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UNITED STATES DEPARTMENT OF THE INTERIOR
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Seismic Reflection Profiles in the Northern Mississippi Embayment

by
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This report is preliminary and has not been edited or reviewed for conformity with U.S. Geological Survey standards.

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Introduction

About 280 kilometers of multichannel (common-depth-point) seismic reflection profiles were obtained in the central Mississippi River Valley by Geophysical Service Inc. and Western Geophysical Company under contracts with the U.S. Geological Survey. The specific area of the profiles is southeastern Missouri, northeastern Arkansas, and northwestern Tennessee. Geologically, the area is located in the northern part of the Mississippi Embayment. Three large earthquakes with magnitudes (m_b) in the range 7 to 7 1/2 occurred there in the Winter of 1811-12, damaging the town of New Madrid, Missouri, and profoundly affecting the land surface over a large area (Fuller, 1912; Nuttli, 1973). Seismicity has continued in the region at a relatively high level compared with elsewhere in the central and eastern U.S.

The profiling was done to improve knowledge of regional geologic structure and to investigate tectonic features associated with the seismicity. Use of the seismic reflection method to delineate seismogenic structures is made necessary by the thick section of Quaternary, Tertiary, and late Cretaceous sediments that covers the Paleozoic and Precambrian rocks underlying the embayment.

This text accompanies copies of the seismic reflection profiles, velocity analyses, and maps of the profile locations, as well as

magnetic tapes of the field and processed data which are being made available to the public through:

United States Department of Commerce
National Oceanic and Atmospheric Administration
Environmental Data and Information Service
National Geophysical and Solar-Terrestrial Data Center (D62)
Boulder, Colorado 80303
Phone (303) 499-1000 x6542

The final-stack record sections and profile location maps may be seen at the USGS libraries in Denver, CO, and Reston, VA. The data is in the form provided by the contract companies without modification or interpretation.

Profile Locations

The profiles are from two different seismic reflection surveys. Initial work was done by Western Geophysical Company (WG) in 1977 to evaluate use of the method. The total length of the profiles obtained by WG is 32 km. A greatly expanded survey of about 250 km of profiling was subsequently performed by Geophysical Service Inc. (GSI) in 1978 and 1979.

Maps of the study area show the profile locations. The locations were chosen through consideration of seismicity patterns, lineaments, sand blow areas, possible igneous intrusives inferred from gravity and magnetic data, and various geomorphic features. Many of these features

are shown on the seismotectonic map of the region by Heyl and McKeown (1978). The primary rationale for selection of the profile locations, however, was to cross linear zones in the seismicity pattern (Stauder and others, 1976). The greatest intensity of recent seismic activity lies in a diffuse, north-northwesterly trending zone running from near Dyersburg, Tennessee, past Ridgely, Tennessee, to near Lilbourn, Missouri. This seismicity zone is actually comprised of several subsidiary zones, including at the northern end (in the vicinity of Lilbourn) a short, linear zone striking northeasterly. The seismicity zone that strikes southwesterly from the vicinity of Caruthersville, Missouri, is the longest zone in the region, and is sub-parallel to and near the zone delineated by Fuller (1912) for the 1811-12 earthquakes.

One profile (D-2) was located substantially away from the main seismic areas. It was selected to pass near a well in Gibson County, Tennessee, which penetrated intrusive rocks thought to be of Precambrian age. Detection of reflections from the Precambrian surface was a goal of the study. Further, the line was intended to investigate the existence of an inferred fault through the area.

The WG profiles are in the vicinity of Tiptonville and Ridgely, Tennessee, and were done specifically to study the Reelfoot Scarp (Zoback, 1979).

Field Parameters

Two types of profiles were run by GSI with significantly different sets of field parameters. For one type the parameters were chosen to enhance shallow reflectors in the geologic section. Parameters for the

other type were chosen to enhance deep reflectors. To distinguish the two types of profiles, they were designated by the letter "S" and "D", respectively. There are thirteen S profiles, labeled S-1 through S-13, and three D profiles, labeled D-1 through D-3. The significant differences between the two profile types are that the S profiles were run with shorter spreads and, in all cases but one, using higher frequencies in the sweep. The specific parameters are summarized in Table 1.

Most of the WG profiles are designated by a "T" because they are near Tiptonville; there are seven T profiles. One WG profile is labeled with an "R" because it is located near Ridgely. The parameters for these profiles are also given in Table 1.

Data Processing

Standard techniques were used in processing the data (see, for example: Dobrin, 1976; Sheriff, 1978; Waters, 1978). The record sections were not migrated.

The processed data provided by the contractors include:

- velocity analyses at intervals of about 100 vibration points.
- brute-stack record sections, before application of final static and normal-moveout corrections and final filtering (S and D profiles only).
- single-fold-coverage record sections (S and D profiles only).
- final-stack record sections.

Correlation of Reflections

Correlation of reflections with stratigraphic units is aided by information from a USGS well near line S-10 (Crone and Russ, 1979). Complete lithologic data were obtained from the well, including a full suite of logs and extensive cores. A synthetic reflection record section derived from the sonic and density logs (obtained from Schlumberger Corp.) is correlated with the stratigraphic information.

The greatest contrast in acoustic impedance is associated with the contact between Late Cretaceous and Paleozoic rocks. This contact gives rise to a strong reflection that can be seen on most of the record sections. The strongest reflection on most of the record sections is associated with the contact between Paleocene and Late Cretaceous sediments. A reflection associated with the contact between the Eocene and Paleocene deposits can be seen on most of the sections, although it is discontinuous in some places. Locally continuous reflectors can be seen within the Eocene section. On two sections, D-1 and D-3, good reflections can be seen below the Paleozoic surface.

Table 1. Field Parameters

	S lines	D lines	T & R lines
Energy source:			
Vibrators	3 or 4, inline	3 or 4, inline	4, inline
Sweeps	15	15 or 20	15
Signal (pilot)	10-80 Hz, 7 sec (except 20-80Hz for S-5 and 10-50 Hz for S-13)	10-50 Hz, 7 sec	16-58 Hz, 7 sec
Vibration interval	200 ft	200 ft	200 ft
Receivers:			
Group array	24 geophones evenly spaced, inline	24 geophones evenly spaced, inline	36 geophones
Group interval	100 ft	200 ft	200 ft
Channels	48	48	48
Spread (VP means vibration point)	S-13: 2500'-200'-VP-200'-2500' Others: 2700'-400' VP-400-2700'	D-2: VP-400'-9800' Others: 5000'-400'-VP-400'5000'	5200'-600'-VP-600'-5200'
Multiplicity	12 fold	24 fold	24 fold
Recording system:			
Filters	Low cut-8Hz, 18db slope High cut-124 Hz Notch-60 Hz	Low cut-8Hz,18db slope High cut-62Hz	Low cut-12Hz High cut- Notch-60Hz
Sample rate	4 msec	4 msec	4 msec
Record length	10 sec	10 sec	9 sec
Format	SEG-Y DFS IV	SEG-Y DFS IV	SEG-C

References

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