Does gravity modelling justify a rifted "Ligurian Basin"?

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The geo-historical development of the Ligurian Basin and the structure of the crust and upper mantle in this area are still being discussed. Yet it remains unclear if rifting caused continental break-up and seafloor spreading and one of the key questions is whether rifting can be identified in geophysical measurements. For our investigations we had the following updated data sets at our disposal: the new gravity maps of the AlpArray Gravity Working Group (complete Bouguer - CBA, Free air, and isostatic anomalies) the seismic results of the Lobster campaigns of our GEOMAR partners in the SPP MB4D as well as the dynamic modelling results from our own subproject. The constraining data are supplemented with seismic profile data from French and Italian offshore campaigns, as far as they are usable in publications for us. The GFZ modelling software IGMAS+ was used for an interactive 3D modelling. The resulting model contains density inhomogeneities in the crust as well as in the upper mantle down to a depth of 300 km following the results of dynamic models of our own subproject. Due to the special hybrid modelling of the crust (by polygonal structures) and the upper mantle (by voxels of recent velocity models), the individual contributions to the gravity field are clearly separable. As a further special feature, we point out that the density model used is based on the gravity modelling from the first phase of the SPP MB4D (our former subproject INTEGRATE). Thus, a largely consistent 3D density model for both the Alps and the Ligurian Sea is available for interpretation. The constrained 3D modelling of the gravity field, as well as numerical analyses of the fields (terracing, clustering, filtering, curvature), calculations of the vertical stress and Gravity Potential Energy (GPE) suggest that a rift structure in the area of the Ligurian Sea can be identified and mapped. The interactive modelling is supported by the use of geological maps in the Ligurian Sea area. By overlaying the model gravity maps and the geological maps, the good agreement becomes visible – refer to the attached figure.

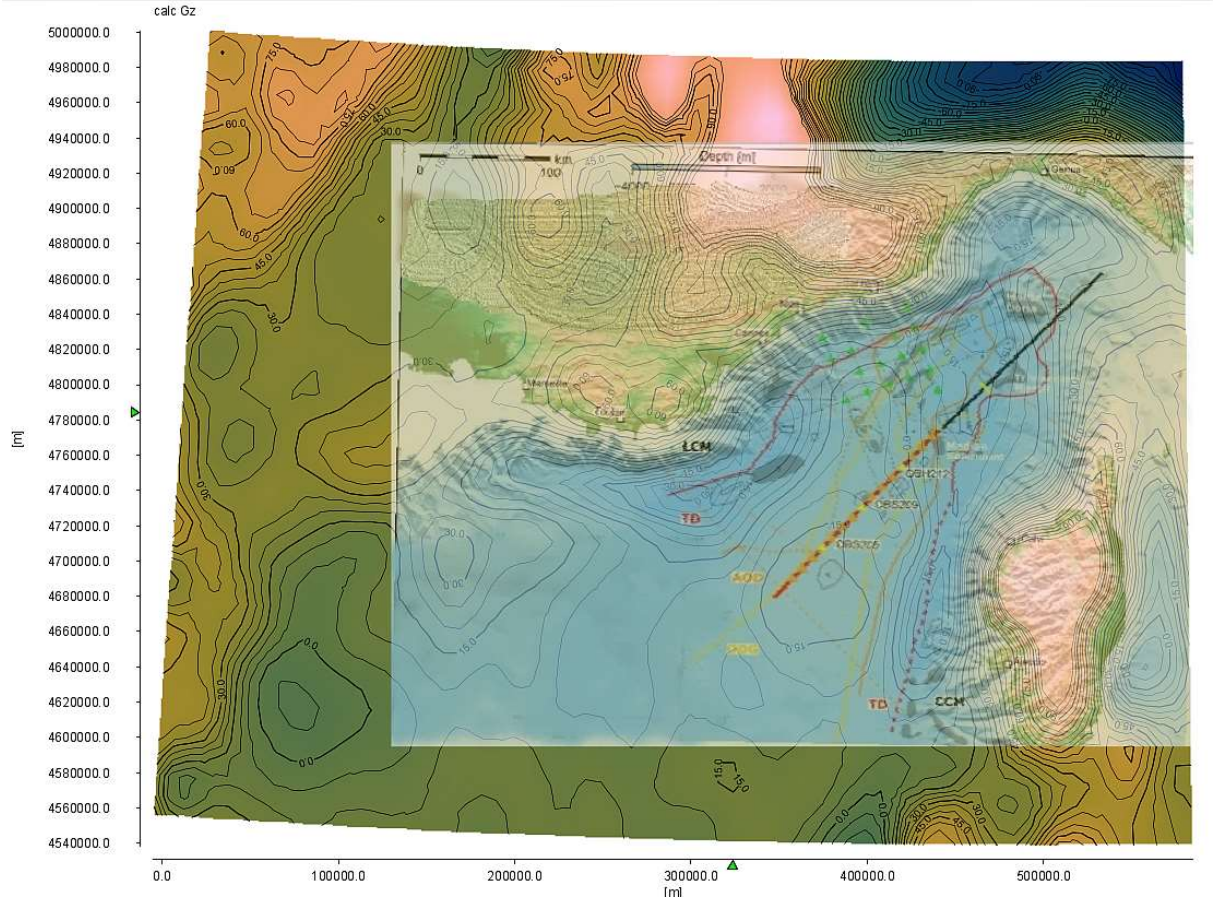

Figure 1: Screen plot of the 3D georeferenced density model (in UTM coordinates) in the area of the Ligurian Basin overlayed by the interpretational map of seismic results (Dannowski et al., 2020). Calculated Free Air anomaly is shown in color (background) and in a gravity contour lines (transparent, isolines spacing: 5 mGals). Greenish and blueish colors indicate lower gravity, reddish tones indicate higher gravity values. The central part with slightly higher gravity values is surrounded by negative anomalies. As a transparent overlay an interpretational map contains the position of the central LOBSTER refraction seismic line in combination with an older profile of Makris et al. (1999). Among other features different crustal domains are marked by thin orange and red lines and are labelled AOD – atypical oceanic domain; CCM – Corsica continental margin; LCM – Ligurian continental margin; and TD – transitional domain. A thin yellow line marks the oceanic domain (ODG). There is a significant correlation between the mentioned domains in the seismic interpretation and the calculated gravity anomalies.