O1.2-535

The crustal thickness and Vp/Vs ratio in Mongolia

Baasanbat Tsagaan[1], Odonbaatar Chimed[1],
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Presentation Date: 10 September 2025, 16:45

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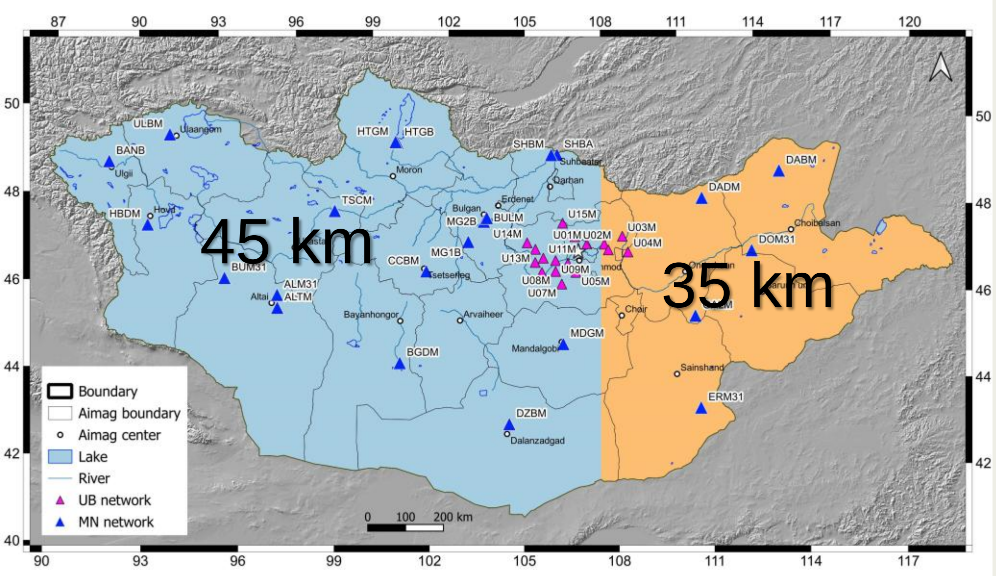
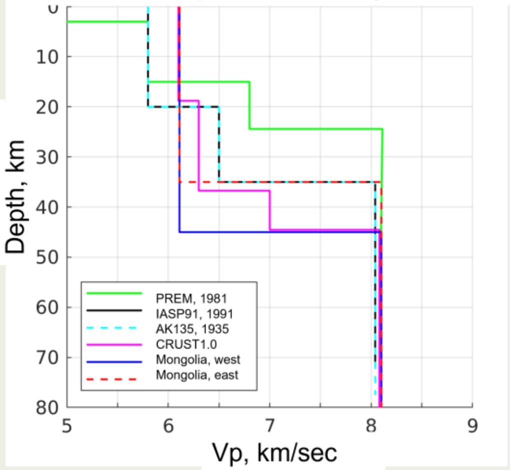
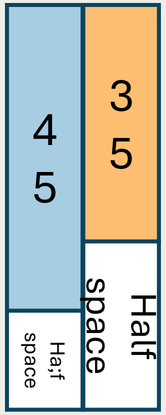
1.1 Study goals

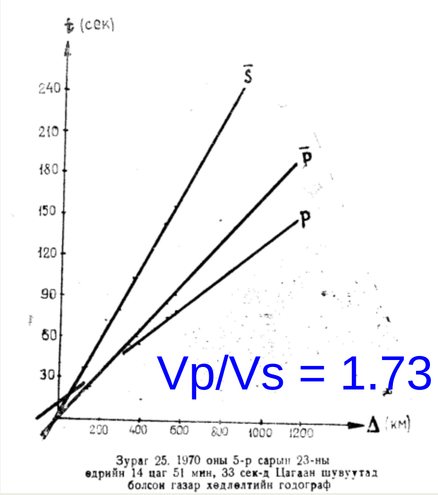


Reference seismic velocity models vs Velocity model of Mongolia



Crustal model





Baljinnyam et al. (1975). Mongolian seismology. 42-

- To determine the average thickness of the Earth's crust beneath each permanent broadband seismic station in Mongolia
- Vp/Vs seismic velocity ratio and Poisson ratio in the crust
- General map of the crust beneath Mongolian territory

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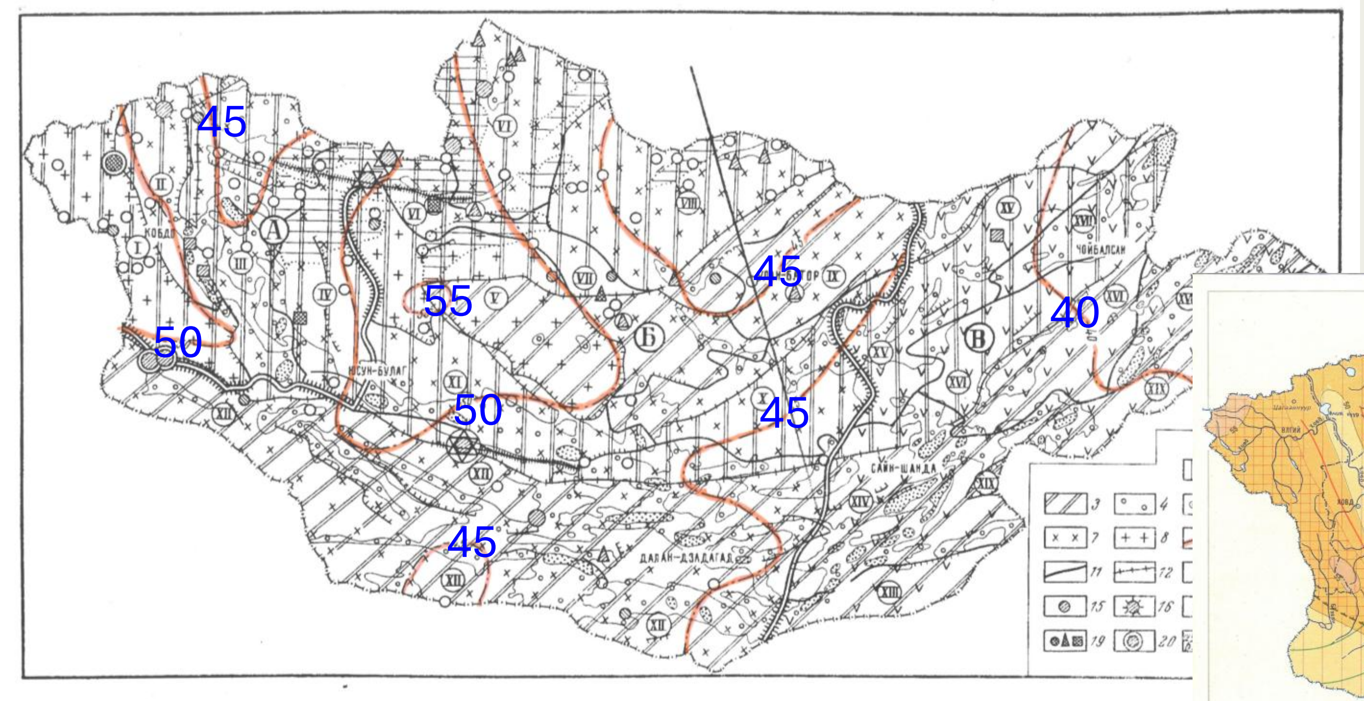
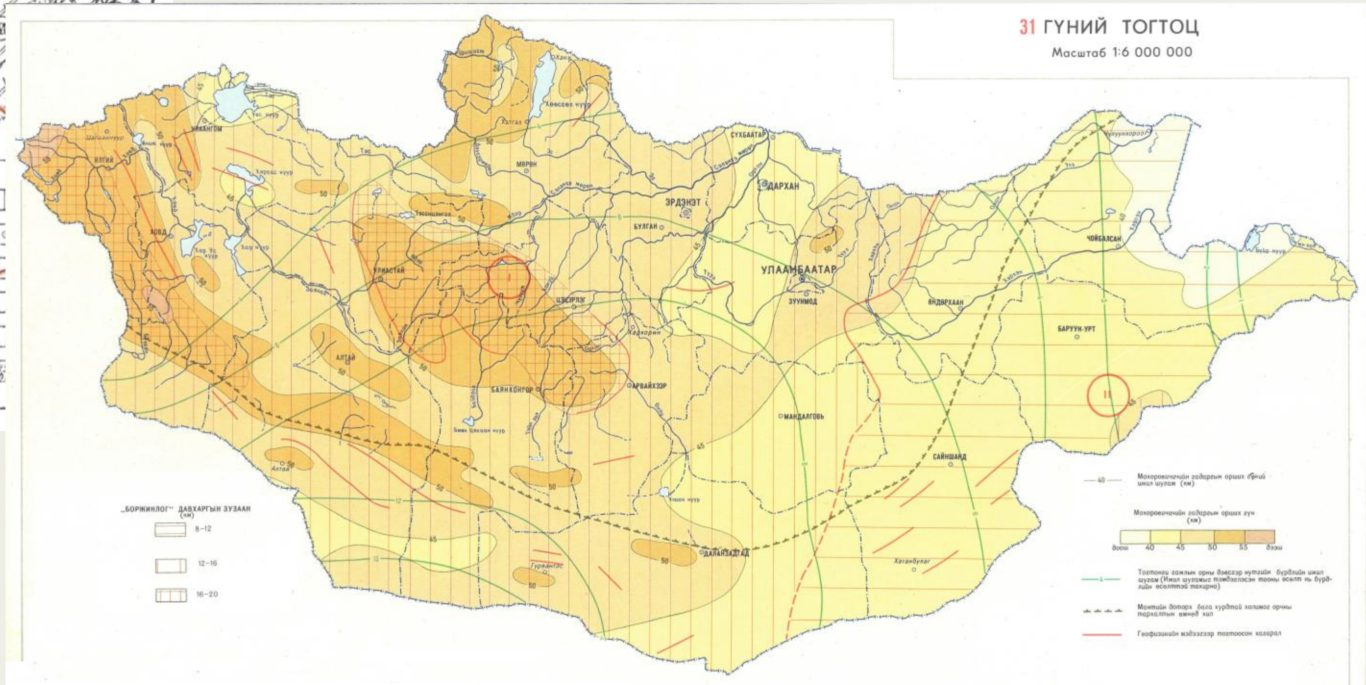
1.2 Previous studies – Crustal thickness determined by gravity study - 1969

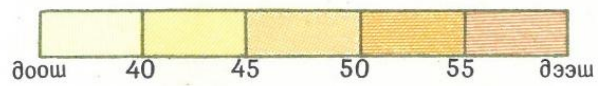


Volkhonin et al., 1969 -
Moho discontinuity depth map

Khilko and Baljinnyam, 1990, National atlas



Moho discontinuity depth, km



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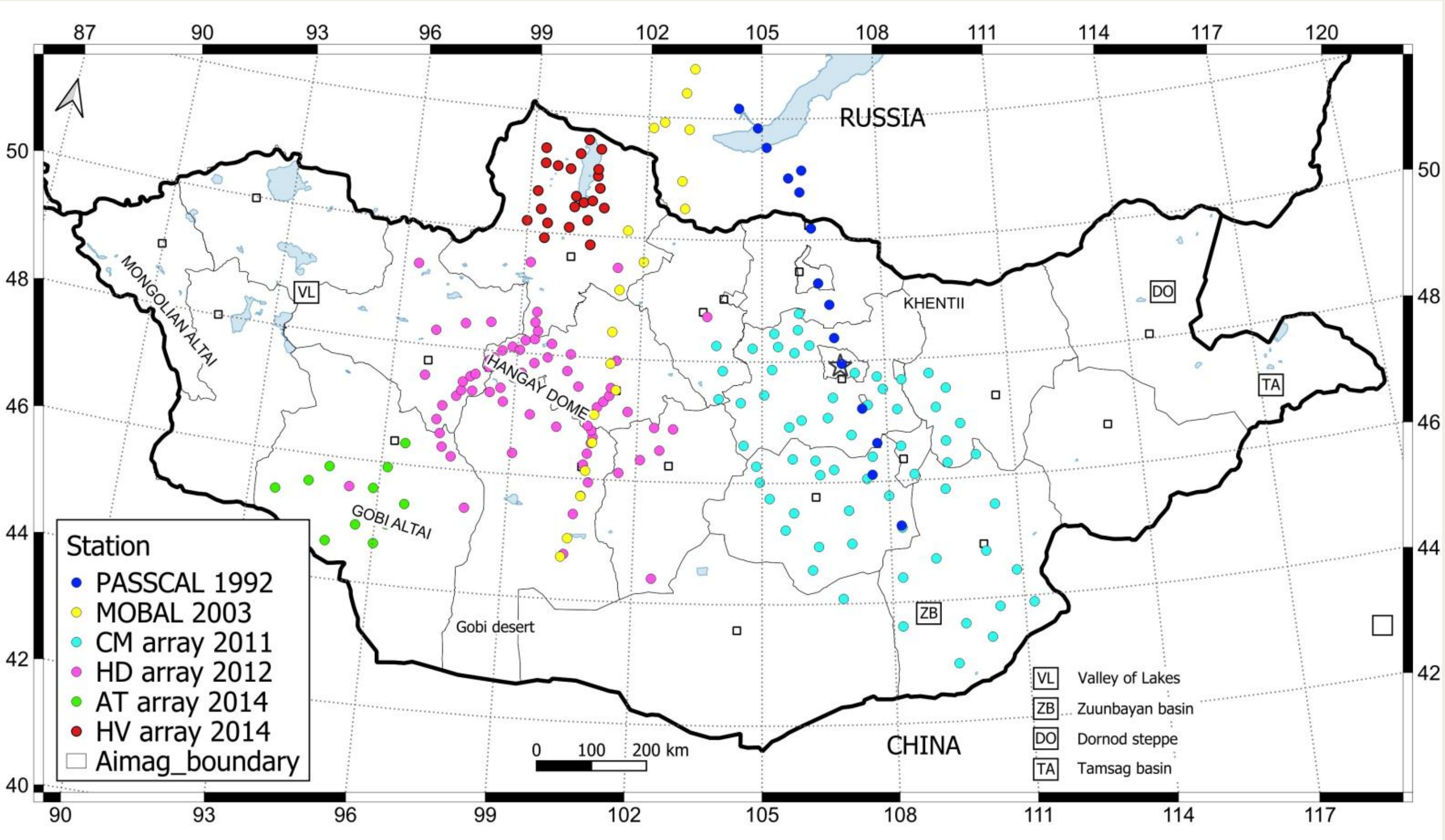
1.2 Previous studies – Seismology – Teleseismic receiver function studies



1991-1992 "The Baikal Rift Zone Experiment" - Mordvinova and Zorin (1996), Zorin et al., (2002)

2001-2003 "Mongolian-Baikal Lithosphere seismological Transect" – Mordvinova et al., (2007)

2011 "The Geophysical Investigation and Deep Structure Modeling for Seismic Hazard Assessment in the Far East – CEA, China" - He et al, (2016)

2012-2016 Intracontinental Deformation and Surface Uplift – Geodynamic Evolution of the Hangay Dome, Mongolia Central Asia – Josh Stachnik et al., 2014

2015 "Receiver function study in the Ulaanbaatar region" – Baasanbat, Shibutani (2015)

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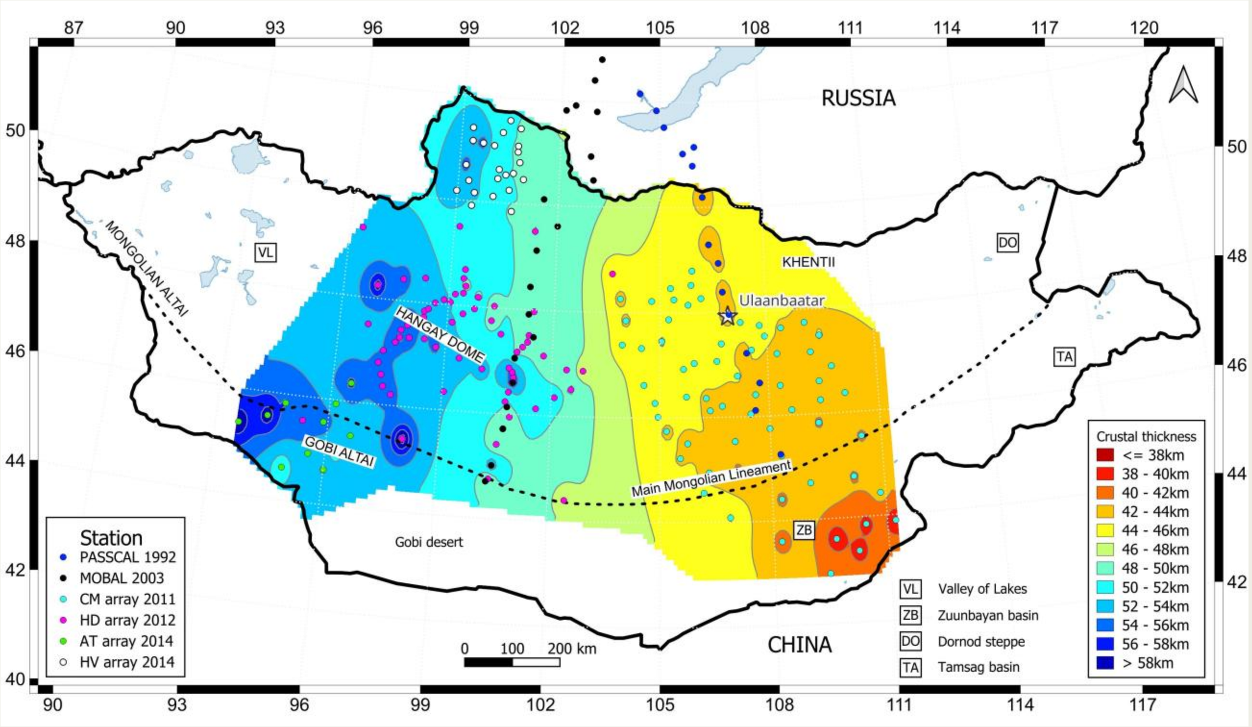
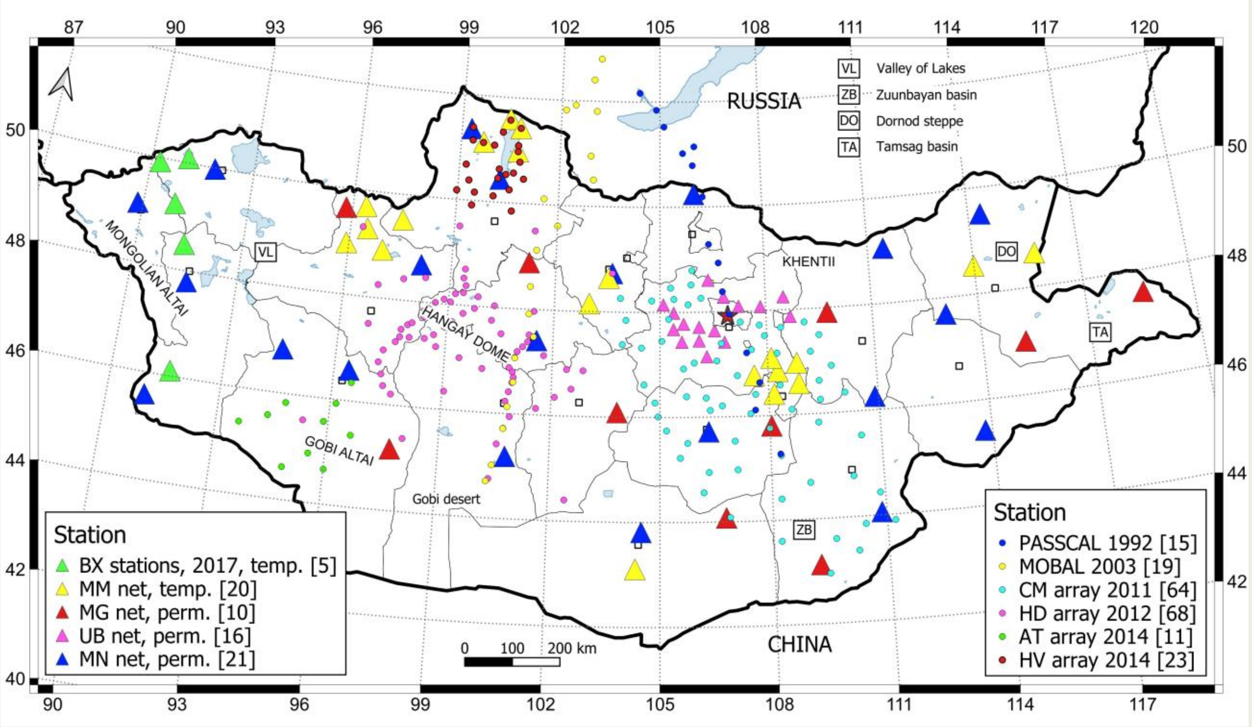
1.2 Previous studies – Seismology – Combined results



Crustal thickness – combined results



Permanent seismic BB stations in Mongolia

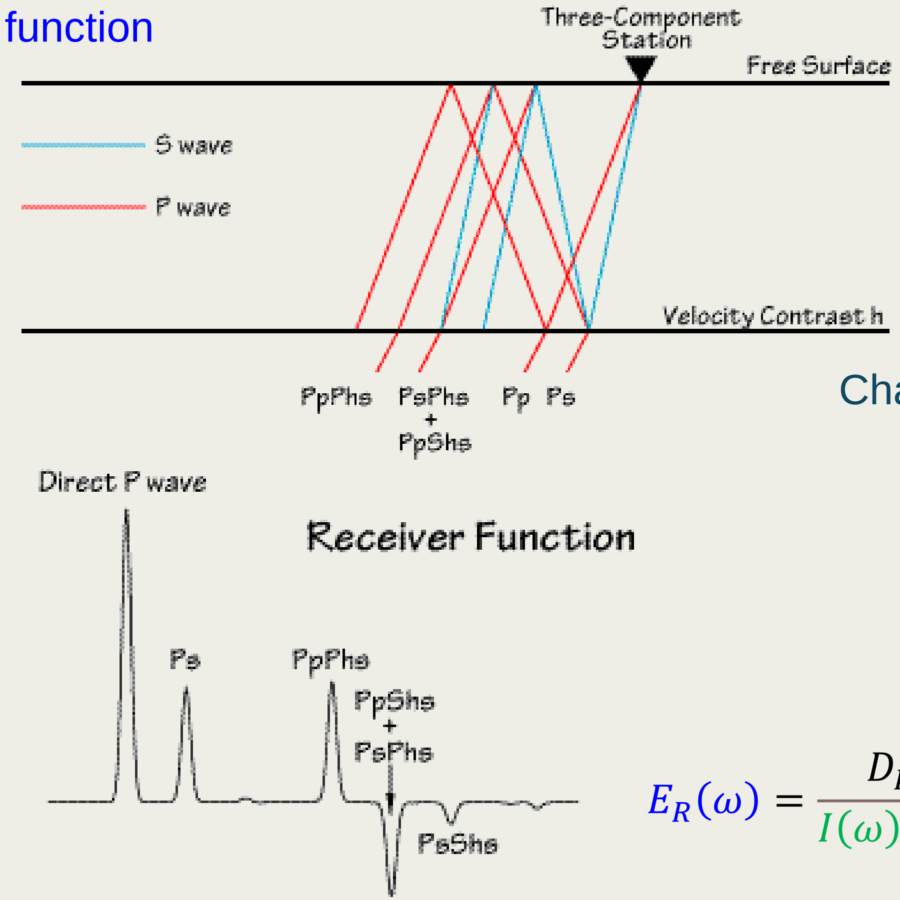
Hypothesis:

- **Thicker crust** under permanent seismic stations in the western region of Mongolia.
- **Thinner crust** under permanent seismic stations in the eastern region of Mongolia.
- The crust under permanent stations in the central region is **~45 km thick,** similar to other studies

Baasanbat Tsagaan[1], Odonbaatar Chimed[1], Baatarchuluun Tsermaa[2], Ulambadrakh Khukuudei[2]

2.1 Study methdod – Teleseismic RF and H-k stacking inversion

Teleseismic receiver function



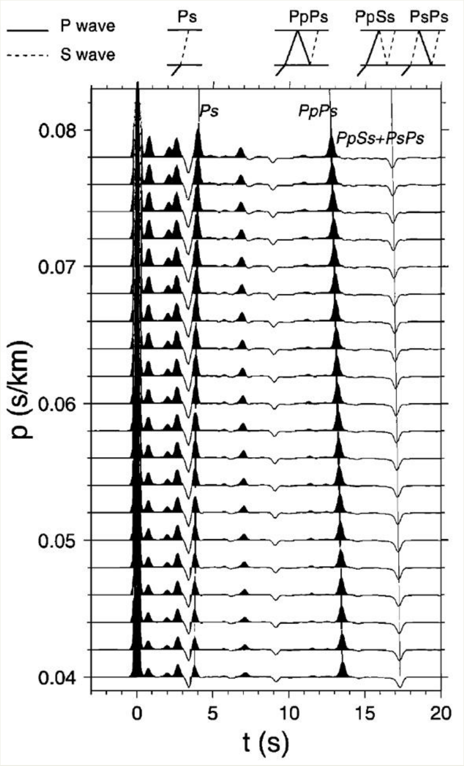
Charles J. Ammon

$$E_R(\omega) = \frac{D_R(\omega)}{I(\omega) * S(\omega)} \approx \frac{D_R(\omega)}{D_V(\omega)}$$

Iterative time-domain deconvolution to calculate observed RFs

Ligarria and Ammon, 1999

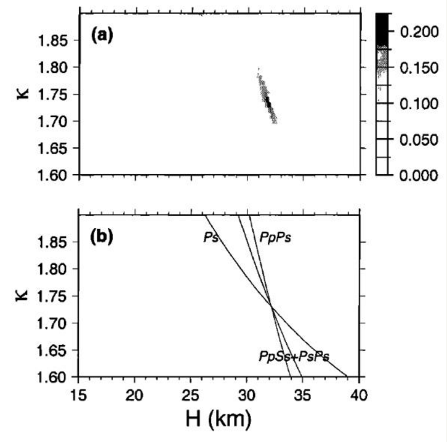
Teleseismic RF H-k stacking inversion



$$H = \frac{t_{Ps}}{\sqrt{\frac{1}{Vs^2} - \rho^2} - \sqrt{\frac{1}{Vp^2} - \rho^2}}$$

$$H = \frac{t_{PpPs}}{\sqrt{\frac{1}{Vs^2} - \rho^2} + \sqrt{\frac{1}{Vp^2} - \rho^2}}$$

$$H = \frac{t_{PpSs+PsPs}}{2 * \sqrt{\frac{1}{Vs^2} - \rho^2}}$$



$$s(H,k) = w_1 r(t_1) + w_2 r(t_2) - w_3 r(t_3)$$

Zhu and Kanamori, 2000

r(t) – radial RFs

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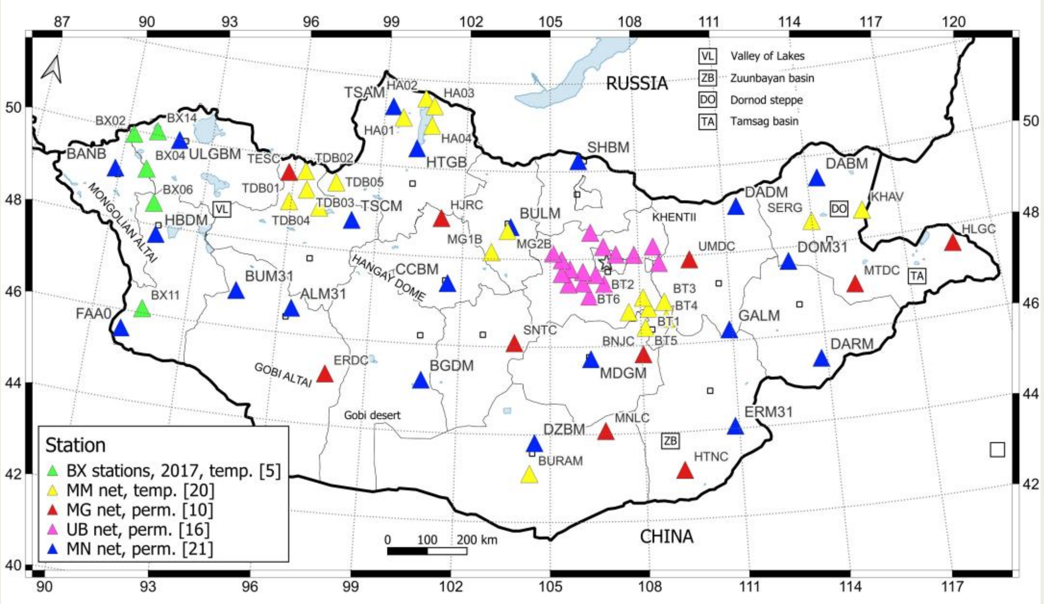
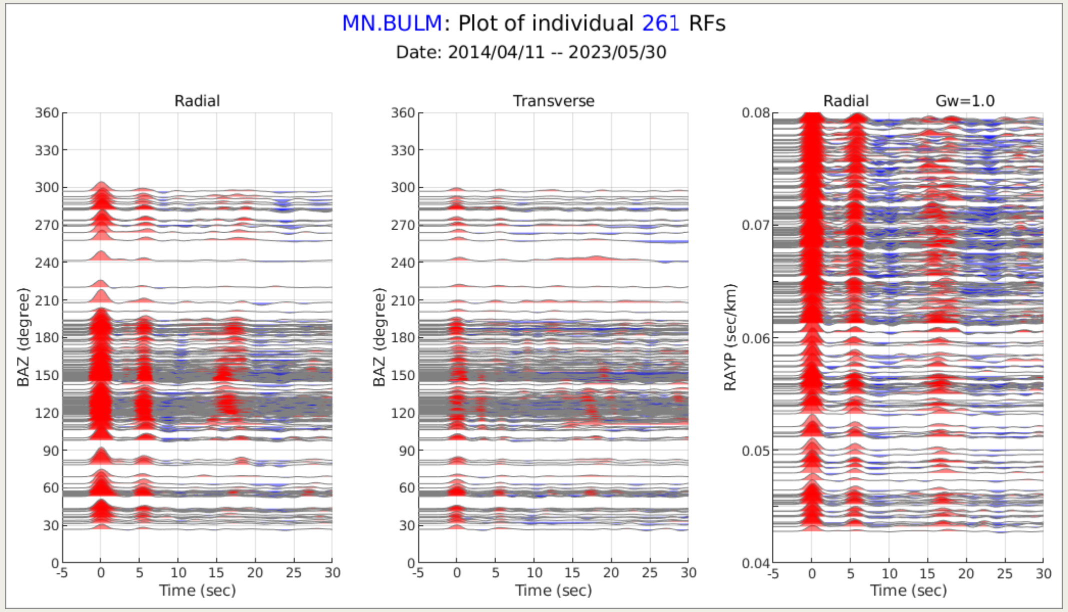
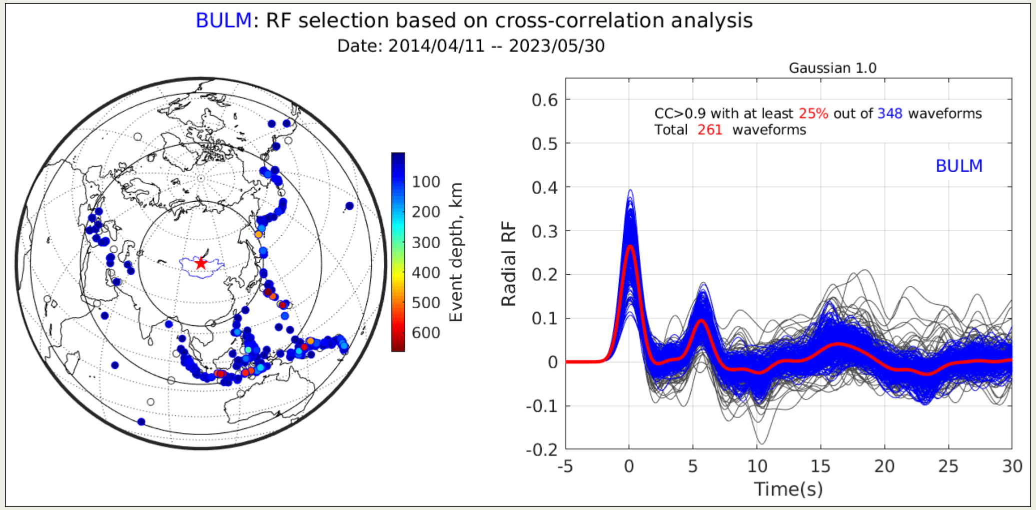
2.2 Dataset: Teleseismic events and their observed RFs





Example of observed individual RFs



BULM station

Date: 2014 – 2023, 9 years

Events in the dataset: 348 events /RF

Selected events based on the correlation:
261 events /RF

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THE STUDY RESULTS

Baasanbat Tsagaan[1], Odonbaatar Chimed[1], Baatarchuluun Tsermaa[2], Ulambadrakh Khukuudei[2]

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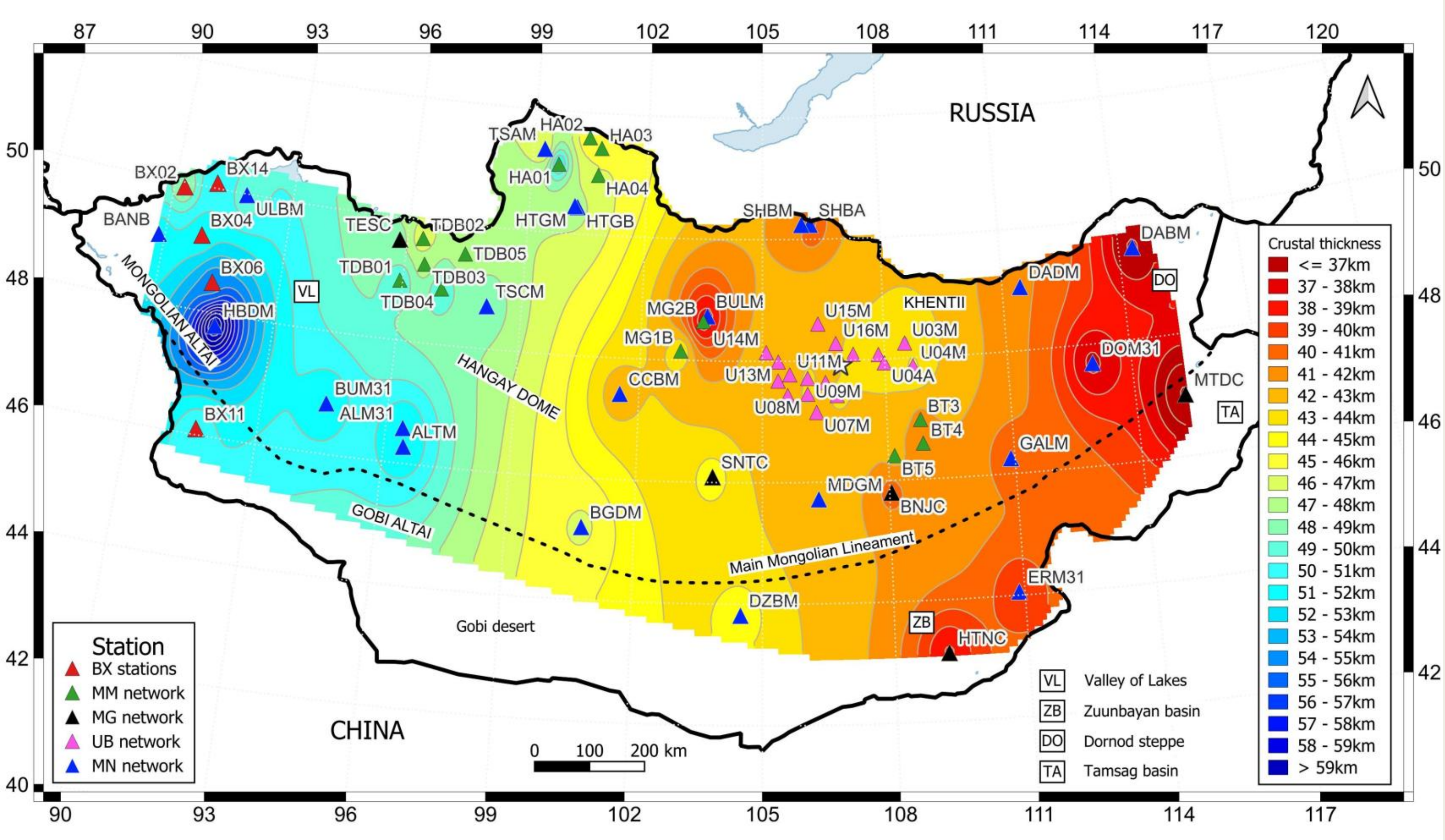
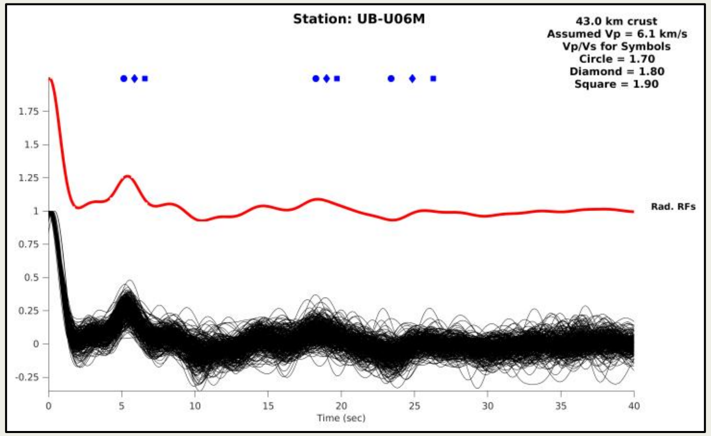
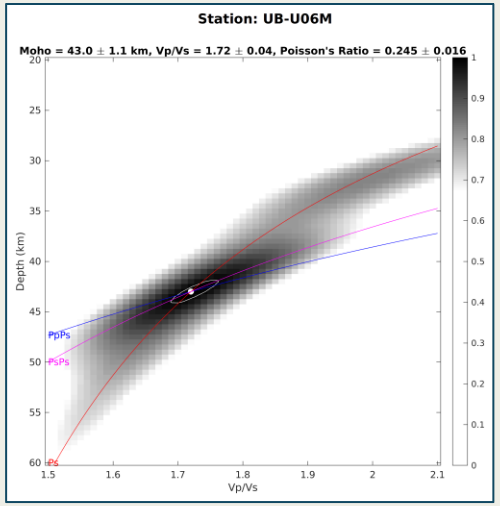
3.1 Study result: Crustal thickness beneath perm. BB stations – H-k stacking







min, thinnest - DABM 35.9±0.5 км
max, thickest - HBDM 63.1±0.4 км

updated July, 2025

Porritt, R. W. and Miller, M. S., (2018)

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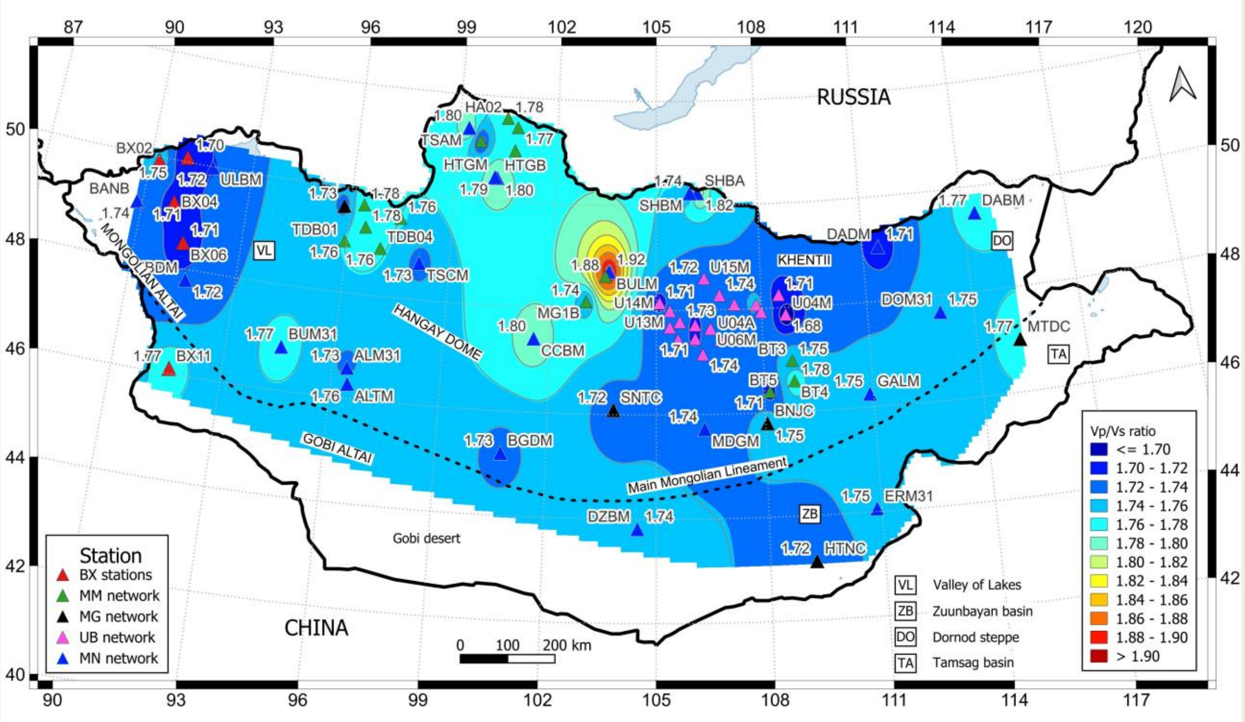
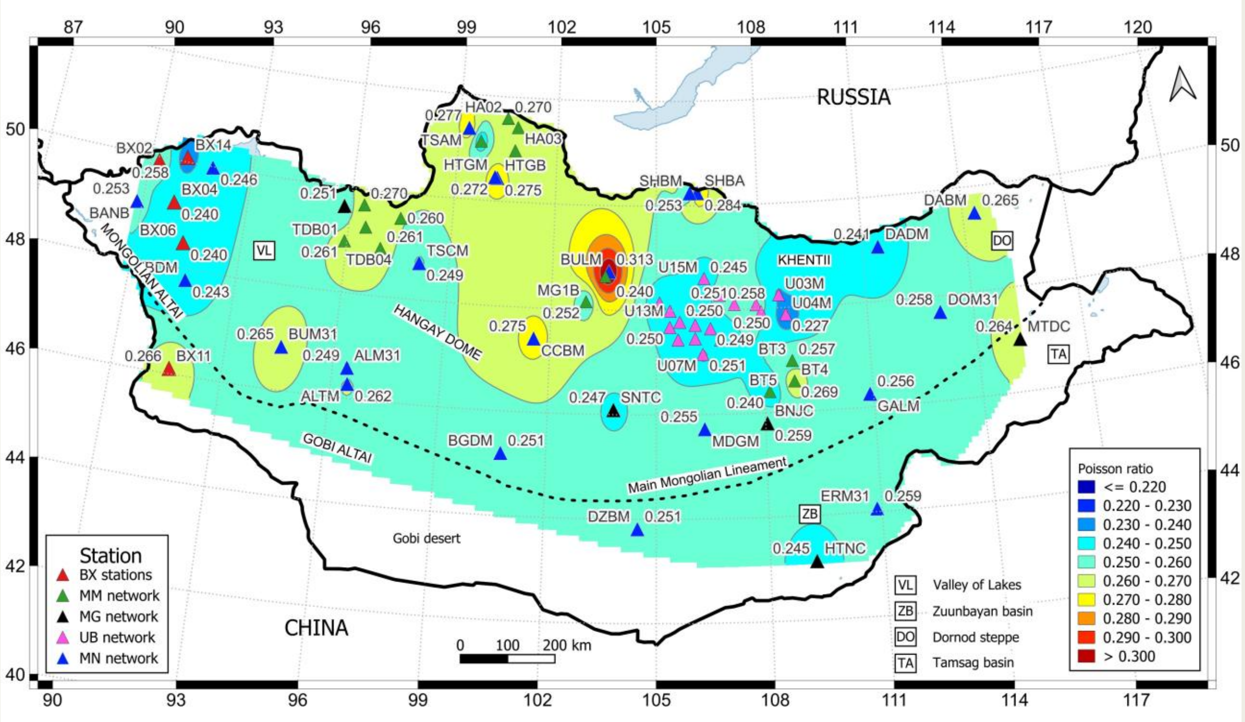
3.1 Study result: Vp/Vs ratio and Poisson ratio

Vp/Vs ratio



Poisson



1.74 < Mongolia-Altai region, Ikh Bogd Mountains, Khentii Mountains region, Dundgovi region

1.74-1.80 – Gobi-Altai region, Khangai Mountains, Khuvsgul region

1.80 > Bulgan, Tsetserleg area

Poisson ratio: Silica SiO_2 content

low < 0.26 – felsic, - Khentii range, Mongol-Altai range
medium 0.26-0.28 – intermediate – remaining area
high > 0.28 – mafic - CCBM, DABM, BUM31, BX11, SHBA stations and Khuvsgul area

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The crustal thickness and Vp/Vs ratio in Mongolia

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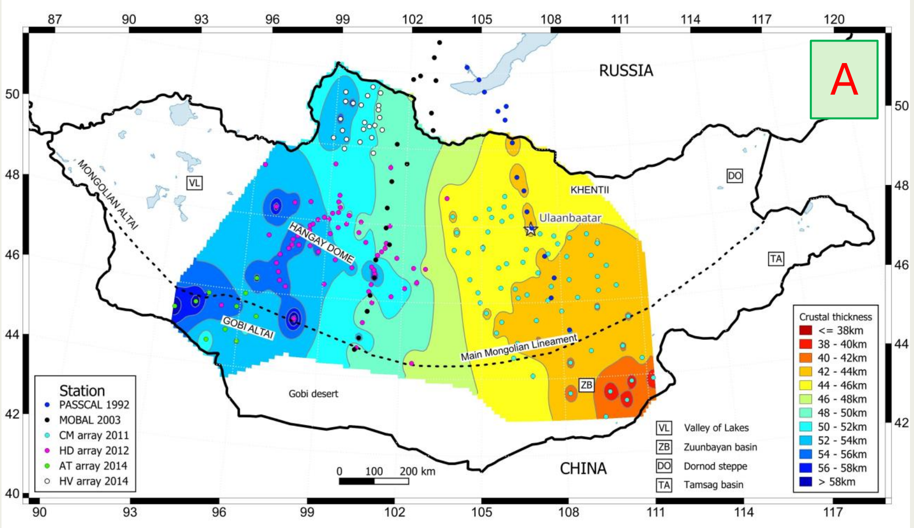
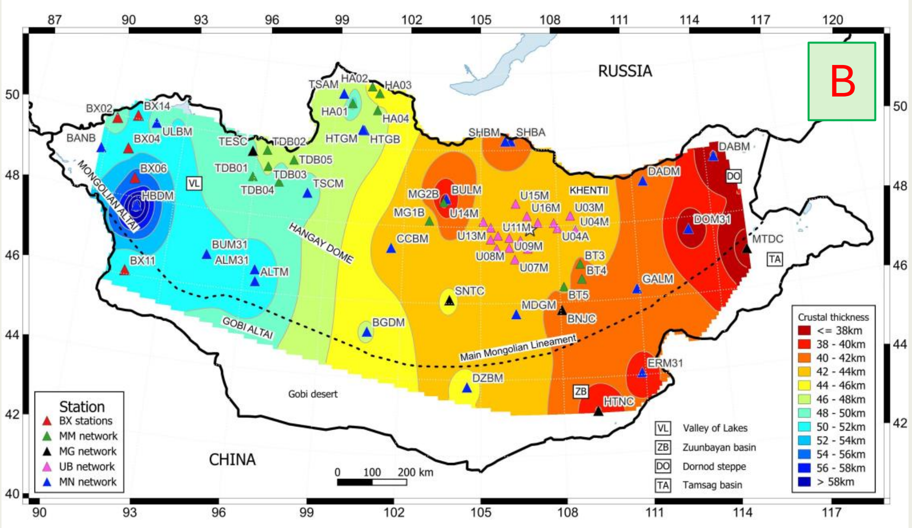
3.2 General map of crustal thickness of Mongolia: A+B+C=D

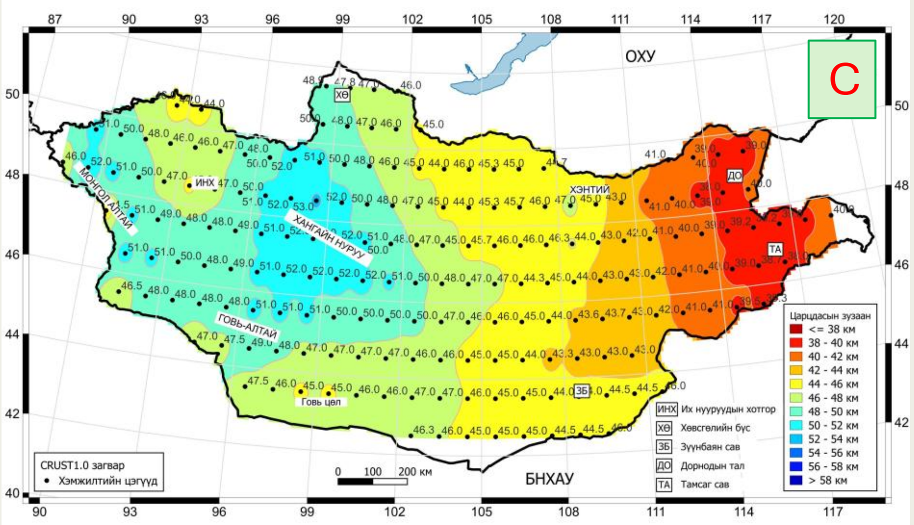
Previous studies – 190 locations



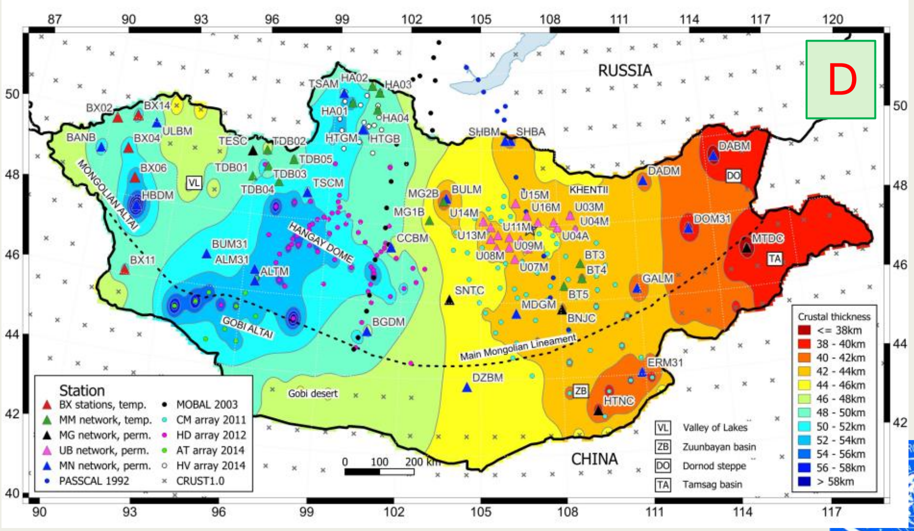
Our study – **63** location



CRUST1.0 model



General map



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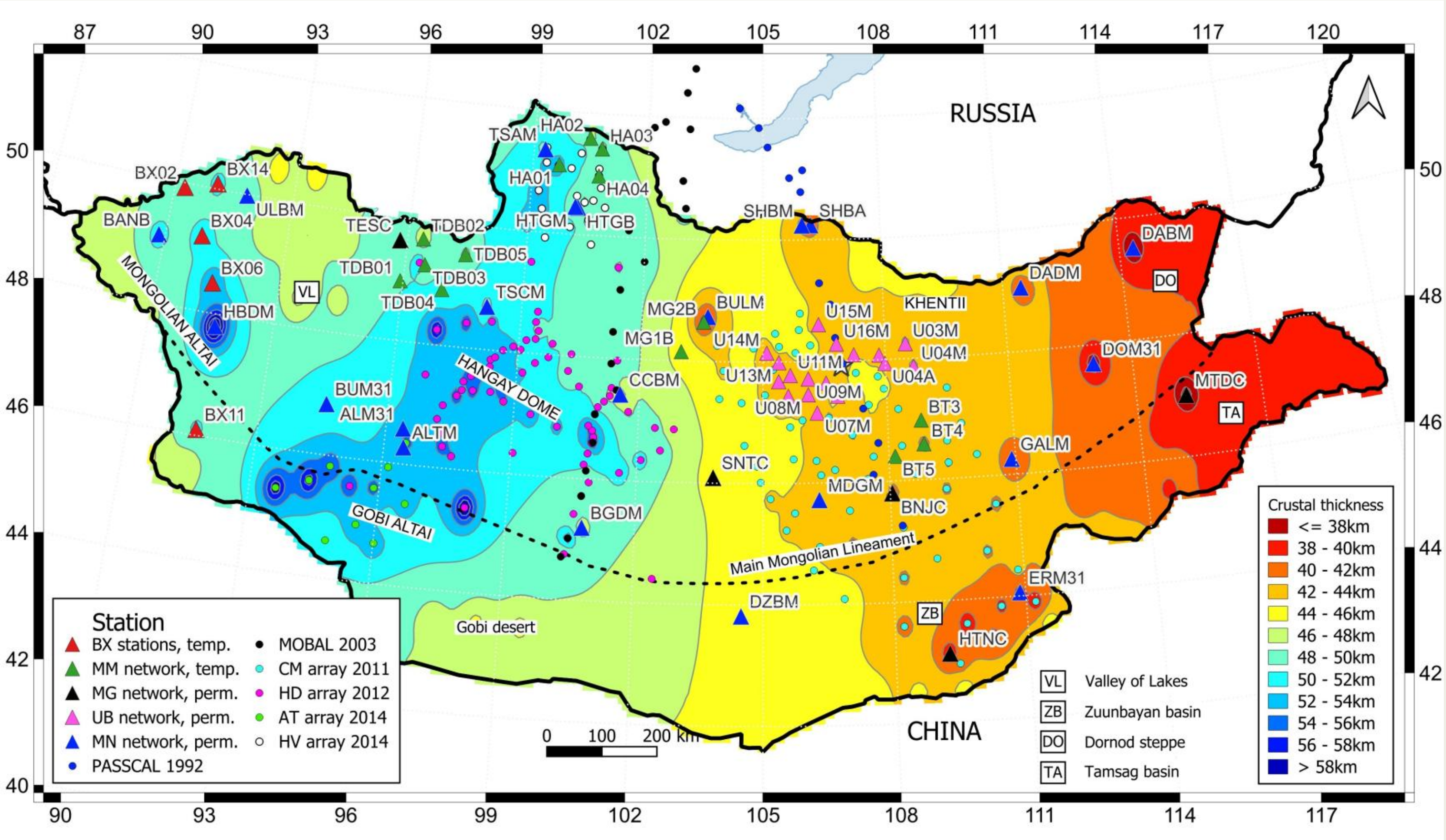
3.2 General map of crustal thickness of Mongolia – updated July 2025



Thinner crust: 36-38km
Eastern Mongolia:
Dornod Mongol steppe

Medium-thick crust: 39-49 km
Central Mongolia:
Northern part, Khentii mountain Khovsgol region, Gobi desert area

Thicker crust: 50-63 km
Western Mongolia:
Mongol-Altai, Gobi-Altai, Khangai mountain ranges

Tsagaan B., Chimed O., Tsermaa B., Khukhuudei U. THE CRUSTAL THICKNESS AND Vp/Vs RATIO IN MONGOLIA. *Geodynamics & Tectonophysics*. 2024;15(4):0771. https://doi.org/10.5800/GT-2024-15-4-0771. EDN: IBNQWM

Baasanbat Tsagaan[1], Odonbaatar Chimed[1], Baatarchuluun Tsermaa[2], Ulambadrakh Khukuudei[2]

DISCUSSION

Baasanbat Tsagaan[1], Odonbaatar Chimed[1], Baatarchuluun Tsermaa[2], Ulambadrakh Khukuudei[2]

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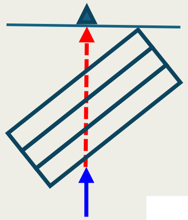
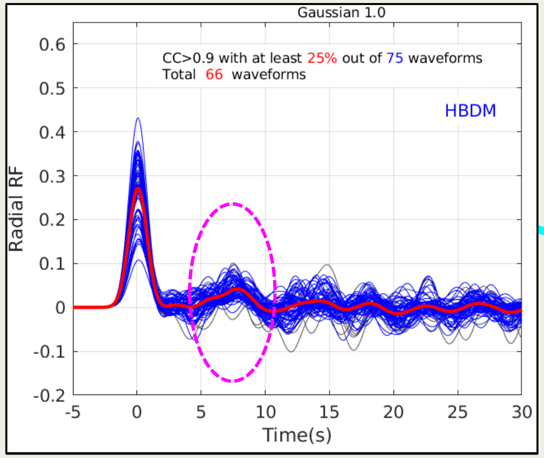
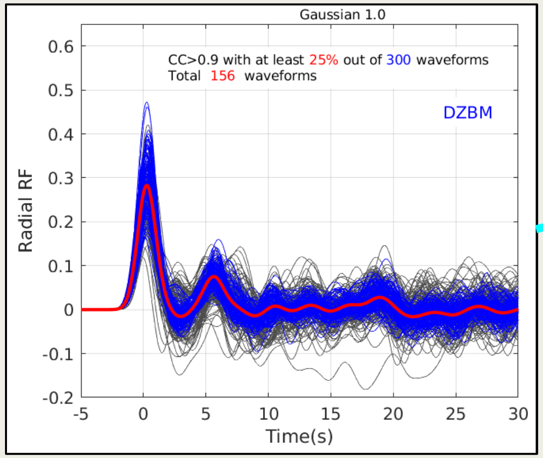
4.1 Characteristics of observed RFs vs terranes

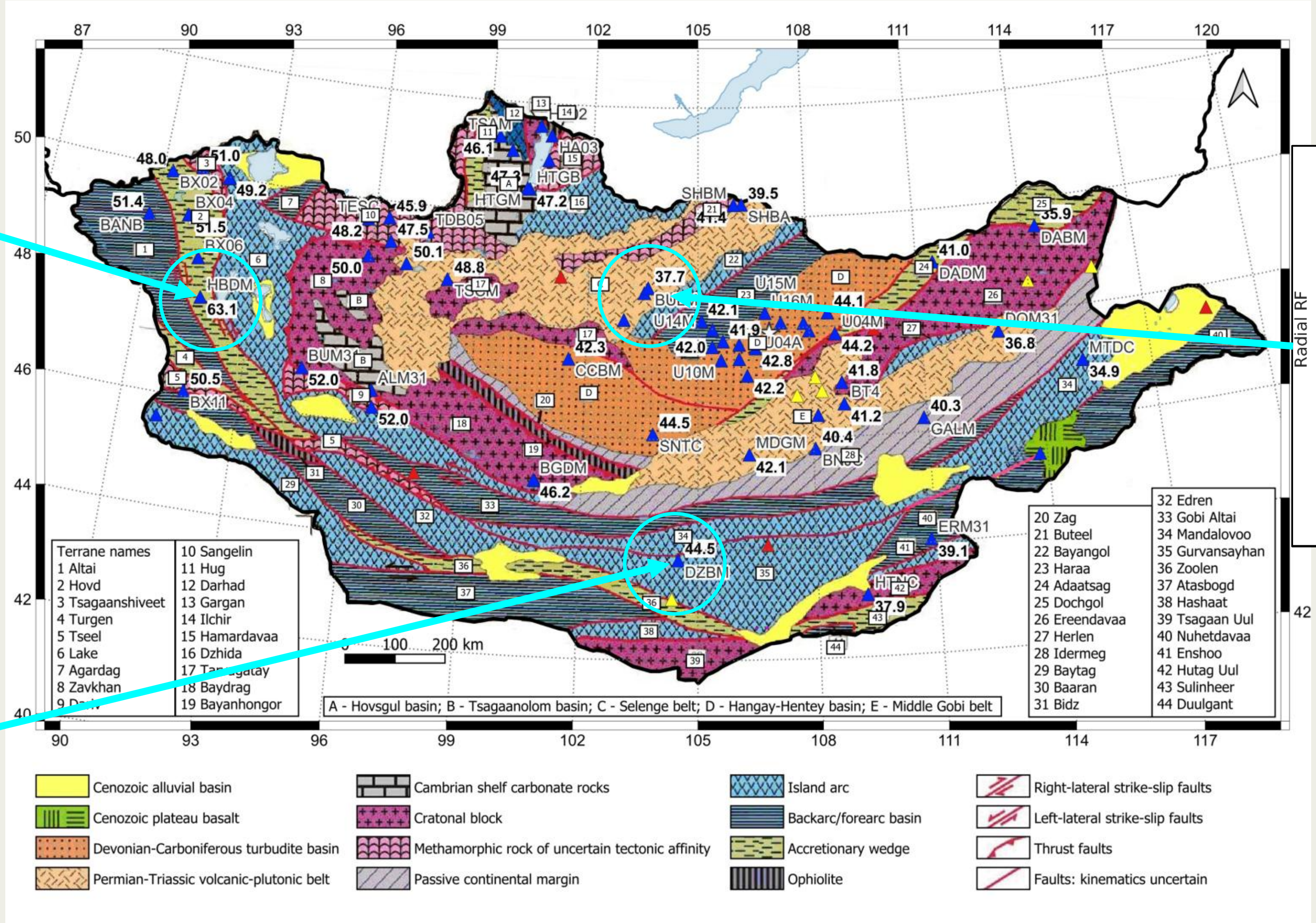


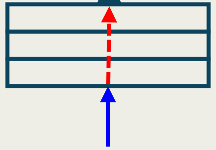
Accretionary wedge

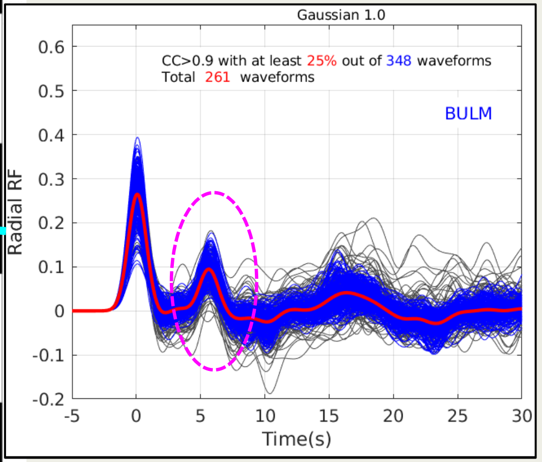


Island arc









Permian – Triassic volcanic-plutonic belt

Badarch et al., 2002

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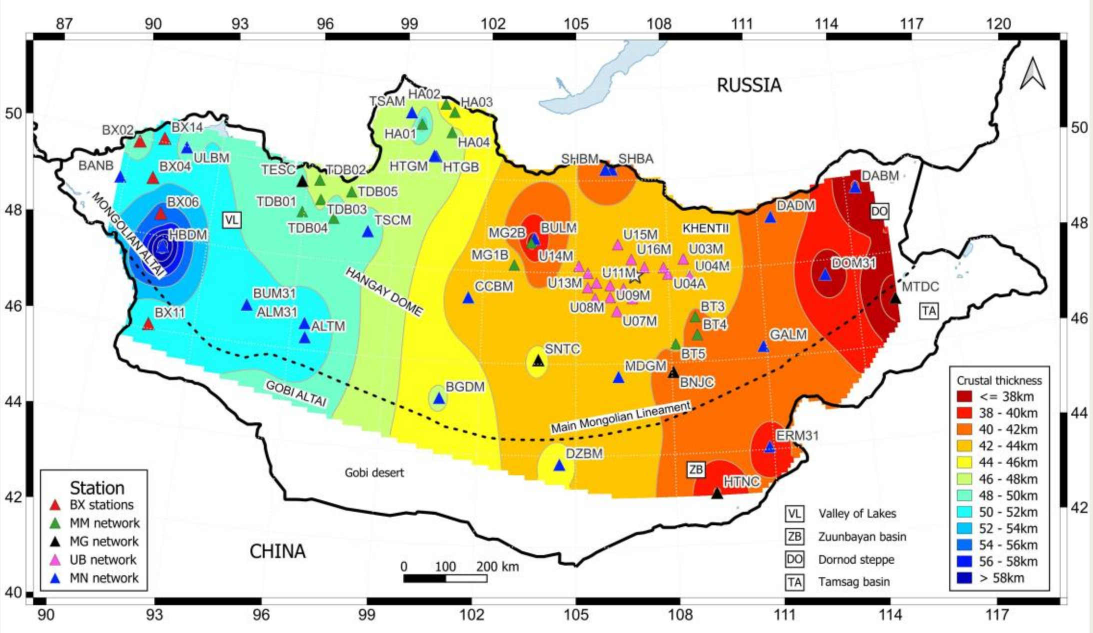
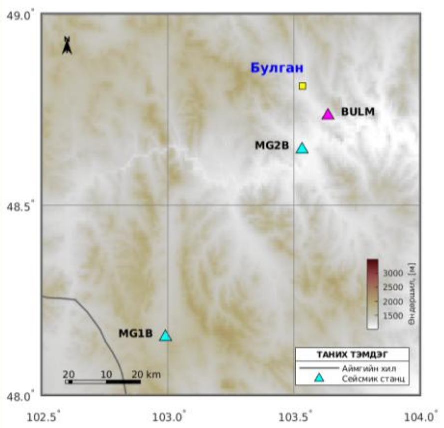
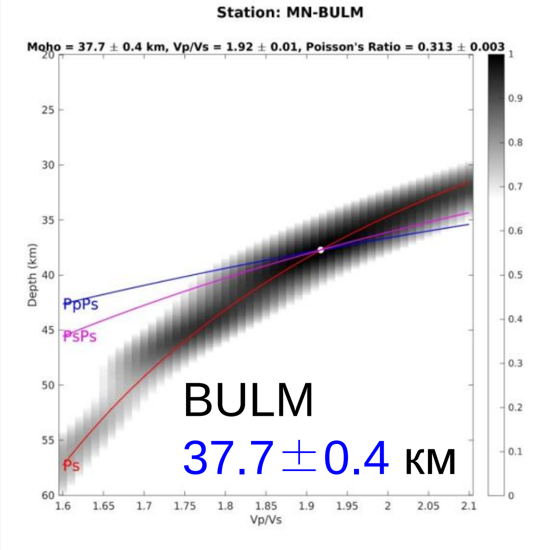
4.2 Anomaly at Bulgan: Crustal thickness beneath BULM and MG2B station

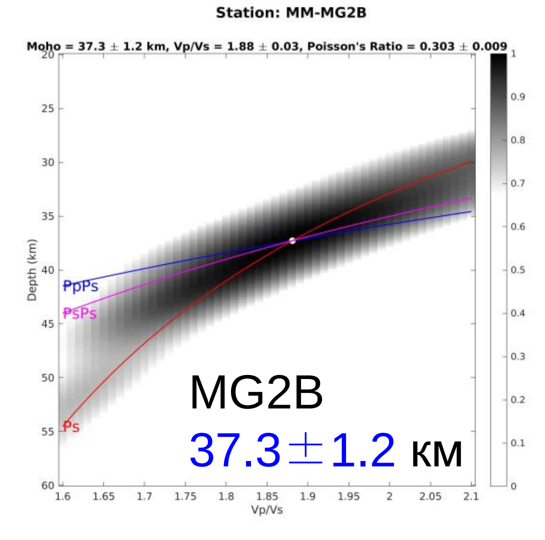


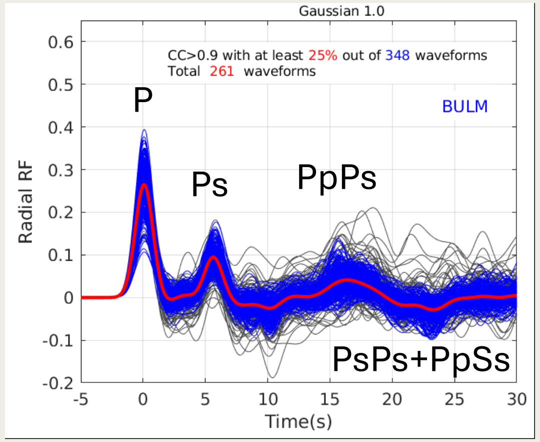


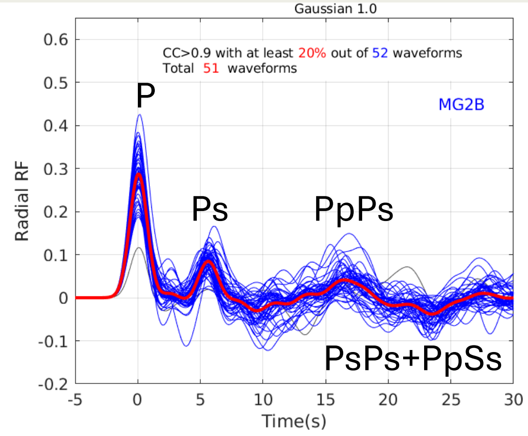


Crustal thickening?

Mantle plume?







BULM:
Vp/Vs=1.92,
Poisson – 0.31

MG2B:
Vp/Vs=1.88,
Poisson – 0.30

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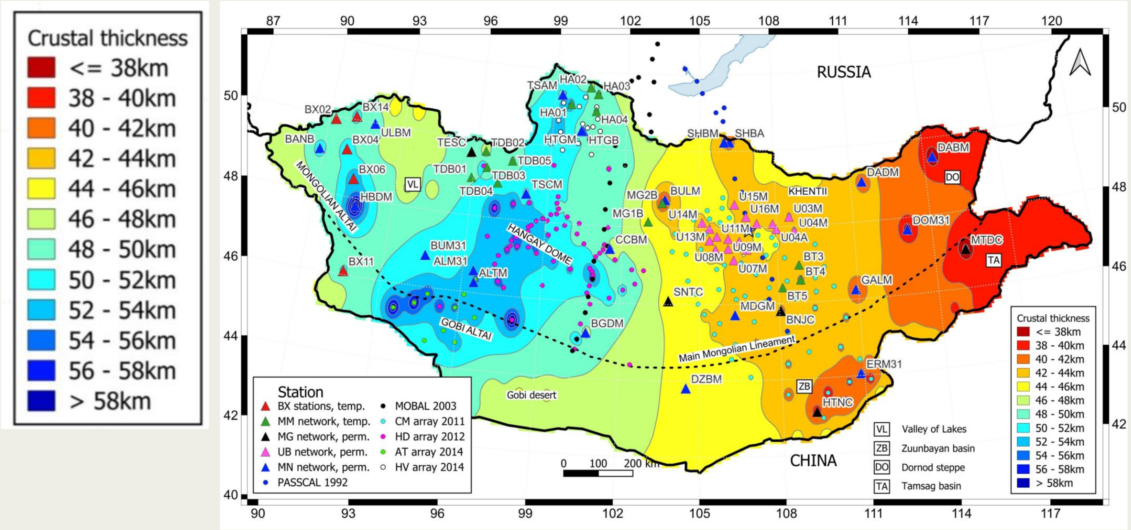
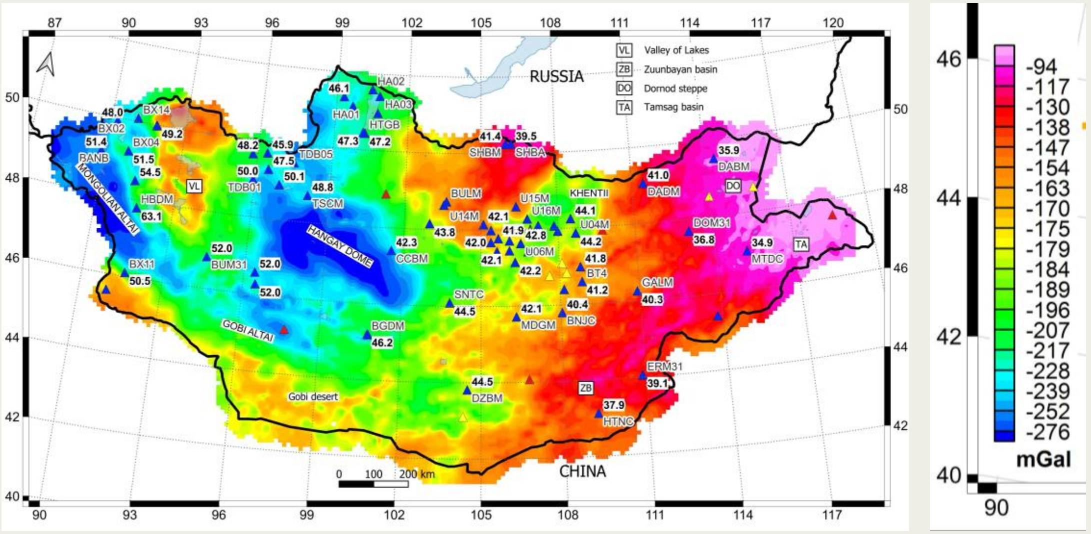
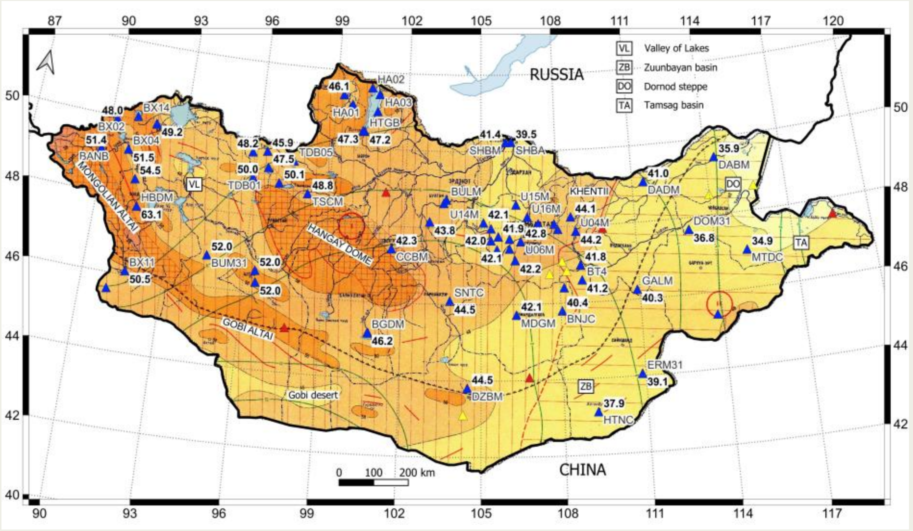
4.3 Seismological study vs Gravity study

Ts.Baatarchuluun et al.





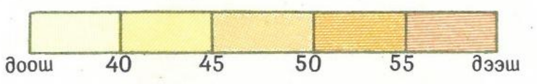


Khilko and Baljinnyam, 1990, National atlas

A zone of **very high negative Bouguer anomaly** indicates an area of **thicker crust**.

Relatively low, negative Bouguer anomaly typically indicates a region of **thinner crust**

Moho discontinuity depth, km



Baasanbat Tsagaan[1], Odonbaatar Chimed[1], Baatarchuluun Tsermaa[2], Ulambadrakh Khukuudei[2]

5. Conclusion

- The crust beneath Mongolia thickens from east to west, with the thickest crust reaching 63 km and the thinnest at 36 km.
- By combining our results with previous seismological studies, we have, for the first time, compiled a general map of crustal thickness in Mongolia based on seismological data.
- Distinct features observed in certain receiver functions have been interpreted in relation to the tectonic terranes beneath each station.
- Our study's results have direct practical applications for seismological research in Mongolia and can also be used to update the CRUST1.0 model for Mongolia's crust, contributing to global seismological efforts.

Baasanbat Tsagaan[1], Odonbaatar Chimed[1], Baatarchuluun Tsermaa[2], Ulambadrakh Khukuudei[2]

THANK YOU VERY MUCH FOR YOUR ATTENTION !