Crustal Structure of Hubei Province of China from Teleseismic Receiver Functions: Evidence for Lower Crust Delamination

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Outline

1. Introduction: Cenozoic extension of eastern China and eastern Asia tectonics.
2. Crustal thickness variation in southeastern China.
3. High-resolution crustal structure images in western Hubei.
4. Discussion and conclusions.
Four topographic steps in China
Crustal thickness variation

Zhu et al., 1997
Basement geology map of China
MIT P-wave velocity tomograph (Li et al. 2010)
Decratonization and extension due to Pacific subduction

Zhao et al. (2007)

Zhu et al. (2011)

A. Yin (2010)
A proposed trench-retreat model

S40RTS (Ritsema et al., GJI, 2011)
1. 121 CNDSN permanent stations.
2. 700 teleseismic events in 2009 and 2010.
3. 23,300 $P$ receiver functions.
Active-source seismic surveys are often not effective to probe deep crust because of weak-energy sources used and high-frequency noise from small-scale heterogeneities. In contrast, passive source surveys have

- Steep incident angles ⇒ good lateral resolution (<10 km).
- Sources from below ⇒ no penetration-depth problem.
- One-way travel ⇒ less contaminated by shallow heterogeneities.
Trade-off between Moho depth and velocities

\[ H = \frac{t_{Ps}}{\sqrt{\frac{1}{V_s^2} - p^2} - \sqrt{\frac{1}{V_p^2} - p^2}}, \]

\[ \frac{\Delta H}{H} = \left( \frac{\partial H}{\partial V_p} \frac{V_p}{H} \right) \frac{\Delta V_p}{V_p}. \]

For \( V_p = 6.3 \text{ km/s} \), \( \frac{V_p}{V_s} = \kappa = 1.732 \), and \( p = 0.06 \text{ s/km} \), one gets

\[ \frac{\Delta H}{H} = 0.9 \frac{\Delta V_p}{V_p}, \]

However, \( H \) is very sensitive to the \( \frac{V_p}{V_s} \) ratio:

\[ \frac{\Delta H}{H} = -2.3 \frac{\Delta \kappa}{\kappa}. \]
$H-\kappa$ stacking technique (Zhu & Kanamori, 2000)
Common Conversion Point (CCP) Stacking (Zhu, 2000)
Zhu, 2000
Conclusions

- The change from thin crust (30–35 km) in eastern China to thick crust (45–50 km) in the west seems to occur sharply (<10–20 km), in a stepwise fashion in some places.

- The thin crust extends beneath the Wuling uplift and Huangling Massif, suggesting a decoupling between the upper crust and lower crust deformation.

- The CCP images also reveal an apparent double Moho beneath the Wudang Mts. which is interpreted to be due to a piece of partially eclogitized lower crust.

- The Moho steps were formed when a segment of eclogitized lower crust became gravitationally unstable and foundered into the mantle.