

A Handbook of Determinative Methods in Clay Mineralogy

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THE OCCURRENCE AND GENESIS OF CLAY MINERALS ASSOCIATED WITH QUATERNARY CALICHES IN THE MERSIN AREA, SOUTHERN TURKEY

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Abstract—Caliche in various forms, namely powdery, nodule, tube, fracture-infill, laminar crust, hard laminated crust (hardpan), and pisolithic crust, is widespread in the Mersin area in southern Turkey. It generally occurs within or over the reddish-brown mudstone of the Kuşçulu Formation (Tortonian, Miocene) and alluvial red soils of the Quaternary. The mineralogical distribution along representative caliche profiles was examined by X-ray diffraction, scanning electron microscopy, differential thermal analysis-thermal gravimetry, and chemical techniques. Calcite is the most abundant mineral associated with minor amounts of polygorskite in caliche samples, whereas smectite is prevalent mainly in the reddish-brown mudstone and alluvial red soils of the caliche parent materials and is associated with appreciable amounts of polygorskite. These minerals are also accompanied by trace amount of illite, quartz, feldspar, and a poorly crystalline phase. Polygorskite fibers and fiber bundles were developed autigenically on euhedral or subhedral calcite crystals of the caliche units and at the edges of smectite flakes in the caliche host-rocks or sediments. Intense, continuous evaporation of subsurface soil-water resulted in an increase in pH and the dissolution of detrital smectite within the red mudstones and alluvial red soils that enclose the isolated caliche forms, and caused an increase in the Al:Fe and Mg:Ca ratio, favoring the formation of polygorskite under alkaline conditions. The calcium required for caliche formation may have originated from eolian dust, detrital carbonate minerals, and/or other caliche materials, which are dissolved by carbonic acid.

Key Words—Caliche, Geochemistry, Mineralogy, Polygorskite, Quaternary, Smectite, Turkey.

INTRODUCTION

Caliche (syn. calcrete) is defined as a near-surface terrestrial accumulation of predominantly calcium carbonate and polygorskite, as a minor component within sedimentary rocks, unconsolidated sediments, and soils. It occurs in a variety of forms, such as hardpan, laminar crust, powder, nodule, tube, and fracture-infill (Wright and Tucker, 1991). Arid and semi-arid climates are favorable for caliche formation because of the alternating wet and dry periods. In the study area, a Mediterranean-type semi-arid climate with a mean annual precipitation of 634 mm, a mean annual evaporation of 1321 mm, and an average annual temperature of 18.7°C is dominant, and this led to widespread caliche formation in the region. Previous studies on caliche in Turkey are limited (Kapur *et al.*, 1987, 1990, 1993, 2000; Atalay, 1996; Atabey *et al.*, 1998). There is some information concerning the caliche-related polygorskite that was provided by Kapur *et al.* (1987) from the Adana region. Nevertheless, in the international literature, polygorskite authigenesis in caliches has received much attention (Singer and Norrish, 1974; Yastou and Wieder, 1976;

Galán and Ferrero, 1982; Inglés and Anadón, 1991; Rodas *et al.*, 1994; Verrecchia and Le Coustumer, 1996; Colson *et al.*, 1998; Khademi and Mermut, 1998; Pimentel, 2002). Therefore, this study was designed to describe polygorskite in the caliche units of the Mersin area in southern Turkey and to determine the relationships with abundant calcite and the host rocks and sediments rich in smectite. The origin of polygorskite is still the subject of debate.

MATERIALS AND METHODS

In all, 82 samples were collected from different types of caliche, such as powders, nodules, tubes, and fracture infills, and from their host sediments in the Mersin area. The mineralogical characteristics of the samples were further determined by X-ray powder diffractometry (XRD), differential thermal analysis-thermal gravimetry (DTA-TG), and scanning electron microscopy (SEM-EDX). The XRD analyses were performed using CuK α radiation at scanning speed of 1°/20 min to determine the mineralogical compositions of the bulk samples. Some samples were prepared for analysis by separation of the clay fraction (<2 μ m) by sedimentation, followed by centrifugation of the suspension after dispersion overnight in distilled water. The clay particles were dispersed by ultrasonic vibration for ~15 min. Four oriented specimens of the <2 μ m fraction from each sample were prepared by air drying, ethylene-glycol

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