GEOLOGY AND PHYSIOGRAPHY OF THE BEYŞEHİR - SUĞLA DEPRESSION, WESTERN TAURSUS LAKE DISTRICT, TURKEY

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Physiography

Two large freshwater lakes, Beyşehir Gölü and Suğla Gölü, occupy a northwest-southeast trending intermontane valley on the northeast flank of the Western Taurus range in southern Anatolia. This valley is rimmed by the Sultan Dağları on the north and northeast and by volcanic uplands in the southeast, which rise to summits between 2200 and 2500 meters above sea level. These uplands separate the Beyşehir-Suğla Depression from the arid plateaus of central Anatolia, such as the Konya Plain and the Cihanbeyli Hills. The western side of the Depression is formed by the central massif of the Western Taurus itself, specifically the Anamas Dağı and its southeastward extension, with summits approaching 3000 meters above sea level. The water level of Beyşehir Gölü is about 1110 meters above sea level, and Suğla Gölü is about 1040 meters. Therefore, the maximum relief of this area is about 2000 meters, The Depression as a whole is about 150 km long and about 50 km wide at its widest part, although generally about 25 km wide.

The two lake basins are separated by a broad divide of low hills which form a southwest-northeast trending belt immediately southeast of Beysehir village. These hills rise to summits of 1200-1300 meters and have been cut through by the Beyşehir kanalı, the outlet stream from Beyşehir Gölü. The Beyşehir-Suğla Depression, thus, can ve subdivided into three sections: (a) Beyşehir Gölü and its surrounding lowlands, (b) Suğla Gölü and the extensive alluvial plain just north of it — the Seydişehir area, and (c) the intervening ridge of low hills. (see map.)

Both of the lakes occupy asymmetrical basins. The western side of each basin is relatively deep and presents a steep rocky coastline of Mesozoic limestone. The eastern side, by contrast, has a very shallow, shelving bottom, and the coast is characterized by sandy beaches, lagoons and reed marshes. Each lake is drained by means of a subterranean outlet dissolved through limestone (Lahn, 1948) and a surface outlet.

The Beysehir-Sugla Depression receives 300 to 500 mm precipitation annually, and the surrouding mountain ridges receive up to 1000 mm, much in the form of snow. Large patches of snow persist on the northeast face of Anamas Dağı, above Beyşehir Gölü, throughout the summer, and very small patches remained on the upper slopes above Seydişehir in 1963, indicating a local snowline at about 3000 meters. Pleistocene glaciation of these mountains is suggested by moranic ridges on their upper slopes, although they were not investigated at close hand.

Beyşehir Gölü concentrates the runoff of the northern part of the Depression and discharges via the Beyşehir kanalı at Beyşehir in the southeastern corner of lake. This outlet runs east and then south into Suğla Gölü, although the lower portion of its course has been conside-

rably modified. In the area just north of Suğla Gölü this stream is known as Kurukafa kanalı. The Kurukafa has an artificial channel along the contour around the east side of Suğla Gölü, completely bypassing that lake. It joins the original outlet of Suğla Gölü at the village of Saray and thence follows a natural course, here called Balıklıavı kanalı, into the large canyon of the Çarşambasuyu. All the drainage of the Beyşehir-Suğla Depression thus passes through the Çarşambasuyu canyon to the Konya in the vicinity of Çumra.

İn 1963, the water level of Suğla Gölü was very low, and broad areas of the former lake floor were exposed. The shoreline has receded one to two kilometers along the northeastern side and at least a few hundred meters from the rocky west coast. Lahn (1948) reports that the lake completely disappears once every twelve years or so as a result of either the climatic (precipitation) regime or alternate plugging and unplugging of its subterranean outlet.

Bedrock Geology

The oldest rocks of the area are Paleozoic sediments and metasediments. These are generally weak shales, phyllites and schists which underlie the floor of the Beyşehir-Suğla Depression. However, the prominent Sultan Dağları, northeast of Beyşehir Gölü, is also composed of these Paleozoic rocks, including some marble. Some rocks in the area of Seydişehir have been identified as Devonian, but in general they are shown as undivided Paleozoic on the Geologic Map of Turkey (1944).

The next major rock unit is the Mesozoic limestone which dominates the western side of the Depression. It also occurs east of the lakes to a limited extent and constitutes the low east-west ridge which separates Beyşehir and Suğla Gölü. This is a non-fossiliferous, light gray, very fine grained limestone. The unit is monotonously uniform in aspect. It is moderately thick bedded; however, it is very difficult to determine the stratification and attitude of these rocks because of strong jointing combined with solution effects at the surface. Where the attitude can be determined, the beds are usually moderately to steeply dipping.

The northwest-southeast trending scarp which delimits the southwestern border of the Beyşehir-Suğla Depression is extremely straight and prominent. It can easily be recognized through a distance of about 125 kilometers, and has more than 1000 meters relief in places. This is undoubtedly a fault scarp, which is the major structural element of the Beyşehir-Suğla Depression. As mentioned above, the western shores of both lakes are rocky and the water is deep, in contrast to the shallow eastern shores. This also suggests that the lakes occupy a foult block which is not only downthrown relative to the western shore, but also has rotated: the western edge of the block moving down more than the eastern edge.

The age of the Mesozoic limestone is generally given as Cretaceous, although in some areas its span is Triassic-Jurassic to Eocene. The age of the faulting, therefore, is post-Cretaceous, and it is pre-Pliocene since Pliocene lake beds occupy the fault depression. robably the age of the faulting is mid-Tertiary since Eocene and Oligocene (?) beds are involved in folds elsewhere in the Western Taurus. Minor intrusive activity followed the faulting. At the north end of Beyşehir lake is a large plug of diabase (Kızıldağ) and at the northwestern corner of the lake is a linear outcrop of diabase which follows the major fault scarp.

Following the creation of the fault depression the Beyşehir-Suğla area was occupied by an extensive, shallow Pliocene lake. Remnants of this lake are

widely preserved around the eastern and southeastern fringes of Beyşehir Gölü in the form of a high terrace. At Beyşehir the terrace is 65 to 70 meters above the present lake level or about 1180 meters above sea level. Pliocene sediments comprise a sequence of very fossiliferous, thin-bedded, freshwater limestone intercalated with thicker beds of similarly fossiliferous calcareous muds and marls. The limestone is white or very light tan, and the clays range from white through tans and yellows to very dark gray. occasional thin layers of fossiliferous peat occur in this sequence, as well shown at Ak Burun on the eastern shore of Beyşehir Gölü, where dried, compressed peat occurs in layers a few centimeters thick, about 3 or 4 meters above lake level. Lower in the Akburun sequence, just at present lake level, the peaty material has been lithified into a lignitiferous limestone. The fossils in the peat are the same as in the non-peaty limestone and clay beds, indicating that the peat is probably a lagoonal or marsh deposit of a very shallow, but extensive lake.

In addition to the high terrace deposits near Beysehir, the Pliocene lake beds also occur in the northern part of the Beyşehir-Suğla Depression, north of Sarkikaraagaç, and southeast of Suğla Gölü. Most likely these deposits were laid down in one continuous lake, about 150 kilometers long, or perhaps in several closely connected lakes. These deposits are missing from the Seydişehir valley, just north of Suğla Gölü, although they occur at about the same elevation both north and south of that area, i.e., up to 1400 meters above sea level. Apparently the Pliocene beds have been removed in the broad alluvial valley of the Seydişehir region.

The Pliocene beds are generally horizontal, but in several localities sharp folding has taken place, perhaps associated with faulting. In a rock quarry beside the cemetery at the southeast corner of Beysehir (on the road to Seydisehir) a thickness of about 6 to 7 meters of Pliocene is exposed. These beds are quite horizontal except at the west end of the quarry where they change abruptly to a 45-degree dip toward the west, i.e., toward Beyşehir Gölü. Elsewhere, such as along the main road between Beyşehir and Konya, other outcrops show moderately dipping or slightly undulating Pliocene beds.

Late Tertiary-Early Quaternary geomorphic development

On the basis of more extensive regional studies Lahn (1948) gas summarized the development of the Western Taurus Lake District as follows:

1. In the Pliocene epoch extensive, shallow lakes covered much of the surface of south central Anatolia (partially shown on map, Figure 1). Broad connections existed between all these lakes.

2. This network of lakes was broken up by alpine tectonic movements in late Pliocene-early Pleistocene time. The basins became isolated and closed (i.e., with no external outlet), and the individual lakes were much smaller than in the Pliocene.

3. The individual lakes then folowed one of two courses.

a. some basins were located on soluable limestone and developed a subterranean, karsitic outlet. Thus the lake water remained fresh, and the drainage was adequate to prevent pluvial-interpluvial fluctuations of the water surface. Examples: Beyşehir, Suğla and Eğridir lakes.

b. basins not located on soluable rocks and not having an outlet became saline. These lakes showed considerable fluctuation of level during the pluvial-interpluvial cucles of the Quaternary. Some of these lakes still exist, e.g., Burdur and Akşehir Lakes. Others have disappeared completely, such as the broad Pleistocene lake in the Konya basin.

4. Finally, sometime in the Quaternary, headward erosion of streams cut into some basing, making a normal, surface outlet. (Examples, Beyşehir and Sugla Lakes captured by the Çarsamba suyu.)

Quaternary Geology

Two types of activity have characterized the area since the deposition of the Pliocene lake beds: volcanism and fluvial erosion. The southeastern flank of the Beyşehir-Suğla Depression is a volcanic massif dominated by the Erenler Dağı (2319 meters) and Alaca Dağı (2203 meters). These volcanic mountains are quite young in form. They are composed of andesitic lavas which clearly overlie the Pliocene lake beds, e.g., in the vicinity of Fasıllar due east form Beysehir. The entire period of volcanism is unknown, however. It may extend from late Pliocene well into Quaternary time. At least one warm spring occurs in the area, near Köşkköy 25 kilometers north of Beyşehir. Furthermore the lava rock has been widely used for building stone in this area since Neolithic times, at least (e.g., Gök Hüyük south of Seydişehir).

Only one major cycle of erosion and filling has been found so far within the Beyşehir-Suğla Depression. Moreover, this cycle seems to be more closely related to tectonic activity than to climatic changes during the Quaternary. Sometime after the deposition of the Pliocene lake beds, and perhaps contemporary with the volcanism described above, the base level within the Depression was lowered considerably below the Pliocene level and the Pliocene deposits were strongly dissected. Most likely this was caused by continuing downward movement along the major fault along the west side of the Depression. However, erosional downcutting of the Balıklıavı-Çarşambasuyu canyon which now drains the Depression must have played a role, which cannot yet be determined. This outlet canyon existed in essentially its present form early in the Quaternary (Lahn, 1948).

As a result of these activities the Pliocene beds were strongly dissected and major valleys, such as that which follows the Beyşehir-Konya road and smallyer valleys entering the north and east shores of Beyşehir Gölü, were eroded below the present lake level (see discussion below). The low, broad ridge which now separates the Beyşehir an Suğla drainages was dissected at this time by the predecessor of Beyşehir kanalı, and all the Pliocene deposits were apparently removed from the central portion of the Seydişehir-Suğla Gölü basin. It is not certain that all of these activities were exactly sychronous, but they cannot be separated on the basis of available data.

This general period of downcutting was not continuous, and in fact may be much more complicated than indicated here. One pause in the erosional activity is witnessed by an erosional bench, or lower terrace, which is well marked in the vicinity of Beyşehir. In the southeastern fringe of the town a prominent terrace is cut into the side of, and about 35 meters below the high (65 meters) terrace described above, or about 30 meters above the present lake. This lower terrace is well developed here and can clearly be seen also along the Beyşehir-Konya road. It undoubtedly represents a major stillstand during the general drop in base level.

The next recorded event in the Beysehir basin is a major rise of lake level which brought about the drowning and filling of the previously cut valleys. This is amply demonstrated by the broad, flat floored valleys which enter Beyşehir Gölü on all sides. These are alluvial valleys, up to several kilometers wide near the lake, and graded to the present lake level. They do not give evidence of more than one period of filling. Some of these valleys are not presently occupied by a stream;

others have only weak, underfit streams. This indicated that the valleys are inherited from the previous regime when base level was below the present lake level and that they have not been prodeuced simply by lateral erosion during the present regime.

The latest event in the Beyşehir basin has been a 2-meter drop in lake level. A prominent abandonned strandline, 2 meters present lake level and beyond reach of modern waves, was observed at many places: Burun Hüyük and Alan Hüyük southwest of Beysehir; at the head of the bay on the south side of Ak Burun and on Gülbent Adası, north of Beyşehir; also in the embayment at the extreme northeast corner of Beyşehir Gölü. In some places multiple beach ridges are found, all lying within 2 meters of present lake level. In general these beaches are more strongly developed than the modern beach. At other places there are wave-cut cliffs with bases about 2 meters above lake level and no longer being attacked by waves.

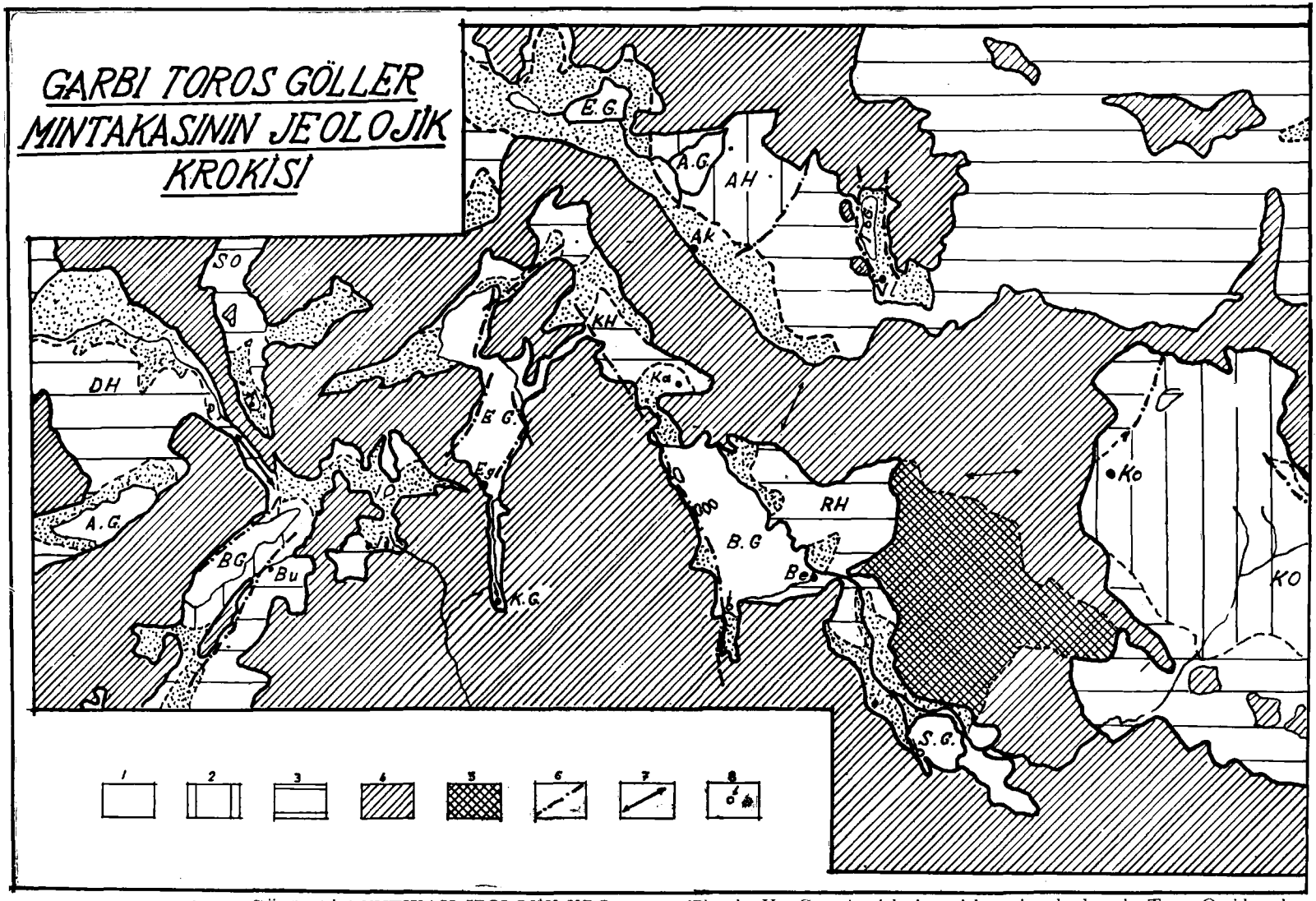
This 2-meter drop in level is quite recent. It appears to postdate the occupation of Burun and Alan Hüyüks which have been truncated by wave erosion at this higher level. Most likely this drop occured as the result of irrigation projects, such as the installation of control gates at Beysehir and enlargement of Beyşehirkanalı. On the other hand, Lahn (1948) remarks on the considerable fluctuations of level in spite of the control gates.

In the Seydişehir-Suğla basin a slightly different series of events took place. As pointed out above, the Pliocene deposits are missing from the Seydisehir valley, north of Suğla Gölü. But they do occur at nearly the same levels both north and south of that area. This arrangement suggests that the Pliocene beds have been completely removed by post-Pliocene erosion by Beyşehirkanalı and its tributaries.

The Seydişehir valley is now a flat-floored alluvial plain which merges in the south with the modern lake floor of Suğla Gölü. The streams traversing this plain are presently highly controlled for irrigation, and an insignificant amount of dissection of the alluvium has occurred. Probably an interesting history lies below the surface of this alluvial plain.

The latest recognizable event is the drainage of Suğla Gölü upon installation of Kurukafa kanalı. Around the eastern and southern shores of Suğla Gölü there is a prominent abandonned beach, about 3 meters above the now-dry lake floor. This beach can be easily seen near Ortakaraviran and Yalıhüyük. The Ortakaraviran hüyüks were truncated by wave erosion when the lake stood at that beach level, and Yalıhüyük then was just on the shoreline.

In the cases of both Beyşehir and Suğla Gölu the rising lake level which culminated at the now-abandonned beaches is cause for speculation. This rise was certainly more important geologically and perhaps culturally than the subsequent fall of 2-3 meters. The level of the lakes prior to this rise is not known. The main evidence for the rise is (a) drowned alluvial valleys entering Beysehir Golu, (b) the 2-3 meter abandonned and (c) wave truncation of Neolithic (?) huyuks along the shores of both lakes. This alluviation on one hand, and wave erosion, on the other, may have been widely separated in time, however. In any case, the culminations of the rise of the 2-3 meter beach is quite recent, being Neolithic or younger. The question can be raised, moreover, whether these Neolithic hüyüks might have been occupied *while* the lake was at its highest level. Several sites-Suberde, Eskiköy, and Kul Adası-were islands when they were occupied. The Ortakaraviran hüyüks, Yalıhüyük, Burun and Alan Hüyüks may have been situated on headlands which were contemporaneously being nipped by waves. The occupants of all these sites may have been strongly oriented toward the lakes.



Levha II - BATI TOROS GÖLLERİ MINTIKASI JEOLOJİK KROKİSİ: 1) Alüvyonlar, 2) Kuvaterner göller teressübatı, 3) Üst Neojen, 4) Pre-Neojen arazi, 5) Genç volkanik sahralar, 6) Faviar, 7) Eski vâdiler, 8) Karstik boşaltma, (E. Lahn'a göre).

Planche II - Croquis géologique dela region des lacs du Toros Occidental: 1) Alluvions, 2) Dépôts de lacs quaternaires, 3) Néogéne Supérieur, 4) Terrains Prénéogénes, 5) Roches volcaniques jeunes, 6) Failles, 7) Vallées anciennes, 8) Drainge karstique (d'aprés E. Lahn).