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A SEPIOLITE-RICH PLAYA DEPOSIT IN SOUTHERN NEVADA*

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Abstract—Sepiolite is seldom reported in playa deposits, even though it is generally believed to form in a highly saline, alkaline environment. Its rareness suggests that unusual conditions are necessary for formation of sepiolite. Sepiolite is a major constituent of a near-surface playa bed 4 ft thick in the Amargosa Desert, southern Nye County, Nevada. Associated materials include dolomite and small to trace amounts of quartz, feldspar, montmorillonite, illite, and volcanic glass. The dolomite, averaging about 2μ in size, makes up about 40% of the bed. The overlying beds and the underlying ones down to a sampled depth of 13½ ft are montmorillonitic (saponite) clays with moderate to trace amounts of sepiolite; dolomite is abundant in all these clays except in the uppermost several feet, where calcite is a major constituent. Ground water in this area contains abundant magnesium compared with that in the rest of the Amargosa Desert. An initial high concentration of magnesium in the playa lake water probably promoted the development of sepiolite and dolomite. Concentration of dissolved salts through evaporation of water is believed to have started chemical precipitation of dolomite, and this precipitation and the continued evaporation later caused deposition of sepiolite.

INTRODUCTION

THIS PAPER describes an occurrence of sepiolite in sediments on the Amargosa Flat playa in southern Nevada. The deposit is unusual because sepiolite is the major constituent in a 4-ft-thick bed.

Although the presence of sepiolite in sediments is generally considered diagnostic of a highly saline and alkaline environment, sepiolite is seldom reported in playa deposits in the western United States. It was not found in any samples taken by Droste (1961) from 45 southern California playas. The rareness of sepiolite suggests that unusual conditions are necessary for its formation. References for some occurrences of sepiolite are given by Hathaway and Sachs (1965) and Parry and Reeves (1968); a few of the occurrences are in playas.

SETTING

The Amargosa Flat playa covers six square miles in the southeastern part of the Amargosa Desert in southern Nye County, Nevada (Fig. 1). The Amargosa Desert, a northwestward-trending valley near the southern edge of the Basin and Range province, is 50 miles long and as much as 30 miles wide, and is drained by the intermittent Amargosa River.

Drainage into the playa comes from an area of more than 300 square miles lying to the north, east, and southeast. Bedrock in this area consists of clastic and carbonate rocks (both limestone and dolomite) of Precambrian to Devonian age (Burchfiel, 1964). The playa is not topographically closed; surface runoff that occasionally reaches the playa is drained by an intermittent stream into Ash Meadows (a few miles to the southwest) and eventually into the Amargosa River.

SEPIOLITE-RICH BED

The sepiolite-rich bed was exposed in several shallow dragline trenches, mostly in an area 1000 × 400 ft, near the southwestern edge of the playa in Section 21, T. 17 S, R. 51 E, but slumping of the sides and water in the bottom of the trenches have concealed the bed in all but one place. Most of the material studied is from a 13½-ft auger hole. Logs of deeper drill holes recently furnished by the owner suggest that one or more sepiolite-rich beds are present in an area of several square miles and that the thickness of the beds in places exceeds the 4 ft measured in the auger hole.

Sepiolite is a major constituent in the auger hole samples from depths of 4·1–7·9 ft (Fig. 2), but also occurs in moderate amounts in samples from depths of 2·2–4·1 ft and small or trace amounts in the other samples. The 3·8-ft-thick sepiolite-rich bed is horizontal, apparently has sharp contacts with the underlying and overlying montmorillonitic clays, and has no internal bedding.

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The sepiolite-rich material is white, compact, homogeneous, has a dull luster, and slakes rapidly in water to form curved chips. The clay becomes brittle and much harder after a few weeks exposure to the air. Associated materials include abundant dolomite, small amounts of quartz and feldspar, trace amounts of montmorillonite and illite, and an occasional fragment of volcanic glass. Dolomite grains, averaging about 2μ across, make up about 40% of the material. The quartz is detrital and mostly occurs as subrounded grains averaging 0·08 mm in diameter. Figure 3 shows a typical X-ray diffraction pattern of the sepiolite-rich material and Fig. 4 a differential thermal pattern of the sepiolite after removal of dolomite by dilute acid.

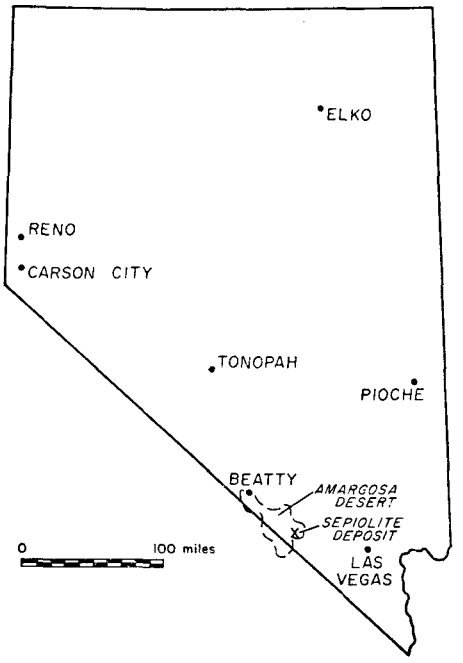

Fig. 1. Index map of Nevada showing location of Amargosa Desert sepiolite deposit.

Figure 2 shows the distribution of dolomite, calcite, and quartz in the auger-hole samples. Calcite occurs in detectable amounts only in the upper 4 ft of the playa sediments, whereas dolomite is sparse in the upper 2 ft but abundant in the rest of the sampled sediments. Based on the position of the (060) X-ray reflection and the Greene-Kelly test as outlined by MacEwan (1961), the montmorillonite occurring below and above the sepiolite-rich bed is the magnesia-rich species, saponite.

GENESIS OF THE SEPIOLITE AND DOLOMITE

Three modes of origin were considered possible for the sepiolite: (1) clastic deposition; (2) diagenesis from volcanic ash; and (3) precipitation from solution. Sepiolite is rare in either soils or material carried by streams. Its presence in large amount in only one bed suggests a non-clastic origin; a more uniform distribution would be expected if the sepiolite was clastic. It was concluded, therefore,

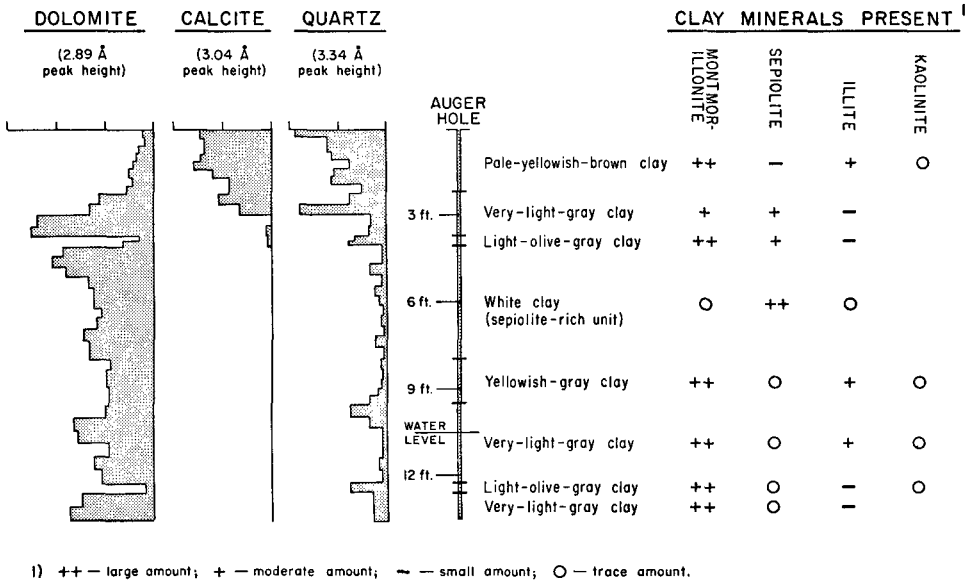

Fig. 2. Log of auger hole showing distribution of some minerals.

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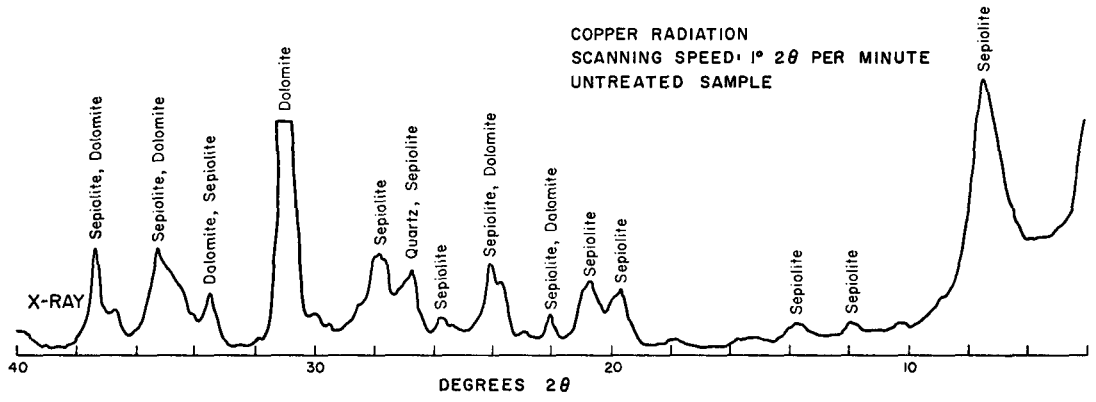

Fig. 3. Typical X-ray diffraction pattern of the sepiolite-rich material.

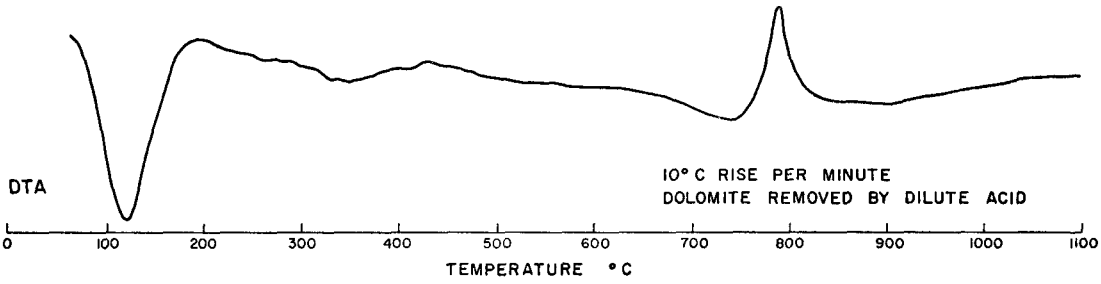

Fig. 4. Typical differential thermal pattern of the sepiolite.

that the sepiolite formed in the playa by one of the other two processes.

Volcanic glass occurs in the sepiolite-rich bed in very minor amount, but it shows no alteration to sepiolite; there is no evidence of a vitroclastic texture. Also, the formation of sepiolite from volcanic glass by diagenesis has never been reported in the literature, although Hathaway and Sachs (1965) infer that sepiolite in marine sediments of the Mid-Atlantic Ridge was formed when silica derived by devitrification of silicic volcanic ash reacted with magnesium in solution. It thus is unlikely that the Amargosa Flat sepiolite formed by diagenesis of volcanic glass.

The intimate mixture of fine-grained sepiolite and dolomite suggests both minerals have a similar origin. The origin of dolomite is a controversial subject: whether it ever forms as a primary sediment, or only forms by diagenesis of calcite. Although evidence is rarely conclusive, some dolomites probably were formed by chemical precipitation, both in sea water and saline lake water; but primary dolomite is not a quantitatively important sediment. The absence of calcite in detectable amounts in the sepiolite-rich samples from this deposit suggests the dolomite was not formed by diagenesis of calcite—it is difficult to conceive conditions in which diagenesis would have been complete everywhere, and all calcite replaced by dolomite. Dolomite is abundant in most of the sampled sediments (Fig. 2), whereas sepiolite occurs in substantial quantity in only one bed, an argument against diagenesis for either dolomite or sepiolite. Thus, development of the dolomite or the sepiolite by diagenesis is believed improbable. The large amounts of saponite in the underlying and overlying beds, however, suggest that this mineral formed by diagenesis of clastic montmorillonite.

Data collected by Walker and Eakin (1963) show that ground water in the Amargosa Flat and Ash Meadows areas at the present time has a high concentration of magnesium compared with that in the rest of the Amargosa Desert. Ten water samples from springs and wells in these areas contained 3–26 ppm magnesium; 8 of the samples contained at least 17 ppm and averaged 21 ppm. Water samples from 18 wells in the rest of the Amargosa Desert had 1 to 21 ppm magnesium and averaged 7 ppm. A high concentration of magnesium in the water coming into an earlier playa lake probably was an important factor in the formation of the

sepiolite and dolomite. All 10 water samples from the Amargosa Flat and Ash Meadows areas are, however, undersaturated with respect to sepiolite. It is of interest that adsorbent clays which once were extensively mined in Ash Meadows are the magnesium-rich mineral saponite but contain no sepiolite (Papke, 1970).

Rapid formation of the sepiolite-rich bed, e.g. by chemical precipitation of the sepiolite and dolomite plus continued clastic deposition, is indicated by the low percentage of clastic minerals in the bed (Fig. 2)—a rather constant amount of quartz, montmorillonite, and illite probably was being deposited in the playa, but the percentage of these clastics is low in the sepiolite-rich bed compared with the adjacent beds. The lack of internal bedding in the sepiolite-rich bed also suggests rapid accumulation or, at least, constant conditions during deposition.

Experimental study by Wollast, Mackenzie, and Bricker (1968) of precipitation of sepiolite from sea water at surface conditions showed that the precipitation is dependent on the pH of the water; less silica is required to precipitate sepiolite from moderately alkaline sea water than from moderately acid water, and sepiolite will not precipitate if the pH is relatively low. They concluded that in a lake where the brine water is concentrated enough by evaporation, with concomitant rise in pH, sepiolite may precipitate directly from the water if dissolved silica is not removed by biochemical processes.

Helgeson, Garrels, and Mackenzie (1969) show an equilibrium saturation diagram for the system $CaO–MgO–CO_2–SiO_2–H_2O$ at 25°C and 1 atm, with the field boundaries between sepiolite, dolomite, calcite, magnesite, and amorphous silica (Fig. 5). The chemical precipitation of dolomite and the later coprecipitation of dolomite and sepiolite is consistent with their saturation diagram and with the observed geologic relations at the Amargosa Flat playa. The intimate, fine-grained mixture of dolomite and sepiolite suggests the brine water might have had a composition close to the field boundary between dolomite and sepiolite and continued concentration of dissolved salts by evaporation caused precipitation of dolomite and sepiolite.

Chemical precipitation of both sepiolite and dolomite thus is the most probable explanation of this occurrence. Gradual increase in magnesium content by evaporation of the lake water, which probably was initially high in magnesium, caused precipitation of dolomite; and this precipitation and the continued evaporation increased the silica content (perhaps the silica content was also greatly increased by deposition and dissolution of volcanic ash) until sepiolite began to be deposited along with the dolomite. The presence of calcite and the decrease in amount of dolomite in the upper several feet of the playa sediments might have been due to an influx of fresher water or the development of an outlet from the lake, either of which would have caused a decrease in salinity of the lake water.

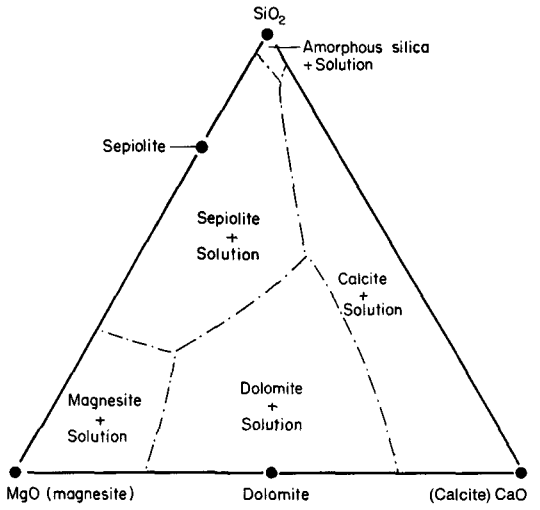

Fig. 5. Saturation diagram for the system $CaO–MgO–CO_2–SiO_2–H_2O$ at 25°C and 1 atm (from Helgeson, Garrels and Mackenzie, 1969).

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Résumé – On rapporte rarement l'existence de sépiolite dans les dépôts de playa, même si l'on pense généralement que cette argile se forme dans un environnement alcalin fortement salin. Cette rareté suggère que des conditions inhabituelles soient nécessaires pour la formation de la sépiolite. La sépiolite est un constituant majeur d'une couche de playa de 4 pieds d'épaisseur proche de la surface dans le désert Amargosa, Nye County du Sud, Arizona. Les matériaux associés comprennent de la dolomite et en quantité faible ou à l'état de traces, du quartz, du feldspath, de la montmorillonite, de l'illite et du verre volcanique. La dolomite, dont la taille moyenne est environ 2μ, constitue environ 40% de la couche.

La zone à sépiolite est encadrée dessus et dessous, jusqu'à une profondeur explorée de 13,5 pieds, par des couches d'argiles montmorillonitiques (saponite) où la sépiolite n'existe qu'en quantité modérée ou à l'état de trace; la dolomite est abondante dans toutes ces argiles sauf dans la zone la plus superficielle de quelques pieds d'épaisseur, où la calcite est un constituant majeur. Dans cette région, l'eau de la nappe phréatique contient du magnésium en quantité abondante par rapport à celle du reste du désert Amargosa. Une concentration initiale élevée de magnésium dans l'eau du lac de la playa a probablement favorisé le développement de la sépiolite et de la dolomite. On pense que la concentration des sels dissous accompagnant l'évaporation de l'eau a initié la précipitation chimique de la dolomite, et que cette précipitation et l'évaporation continue ultérieure ont entraîné le dépôt de sépiolite.

Kurzreferat – Es wird nur selten über Sepiolit in Playalagern berichtet, obwohl allgemein angenommen wird, dass sich derselbe in hochsalzhaltigen, alkalischen Umgebungen bildet. Sie Seltenheit des Vorkommens deutet darauf hin, dass ungewöhnliche Bedingungen für die Bildung von Sepiolit erforderlich sind. Sepiolit ist ein Hauptbestandteil eines 4 Fuss dicken, oberflächenahen Playalagers in der Amargosa Wüste, im südlichen Nye County, Nevada. Zugehörige Materiale umfassen Dolomit und kleine bis spurenartige Mengen von Quarz, Feldspat, Montmorillonit, Illit und vulkanischem Glas. Der Dolomit, von einer Durchschnittsgrösse von etwa 2μ, stellt ungefähr 40 Prozent des Bettes dar. Die darüber-und darunterliegenden Schichten, bis zu einer erprobten Tiefe von 13½ Fuss, sind Montmorillonit (Saponit) Tone mit mässigen bis spurenartigen Mengen von Sepiolit; Dolomit kommt in allen diesen Tonen reichlich vor, mit Ausnahme der obersten paar Fuss, wo Calcit einen Hauptbestandteil darstellt. Das Grundwasser in dieser Gegend enthält reichlich Magnesium im Vergleich mit dem Rest der Amargosa Wäste. Eine hohe Anfangskonzentration von Magnesium im Playaseewasser hat vermutlich die Entwicklung von Sepiolit und Dolomit begünstigt. Es wird angenommen, dass die Konzentration gelöster Salze durch Verdunstung von Wasser die chemische Ausfällung von Dolomit hervorgerufen hat, und dass diese Ausfällung und die fortgesetzte Verdunstung später die Ablagerung von Sepiolit verursacht hat.

Резюме — Сепиолит очень редко находят в побережных отложениях, хотя, предполагают, что он обычно формируется в очень соленой щелочной среде. Вследствие его редкости полагают, что для образования сепиолита необходимы необыкновенные условия. В пустыне Амаргоза на Юге Невады сепиолит является главной составной частью близкого к поверхности слоя берега 4 фута толщиной. Ассоциированные материалы включают: доломит, небольшое количество кварца, полевой шпат, монтмориллонит, иллит и вулканическое стекло. Доломит, средним размером 2 μ, составляет почти что 40 процентов этого слоя. Сверхлежащий и нижележащий слои, до испытанной глубины в 13½ фут, являются монтмориллонитными (сапонитными) глинами со средним содержанием сепиолита. Во всех этих глинах, за исключением в верхних слоях, имеется изобилие доломита. В верхних слоях на несколько фут кальцит является главной составной частью. Почвенная вода в этом районе содержит большое количество магнезия по сравнению с остальной частью пустыни Амаргоза. Начальная высокая концентрация магнезия в озерной воде вблизи берега, вероятно, способствовала развитию сепиолита и доломита. Думают, что концентрация растворенных солей вследствие испарения воды положила начало химическому осаждению доломита, и это осаждение и позднее непрерывное испарение привели к отложению сепиолита.