Harnessing Modern 3D Gravity Analysis Techniques: A Study of the Ligurian Offshore Area

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This interdisciplinary study describes the integration of gravity field analysis, curvature techniques and various spatial applications. The data are based on land-based Free Air and Bouguer gravity data from the AlpArray Gravity Research Group, complemented by recent satellite missions. New seismic and seismological data from the AlpArray initiative and the German MB-4D Priority Program were used as independent boundary conditions for the 3D modeling and inversion of the gravity data. Prior to this modeling, Euler deconvolution, terracing/clustering techniques, and advanced filtering methods were employed to reveal intricate details of the region's gravitational signatures. For example, a distinct zoning of gravity is observed in the central part of the Ligurian Sea, pointing to traces of past rifting processes. Analysis of various curvature parameters (e.g., dip-, min-, max- and shape-curvature) of the processed gravity fields, in particular gradients and residual fields support the identified zonation of the gravity fields, which reflect the geological structures in the crust. The final 3D modeling of the Ligurian Sea area is based on a previous density model of the entire Alpine region and includes density distribution of the upper mantle. These densities were derived from tomographic velocity models, accounting for petrology, temperature, and pressure. Additional information of the upper crust was obtained from the refraction seismic results of the LOBSTER project, offering a comprehensive understanding of spatial phenomena. Calculations of the gravitational potential energy (GPE) provide additional information on local stresses, facilitating a deeper understanding of the flexural rigidity in the area. By elucidating the relationship between processing techniques and 3D modeling, this work advances interdisciplinary interpretation crucial for geological studies in the Ligurian offshore area.