A NEW APPROACH TO TURKEY'S SEISMOTECTONIC BASED ON EPICENTER DISTRIBUTION

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Abstract.

A new and extremely simple method has been applied to solve the chaotic tectonically behavior of Turkey in this work. This method can be represented to be "the 3.0<M<3.9 epicenter distribution can control the earthquakes caused by heat flow, besides tectonically events, and the M>5.9 epicenter distribution can control the earthquakes caused by pure tectonic activities".

The epicenter distribution which has magnitudes higher than 5.9 and occurred after 1900 have a perfect fitting by the North Anatolian Fault Zone (NAFZ) and East Anatolian Fault Zone (EAFZ) in Turkey. At the Aegean District (western part) of Turkey, the same distribution map has not an easy understandable relation with the shallow tectonically events. On the contrary, the two different epicenter lineations are parallel and perpendicular to the general strike of the African Plate movement and their production process has a scissors effect on Karlıova Cross. The epicenter lineation are not seen on surface but occurred in a deltoidal pattern parallel and perpendicular to this direction. This pattern shows the existence of deep fractions built by buried deep hot-creeps.

On the other hand if the earthquakes have the magnitudes lying between 3.0 and 3.9 and dated between 01.01.2003 and 01.07.2003 interval will select, their epicenter distribution will configure some regular elliptical loops (like a Cone Sheet distribution) related with the crustal heat flow activities. The short axes of these elliptical loops are parallel to the axes of the compression stresses, effected them.

INTRODUCTION

Turkey is one of the rare countries which have some 4000 annual earthquake records in the World, because the seismicities of historical period records especially in the Aegean Region involve the time period of 2000 annual BC.

These earthquakes established on some Historical Earthquake Catalogues ([1, 2, 3, 4]). The whole works done on earthquake item ([2, 3, 4, 13, and 15]) maintain some important additions to minimize the earthquakes hazard. The works done on the NAFZ ([5, 7, 8, 9, 10, 11, 12, 16, 17, and 18]) built a basic interpretation platform on the "Global New Tectonic" sight of Turkey. The works about seismotectonic are aimed to discuss the seismotectonic problems of Turkey ([6, 13, and 15]). In ([14]), the authors discussed the age of the NAFZ. In the articles of ([19, 20, 21, and 22]) and brought some essential aspects of the Plate Tectonics of World and Turkey. In ([23]) the authors brought a new sight on post collisional tectonics of Tibet and Anatolia. The strike slip basins deformations and sedimentations of Turkey are represented in ([24]). In the work numbered ([25]) a prediction has been made about the Southern Parts of Turkey.

The Seismotectonic Maps are one of the most important Earthquake Precursor Operators. The most important data which can take place on seismotectonic map are; seismicities of instrumental period, seismicities of historical period, seismicities of prehistoric and geologic period, active or inactive faults, grabens, horsts, volcanoes, tectonical outcrops, orogenesis, continental joints, uplifts, subsidence's, subductions, obductions, trenches, isostatic oscillations… But in this work, only the instrumental period epicenter distribution data have been regarded instead of classical data input process.

DISCUSSION AND INTERPRETATION
The Big Earthquakes of Anatolia

The distribution map of the earthquakes with magnitudes M > 5.9 Richter is given in Figure-1.

To prevent us from every kind of prejudice, the whole geological surface conditions of Turkey are neglected while these epicenter distribution maps were interpreted. It has been attempted to bring a pure kinematic and dynamic explanation to those of complex tectonically behavior as a final product of this work.

An imaginary pseudo filter, automatically applied by this selection, showed in Figure-1, to eliminate the effects of the earthquakes produced by the normal faults, karstic depressions, volatile pressure uplifts, quick isostatic balancing or tidal rolling of crust. The big portion of this group of earthquakes has sub crustal depths and rest shallower.

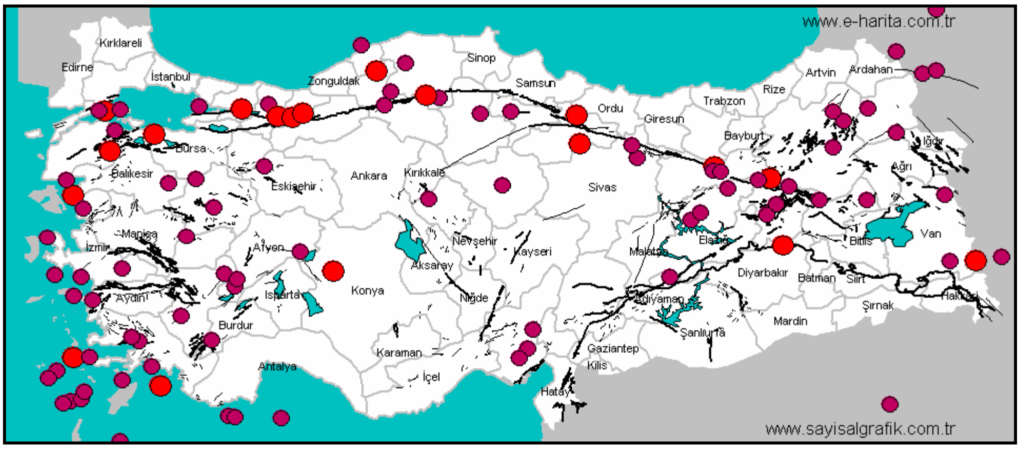

Figure-1. The Epicenter Distribution Map of Turkey in the M > 5.9 interval, covering the Instrumental Period (The 21.02.1046 M=5.5 Konya – Ilgın Earthquake especially was taken into consideration because of it's supplementary position to the last lineation) (The epicenter distribution maps were obtained from Bogaziçi University Kandilli Observatory and Sayısal Grafik Ltd.WEB Sites.)

As illustrated in Figure-2, if the interpolation lines were applied suitable with the clearly detectable epicenter lineation on M > 5.9 distribution map, one can obtain some of lines which are superimposed with the well known geological events but others are not.

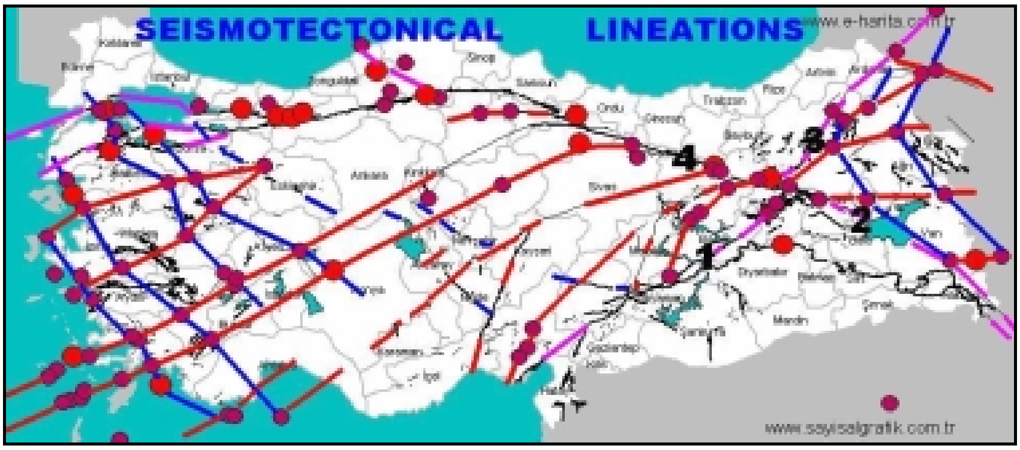

Figure-2. The imaginary Lineation has drawn by means of the ground verification of the M > 5.9 Epicenter Distribution of Turkey during the Instrumental Period.

The NAFZ and the EAFZ are crossing each other at Karlıova town which take place in the mid point of the Eastern Part of Anatolia. We can call those cross cutting of the two faults as “Karlıova Cross” and the peninsula divided in four parts by the two faults as “Karlıova Quadrants”. The bilateral narrow angle sides are pushing outward by decreasing the bilateral narrow angles which were 60° and 60° at the beginning. All of the fault samples crossing each other and cutting the crust have these scissors effects in the World.

The lines numbered from 1 to 4 have a good accordance with the famous strike slip faults of the NAFZ and EAFZ which can be detectable on surface. But the epicenter lineation taking place in the West Anatolia which builds a deltoid pattern, overlap with only some geological lineation known as second order branches of the Graben or local (second order) faults on surface.

On the other hand, in Regional Aeromagnetic Anomaly Map of Turkey, there is a perfect adaptation and overlap between the magnetic anomalies and tectonical components, offered in this work. This meaningful relation is shown in Figure-3.

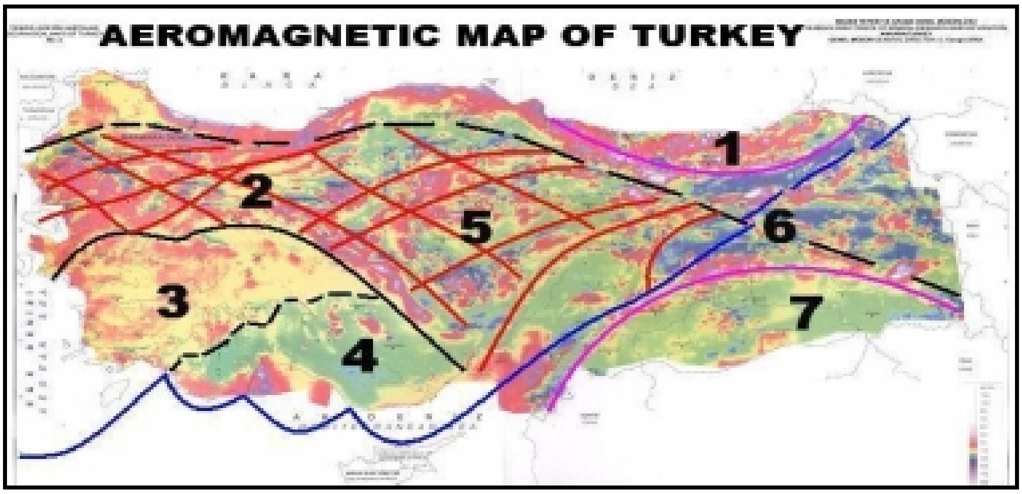

Figure-3. The clear relationship between the regional aeromagnetic Map and the new tectonic events offered in this work of Turkey are;

1. Old Andesitic Cumulates.
2. Old Sakarya Micro Plate.
3. The Area Affected by Hellenic Subduction. (Dominant magnetic effect of the subducted ultrabasic Mediterranean Crust erased the hot-creep rolling effect).
4. The Area Affected by Kaş-Antalya-Cyprus mini Subductions. (Dominant magnetic effect of the subducted ultrabasic Mediterranean Crust erased the hot-creep rolling effect).
5. The Area including (2), Affected by Hot-creep fracturing.
6. The Compression Cross over area.
7. The Old-Thin-Rigid Arabian Plate. (Map: MTAE-Turkey, detail addings – U. Kaynak).

Adding to this group, we can also choose the earthquakes having the magnitudes between 3.0 and 3.9 in the recent (01.01.2003 – 01.07.2003) period, given in Figure-4, as a reverse pseudo filter operator mentioned above.

In this case we have some elliptical epicenter distribution loops having NE-SW short axes in west Anatolia and NW-SE short axes in East Anatolia. As it is seen in Figure-4, the short axes of those of ellipses are parallel to the strike of the local regional compression. All of the epicenter loops have a famous geothermal area in the central parts (near of the mass centers) of the ellipses. The small clusters belong to the aftershocks of the local earthquakes that they mustn’t be taken in account.

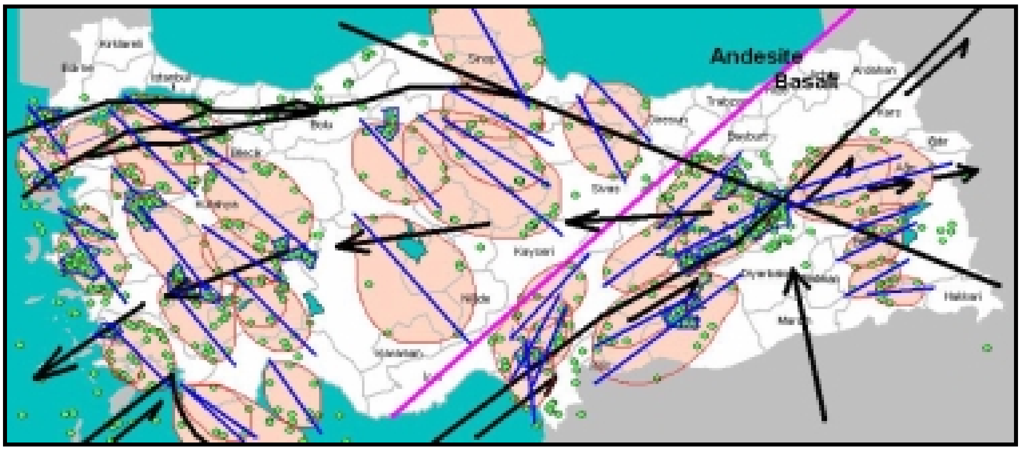

Figure-4. This Map shows the epicenter distribution group of the earthquakes, with magnitudes lay between 3.0 and 3.9 during the period of 01.01.2003 and 01.10.2003. The Long Axes of the East Anatolian Heat Flow Elliptical Loops seem that they show the far turning pole of Arabian Autochthon. We can call the Heat Flow Elliptical Loops as “Cone Sheet Deformations”. On the other hand The Short Axes of the West Anatolian Heat Flow Elliptical Loops took parallel position to the African Plate moving direction. The small polygonal loops belong to the aftershocks of local weak earthquakes. The compression vectors on this map are not suitable according to the vectors offered by the former researchers, which were generally shown in northward direction, because of their direct dependence of the cone sheets deformations. The “Andesite - Basalt separation line can be taken as “The elliptic loops separation line” and then it can be proved that there is a chemical differentiation between these two districts.

The Small Earthquakes of Anatolia

From now, instead of the “**earthquakes with magnitudes lying between 3.0 and 3.9**” auxiliary sentence, their abbreviations such as “**the 3rd”** will be used.
We took in consideration the earthquakes interval as $4.0 < M < 4.9$ and occurring between 2001and 2003, to prevent aftershocks of the big 1999 earthquake and also a non crowded distribution. As expected the 4^{th} map has a random distribution in Figure-5.

The epicenters are nearly occurred out of the big transform fault lines. There are some non-closed elliptic (heat flow driven) cone sheet type epicenter distribution patterns, because of the short cumulating time.

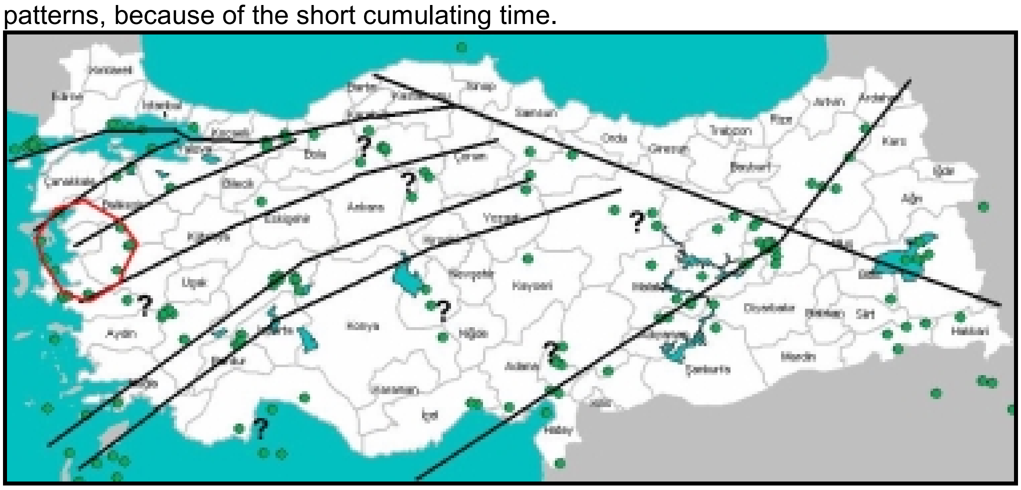

Figure-5. The distributions Map of the earthquakes with magnitudes lying between 4.0 and 4.9 occurred between 2001 and 2003 in Turkey. The question marks show the epicenters which are on unknown tectonically lineation. Also rarefies of epicenters take place on the lineation well known. The elliptical loops also have a question mark because of their unexpected orientations.

The orientations of these 4th loops are not as meaningful as in the 3rd magnitude distribution map. Contrary, the Bitlis Thrust Fault Zone, which is not identified neither in the 3rd nor in the 6thdistributions, but this time identified by the six 4th earthquakes that they are characteristic magnitudes for a thrust fault zone. One of the most regular elliptic loops occurred near İzmir. If the 3rd are successful to represent the heat flow activity and the 6th successful to represent the tectonic activity of deep fracturing, the 4th will take place between these two and show a random distribution also will act a transition role.

The Mini Earthquakes of Anatolia

At the end of the year of 2003, I wanted to check once more whole of the magnitude intervals between 01.01.2003 and 31.12.2003. I faced with a new surprise when I choose the newly established mini earthquakes having the magnitudes between 2.0 and 2.9. Unfortunately I believe that the 2nd earthquakes must depend upon the tidal effect of the moon “as a postulate”. Thousands and thousands of fault plane which equal to one or two stadium area can be success to damp the crustal deformation, every 27 days of 50 cm - 70 cm tidal rising. What kind of hyperfine tectonic activity can trigger a fault plane equal to some 5-6 deca-ars? By the increasing of the depths, how those of high hydrostatic pressure survived in the vicinity and can be allowed those several cm of (minimal) strikes?

Now it is seen that this postulate is not right. The importance of the theoretical predictions can’t be discussed. One more, it is emphasized that the reliability of a postulate is not exact unless the experimental data verification done. Now let us look at the map which interpreted the distribution of the 2nd earthquakes given in Figure-6.

1) It is seen that the 2nd earthquakes are completely working under the effect of tectonic events.

2) The 2nd earthquakes are dominantly gathered on the Western Quadrant of Karlıova Cross. The highest speed plastic hot-creeps are produced on the basement of this quadrant. Thus it has been proved that the plastic hot-creeps can trigger the mini earthquakes in the elastic crust above, instead of tidal effect.

3) The rare 2nd epicenters distribution on the East Quadrant may be caused by the heavy mass recoil of the adjacent Cimmerian Plate.

4) According to this hypothesis, it is seen that the northern and southern quadrants of the Karlıova cross are completely quiet in regard of the 2nd earthquakes.

5) It can be thought that these zones are also affected by the plastic hot-creep and important fault zones together because of the 2nd earthquakes epicenters are crowded in the western narrow bands.

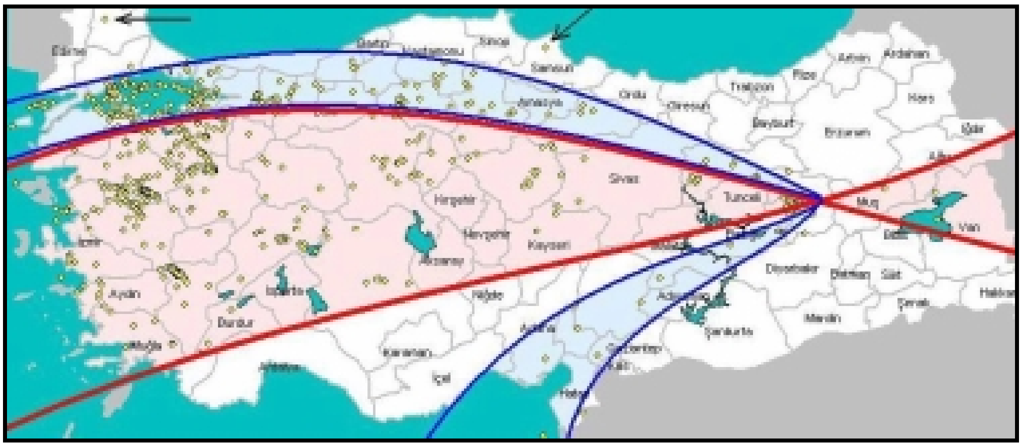

Figure-6. The Epicenter Distribution Map of the 2.0 < M < 2.9 Earthquakes occurred in 2003 and its Interpretation.

6) The two disordered earthquakes shown by arrows can not make any unreliability on this interpretation so the existence of hundreds of earthquakes obeys in rule. In other words, it is surprised that approximately 50% colorless part of Turkey has only two 2nd earthquakes during whole 2003 year at least. It has been seen that the Earth Crust has dump approximately 53 cm of tidal effect by some slow motion but continuously earthquakeless displacements, instead of the sudden mini faulting in the vertical-horizontal-transversal fissure-cracks system.

The Symmetric Bays of the Western Turkey

Four dark drawn symmetric bays namely Saros, Edremit, Çandarlı and Gökova on the Aegean Coast of Western Anatolia were built by the E-W strike slip faults in the first step and then NE-SW Strike Slip Faults in the second step as shown in Figure-7. These important tectonic evolutions of the Western Anatolia are shown in Figure-8.

The thick lines drawn on inland of the Aegean Shore are the graben valleys, which are identified by means of the active faults and geomorphologic structure.

The northern flanges of the (probable Miocene aged) four bays were built on the first step and they were parallel to the old slow hot-creep vector of the western quadrant of the Karlıova Cross. The southern flanges of the bays were built on the second step which was parallel to the African Plate moving direction shown in Figure-4, 11 and 12. On the western Anatolia, by the effect of the anticlockwise torque and 2.5 mm/year of moving speed to Southwest, produced by Karlıova Cross Western Quadrant, it is unexpectedly seen that, neither main graben are parallel to the 6th lineation nor the shores of the bays built by faults are superimposed by one of the known faults, except Saros, on surface. Although the Çandarlı Bay looks like the other three bays, its dimension is smaller than the others.

Under the proceeding evaluations, it will be shown in the following paragraph that the "mini drift of Western Anatolia" is not a real drift.

Figure-7. The Deltoid Fracture Pattern of Western Anatolia Shown in Figure-2 are parallel to the second order peripheral graben branches occurred in NE-SW and NW-SE strikes. The four "Fault Bays" marked with thick black lines look perfectly like each other. Total length of their northern shores is 234 km. Total length of their southern shores is 215 km. The total slip is 449 km.

One of the interesting situations is the slightly equality between the total length of the southern shores (80km + 45km + 45km + 45km = 215km) of the symmetric bays and the mid Anatolian volcanoes total walking length (Karadağ-Karacadağ-Melendiz-Erciyes = 220 km). The other one is the approximate equality of the total strike length of the bays (449 km) and the total strike of the EAFZ, mentioned as 450 km in this work.

In the first step, the E-W striked faultings which build up the total length of the northern shores of these bays (60km + 74km + 20km + 80km = 234km) could not find an ability to make any volcanic lines, because of the probably higher speed of the Karlıova Western Quadrant Hot-creep in Miocene than Pliocene + recent.

In the second step the faults with strike of NE-SW was built the southern shores of these bays (80km + 45km + 45km + 45km = 215km). Temporarily the walking crust of the western Anatolia on a steady state hot point was built up the Karadağ-Karacadağ-Melendiz-Erciyes = 220 km volcanic line.

The Bays in Figure-7 have a good accordance with the main and second order strikes of the graben system. But the graben system and the bays do not have any relations clear enough to be having an explanation about their building process, on the geographical map. In this situation the most reliable explanation about “why these bays except Saros do not have some active strike slip faults just on one of their shore” is the reality of a thick overburden material will cover these faults in a few decades, even if they were active in the past but locked in recent.

On the other hand, while the southern border of the western quadrant stays under the control of EAFZ, the Alagöz - Ağrı - Tendürek - Süphan - Nemrut Volcanoes and the “on line” Tectonic Window of Hazro, being the total slip of EAFZ, will have the length of 450 km, nearly equal to the total 449 km slip of the four bays. Hazro takes place on the southwestern end of the eastern volcanic line.

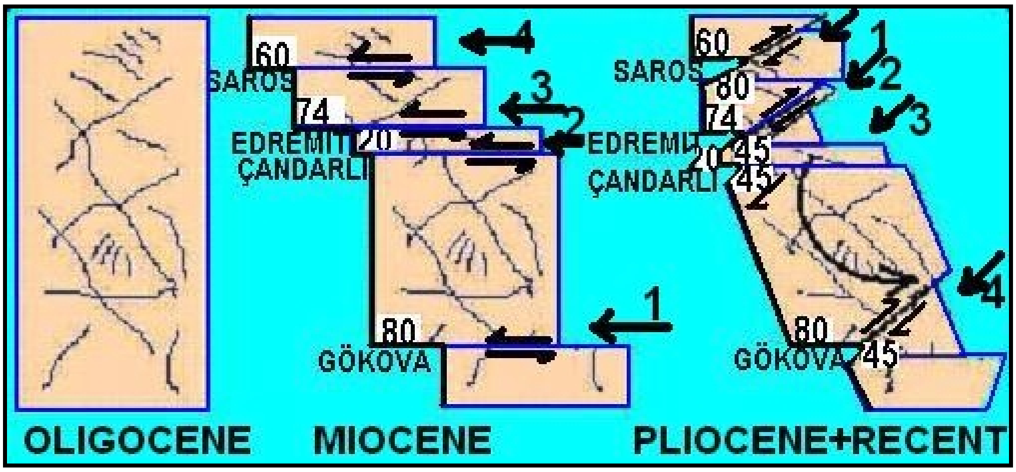

Figure-8. The total angles of 30° between Pliocene and Miocene directions of the Karlıova Cross Western Quadrant have a good relation with the rapid closing of the eastern part of Neotethys Ocean and rapid spreading of the southern part of the Atlantic Ocean or as an another argument, the total torque of Gondwanaland. The numbers in the figure are the lengths of the shores in kilometers.

As a result of the evaluations above, the epicenter distributions of Turkey can be classified under two groups.

1. Epicenter Lineation Related with Strike-Slip Faults

The great dextral NAFZ and sinistral EAFZ strike slip faults are produced by the “compression stress and torque stress” of Arabian autochthon, driven by African Plate and the “Sea Floor Spreading” Activity of Red Sea. The radial compression vector shown in Figure-4, 11 and 12 has a general direction of SE-NW and just located on the center point of the concave bending of the SE Taurides. This type of compression causes two strike slip crossing faults having the angles 60°-120°-60°-120° among the cross over point. If we suppose that the Eurasia is in steady state behavior, the “Karlıova East and West quadrants Bilateral Outward Creeping Process” can not draw the big mass of the Cimmerian peninsula on the east boundary to the Indochina on the Far East. By the way the total creep will have two time speed towards the freedom of the Hellenic obduction area on the west – southwest on the west quadrant. A similarity known as an important Plate Tectonic Rule, occurs in the mid ocean ridges when one of their flanges has been stopped.
To simplify the complex behavior of Anatolia elastoplastic cumulates in the mid eastern part of Turkey, a model tank is imagined and shown in Figure-9. According to this model tank, as the width of Turkey decreases, the length of Turkey increases as a whole.

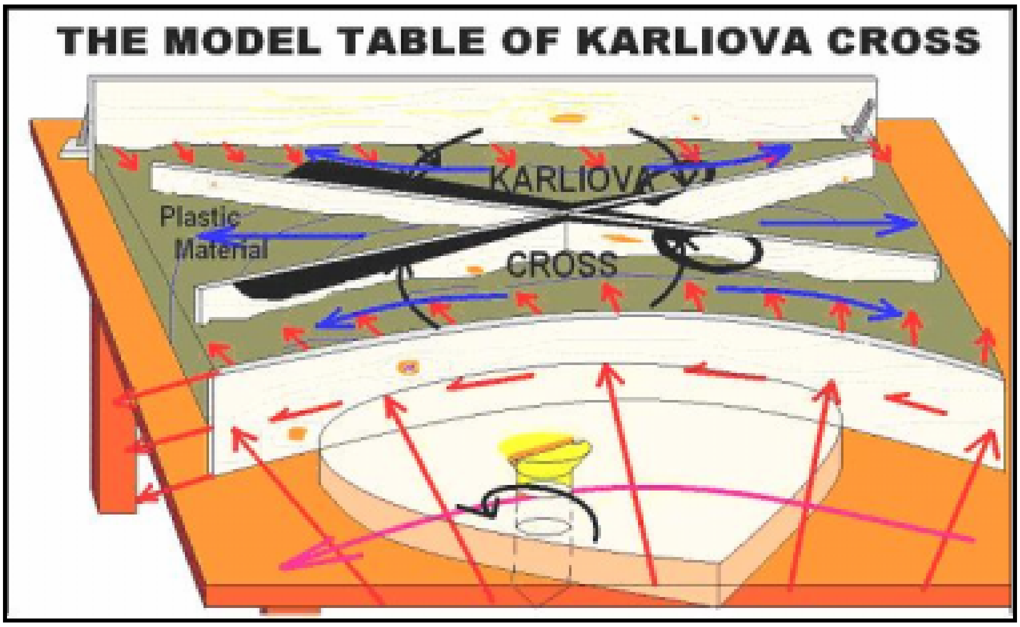

Figure-9. The Model Tank of Karlıova Cross

The crossing type strike slip twin faults are characteristic in the world. In this case, if a compression vector doesn’t have a zero application angle with the affected plate margin, or if a torque component begins to work, the responses of the compressed crust will have one or more parallel strike slip faulting which compensate the horizontal component of compression. The fomous Parallel Faults trlpplet are

1. Rawalpindi – Katmandu
2. Indus – Tsang Po
3. Altintag – Nansan.

Or a pair of cross fault beign to work on elastoplastic crust, to dump and disperse of the compression effect by a bilateral outward hot-creep. The well known Cross Faults, caused bilateral outward hot-creep samples in the World are known as,

1. San Andreas – Garlock cross faults in California,
2. NAFZ – EAFZ cross faults in Eastern Part of Turkey,
3. Zagros – Kirman cross faults in SW of Iran,

4. Hindukush – Karakouroum faults in Kashmir,
5. Tsöng Too – Yunnan cross faults in Southern Part of China,
6. Main Fault – Mino Owari cross faults in Nippon Island, Japan.

2. Epicenter Lineation Related with the African Plate Movement

The Main vector of the African Plate Movement lies from SW to NE. Also the drift strike is parallel to,

A) Crete Transform Fault Shown by (5) in Figure-10,
B) Cyprus Transform Fault Shown by (8) in Figure-10.

In other word, they are parallel to the (The Trenches Looking Same Direction - Transform Faults) faults shown by “2-3-5-6-8 System” in Figure-10. These faults are marked with (12) and (14) in Figure-12. The (14) fault is also known as EAFZ.
As the African Plate Movement applies a compression to the whole of the Europe and south-eastern part of Anatolia, from SW to NE, the opposite movement of the western part of the Karlıova Quadrant which has a dominant movement on the north, has divided the Western Part of Anatolia into six flakes, identified by the epicenter lineation. They are antiparallel to the African Plate Movement direction. The flakes separating lines can not clearly observed on surface by the geological ground verification or space image verification (but newer Doppler Effect Topographic Maps). Hence one can imagine that the flakes separations are deep enough to have a masking effect on surface. For example these deep separation planes may reach to the Conrad Discontinuity which is located on the depth of 17-20 km level in the Anatolian Plate and end there.

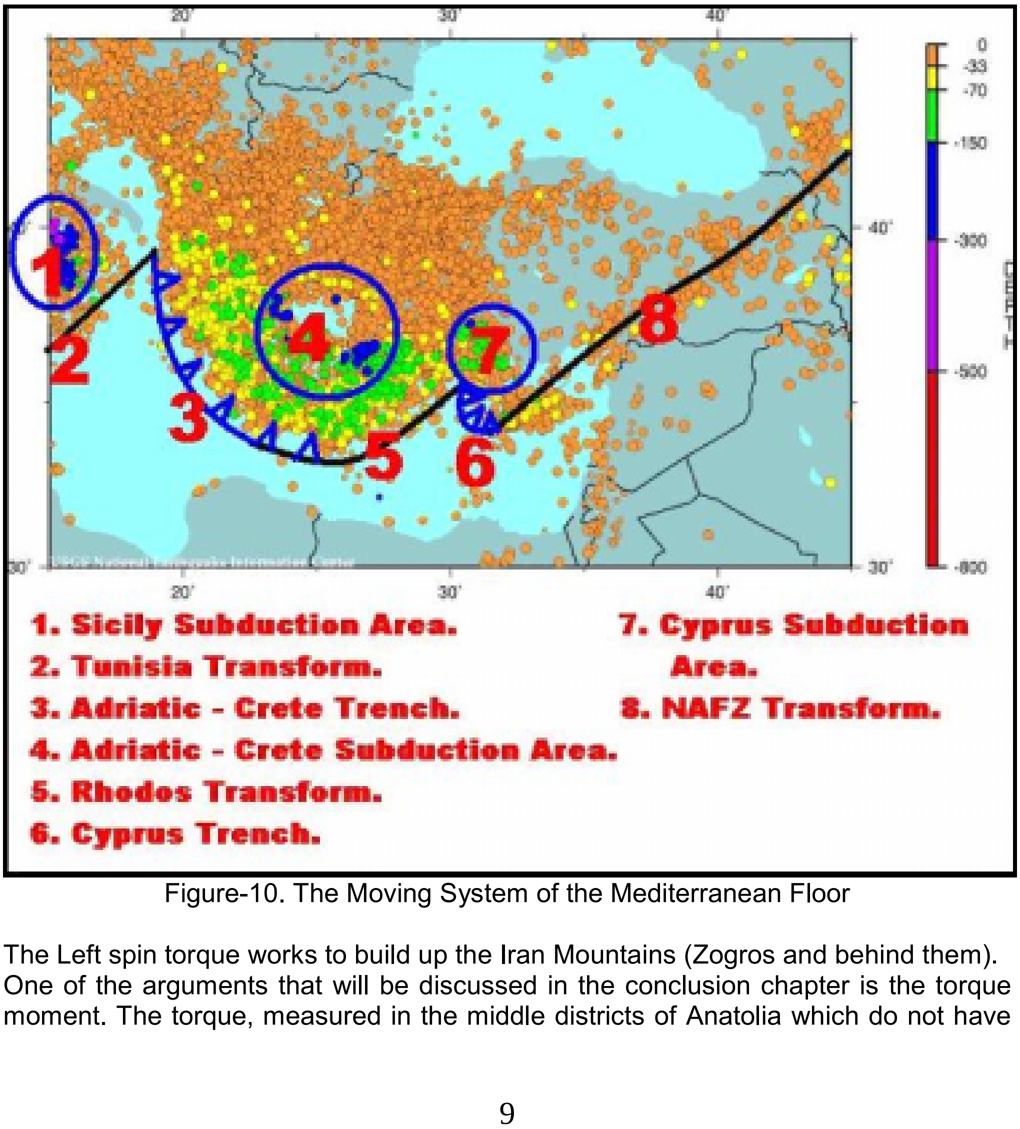

Figure-10. The Moving System of the Mediterranean Floor

The Left spin torque works to build up the Iran Mountains (Zogros and behind them).
One of the arguments that will be discussed in the conclusion chapter is the torque moment. The torque, measured in the middle districts of Anatolia which do not have

any relation with the Arabian compression and caused by the bilateral outward hot-creep, produced by the Karlıova Cross will also be discussed. The other one is the African Plate Moving vector effects whole Turkey towards NE.

CONCLUSION

Although the Seismotectonic Map given in Figure-12 seems complex because of its scale, the maps which are components of this map are simple, shown in Figure-1, 2, 4 and 7. If there are some complexes parts on Seismotectonic map, one can make a flash back to the related supplementary maps for details. The target of this work is to produce the map given in Figure-12. All of the data on this map are obtained from earthquake epicenter distribution maps which were specially chosen in proper magnitude interval. For example the earthquakes having the magnitudes bigger than 5.9 Richter have been selected to exaggerate only the elastic deformation energy release as a cause of earthquakes. On the other hand, the selection of earthquakes having the magnitudes smaller than 3.9 Richter have been exaggerated the cause of earthquakes of sub marine land slides, deep vapor pressure driven expansion stress, isostatic balance, natural or man made (such as Dam Reservoir lakes) rapid crustal accumulations, upward stress of all the geothermal activities, tidal effects (?), and naturally small elastic deformation energy release activities.
If we start to observe the interactions between the African Plate and West Anatolia first, we can reach the following criteria:

In the Western Part of Turkey

1. The African Plate Movement effects Turkey by a twin subduction system called Hellenic (Crete) and Cyprus Subductions.

2. Deeping and sinking of these two subducted Mediterranean Crust must reach about 454 km beneath Aegean Floor and West Anatolia Crust at least. The elongation about 450 km is measured on the map, for the Mid Continent Walking Volcanoes of East Anatolia. These are Alagöz - Ağrı - Tendürek - Süphan – Nemrut volcanoes and the “Hazro Tectonic Window” on the end of the same line. (Figure-12) The 450 km total slip may seem a lot. But this slip amount is just small, comparing to the 10.000 km’s of southern part spreading of the Atlantic Ocean. In this circumstance in the geological past, the annual velocity average of the strike slip of the EAFZ may be four times greater than recent amount, just like the Western Pacific Ocean Floor Transform Faults.
On the other hand if the radial distance between the deepest earthquakes area marked (4) in Figure-12, and the Trench of Hellenic Subduction measured, the total deep including the subduction just stayed beneath West Anatolia, will be found 454 km, which is close to the 450 km given above. According to the Plate Tectonic Theory, this net deep amount is related to the total strike of the EAFZ.

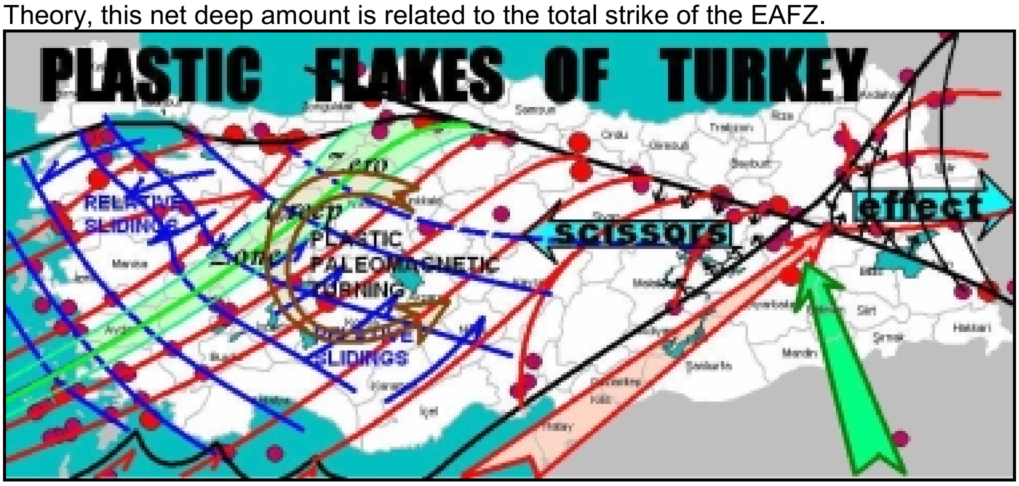

Figure-11. The Chaotic Elastoplastic Movements and Plastic Flakes of Turkey which Build Up the Symmetric Bays on the Aegean Coast and Zero Creep Zone on the Mid-West Districts

While the East of Turkey drifts to the NE, Middle of Turkey creeps to west, west of Turkey creeps to SW and the middle and western parts of Turkey turn plastically anticlockwise, the responses of these activities seem extremely chaotic as seen in Figure-11.

At the end of this process the Caucasoids started to rise by closing the eastern part of the ancient floor of Black Sea, just behind of the Baku-Tibilisi-Kutais Trench. Under these circumstances, Hazro tectonic window, the last attack location of the hot point which takes place just on the SW end of the eastern volcanic line, must be taken account while measuring of the length of East Anatolian Walking Volcanoes.

The total 234-km's length of the symmetric bays northern shores was depended upon the total movement of the Western Quadrant of Karlıova Cross, in the first step. The total 220 km's length of the Middle Anatolia walking volcanoes line also depended upon the total movement of the Western Quadrant of Karlıova Cross in the second step. As a result, the total 450-km's length of the East Anatolia Walking Volcanoes Line depended upon the total slip of the EAFZ. This total movement is equal to the total length of the northern and southern shores of symmetric Aegean bays occurring in two different phases.

Because of the folding of the crust, thickening of the crust, erosion of the crust, right angle thrust faulting and right angle obduction, the ground verification of this total slip calculation is not applicable. According to the arguments above, though the recent activity seems low level, the EAFZ can be called as the Main Fault Zone of Anatolia.

3. The main fracturing line is just superimposed with the EAFZ which enter to the continental crust of Turkey on the south shores of Adana, located at the far end of north-eastern Mediterranean Sea. While passing Karlıova Cross, it has some right and left offset by the effect of NAFZ and then leaves Turkey at Kars on the border line of Armenia. But surprisingly this Fault is also parallel and closed to the separating line of Andesitic-Basaltic differentiation regime of Anatolia. (Figure-4)

4. As it is well known, the rigid Earth Crust shows plastic behavior on long distances and acts elastic behavior on short distance. This phenomenon is current on the crystalline autochthons in decreasing intensity. Even a strike slip fault elongation may be over 1500 km's, suppose an earthquake the biggest one occurred on it, the fault crack will work about 500-km's as a maximum segment. The lengths of these segments probably depend upon distance and have the elastoplastic or plastic behavior of fault compartments. As the subduction zones not a real fault, they can slowly walk down like an ant, some times along some 1000 km part of the whole zone.

5. The hot-creep vector directed to the west is dominant on the Western Quadrant of Karlıova Cross which involves the West and Middle part of Turkey. By means of the compression of the African Plate Movement which has a decreasing effect on the northern part of Turkey, the hot-creep of the "Karlıova Cross Western Quadrant" has been divided approximately 49 plastic parts the West Anatolia, by means of the 7x7 imaginary lines, only identified by the earthquakes epicenter. The main causes of the West Anatolian Deltoid Fracture Pattern are the Southwest directional hot-creep movement and the sliding effect, which will instantly occur on the normal direction of the hot-creep vector. The arc shapes of hot-creep lineation depended upon the relative torque moment.

6. The Mediterranean Floor which subduct under West Anatolia (and also Italia, Yugoslavia and Greek) may have a lot of diapiric rise, mantle plumes and probably a convection circulation within East-West strike beneath of them. This system causes rising on the Aegean district. Especially the plastic fracture system and two main compression vectors that were valid from the third and fourth geological times and upward stress together produced on the East-West main pull-apart zones under 30°

angle and the Northwest-Southeast peripheral pull-apart zones which are known as the Graben system on surface.

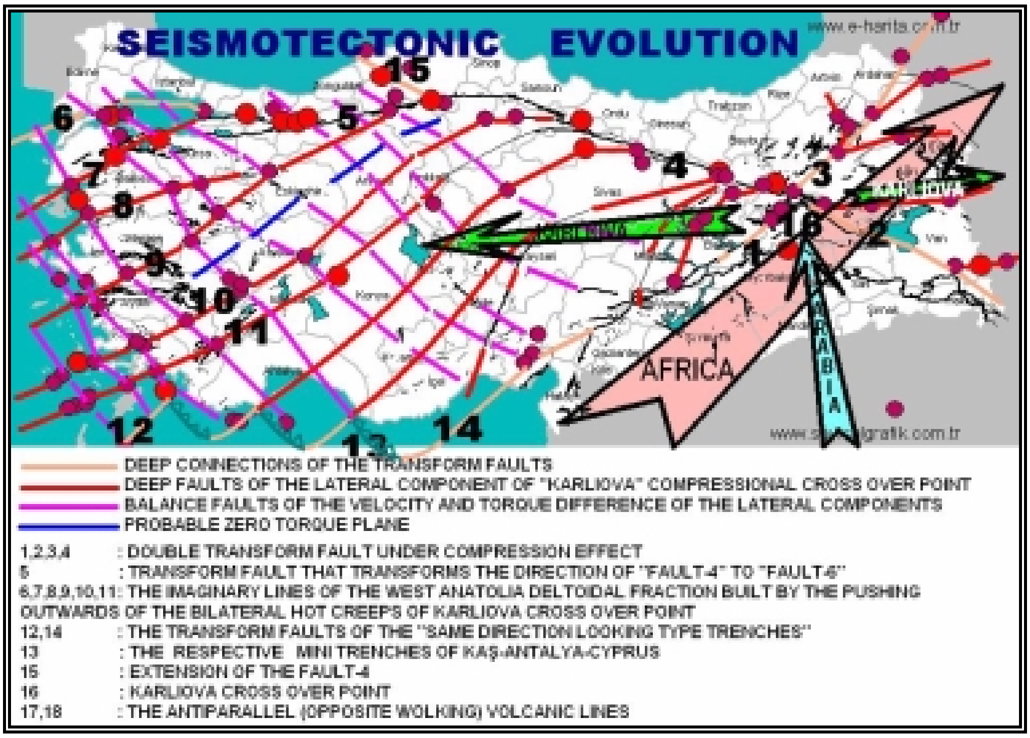

Figure-12. The General Seismotectonic Map of Turkey produced from the beginning of the Instrumental Seismic Period. This map is drawn out by overlapping the maps including details given in Figure- 1, 2, 3, and 5. The whole of lineation on this map are independent of the fault line detected on surface. This lineation depends only on the occurred earthquakes, regardless if they are shallow, deep, strong or weak.

7. Although the epicenter lineation generally doesn't make any trace on the surface because of the characteristic of hot-creep process, the peripheral branches of graben have a good accordance with the deltoid pattern of Western Anatolia.

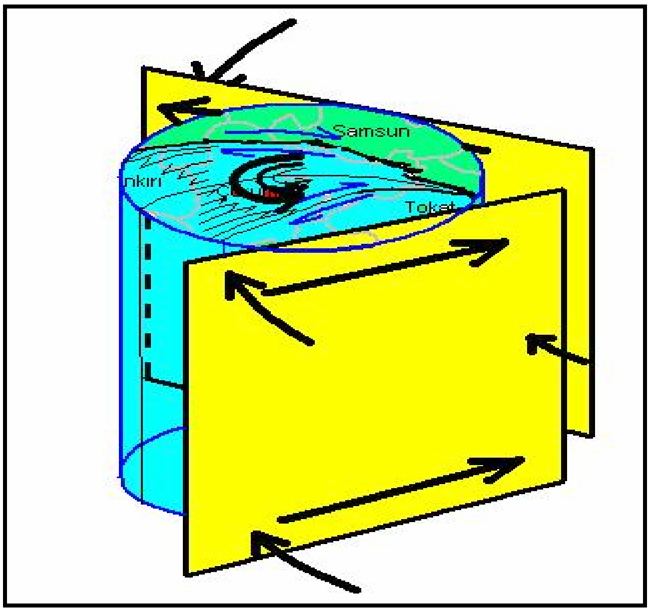

Figure-13. The Plastic Rolling Model of Middle-West Anatolia Crust

8. There are not any big earthquakes on the widest Deltoidal flake shown by (9) and (10) in Figure-12. Because of this phenomenon, Figure-12 has seven fracture lines which are drawn by related epicenter lineation. Figure-11 has seven fractures line drawn by related Aegean Bays. The quiet earthquake zone is located between the lines (4) and (5) in Figure-11. Although all of fracture lines are suitable with the epicenter lines, the existence of a “seismically-quiet fracture zone” supports the hot-creep thesis. This seismically-quiet fracture zone can be called as “The Zero Creep Axis of Nowadays”. There is not any stress vector symbol on this zero creep axis as seen on Figure-11. The production process of the zero creep axes can be explained by antiparallel vectors shown in Figure-13. <u>If the Midwest Anatolia was drift to the west rigidly, the earthquakes would have to occur only just on the NAFZ and EAFZ. But this is not true.</u>

In the Eastern Part of Turkey

1. All of the compression stresses will have a horizontal component in global manner, because existing of a far turning pole of all plates or deviation of the collision angle from right angle.

2. Adding to this, In Arabian autochthon, this horizontal component has been exaggerated because spreading effect of the Red Sea. This effect is causing a torque momentum component especially in the northern part of Arabian Peninsula. This compression component effects Turkey, but the torque component mostly effects Iran more than the east of Turkey.

3. A couple of hot-creep system continuously progressing in bilateral outward direction on “Karlıova Cross Over Point” which takes place on the decreasing angles side, occurs in east and west.

4. The northern board of the western quadrant that controlled by NAFZ, transforms the direction of the (4) to the direction of the (6) by means of the (5) segment, shown in Figure-12. That means this transforming angle reaches to 60° of the Karlıova Cross narrow side angles at least. According to this concept, there are some genetic differences between the east part and west part of the NAFZ in Havza town located about on the mid point of the whole fault of Turkey Part. This fault can be identified as a transform fault in the west part of Havza Town, a continental joint on the near east of Havza Town and a transcurrent fault on the Karlıova Cross.

5. The short axes of the entire elliptical epicenter “heat flow areas” turns parallel to the dominant compression vector. By means of this phenomenon, the direction of the compression vectors can be measured, instead of estimation. Also this behavior forces us to imagine that the deep material under compression stress will have a hot-creep at all. The long axis of the East Anatolia elliptic loops seem to be showing the Arabian Plate turning pole located somewhere on the Red Sea. The long axes of the West Anatolia Elliptic Loops take perpendicular position to the numberless parallel moving vector of the Africa Plate.

The seismotectonical differences of the East and West Anatolia are developed by a border line, lying from Anamur located on Mediterranean coast to Artvin located on the East Black Sea coast which separates Anatolia two parts as andesite regime on the west and basalt regime on the east. Under these circumstances, the Eastern part of Turkey had been longer collision exposure than the Western part of Turkey. Then the Eastern Volcanic Evolution finds an ability to reach the basaltic composition.
According to the Seismotectonic model offered in this work, the torques calculated by paleomegnetic works applied to the middle and west Anatolia are related to the hot-creep and fracturing processes instead of Arabian torque. As seen in Figure-13, this phenomenon is not a real torque but it is a pseudo torque derived from the inequality and antiparallel position of the drifting vectors. So it can be stated here that the Anatolian torques carried out by paleomagnetic works, suitable with hot-creep

process are independent from the Arabian mini plate movements as believed before this work.

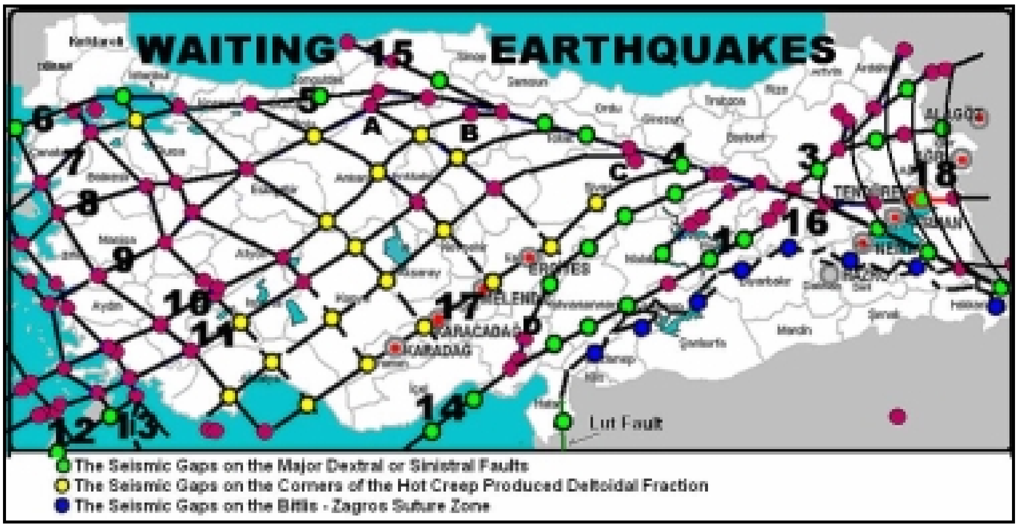

Figure-14. The deep Kinematical Behavior Pattern of Turkey and waiting (probable) Earthquake Locations. It must be importantly stated here that the occurred earthquake locations permit to occur a second or third one in the short period. So it is more realistic to say “There are short term earthquake occurring risks in entire of Turkey, without control of legend above”.

The Seismotectonic data given in Figure-12 has been simplified by only showing the lines in Figure-14, another important product of this work. The most interesting specification of Figure-14/A, B, C and D is the bounding of a secondary faulting or a fracturing line which makes a little bit off set on the epicenter just located on the crossroad.

There are only two epicenters which are not suitable with this pattern in Marmara and Aegean Sea. This good accordance will increase the reliability of this pattern. On the other hand, as this pattern is built up by the bounding of the epicenters by lines and not a subjective opinion or an interpretational product, then there is no need to discuss its reliability.

The “most important earthquake prediction operator is seismotectonic maps” phrase is a rule in earth science. As a conclusion of this work, one can make a prediction or projection about the location of the earthquakes that will cause big casualties in Turkey, especially on transform fault zones and (after this work) Deltoidal fracture corners. Adding to this one can detect approximately occurring type of the waiting earthquakes by means of a statistical or seismological method, except occurring time. (Figure-14).

It is important to state here that, Ankara the capitol city of Turkey can be taken out of Deltoidal corner risk group, because it is quite near to the zero creep axes shown in Figure-11. Unfortunately we must explain here that the silence effect of the zero creep axes do not effect the Aegean and NAFZ bounding districts seismic intensity because of the high tectonic and magmatic activity on and hinterland of them. In other words, these physically existed surfaces can not be successful to decrease the seismicity of two end parts of it. But a lot of 4-5 magnitude earthquakes occur on this seismically quiet zone and couldn’t get the attribute of the people. Probably the big earthquakes will be rare, because they are continuously retarded by these small ones. There are minimum one or more earthquakes just on the corner points showed by red dots.

The triplet’s of red dotes occurred in the instrumental period of 20th century that means the Deltoidal corners; such as no marked, marked single dot or marked double dots are not important to affect the seismic risk (occurrence probability). Unfortunately all of the Deltoidal corners are candidate to be having an intensive earthquake without regard to the dots number.

The map illustrated in Figure-14 can be evaluated by the investigators with its rights and wrongs. This century is a short period for the big earthquakes occurring frequency to control the seismicity in future. For example, if this work was been done in 1996, nobody could announce for a third “short term” earthquake on the two red dotted in Adana and for a third short term earthquake on the two red dotted in Dinar. But at that time, for yellow dotted Sultandağ town or Çankırı-Orta town, an earthquake would be predicted.

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*: Retired from Kocaeli University at Turkey.

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References

1. PINAR, N. and LAHN, E., 1952, **Türkiye Depremleri İzahlı Katalogu**, İmar ve İskân Bakanlığı, İmar Reisliği yayın no.36, seri.6.

2. ERGİN, K., GÜÇLÜ, U. ve UZ, Z., 1967, **Türkiye ve Civarının Deprem Katalogu**, İTÜ.,Maden Fakültesi Yayını.

3. ERGİN, K., GÜÇLÜ, U. ve AKSOY, G., 1971, **Türkiye ve Dolaylarının Deprem Katalogu**, İTÜ., Maden Fakültesi, Arz Fiziği Enstitüsü Yayını.

4. SOYSAL, H., SİPAHİOĞLU, S., KOLÇAK, D. ve ALTINOK, Y., 1981, **Türkiye ve Civarının Deprem Katalogu,** TÜBİTAK proje no.TBAG 341.

5. AMBRASEYS, N.N., 1970, **Some Characteristic Features of the North Anatolian Fault Zone,** Tectonophysics, 9, 143-165.

6. DEMİRTAŞ, R. and YILMAZ, R., 1996, **Seimotectonic Map of Türkiye Showing MS3-4.0 for 1990-1993 (ERD),** International Symposium, Earthquake Research in Türkiye, State of Art, 30-October – 5 September, Ankara.

7. IKEDA, Y., 1988, **Geomorphological Observation of the North Anatolian Fault, West of Mudurnu,** Multidisciplinary Research on Fault Activity in the Western Part of the NAFZ, Eds: Y.Honkura and A.M.Işıkara.

8. IKEDA, Y., SUZIKI, Y., HERECE, E., ŞAROĞLU, F. and IŞIKARA, A., 1991, **Geological Evidence for the Last Two Faulting Events on the NAFZ in the Mudurnu Valley,** Western Turkey, Tectonophysics, 193, 335-345.

9. DEWEY, J. W., 1976, **Seismicity of Northern Anatolia,** Bull. Seism. Soc. Am. 66, 843-868.

10. TOKAY, M., 1973, **Kuzey Anadolu Fay zonunun Gerede ile Ilgaz arasındaki kısmında jeolojik gözlemler,** Kuzey Anadolu fayı ve deprem kuşağı simpozyumu, Ankara,12-29.

11. SEYMEN, İ., 1975, **Kelkit vadisi kesiminde Kuzey Anadolu Fay zonunun tektonik özelliği,** İTÜ maden fakültesi yayını, 192 s.

12. SİPAHİOĞLU, S., 1984, **Kuzey Anadolu fay zonu ve çevresinin deprem etkinliğinin incelenmesi,** Deprem Araştırma Bülteni, Ankara, 45, 5-138.

13. SİPAHİOĞLU, S., 1975, **Sismotektonik ve Metodları**, TC.MEB.Kandilli Rasathanesi Yayınları,No.49. (Huzur İçinde Yatsın)

14. BARKA, A. and GÜLEN, L., 1987, **Age and total displacement of the North Anatolian fault zone and its significance for the better understanding of tectonic history and present day dynamics of the Eastern Mediterranean region,** abstract book of Melih Tokay Geology Symposium, 87, 57-58.

15. KAYNAK, U., (1992), **"Sismotektonik",** Kocaeli Müh.Fak.Matbaası, Birinci baskı, 46-54

16. NURLU, M., BATMAN, B., CHOROWICZ, J. and GENÇ, M.A., 1995, **A geometrical approach relating to the movement mechanism of North Anatolian Fault Zone, I**nternational Symposium on the Geology of the Black Sea region, Erler, A., Ercan, T., Ergüzer, B. and Örçen, S. (ed), Ankara, 283-291.

17. ŞAROĞLU, F., 1988, **Age and offset of the North Anatolian fault,** METU journal of pure and applied sci., 21, 1-3, 65-79.

18. TATAR, Y., 1975, **Tectonic structures along North Anatolian fault zone, Northeast of Refahiye (Erzincan),** Tectonophysics, 29, 401-409.

19. G.BOILLOT, 1981, **Geology of the Continental Margins**, Longman Group Limited, Printed in Great Britain William Clowes Ltd.

20. K.C.CONDIE,1989, **Plate Tectonics and Crustal Evolution**, Pergamon Press, Oxford.

21. CANITEZ, N. (Editör), 1983, **Levha tektoniği** (Ders Notları), TUBİTAK İTÜ. Yaz Okulu Yayını.

22. ŞENGÖR, A. M. C., 1980, **Türkiyenin Neotektoniğinin Esasları.,** Türkiye Jeoloji Kurumu, Yayınları, DSİ Matbaası-Ankara.

23. ŞENGÖR, A.M.C. and V.S.F. KIDD, **Post Collisional Tectonics of the Turkish-Iranean Plateau and a Comparision With Tibet**, Tectonophysics, c.55, pp.361-376.

24. ŞENGÖR, A.M.C., GÖRÜR, N. and TARODLU, F., 1985, **Strike-slip faulting and related basin formation in zones of tectonic escape: Turkey as a case study, Strike-slip deformation, basin formation and sedimentation,** Biddle, T.R. and Christie-Blick, N. (ed.),Soc. Econ. Paleontol. Mineral., Special publication, 37, 227-264.

25. KURAN U., (1980), **The location magnitude and long-term time prediction of damaging earthquake along Anatolian faults and Levant coast**, Bulletin of the Geophysical Congress of Turkey No:2, 151-163.

26. EKSTRÖM, G. AND ENGLAND, P. (1989). **Seismic strain rates in regions of distributed continental deformation.** J. Geophys. Res. 94, 10231-10257.