Funded by the European Union

REPUBLIKA E SHQIPËRISË
MINISTRIA E KULTURËS

UNOPS

EU4CULTURE

TECHNICAL REPORT
KURCAJ BRIDGE

ATELIER 4
ARCHITECTURE • ENGINEERING • CONSULTING

TABLE OF CONTENTS

1. INTRODUCTION

The laboratory "ALTEA & Geostudio 2000", in cooperation with the company "FOCUS ARCHITECTURE" sh.pk, has conducted an investigation to determine the existing condition of the constructive elements in function of the project "Conservation Plan, Reinforcement and Restoration Interventions in 5 cultural buildings" (Kurcaj Bridge on Zerza stream, Kruja; Bashtova Castle, Rrogozhina; Preza Castle (Clock Tower and Northeast Tower) Preza; Lezha Castle - Archaeological Park; Kruja Castle (Clock Tower and fortification walls) , Kruja).

KURCAJ BRIDGE ON ZERZA STREAM, KRUJA

Figure 1: Object Position from Google Earth

Figure 2: Overview of the Structure

2. FIELD INVESTIGATION AND SAMPLE RECOVERY

Figure 3: Cracking at an angle of 70 ° at the foot of the bridge from the side of the village Zgerdhesh, width> 10mm, filled with mortar.

Figure 4 : Detachment of outer shell and inner fill material at the bridge abutment

Figure 5: Recovering Limestone sample at the foot of the bridge by the village of Zgerdhesh.

Figure 6: Recovering Sandstone sample at the foot of the bridge by the village of Zgerdhesh.

Figure 7: Recovery of Limestone sample at the small arch of the bridge by the village of Zgerdhesh.

Figure 8: Recovering Mortar sample at the small arch of the bridge.

.

3. THE PHYSICO-MECHANICAL PROPERTIES

3.1 DETERMINATION OF COMPRESSIVE STRENGTH OF CYLINDRICAL STONE SAMPLES

No	Location of sample	Type of sample, Geological description	Sample dimension		Compressed area (mm^2)	Weight of sample (g)	Unit weight (g/cm^3)	Load (kN)	Strength (N/mm^2)
			Diam. (mm)	Height (mm)					
1	Kurcaj Bridge	Limestone sample from the foot of the bridge by the village of Zgerdhesh	81.1	83.7	5163.1	1145	2.65	527.26	102.12
2	Kurcaj Bridge	Sandstone sample from the foot of the bridge by the village of Zgerdhesh	81.1	83.7	5163.1	1123	2.59	448.73	86.91

3.2 DETERMINATION OF WATER ABSORPTION OF STONES SAMPLES

Water absorption of Rock samples
ASTM D 6473-'05

Rezults of Tests for Rock Samples				
	Unit	Test 1	Test 2	Test 3
Test Temperature	[°C]	22.1	22.1	22.1
Weight of oven dried sample, on air (A)	[g]	2384	2189	3567
Weight of saturated-surface dried sample, on air (B)	[g]	2405	2196	3576
Absorption	[%]	0.88	0.32	0.25
Average - Absorption	[%]	0.48		

3.3 DETERMINATION OF COMPRESSIVE STRENGTH OF MORTAR SAMPLES

DETERMINATION OF COMPRESIVE STRENGTH OF MORTAR CUBE
SSH EN 1015-11: 2005
REZULTS OF TESTS

No	Location of sample	Type of sample, Geological description	Sample dimension			Compressed area	Load	Strength
			Width	Length	Height			
			(mm)	(mm)	(mm)	(mm^2)	(kN)	(N/mm^2)
1	Kurcaj Bridge	Mortar sample at the small arch of the bridge	40	39	40	1560	5460	3.50
2	Kurcaj Bridge	Mortar sample at the small arch of the bridge	40	38	40	1520	3283	2.16

4. MINERALOGICAL COMPOSITION (PETROGRAPHIC ANALYSIS)

The bridge abutment, Kurçaj, Kruja (Limestone)

The sample represents a compact limestone of light gray to white color (Figure 9). There is no special texture in it. The sample reacts rapidly in contact with 10% HCl (Figure 9). The microscopic observation shows a large amount of carbonate particles, mainly of biogenic origin. Based on the distinct deposition texture in limestone, which is of the grain-supported type, we can say that we are dealing with a clastic type limestone (Dunham classification, 1962) (Figure 11).

According to Folk (1962) classification the sample represents a compact biomicrite (limestone with numerous microfauna in a micritic matrix) (Figure 11). The carbonate particulate material, which makes up about 85% of the mass fraction of the sample consists of bioclasts, rock fragments (extra-clasts) and micritic particles (Figure 11 and Figure 13). The micritic matrix does not make up more than 10% of the sample. Bioclasts are mainly represented by foraminiferal skeletons. The rock fragments and micritic particles are mainly angular to sub-angular and with a size ranging from 0.1 to 0.2 mm (Figure 10). They are in contact with each other and form a tight pack.

In addition to the carbonate material in the sample, the presence of a relatively high amount of terrigenous material is observed. They make up about 5% of the total sample mass (Figure 12, Figure 13, Figure 14, Figure 15, Figure 16, and Figure 17). They generally appear rounded. Quartz crystals in the form of either single crystals or polycrystals are found in the sample (Figure 12, Figure 17 and Figure 18). They appear randomly distributed throughout the sample. Plagioclase crystals are also present in the sample, they often appear with varying degrees of alteration (Figure 13 and Figure 19). In addition to quartz and plagioclase in the limestone sample there are also fragments of igneous rocks (Figure 16) and are mainly fragments of volcanic rocks. In the sample there is only one biotite crystal which without analyzer is easily distinguished from the rest of the rock components due to its pleochroism (Figure 14 and Figure 15). A rock cutter does not show any preferred orientation and has a thickness of less than 15 μm (Figure 20 and Figure 21). The cutters are mainly filled with microsparic calcium (Figure 20).

Based on the above we conclude that the sample represents a compact limestone of the biomicritic type (according to the Folk classification) or a bioclastic grainstone (according to the Dunham classification). The fragmentary material represents an intermingling of the carbonate material with that of the predominant terrigenous of the former. The amount of calcite debris traversing the rock is negligible.

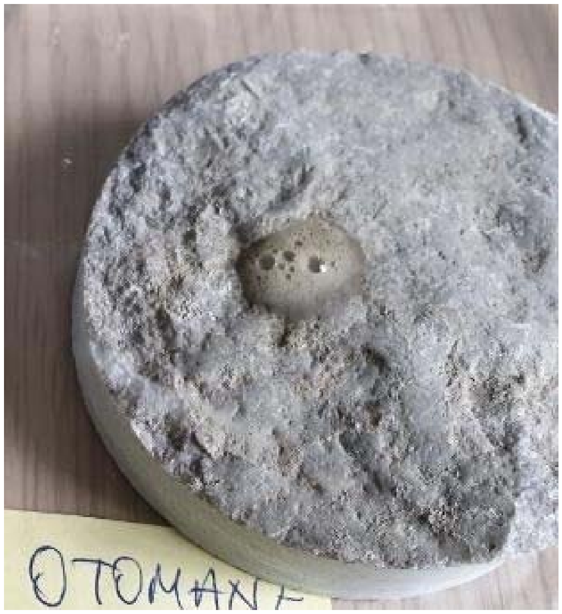
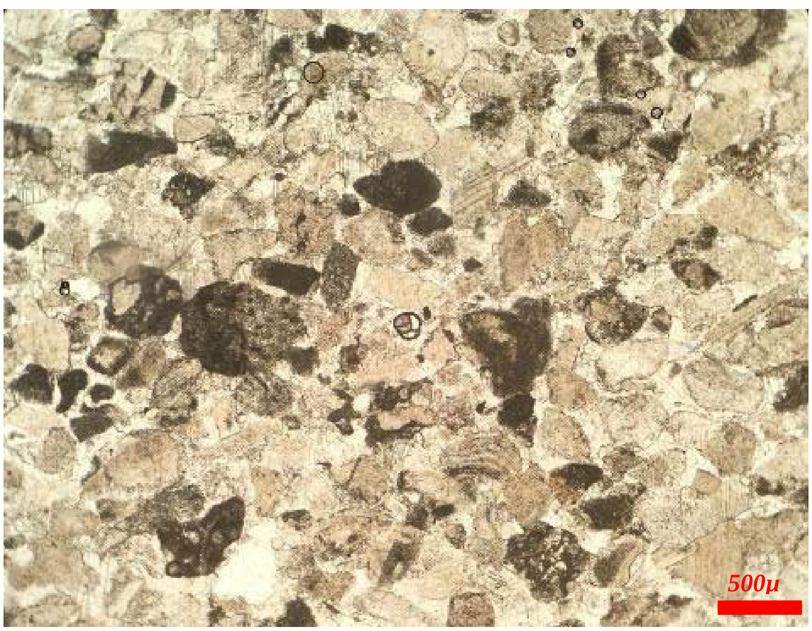


Figure 9. Overview of the 5D sample - Ottoman Bridge, where a rapid reaction is observed below



5% HCl.

Figure 10. Biogenic material which forms a supporting granular texture of rock. 5D sample, light penetrated without analyzer

Figure 11. Carbonate material represented by fragments of fauna and subcondytic micritic particles (red circles). 5D sample, light penetrated without analyzer.

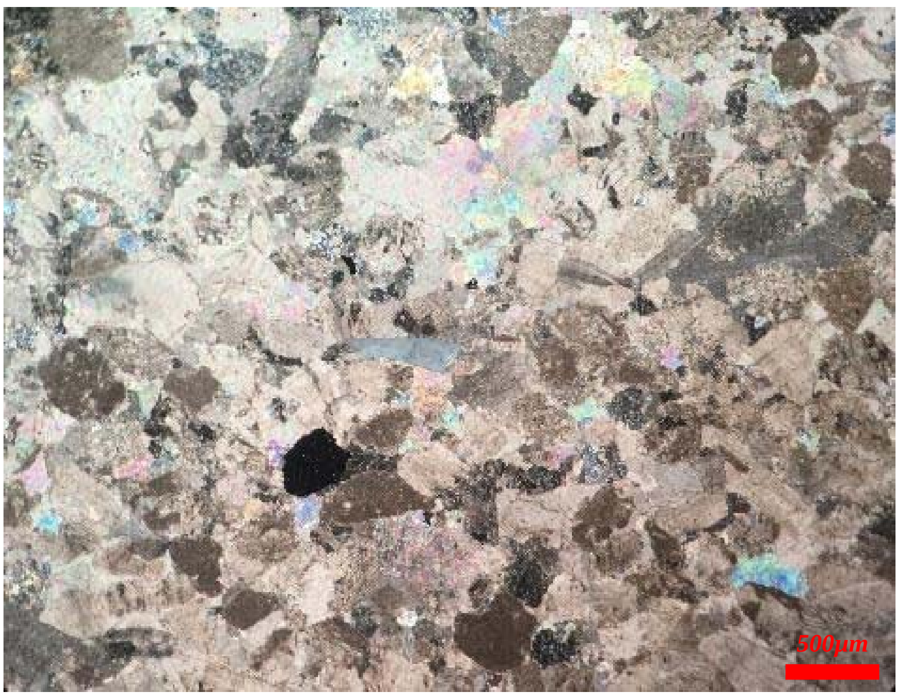


Figure 12. The same area as Figure 1, where in addition to the carbonate material the presence of terrigenous material is observed. 5D sample, light penetrated by analyzer

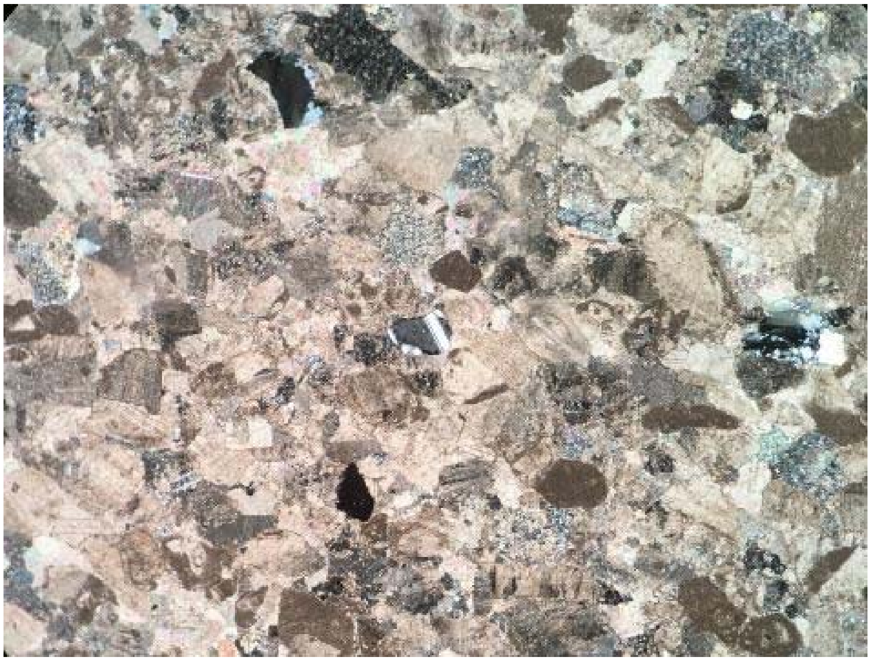


Figure 13. Plagioclase subrounded particle located between carbonate particles. 5D sample, light penetrated by analyzer

Figure 14. Biotite crystals with typical brown color. 5D sample, light penetrated without analyzer.

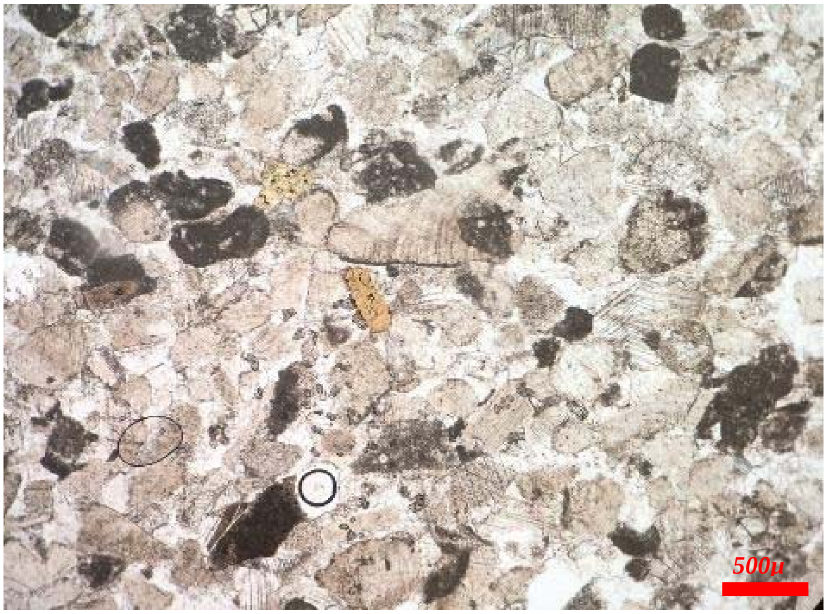


Figure 15. Same area as Figure 5, where biotite anisotropy colors are clearly visible. 5D sample, light penetrated without analyzer.

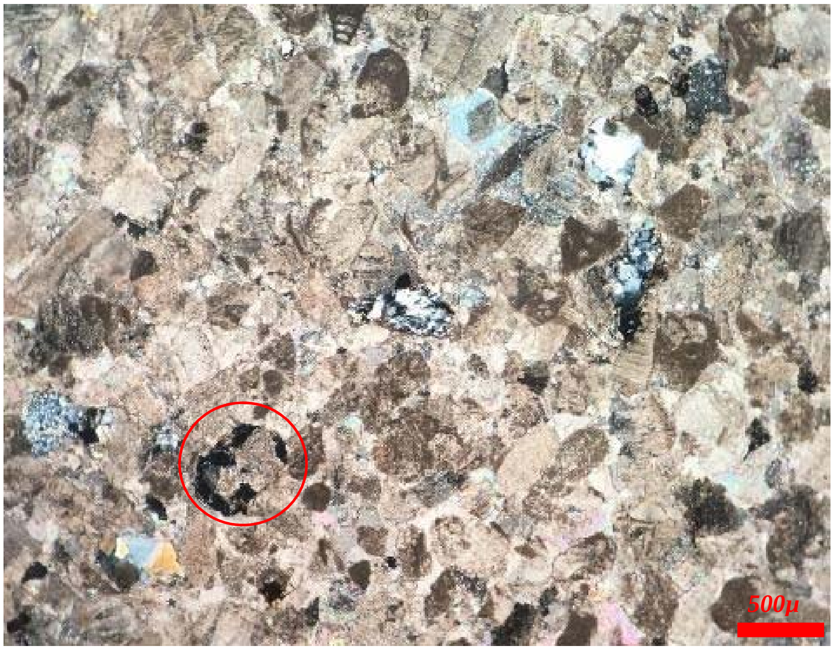


Figure 16. Fragments of well-preserved to partially altered igneous rocks (red circle). 5D sample, light penetrated by analyzer.

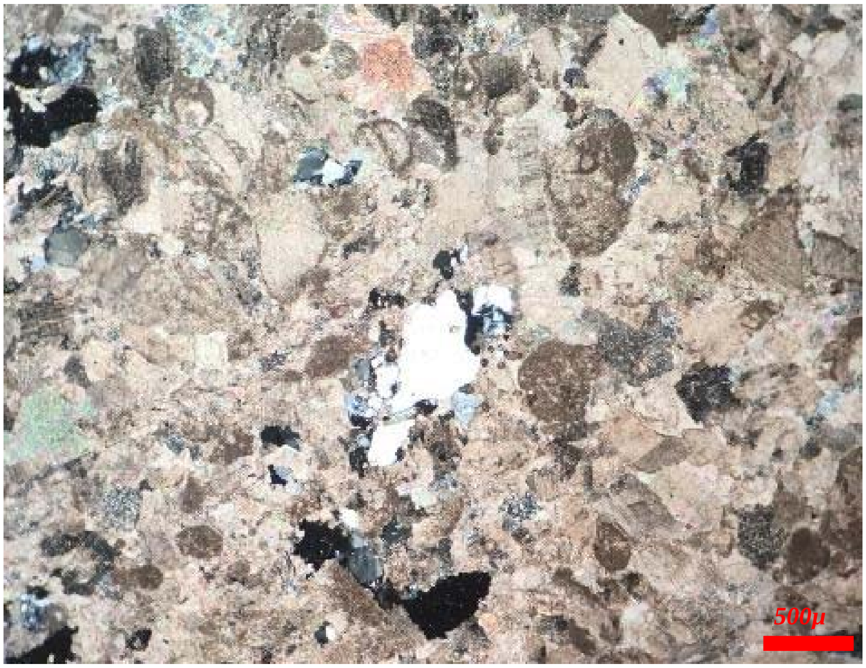


Figure 17. Combination of monocrystalline quartz with polycrystalline. 5D sample, light penetrated by analyzer.

Figure 18. Polycrystalline quartz with straight boundaries between crystals (red circle). 5D sample, light penetrated by analyzer.

Figure 19. Plagioclase crystals which appear in the early stages of alteration. 5D sample, light penetrated by analyzer.

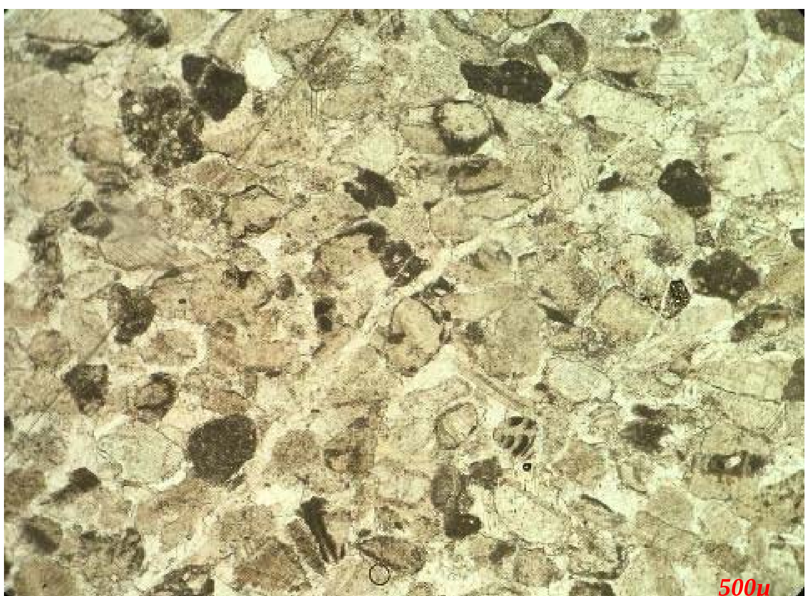


Figure 20. String that interrupts all the granular material found in the rock. 5D sample, light penetrated without analyzer.

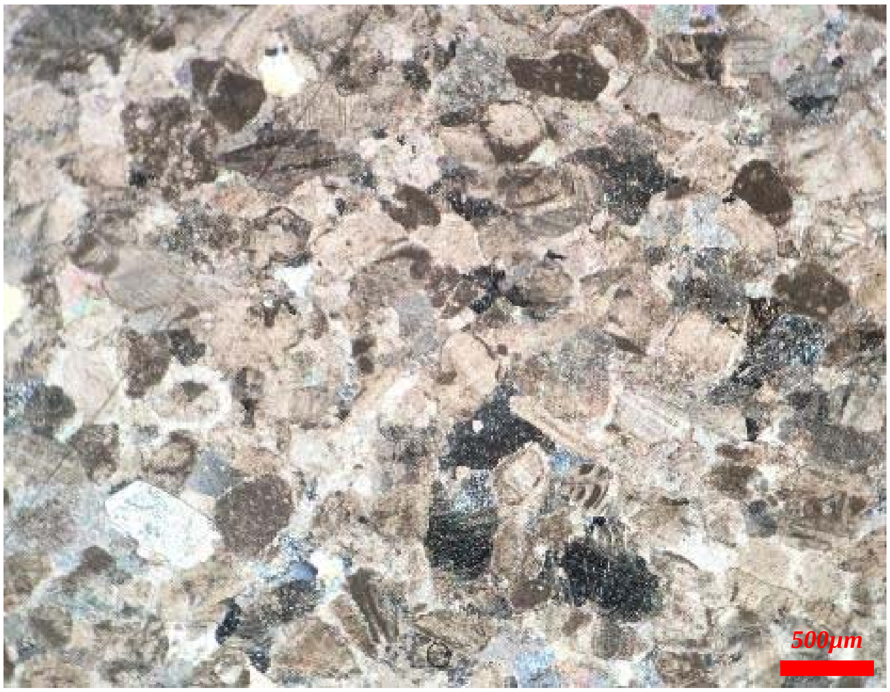


Figure 21. The same area as Figure 11, where the calcitic composition of the plant is observed. Figure 1 5D sample, analyzed light.

Abutment of the bridge, Kurçaj, Kruja (Ranor)

The sample represents a sandstone rock with calcite veins. Macroscopically, the sample is presented in gray with a green nuance. In fracture, the specimen exhibits a relatively rough surface constructed of fine granules. The presence of tiny mica leaves, which glow on the fracture surface of the specimen, is noticeable.

Rapid reaction to 10% HCL (Photo 1) indicates the presence of calcite in the sample. The sample is also traversed by a very irregular vein that passes immediately from the vein to the daisies (Photo 2). The thickness of this vein varies from 1 mm to 1 cm.

Microscopic observation reveals the granular texture of the sample (Figure 1). The granules are about 0.2mm in size, are generally isometric and angular in shape (with no rounded corners) and make up about 65% of the sample volume. The presence of mica leaves, about 0.5mm in length, is also noticeable.

Grain anisotropy colors (Figure 2) show that 90% of them are composed of quartz, while mica anisotropy colors indicate that we are dealing mainly with muscovite and only rarely are biotite sheets observed (Figure 8). Biotite also presents its characteristic pleochroism with variation of colors from light brown to dark brown (Figure 7).

In addition to quartz and mica, there are also fine angular grains of opaque minerals that define a certain discrete stratification of the sandstone (Figure 5). Mica leaflets are also oriented almost parallel to this stratification. However, some very thin sheets of muscovite are also observed, with a thickness of several microns and an extension of less than 100µm oriented across the general stratification (Figure 8). The sandstone cement is mainly carbonate, where calcite crystalline formations are clearly distinguished (Figure 6 and Figure 8). In addition to calcite in cement, chlorites or rare amorphous silica formations can be distinguished, as well as clusters of organic matter expressed in dark brown color in observations without analyzer (Figure 4 and Figure 5).

The calcite vein has an orientation generally parallel to stratification and consists of well-crystallized calcium (Figure 9). Its orientation parallel to the alignment of the mica leaflets is clear (Figure 4). The contact of this vein with the sandstone part of the sample is clear and cut (Figure 3).

In conclusion it can be said that the sample represents a fine-grained sandstone rock with carbonate cement. Sandstone grains make up about 65% of the rock and are represented mainly by quartz and rare mica combinations (mainly muscovite and to a lesser extent biotite) as well as opaque mineral particles. Together, mica and opaque minerals make up less than 1% of the rock. The specimen has a pseudolayer texture that is difficult to distinguish and is best expressed by the extension of the mica leaves and is permeated by calcareous veins up to 1 cm thick which is very unstable in extension.

Figure 22. View of the sand sample from the foot of the Ottoman bridge Kurçaj reacting with 10% HCl acid.


Figure 23.. Irregularly shaped calcite vein that traverses the sand sample from the foot of the Ottoman bridge, Kurçaj.

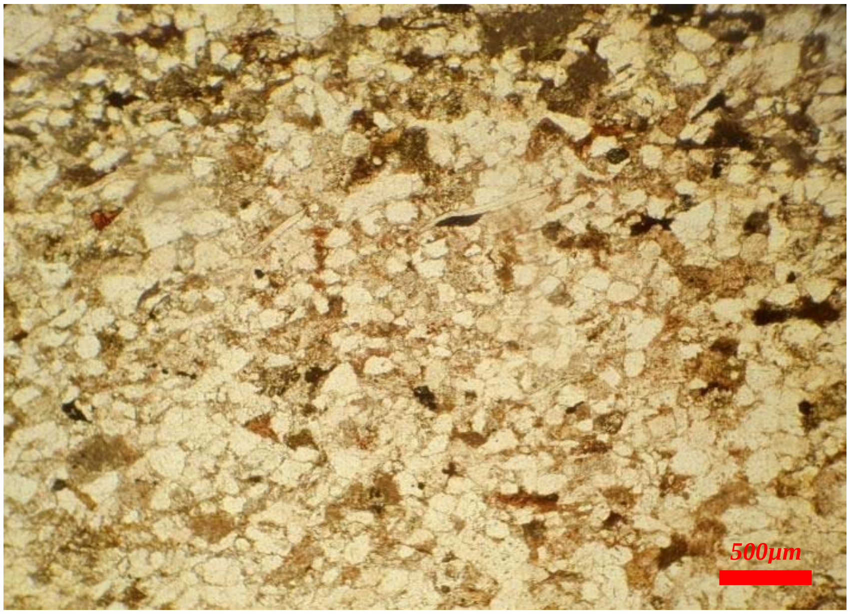


Figure 24. General view of the sample where the angular shape of the granules and the elongated leaves of the mica are distinguished. Thin section of the sand sample from the foot of the Kurçaj bridge. Planar polarized light and permeable, without analyzer

Figure 25. Same area as Figure 14, the colors of the anisotropy show that the grains are mainly quartz and carbonate cement. The plates of mica have a subparallel orientation. Thin section of the sand sample from the foot of the Kurçaj bridge. Planar polarized light and permeated, with analyzer.

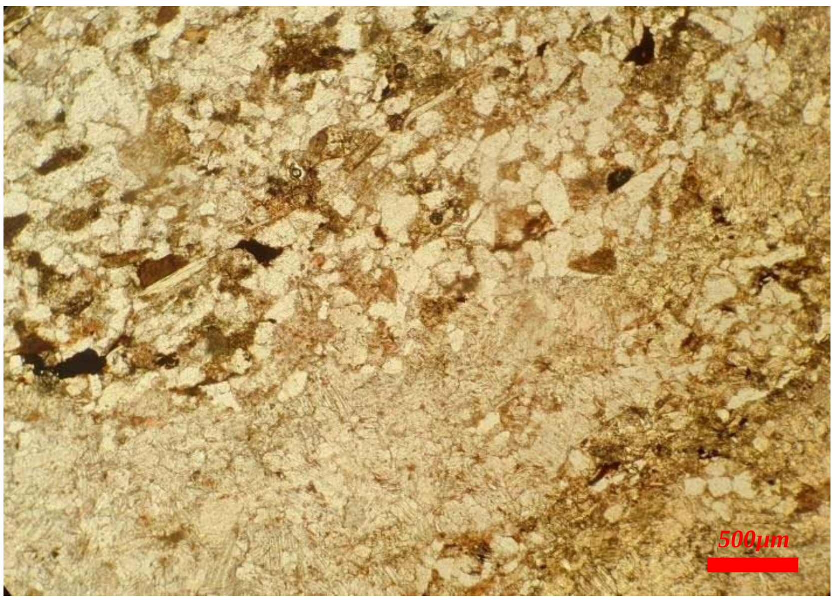


Figure 26. Parallel calcite vein with thickness> 1mm. Thin section of the sand sample from the foot of the Kurçaj bridge. Planar polarized light and permeable, without analyzer.

Figure 27. Muscovite leaflets are oriented subparallel to the calcite vein. Thin section of the sand sample from the foot of the Kurçaj bridge. Planar polarized light and permeated, with analyzer.

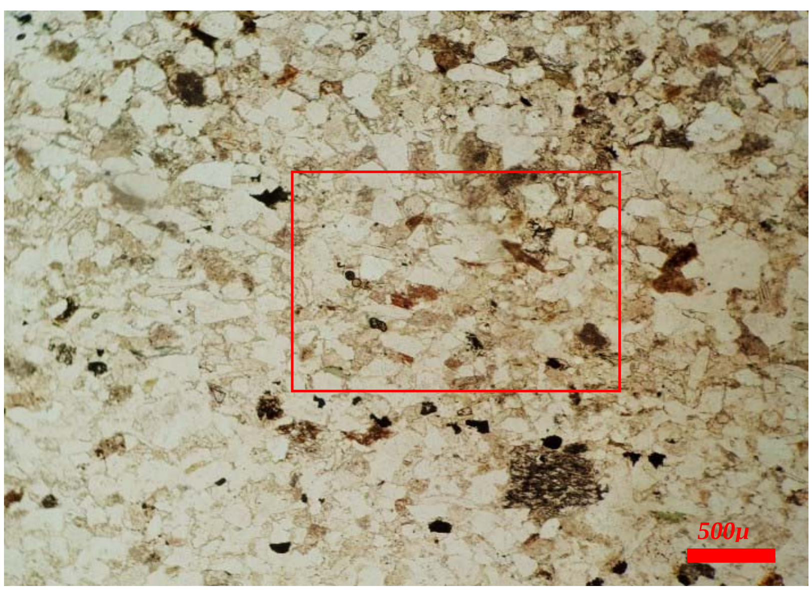


Figure 28. In addition to quartz granules, there are also finer opaque granules, biotite sheets and cement with material of organic origin. Red square: the contours shown in Figure 20. Thin section of the sand sample from the foot of the Kurçaj bridge. Planar polarized light and permeable, without analyzer

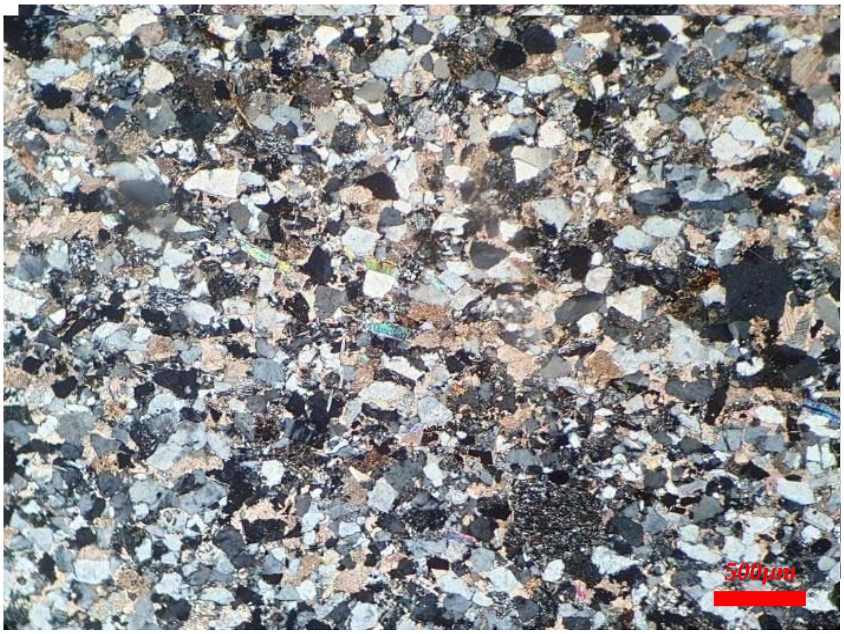


Figure 29. The grains are cemented by calcium. Thin section of the sand sample from the foot of the Kurçaj bridge. Planar polarized light and permeated, with analyzer.

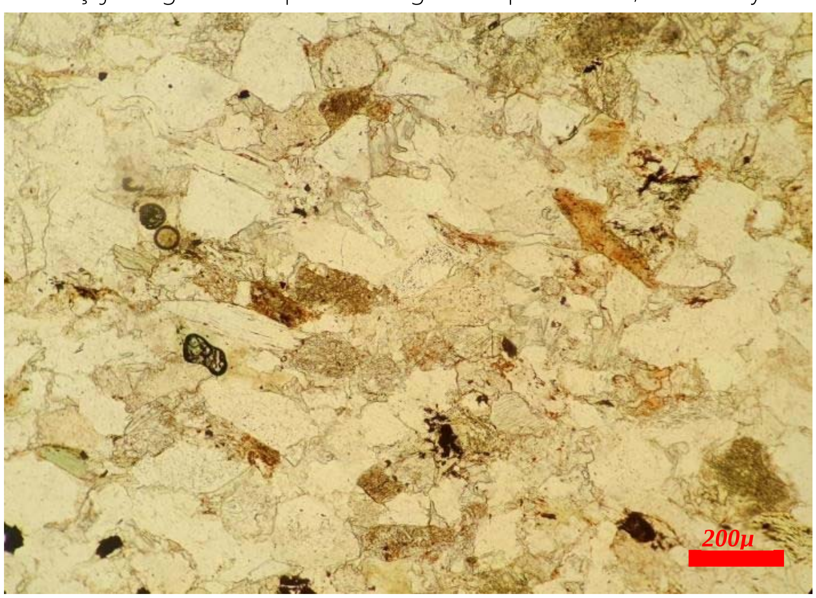


Figure 30. Detail of Figure 18, biotite and chlorite formations. Thin section of the sand sample from the foot of the Kurçaj bridge. Planar polarized light and permeable, without analyzer

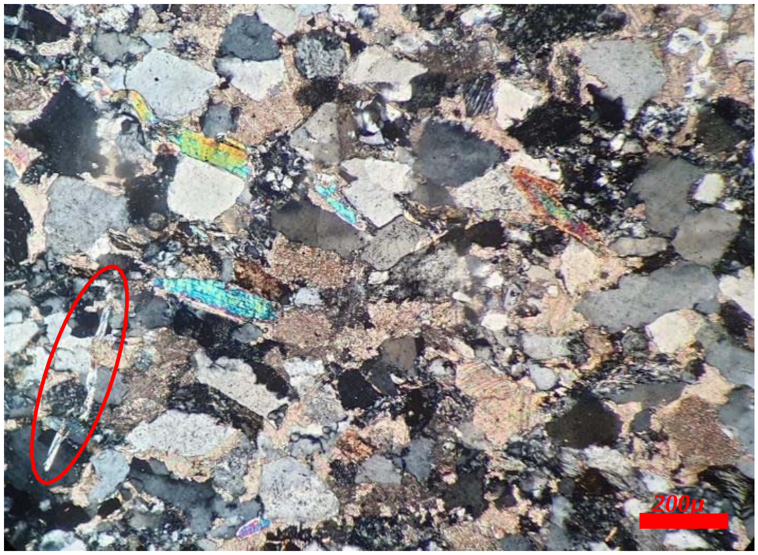


Figure 31. The same area as Figure 20, in addition to the larger sheets of muscovite and biotite, there are also small sheets of muscovite (red circle) with a transverse orientation to the first. Calcium cement has a clear crystalline structure. Thin section of the sand sample from the foot of the Kurçaj bridge. Planar polarized light and permeated, with analyzer.

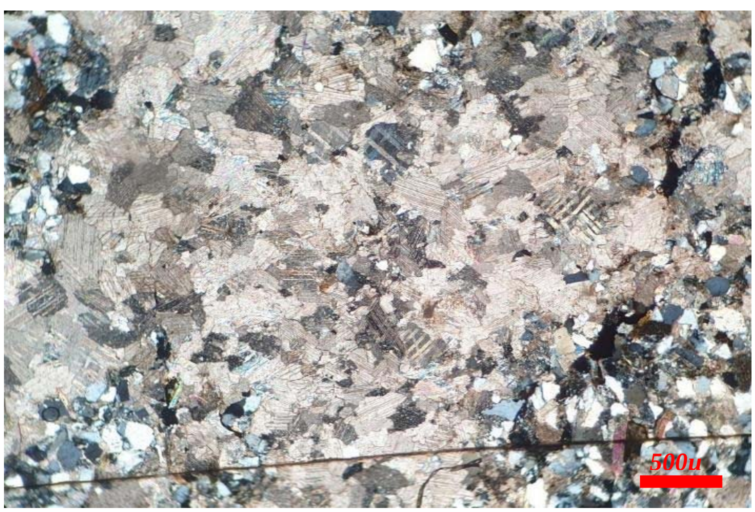


Figure 32. View from the calcite vein constructed of granules measuring approximately 0.3mm. Shlif of the sand champion from the foot of the bridge, Kuçaj. Planar polarized light and permeated, with analyzer.

5. CHEMICAL COMPOSITION (CHEMICAL ANALYSIS OF MORTAR)

CHEMIC ANALYSIS OF MORTAR

No.	Elements	Unit	Measured Value	Reference Method
1	SiO_2	%	37.6	S SH
2	Al_2O_3	%	5.22	S SH
3	Fe_2O_3	%	3.32	S SH
4	MgO	%	9.28	S SH
5	CaO	%	21.32	S SH
6	$CaCO_3$	%	38.06	S SH
7	Na_2O	%	0.74	S SH

UN House Skanderbeg Street, Gurten Building 3rd Floor, Tirana, Albania, www.unops.org
Rr. "E Kosovarëve", Nd.35, H. 6,Ap.4/1,Njësia Administrative Nr. 5,1019, Tiranë, Shqipëri info@atelier4.al