	6	Canvasback (Gemini) Prospect OCS-Y 0729 Geologic Hazard Assessment Beaufort Sea, Alaska OCS	Mar-90	Chevron U.S.A. Inc.	Pelagos Corporation
Corona	1	Corona Prospect Block NR-6-4-678 Vicinity, Geologic Hazards and Constraints Camden Bay Area, Beaufort Sea, Alaska	Apr-85	Union-Shell-Amoco Bidding Group	Dames And Moore
Eric	1	Eric OCS Y-0912 Potential Geologic Hazards and Constraints Block NR7-3-705/Vicinity Camden Bay Area, Beaufort Sea Alaska	Apr-85	Union-Shell-Amoco Bidding Group	Dames And Moore
Fireweed	12	Fireweed Report of Geotechnical Data Acquisition and Analyses Document 0480-092-400	Sep-90	ARCO Alaska, Inc.	ENSR Consulting And Engineering
Fur Seal Island	1	Fur Seal Island Site Potential Geologic Hazards and Constraints Block NR 5-4-370, Lease OCS Y-0353, Tract 71-220 Harrison Bay, Alaska	Nov-83	Texaco USA	Dames And Moore
Hammer-head	10	Hammerhead (624 & 625) Data Report NR 6-4 Federal OCS Lease Blocks Beaufort Sea, Alaska OCSY 0849 & 0850	Feb-85	Union Oil Company Of California	Northern Technical Services
Karluk	8	Karluk Prospect Geophysical and Geotechnical Site Evaluation Beaufort Sea, Alaska	10/11/88	Chevron U.S.A. Inc.	Harding Lawson Associates
Liberty	30	1997 Geotechnical Exploration Liberty Development North Slope, Alaska	9/10/97	BP Exploration (Alaska), Inc.	Duane Miller & Associates
Liberty	27	1998 Geotechnical Exploration Liberty Development North Slope, Alaska	7/6/98	BP Exploration (Alaska), Inc.	Duane Miller & Associates and Walter Phillips,
Mukluk	4	Mukluk Island Site OCS Y-0334 Potential Geologic Hazards and Constraints Block NR5-4 280 Harrison Bay, Beaufort Sea Alaska	4/1/93	Sohio Alaska Petroleum Company	Dames And Moore
Northstar	61	1996 Geotechnical Investigation Northstar Development Beaufort Sea, Alaska	5/31/96	BP Exploration (Alaska), Inc.	Duane Miller & Associates
Northstar	12	1999 Geotechnical Investigation Northstar Development Beaufort Sea, Alaska	8/15/99	BP Exploration (Alaska), Inc.	Duane Miller & Associates
Orion	8	Orion Prospect OCS Lease Y-0804, Geophysical and Geotechnical Site Evaluation, Beaufort Sea, Alaska	7/15/85	Exxon Company USA	Harding Lawson Associates
Sandpiper	4	Sandpiper Island Exploration Site Potential Geologic Hazards and Constraints Block NR 6-3-424, Lease OCS Y-370, Tract 71-322	Dec-83	Shell Oil Company	Dames And Moore
Tern Island	4	(Tern Island) Geotechnical Investigation Tract 42 Well Site	2/1/81	Shell Oil Company	Harding Lawson Associates
Warthog	7	1996 Geotechnical Investigation Warthog Prospect Beaufort Sea, Alaska	7/8/96	ARCO Alaska, Inc.	EBA Engineering Inc.
Warthog	7	Final Report Warthog Winter Geotechnical and Bathymetric Programs	10/1997	ARCO Alaska, Inc.	Fairweather E&P Services, Inc.

		BORE HOLE INFORMATION IN DATABASE			
Site Name	# of Samples	Report Name	Report Date	Operator	Contractor
Warthog	1	Warthog No. 1, OCS Y- 1663, Camden Bay, Beaufort Sea Shallow Hazard Survey Results	Sep-97	ARCO Alaska, Inc.	Fairweather E&P Services, Inc.
West Maktar	3	West Maktar (10) Prospect, OCS Y-0852, Geologic Hazard Assessment Beaufort Sea, Alaska OCS	Jun-90	Chevron U.S.A. Inc.	Pelagos Corporation

ArcView Geohazards Extension Tutorial

The Geohazards Extension, designed for use with the ArcView application, allows access to the Geohazards Database through a customized Graphical User Interface (GUI). When loaded into ArcView, this Geohazards Menu System allows a quick and easy way to display and identify the Geohazards data. Almost all of the spatial features and attributes from the maps and tables within the site-specific and pipeline-route survey reports are contained within the ArcView Shapefiles and Access 97 tables that make up the extension. All information is stored on the Geohazards CD *(including the Geohazards.avx Extension)*.

System Requirements and Software

Minimum system requirements are a Pentium 400 with 128 MB RAM, with Windows 98 Operating System. The database can be used with ESRI's ArcView 3.2a and Microsoft Access 97.

Installing the Geohazards Extension

To install the Geohazards Extension, you will

- download data off the CD
- create an ODBC Microsoft Access Data Source in Windows
- load the Geohazards Extension in ArcView

Download Data off the CD

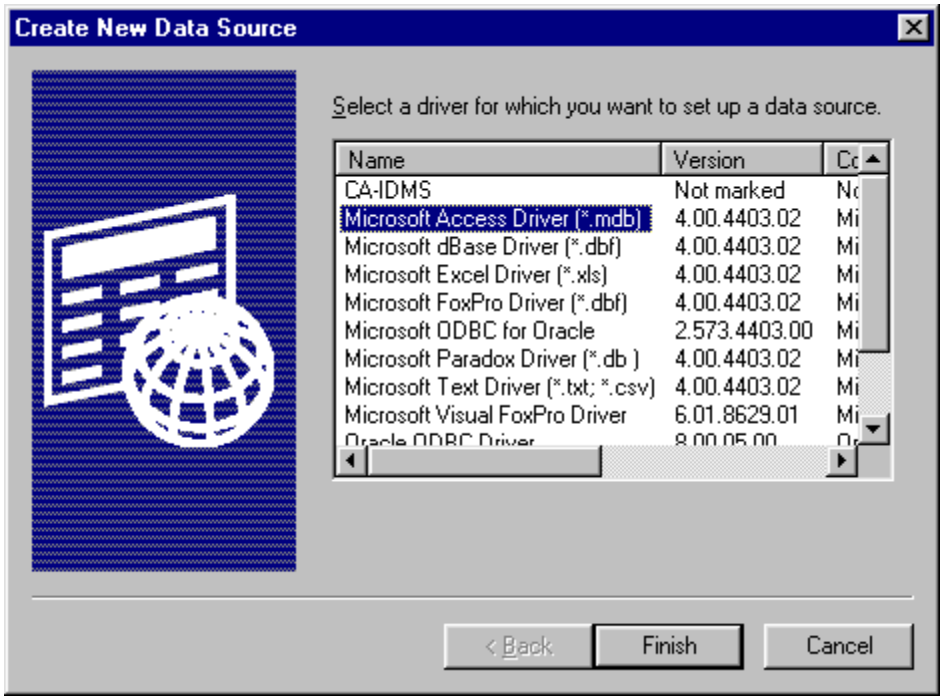
- Copy the Geohazards directory "\mms_data" to the C:\ drive (ex. C:\mms_data). The extension will work if the data is copied to a path other than C:\mms_data. The drawback will be that the user will be prompted for a path at the beginning of each ArcView Geohazards session. Directory path hard coding is addressed in Appendix I.
- Copy the file "mms_data\geohazards_shp.avx to AV_GIS30\ARCVIEW\EXT32\geohazards_shp.avx
  or, for network users, to the USER_EXT directory or a temporary directory
  USER_EXT directory: Ordinarily, ArcView looks for extensions in the ArcView/EXT32 directory, but if you are using a network copy of ArcView you may not have privileges to copy the extension to that network directory. The best solution is to tell ArcView to also look for the extension in a location you choose by setting the system environment variable USER_EXT to that directory. You may require the assistance of a network administrator to do this.
  Temporatory directory: ArcView also looks for files in your temporary directory, so an easier short-term solution is to copy the extension file to your temporary directory. The temporary directory is usually C:\Windows\Temp for Windows 98, C:\WINNT\Temp for Windows NT, or C:\Documents and Settings*username*\Local Settings\Temp (hidden folder) for Windows 2000.

Create an ODBC Microsoft Access Data Source

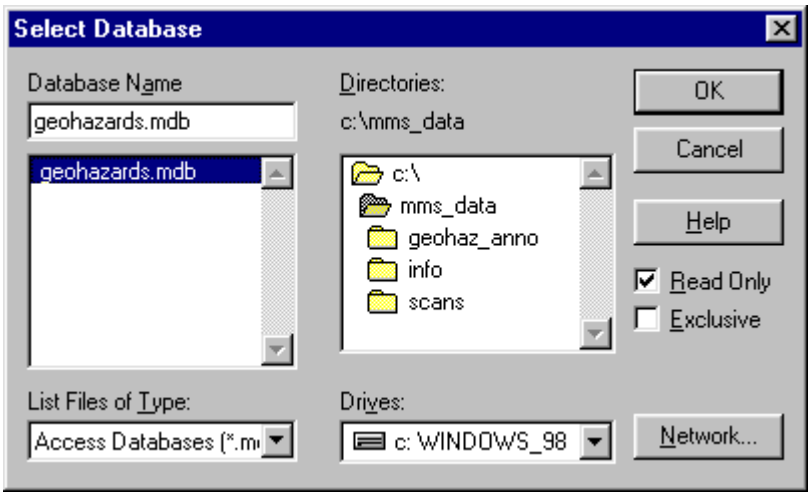
An ODBC Microsoft Access Data Source allows ArcView to connect to and read data from the geohazards.mdb file. All relating tables are stored in the geohazards.mdb file. It is necessary to create a data source to run the application.

- From the Windows Desktop, click Start – Settings – Control Panel – Data Sources (ODBC)
  or
  If using Windows 2000, click Start – Settings – Control Panel – Administrative Tools – Data Sources (ODBC)

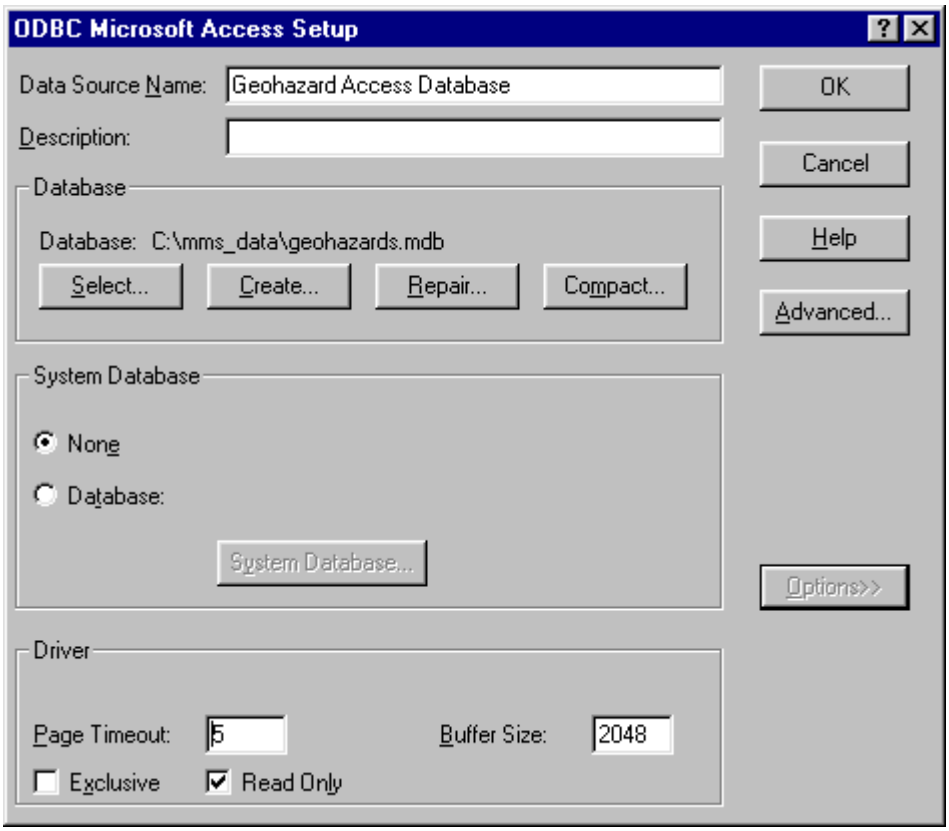
- In the ODBC Data Source Administrator dialog, click Add.
- In the Create New Data Source dialog, select Microsoft Access Driver (*.mdb) – Finish:



- In the ODBC Microsoft Access Setup dialog, type "Geohazard Access Database" in the Data Source Name field and click Select.
- In the Select Database dialog, navigate to geohazards.mdb, then click OK:

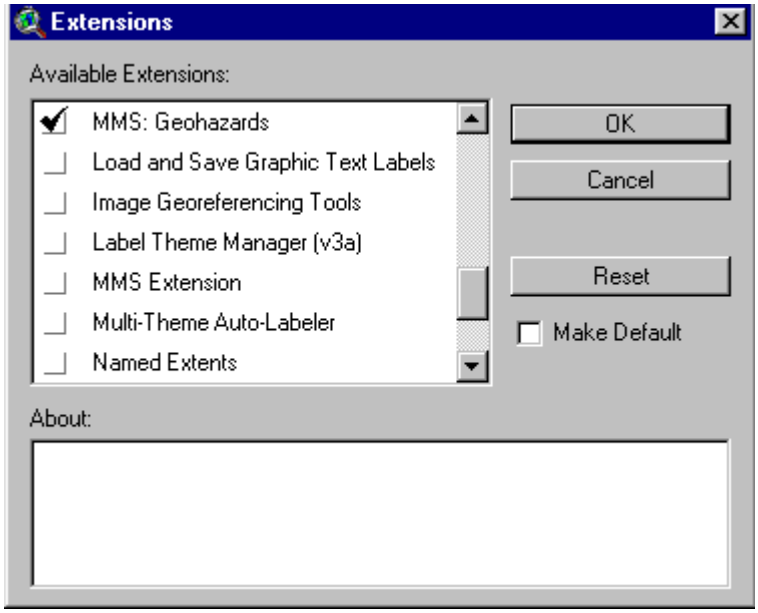


The ODBC Microsoft Access Setup dialog will reappear. Click Options – Read Only – OK – OK. *Note:* It's important to check Read Only. If left unchecked, multiple user capability may be sacrificed:



Load the Geohazards Extension

- In ArcView, from the main menubar, click File – Extensions.
- In the Extensions dialog, click the checkbox for MMS: Geohazards, then click OK:



Using the Geohazards Extension

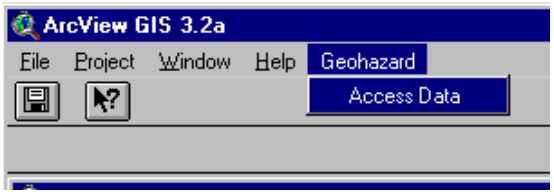
This section describes how to use the Geohazards Extension in ArcView. Specifically:

- how to access survey and core data with the Select Site Surveys and Pipeline Surveys tool
- how to view attributes of spatial data with the Identify tool
- how to view metadata with the Source Identify tool
- how to view seismic cross-sections with the Hotlink to Seismic Cross-Sections tool

Accessing Site-Survey, Pipeline-Survey, and Core Data

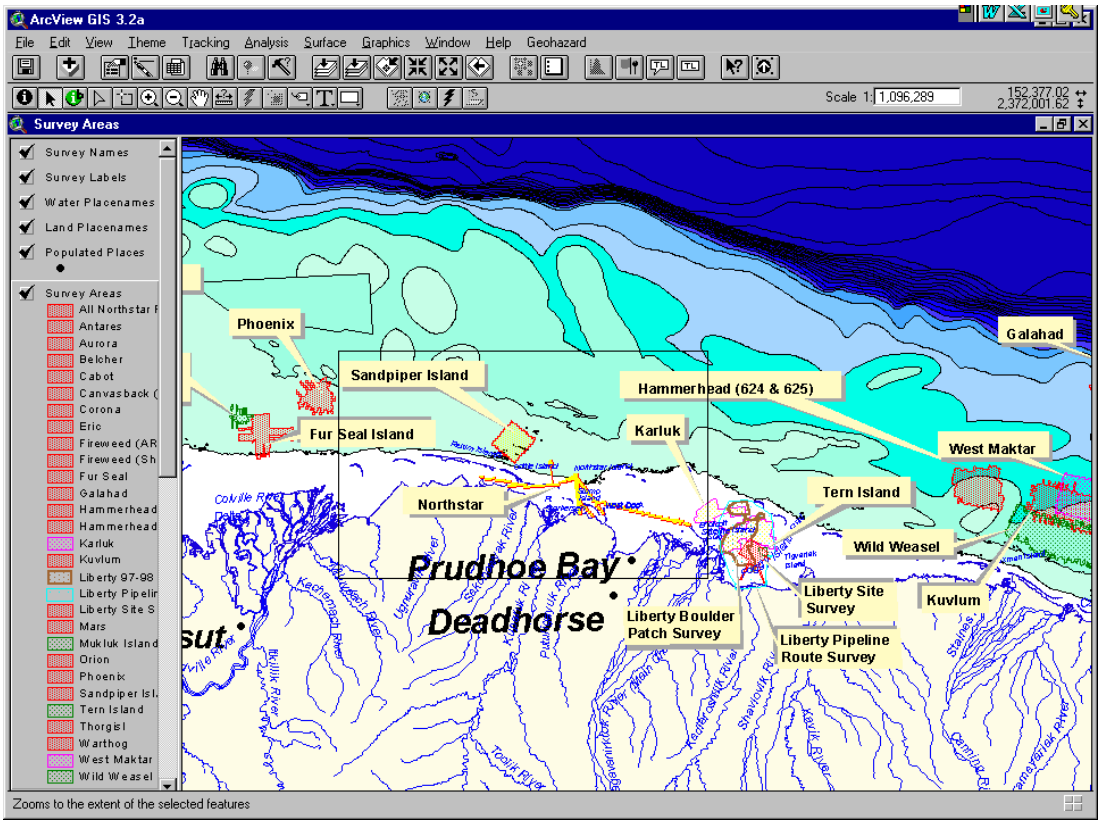
All of the geohazard data can be accessed via the Graphical User Interface (GUI) as illustrated below.

- In ArcView, from the main menubar, click Geohazard – Access Data.

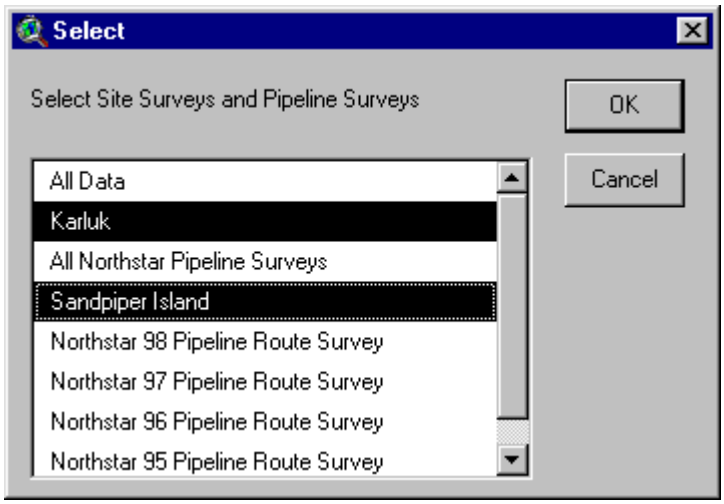


- The ***Survey Areas map*** displays. The ***Table of Contents*** lists the default ***themes***, such as Water Placenames, Land Placenames, Survey Areas, Bathymetry and Detailed Coastline.

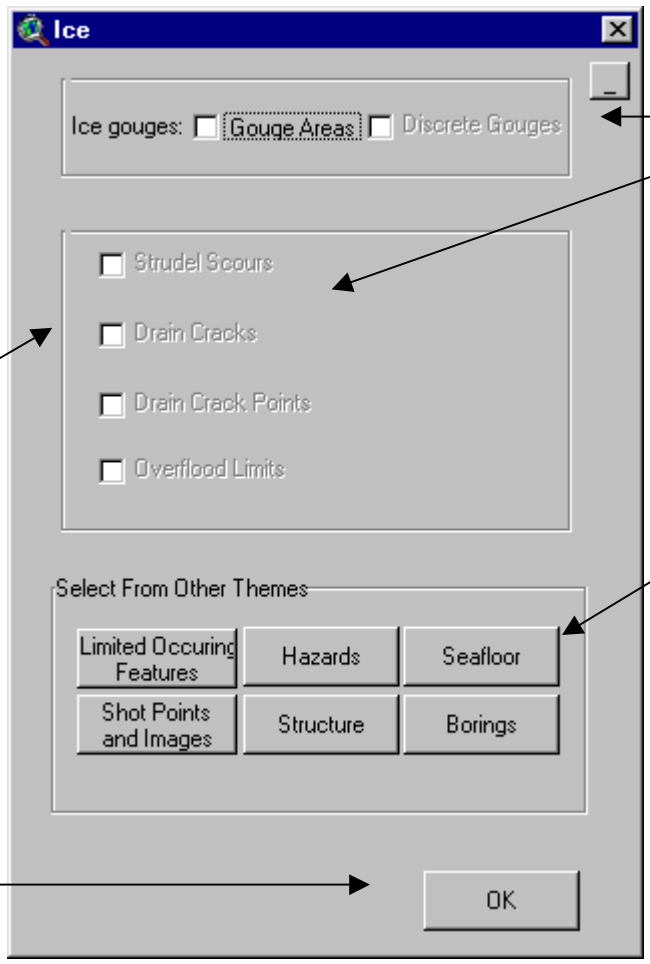
- Choose the "Select Site Surveys and Pipeline Surveys "tool , then select the area of interest by drawing a rectangle around it. In the example below, the user selected the area that included the Sandpiper, Northstar, and Karluk surveys.



- The Select dialog appears. Here you can refine your selection by highlighting individual surveys, or choose "All Data" to select data sets from all surveys. When done, click OK.



- The Ice dialog appears. This dialog is one of seven ***Group Menus*** that allow you to select various ***themes***, or data types. *Note:* If ArcView prompts for the Geohazards.mdb file, read the section "Create an ODBC".



Select the data types you want to view.

The Group Menu queries the associated data from the surveys. The data type will be grayed-out if not available. In this example, the grayed-out features were not available for Karluk and Sandpiper.

There are seven Group Menus (including Ice) which contain specific types of data that can be viewed. Each Group Menu allows the user to access the other six menus by clicking the buttons on the bottom of the menu.

Click OK only after selections from all the Group Menus have been made.

- When you have selected all the themes you want in the Group Menus, click OK.
- The Survey Areas Map redisplays. The ***themes*** you chose in the Group Menus are checked in the ***Table of Contents***. To ***activate*** a theme, click on its name in the Table of Contents.
  To ***zoom in*** on the area of interest, use the Zoom In tool. To ***zoom out***, use the Zoom Out tool or select View – Zoom Out. Repeat as necessary.

Viewing Attributes of the Spatial Data

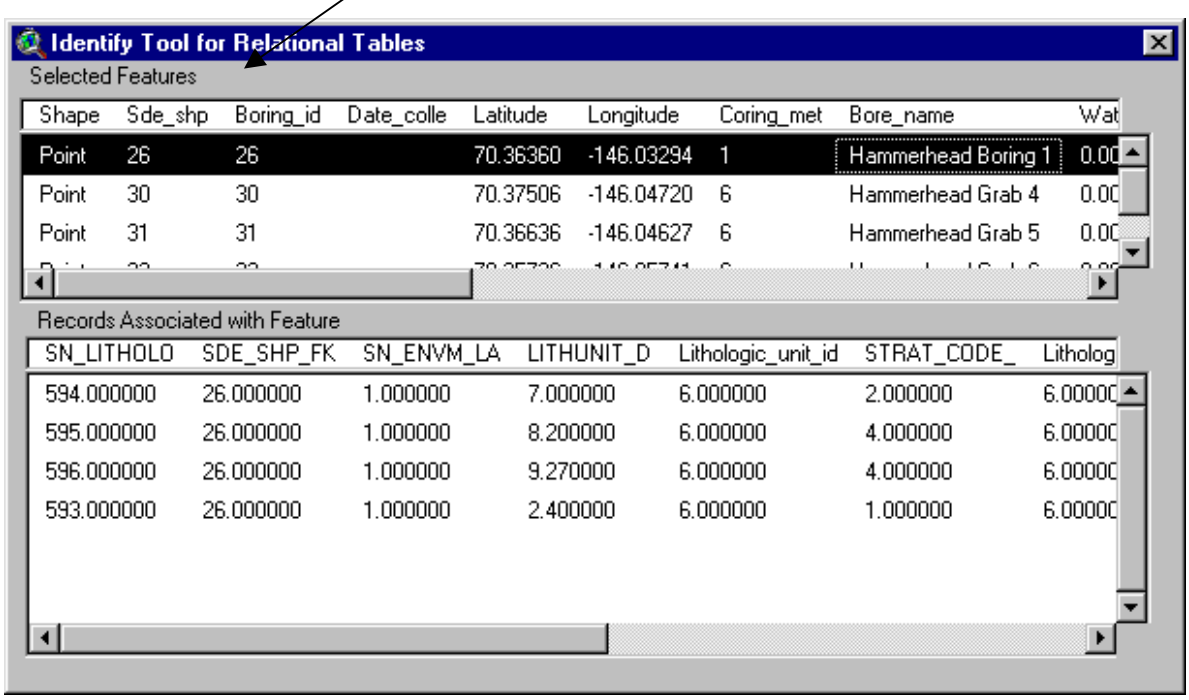
The Identify tool lets you display the attributes of features in a View. Choose the Identify tool and click on any feature in the *active theme(s)*. Attributes of all features located at the same point are displayed.

For features with one to many relationships, the Identify tool also lets you identify related records. Simply choose a theme with relationships—Lithology, Cryology, Ground Temperature, Penetration B Counts, Core Samples—and activate the theme. Then choose the Identify tool and click on any feature in the active theme to display the Identify tool for Relational Tables dialog, shown below. In the dialog, select different rows in the Selected Features box to list associated information in the Records Associated with Feature box.

For example, to see the dialog shown below, display the Survey Areas map, then:

- select the Hammerhead area with the Select Site Surveys and Pipeline Surveys tool;
- select both Hammerhead surveys in the Select dialog;
- select the Borings Group Menu, then the Boring Locations theme;
- activate the Boring Locations theme in the Table of Contents;
- choose the Identify tool and draw a rectangle around all the Hammerhead boring locations.

Select different rows in the Selected Features box to list related information in the Records Associated with Feature box.

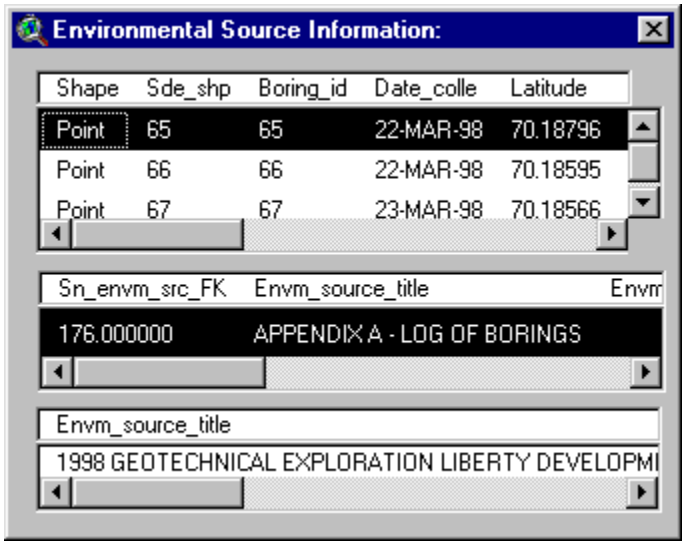


Viewing Metadata

Most of the spatial data in the Geohazards Database were digitized from maps found within the final survey reports. The attributes for the spatial features were taken from the maps and tables within the reports. The titles of the reports and the titles on the map plates inside the reports are the names of the source documents for all of the spatial features within the Geohazards Database. These data are stored in the ENVM_SOURCES table. The Source Identify tool is used to identify the report or map source for any spatial feature (structure contour, isopach contour, boring, etc.) Click on any spatial feature with the Source Identify tool to display the name of the source document.

For example, to see the dialog shown below, display the Survey Areas map, then:

- select the Liberty area with the Select Site Surveys and Pipeline Surveys tool
- select All Liberty Surveys in the Select dialog
- select the Borings Group Menu, then the Boring Locations theme
- activate the Boring Locations theme in the Table of Contents
- choose the Source Identify tool and click on a boring location.



Select Different Records to List Meta Data of a Selected Record

Environmental Source Map Meta Data

Environmental Source Report Meta Data

Selecting and Viewing Seismic Cross-Sections with the Hotlink Tool

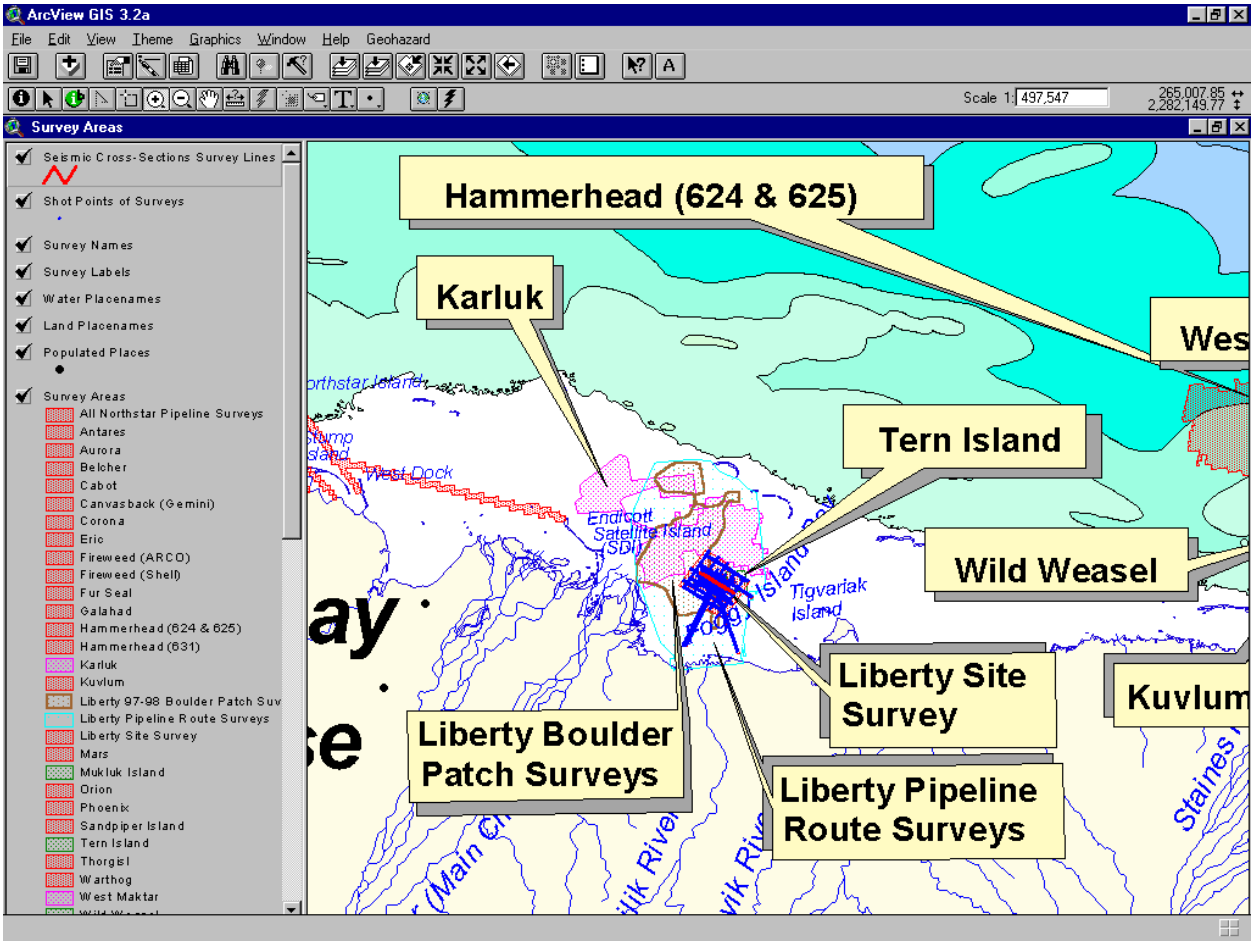
Selected seismic sections, mostly from the back of the final reports, were scanned and incorporated into an Access 97 table called Interpreted Seismic Sections. These seismic sections were taken directly from the reports and were not interpreted by MMS. They include Side-Scan Sonar, Sub-Bottom Profiler, GeoPulse, and Boomer seismic data.

Seismic surveys are made available by choosing the Seismic Cross-Sections Survey Lines Theme from the Shot Points and Images Group Menu. The cross-sections themselves are available through the Hotlink to Seismic Cross-Sections tool .

For example, to see the Sub-Bottom Profiler and Side-Scan Sonar Imagery for the Liberty Site Survey as shown below, display the Survey Areas map, then:

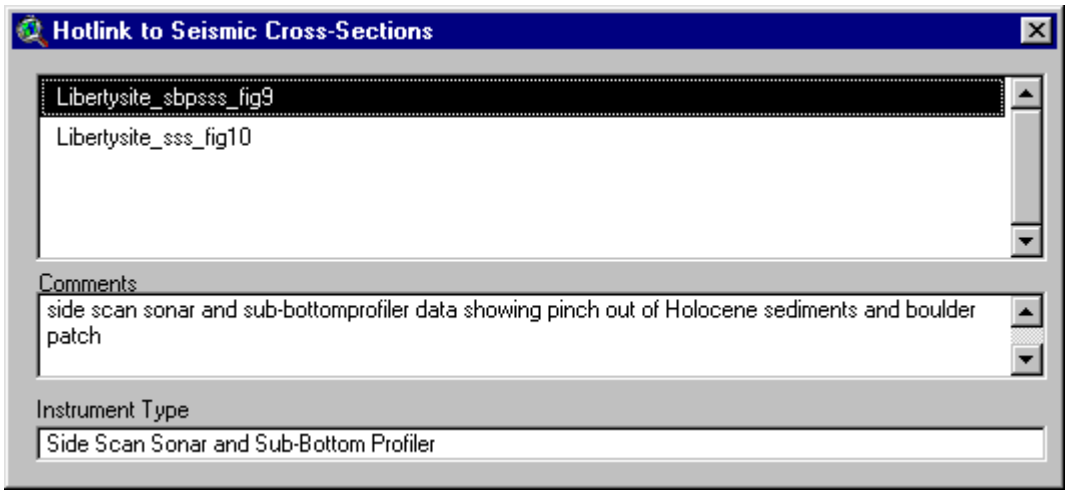
- use the Select Site Surveys and Pipeline Surveys tool to select an area that includes the “Liberty Site Survey”.
- select the “Liberty Site Survey” from the menu

- select the Shot Points and Images Group Menu, then check the Seismic Cross-Sections Survey Lines and shotpoint survey data themes to load the data into the view.
- activate the Seismic Cross-Sections Survey Lines Theme in the Table of Contents

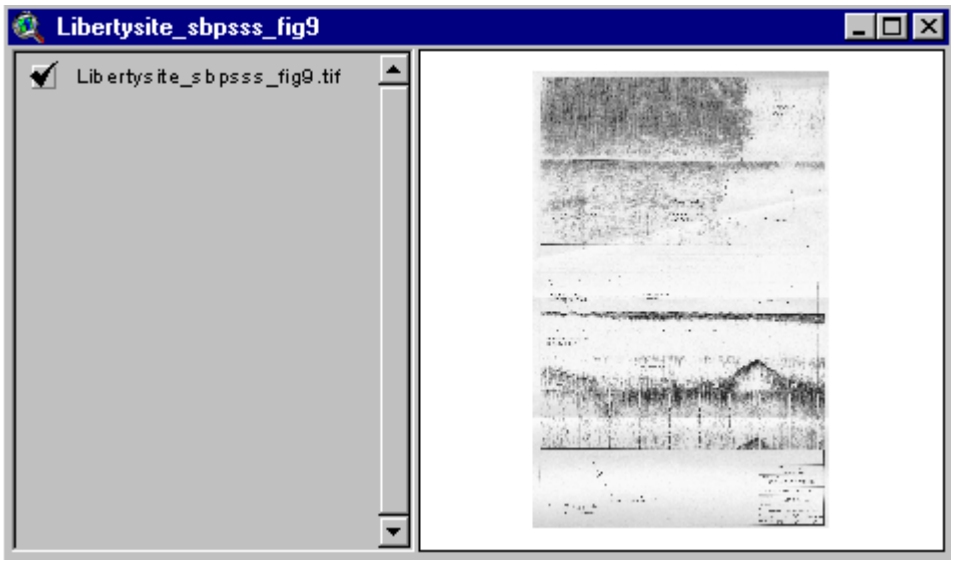


To view a seismic section, choose the Hotlink to Seismic Cross-Sections tool and click on the seismic line (in red).

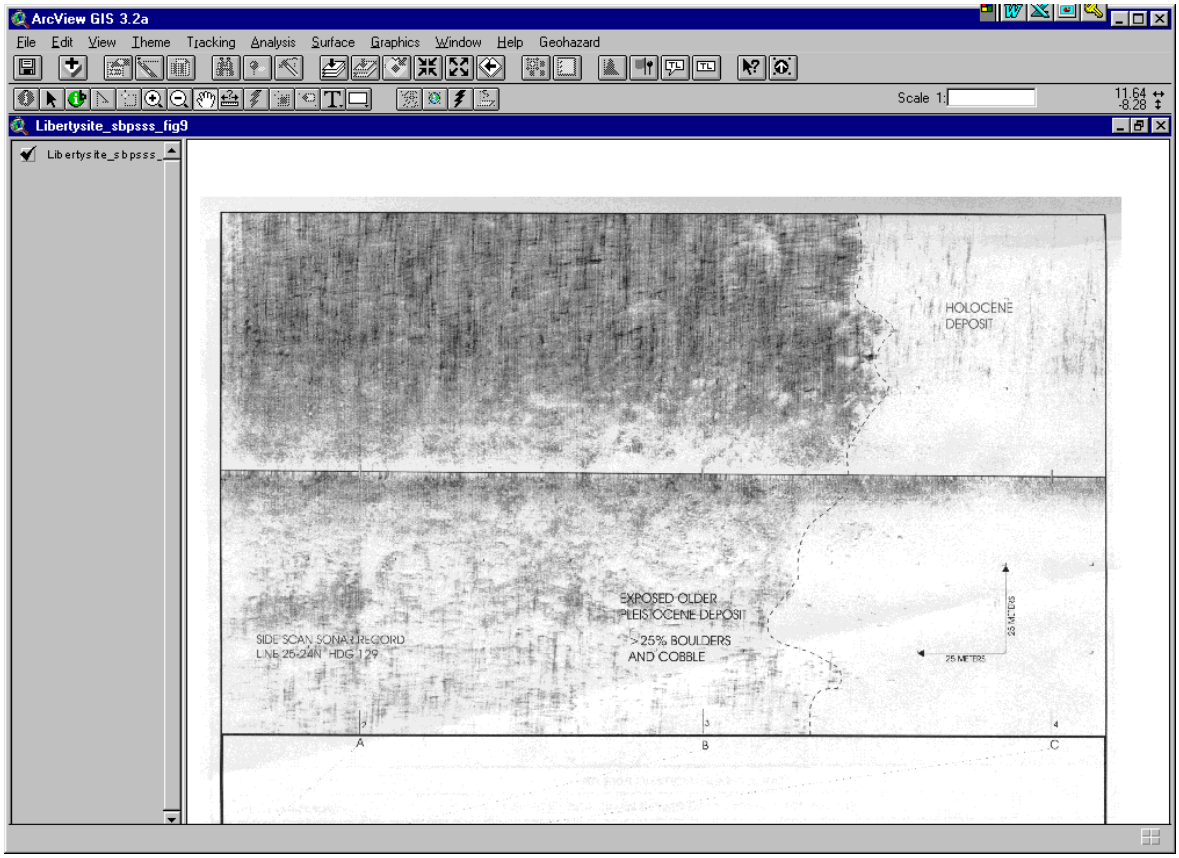
- In the Hotlink to Seismic Cross-Sections dialog, using the mouse, single-click a seismic cross section filename to view the comments and the instrument type.



- Double click the cross section name to view the scan.



- Use the View's zooming and panning tools to review the scanned image in greater detail.

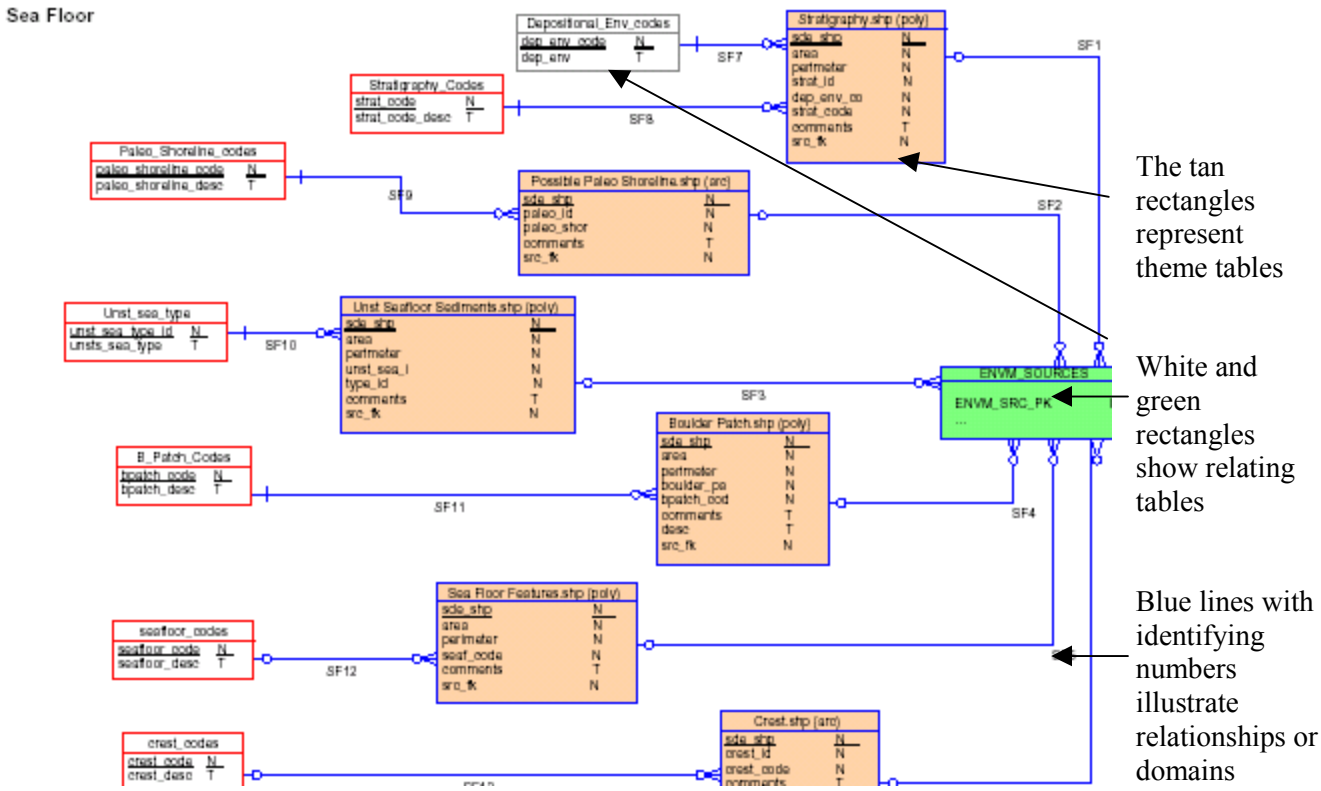


Database Design Documentation

The Entity Relationship Diagram (ERD), data dictionary, relationships table and domains table are included in the Database_Documentation.pdf document. Click on the Database Documentation.pdf to link to the document. (Please keep the Database Documentation.pdf in the same folder as the User Manual to ensure linkage). This information describes the database design of the Geohazards Database. Users can refer to this document as a resource for help on questions concerning the relationships between the spatial and attribute data. *Note: Adobe .pdf format is not compatible with most software, shareware versions of Adobe Reader are available through the Internet (www.adobe.com).*

Entity Relationship Diagram (E.R.D)

Page one of the Database_Documentation.pdf document is the E.R.D. The E.R.D illustrates how the tables of the Geohazards Database are structured. Displayed below is a small portion of the E.R.D showing the table relationships for the "Seafloor Features".



Adobe Links

The E.R.D. has been constructed with "links" to the Data Dictionary, Domains and Relationships tables within this document.

- Click on any table and the user links to the data dictionary, using the pan or zoom tools ,.
- The pan and zoom tools can also link to the relationships or domains table when the user clicks on the Relates (any blue lines).

Technical Documentation

Geohazards Database Specifics

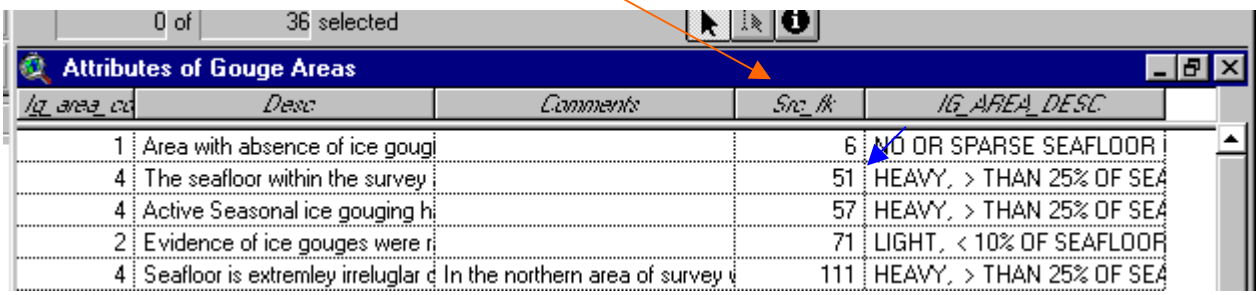
The Geohazards Database includes

- 50 Themes in ESRI Shapefile Format
- 3 Annotation Themes and 1 Label Theme derived from 1 ESRI Coverage
- 51 Tables in a Access 97 Database
- 17 Scanned Images of Seismic Sections

Meta Data Relationships

The shapefiles in the Geohazards Database have many relationships with the tables in the Geohazards.mdb Microsoft Access Database, one of which is the relationship with the Environmental Source Meta Data Table. As illustrated previously, the Environmental Source Identify tool is used to access Environmental Source Meta Data from the spatial features in the database.

All the relationships are based on the values of a common field found in both tables. Regarding the relationship with Environmental Sources Meta Data, most themes in the Geohazards Dataset have a Src_FK Field *(Source Foreign Key field)*.



The common field in the Geohazards.mdb Microsoft Access Database is the sn_envm_src_pk field of the envm_sources table. This data link shows the source map used to generate data.

envm_sources : Table

sn_envm_src_pk	sn_envm_src_FK	ENVM	envi	envm_source_title
48	44	26		COMPOSITE ANOMALY MAP
49	49	18	20-J.	WILD WEASEL PROSPECT OCS Y-1597,
50	49	82	JAN-	POSTPLOT MAP
51	49	83	JAN-	BATHYMETRY AND SEAFLOOR TOPOGR.

Record: 1 of 243

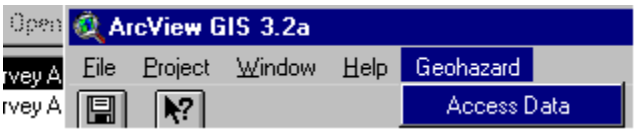
There is a final relationship that links data back to the corresponding report. The sn_envm_src_FK of the envm_sources table relates back to the sn_envm_src_pk field of the envm_sources table. This is a recursive relationship – the relationship relates records of a table with records in the same table.

For example, the 2rd record down of the "Attributes of Gouge Areas" shapefile table has a Src_fk = 51. This relates to the 4th record shown in the envm_sources table, sn__envm_src_pk = 51. The source map of the feature in the shapefile is BATHYMETRY AND SEAFLOOR … Next the 4th record down has a sn_envm_src_fk value of 49 and this relates to the 2nd record displayed, sn_envm_src_pk = 49. This final relationship gives us the report name WILD WEASEL PROSPECT OCS Y…

Survey Areas View

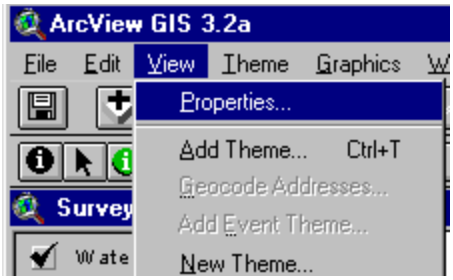
VIEW PROPERTIES

All of the spatial data are non-projected, in Latitude, Longitude, and Decimal Degrees. The View properties are automatically set to the Projection Albers Equal-Area Conic (Alaska Albers) after a new Survey Areas View is opened from the Geohazard Menu.



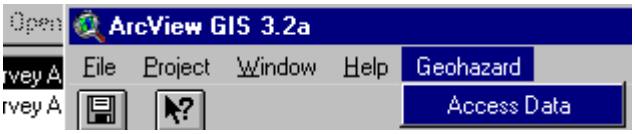
Name: Survey Areas
Map Units: Meter
Distance Units: Meter
Projection: Albers Equal-Area Conic (Alaska Albers)
Spheroid: Clark 1866
Central Meridian: -154
Reference Latitude: 50
Standard Parallel 1: 55
Standard Parallel 2: 65
False Easting: 0
False Northing: 0

Users may change view properties after selecting the view and choosing Properties under the View Menu.



VIEW BASEMAP DATA

MMS has provided basemap data on the MMS Geohazards CD. The data is automatically loaded after a new Survey Areas View is opened.



Geohazard's basemap data not only provides the user with spatial reference functionality but also allows the user to produce quality display for output.

Listing of Basemap Data Contained on the CD

Name	Filename	Feature Type	History
Water Placenames	geohaz_anno	anno.water	Unprojected and copied annotation from the 1:million Alasks DNR Annotation Coverage. Additions and edits completed my MMS.
Land Placenames	geohaz_anno	anno.land	Unprojected and copied annotation from the 1:million Alasks DNR Annotation Coverage. Additions and edits completed my MMS.
Populated Places	populated_places.shp	points	Copied village points from the MMS majc_lbl.shp file.
Survey Areas	areas.shp	polygon	MMS created polygons using data of Survey Post Plot as a reference. If Survey Post Plots not available (i.e. Lag Deposites Data), other data was used as a reference.
Streams	rivers.shp	line	MMS unprojected and clipped the ADNR 1:250,000 Rivers shapefile.
Detailed Coastline	ak_coast_detailed.shp	polyogn	MMS unprojected the USGS 1:63,360 Coastline and continuoulsy updated with detailed coastline data (i.e. Barrier Islands)
Generalized Coastline	ak_coast_generalized.shp	polygon	Unprojected ADNR 1:2,000,000 coastline.

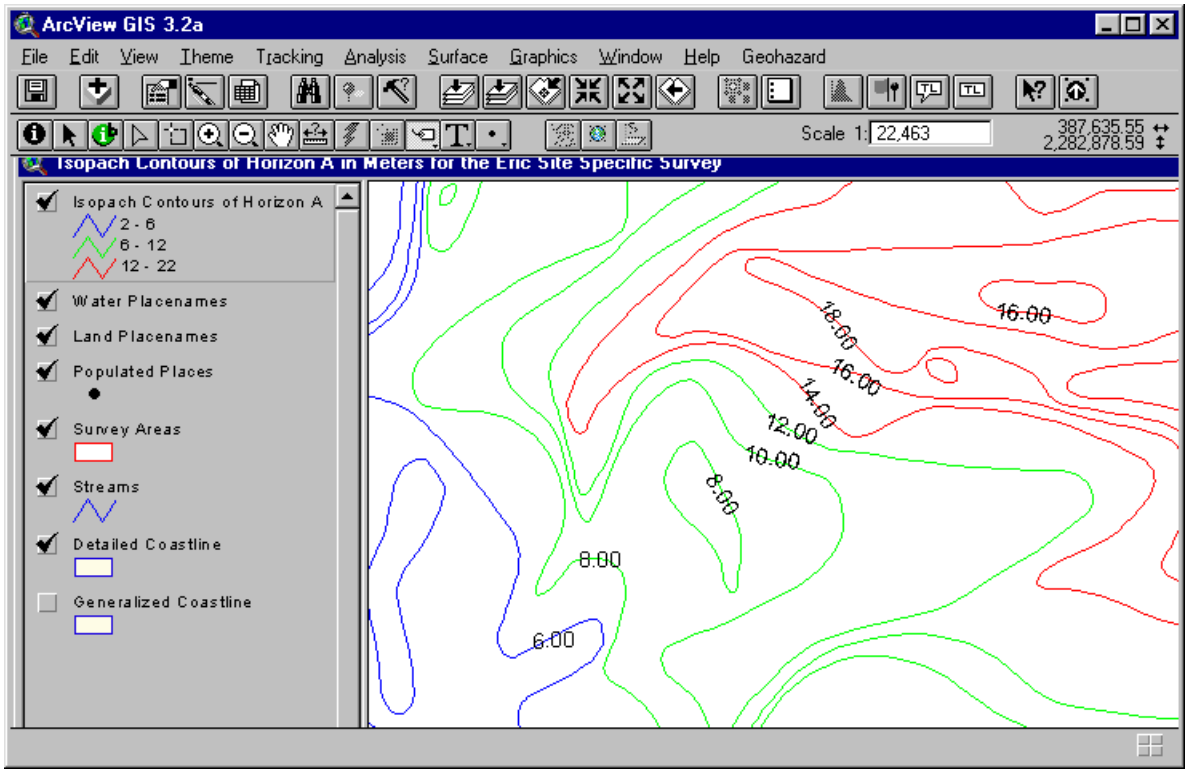
This data is automatically loaded and the themes made active after the data selections are made from the " Select Site Surveys and Pipeline Surveys" menu.

Case Examples

Case Example 1: Display Isopach Contours for the Eric Site-Specific Survey

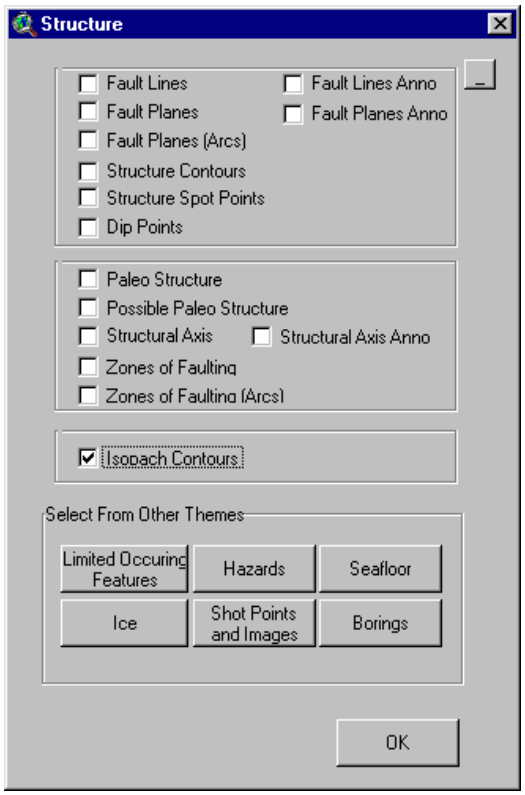
An isopach contour map shows the thickness of a particular geological stratum formation or group of formations—the contours are isolines of equal thickness.

GOAL:



PROCEDURE:

- In ArcView, in order to display the Survey Areas map, select Geohazard – Access Data from the main menubar.
- With the Survey Areas map displayed, choose the Select Site Surveys and Pipeline Surveys tool and draw a rectangle that includes the Eric site (northwest of Kaktovik).
- In the Select dialog, select Eric – OK.
- In the Ice dialog, select the Structure Group Menu.
- In the Structure dialog, select Isopach Contours – OK:

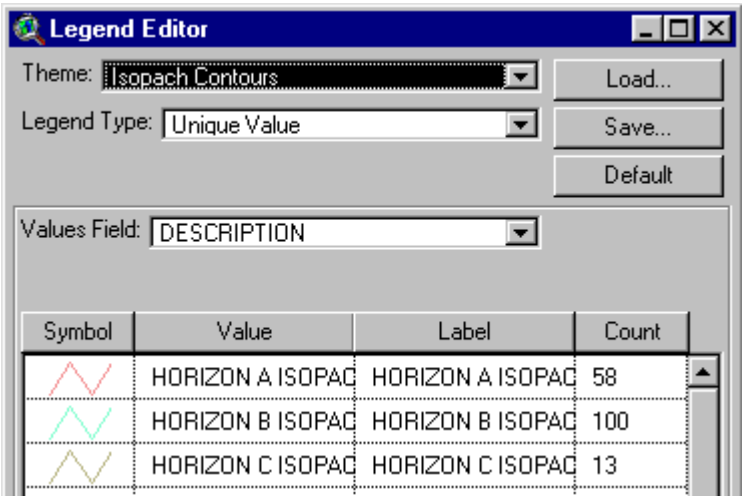


- To enlarge the Eric site, use the Zoom In tool to draw a rectangle around the site.

To make the contour-line map more informative, you will need to label the contours with sediment thickness from the field name “Meas_iso_c”.

- In the Table of Contents, the Isopach Contours theme is checked. Activate the theme by clicking on its name.
- From the main menubar, select Theme – Edit Legend:

- To determine which horizons were mapped in the survey, within the Legend Editor dialog:
  –under Legend Type, select Unique Value
  –under Values Field, select DESCRIPTION
  –click Apply
  A description of the horizons will display in the lower part of the dialog:



- Three isopachs were mapped for the Eric Site Survey
- Select horizon A for contouring, within the Legend Editor dialog:
  –activate the "Isopach Contours" theme
- Click on "Theme" and "Properties"

  –In the Theme Properties menu click on "Definition"

  –Click on the hammer graphic (query button).

  –Highlight and delete everything in the box below

  – Complete the following query "Description" "=" "Horizon A Isopach…"

The view will display only the horizon A isopach contours

- Now, label the horizon A contours by double clicking on the "Isopach Contours Theme"

  –Under Legend Type, select "unique value"

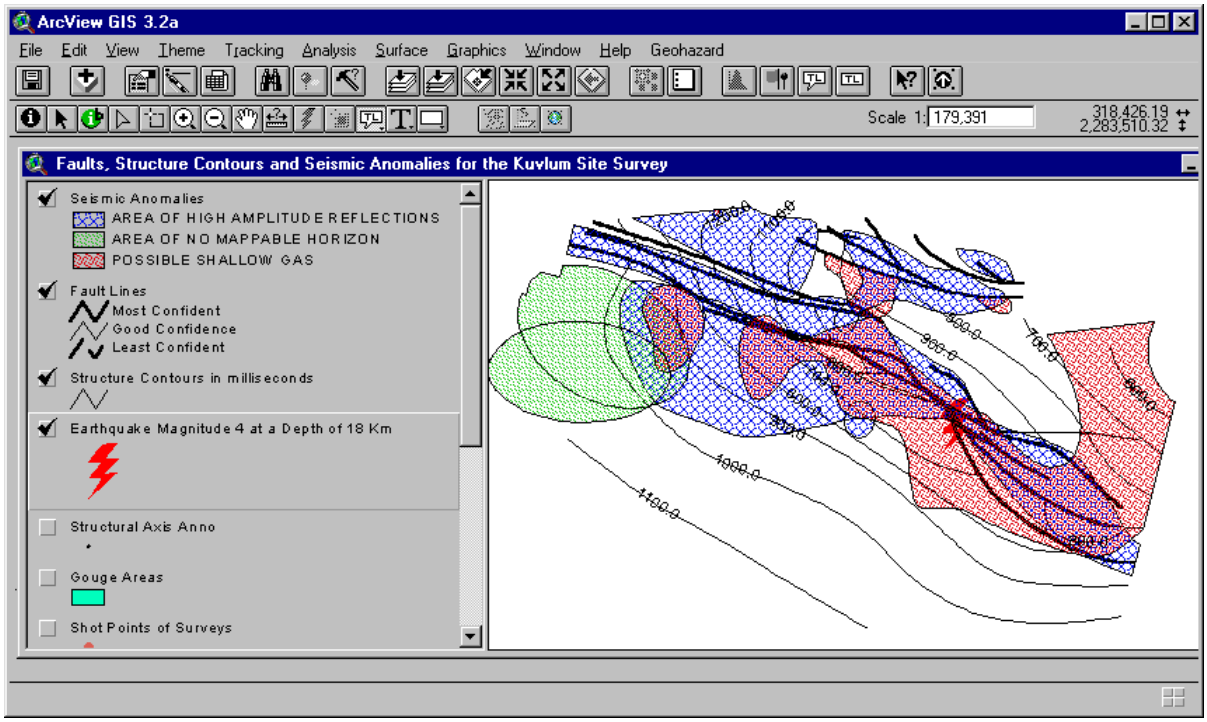
  –Under the field "Values Field" select Meas_iso_c
- Change the values in the field named "value", within the box below in the following manner:

  –Change the value to a range of values for the first contour to 2 – 6, the second from 6 – 12 and the third from 12-22 and click apply.

  –Change the colors in the following manner: 2-6, blue; 6-12, green; 12-22, red
- To label contours, from the main menubar, click Theme and click Text-label.
- under Label Field, select meas_iso_c
  –click OK
- Select Theme, then auto-label (adjust font size as necessary)

Case Example 2: Display Faults, Structure Contours, Seismic Anomalies, and Earthquakes for the Kuvlum Site-Specific Survey

GOAL:



PROCEDURE:

- In ArcView, in order to display the Survey Areas map, select Geohazard – Access Data from the main menubar.
- With the Survey Areas map displayed, choose the Select Site Surveys and Pipeline Surveys tool and draw a rectangle that includes the Kuvlum site.
- In the Select dialog, select Kuvlum – OK.
- In the Ice dialog, select the Structure Group Menu.
- In the Structure dialog,
  –select Fault Lines
  –select Structure Contours
  –then select the Hazards Group Menu to display the Hazards dialog.
- In the Hazards dialog,
  –select Seismic Anomalies
  –select Earthquakes
  –click OK when done.
- To enlarge the Kuvlum site, use the Zoom In tool.

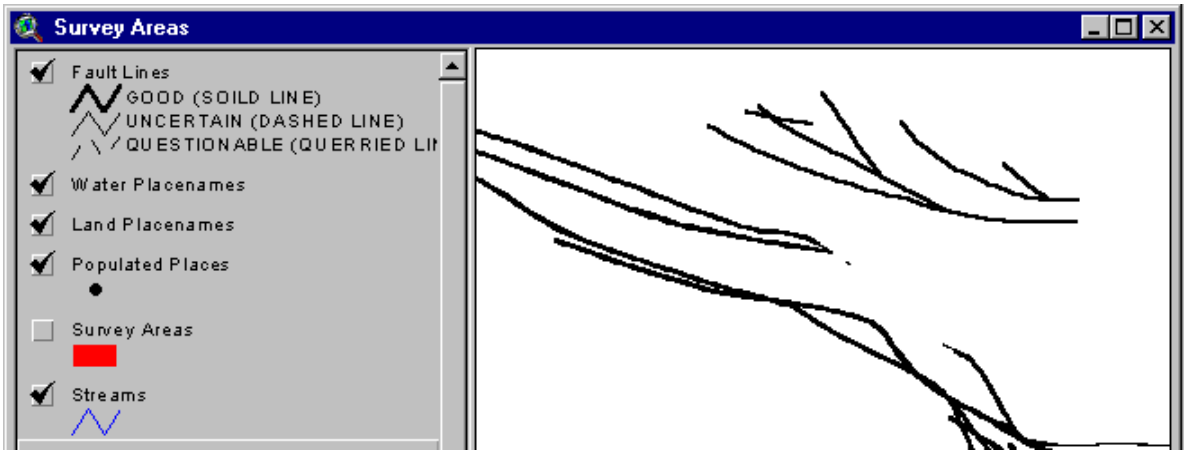
FAULTS

The Fault Line theme contains information on fault location and accuracy of the digitized fault line.

To make the fault lines easier to see, you will need to remove the Survey Area symbols from view and edit the legend:

- In the View, click on the checkmark beside the Survey Areas theme to delete the checkmark and remove the area symbols from the View.
- Activate the Fault Lines themes in the View by clicking on its name.
- From the main menubar, select Theme – Edit Legend.
- In the Legend Editor dialog:
  –under Legend Type, select Unique Value
  –under Values Field, select CONF_LEVEL_DESC
  –in the Symbol column, double click on the line symbol to display the Palette, choose the color and line width you prefer, repeat for the other lines, then close the Palette.
  –when done in the Legend Editor, click Apply.
- Close the Legend Editor dialog.

The fault lines should resemble those shown below:

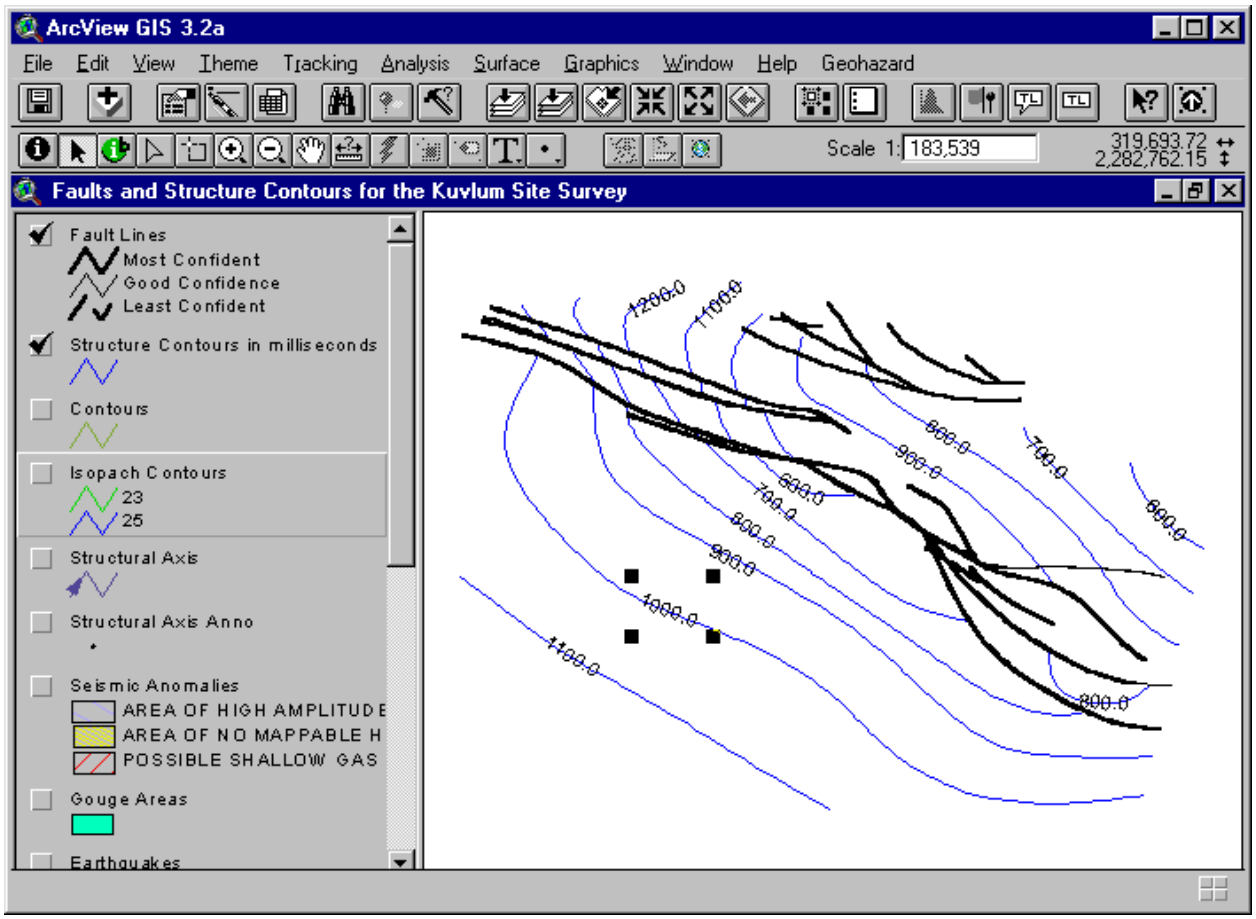


STRUCTURE CONTOURS

Next edit the legend to make the structure contours easier to see:

- In the Table of Contents, the Structure Contours theme is checked. Activate the theme by clicking on its name.
- From the main menubar, select Theme – Edit Legend.
- In the Legend Editor dialog:
  –under Legend Type, select Single Symbol
  –click Apply
- Close the Legend Editor dialog.
- To label contours, from the main menubar, activate the Theme "Structure Contours"
- Select Theme, Autolabel
- –under Label Field, select Meas_value
- select " Line Label Positions Option" "On"
  –click OK

The structure contours should resemble those shown on the following page.



Seismic Anomalies

Next edit the legend to make the seismic-anomaly areas easier to see:

- In the Table of Contents, the Seismic Anomalies theme is checked. Activate the theme by clicking on its name.
- From the main menubar, select Theme – Edit Legend.
- In the Legend Editor dialog:
  –under Legend Type, select Unique Value
  –under Values Field, select SEIS_TYPE
  –in the Symbol column, double click on a symbol to display the Palette, choose the color and pattern you prefer, repeat for the other symbols, then close the Palette.
  –when done in the Legend Editor, click Apply.
- Close the Legend Editor dialog.

Earthquakes

Finally, edit the earthquake symbols to make them easier to see:

- In the Table of Contents, the Earthquakes theme is checked. Activate the theme by clicking on its name.
- From the main menubar, select Theme – Edit Legend.
- In the Legend Editor dialog:

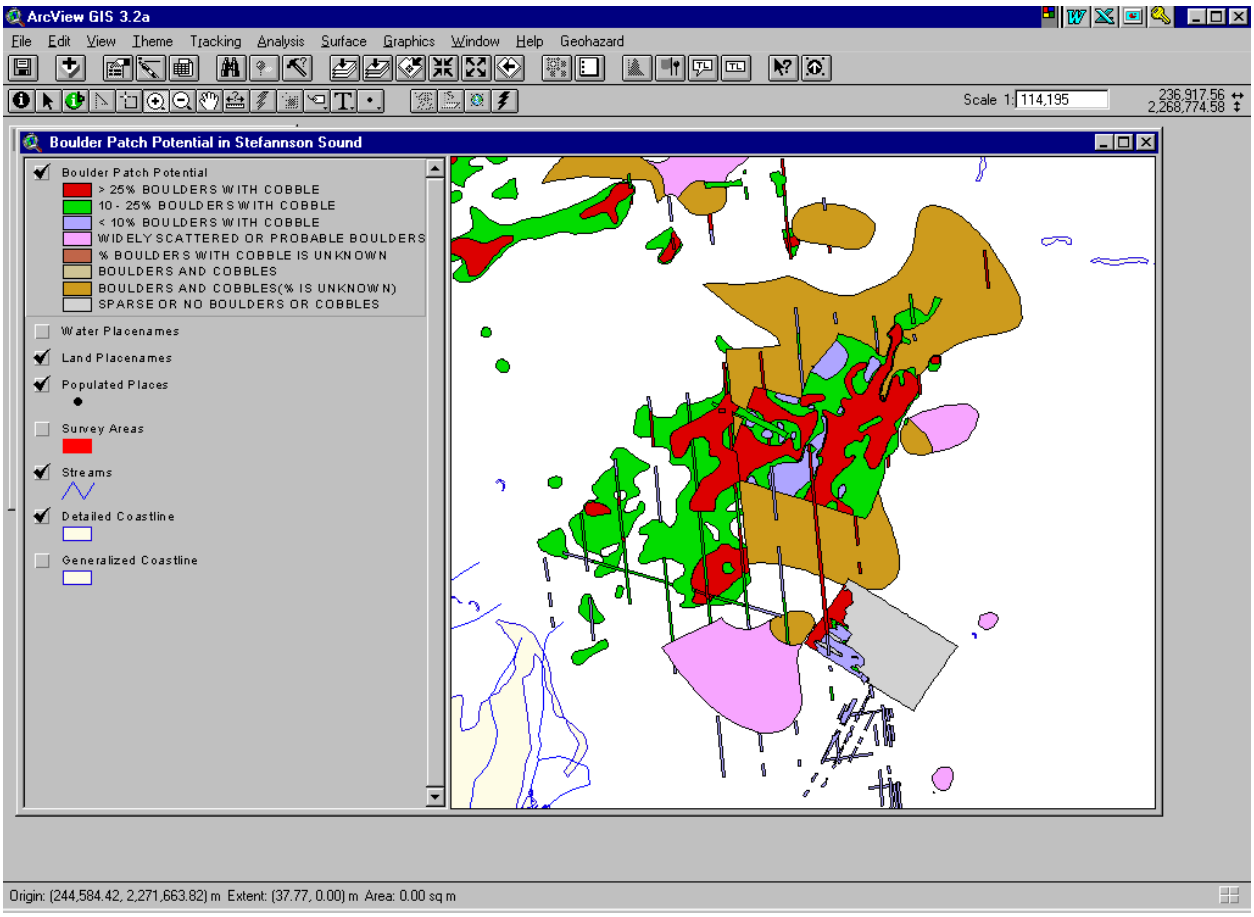
–under Legend Type, select Single Symbol
–in the Symbol column, double click on the symbol to display the Palette, choose the symbol and color you prefer, then close the Palette.
–when done in the Legend Editor dialog, click Apply.

- Close the Legend Editor.

Additional attributes of earthquakes, such as magnitude and depth, can also be displayed with the Legend Editor (select a different Legend Type, then select the attribute in the Values or Classification Field). Attributes are described in the earthquake theme table.

Case Example 3: Display the Boulder Patch In the Liberty Area

GOAL:



PROCEDURE:

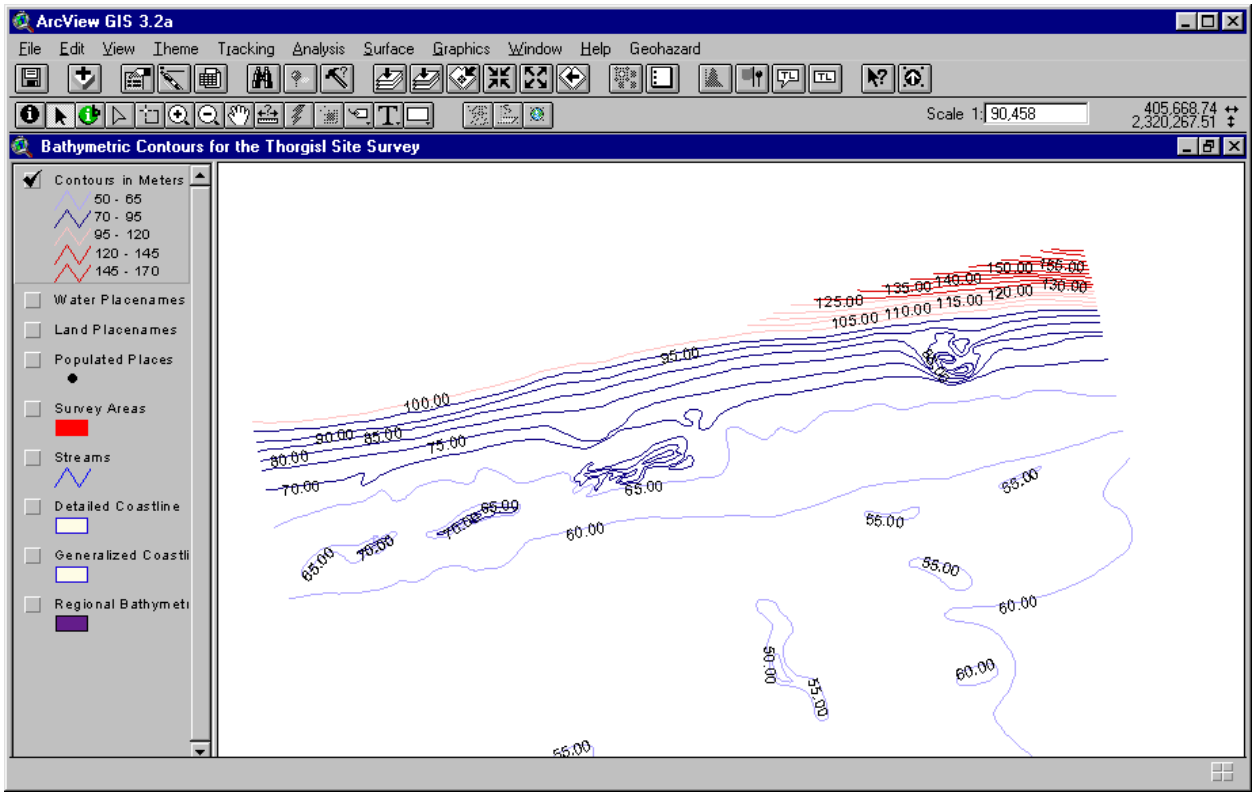
The Boulder Patch can be displayed effectively by presenting the data based upon the boulder patch description (field name = BPATCH_DESC)

- In ArcView, in order to display the Survey Areas map, select Geohazard – Access Data from the main menubar.
- With the Survey Areas map displayed, choose the Select Site Surveys and Pipeline Surveys tool and draw a rectangle that includes the Boulder Patch Area around the Liberty surveys
- In the Select dialog, select Karluk, All Liberty Surveys, and Liberty 97-98 Boulder Patch Survey, then click OK.
- In the Ice dialog, select Seafloor.
- In the Seafloor dialog, select Boulder Patch Potential – OK
- To enlarge the Boulder Patch area, use the Zoom In Tool to draw a rectangle around the Liberty and Karluk sites.
- In the Table of Contents, the Boulder Patch Potential theme is checked. Activate the theme by clicking on its name.
- From the main menubar, select Theme – Edit Legend.

- In the Legend Editor dialog:
  –under Legend Type, select Unique Value
  –under Values Field, select BPATCH_DESC
  –in the Symbol column, double click on a symbol to display the Palette, choose the fill and pattern you prefer, then close the Palette.
  –when done in the Legend Editor, click Apply.
- Close the Legend Editor.

Case Example 4: Display Bathymetry for the Thorgisl Site Specific Survey

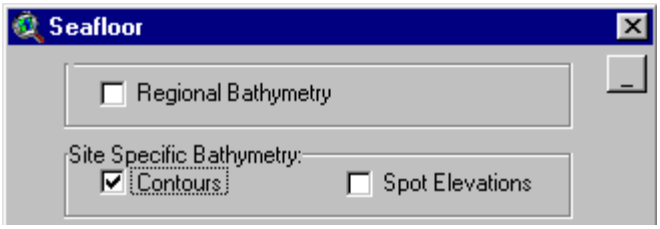
GOAL:



PROCEDURES

Bathymetry data for the surveys display the measurement of water depths as either lines (contours) or as points (spots).

- In ArcView, in order to display the Survey Areas map, select Geohazard – Access Data from the main menubar.
- With the Survey Areas map displayed, choose the Select Site Surveys and Pipeline Surveys Tool and draw a rectangle that includes the Thorgisl site.
- In the Select dialog, select Thorgisl – OK
- In the Ice dialog, select Seafloor.
- In the Seafloor dialog, under Site Specific Bathymetry, select Contours – OK



- To enlarge the Thorgisl site, use the Zoom In tool to draw a rectangle around it.

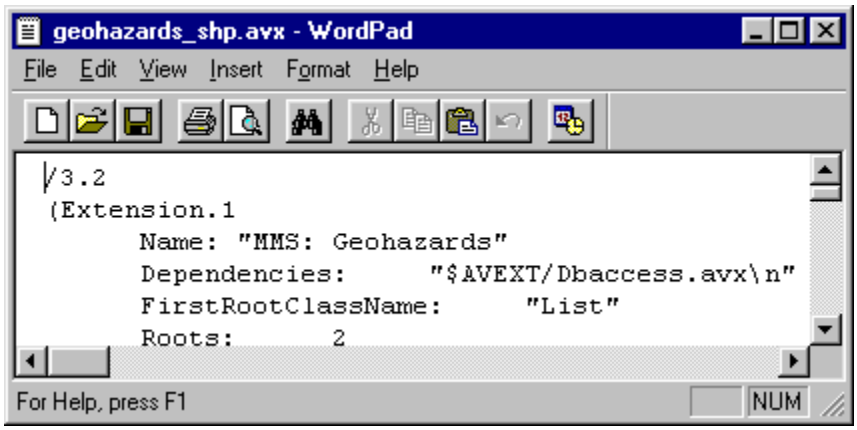
To make the bathymetry easier to see, you will need to remove the Survey Area symbols from view and edit the legend:

- In the Table of Contents, click on the checkmark beside the Survey Areas theme to delete the checkmark and remove the area symbols from view.
- In the Table of Contents, the Contours theme is checked. Activate the theme by clicking on its name.
- From the main menubar, select Theme – Edit Legend.
- In the Legend Editor dialog:
  –under Legend Type, select Graduated Color
  –under Classification Field, select Depth_valu
  –click on the Classify button, classify by 5 sets of values, then click OK
  –in the Value Column, change the values to 50-65, 70-90, 90-120,120-145,145-170
  –when done, click Apply.
- Close the Legend Editor dialog.
- To label the contours, from the main menubar, select Theme –Auto-label.
- In the Auto-label dialog:
  –under Label Field, select Depth_valu
  –click OK.

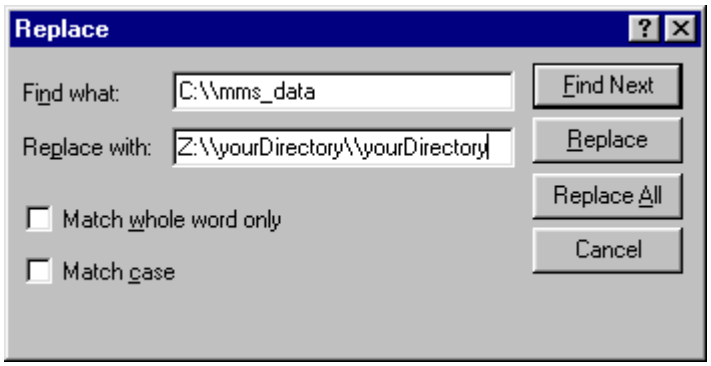
Appendix I. Path Hardcoding

If the geohazards dataset is not located on C:\mms_data and the user would like to avoid path prompting, the path hardcoded in the extension may be changed.

- Open geohazards_shp.avx with a text editor:



- Replace the string C:\\mms_data with the new path. Note the use of double backslashes.



- Save the new geohazards_shp.avx and test by loading the edited extension into ArcView and adding new themes using the Geohazards extension.

Appendix II. Group Menu Index

Ice	**Limited Occuring Features**	**Shot Point and Images**
Gouge Areas	Erosional Cut-Outs	Shot Point of Surveys
Discrete Gouges	Dip Points	Seismic Cross Sections Survey Lines
Strudel Scours	Crest	**Seafloor**
Drain Cracks	Magnetic Intensity Contours	Regional Bathymetry
Drain Crack Points	Interpreted Section Locations	Contours
Overflood Limits	**Structure**	Spot Elevations
Hazards	Fault Lines	Boulder Patch Potential
Seismic Anomalies	Fault Lines Anno	Seafloor Visual Observations
Seismic Anomalies Anno	Fault Planes	Seafloor Visual Observations (point)
Fault Lines	Fault Planes Anno	Seafloor Features (various)
Fault Lines Anno	Fault Planes (Arcs)	Unstable Seafloor Sediments
Fault Planes	Structure Contours	Unidentified Sonar Targets
Fault Planes Anno	Structure Spot Points	**Borings**
Zones of Faulting	Dip Points	Lithology
Unstable Seafloor Sediments	Paleo Structure	Cryology
Stratigraphy (Near Surface)	Possible Paleo Structure	Ground Temperature
Buried Channels	Structural Axis	Penetration B Counts
Buried Channels Anno	Structural Axis Anno	Core Samples
Permafrost	Zones of Faulting	Boring Locations
Earthquakes	Zones of Faulting (Arcs)	
Buried Channel Boundaries	Isopach Contours	

The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

The Minerals Management Service Mission

As a bureau of the Department of the Interior, the Minerals Management Service's (MMS) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilities, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil and other mineral resources. The MMS **Royalty Management Program** meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of: (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protection.