

Application of the Talwani modeling method to the magnetic data of Sinop and its surrounding

Talwani modelleme yönteminin Sinop ve civarının manyetik verilerine uygulanması

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Abstract

In this study, Talwani modeling method is applied to total magnetic anomaly map of Sinop and its surrounding area. As a result, the high anomaly values observed in the map were attributed to volcanic formations. The lower anomaly values were attributed to the effect of sediment cover. Tectonically structural elements existent in this area are evaluated as fault anomalies on the profiles in the magnetic map. The calculated average depth (1.5 - 8 km) values obtained during this model study are consistent with the former studies.

Keywords: Talwani modeling method, Sinop, magnetic data, fault

Introduction

Sinop is a peninsula in the Black Sea. The offshore part of Black Sea shelf area ends with -100 m slope in most of the basin as in Sinop (Fig.1). The shelf is relatively wider in the front part of Sinop and the deployment and width have a strong relationship with the tectonic structure of posterior rock and aggregation structures (Erinç, 1984). This region is on the agenda nowadays, relating to oil and natural gas prospects and possible nuclear plant establishment.

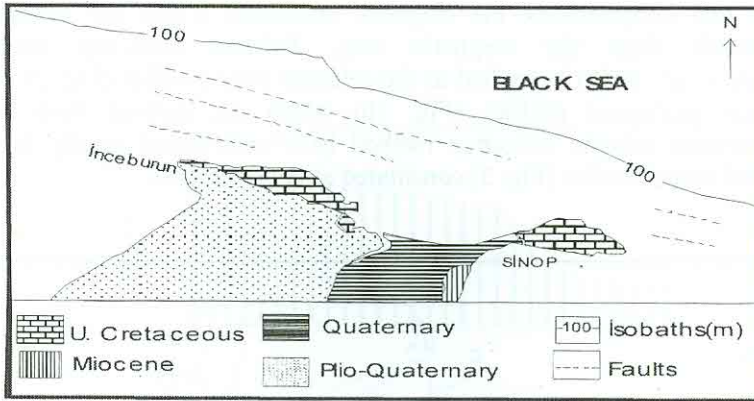
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Previous magnetic studies

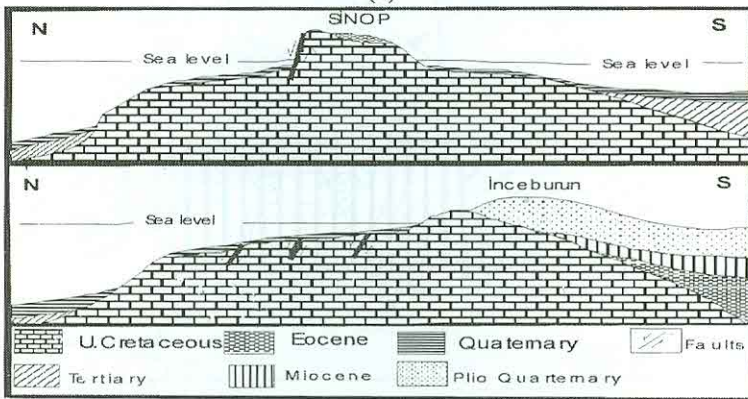
Some magnetic studies have been executed earlier different researchers (Tahran, 1987; Yiğiter, 1989; Demirel and Adatepe, 2003; Demirel and Adatepe, 2006) in areas neighboring the coast of Sinop. In these studies, master curves were used with one dimensional Fourier analysis, and it is determined that average depths of masses, which give correspondence to magnetic anomalies, are between 2 and 8 km. Structure depths of magnetic masses calculated in the studies done in deeper sea basins of Black Sea, are determined between 10 and 20 km (Belousov *et al.*, 1988).

Regional geology of Sinop

Great numbers of studies have been done relating the geological evolution of Black Sea (Saner, 1980; Annon., 1985; Gökaşan, 1996; Yılmaz *et al.*, 1997). The study done in land and sea areas of Sinop has contributed to the understanding of local geology of the region (Özhan, 2004). According to these points, the primal unit of the region is a volcanic formation which is composed of Upper Cretaceous aged agglomerate, basalt lava and dikes. In Sinop peninsula, Miocene aged sandy limestones are over Upper Cretaceous aged agglomerates (Fig. 1a). In İnceburun peninsula, Plio-Quaternary sediments composed of fluvial and aeolian origin sands are above the Upper Cretaceous aged volcanic structures (Fig. 1a). The region was under the effect of compressive forces in the direction of North Northeastern – South Southwestern between Upper Cretaceous – Upper Miocene periods, and at the end of Miocene, this activity was decreased by the activity of North Anatolian Fault (NAF) system (Özhan, 2004). Active lineament in the sea bottom has been observed in higher differential seismic reflection records of the same study (Fig. 1a). The reflection characters in the profiles, suggest that the basic rock under the sea bottom covered with young sediments belongs to the Upper Cretaceous aged old volcanic formations (Fig. 1b) and also includes faults (Özhan, 2004).



(a)



(b)

Figure 1. (a) Regional geology of study area and local faults,
(b) Structural geological profiles (modified from Özhan, 2004)

Material and Method

The total magnetic anomaly map used in this study was prepared by the Turkish Navy Department of Navigation, Hydrography and Oceanography (TNDNHO) (Fig. 2). The observed anomalies forming the north and south of 42° N latitude have different characteristics. Positive 100 and 200 nT contours of the south edge of 42° N latitude increase to positive 500 nT towards the south, whereas the magnetic values that constitute the north of the same latitude degrees to negative 200 nT towards the offshore.

Taking into consideration the magnetic anomalies which are evaluated qualitatively from the magnetic map, Talwani modeling method (Talwani *et al.*, 1959) is applied to the selected three profiles (Fig. 2). The structural geological profiles (Fig. 1b) which are derived from high differentiation seismic reflection method have contributed greatly to the structural model studies (Fig. 3) constituted after application.

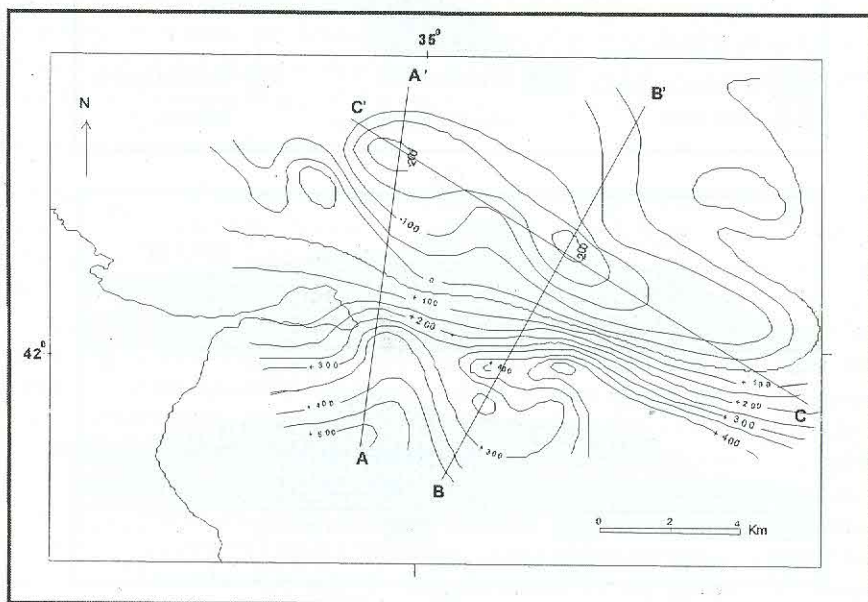


Figure 2. Total magnetic anomaly map (TNDNHO) of study area and profiles (original scale 1:150 000)

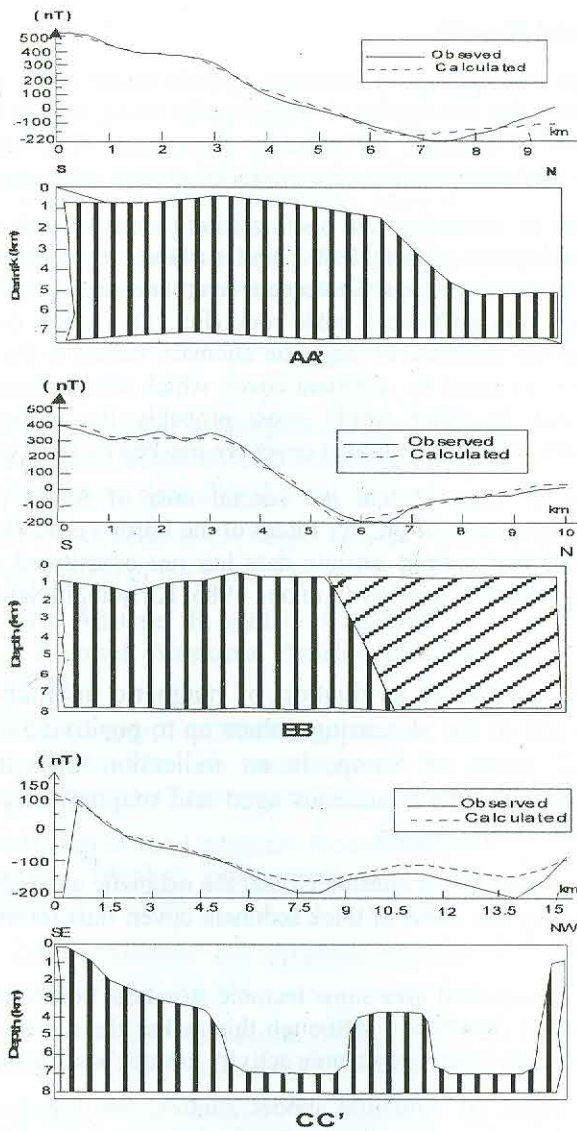


Figure 3. Magnetic profiles (AA', BB', CC') and their structural models

Discussion and Results

The numerical calculations of structure models which were gained after application show that the depths of magnetically active masses are between 1.5 and 8 km in average. In addition, the points of evident changes determined in magnetic profiles were evaluated as fault anomalies (Fig. 3).

The high value of anomaly from shelf offshore area through the coast of Sinop is an indication of heightening and surfacing through the south of volcanic unit containing Upper Cretaceous-aged and magnetically intensive material, which was given as a basic rock (Fig. 1). On the contrary, it is considered that the decrease in magnetic anomaly values to the negative in the coast offing is caused by sediment cover, which was thickening towards the abyssal area. In other words, most probably the higher values of magnetic masses under the sediment cover are masked by sediments.

Another point of issue is that the coastal area of Sinop peninsula is heightened by the effects of interior forces of the Earth's crust (Erinç, 1984). It is determined that current seismic data has not constituted a consistent activity with Quaternary geology (Annon., 1985; Kirişçioğlu Sancar, 1999).

1. In the qualitative evaluation of magnetic anomaly map, the existence of the increasing values up to positive 500 nT in the coastal areas of Sinop, is an indication of volcanic unit containing Upper Cretaceous aged and magnetically consistent material in the region.
2. In the offshore, it is considered that the magnetic anomaly values are masked by the effect of thick sediment cover, thus resulting in lower values.
3. In the Sinop shelf area some tectonic structural components may be interpreted as a fault. Although this makes the region tectonically sensitive, an extensive seismic activity has not been detected.
4. As a result of structural model studies, the average depths of magnetic masses are calculated to be between 1.5 and 8 km. These are consistent with the results of the previous magnetic studies, which were obtained by using different methods in the regions near coastal areas.

