

Density heterogeneity of the North American upper mantle from satellite gravity and a regional crustal model

Herceg, Matija; Artemieva, Irina; Thybo, Hans

Publication date: 2014

Document Version Peer reviewed version

Link back to DTU Orbit

Citation (APA):

Herceg, M. (Author), Artemieva, I. (Author), & Thybo, H. (Author). (2014). Density heterogeneity of the North American upper mantle from satellite gravity and a regional crustal model. Sound/Visual production (digital)

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

• Users may download and print one copy of any publication from the public portal for the purpose of private study or research.

- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

UNIVERSITY OF COPENHAGEN



Density heterogeneity of the North American upper mantle from satellite gravity and a regional crustal model

Matija Herceg, Irina Artemieva, Hans Thybo

IGN, University of Copenhagen, Denmark

European Geosciences Union, General Assembly 2014 | Vienna, Austria | 27 April - 02 May 2014

Motivation and objectives

- Motivation
 - Determine density of the mantle in North America
 - Uncertainties in the velocity density conversion
- Data
 - Crust 1.0 model
 - Gravity from GOCE satellite mission
- Method
 - Removing the effect of the deep mantle and crustal structure from gravity field
- Main uncertainties
 - Velocity density conversion
 - Crustal structure (thickness and Vp)



North America Moho (Crust 1.0)





Crustal correction to gravity anomalies

- Subtracting (stripping) gravity effect of the crust (including topography, 2.67 g/cm³) from free-air gravity anomaly
- Gravity anomaly is based on GOCE Direct release 3 global geopotential model



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



Crustal correction to gravity anomalies





Crustal correction to gravity anomalies



- Crustal contribution to gravity is large and spatially heterogeneous



04/22/14

Slide 7

Mantle residual gravity =



Residual mantle gravity for Crust 1.0 model





North American upper mantle surface wave tomography model



NA04, 150km (van der Lee and Frederiksen, 2005)



Residual mantle gravity comparison



Mooney and Kaban, 2010

Mantle gravity (Crust 1.0)



Defining lithospheric mantle



Mantle density anomaly

(Assumption - all density anomalies are in lithospheric mantle)

Residual mantle gravity $5^{5^{\circ}}_{0^{\circ}}_{4^{\circ}}_{$

Mantle density anomaly





Free bord (mass balance) method

- Assuming astenosphere density (3.34 g/cm³)
- Crustal contribution to the surface topography

– Bc=Hc*(RhoA-AvgRhoC)/RhoA;

- Height of the sea level above the asthenosphere estimated at mid ocean ridge, D = 4.25km
- Lithospheric mantle contribution to the surface topography
 - Bm=Topo-Bc+D
- Thickness of lithospheric mantle (LAB)
- Lithospheric mantle



Mantle density anomaly





Mantle density anomaly comparison



Correlation coefficient between calculated mantle density and crustal and LAB structure



- Correlation coefficients are calculated for the final Mantle density anomaly grids, produced by two different methods
 - Gravity modelling (layer stripping)
 - Free-board (mass balance)

Conclusions

- Uncertainty in sediment thickness of 1km corresponds to an uncertainty of 0.05 g/cm³ in average crustal density
- Uncertainty in sediment Vp velocity corresponds to the uncertainty of 0.01 g/cm³ in average crustal density
- Moho thickness has strongest impact on both methods
 - Free-board (mass balance), 67%
 - Gravity method (Layer stripping), 94%
- Upper (86%) and middle crust (89%) thickness grids have also significant correlation with mantle density grid

