Geophysical Research Abstracts
Vol. 14, EGU2012-3110-2, 2012
EGU General Assembly 2012

Seismic tomography of the upper crust beneath the Three Gorges reservoir, China

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A seismic experiment provides new insights on the crustal structure of the head area of the Three Gorges reservoir in central China. The region is characterized by a relatively high rate of reservoir-induced seismicity (RIS) that is often triggered within those area associated with the ascending water level. Our 3D velocity model of the Three Gorges region shows that the Huangling anticline is characterised by a high velocity crust, and the Zigui basin has lower crustal velocities. The 3D tomographic inversions are conducted using 11,901 P-wave and 12,032 S-wave arrival times from 1,342 events recorded by the local network of seismic stations from early 2001 to late 2006. A step length of 100 m is selected for forward modelling of travel times using a bending method. Initial models with varying velocity gradients are extracted to constrain a data-driven optimum 1-D model for 3-D iterative inversion scheme. Ray coverage density and checkerboard tests are applied to assess model reliability, indicating a reasonable level of lateral and vertical resolutions. The Vp and Vs tomographic models reveal a local high velocity anomaly from 5 to 10 km beneath SW portion of the Huangling craton and a strong, large low-velocity anomaly between about 5 to 10 km depths at the south margin of the Zigui basin. Moreover, the southwest border of Huangling anticline underthrust the Zigui basin with slightly bigger angle. Also, a prominent high velocity anomaly is located below 5 km beneath Shazhenxi, and to the west, the velocity anomaly turns out to be negative. There is no record help explaining the dramatic feature since incorporating local tectonic and topography, it suggests sharp gap in velocity near surface is primarily due to several secondary fracture zones. Frequent landsides in Xietan, on the opposite side of Yangtze River, might indicate its feedbacks. The surface responses of velocity discontinuity are generally aligned parallel to the trending of fault. Relatively good agreement between regional features and the velocity perturbations promotes further interpretation. Earthquake swarm activities from source relocation occur on the outer portions of high velocity anomaly with nearly perpendicular dip angle. Thus, the seismicity pattern could be interpreted based on the velocity models, regional geostress and dynamic load of reservoir. The Vp/Vs ratio pattern in this study may provide clues to the underlying links to the corresponding lithology, porosity, and permeability.