Micromorphology investigation of sepiolite bearing petrocalcic horizons formed from lacustrine sediments on the southern high planes of Texas and New Mexico

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The presence of sepiolite in soils has long been thought to have been attributed to inheritance from alternative parent material via secondary (eolian, alluvial) depositional processes due to sepiolite being unstable in pedogenic environments (McLean et al., 1972; Bigham et al., 1980; Singer, 2002). Sepiolite deposits have been identified throughout the world in many environments including sedimentary (lacustrine), mafic igneous and metamorphic rocks (Isphording, 1973; Singer et al., 1998; Hüseyin and Bozkaya, 2004). Sepiolite is a complex magnesium silicate with fibrous morphology with an ideal structural formula of $Si_{12}Mg_8O_{30}(OH)_4(OH_2)_4.8H_2O$ (Brauner and Preisinger, 1956; Singer, 2002). Sepiolite identified within soils occurs in xeric, ustic and aridic moisture regimes, where evapotranspiration rates exceed precipitation (Singer, 2002).

According to Jones et al. (1984) pedogenic sepiolite may be correlated to one of three specific conditions in the continental environment. The first is current soils that are or have been affected by rising ground water. Typically, these reside on floodplains and/or low terraces and usually contain fine-textured calcareous eolian or alluvial sediments. The second environment includes soil strata with sharp and distinct textural transitions, an example of which is paleosols. Accumulation of the clay minerals takes place on the coarse-grained side of the size transition (Jones et al., 1984). The third condition is the formation within crusts, caliches and calcretes. Well-developed caliche or calcrete paleosols often contain the best documented pedogenic deposits of chain-structure clays (Vanden Huevel, 1966; Jones et al. 1984). Abundance of sepiolite and palygorskite increases with age within calcified geomorphic surfaces (Hay and Wiggens, 1980; Jones et al., 1984; Monger and Daugherty, 1991). Some of the best developed accumulations of sepiolite in the world reside in Spain and are associated with lacustrine deposited sediments. However, the largest deposits of sepiolite occur in New Mexico and Texas.

Petrographic analyses and Scanning Electron Microscopy (SEM) were used in the investigation of depositional and pedogenic processes of petrocalcic horizons formed from lacustrine sediments on the Southern High Plains (SHP) of Texas and New Mexico. This investigation was carried out within the ancestral Brazos River drainage system. Sepiolite formation on the SHP of Texas and New Mexico has been found to be commonly associated with alkaline lacustrine environments in conjunction with dolomite and calcite. The presence of sepiolite in soils has long been thought to have been attributed to inheritance from alternative parent material via secondary (eolian, alluvial) depositional processes due to sepiolite being unstable in pedogenic environments. The petrocalcic horizons that formed from the lacustrine sediments are multicyclic with varying degrees of laminae and pisolitic characteristics (Fig. 1). Macromorphology and micromorphology of the petrocalcic horizons show extensive influence of pedogenic processes. Typical sepiolite morphology displays lath-like or fibrous needle shaped particles (Fig. 2) and on the SHP often interbedded with calcite and dolomite (Fig. 3). Petrographic analysis and SEM's show unique spheroids comprised of sepiolite (Fig. 4). The sepiolite spheroids occur within multiple laminae throughout the petrocalcic horizons. Micritic calcite has precipitated on to the surface of the sepiolite spheroids. The sepiolite spheroids formed as Mg-rich waters reacted with the silica-rich volcanic ash, which weathered and the silica reacted with Mg to form sepiolite or precipitated to form silica needles (Fig. 5) or plates (Fig. 6).

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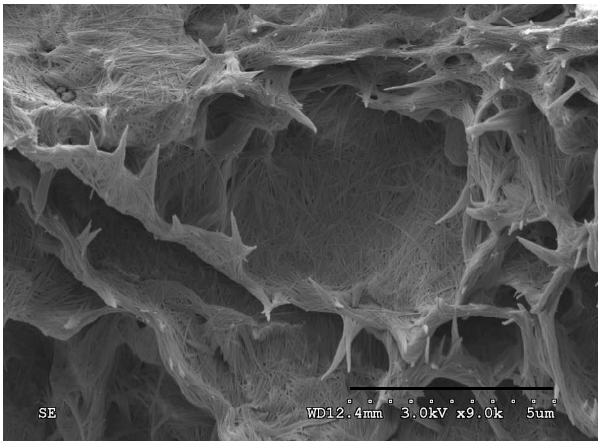

Fig. 1. Sepiolite bundles.

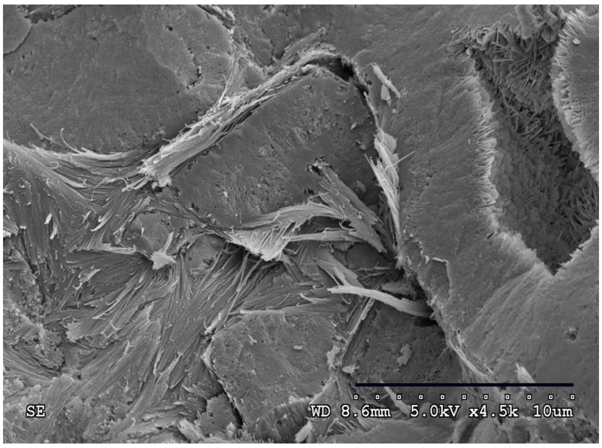

Fig. 2. Sepiolite surrounding opal.

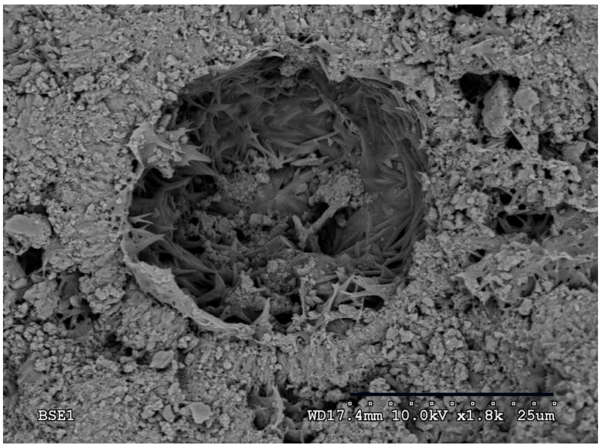

Fig. 3. Sepiolite spheroid.

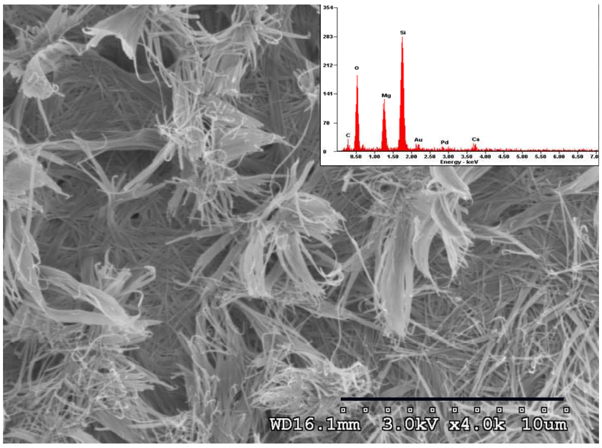

Fig. 4. Sepiolite fibers.

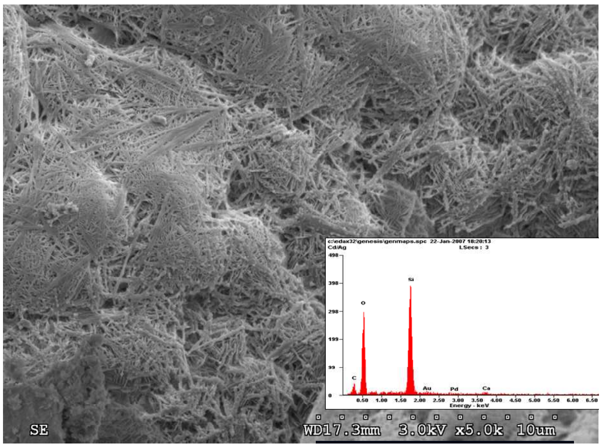

Fig. 5. Silica fibers.

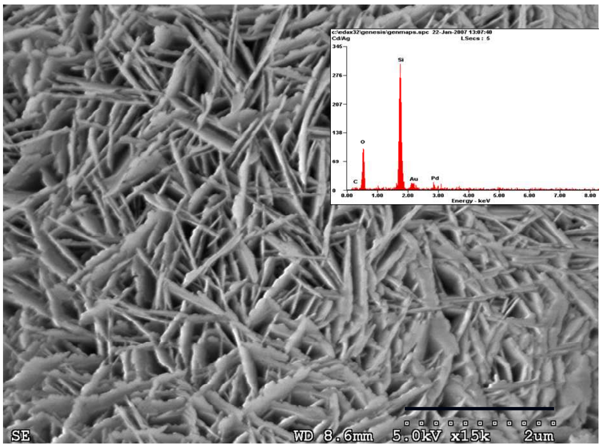

Fig. 6. Silica plates.