Moho Depth of the Ordos Block in North China from Lithospheric-Mantle-Corrected Virtual Deep Seismic Sounding (VDSS)

1. Background: VDSS under 1D assumption

2. Motivation: Effects of mantle heterogeneity on VDSS

3. Data and methods: ChinArray Project

- The Ordos Block (OB), surrounded by active rifts, is a remnant of the Archean North China Craton, the eastern part of which is reactivated during Mesozoic
- A previous VDSS study claimed a ~60 km deep Moho near the eastern edge of OB (Yu et al., 2012), much deeper than found by receiver functions (RF; e.g. Feng, et al., 2017)
- The ChinArray (~50 km station spacing) in the region recorded a high-quality deep event in the Banda sea
- We measure the 5a traveltimes of the event and krige them to make a map
- Residual correlates reasonably with geologic provinces

4. Data and methods: Measuring SsPmp traveltimes (T_{sdpmp})

- Stack S components of all the stations with Ss residuals to make an estimated source time function
- Align the traces so that the peak on the envelope function of the estimated source time function is at time zero.
- Manually pick the stations with good SsPmp waveforms.
- Measure T_{sdpmp} at the peak on the P-component envelope functions with respect to time zero, not the peak on the corresponding S-component envelope function.

5. Results: VDSS Moho depth with lithospheric-mantle-correction

- 1D assumption (no correction): T_{sdpmp} is directly converted to Moho depth.
- Correction with fixed virtual source location: Compute the distance between station and virtual source assuming a Moho depth of 40 km. The distance and the event back azimuth determines the virtual source location. Then use the difference in residual between the virtual source and station to make the correction (Yu et al., 2016)
- Correction with varied virtual source location: find the best-fit Moho depth and virtual source location simultaneously (Yu et al., 2016)
- For an average crustal V_p = 6.3 km/s, we find deep Moho (40-40 km) in the OB and shallow (20-40 km) Moho in the rifts, and significantly (up to 15 km) shallower Moho near the eastern edge of OB after correction.

6. Discussion: Moho depth from different methods

- Corrected VDSS Moho depth (b) is more consistent with RF (c) (RMS = 6 km vs 11 km) and active-source Moho (d) (RMS = 6 km vs 9 km) near the eastern edge of OB, which is slightly deeper.
- Corrected VDSS Moho depth (b) agrees equally well with active source (d) and RF Moho (c).

7. Discussion: SsPmp as turning wave in the upper mantle

- Horizontal gradient of the travel time residual gives correction to AK135 ray parameters for surface points
- Reciprocal of the corrected ray parameter at any surface point gives the turning velocity of SaPmp wave initiating from that point (virtual source)
- Virtual sources of reflections points near the eastern edge of OB have high (> 5.6 km/s; blue) turning velocity (low p). SaPmp in this region has high p so may be turning in the upper mantle, causing the apparently deeper VDSS Moho (b) vs 6c,d above)

8. Conclusions

- Lithospheric mantle correction is necessary in regions with strong lateral variation
- No thick crust (>50 km) exists beneath the eastern edge of the Ordos Block
- A positive velocity gradient likely exists right beneath the Moho in most of the Ordos Block and perhaps other cratons as well.

**Reference**


Tao, K., Ning, J.Y. and Yu, C.Q., 2016. Lithospheric mantle structure beneath the Ordos Block. JGR: Solid Earth, 121(8), pp.5917-5930.