Density heterogeneity of the upper mantle beneath Siberia from satellite gravity and a new regional crustal model

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Density heterogeneity of the upper mantle beneath the Siberian craton

from satellite gravity and a new seismic crustal model (SibCrust)

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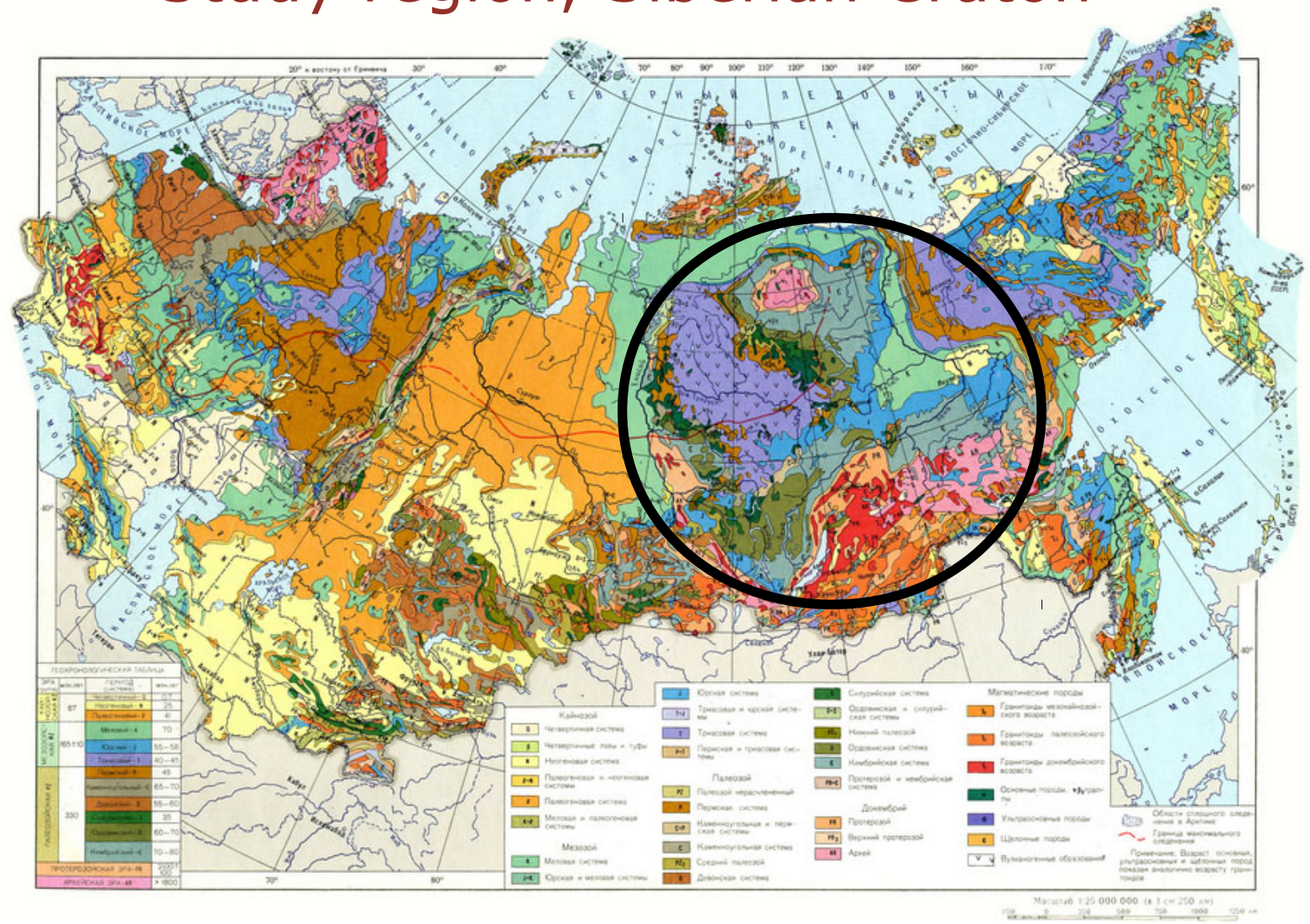
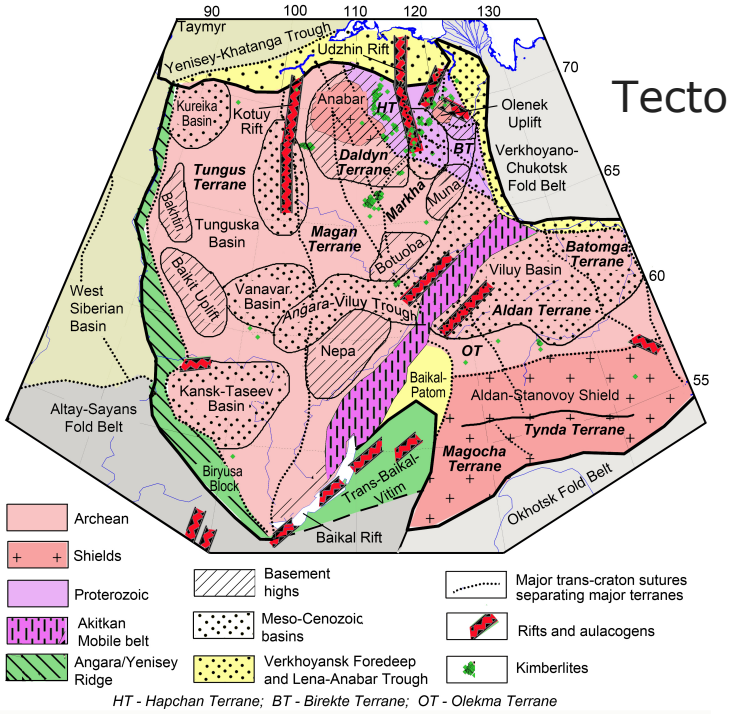
Study region, Siberian Craton



Motivation and objectives

- **How heterogeneous is the lithospheric mantle in Siberian craton?**
- **Are there density anomalies around kimberlites fields?**
- **Looking into the mantle density structure**



Tectonic map of the region

Herceg et al., paper in preparation, Lithos

Motivation and objectives

Goals:

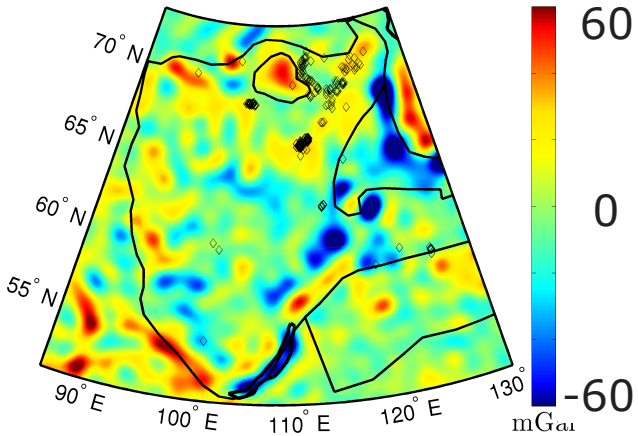
- Correlate density structure of the upper mantle below Siberia with surface tectonic structure
- by calculating residual mantle gravity and density anomalies after removing crustal effects

Take advantage of new datasets:

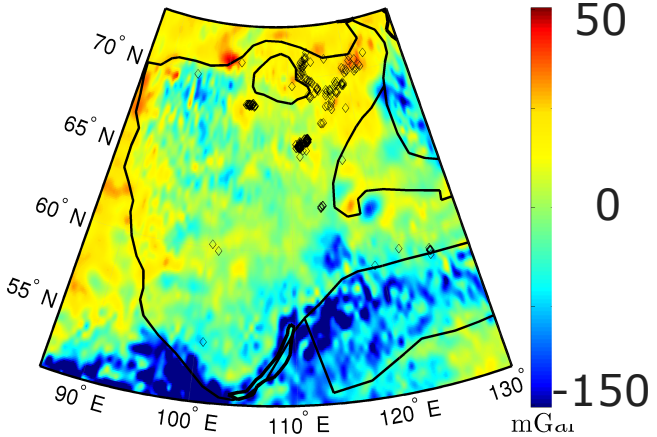
- crustal seismic structure database (SibCrust, Cherepanova et al., Tectonophysics, in press)
- satellite only, gravity data from GOCE satellite

Truncated gravity data from GOCE

- GOCE DIR release 3 geopotential model (Pail et al., 2011)
- Truncation of free air gravity anomaly (spherical harmonic degree 10)
  - to eliminate those components that presumably are of deep mantle origin



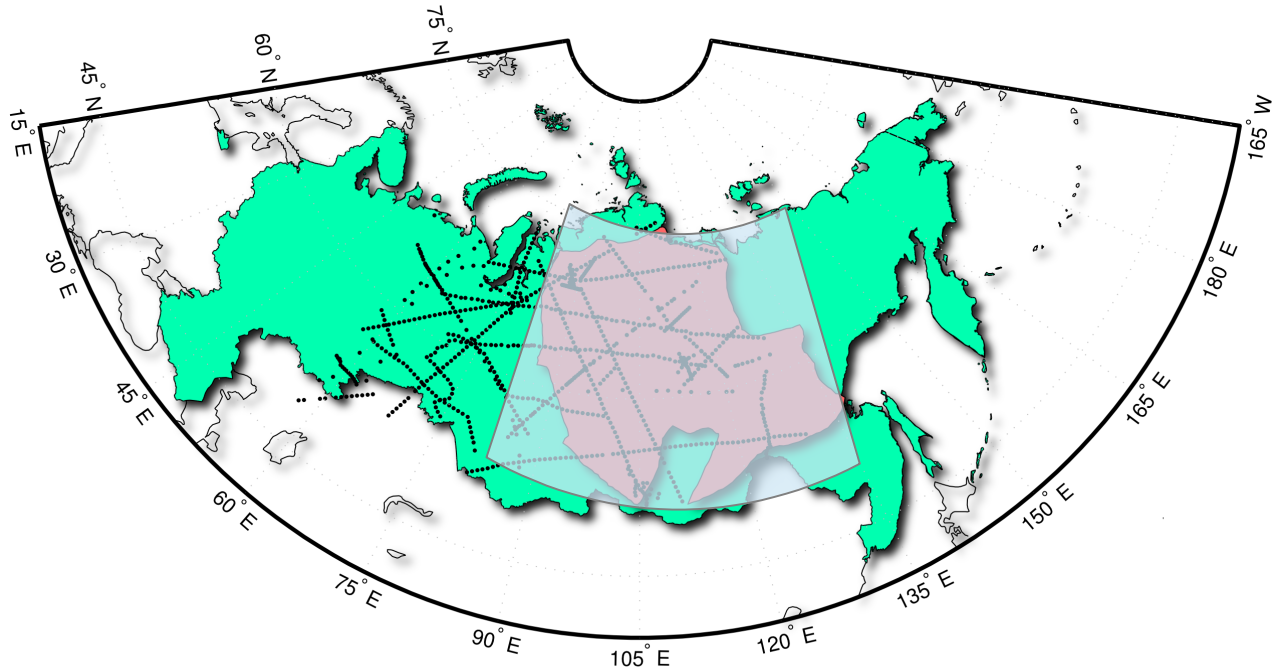
Free air gravity anomaly [mGal]



Bouguer gravity anomaly [mGal]

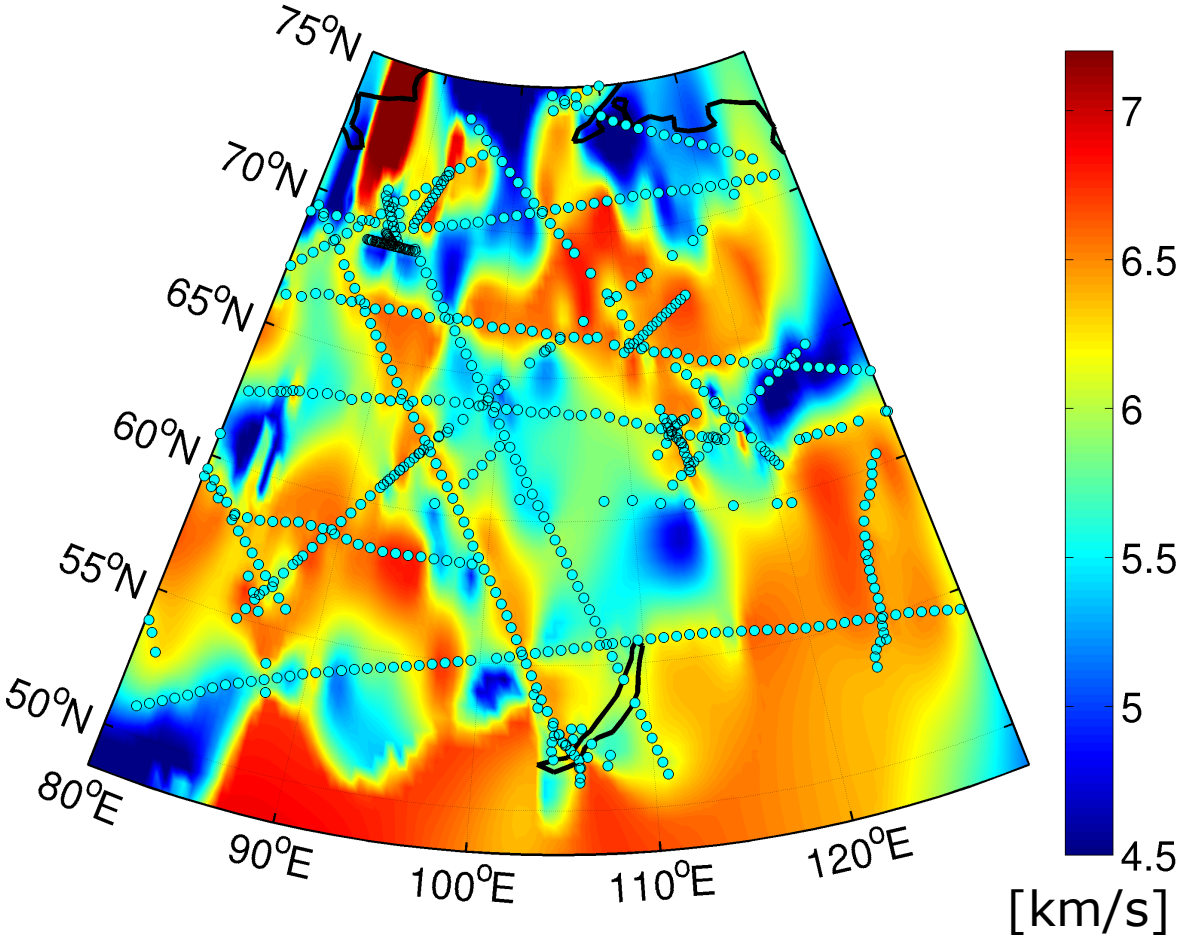
The SibCrust model

- regional crustal velocity model: West Siberian basin and the Siberian craton (50N-70N, 65E-132E).
- all published seismic profiles, digitized



Study region of Siberian craton with seismic profiles

The SibCrust model column averaged P velocity

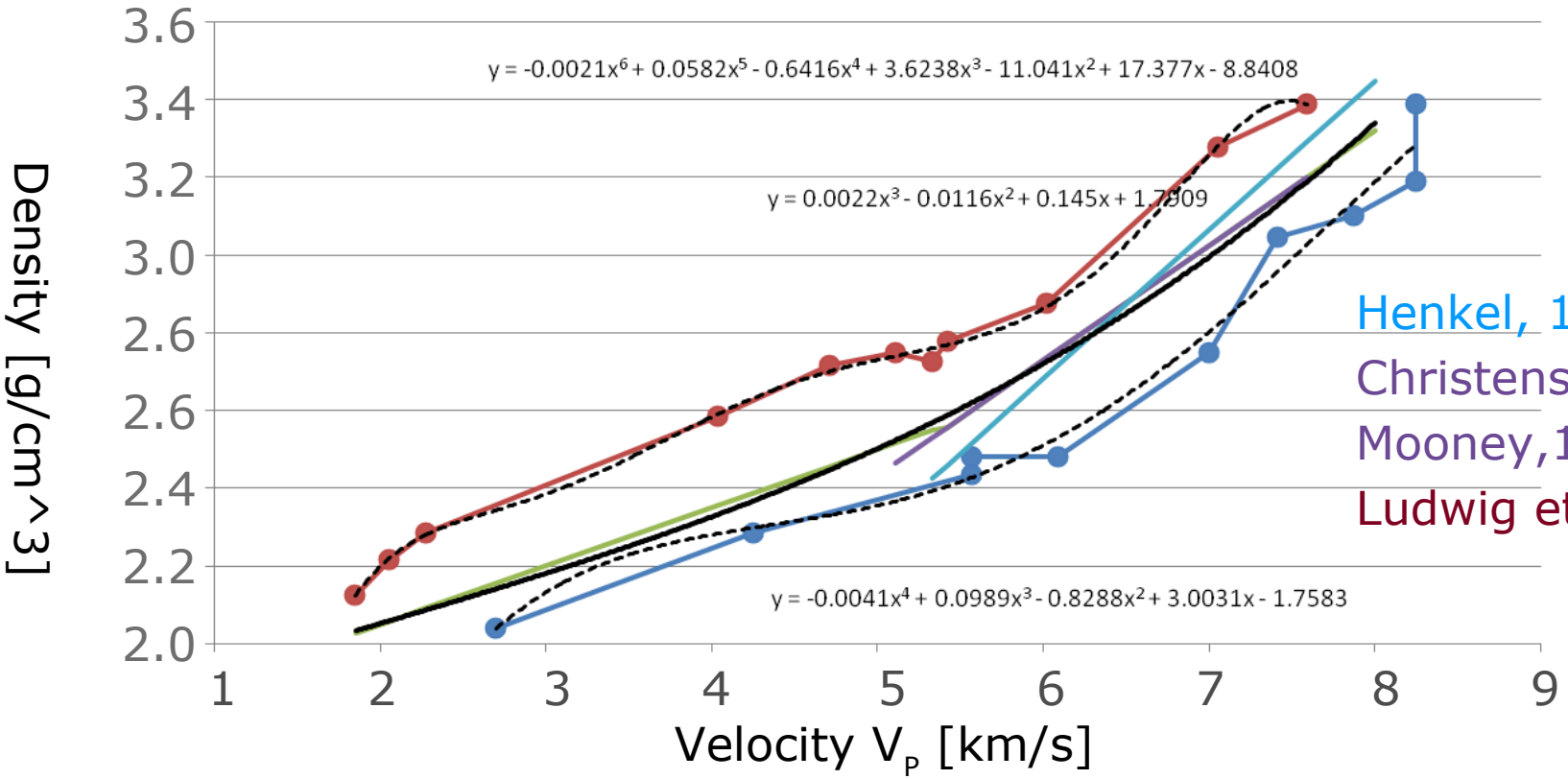


- 5 layers:
  - sediments,
  - upper crust,
  - middle crust,
  - lower crust,
  - lower-most crust.

Dots show the seismic profiles

Cherepanova et al., Tectonophysics, in press

Comparison of different conversion formulas from P-wave velocity to density

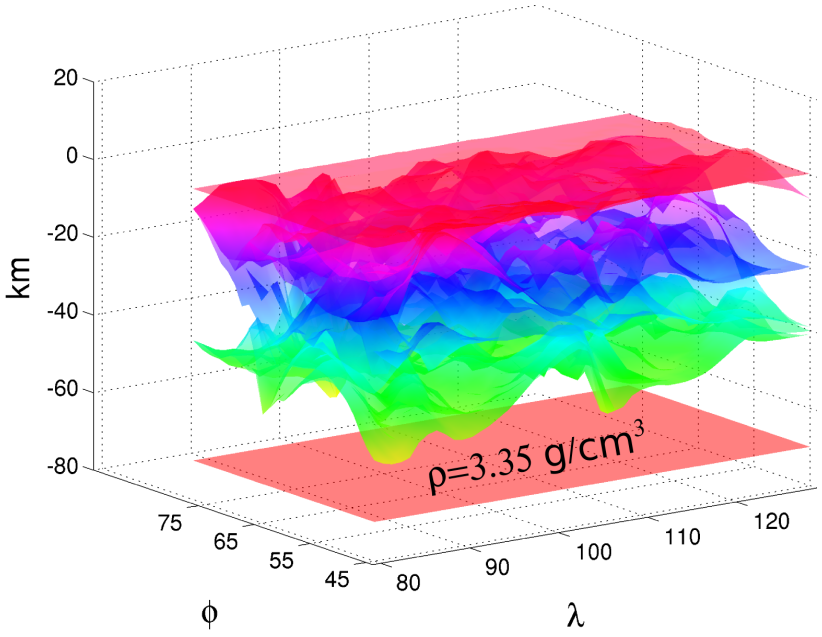


Henkel, 1990

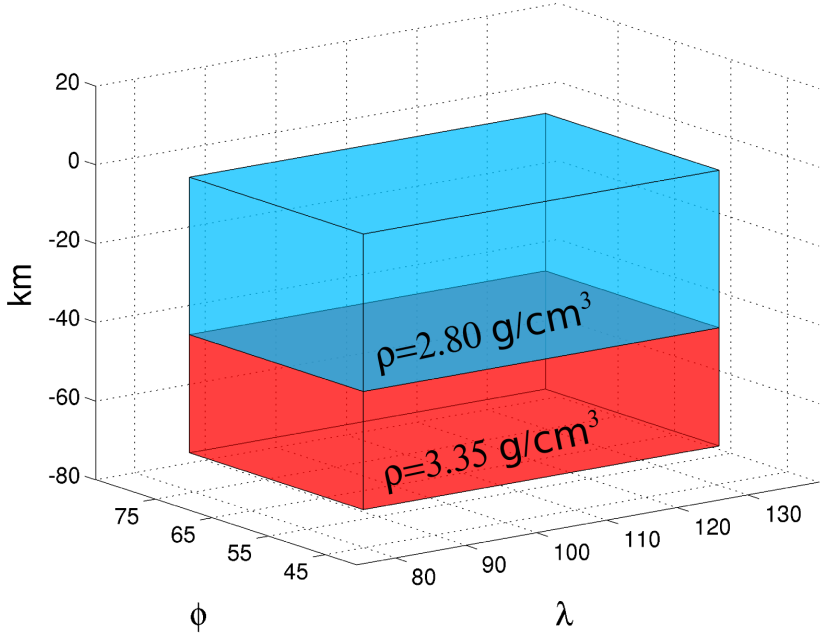
Christensen and Mooney,1995.

Ludwig et al. 1970

Crustal correction to gravity anomalies

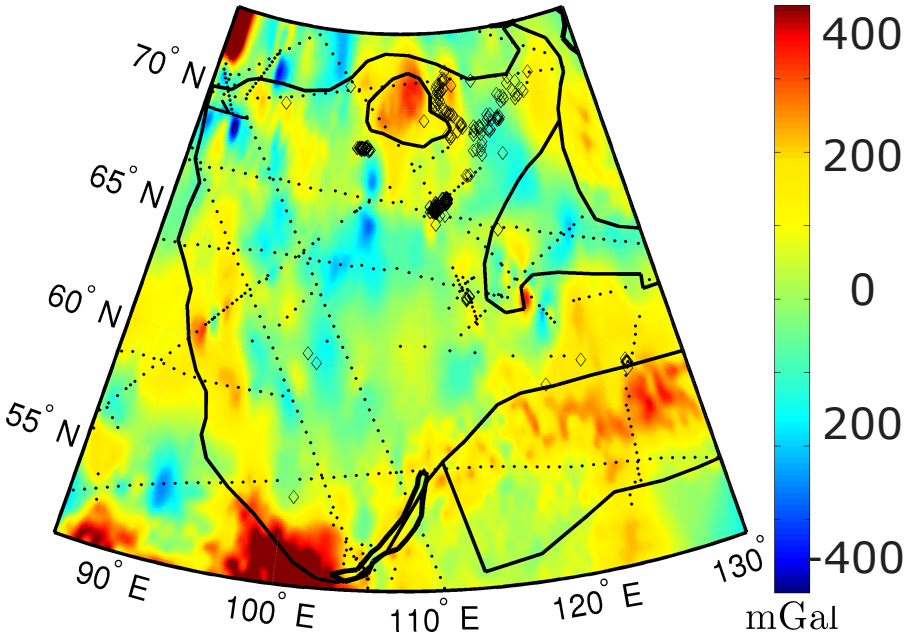


SibCrust model

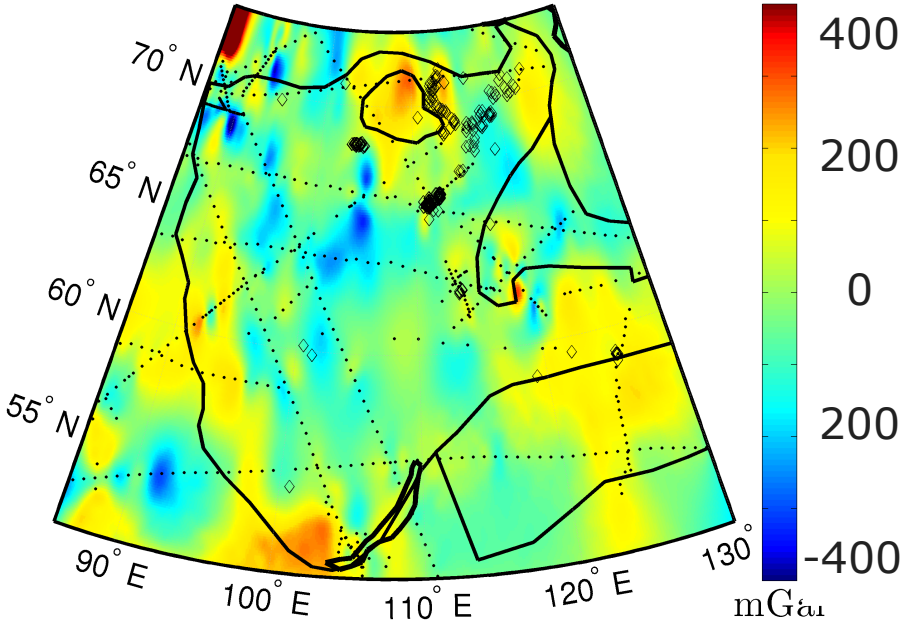


Reference density model

Crustal correction to gravity anomalies



Free air gravity correction [mGal]

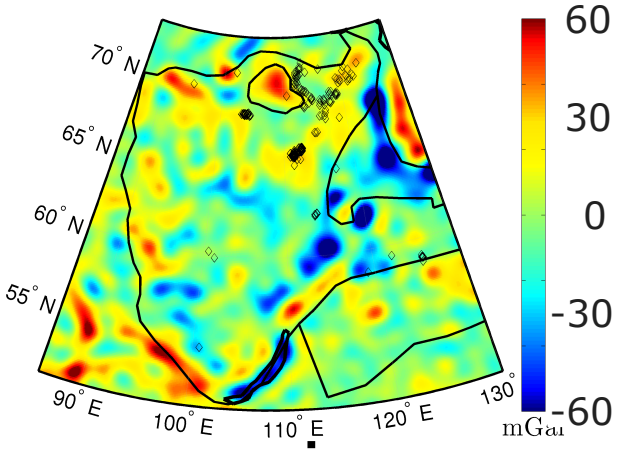


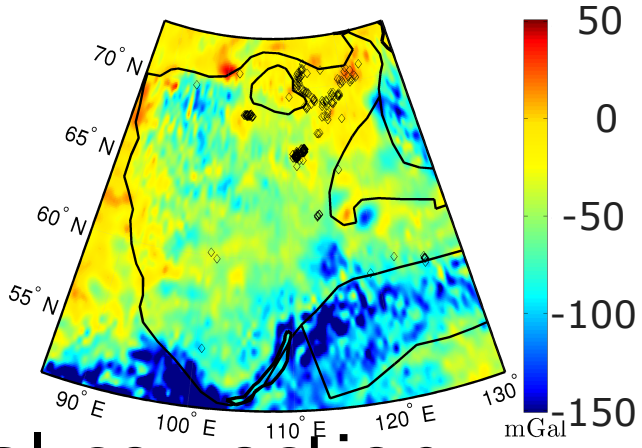
Bouguer gravity correction [mGal]

- Large anomalies in Anabar shield, and Tunguska basin
- **Crustal contribution to gravity is large and spatially heterogeneous**

GOCE gravity anomalies

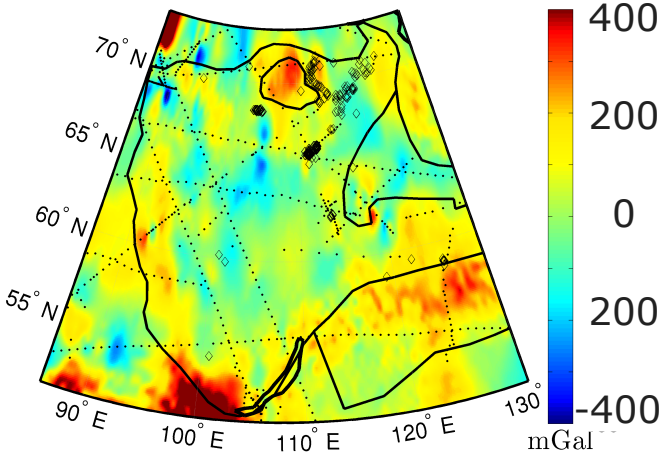
Free air

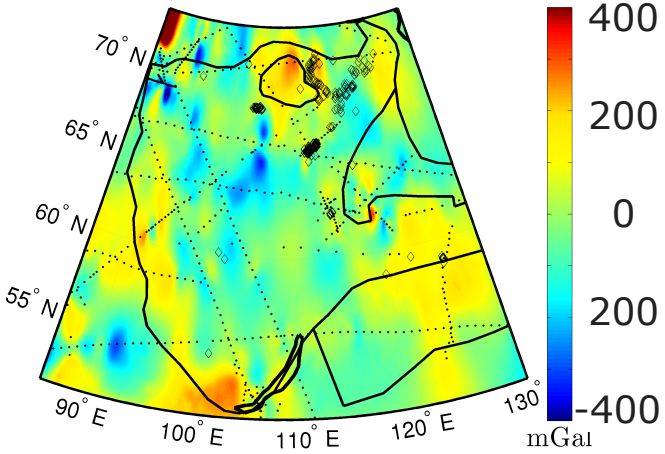




Bouguer

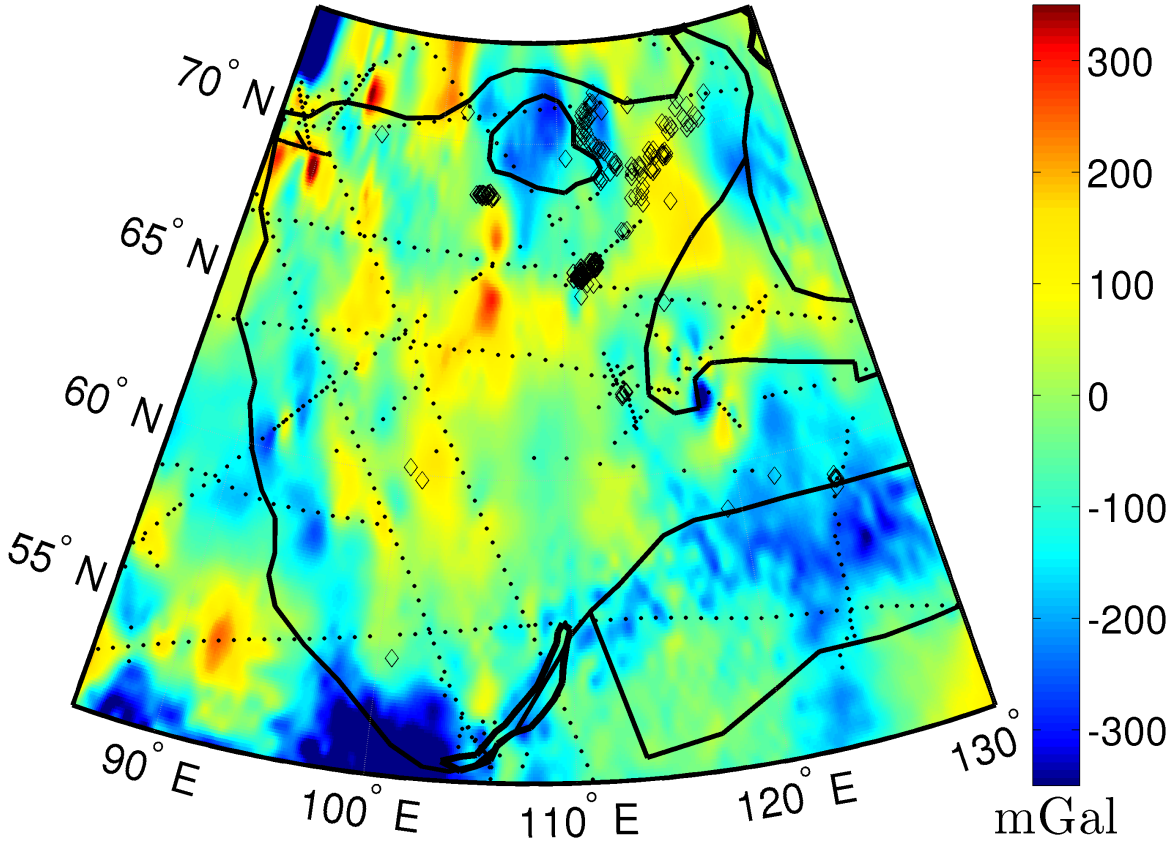
minus crustal correction





= Mantle residual gravity

Mantle residual gravity (GOCE gravity minus crustal correction)



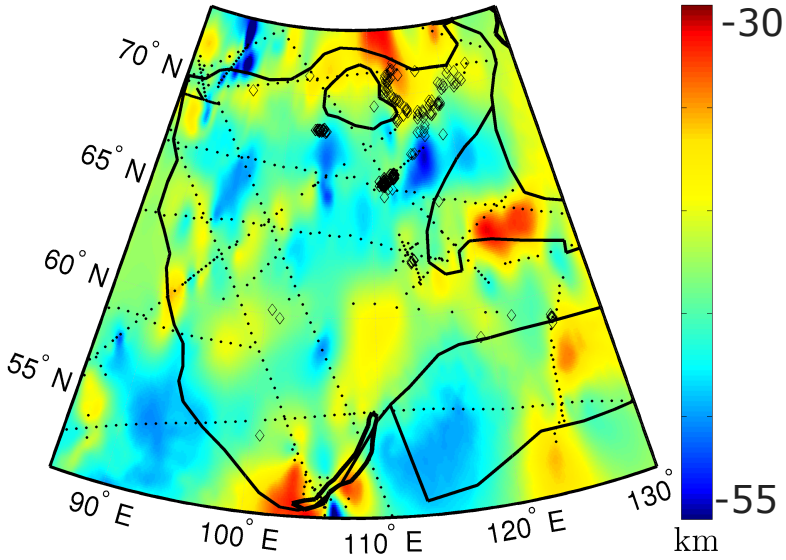
Dots are seismic profiles used in SibCrust

Symbols are kimberlites

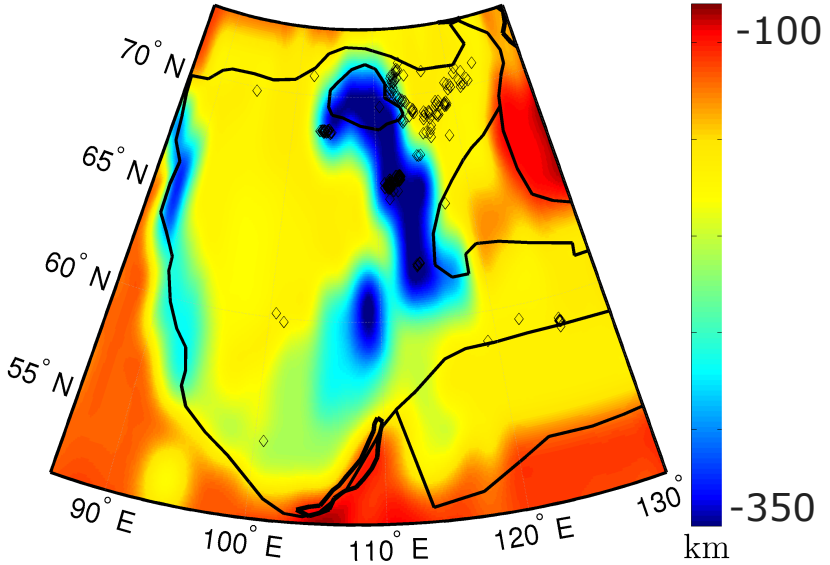
- Very significant heterogeneity

Conversion of gravity to density

Assumption - all density anomalies are in lithospheric mantle



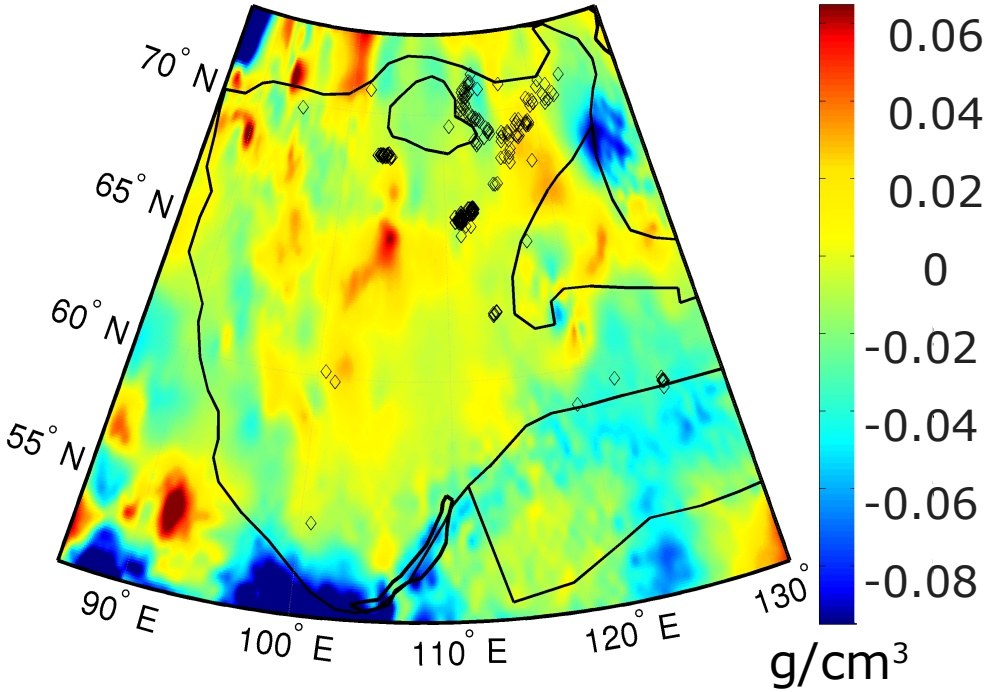
SibCrust Moho depth (Cherepanova et al., 2013.)

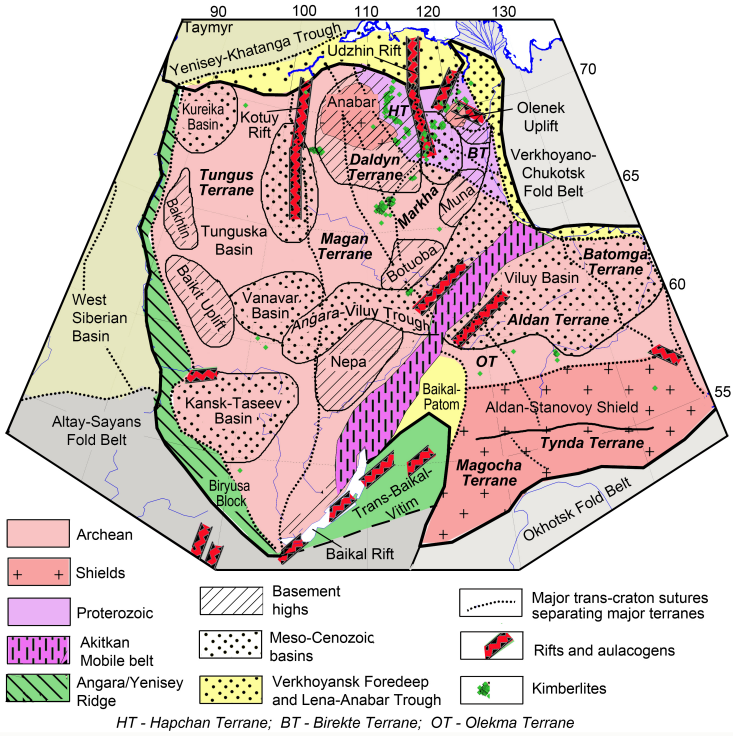


Lithospheric thickness from global thermal model, TC1 (Artemieva, 2006).

- debate about lithosphere thickness in Siberian Craton

Mantle density anomalies





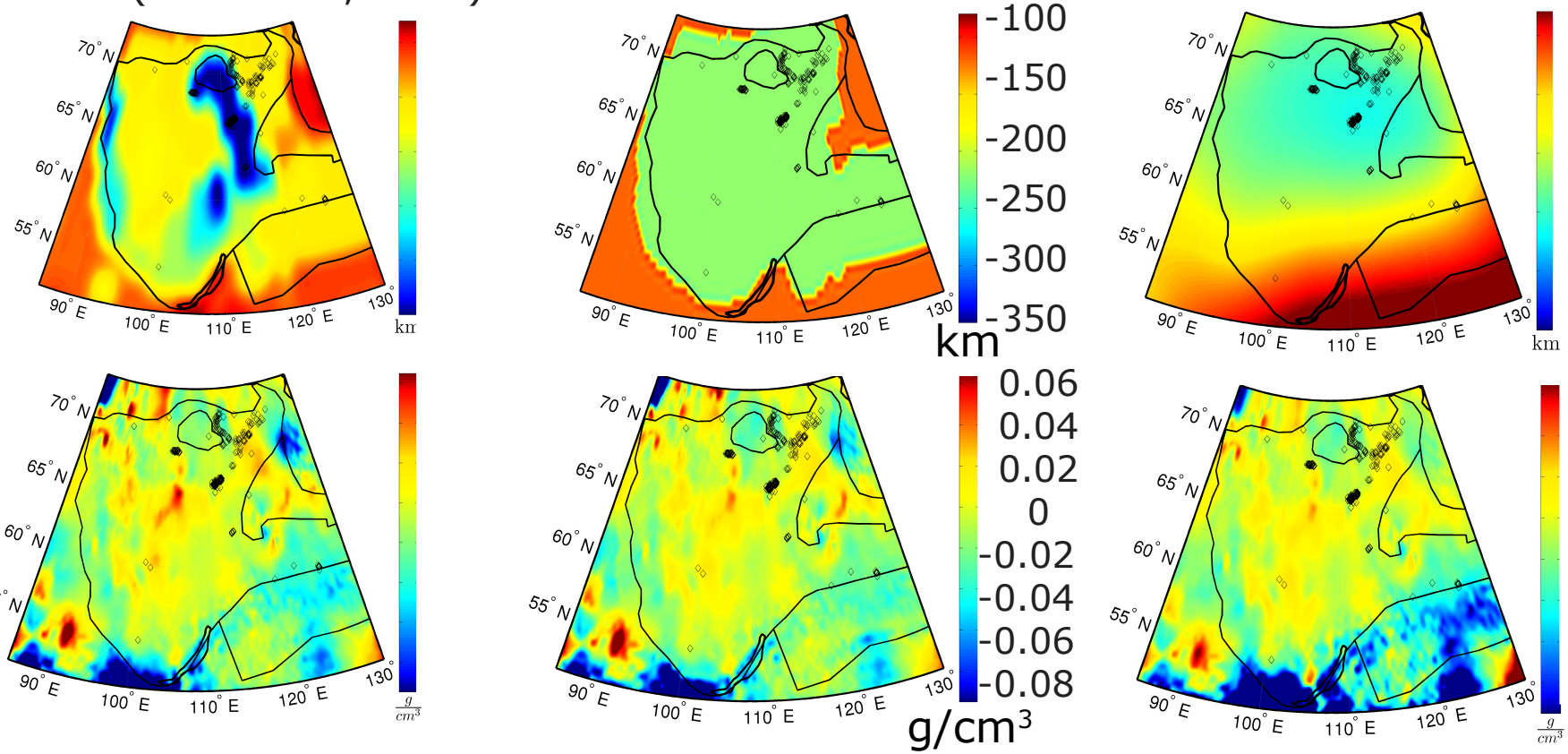
- Near zero density anomalies support an overall fit of the isopicnicity hypothesis
- Basins have positive anomalies
- Basements highs and Anabar shield have weak negative anomalies
- Kimberlites are around zero

Mantle density anomalies (bottom) for 3 models of lithosphere thickness (top)

Based on global thermal model (Artemieva, 2006).

LAB fixed at 220km for cratonic and 120km for non cratonic

Based on seismic tomography model (Shapiro and Ritzwoller, 2002)



- reflects temp and compositional variations

Conclusions

- Crustal correction to gravity is very important
- Near zero mantle density anomalies support an overall fit of the isopicnicity hypothesis
- Basins have positive mantle density anomalies
- Basement highs and Anabar shield have weak negative mantle density anomalies
- Kimberlites are around zero mantle density anomaly
- Work in progress:
  - Separate temperature and compositional density anomalies

Please see poster about SibCrust: Cherepanova et al., Poster B149 on Friday