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GENERAL GEOLOGICAL SETTING AND CHARACTER OF TURKISH SEPIOLITE DEPOSITS

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ABSTRACT

Field exploration work and analytic research on the Konya-Yunak sepiolite clearly revealed that the occurence was a result of the replacement of magnesite by sepiolite mineral in the magnesite pebbles and fragments derived from the surrounding magnesite deposits, and transported to the Miocene sedimentary basin. The replacement process developed under alcaline conditions bearing sufficient silica. Along with the pebbles composed wholly of magnesite or sepiolite, there also occur pebbles composed of both minerals in a crystalline mixture. But even sepiolitic concretions still preserve more or less the primary physical properties of magnesite. Serpentine minerals, dolomite and calcite have not entered into the formation reactions. Excess silica has precipitated as nodules or veinlets. On the other hand, matrix of the meerschaum consists mostly of the mineral palygorskite, which generate under almost the same contitions, except of a higher Al^{3+} ion concentration.

INTRODUCTION

Natural ore deposits of economic significance, composed principally of the mineral "sepiolite" may occur as sedimentary type bedded deposits or as concretional type meerschaum (in Turkish "lütetasi") deposits. While the first type occurs as small or relatively large scale deposits in various countries, the occurence of meerschaum is recorded only at a number of districts (e.g. in Tanzania and the USA), the most outstanding of which are located in Turkey. Turkish meerschaum is unique from the point of view of several mineralogic and physical properties demanded in the world markets, such as pureness, softness, whiteness, etc. Considering these phenomena, the geologic features and genesis of Turkish meerschaum will be brought principally as the subject of discussion in this paper, and will be completed by giving some brief information on the sedimentary, bedded type occurrences in the vicinity of Eskişehir Province in Central Turkey, with a table of comparison of various geological and physical properties of both types.

Turkish sepiolite (meerschaum type) mining activity is based mainly on the deposits in Eskisehir Province. In recent years, however, meerschaum deposits of similar physicochemical properties have been discovered in the Kony Province in Central Turkey, about 150 km southeast of Eskişehir *(Fig. 1)*.

Academic investigation on meerschaum have been concentrated mainly on these deposits (YENIYOL, 1982; YENIYOL and ÖZTUNALI, 1985), and correlation to those in Eskişehir has been realized, resulting in the establishment of many common geological features. Analytic data concerning XRD, DTA and TG investigation of Konya sepiolite exhibit an exact similarity of the two occurences.

Geological features and genesis of the above-mentioned two meerschaum occurrences will be described hereunder.

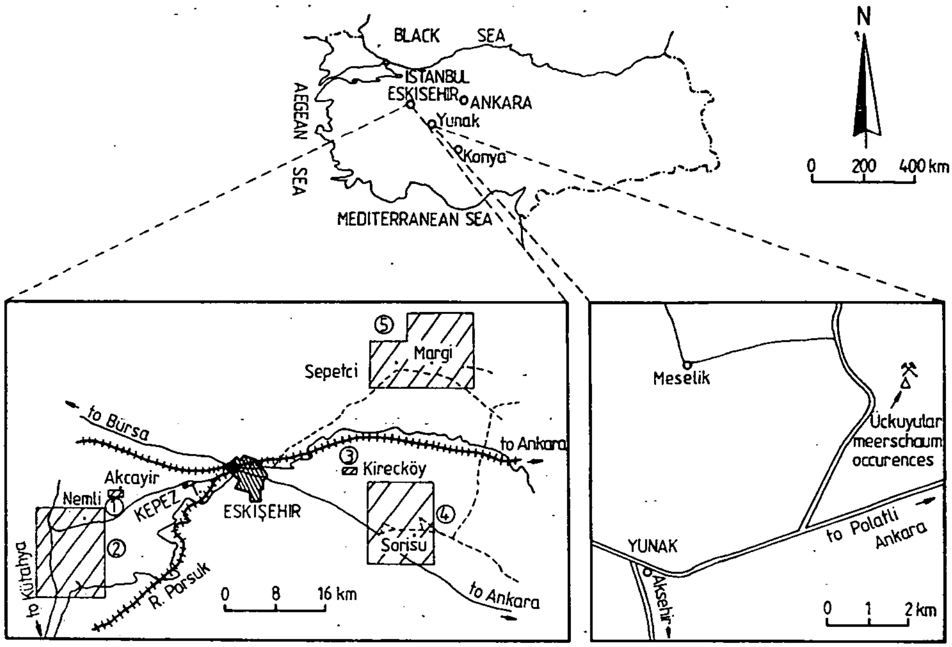

Fig. 1. Location map of the meerschaum deposits around Eskeşehir and Konya provinces, Central Turkey.

BRIEF HISTORY OF SEPIOLITE PRODUCTION IN ANATOLIA

Occurrence of sepiolite in Anatolia has been known since the Roman Epoch, and records on this are met in many historical documents. The first record on production and beneficiation date, however, is as late as the last decades of the 15th century (ÖNCEL and DENIZCI, 1982).

Sepiolite based industrial activity in Europa began to develop in the first half of the 18th century. Pipes and other ornametal goods were manufactured in Austria, Belgium and France, utilizing essentially the Turkish meerschaum. However, not long after, Vienna became the real and unique center of the world sepiolite trade. This situation continued until 1950, when goods made of meerschaum started to be manufactured in the Eskişehir Province.

Large-scale meerschaum mining activity in the vicinity of Eskişehir started around 1850's, in order to supply raw material to the European sepiolite industry. Production, which reached the peak with 12 000 boxes (1 box=app. 25 kg. of dry sepiolite) at the end of 19th century ceased in 1912, due to the political developments in Europe and Turkey. In the war years between 1913 and 1922, a small amount of procudtion was realized, and marketed together with the present stocks at a rate of about 200 boxes p.a. Since 1923, sepiolite production and mining activity have continued in an unstable way by traditional simple mining methods, with the production amount ranging from 41 to 3691 boxes p.a.

BRIEF INFORMATION ABOUT SEPIOLITE

Meerschaum, which is the concretional concentration of sepiolite, is mineralogically a hydrated magnesium silicate. Typical color of meerschaum is white to light gray. The mineral has a hardness of 2 to 2,5, with conchoidal to irregular fracturing. Specific gravity varies with porosity from about 2 to less than 1 (INDUSTRIAL MINERALS and ROCKS, 1975). Crystallographic structure may be monoclinal or pseudo-rhombohedra, while its chemical composition being stated in different forms by several investigators. BRAUNER and PREISINGER (1956) stated the chemical formula of meerschaum as $2MgO.3SiO_2.nH_2O$, while CAILÉRE and HÉNIN (1961) suggested a formula as $(Si_{12})(Mg_9)O_{30}(OH_6)(OH_2)_4.6H_2O$, based on X-ray determination of crystal structure. YENIYOL and ÖZTUNALI (1985), give the structural formula for the dehydrated half unit cell of the Konya sepiolite, on the basis of the chemical analysis carried out on specimens previously ignited at 1000 °C, as $Si_{12}/Al_{0.04}\ Fe_{0.09}\ Mg_{7.87}/O_{32}\ Ca_{0.01}$.

The mineral sepiolite contains zeolitic water, bound water, and constitution water in its structure, and dehydration occurs in four steps (NAGATA *et al.,* 1974; BAILEY, 1980).

Predominant occurence of crystalline fibers, which merge into sheetlike forms in a complex, interwined mass is characteristic at the scanning electron microscope (SEM) photographs of a Turkish meerschaum specimen (INDUSTRIAL MINERALS and ROCKS, 1975; p. 834). Structure of some sepiolites resemble to that of attapulgite and these have been named as "-sepiolite" or para-sepiolite (AKINÇI, 1967). The principal difference between fibrous attapulgite and sepiolite is that magnesium is replaced to some extend by aluminum in the former. Randomly distributed flaky type sepiolite, on the other hand, is termed as "β-sepiolite" (AKINÇI, 1967).

According to BRAUNER and PRESINGER (1956), no structural change occurs in meerschaum at igniting up to 350 °C, thus providing good absorption capability for iodine, mercury, oil and alcohol, which make the mineral utilizable in filtration and in the chemical industry, besides its traditional usage in ornamentation.

Genesis of sepiolite has been explained by diversing theories. In some of these, sepiolite occurence is suggested to be in direct relation to magnesite formation, while in some others direct generation, from serpentine being proposed (PARRY and REEVES, 1968; MILLOT, 1970; POST, 1978). Recent field and laboratory investigations on the Konya—Yunak sepiolite in central Turkey has shown clearly that the sepiolite formation took place in the detritic magnesite pebbles, which must have been derived from the surrounding magnesite deposits, and the co-existence of equi-dimensional rock fragments may support that the formation took place in diagenetic stage (YENIYOL, 1982; YENIYOL and ÖZTUNALI, 1985). The occurrence of pebbles with variable sepiolite to magnesite ratio point to the formation of sepiolite replacing magnesite. Quartz and dolomite minerals occuring as primary constituents of magnesite, on the other hand, have not taken place in the sepiolite formation process.

The mineral palygorskite, the main constituent of the matrix, is also a product of the "alkaline media rich in silica". In this case, however, the Al:Si ratio is higher. Existence of serpentinite, dolomite and calcite in the matrix show that these minerals have not entered into the sepiolite formation process (YENIYOL and ÖZTUNALI, 1985).

SEPIOLITE DEPOSITS IN TURKEY

Sedimentary, bedded type and concretional meerschaum type sepiolite occur in a number of districts in Turkey, but deposits of economic interest are located only in the vicinity of Eskişehir Province in central Turkey. On the other hand, field investigations supported by analytical results have been concentrated on the occurrences around the Yunak town, which is located about 8 km. NE of Konya in central Turkey. Province of Konya is located about 150 km SE of Eskişehir *(Fig. 1)*. Similar geological setting of the two districts make the correlation of the data possible. These two deposits will be described under this heading.

Sepiolite deposits in Konya Province (Central Turkey)

These deposits are located at the Ückuyular district, close to the Yunak town in Konya Province *(Fig. 1)*. Magnesite deposits occur in the close vicinity. The deposits are not exploited at present.

General geology. The Yunak sepiolite occurrence is located in the Neogene conglomeratic sequence. It represents a lense 3 to 4 m. thick with 500 m of extension, gently dipping south concordant to the general trend of the sequence. The conglomeratic sequence, composed of large but generally rounded pebbles, is cemented by a light creamy matrix of dolomite, serpentinite, silicified serpentinite, recrystallized limestone, magnesite fragments and grains. Variable matrix type and pebbles, and degree of cementation are common throughout the sequence. Horizons of clay, sand and tuffs of alkaline volcanism may be observed occasionally (YENIYOL and ÖZTUNALI, 1985).

Massive, vein type and Blumenkhol type magnesite deposits occur within the surrounding serpentinized rocks, belonging to the ophiolitic assamblage. Pebbles of the conglomerate, whose diameters occasionally reach 25 to 30 cm, include magnesite and sepiolite in various ratios, preserving the composition and physical properties of the initial magnesite. Fractures of drying in the pebbles of sepiolitic composition, which are light creamy colored and slippery when wet, are filled with a sandy or silty material, and they partly bear very thin silica veinlets. Gradual change from magnesite to sepiolite may even be observed in a single pebble, and beside pebbles of total magnesite or sepiolite composition, those with sepiolitic magnesitic composition in various degrees may be found too. (YENIYOL and ÖZTUNALI, 1985).

Mineralogical composition. YENIYOL and ÖZTUNALI (1985) have studied the mineralogy and chemistry of the Yunak (Konya) sepiolite by using XRD, DTA, TG and chemical analysis techniques. For this purpose, specimens of sepiolite-magnesite and sepiolite composition, and highly altered serpentinite pebbles were chosen. The results will be summarized here.

The mineral sepiolite could be determined only in the pebbles of magnesitic appearance. The most intensive reflection of the sepiolite is from the (110) plane at 12,34 Å. Other reflections, their intensities and correlation to those of Eskişehir sepiolite are given in Table 1.

According to the mineralogical investigations, sepiolite is found together with magnesite in a crystal-mixture in the pebbles. The pebbles may contain quartz and dolomite. Sepiolite is not observed in serpentinite pebbles or in the "serpentinite matrix" (YENIYOL and ÖZTUNALI, 1985). XRD investigations reveal that the matrix composes completely of palygorskite, with very low amounts of serpentine mineral (essentially antigorite), dolomite and calcite.

The thermal behaviour of Konya and Eskişehir sepiolites may be followed from the DTA and TG patterns in *(Fig. 2)*. Endothermic reaction peaks at 100 °C, 320 °C an 490 °C are due to the release of zeolitic water and bound water, in two stages. With the release of water in the last two stages, "unhydrous sepiolite" forms, and a twining in mineral structure occurs (NAGATA *et al.*, 1974; SERNA *et al.*, 1975).

TABLE 1

X-ray powder diffraction data of Eskişehir and Konya sepiolites (after YENIYOL *and* ÖZTUNALI, *1985)*

hkl	Eskişehir d(observed)	Eskişehir I	Konya d(observed)	Konya I
110	12.36	100	12.34	100
130	7.6	9	7.6	10
200, 040	6.7	5 b	6.8	7 b
150	5.0	5 b	5.0	8 b
060	4.51	35	4.50	30
131	4.32	25	4.30	35
260	3.74	20	3.73	25
080	3.36	25 i, b	3.36	25 i, b
420	2.28		3.30	
331	3.18		3.18	
261	3.05		3.05	
0.10.0, 510, 002, 441, 281, 530, 022, 112, 371, 191, 2.10.0, 390, 132	2.67–2.49	40 i	2.68–2.49	40 i
202, 042, 550, 1.11.0, 222	2.45–2.40	20 i, b	2.45–2.37	15 i, b
062, 312, 2.10.1	2.26	20 i	2.26	15 i
082	2.07	8 b	2.06	9 b
	1.88	4 b	1.88	5 b
			1.72	6 b
	1.69	6 b	1.69	8 b
	1.59	5 b	1.59	10 b
	1:55	6	1.55	10 b
	1.51	11	1.52	12

i = indistinguished, b = broad

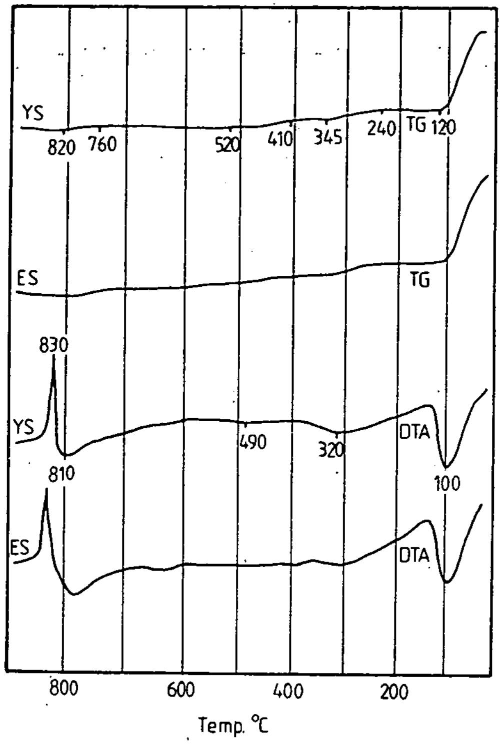

Fig. 2. TG and DTA patterns of Konya and Eskişehir sepiolites. YS=Yunak (Konya) sepiolite, ES=Eskişehir sepiolite.

The exothermic reaction at 810 °C reflects the transformation of sepiolite to a new mineral. the enstatite. As seen in *(Fig. 2)*, thermal characteristics of Konya and Eskişehir sepiolites show great similarity, except for some insignificant deviations.

Total release of water for the Konya sepiolite at 1000 °C is determined to be 21,63% (Yeniyol and Öztunali, 1985). Chemical composition is given in Table 2.

Table 2

Chemical composition of the Konya sepiolite.
after Yeniyol *and* Öztunali *(1985)*

	wt %
SiO_2	53.02
Al_2O_3	0.19
Fe_2O_3	0.51
MgO	23.13
CaO	0.06
K_2O	0.02
Na_2O	0.02
Total H_2O	21.63
	99.58

According to these data, sepiolite formula calculated for dehydrated half unit cell is:

$$Si_{12}/Al_{0.04}Fe^{3}_{0.09}Mg_{7.87}/O_{32}Ca_{0.01}$$

Genesis. Konya sepiolite shows an exact similarity to that of Eskişehir, from the point of view of the sedimentary sequence in which it occurs, and the surrounding lithologic units. Occurrence of magnesite deposits around the sepiolite-bearing horizons and the close relation between the magnesite and sepiolite pebbles in the sedimentary sequence suggest a close genetic relation of sepiolite formation to magnesite. Even pebbles, composed of only sepiolite bear the imprint of all the physical properties of magnesite pebbles. These all lead to the conclusion that the sepiolite was formed in the diagenetic stage of conglomerates by in situ replacement of magnesite mineral, replacement being realized in several degrees (YENIYOL and ÖZTUNALI, 1985).

Quartz and dolomite minerals of the primary magnesite composition are preserved even in the wholly sepiolitized pebbles, i.e. these minerals have not interferred with the sepiolite formation reactions. On the other hand, absence of sepiolite formation in serpentinite may be considered as a distinct proof for the genetice relation of sepiolite to magnesite.

In consequence with the mode of occurence given above, it is not possible to relate directly the sepiolite formation to any rock member of the ophiolitic assemblage. Sepiolite formation is the result of a multi-stage alteration process of magnesium rich basic and ultrabasic rocks of the ophiolitic association. The alteration progressed from the serpentinization of the stated rocks through the magnesite formation under available physicochemical conditions, the transport of fragments to the sedimentary basin, and formation of nodules of magnesite in the sediments, with finally origin of sepiolite by the in situ replacement of magnesite under the influence of alkaline media rich in silica.

The mineral palygorskite, which is the main constituent of the matrix, is also formed under alkaline media rich in silica, like the sepiolite. However, the Al:Si ratio of these solutions must be higher (app. 3:1). For the formation of this mineral, beside Mg^{2+}, the presence of Al^{3+} ion in the media is necessary. This factor is responsible for the formation of palygorskite, consuming small magnesite grains which offer a much greater specific surface in the matrix, while sepiolite is forming by replacing magnesite in the pebbles. Presence of serpentinite, dolomite and calcite minerals in the matrix prove that these minerals have not entered into the formation process (YENIYOL and ÖZTUNALI, 1985). Palygorskite formation may be explained by "neoformation" from the solutions carrying Mg^{2+}, Si^{4+} ions, derived from the magnesian rocks in the vicinity, but needs support on the basis of detailed and laboratory investigation data.

Sepiolite deposits in Eskişehir Province (Central Turkey)

Although Konya—Yunak sepiolites are those on which scientific researches aiming to solve the mineralogy and genesis problems of sepiolite have been concentrated, deposits with economic reserves and on which mining activity is being carried out today are located in the Eskişehir Province. So far that the weerschaum type sepiolite is sometimes referred as "Eskişehir tasi" (Eskişehir stone) domestically. Meerschaum, which is produced by traditional simple mining methods in general, is beneficiated in the workshops in Eskişehir, after which the manufactured goods, mostly pipes and boul inserts, are offered to international and domestic markets.

Sepiolite occurrences in the Eskişehir Province are located at about 30 to 40 km. east and west of Eskişehir town center, and may be examined in 5 groups close to each other. These districts are shown in *(Fig. 1)*.

General geology. The meerschaum type sepiolite occurs in Neogene formations in the Eskişehir region

Lithologic units of pre-Neogene are schists, gneiss, greywacke, marble and granite of Palaeozoic, and ophiolitic rocks of Mesozoic.

Rocks of the ophiolitic assemblage are harzburgite and dunite type peridotites, pyroxenite, gabbro, radiolarian chert, serpentinite and silica-carbonate alteration products of the stated rocks. These rocks are exposed in wide areas in the west, northeast and southeast of Eskişehir.

Peridotites are located mostly in the central parts of the ophiolite areas. Those of dunitic composition are the host rocks for chromite, and chrysotile asbestos deposits, in minor.

In the northeast occur tectonite harzburgites. In the serpentinized sections, chrysotile and antigorite occur together with small magnetite grains, Stockwork, Blumenkhol and vein type magnesite deposits compose important reserves in the area.

In the northeast, around Margi and Sepetci villages *(Fig. 1)*, dunite is widely exposed. Along the Neogene contacts, wholly dolomitzed peridotites, undergone carbonate alteration are exposed.

Silica-carbonate alteration products are composed of chalcedony, microcrystalline quartz and limonite infiltrations. They carry small magnesite nodules in the west, around the Nemli village *(Fig. 1)*.

Gabbroic rocks crop out in the northeast and west of Eskişehir. These are composed of saussuritized plagioclase and augite, uralitized pyroxene, and rarely magnetite. Various schists and radiolarian cherts partly impart the assemblage. Mostly albite-epidot-chlorite schists crop out in the northeast. Neogene formations around Eskişehir overlie the Mesozoic formations unconformably, and are composed of Upper Miocene and Pliocene rocks. The widespread lithologic units of Neogene sediments are important for their being the host rocks for meerschaum and sedimentary, bedded type sepiolite occurences.

Upper Miocene in the Eskişehir region is represented by terrestrial conglomerate, composed of reddish-brown, angular ophiolitic rock fragments, schists and marble pebbles. The matrix is dolomite, and the economically important nodular sepiolite horizons occur in this unit. Thickness of the conglomerate varies from 160 m to 250 m. In some parts, concordant rhyolitic tuff horizons are observed (Öncel and Denizci, 1982).

Pliocene consists of sandstone, dolomite, magnesite, sepiolitic clay, sedimentary sepiolite and limestone. Horizontal gradual change into rhyolitic tuff is observed occasionally. These lithologic units are exposed in a wide area in the east and west of Eskişehir. Thickness of the Pliocene sequence varies from 500 m to 800 m. The serie carries the sedimentary magnesite and sepiolite deposits. Sedimentary magnesite overlies the dolomite, 5 to 10 m thick, with ultrabasic rock fragments. The thickness of the generally compact magnesite horizon locally reaches up to 10 m. Sepiolite beds occur as 0.3 to 3.0 m thick, redish to greenish colored clayey horizons. This type of sepiolite is soft, easily grindable, and it disintegrates upon wetting. The horizons frequently carry silica-chert veinlets. A geological profile of the Pliocene sedimentary sequence with sepiolite, from Kepeztepe (W Eskişehir) is given in *(Fig. 3)*.

A massive, detritic, generally white colored limestone overlies the Pliocene sequence. This unit generally includes silica veinlets and nodules.

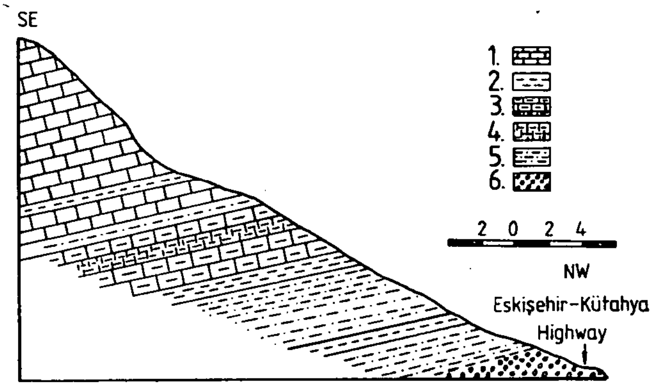

Fig. 3. Geological profile from the Kepeztepe bedded sepiolet occurrence, Western Eskişehir. (1) white massive-detritic limestone, (2) yellowish-white clayey marl, (3) yellowish marly limestone, (4) bedded sepiolite (meerschaum type), (5) brown, sandy sepiolitic clay, (6) conglomerate, partly containing sepiolite nodules or concretions.

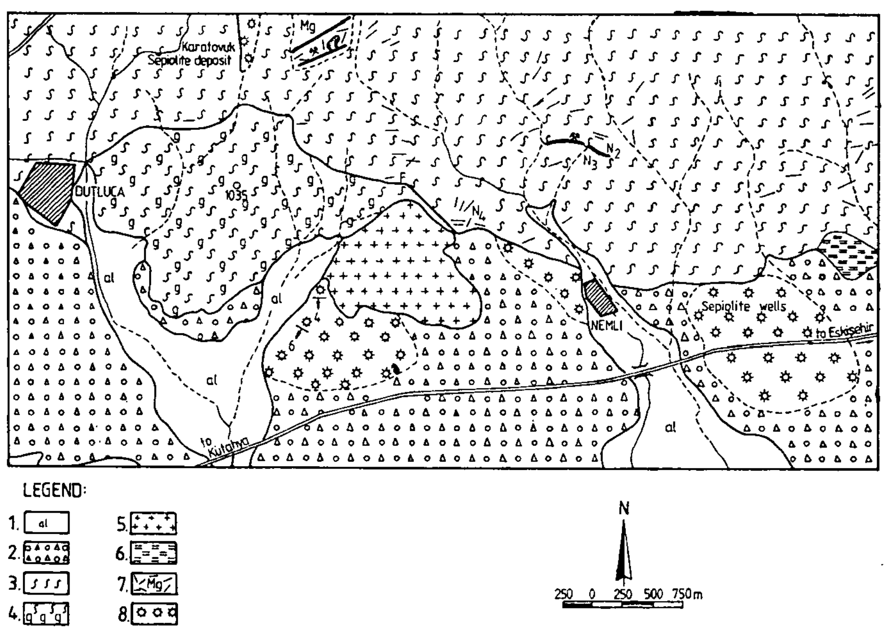

Fig. 4. Geological map of a section of the magnesite-sepiolite bearing area, around the Nemli and Dutluca villages, Western Eskişehir. (1) alluvium, (2) Neogene dolomite-cemented conglomerate, (3) Mesozoic serpentinized peridotite, (4) Mesozoic Gabbro (saussuritized, uralitized), (5) Paleozoic granite, (6) Paleozoic schist, (7) Magnesite veins, (8) sepiolite wells. After ÖNCEL and DENIZCI (1982).

Influence of region tectonism is seen in Pre-Neogene lithologies. In Palaeozoic units dominant strike trend is NW, dipping 70°—80° NE. Volcanism is mostly of alkaline character, and is effective in Neogene.

A simplified geologic map, partly covering the area in Bo. 2 in *(Fig. 1)*, bearing magnesite and meerschaum deposits in the west of Eskişehir is given in *(Fig. 4)*.

Modes of occurrence of sepiolite ground Eskişehir. Meerschaum and sedimentary type sepiolite deposits, as stated previously, occur in the Neogene formations in Eskişehir Province. The first type occurs in the Upper Miocene conglomerate, and the second type is generally in Pliocene.

A. *Meerschaum type sepiolite:* Distribution of the Upper Miocene conglomerate-bearing meerschaum is shown in *(Fig. 1)*, in 5 groups.

Genesis of the Eskişehir meerschaum is similar to that of Konya. Both the individual magnesite and sepiolite pebbles, and concretions made up of a crystal mixture of the two minerals occur in the conglomerate. By analogy, it may be concluded that the sepiolite concretions were formed by the replacement to several degrees of the magnesite in alkaline media rich in silica. Due to this feature, no direct relation to any ophiolitic rock unit can ever be established.

No occurence of sepiolite in serpentinized rocks of the ophiolitic assemblage has ever been recorded from Eskişehir region. Serpentinite, dolomite and quartz have not entered into the formation reactions, but their compounds being dissolved by alkaline solutions have been partly concentrated as nodules or thin films of silica under the meerschaum bearing horizon. Thus, it is clear that the theory about meerschaum formation, directly from the magnesium and silica-bearing solutions as a neoformation is not suitable for the Eskişehir deposits, although being proposed formerly and accepted for long (YENIYOL and ÖZTUNALI, 1985).

Chemical composition of a typical meerschaum specimen from No. 5 in *(Fig. 1)*, in the Eskisehir Province is given in Table 3, as A.

TABLE 3

Chemical composition of a meerschaum (A) and a sedimentary sepiolite (B) specimen from Eskişehir.
(A — after ÖNCEL *and* DENIZCI, *1982., B — after* AKINÇI, *1967)*

	A (%)	B (%)	
SiO_2	54.49	58.65	
Fe_2O_3	0.44	2.86	
Al_2O_3	0.50	4.14	(including TiO_2)
CaO	3.52	2.93	
MgO	26.61	18.14	
LOI	14.53	13.14	
	100.10	99.86	

B. *Sedimentary, bedded type sepiolite:* Sepiolite deposits of sedimentary formation are found within the Pliocene lacustrine sequence, which is exposed in the east, northeast and west of Eskişehir. Sepiolite generally occurs between two dolomitic beds, and sometimes in alternation with magnesite and dolomite.

Kepeztepe sedimentary sepiolite occurence, whose vertical geological profile is given in *(Fig. 3)*, is located about 15 km west of Eskişehir. Here, the Pliocene sequence has been deposited from basement to top in the order: brown-sandy sepiolitic clay overlying the Upper Miocene conglomerate, greenish-white clayey marl, bedded sepiolite-yellowish marly limestone alternation, brown-sandy sepiolitic clay, and the overlying white-massive, detritic limestone. The thickness of the bedded sepiolite horizon is approximately 1.5 m.

Sedimentary sepiolite does not resemble the meerschaum by its appearance. It is brown colored when moisty, but turns beige-dirty white upon drying. The contained amount of impurity is much higher than in meerschaum, and in economic aspect, its quality could never be compared to that of the latter.

Chemical analysis of a sedimentary sepiolite specimen from Kepeztepe is given in Table 3 as B.

X-ray diffraction investigations of sedimentary sepiolite yielded that the main constituent was poorly crystalline sepiolite with some gypsum (AKINÇI, 1967).

Comparison of various geological and physical properties of meerschaum and sedimentary sepiolite from Eskişehir area is given in Table 4.

TABLE 4

Comparison of several features of meerschaum and sedimentary sepiolite from Eskişehir area (partly after AKINÇI, *1967)*

Feature	*Meerschaum*	*Sedimentary sepiolite*
host rock	comglomerate, composed mostly of serpentinite garvels, and cemented by dolomite	dolomite or detritic marly, lacustrine limestone
geologic age	Miocene	Pliocene
color and shape	snow-white concretions	chocolate-colored layers
dry color	snow-white	light-beige, dirty white
dry surface property	very thin fractures	relatively deep fractures
processability when dry	processable upon moistening	disintegrates when moistened
cavities, foreign particles, veinlets	very rare	generally present
specific gravity	0.508 g/cm³	0.894 g/cm³
crystal lenth in electron microscope photo	1.5—2 μ	0.5—1 μ
shape of fibers	acicular, slightly cylindrical	acicular

CONCLUSIONS

In this paper, it has been tried to approach the genesis and geological features of the meerschaum type sepiolite occuring around Eskişehir and Konya, both of the provinces being located in central Turkey.

Eskişehir meerschaum carries the same geologic and mineralogic properties with that of Konya, with the exception that the main constituent of the matrix is dolomite.

Around the meerschaum bearing Neogene basins, there occur abundant magnesite deposits, both in Konya and in Eskişehir. Within the Neogene units, interlayering of volcanic material, mainly rhyolitic tuffs which liberate silica and alkalies, is seen frequently.

SAMPSON (1975) gives a detailed description of the Tanzanian meerschaum deposits, and contributes to their genesis problem. He mentions the occurence of irregular masses, veins and films of meerschaum along faults, fracture zones and bedding planes in dolomitic limestone and in the overlying unit of sepiolitic mudstone. In his proposed mode of occurence, sepiolite is derived from the overlying sepiolitic mudstone, and carried into cavities of limestone by percolating water. Thus the process is simple deposition in a sedimentary basin, which later was affected by structural movements, and a redeposition took place.

From the description above, it may be seen that the modes of occurence of Turkish and Tanzanian meerschaum are quite different. Obviously, this is a factor controlling the quality.

Occurrence as concretions in Neogene conlomerate makes the exploration of meerschaum deposits extremely difficult. Drilling is only useful to determine the base level, and it may just cut the sepiolite concretions by chance.

Due to the difficulties involved, until today, only the meerschaum horizons above the ground water level have been exploited in Turkey. The ground water level extends at depths form 28 m to 63 m.

It is almost impossible to calculate proven reserves for meerschaum occurences in Turkey. Only the probable reserve for some deposits may be estimated. Reserves for sepiolite are given in boxes and each box contains 12 kg of dry sepiolite. For Eskişehir region, probable reserve of about 1.4 million boxes of meerschaum has been estimated (Öncel and Denizci, 1982).

What may be concluded at this point is that Turkey will carry on holding the world monopoly in high quality meerschaum production, although a stable trend is difficult to achieve, with the production figures ranging from a few hundred boxes to several thousands p.a., since long years.

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REFERENCES

Akinçi, Ö., 1967, "Eskişehir I 24-cl Paftasinin Jeolojisi ve Tabakali Lületaşi Zuhurlari", Maden Tetkik ve Arama Enst. Derg. (Bull. of Min. Res. Exp. Inst. of Turkey) **V. 67**, Ankara. 82—97.

Bailey, S. W., 1980, "Structures of Layer Silicates, Crystal Structures of Clay Minerals and Their X-Ray Identification", G. W. Brindley—G. Brown (ed.) Mineralogical Society, London 125—195.

Brauner, K. and Preisinger, A., 1956, "Struktur und Enstehung des Sepoiliths", Tschermaks Min. Petr. Mitt. **6**, 120—140.

Caillére, S. and Hénnin, S., 1961, "Sepiloite", The X-ray Identification and Crystal Structures of Clay Minerals Mineralogical Society, Clay Minerals Group, London, 325—342.

Industrial Minerals and Rocks, 1975, S. J. Lefond (ed.), Amer. Soc. of Pet. Geol. New York. 833—836.

Millot, G., 1970, "Geology of Clays". Springer Verlag, New York.

Nagata, H., Shimoda, S. and Sudo, T., 1974, "On Dehydration of Bound Water of Sepiolite", Clays and Clay Minerals. **22**, 285—293.

Öncel, Z. and Denizci, F., 1982, "Eskişehir Bölgesi Lületaşi ve Magnezit Etüdleri Raporu", Rep. of Min. Res. Exp. Inst. of Turkey (MTA). No. **7181**, Ankara. 3 V.

Parry, W. T. and Reeves, C. C. Jr., 1968, "Sepiolite from Pluvial Mound Lake, Lynn and Terry Counties, Texas". Amer. Mineral. **53**, 984—993.

Post, J. L., 1978, "Sepiolite Deposits of the Las Vegas, Nevada Area", Clays and Clay Minerals. **26**, 58—64.

Sampson, D. N., 1975, "Sinya Meerschaum Mine, Northern Tanzania" in Industrial Minerals and Rocks (S. J. Lefond, ed.), p. 834.

Serna, C., Ahlrichs, J. L. and Serratosa, J. M., 1975, "Folding in Sepiolite Crystals", Clays and Clay Minerals **23**, 452—457.

Yeniyol, M., 1982, "Yunak (Konya) Magnezitlerinin Oluşum Sorunlari, Degerlendirilmeleri ve Yöre Kayaçlarinin Petrojenezi", Istambul Yerbilimleri Derg. (Bull. of Earthsciences, Istanbul) **3**, 21—51.

Yeniyol, M. and Öztunali, Ö., 1985, "Yunak Sepiyolitinin Mineralojisi ve Oluşumu", Proc. of the 2nd National Clay Symp., Univ. of Hacettepe, Ankara 171—186.

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