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Estimation of Tectonic Structure of Eastern Anatolia Region using Gravity Data

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Abstract – It was aimed to find the structural discontinuities of the Eastern Anatolia Region by using horizontal gradient magnitude technique. When determining the structural discontinuities of the region, the maximum amplitudes of the horizontal gradient magnitude were used. Along with a good harmony between this study and previous studies, new discontinuity boundaries were found. In addition, the basement topography of the region was calculated using the Parker-Oldenburg inversion algorithm.

Keywords – *Horizontal gradient magnitude, Eastern Anatolia Region, vertical first derivative*

I. INTRODUCTION

In the literature, edge analysis techniques such as horizontal gradient magnitude (HGM) are usually arranged according to the Bouguer gravity data to find lineaments [2]. In this study, HGM technique was applied to vertical first derivative (VFD) values of regional gravity data. Therefore, low pass filters was utilized to obtain regional gravity values. Then, the Fast Fourier Transform (FFT) method [6] was utilized to compute the VFD values of the regional gravity values. In order to find the discontinuities of the tectonic unit in the study area, the POTENSOFT program advanced by [1] was used. [5] have published an algorithm that computes the basement topography. In this study, tectonic structure, and topography of basement of the region have been tried to be revealed by applying VFD method, HGM and inversion techniques to regional gravity data of Eastern Anatolia Region.

II. METHODS

The North Anatolian Fault Zone (NAFZ) is an EW right lateral strike slip fault that styles the northern edge of the Anatolian block and also accommodates the relative motion between the Eurasian Plate and the Anatolian block (Fig. 1). Some researchers investigated the tectonic structure of the region using different data sets [8, 12]. In this study, the VFD values of the regional gravity data belonging to the region were used to re-evaluate the tectonic structure of the region. Bouguer gravity anomalies were obtained from EGM08 model [10] (Fig. 3).

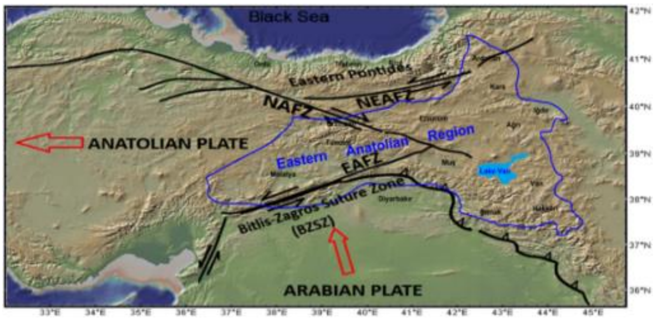

Figure 1. The Main tectonic characters of Eastern Anatolian and the surrounding regions. An image map from [11].

Active faults in the study area are shown in Fig 2.

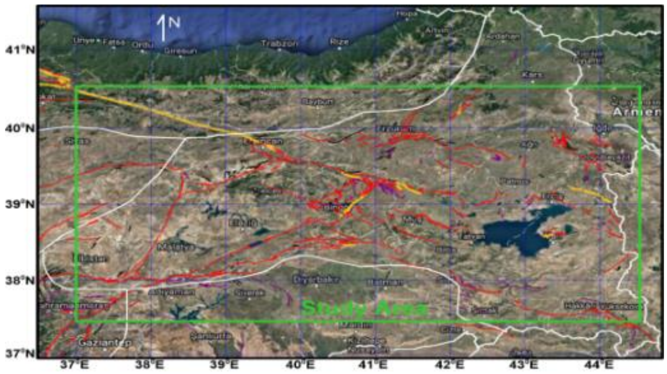

Figure 2. Active fault map of Eastern Anatolia Region (after [4]).

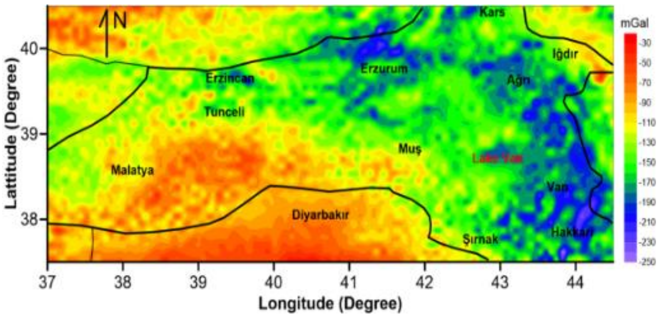

Figure 3. Bouguer gravity anomaly of the region.

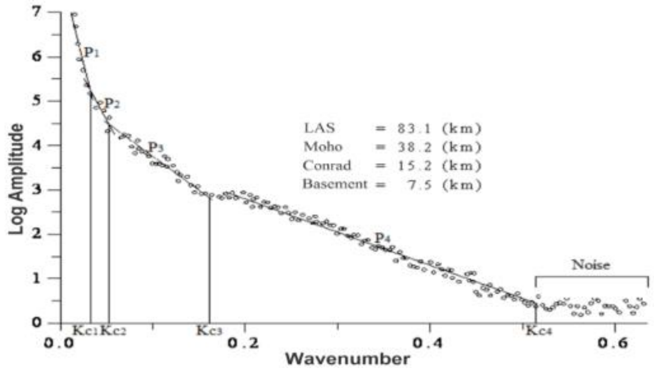

Figure 4. Radial average logarithmic amplitude spectrum of the Bouguer data.

Four different interface depths were found at the end of the radial averaged amplitude spectrum calculation. The depths of LAS, Moho, Conrad and the basement interfaces are 83.1 km, 38.2 km, 15.2 km and 7.5 km, respectively, from the slopes of the amplitude spectrum (Fig. 4). The Parker-Oldenburg algorithm [7, 9] was used to model the topography of basement, which calculated 7.5 km depth value using the amplitude spectrum technique. HGM filter was developed by [3]. The highest amplitude values of the anomaly of the HGM filter pass over the lateral edged of sources. The amplitude of HGM is given as:

$$HGM = \sqrt{\left(\frac{\partial^2 g}{\partial x \partial z}\right)^2 + \left(\frac{\partial^2 g}{\partial y \partial z}\right)^2} \qquad (1)$$

In Formulas 1; $\partial^2 g/\partial x\partial z, \partial^2 g/\partial y\partial z$ are the VFD of the gravity field (g) variations in the x, y and z directions.

The maximum values of the HGM amplitudes calculated from the VFD data of the regional gravity data represent the discontinuities of the tectonic structure in the study area (Fig. 5d). New lineaments can be seen in some parts of the study area (Fig. 5e). The basement topography of the study area was determined by applying the Parker-Oldenburg algorithm to the filtered gravity data (Fig. 5e). The depths of the basement topography vary between 3.2-12.5 km (Fig. 5e).

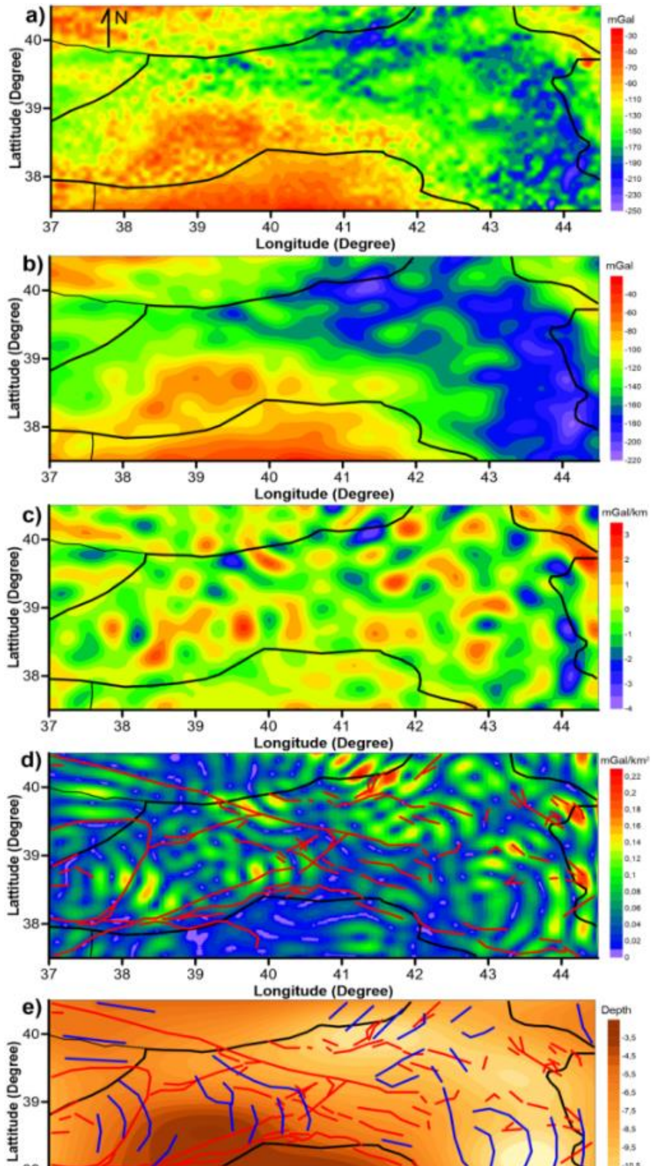

Figure 5. a) Bouguer gravity map, b) Regional gravity map, c) VFD map of the regional gravity data, d) HGM map of the VFD data, e) Basement topography of the region. Red lines represent existing faults and blue lines represent newly found lineaments.

III. RESULTS

In this study, a linearity map of the Eastern Anatolian Region was created and updated tectonic structure was given. In the various sections of the region, new lineaments extending in the northeast-southwest and northwest-southeast directions were found. Some new lineaments extending in various directions cutting old faults were found in the various sections of the region. As a result of this study, the sections of the tectonic structure that can produce earthquakes should be determined by the work to be done later. In particular, it should be emphasized to what degree earthquakes can be produced by the found lineaments by deeper studies, such as the modeling of the lithosphere-asthenosphere boundaries.

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