USE OF GRAVITY MODELLING TO DETERMINE THE GEOMETRY OF FAULTS BOUNDING THE ALAŞEHIR, BÜYÜK MENDERES AND DENIZLI BASINS, WESTERN TURKEY

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CHAPTER I

INTRODUCTION

The Menderes Massif of the Western Anatolian Extended Terrain is one of several metamorphic core complexes located in the Aegean region (Figure 1) and is part of the Alpine-Himalayan belt which experienced a series of continental collisions from the late Cretaceous to the Eocene (Şengör and Yılmaz, 1981; Tankut *et. al.*, 1998; Dilek *et. al.,* 1999; Stampli, 2000; Çemen *et. al.*, 2006). It covers an area greater than 50,000 km^2 of exposed metamorphic and igneous rocks of the Menderes Massif (Bozkurt and Park, 1994; Hetzel *et. al.*, 1995a,b; Emre and Sözbilir, 1997; Işık and Tekeli, 2001; Çemen *et. al.*, 2006), and is bound by the North Anatolian Fault Zone to the north, the Lycian Nappes to the south and the Southwest Anatolian Shear Zone to the east and southeast (Çemen *et. al.,* 2006). Some of the models proposed in order to explain the evolution of the region are (1) tectonic escape in which the collision of the Arabian and Eurasion Plates caused the Anatolian Plate to move westward along the North and East Anatolian Faults (Dewey and Şengör, 1979; Şengör, 1979; Şengör and Yılmaz, 1981; Şengör *et. al.,* 1985; Çemen *et. al.*, 1993, 1999); (2) back-arc extension caused by subduction along the Hellenic Arc (McKenzie, 1978; Le Pichon and Angelier, 1979, 1981; Muelenkamp *et. al.,* 1988; Spakman *et. al.*, 1988); and (3) orogenic collapse caused by Paleogene compression experienced over thermally weakened lithosphere (Dewey, 1988; Seyitoğlu and Scott, 1996; Dilek and Whitney, 2000). All of these proposed models infer to different timing for the initiation of extension along the Western Anatolian Extended Terrain.

The Menderes Massif was exhumed due to post-collisional extension experienced in the region (Çemen *et. al.,* 2006). It is bound by the Izmir-Ankara Suture Zone to the north and The Southwest Anatolian Shear Zone (SWASZ) to the south and east. The exhumation process caused several basin-forming graben like structures to form which are bounded by detachment surfaces and their antithetics. The most prominent features within the massif from north to south are the E-W trending basins called The Alaşehir, Küçük Menderes and Büyük Menderes Basins. The timing involved in the exhumation of the Menderes Massif and the formation of the various structures within the massif have been proposed to be episodic (Koçyiğit *et. al.,* 1999; Yılmaz *et. al.,* 2000; Bozkurt & Sözbilir, 2004, 2006; Beccaletto & Steiner, 2005; Bozkurt & Mittwede, 2005; Bozkurt & Rojay, 2005; Purvis & Robertson, 2005a, b; Emre & Sözbilir, 2007) and continuous by (Seyitoğlu *et. al.,* 2000,2002,2004; Glodny & Hetzel, 2007, Çemen *et. al.,* 2006).

Over the last decade there have been many field oriented studies within the Menderes Massif focused on the understanding of the age and structural relationships within the Massif. The timing, evolution and geometries of these structures within the massif remain a subject of controversy. In order to clarify the ages involved with the initiation of extension, radiometric dating studies have been conducted over the various stratigraphic units found around the Menderes Massif by Hetzel et. al., (1995a,b) and Catlos and Çemen (2005). A better understanding of the subsurface structures and structural relationships of the major structures within the massif can help us gain insights into the evolution of the Menderes Massif. Due to the hydrocarbon and hydrothermal potential within the Menderes Massif, the Turkish Petroleum Corporation (TPAO) has conducted several two dimensional seismic surveys over the Alaşehir and Büyük Menderes Basins. Details and results of these surveys are reported in Çiftçi et. al., (2010) and Çiftçi & Bozkurt, (2011). These studies cover only the Alaşehir and Büyük Menderes Basins. Results from Çiftçi et. al., (2010) study over the Büyük Menderes Basin indicates that the structural features are driven by a complex extensional fault system bound by a low angle south dipping detachment and its synthetic and antithetic faults. Results from the studies of Çiftçi & Bozkurt, (2011) over the Alaşehir Basin indicate a north dipping detachment surface with a flat ramp low dipping shallow segment a steep middle segment and a deep low angle segment. Çiftçi & Bozkurt, (2011) suggest that the graben containing the Alaşehir Basin (Gediz Graben) forms two sub basins the Salihli Basin and the Alaşehir Basin with a shallow middle section. Çiftçi & Bozkurt, (2011) indicate that thickness of sedimentary rocks within the Gediz Graben average around 4 km.

Very little is known about the subsurface geometry of structures within the Denizli Basin and the relationship of these structures to the Alaşehir and Büyük Menderes basins. In this study we extend the work of Çiftçi et. al., (2010) and Çiftçi & Bozkurt, (2011) and include the Denizli Basin in our study area. We use Bouguer gravity data together with Shuttle Radar Topography Mission Digital Elevation Model (SRTM-DEM) data over the Western Anatolian extended terrain to provide insights into the surface and sub-surface structures in the area.

Our specific objectives include: (1) investigate the geometry of the faults bounding the Alaşehir, Büyük Menderes and Denizli basins, (2) Delineate the extents of the Southwest Anatolian Shear Zone and (3) investigate the relationship between the Southwest Anatolian Shear Zone and the faults associated with these basins.

CHAPTER II

GEOLOGIC AND TECTONIC SETTING

The Menderes Massif metamorphic core complex is one of several metamorphic complexes located in the Aegean region (Figure 1). It contains several basins that are bounded in the north by the Izmir-Ankara suture zone and by the Southwest Anatolian shear zone to the south and east (Figure 2). The Menderes Massif is divided up into three sections: the northern section called the Northern Menderes Massif containing the north to south trending Gördes, Demirci and Uşak-Selendi basins, the Central Menderes Massif covering the area between the Alaşehir and Büyük Menderes basins and the Southern Menderes Massif covering the areas south of the Büyük Menderes basin containing the ENE trending Gökova and Kale-Tavas basins (Çemen *et. al.,* 2006) (Figures 1 & 2). Field-oriented geological studies in the Central Menderes massif indicate that the E-W trending grabens are bounded by low angle detachment surfaces, which are the north-dipping Alaşehir and the south-dipping Büyük Menderes detachment surfaces (Hetzel *et. al.*, 1995b; Emre, 1996; Seyitoğlu *et. al.,* 2002; Gessner *et. al.*, 2001a).

The footwall of the Alaşehir detachment contains the Salihli granitoid which is comprised of gneiss, schist, quartzite, marble and igneous rocks (Hetzel *et. al.,* 1995a). The southern margin of the Alaşehir graben (Figure 2) is locally bounded by the Horzum Turtleback fault surface (Çemen *et. al.,* 2005). The Büyük Menderes detachment surface separates high-grade metamorphic gneisses and a lower Miocene sedimentary rock succession in its hanging wall from the marble-intercalated mylonitized schists in its footwall (Göğüs, 2004).

The stratigraphic sequence within the massif consists of core material composed of augen gneisses, migmatites, and gabbros with some granulite and eclogite relics with medium to high grade metamorphic schists along with a cover sequence consisting of a Paleozoic schist envelope overlain by a Cenozoic marble envelope (Dürr, 1975; Akkök, 1983; Ashworth & Evirgen, 1984a; Şengör et. al., 1984; Satir & Friedrichsen, 1986; Konak et. al., 1987; Bozkurt, 1996; Oberhänsli et al., 1997; Hetzel et. al., 1998; Candan et al., 2001; Whitney & Bozkurt, 2002; Régnier et. al., 2003; Rimmelé et. al., 2005).

The Lycian Nappes contain the Karaova Formation (Upper Permian to Lower Triassic reddish to greenish metapelits) overlain by a thick succession of limestones and dolomites (Middle Triassic to Middle Jurassic) that grades upwards into cherty limestones (Upper Jurassic to Upper Cretaceous) with the upper layers containing calcite forming Rosetta limestones which in turn is overlain by the Campanian to Maastrichtian Karaböğürtlen wildflysch (Phillippson (1910–1915), de Graciansky, 1972; Bernoulli et. al., 1974; Çakmakoğlu, 1985; Okay, 1989; Rimmelé et. al., 2005).

The Denizli Basin is bounded by the south dipping Pammukkale fault zone to the north and the north dipping Babadağ fault zone to the south. The Denizli Basin contains Quaternary sedimentary units along with Neogene sedimentary units and volcanics with low-grade metamorphics.

The Menderes Massif is bound by a fault zone to the south that has an ENE trend termed the Southwest Anatolian Shear Zone (SWASZ) (Çemen et. al., 2006). Çemen et. al. (2006) suggests that SWASZ contains mostly normal faults in the vicinity of the Gulf of Gökova, but its movement is mostly oblique slip from the vicinity of Tavas toward Lake Acigöl where it makes a northward bend and possibly joins the Eskişehir fault zone north of the city of Afyon (Figure 2).

The Menderes Massif is believed to have been exhumed due to postcollisional extension during the Cenozoic (Bozkurt and Park, 1994; Hetzel et. al., 1995a,b; Emre and Sözbilir, 1997; Gessner et. al., 2001a; Ring and Collins, 2005; Çemen et. al., 2006). Studies suggest that the Alaşehir and Büyük Menderes detachment surfaces where initiated as high-angle normal faults during the early Miocene and due to footwall rotation became low-angle normal faults as Cenozoic extension continued (Seyitoğlu, 2002, 2004).

Çemen et. al., (2006) proposed a 3D model for Cenozoic extensional tectonics evolution of the western Anatolia extended terrain in order to clarify some of the confusion involved with the evolution of the Menderes Massif (Figure 3). The 3D model proposed by Çemen et. al., (2006), suggests that the Cenozoic extension in the western part of Turkey is a product of a continuous north directed extension. Çemen et al. (2006) proposed a three stage extensional deformation model of the region with each stage triggered by different mechanism (Figure 3). The first stage of extension was possibly triggered as the same time as the formation of the Southwest Anatolian Shear Zone during the late Oligocene, followed by the formation of the Büyük and Alaşehir detachment surfaces during the early Miocene and continuing with the third stage of extension initiated in the late Miocene which produced continuous extension along the Alaşehir, Büyük Menderes, Simav detachment surfaces and the oblique slip movement along the Southwest Anatolian Shear Zone (Çemen et. al., 2006). This extension was probably also responsible for the formation of the Küçük Menderes Graben and the second- and third-order-normal faults (Seyitoğlu et. al., 2000; Seyitoglu et al., 2002; Çemen et. al., 2006).

CHAPTER III

METHODS

3.1 SRTM-DEM

Shuttle Radar Topography Mission Digital Elevation Model (SRTM-DEM) data over the Menderes Massif was obtained from Geosoft's Dapple Servers. The data were gridded using Geosoft's Oasis Montaj software. In addition, a density slice map was produced of the topography using Environment for Visualizing Images (ENVI) software and an elevation range of 0 to 500m, with a 50m contour interval.

3.2 Gravity Data

The data were gridded using the minimum curvature technique (Briggs, 1974; Swain, 1976). Minimum curvature gridding is accomplished by fitting the smoothest possible surface to data values. Additionally, derivative filters were applied to the gravity data in order to enhance shallow subsurface structures. First order derivatives enable us to enhance shallow anomalies with high contrasts from their surroundings. Both the horizontal and vertical derivatives of potential fields are useful; horizontal derivatives enhance edges, whereas vertical derivatives narrow the width of anomalies and so calculate the source bodies more accurately (Cooper and Cowan, 2004). Variable order derivatives of potential fields are dependant on the amplitude and are a type of high pass filter. As a result, they enhance any noise within the data making it difficult to interpret structures (Miller and Singh, 1994).

In addition, the tilt derivative technique first proposed by Miller and Singh (1994) was applied to the gravity data. This method is useful in enhancing edges of anomalies for both shallow and deep sources because it is independent of amplitude. The tilt angle is the ratio of the first vertical derivative of the potential field to the horizontal gradient of the field. The tilt angle is positive over a source and negative elsewhere. When compared to other edge enhancement techniques such as the horizontal gradient, the second vertical derivative, and the analytical signal, the tilt angle is found to have the added advantage of responding well to both shallow and deep sources (Miller and Singh, 1994)

The upward continuation method is useful in removing shallow sourced anomalies from potential field data enhancing deep seated anomalies. Several upward continuation maps where created at different elevations (5km, 10km, and 20km) in order to gain an understanding of the deep structure of the anomalies.

Finally, 2-D Forward models of the Büyük Menderes, Alaşehir, and Denizli basins where created using GM-SYS by Geosoft. We assumed a very simple subsurface model consisting of two layers, the sedimentary rocks filling the basin and the basement rock of the metamorphic core complex. An average density value of 2.7 g/cm^3 was used for the basement metamorphic rocks observed within the metamorphic core complex, which mainly are gneisses and schists. For the sediments within the basins, an average density value of 2.4 g/cm^3 was used to represent the Quaternary and Neogene deposits. Depths observed in seismic sections interpreted by Çiftçi et. al. (2010) and (2011) over the Alaşehir and Büyük Menderes basins were used to constrain the initial models. Thickness of sediments within the Alaşehir and Büyük Menderes basins ranged from 2 to 4 km depending on the location of the seismic survey. For the profiles perpendicular to strike a depth of 4 km was used as a constraint due to the location of profiles, corresponding to the deeper sections of the basins. GM-SYS profiles taken along strike where drawn along shallower sections of the basins, therefore a depth constraint of 2-3 km was applied. Due to a lack of seismic data from within the Denizli basin, we applied similar depth constraints from the Alaşehir and Büyük Menderes basins for the initial starting models.

CHAPTER IV

RESULTS OF INVESTIGATION

The Bouguer gravity map, vertical derivative, tilt derivative and upward continued maps are shown in Figures 4 through 9. In addition the SRTM-DEM and SRTM density slice maps are shown on Figures 10 and 11. The GM-SYS 2-D profiles are shown on Figures 12 through 20.

4.1 Bouguer gravity and filtered maps

The Bouguer gravity values over the study area range from -80 to 3 mGals (Figure 4). These variations in the Bouguer Gravity map reflect the relative composition of the metamorphic core complex and sediments. In general three main ranges are observed, -60 to -80 mGals; -40 to -60 mGals and 3 to -40 mGals. The -80 to -60 mGals is observed over Lycian Nappes, whereas the -60 to -40 mGals is associated with the Eocene, Neogene, Pliocene and Quaternary deposits. Finally the most positive anomalous Bouguer values (-40 to 3 mGals) are associated with the high-grade metamorphics and granitoids from within the massif. The various basins within the massif indicate a Bouguer gravity range of -40 to -60 mGal and correspond to the Quaternary alluvium and Neogene sediments as seen on Figure 2.

The Bouguer gravity map (Figure 4) does not effectively resolve all structural features associated with the massif. The Küçük Menderes basin, the N-S trending Gördes, Demirci, Uşak and Selendi Basins and the SWASZ are barely visible on the Bouguer gravity map.

The first vertical derivative map (Figure 5) of the Western Anatolian extended terrain gives a clear image of the edges of structures of the massif. The Küçük Menderes Basin is better defined on this map and the juncture of the Alaşehir and Büyük Menderes basins with the Denizli Basin is evident. Along the southeastern edge of the Denizli basin we observe the Southwest Anatolian Shear Zone bordering this basin. The Southwest Anatolian Shear Zone (SWASZ) is well defined and the most eastward edge of the anomaly representing the Denizli Basin is curved. This curve is possibly due to right lateral shearing associated with the SWASZ.

The tilt derivative map (Figure 6) contains much better resolved edges for the anomalies observed. The edges of the anomalies representing the basins connected to the Alaşehir Detachment surface are better resolved in comparison to the vertical derivative map (Figure 5). The anomalies representing Alaşehir, Büyük and Küçük basins are also better resolved in the tilt derivative map. In the tilt derivative map (Figure 6) we observe that the SWASZ begins to curve towards the northwest past the Denizli basin and possibly continues westward following the northern edges of the N-S trending Uşak, Güre, Selendi, Demirci and Gördes Basins continuing outside of our dataset.

The edges for N-S trending Uşak, Güre, Selendi, Demirci and Gördes Basins are clearly delineated in both the vertical derivative (Figure 5) and tilt derivative maps. The Uşak-Güre Basin is clearly resolved as two separate basins with an edge separating both anomalies. Another noticeable anomaly within both filtered maps is an anomaly representing a buried basin located to the northwest of the Denizli Basin.

The major structures associated with the Central Menderes Massif are deep seated structures. Anomalies observed in the three upward continued maps (Figures 7, 8, 9), which correspond to the Alaşehir, Büyük Menderes and Denizli basins indicate anomalies at elevations greater than 20km which indicates that structures associated with the massif are very deep seated.

4.2 SRTM-DEM Maps

The Shuttle Radar Topography Mission Digital Elevation map (Figure 10) indicates the various ranges of elevations observed within the region. Elevations within the massif and surrounding areas range from 35m within the sedimentary basins to >1730 m over the Lycian Nappes. The Alaşehir, Büyük Menderes, Denizli, Uşak, Güre, Selendi, Demirci and Gördes Basins are well delineated. The SRTM-DEM density slice map (Figure 11) suggests a NW trend between the Alaşehir and Denizli Basins, whereas the Büyük Menderes Basin trends to the west of the Denizli Basin. The Denizli basin appears to be a segmented section of the Alaşehir basin with an elevation high separating them.

4.3 2-D Gravity Models

Several GM-SYS profiles where created along the Alaşehir, Büyük Menderes and Denizli basins. The locations of the profiles are shown on Figure 4. Profiles A-A' through D-D' (Figures12-15) cover the Alaşehir Basin. The southern edge of the basin indicates the location of the low angle detachment surface known as the Alaşehir detachment. Profiles over the Alaşehir Basin indicate low angle fault surfaces that steepen with depth. The basins are wider at the top and get narrower at depth. Faults bounding both sides of the basin are near symmetrical representing a full graben structure. Depths within the Alaşehir Basin range from 2.6 to 4.2 km. The along strike profile (Figure 15) suggests a basement high separating it into two sub basins.

Profiles E-E' through G-G' (Figures16-18) cover the Büyük Menderes basin. The northern part of the Büyük Menderes basin contains the Büyük Menderes detachment surface which is a low angle detachment surface. The fault surfaces bounding the basin indicate low angle fault surfaces that get steeper with depth. The geometries of the faults are near symmetrical on both ends indicating a full graben structure. Depths within the basin range from 3.8 to 4.8 km. The along strike profile (Figure 18) suggest that the basin depths increase to the east.

The Denizli Basin is bounded by the Pammukkale Fault Zone to the north of the basin and the Babadağ Fault Zone to the south. The profile created over the northwest section of the Denizli basin H-H’ (Figure 19) indicate low angle normal faults on either side of the basin suggesting full graben structure. When investigating the profile I-I’ (Figure 20) we observe a change from low angle faults to steep faults at depth. Depths within the Denizli Basin range from 4.2 to 9km.

CHAPTER V

DISCUSSION

Results from our study indicate that Bouguer gravity values over the basins range from -40 to -60 mGals and correspond to a thick package of Quaternary sedimentary rocks with a 3-4 km thickness for the Alaşehir and Büyük Menderes basins. Thickness for sedimentary units within the Denizli Basin range between 7-9 km along the southeast part of the basin closest to the SWASZ and up to 4km in the northwest part.

5.1 Basin Geometry

The geometries of the basins indicate a low angle detachment surface with a corresponding low angle antithetic fault for the Alaşehir and Büyük Menderes Basins. This correlates well with results from interpreted seismic sections from Çiftçi et. al., (2010) and Çiftçi & Bozkurt, (2011). The faults bounding the Alaşehir and Büyük Menderes Basins have a shallow angle near the surface and become steeper with depth suggesting that high angle normal faults bounding the Alaşehir and Büyük Menderes basins where rotated due to the initiation of extension during the Cenozoic (Seyitoglu *et. al.*, 2002, 2004).

The southeast section of the Denizli Basin contains almost flat ramp geometries that become very steep at depth as indicated in Figure 20. Sedimentary rock thicknesses within the basin vary from 4-8 km however due to the ambiguity of potential field data such as gravity it is possible that thicknesses of sedimentary rocks may be less. The profiles are dependant on density constraints and because there isn’t enough information from well data, it is not possible to create a model with exact densities of the various units within the basin. However, the profiles do suggest that sedimentary rock thicknesses within the southeast section are greater than the northwest margin. Filtered gravity maps suggest curvature along the southeast margin of the Denizli Basin where it comes into contact with the SWASZ. This shearing may have influenced the geometries of the faults bounding the Denizli Basin along the southeast margin which can be observed in Figure 20.

5.2 Gravity and SRTM-DEM

Investigating the SRTM-DEM 30m elevation and Bouguer gravity maps we noticed that the high elevations located to the east and southeast of the massif correspond to low mGal values that are attributed to the low density units associated with the Lycian Nappes. Another notable feature is the presence of a buried basin located to the northwest of the Denizli Basin. When comparing elevations observed on the SRTM-DEM data over the area indicates high elevations where the buried basin is located within the filtered maps. The results from the SRTM-DEM density slice map (Figure 6) are interpreted to suggest that the Denizli Basin appears to be a segmented continuation of the Alaşehir Basin. The break observed between these two basins correlates to Neogene sedimentary units and and volcanics observed on the surface in this area. However this covered area also corresponds to the location of the buried basin.

5.3 The Southwest Anatolian Shear Zone

The shear zone located to the south and east of the Menderes Massif was termed the Southwest Anatolian Shear Zone (SWASZ) by Çemen et. al., (2006). No detailed studies or mention of the SWASZ are discussed in previous studies of the massif. Therefore, analyzing the vertical derivative and tilt derivative map to delineate the extent of the SWASZ and recognize shear sense indicators was an important objective for this study. Results from the filtered maps indicate that the SWASZ is characterized by en echelon step patterns and the shear sense is evidenced by the curved margin of the southeast extent of the Denizli basin as pointed out with an arrow in the vertical derivative map (Figure 5). As mentioned in the tectonic settings section of this paper, Çemen et. al., (2006) stated that the SWASZ has an ENE trend and possibly joins the Eskişehir fault zone north of the city of Afyon. Observations from the tilt derivative map (Figure 6) indicate a slightly different pattern as the SWASZ curves towards the northwest past the Denizli Basin continues along the edges of the N-S trending Gördes, Demirci, Uşak and Güre Basins.

CHAPTER VI

CONCLUSION

The Menderes Massif of the Western Anatolian extended terrain is one of several metamorphic core complexes located in the Aegean region. Various field oriented studies conducted over the years have resulted in conflicting ideas as to the origin, timing, and evolution of the structural elements of the massif. Bouguer gravity data along with SRTM-DEM data from the Western Anatolian Extended Terrain has proven to be crucial in deciphering the subsurface geometries of the faults bounding the Alaşehir, Büyük Menderes and Denizli basins, delineating the extent of the SWASZ and understanding the structural relationships between the SWASZ and the faults associated with these basins.

Bouguer gravity maps along with profiles generated using GM-SYS have indicated that the Alaşehir, Büyük Menderes and Denizli Basins contain gravity anomaly values within a range between -30 to -60 mGals corresponding to a Quaternary and Neogene sediment thicknesses of 3-4 km with the thickest (~7-8 km) sediments modeled over the eastern part of the Denizli basin. The southeastern part of the Denizli Basin contains steep high angle faults caused by the shearing of the SWASZ and may be the reason for earthquake activity in the area. The Alaşehir, Büyük Menderes Basins are bound by low angle detachment surfaces and their corresponding antithetic faults. The SRTM-DEM density slice image suggests that the Denizli Basin is possibly a segmented portion of the Alaşehir Basin. Various filtered maps suggest that the SWASZ is characterized by right-stepping en echelon faults with a shear sense to them. The SWASZ extends past the Denizli Basin where it begins to curve in a NW direction and possibly continues along the edges of the N-S trending faults forming the Gördes, Demirci and Uşak-Güre Basins.

REFERENCES

Akkök, R., 1983, Structural and metamorphic evolution of the northern part of the Menderes Massif: New data from the Derbent area and their implication for the tectonics of the massif: Journal of Geology, v. 91, p. 342–350.

Ashworth, J.R., and Evirgen, M.M., 1984, Garnet and associated minerals in the southern margin of the Menderes Massif, southwest Turkey: Mineralogical Magazine, v. 121, p. 323–337.

Barka, A., 1997, Neotectonics of the Marmara region, *in* Schindler, C., and Pfister, M., eds., Active tectonics of northwestern Anatolia: The MARMARA Ploy-Project, a multidisciplinary approach by space-geodesy, geology, hydrogeology, geothermic and seismology: Zurich, Vdf Hochschulverlag AG an der ETH, p. 55–87.

Beccaletto, L. & Steiner, C., 2005, Evidence of two- stage extensional tectonics from the northern edge of the Edremit Graben, NW Turkey: Geodinamica Acta, v. 18, p. 283-297.

Bernoulli, D., de Graciansky, P. C. & Monod, O. (1974). The extension of the Lycian Nappes (SW Turkey) into the southeastern Aegean Islands: Eclogae Geologicae Helvetiae v. 67, p. 39–90.

Bozkurt, E., 1996, Metamorphism of Palaeozoic schists in the Southern Menderes Massif: field, petrographic, textural and microstructural evidence: Turkish Journal of Earth Sciences v. 5, p. 105–121.

Bozkurt, E. and Mittwede, S.K., 2005, Introduction: evolution of Neogene extensional tectonics of western Turkey: Geodin. Acta, v. 18, p. 153-165.

Bozkurt, E., and Park, R.G., 1994, Southern Menderes Massif: An incipient metamorphic core complex in West Anatolia, Turkey: Journal of the Geological Society, v. 151, p. 213–216.

Bozkurt, E. and Rojay, B., 2005, Episodic, two- stage Neogene extension and short-term intervening compression in western Anatolia: field evidence from the Kiraz basin and Bozdağ horst: Geodin. Acta, v. 18, p. 299-316.

Bozkurt, E. and Sözbilir, H., 2004, Tectonic evolution of the Gediz Graben: field evidence for an episodic, two-stage extension in western Turkey: Geology Magazine, v. 141, p. 63-79.

Bozkurt, E. and Sözbilir, H., 2006, Evolution of the large-scale active Manisa Fault, southwest Turkey: implications on fault development and regional tectonics. Geodinamica Acta, v. 19, p. 427-453.

Briggs, I. C., 1974, Machine contouring using minimum curvature: Geophysics 39, DOI:10.1190/1.1440410.

Çakmakoğlu, A. (1985). Aydın N19-d3, Marmaris O19-a2 ve Denizli M21-d3-c4, MTA report (‘Paftasına ait genelleştirilmis dikme kesit’). Bornova–Izmir: MTA enstitüsü Jeoloji.

Candan, O., Dora, O.O., Oberhänsli, R., Centinkaplan, M., Partzsch, J.H., Warkus, F.C., and Dürr, S., 2001, Pan-African high-pressure metamorphism in the Precambrian basement of the Menderes Massif, western Anatolia, Turkey: International Journal of Earth Sciences, v. 89, p. 793–811, doi: 10.1007/s005310000097.

Catlos, E.J., and Çemen, I., 2005, Monazite ages and the evolution of the Menderes Massif, western Turkey: International Journal of Earth Sciences, v. 94, p. 204–217, doi: 10.1007/s00531-005-0470-7.

Çemen, I., Goncuoglu, M.C., Erler, A., Kozlu, H., and Perincek, D., 1993, Indentation tectonics and associated lateral extrusion in east, southeast and central Anatolia: Geological Society of America Abstracts with Programs, v. 25, no. 7, p. A116.

Çemen, I., Goncuoglu, C., and Dirik, K., 1999, Structural Evolution of the Tuzgolu Basin in Central Anatolia, Turkey: Journal of Geology, v. 107, p. 693–706, doi: 10.1086/314379.

Çemen, I., Tekeli, O., and Seyitoğlu, G., 2005, Are turtleback fault surfaces common tectono-morphologic features of highly extended terranes?: Earth Science Reviews, v. 72, p. 139–148.

Çemen, I., Catlos, E. J., Göğüs, O., and Özerdem, C., 2006, Postcollisional extensional tectonics and exhumation of the Menderes massif in the Western Anatolia extended terrane, Turkey: Geological Society of America, Special Paper 409, p. 353-379.

Çiftçi, N. B., Bozkurt, E., 2009, Structural evolution of the Gediz Graben, SW Turkey: temporal and spatial variation of the graben basin: Basin Research v. 22, p. 846-873, doi:10.1111/j.1365-2117.2009.00438.

Çifçi, G., Pamukçu, O., Çoruh, C., Çopur, S., and Sözbilir, H., 2011, Shallow and Deep Structure of a Superdetachment Basin Based on Geological, Conventional Deep Seismic Reflection Section and Gravity Data in the Büyük Menderes Graben, Western Anatolia: Surveys in Geophysics v. 32, p. 271-290, DOI 10.1007/s10712-010-9109-8.

Cooper, G.R.J., Cowan, D.R., 2004, Filtering using variable order vertical derivatives: Computers & Geosciences 30, p. 455-459.

de Graciansky, P. C. (1972). Recherches géologiques dans le Taurus Lycien occidental. Ph.D. thesis, Université Paris Sud, Orsay, 571 pp.

Dewey, J.F., 1988, Extensional collapse of orogens: Tectonics, v. 7, p. 1123– 1139.

Dewey, J.F., and Şengör, A.M.C., 1979, Aegean and surrounding regions: Complex multiplate and continuum tectonics in a convergent zone: Geological Society of America Bulletin, v. 90, p. 84–92, doi: 10.1130/0016-7606 (1979)90<84:AASRCM2>2.0.CO;2.

Dilek, Y., Thy, P., Hacker, B., and Grundving, S., 1999, Structure and petrology of Tauride ophiolites and mafic dike intrusions (Turkey): Implications for the Neo-Tethyan ocean: Geological Society of America Bulletin, v. 111, p. 1192–1216, doi: 10.1130/0016-7606(1999)111<1192:SAPOTO>2.3.CO;2.

Dilek, Y., and Whitney, D.L., 2000, Cenozoic crustal evolution in central Anatolia: extension, magmatism, and landscape development, *in* Panayides, I., Xenophontos, C., and Malpas, J., eds., Proceedings of the Third International Conference on the Geology of the Eastern Mediterranean: Geological Survey Department, Nicosia, Cyprus, p. 183–192.

Dürr, S., 1975, Über Alter und geotektonische Stellung des Menderes-Kristallins-SW-Anatolien und seine Aequivalente in der mittleren Aegaeis. Habilitation thesis, University of Marburg-Lahn, p.106.

Emre, T., 1996, Tectonic evolution of the Gediz graben: Geological Bulletin of Turkey, v. 39, p. 1–18.

Emre, T., and Sözbilir, H., 1997, Field evidence for metamorphic core complex, detachment faulting and accommodation faults in the Alasehir and Büyük Menderes grabens (western Turkey), *in* Proceedings, International Earth Science Colloquium: Aegean Region, Izmir, v. 1, p. 73–93.

Emre, T. and Sözbilir, H., 2007, Tectonic evolution of the Kiraz Basin, Küçük Menderes Graben: evidence for compression-uplift-related basin formation overprinted by extensional tectonics in West Anatolia: Turk. J. Earth Sci., v. 16, p. 441-470.

Gessner, K., Ring, U., Johnson, C., Hetzel, R., Passchier, C.W., and Güngör, T., 2001a, An active bivergent rolling-hinge detachment system: Central Menderes metamorphic core complex in western Turkey: Geology, v. 29, p. 611–614, doi: 10.1130/0091-7613 029<0611:AABRHD> 2.0.CO;2.

Gessner, K., Piazolo, S., Güngör, T., Ring, U., Kroner, A., and Passchier, C.W., 2001b, Tectonic significance of deformation patterns in granitoid rocks of the Menderes nappes, Anatolide belt, southwest Turkey: International Journal of Earth Sciences, v. 89, p. 766–780, doi: 10.1007/s005310000106.

Glodny, J., and Hetzel, R., 2007, Precise U-Pb ages of syn-extensional Miocene intrusions in the central Menderes Massif, westernTurkey. Geology Magazine, v. 144, p. 235-246.

Göğüs, O., 2004, Geometry and tectonic significance of the Büyük Menderes detachment in the Bascayir area, Buyuk Menderes graben, western Turkey [M.S. thesis]: Oklahoma State University, Stillwater, Oklahoma.

Hetzel, R., Ring, U., Akal, C., and Troesch, M., 1995b, Miocene NNE-directed extensional unroofing in the Menderes Massif, southwestern Turkey: Journal of the Geological Society of London, v. 152, p. 639–654.

Hetzel, R., Passchier, C.W., Ring, U., and Doram, O.O., 1995a, Bivergent extension in orogenic belts: The Menderes Massif (southwestern Turkey): Geology, v. 23, p. 455–458, doi: 10.1130/0091-7613(1995)023<0455: BEIOBT>2.3.CO;2.

Hetzel, R., and Reischmann, T., 1996, Intrusion age of Pan-African augen gneisses in the southern Menderes Massif and the age of cooling after Alpine ductile extensional deformation: Geological Magazine, v. 133, p. 565–572.

Hetzel, R., Romer, R.L., Candan, O., and Passchier, C.W., 1998, Geology of the Bozdag area, central Menderes Massif, SW Turkey: Pan-African basement and Alpine deformation: Geologische Rundschau, v. 87, p. 394–406, doi: 10.1007/s005310050218.

Isik, V., and Tekeli, O., 2001, Late orogenic crustal extension in the northern Menderes massif (western Turkey): Evidences for metamorphic core complex formation: International Journal of Earth Sciences, v. 89, p. 757–765, doi: 10.1007/s005310000105.

Isik, V., Seyitoğlu, G., and Çemen, I., 2003, Ductile-brittle transition along the Alasehir shear zone and its structural relationship with the Simav Detachment, Menderes Massif, western Turkey: Tectonophysics, v. 374, p. 1–18, doi: 10.1016/S0040-1951(03)00275-0.

Kocyigit, A., Yusufoglu, H., and Bozkurt, E., 1999, Evidence from the Gediz graben for episodic two-stage extension in western Turkey: Journal of the Geological Society of London, v. 156, p. 605–616.

Konak, N., Akdeniz, N. & Öztürk, E. M., 1987, Geology of the south of Menderes Massif. In: Correlation of Variscan and Pre-Variscan Events of the Alpine Mediterranean Mountain Belt. Field Meeting, IGCP Project 5. Publications of the Mineral Research and Exploration Institute of Turkey, pp. 42–53.

Le Pichon, X., and Angelier, J., 1979, The Hellenic arc and trench system: Akey to the neotectonic evolution of the Eastern Mediterranean area: Tectonophysics, v. 60, p. 1–42, doi: 10.1016/0040-1951(79)90131-8.

Le Pichon, X., and Angelier, J., 1981, The Aegean Sea: Philosophical Transactions of the Royal Society of London, v. A 300, p. 357–72.

McClusky, S., Balassanian, S., Barka, A., Demir, C., Ergintav, S., Georgiev, I., Gurkan, O., Hamburger, M., Hurst, K., Kahle, H.G., Kastens, K., Kekelidze, G., King, R., Kotzev, V., Lenk, O., Mahmoud, S., Mishin, A., Nadaria, M., Ouzounis, A., Paradissis, D., Peter, Y., Prilepin, M., Reilenger, R.E., Sanli, I., Seeger, H., Tealeb, A., Toksöz, M.N., and Veis, G., 2000, Global Positioning System constraints on plate kinematics and dynamics in the Eastern Mediterranean and Caucasus: Journal of Geophysical Research, v. 105, p. 5695–5720, doi: 10.1029/1999JB900351.

McKenzie, D., 1978, Active tectonics of the Alpine-Himalayan belt: The Aegean Sea and surrounding regions: Geophysical Journal of Royal Astronomical Society, v. 55, p. 217–254.

Miller, H. G., Singh, V., 1994, Potential field tilt – a new concept for location of potential field sources: Journal of Applied Geophysics v. 32, p. 213-217.

Meulenkamp, J.E., Wortel, W.J.R., Van Wamel, W.A., Spakman, W., and Hoogerduyn Strating, E., 1988, On the Hellenic subduction zone and geodynamic evolution of Crete since the late Middle Miocene. Tectonophysics, v. 146, p. 203–215.

Oberhänsli, R., Candan, O., Dora, O.O., and Durr, S., 1997, Eclogites within the Menderes Massif, western Turkey: Lithos, v. 41, p. 135–150, doi: 10.1016/ S0024-4937(97)82009-9.

Oberhänsli, R., Candan, O., Warkus, F.C., Partzsch, J.H., and Dora, O.O., 1998, The age of blueschist metamorphism in the Mesozoic cover series of the Menderes Massif: Schweizerische Mineralogische und Petrographische Mitteilungen, v. 78, p. 309–316.

Okay, A. I., 1989, Geology of the Menderes Massif and the Lycian Nappes south of Denizli, western Taurides: Bulletin of Mineral Research & Exploration (Turkey) v. 109, p. 37–51.

Okay, A.I., 2001, Stratigraphic and metamorphic inversions in the central Menderes Massif: A new structural model: International Journal of Earth Sciences, v. 89, p. 709–727, doi: 10.1007/s005310000098.

Phillipson, A., 1910–1915, Reisen und Forshungen im westlichen Kleinasien: Erganzunghefte 167, 172, 177, 180, 183 der Petermanns Mitteilungen Gotha, Justus Perthes.

Purvis, M., and Robertson, A., 2004, Apulsed extension model for the Neogene-Recent east-west trending Alasehir Graben and the NE-SW-trending Selendi and Gördes Basins, western Turkey: Tectonophysics, v. 391, p. 171-201, doi: 10.1016/j.tecto.2004.07.011.

Regnier, J.L., Ring, U., Passchier, C.W., Gessner, K., and Güngör, T., 2003, Contrasting metamorphic evolution of metasedimentary rocks from the Cine and Seliyme nappes in the Anatolide belt, western Turkey: Journal of Metamorphic Geology, v. 21, p. 699–721, doi: 10.1046/j.1525-1314.2003.00473.x.

Rimmele, G., Oberhänsli, R., Goffe, B., Jolivet, L., Candan, O., and Çetinkaplan, M., 2003, First evidence of high-pressure metamorphism in the “Cover series” of the southern Menderes Massif: Tectonic implications and metamorphic implications for the evolution of SW Turkey: Lithos, v. 71, p. 19–46, doi: 10.1016/S0024-4937(03)00089-6.

Rimmelé, G., Parra, T., Goffé, B., Oberhänsli, R., Jolivet, L., Candan, O., 2005, Exhumation Paths of High-Pressure–Low-Temperature Metamorphic Rocks from the Lycian Nappes and the Menderes Massif (SW Turkey): a Multi-Equilibrium Approach: Journal of Petrology, v. 46, p. 641-669.

Ring, U., and Collins, A.S., 2005, U-Pb SIMS dating of syn-kinematic granites: Timing of core-complex formation in the northern Anatolide belt of western Turkey: Journal of the Geological Society of London, v. 162, p. 289–298.

Satir, M., and Friedrichsen, H., 1986, The origin and evolution of the Menderes Massif, W-Turkey: Arubidium/strontium and oxygen isotope study: Geologische Rundschau, v. 75, no. 3, p. 703–714, doi: 10.1007/BF01820642.

Şengör, A.M.C., Görür, N., and Şaroğlu, F., 1985, Strike-slip deformation basin formation and sedimentation: Strike-slip faulting and related basin formation in zones of tectonic escape: Turkey as a case study, in Biddle, K.T., and Christie-Blick, N., eds., Strike-slip faulting and basin formation: Society of Economic Paleontologists and Mineralogist Special Publication, v. 37, p. 227–264.

Şengör, A.M.C., 1979, The North Anatolian transform fault: its age, offset and tectonic significance: Journal of the Geological Society of London, v. 136, p. 269–282.

Şengör, A.M.C., Satir, M., and Akkök, R., 1984, Timing of tectonic events in the Menderes massif, western Turkey: Implications for tectonic evaluation and evidence for Pan-African basement in Turkey: Tectonics, v. 3, p. 693–707.

Sengör, A.M.C., Yilmaz, Y., 1981, Tethyan evolution of Turkey: a plate tectonic approach: Tectonophysics 75, p. 181–241.

Seyitoğlu, G., Çemen, I., and Tekeli, O., 2000, Extensional folding in the Alasehir graben, western Turkey: Journal of the Geological Society of London, v. 157, p. 1097–1100.

Seyitoğlu, G., and Scott, B.C., 1996, The cause of north-south extensional tectonics in western Turkey: Tectonic escape vs. back-arc spreading vs. orogenic collapse: Journal of Geodynamics, v. 22, p. 145–153, doi: 10.1016/0264-3707(96)00004-X.

Seyitoğlu, G., Tekeli, O., Çemen, I., Sen, S., and Isik, V., 2002, The role of the flexural rotation / rolling hinge model in the tectonic evolution of the Alasehir graben, western Turkey: Geological Magazine, v. 139, p. 15–26, doi: 10.1017/S0016756801005969.

Seyitoğlu, G., Isik, V., and Çemen, I., 2004, Complete Tertiary exhumation history of the Menderes massif, western Turkey: An alternative working hypothesis: Terra Nova, v. 16, p. 358–364, doi: 10.1111/j.1365-3121.2004.00574.x.

Spakman, W., Wortel, M.J.R., and Vlaar, N.J., 1988, The Hellenic subduction zone: Atomographic image and its geodynamic implications: Geophysical Research Letters, v. 15, p. 60–63.

Stampli, S.M., 2000, Tethyan oceans: Geological Society of London Special Publications, v. 173, p. 1–23.

Swain, C. J., 1976, A FORTRAN IV program for interpolating irregularly spaced data using the difference equations for minimum curvature: Computers and Geosciences v. 1, p. 231-240.

Tankut, A., Dilek, Y., and Önen, P., 1998, Petrology and geochemistry of the Neo-Tethyan volcanism as revealed in the Ankara mélange, Turkey: Journal of Volcanology and Geothermal Research, v. 85, p. 265–284.

Whitney, D.L., and Bozkurt, E., 2002, Metamorphic history of the southern Menderes massif, western Turkey: Geological Society of America Bulletin, v. 114, p. 829–838, doi: 10.1130/0016-7606.

Yılmaz, Y., Genç, Ş.C., Gürer, F., Bozcu, M., Yılmaz, K., Karacik, Z., Altunkaynak, Ş., and Elmas, A., 2000, When did the western Anatolian grabens begin to develop?: Geological Society Special Publication 173, p. 353–384.

FIGURES

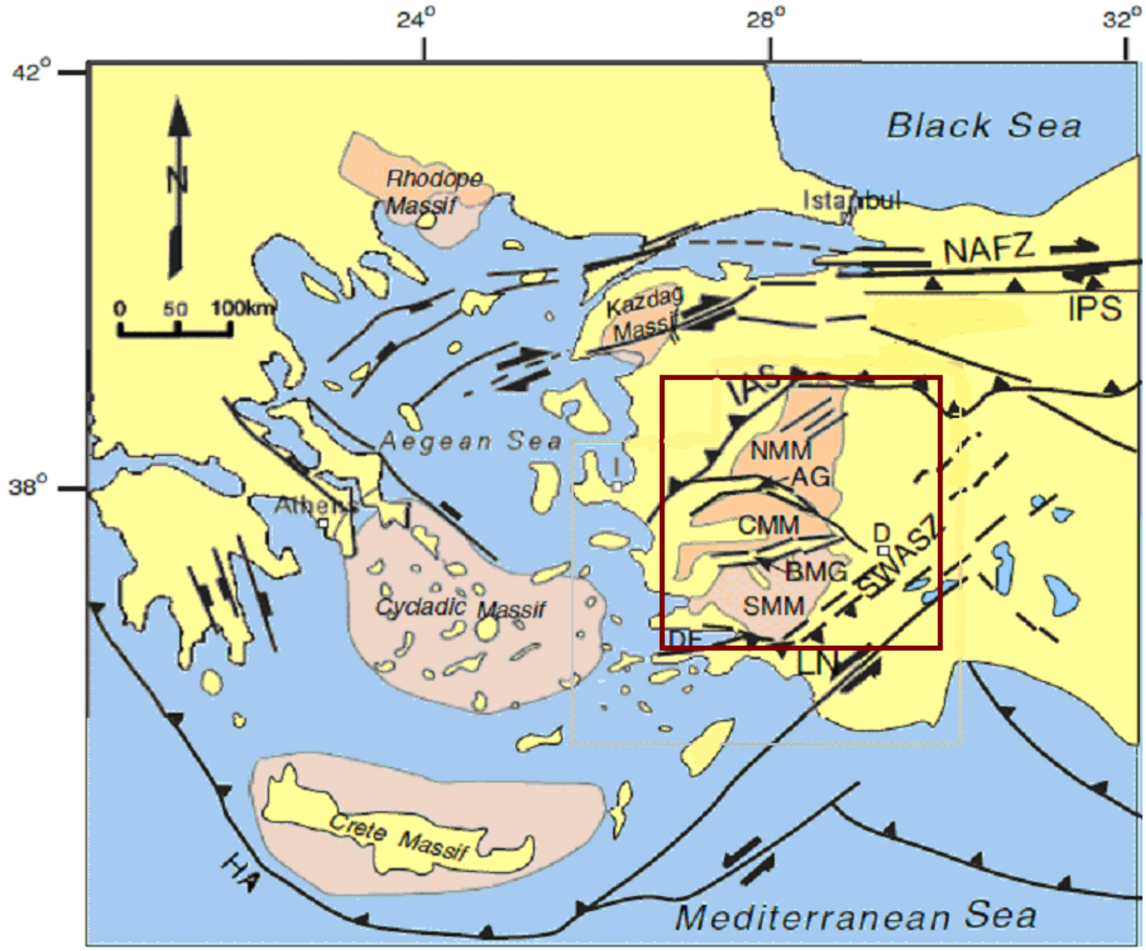

Figure 1. Map of the Aegian region indicating the locations of the various metamorphic core complexes located in the region. The red box outlines the Menderes massif in western Anatolia, Turkey (see Figure 2). Abbreviations: Towns: D-Denizli; I-Izmir. Structural elements: AG - Alasehir graben; BMG - Büyük Menderes graben; CMM - Central Menderes massif; DF - Datça fault; HA - Hellenic arc; IAS - Izmir-Ankara suture; IPS - Intra-Pontide suture; LN - Lycian nappes; NAFZ - North Anatolian fault zone, NMM - Northern Menderes massif; SMM - Southern Menderes massif; SWASZ - Southwest Anatolian shear zone (from Çemen *et. al.*, 2006).

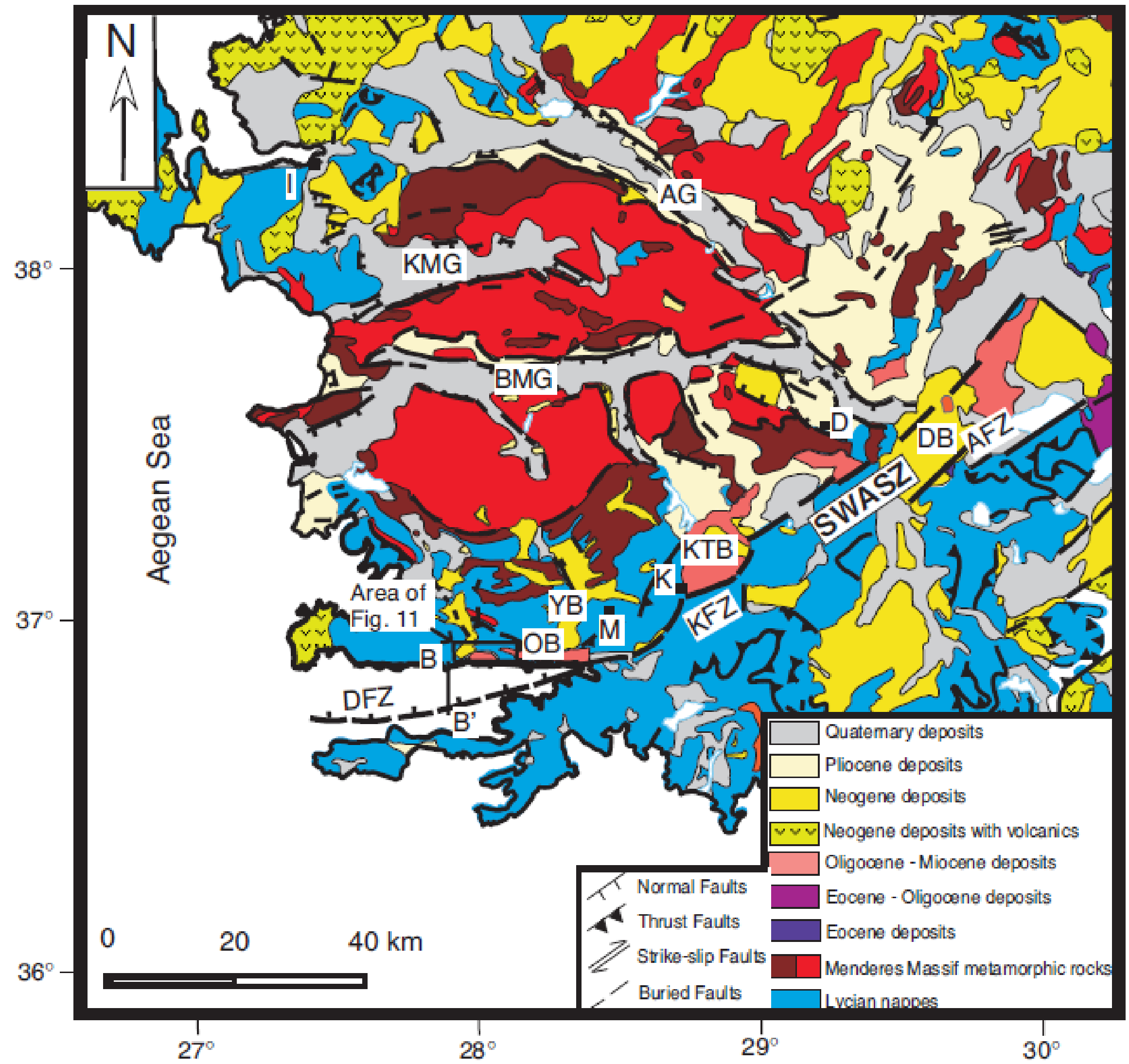

Figure 2. Simplified geologic map showing the sedimentary basins and the Southwestern Anatolian shear zone in the Büyük Menderes Massif. Abbreviations: Towns: D- Denizli; I- Izmir; K- Kale; M- Muğla. Structural elements: AFZ- Acigöl fault zone; AG- Alaşehir graben; BMG- Büyük Menderes graben; DB- Denizli Basin; DFZ- Datça fault zone; KFZ- Kale fault zone; KMG- Küçük Menderes graben; KTB- Kale-Tavas basin; OB- Ören Basin; SWASZ- Southwest Anatolian shear zone; YB- Yatağan Basin (from Çemen *et. al.*, 2006).

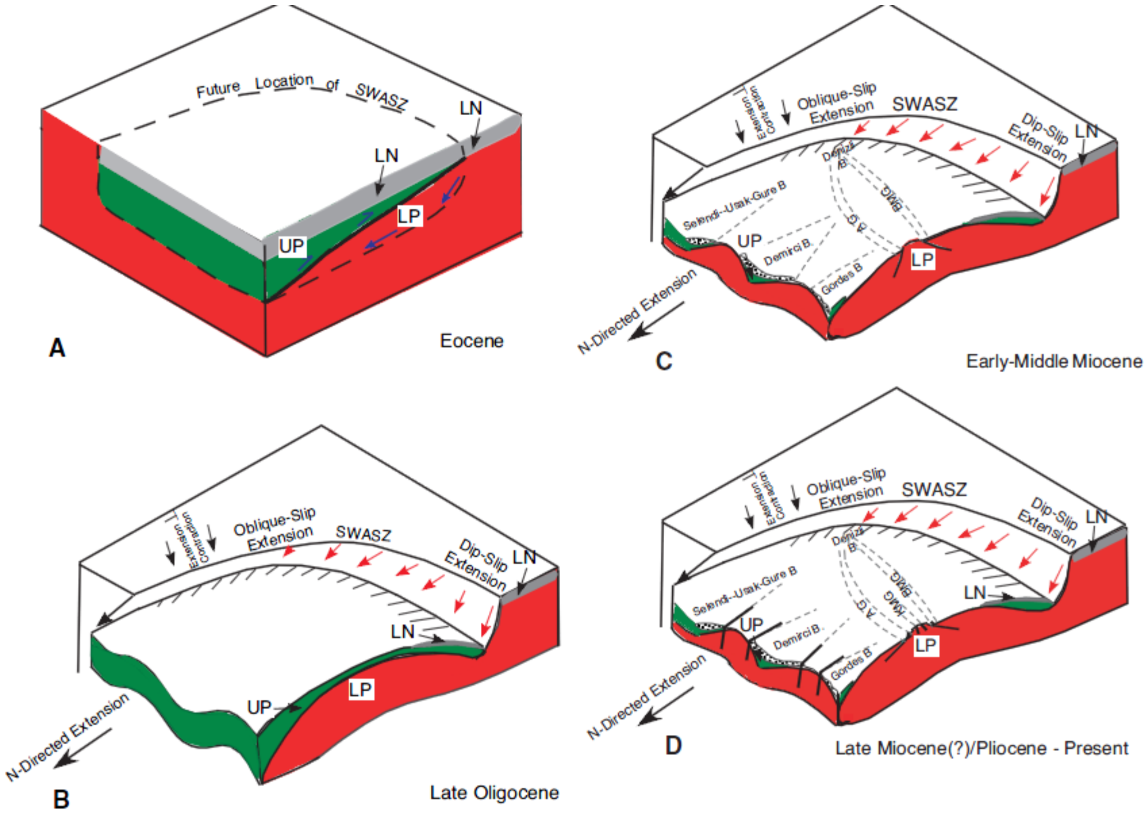

Figure 3. 3D blocks emphasizing the role of the Southwest Anatolian shear zone (SWASZ) in the structural evolution of the Western Anatolia extended terrain in (A) the Eocene, (B) the Late Oligocene, (C) the early-middle Miocene, and (D) the late Miocene or the Pliocene to the present. They do not include the Simav detachment area. The 3D blocks are not drawn to scale and do not indicate the amount of extension in each stage. Abbreviations: AG– Alaşehir Graben, BMG– Büyük Menderes Graben, OB/KTB – Ören and Kale-Tavaş basins, LN– Lycian Nappes, KMG– Küçük Menderes Graben, LP– lower plate, SG– Simav Graben, SWASZ– Southwest Anatolian Shear Zone, UP– upper plate (from Çemen *et. al.* 2006).

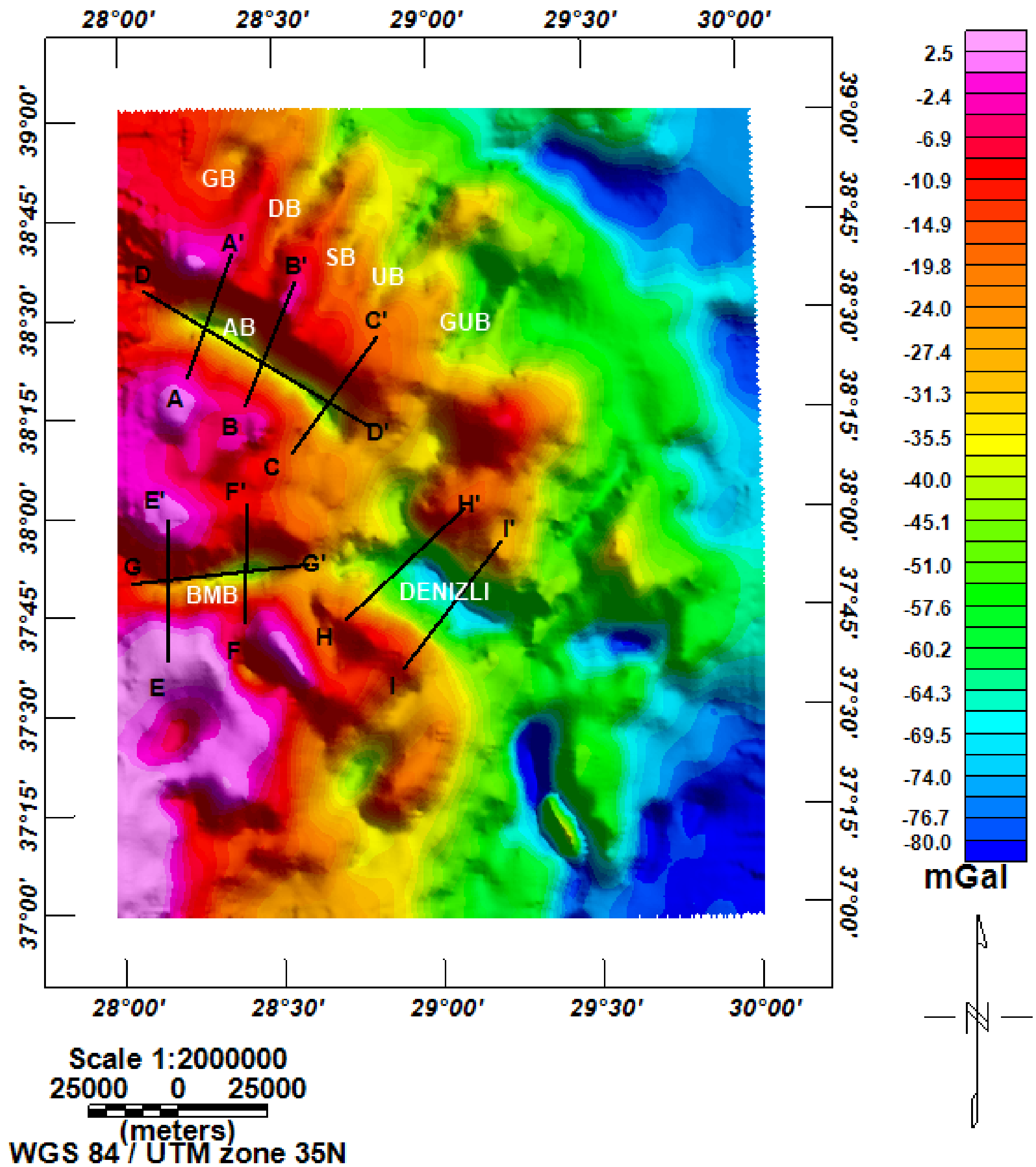

Figure 4. Bouguer gravity map of the Menderes Massif with locations of GM-SYS profiles. Abbreviations: AB- Alaşehir Basin, BMB- Büyük Menderes Basin, DB- Demirci Basin, GB- Gördes Basin, SB- Selendi Basin, UB- Uşak Basin, GUB- Güre Basin.

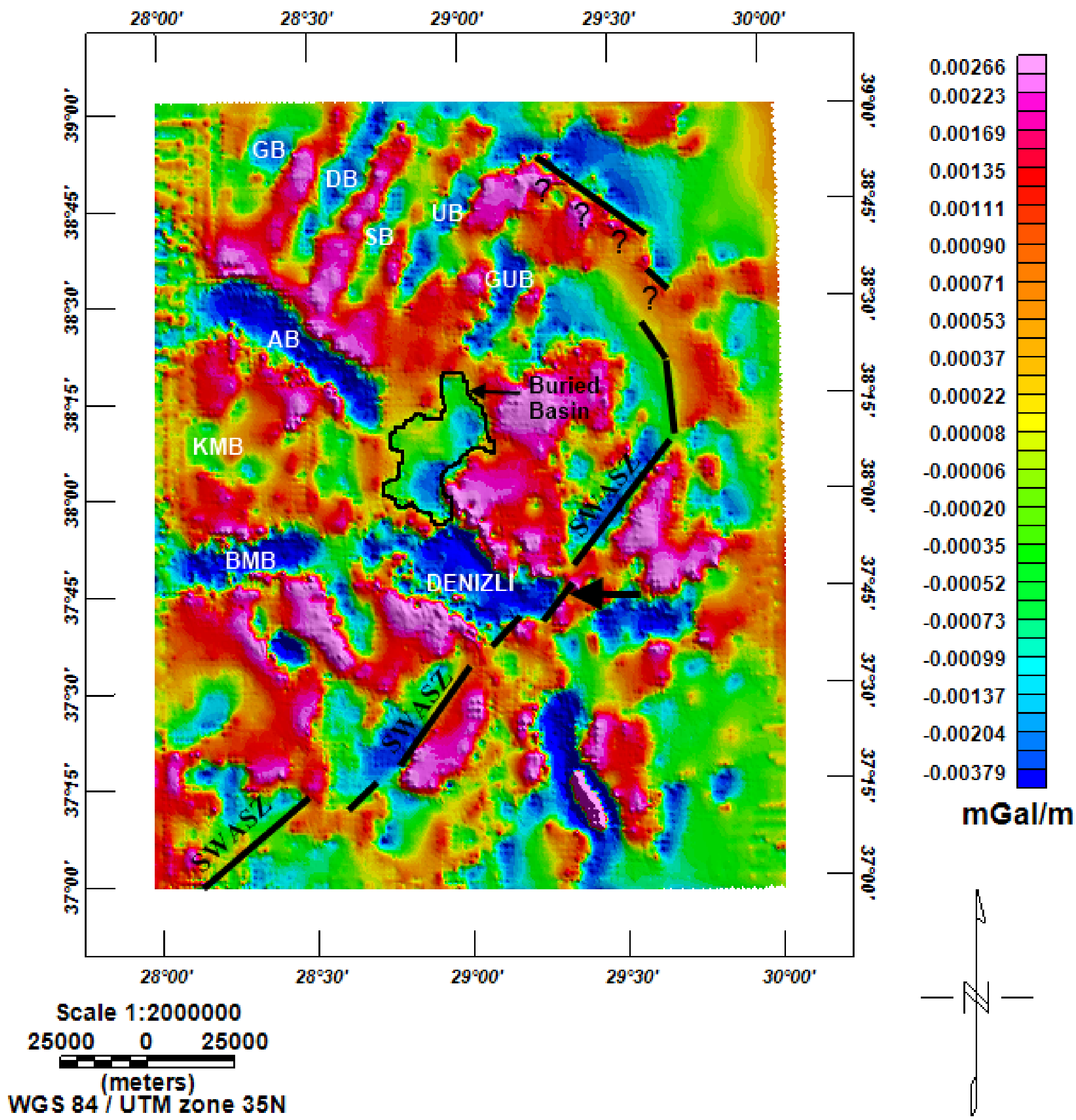

Figure 5. First vertical Derivative map of the Menderes Massif. Location of the buried basin is circled on the map. Abbreviations: AB- Alaşehir Basin, KMB- Küçük Menderes Basin, BMB- Büyük Menderes Basin, DB- Demirci Basin, GB- Gördes Basin, SB- Selendi Basin, UB- Uşak Basin, GUB- Güre Basin, SWASZ- Southwest Anatolian Shear Zone.

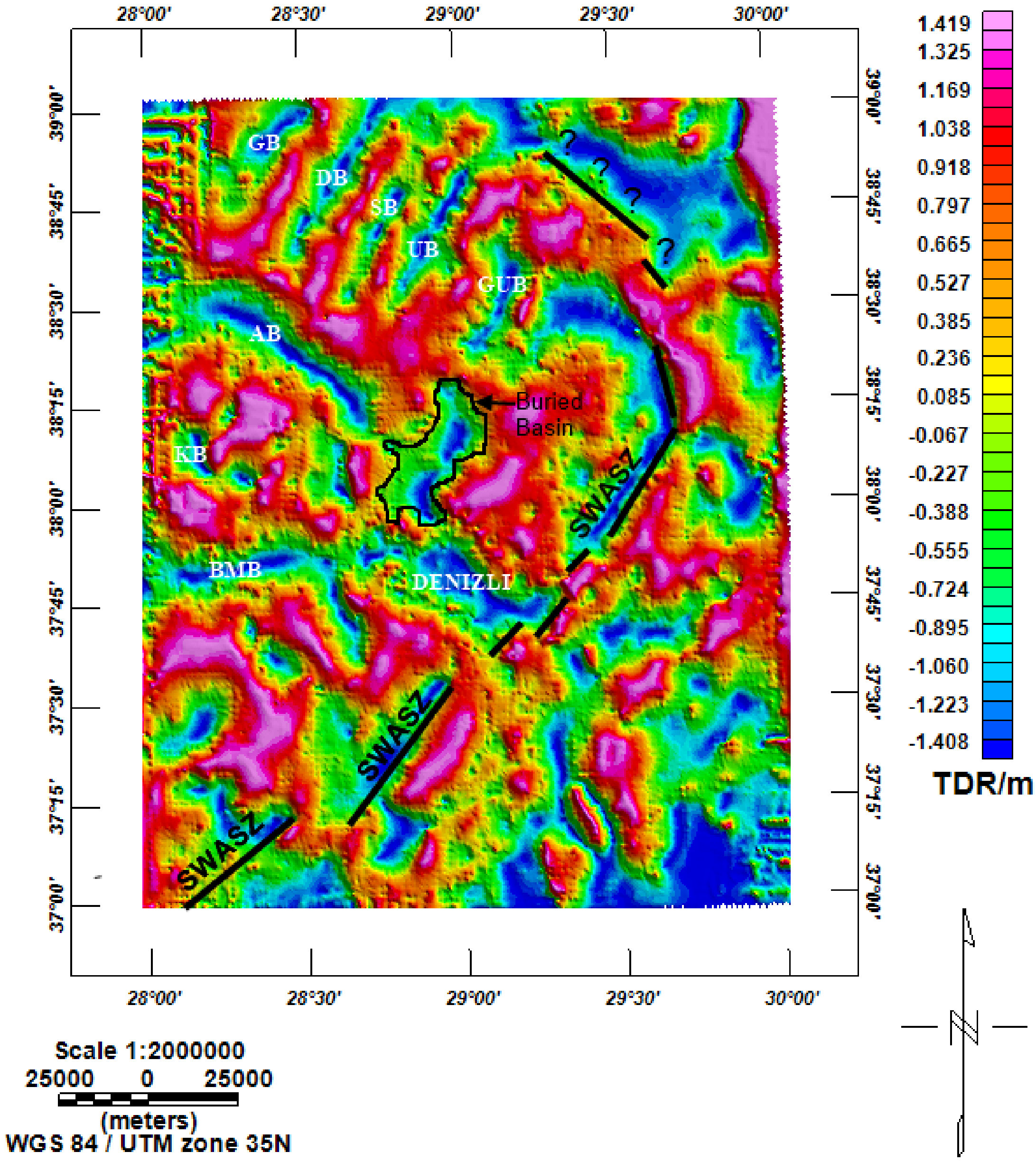

Figure 6. Tilt Derivative map of Menderes Massif. Abbreviations: AB- Alaşehir Basin, KMB- Küçük Menderes Basin, BMB- Büyük Menderes Basin, DB- Demirci Basin, GB- Güre Basin, SB- Selendi Basin, UB- Uşak Basin, GUB- Güre basin, SWASZ- Southwest Anatolian Shear Zone.

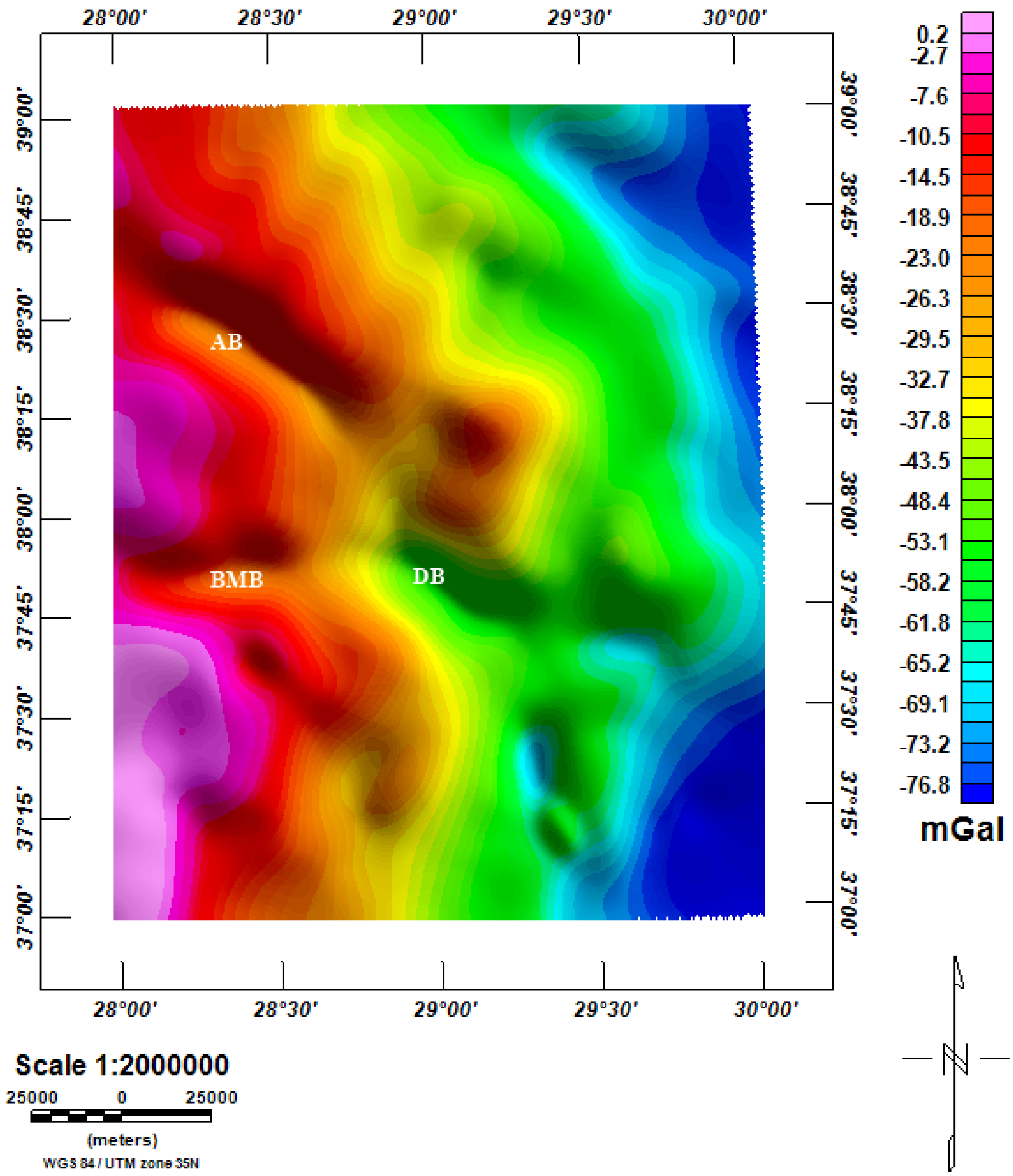

Figure 7. 5 km Upward continuation map of Menderes Massif. Abbreviations: AB- Alaşehir Basin, BMB- Büyük Menderes Basin, DB- Denizli Basin.

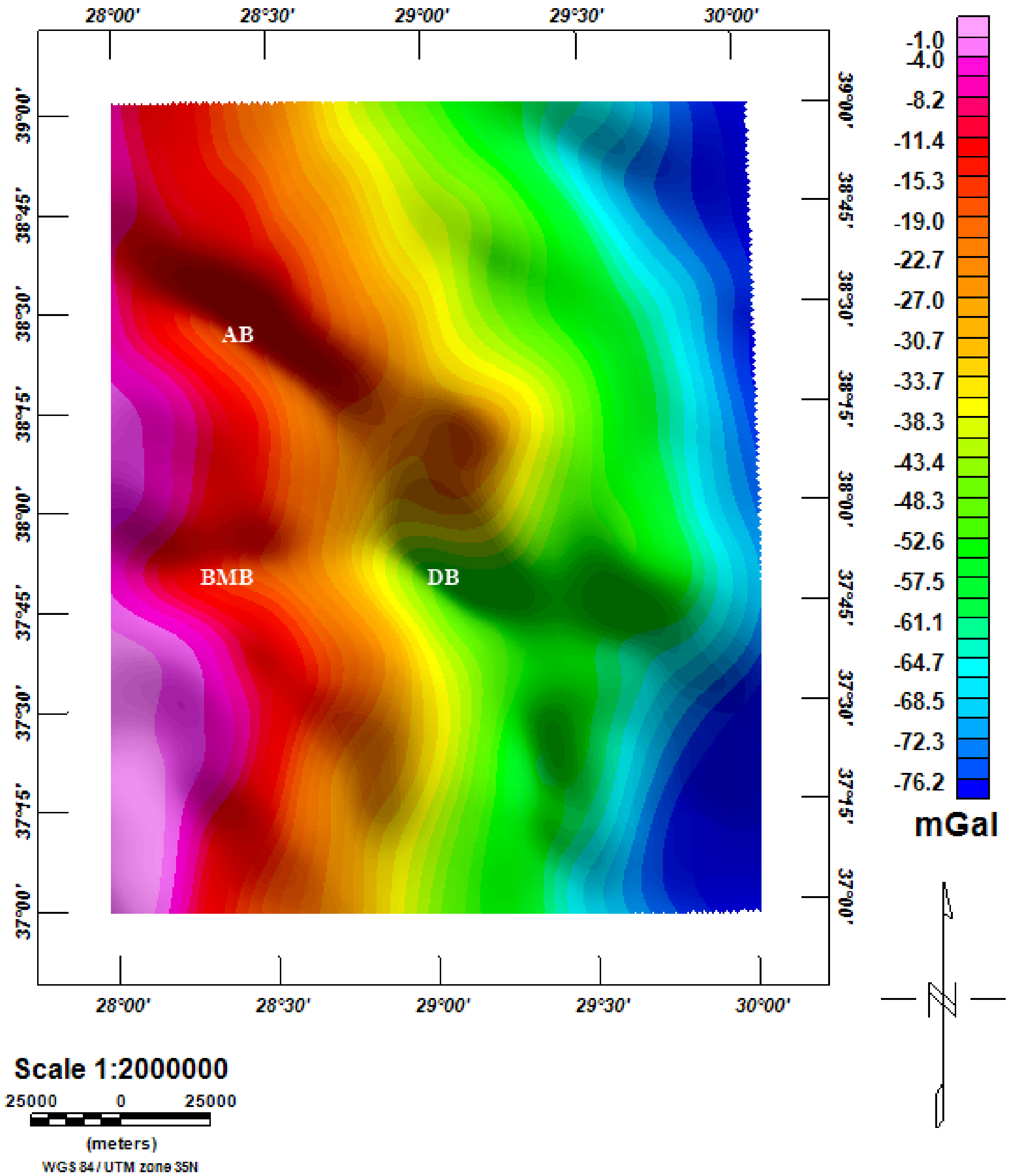

Figure 8. 10 km Upward continuation map of Menderes Massif. Abbreviations: AB-Alaşehir Basin, BMB- Büyük Menderes Basin, DB- Denizli Basin.

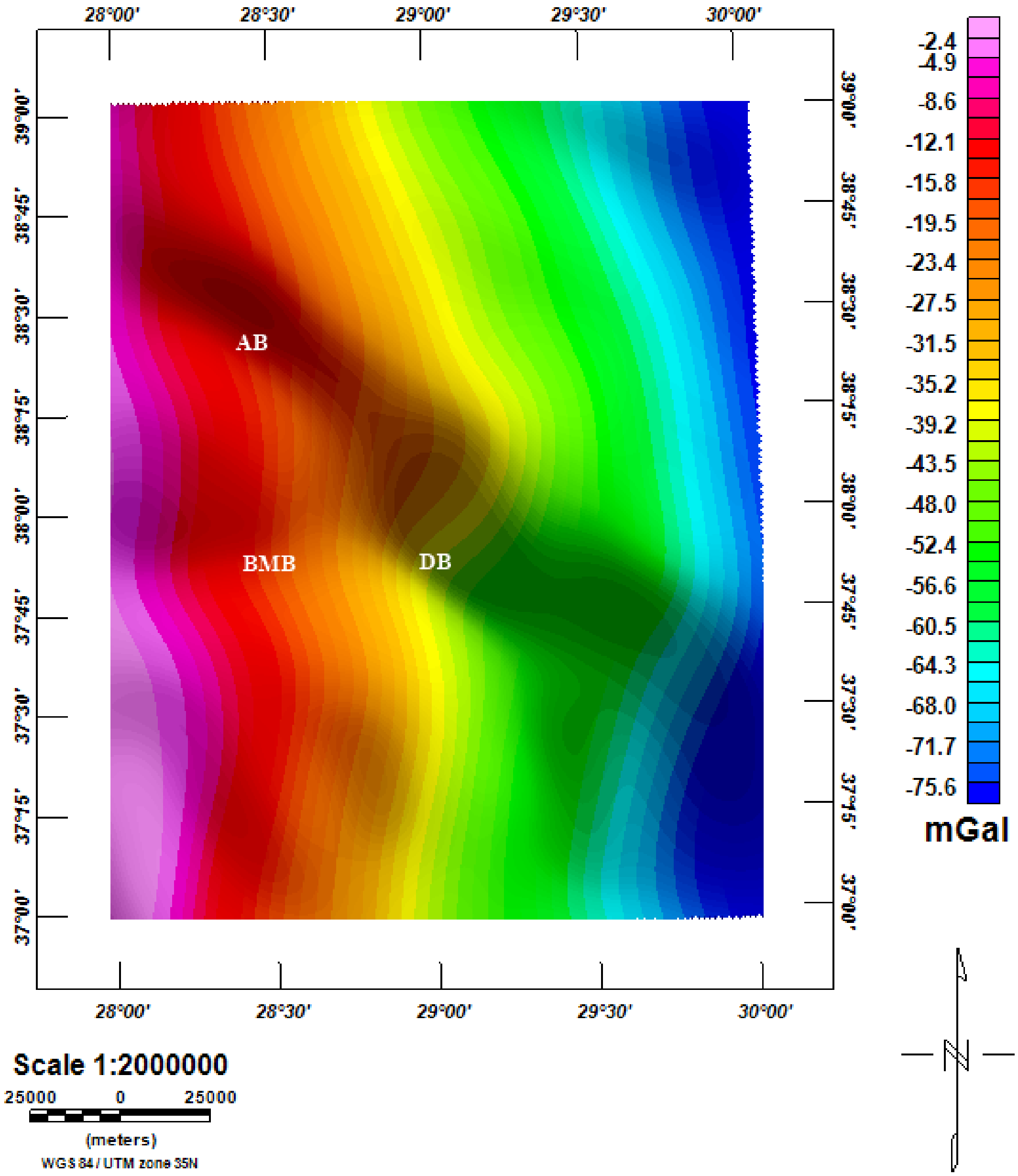

Figure 9. 20 km Upward continuation map of Menderes Massif. Abbreviations: AB- Alaşehir Basin, BMB- Büyük Menderes Basin, DB- Denizli Basin.

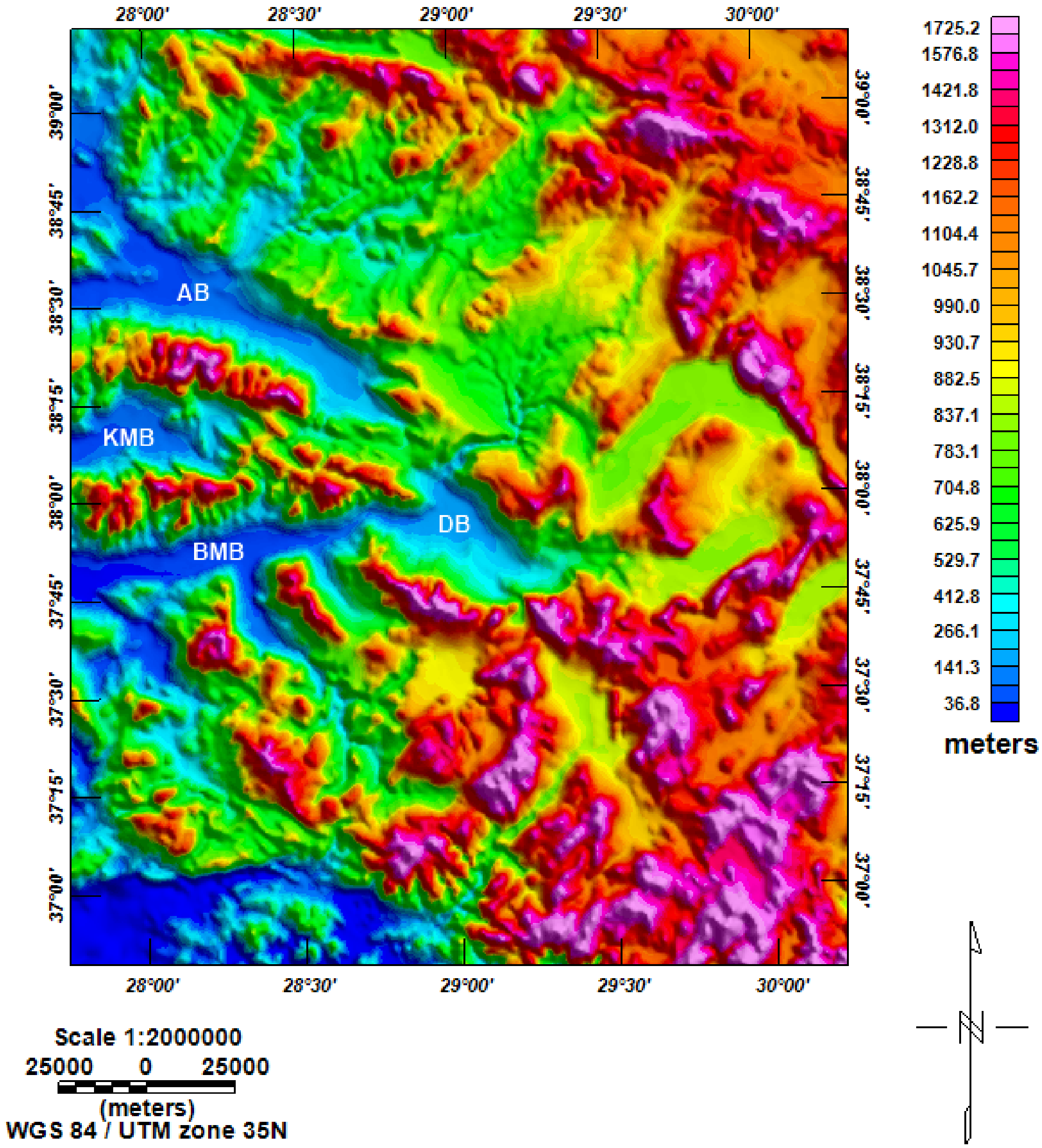

Figure 10. Shuttle Radar Topography Mission Digital Elevation Model (SRTM-DEM) 30m map of the Menderes Massif. Abbreviations: AB- Alaşehir Basin, KMB- Küçük Menderes Basin, BMB- Büyük Menderes Basin, DB- Denizli Basin.

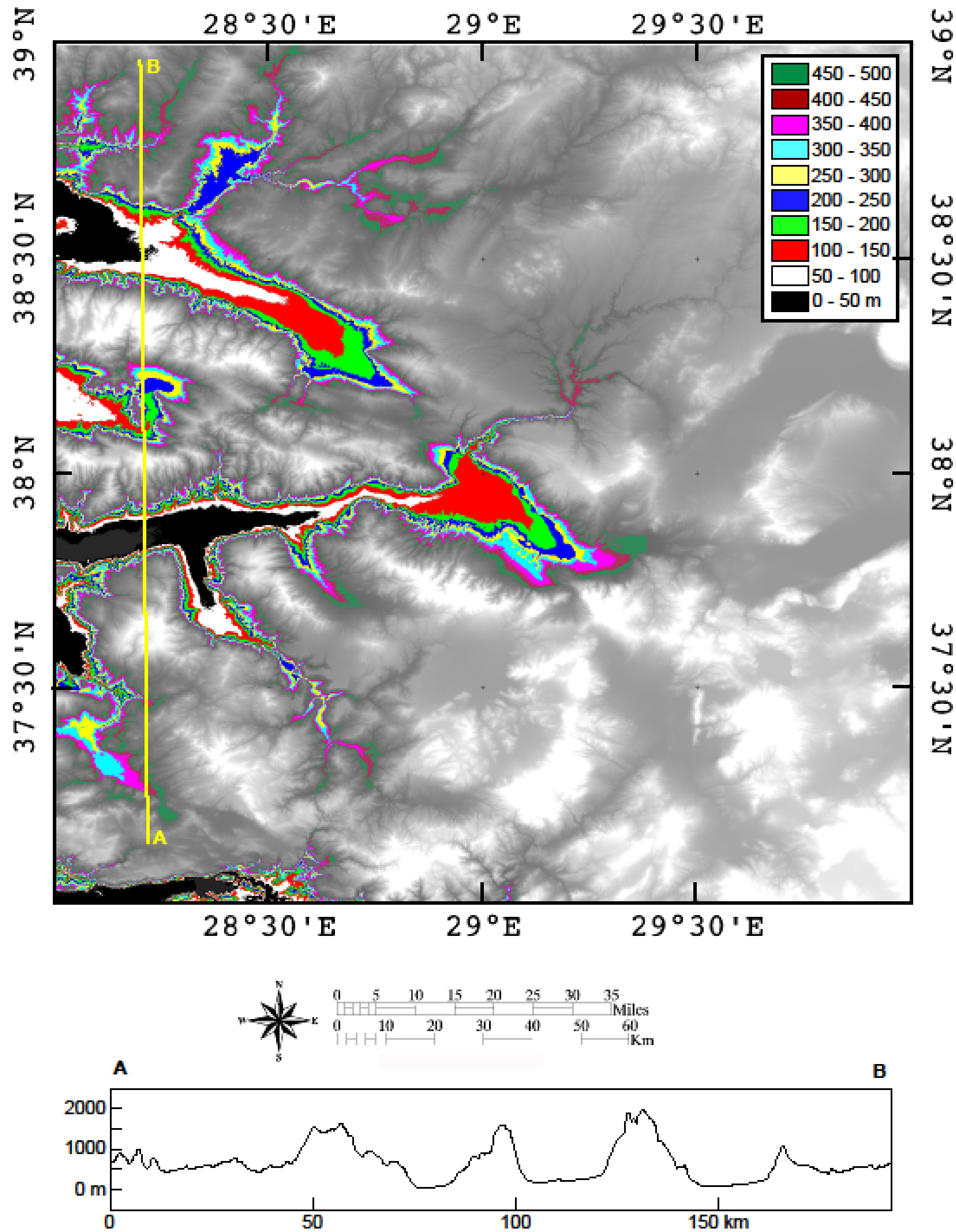

Figure 11. Shuttle Radar Topography Model Digital Elevation Model (SRTM-DEM) density slice map.

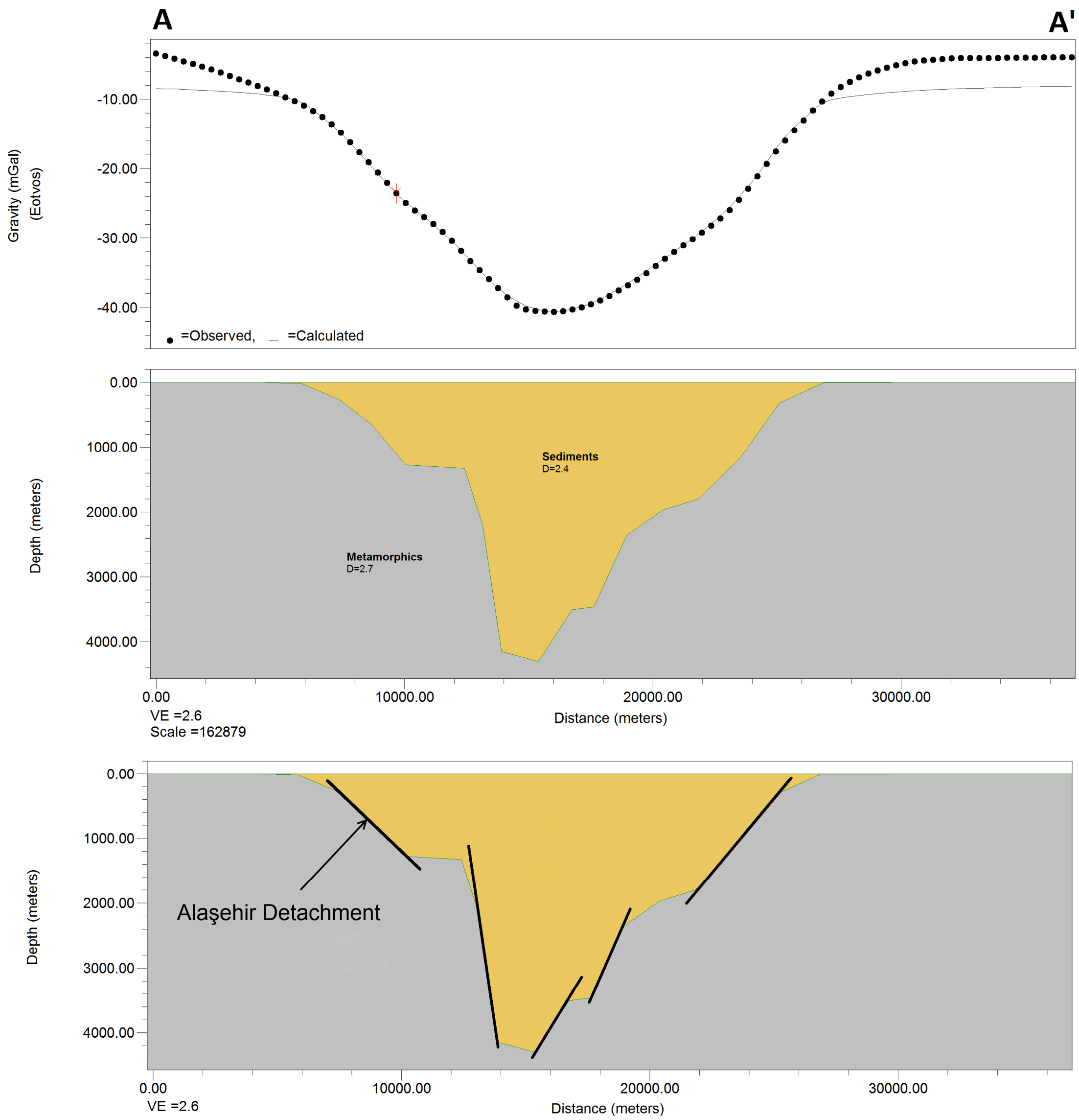

Figure 12. GM-SYS 2D model created from profile line A-A’ over the Alaşehir basin.

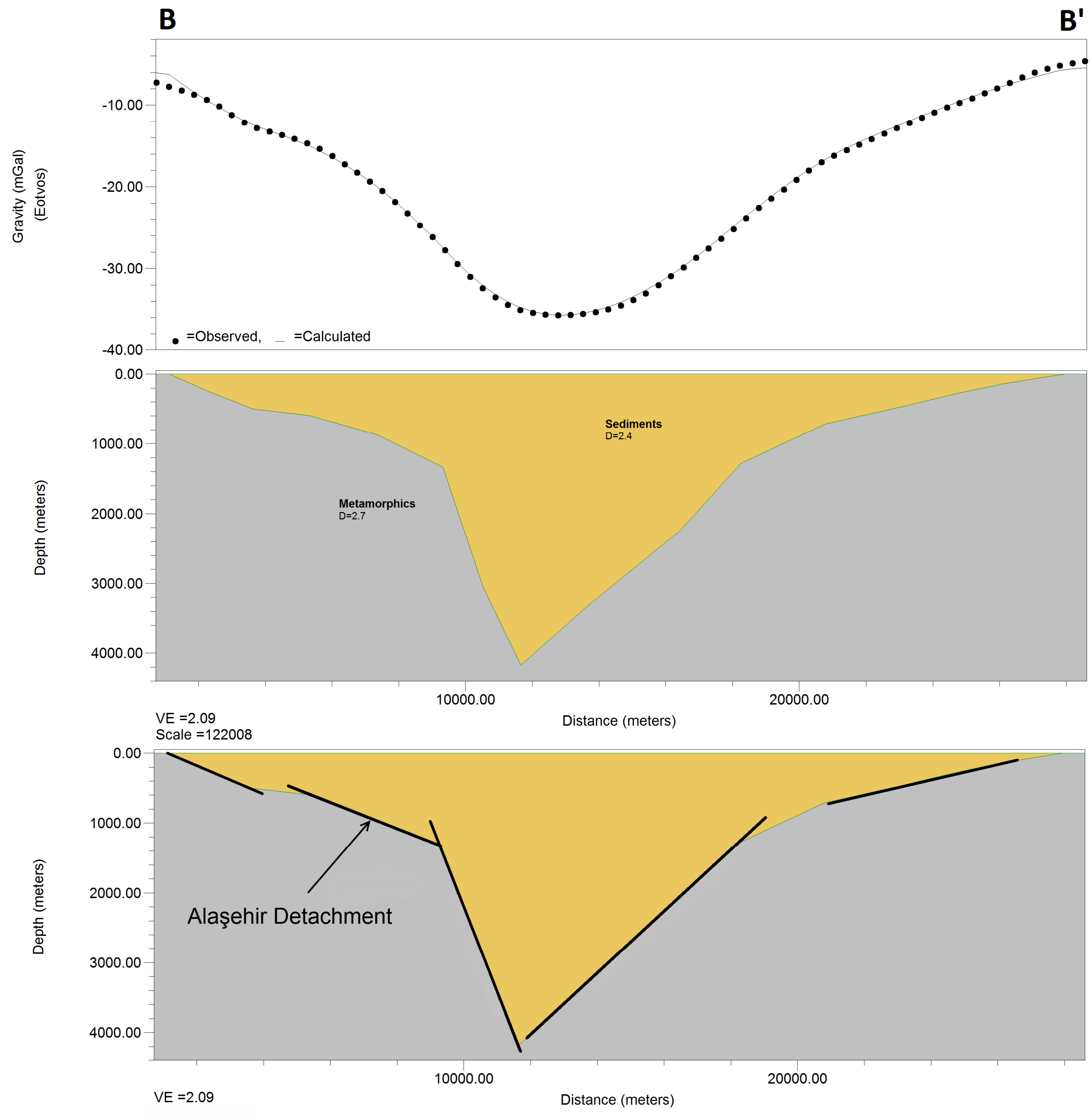

Figure 13. GM-SYS 2D model created from profile line B-B' over the Alaşehir basin.

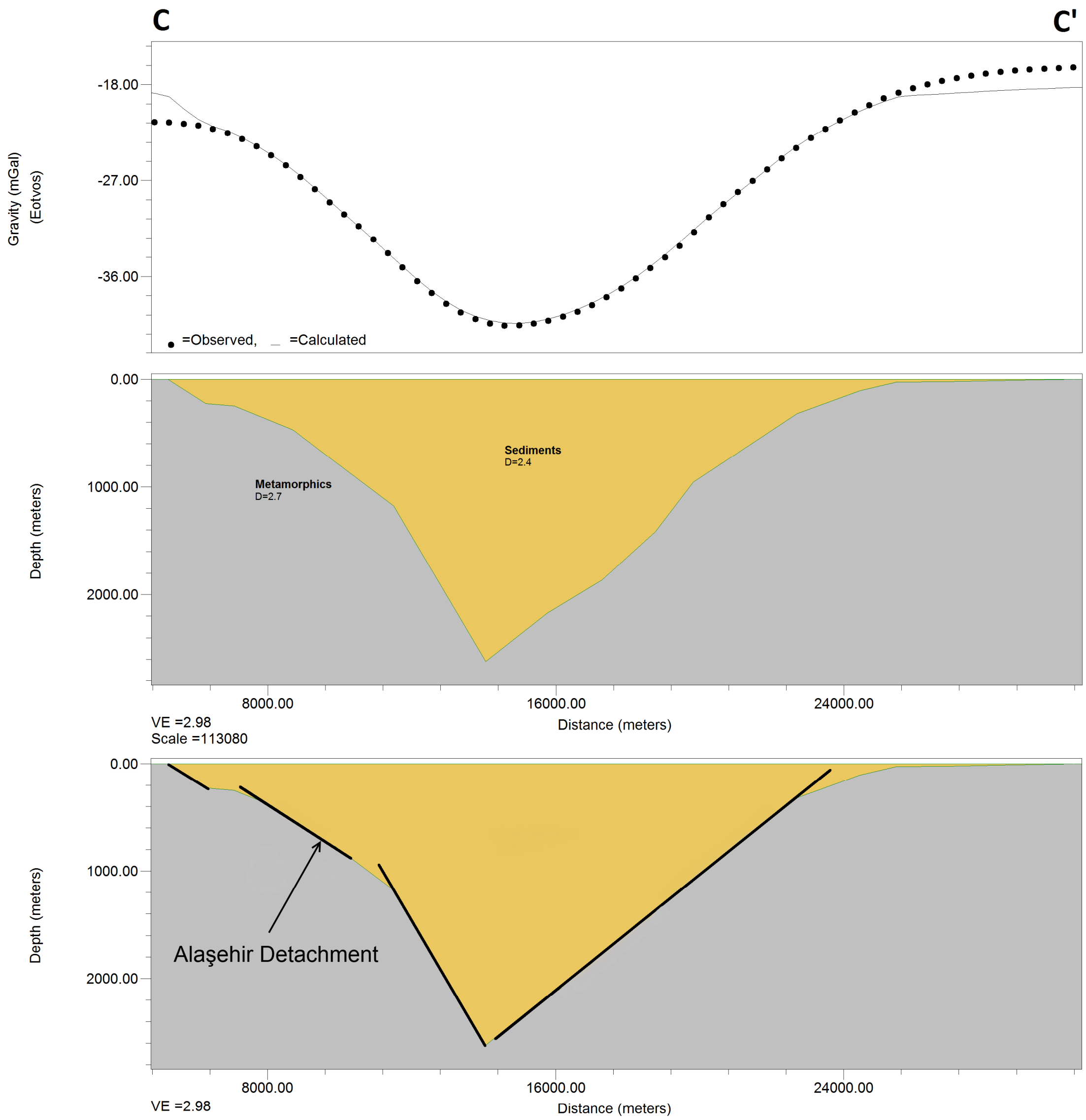

Figure 14. GM-SYS 2D model created from profile line C-C' over the Alaşehir basin.

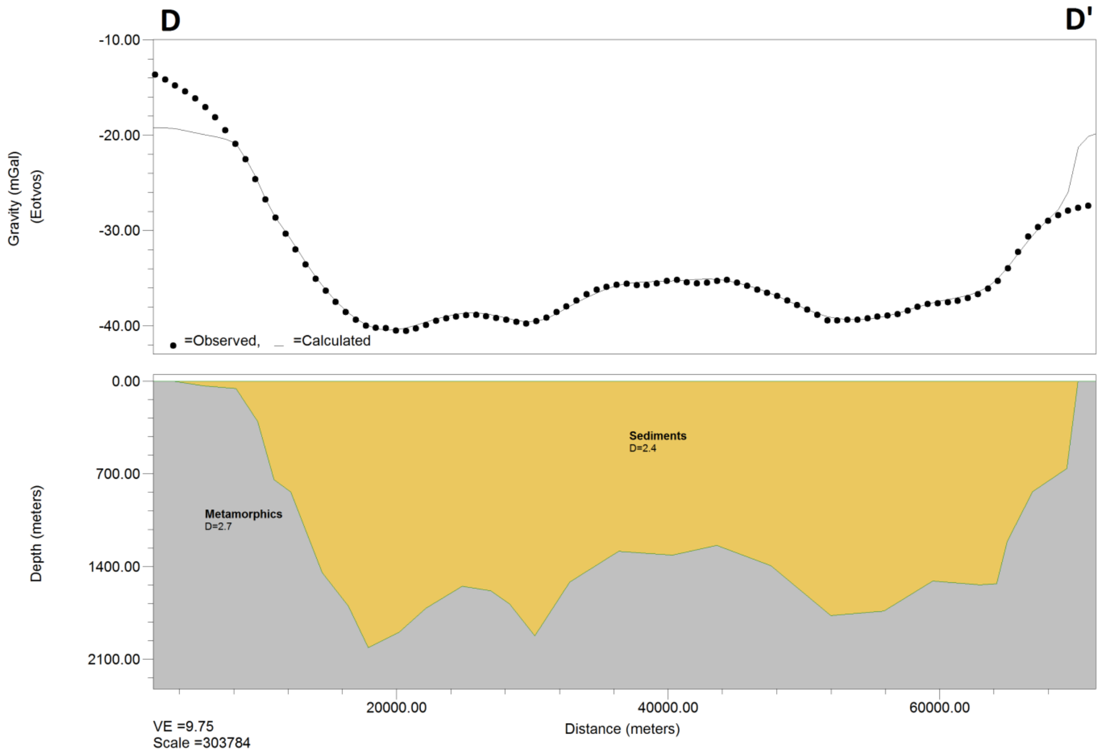

Figure 15. GM-SYS 2D model created from profile line D-D' over the Alaşehir basin.

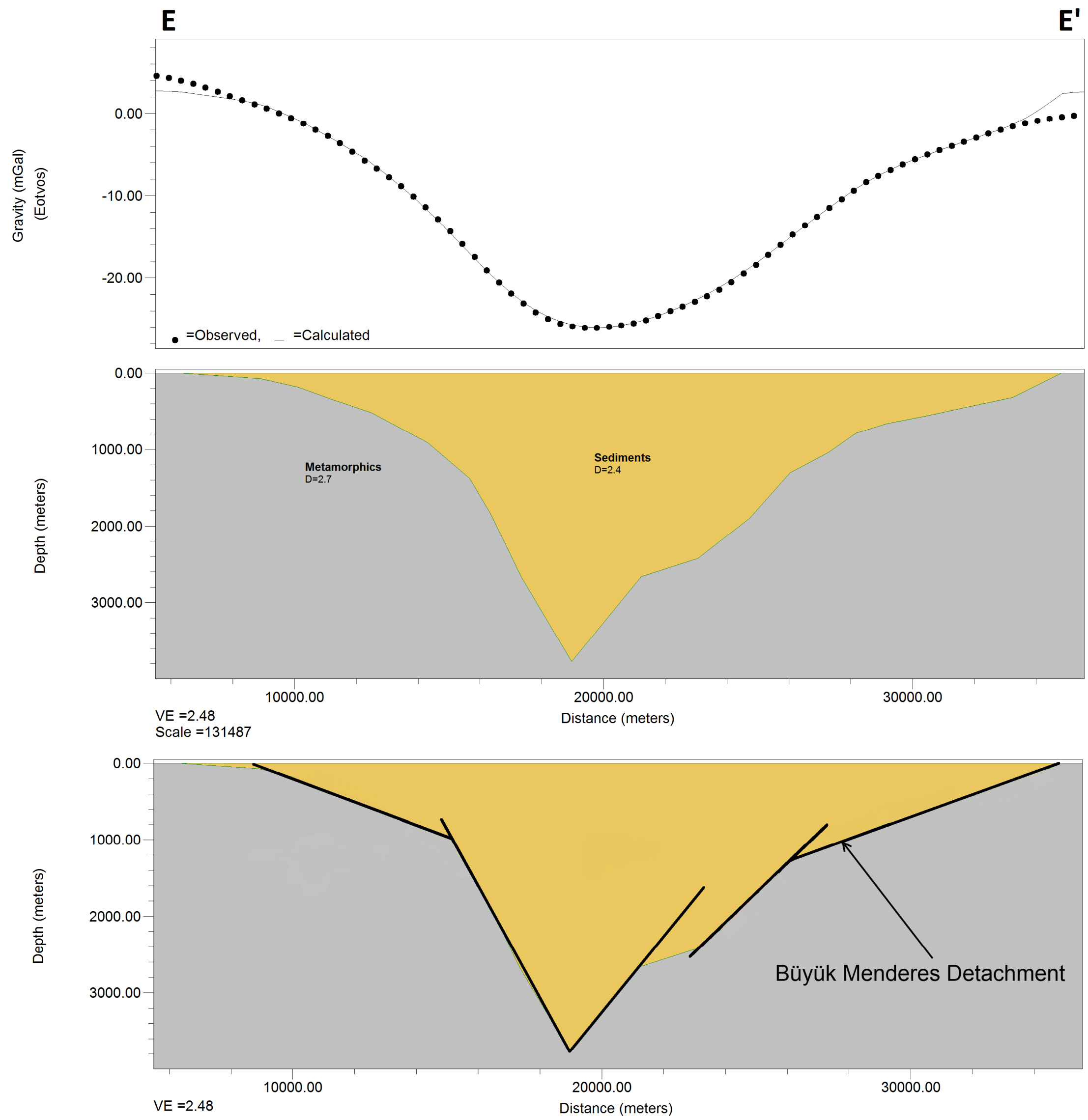

Figure 16. GM-SYS 2D model created from profile line E-E' over the Büyük Menderes basin.

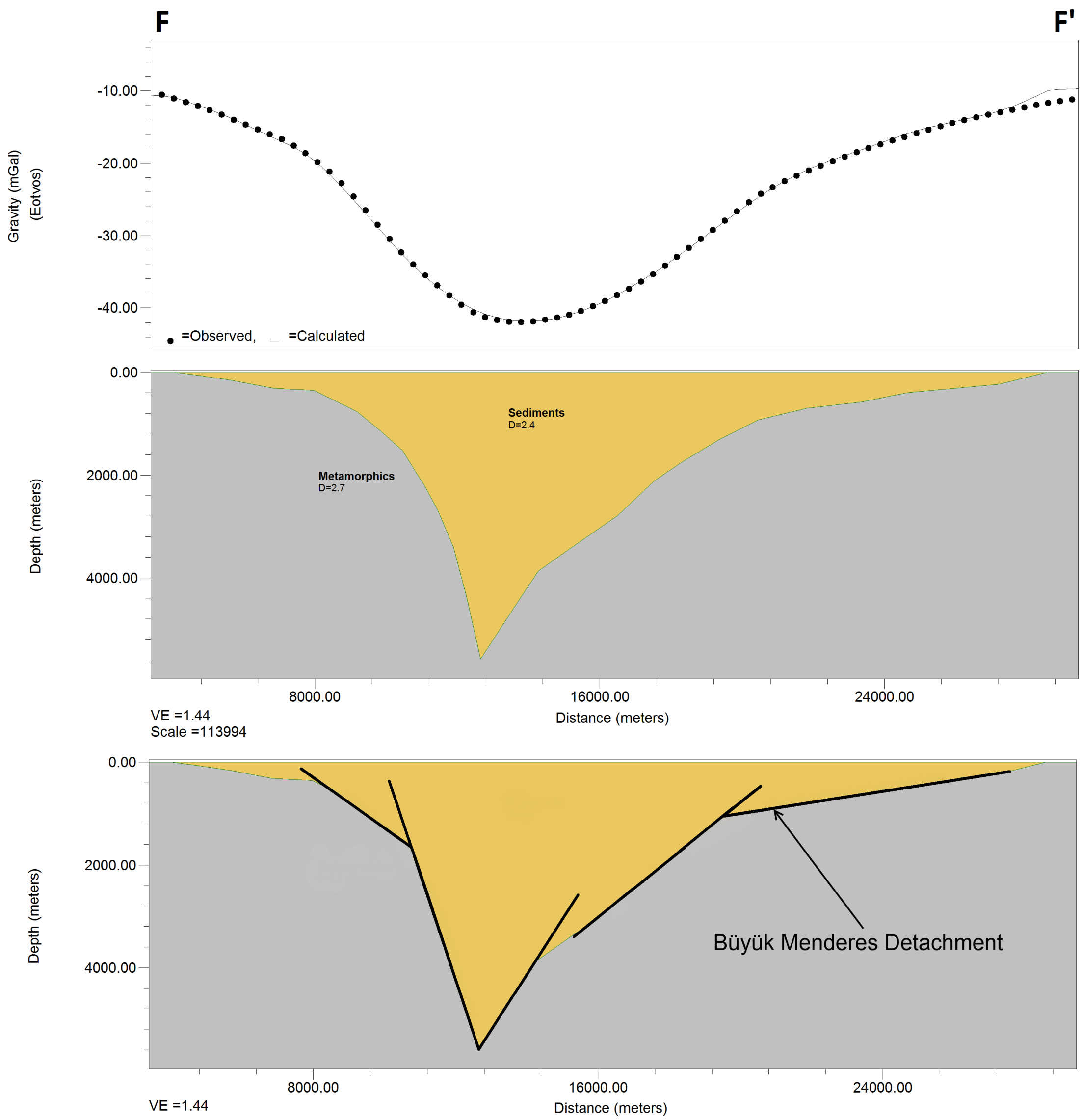

Figure 17. GM-SYS 2D model created from profile line F-F' over the Büyük Menderes basin.

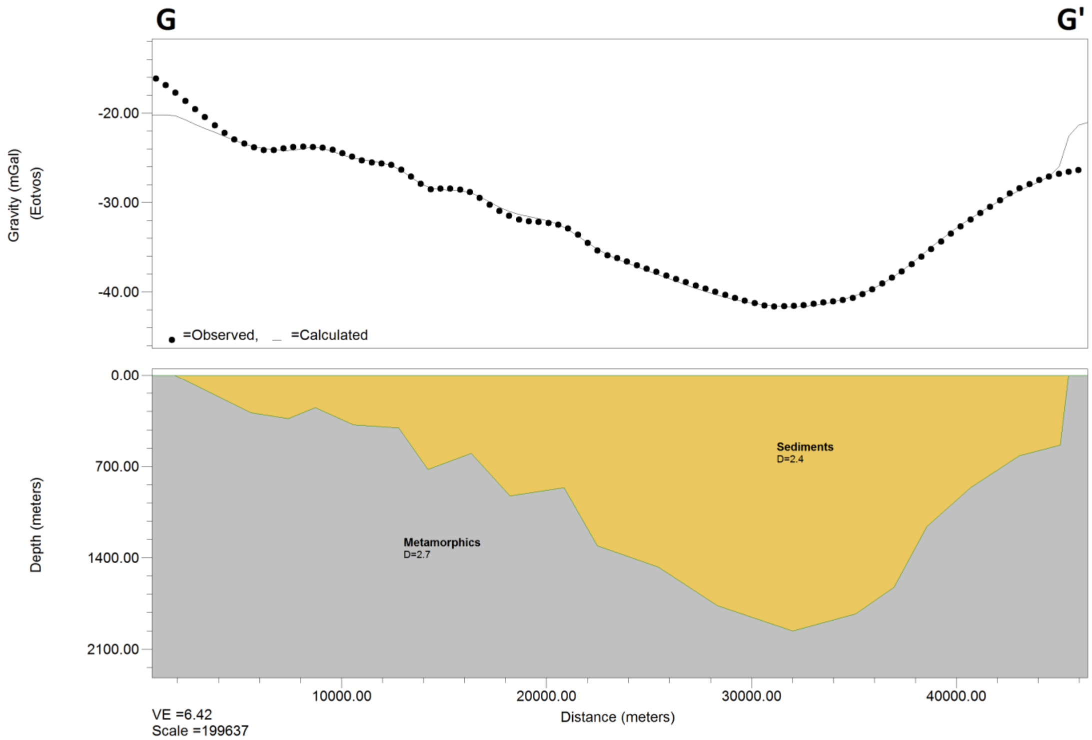

Figure 18. GM-SYS 2D model created from profile line G-G' over the Büyük Menderes basin.

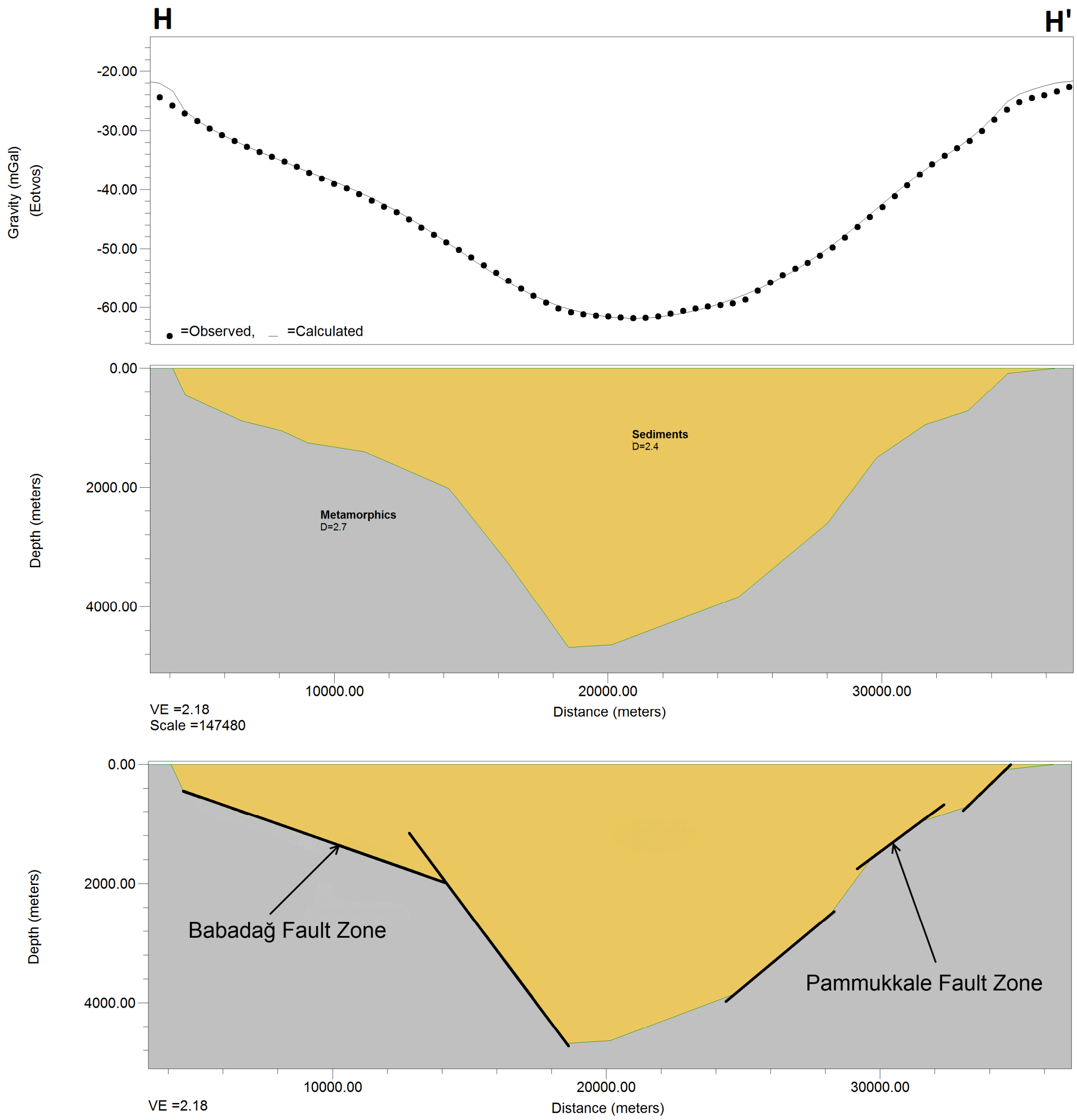

Figure 19. GM-SYS 2D model created from profile line H-H' over the Denizli basin.

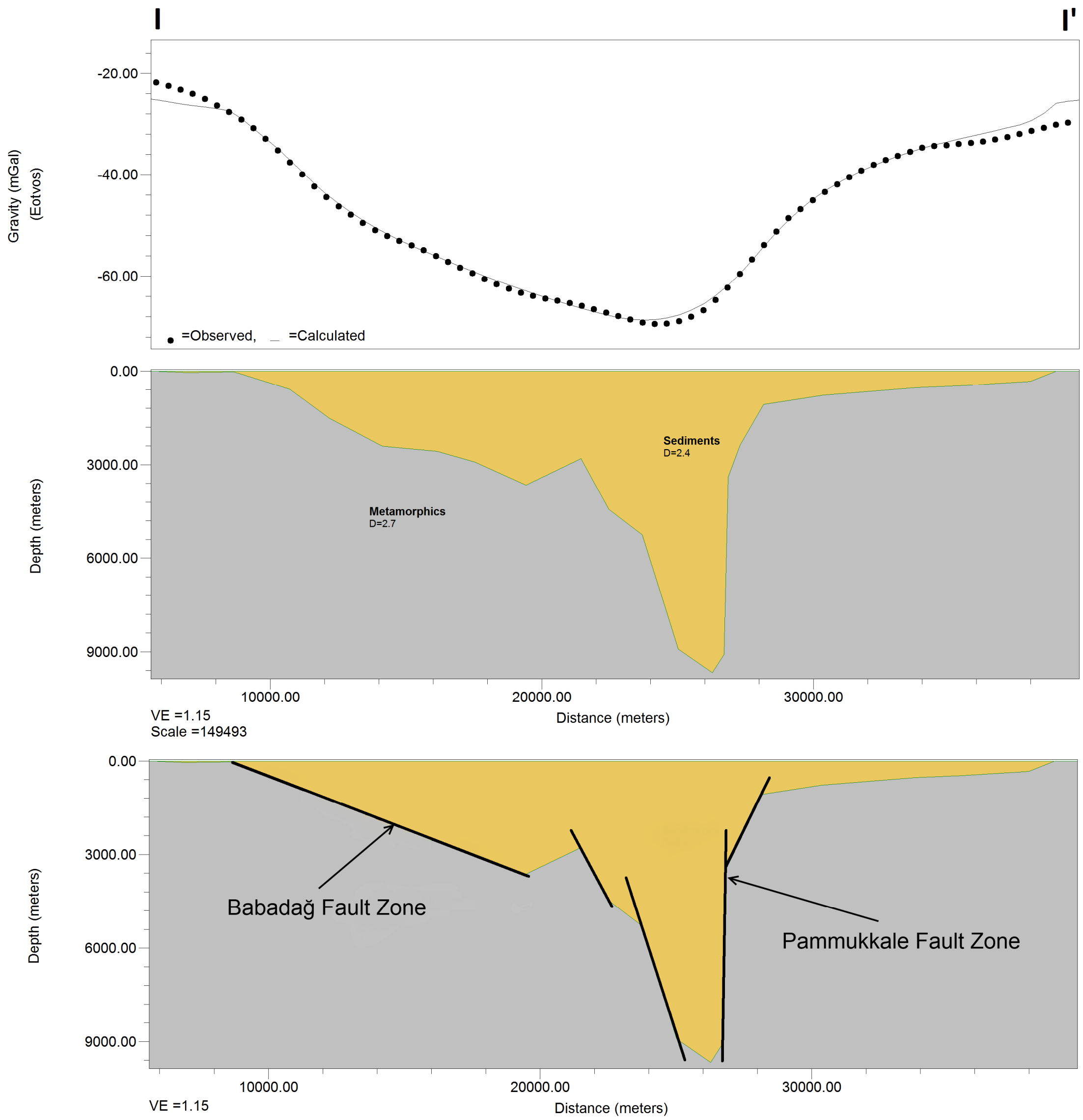

Figure 20. GM-SYS 2D model created from profile line I-I' over the Denizli basin.

VITA

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Attended Full Tensor Gravity workshop offered by Bell Geospace in 2011.

Attended GSA Workshop “Structural & Stratigraphic Concepts: Basin Analysis” by Exxon Mobil ’10

Professional Memberships:

Student member of American Association of Petroleum Geologists

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Name: Mehmet I. Kaldirim　　　　Date of Degree: May, 2012

Institution: Oklahoma State University　　　　Location: OKC or Stillwater, Oklahoma

Title of Study: USE OF GRAVITY MODELLING TO DETERMINE THE GEOMETRY OF FAULTS BOUNDING THE ALAŞEHIR, BÜYÜK MENDERES AND DENIZLI BASINS, WESTERN TURKEY

Pages in Study: 45　　　　Candidate for the Degree of Master of Science

Major Field: Geology

Scope and Method of Study: In this study, we use Bouguer gravity data and Digital Elevation Models (DEM) extracted from Shuttle Radar Topographic Mission (SRTM) data over Western Anatolia region to investigate the surface and subsurface structures of the Menderes Massif. The specific objectives were to: (1) investigate the geometry of the faults bounding the Alaşehir, Büyük Menderes and Denizli basins, (2) delineate the lateral extent of the Southwest Anatolia Shear Zone (SWASZ) within the study area and (3) investigate the relationship between the SWASZ and the faults associated with these basins.

Findings and Conclusions: Our results suggest the following: (1) gravity anomaly values over the basins range between -30 to -60 mGals corresponding to a Quaternary sediment thickness of 3- 4 km with the thickest (~7-8 km) sediments modeled over the eastern part of the Denizli basin. The steep angle and deep nature of faults bounding this basin may provide conduits for bringing deep hydrothermal waters to the surface (2) the geometry of the basins is characterized by detachment faults that have a low angle due to flexural rotation and by the steeper angle antithetic faults bounding the opposite sides of the basins. (3) The SRTM-DEM density slicing suggests that the Denizli Basin might be a southeasterly extension of the Alaşehir basin but segmented by cover volcaniclastic material. (4) The SWASZ is well defined on the filtered gravity maps and is characterized by right-stepping en echelon faults that extend as far as the north of the Denizli basin where it curves westward and continues along the edges of the north south trending faults forming the Gördes, Demirci and Uşak-Güre Basins. (5) SWASZ controls the eastern margin of the Denizli Basin and may possibly explain the earthquake activity observed within the eastern part of the Denizli Basin.

ADVISER'S APPROVAL: Dr. Estella Atekwana