The Geochemical Implications of Shear Wave Tomography

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The availability of digital broad band seismograms from thousands of seismometers now allows the three dimensional velocity structure of the mantle to be determined. Surface wave tomography has a vertical resolution of about30 km and a horizontal resolution of about 400 km. Some of the observed tomographic features are of particular relevance to the problem of craton formation. Tomography shows that the lateral extent of thick lithosphere is considerably greater than the surface outcrop of Archaean and Proterozoic rocks. Surprisingly, the thickest lithosphere underlies Tibet. In N Tibet it is still being thickened, and the material beneath the Moho has a lower velocity than that at a depth of about 120 km, probably because it is being heated by downward conduction of heat from the thick, hot, crust.

Tomography can also map the seismic anisotropy. Shearing beneath oceanic plates causes horizontally polarised shear waves to travel faster than those that are vertically polarised. But the opposite is true beneath cratons. This behaviour is consistent with their formation by shortening, and is therefore in agreement with geochemical arguments. Tomography is also relevant to the question of whether cratons are deformed by continental tectonics, and whether cratonic roots always move with the crust on top.

Reconstruction of Pangea shows that thick lithosphere formed a contiguous arc before the continent broke up, which requires cratonic deformation during the assembly of Pangea. The present lithospheric thickness beneath NE China and Peninsula India is now less than it was in the early Phanerozoic. NE China has since undergone extensive stretching but India has not.