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HIDDEN MESSAGE IN STONE MASONRY OF GALATA MONASTERY - IASI CITY, ROMANIA

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Abstract

Galata Church is one of the oldest architectural monuments in Iasi City, Romania, was being built predominantly from geological period of Cenozoic (Sarmatian) calcareous rocks, locally known as the Repedea Limestone and Scheia Sandstone. These rocks are composed of different facies and microfacies types and were deposited on a beach environment. This paper presents a number of data regarding the present status of wall of enclosure conservation based on petrographic and sedimentological microscopic analysis that were correlated with microscopic analysis of lithic materials from the current open pits from Iasi area, from where the stone used was extracted.

***Keywords**: Galata Monastery; Enclosure walls; Repedea oolite; Sedimentary facies; Sarmatian rocks open pits*

Introduction

In his last years of reign, Petru Schiopul (Peter the Lame) built the church and monastic ensemble *Galata din Deal* (Galata on the Hill). The construction/foundation was built within 1582 and 1584, being designed as a fortress surrounded by a stone wall that, together with the belfry, due to its strategic position towards the old urban core of the city of Iasi, ensured a place for refugee for the prince and his family [1]. The Monastery Galata is situated in the South – West side of Iasi city, on the hill with the same name, Galata. The position (47°08'46.5"N 27°34'07.9"E) corresponds geomorphologically with a plateau that rises in a smooth slope towards South – West. It is the first monument of church architecture in Moldavia, elevated on a dominant height that reminds the Byzantine Cities, inheritors of the Hellenic traditions, of an Acropolis type (Fig.1).

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This monastery is included on the national list of historical monuments with the classification codes IS-II-m-A-03940.04 for the wall of enclosure and IS-II-m-A-03940.03, respectively, for the belfry [2].

There are different opinions regarding the wall of the enclosure and the belfry from the entrance in the Monastery Galata. Some historians claim that Petru Schiopul (Peter the Lame) did not build the wall, opinion based on Paul de Alep's assertion that he found the Monastery surrounded by a wooden fence during his visit in 1653. Thereby, some authors assert that the wall of the enclosure was built during the reign of Grigore Ghica II, beginning with the year 1753 [3].

Periodically, the Monastery Galata suffered from fires and because of social and historical convulsions such as the Revolution from 1821, Secularization of the Monastic Patrimony in 1863, The First and the Second World War, the instauration of the communist regime in 1947, ending up after that in a precarious status of preservation and conservation, mostly between 1950 and 1960.

Fig. 1. Aerial view of the monastic ensemble from Galata – Iasi, Romania. Geographical coordinates: 47°08'46.5"N 27°34'07.9"E [4]

Within 1961 and 1971 restoring work was performed for the entire monastic ensemble. With that occasion the wall of enclosure, the belfry and the two towers of the church were consolidated, the exterior of the building was cleaned up and the parget added in time as well as depositions due to the effect aero-foil were removed. The roof was also restored.

For the valorization of a historical monument, the scientific investigations have in attention a number of expertizes that should respond to the objectives imposed by the interventions for preservation and restoring. Such objectives are the nature and provenience of building materials, the conservation status of the structural and functional elements, procedures used, historical contexts in the evolution of the monument (including its role and patrimonial functions, owners, exchanges and events that influenced its status) etc. A special aspect for actual or future interventions of restoring is the identification of natural resources referred to the extraction of the compatible rock with physical and mechanical characteristics, petrographic, mineralogical and esthetical characteristics specific to the geomaterials used for the initial construction [5]. An important issue is the cleaning of the depositions on the wall surface, laser cleaning method being recommended especially when assisted by simulation in COMSOL for estimation of laser parameters [6].

This paper work presents a number of data regarding the present status of conservation of the wall of enclosure. The evaluation is based on macroscopic analysis from a petrographic and sedimentological perspective correlated with microscopic analysis of lithic materials from current quarries within Iasi area where the stone used for the initial construction in 1735 of the enclosure wall from Galata Monastery was extracted from. The aim of this analysis is to identify the sources of natural rock that could be used for restoring process.

The geology of the urban and periurban areas of Iasi city

From a geological perspective, the urban and periurban area of Iasi City fits in the Moldavian Platform being characterized by the geological period known as *Sarmatian* from a chronostratigraphic perspective and represents a level of the Upper Middle Miocene, characterized by deposits with brackish fauna. The term of *Sarmatian* was introduced by *Eduard Suess* (1866) and *Barbot de Marny* (1866). It derives from the name of historical province Sarmatia that extended from the river Vistula to West (Poland) to the river Volga to East (Russian Federation), and from the Baltic Sea to North to the Black Sea to South (European Sarmatia), including therewith the area between the Black Sea and Caspian Sea (Asian Sarmatia) [7, 8].

The *Besssarabian* or the *Middle Sarmatian* is in the continuity stratigraphy over the *Volhynian (Lower Sarmatian)* and outcrop on a significant surface between the Siret and Prut rivers. The geological deposits which outcrops in the Repedea Hill nearby Iasi city represent the Repedea Formation and is part of so-named *Upper brackish-marine biofacies* (end of *Bessarabian*) with oolitic and bioclastic limestone with high thickness in the North of the Central Moldavian Plateau (Podisul Central Moldovenesc), up to 25m in the Repedea Hill. Some authors, *Jeanrenaud* and *Saraiman* (1995) [9], investigated the Repedea Limestone on an area lying from the Eastern Romania (between Siret and Prut rivers), showing for the first time that in other areas of the Moldavian Plateau, the limestone from the Repedea Hill represents the equivalent of three geological horizons:

a. The limestones with *Mactra podolica*,
b. The loamy horizon and
c. The Scheia sand and sandstones.

In the upper brackish - marine biofacies, *L. Ionesi et al.* [10] in 2005 separated the *limestone lithofacies* (with *oolitic* and *bioclastic limestone*) that ends the sedimentary sequence of the *Bessarabian* from the Repedea Hill (Fig. 2).

Thereby, *L. Ionesi et al.* [10] described:

a. *Oolitic limestone* (*oosparite*) of a yellowish to light color with small oolids fixed in calcareous cement (*sparitic*). They generally form homogeneous layers that may have transversal or oblique cracks, filled with sand. The surface of the limestone may have calcite and iron – oxidizing crusts. The limestone may be substituted in lateral side by sandstones.

b.*Bioclastic limestones* (*biosparite*) that are formed mostly by bioclasts or fragments of *Mactra Podolica* caught in carbonate cement characterized by long crystals (sparitic). Micritic and limonitic crusts appear on the bioclasts surface.

c. The *sandstones* form thin layers and they have in their composition: *allogenic fraction* (> 40% Quartz, Feldspars, Muscovite, Hornblende, Zirconium and Lithoclast – fragments of Sandstones, Gneiss, Quartzite, Limestone) and *authigenic fraction* (Glauconite, Oolids, Bioclasts, Limonites, clay minerals, e.g Kaolinite, all caught in a *sparitic cement*).

Depending on the proportion of each component, the sandstones may be calcareous to sandy limestone.

L. Ionesi et al. [10] deems the rocks of the Scheia quarry as belonging to the *quartz – lithic* and *quartz – feldspatic arenites*, as subordinated intercalations between the *oolitic* and *biosparitic limestone*.

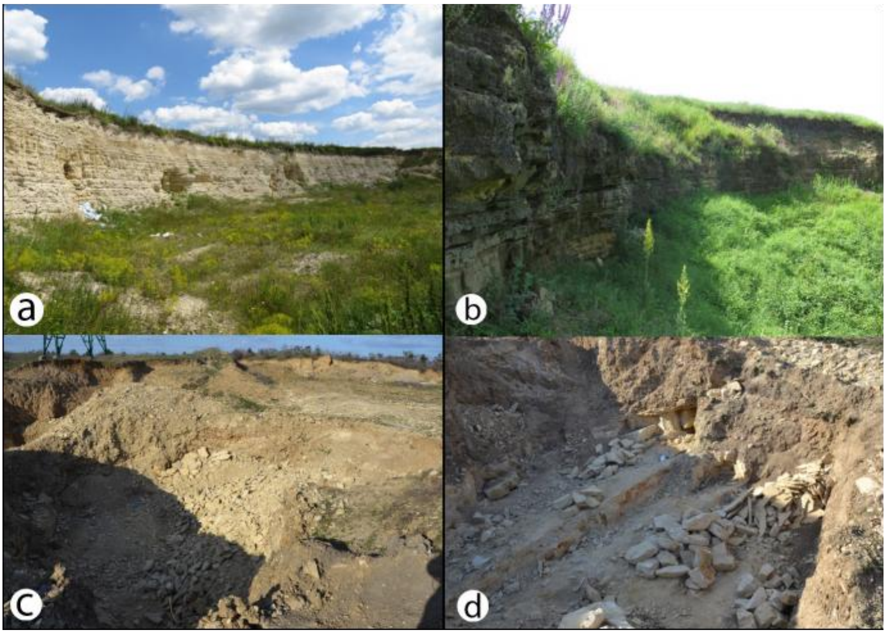

Fig. 2. The current situation of quarries in Iasi neighborhood:
a. Zupaita - Scheia Quarry, coordonate 46°55'30.50"N 27°29'14.45"E;
b. Scheia Quarry; c. and d. Points of exploitation
in Paun Quarry, coordonate 47°06'33.0"N 27°39'58.9"E

Experimental part

Analysis of preservation status of the wall of enclosure

The enclosure wall of Galata Monastery was evaluated from the perspective of the preservation status using the analysis of the progressive effects of the *deterioration* physical state of the structural-functional elements and the *degradation* of the chemical nature from component materials. For this purpose, pictures of the formations with pronounced destructions and alteration were taken and macroscopic analysis was performed in situ, following possible endogenic and exogenic causes that affected the status and integrity of the construction in study [11].

Identification of the construction stone provenance

Because it is not known exactly the quarry where the lithic material used for the construction of the wall of enclosure was extracted from, the provenance was determined using petrographic analysis and sedimentological interpretation, correlating these data with regards to the stone from the wall and the stone available in the current quarries in the periurban areas of Iasi City

Microscopic Analysis of the stone from the quarries in Iasi and description of oolites was studied using an optical microscope Zeiss Imager A1m*,* which has a camera attached AXIOCAM and specialized software. In addition, optical microscopy was used to evaluate certain aspects of the microfacies types of the limestones analyzed in this paper.

Results and Discussions

Conservation state of the wall of enclosure

The current form of the wall of enclosure from the Galata Monastery represents the result of the last restoring interventions and reconfiguring within 1961 – 1971. Analyzing the images from Figs. 1 and 3 one can observe that the form of the current South and South – East side of the wall of enclosure re – built within the mentioned period of time have a slightly angular form compared to the wall from 1900 (Fig. 3d).

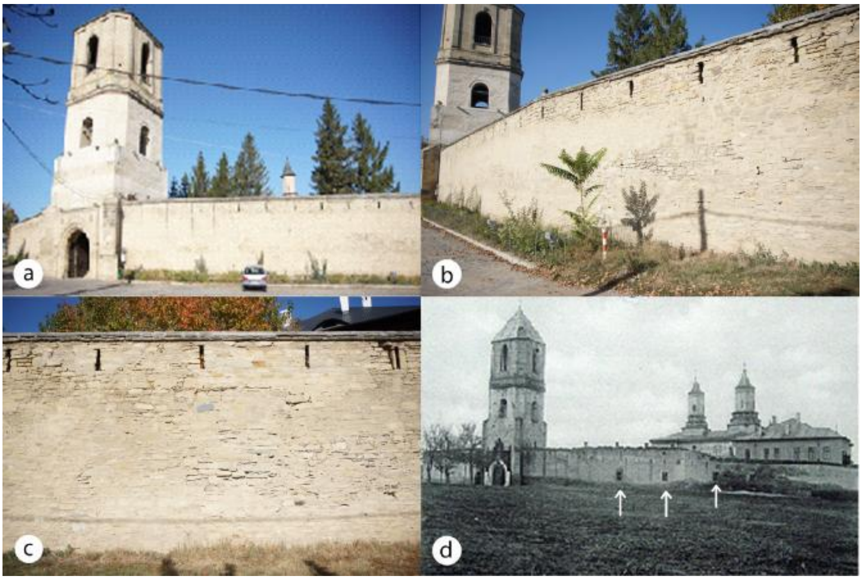

Fig. 3. Portions of the wall of enclosure of the Galata Monastery:
a – the belfry and the South – central side of the wall; b and c – the South –East side of the wall of enclosure that borders the Reign Palace from the monastic ensemble; d – images from the South – East side of the monastery from 1900 where the Reign Palace can be observed and three access secondary paths (through the inferior side of the wall) [12]

In the photography from 1900 in figure 3d, one can see that at the soil level access paths existed, made after the fire from 1814 [1] that later on were filled with masonry of lithic material similar from an esthetic perspective. These modifications of renouncing to the secondary paths of access generated in time altering phenomena caused by incompatibility of the shaped stone with the mortar used that was different than the initial one [13]. That explains why shaped stones of different origin were built and incised, endogenic and metamorphic instead of sedimentary rocks similar to those used at the initial construction

As can be seen in the figures 3a, b and c, the perimeter wall with South and South-East exposure has a background color similar to the sedimentary carbonate rocks natural colors from the Iasi area. In contrast in the North part of the perimeter wall the black crust appears on the lithic surfaces due to the predisposition of the lithic material to retain the moisture. At the same time, the presence of the urban pollution factors, increasing in last years in the city of Iasi area, has favored surface alteration, by closing the apparent color specific to porous rocks (Fig. 4) [14-19].

Fig. 4. Presence of black crust in North part of the perimeter wall of Galata Monastery (note: the respective crust also affected the lithic framing of a secondary pathway)

In the macroscopic evaluation activity, it is observed the sedimentary carbonate rocks used in the historical constructions of Iasi are *oolitic* limestone of great variability [14, 20]. These limestone rocks consist mostly of a multitude of small grains, rounded, covered with $CaCO_3$ and incorporated in calcic cement.

This petrographic structure provides a variable durability, depending on the quarry source as well as of its behavior in time, after construction as a response to the characteristics connected with the porosity and the contain of bioclast [20, 21]. These characteristics determine a number of secondary properties such as permeability, saturation coefficient and absorption of water that influence the appearance of degradation phenomena assisted later by deterioration [13, 20, 22]. The general susceptibility of oolitic limestone species of suffering different chemical altering after construction, followed by micro- and macro- structural destructions (change of physical status) that lead to the loss of material by embrittlement in the form of gaps in the volume phase, make them different than the dense limestone species [13, 20]. These degradations and/or altering may start in a first stage with the loss of material from the surface by dissolution and granular disaggregation generated also by the radiative climate (direct exposure to the Sun radiation) [13], exacerbating eventually by a special concentration in cracks or micro crevase that generate an alveolar characteristic loss: honeycomb weathering (Fig. 5a) [20]. Once dissolution triggered with diffusion, followed by disaggregation, the initial fine cracks enlarge, resulting cavernous larger gaps (Fig. 5b) and loss of material, including mortar (Fig. 5c, d and e). Also, the dissolution present in the lithic material also causes the appearance of gypsum crusts (Fig. 5f).

B.J. Smith, H.A. Viles [23], identified meso-scale structural diversity, such as that associated with distinctive bedding (Fig. 6a), fossil bioturbation (Fig. 6b si c) and texturally different inclusions such as clay lenses, as potential focal points for localized decay (Fig. 6d).

The herein presented study is on the construction rocks of the wall of enclosure of the Galata Monastery (initial and subsequent restored in different stages) from a petrographic, paleontological and sedimentological perspective. The petrographic study referred to this wall confirms the predominant presence of sedimentary rocks from the Repedea and Scheia open pits.

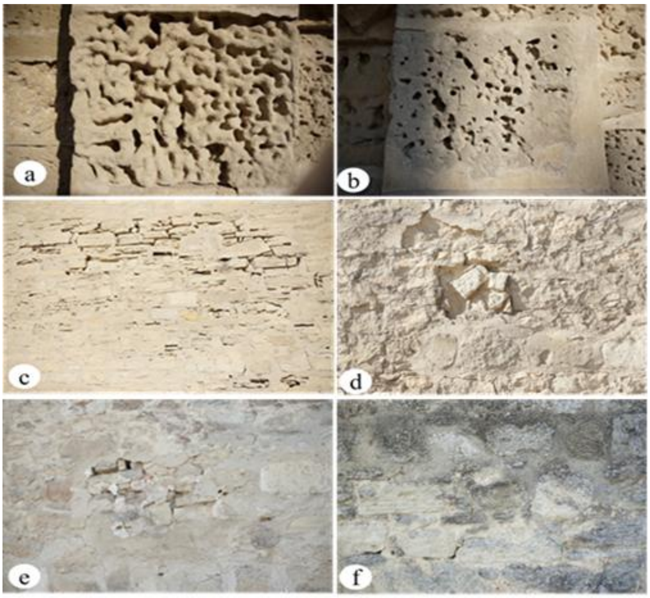

Fig. 5. Degradations and deteriorations specific for different types of rocks present in the wall of enclosure: a - honeycomb weathering; b - cavernous hollows; c,d,e - catastrophic decay; f - multiple gypsum crusts

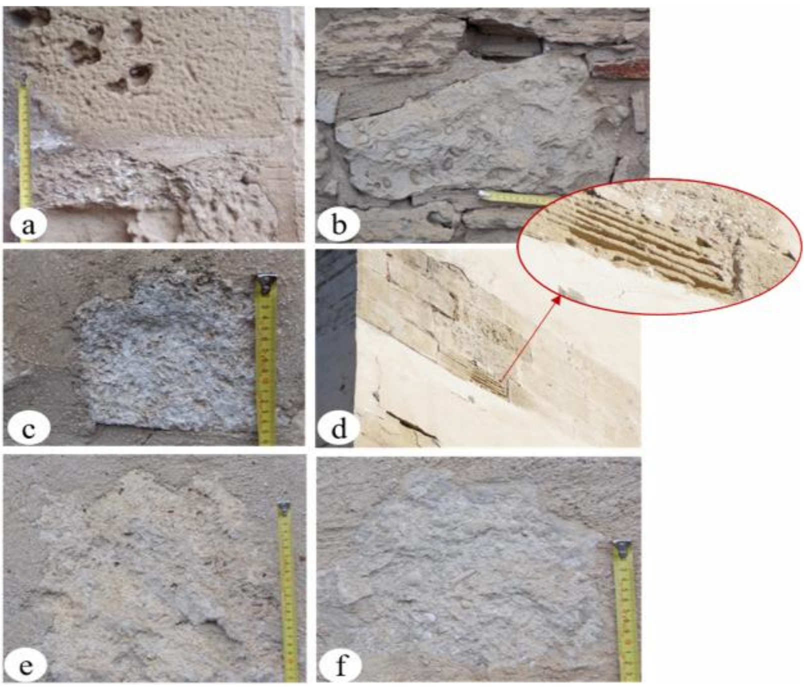

Fig. 6. Sedimentary facies from the wall of enclosure of the Monastery Galata: a- bioclastic limestone (*storm bed*); b- trace fossil (*Lockeia* type); c – lumachellic limestone; d – plan – parallel stratification; e – Limestone with different species of *Potamides*; f – limestone with *Obsoletiforma* sp., *Mactra podolica* and *Solen subfragilis*;

The sedimentary rocks in discussion consist of bioclastic limestone, oolitic limestone, bioclastic and lithic sandstones. In some isolated cases, also metamorphic rocks could be identified, e.g. Quartzite (Fig.7a) and magmatic rocks (most possible Granite) (Fig. 7b). The source of these isolated rocks, allochtone for Iasi area, is without doubt the Eastern Carpathian belt (Fig.7a, b and c).

From the paleontological point of view, within the Sarmatian limestones and sandstones, it can be observed shells of bivalves that belong to *Mactra podolica*, *Solen subfragilis*, *Oboletiforma nefanda* and *Obsoletiforma obsoleta* (Fig. 6f). The gastropods are mainly represented by two families: *Potamididae* with the following species *Potamides nefaris* and *Potamides disjunctus;* and *Hydrobiidae* with the following species *Hydrobia stagnalis* and *Hydrobia soceni* [24 - 27].

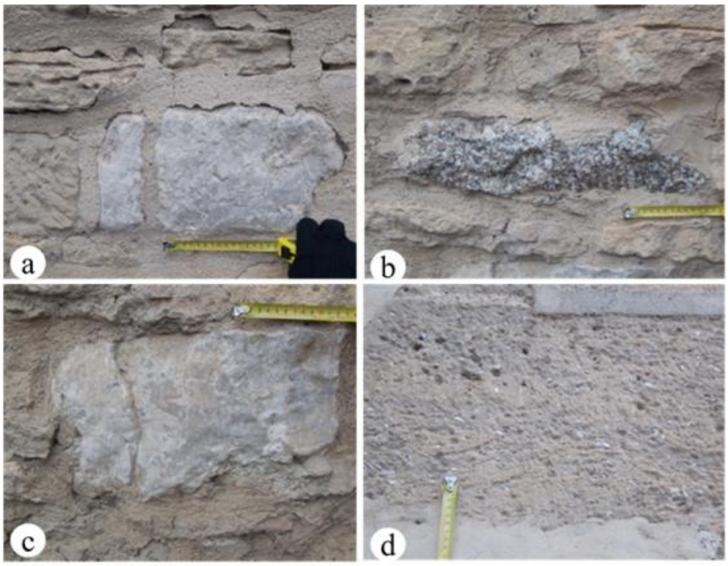

Fig. 7.Legibility of the difference between the old and the new rocks from the Galata Monastery wall of enclosure: a – Granite (magmatic rock); b – Litographic limestone (sedimentary rock); c – Quartzite (metamorphic rock); d – bioclastic sandstone

Another distinctive element from the sedimentary material used is the sedimentary facies. Facies described by a combination of physical rock characteristics such as mineral composition, grain size, color, and texture. One of the more common forms of facies modeling, as most of the facies, are discernible on an outcrop scale. Facies were an important development into the concept of stratigraphy because when compiled together, facies can generate a succession that can give insight into an assortment of different process and systems that acted on or within the region and rock record [28]. The sedimentary facies [29-31] from the wall of enclosure it can be identified:

- *planar parallel stratification* (Fig. 6d),
- *low angle cross stratification* and
- the so-called *storm lag* (Fig. 6a) .

Some rocks with bioturbation were noticed too, with molds of Sarmatians mollusks incorporated (Fig. 6b and c). Based on these trace fossils, a number of scientific papers [32] indicate the presence of so called *Lockeia Ichnogenus,* sourced from the aquatic environments with bivalve (such as marine, brackish, rivers and lacustrine environments).

Microscopic analysis and ooids description

Within the sedimentary rocks from the Iași area, it can be identified in major number of the grainstone limestones [33]. The *Ooids* show spherical forms and in some cases they appear with two or three nuclei successively attached and covered by common layers closer to the spherical form. The nucleus of the ooids is formed, in most cases, from monocrystalline quartz. The bioclasts are represented by bivalves and bentonic foraminiferes. The cement is calcisparitic *I. Kalmar* [34] shows that *Repedea* oolites represent a variable proportion, between 5 and 85%; they show spherical forms, rarely ovoid or irregular, and do not exceed 0.4mm in diameter (Fig. 8).

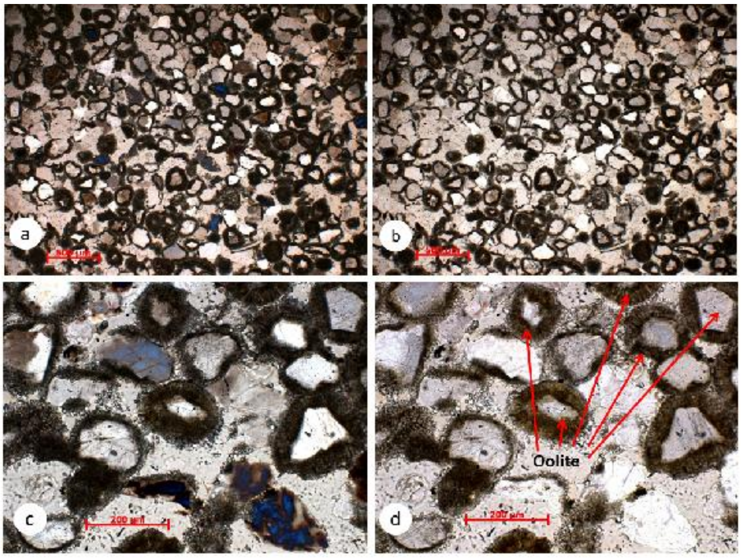

Fig. 8. The structure in cross section of porous limestone from an isolated open pit from the village Paun – Repedea Hill

The structural elements specific to such oolits are as follows (Fig. 9):

- a nucleus in which morphology represents the mold for the first layer, evolving gradually to the spherical characteristic shape;
- at least two, but usually over ten concentric layers of nanogranular fibrous calcite that are distinct by size, color and by the interruption of the fibers;
- gaps of parallel detachment, with the layers of oomicrite near the nucleus, between the layers or in the immediate vicinity of the last layer;
- complete or discontinuous crusts of siderite, partially or totally affected by limonitization, at the contact of two successive bands of oomicrit;
- particles of silt included in the oomicrite.

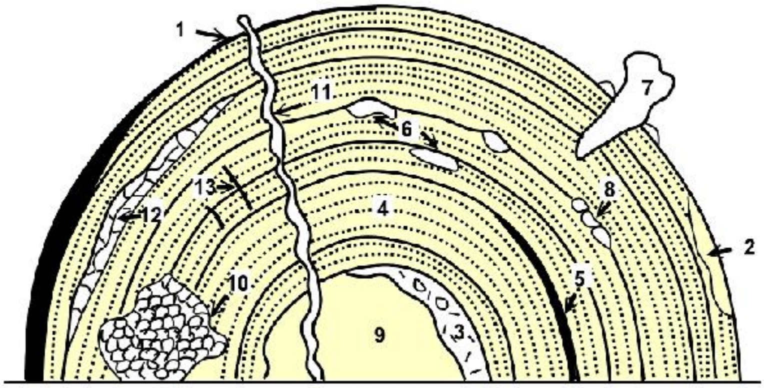

Fig. 9. Internal structure of an ooid corpuscle [34]: 1 - sideritic or limonitic crust; 2 - corrosion front; 3 – sparitic calcite; 4 - oomicrite; 5 - sideritic or limonitic layers; 6 - sideritic or limonitic drops; 7 - extraclast or bioclast; 8 - embedded silt particles; 9 - nucleus; 10 – micrite/sparite recrystallization of ooid (or oomicrite); 11 – calcitic microfracture; 12 - oomolds; 13 - goethite needles

Comparative study of the provenience of the rocks from the wall of the enclosure of the Galata Monastery

Following the petrographic macroscopic analysis of the rocks from the wall of the enclosure of the Galata Monastery, a number of aspects can be highlighted on the sedimentological and paleontological point of view. A high number of the rocks from the wall comes from the open pits form the Repedea Formation, nearby the village Pietrarie – Barnova, exhausted nowadays and transformed into scientifical reservation.

From a paleontological perspective, it is noticeable to this rocks the predominance of the shells of *Mactra podolica*, sometimes as agglomerations of bioclastic limestone, demonstrated in some scientific papers [10].

Part of the rocks from the wall of the enclosure of the Galata Monastery, especially in the South side, with the belfry, have a petrographic and paleontological characteristics similar to the calcarous – sandstones of Scheia. A first argument is the macroscopic sandstone matrix of some of the rocks. From a paleontological perspective the main characteristic of the calcarous sandstones of Scheia is given by the abundance of bivalve taxons of *Mactra fabreana* and *Plicatiforma fittoni*, but also the presence of gasteropodes belonging to different species of *Potamides*. These rocks originate form the open pits of Scheia area (mostly from Floresti open pit), as well as from a number of open pits from South of Iasi City, especially from Schitu Duca or Dobrovat areas.

Besides, *M. David* [35] draw some geological sectiones, since 1922, and shows that on the Dobrovat area had been open a number of construction rocks open pits. Our researches in the Schitu Duca area, (Dobrovat neighborhood) identified some open pits in the Scheia Formation, in the slopes from the left side of the Vasluiet river. *A. Chelarescu et al.* [36] shows a number of geological sections in the open pits from the Scheia area. Nowadays, rocks from *Zupaita* and *Din Fata* (*From the Front*) open pits are still extracted.

Some authors, analyzing the provenience of the material from the Wall of the Enclosure of another medieval monastery from Iasi (Golia), identify as source of component rocks the open pits from Repedea – Paun, Scheia, Vararia – Mitoc, from the right bank of Prut river, Eastern border of Romania [37]. Thus, it can be estimated that the geomaterials used for the

Masonry of the Galata Monastery are also mostly from the Repedea and Șcheia open pits, intensly extracted in the past. The use of rocks from Dobrovat quarry is not excluded as well [35], mostly for the restoring work within 1961 and 1971 years but also some different magmatic and metamorphic rocks of Eastern Carpathian was used.

Conclusions

The petrographic study of the wall of enclosure of the Monastery Galata confirms the prevalent presence of the sedimentary rocks from the open pits of Repedea and Scheia Formations. In the composition of carbonate rocks from Iasi area there are mostly oolitic and grainstone limestones. From a paleontological perspective, prevalence of *Mactra podolica* shells is noticed in the composition of these rocks, sometimes as bioclastic limestone. Thereby, it can be appreciated that geomaterials from the open pits of Repedea and Scheia area were predominantly used, but also the open pit from Dobrovat is not excluded as the rock source. These open pits were intensely exploited within the Middle Ages to the first decades of XX century.

Nowadays, these open pits mentioned have a low volume of geomaterials for constructions that imposes to start interdisciplinary studies and research from the perspective of *Preservation Science* for the historical monuments with the following major objectives:

- for any preserving and restoring actions, same or similar materials as the initial ones should be used for prevention of possible technical and esthetic incompatibilities;
- evaluation, data and information on the resources of natural rock compatible with geomaterials present in the most of medieval historical monuments of Iasi city.

Thereby, it can be concluded that the decryption of any message hidden in the petrography, sedimentology and/or mineralogy of the rocks from the building of the Galata Monastery – Iasi is an useful step and necessary for all the specialists involved or interested in the preservation and restoring of the historical buildings.

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