INTEGRATE-Integrated 3D structural, thermal, gravity and rheological modeling of the Alps and their forelands

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Summary
The aim of this project is to obtain a better understanding of the crust and the uppermost mantle beneath the Alpine orogen and its forelands and to test different hypotheses on the configuration of the subduction system as well as on the distribution of deformation and seismicity. Therefore, we plan to integrate the geoscientific observations publicly available so far on properties of the sediments and the crystalline crust (geometry, seismic velocities, and densities) with seismologically derived heterogeneities in the sub-crustal mantle into a consistent data-based 3D structural model that resolves the first-order contrasts in physical properties of the units composing the orogen and the forelands.
The derived structural model will be compiled by 3D gravity modelling using new petrological concepts and a digital surface density model (3D). Therefore, the resulting density model will be validated by both high-resolution terrestrial gravity/magnetic field data and modern satellite fields, gravity gradients and magnetic field data. Such a combined model provides a reference for other types of data processing and is a crucial step forward in deciphering how deep-seated mass changes affect the evolution of the orogen. These 3D models will be used for estimates of flexural rigidity, loads, GPE (gravitational potential energy) and stresses in addition to investigations of existing isostasy models of the lithosphere and will continuously be extended with the use of the upcoming AlpArray seismological data.
A further application is to derive a lithospheric temperature field based on petrological assumptions on the composition of the crust and mantle. This is done to study the effects of regional heat-flow into the Alps and their foreland basins and the flexural regime changes through time, which govern the response to the dynamic evolution of the mountain belt. Starting from these 3D density thermal and lithology models, the integrated strength will be derived and discussed in the context of stress and deformation fields.
The project contributes to Themes 3 and 4 of the call for proposals. For “Theme 3: deformation of the crust and mantle during mountain building”, the project will provide the configuration of the different crustal units and of the lithospheric mantle and the isostatic and rheological conditions of the orogen-foreland system at the present-day. For “Theme 4: motion patterns and seismicity”, the outcome of the proposed project will support identifying spatial patterns of faulting and seismicity in relation to the rheological configuration, the variations of flexural rigidity across the system and the distribution of contrasts in physical properties in the crust as well as the lithospheric mantle. In response to its regional character, the project links with the different activity fields of the SPP and a continuous exchange of observations and modelling results with many working groups in the SPP will support data processing and interpretation.

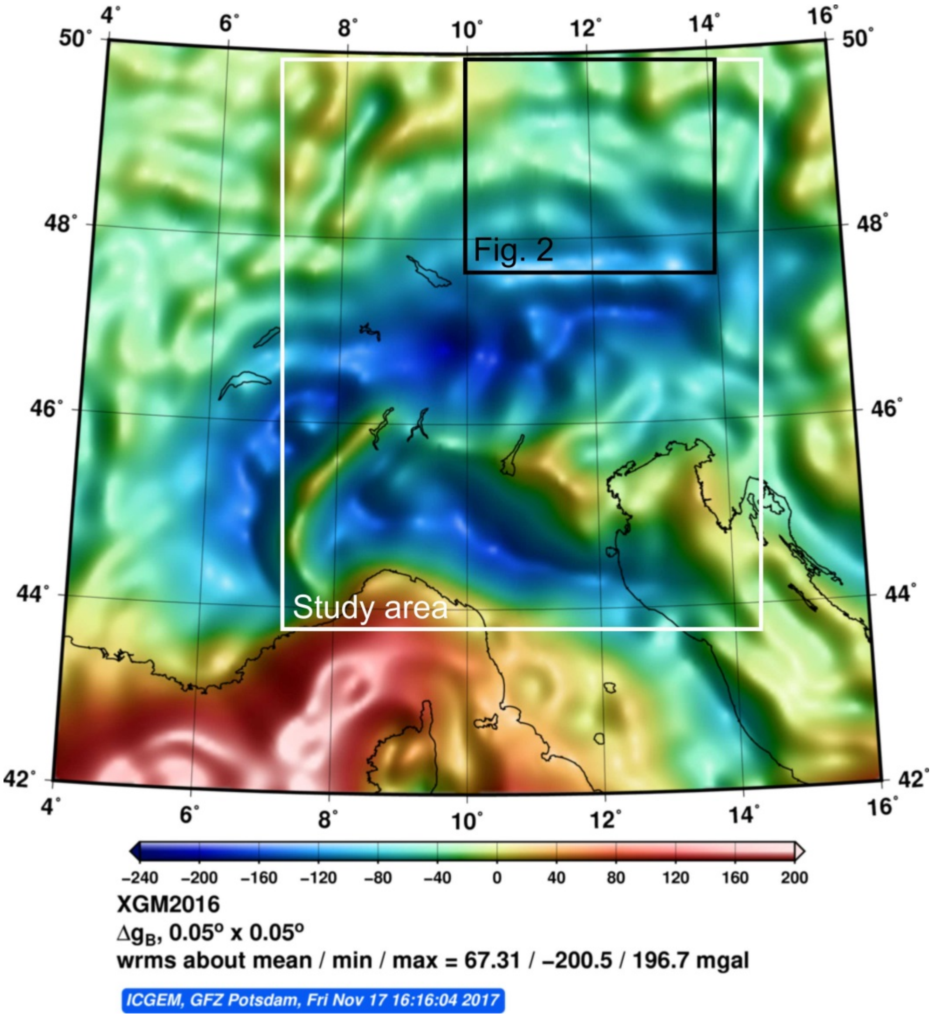

Fig. 1: Bouguer gravity anomaly XGM2016 (Pail et al., 2017).

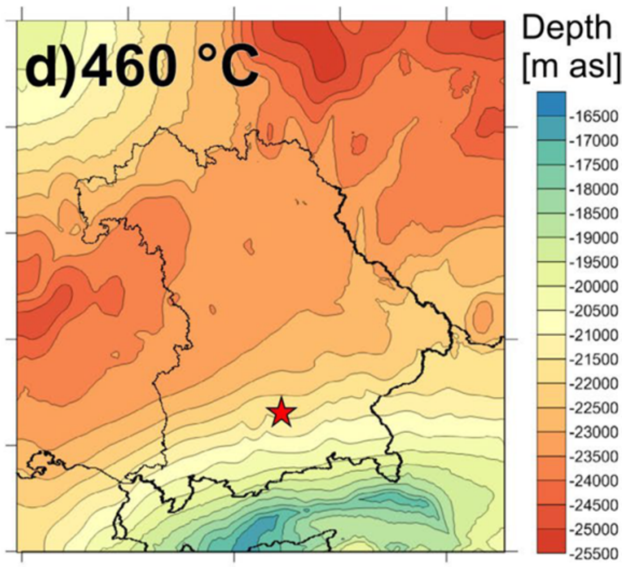

Fig. 2: Depth of the 460°C-isotherm as derived from a steady-state 3D conductive thermal model of the Molasse Basin (Przybycin et al., 2015). Contour delineates the political boundary of the Federal State of Bavaria; red star indicates the city of Munich.