TU Delft **AE4893 (2025) – PHYSICS OF PLANETARY INTERIORS**

Assignment 3 – Lithosphere model of a rocky planet

Responsible instructor
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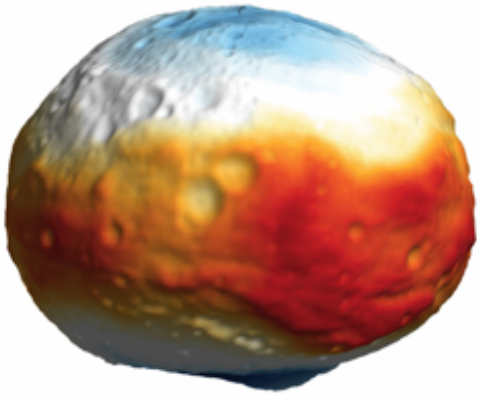

Group Size: **2** Students (one report)
Due: 09:00h, Friday 13th of June, 2025
Estimated time: 40 hours
Page limit: 8 pages

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 crust/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 three different crust/lithosphere models (M1, M2, M3), from simple to complex and assess their validity with respect to the observed values of the chosen planetary body.

A *Code you can use:*

- Matlab GSH Tools

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 crustal models of your chosen planetary body from literature to validate your results with. Describe and reference them in your report. **Hypothesis/Validation**

2) Import the topographic and gravity data from the PDS database. Make maps of the topography and gravity data and construct a Bouguer gravity map. Use different colormaps for topography, gravity, and residual maps. Check these models with literature. **Physical model/Verification**

M1: 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. Discuss how you found the optimal value for (D) **Numerical model**

M2: Airy model of the crust
4) Use Airy isostasy to model the variation on the crust-mantle interface. Use same reference crustal thickness (D) from step 3. **Model Setup**

M3: 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

Compare with gravity data
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/ Production run**

Improve your model
7) Use the flexural model code and try to find the optimal Te value by fitting the degree variance of your model with that of the observed gravity field (PROTip: only use the spectral domain that is sensitive to the lithosphere flexure). Discuss the optimal fitting crustal model and compare with literature. What does it tell of the tectonic state of your chosen planet? **Validation 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
- Send your code as a zip file or single python/matlab file.
- Check that your report stays within the page limit