DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

OPEN FILE REPORT 81-722

MAP SHOWING ACOUSTIC ANOMALIES AND NEAR-SURFACE FAULTING

Acoustic anomalies and near-surface faulting were mapped because they reflect potential hazards in the Outer Continental Shelf (OCS) Oil and Gas Lease Sale 57 area. The interpretation presented in this map was based on 5,320 km of multisensored, high-resolution, processed seismic data. The seismic systems used either a minisleeve exploder or a 15-cubic-inch watergun as an energy source. The incoming signal was sampled at a 0.5-ms rate for 1 second. The data were processed using a twelve-fold, common-depth-point (CDP) stack, and were displayed with both automatic gain control and true amplitude.

Acoustic Anomalies

Many acoustic anomalies that occur in the multichannel processed data are characterized by one or more of the following features: reflector amplitude increase, abrupt reflector termination, reflector "pull-down," reflector "wipe-out," phase reversal of reflector, and high-frequency attenuation. These acoustic anomalies were classified as either "shallow" (within the first 100 ms, two-way time) or "deep" (below 100 ms, two-way time). The 100-ms boundary (140 m) was used because it separates an areally large, continuous, shallow anomalous zone from the areally smaller, deeper anomalies that are scattered throughout the survey area.

Shallow acoustic anomalies (Seismic Section 1) are recognized by an amplitude increase (brightening) of a near-surface reflector(s), which may also exhibit a phase reversal. Below this brightened reflector(s) either a "wipe-out" or only low-frequency (10 to 30 Hz) reflections occur. "Wipe-out" is generally marked by reflector terminations at its margin. "Pull-down" of reflectors may also be present at the "wipe-out" margin, and usually indicates that a low-velocity zone such as gas-charged sediments are causing the anomaly. Acoustic anomalies which exhibit reflector "pull-down" at their margins are indicated on the map. Not all shallow anomalies exhibit "pull-down," and those that do may exhibit "pull-down" on only part of the anomaly's margin. Brightened reflectors with no associated "pull-down" may indicate a strong reflecting horizon with or without gas-charged sediments. Holmes and Thor (1981) describe similar anomalies in Norton Sound and attribute them to the presence of near-surface, gas-charged sediments. Holmes and Thor state that most of the gas is probably biogenically produced by a buried, Quaternary peat layer(s). This peat layer(s) has been identified and mapped in the survey area by Steffy and others (1981).

Deep acoustic anomalies (Seismic Section 2) have the same characteristics as shallow anomalies except for their lack of high frequency attenuation beneath brightened reflectors. Times to the top of these brightened reflectors range between 170 and 440 ms, two-way time, (140 to 370 m) and average 330 ms, two-way time, (280 m). These brightened reflectors commonly occur at the base of the Quaternary and upper Tertiary strata mapped by Hoose and others (1981). The "pull-down" and phase reversal of reflectors that define the deeper acoustic anomalies suggest that the anomalies are produced by gas accumulations. A gas accumulation associated with the shallow and deep acoustic anomalies centered around the intersection of survey lines 116 and 123 has been investigated. Holmes and Thor (1981) document these investigations and conclude that thermogenic gas which is migrating upwards along basin margin faults is causing the local acoustic anomalies. Several other shallow and deep anomalies are associated with faults indicating that gas of deeper origin may be migrating upward along these faults.

Faults

Two types of faults are shown on the map. These faults are differentiated based upon the age of the strata they displace. "Deep faults" displace strata older than the unconformity at the base of the Quaternary and upper Tertiary strata mapped by Hoose and others (1981). Most of the deep faults are normal, and some of these normal faults are growth faults. These faults occur as sets forming grabens or as single faults downthrown towards the axis of the Norton Basin (Johnson and Holmes, 1981). On the northeastern portion of the map, deep faults trend predominantly west, parallel to the basin axis. In the northwestern portion of the map, the deep faults trend west-southwest, which is slightly oblique to the northwesterly trend of the basin axis. "Shallow faults" displace the Quaternary and upper Tertiary strata (Seismic Section 1), but not the Holocene sediments mapped by Steffy and others (1981). Shallow faults are growth faults that continued to move through Quaternary time as the basin subsided. Over most of the area, shallow faults trend parallel to deep faults. Shallow faults are downthrown towards the basin axis on the northeastern portion of the map, and downthrown away from the basin axis in the northwestern portion of the map.

No faults were mapped in the southern half of the survey area because of the widespread occurrence of acoustic anomalies that mask the underlying structure. It is assumed, however, that both shallow and deep faults are present in the southern portion of the map area. Johnson and Holmes (1981) identified several faults in the southern portion of Norton Sound but could not correlate them between their track lines. Biswas and others (1981) located epicenters throughout Norton Sound that cluster around known and inferred fault traces, particularly around the Kaltag fault zone. They classify the seismicity of the area as moderately active.

REFERENCES CITED

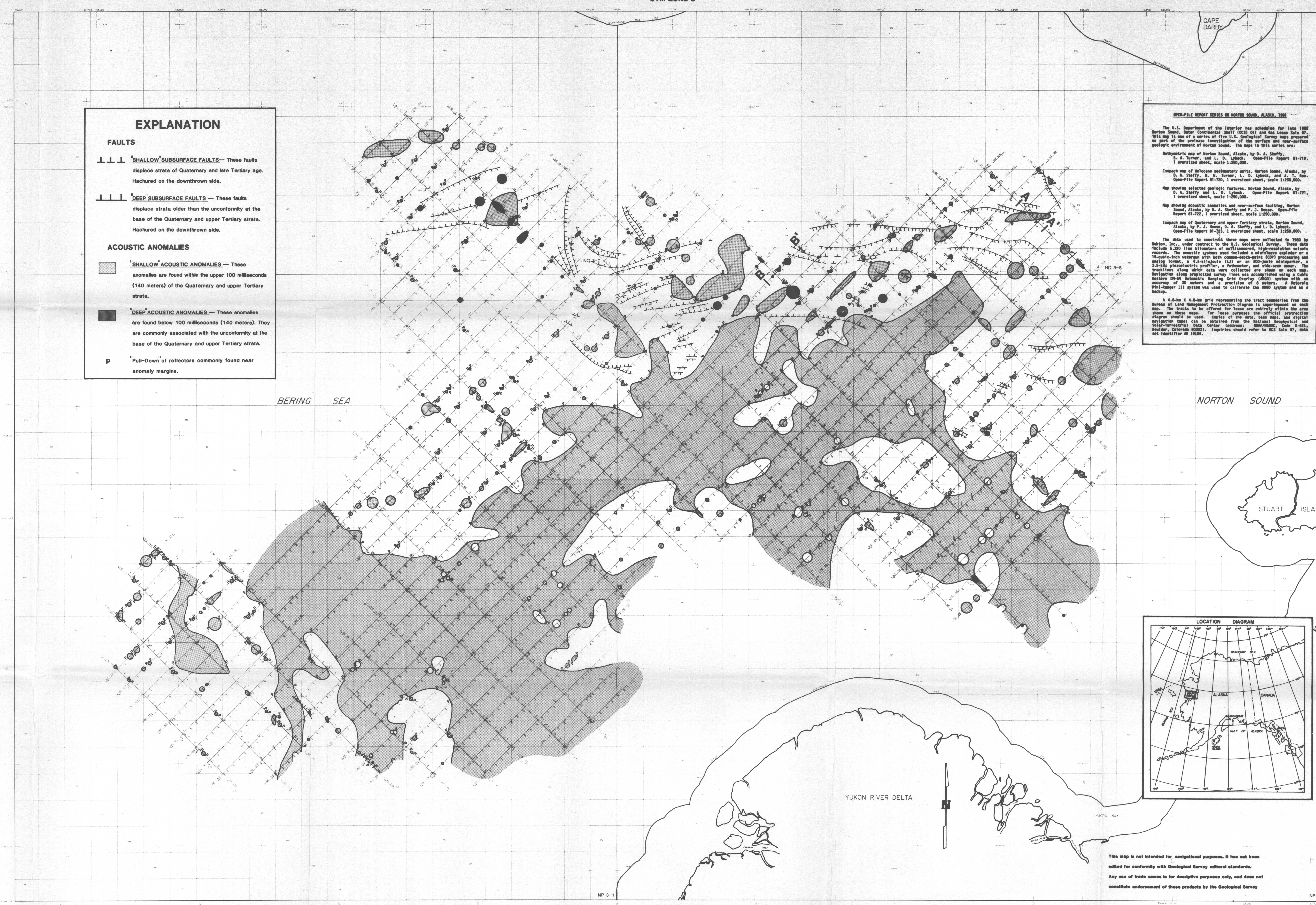
Biswas, N. N., Sackinger, W. M., Gedney, L., 1981, Seismotectonic studies of Western Alaska and sea ice studies in Beaufort Sea: Environmental Assessment of the Alaskan Continental Shelf, Annual Reports of Principal Investigators for the year ending March 1980, NOAA, Dept. of Commerce, v. 5, p. 575-618.

Holmes, M. L., and Thor, D. R., 1981, Distribution of gas-charged sediments in Norton Basin, Northern Bering Sea: Environmental Assessment of the Alaskan Continental Shelf, Annual Reports of Principal Investigators for the year ending March 1980, NOAA, Dept. of Commerce, v. 5, p. 261-285.

Hoose, P. J., Steffy, D. A., Lybeck, L. D., 1981, Isopach map of Quaternary and upper Tertiary strata, Norton Sound, Alaska, USGS Open-File Report 81-723, 1 oversized sheet, scale 1:250,000.

Johnson, J. L., and Holmes, M. L., 1981, Report on surface and subsurface faulting in Norton Sound and Chirikov Basin, Alaska: Environmental Assessment of the Alaskan Continental Shelf, Annual Reports of the Principal Investigators for the year ending March 1980, NOAA, Dept. of Commerce, v. 5, p. 420-444.

Steffy, D. A., Turner, B. W., Lybeck, L. D., and Roe, J. T., 1981, Isopach map of Holocene sedimentary units, Norton Sound, Alaska, USGS Open-File Report 81-720, 1 oversized sheet, scale 1:250,000.



EXPLANATION

FAULTS

"SHALLOW" SUBSURFACE FAULTS— These faults displace strata of Quaternary and late Tertiary age. Hachured on the downthrown side.

"DEEP" SUBSURFACE FAULTS — These faults displace strata older than the unconformity at the base of the Quaternary and upper Tertiary strata. Hachured on the downthrown side.

ACOUSTIC ANOMALIES

"SHALLOW" ACOUSTIC ANOMALIES — These anomalies are found within the upper 100 milliseconds (140 meters) of the Quaternary and upper Tertiary strata.

"DEEP" ACOUSTIC ANOMALIES — These anomalies are found below 100 milliseconds (140 meters). They are commonly associated with the unconformity at the base of the Quaternary and upper Tertiary strata.

P "Pull-Down" of reflectors commonly found near anomaly margins.

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, B. 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, B. W. Turner, L. D. Lybeck, and J. T. Roe. Open-File Report 81-720, 1 oversized sheet, scale 1:250,000.

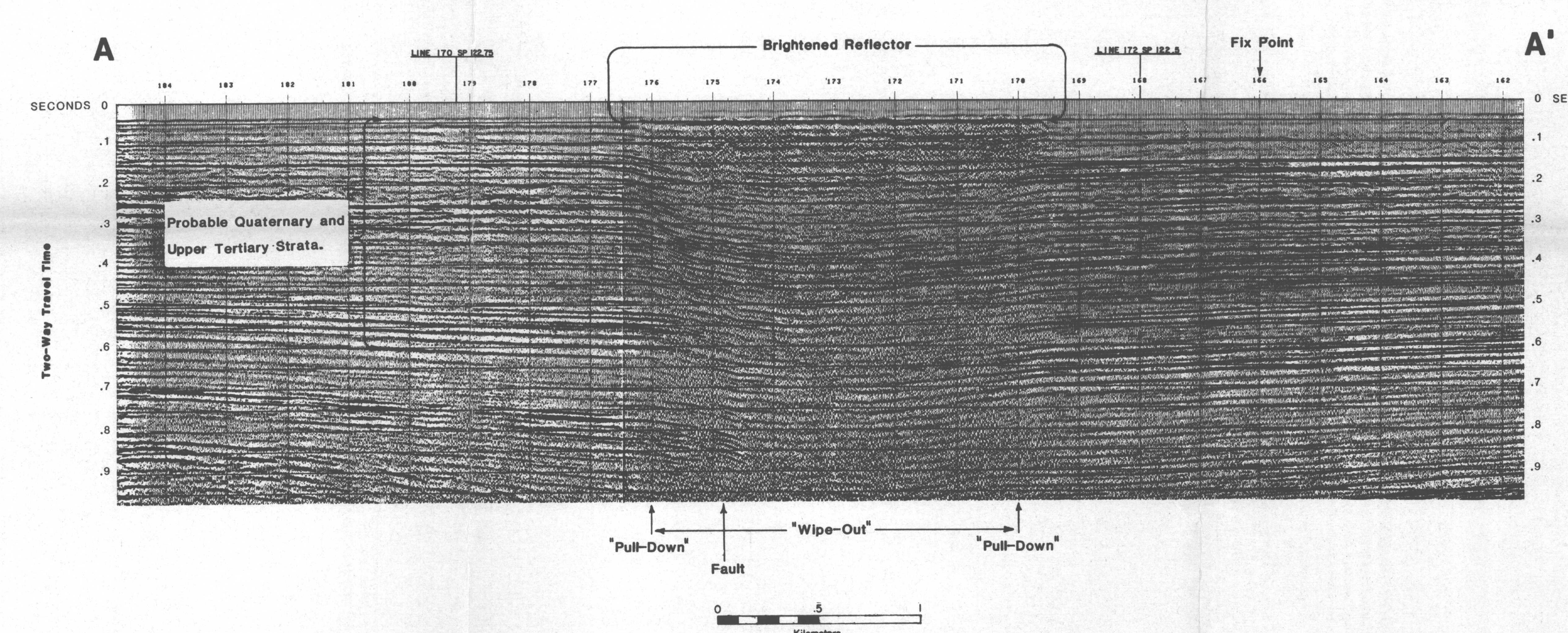
Map showing selected geologic features, Norton Sound, Alaska, by D. A. Steffy and L. D. Lybeck. Open-File Report 81-721, 1 oversized sheet, scale 1:250,000.

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.

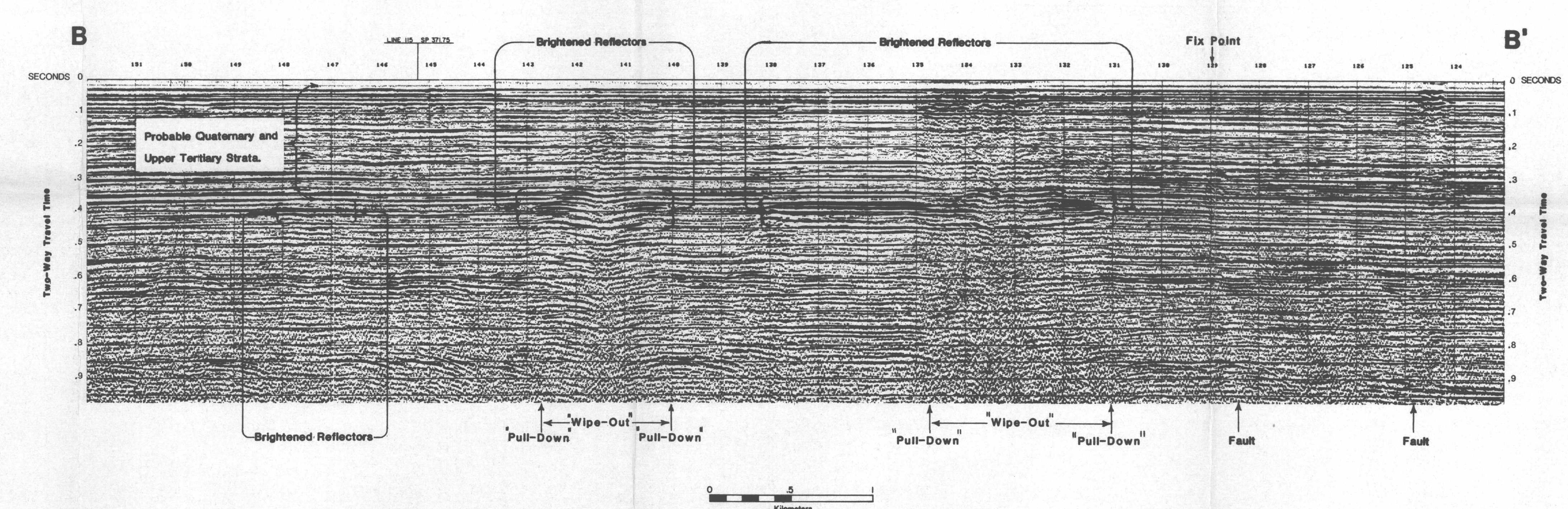
Isopach map of Quaternary and upper Tertiary strata, Norton Sound, Alaska, by P. J. Hoose, D. A. Steffy, and L. D. Lybeck. Open-File Report 81-723, 1 oversized sheet, scale 1:250,000.

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 3.5-kHz piezoelectric profiler, a fathometer, and side-scan sonar. The tracklines along which data were collected are shown on each map. Navigation along preplotted survey lines was accomplished using a Cubic Western DM-54 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.



Seismic Section 1. Shallow acoustic anomaly on survey line 103 between fix points 170 and 176.



Seismic Section 2. Deep acoustic anomalies on survey line 156 between fix points 125 and 150.

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

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

MAP PROJECTION UTM CLARKE 1866 SPHEROID, ZONE 3.

MAP SHOWING ACOUSTIC ANOMALIES AND NEAR-SURFACE FAULTING, NORTON SOUND, ALASKA

DAVID A. STEFFY AND PETER J. HOOSE

1981