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*Full Length Research Paper*

# The clay minerals observed in the building stones of Aksaray-Guzelyurt area (Central Anatolia-Turkey) and their effects

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**Characterization of Aksaray-Guzelyurt clays in the Central Anatolian region were carried out and the clay minerals used in the building stones and their effects were evaluated. The clay samples taken from Guzelyurt area located to the southeast of the city of Aksaray were investigated employing the spectroscopic methods. The differential thermal analysis (DTA) and the thermogravimetric analysis (TGA) measurements have been carried out for determinations of thermal behaviour of the clay samples. First, the Fourier Transform Infrared (FTIR) spectra of the standard clay minerals-"The World Source Clay Minerals" such as illite (IMt-1; Silver Hill, Montana, USA), illite-smectite mixed layer (ISMt-1; Mancos Shale, Ord.), beidellite (SBld-1; Idoha, USA), kaolinite (KGa-1; Washington Country, Georgia, USA), chlorite (ripidolite, CCa-1; Flagstaff Hill, El Dorado Country, California, USA), nontronite (NAu-2; Uleynine, South Australia), montmorillonite (SCa-3; Otay, San Diego Country California, USA) were obtained. Then the spectra of anhydrite, gypsum, illite+quartz+feldspar, quartz+feldspar were recorded together with the standard clays. Then, the mineral phases included in samples taken from Aksaray-Guzelyurt area were identified by comparing their FTIR spectra with those of the standard clay minerals and X-ray Diffraction (XRD) patterns. It was found that the clay samples include quartz, illite (T-O-T), kaolinite, amorf silica and they have T-O (Tetrahedral-Octahedral) or O-T (Octahedral-Tetrahedral) structure. The main clay mineral in the samples is kaolinite. Clays constitute the majority of occurring minerals that occur as the alteration product of building stones. The carbonate rocks using in various constructions are mainly composed of calcite. In general, dolomite, silica and clay minerals accompany this mineral. The clay type and their characteristics that result in shortening life of buildings are first examined and then visual deteriorations occurring associated with exteriors have been discussed. Common use of the carbonate rocks containing clays such as marl as building stones quarried from the Guzelyurt area increases such incidences at the regional scale.**

**Key words:** Central Anatolia, FTIR, clay, illite, smectite.

## INTRODUCTION

One of the most ancient and most important raw materials benefited by humanity throughout the history, "clay", has never lost its significance. It is still the most important raw material for the industry today. Clay is a term used to describe a group of phyllosilicate minerals.

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The "pure" clay is rare in nature and usually mixed not only with other clays but with microscopic crystals of carbonates, feldspar, micas and quartz. As a sedimentological term, it is typically less than 0,002 mm (2 µm) in diameter. Plasticity, sintering and absorption of water account for the important characteristics of the clay minerals. Clay, as a material mirroring the history, provides the mankind with many opportunities since the discovery of the fire. Clay used in many areas allow activities of research and applications to be carried out in different disciplines.

Clay minerals are formed as a result of certain changes in temperature, pressure, geochemical, and physical conditions (Murray, 1999). Although clay minerals could be resulted from weathering, sedimentation, burial, diagenesis and hydrothermal alteration processes in general, occurrence of monomineralic clay deposits is scant. Even in an ordinary clay sample, several clay species could co-occur. Clay minerals can be categorized in 4 subgroups in natural environments: (I) kaolinite group, (II) smectite group, (III) illite group, and (IV) chlorite group. They may occur in various colors including yellowish, reddish, green, white, various shades of brown, and dark. Since they occur with metal-oxides, they naturally acquire such colors. They may also contain organic matter. Consequently, its color gives qualitative idea regarding its elemental content. When it contains limonite color becomes dark, when iron peroxide is present, color turns red, if there is manganese dioxides, color becomes black, if there is organic matter, and color becomes purple. Besides, color could not remain unchanged after cooking. Because oxides change color at elevated temperatures (Grim, 1988). Clays inherently absorb water, thus they are always wet.

Physical and chemical properties of the clays make them adequate material for different purposes in different fields (Murray, 1999). Clay-organic complex structures have been a research subject particularly since 1930's. Outcome of these researches made constructive contribution to the process of expanding of their use in diverse areas (Smith, 1934). Besides, progresses in analytical techniques that made possible to determine mineralogical and chemical compositions of the clays appreciably expedited this process. It is obvious that clay reserves are very imperative to the state's economy. When clay reserves in terms of commercial values were considered in three groups as kaolinite, smectite, and sepiolite, it is remarkable that although Turkey has world class reserves for smectite and sepiolite, it trails way behind in terms of capitals generated through international market. Principal reason of this is lack of quality and sustained products produced and its use as raw material instead (Sabah and Celik, 2006).

Clay mineral characterization could be carried out employing spectroscopic methods for various purposes in the geological sciences (Heroux et al., 1979). In the literature, there is a voluminous research on determination of clay mineral chemistry using diverse techniques. Today, one of the most preferred methods is the FTIR (Fourier Transform Infrared) Spectroscopy. There is a significant increase in number of studies using this method dealing with the clay characterization in Turkey (Akyuz and Akyuz, 2003; Davarcioglu et al., 2005; Davarcioglu and Kayali, 2007; Davarcioglu et al., 2007; Davarcioglu and Ciftci, 2009). One of such studies is on the quantitative and qualitative characterization of Central Anatolian clay deposits and diatomites by employing the spectroscopic methods (Kayali et al., 2005; Davarcioglu, 2009). The Central Anatolia is one of the richest area in terms of the occurrence of clay deposits in the world. Therefore, investigation of these deposits, their quantitative and qualitative characterization is highly important.

Majority of the alteration products of building stones are represented by various clay minerals. In this study, clays that result in diminution of life of building stones were characterized and visual deterioration of exteriors were argued. Visual effects can be viewed different thus visuality and aesthetics are somewhat subjective issues. However, in order to deal with visual effect as an object, factors affecting it should be considered. Fundamental criterion is to create a visual effect compatibly integrated with nature. Although there are a few study deals with the area with regards to various aspects, current study is the first to report quantitative and qualitative data for the deleterious components of the building stones. Thus, the professionals dealing with both constructing and restoring buildings should consider main causes at mineralogical scale.

## REGIONAL GEOLOGY

One of the various studies on clay occurrences in the Central Anatolia is on the clays occurring around Guzelyurt and it's near vicinity. In type profile, it is composed of fine-grained and gravel bearing, deep red and brown clays at the top, light color clay in the middle, and light brown and deep red clays at the bottom (Ayhan and Papak, 1988). Another study dealing with the area is on the geological formation of the clays (Figure 1). According to the data presented in this study, smectite was transported to kaolinitic zone following its removal through washout of palesoils and they also are entirely result of hydrothermal alteration of feldspars, not of glass (Temel et al., 1995).

Collective information acquired from various profiles around Guzelyurt area was presented in one generalized columnar section in Figure 2. Utilizing columnar sections and local observations, distribution of clayey zones and their lithostratigraphic relationship were investigated. Here three distinct zones, progressing upward, were formed as a result of hydrothermal alteration of the Gordeles ignimbrite that is lateritic, kaolinitic with natroalunite and smectitic-kaolinitic. In the natroalunitic-kaolinitic zone, three subtle zones including pumice-rich zone, halloysite-rich zone, and a zone in which natroalunitic kaolinite occurring layers enveloping grains. Smectite-kaolinite zone occurs at the top of the profile and contains kaolinite and smectite. As would be seen in Figure 2, 50 - 90 cm thick, dark brown basaltic lava occurs at the top (Figure 2). Intense red or brown paleosoils occur immediately under the basaltic layer. 80 cm thick, white color, altered Gordeles Ignimbrite (smectite-kaolinite zone) occurs and it is underlied by 260 - 280 cm thick, white color and fine grained altered Gordeles Ignimbrite (kaolinite with natroalunite zone). Underlying this, a 40 - 60 cm thick, reddish altered Gordeles Ignimbrite (lateritic zone) is observed. At the base, either unaltered Gordeles Ignimbrite or basement rocks are found.

Principal mineral of carbonate rocks that are frequently used in constructions is calcite and it is locally accompanied by dolomite, silica and various clay minerals. Mineralogical studied indicated that those clay minerals, essentially illite, are alteration products of co-occurring minor feldspars (3% vol.) (Dal and Gultekin, 2007). Occurrence of clay contents in this calcareous and/or dolomitic

**Table 1.** Classification of building stones (Mutluturk, 1999).

| Building stone | Recovery method | Processes | Requirements | Use |
|---|---|---|---|---|
| Block stone | Through exploding | Picking desired sizes | Every shape excluding long, flat and suitable physico-mechanical values | Filler in harbor and dam constructions etc. |
| Crushed stone | Through exploding | Crushing and sieving | Every shape excluding long, flat and suitable physico-mechanical values | Crushed stone in stabilized road constructions etc. |
| Marble | Wedging, wire-cutting etc. | Cutting and dimensioning through suitable methods | Rectangular prismatic shape, color, and suitable physico-mechanical values | Marble slabs, kitchen counter, pavement etc. |
| Hewn stone | Sing excavator and compressor, etc. | Dimensioning and shaping by using hand tools | Shapeable using hand tools and color | Wall and road construction, exterior tiling |
| Natural stone | Splitting through natural cleavages, free portions, stream pebbles | Picking | Color | Road-wall construction and tiling, environmental friendly. |

carbonate rocks results in decrease of resistance of the building stones and gives rise to static failure and deterioration in aesthetics and exterior look (Celik et al., 2003). Thus it is a deleterious content in the building stones.

Clay stones that bear 35 - 65% calcar ($CaCO_3$) in their composition are called as marl. In addition, mica, quartz and iron oxides may occur at varying proportions. They have colors including yellowish, greenish, blackish and grey based on mineral content. It is effervescent when subjected to dilute acid (such as HCl). Based on carbonate proportion it is named as calcar (95 - 100% $CaCO_3$ plus 0 - 5% clay), calcar with marl (85 - 95% $CaO_3$ and 5 - 15% clay), marl-calcar (75 - 85% $CaO_3$ and 15 - 25% clay), marl with calcar (65 - 75% $CaO_3$ and 35 - 25% clay), marl (35 - 65% $CaO_3$ and 35 - 65% clay), marl with clay (25 - 35% $CaO_3$ and 65 - 75% clay), clay-marl (15 - 25% $CaO_3$ and 75 - 85% clay), clay with marl (5 - 15% $CaO_3$ and 85 - 95% clay), clean clay (0 - 5% $CaO_3$ and 95 - 100% clay) (Erguvanli, 1983).

Mineralogical and petrographic analyses are imperative in that textural and internal structures are revealed. Texture is manifestation of rock-forming minerals in that grain-grain relation, their orientations, sizes, distributions and shapes are all covered. Thus, physical properties such as hardness, brittleness, polishing, and slabing are all interrelated with internal structures (Table 1). Consequently, detailed petrographic analyses should be carried out to prevent texture-related failures in the future before making final decision for the use of such rocks (Onargan et al., 1997; Triplehorn et al., 2002).

## SPECTRAL CHARACTERIZATION

There is no study on the qualitative and quantitative characteristics of the clays of Aksaray-Guzelyurt (Turkey) area to date. In this study, clays of Aksaray-Guzelyurt area occurring within the building stones were studied employing spectroscopic methods and their effects were considered.

A combined profile representing the constructed profiles chosen for this and nearby area was shown in Figure 1. The clay samples were taken from three different levels shown in the litostratigraphic columnar section of a selected locality in the Aksaray-Guzelyurt region (Figure 2). The samples taken from lower, middle and upper levels were labeled as (K-5, K-4, K-3), (K-2), and (K-1), respectively. The following processes were applied to prepare the samples for the FTIR measurements. Samples were ground into powder. Powdered samples were alternately washed with pure water, ethyl alcohol and ether. Then, they were dried in an oven at 110℃ for 24 h.

In general, the clay minerals contain significant amount of water. Conversely, they contain less alkaline and alkaline earth elements. Absorption bands due to the water molecules occupy large spectral fields, the ones critical for identification of clay minerals. Thus in order to minimize this undesired overlap, samples for the FTIR measurements were prepared through clay concentration without employing a centrifuge. However for the chemical analyses, samples were analyzed as bulk sample without concentrating for clay fraction. Organic matter was removed through boiling in $H_2O_2$ and then samples were dried in an oven at 110℃ for 24 h. The chemical analyses of the Aksaray-Guzelyurt clay samples (dried in an oven at 110℃) were carried out at the ACME-Canada laboratories by means of XRF-ICP (X-ray Fluorescence spectrometry-Inductively Coupled Plasma) technique (Table 2).

These samples were prepared applying the disc technique (mixing ~1 mg clay sample with ~200 mg KBr) and put in molds. These intimate mixtures were then pressed at very high pressure (10 tons per $cm^2$) to obtain the transparent discs, which were then placed in the sample compartment. Bruken Equinox 55 Fourier transform FTIR spectrophotometer (Department of Physics, METU, Ankara-Turkey) was used for the IR spectral measurements of these samples with standard natural clay and the spectra were recorded over the range of 5000-370 $cm^{-1}$ (% transmission versus $cm^{-1}$). Before taking the spectra measurements of the samples, spectrophotometer was calibrated with polystryrenes and silicate oxide of thickness 0.05 nm.

On the other hand, the infrared spectra of the illite (IMt-1; Silver Hill, Montana, USA), illite-smectite mixed layer (ISMt-1; Mancos Shale, Ord.), beidellite (SBId-1; Idoha, USA), kaolinite (KGa-1;

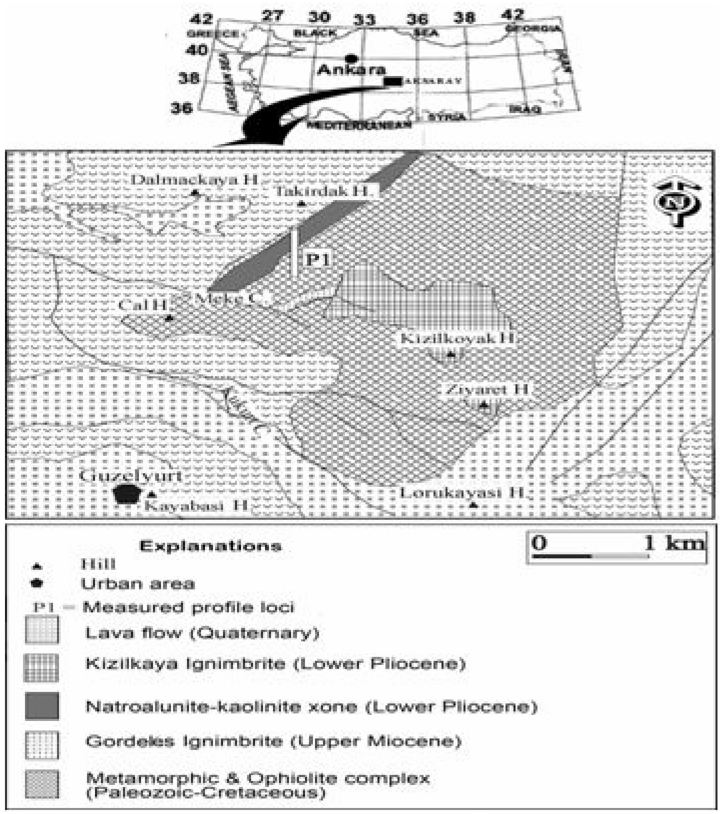


**Figure 1.** Generalized geological map of the Guzelyurt area (adapted from Ayhan and Papak, 1988).

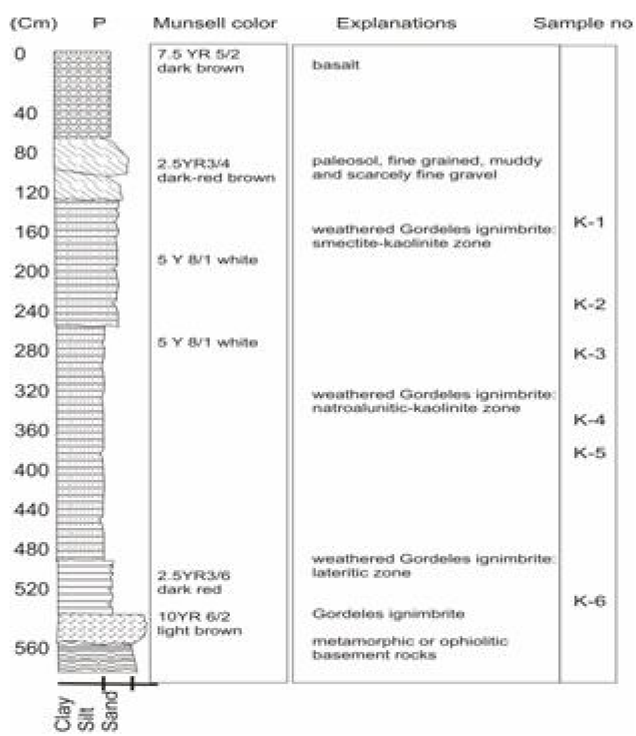


**Figure 2.** Generalized columnar section for the Guzelyurt area (adapted from Kayali et al., 2005).

**Table 2.** The percentages of the minerals included in the Aksaray-Guzelyurt clay samples taken from lower, middle and upper layers obtained from laboratory results.

| Element | K-4 (lower level) | K-2 (middle level) | K-1 (upper level) |
|---|---|---|---|
| $SiO_2$ | 58.38 | 68.63 | 57.60 |
| $TiO_2$ | 0.40 | 0.47 | 0.02 |
| $Al_2O_3$ | 29.03 | 18.64 | 30.11 |
| $Fe_2O_3$ | 0.45 | 0.22 | 0.08 |
| MnO | 0.01 | 0.01 | 0.01 |
| MgO | 0.11 | 0.06 | 0.01 |
| CaO | 0.26 | 0.26 | 0.22 |
| $Na_2O$ | 0.20 | 0.07 | 1.85 |
| $K_2O$ | 1.12 | 0.44 | 8.32 |

Washington Country, Georgia, USA), chlorite (ripidolite, CCa-1; Flagstaff Hill, El Dorado Country, California, USA), nontronite (NAu-2; Uleynine, South Australia), montmorillonite (SCa-3; Otay, San Diego Country California, USA) known as standard natural clays ("The World Source Clay Minerals") were taken, and then the spectra of anhydrite, gypsum, illite+quartz+feldspar, quartz+feldspar have been taken together with the standard clays since those spectra were necessary for the analyses of subject samples.

The assignments of the vibration bands of the samples, using the fundamental vibration frequencies of the clays known standard natural clays, each of the vibration bands corresponding to which clay species in the spectra of the samples were determined and results for the clay samples given in Table 3 and the results obtained for each clay sample representing certain levels within the profiles were given in Tables 4 through 5, respectively.

Along with XRD (X-ray powder diffraction), the FTIR investigation in clay mineral speciation could be regarded as useful and multipurpose application since some physical details of clay lattices and experimental qualitative correlation between the samples were made possible. Besides, for the minerals that were observed with the both techniques, functional groups could only be determined through the FTIR spectra. Therefore, qualitative and quantitative speciation of the minerals by employing the FTIR spectroscopy is very important and promising.

The XRD measurements were employed to determine the crystalline mineral phases included in the same samples (Siemens D-5000 Diffract AT V 3.1 diffractometer, CuKα radiation λ=1.54056 A˚ and 0.03 steps; General Directorate of Mineral Research and Exploration laboratories-MTA, Ankara-Turkey). According to the XRD results (Figure 3), the Guzelyurt clay samples are composed of quartz (66.51%), illite (26.23%), kaolinite (7.26%) and trace opal-CT, biotite and iron oxides. In the clay profile (Figure 2), kaolinite content is very high at the base, and tends to decrease towards the top. Quartz content is always significant (57.60 - 68.63%).

The DTA (Differential Thermal Analysis) and the TGA (Thermogravimetric Analysis) measurements were carried out for the determinations of the thermal behaviour of the clay samples (Figure 4). Measurement were carried out in the MTA Labs (Ankara-Turkey) using a Rigaku Thermal Analyzer Ver. 2.22EZ (SN#39421). In the DTA-TGA graphs of the sample representing kaolinite-rich zone (K-4 lower level), endothermic peak at 521.2°C and an exothermic peak at 977.9°C were observed (Paterson and Swaffield, 1987). Presence of a minor peak at 64.1°C could be associated with disappearance of absorbed water (in crystal structure) and consequently about 11.3% weight loss was measured at 512.2°C (Brindley, 1978; Kok, 2006; Kok and Smykatz-Kloss, 2008).

## RESULTS

The clay samples were taken from three different levels shown in the litostratigraphic columnar section of a selected locality in the Aksaray-Guzelyurt region (Figure 2). The FTIR spectra of the samples taken from lower level (K-4), middle level (K-2), and upper level (K-1) of Aksaray-Guzelyurt (Turkey) clay profile are given in Figures 5 through 7, respectively. Interpretation of the observed vibrational bands in these samples were carried out by comparing with those found in the world clay standards with known fundamental vibration frequencies for illite, illite-smectite mixed layer, beidellite, kaolinite, chlorite (ripidolite), nontronite, montmorillonite and the other clay standards. Results are listed in Tables 4 through 6, respectively.

## DISCUSSION

As would be seen from Tables 4 through 6, while mid levels of the clay profile are dominated by illite, amorphous silica, and quartz, lower and upper levels were enriched in illite, kaolinite, amorphous silica and quartz. The XRD results (Figure 3) are in accordance with the FTIR findings. From both analyses, it is concluded that major clay mineral is kaolinite. Since all the clay samples include, such as T-O (Tetrahedral-Octahedral) or O-T (Octahedral-Tetrahedral). On the other hand, it has been observed O-H, Al-Al-OH, Si-O-Al, and Si-O-Si groups in their FTIR spectra. It is because of exchange of structural ions with ions or molecules with different valences occurring in between octahedral and tetrahedral layers of clay structure. Organic molecules enforce the silicate layers and may be penetrated into the vacancies among them. They form H-bonding with the surface hydroxyles breaking the strong electrostatic and van der Waal forces between the layers. This hydroxyle planes are weak proton donors, so they can form hydrogen bonds with the strong bases (Olejnik et al., 1968; Thompson and Cuff, 1985). Bipolar molecules

**Table 3. F**undamental vibrational frequencies of standard natural clay ($cm^{-1}$).

| Natural clay | Vibrational frequency ($cm^{-1}$) |
|---|---|
| Illite | |
| ν(OH) stretching | 3622 |
| ν(Si-O) normal to the plane stretching | 1090 |
| ν(Si-O) planar stretching | 1031 |
| (Al-Al-OH) deformation | 916 |
| (Al-Mg-OH) deformation | 832 |
| (Al-O-Si) inner surface vibration | 756 |
| OH deformation | 688 |
| OH deformation | 622 |
| (O-Si-O) bending | 525 |
| (O-Si-O) bending | 468 (Wilson, 1987) |
| | |
| Illite-smectite mixed layer | |
| ν(OH) stretching “shoulder” | 3685 |
| ν(OH) stretching | 3622 |
| ν(Si-O) normal to the plane stretching | 1090 |
| ν(Si-O) planar stretching | 1031 |
| (Al-Al-OH) deformation | 916 |
| (Al-Mg-OH) deformation | 810 |
| (Al-O-Si) inner layer vibration | 750 |
| OH deformation | 622 |
| (O-Si-O) bending | 525 |
| (O-Si-O) bending | 468 (Wilson, 1987) |
| | |
| Kaolinite | |
| Inner-surface OH, (Al-O...H) stretching | 3679 |
| Inner cage OH stretching | 3655 |
| Inner-layer OH, (Al-O...H) stretching | 3623 |
| ν(H-O-H) stretching | 3433 |
| ν(Si-O) normal to the plane stretching | 1118 |
| ν(Si-O) planar stretching | 1027 |
| ν(Si-O) planar stretching | 1009 |
| Inner-surface Al-OH deformation | 942 |
| Inner-layer Al-OH deformation | 914 |
| M-OH stretching | 791 |
| Si-O deformation | 754 |
| (Si-O-Al) deformation | 546 |
| (Si-O-Fe) deformation | 470 |
| (Si-O-Mg) deformation | 428 (Olejnik et al., 1968) |

which behave as both powerly proton donor and acceptor place on the tetrahedral surface giving protons to the oxygens while placing on the octahedral surface taking protons from hydroxyles (Ledoux and White, 1966). Formed hydrogen bonds are very weak since oxygen plane is very weak electron donor. Therefore, the atoms having different valances and substituting on the octahedral layer form H-bonding with inner-surface hydroxyles.

Clay minerals determined in this study, “kaolinite-illite”, are industrial minerals with high demand due to their desired thermal properties (heating and cooling capacities). Kaolinite in particular, after certain treatment to meet certain required physical and chemical standards, is used in various construction materials. Besides due that it is natural and environment-friendly, it is suggested as a relatively low cost alternative to various chemicals.

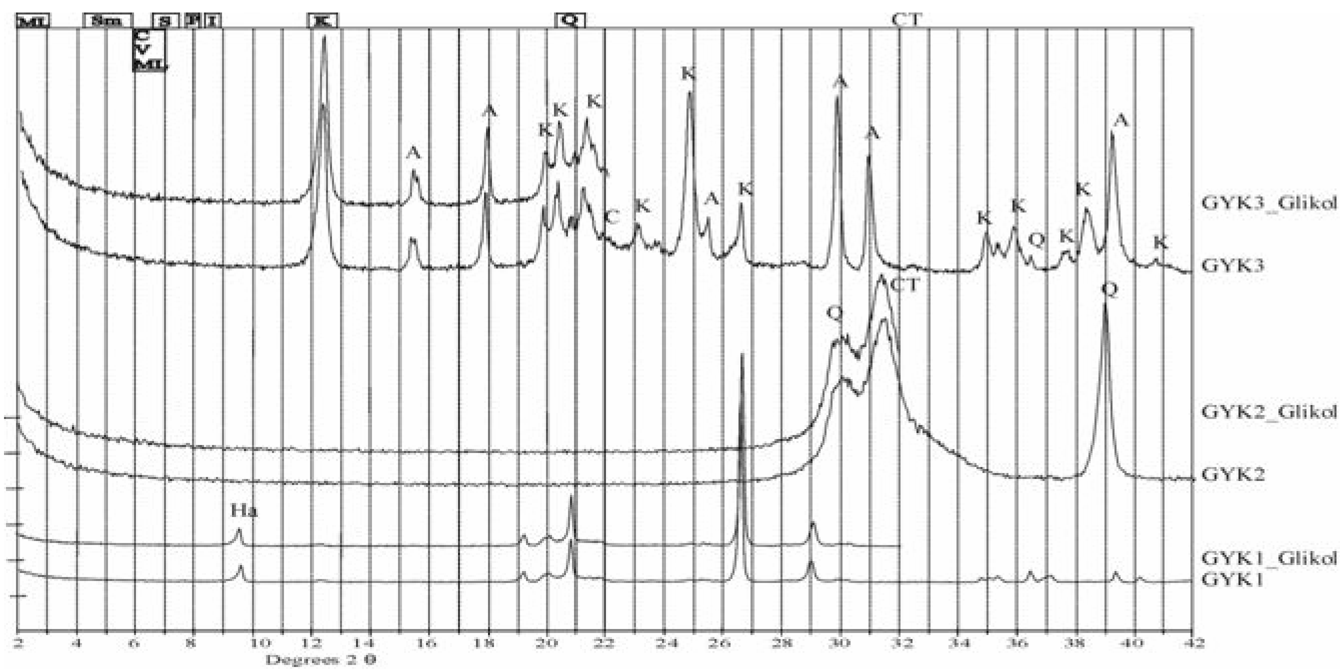

**Figure 3.** X-ray diffractograms of the Aksaray-Guzelyurt clays (Q: quartz, I: illite, K : kaolinite, Ha:halloysite, CT: opal-CT, A: alunite).

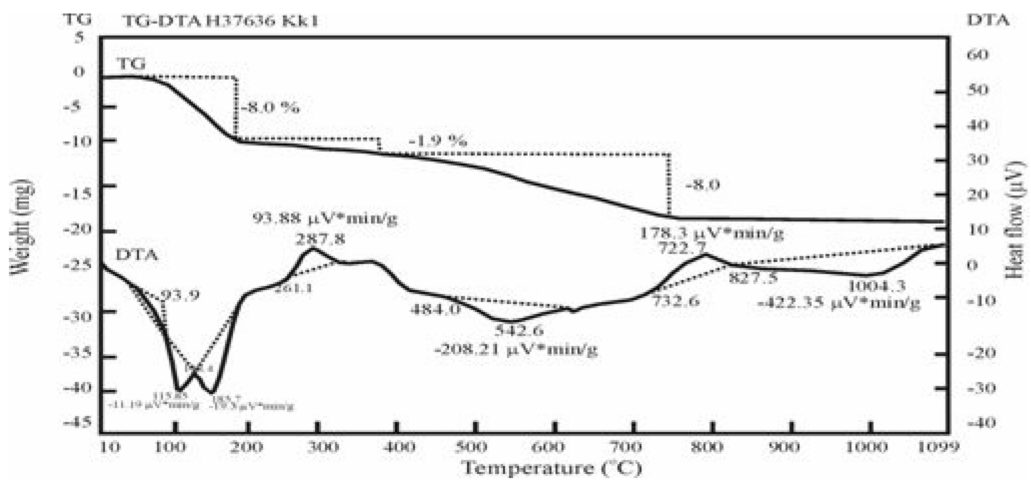

**Figure 4.** DTA-TGA measurements of the Aksaray-Guzelyurt clays.

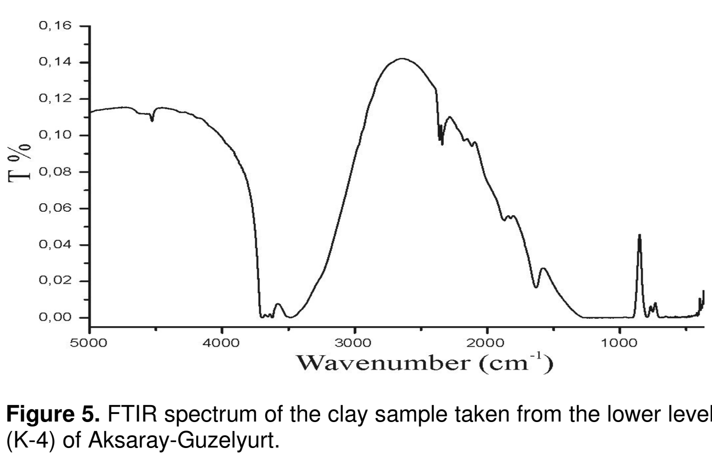

**Figure 5.** FTIR spectrum of the clay sample taken from the lower level (K-4) of Aksaray-Guzelyurt.

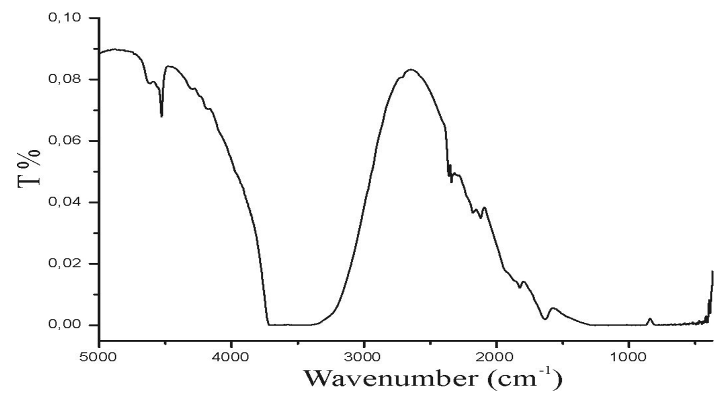


**Figure 6.** FTIR spectrum of the clay sample taken from the middle level (K-2) of Aksaray-Guzelyurt

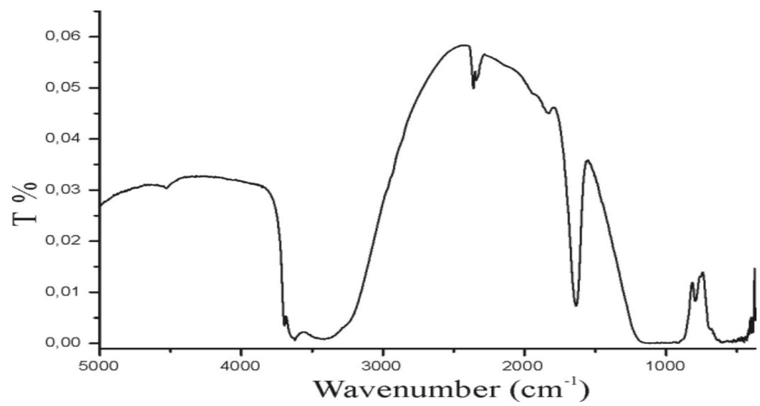


**Figure 7.** FTIR spectrum of the clay sample taken from the upper level (K-1) of Aksaray-Guzelyurt.

**Table 4.** FTIR spectrum analysis results of Aksaray-Guzelyurt clay sample (K-4).

| Wavenumber ($cm^{-1}$) | Assignment | Clay mineral type |
|---|---|---|
| 3679 | Inner-surface OH, (Al-O...H) stretching | Kaolinite |
| 3655 | Inner cage OH stretching | Kaolinite |
| 3623 | Inner-layer OH, (Al-O...H) stretching | Kaolinite |
| 3623 | ν(OH) stretching | Illite |
| 1120 | ν(Si-O) normal to the plane stretching | Kaolinite |
| 1030 | ν(Si-O) planar stretching | Kaolinite / Illite |
| 1010 | ν(Si-O) planar stretching | Kaolinite |
| 942 | Inner-surface Al-OH deformation | Kaolinite |
| 914 | Inner-layer Al-OH deformation | Kaolinite |
| 914 | (Al-Al-OH) deformation | Illite |
| 798 | v(OH) stretching | Amorphous Silica / Quartz |
| 791 | M-OH stretching | Kaolinite |
| 788 | v(OH) stretching | Quartz |
| 754 | Si-O deformation | Kaolinite |
| 754 | (Al-O-Si) inner surface vibration | Illite |
| 697 | v(OH) stretching | Quartz |
| 545 | (Si-O-Al) deformation | Kaolinite |
| 472 | (Si-O-Fe) deformation | Kaolinite |
| 425 | (Si-O-Mg) deformation | Kaolinite |

**Table 5.** FTIR spectrum analysis results of Aksaray-Guzelyurt clay sample (K-2).

| Wavenumber ($cm^{-1}$) | Assignment | Clay mineral type |
|---|---|---|
| 3623 | ν(OH) stretching | Illite |
| 1030 | ν(Si-O) planar stretching | Illite |
| 914 | (Al-Al-OH) deformation | Illite |
| 798 | ν(OH) stretching “splitting” | Amorphous Silica / Quartz |
| 788 | ν(OH) stretching | Quartz |
| 754 | (Al-O-Si) inner surface vibration | Illite |
| 697 | ν(OH) stretching | Quartz |

**Table 6.** FTIR spectrum analysis results of Aksaray-Guzelyurt clay sample (K-1).

| Wavenumber ($cm^{-1}$) | Assignment | Clay mineral type |
|---|---|---|
| 3679 | Inner-surface OH, (Al-O...H) stretching | Kaolinite |
| 3655 | Inner cage OH stretching | Kaolinite |
| 3623 | Inner-layer OH, (Al-O...H) stretching | Kaolinite |
| 3623 | ν(OH) stretching | Illite |
| 1120 | ν(Si-O) normal to the plane stretching | Kaolinit |
| 1030 | ν(Si-O) planar stretching | Kaolinite / Illite |
| 1010 | ν(Si-O) planar stretching | Kaolinite |
| 942 | Inner-surface Al-OH deformation | Kaolinite |
| 914 | Inner-layer Al-OH deformation | Kaolinite |
| 914 | (Al-Al-OH) deformation | Illite |
| 798 | ν(OH) stretching | Amorphous Silica/quartz |
| 791 | M-OH stretching | Kaolinite |
| 788 | ν(OH) stretching | Quartz |
| 754 | Si-O deformation | Kaolinite |
| 754 | (Al-O-Si) inner surface vibration | Illite |
| 697 | ν(OH) stretching | Quartz |
| 545 | (Si-O-Al) deformation | Kaolinite |
| 472 | (Si-O-Fe) deformation | Kaolinite |
| 425 | (Si-O-Mg) deformation | Kaolinite |

At the regional scale, rocks quarried from the close vicinity were used in constructions in the Guzelyurt area. Deterioration of these rocks occur through weathering, erosion and break-down due to atmospheric interactions, water course and activities of organisms. Thus, buildings constructed using such rocks weaken very fast if they don’t get protected from atmospheric, biologic and physical deteriorators. While some stones are very prone to weathering, some others are very resistant and remain unaltered for long times. As a result of weathering, structural properties, chemical composition, physico-mechanical characteristics will change leading to breakdown, disintegration, exfoliation and failing in the rocks (Korkanc, 2007). Since marl and similar clayey-carbonated rocks are commonly used as building stone in the Guzelyurt area, visual exterior failures show high frequency. If marls will be used in foundations, particular attention should be directed to their structures, calcar content and groundwater characteristics of the near vicinity. When marls get in contact with water, due to the water content, they swell leading to significant increase in volume and then to decrease in strength, to fragmentation and total breakdown. Thus, marls should be avoided, particularly in foundations.

Use of clay-containing varieties in building stones will reduce the life of whole construction. Thus before making any final decision in use of natural materials, their usability should be extensively investigated. Weathered rock samples taken from the restoration works carried out in the area were studied for petrographic and mineralogic properties. There is a strong positive correlation with the degree of weathering and clay contents. Building stones are found to be calcar with marl and composed of calcite (90%), quartz (5%) and illite (5%).

Another important point in their use is way of their stacking style. Stones with high mechanical strength and the ones with low mechanical strength should not be use side by side or successively. It is because when the stones with poor characteristics deteriorate, it will affect the one at contact. Besides deteriorations in place of use depending on wind and rain direction and intensity are commonly observed. Aksaray-Guzelyurt building stones have poor and almost constant engineering and color properties and they have been used in constructing not only houses but also mosques, churches, complex of buildings adjacent to a mosques etc., for years in the area. As a matter of fact, they have better decorative properties and potential and should be considered as an alternative material for those commonly used in other regions of the state. Moreover these rocks are also relatively lighter (low density) and softer, thus transportation (light construction material), processing and shaping out them will be less costly.

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