

# Shallow Seismic Reflection Surveys in the New Madrid Seismic Zone

Agreement No. 14-08-0001-1926

Roy B. VanArsdale  
Geology Department  
University of Arkansas  
Fayetteville, Arkansas 72701

(501) 575-3355

## Objective

Shallow seismic reflection surveys in the New Madrid seismic zone is a project that includes three primary targets in northeastern Arkansas and southeastern Missouri. These targets are Crowley's Ridge (AR), the Bootheel Lineament (MO), and the Crittenden County fault zone (AR). Roy VanArsdale (University of Arkansas), Eugene Schweig and Lisa Kanter (Memphis State University), and Kaye Shedlock (U.S. Geological Survey) are collaborating on this project. The focus of this status report is on the Mini-Sosie reflection lines across the margins of Crowley's Ridge. The principal objective of the Crowley's Ridge study is to determine if the ridge is fault bounded.

## Progress

Crowley's Ridge in northeastern Arkansas has been interpreted as an erosional remnant of Tertiary and Pleistocene sediments, formed as a drainage divide between the Pleistocene ancestral Mississippi and Ohio Rivers (Call, 1891; Fisk, 1944; Guccione et al., 1988). However, Crowley's Ridge is formed of two segments with very different trends and widths and there are a number of unusual geomorphic characteristics of the ridge that suggest that its formation may be tectonically controlled. Most striking is the linearity of the ridge margins, which suggests that the ridge may be fault bounded. Furthermore, Cox (1988) noted that the northern segment of the ridge is asymmetric in profile, with steep slopes on the west and gentle slopes on the east. He concluded that the drainage asymmetry present here is a response to southeast tilting.

A recently completed COCORP deep reflection survey across the Mississippi embayment shows minor offset of post-Late Cretaceous reflectors beneath the west flank of Crowley's Ridge at location one in Figure 1 (Nelson and Zhang, 1991); examination of the profile suggests that offset may also be present on the east flank.

During the summer of 1990, five Mini-Sosie reflection lines totalling 11 km were recorded across the margins of Crowley's Ridge (Fig. 1). All of the lines, with the possible exception of line 4, reveal faulting that displaces Cretaceous and overlying

Tertiary strata (VanArsdale et al., 1990). However, reflectors were not imaged in the upper 200 m so it is not possible to determine whether Quaternary strata are displaced.

The most interesting of the profiles is line 5. This line reveals a gentle anticlinal fold (10 m amplitude) beneath Crowley's Ridge, a down-to-the-east fault (10 m of displacement) at the eastern boundary of the ridge, and a major normal fault system (50 m of displacement) in the eastern portion of the line that may be west-bounding faults of the Reelfoot rift (Figs. 1 and 2). The faults clearly displace Cretaceous strata and appear to displace Tertiary strata. Tertiary strata in profile 5 generally dips gently eastward; however, east of the fault labeled RR in Figure 2 the Tertiary strata dips gently westward. Thus, it appears that Tertiary or Holocene reactivation of fault RR tilted the Tertiary strata westward. Continuing studies are underway to better define the structure and stratigraphy revealed in the Mini-Sosie lines.

#### References:

- Call, R.E., 1891, Annual report of the Geological Survey of Arkansas for 1889, v. II. The geology of Crowley's Ridge: Little Rock, Arkansas, Woodruff Printing Co., 283 p.
- Cox, R.T., 1988, Evidence of Quaternary ground tilting associated with the Reelfoot rift zone, northeast Arkansas: Southeastern Geology, v. 28, p. 211-224.
- Fisk, H.N., 1944, Geological investigation of the alluvial valley of the lower Mississippi River: Vicksburg, Miss., Mississippi River Commission, 70 p.
- Guccione, M.J., Prior, W.L., and Rutledge, E.M., 1988, Crowley's Ridge, Arkansas, in Hayward, O.T., ed., South-Central Section: Geological Society of America Centennial Field Guide v. 4, p. 225-230.
- Nelson, K.D., and Zhang, J., 1991, A COCORP deep reflection profile across the buried Reelfoot rift, southcentral United States: Tectonophysics, in press.
- VanArsdale, R.B., Scherer, G.G., Schweig, E.S., III, Kanter, L.R., Williams, R.A., Shedlock, K.M., and King, K.W., 1990, Seismic reflection survey of Crowley's Ridge, Arkansas, EOS, v. 71, p. 1435-1435.

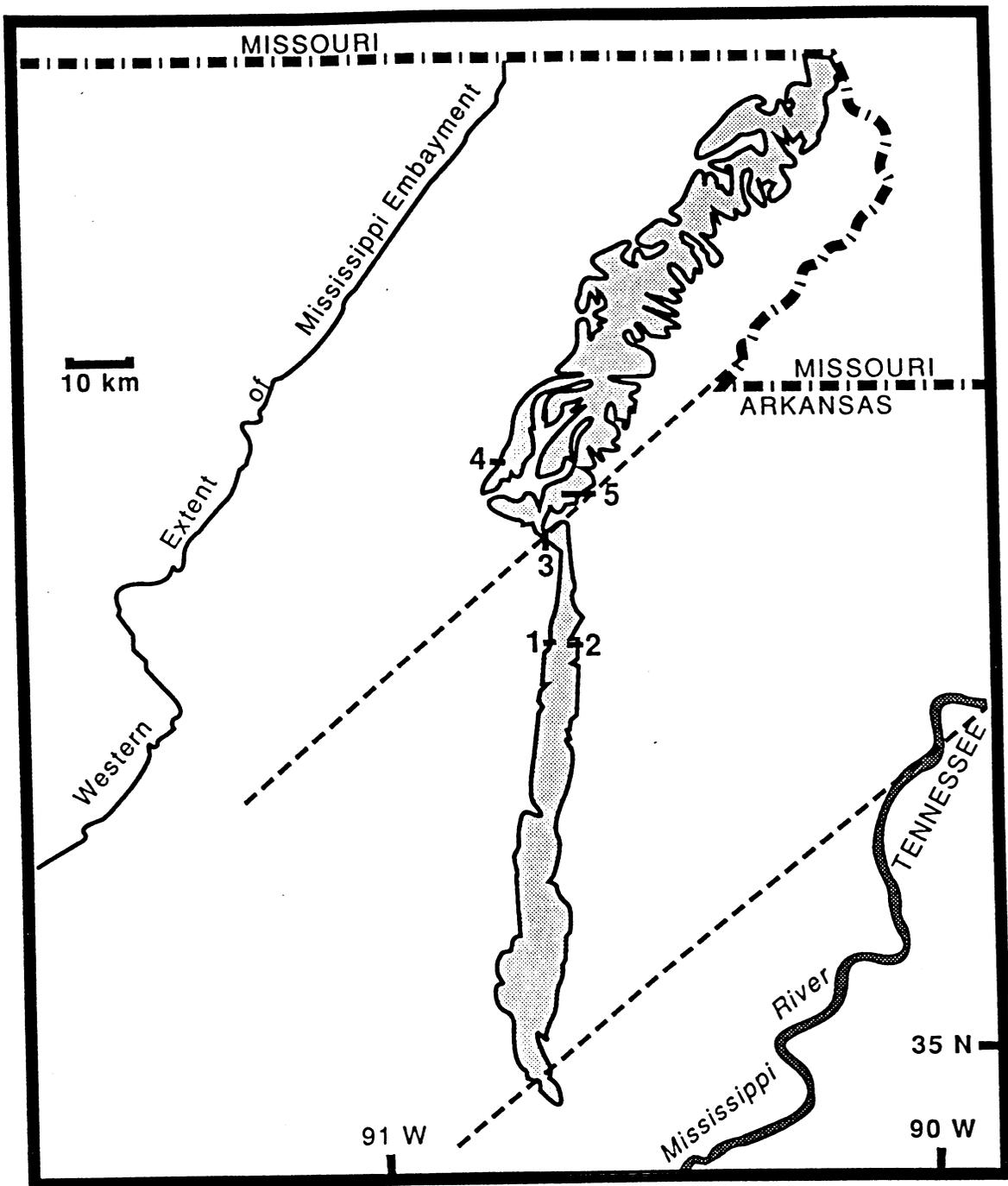


Fig. 1. Index map of Crowley's Ridge (shaded) seismic lines. Seismic line locations are labeled 1-5 and the Reelfoot rift boundaries are represented by dashed lines.

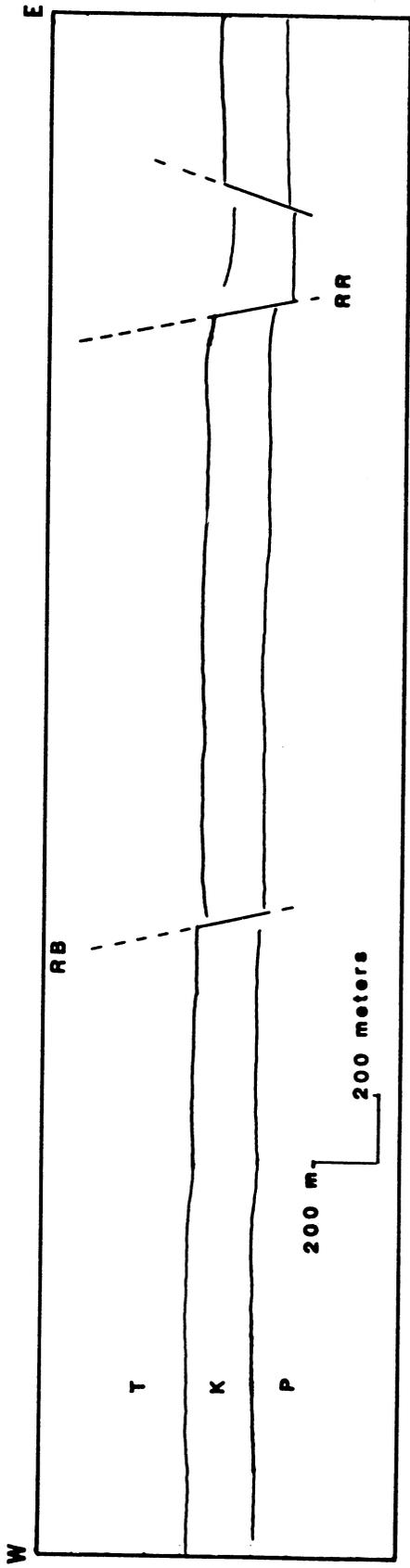


Fig. 2. Geologic interpretation of seismic line 5 of Figure 1.  
RR = fault discussed in text and RB = ridge boundary.  
T = Tertiary, K = Cretaceous, P = Paleozoic.