MINERALOGICAL PROPERTIES OF EVAPORITE DEPOSITS IN AROUND TUZGÖLÜ BASIN, TURKEY

DOI: http://dx.doi.org/10.18509/GBP.2017.09
UDC: 553.63:549.4.02(560)

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ABSTRACT
The study area is located in the southern part of the Tuz Gölü in central Anatolia, Turkey. The investigated evaporates were taken from ten drill holes depths ranging from 650 to 1100 meters in Miocene to Quaternary deposits. The determined evaporite minerals are formed from the sulfate group minerals (gypsum, anhydrite, glauberite and partially bloedite), carbonate minerals (dolomite and partially magnesite, rarely calcite), and chloride group (halite and rarely polyhalite in the study. Detrital and/or non-evaporitic mineral are composed of quartz, feldspar, mica, and rarely zeolite minerals.
The purpose of the study is to determine the mineral types and contents at the basin in the lateral and vertical direction. The mineralogical compositions of the samples were investigated using X-ray diffraction, optical microscopy, and scanning electron microscopy methods.
In optical microscopic examinations, distribution of these minerals and their frequency was determined, their textural properties and their conversion to each other were also defined. In particular, the thickness of the halite-bearing sediments can reach several hundred meters, partly even if the halite beds intercalated with glauberite and/or anhydrite layers. Carbonate-halite and sulphate minerals are usually precipitated with each other in succession. Carbonate sedimentation has been reduced or has not occurred at the levels of sedimentation of halite precipitated layers. Carbonate minerals are mostly accompanied by sulphate group minerals, halite and clay minerals.
Calcite is usually found in the upper parts of the drillings. Dolomite-magnesite and dolomite-calcite mineral couples can be found together in the drillings. While dolomite is more common in moderate levels in drillings, magnesite is found in lower levels and is less prevalent. Sulphate minerals are the most common mineral group in the basin. The most common sulphate minerals are gypsum, anhydrite and glauberite. Along with these minerals, bloedite, epsomite, loveite, eugasterite and konyaite have been determined at various levels.

Keywords: Evaporite, halite, glauberite, Tuzgölü, Turkey

INTRODUCTION

Tuzgölü Basin located at the Central Anatolia is an inner enclosed basin and is bounded by Ankara uplift in the north, the Kırşehir massif from in the east and the Sivrihisar-Bozdağ massif from the west. There are many recent lakes formed in fault controlled depressions in different sizes in closed Konya basin. The largest lake is Tuzgölü and halite was precipitated and has been mined from this recent lake while the others are Terakan and Bolluk lakes according to their size. Some soda minerals, e.g., thenardite, mirabilite, glauberite, and Mg-salts have been being operated in the Tersakan and Bolluk lakes (Figure 1). There are also numerous small lakes where soda or salt minerals were precipitated or their water are enriched Na-Ca-Mg-Cl-SO_4-HCO_3 but any economical mineral was not occurred.

The closed Tuz Gölü Basin is tectonically active and arid lacustrine environments which effected time to time intake of seawater in ancient times ([1], [2], [3]). In this study area, more than a few hundred meters salt and Ca-Na-sulfate minerals were deposited during Miocene period. Many studies have been carried out in the study area mostly about geological features of the basin ([4], [5], [6], [7], [8], [9] and [10]).

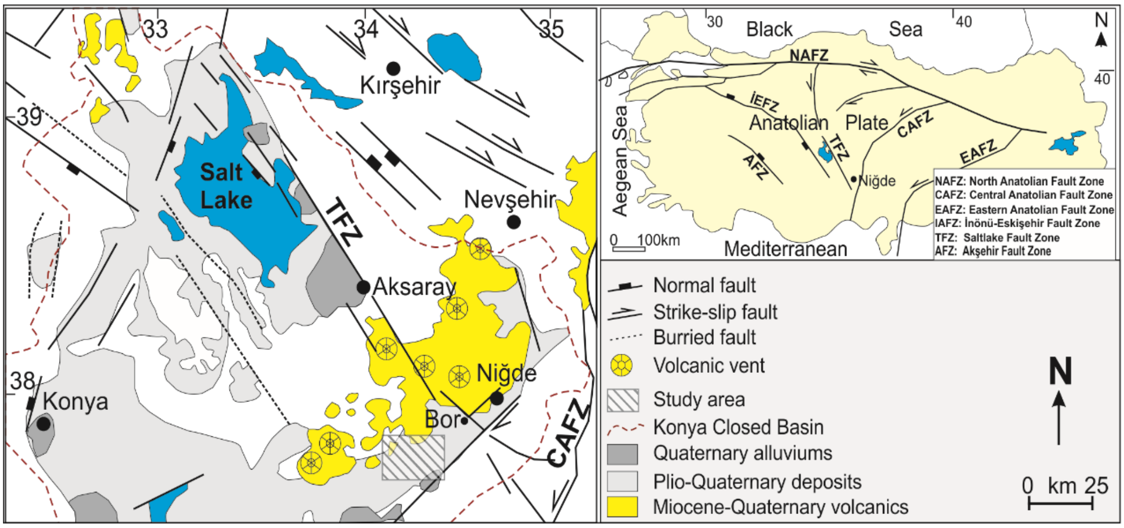

Figure 1. Simplified geology map (after [11] location map of study.

GEOLOGY

The Konya basin is situated in the central part of the Turkey. Basement rocks of the study area are composed of metamorphic (metaschist, metacarbonate, gneiss, quartzite, calc-schists, marbles, etc.) in Paleozoic and ultrabasic rocks Upper Cretaceous in age. Intermediary and basic rocks, e.g. andesitic and basaltic volcanites and volcanoclastics of various ages since from Miocene to Quaternary have been activated in the Basin (Figure 1). The main tectonic lines in the closed Konya basin are right lateral Salt Lake fault extending in N–NW direction and the S-SW trending Ecemiş fault along the eastern boundary of the Lake Tuzgölü. There are also many small tectonic lines which mostly parallel to the main lines. The basement rocks are cover unconformably by the Paleocene-Eocene-aged units formed from basaltic pillow lava, graded, bedded detrital sediments and volcanoclastics. The basin was an inner shallow marine character during the Paleocene-Eocene period while it was a closed lake in the Miocene-Pliocene.

RESULTS

The mineralogical compositions of the samples were investigated using X-ray diffraction, optical microscopy, and scanning electron microscopy with energy-dispersive X-ray spectroscopy (EDS) methods.

Halite, Na-Ca-sulfate minerals (anhydrite, gypsum, glauberite, eugasterite and thenardite), Mg-sulfate minerals (bloedite, epsomite, loweite), dolomite, magnesite and calcite minerals were found in the basin as evaporite minerals. In optical microscopic examinations, distribution of these minerals and their frequency was determined. Textural properties and conversion to each other were also investigated. In particular, the thickness of the halite-bearing sediments can reach several hundred meters, partly even if the halite beds intercalated with glauberite and/or anhydrite layers. Carbonate-halite and sulphate minerals are usually precipitated with each other in succession. Carbonate sedimentation has been reduced or has not occurred at the levels of sedimentation of halite precipitated layers. Carbonate minerals are mostly accompanied by sulphate group minerals, halite and clay minerals.

Microcrystalline (alebaster) and especially fibrous (selenitic, satin spar) of gypsum minerals have been widely found (Figure 2a). Satin spar gypsum is usually observed as intercalated gypsum veins in the evaporites and carbonates. In some of the sections gypsum is partially observed as a matrix. In some thin sections, mossy bloedite crystals developed in monoclinic system were found in gypsum mineral. In thin section observation, gypsum minerals are mostly converted to anhydrite and/or glauberite minerals, and in some cases anhydrite and glauberite minerals to gypsum (Figure 2c, d).

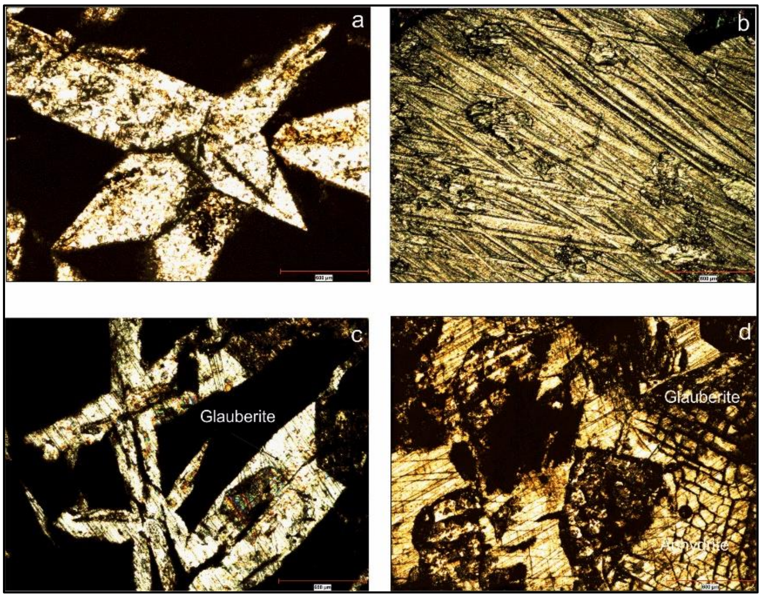

Figure 2. Microscopical morphologies of gypsum (a, b), glauberite and anhydrite minerals.

In addition, in some of the sections, the anhydrite mineral has been transformed into the glauberite pseudomorphs. Fibrous gypsium growths have been developed around of these pseudomorphs. The glauberite mineral is observed as usually euhedral to semi euhedral in shape or massive and microcrystalline aggregates. Glauberites were partially formed as secondary from gypsum and/or anhydrite (Figure 2c, d). The primary glauberite crystals was seen as euhedral, lenticular, and hemi-bipyramidal twins especially rich in organic matter and sometimes with euhedral halite. In some sections, it was determined that the crystal growths of the glauberites did not show a parallel arrangement to the sedimentation surface, and sometimes they grew in the dissolution cavities in the halite.

Halite is observed as massive or euhedral crystals (Figure 3a). The chevron texture of the halite is observed in both macro and micro dimensions, indicating that the mineral first collapses and is precipitated in shallow environments during the first sedimentation ([12]). Fluid inclusions observed in halite minerals two types: i) primary fluid inclusions parallel to the growth traces and ii) secondary inclusions locating perpendicular to the growth traces (Figure 3b, c).

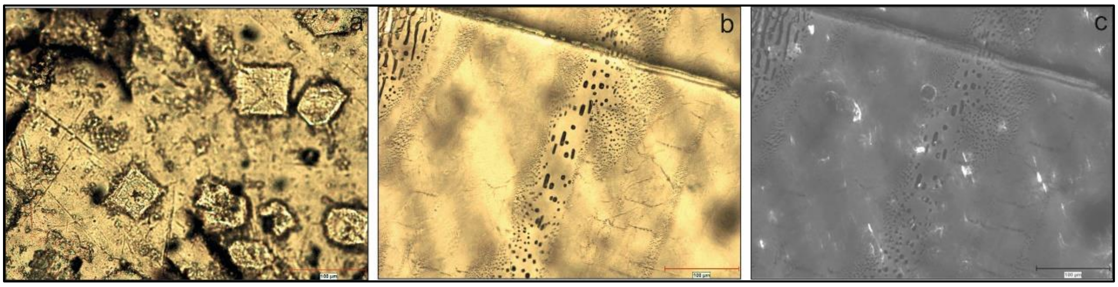

Figure 3. Thin section photograph of euhedral halite crystals (a), fluid inclusions (a), crossed nichols (c).

In general, anhydrite minerals are crystallized as orthomorphic euhedral crystals in microscopic and especially in SEM observations whereas gypsum mineral is generally brittle and fibrous. In the SEM examinations, the conversion between gypsum and anhydrite minerals was observed (Figure 4, 5). Some examples of glauberite minerals have also been found in needle and radial morphology like as eugasterite.

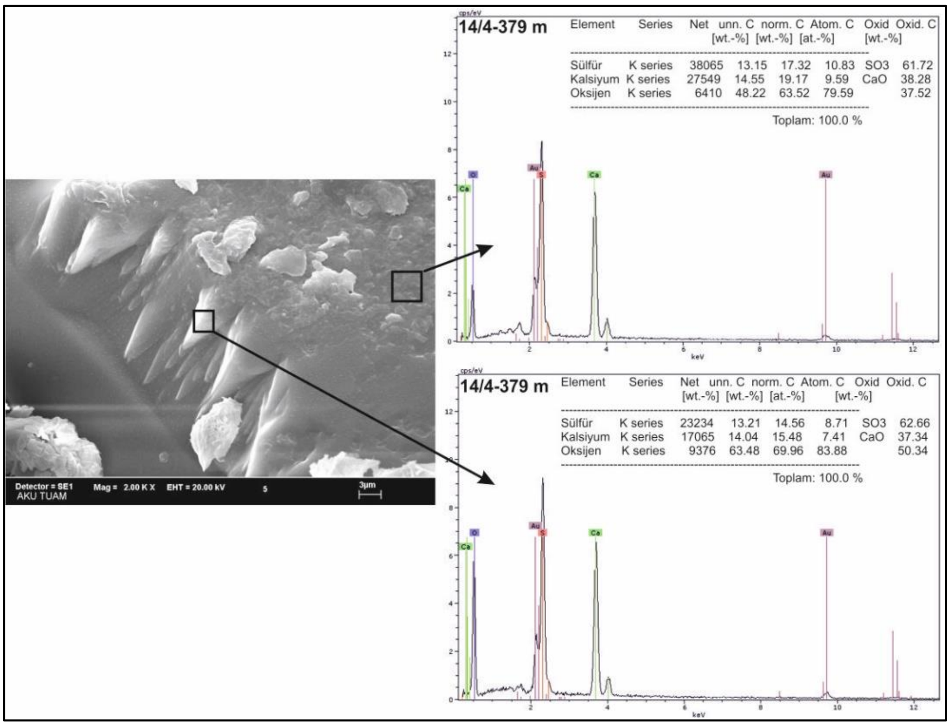

Figure 3. SEM image of gypsum anhydrite mineral transformation.
EDS analysis of the anhydrite mineral (upper) and gypsum mineral (bottom).

Calcite is usually found in the upper parts of the drillings. Dolomite-magnesite and dolomite-calcite mineral couples can be found together in the drillings. While dolomite is more common in moderate levels in drillings, magnesite is found in lower levels and is less prevalent. Sulphate minerals are the most common mineral group in the basin. Frequently found sulphate minerals are gypsum, anhydrite and glauberite. Along with these minerals, bloedite, epsomite, loweite, eugasterite and konyaite have been determined at various levels.

Massive magnesite bands of several centimeters thick were observed at these levels. The content of these minerals in total rocks can reach up to 100% in some cases. Eugasterite has been observed as silky, radial, semi-oily, fine fibers, especially in clayey levels rich in organic matter and partly in clayey carbonated lithologies containing massive glauberite.

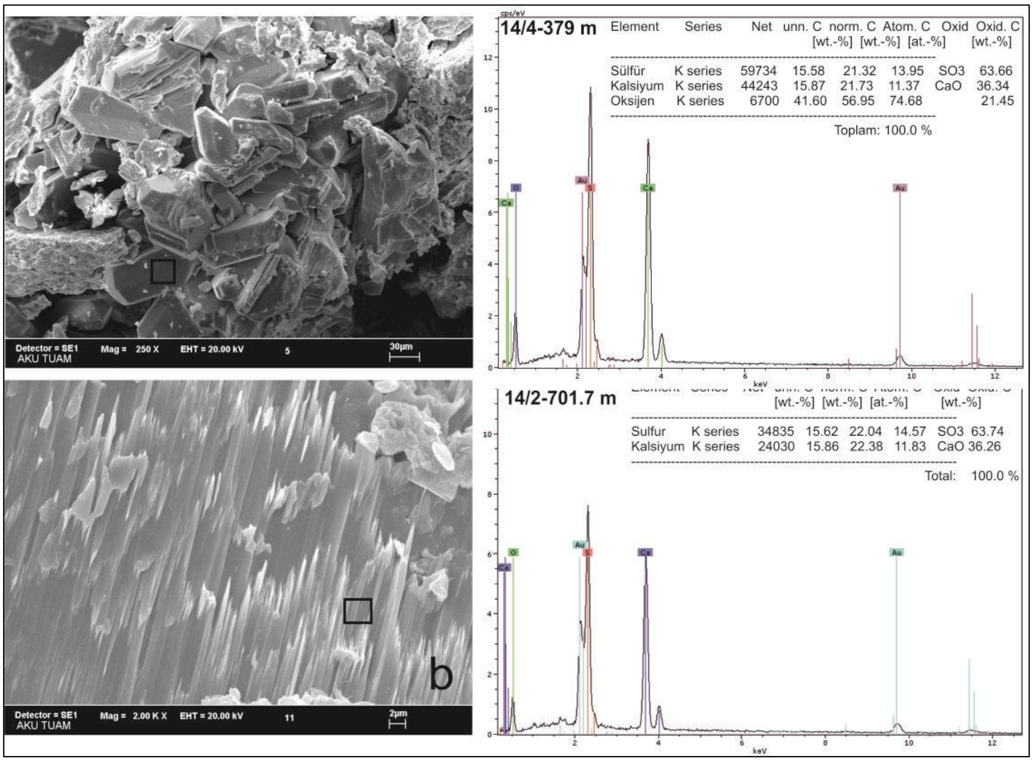

Figure 4. SEM images EDS results of anhydrite and gypsum a) micro photo and EDS analysis of euhedral anhydrite, b) micro photo and EDS analysis of fibrous structures of gypsum mineral.

Diagenetic transformations of gypsum minerals have been observed along with autogenetic occurrences. Particularly diagenetic gypsum occurrences have been observed to be transformed from anhydrite to secondary form, with carbonate enrichment of later solutions in the form of envelope around the glauberite mineral in some places.

Gypsum mineral content is higher in the samples representing south-southwest and south-east of the study area, whereas is lower in the upper levels of sequence especially in the north-east drilling of north-east of the study area. Present of gypsum minerals in the upper levels and anhydrite in lower levels are generally related to diagenesis whereas dominance of gypsum mineral in the southern part of the is related to the conversion of anhydrite minerals to gypsum and/or precipitation primary gypsum. The content of halite was decreased in the south and south-eastern part and partially in the south-west of the study area. Therefore, the glauberite mineral is rarely present in these boreholes. Halite and glauberite contents were increased especially in the center of the study area. The absence or decrease of halite and glauberite minerals in the south of the study area may be indicate that there is groundwater entry from the south to the basin.

Acknowledgement
The project was funded by The Scientific and Technological Research Council of Turkey (TÜBİTAK 114Y629) and the Selçuk University Scientific Research Projects (16401034) support program.

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