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Digital processing of a 24 channel, single-fold seismic
reflection line from Naval Petroleum Reserve No. 4, Alaska

by

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Open-File Report 77-707

1977

This report is preliminary and has not
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Introduction

Public availability of North Slope seismic reflection data has generally been limited due to the high purchase costs of industry-acquired data and the confidentiality of the U.S. Navy's current exploration program in Naval Petroleum Reserve No. 4 (NPR-4). This data shortage will be somewhat alleviated when the jurisdiction of Naval Petroleum Reserve No. 4 is transferred to the Department of Interior this year. To the knowledge of the authors, however, no timetable has yet been set for the release of NPR-4 seismic data.

During the period 1945-1953, the U.S. Navy acquired extensive regional and detailed seismic coverage on the North Slope which subsequently has been released to the public (fig. 1). The majority of this data is located within the boundaries of NPR-4. All of these profiles are single-fold and were obtained using a split-spread pattern.

Interpretation of the original paper seismograms is extremely difficult because of strong reverberations which effectively mask much of the detail in the deeper reflecting horizons. These reverberations originate primarily from the permafrost layer (earth material whose temperature remains below 0°C in both winter and summer). At the time these early seismic surveys were completed little could be done to eliminate such reverberations. They can be eliminated, however, by applying modern, digital, seismic-processing techniques, such as deconvolution and filtering. Accurate transcription of

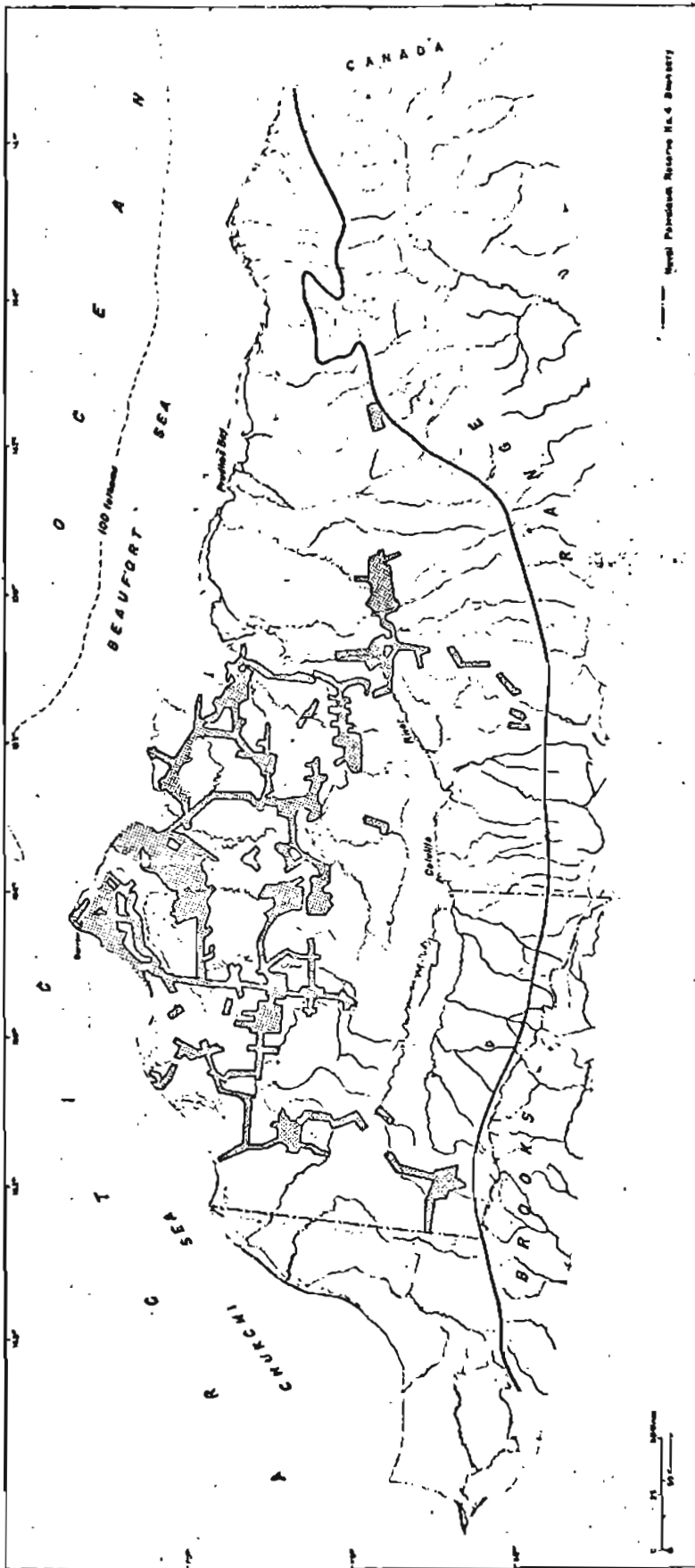


FIGURE 1 — PET 4 PROGRAM SEISMIC COVERAGE 1945-1983, NORTH SLOPE OF ALASKA

the original paper seismograms from NPR-4 to magnetic tape enables the original paper records to be converted into a digital format. Digital-processing techniques can then be utilized on this transcribed data to eliminate reverberation problems and produce a continuous seismic section of superior quality.

This report outlines the method used to digitally reprocess the original seismic data from line 5-50-144, a south-trending profile terminating near Umiat, Alaska, (fig. 2). When reprocessed, the quality of this data is vastly improved and a great deal of information previously obscured becomes available for interpretation.

Processing Procedure and Results

The procedure and parameters utilized in processing seismic line 5-50-144 are illustrated in figure 3. As noted in this figure, traces were hand-picked for residual static correction. This method of static refinement, in conjunction with dereverberation filtering, produced the greatest improvement in the data. The results of the processing are illustrated in the attached seismic section of line 5-50-144 (pl. 1). For single-fold data, the continuity of many of the reflecting horizons on this section is remarkable.

Discussion

With the Navy currently utilizing the latest in digital field equipment and seismic processing systems to acquire and process several thousand miles of multifold seismic reflection data within Naval Petroleum Reserve No. 4, one might logically question the importance of the older digitally-reprocessed single-channel seismic records. It must be remembered, however, that the unusually good reflecting properties of the Alaskan North Slope make this data extremely valuable. It should also be

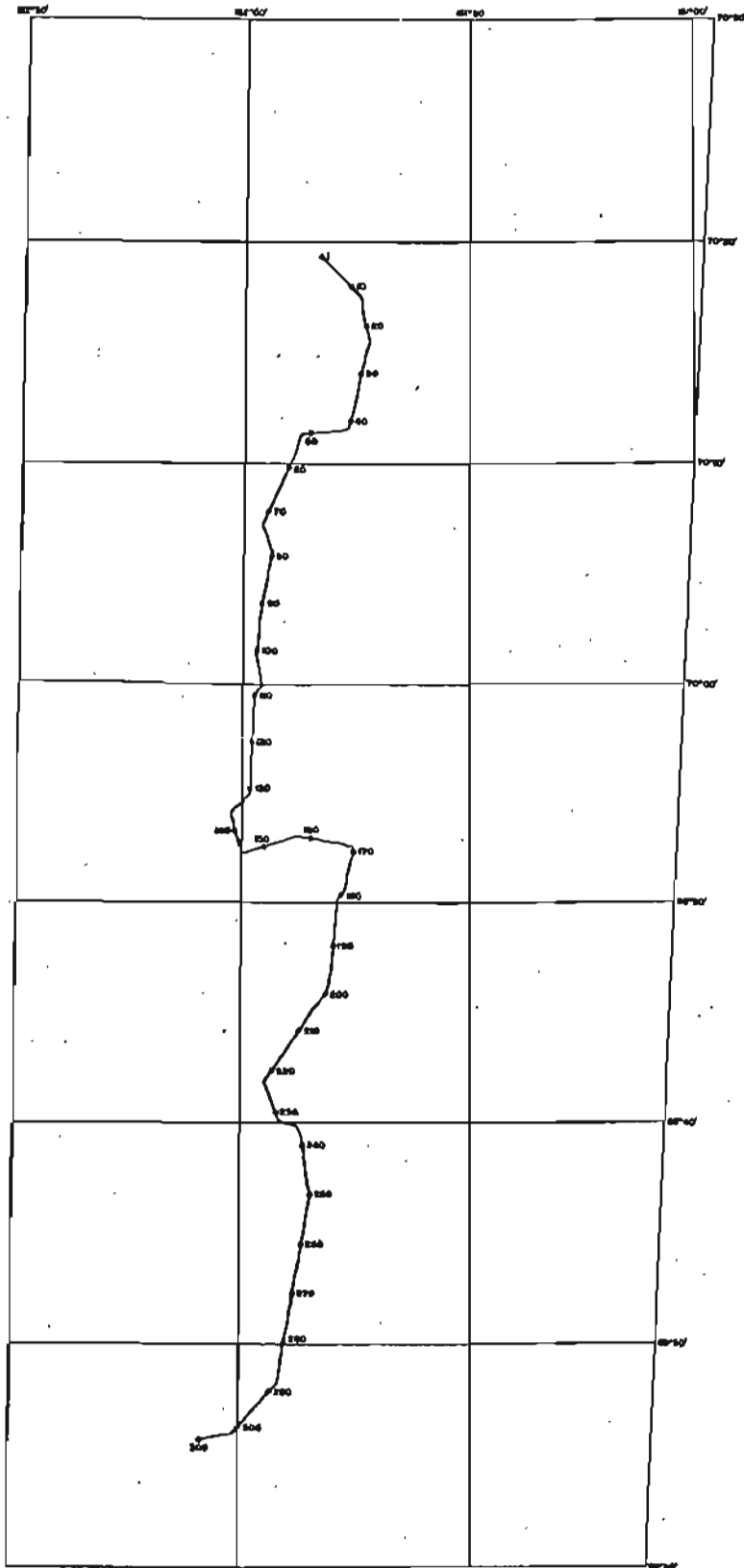


FIGURE 2.- SHOT POINT LOCATION MAP, LINE 5-50-144

LINE 5-50-144	NAVAL PETROLEUM RESERVE-4 ALASKA
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RECORDED BY UNITED GEOPHYSICAL COMPANY, INC.
 PROCESSED BY U.S. G. S. OIL AND GAS BRANCH, STRATIGRAPHIC SEISMIC PROGRAM, DENVER, COLORADO
 PRINCIPAL INVESTIGATOR BRUCE KOSOSKI

RECORDING PARAMETERS		RECORDING GEOMETRY	
PARTY	144	SP INTERVAL	402.3 METERS
DATE RECORDED	1950	GEOPHONE INTERVAL	36.6 METERS
RECORDER	ANALOG	NEAR OFFSET	0 METERS
FIELD FILTER	OUT/OUT	FAR OFFSET	438.9 METERS
SAMPLE RATE	4 MS	NUMBER OF TRACES	24
RECORD LENGTH	4 SEC	SP LOCATION	ON TRACE 12
		PROGRESSION	NORTH TO SOUTH

PROCESSING SEQUENCE	PROCESSING PARAMETERS/COMMENTS
CONVERT FIELD FORMAT TO PHOENIX FORMAT	
GEOMETRY	APPEND RECORDING GEOMETRY TO TRACE HEADERS
VELOCITY ANALYSIS	SUM 6 ADJACENT SP'S; INCREMENT EVERY 50 SP'S
APPLY ELEV.-DATUM STATICS	
NORMAL MOVEOUT CORR.	VELOCITIES LINEARLY INTERPOLATED BETWEEN ANALYSIS POINTS
RESIDUAL STATICS	HAND PICKED STATIC ANALYSIS
APPLY MUTING	BLANK OUT REFRACTION ARRIVALS
BANDPASS FILTER	ZERO PHASE FILTER, 10-40 HZ
DEREVERBERATION FILTER	WIENER PREDICTION TYPE, 160 MS LAG TIME
RUNNING 3-TRACE MIX	WEIGHTED 1-3-1
AMPLITUDE EQUALIZATION	TIME-VARYING, CONSTANT WINDOW NORMALIZATION
CAMERA DISPLAY	
DISPLAY	VERTICAL 3.8 CM/SECOND HORIZONTAL 20 TRACES/CM

FIGURE 3.—RECORDING AND PROCESSING PARAMETERS

remembered that the reflection data which led to the drilling of the Prudhoe Bay discovery well was shot single-fold and recorded on analog tape. Multi-fold seismic data were not acquired on the North Slope until after the Prudhoe Bay discovery (Morgridge and Smith, 1972). The authors are not implying that the subsurface resolution needed for the current NPR-4 exploration effort can be obtained from single-channel seismic records, but single-fold digitally-reprocessed seismic data can certainly be useful in solving various exploration problems in NPR-4.

Bibliography

Morgridge, J. D., and Smith, W. B., Jr., 1972, Geology and discovery of Prudhoe Bay field, Eastern Arctic Slope, Alaska, in Stratigraphic oil and gas fields; classification, exploration methods, and case histories: Am. Assoc. Petroleum Geologists Mem. 16, p. 489-501.