Experiment name* North China Interior Structure Project-Experiment 3 (NCISP3)

Names of Principal Investigators and their institutions* Tianyu Zheng, Institute of Geology and Geophysics, Chinese Academy of Sciences (IGGCAS)

Mobilization date* 2003-01-21

Demobilization date* 2004-10-22

Number of stations: 47

Network Code and Years: ZX 2004-2004

A brief summary of the experiment:

The North China Craton (NCC) is one of the world's oldest, preserving continental rocks as old as 3.8 Ga; the basement consists of variably exposed Archean–Paleoproterozoic rocks. The craton is composed of two major Archean blocks, the eastern and western NCC, that was sutured along the Trans-North China orogeny in the Paleoproterozoic. After cratonization, the NCC remained relatively stable with a thick Archean lithospheric keel until the early Mesozoic. The NCC settled into the East Asia continent by amalgamating with the surrounding continental blocks. To the north, amalgamations of the NCC with the accretion terranes of the Central Asian Orogen occurred during the Late Permian to Early Triassic. To the south, the continent-continent collision between the NCC and the Yangtze craton was one of the most important accretion events in the Triassic. Since the Late Mesozoic, the craton has become unstable and marked by large-scale structural deformation and magmatic activity occurred in the eastern NCC.

The NCC is a classic example of ancient destroyed cratons. For understanding the interior structure and the tectonic evolution of the NCC, the North China Interior Structure Project (NCISP) had been carried out in 2000-2009. This seismic experiment had deployed 478 portable broadband seismometers with an average spacing of about 10–17 km in eight profiles and covered several major tectonic units. Seismic results based on such observations had revealed many interesting features of the crust and upper mantle of the NCC.

The stations in the NCISP-3 oriented in an N-S direction crossed the Yanshan belt in the northern boundary of the eastern NCC from near Bohai Sea to the Central Asian Orogenic Belt over a distance of ~500 km.

Preliminary seientific results, if any:

The velocity structure information, including crust, lithospheric mantle and upper mantle, as well as the seismic anisotropy in the observation area and NCC have been extracted based on these observations.

The receiver function imaging revealed substantial lateral heterogeneities in the crust beneath the NCISP-3 profile, as displayed by the undulating intra-crustal interfaces, highly varying upper-, middle-, and lower crust thicknesses, and interlayers of low and high velocities. The distinct features and structural complexity of the Yanshan belt might be attributed to the complex tectonic history of the region, especially the crustal extension related to the Paleo-Pacific Plate in conjunction with gravitation collapse following previous crustal thickening. (Zheng et al., 2007)

The shear wave splitting measurements reveal a complex pattern of mantle deformation at the cratonic edge. Inside the eastern craton, the majority of fast direction trends SE–NW parallel to the tectonic extension direction accompanying with the lithospheric thinning. At the cratonic edge, 15 stations with only null splitting results indicate undetectable anisotropy beneath the stations. This may be due to upwelling or chaotic ascension of mantle flow. To the north, off the craton, large delay times and variation of splitting parameter with back azimuth are generated by the combination of lithospheric and asthenospheric anisotropy. Based on comparison of the splitting results and the predicted ones by the compelling models, it is likely that lithospheric delamination dominated the lithospheric thinning at the north edge of the NCC during the Mesozoic to Cenozoic. (Zhao et al., 2007)

Rayleigh wave dispersion analysis and inversion were used to produce a high resolution S-wave velocity imaging profile of the crust and uppermost mantle structure beneath the study region. The overall structural features of the study region resemble those of typical continental rift zones and are probably associated with the lithospheric reactivation and tectonic extension widespread in the eastern NCC during Mesozoic–Cenozoic time. Distinctly high velocities were found beneath the northern Yanshan Belt, extending down to ~100-km depth. The anomalous velocities are interpreted as the cratonic lithospheric lid of this region. (Tang and Chen, 2008)

Approximate amout of data (in MB): 348000

Describe any known problems with the data or particular problems encountered during the experiment:

List of publications submitted:

1. Zheng, T. Y., Chen, L., Zhao, L. & Zhu, R. X. Crustal structure across the Yanshan belt at the northern margin of the North China Craton. *Physics of the Earth and Planetary Interiors, 161*, 36-49 (2007).
2. Zhao, L. & Zheng, T. Y. Complex upper-mantle deformation beneath the North China Craton: implications for lithospheric thinning. *Geophysical Journal International, 170*, 1095-1099 (2007).
3. Zheng, T. Y., Zhao, L. & Zhu R. X. Insight into the geodynamics of cratonic reactivation from seismic analysis of the crust-mantle boundary. *Geophysical Research Letters, 35*, L08303, doi:10.1029/2008GL033439 (2008).
4. Chen, L., Wang, T., Zhao, L. & Zheng, T. Y. Distinct lateral variation of lithospheric thickness in the northeastern North China Craton. *Earth and Planetary Science Letters 267*, 56-68 (2008).
5. Tang, Q. S. & Chen, L. Structure of the crust and uppermost mantle of the Yanshan Belt and adjacent regions at the northeastern boundary of the North China Craton from Rayleigh Wave Dispersion Analysis. *Tectonophysics 455*,

43–52 (2008)

6. Chen, L., Cheng, C. & Wei, Z. G. Seismic evidence for significant lateral variations in lithospheric thickness beneath the central and western North China Craton. *Earth and Planetary Science Letters, 286,* 171-183 (2009).
7. Zhao, L., Richard, M. A., Zheng, T. Y. & Hung, S. H. Reactivation of an Archean craton: Constraints from P- and S-wave tomography in North China. *Geophysical Research Letters, 36*, L17306, doi:10.1029/2009GL039781 (2009).
8. Chen, L. & Ai, Y. S. Discontinuity structure of the mantle transition zone beneath the North China Craton from receiver function migration. *Journal of Geophysical Research, 114,* B06307, doi:10.1029/2008JB006221 (2009)..
9. Wang, T. & Chen, L. Distinct velocity variations around the base of the upper mantle beneath Northeast Asia. Physics of the Earth and Planetary Interiors, 172, 241-256 (2009).
10. Zhao, L. & Xue, M. Mantle flow pattern and geodynamic cause of the North China Craton reactivation: Evidence from seismic anisotropy. *Geochemistry, Geophysics, Geosystems*, 11, Q07010, doi:10.1029/2010GC003068 (2010).
11. Xu, W. W., Zheng, T. Y. & Zhao, L. Mantle dynamics of the reactivating North China Craton: Constraints from the topographies of the 410-km and 660-km discontinuities, *Science China Earth Sciences, 54,* 881-887 (2011).
12. Zheng, T. Y., Zhu, R. X., Zhao, L. & Ai, Y. S. Intralithospheric mantle structures recorded continental subduction. *Journal of Geophysical Research, 117*, B03308, doi:10.1029/2011JB008873 (2012).
13. Zhao, L., Allen, R. M., Zheng, T. Y. & Zhu, R. X. High-resolution body-wave tomography models of the upper mantle beneath eastern China and the adjacent areas. *Geochemistry, Geophysics, Geosystems, 13,* Q06007, doi:10.1029/2012GC004119 (2012).
14. Zhao, L., Zheng, T. Y., & Lu, G. Distinct upper mantle deformation of cratons in response to subduction: constraints from SKS wave splitting measurements in eastern China. *Gondwana Research 23*, 39-53 (2013).

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