DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

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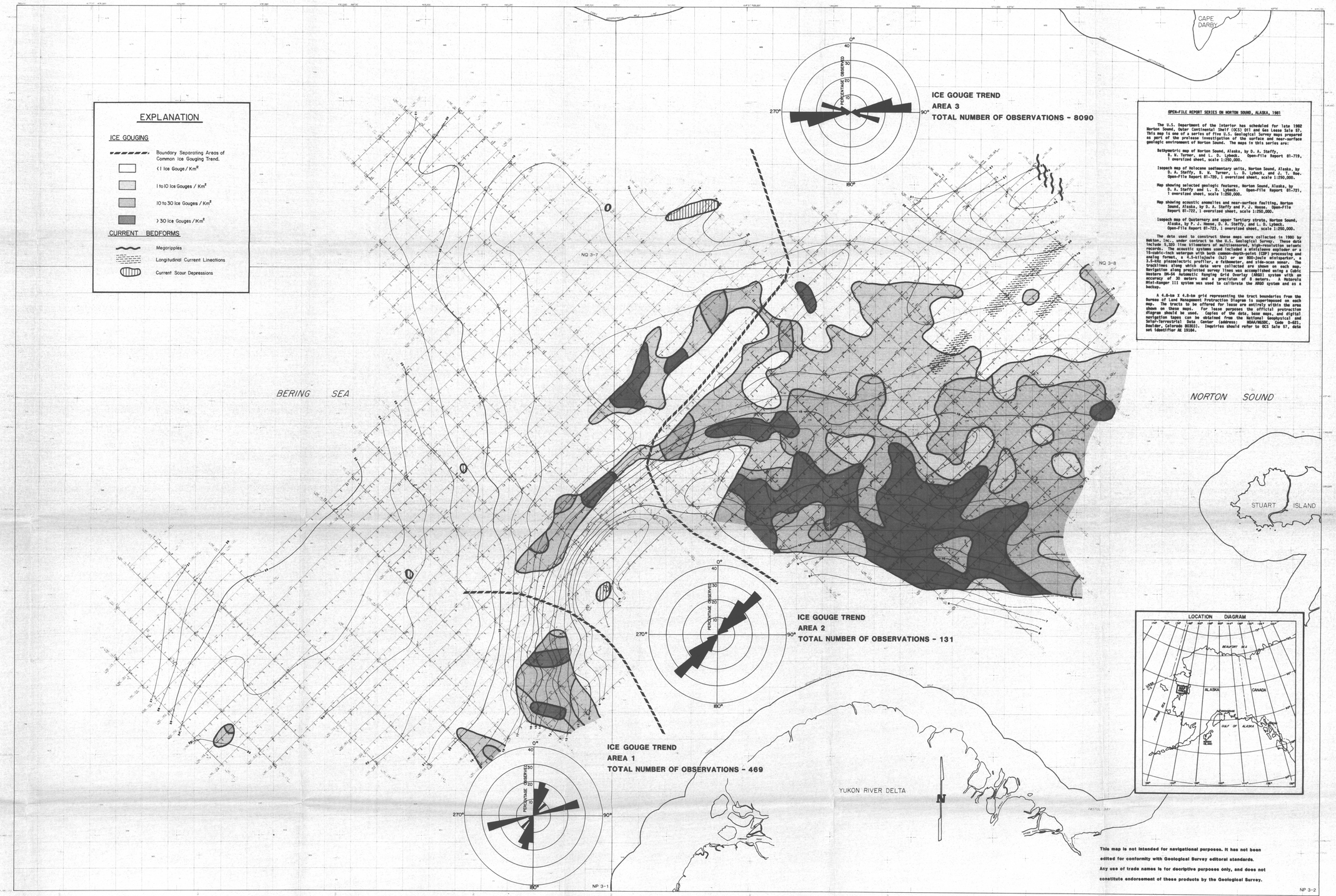
U. S. GEOLOGICAL SURVEY
ANCHORAGE, ALASKA

OPEN FILE REPORT 81-721




## MAP SHOWING SELECTED GEOLOGIC FEATURES

Selected bedform features, such as ice gouging, megaripples, longitudinal current lineations, and current scour, were mapped because they reflect active sedimentary processes. The data used to construct this map includes 5,320 line kilometers of narrow-beam fathometer echograms and side-scan sonograms. The fathometer system consisted of an Edo Western transducer with a beam width of 2.5° and a frequency of 40 kHz. Echograms from this system were resolvable to 0.4 m assuming a water column acoustic velocity of 1,500 m/s. The side-scan sonar system consisted of either an EG&G Model 272 towfish and an EG&G Model 259-3 wet paper recorder or an Ocean Research Equipment (ORE), Inc., Model 198-A towfish and an EPC 3200 dry paper recorder. Sonograms were recorded at a 125-m sweep range and have a transverse resolution of 1.0 m (Fleming, 1976). For interpretation purposes, the bathymetric map for the area (Steffy, Turner, and Lybeck, 1981) has been superimposed on this map.

### Ice Gouge

Ice gouges are recognized as furrows in the surficial sediment caused by single-keeled or multikeeled ice floes that drag across the seafloor driven by wind and water currents. Ice gouges were mapped with respect to gouge density and gouge trend.

Ice gouge density:--Gouge densities were determined by counting the number of single-keeled gouges and individual gouges of a multikeeled floe that intersect the survey line over a 1.5-km (5 shot points) interval. This observed number of line crossings was then normalized to a 1-km interval. Normalization entailed (1) adjusting the observed number for the change in sample interval by multiplying the observed number by 2/3 and (2) adjusting the observed number, because the ship's course and the gouge trend are not perpendicular, by multiplying the observed number by 1/sin θ, where the angle, θ, is the difference in bearings (Barnes and others, 1978). The normalized value represents the number of gouges per square kilometer with the assumption that the distribution of gouges viewed on the sonogram is similar to the immediately adjacent area. Areas having a density range of 1 to 10, 10 to 30, or greater than 30 ice gouges per square kilometer are shaded correspondingly darker. The unshaded area has a gouge density of less than 1 per square kilometer.

Ice gouge trend:--Gouge trends were determined by measuring the relative bearing of individual gouges with respect to the survey line. These relative bearings were then adjusted to true bearings. Three areas (1, 2, 3) having common ice gouging trends were identified and are statistically displayed by rose diagrams. Each rose diagram illustrates the percentage of ice gouges within an area that have a common bearing.

The map indicates that most of the gouges occur between water depths of 7 to 24 m and are most dense between depths of 10 to 17 m. The majority of gouges are found in Area 3, the delta front north of the Yukon Delta (8090 observed ice gouges). Thor and Nelson (1981) attribute this concentration of ice gouging to the westward-moving ice pack of Norton Sound shearing against the shorefast ice that covers the shallow water offshore from the delta. This shearing overrides normally thin (less than 2 m) annual ice into ridges of ice thick enough to gouge the seafloor. These pressure ridges produce multikeeled ice gouges. Smaller amounts of ice gouging occur in Area 1 (469 observed ice gouges) and Area 2 (131 observed ice gouges). Ice gouging in Area 1 may be caused by the Bering pack ice shearing against the shorefast ice extending westward from the delta (Dupré, 1978). Ice gouging in Area 2 results from an interaction of shorefast ice with both Norton Sound or Bering Sea pack ice (Thor and Nelson, 1981). In all three areas, the major ice gouge trend parallels the bathymetric contours. On sonograms, the single-keeled ice gouges range from 5 to 50 m wide and appear to be infilled to varying degrees by active sedimentary processes. Echograms displayed no resolvable relief for the ice gouges.

### Current Bedforms

Megaripples:--The sonogram for survey line 101 shows the only indication of megaripples. Megaripples occur as a series of ripples having a wavelength of 20 to 50 m and an amplitude of less than 0.5 m, the crests of which trend N. 10° W. along the bottom of a bathymetric trough. This trend is normal to the prevailing westerly current direction (Nelson and others, 1981). Bottom samples indicate that the local surface sediment consists of a silty fine sand (Larsen and others, 1981). The echogram for line 101 reflects this composition by displaying a slightly diffuse appearance beneath the sea-floor reflector.

Longitudinal Current Lineations:--The sonograms for survey lines 176 and 180 show the only indication of longitudinal current lineations. These lineations occur as a series of furrows having a wavelength of 10 to 30 m and depths of less than 0.5 m. These features trend N. 10° W. along the flank of a bathymetric trough. This trend is parallel to the prevailing westerly current direction. Bottom samples indicate that the local surface sediment ranges from a silty fine sand to sand (Larsen and others, 1981). The echograms for lines 176 and 180 show that the seafloor is highly reflective, which could indicate the presence of a hard (sandy) seafloor.

Current scour depressions:--On the sonograms, current scour forms broad, shallow, flat-bottomed, elongated depressions. The two most extensive scour areas are in the shallow water just west of the Yukon Delta and the flat prodelta area 80 km north of the delta. The scour area north of the delta is characterized by elongated depressions 100 to 150 m long, 35 to 80 m wide, and less than 1 m deep. These depressions trend N. 100° W., and are found on the flank of a bathymetric trough. This trend is parallel to the prevailing westerly current direction. Bottom samples indicate that the local surface sediment is a silty fine sand (Larsen and others, 1981). This composition is also indicated by echograms in the area which display a slightly diffuse appearance beneath the sea-floor reflector. The scour area west of the delta is characterized by elongated depressions 140 to 160 m long, 80 to 100 m wide, and less than 2 m deep. These depressions trend N. 15° W., and are found on the flat, shallow, subice platform. This trend is oblique to the prevailing northeasterly current direction, but matches dominant bottom-current flow. Bottom samples indicate that the local surface sediment is a silty fine sand (Larsen and others, 1981), and a slightly diffuse sea-floor reflector is visible on the echograms.

### REFERENCES

Barnes, P. W., McDowell, D., and Reimnetz, E., 1978, Ice gouging characteristics: their changing patterns from 1975-1977, Beaufort Sea, Alaska: U.S. Geological Survey Open-File Report 78-730, 42 p.

Dupré, W. R., 1978, Yukon Delta coastal processes study: Environmental Assessment of the Alaskan Continental Shelf, Annual Report of Principal Investigators for the year ending March 1978, NOAA, U.S. Department of Commerce, v. 11, p. 384-446.

Fleming, B. W., 1976, Side-scan sonar: A practical guide, in Side-Scan Sonar; A comprehensive presentation: EG&G International Inc., Environmental Equipment Division, Waltham, MA, p. A-1 - A-45.

Larsen, B. R., Nelson, C. H., Heropoulos, C., and Patry, J. J., 1981, Distribution of trace elements in bottom sediments of northern Bering Sea: Environmental Assessment of the Alaskan Continental Shelf, Annual Reports of Principal Investigators for the year ending March 1980, NOAA, Department of Commerce, v. 5, p. 445-567.

Nelson, C. H., Rowland, R. W., Stoker, S. W., and Larsen, B. R., 1980, Interplay of physical and biological sedimentary structures of the Bering Epicontinental Shelf, 53 p., in Larsen, R. C., Nelsom, C. H., and Thor, D. R., eds., Geological, geochemical, and geotechnical observations on the Bering Shelf, Alaska: U.S. Geological Survey Open-File Report 80-979, 476 p.

Thor, D. R., and Nelson, C. H., 1981, Ice gouging on the subarctic Bering Shelf: Environmental Assessment of the Alaskan Continental Shelf, Annual Reports of Principal Investigators for the year ending March 1980, NOAA, Department of Commerce, v. 5, p. 286-314.

### OPEN-FILE REPORT SERIES ON NORTON SOUND, ALASKA, 1981

The U.S. Department of the Interior has scheduled for late 1982 Norton Sound, Outer Continental Shelf (OCS) Oil and Gas Lease Sale 57. This map is one of a series of five U.S. Geological Survey maps prepared as part of the prelease investigation of the surface and near-surface geologic environment of Norton Sound. The maps in this series are:

Bathymetric map of Norton Sound, Alaska, by D. A. Steffy, D. W. Turner, and L. D. Lybeck. Open-File Report 81-719, 1 oversized sheet, scale 1:250,000.

Isopach map of Holocene sedimentary units, Norton Sound, Alaska, by D. A. Steffy, D. W. Turner, L. D. Lybeck, and J. T. Hoe. Open-File Report 81-720, 1 oversized sheet, scale 1:250,000.

Map showing selected geologic features, Norton Sound, Alaska, by D. A. Steffy and L. D. Lybeck. Open-File Report 81-721, 1 oversized sheet, scale 1:250,000.

Map showing acoustic anomalies and near-surface faulting, Norton Sound, Alaska, by D. A. Steffy and P. J. Hoose. Open-File Report 81-722, 1 oversized sheet, scale 1:250,000.

Isopach map of Quaternary and upper Tertiary strata, Norton Sound, Alaska, by P. J. Hoose, D. A. Steffy, and L. D. Lybeck. Open-File Report 81-723, 1 oversized sheet, scale 1:250,000.

The data used to construct these maps were collected in 1980 by Nekton, Inc., under contract to the U.S. Geological Survey. These data include 5,320 line kilometers of multisensored, high-resolution seismic records. The acoustic systems used included a minisleeve exploder or a 15-cubic-inch watergun with both common-depth-point (CDP) processing and analog format, a 4.5-kilojoule (kJ) or an 800-joule minisparker, a 3-kHz pinger-hydrophone profiler, a fathometer, and side-scan sonar. The tracklines along which data were collected are shown on each map. Navigation and preplotted survey lines was accomplished using a Cubic Western DM-80 Automatic Ranging Grid Overlay (ARGO) system with an accuracy of 30 meters and a precision of 8 meters. A Motorola Mini-Ranger III system was used to calibrate the ARGO system and as a backup.

A 4.8-km X 4.8-km grid representing the tract boundaries from the Bureau of Land Management Protraction Diagram is superimposed on each map. The tracts to be offered for lease are entirely within the area shown on these maps. For lease purposes the official protraction diagram should be used. Copies of the data, base maps, and digital navigation tapes can be obtained from the National Geophysical and Solar-Terrestrial Data Center (address: NOAA/NGSDC, Code D-621, Boulder, Colorado 80303). Inquiries should refer to OCS Sale 57, data set identifier AK 19184.

SOURCE OF SHORELINE FROM BLM
PROTRACTION DIAGRAMS NQ3-7,
NQ3-8, NP3-1 AND NP3-2.
PUBLISHED IN 1976.

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SCALE 1:250,000

5 0 5 10 15 20 25 STATUTE MILES

5 0 5 10 15 20 25 KILOMETERS

5 0 5 10 15 NAUTICAL MILES

Bathymetric Contour Interval 1 Meter ( Index C.I. 5 Meters)

MAP PROJECTION UTM CLARKE
1866 SPHEROID, ZONE 3.

# MAP SHOWING SELECTED GEOLOGIC FEATURES, NORTON SOUND, ALASKA

DAVID A. STEFFY AND LYNN D. LYBECK

1981