

Geo-INQUIRE installation: Eastern Sicily - Pool Instruments (TA3-83-1)

Project title: Gravimetric 3D structural model of Etna summit

TA principal investigator: Peter Vajda (Earth Science Institute, Slovak Academy of Sciences, Slovakia)

Project acronym: ETNAGRAV

Project report ID: C1_TA3-83-1_1

Transnational access (TA) team:

Pavol Zahorec (Earth Science Institute, SAS, Bratislava, Slovakia)

field work (gravimetric survey, gravity measurements), CBA data compilation

Jaroslava Pánisová (Earth Science Institute, SAS, Slovakia)

forward modelling CBA data with IGMAS+ software tool

Juraj Papčo (Slovak University of Technology, Bratislava, Slovakia)

field work (gravimetric survey, GNSS positioning), DEM processing for topographic correction

approved replacement for field work for Jaroslava Pánisová

Date of visit: 11–15 July, 2024

Geo-INQUIRE Virtual Access: Data/Products: <https://zenodo.org/records/15039921>

Project report:

The team (PI, Pavol Zahorec, Juraj Papčo) conducted a 5-day gravimetric survey, with cooperation of the INGV-OE team lead by Filippo Greco, in the SE sector of the summit area of Mt. Etna. The measurements were carried out in difficult conditions due to intense eruptive activity of Etna during the survey. On day 3 the crew had to escape from the observed gravimetric traverse from the area of Torre del Filosofo to the Piano delle Concazze (towards PDN) straight down into the Valle del Bove due to an issued alert. On day 4 the crew was completing the traverse when an ash cloud eruption came out from the NEC. Considering the conditions and the character of the surveyed area (fall-out products, broken-surface cooled lava flows), the survey (number of observed gravity points) can be considered successful. The points observed are shown (day by day) in [figure 1 \(left\)](#).

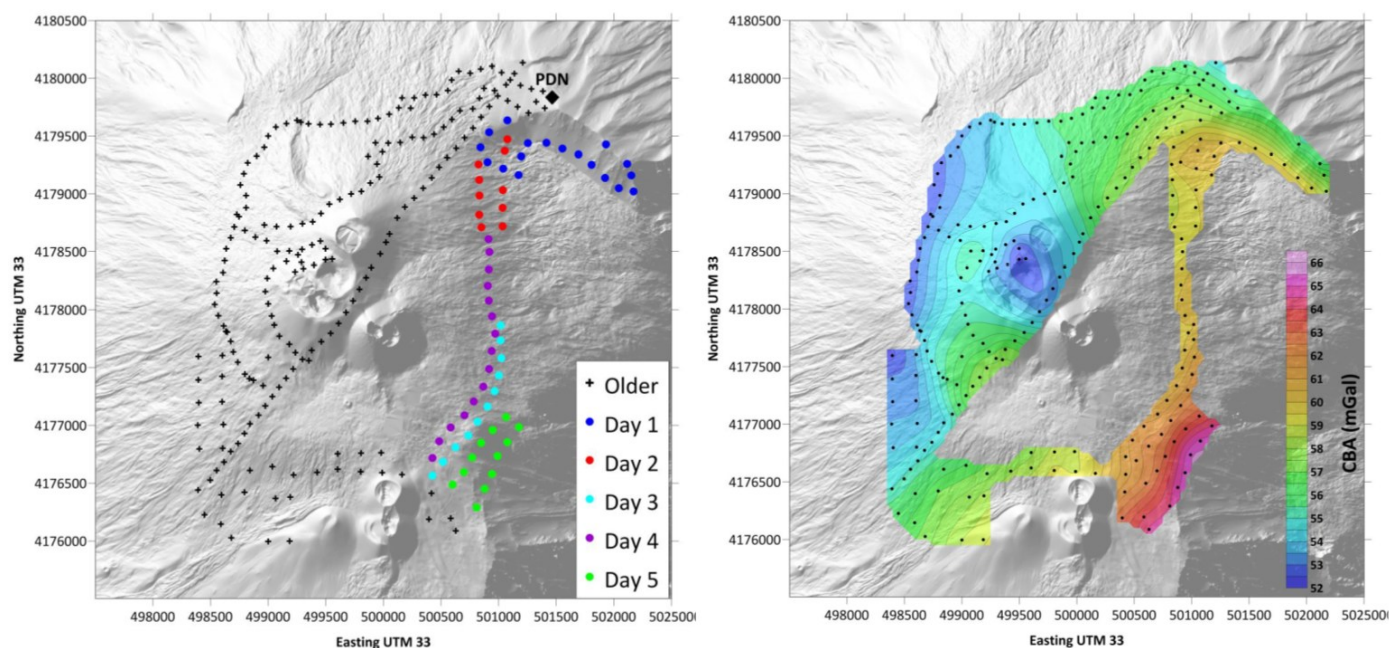


Figure 1

The gravity points of the gravimetric surveys (left) and the CBA map of the Etna summit area (right)

The observed gravity data were merged with those measured by the crew in 2021 in terms of the TA project “Gravimetric investigation of the structure of the Etna summit craters system” (acronym G-ET-SUMMIT) of

the EUROVOLC project, as well as the profile data of 2016 provided by the INGV team (see Pánisová et al., 2023). For each dataset an as close as possible (temporarily) high-resolution DEM was used or compiled (De Beni et al., submitted) for the sake of the topographic/terrain correction in order to compile the complete Bouguer anomalies (CBA data). The resulting CBA data in the summit area of Etna are shown in figure 1 (right).

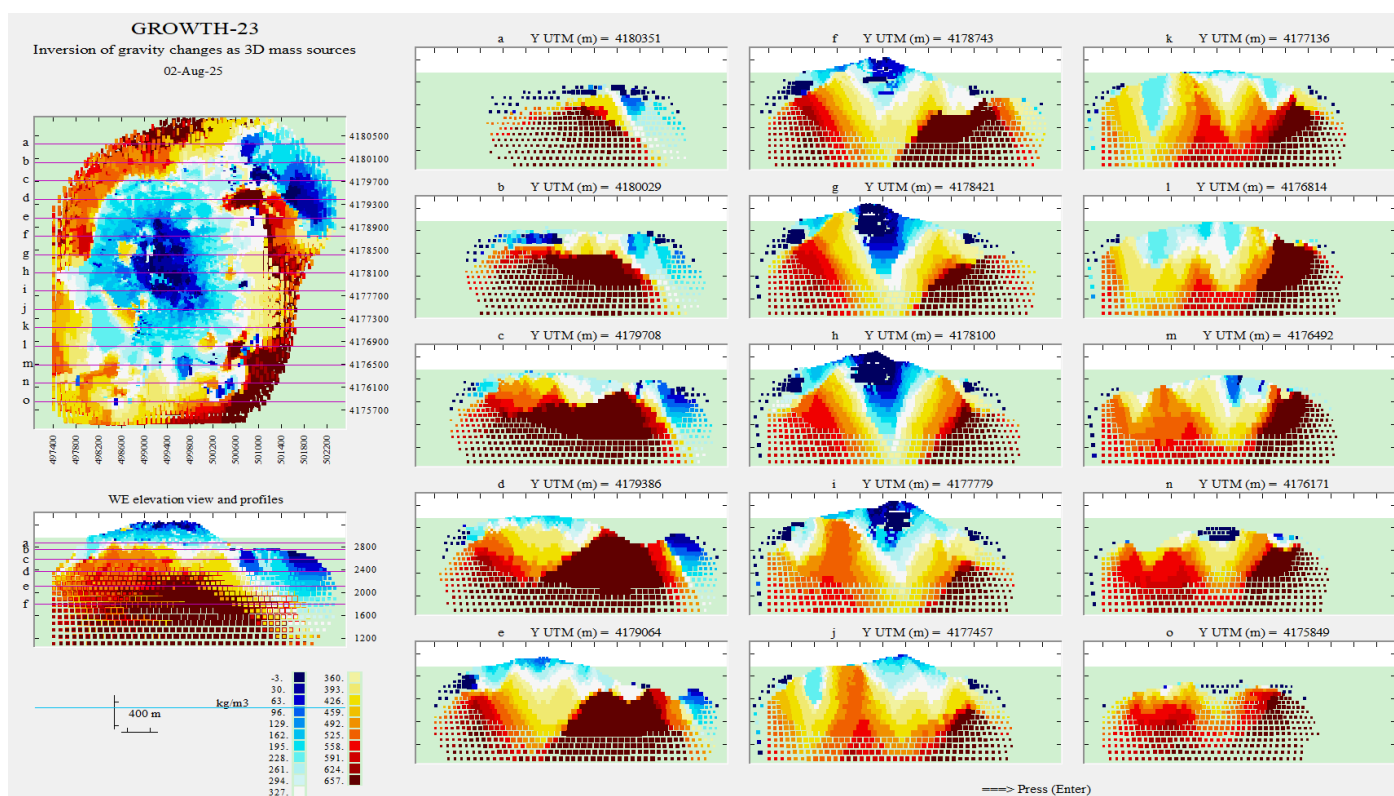
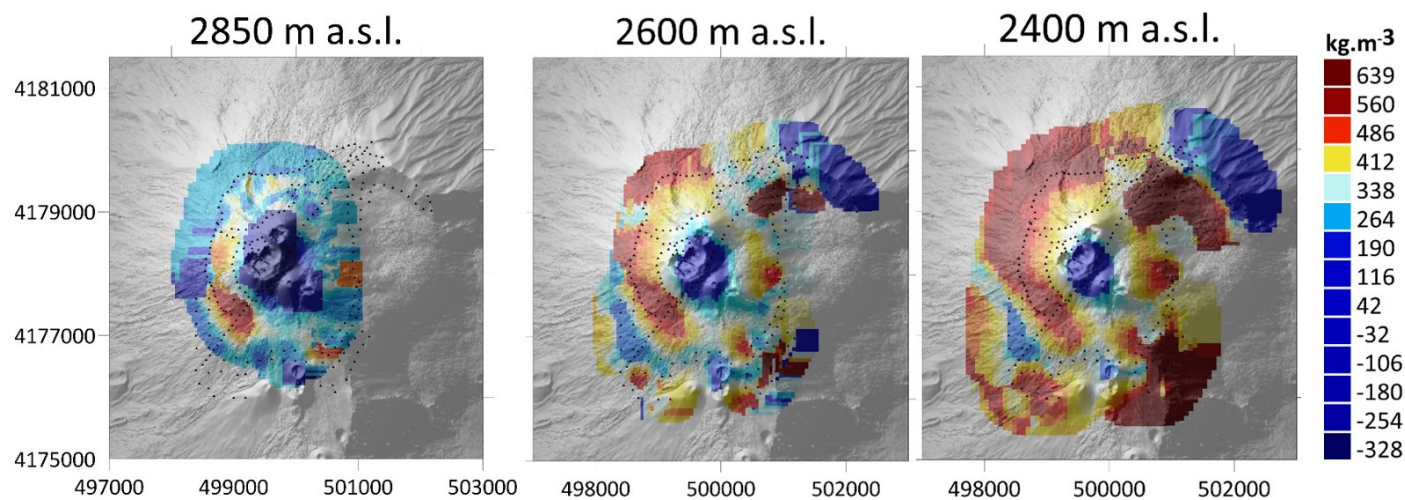


Figure 2
Horizontal slices (top) and vertical sections (bottom) of the 3D structural gravimetric Growth model of the summit part of the Etna edifice

The CBA gravity data were inverted with the free-geometry growing source bodies inversion approach called Growth (Vajda et al., 2023, 2024) using the GROWTH-23 implementation of the inversion methodology (Camacho et al., 2024). Horizontal slices and vertical sections of the 3D structural gravimetric Growth model of the summit part of the Etna edifice is presented in figure 2. The model shows subsurface structural elements that seem to be related to the Mongibello and Ellitico formations (calderas) as well as to recent eruptions feeding systems. It is currently under intense interpretation effort. Work is currently in progress to prepare a 3D structural gravimetric (density) model based on 3D forward modelling using the IGMAS+ modelling tool. The forward modelling approach will take into account all available geological and volcanological information (constraints).

Deliverables

(1) De Beni E., C. Proietti, M. Cantarero, F. Greco, L.T. Mirabella, A.A. Messina, D. Carbone, Contrafatto D., J. Papčo, P. Zahorec, P. Vajda: The dynamic summer of 2024 at Etna volcano documented by UAS: morphological changes and their gravimetric effects.

Journal of Volcanology and Geothermal Research (submitted 08/11/2025, ms VOLGEO-D-25-00308)

(2) joint publication under preparation: “Gravimetric structural 3D model of Etna summit edifice segment based on inversion and constrained forward modelling”

References

Pánisová, J., F. Greco*, D. Carbone, S.F. Branca, Peter Vajda (2023) New insights into geological setting of the summit area of Mount Etna volcano (Italy) inferred from 2D gravity data modelling.

Frontiers in Earth Science (2023) 11: 1171884, doi 10.3389/feart.2023.1171884

Vajda Peter, Antonio G. Camacho, José Fernández (2023) Benefits and limitations of the Growth inversion approach in volcano gravimetry demonstrated on the revisited Tenerife 2004–2005 unrest.

Surveys in Geophysics (2023), 44(2): 527–554, <https://doi.org/10.1007/s10712-022-09738-9>

Vajda Peter, J. Bódi, A.G. Camacho, J. Fernández, R. Pašteka, P. Zahorec, J. Papčo (2024) Gravimetric inversion based on model exploration with growing source bodies (Growth) in diverse earth science disciplines (review paper).

AIMS Mathematics 9(5): 11735–11761, doi: 10.3934/math.2024575

Camacho A.G., Peter Vajda, J. Fernández (2024) GROWTH-23: An integrated code for inversion of complete Bouguer gravity anomaly or temporal gravity changes.

Computers and Geosciences, Vol. 182, 105495, <https://doi.org/10.1016/j.cageo.2023.105495>,