Meerschaum from Eskisehir Province, Turkey

By Kadir Sariiz and Iskender Isik

This study presents a model for the origin of the Eskisehir, Turkey, sepiolite deposits. Known as "meerschaum" in the gem trade when it occurs as compact masses (especially nodules), sepiolite is mined by local farmers using basic implements and traditional tunneling methods. The best nodules are carved into objects such as pipe bowls, bracelets, and necklaces. The sepiolite nodules occur in the Miocene-age Tuzkent-eyupoglu deposits, associated with dolomite, magnesite, opal-CT, and lizardite. Fibrous in morphology, they probably formed in relatively shallow water under alkaline conditions, as a result of the replacement of magnesite levels that were subjected to pore waters with high \( \text{SiO}_2 \) concentrations.

Sepiolite, \( \text{Mg}_4\text{Si}_6\text{O}_{15}((\text{OH})_2) \cdot 6\text{H}_2\text{O} \), is a clay mineral that has many industrial uses. One of the earliest uses was soap, because the compact material has a greasy texture and lathers when first recovered. White, compact, massive sepiolite is called meerschaum (from the German) [sea] and seivahn [foam]; it has a very low specific gravity (dry, it can float on water) and low hardness. Because it is easily carved and polished, meerschaum has been a popular ornamental gem material. It is best known as a carving material for pipe bowls (figure 1), but it has also been used for objects such as carveos and jewelry. Although meerschaum may have been used as early as the days of the Roman Empire (Ball, 1950; Ece and Coban, 1994), its use as a carving material has been documented since the late 1600s, when it was mined for the manufacture of pipe bowls, cigarette holders, and building material from the sepiolite deposit in Vallecas, Spain (Galan and Castillo, 1984). At present, the Spanish sepiolite deposits, the largest in the world, are mined for industrial uses only; there are no recent reports of gem-quality (nodular) material from Spain. Relatively new occurrences of sepiolite, some of which contain material classified as meerschaum, have been reported in the United States (California, Nevada), Spain, Kenya, Japan, Russia, and China (Singer and Galan, 1984; Jones and Galan, 1988), but the published reports on these areas do not mention material suitable for carving.

Within Turkey, virtually all meerschaum produced is from Eskisehir Province. Although another deposit of meerschaum nodules has been identified in Yozgat Township, Konya Province, no deposit from Eskisehir Province has been a popular ornamental gem material. It is best known as a carving material for pipe bowls (figure 1), but it has also been used for objects such as carveos and jewelry.

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Figure 1. Made for the 1873 Viennese World’s Fair, this intricately carved meerschaum pipe bowl is decorated with amber, turquoise, and enamelled silver. Courtesy of the Austrian Tobacco Museum, Vienna, photo by Thomas Reinagl.

miles] southeast of the city of Eskişehir, Yeşiyol and Oztunali, 1985], to date there is no known commercial production from that area. In the vicinity of Eskişehir (the provincial capital), there are three major and two minor sepiolite districts (figure 2). Turkmensotukat-Gökçeoglu is the most important meerschaum-producing district in Eskişehir, because of the superior whiteness, purity, and ease of carving of the material. With regard to the two other important sepiolite deposits in the region, Sepetci and Nemli, some meerschaum has been extracted from the former, whereas both meerschaum and industrial-grade sepiolite have been mined from the latter.

The Eskişehir sepiolite deposits are known to have been exploited since the 18th century. For much of this time, the district’s meerschaum was exported to Vienna, Austria, as preforms, as well as to Budapest (Hungary) and throughout Germany, primarily for carving into objets d’art (figure 3) and articles for smokers (figure 4). Historically, meerschaum was known as “Vienna stone” in the European market (Uzkesici, 1988); even today, European pipe makers will use this term to refer to the finest quality meerschaum (Necdet Atinay, pers. commun., 1995).

At present, meerschaum products carved by Eskişehir artisans are supplied directly from Turkey to the world market. Meerschaum [sometimes called “Eskişehir stone”] articles have been exported primarily to the United States, Australia, and Canada, as well as to England, Germany, Norway, Denmark, and other European countries.

Sepiolite usually occurs in sedimentary rocks, in forms ranging from massive to earthy, as thin layers, disseminated, and as concretions. Although

Notes and New Techniques GEMS & GEMOLOGY Spring 1995 43
the Eskisehir sedimentary sepiolite deposits have been exploited for more than 200 years, their geologic origin has not been studied in detail. The objective of this study was to develop a genetic model for the geologic origin of the deposits at Turkmenotuk-Gokceoglu. In the course of this research, we also studied current mining practices, the gemological properties of meerschaum, and the fashioning and distribution of this ornamental gem material.

LOCATION AND ACCESS
The meerschaum is mined from shafts (or holes) in an area between the villages of Turkmenotuk and Gokceoglu, approximately 20 km (12.5 miles) east of the city of Eskisehir (again, see figure 2). This region is about 1,000 m (3,280 feet) above sea level; vegetation is subtropical. The mean temperature is 11.3°C (about 52°F). The mean rainfall in the region is 250 to 300 mm (10 inches to 1 foot), with cool summers and cold winters (rainy and snowy). The city of Eskisehir is located about 250 km west of Ankara, the capital of Turkey, and 360 km south-east of Istanbul by road. Access to the mining area is possible by car via Highway E90 from Eskisehir to the center of the villages, and then by horse or by foot (and, in some cases, by car) via dirt trails for about another 1-2 km.

Eskisehir was founded in the first millennium before Christ by the Phrygians, as they settled on the banks of Porsuk River. It has an active artistic and cultural life, with world-class performances of the ballet, theater, opera, and folk dancing. The main industries of Eskisehir Province are farming, mining, carving, clothing, brick, and tile manufacture.
MATERIALS AND METHODS

Detailed geologic mapping of the study area was completed during the summer of 1990 (Sarız, 1990). Descriptions and study of about 100 samples from the conglomerates in which the meerschaum deposits occur provided the primary data for this study.

Polarizing microscopy, X-ray diffraction (XRD) analysis, and scanning electron microscopy (SEM) were used to identify, study, and characterize meerschaum and other minerals within the deposit. XRD analysis was done at the Department of Geological Engineering of Istanbul Technical University using a Philips Model 1140 X-ray powder diffractometer. SEM analysis was done at the Department of Metallurgy of the University of Texas at El Paso with a dual-stage scanning electron microscope (Model ISI-DS I30).

Carved meerschaum articles provided by the meerschaum company KoncaZ and from the authors' personal collections were used for geological testing (i.e., determination of optical and physical properties).

GEOLoGY AND OCCURRENCE

Geology of the Eszisehir District. The oldest rocks in the district belong to the Upper Paleozoic Karatepe group, which is composed of deep marine (oceanic trench) rocks that have undergone metamorphism (high pressure and low temperature) as a result of subduction. The group is divided into three units: the Sarıkavakız marble, the Kızilkaya metamorphic (calc-schist and quartz schist), and the Gökçeoglu formation (quartz-bearing muscovite schist, glauconite schist, marble, "schisty" diabase, and phyllite). This group is overlain by the Turkmensak ophiolites (ultramafic igneous rocks associated with a geosyncline), which are probably Triassic in age and are composed of dunite, serpentine, and gabbro. The Turkmensak ophiolites are overlain by the Jurassic Yıldıztepe formation (a succession of fine-grained sandstones) and...
Figure 5. These cross-sections from the Türkmenokat-Gökçeova district show the location of the stratigraphic sequence of rocks (see text for details) and the sepiolite (meerschaum) deposits. Locations of cross-sections are labeled “A” and “B” in figure 2.

The Yorukazaroren limestones (nowy massive and partly recrystallized). These, in turn, are overlain unconformably by the Pliocene-age İniselir conglomerates and Köşkümatağ limestones, the forster contain the economically important sepiolite nodules as well as peridotite, diabase, magnesite, and serpentinite gravels and sand-size grains of quartz, feldspar, and biotite, all of which are cemented by dolomite. The conglomerates are 35-40 m (about 115-130 feet) thick, the gravels (as distinct from the larger nodules) range up to 4 cm (about 1.5 inches) in diameter. The Türkmenokat ophiolites and the Jurassic rocks are cut by dikes and stocks of Paleocene-age İcarlık quartz diorite porphyry (figure 5).

The present geologic structures (e.g., grabens) of the study area formed during a major deformatinal (tectonic) stage in the complex geologic history of the Aegean region during lower Miocene time. This was a result of the Arabian platform being pushed toward the Anatolian (Asia Minor) plate (Sengör, 1980).

The Sepiolite Nodules. At Eskişehir, sepiolite nodules occur in the İniselir conglomerates (figure 6). Typically, the nodules are 8-10 cm in diameter, but some are as large as 25 cm. In natural form, they are gray to white, compact, and soft as some soaps. Some sepiolite nodules, when broken, display a magnesite core (figure 7), indicating a genetic relationship between the two minerals—in this case, that the magnesite formed first and later was replaced by sepiolite. In addition, we observed that magnesite gravels, like the sepiolite nodules that form from them, are randomly distributed in different levels of the İniselir conglomerates, which suggests that the gravels were transported from the magnesite deposits in the region.

Although banded sepiolite is found in some parts of the Eskişehir district, this material is typically an undesirable gray color, is contaminated by

Figure 6. This view of the extruded İniselir conglomerates shows the white meerschaum nodules and fragments, the dark gray serpentinite, light gray silica, and the brown dolomitic cements that bind the minerals.
clay and other materials, has a relatively high specific gravity, and is subject to multiple cracking as it dries. Some has been used for carving, but the product is of very low quality. Gem-quality meerschaum occurs only in the sepiolite nodules.

On the basis of microscopic studies, we identified quartz and dolomite grains up to 30 μm in the sepiolite nodules. XRD patterns recorded the presence of dolomite, magnesite, and minor amounts of opal-CT (opal-cristobalite) and lizardite (a member of the kaolinite-serpentine group) in the nodules. The cement of the conglomerates contains dolomite and minor amounts of opal-CT and serpentine.

Sepiolite shows a fibrous morphology in the scanning electron micrograph (figure 8), with fibers as wide as 0.5 μm and up to 35 μm long. The fibers are intimately intergrown, and terminations are rare. The ends of the fibers are bent slightly.

Occurrence of Sepiolite. Singer and Galan (1984) and Jones and Galan (1988) made the most recent and authoritative compilations on all aspects (history, crystal structure, chemistry, synthesis, physical properties, geologic and geographic occurrences, industrial applications) of sepiolite, Mg₄Si₆O₁₅(OH)₂·6H₂O. They show that it is closely related to palygorskite (varietal names for which include "mountain leather" and "mountain wood"). [Mg₄Al₂Si₄O₁₀(OH)₂·4H₂O, with which it frequently occurs.

Both minerals have been found in a number of geologic environments. These include: (a) marine environments (sediments) ranging from deep seas to shallow lagoons; (b) continental environments ranging from soils, calcareous (caliche), and alluvium (all characteristiclly alkaline and in arid or semi-arid regions); (c) continental saline and alkaline lake sediments; and (d) associated with igneous rocks as veins and alteration products, some of which may be related to hydrothermal alteration of Mg-rich (ultramafic) rocks (Singer and Galan, 1984; Jones and Galan, 1988). In addition, Ece and Coban (1994) discuss the diagenetic replacement of magnesite cobbles and pebbles by sepiolite with specific reference to those [Eskisehir] deposits. Because sepiolite may form in many environments, it is not surprising that this mineral is found in several physical states, ranging from compact (meerschaum) to earthy (as in soils).

The random distribution of sepiolite nodules within the Imisehir conglomerates can be related to ground-water fluctuations over time as well as to
the proximity of the conglomerates to fault systems that enhance the flow of fluids. Also, clay layers may have influenced sepiolite distribution, because they affect the ability of pore water (subsurface water in the voids of the rock) to penetrate the formation. On the basis of the field investigations and on chemical, mineralogic, and petrographic analyses performed on sepiolite nodules (taking into consideration the stability diagram of Wollast et al. [1968]), we determined three main points about the physico-chemical behavior of the Mg$^{2+}$-$SiO_2$-$H_2O$ system: 1. Under alkaline conditions (pH = 8-8.5), when the SiO$_2$ concentration of the pore waters in the magnesite gravels reached saturation, sepiolite formed in situ as a replacement of the magnesite gravels. (Sepiolite does not form when the SiO$_2$ concentrations in pore waters are low.) 2. When pore waters were supersaturated with respect to SiO$_2$, both sepiolite and opal-CT formed together, as evidenced by the presence of opal-CT areas associated with sepiolite in the nodules (figure 9). 3. As no talc was detected in our samples, it can be assumed that dolomite—unlike magnesite—in the nodules did not react with the SiO$_2$-saturated pore waters. If such a reaction had taken place, talc would have been produced (Mueller and Saxena, 1977).

**MINING**

The Türkmenovaç-Gölceoglu district contains hundreds of shafts that are believed to have been worked intermittently for sepiolite. Traditional methods for mining meerschaum, using simple hand tools, still appear to be the most economic. Specifically, shafts about 1 m in diameter and anywhere from 10 to 75 m deep are dug into the ground to reach the sepiolite-containing beds. When miners reach a layer that may have economic amounts of sepiolite, they drive a production gallery (horizontal "drift" or opening), approximately 120 cm (about 1.5 yards) high and 150 cm wide, in the direction that the sepiolite nodules appear to occur. Because the conglomerates bearing the sepiolite nodules are strongly cemented by the dolomitic material, miners can operate in the gallery without adding any structural supports.

To extract the sepiolite, miners use the traditional room-and-pillars style of digging. Both waste materials and sepiolite nodules are raised to the surface in buckets by a simple "spinning wheel" (rope and pulley system) at the top of the shaft (figure 10). Common excavation tools include picks, shovels, and wedges to pry the sepiolite from the conglomerate. Because wet sepiolite is very soft, miners must be extremely careful not to damage the nodules during extraction. Explosives are not used.

In the Eskişehir district, meerschaum is mined by small companies and groups (2-5 people, figure 11). Because most of the miners are farmers, the deposits are worked most intensively after the
Figure 11. A group of miners return to Karsepe village (visible in the background) at the end of a workday. Note the mining tools: a wedge, a shovel, and a carbide lamp.

farming season, in late fall through early spring (November through April). In addition, the relatively shallow depth of the water table in some areas means that flooding of the tunnels can be a major problem, especially in the spring.

PRODUCTION

Meerschaum is believed to have been exploited in the region since the time of the Roman Empire. From the end of the 19th century until the beginning of the 20th, meerschaum was mined extensively in Eskisehir, and the rough was exported to Europe and the United States. According to the State Institute of Statistics, Prime Ministry, Republic of Turkey (1990 and 1992), Eskisehir production at that time averaged an estimated 12,000 cases a year (one case = 12 kg). Between 1913 and 1992, sepiolite production fell to a total of 6,600 kg, while a total of 176,856 kg was produced from 1954 to 1973. To support the local calving industry, the Turkish government has banned the exportation of rough meerschaum since 1972. Production reported for the period since then peaked at about 525 cases in 1975 and dropped to a low of 40 cases in 1992. (Note that these figures represent production recorded by government sources. Because much of the meerschaum is extracted outside of government supervision, actual production is undoubtedly much greater.) About half of this reported production is believed to be mined from the Turkish government has banned the exportation of rough meerschaum since 1972. Production reported for the period since then peaked at about 525 cases in 1975 and dropped to a low of 40 cases in 1992. (Note that these figures represent production recorded by government sources. Because much of the meerschaum is extracted outside of government supervision, actual production is undoubtedly much greater.) About half of this reported production is believed to be mined from the Tuncmenok-Gokceoglu region (Necdet Altiay, pers. comm., March 1995). On the basis of information provided by the State Organization of Planning (Prime Ministry, Republic of Turkey), we estimate that meerschaum reserves in the district exceed six million kilograms.

THE GEMOLOGICAL PROPERTIES OF MEERSCHAUM

The Tuncmenok-Gokceoglu meerschaum nodules have distinctive mineralogic and physical properties (table 1), as well as size, shape, and texture—that make them particularly suitable for carving decorative objects such as pipe bowls (figure 12), objects d’art, and jewelry (figure 13).

Properties such as sorption, chemical composition, the white color, high porosity, and low specific gravity, make meerschaum ideal for use in pipe bowls. Although some manufacturers produce sepiolite articles in tourist venues elsewhere in Turkey, Eskisehir Province is the center of sepiolite manufacture.

CARVING MEERSCHAUM

The first step in making a sepiolite carving is to pick the right nodule. Only by careful selection can defects such as cracks, color irregularities, and inclusions of other minerals be avoided in the final product. Sepiolite can be easily carved as long as it is somewhat moist. Because the nodules typically lose some of their natural moisture during the often lengthy carving process, they usually have to be soaked in water periodically to maintain sufficient softness. Eskisehir carvers use as many as 40 types of meerschaum for carving.

TABLE 1. Physical appearance and gemological properties of gem-quality sepiolite (meerschaum) from Eskisehir, Turkey.

<table>
<thead>
<tr>
<th>Property</th>
<th>Value (brandy, cream)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>White (brandy, cream)</td>
</tr>
<tr>
<td>Refractive indices</td>
<td>n&lt;sub&gt;20&lt;/sub&gt; = 1.525-1.529, n&lt;sub&gt;22&lt;/sub&gt; = 1.506-1.520 with a birefringence of 0.009 to 0.019</td>
</tr>
<tr>
<td>Specific gravity (2.0 for compact material)</td>
<td>2.0 for both long- and short-wave UV radiation</td>
</tr>
<tr>
<td>Fluorescence</td>
<td>Inert to both long- and short-wave UV radiation</td>
</tr>
<tr>
<td>Internal characteristics</td>
<td>Quartz, dolomite, and magnesite inclusions (all identified by X-ray diffraction)</td>
</tr>
<tr>
<td>Hardness (Mohs scale)</td>
<td>2-2.5</td>
</tr>
<tr>
<td>Other</td>
<td>Floats on water and adheres to tongue in its raw state</td>
</tr>
</tbody>
</table>

Notes and New Techniques

GEMS & GEMOLOGY Spring 1995 49
of knives and other tools, which they usually manufac-
ture themselves.

Once a nodule has been selected, the carver must choose a design that best fits the natural shape of that nodule and minimizes waste. From this point on, the single most important point in deciding on a design is the carver’s vision and imagina-
tion. With talent, experience, and patience, the artisan can produce a variety of intricate designs.

After the nodule has been given the desired or requested form, it is partially dried slowly in the
sun. Subsequently, the piece is carefully hand carved. Once the meerschaum carving is comple-
ted, it is dried in an oven at 110°C for two hours. Next, it is polished with a very fine abrasive and then immersed in heated, liquid beeswax for a few minutes last, it is polished with a very soft cloth. This waxing and polishing treatment gives the fin-
ished meerschaum article a creamy white color and shiny appearance. Meerschaum turns a progressive-
ly darker yellow when used as a pipe bowl because it absorbs nicotine from the tobacco.

DISTRIBUTION

In Eskişehir and nearby villages, all meerschaum products are manufactured by independent artisans at their workshops or homes. Currently, there are about 150 meerschaum carvers in Eskişehir Province. There are no large-scale, mechanized carving operations in Turkey. To educate meer-
schaum carvers and miners, and to raise future carvers, the local government established a meer-
schaum school in Eskişehir in 1989. However, it is not currently in operation.

To purchase meerschaum objects, one can con-
tact either the Chamber of Trade of Eskişehir, as they publish requests in their journal, or any one of the several companies operating out of Eskişehir (e.g., Oztas, Altinay, Altintas, or Konak). Meerschaum articles from Eskişehir artists reported-
ly have sold at high prices. For example, one by noted pipe-maker Ismail Ozel was auctioned for $18,000 five years ago (Necdet Altinay, pers. comm., 1995). According to Mr. Altinay, the owner of Altinay Co., collectors of meerschaum carvings con-
sider three main factors: the date of manufacture [the older, the better], the carver [the more famous the better], and the artistry of the piece itself.

CONCLUSIONS

On the basis of a geologic map of the Turkmenolat-Gokceoglu district completed by the senior author, study of the local stratigraphy, and field observations, as well as X-ray diffraction, scanning electron microscopy, and petrographic analyses, the authors have concluded that the sepí-
olite (meerschaum) nodules probably formed at
shallow depths and in alkaline conditions, in the vicinity of paleo-shorelines of a lacustrine basin (large, inland lake). They are the result of replacement of transported magnesite gravels when these gravels were subjected to pore waters with high SiO₂ concentrations. Sepiolite's properties make it especially suitable for carving and polishing when it occurs in a compact, massive form, as meerschaum. Although significant quantities of meerschaum were mined and exported from the 18th through the early 20th centuries, production appears to have declined greatly in recent decades. Since 1972, government regulations have limited export to only fashioned meerschaum. However, there are a number of expert carvers in Turkey, especially in Eskinehir Province. Some of their works of art have been sold at auction for significant sums. The worldwide decline in the popularity of smoking has undoubtedly affected the demand for meerschaum pipes. However, sepiolite has many other industrial uses, which suggests that mining is likely to continue. One potential use for meerschaum could be as an alternative to ivory, which is banned in many countries. Both have a similar color, take a high polish, and are easy to carve and cut. It must be noted, however, that ivory is harder than meerschaum and unlike meerschaum—bends without breaking.

REFERENCES


