Near-surface velocity structure study using surface waves and first breaks in the middle segment of the Bangong-Nujiang suture zone, Tibetan Plateau

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The Bangong-Nujiang suture zone, located in the central Tibet, is one of several important geological boundaries in Qinghai-Tibet plateau. Abundant researches have been performed and most of them focused on deep tectonic structure and its dynamic mechanism through recent geophysical projects such as INDEPTH-III, Hi-CLIMB, ANTILOPE, SinoProbe, etc. (Zhao Wenjin et al., 2008; N´abelek et al. 2009; Gao Rui, et al., 2013; Zhao Junmeng et al. 2014; He Rizheng et al., 2014; Xu Qiang et al., 2017; Shang Xuefeng et al., 2017; Davlatkhudzha et al.,2018). Near-surface velocity study can not only obtain the physical parameters such as Vp and Vs in the area, but also improve seismic image quality of deep structure (Zhao Lingzhi et al., 2018). However, the velocity information obtained from passive seismic stations using either receiver function or ambient noise tomography is not enough to elaborate the near surface velocity structure of the Bangong-Nujiang suture zone. Besides, the active-source seismic reflection data usually doesn't have sufficient offset density at near surface which poses a challenge to conventional near-surface velocity analysis methods.

This study makes full use of surface waves and first breaks to obtain near-surface P- and S-wave velocities based on a 2D deep seismic reflection survey data which was acquired by SinoProbe project in 2009. We adopt the method of superposition of surface waves in common receiver domain to generate high quality F-K spectrum which enables us to obtain fundamental-order and high-order dispersion curves. First, a 2D layered model with an irregular topography was built and the 2D elastic finite difference modeling was executed to generate 161 synthetic seismic shot gathers which mimicking the actual acquisition geometry. These gathers contain surface waves, refractions, reflections and multiples energy, and the maximum offset is about 18 km. It is shown that the F-K spectrum quality has been improved for each receiver station using superposition of surface waves in the F-K domain by adding more shots. The S-wave velocity inverted from dispersion curves showed good agreement with the synthetic model. Second, high quality F-K spectrum generated from the above method enabled us to pick both fundamental and 1st order dispersion curves from the SinoProbe field data. The S-wave velocity was generated using three methods: 1) empirical equations based on dispersion curves; 2) fundamental order dispersion curves inversion; and 3) both fundamental and 1st order dispersion curves inversion. Results show that using higher order dispersion curves can generate a more reliable near-surface model.
first breaks were picked up to 18 km offset and diving wave tomography was applied to derive near-surface P-wave velocity from abundant first break information. It is shown that there is an excellent correlation between P- and S-wave velocities, the bottom of basin is clearly revealed, and over-thrusts are identified accordingly which is consistent with field geological survey in the middle segment of Bangong-Nujiang suture zone.

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