Three-dimensional seismic velocity structure of the crust in Central Tien Shan

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1. Introduction

Detailed tomographic images of the crust under the Central Tien Shan, Eastern Kyrgyzstan, Central Asia, are determined by using P and S wave arrivals data from local earthquakes and applying tomography method. These data were recorded by the Tien Shan temporary seismic network operated within the framework of a two-year experimental project. Seismically active Tien Shan mountain range as a prominent secondary aftermath of the India-Asia collision process (50 Ma) is upthrusted by two relatively stable micro-plates: Kazakh Shield to the north and Tarim Basin to the south. The Tien Shan is cut by enormous number of active marginal faults, mainly thrusts with compression in north-south direction, representing margins between local basins and mountains. Seismicity in this region is very diffusive in lateral direction, but clustered in the upper crust. The obtained three-dimensional (3D) seismic velocity structure of the subsurface of the Tien Shan sheds light on enigmatic dynamic process as mountain building complicated by crustal deformation. This study is an attempt to study crustal structure of the Central Tien Shan by means of a relatively new data set.

2. Data and method

Study area is enclosed by 40.00-43.00N and 74.00-80.00E based on the station distribution and ray coverage or hit count information. Arrival time data used are from 1500 local earthquakes from the Central Asia Bulletin recorded by the Tien Shan temporary observation network composed of the KNET (10 stations), KazNet (10 stations) and GHENGIS (28 stations) digital broadband stations covering the eastern part of Kyrgyzstan, south Kazakhstan and north-west China for the period during 1997-2000. The tomography method by Zhao et al. (JGR, 1992) has been used in this study. Most of the earthquakes are located atdepths of 10-20 km. We set all layers of grid net up to 65 km in the upper and lower crust with a spacing of 5 km and 10 km, respectively. The Moho discontinuity is set at a depth of 50 km. The spacing between grid nodes is 0.5 degree (about 50 km) in horizontal direction. The total number of grid nodes is 950.

3. Results

The 3-D seismic velocity structure images of the upper crust show thick sediments within each of the major depression in the north and south of the region bounded by high-V zone that are believed to be basement. More or less homogeneous structure at medium depth may contribute to mountain root. Wide low-velocity zones are visible at depths of 50-60 km, especially along the border with Tarim basin. Mosaic alternation of high-V and low-V layers beneath ranges and basins in lateral direction, as well as in depth direction is observed. Low-V zones underlie seismically active zones with some exceptions. Earthquakes are located either in or on the edge (transition zone) of high-V layers. The tomographic results exhibit considerable amount of crustal heterogeneities, which confirms the tectonic complexities of the study area. The subsurface of the study area is divided into two parts; the seismic and the most deformable upper crust and aseismic lower crust. Obtained results show strong relationship with topography of the region.

Acknowledgments: We would like to thank Institute of Seismology and Experimental and Methodological Seismic Expedition, National Academy of Sciences, Kyrgyz Republic, responsible for acquisition and processing data from the Tien Shan network along with Dr. G.Pavlis for providing the data. Deep appreciation is expressed to Prof. D.Zhao for tomographic program used in this study.