JOURNAL OF BALKAN GEOPHYSICAL SOCIETY, Vol. 8, No.1, February, 2005, p. 7-19

Preliminary evaluation of Central Anatolian basins in Turkey by using the gravity & magnetic data

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Abstract: *One of the largest interior basins in Turkey, the Tuzgölü Basin related with the Haymana and Kırıkkale Basins, has smooth topography, a stable young sedimentary cover and limited outcrop zones. But the study area bears a complex geology with intensive tectonism and poor seismic data quality beneath the surface. The complexity of the subsurface geology was attempted to be solved and important structural components giving evident anomalies were determined using the gravity and magnetic methods in integration with each other.*

Most important determination from the gravity anomaly map is the existence of a large and unique basin (named as Tuzgölü Basin in this study) in the south of Tuzgölü, in spite of separate classification as Tuzgölü Basin and Ulukışla Basin in the previous studies. Another evident anomaly is caused by a channel shaped basin named Tersakan Basin that is connecting Tuzgölü and Haymana Basins each other. Kırıkkale Basin, also, is connected to the Haymana Basin. The most important anomaly in the magnetic anomaly map is the Sülüklü-Cihanbeyli-Gölören Anomaly, which is extending through the western margin of Tuzgölü, Tersakan and Haymana Basins in NW to SE direction.

Upward continuation up to 4 km with 1 km intervals was applied to gravity and magnetic anomaly maps in order to observe regionality of these anomalies.

Key Words: *Tuzgölü, Haymana, Kırıkkale, Sülüklü-Cihanbeyli-Gölören, Upward continuation*

INTRODUCTION

Some of the interior basins in Turkey take place in the central part of the Anatolia. The biggest and most important is the Tuzgölü Basin related with the Haymana and Kırıkkale Basins. The study area is geographically located in the south of Ankara, down to the Taurus Mountains including the area commencing from the eastern part of Kırşehir and Aksaray in the east, through Polatlı and Konya to the west. Many authors have studied the area considering sedimentology and stratigraphy by using surface geology and limited outcrop data (Rigo de Righi and Cortesini 1959, Ünalan et al. 1976, Görür and Derman 1978, Derman 1979, Dinçer 1982, Dellaloğlu and Aksu 1984, Dellaloğlu 1991, Görür et al. 1998, Çemen et al. 1999). None of them used the geophysical data for analysing the basin development and evolution of the area considered. Only Çemen et al (1999) used very limited amount of seismic lines in their study. But as shown on the Figure 1, the surface of the study area was covered by young sedimentary units (mostly Quaternary) and outcrops of the basin fill are observed in some limited zones. All sedimentary units are surrounded by two important metamorphic massifs; Kırşehir and Kütahya-Bolkardağı from the east and west, respectively. Ophiolithic rocks originated from the Ankara Melangé and mafic-ultramafic rocks can also, be seen as small outcrops within the sedimentary cover. In addition, the Cappadocian volcanic complex covers the southeastern part of Tuzgölü Basin. In spite of stable surface geology, basins in the study area have complex geology with intensive tectonism and poor seismic data quality beneath the surface. Some of the burried structural components giving evident anomalies were studied by Kadıoğlu et al. (1998), Ateş (1999), Ateş and Kearey (2000). But these studies were performed by using aeromagnetic data, dominantly on small and local areas. As a result of difficulties explained above, all available geophysical data must be used in integration with each

other and the geological data (either well data and surface geology) for more regional studies.

This is the preliminary study of the main goal for regional basin evaluation of the Central Anatolian Basins.

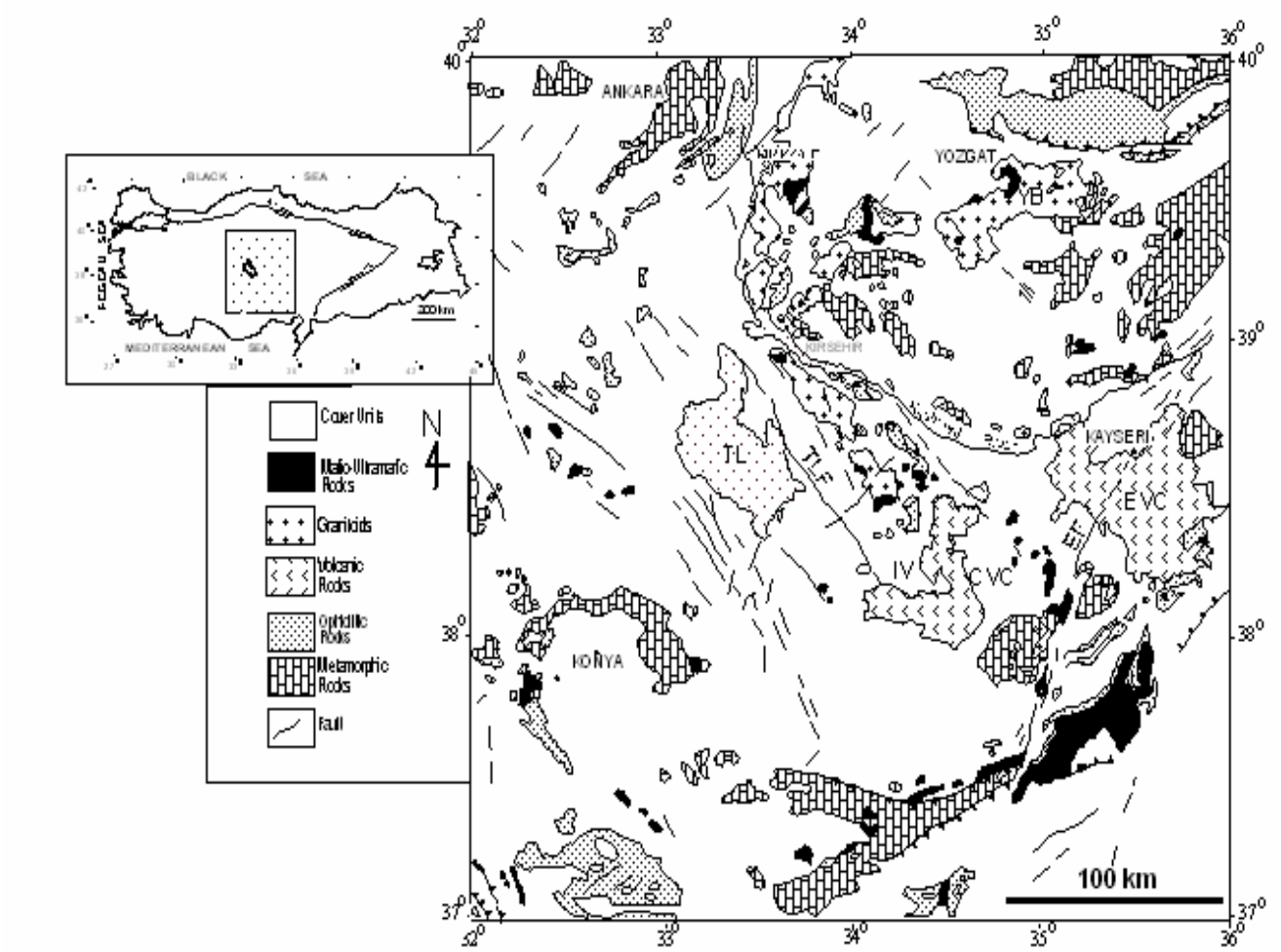

Figure 1. Geology Map. TL: Tuzgölü; CVC: Cappadocia Volcanic Complex; EVC: Erciyes Volcanic Complex; TLF: Tuzgölü Fault; IV: Ihlara Valley; EF: Ecemiş Fault

DATA AND APPLIED METHOD

Gravity & aeromagnetic data used in this study were obtained from the General Directorate of Mineral Research and Exploration (MTA) of Turkey. The aeromagnetic data was collected by Canadian Aero Service (CAS) with 600 m flight altitude above the surface. The topography is quite smooth and easy to acquire all kinds of geophysical data (Figure 2).

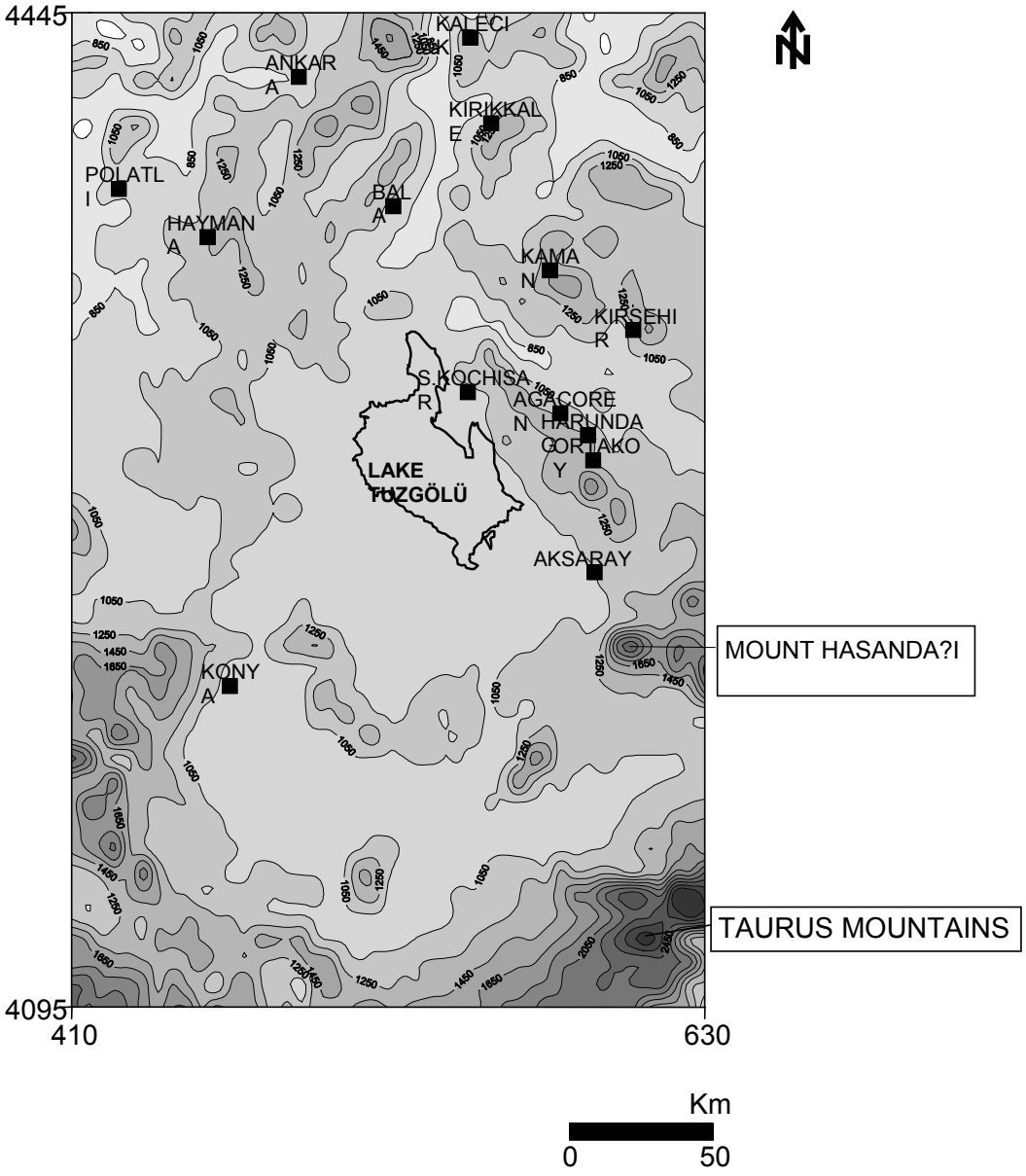

Figure 2. Topographical Map of the study area - Contour Interval: 200 m

However, it is easy and more practic to collect the data using an aeronautical service when considering the wideness of the study area. The total components of geomagnetic field was measured on N-S trending profiles. The measured values were reduced to October 1982 tables with daily variation and direction error corrections. The "International Geomagnetic Reference Field-IGRF" values were obtained by the use of a programme from the Baldwin and Langel (1993). The residual magnetic anomaly map after removing IGRF values was given in Figure 3. Important population city centers and boundary of the Lake Tuzgölü are also shown in this map.

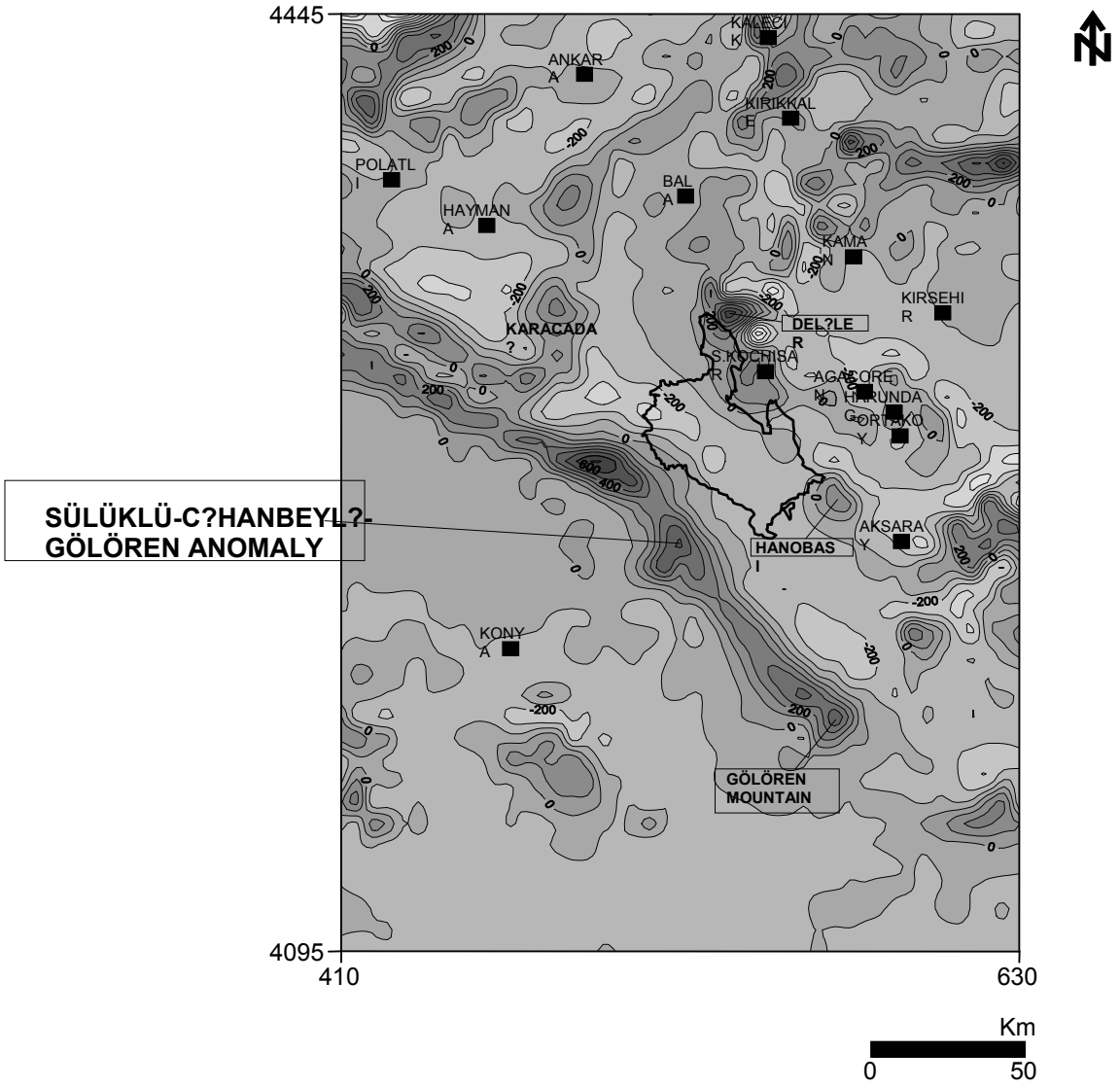

Figure 3. Magnetic anomaly map - Contour Interval: 100 nT

The gravity data was acquired by MTA, Geophysical Department. To the acquired data were applied the necessary corrections such as latitude correction, free-air correction, Bouguer correction, topographical and tidal corrections. Then both, the gravity & magnetic data were gridded at 2.5 km grid interval. The gravity anomaly map was given in Figure 4 including city centers and the Lake Tuzgölü. In this study, the gravity and magnetic anomaly maps are examined very carefully in order to determine the main anomalies and possible places of the basins. Later, both anomaly maps were applied to upward continuation to enhance the low wavenumber components of anomalies suppressing the short wavelengths. The reason of usage upward continuation is to separate the deep source spectrum which overlaps with the shallow source effects. This method has been employed up to 4 km with 1 km steps. Each step has been applied to both anomaly maps.

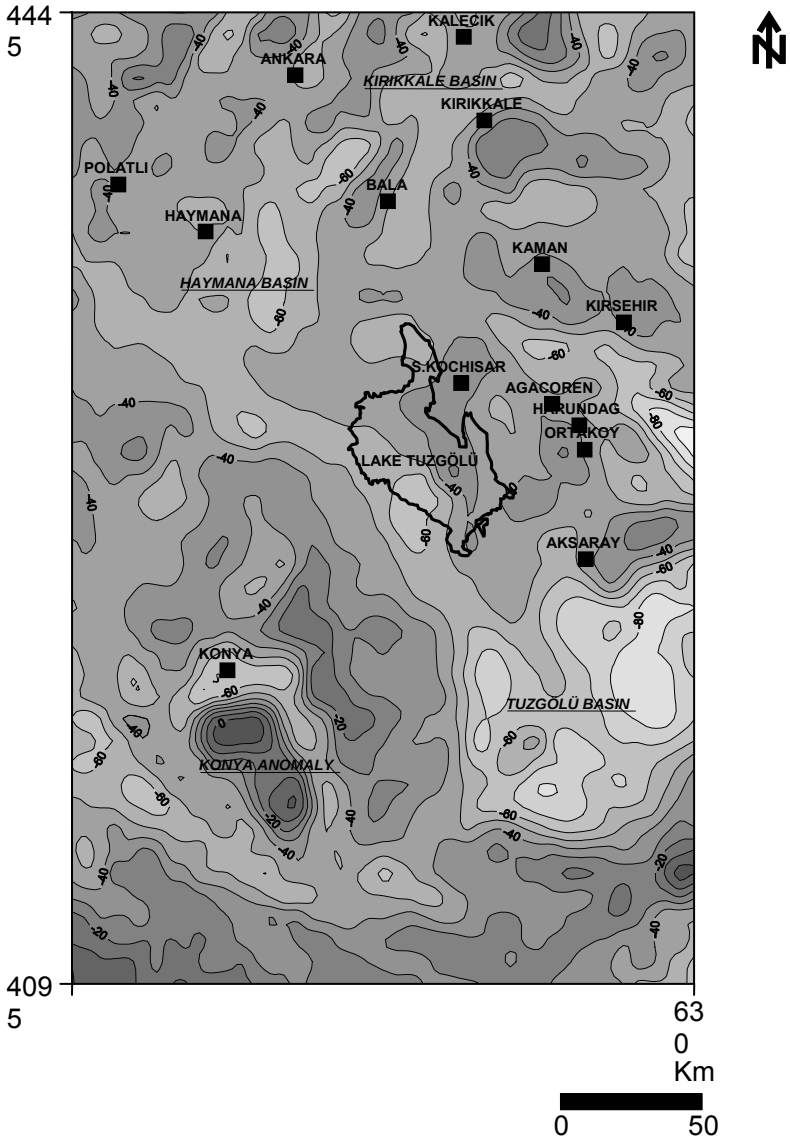

Figure 4. Gravity anomaly map - Contour Interval: 10 mGal

INTERPRETATION

Magnetic Data and Upward Continuation

The most attractive feature of the magnetic anomaly map (Figure 3) is the existence of an anomaly crossing the study area in the NW to SE direction which is named for the first time by authors of this study as "Sülüklü – Cihanbeyli - Gölören Anomaly". This important anomaly can be followed in all upward continuation maps from now on. A volcanic mass arising from the fault zone causes the anomaly and it gives an outcrop as a volcanic high in Gölören Mountain located in the southernmost edge of the anomaly. The anomaly has a branch extending N-NE direction through the Haymana Basin. The younger volcanics observed in the surface geology (Dinçer 1978) are thought to be related with this anomaly branch. The small volcanic high named Karacadağ is located on the area where the first closed contours on the northern branch of the anomaly. In comparison with the gravity anomaly map (Figure 4), two possibilities can be discussed for the magnetic anomaly arising from the volcanic origin, extending in the center of the

low gravity contours where the deeper part of Haymana Basin takes place. First, the basin fill could be composed of the volcano-sedimentary clastics, second; the volcanic lava flows could have been settled down among the sediments when the deposition laying down regularly. The same possibilities are valid for the Kırıkkale Basin located between Kırıkkale – Kalecik - Bala. Another magnetic anomaly is observed around the northernmost corner of the Tuzgölü Lake which is named as "Deliler Anomaly". Because the anomaly laying down beneath another younger volcanics outcropping between Deliler - Çatalören villages (Dellaloğlu 1991), it is thought to be a volcanic mass comprising the anomaly. Same kind of small anomaly is situated in the area close to the south eastern edge of the Tuzgölü Lake. It is named as "Hanobası Anomaly". The Cappadocia Volcanic Complex is extending to the study area and giving magnetic anomaly through the east and south east of Aksaray City center. Mount Hasandağı, shown in Figure 2 is an eruption center for the volcanic complex. Although the surface around the Mount Hasandağı is covered by volcanic lavas and ash flows, the effect of them is removed and changed positions either in the magnetic anomaly map (Figure 3) and upward continuation maps (Figure 5-6-7-8). Because of this reason, it is thought that the root of Mount Hasandağı does not take place beneath the high, probably the eruption has an inclined chimney to the east with high angle and the volcanic cover around the mountain is not thick enough to keep their contribution to magnetic anomaly. Upward continuation (1 km) map is shown in Figure 5.

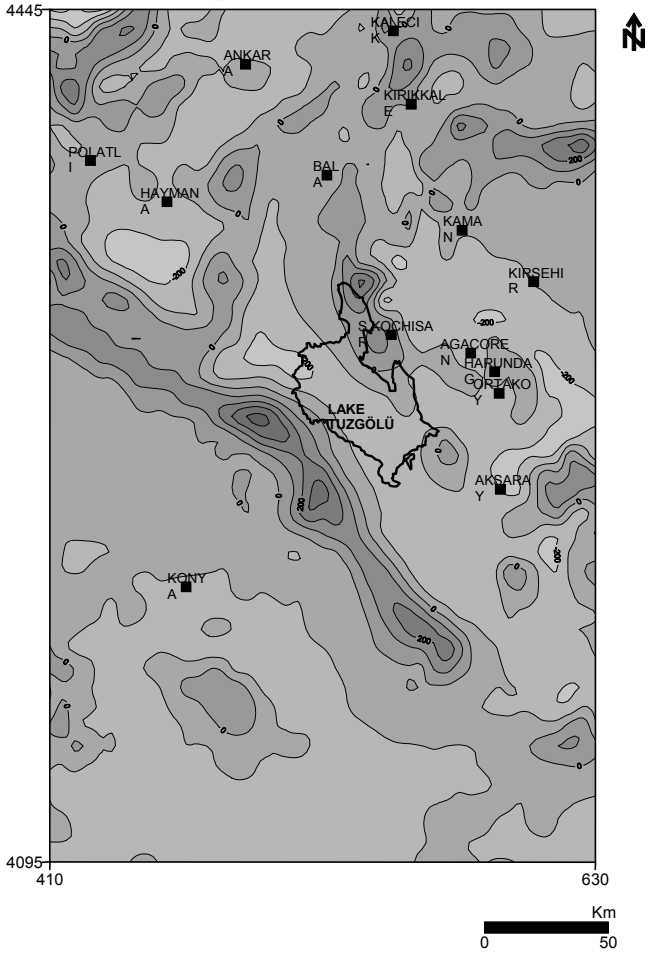

Figure 5. Upward continuatıon (1 km) map of the magnetic data - Contour Interval: 100 nT

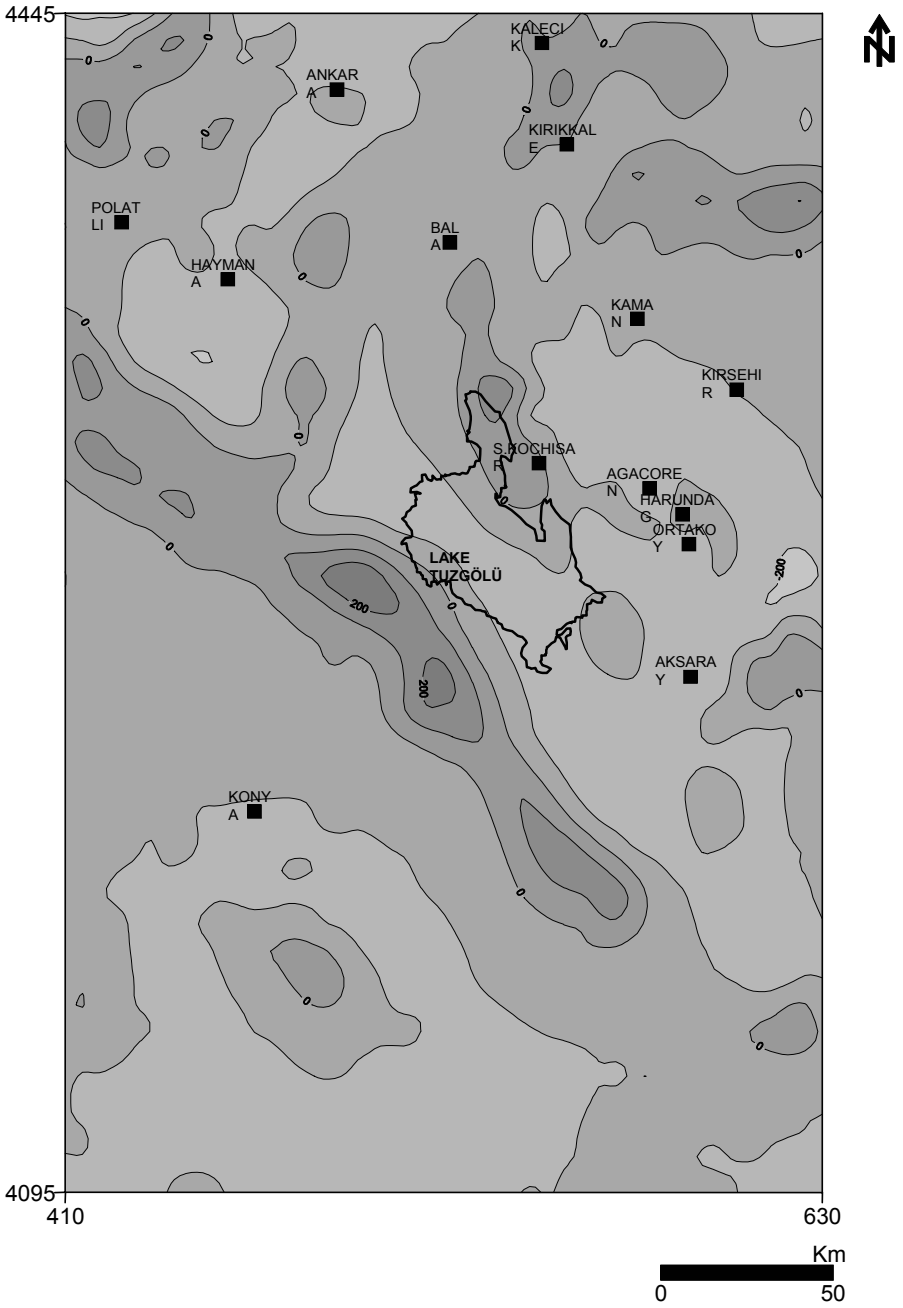

Figure 6. Upward continuatıon (2 km) map of the magnetic data - Contour Interval: 100 nT

Although all anomalies keep their position, contours are much more smooth when compared to the magnetic anomaly map (Figure 3). The smoothness of contours increases in the upward continuation (2 km) map in Figure 6. The contribution of Hasandağı Volcanics are getting weaker and/or removing. The northern branch of Sülüklü – Cihanbeyli - Gölören Anomaly is almost removed in upward continuation (3 km) map given in Figure 7. The Sülüklü-Cihanbeyli-Gölören Anomaly is localised in the west of the most deeper part of the Tersakan Basin which will be explained in the next chapter of this study. The last upward continuation (4 km) map does not include much differences from the previous map and given in Figure 8.

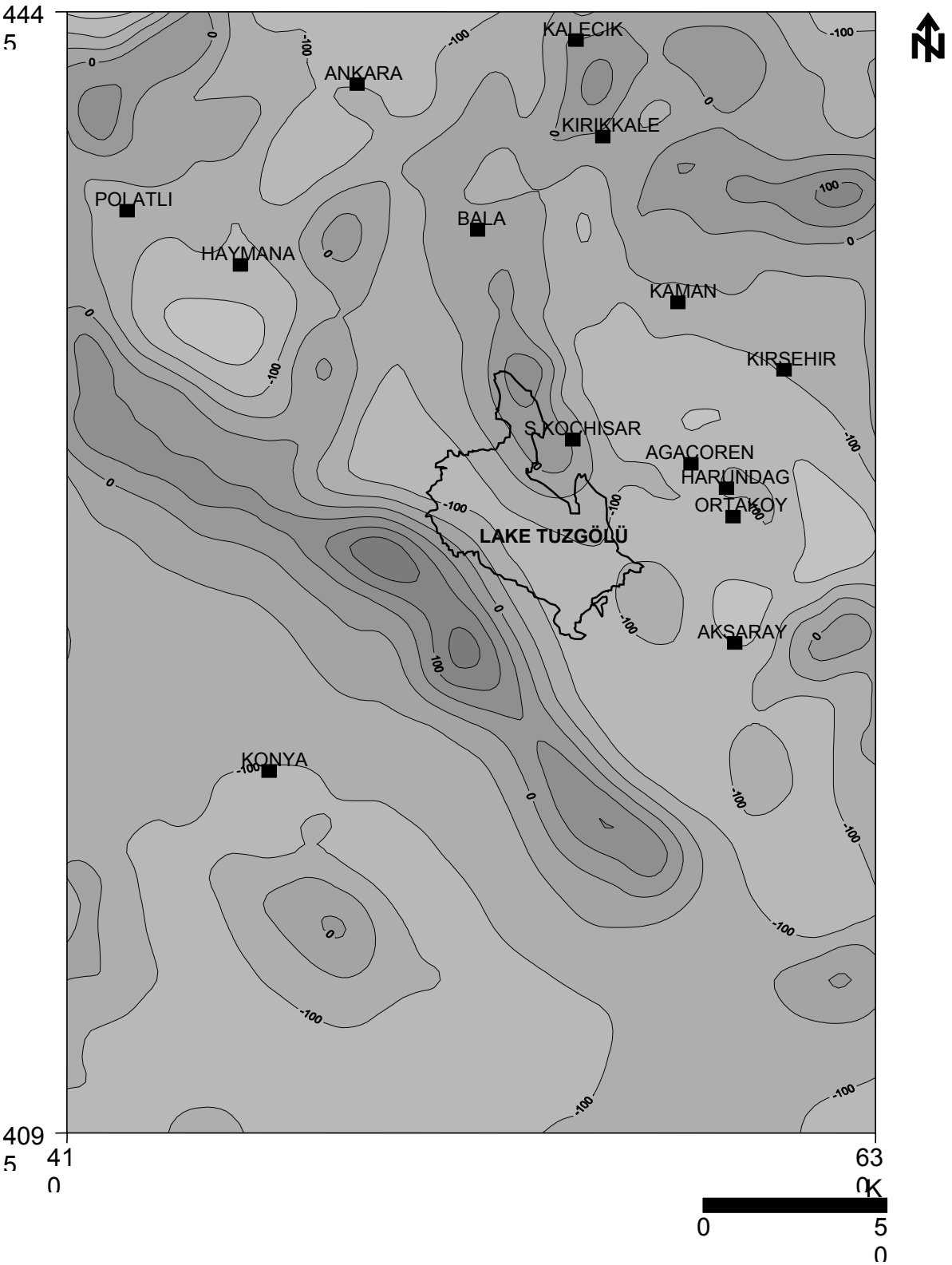

Figure 7. Upward continuatıon (3 km) map of the magnetic data - Contour Interval: 50 nT

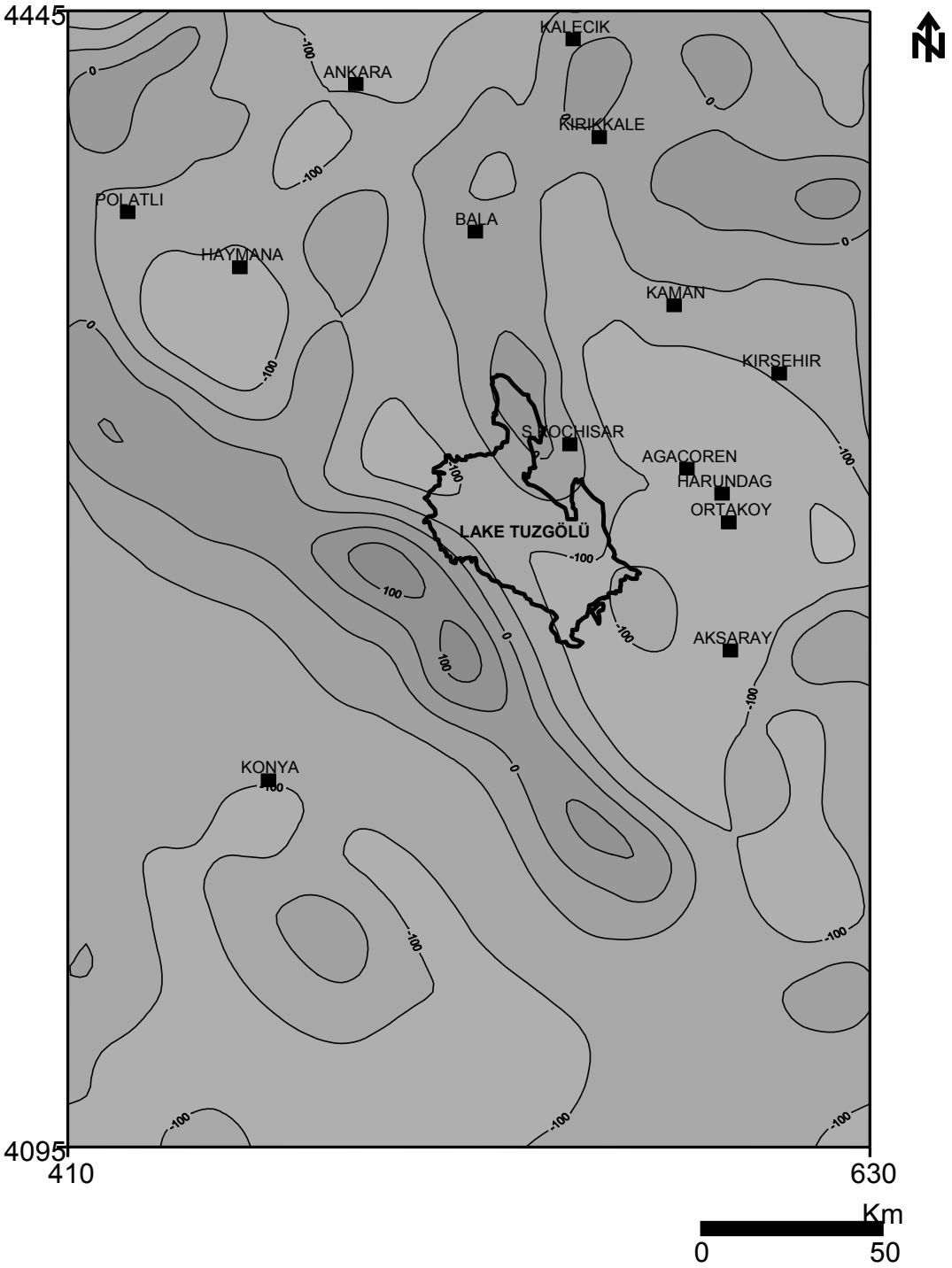

Figure 8. Upward continuatıon (4 km) map of the magnetic data - Contour Interval: 50 nT

Gravity Data and Upward Continuation

A few important results can be concluded after interpretation of the gravity anomaly map (Figure 4) and successive upward continuation maps. The first conclusion is about Tuzgölü and Ulukışla Basins. Southeastern part of the Tuzgölü Basin is sometimes named as "Ulukışla Basin" in previous studies. According to the gravity and magnetic anomaly maps and their upward continuation maps, there is no

separating structure and/or anomaly to divide the greatest basin into two basins. Because of this reason, only one name, the "Tuzgölü Basin" will be used from now on. Partition of the whole basin is geographically valid, only. Even though, the basin does not evidently extend through the southeast. Extremely negative contours are observed in the south and southeast of Aksaray covered by the Cappadocian Volcanic Complex (especially volcanic ash flows and tuffs from the Mount Hasandağı). The other observation: Haymana Basin is located to the east of Haymana, extending in the N-NE to S-SW direction, on the contrary to expectations of the basin around Haymana and to the west of Haymana city center. The third important observation is existence of channel shaped basin in the west of Tuzgölü Lake, connecting Tuzgölü and Haymana Basins to each other. This basin is named for the first time in this study as "Tersakan Basin". The Sülüklü-Cihanbeyli -Gölören Magnetic Anomaly extends to the west of considered basins as a boundary. The fourth observation is the Kırıkkale Basin located in between Kırıkkale, Kalecik and Bala. This basin is not evident as much as the other basins and it is seperated from the Haymana Basin by a saddle around Bala, extending parallel to the basins, both Haymana and Kırıkkale. The last observation is the existence of an anomaly in the south of Konya which has already been studied by Ateş and Kearey (2000). All basins mentioned above become more evident in the upward continuation (1 km) map shown in the Figure 9. The map is much more smooth, as expected, in the upward continuation (2 km) and basins are easily distinguished (Figure 10). In the upward continuation (3 km) map shown in Figure 11, the Haymana Basin becomes larger by removing of the saddle around Bala and it includes the Kırıkkale Basin by spreading over it. Another important development is the effect of the Cappadocian Volcanic Complex to the east of Aksaray. The contours representing this complex are getting more smooth and narrower by the increment of upward continuation. Finally, it gets completely removed in the upward continuation (4 km) map as shown in Figure 12. The Haymana Basin becomes larger together with the Kırıkkale Basin. The contour carrying –50 mGal value breaks off around the Tersakan Basin from the Tuzgölü Basin.

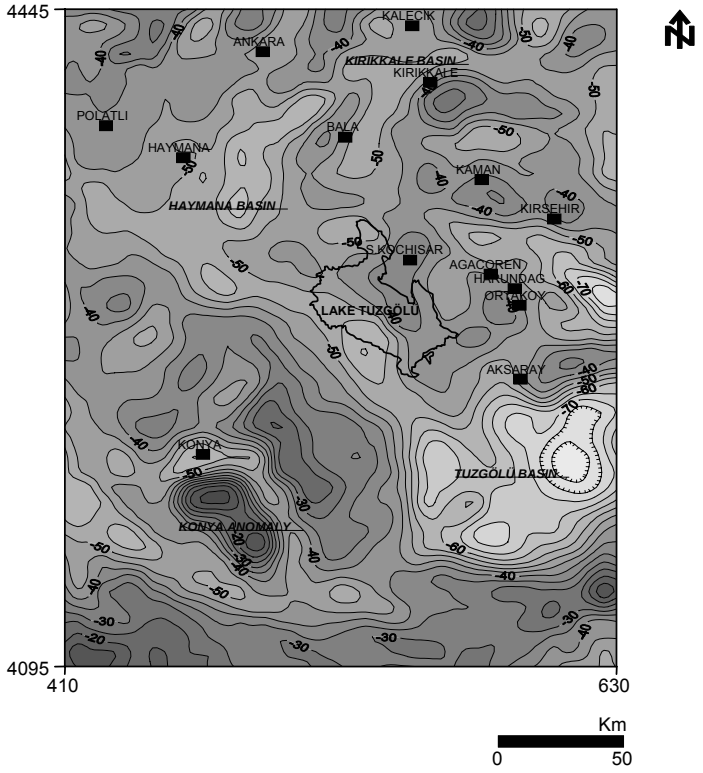

Figure 9. Upward continuatıon (1 km) map of the gravity data - Contour Interval: 5 mGal

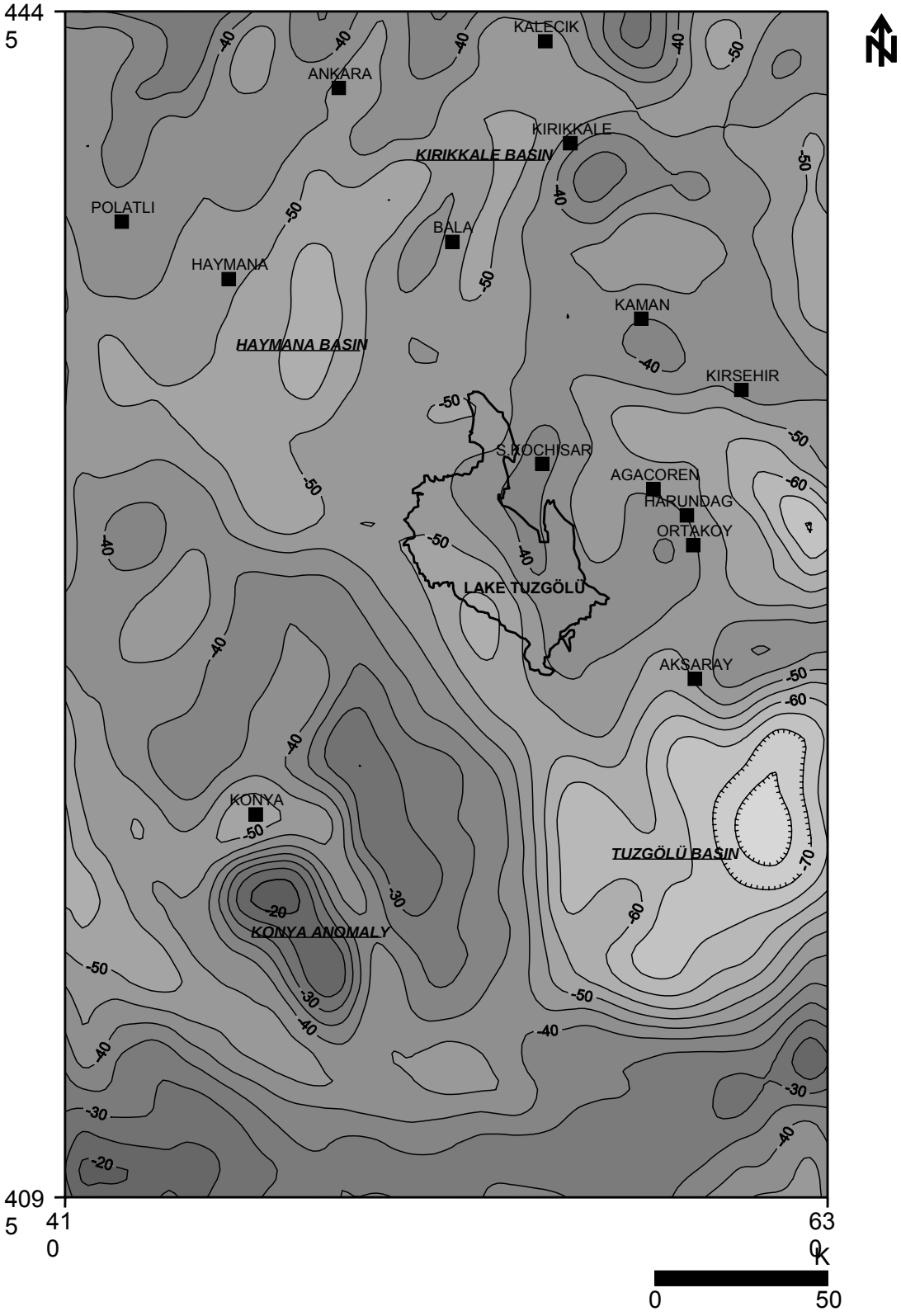

Figure 10. Upward continuatıon (2 km) map of the gravity data - Contour Interval: 5 mGal

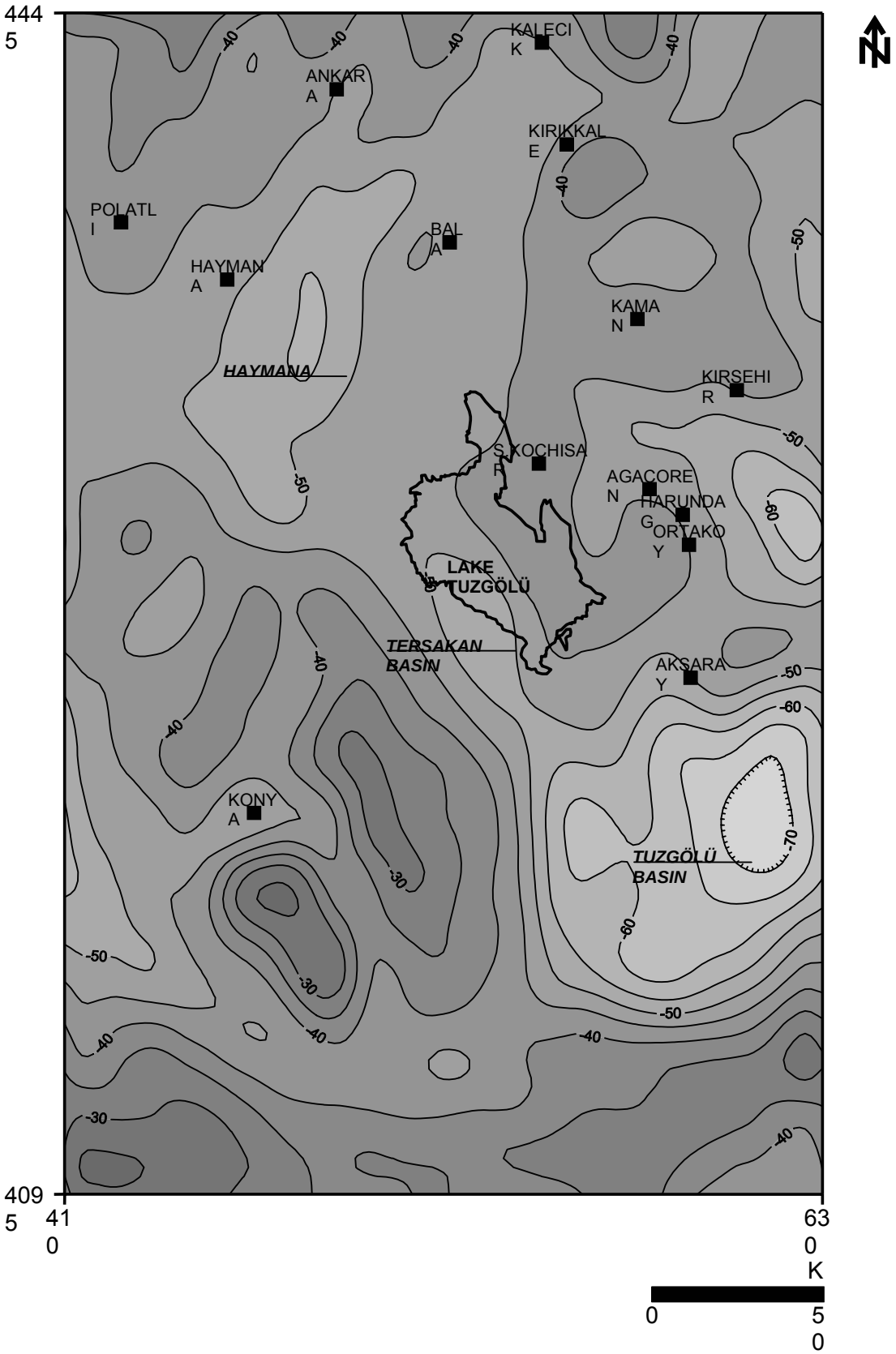

Figure 11. Upward continuatıon (3 km) map of the gravity data - Contour Interval: 5 mGal

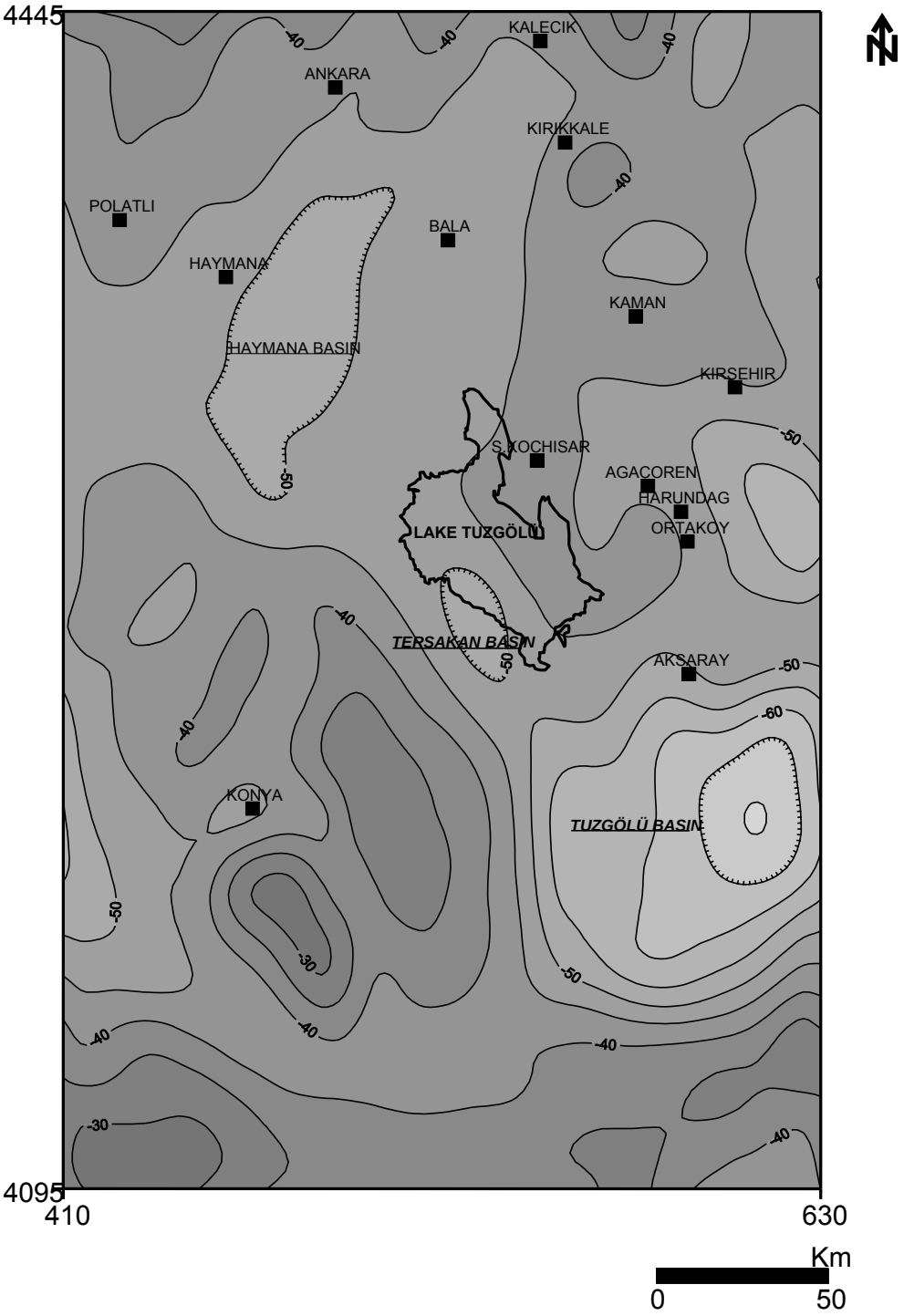

Figure 12. Upward continuatıon (4 km) map of the gravity data - Contour Interval: 5 mGal

DISCUSSION AND CONCLUSIONS

There is no tectonic and/or volcanic mass giving gravity & magnetic anomaly to divide the Tuzgölü Basin into two pieces as Ulukışla Basin and Tuzgölü Basin. As a result of this, it can be concluded that there is only one, unique basin in the south of central Anatolia. Extremely negative contours of this unique basin are observed in the south and

southeast of Aksaray covered by the Cappadocian Volcanic Complex (especially volcanic ash flows and tuffs from the Mount Hasandağı) and these volcanics do not have permanent magnetic anomaly in the upward continuation applications. Therefore, they are thought to be very shallow and not to be thick enough to keep their anomaly. Except the Tuzgölü Basin, there are three more basins named Haymana, Tersakan and Kırıkkale Basins. The Tersakan Basin extends as a channel shaped basin in between Tuzgölü and Haymana Basins in NW-SE direction. Although, the Kırıkkale Basin is observed as a different basin separated by a (possible) saddle around Bala, it becomes to be included by Haymana Basin in the upward continuation maps. It was believed that these basins have to be three dimensionally modelled in order to determine their accurate geometry, deepness and the thickness of the sedimentary deposition, properly. The most important part of the Tuzgölü Basin is observed in the area that covered by volcanics in the SE of Aksaray. This area should also, be modelled for confirmation of opinion that the deeper part of the Tuzgölü Basin is located in this zone. The relationship between the Haymana Basin and Kırıkkale Basin needs to be investigated by means of sedimentology and stratigraphically along with the geophysical research in detail.

Sülüklü-Cihanbeyli-Gölören Anomaly is the most important magnetic anomaly crossing the study area in the NW-SE direction. This anomaly could be investigated with the method of two dimensional modelling and characteristics of the body causing this anomaly should be subjected to further research in order to determine geometry, shape, thickness and the relationship between the neighbouring basins.

Results of this study and the suggested further investigation results should be comfirmed by the available seismic and borehole data. If the future investigation results are consistent to cover expectations, new seismic lines should be shot and some of the features should be tested by borehole drilling.

ACKNOWLEDGEMENTS

We would like to express our sincere thanks to the Mineral Research and Exploration Institute of Turkey for the use of gravity and magnetic data.

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