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## **NATURAL STONES IN THE BASEMENT OF THE GALISIAN HISTORICAL BUILDINGS**

*The data on the rocks composition and their origin in the basement of sacral, defense, cultural and popular historical buildings of Galicia (the modern Western Ukraine) are given. The region has been recognized as a good area for testing of natural stones sources to establish monumental buildings for different purposes from ancient epochs up to modern time. Mineralogical and petrographic approach has been involved to determined initial rocky materials of the buildings and their possible initial origin. Conclusions were made on the raw stone materials used and the probable locations of their ancient mining. Limestone, sandstone and gypsum (alabaster) were the most common materials for the buildings. They came mainly from nearest local quarries. An ancient building in a good state of preservation is determined by low activity of natural and anthropogenic factors of destroying.*

**Keywords:** *natural stones, limestone, sandstone and gypsum (alabaster), basement, Galicia, historical buildings, archaeological and architectural petrography, preservation of constructions.*

### **Introduction and statement of the problem**

In spite of purposes any buildings need in strong basement. As a basement we regard underground part of buildings which is carrying construction to protect it from loading of ground parts and support regular distribution of pressure on the soil. In course of time clay basements and made with wood replaced by common for us stone basements to supply its operation for much more long time and protect against more higher pressure on the basements.

Usually, old basements of the buildings are detected at the places with cultural layers within present time towns or among ancient villages during archeological excavations. Due to these finds there is a possibility to reconstruct general view of the historical buildings. Galicia (the modern Western Ukraine) is rich in sacral, defense, cultural and popular historical buildings [2, 4, 5, 10] and therefore

the region has been recognized as a good area for testing of natural stones sources to establish monumental buildings for different purposes from ancient epochs up to modern time. We observed and described natural stone utilization in basements of historical buildings in Galicia (Figure) as well as analyzed of its composition, causes and character of alterations and destructions.

### **Analysis of last investigations**

Today there are numbering literature sources on history, location and general peculiarities of different ancient monuments in Galicia [2, 3, 5, 6, 10]. A large amount of data are being accumulated which will enable architects, historians, geographers etc. to construct a knowledge model of life of the old monuments. We can find registers of relatively well dating, geometry, legends on foundation and future development the most famous old buildings here. Besides

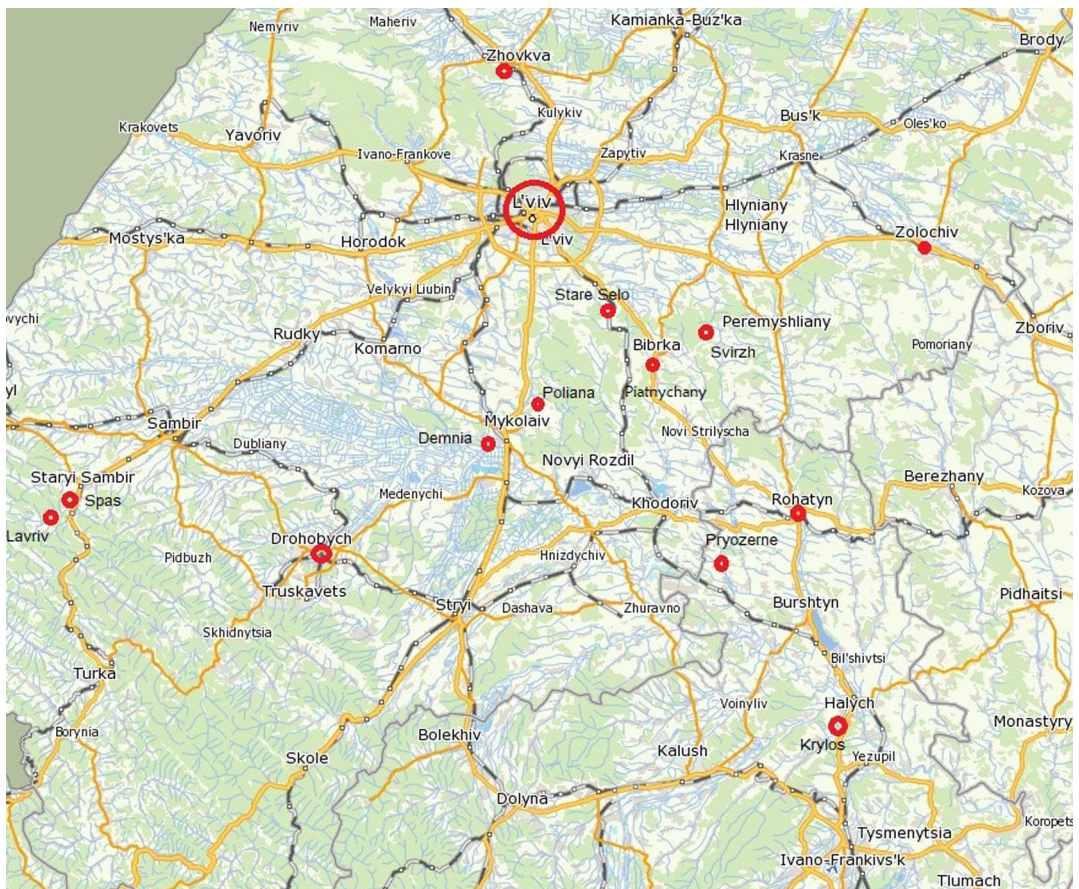
this rich information there is a little data on composition, origin and physical properties of involved natural materials. For example, in description of defensive and sacral architecture of Precarpathian [4] there is only sentence on name of rocks which used to do walls near the Church of Virgin in Rogatyn town (Ivano-Frankivsk Province).

But for purposes of restoration and creation of separate building history we need in information on source of involved materials and their peculiarities. According to results of the Scythian stone sculpture investigations with mineralogical and petrographic methods [8] there is a great possibility to get suitable information for scientific and practical purposes. Similar success geologists [1] obtained to determine data on origin of

limestone which has been used to build the defense tower (See Figure) near Piatnychany village (Zhydachiv district, Lviv Province). Authors [1] detected there five lithotypes of the limestones with different structural and textural features by mineralogical and petrographic investigations. Mechanical and chemical properties of the limestones are closely connected to their petrographic traits. So, this way is promising in the architecture, building, history and rock mechanic.

### Obtained data and materials

Firmness, wide distribution of different natural materials and its perennial cause intensive utilization of natural stones to build the construction basements for living, defense, sacral etc. purposes since the most old



**Figure.** Map showing locations of the observed objects

times. Separate rock blocks are main components of stone constructions of the basements. They are joined predominantly into one whole by mortars and after harden form solid and monolithic massive. Sometimes old stonemasons skilled selected separate blocks and obtained stable constructions without any mortars.

To build basements since old times masters used rocks broken up to 500 mm with weight up to 50 kg as well as sawn blocks different in sizes. In last case the sizes of blocks depend from physics and mechanical peculiarities of stone and abilities of stonemasons in given historical period. Depths of basement lying were determined as rule by depths of soil freezing. The most typical depths are varying from 70 cm up to 1,8 m. Width of the basements should be more than thickness of walls.

#### **Composition and peculiarities of the building rocks**

As broken pieces of rocks for basements have been used whole suitable and present local stone materials. For these purposes alluvial pebbles and boulders have been often collected. For example, construction of basement of rocky Cyril and Mephodii's Church, which was found in 1882 year by L. Lavretskyi and I. Sharanevych in the former metropolitan forest Dibrova (to the western from Krylos village, Ivano-Frankivsk Province), is made with alluvial stones series. The Church has four pillars, three apses and is dated by last third of the XII century. The basement was built with clay and lime-sanded mortar which contained admixtures of wood coal and fired clay [6].

Basement of the Church upon Tsaryntsi (Tsarynka value) has similar construction with alluvial materials and clay [2], but basement of the Annunciation Church (XII–XIII centuries, located on the Tserkvys'ka field near Chetverky village at the left side of Lukva River) is much complicated due to slanting spread of alluvial stones with lime-sanded mortar (in fir style) [2, 6]. Basement of the Resurrection Rotunda (Resurrection value, in opposite of Krilos site of ancient,

at the right side of the Mozolev spring) contains marl slabs or silica clay which are lay down on soil and clay beside alluvial pieces. All construction is dated by XIII century [2, 6].

Irregular in shape break stones have been used in the basement (Photo 1) of rocky defense tower at the hill near Piatnychany village. It is dated by XIV–XV centuries [2, 10]. This material put at the low levels of basement. It's represented by boulders with irregular-prismatic or isometric shapes and different in sizes. The fragments have been put to the basement irregular to each another (under some angle) or with some similar directions (long axis of the boulders are sub parallel to each another). Limestone is main component of the break stones. It is represented by different lithological types including separate lithotamnia alga nodules [1].

Fine crushed limestone with lithotamnia alga and mortar with thickness from 2 up 5 cm have been involved to connect separate blocks in this tower. Besides described early the break stones to build the basement the separate lithotamnia nodules have been used as an independent element. Source of these nodules we found in colluvium sediments near deserted quarry near the village [1].

So, different in origin, dimensions and composition material were involved for the basements with rough-stones. Accessibility of the stone materials and possibilities to make from them monolithic and strong constructions, which will serve for a long time, were the most important factors for selection of the material.

The most historical buildings which came to modern time with different stages of safety contain the basements composed by stone blocks. The sorts of used rocky materials are various and depend by quarries presence near new build constructions. Dimensions of the block are different in the same construction therefore we cannot make any conclusions in relation to typical sizes of the blocks.

The most common material of the basements in historical part of Lviv City is limestone with different lithological types, and less sandstone (Photo 2). Popularity of limestone among stonemasons is related to



**Photo 1. Fragment of the basement of rocky defensive tower near Piatnychany village**



**Photo 2. Basement of the ancient buildings of Lviv City made with trim sandstone (a) and limestone (b) blocks**



a

presence a number of limestone quarries surrounding and near the City places. Relatively easy processing of the limestone blocks is a second important factor for its utilization.

Sandstones in the basements are also common in historical buildings surrounding of the Lviv City. For example, we can see only sandstones blocks in the basements of castle in Stare Selo village (Pustomyty District) which is dated by XVI–XVII centuries (Photo 3). Sandstone also has been used to build the basement of the Svirzh Castle (Peremyshlynu District) since XVI century, and it was come from quarry exactly near the castle.

Sometimes in the basements involved rocky materials which are not typical for old building industry. It determined by presence of suitable materials in significant volumes in the absent traditional for region rocks. Good example of this case is utilization of alabaster blocks for the basement of the Assumption Cathedral Church in Krylos Village which is dated by XII century



b

**Photo 3. Trim sandstone blocks in the basement of the Castle in Stare Selo village (a) and trim limestone blocks in the basement of St. Joann in Poliana Village (b)**

(Photo 4a). The basement is built with trim alabaster blocks connected by gypsum mortar. In this area alabaster was a usual material for a long time due to its accessible up to appearance of more stable and suitable materials. Basement of the primary building of the Earl's Ray Palace (since XVIII–XIX centuries) in Pryozerne Village (Ivano-Frankivsk Province) is composed by fine-, middle, and coarse-grained gypsum and alabaster blocks (Photo 4b). In both cases raw material was transported from nearest quarries.

As we noted above, to put basements as not ever masters used mortars. For instance, during observations of the Monastery in Spas Village (Lviv Province) relics of the basement with local plate-rock without mortar were found [10]. Sometimes the basement constructed in two stages, and firstly put rock pieces different is sizes with addition of fine material, and then all mixture covered by mortar [10]. This technic we determined in the St. Onufriy Church in Lavrov Village (Staryi Sambir District) which dated by XIII century.

#### **Alteration and destroying of the buildings**

Wear and tear of time for the basements is most significant due to natural and anthropogenic factors. Dampness is most important natural factor for basement destroying. High levels of ground water in connection with imperfect systems of water drainage are conductive to active damping of stone constructions. Presence of pores and capillaries in rocky material and mortar of the basements led to capillary pull up of water and passing of force water [7]. Materials with small capillary diameters pass a little of force water, but capillary pull up a lot of water and vice versa. Basements made with small amounts of pores, but with carbonate or clay mortar will pull up of water only by mortars.

Probably, ancient masters already knew a lot about water migration through stone fragments or mortar in the basements and to get out of a humid influence on walls and basements used for constructions coarse sands, gravels or detritus, which practically don't soak up of water. For these purposes the

masters significantly increased also amount of sand in mortars.

But active destroying of stones in basements take place not only due to influence of soil waters. Sometimes rocks which cover the basement are a good protector against atmospheric factors, day and season temperature variations. At the same time the elements of basements are intact after even thin layer of rock cover.

Natural and anthropogenic factors support mechanical and chemical destroying and dissolution of rocky material of the basements and as a result we can see loss of power abilities of constructions. It is important that tendency of alteration and destroying of the same rocks is similar in open air nature [9] and in buildings [7]. The difference has been depended only from scale of process.

Imperfection of technologies, future modern rebuilding according to new times and styles of life, presence of roads with intensive traffic, constructions near historical objects, war times are main anthropogenic factors which lead to destroying of the historical architecture monuments.

Crack with atmospheric factors, softening and fluff of solid fragments to the centers, changes of relief of rock surfaces, appearance of salting-spots can be detected visually during main stages of primary material reworking.

Later on intensity of its factors is increasing and after development of cracks systems and dissolving and moving off important components complete destroying has stopped history of buildings.

#### **Conclusions**

Galicia is a good area for testing of kinds natural stones which used to establish monumental buildings for sacral, defense, cultural and popular purposes from ancient epochs up to modern time. Mineralogical and petrographic approach should be involved to determine initial rocky materials of the buildings and their possible initial origin. Limestone, sandstone and gypsum (alabaster) were the most common materials for the basements. They have been transported



a



b

**Photo 4. Basement of the Assumption Cathedral Church in Krylos Village made with trim alabaster blocks (a) and fragment of the trim gypsum basement (b) of the Earl's Ray Palace in Pryozerne Village**

mainly from nearest ancient local quarries. Compositional and structural-texture peculiarities of the raw stone materials were very important characteristic for their ancient utilization and are significant criteria for involving these materials for restorations. For present day restorations these materials can be used to create similar fragments of buildings or surrounding walls. An ancient building in a good state of preservation is determined by low activity of natural and anthropogenic factors of destroying. To keep for a long time in a good condition details of ancient constructions is expedient protection with natural materials.

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#### ПРИРОДНІ КАМЕНІ У ФУНДАМЕНТІ ІСТОРИЧНИХ БУДІВЕЛЬ ГАЛИЧИНИ

У статті наведено дані про склад і походження порід з фундаменту сакральних, оборонних, культурних і публічних історичних будівель Галичини (сучасна Західна Україна). Регіон розглянуто як гарну територію, придатну для визначення джерел природного каменю, який використовували під час спорудження монументальних будівель різного призначення від давніх епох до нашого часу. Мінералогічні та петрографічні дослідження використано для визначення вихідного кам'яного матеріалу в будівлях і можливого їхнього первинне походження. Зроблено висновки щодо використаного матеріалу-сирцю і ймовірного розміщення давніх каменярень. Найзвичнішими породами для будівництва фундаментів були вапняк, пісковик і гіпс (алебастр), які розробляли здебільшого в найближчих міс-



цевих каменярень. Збереження стародавньої будівлі в доброму стані зумовлювала низька активність природних і антропогенних чинників руйнування.

**Ключові слова:** природні камені, вапняк, пісковик і гіпс (алебастр), фундамент, Галичина, історичні будівлі, археологічна та архітектурна петрографія, збереженість будівель.

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## **ПРИРОДНЫЕ КАМНИ В ФУНДАМЕНТЕ ИСТОРИЧЕСКИХ СТРОЕНИЙ ГАЛИЧИНЫ**

В статье приведены данные о составе и происхождении пород из фундамента сакральных, оборонных, культурных и публичных исторических строений Галичины (современная Западная Украина). Регион рассматривается как подходящая территория, удобная для определения источников природного камня, использованного при возведении монументальных зданий разного назначения от древних эпох до нашего времени. Минералогические и петрографические исследования использованы для определения исходного каменного материала в строениях и возможного их первичного происхождения. Были сделаны выводы об использованном материале-сырце и вероятном расположении древних каменоломен. Наиболее обычными породами для строительства фундаментов были известняк, песчаник и гипс (алебастр), которые разрабатывали главным образом в ближайших местных каменоломнях. Сохранность древнего строения в хорошем состоянии определялась низкой активностью природных и антропогенных факторов разрушения.

**Ключевые слова:** природные камни, известняк, песчаник и гипс (алебастр), фундамент, Галичина, исторические строения, археологическая и архитектурная петрография, сохранность строений.