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Some Geological Features of Limestone Aggregates Produced from Central Anatolian Carbonate Formations

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ABSTRACT

For the last fifteen years, there has been extensive motorway and railway constructions in Turkey. This requires enormous amount of road-fillers and aggregates, and the construction companies open many open-pit limestone quarries to fulfill their aggregate needs. The partly double (four lines), partly one-way (double line) motorway of Konya-Hüyük have recently been enlarged and partly re-constructed. During this construction, a total of five limestone quarry were opened to produce limestone aggregate. The Bozlutepe Limestone member of Asmalıtepe Formation near the town of Selki (Hüyük-Konya, central Anatolia) were used for this demand, and it has been operated for the last 6 years. The limestone member is approximately 200 m thick at most and mostly made of three type of minerals and these are dolomitic limestone, crystalline limestone and quartz-bearing crystallized limestones. All the minerals are crystallized and the minerals locally dominate at the quarry. The produced aggregates have relatively flat granulometry curve indicating most of the grains are of thin and have clay-silt sized particles. Our studies revealed that Bozlutepe Limestones are formed in carbonate facies in shallow marine environments during Permian-Carboniferous times. The member most likely have low-grade metamorphism during Paleozoic and Mesozoic eras.

Keywords:
Limestone aggregates, Bozlutepe Limestones, Granulometry curves, Konya, Turkey

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INTRODUCTION

The limestones are the most important rock groups as a source of aggregates since these rocks can easily found at most places (10 % -by volume- of the sedimentary rocks are of carbonates). These rocks have a variety of uses. The most important uses are in the cement industry, road construction, the building blocks and lime manufacturing industry. The silica ratio of the cement is strongly depend on the silica contents of the limestone used as aggregates [1]. On the other hand Alhozaimy [2] stated that the water absorption capacity of limestone aggregates strictly controls the cement resistance. The grain size of limestone aggregates used in cement also controls the development of cracks system in the produced cement [3]. The biggest drawback in the use of limestone as aggregate for all purposes is the weakness against acid, especially sulfuric acid which widely available in the nature [4].

The main aim of this study is to reveal that some mineralogical, petrographic and physical features of Bozlutepe limestones which were used for local aggregates need at Yazı Places of Selki, Hüyük, Konya.

GENERAL GEOLOGY

The study area is geographically located at the southeastern tip of Sultan Dağları Mountains which geologically comprise a variety of rock units of mainly metamorphic. These rock units essentially are schists, quartzites and metamorphosed carbonates. The alluviums and rock talus are widespread in intermountain valleys and depression areas, for example east of Lake Beyşehir region and Akşehir-Eber area.

Easy crack-down of the limestones is the result of weak bond values between Ca-O-C even in the metamorphic limestones. The Bozlutepe Limestones are

highly fragmented and have irregularly scattered fracture and joint systems. The unit is first described by Zedef [5] and interpreted as a member of Asmalıtepe Formation.

The Bozlutepe Limestone Member is geographically found at approximately 80 km west of Konya (Figure 1).

Figure 1. The location map of the study area.

BOZLUTEPE LIMESTONE MEMBER

Asmalı Tepe Formation covers quite large areas in the northern part of Selki (Hüyük, Konya) (formerly Selki Kasabası-Köyü) (Figure 2).

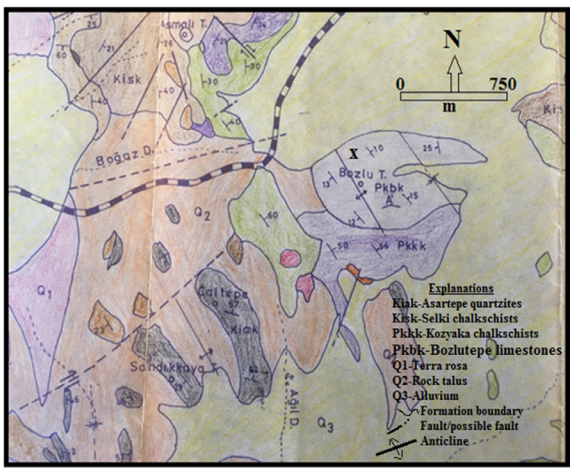

Figure 2. Geological map of the study area [5]. The Bozlutepe Limestones are shown with a light blue color on the Bozlu Tepe with the sign of Pkbk

Zedef [5] stated that the limestones composed mainly of recrystallized limestones are with 95% calcite and 5% quartz. The investigations were further elaborated and new mineralogical and petrographic findings were obtained as a result of resent observations and more representative sample compilation in open quarry for aggregate. These findings will be detailed in the following section.

At a macro-scale, the Bozlutepe Limestones are light gray, whitish and dark gray-black in places where recrystallization is severe (Figure 3). The limestones cover an area of about 1 km2 in the area. The member is intercalated with fine calcschist layers which are not locally persistent, but these are not very common. The thickness of the limestone layers (ranging from the metamorphism to the extent that the partially protected borders can be observed) generally ranges from 10 to 40 cm.

The thickness of Bozlutepe Limestone Member is determined as 150-200 m. The unit is concordant with both the Kozyaka Chalkschist member under it and the Ortaburun Limestone Member above it. The stratigraphic location of the unit is shown in detail in Figure 4.

No fossils were found that during the investigations, but [5] gave Permo-Carbonifer age to the member considering the stratigraphic position of the unit. Detailed information about the Bozlutepe limestones can be found in [5]

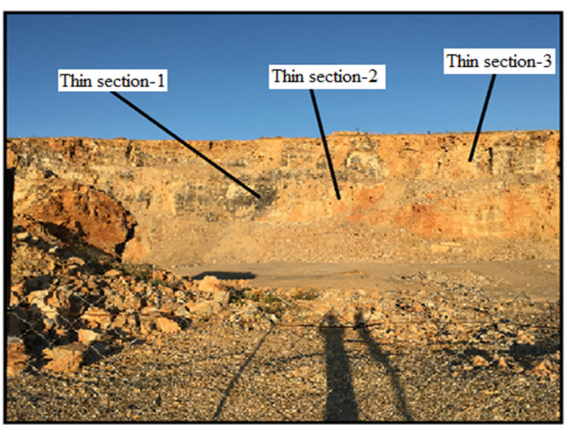

Figure 3. Open pit for the aggregate plant in Bozlutepe Limestone. Note: The locations where thin sections for petrographic-mineralogical examinations are taken are also marked. The place of this figure is indicated in Figure 2 as the point x (Just close to North of Bozlu T).

(together with the meanings of the symbols and signs used in the geological map and stratigraphic section).

MINERALOGY AND PETROGRAPHY

The Bozlutepe limestones were investigated in detail under a polarizing microscope and the following findings were obtained. The sample locations where the thin sections examined are shown in Figure-3.

Thin section-1

The rock is fine grained. Large crystals are observed in places. The rock is composed of carbonate crystals (Fig. 5-a) and locally observed stilolites. The result of the alizarin test, which was applied to the rocks, show that the rock have ~ 85% calcite and ~ 15% dolomite (Figure 5-b). The calcites in the rock are in the form of very high anhedral crystals. Dolomites are again very high double-crusted and semi-spherical and euhedral (usually romboeder) crystals (Figure 5-b).

There are some brecciation (as broken structure) in the rock and it has abundant veins. These veins contain secondary calcite and quartz crystals. Considering the mineralogical composition, the rock is called "dolomitic limestone". The rock has mostly lost its original texture. On the other hand, very few of the rocks retained their original texture properties like micritic levels. According to these properties, the rock is primarily micritic limestone. The rock was deposited in a very shallow marine environment.

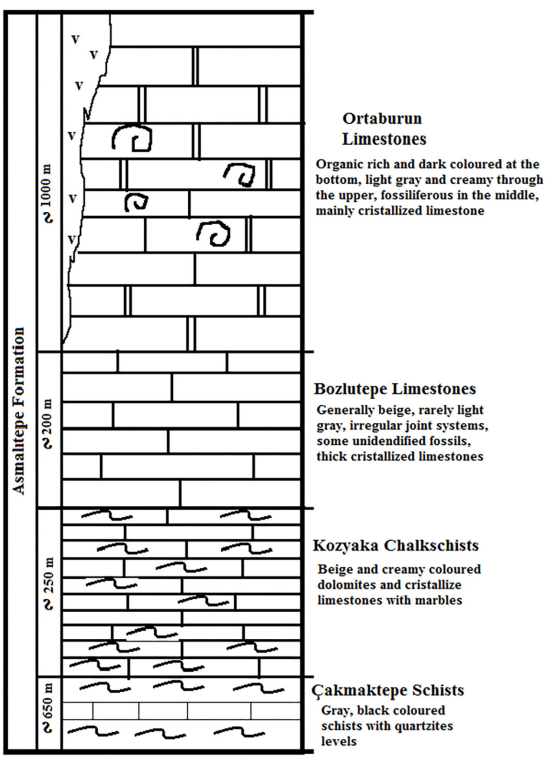

Figure 4. Stratigraphic column section of Bozlutepe Limestone [5]. For details, please see Figure 2-explanations [5]

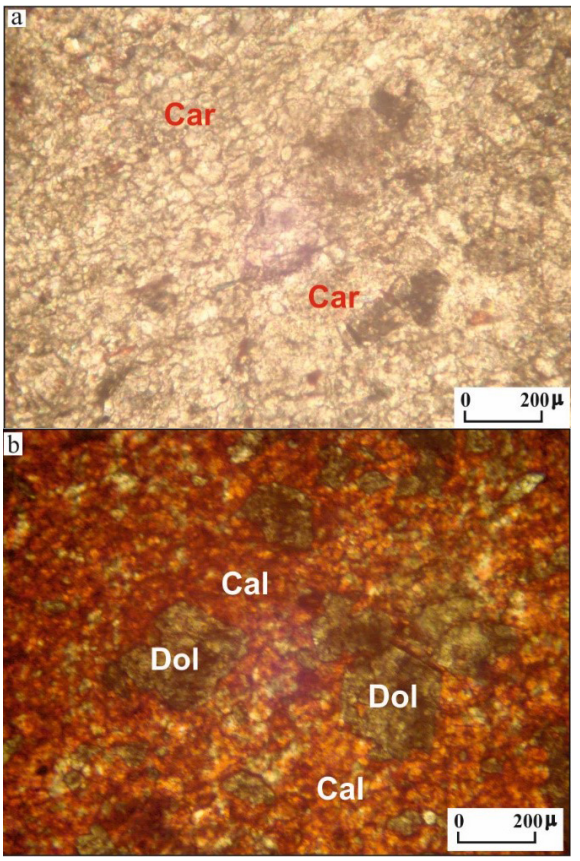

Figure 5. Thin section photograph of Bozlutepe limestones, (b): Same thin section with alizarin red. Car: Carbonate, Dol: Dolomite, Cal: Calcite (// N).reticulum. (TEM) X 20 000.

Thin section-2

The rock is medium granular. According to the modal analysis result, it is composed of ~ 98% carbonate and ~ 2% quartz crystals (Figure 6-a). The result of the test of the alizarin red reveal that the entire carbonates are in the form of calcite (Fig. 6-b). Calcite is anhedral and has very high double-refraction. In the rock, coarse-grained secondary calcite crystals are observed in the form of void fill (patch) in small quantities. Considering the mineralogical composition, the rock is called "crystallized limestone". The rock has completely lost its original texture. The rock was deposited in shallow marine conditions in a relatively deep shelf environment.

Thin section-3

The rock is fine grained and the modal analysis result shows that the rock have ~ 99% carbonate and ~ 1% quartz crystals (Figure 7-a). It is seen that ~ 97% of the carbonate minerals in the rock are calcite and ~ 2% dolomite (Figure 7-b). Of these carbonate minerals with very high double-refraction, calcite is characterized

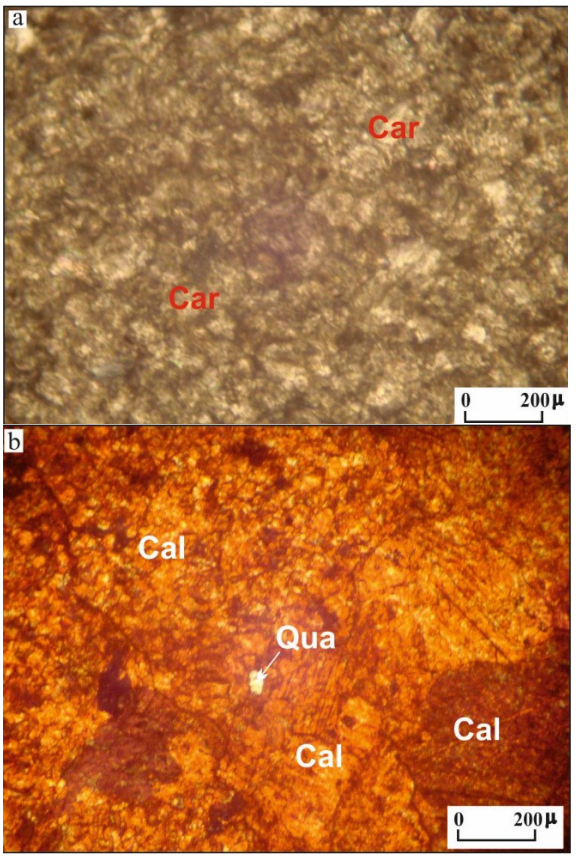

Figure 6.(a): Microphoto of Bozlutepe limestones, (b): Alizarin-red test applied to the same rock. Car: Carbonate, Qua: Quartz, Cal: Calcite (// N).

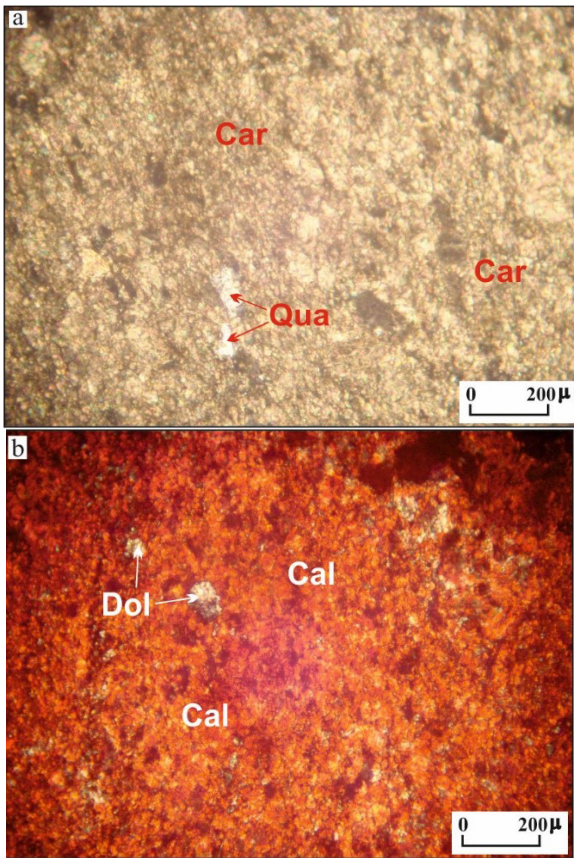

Figure 7.(a): Thin section photograph of Bozlutepe limestones, (b): Same thin section with alizarin red. Car: Carbonate, Dol: Dolomite, Cal: Calcite (// N).

by anhedral crystals and dolomite is characterized by semispherical-euhedral (romboeder-shaped) crystals. Considering the mineralogical composition, the rock is called "crystallized limestone".

The rock has completely lost its original texture. The rock was deposited in a shallow marine conditions which somewhat deeper shelf environment than the rocks of thin-section 1.

AGGREGATE FEATURES

Table 1. The particle size distribution of the aggregates of Bozlutepe Limestones.

Range of sieve diameter (mm)	*Passing (gr)*	*Passing (%)*	*Passing cumulated (%)*
25-14	*542.84*	*7.15*	*100*
14-10	*782.38*	*10.30*	*92.85*
10-7	*710.273*	*9.35*	*82.55*
7-4.75	*464.42*	*6.12*	*73.2*
4.75-1.7	*2382.17*	*31.37*	*67.08*
1.7-0	*2710.80*	*35.71*	*35.71*
	Total 7592.97	*Total 100*	

The granulometry values of approximately 7.5 kg sample collected from various places of the aggregate stock in the open-pit quarry of Bozlutepe Limestones are shown in Table 1.

From the Table 1, it can be revealed that the most of the grain of the aggregates are smaller than the 4.75 mm. Approximately 67 % of the grains are within the range 0 to 4.75 mm. The granulometry curve of the aggregates is shown in Figure 8. The curve is relatively flat when compared to ideal

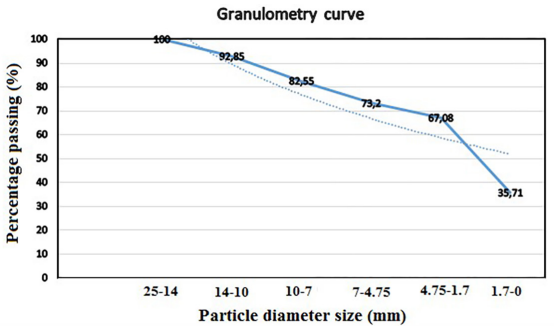

Figure 8. The granulometry curve of the aggregates of Bozlutepe Limestones.

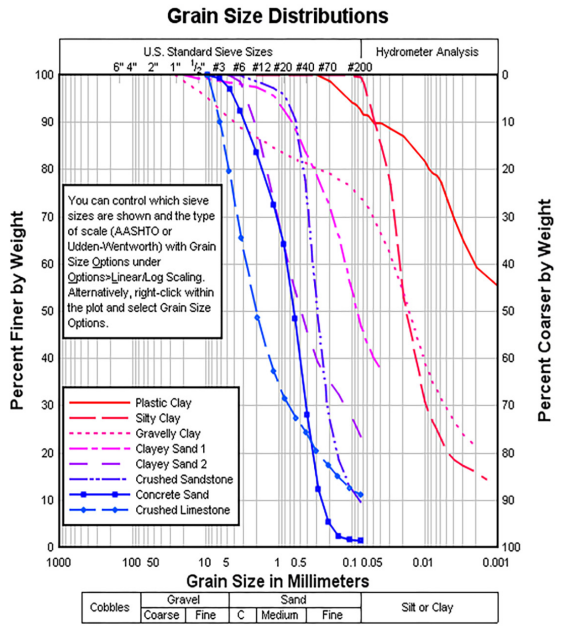

Figure 9. The U.S. standard sieve sizes and typical granulometry curves of various detrital [6].

granulometry curves of the aggregates used by cement industry. Despite these, there has been no negative feed-back from the local consumer of the aggregates.

The American classification of grain size related to granulometry curve of variety of detrital is shown in Figure 9. Our grain size distribution is in the range of crushed limestone area.

RESULTS AND RECOMMENDATIONS

The Bozlutepe Limestone Member is a unit belonging to Asmalitepe Formation and the rock is mainly represented by recrystallized limestones. The rock has mostly made of calcite and dolomite, and contains quartz mineral in places.

The metamorphism of the rock probably led to a widespread recrystallization, during which most of the primary textures disappeared. The limestones belonging to the member are very suitable to be evaluated as aggregate with abundant fractured, cracked and perfectly developed joint sets. The main disadvantages are that the reserves are very small (about 1 km2 area and 150-200 m thickness).

The aggregates produced from the Bozlutepe Limestone Member is generally fulfill the local consumer in spite of the differences of typical granulometry curve. For more proper interpretations, all the test should be done with more samples.

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