TU Delft **AE4893 (2023) – PHYSICS OF PLANETARY INTERIORS**

Assignment 3 – Lithosphere model of a rocky planet

Responsible instructor
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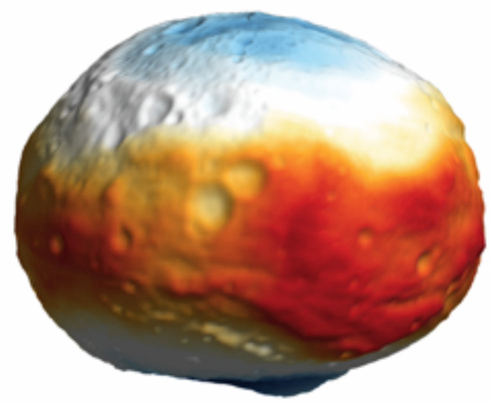

Group Size: **1** Student (individual report)
Due: 18:00h, Friday 30th of June, 2023
Estimated time: 25 hours
Page limit: 8 pages

General introduction/background

The surface of a planetary body captures the tectonic evolution and the current state. To understand the creation of surface features will give you information about the interior. For this assignment you have to choose one of the following planetary bodies: Mercury, Venus, Earth, the Moon, Mars, Ceres, or Vesta.

At the end of this assignment, you will be able to develop a model of the lithosphere of your chosen body, by using topography and gravity data. You will be able to map crustal density structures from gravity inversion and assess the validity of your model with respect to literature.

Assignment description

You are building different models for the crust/lithosphere of your planet from simple to complex and assess their validity.

A *Code you can use:*

- Matlab GSH Tools
- Python SHtools jupyter notebook

B *Literature to be found:* Find at least 2 different scientific papers describing the lithosphere structure of your chosen body. The models should include the crustal thickness, density value and (elastic) lithosphere thickness.

C *Input to be used:*

Topography, Mass, gravity, crustal density.

Deliverable

Your report should contain (answers to) the following:

1) Collect 2-3 models of your chosen planetary body from literature to validate your model with. Describe and reference them in your report. **Hypothesis/Validation**

2) Collect and add the data from the planetary data sheet for this assignment described in section C. Make maps of the topography and gravity data and construct a Bouguer gravity map. Use different colormaps for topography, gravity, and residual maps. **Physical model**

Bouguer inversion model of the crust

3) Perform a Bouguer inversion to determine the crustal deviations. Choose an appropriate reference crustal thickness (D) based on literature. How does crustal density value effect the models. **Numerical model**

Airy model of the crust

4) Make Airy model for the crust. Use same reference crustal thickness (D) from step 3. **Model Setup**

Flexure model of the crust

5) Construct a code to compute flexure model: Perform spectrum analysis of the Airy crust to SH domain and multiply with flexural responds function (infinite plate). Choose an appropriate elastic lithosphere thickness (Te) based on literature.
Physical model/Numerical model

Gravity data insertion

6) Use the crustal models from previous steps and calculate gravity responds. This will be done with the GSH code from Root et al. (2021) Analyze and plot the degree variance responds of those signals with the gravity observations. Discuss this plot. Compare all three basic models with literature and each other? Discuss similarities and differences. **Analysis**

Lateral density variations

7) Use the flexural model code and try to find the optimal Te value by fitting the degree variance (PROTip: only use the spectral domain that is sensitive to the lithosphere flexure). Create the optimal fitting crustal model **Production Run/Validation**

8) Use residual gravity data from the best fitting model for inverting for lateral density variations in crust. Interpretation of the crustal density map with geologic map, discuss similarities and differences. **Analysis/Communication**

Prerequisites for Report to be assigned a grade.
Please check if report includes:

- your name
- study number
- write how many hours you approximately spent on the assignment.
- Use proper referencing of literature (not included in page limit)
- Colormaps should be unbiased
- Code is attached to the report (not included in page limit)
- Check that your report stays within the page limit (6 pages)