U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

# U.S. Geological Survey common-depth-point seismic-reflection survey between Mississippi River Miles 195 and 210 (R/V NEECHO, Cruise NE-80-3)

by E.A. Winget[1] and G.B. Tirey[2]

Open-File Report 84-82

This report is preliminary and has not been reviewed in accordance with U.S. Geological Survey editorial standards. Use of tradenames is for purposes of identification only and does not imply endorsement by the U.S. Geological Survey or the U.S. Army Corps of Engineers.

1. U.S. Geological Survey, Woods Hole, Mass.
2. Minerals Management Service, Vienna, Va.



1984

U.S. Geological Survey common-depth-point seismic-reflection survey between Mississippi River Miles 195 and 210 (R/V NEECHO Cruise NE-80-3)

In December 1980, the U.S. Geological Survey (USGS), in cooperation with the U.S. Army Corps of Engineers (COE), conducted a seismic survey of the Mississippi River in the vicinity of Alton, Illinois, near St. Louis, Missouri (fig. 1). Seismic lines were run from the mouth of the Missouri River up the Mississippi River to a point approximately seven miles upriver from Lock and Dam No. 26 at Alton, Illinois (fig. 2a,b). Additional lines were run upriver from Lock and Dam No. 25 between the dam and River Mile 244, but these data are not reported because of mechanical problems with the larger sound-source equipment and inexact navigational control.

The objective of the cooperative study was to utilize marine common-depth-point (CDP), digital, and multichannel techniques to locate a monoclinal flexure of the Cap au Gres Fault that earlier had been interpreted from land seismic data to be in the vicinity of Lock and Dam No. 26 (Shannon and Wilson, 1980). A second objective was to demonstrate that the marine seismic system could be used for making relatively deep penetration seismic-reflection surveys on shallow (less than 10-m water depth) inland waterways that have organic sediment floors.

The survey was conducted using the RR/V NEECHO, a trailerable, 38-ft, aluminum research vessel specially equipped for this work. The multichannel digital seismic-reflection system aboard consisted of three parts: a digital, field marine, multichannel, seismic recording system; a multichannel hydrophone array; and a seismic energy source. The Digital Field System V (DFSV) used was a modified multichannel, marine seismic-recording system manufactured by Texas Instruments Company. The system consists of the following main components:

a. 12 gain-ranging amplifiers, 2 nongain-ranging auxiliary amplifiers, multiplexer, and analog filters;
b. Analog-to-digital converter;
c. Two 9-track, sequentially connected, magnetic-tape transports;
d. Multichannel recording oscillograph and camera;
e. Twelve-volt DC power and battery system;
f. Data encoder and extended header system;
g. Electronics interfaces between all components.

A 12-channel streamer array was used for the survey. Channel spacing was at a 10-m group interval. There were 20 hydrophones in each group, and each group was preamplifier coupled to the signal cable. Because the water was extremely shallow, the array was made slightly bouyant and towed as near surface as possible.

Two different types of pneumatic seismic-energy sources were used: a Bolt Associates, Inc. Par Model 600B with a 40-$in^3$ air chamber, and a Seismic Systems, Inc. 15-$in^3$ T-Watergun. Both were operated at approximately 1800 psig air pressure. A small single-channel, 25-joule, Innerspace Technology Model 201 sparker and recording system was used to make a monitor record for the multichannel system from a single hydrophone array. The same system with its sparker transducer was also used above Lock and Dam No. 25 when the watergun and airgun systems malfunctioned.

The data were processed on the USGS's Digicon Interactive Seismic Computer (DISCO), a dedicated seismic-data processing system. The system hardware, a standard VAX 11/780 CPU built by Digital Equipment Corp., has been modified by Digicon Geophysical Corp.

The processed data were 12-channel, 12-fold digitally recorded data that were recorded at a 0.5-ms sample rate for one second in a SEGB seismic format.

Results of processing in a standard processing flow were very poor. A detailed description and analysis of data processing, deconvolution testing, velocity and stacking procedures, etc., is given in Tirey and others (in press).

The quality of the multichannel seismic data can be classified as fair to good between 40-200 ms of two-way travel time in the subbottom. Because the survey was designed primarily to detect faults by using CDP seismic-reflection methods, a detailed interpretation of the stratigraphy in the unconsolidated sediment data that had been recorded during analog monitoring was not made. The resolution of single-channel monitor record is limited due to the low-frequency output of the airgun seismic source, low-frequency filtering, and the slow sweep speed of the analog recorder.

It was not possible to resolve any reflections in the first 30 to 40 milliseconds of recording because of the streamer (hydrophone array) length. Strong bottom multiples were recorded in several places, indicating organic mud or silt deposits on the river bottom at those locations.

Seismic-reflection events could be interpreted in the upper 40-200 milliseconds of data, and no evidence was recorded that would indicate faulting of the magnitude suggested by the Shannon and Wilson (1980) report and by the information provided to COE by Laclede Gas Company, St. Louis, Mo. Five reflecting horizons were recorded more or less continuously on the river between Miles 195 and 210; they showed very little slope or structure. Minor faulting (less than 5-10 m) can be detected in some places, and a couple of buried stream channels are cut in the bedrock more or less perpendicular to the direction of the river.

The survey has successfully demonstrated the value and economy of obtaining deeper penetration seismic data by using a multichannel, digital seismic system on inland waterways rather than conventional land-seismic techniques. Newer, all-hydraulic waterguns (80-, 200-, and 400-$in^3$) require a much smaller power source in terms of physical size and weight, and will make a more powerful seismic-energy source easier to use from small boats. Additional modifications in operating procedures, techniques, and equipment should improve the penetration and signal-to-noise ratio currently obtained in this type of study by several orders of magnitude.

## References

Shannon, W. L., and Wilson, S. D., 1980, Analysis of geophysical data, Cap au Gres structure: St. Louis, Mo., Shannon & Wilson, Inc.

Tirey, G. B., Wise, R.A., and Winget, E.A., 1984, Common-depth-point seismic-reflection survey on the Mississippi River in the vicinity of Alton, Ill.: U.S. Geological Survey Open-File Report 84-51

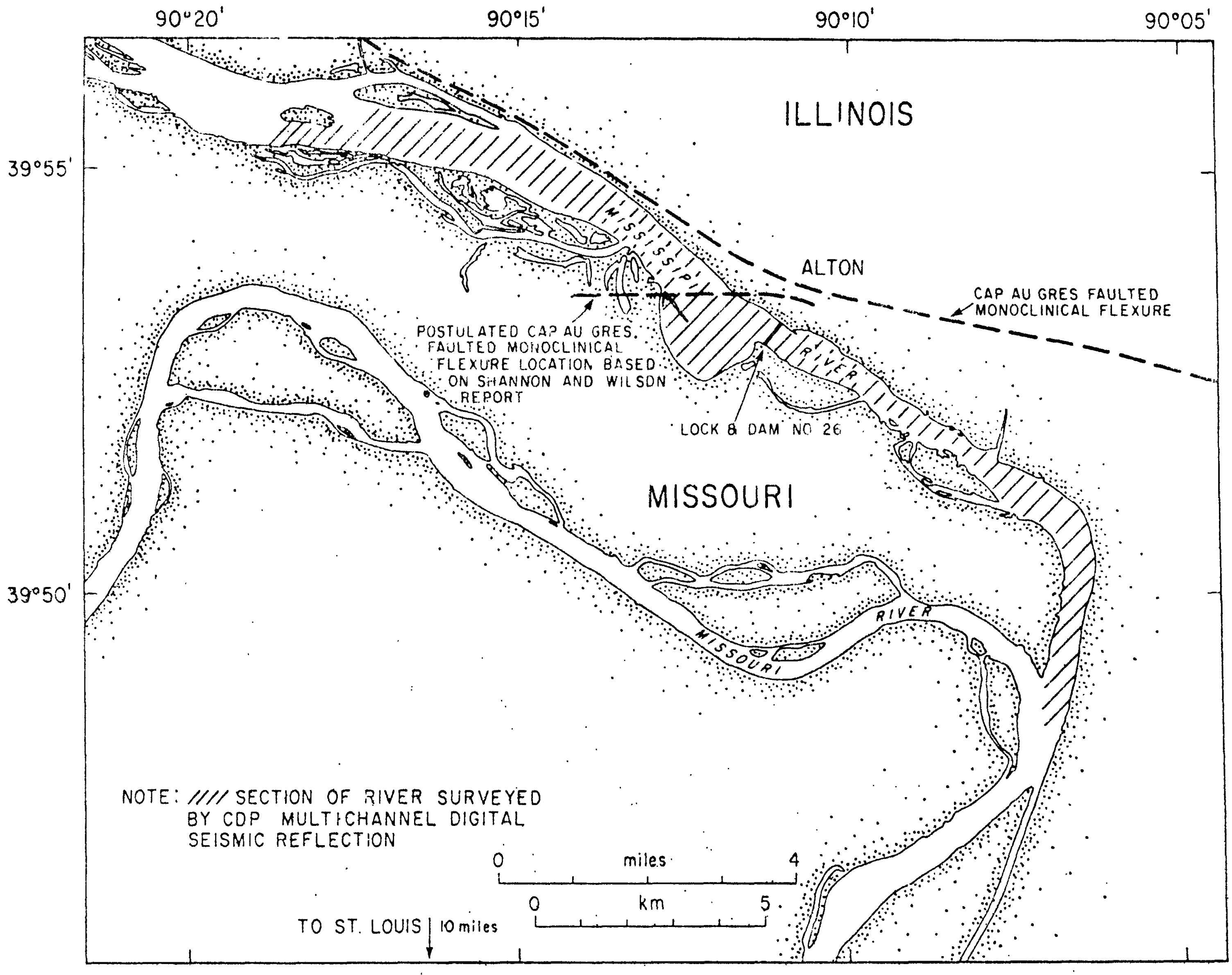


FIGURE 1: STUDY AREA

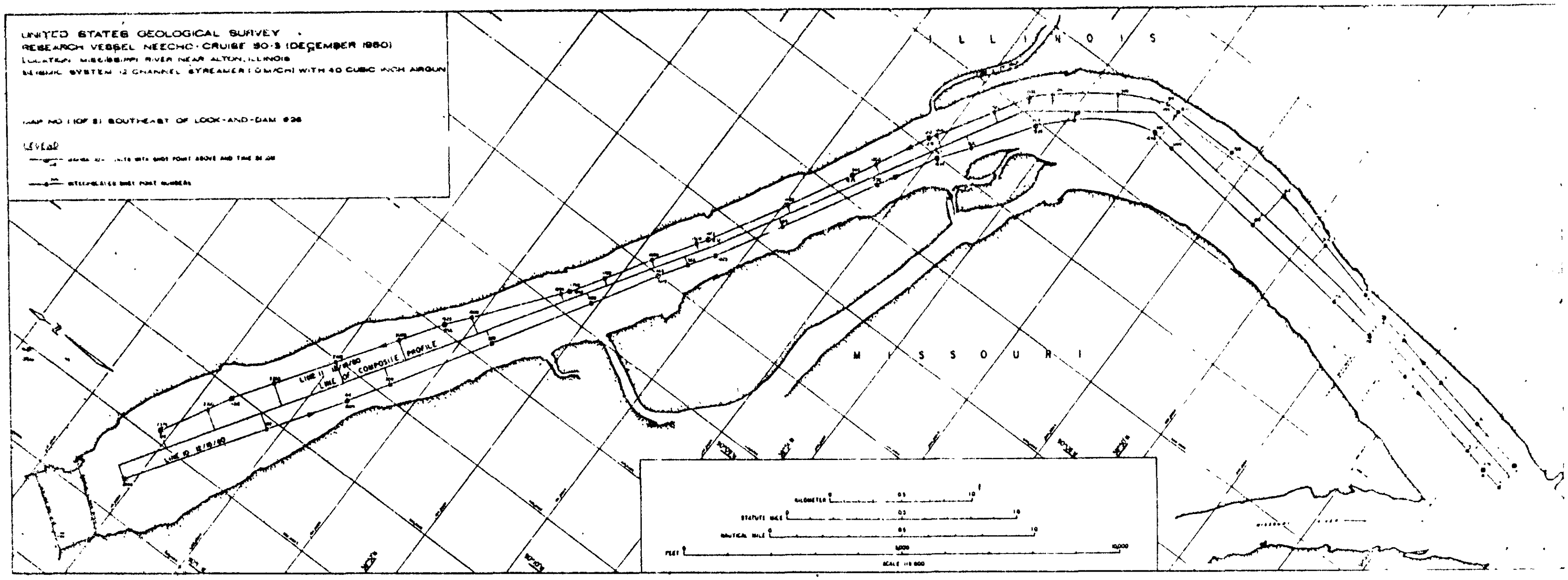


Figure 2a.-- Navigation map indicating seismic lines run downriver from Lock and Dam No. 26

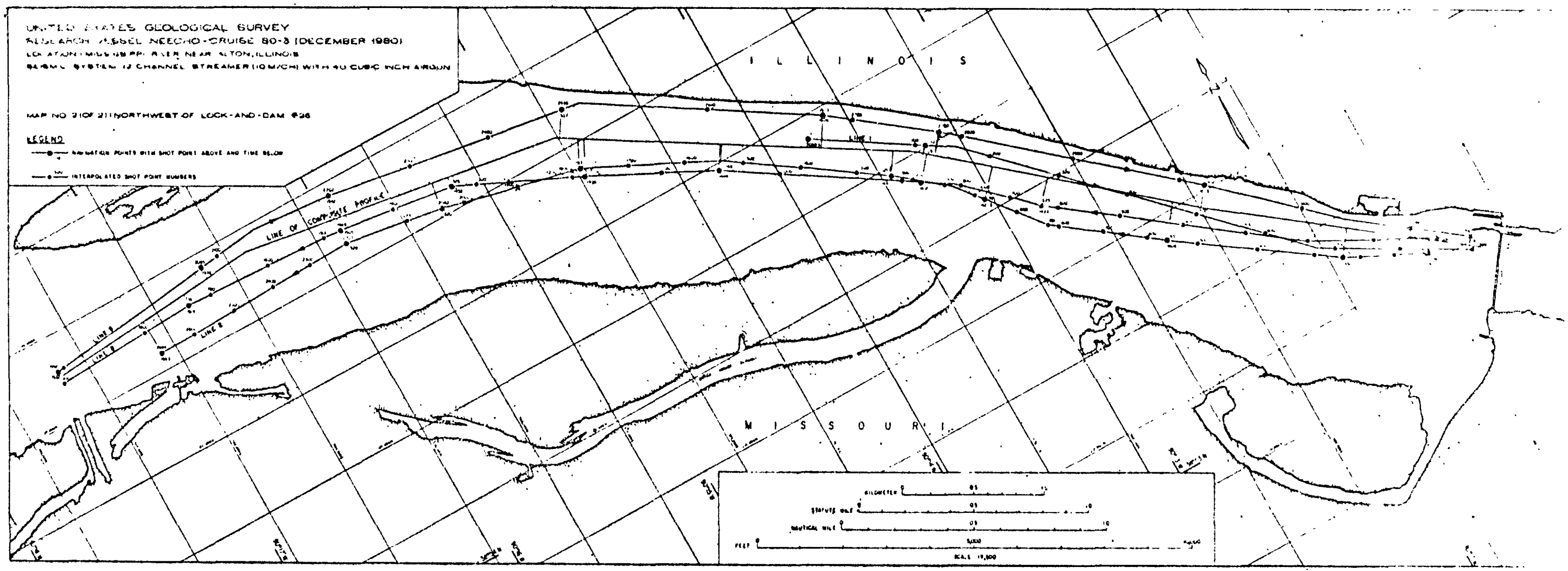


Figure 2b.-- Seismic lines run upriver from Lock and Dam No. 26. The composite profile indicated in figs. 2a and 2b is reported in Tirey and others, 1984.