New magnetic maps and the Tectonic implications of the Eastern Mediterranean

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All magnetic data available for the eastern Mediterranean Sea, Black Sea and Turkey were reevaluated and reprocessed into new magnetic maps.

The total data set available for the studied area was collected over a period of 22 years. Having taken the secular variation of the earth's magnetic field into consideration, we used the revised IGRF (International Geomagnetic Reference Field) i.e. DGRF (Definitive Geomagnetic Reference Field) to calculate a series of magnetic reference fields which were reduced from the observed total magnetic intensity data respectively. Errors of some data sources were also corrected during the reprocessing.

The onshore aeromagnetic data in Turkey were measured with a mean terrain clearence of 2 000 ft. The offshore data were upward continued to a level of 3 000 m so that it is possible to compair and interpret both data sets.

The total magnetic anomalies achieved as described above were reduced to the geomagnetic pole. In general, the magnetic anomalies shift with respect to the magnetic sources when they are observed away from the geomagnetic pole. The pole-reduced magnetic anomalies show clear correlation with the crustal structures.

Both the non-pole-reduced and pole-reduced anomalies were interpolated for the maps with a grid of 6 km x 6 km. The new magnetic maps show NW-SE positive trends which are parallel in the eastern Mediterranean Sea, in the Black Sea and in the Turkey. They are probably the indication of the active zone of the lithosphere. The bending zone of the positive anomalies near the Cyprian and Hellenic arcs may be related to the boundary of the Africa plate and Eurasia plate.

The results of the qualitative and quantitative analysis of the magnetic anomalies will be presented and the implications for the tectonic features in the studied area will be discussed.

The Anaximander mountains : linking the Hellenic and Cyprus Arcs

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The Anaximander Mountains lie at the northeast and northwest ends respectively of the Hellenic Arc and the Cyprus Arc, in the region where the two arcs intersect each other. The Mediterranean Ridge extends southwest from the mountains and the Florence Rise is continuous to the southeast. To the north, the Lycian Promontory of southwestern Turkey projects southwards toward the Anaximander Mountains.

The depths of three peaks identifiable on the International Bathymetric Chart of the Mediterranean (IBCM) are, from west to east, 1022 m, 973 m, and 927 m. A fourth peak with a depth of 1155 m was observed by us further to the east. Deeper water surrounding the mountains varies from over 4000m in the Rhodes Basin to the west to about 2500 m in the Antalya Basin to the east.

The 10 day 1991 geophysical and geological survey addressed the problem of the nature and development of the mountains. Transpressive motion along the southeastern Hellenic Arc is expected from the relative movement of the Aegean microplate with respect to the African plate; and compressive motion is expected along the southwestern boundary between the Turkish microplate and Africa, in analogy to the southwestern margin of the Aegean microplate. Dissimilarities between both arcs (e.g. compared to the Cyprus arc, the Hellenic arc has higher seismicity, active vulcanism in the Aegean backarc, a thick acretionary sedimentary prism south of Crete, and a trench system) suggest interesting geological and deformational differences. Using over 2100 km of seismic profiles, long-range sidescan sonar data (OKEAN), gravity and magnetic measurements, and bottom samples we examined the structure, trends, and deformational fabric to determine the neotectonics, with the hope of identifying influences of both arcs in the evolution of the mountains.

At first glance the Anaximander Mountains appear to have more affinity to the Florence Rise because they lie on two regional swells extending along the rise to the southeast. Furthermore there is a narrow seafloor valley separating them from the Mediterranean Ridge. On the other hand, the southernmost peak of the mountains is roughly linear and aligned with the Mediterranean Ridge trends, along with a northeast-southwest fault zone lying immediately to the southeast of it. There appears also from the gravity data to be a major structural difference between the southwestern and northeastern peaks. The Bouguer anomaly (density 2.67 $g\text{-}cm^{-3}$) is as high as 190 mGal over the southern peak and drops to 40 mGal along the northeastern boundary between the Anaximander Mountains and the Antalya Basin. A strong gradient of about 3 $mGal\text{-}km^{-1}$ separates the southwestern two peaks of the mountains from the northeastern two, and coincides with structural and tectonic divisions. There appear to be more variations in the magnetic anomaly (-30 to +200 nT) east of this dividing line than to the west.

The relative gravity high disrupts a low which follows the Mediterranean Ridge (centred on the Strabo Trench) and the Florence Rise. The fact that it also coincides with topographic highs indicates under-compensation and suggests that the topography may still be in the process of being pushed up. Later compensation would result both in the mountains sinking back on a down-flexing lithosphere and an associated reduction in the gravity high. The regional low over the Mediterranean Ridge results from a thick accretionary prism of sediments lying on the depressed lithosphere of the African plate dipping into the Hellenic Arc subduction system.

All the Anaximander Mountains appear to be fault-bounded along their steep sides. All appear to be composed of sedimentary rocks which have been folded and thrusted (generally southward although they all tilt in different directions). The basement sedimentary strata have very strong reflections compared to the overlying sedimentary strata; and they are thought to be pre-Miocene, and probably older than Messinian as the characteristic seismic signature of the Late Miocene is not observed (i.e. neither the Messinian evaporites nor the rough-looking erosional surface). A fragment of Early to Middle Eocene nummulitic limestone was retrieved along with other rock fragments from one gravity core on the steep fault scarp of the southern peak. One preliminary working hypothesis is that the rocks are from a southern extension of the Lycian promontory of southern Turkey, in which case they might be continuous with the Bey Daglari and the Lycian or Antalya nappes.

The western mountain is a north-tilted (at about 2° to 4°) sedimentary basin of about 30 km long. The basin was probably tilted as a large unit as there is almost no internal deformation. The upper sediments are about 600 ms thick (TWTT, two-way travel time) on average but are locally as thick as 1400 ms TWTT. These sediments are continous with flatlying sediments in the Fineke Basin to the north. The whole unit appears to be sliding down to the northeast beneath a thick pile of off-scraped sediments which shows no coherent internal reflections in the seismic profiles.

Virtually none of the upper sediments seen on the west mountain are present on the southernmost mountain. This mountain is crescent shaped because it is a northwestward dipping syncline with a steep southeast face exposing the edges of the folded strata. The dip of the strata to the northwest is about 21°. They curve westwards towards the south and can be observed cutting obliquely across the narrow valley separating the mountains from the Mediterranean Ridge. The distinctive seafloor pattern made by the truncated strata of the northward dipping folds in this area indicate that the folding effects strata over a wide region south of the peaks and west towards the Rhodes Basin. There are also indications of karstic topography in the region of low relief south of the mountains and along the Florence Rise.

The easternmost of the mountains resembles the western one insofar as it is a tilted block of sediments, but its northeastward dip is more in keeping with the expected compressional axis across the Florence Rise. Tight folding (with northwest-southeast fold axis) in the Antalya Basin sediments immediately to the northeast of the rise also testifies to the compression. These structures are roughly parallel to and coincident with the gravity low. The northernmost mountain lies on the same broad swell with the same trend as the Florence Rise. The morphology of this mountain is more rugged and varied than that of the other mountains.

It seems clear that there is a mixing of influences from the Hellenic Arc and the Cyprus Arc; however, there is also a discontinuity between the arcs. It may be the episodic tectonic activity associated with the arcs that has produced the mix. Neotectonic deformation within the region of the Anaximander mountains appears to have begun only post-Miocene.

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