ANALYSIS OF THE SOUTHEAST MISSOURI EARTHQUAKE OF MARCH 3, 1963

by

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DIGEST

The southeast Missouri earthquake of March 3, 1963 occurred on a Sunday morning at approximately 11:30 AM, CST. The felt area of this magnitude 5.2 event had a radius of about 200 miles from a point 25 miles southeast of Poplar Bluff, Missouri.

A computer program was written for the University's IBM 1620 computer to locate the epicenter of this and other seismic events. The epicenter location program, based on Geiger's method, was written primarily to locate local earthquake epicenters. The epicenter of the March 3, 1963 earthquake was determined to be 36.65° N., 90.03° W., with an origin time of 17:30:12.7 GMT.

The P_n velocity for all stations out to 910 km. from the epicenter is given by the following equation for the travel times, "t":

$$t = (5.71 \pm 0.36)\text{sec.} + \Delta / (8.22 \pm 0.04)\text{sec.}$$

where Δ is the epicentral distance.

For a prominent phase arriving 2 to 4 seconds after the first arrival, the travel times for eight stations within 1135 km. of the epicenter is:

$$t = (8.87 \pm 0.90)\text{sec.} + \Delta / (8.33 \pm 0.07)\text{ sec.}$$

The travel times for this phase for eleven stations up to 1600 kilometers from the epicenter are given by

$$t = (7.33 \pm 0.96)\text{sec.} + \Delta / (8.17 \pm 0.06)\text{sec.}$$

The author advances three possible explanations for this phase associated with the first arrival. First, it may be a P wave dipping slightly below the Mohorovicic discontinuity. Second, it may be a P-wave that has first been reflected from the free surface, and then travels as P_n. Third, in a discussion, Doctor Peter Dehlinger of Oregon State University indicated that this phase may be an S-wave that has been reflected from the free surface, and then travels as a P_n wave.

The travel time for S_n was found to be

$$t = (5.09 \pm 1.37)\text{sec.} + \Delta / (4.48 \pm 0.04)\text{sec.}$$

A tentative L_g velocity was established to be 3.60 ± 0.01 km./sec.

Phase velocities were computed between pairs of stations along two azimuths (north and southwest) from the epicenter. At stations with short epicentral distances, the time length of the surface wave train restricted the maximum period at which phase velocities could be computed. Along the southwest azimuth, the phase velocities are different for different distance ranges.

A perturbation technique was used to compute shear-wave velocity models for the observed Love- and Rayleigh-wave phase velocities. A difference in the shear-wave velocity models for Love and Rayleigh waves suggests anisotropy between the depths of 38 and 102 kilometers.

The observed radiation patterns of the Love and Rayleigh waves were asymmetrical. It was not possible to match the observed radiation patterns with theoretical radiation patterns for known source functions.

The observed phase velocities between a pair of stations caused the least amount of variation in the initial phase difference between Love and Rayleigh waves computed for each of the pair of stations. Phase velocities from another area caused the initial phase difference between Love and Rayleigh waves to change rapidly with period.

At ten of the stations recording this earthquake, the vertical and horizontal long period records showed an impulse type response on the trace. The vectorial sum of the horizontal trace displacements indicates a counterclockwise motion about the epicenter.