REVISED HYPOCENTERS AND CORRELATION OF SEISMICITY AND TECTONICS IN THE CENTRAL UNITED STATES

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Approximately 270 regionally recorded seismic events in the Central United States have been relocated and the revised hypocenters have been correlated spatially with ancient plate tectonic remnants. The events considered include all regionally recorded earthquakes with $m_{bLg} \geq 3.0$ through 1980 with sufficient associated station data to warrant hypocenter recomputation.

Earthquake relocation has been accomplished by Joint Hypocenter Determination applied to groups of earthquakes representing separate seismic zones. Input data included phase arrivals taken from seismological bulletins and read on WWSSN film chips from regional stations. Joint Hypocenter Determination is a least squares procedure that computes revised hypocenters and station travel time corrections for a group of earthquakes simultaneously. The version of the JHD method used in this study includes P, Pg, S, and Lg phase data in the computations. Weights are derived from observed variances.

Tests of accuracy with respect to events having known or independently determined source coordinates indicate that the confidence regions associated with the relocated events are reasonable estimates of hypocenter accuracy. About 25% of the previously accepted epicenters differ from the revised epicenters by 0.2^{o} or more in latitude or longitude. These old epicenters also lie outside the 95% confidence ellipses associated with the new epicenters. Reasons for the discrepancies between the old and new epicenters could often be identified. In some cases the

revised hypocenter represents the first electronic computer solution ever obtained for the event considered. Many of the original epicenters in the period through the 1960's were essentially macroseismic epicenters. Other epicenters changed significantly when new phase data were added to the solution. The revised hypocenters are better than the previously accepted ones because they are more accurate and because they are accompanied by uniformly determined error estimates.

Within the resolution of the estimates, the focal depths determined in this study agree with independently determined focal depths. The deepest reliable focal depths computed represent the Wabash Valley of southeast Illinois, where focal depths in the 20 to 25 km range were determined. Well-determined focal depths of 10 to 15 km were computed for shocks in the New Madrid Zone.

The revised epicenters in the New Madrid Zone converge on areas of high seismicity delineated by recent microearthquake locations.

The relocated earthquakes were assigned m_{bLg} magnitudes taken from published sources or derived from amplitudes read on WWSSN film chips. Magnitudes published in seismological bulletins before 1973 overestimate Central U.S. earthquakes by 0.3 magnitude units on the average. Comparison with lists of all known earthquakes indicates that the catalog of relocated earthquakes is incomplete at the magnitude 4.2 level for the period 1961-1980. Thus, for this period, the catalog is reasonably complete only for events that are recorded teleseismically.

Examples of possible correlation between earthquakes and previously mapped faults include the 1931 West Texas earthquake, a swarm of shocks on the Texas-Louisiana border in 1964, and recent earthquakes on the Mississippi-Alabama border. However, most of the revised epicenters do not correlate with known faults. Estimates of the focal depths of the relocated events suggest that significant earthquakes in the region have sources below most geologic structures that have been mapped in the surface and subsurface.

Correlation of seismicity and tectonics in this study has emphasized ancient plate tectonic elements that penetrate deeply into the crust. Approximately 80% of the known earthquakes with $m_{bLg} \geq 4.0$ correlate spatially with a simplified model of ancient plate tectonics in the Midcontinent. Most of the seismicity in the region is associated with aulacogens and paleo-rifts along the southern margin of Ancestral North America.

The New Madrid Zone coincides with the intersection of the Mississippi Valley Graben and the Missouri Gravity Low. Few of the revised hypocenters correlate with dense, magnetic plutons that mark the boundaries of paleo-rifts in the Central Mississippi Valley. Seismicity patterns and geological data suggest that a transverse structural lineament crosses the New Madrid Zone near Marked Tree, Arkansas.

The results of this investigation support the currently evolving concept that most significant intraplate earthquakes occur within zones of crustal weakness associated with ancient plate tectonic elements that have been reactivated, repeatedly, through geologic time.