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Research Article

Color Differentiation of Wall Stones: Historic Karatay College Building

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Abstract

People in Anatolia have lived mainly in residential houses constructed by concrete and bricks. There are also historic houses in small towns and villages which were built by using building stones, bricks, adobe and wood in combination. However, in the case of public buildings, dimension stones had been used in Anatolia for the main construction material since early times in history. Similarly, Karatay College, (Karatay Madrasah, "*Karatay Medresesi*") buildings in Konya had been built by using stones, wood and dimension stones in combination in 1251 for educational purposes. It is logical to think that this building have been repaired several times in history. Some of the early historic photographs (dated 1890) of Konya which were taken for general scenery purposes, covered also Karatay College building. These photos present the college's main entrance door and its frontier wall. Dimension stones in this wall were also identified through the earlier photographs and their current digitized surface colors have been defined one by one. Color differentiation among them, together with similar stone types' surface colors observed around Konya city were determined to evaluate weathering influences on this frontier wall stones. Defined surface color changes for analyzed frontier wall stones demonstrated rock weathering due to climate, environments and human influences which should be set to minimum level to protect Karatay college building.

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INTRODUCTION

Education has also been main concern of States in history like today. Therefore, Seljuk Empire governing Middle-East and Anatolia during 1037-1157 established several education centers in their homeland. Konya city located at the centre of the Anatolia had been main residential and governing base in the history. Thus, Seljuk Empire State and its successors Anatolian Seljuk State (1077-1308) in later years had paid enough attention to this city as well. Moreover, Konya had been the capital of the Anatolian Seljuk State until the Ottomans' had become governing body in Anatolia. Therefore, Konya had not been only the capital city, but also trade, culture and education centre for Anatolian Seljuks at those years. Colleges for education purposes had been established in Konya and nearby cities. One of them was "Karatay College" named after "Celaleddin Karatay" who was one of the high degree civil officers after Sultan in Anatolian Seljuk State. Odabası [1] presented information about history of the college together with the meaning of the headers on its monumental entrance door. Karatay College was the school for theological, religious and natural sciences. Karatay College building was located at the centre of Konya and it had been started to build just near the Konya Castle (~125 meters away) in 1251.

Karatay College buildings had been constructed by using different materials like bricks, stones, marbles, woods and dimension stones. In this work, dimension stones which were used to cover outer face of the frontal wall were analyzed for their surface colors. This wall surrounds South-East side of the college building and its current height (October_2018) and length are around 6.75m and 15.50m respectively. Since this wall is also bordering frontier side of Karatay College building, (together with aesthetic preferences to enhance the main college entrance door's features), it was built in mainly flat appearance (without ornaments). Karatay College frontier wall's thickness is around 126cm and it was built by using mortar and stone combination (Fig. 1b). However, dimension stones facing outer part of the wall were selected purposely and they were dimensioned to form flat but monumental appearance (Fig. 1a). Frontal appearance of Karatay College building contains this flat, plane, stone-wall and monumental entrance door together with doomed main hall became visible at the backside of the wall. Dimension stones used to cover the frontier wall have height, width and thickness dimensions around; 40-45cm, 25-75cm and 15-40cm respectively. The rocks selected for the face of the wall were locally supplied building stones; mainly light-brown colored rhyodacite-dacite, grayish-light brown colored andesitic (pyroclastic) tufts and whitish limestone/travertine rocks. Rhyodacite-dacite had mainly been deposited near Sille village [2] and it is approximately 10km away from the Karatay College building in Konya city center. Andesitic tuff rocks can be located at west part of Konya city limits and they are member of the Kucuk Muhsine (KMuhsine) formation. These rocks have widespread outcrops around Kucuk Muhsine village (15 km away from Konya).

Figure 1. Karatay College building photographs; a) Karatay College main entrance and frontal wall, photo, dated Feb.2017, [3], b) Back side of Karatay College frontal wall, dated Feb.2017, [3].

Sille dacites are well known building stone around Konya and they had been used to build several monuments, mosques, houses, bridges in Konya throughout the history. Konya city has several limestone/travertine rock resources as well and Godene travertine resource (18 km away from Konya) is one of them. There are 12 dimension stone layers one over the others at the apparent face of the Karatay College frontier wall. Top layers of the wall were especially built in a way that magmatic/volcanic rocks (andesitic tuffs / rhyodacite-dacite) and limestone / travertine building stone layers were placed simultaneously. This wall was built (or repaired) in a way that limestone/travertine building stones might have purposely used to obtain the top layer of the wall (Fig. 1a and 1b). General conditions of Karatay College building and its frontier stone wall were also evaluated here through the historical photographs and related literatures. It is obvious that this frontier wall is original part of Karatay College building and probably it hasn't been repaired in macro scale since 1890. Yilmaz & Ulusoy [4] wrote about the architectural features of Karatay College building and they mentioned a few totally ruined inner room walls and demolished outside walls at South-East part of the building according to officially archived documentation. According to Yilmaz & Ulusoy, first repair work was performed in 1609 (there is no recorded data for pre-1609 periods), they also reported several other repair works which were performed in 1935, 1952, 1953 and 1957, [5, 6, 7, 8]. Karatay College building was repaired over again a few times by *"General Directorate of Foundations"* of Turkey at 1988, 1993, 2008, 2015, and 2018 (last restoration work has still continued in December 2018). Dimensioned face stones on this frontier wall were analyzed for their surface colors differentiations. Different shades of colors can be identified on the surfaces of the stones by even with naked eyes (Fig. 1a) which might have been resulted due to weathering of rock materials in various environmental factors.

MATERIAL AND METHOD

There are monumental historic buildings in Konya and most of them have still been used for public purposes as; governor building, hotels, mosques or museum buildings. There are rare historic private houses which were built by using dimension stones in Konya. Most of the people had lived in one or two storey houses which were built by using brick, adobe, stone and wooden materials in Konya until 1950s'. Since then concrete has been started to be used for much more modern houses and apartments. Due to limited number of dimension stone resources, trade of these stones and its tradition in private house construction have not common in Konya like in Kayseri, Gaziantep and Mardin cities in Turkey.

Dimension stone potentials around Konya city

There are several rock masses available to produce building and dimension stones around Konya but, they are around 10-25km away from the city centre. These distances might have been far enough for ordinary people to compensate their supply costs. Another reason might have been physical and mechanical features of stone resources. There are limestone and travertine sources around Konya but it was difficult to produce dimension stones because of their strength and (building stone block) chipping, shaping, properties. When the building stone productions steps are considered (quarrying, excavation, dimensioning, shaping and transportation) for historical quarry conditions, mining operations should be considered especially for those years, human and horse powers were the only option to handle the building stones. Therefore, stone workers had preferred the rock types which had lightweight and good chipping features. That's may be the reason, why these workers had preferred rhyodacite-dacite and andesitic tuff stones to built most of the historical public buildings in Konya. Because it is valuable asset, dacitic and andesitic rock resources near Sille village have been studied by several researchers. Saydam [2] had studied on mechanical, mineralogical, geochemical and puzzolanic properties of Sille stone and he wrote that Sille stones are part of *Sulutas volcanites* in the region. Erturk [9] pointed also that Goger & Kiral [10] called this rock type as *Sulutas andesite unit* in *Dilekci rock formation*. Eren studied [11] structural geology around Sille village. He called this rock unit as *Sulutas volcanites*, and he pointed their age as *Late-Miocene and Early-Pliocene*. This unit consists of calcaleno-dacites, dacites, rhyodacites, rhyolites, andesites and minor amount of basaltic rocks [11]. Saydam [2] worked also on chemical compositions of the Sille stones and he plotted related data on diagram offered by Winchester & Floyd [12] to define the rock types (Fig. 2). He wrote that one of his samples (obtained from KMuhsine formation) was defined as *andesitic tuff*. The other tuff samples from the same rock formations were defined as rhyodacitic-dacitic tuffs.

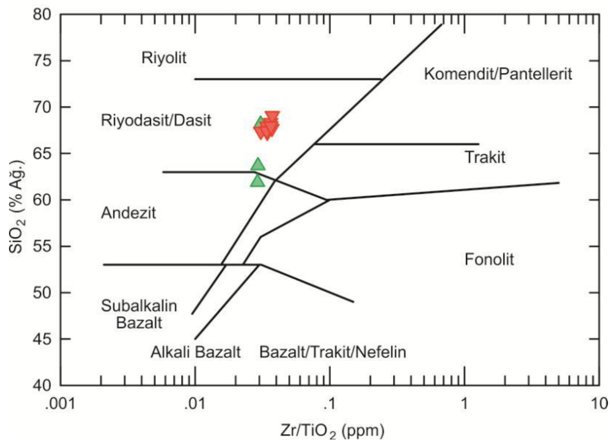

Figure 2. Classification of rocks according to SiO_2 - Zr/TiO_2 composition on Winchester & Floyd [12] diagram; Green triangles: Tuff samples from KMuhsine formation, Red triangles: Lava rocks from Sulutas volcanites, [2].

Saydam defined his samples obtained from *Sulutas formation (lava rocks)* as *rhyodacite-dacite* by using the graph given in Fig. 2. Besides geological background of Sille stones (mainly Sulutas volcanics), certain mechanical properties of this rock have also been studied by other researchers [13, 14, 15] to understand Sulutas volcanites' building stone behaviors and characteristics. Fener & Ince [15] named their test samples obtained from Sulutas volcanites (Sille stone quarry) as *quartz-andesite*. They tested these building stones for freeze-thaw characteristics. They wrote that freeze-thaw cycles influenced *quartz-andesite* stone samples' physico-mechanical properties. Kansun [16] worked also on Sille stones and he noted that, quartz-andesitic and rhyodacitic-dacitic rocks are very similar to each others and they can transitionally be observed in Sulutas rock formation at Sille quarry. Andesitic rocks especially andesitic tuffs as a member of KMuhsine formation give outcrops widely enough around Kucuk Muhsine village near Konya. As Ozkan [17], wrote that, KMuhsine rock formation consist of beige, creamy and pink colored volcanic breccias, tuffitic rocks, tuffs and agglomerates. Ince [18] pointed that andesitic tuffs around Konya have also been used for building purposes together with Sille stones throughout the historical times.

Building stones have been selected (preferred) by experiences after observing their long-term durability properties. However it is obvious that; porosity, permeability, density, hardness, toughness, trimming, weathering, decomposition, mechanical strength values, elastic modulus, heat isolation characteristics of building stones are mainly very important on their usage as a building stones. These properties are influenced by freeze-thaw cycles occurred in winter times. Wedekind etal.'s [19] works can be given here as an example to define building stones' long-term durability. They tested 14 different rocks to define their suitability for building stones category. They concluded (similar to common observations) that; "*moisture expansion in natural building stones is considered one of the most important factors affecting their weathering and deterioration*". They stressed also on the importance of swellable clay mineral ratio in building stone compositions. They said that clay minerals were main reasons of building stones weathering. However, they showed also that moisture expansion could also be taken place in "*volcanic tuffs stones almost free from clay minerals*". At this point the work performed by Jamshidi etal. [20] is required to be mentioned. They tested 14 different building stones for their long-term stability against freeze-thaw action by a decay function model supplied by Mutluturk etal., [21]. In this model, test samples' mechanical properties (density, porosity, water absorption, Brazilian tensile strength, and point load index values) were first determined. Then 30 cycles of freeze-thaw were performed. After every 5 cycles, Brazilian tensile strength and point load index values of the test samples were determined. They said that freeze-thaw action influenced all the tested building stones and these tests revealed that the longest half-life ($N_{1/2}$) values were obtained for Dacite, Amphibolite and Granite-II samples (Fig. 3). Another conclusion they supplied that *"half-life has no meaningful pattern based on the rock type*". For example; they obtained different half-life values for "Granite" samples; Granite-I and Granite-II.

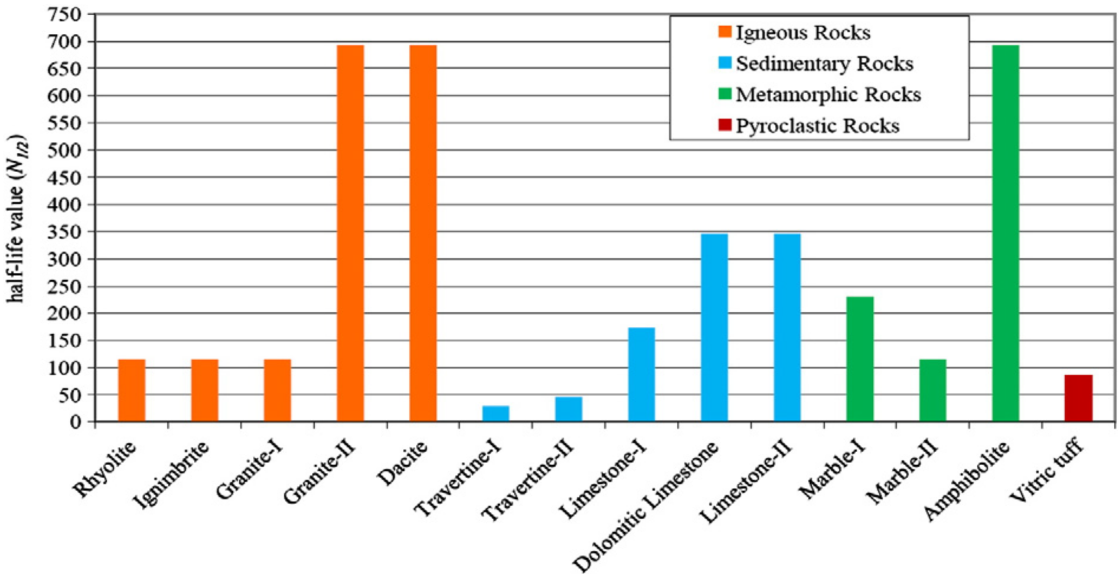

Figure 3. The half-life values of Brazilian tensile strength (for 14 different building stones). The half-life ($N_{1/2}$), of the tested rocks is defined as the number of cycles required to reduce Brazilian tensile strength (in this graph) to its half value, [20].

Rock surface colors to define physical surrounding environments

Rock masses have particular colors according to their mineral contents. Some colors can be differentiable by naked human eyes, but 255x255x255=16,581,375 different rock surface color tones in Red-Green-Blue (RGB) format could definitely be separated by digital manner [22]. Original fresh rock surface colors can then be digitized to use in engineering purposes. If colors of the rock surfaces are important in certain projects, companies are advised to describe colors not only by human eye descriptions, but also by means of digitized RGB color codes. When the rock surface have started to exposed sunshine and climate effects, like at the outcrops, their colors changed in time due to weathering effects. In nature, original rock mass colors have been changed in mainly two manners. First one is occurred during chemical weathering of rocks. In this case, chemical compositions of original rock masses are differentiated during weathering processes. Second type of rock surface color changing is happened due to surface dying of main rock masses by colorful intrusions through discontinuities (i.e. external sources of dying material; colorful gasses, cohesive liquids and dusts etc). When colors of building stones have been changed at historical monuments, there may be combined effects of them. Colors of building stones at historic houses, mosques, churches, bridges, college buildings, status etc. have gradually changed due to chemical reactions or surface covering/dying effects of climate. Building stone's surface colors can also be differentiated by the traces of colored liquid (groundwater, contaminated rain water or industrial/residential/commercial waste waters etc.) run over them. Building stone's surface colors are also definitely influenced by sequential growth of micro organism on them (biological influences).

Chemical compositions which influence visible lights returning from building stone's surfaces determine the final surface colors of them. Weathered rock surface colors on the other hand include slow rate of weathering progresses in general. Thus, weathering rock surfaces have colors which gradually differentiating in time. Surface dying (light and dark), surface acidic or basic chemical reactions through discontinuity surfaces, rock surface decaying/weathering, rocks' total weathering as a whole mass have changed the rock and rock surface appearances. These changes might be occurred only on rock surface colors or surface color changes may be occurred together with rocks' (inside as well) color changes. Color is very sensitive physical differentiation property; therefore even slight surface dying (or slight chemical reaction) is realized on rock surfaces, this new conditions produce new rock surface appearances. These slight color changes might not be sensible by human eyes but, image analyses methods in color detection systems lead to determine these differences in digital manner [22, 23, 24, 25, 26, 27]. Rock surfaces at outcrops or rock masses interrupted by different discontinuity sets have influenced by climate and groundwater factors and their colors are differentiated. These changes for certain rock mass samples have been determined in digital manner (RGB color values) in detail and filed as computer image captured data. Gokay [28, 29] coded fresh (just broken) and weathered rock surfaces to comprehend color changes due to rock weathering. Pixels' RGB values obtained from different rock surfaces were plotted to obtain general color changing behavior of the tested rocks (Fig. 4). In nature, rock surfaces and the rocks' inner layers next to the rock surfaces have usually different colors. To describe color differentiation due to weathering, riverbank rocks' weathered surfaces can be counted here as an example. In order to express weathering actions on these rock surfaces followings are the adjectives which are used; rusty, wet, greenish, brownish and brown covered by dark green algae, dark black mud covered limestone, etc. When the usage of natural stone under consideration for human civilization; houses, bridges, cottages, mosques, churches, castle and monuments should be analyzed for their dimension stones' color characteristics as well.

If there are written documents for these building stones, mining sites (or mining sites can be resolve by evaluations), their appearances can be compared with respect to original fresh rock surface colors. Weathering of rocks has been continuous progress and it can be observed at natural rock masses located in underground or surfaces. Weathering is also natural fact for dimension stones used for buildings. There are always influencing factors which disturb the dimension stones' integrity and surfaces. However, natural stone usages (for pavements, house & garden walls, monuments, mosques, museums, churches etc.) have increased as the cities have gradually been expanded in time. Thus, it is

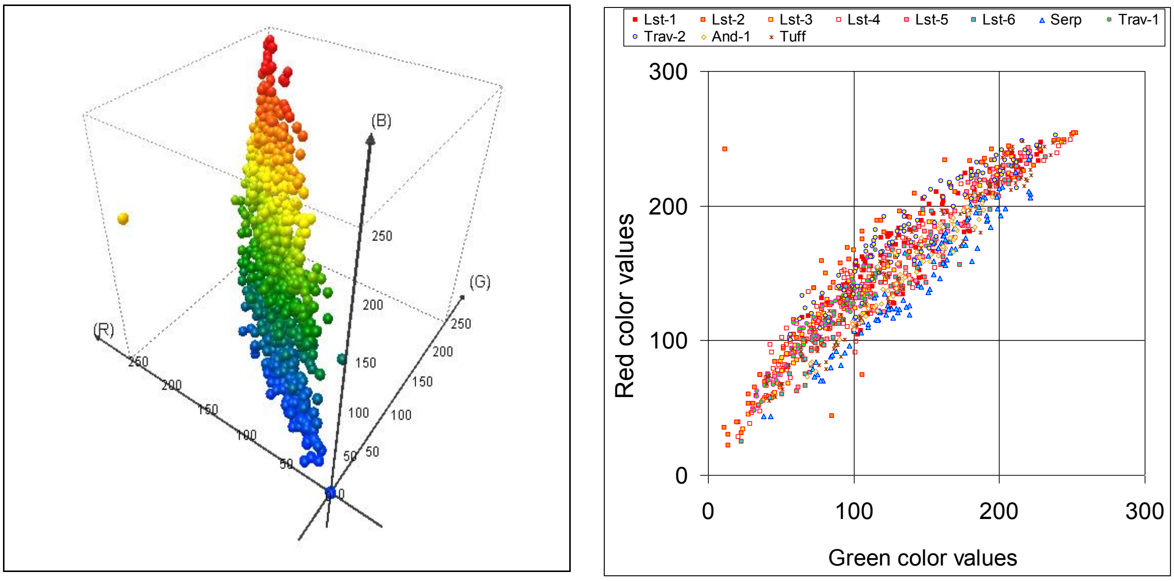

Figure 4. Selected 3D and 2D color-band graphics for selected rock surface colors (digitized in RGB data) obtained for fresh and weathered rock masses around Konya-Turkey region; *[Limestone formations (**Lst-1**: Konya-Yukselen road cut, **Lst-2**: North-west side, Konya, **Lst-3**: Cement factory quarry, Konya, **Lst-4**: Limestone aggregate quarry, Konya, **Lst-5**: Landslide area, Taskent-Konya, **Lst-6**: Hydraulic dam construction area, Ermenek-Karaman), **Serp**: Serpentine rock mass outcrops, Dere village, Meram-Konya, **Trav-1**: Travertine mine, Ardicli-Konya, **Trav-2**: Abandoned travertine mine, Esentepe-Konya, **And-1:** Andesite quarry, Sandikli–Afyon, **Tuff:** Crystalline tuff mine, Evliyatepe, Konya]*, [29].

better to have control manner for dimension stone businesses (especially in historical building restoration projects) to have required knowledge of rock related chemistry and rock mechanics. In this study; importance of rock surface colors has been explained. Then, beside the mechanical, chemical and related physical properties of dimension stones, their surface colors are advised to be determined to understand any color changes which have been taken places (Fig. 5). If colors of dimension stones used for walls have changed due to acidic environments, these changes might also be the sign of rock or rock surface decomposition. Therefore after recognizing color changes, in some limits, on surfaces of building stones, other physical, chemical and mechanical etc. tests should be followed to reach final

Figure 5. Digitized photograph of Karatay College frontal wall [3]. Dimension stones were numbered according to their positions over the main road (pedestrian, pavement) level.

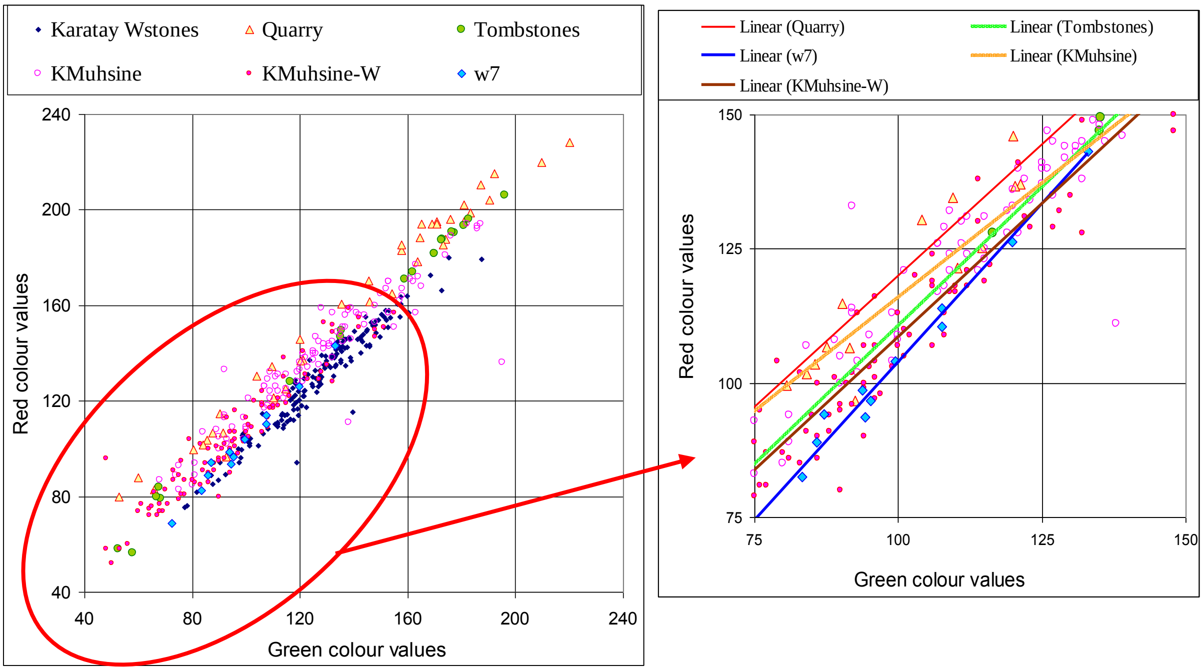

Figure 6. Green–Red digital color codes of selected Sille stones' and KMuhsine tuffs' surfaces colors *(together with representative linear lines to compare their positions);* **Karatay Wstones**: Karatay wallstone surface colors, **Quarry:** Sille stone surface colors at the quarry (fresh rock surfaces), **Tombstones:** Rhyodacitic-dacitic tombstones in Sille cemetery (200-400 years of weathering), **w7:** Rhyodacitic-dacitic stones used at Karatay College frontal wall's 7th layers (more than 128 years of weathering). **KMuhsine**: Surface colors of andesitic tuffs in KMuhsine formation, **KMuhsine-W:** Surface colors of weathered andesitic tuffs around Kucuk Muhsine village.

decisions if the stones should be replaced or not. In this research Sille stones, (rhyodacitic-dacitic lava rocks in Sulutas formation) and andesitic tuffs (KMuhsine formation) were analyzed for their surface color changes. After obtaining each building stone's surface colors, their differences were evaluated through Green-Red and Blue-Red color band graphics (Fig. 6 and 7) as it was performed for weathered rocks before (Fig. 4). In addition, recognized rhyodacitic-dacitic stones used as tombstones in Sille-Konya were then photographed together with these rocks' mining sites at Sille stone quarry. Thus, the data sets for rhyodacitic-dacitic lava rocks' surface colors were formed for further color analyses to recognize their color differences. Surface colors of weathered rhyodacitic-dacitic rocks in this data set were obtained from; Karatay College frontal wall, historic Sille cemetery tombstones. Fresh rhyodacitic-dacitic rock surface colors were also digitized through the photographs of related locations at Sille stone quarry site. Similar data set were prepared for andesitic tuffs and weathered surface of them. Surface colors obtained from rhyodacitic-dacitic Sille stones and andesitic tuffs were plotted in Fig. 6 and 7 to understand if there is any pattern for logical reasoning and conclusions. In these graphs, colors of Karatay College frontier wall's face stones can be differentiated without difficulty from the other test samples. They have in general lower Red color values and higher Green and Blue color values. Especially face stones of 7th layers of this wall have illustrated more darkened colors (Fig. 5) which were distinguished through the color graphics given in Fig.6 and 7. Curves defining color data obtained from face stones of Karatay College frontier wall's 7th layers stones have:

$$y=(1.1776)x+13.859\ (R^2=0.9835),\ y=(1.4127)z+29.595\ (R^2=0.9516) \text{ linear relation.}$$

Similar color relations for rhyodacitic-dacitic quarry stone surfaces have:

$$y=(0.9788)x+22.118\ (R^2=0.9796),\ y=(0.9293)z+47.295\ (R^2=0.8566)$$

similar linear color relation of rhyodacitic-dacitic tombstone surfaces at Sille cemetery have:

$y=(1.0366)x+6.7428$ ($R^2=0.9956$), $y=(1.0758)z+17.388$ ($R^2=0.9835$)

similar linear color relation of andesitic tuffs and weathered andesitic tuffs surfaces observed around Kucuk Muhsine village simultaneously have:

$y=(0.8541)x+30.332$ ($R^2=0.8656$), $y=(0.7148)z+63.564$ ($R^2=0.7519$)

$y=(0.992)x+9.3924$ ($R^2=0.9405$), $y=(0.8642)z+31.099$ ($R^2=0.7857$)

In these equalities, y, x and z variables are representing x: Red, y: Green and z: Blue color codes in RGB color system.

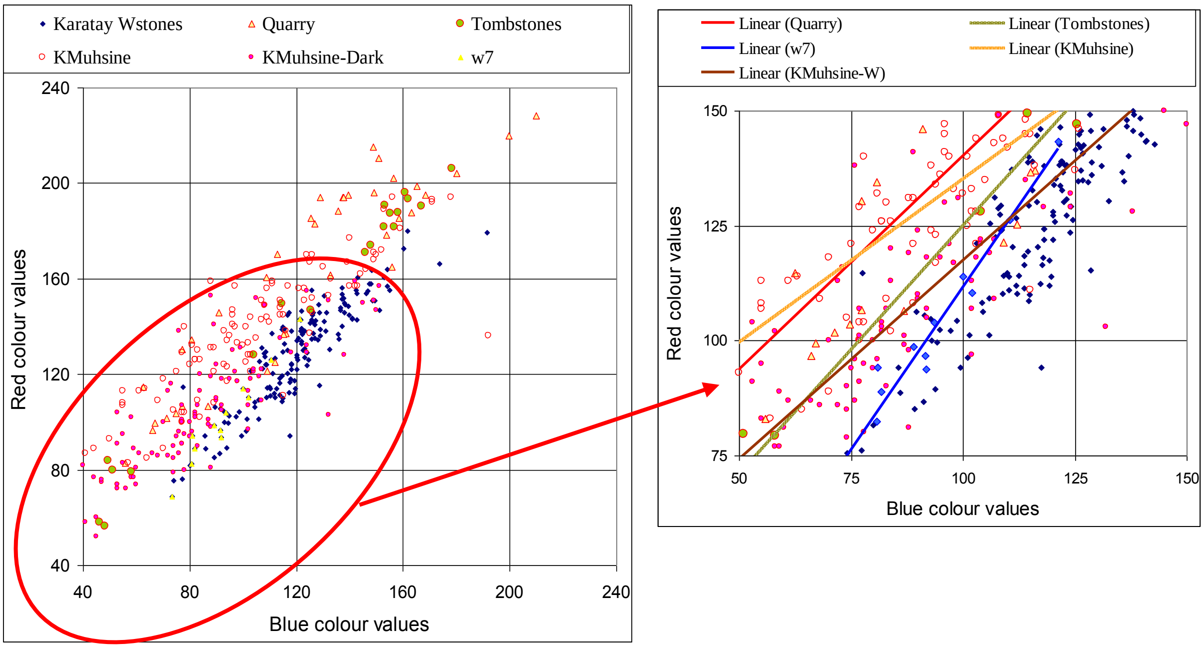

Figure 7. Blue–Red digital color codes of selected Sille stones' and KMuhsine tuffs' surfaces colors *(together with representative linear lines)*; **Karatay Wstones**: Karatay wallstone surface colors, **Quarry:** Sille stone surface colors at the quarry (fresh rock surfaces), **Tombstones:** Rhyodacitic-dacitic tombstones in Sille cemetery, **Sille-Wstones:** rhyodacitic-dacitic Sille stones used at the walls of Sille village historical houses, **w7:** rhyodacitic dacitic stones used at Karatay College frontal wall's 7th layers. **KMuhsine**: Surface colors of andesitic tuffs in KMuhsine formation, **KMuhsine-W:** Surface colors of weathered andesitic tuffs around Kucuk Muhsine village.

RESULT AND DISCUSSION

Surface colors (RGB values) of dimensioned building stone used for Karatay College building frontier wall's outer face had been determined one by one through the digitized photograph shown in Fig. 5. The differences in RGB colors among face stones of the wall and other rhyodacitic-dacitic and andesitic tuff stones surfaces photographed for this research can easily be detectable in Fig. 6 and 7. Karatay College wall stones have been influenced by weather conditions similar to Konya city centre. These face stones were situated in vertical plane and thin concrete protection (8 cm thick) layer at the top of the wall was molded at earlier repair works. Therefore, building stones of this wall have rarely been affected by direct snowing and raining. However, indirect influences on the wall have possibly been occurred for years. In addition, foundation of this wall might have been bothered by groundwater (capillary effects). Beside of these features, the wall stones have been dreadfully influenced by heavy city traffic vibrations, exhaust fumes and particles. One of the busy city roads in Konya is just located after 3 meters of pavement (Fig. 1a). This fact has been one of the main disturbing factors on surface colors of the wall. In addition, Karatay College rooms at the back of the analyzed frontier wall were diminished in history [4]. Therefore, any permanent/temporary room facilities had been located there have roof structures intersecting the backside of analyzed frontier wall (Fig. 1b). These roof facilities might have been effective on extra moisture (water seepage) inside the Karatay College frontier wall. This wall has 3 small gaps of embrasure at 7th layer as well. Since, moisture content in each dimension stones at this wall seems slightly different, absorption, adsorption and adhesion characteristics of them have been expected dissimilar. When surface colors of stone layers at Karatay College frontier wall were plotted, the graph given in Fig. 8 was obtained. The color differences in these layers produced different slope ratios for their linear curves. Almost all of the slope ratios are analogous to each other (most of the curves were determined almost parallel to each others) except the one obtained from 7th layer. The curve obtained at Upper-Left corner *(higher Red codes - lower Blue codes)* in this graph is the one representing *rhyodacitic-dacitic quarry stone* surfaces (Fig. 8). That means this curve was plotted by using the data obtained from fresh surface colors of rhyodacitic-dacitic stones in Sille stone quarry. The other layers' curves are listed according to their distance to this quarry curve as follows (nearest first); w8, w4, w5, w6, w9, w12, w3, w10, w11, w2, w1. Besides these curves, 7th layer's curve in Fig.8 presents different situation, this curve is crossing the other curves because it has higher slope angle. Karatay College frontier wall's 7th layer's stones were showed comparably darker (weathered stones) surface color shades. They had also normal levels of surface color values which were nearer to quarry stone surface colors as well. In the supplied list above, underlined layers (w8, w12, w10 and w1) have limestone/travertine type building stones, the others (w4, w5, w6, w9, w3, w11, and w2) have rhyodacitic-dacitic/andesitic-tuffs building stones. These layers are given in here, in ordered lists, which present degree of weathering; from less affected to highly affected, weathered, ones. According to the list; rhyodacitic-dacitic/andesitic-tuffs stones showed worst weathering color differences for w2 layer. After w2 layer, w11 layer was determined second worst weathered layer for the same stone types. At this wall, w11, is highest layer built by using rhyodacitic-dacitic/andesitic-tuffs stones.

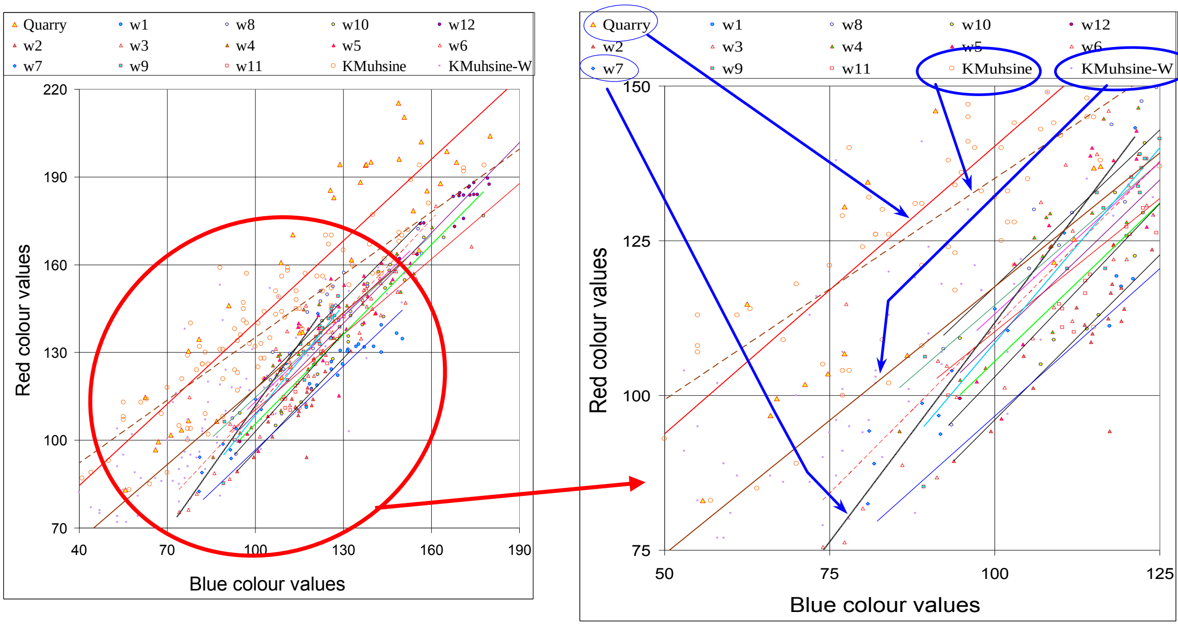

Figure 8. Blue–Red digital color codes of selected Sille stones' and KMuhsine tuffs' surfaces colors *(together with representative linear lines)*; **Karatay Wstones layers:** w1, w2, w3, w4, w5, w6, w7, w8, w9, w10,w11, w12, **Quarry:** Sille stone surface colors at the quarry (fresh rock surfaces), **KMuhsine**: Surface colors of andesitic tuffs in KMuhsine formation, **KMuhsine-W:** Surface colors of weathered andesitic tuffs around Kucuk Muhsine village.

CONCLUSION

Experience in house and monumental building constructions in history turn out different manners to build them. Building stones usage was one of the methods which stones carry the building loads. Rhyodacitic-dacitic Sille stones and andesitic tuffs have mined around Konya for building stone purposes. These rocks have been used for houses, mosques, tombstones, bridges and college buildings in history. Sille stone's handling and practical shaping features have made it convenient building stone. Rhyodacitic-dacitic Sille stones used as tombstones are also the indications that Sille stone's long time durability had been experienced in history as well. Similarly, Jamshidi etal. [20] stated that their dacitic test samples presented higher valued half-year (longer durability) strength features with respect to many other building stones. In different locations, digitized surface colors of rhyodacitic-dacitic and andesitic tuffs stones were determined in this study to compare their color differences. Color differentiations on these rock surfaces are given in Fig. 6, 7 and 8 to illustrate color differences between the test samples. Surface color analyses showed that climatic weathering has gradually differentiated rocks surface colors. It was determined that rock surface color changes were higher for some of the Karatay College frontier wall's outer face stones with respect to tombstones located in Sille-Konya. It is necessary to point here that if there are micro organisms living on/in historical tombstones and historical wall stones, they have changed appearance of the building stones and tombstones totally. These kinds of biological weathering effects are sometimes combined with air pollution of cities (together with traffic fumes) to form darkened surface colors of building stones. It was concluded that Karatay College frontier wall's face stones have been affected from fumes, dust and chemical exhaust particles (air pollution) originated from vehicles and residential houses around. Digitized rock surfaces' colors pointed these color changes (weathering effects, Fig. 8) for different rock surfaces at different location. It was evaluated that moisture content and air pollution are considerably influencing surface colors of building stones in cities.

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