Regional-residual separation: an essential first step for building and validating 3D maps using gravity data

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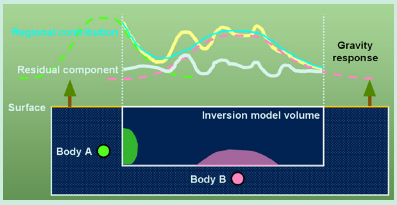
The nature of the problem

"Often, one of the most troublesome parts of the interpretation process is finding a way to isolate anomaly patterns of the kind one is looking for from the remainder of the field"

F.S. Grant

Even though, I may only be interested in the mass distribution of rocks in the upper 10 km of the crust, measured gravity data includes the response of deep sources such as variations in the depth of the Moho. How do I isolate the response from sources within my volume of interest? Many different approaches have been used to solve this classic regional-residual problem.

Without a valid procedure, I cannot expect my forward or inverse models of potential field data to reflect the contents of my volume of interest (e.g., upper 10 km of the crust), and I therefore cannot expect to produce a reliable 3D map!



(modified from Williams et al., 2004)

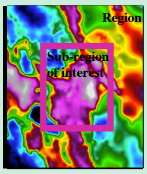
On the left, the total gravity field (yellow curve) includes contributions from bodies A and B (green and pink curves respectively) which are outside our volume of interest.

Regional (blue curve) and residual (white curve) separation permits investigation of bodies within the inversion model volume only. For **valid** forward and inverse modelling of upper crustal geometries, the white curve needs to be derived through a regional removal process. This "residual" data becomes the "observed" data for this critical component in the 3D map work flow.

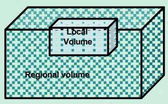
A model-based solution for gravity modeling (modified from Li and Oldenburg, 1998)

STEP 1: Obtain grided gravity data for a region much larger than the region of interest.

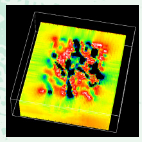
STEP 2: Configure a prismatic model volume whose aerial extent is larger than the region of interest and which has a depth extent greater than the depth of the region of interest.



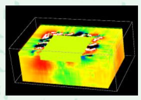
STEP 3: To avoid aliasing, upward continue the data to a level equal to the grid cell size of the regional model mesh, remove a first-order trend and then decimate the grid to leave a cell size equal to the horizontal cell size of the model mesh.



STEP 4: Invert the regional volume using UBC-GIF software.

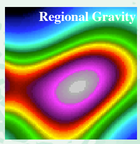


STEP 5: Set the density contrast within the region of interest to zero.

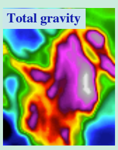


STEP 6: Compute gravity response of the modified inversion volume using UBC "forward solver", to provide the **REGIONAL** gravity data.

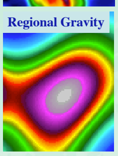
STEP 7: Subtract the regional response from the measured data to produce the residual data.



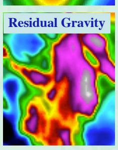
A test of the approach



Profile of the total field



Profile of the regional field



Profile of the residual field

The total measured gravity field has been **successfully** separated into a **regional** component and a **residual** component.

Concluding statement

The residual dataset above is the <u>starting</u> point for testing my upper crustal geometry. If the regional-residual separation is done poorly, my 3D map will always be wrong! Therefore, I must ensure that a valid procedure is employed

References

Li, Y., and Oldenburg, D. W., 1998, Separation of regional and residual magnetic field data: Geophysics, **63**, 431-439.

Williams, N., Lane, R., and Lyons, P., Mapping through cover: 3D inversion of gravity magnetic data: Geoscience Australia Seminar, 26 May, 2004.

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