A - 139 Numerical analysis of gravity and magnetic fields prior to structural modelling

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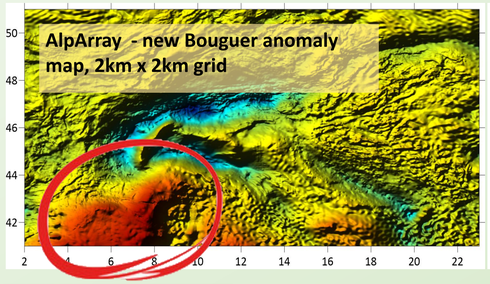
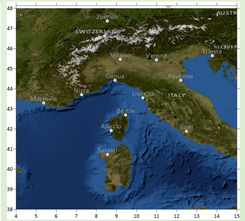
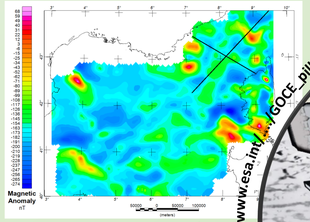
Mountain Building Processes in 4D

Abstract

The work presented here is part of ongoing studies in the AlpArray initiative and the priority program "MB-4D" regarding the modelling of the lithosphere in the Ligurian Sea (northwestern Mediterranean Sea). It will be based on constraining data from LOBSTER and LISA campaigns of past GEOMAR projects and a study in our research group at CAU Kiel. Our motivation is the combination and interdisciplinary interpretation of independent information from geology, tectonics, geophysics, and petrology. The existing gravity fields, especially the new compilation of the AlpArray Gravity Research Group (AAGRG) is considered as database (high resolution Free Air- and Bouguer anomalies) and the isostatic residual field, besides data of the ICGEM Potsdam (disturbance) and the ESA GOCE gradients for gravity and data for the magnetic field anomaly. The gravity and magnetic fields are analyzed using Euler deconvolution with regularization (R. Pašteka, Comenius University Bratislava) and application of curvature analysis we use both, the fields themselves and their gradients. Besides the calculation of the so-called "3rd derivative" of the gravity potential, we also investigate a possible use of the invariants of the gravity field based on gradient data and compare and correlate the results with structural and tectonic maps in the area of the Ligurian Sea and the adjacent French and Italian mainland. The findings from these comparisons will later be used to initiate the compilation of 3D density and susceptibility models for the studied region.

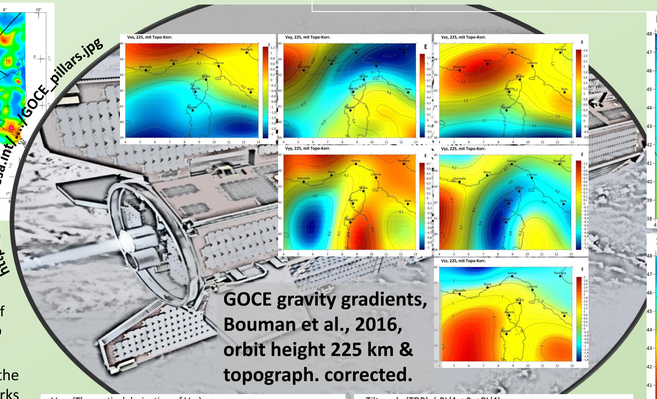


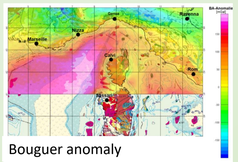


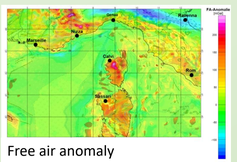


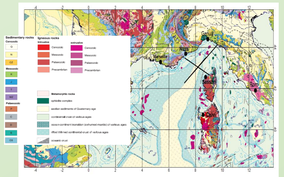
←The new pan-alpine Bouguer gravity map of the AlpArray Gravity Group, to be finished just now; above the studied area.

The magnetic map (Rathjens, 2020) processed by IGRF data of 1966 in the CAU research group



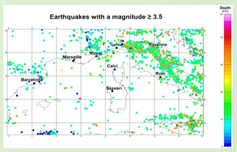


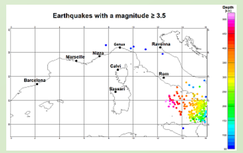




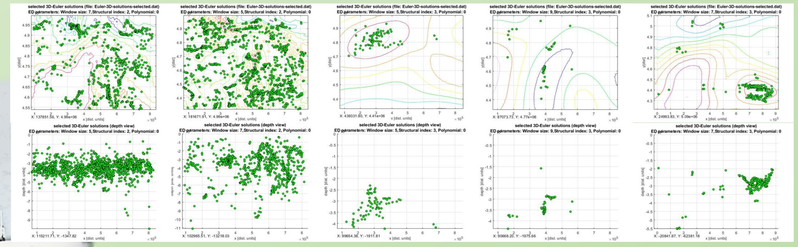
↑ To the left, this map has been superimposed on the Bouguer and Free Air anomaly. The black cross marks the seismic lines of the Lobster campaign of GEOMAR.

The "third derivative" (of the gravity potential) marks domains of different density and geometry in the subsurface. There have been attempts to use Vzzz to mark the boundary between continental and oceanic crust. →

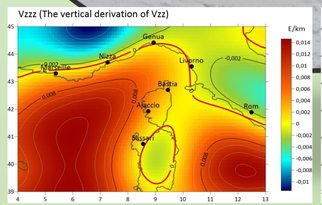


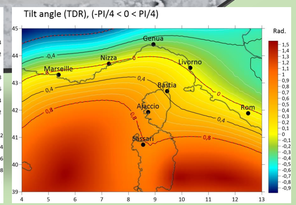


↑ Earthquakes: Both shallow earthquakes (focal depth of < 50 km, left) deeper earth- quakes (focal depth of > 50 km, right) play only a minor role in the Ligurian Sea.

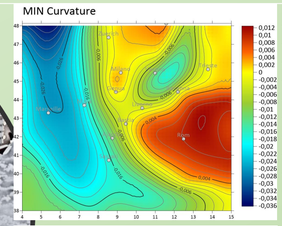


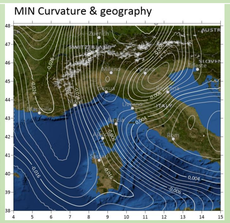
↑The best solutions of 3D Euler deconvolution (ED): top row visualizes a map view of Free Air anomaly (FA), Bouguer anomaly (BA) and three GOCE gravity gradients Vxz, Vyz and Vzz (from left to right: different structural indices and window sizes). Distance units in UTM x 10^5 . Bottom row: depth views scaled in 10^4 m. For FA the ED results in depths between 20 to 50 km. ED of BA indicates structures that are highly variable in depth and correspond to the Alps and the Apennines and Corse. In the Ligurian Sea, only one structure can be identified west of Sardinia. The ED of the three gradients point to structures in different areas and depths from 200 km downwards.

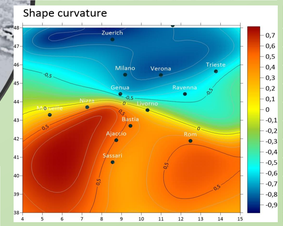


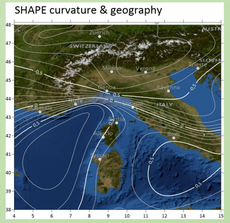


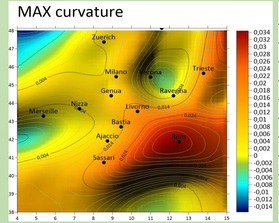
↑ In the "numerical gimmick" the zero isoline of the tilt angle (red) marks the boundary of dominant masses in the lithosphere.

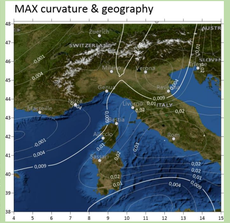






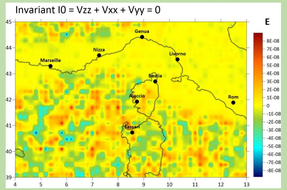


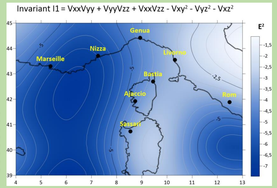


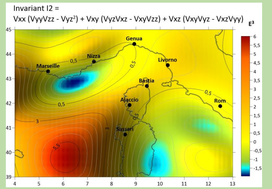


Different types of curvatures of the gravity field allow conclusions to be drawn on the structural units in the crust and mantle. ↑

The invariants I1 and I2 of the gravity field give evidence for structural units in the lithosphere. Especially I1 shows a clear relationship between the Corsica-Sardinia area and the Italian mainland. I0 confirms the correctness of the assumption that the trace of the Eötvös tensor must result in zero. ↓







References, contacts and acknowledgement

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- Pašteka, R., Karcol ,R., Pasiakova, M., Panisova, J., Kušnirak, D. and Beres, J (2011) Depth Estimation of Microgravity Anomalies Sources by Means of Regularized Downward Continuation and Euler Deconvolution, 73rd EAGE Conference and Exhibition May 2011, published by: European Association of Geoscientists & Engineers, DOI: https://doi.org/10.3997/2214-4609.20149399.
- Rathjens, K. 2020: Interpretation of magnetic anomalies in the Ligurian Sea, BSc. thesis Christian-Albrechts-University Kiel.
- Wolf, F. N., Lange, D., Kopp, H., Dannowski, A., Grevemeyer, I., Crawford, W., Thorwart, M. and Paul, A. and AlpArray Working Group (2020) Crust and upper mantle structure of the Ligurian Sea revealed by ambient noise tomography and receiver function analysis. [Invited talk], GeoUtrecht 2020, Online.

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Additional data sources and software used:

Geology:
https://services.bgr.de/geologie/Igme5000

Seismology:
https://earthquake.usgs.gov/earthquakes/map

Gravity:
Bouguer anomaly, AAGRG
Geoid (EIGEN 6C4 & XGM),
Free Air/disturbance: ICGEM
http://icgem.gfz-potsdam.de/home

Magnetic:
Rathjens and Centre National de la Recherche Scientifique (CNTS)

Bathymetry:
Emodnet,
https://www.emodnet-bathymetry.eu/

Coastline:
https://www.naturalearthdata.com/downloads/10m-physical-vectors/10m-coastline/
NOAA,
https://www.ngdc.noaa.gov/mgg/shorelines/

Software:

- Curvature by Sabine Schmidt, CAU
- Euler Decon. Regder2_0v5 by
- R. Pašteka and D. Kušnirak (Matlab R2019b)
- Geosoft Oasis montaj Version 9.7.1
- 20191211.18 Geosoft Inc.
- QGis 3.16.0-Hannover
- SURFER, vers. 19, Golden Software