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Swiss Journal of Geosciences

REPORT

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Report on an open dataset to constrain the Balmuccia peridotite body (Ivrea-Verbano Zone, Italy) through a participative gravity-modelling challenge

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Abstract

The Balmuccia peridotite exposes relatively fresh mantle rocks at the Earth's surface, and as such it is of interest for geologists and geophysicists. The outcrop is a kilometre-scale feature, yet its extent at depth is insufficiently imaged. Our aim is to provide new constraints on the shape of the density anomaly this body represents, through 3D gravity modelling. In an effort to avoid personal or methodology bias, we hereby launch an invitation and call for participative modelling. We openly provide all the necessary input data: pre-processed gravity data, geological map, in situ rock densities, and digital elevation model. The expected inversion results will be compared and jointly analysed with all participants. This approach should allow us to conclude on the shape of the Balmuccia peridotite body and the associated uncertainty. This crowd effort will contribute to the site surveys preparing a scientific borehole in the area in frame of project DIVE.

Keywords Gravimetry, Gravity anomaly, Modelling, Open science, Alps, Balmuccia peridotite

1 Rationale

Modelling of geophysical data is often subject to choices made by the researcher(s) undertaking the work. The level of structural complexity in the model, the bounds on parameters imposed by a priori knowledge, the thoroughness and efficiency in exploring the parameter space may all lead to bias in determining what the best fitting models can be.

To avoid personal or any other bias related to prior information and methodology in constraining the subsurface shape of a given density anomaly, we hereby invite anyone interested to create their own model(s) on a targeted case study: the Balmuccia peridotite body (45.84°N, 8.16°E) in the Ivrea-Verbano Zone (IVZ), Western Alps, Italy. Here the least serpentinized mantle rocks are naturally exposed at the surface, in the broader context of the IVZ, a middle- to lower crustal terrain along the Eurasia-Adria plate boundary's eastern side. The surface exposure of the Balmuccia peridotite is ca. 4.4 km N–S by ca. 0.6 km E–W, with outcrop elevation changes exceeding 1000 m.

We here provide the same starting conditions to all participants in this crowd-modelling effort. Practically,

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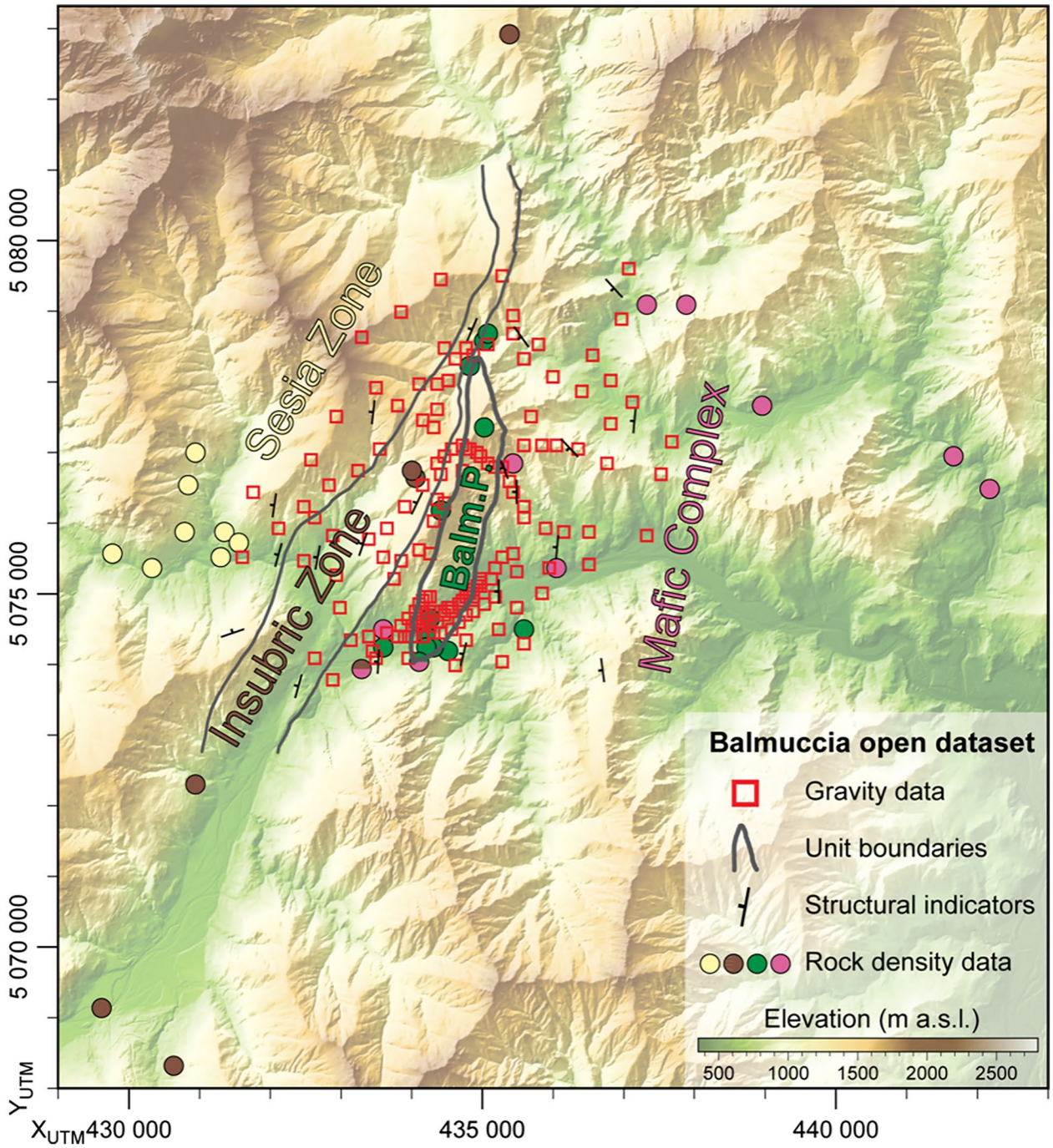

Fig. 1 Overview of the openly shared datasets. Topographic map, based on the "RIPRESA AEREA ICE 2009–2011 - DTM 5" digital elevation model of the Piemonte Region geoportal (https://www.geoportale.piemonte.it/geonetwork/srv/ita/catalog.search#/metadata/r_piemon:224de2ac-023e-441c-9ae0-ea493b217a8e, last download 02.11.2023). Gravity data: 151 new points acquired and pre-processed for this study. Geological-lithological boundaries of four main units: from literature compilation. Structural indicators (20): from literature compilation and own observations. Rock density data: from literature compilation (30) and newly taken samples subsequently measured in the laboratory (11), coloured according to the respective lithologies. All references are cited and listed in the detailed description

all the necessary input data have been measured, pre-processed, and are shared in this work:

1) gravity data measured in the field at 151 new points;
2) the local geological map, including four units and structural indicators;
3) in situ rock density values for each of the four units;
4) the local digital elevation model (DEM).

These datasets are shown in Fig. 1. Both the full dataset, as well as the detailed data and pre-processing description are openly available for download from https://zenodo.org/records/10390437.

Each participating researcher or group is now able to download the data freely, and will subsequently be expected to submit their solution(s). The resulting collection of models will be compared during a dedicated workshop, based on which a joint publication can be envisaged. The proposed timeline and framework are also in the detailed description file.

Beyond the modelling challenge, the interest in constraining the subsurface shape of the Balmuccia peridotite body is that it is a future target of the Phase 2 of the DIVE continental drilling project (Drilling the Ivrea-Verbano zonE; www.dive2ivrea.org and https://www.icdp-online.org/projects/by-continent/europe/dive-italy/). Therefore, the expected results will be of practical use in planning the drilling site and geometry, and in case of drilling the model(s) can be compared with real data at depth.

As much as possible we intend to keep the format of this modelling challenge flexible, and remain open to suggestions. At the same time, we expect the model results to be in a comparable format, such that the timeline also remains reasonable.

Author contributions

GH has drafted the manuscript and all authors have read and approved the final version of this short report. The detailed contributions to the data can be found in the detailed description.

Published online: 29 January 2024