3-D Upper Crustal V_p and V_s Structures in the New Madrid Seismic Zone using PANDA and Regional Seismic Network Data

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Abstract

Travel time differences between the direct S and converted S_p waves from the bottom of the sediments are systematically measured from 3-component seismograms recorded at each of the CERI New Madrid seismic network stations. Sedimentary profile in the Upper Mississippi Embayment can be briefly subdivided into 8 horizontal layers according to its lithology and sonic logs (P-wave velocity) available from a few deep well-logs (e.g. Dart, 1992; Gao et al., 2001a) and from geological model information (Mihills, 1998). 3-dimensional V_p model for the sediments can be determined by interpolation or extrapolation from deep well-log data. Along with a few shallow V_p and V_s from in-situ measurements and from shallow seismic lines, the V_s profiles for the sediments beneath each regional seismic network station can be determined from a simple one-dimensional inversion of V_p/V_s ratio from the travel time differences between the direct and converted waves (e.g. Gao, et al. 2001a). Including the 3-dimensional velocity model of the sedimentary basin in the initial velocity model, 3-dimensional upper crustal V_p and V_s velocity structural model in the New Madrid Seismic Zone (NMSZ) can be reliably determined from a 3-dimensional tomographic inversion of a set of high quality arrival time data from 3-component seismograms. The inversion method of Benz et al. (1996) modified by Shen (1999) has been applied to a group of selected earthquake data from the PANDA experiment (1989-1992) (Chiu et al., 1992) and from the recently upgraded New Madrid seismic network (1995-2000) (Chiu et al., 2001). During the velocity inversion, earthquake hypocenters are simultaneously relocated using the new resultant 3-dimensional V_p and V_s velocity model. Very significant reduction of travel time residuals for both P- and S-arrivals has been achieved after the velocity inversion is converged. Similar to the results of Gao et al. (2001b), patches of anomalous velocities are randomly distributed and no systematic patterns of velocity anomalies can be closely correlated to the seismogenic zones in the NMSZ. However, the relocated hypocenters can, in general, be associated mostly with either regions of lower velocity or within the transition boundaries between the low- and high-velocity anomalies. In the northern study area, it is apparent that the relocated hypocenters are deeper than the initial PANDA locations due to slightly over-estimated thickness of the sedimentary basin for this region in the original PANDA velocity model. On the other hand, the relocated hypocenters are shallower than the initial PANDA locations in the southern study area due to the under-estimated thickness of sediments for this region in the original PANDA model. Therefore, the relocated hypocenters allow a reliable image of the vertically dipping SW, NW, and NE segments and the gently dipping

Central segment of the NMSZ, which are similar to those reported in Chiu et al. (1992), but with better constraints on focal depths and epicenters.