THREE-DIMENSIONAL VELOCITY AND ATTENUATION STUDIES IN THE NEW MADRID SEISMIC ZONE

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Digital seismograms of teleseisms and local earthquakes are used to derive the three-dimensional velocity and attenuation structure for the crust and upper mantle beneath the New Madrid seismic zone and surrounding areas. A regional three-dimensional velocity model derived from 95 teleseisms and 270 local earthquakes shows a band of anomalous velocities that correlates in position and orientation with a basement rift system which has been delineated from gravity and magnetic data. This band occurs as a low-velocity zone through the upper crust and upper mantle and a higher-than-average velocity zone in the lower crust. Several localized regions of high velocity in the crust inferred from teleseismic data correlate with the sites of intrusions found from gravity and magnetic data.

A local three-dimensional velocity structure derived from the inversion of P-wave travel-time residuals from local earthquakes reveals a remarkable pattern of low seismic velocities in crustal rocks immediately adjacent to the active portions of the New Madrid fault system. Seismic velocities are lowest in regions of greatest concentration of earthquake activity near two intersections of linear trends in seismicity, the reductions being at least 7 per cent and 4 per cent in the upper 5 km and 5 - 14 km range, respectively.

Attenuation values of body waves (Q_p^{-1}) from local earthquakes are calculated for 252 seismograms using spectral decay technique assuming Q_p^{-1} independent of frequency. The observed Q_p^{-1} values are inverted to determine a three-dimensional model of Q_p^{-1} in the upper crust. The

resulting model includes a dramatic increase of attenuation within and close to the zones containing the most active faults of the New Madrid seismic zone.

The reduction in velocity and increased attenuation in the active portions of the New Madrid seismic zone are most easily explained as being caused by fluid-filled cracks in the upper crust of the studied region. The presence or absence of such fluids may explain why some portions of the faults in and surrounding the upper Mississippi Embayment are active while others are not.