

GEO y Asociados (Peru)

Institute of Tectonics and Geophysics named after Yu. A Kosygin (Russia)

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REPORT

“Research of structure and nature of stone samples, taken from the walls of Saqsaywaman fortress and samples from an ancient quarry, where the possible material for construction was extracted.”

Customer:

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with assistance of GEO y Asociados

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Developer:

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Objectives: to show the similarity and difference of the chemical composition and structure of the samples, taken from the walls of the Saqsaywaman fortress and a stone quarry, where the possible material for fortress construction was extracted. This research is necessary for solving two questions: determination of the quarry, from which the stone for the construction for the Saqsaywaman was taken; clarification of the polygon-block processing method.

Research methods and equipment:

1. Optical microscopy (polarizing microscope Axio Imager A2m, Carl Zeiss (Germany); binocular microscope Discovery v. 12, Carl Zeiss, (Germany)).
2. X-ray- fluorescent analysis of chemical composition (S4 Pioneer, Bruker, Germany).
3. X-ray - phase analysis of structure (Miniflex II, RIGAKU, Japan).

RESULTS

Samples to study:

Sample № 115. Third level of Saqsaywaman fortress, close to damaged wall.

Panoramic view:



Place, where the sample was taken:



Sample № 4. This item was taken from the quarry, where the possible material for the Saqsaywaman fortress construction was extracted.

Panoramic view:



Place, where the sample was taken:



The **sample № 4** is a stone material of a gray color.

The **sample № 115** has uniform fine-grained structure, can be easily scratched by a knife or a nail leaving a white strip on its surface. The **sample № 4** is more dense, hardly can be scratched, has non-uniform structure with dots of light and dark tone. Both samples (**№ 115 and № 4**) are easily dissolved in acetic and hydrochloric acids.

Studying of the petrographic thin sections, taken from the both samples, showed that the **sample № 4** is an organic limestone, formed by the sea microorganisms (photo 1). No doubts – it is a nature stone.

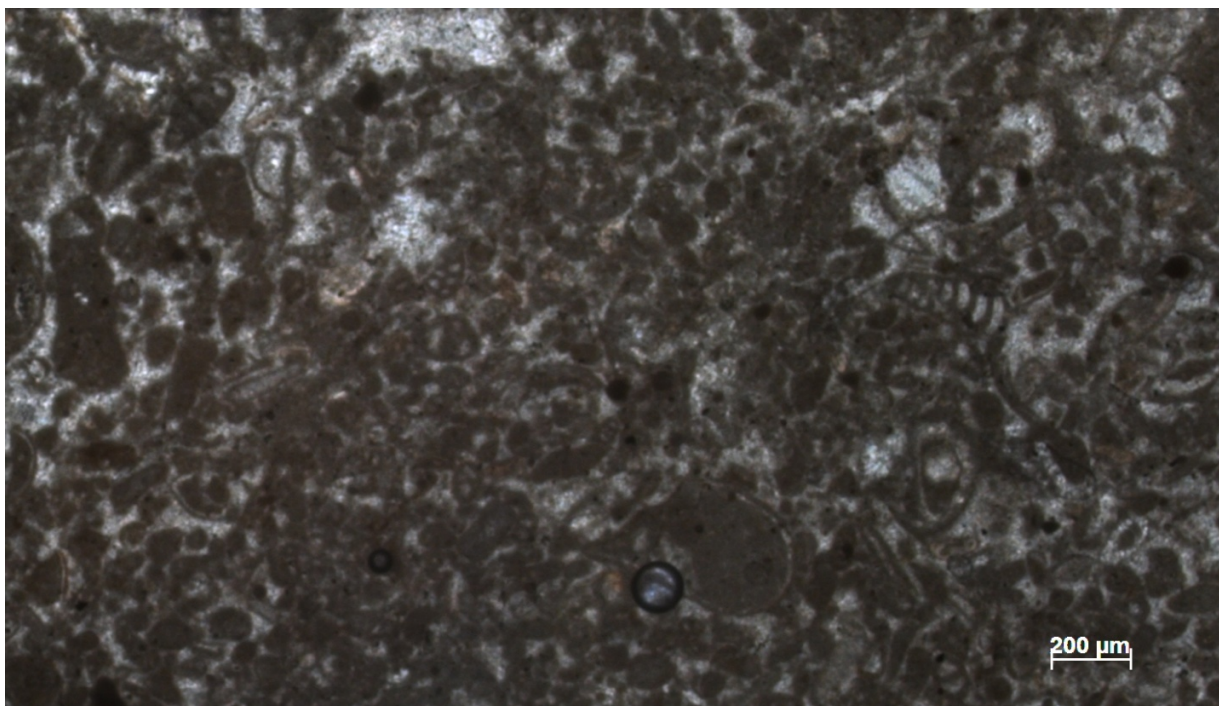


Photo 1. Sample № 4 – organic limestone.

Sample № 115 is evenly formed with calcite microcrystals of 1-10 microns (photo 2). Identification of calcite is confirmed by the X-ray-phase analysis. Also we can see small strings and “lenses” filled with more coarse-crystalline calcite.

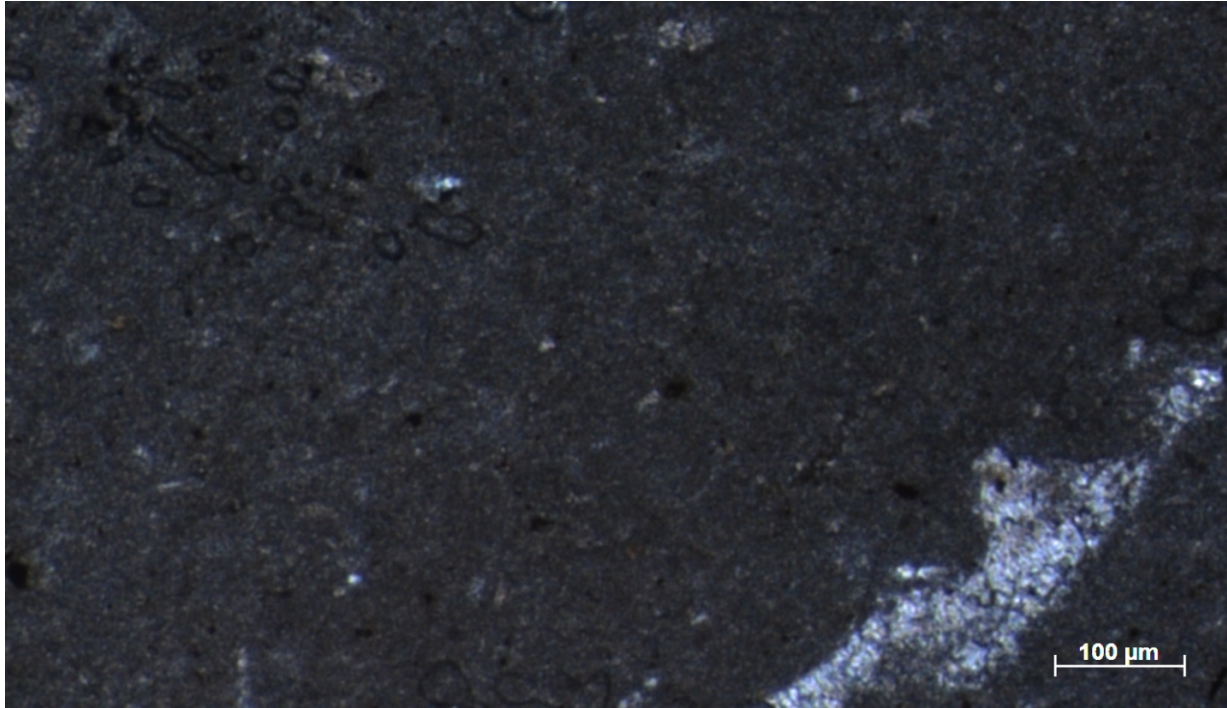


Photo 2. Sample № 115 – Saqsaywaman block material.

X-ray- fluorescent analysis showed almost identical chemical composition of both samples (Table 1).

Table 1

CHEMICAL COMPOSITION OF BOTH SAMPLES

Oxide / element	<i>Sample № 4</i>	<i>Sample № 115</i>
SiO ₂	13,20%	13,36%
TiO ₂	0,06%	0,09%
Al ₂ O ₃	0,56%	0,90%
Fe ₂ O ₃	1,11%	0,94%
MnO	0,07%	0,07%
CaO	69,86%	70,15%
MgO	0,70%	0,65%
K ₂ O	0,35%	0,68%
S	0,05%	0,04%
Cu	0,01%	0,01%
Pb	0,00%	0,00%
Co	0,00%	0,00%
Sr	0,03%	0,04%
V	0,01%	0,01%
Sc	0,01%	0,01%
Zr	0,01%	0,01%
TOTAL	86,04%	86,98%

Conclusions

Such identical chemical compositions of the studied samples, shows that the material of blocks (**sample № 115**) is made from the limestone, extracted from the quarry (**sample № 4**).

The process of making the block material - is impossible to be a nature process. Organic limestone with hidden crystal structure, together with water and high temperature can be trans-crystallized up to a marble, but in this case the crystals will be large, because nature processes are going slowly, allowing the crystals to grow in its natural way. Uniform small crystal structure, as we see in the **sample № 115**, is possible to get only if the processes are going very fast and every point of the system is provided with water, and carbonate material.

Further direction of researches:

1. To repeat researches on other samples of a wall blocks and quarry.
2. Experimentally to find the way, how the material of blocks was formed and processed.