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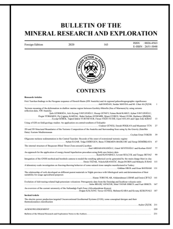

2D and 3D structural boundaries of the tectonic composition of the Anatolia and surrounding seas using by the gravity (Satellite Data): Eastern Mediterranean

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Research Article

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ABSTRACT

Gravity data is processed and the problems of the earth are examined. The density of the data can be arranged to solve detail, semi-detail and regional problems. Here, the gravitational data obtained by processing the linearity of the 2D and 3D visuals in terms of plate size large wavelength structures are examined. 2D linearities determine important stress areas but they are affected at different rates with respect to the spatial distribution of source effect. Due to grid formation, these boundaries are affected at different rates from less dense and very dense structures. Different wavelengths in structure boundary analysis; derivative and phase elements and filters. Vertical change in 3D analysis can be made at the approach level with the analytical examination of 2D change. At this stage, the distribution of source effect and depth model structure parameters are calculated. When examining large wavelength structures, some of the buried structures appear due to cover removal. In search of solutions for tectonic structures that we may miss; The tectonic components that need to be confirmed in the Eastern Mediterranean have been tried to be elucidated in this study. 3D building solutions are important in this respect.

1. Introduction

The Anatolia, which resembles a horizontal rectangle extending from the Aegean coast to the Iranian border, has intracontinental movements and mobile microplate boundaries. These boundaries can be observed in processed gravity data (Figures 1 and 2). Roughly, the lower right corner (SE) of this rectangle is pushed northward by the Arabian plate. This pushing is stopped by the inverse forces on the upper right (NE) of the rectangle. While the main block escapes westward along the North Anatolian Fault (NAF) by 25 mm/year (Barka, 1992; McClusky et al., 2000; Reilinger et al., 2006) and the Eastern Anatolian Fault (DAF) by 10 mm/year (Nalbant et al., 2002; Barka and Reilinger, 1997) it is met by the shear zone in the Aegean plate (McKenzie, 1972). It then moves towards the left by the influence of Hellenic and Cyprus arcs (SW). The left north (NW) and south of the rectangle were compressed (SW) and enlarged. All of these movements caused large transformations and plate ruptures. The North Anatolian transform extends from the Anatolia to Greece and covers a large part of the geography which is the subject of the data. While there are many reasons for the rectangular structure to be cut in a north-south direction with large transforms, the discontinuities in this direction cannot be seen. The flattened structure of the Black Sea (NS) and the mid-Mediterranean ridges (EW) where discontinuities are covered by additional accretions and plains in the Central Anatolia show that they have stress lines of which the main axes are in north-south directions and accordingly developed lineaments in different times. Several deformations have developed along with the

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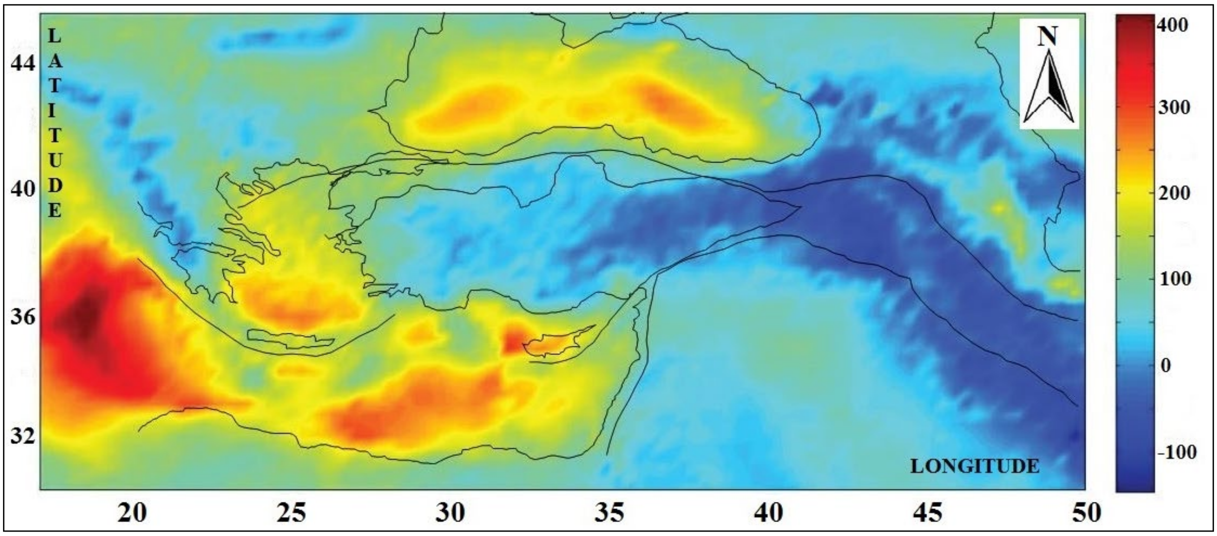

Figure 1- Bouguer gravity data.

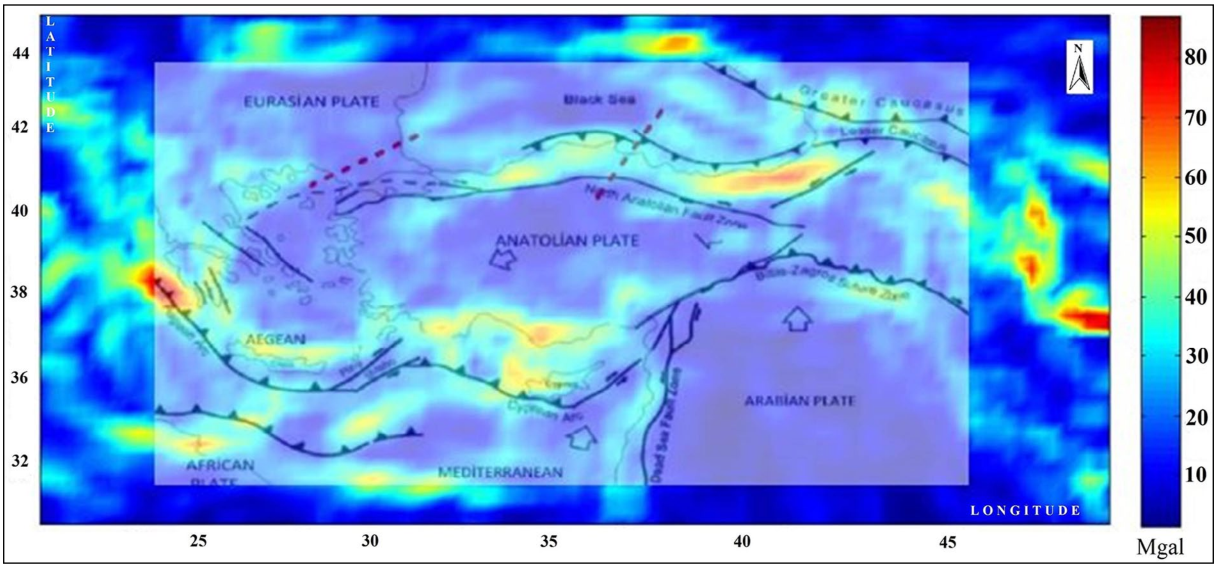

Figure 2- 2D, shifting window, non-derivative filter and tectonic elements (Toker, 2019).

Anatolian plate under big compressional load in the region among the Crimean shores in the north, the Egyptian shores in the south, Iran in the east and Greece in the west. The accompanying of the Eastern Mediterranean by subducting to the upward movement of the Arabian plate should indicate the presence of NS directing stress axis and/or plate boundaries. The tectonic activities in the continental crust have been investigated in previous studies [McClusky et al. (2000); Reilinger, et al. (2006); Aktuğ et al. (2009)] by global positioning (GPS) data. Özdemir and Karslıoğlu (2019) also investigated the microplate boundaries by classifying the vectorial slip rates in global positioning data.

The aim of this study is to reveal the unclear tectonic formations of regional tectonics and the Eastern Mediterranean. For this purpose, the 2D and 3D lineaments were examined.

2. Data and Method

Data set is a network data formed by satellite data that has a sampling point at each 7 km. (URL1). This data was filtered for 2D linearity (Toker, 2019). For 3D, Pham et al. (2018), a hybrid method developed by Cordell - Henderson inverse solution was applied. An algorithm, which quickly reaches the interface where the observed and calculated values overlap, is used to identify the density contrast that does not need to be predicted for the target depth.

Non-linear filtering technique that can perform non-derivative boundary analysis by limiting the data neighbourhoods by shifting and shifting this limitation by controlling the deviation without using derivative (Figure 2) (Toker 2019).

3. Findings

Figure 1 shows the Bouguer gravity data and the generated grid. In figures 2 and 3, the discontinuities in the scale of long-wavelength plate obtained by the 2D filter and in figure 3; the microplate and longwave boundary relationships observed by the "0" contour of the tilt angle are seen. In figure 4, the structure boundaries of the inverse solution take place. Figure 5 shows the traces on the interface of the gravity foundation without cover, and figure 5b shows 3D lineaments looking from Southwest-Northeast directions. Figure 6 shows the three-dimensional shell structure of the Aegean region. Since the depths in the Aegean region are known as graben and sub-graben depths, the results representing the approximate upper crust and lower crust depth were reached. The fact that the region is a smaller area than the main data has enabled the depths to be seen as more sensitive. In figure 6, the "0" (zero) contour on the upper surface

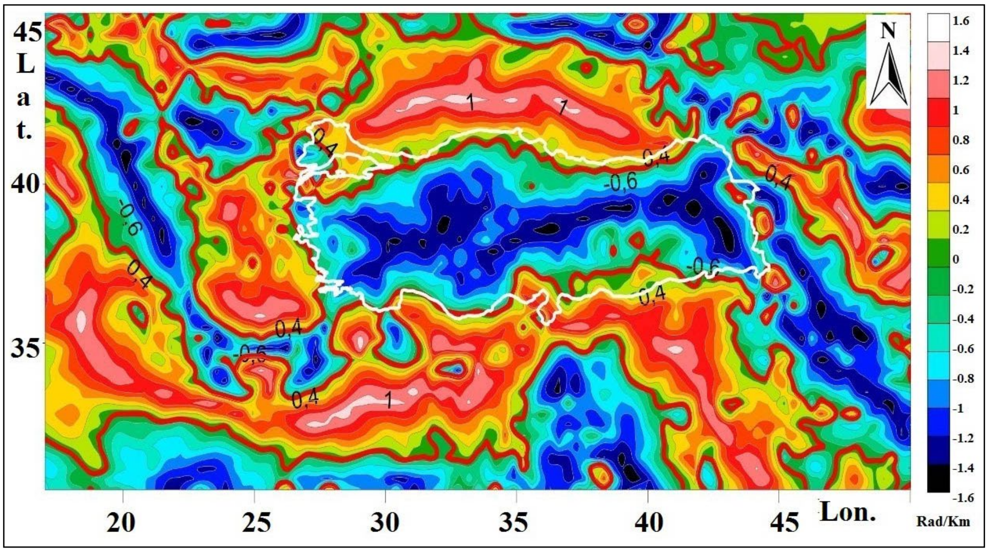

Figure 3- Tilt angle and its "0" contour (red line).

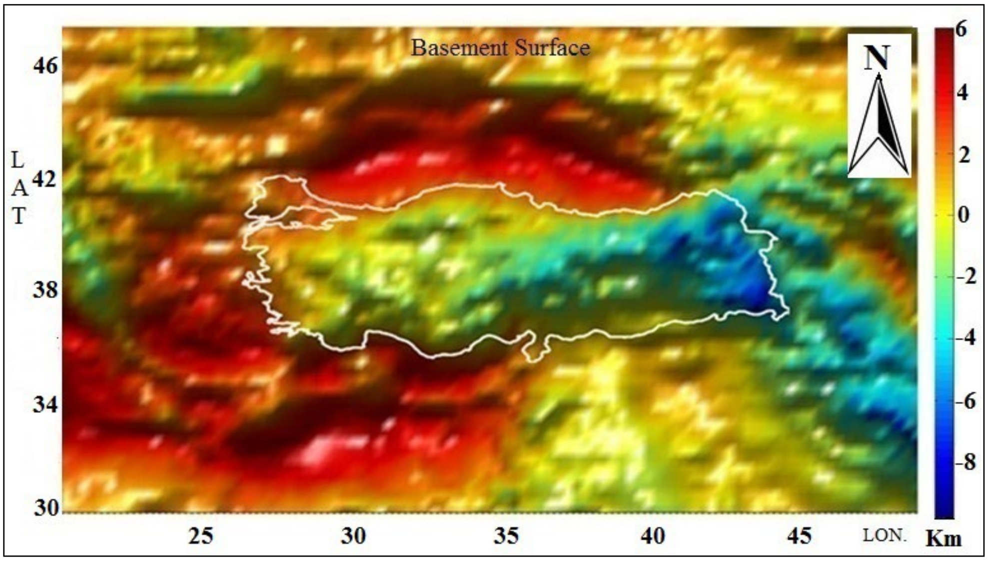

Figure 4- 3D, gravity inverse solution (no comment).

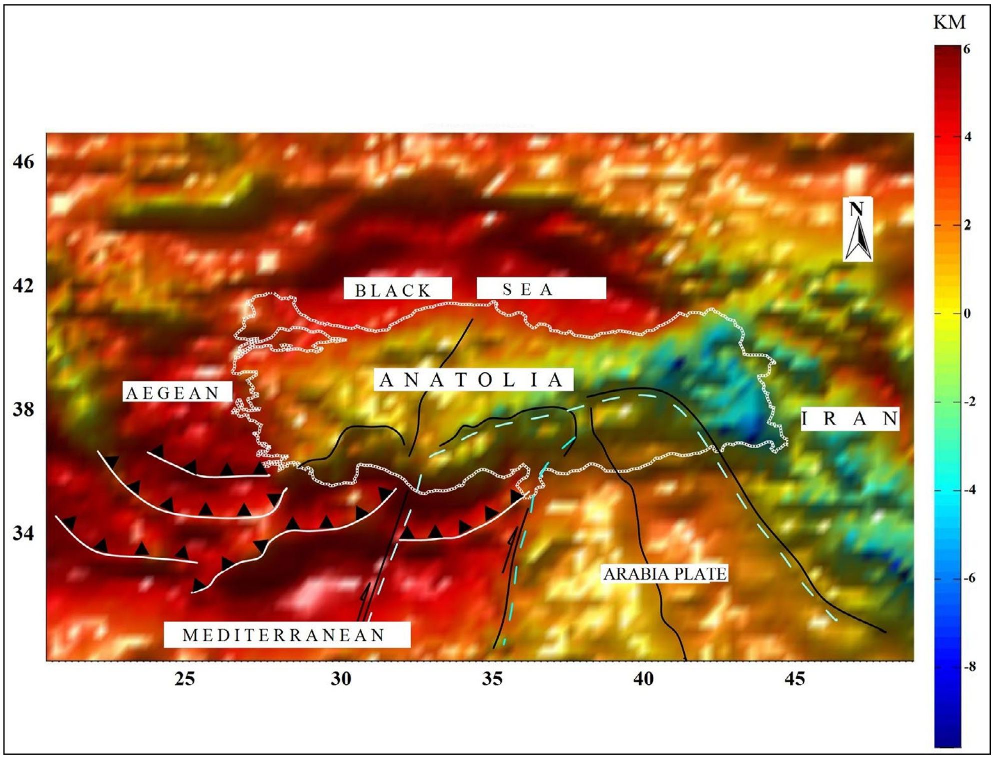

Figure 5- Main tectonic lineaments and the Antalya arc. (Özdemir et al., 2019) showed the anomaly which formed by the variations of GPS velocities in Antalya-Sinop axis.

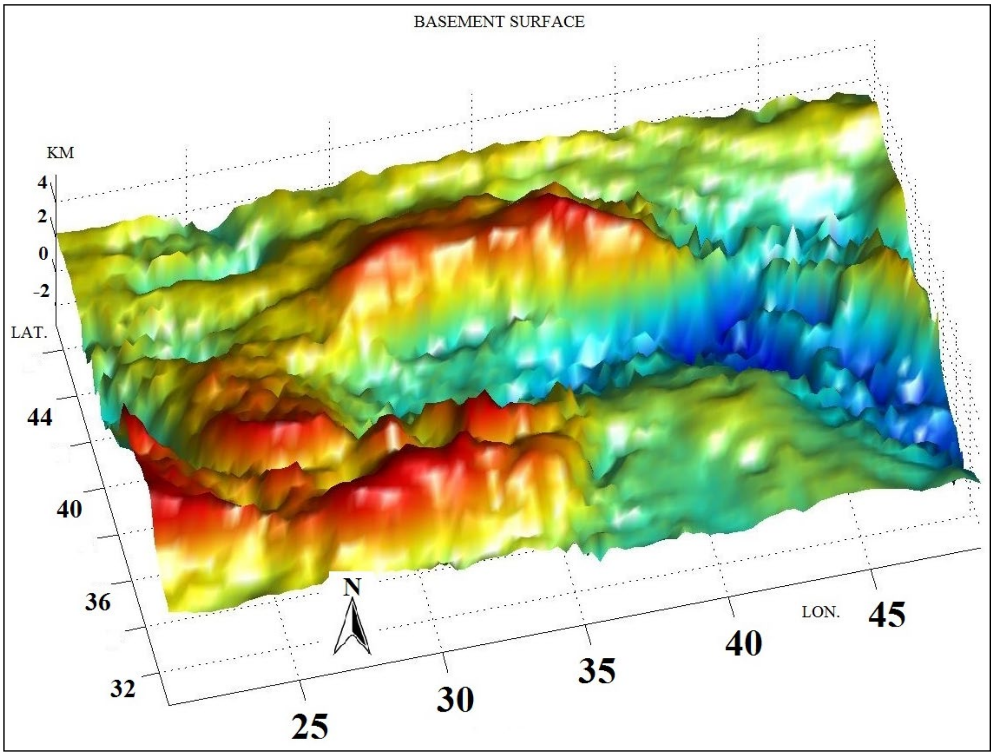

Figure 6- Look direction SW-NE. Angular 3D interface view. The regions in which the interface topography is dense due to gravitational magnitude present interface close the surface.

of the grabens is clearly observed. The depth contour (zero) and the tilt angle contour (zero) are concepts that should not be confused. Zero contour is the actual plate boundary. However, boundaries are actually zones of anomalies. The zero contours are the actual plate boundary. It is seen that the Thrace plate forms a microplate within the closed red line. It is seen that the plates converge as interlaced sequentially on the subduction boundary in the Hellenic arc. It is also seen that there is an offset with the northward movement of the Arabian plate along the Turkey-Iran border in the east and crust scale basins were developed in places where offsets are observed. The yellow-orange belt that represents high angular values along the border of the Arabian plate and Turkey is considered to have been the borders of the Neotethys remnants. Tilt angle values on the map in figure 3 vary between -1.57 and +1.57. However, the visual scale is defined by 0.2 colour ranges. It is seen that there is a block structure boundary closed under the sedimentary cover in the Thrace. The deep structure boundary extending from its southwestern part to the Black Sea with arc-shaped curvature indicates the great block structure. In figure 7, the displays in which the Moho interface was calculated and the lineaments sensed by software took place are seen. It is seen that the lineaments of Moho do not match with topographic lineaments.

Antalya - Sinop orienting lineament in figure 5 was shown as a large zone anomaly where GPS velocities vary by Özdemir et al. (2019). The density along this direction forms a boundary between east and west. Epellbaum (2017), defined the Southern Taurus belt extending from east of the Sırrı Erinç Plateau and the south of Cyprus to the northeast (İskenderun bay), as parallel to the Taurus mountain belt in the southern Anatolia and as a conjugate in the south. Le Pichon et al. (2019) stated that gravity data represented the continental crust in the southeast of the Eastern Mediterranean. The detailed data processing results show that tectonic events in the south of Antalya (Figure 2) are more complex. There is a covered and dense structure that draws an arc towards the east of the Antalya Bay. There is a third depth structure called the "Antalya subduction" between Cyprus and the Hellenic arcs.

The Geoid is called the equipotential surface formed by the gravitational field which best fits with the average sea surface. Another definition is the average earth surface ellipsoid (URL2). It is a dynamic (variable) interface sensitive to topographic changes. In spite of the data sets created at different times, it seems possible that the inverse solution and geoid structures can be related to shedding light on

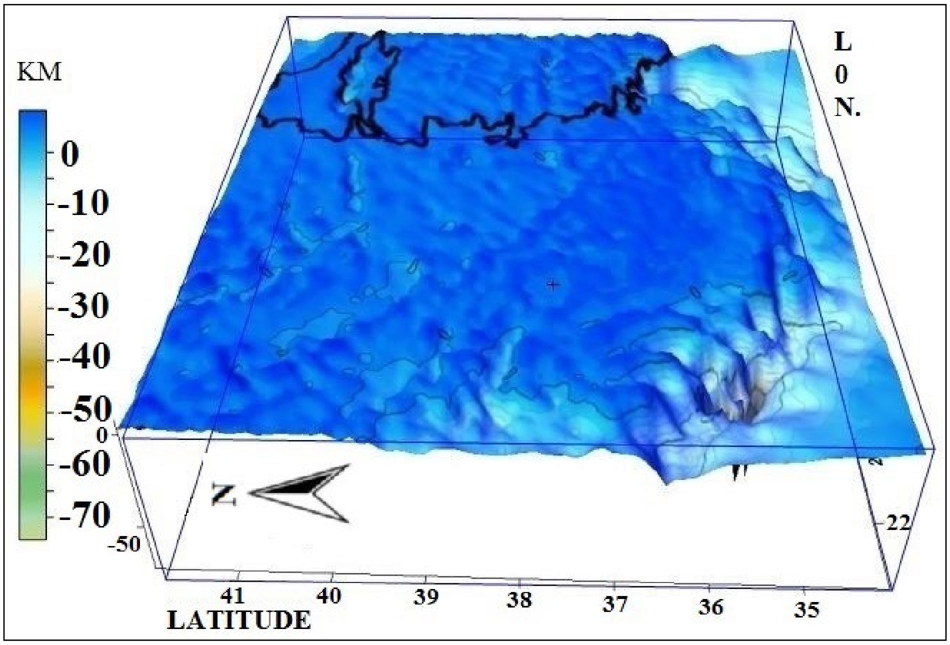

Figure 7- The interface topography of which the 3D, Aegean crust structure (inverse solution) is dependent on the magnitude. The Aegean region grabens, the lineaments of the Sea of Marmara and the North Anatolian Fault are clearly seen. The tectonic events overlap with the inverse solution.

the problem (Figure 8). In figure 8, the Geoid image created with open sources is correlated with the satellite data filtered by the non-derivative filter. In both maps, the harmony in tectonic structures in front of the Gulf of Antalya in the Eastern Mediterranean is observed. Since the geoid surface takes the average sea level as a reference, it has smooth transitions similar to the inverse solution interface and it is compatible with the inverse solution. Inverse solution depths are meaningful depths that require a reference depth and are relative to each other.

4. Discussion

The 3D lineaments and the known tectonic situation may not correspond exactly with tectonic elements and displacements. For example, the North Anatolian Fault (NAF) may not be displayed as a lineament. When the cover structure is removed by the 3D inverse solution, the lineaments may indicate different situations. For example; when lineaments in the depth map created by calculating the Moho interface are examined, it is seen that NAF is not really seen among the lineaments in Moho. However; it is a discontinuity called as the Paleotethys residual following the Black Sea coasts and/or as a discontinuity representing the Black Sea subductions. In the Mediterranean, there are two southwest-northeast oriented discontinuities belonging to two different subductions. The reference information here is that the crust deformations and discontinuities in Moho do not overlap. When the crust behaves as a ductile, there will be no lineament on the surface. The crust has to break away as it cannot keep up with the movement in the Moho (lower shell). This is reactive, but the movements at the Moho interface may not produce discontinuity. Moho discontinuities were determined by the software and an algorithm. Very deep structures aligned in the N-S direction in the east could be detected by the algorithm (Figure 9).

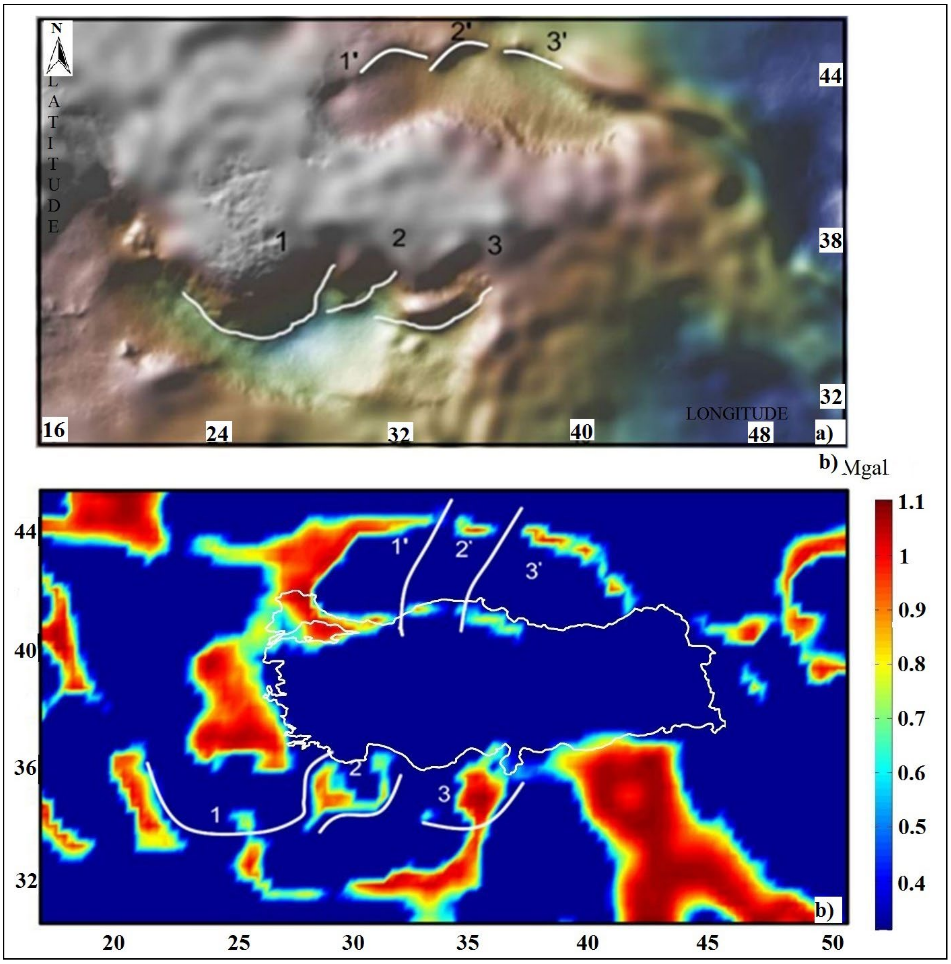

Figure 8- a) Correlation between the Geoid (GeoMapApp) and b) 2D filtering.

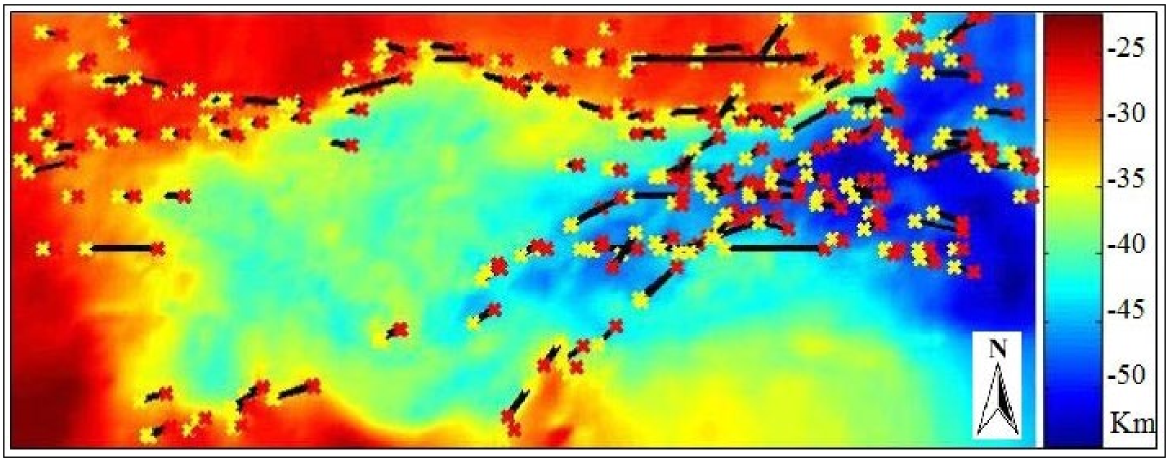

Figure 9- Moho interface and loop point. Discontinuities perceived by the software.

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