Crustal heterogeneity and seismotectonics of the Chinese capital region

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A detailed 3-D P-wave velocity model of the crust and uppermost mantle under the Chinese capital (Beijing) region is determined with a spatial resolution of 25 km in the horizontal direction and 4-17 km in depth. We used 48,750 precise P-wave arrival times from 2973 events of local crustal earthquakes, controlled seismic explosions and quarry blasts. These events were recorded by a new digital seismic network consisting of 101 seismic stations equipped with high-sensitivity seismometers. The data are analyzed by using a 3-D seismic tomography method. Our tomographic model provides new insights into the geological structure and tectonics of the region, such as the lithological variations and large fault zones across the major geological terranes like the North China Basin, the Taihangshan and the Yanshan mountainous areas. The velocity images of the upper crust reflect well the surface geological and topographic features. In the North China Basin, the depression and uplift areas are imaged as slow and fast velocities, respectively. The Taihangshan and Yanshan mountainous regions are generally imaged as broad high-velocity zones, while the Quaternary intermountain basins show up as small low-velocity anomalies. Velocity changes are visible across some of the large fault zones. Large crustal earthquakes, such as the 1976 Tangshan earthquake (M 7.8) and the 1679 Sanhe earthquake (M 8.0), generally occurred in high-velocity areas in the upper to middle crust. In the lower crust to the uppermost mantle under the source zones of the large earthquakes, however, low-velocity and high-conductivity anomalies exist, which are considered to be associated with fluids. The fluids in the lower crust may cause the weakening of the seismogenic layer in the upper and middle crust and thus contribute to the initiation of the large crustal earthquakes.