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Small-scale upper mantle flow during the initiation of craton destruction

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The North China Craton (NCC) is an old craton which has experienced multi-episodic tectonism with surrounding plates. Bordered to the north by Xing'an-Mongolian Orogenic Belt, to the south by Qingling-Dabie-Sulu Orogen and to the far-east by (Paleo-) Pacific plate, the NCC has lost the cratonic properties within its eastern part. Evidently, the initiation and mechanism of craton destruction attract tremendous attention and remain hot debated. During the Mesozoic to the Cenozoic, the northeastern part of the NCC has been intensively revoked, along with the transition from NE shortening to NW-SE extension. The subduction of Paleo-Pacific plate becomes the prime suspect due to the same kinematic direction. Here we present a hybrid shear wave splitting measurement to investigate the mantle deformation of the NCC, and intend to constrain geodynamic process during the initiation of craton destruction.

The SKS waveform data is recorded from 60 broadband stations with an average spacing of 15 km. We employ the traditional routine method to obtain fast polarization directions (FPDs, Φ) and delay times (δt) for the teleseismic events with epicenter range in 85º-115º. One may often have troubles in delimiting SKS and S wave with regard to the events at distances <85º. Waveform modeling has the advantages through repeated compatibility tests which thus can help us acquire more accurate Φ and δt. Combining these two methods, we depict the major FPDs overlapping on the geological map. Three segments along the profile exhibit NW-SE trending, which are parallel to the extension direction recorded in Erlian Basin, Songliao Basin and metamorphic core complex in Liaoning Peninsula. However, the in-between E-W trending FPDs cannot be neglected. Our previous tomography results show a high-velocity anomaly extend to the depth greater than 200 km beneath the Yanshan belt (118º-120ºE). In comparison with other SKS observations in the NCC, the east-end nearly E-W FPD is possibly owing to the fossil anisotropy in the lithosphere during the N-S shortening in Jurassic. The other is located in the Solonker suture zone beneath where the Moho and lithosphere and asthenosphere boundary (LAB) have sharp variation in depth. It suggests that the subduction of Pacific plate apparently reactivates the upper mantle of the north edge of the NCC but has minor effects westwards. The inconsistency in FPDs may result from small-scale mantle flow in the upper mantle, which could be the dominant operating mode of the Pacific subduction during the initiation of cratonic destruction.