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Copying Geological Relics in the Process of Preservation and Restoration of Architectural Monuments

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Abstract: Lviv is a historic city known for its architectural landmarks. The historic part of Lviv, which is included in the UNESCO World Heritage List, has the majority of its buildings constructed from stone. This architecture – walls, towers, townhouses on Rynok Square, sacred structures, and so on – requires preservation, constant care, and often restoration. For professional and thorough restoration of stone objects, it is essential to understand the nature of the material from which the monument was built. Here, collaboration with the Faculty of Geology at Lviv University provides invaluable support. Professors and geology students study the geological material from which Lviv was built, including its precise dating and origin. Such information is particularly valuable when it is necessary to supplement damaged details or replicate lost ones.

At the same time, during such detailed study of geological materials on Lviv's streets, geology students discover fossils or remnants of ancient organisms, which are valuable scientific objects. Most often, these are various shells, and sometimes plant leaves. A true gem discovered on a stone in a street curb at 6 Akademika Hnatyuka Street in Lviv is a fossil of a starfish. This unique and extraordinary geological relic undoubtedly deserves preservation. Simultaneously, this geological relic is part of the city's street, meaning it is part of its architecture, and currently cannot be removed.

As part of the collaboration between Lviv University and Polytechnic University, involving the Department of Geology and the Department of Architecture and Restoration, a mold was taken from the relic, and subsequently, a replica of the starfish fossil was created. Today, the object is housed in the university's geological museum and is one of its valuable exhibits. This article analyzes the methodology for copying geological relics and presents the step-by-step process of creating a copy of such a relic, using the example of the starfish from Lviv.

Keywords: architecture, stone, geology, preservation of monuments, copying

Introduction

The study and preservation of geological monuments are essential for understanding the history and evolution of the Earth. Fossil collecting dates back to prehistoric times, practically to the beginning of humanity's written history. In Europe, there are examples of stone knives with fossils embedded in their handles, dating to prehistoric times. Neanderthals also used large fossil shells as ornaments, particularly as beads, by drilling holes in them. Thus, we can say that fossils were used as works of art even in ancient times. Unique "paleontological" collections also existed in ancient Egypt, where they were associated with religion. For example, five-pointed fossil shells of sea urchins were associated with the deity of the rising sun and were stored in the temples dedicated to that deity. During the times of Ancient Rome, fossils were studied by naturalists, including Pliny

the Elder. It was during this period that many groups of fossils received their names (The Geological Society of London, 2024).

The environment in which geological monuments are formed is stone, which can be part of a rock, a cave, or sometimes even architecture, as in the case of Lviv. Due to the natural fragility of such objects, it becomes necessary to develop methods for copying and replicating geological monuments. The precision and reliability of these methods are crucial since they determine the preservation of information about our planet for future generations and the scientific community.

This paper discusses methods for preserving geological objects that can be part of architecture using conservation techniques based on copying sculptural compositions. Sculptural copying is the process of creating duplicates of sculptural works, usually using various techniques and materials (Marjorie Trusted, 2007). This process can be significant for the preservation and restoration of historical artifacts, as well as for creating reproductions or copies for scientific, research, commercial, and other purposes.

The aim of the work

The aim of this work is to present methods for creating copies of geological monuments that cannot be removed from their environment of formation, for their preservation and further study.

Presentation of the research material

Fossils, or fossilized remains of organic origin, are either the remains of ancient organisms or their imprints (such as traces or burrows, etc.). They are an important source of information about ancient life on Earth. The territory of Ukraine, due to its geological diversity, is rich in fossil discoveries from different eras (Buell, 2007). In ancient times, an ocean existed where the Carpathian Mountains would later form, as evidenced by the fossilized remains of marine organisms found here. The variety of inhabitants of that ancient sea is impressive. The most commonly found fossils include shell imprints, corals, sponges, and sea urchins. The shape and size of these fossils can be extremely varied. Alongside them, plant remains (such as ferns and bamboo) are also occasionally found.

Fig. 1. Photographic documentation of the fossil on Akademika Hnatyuka Street 6 in Lviv. *Photo by O. Stasyuk, 2024*

The study of these remains allows for the examination of evolutionary processes that took place in the past. Therefore, the preservation and copying of fossils are important tasks for paleontologists, as these fossilized remains are valuable scientific objects that require proper care to preserve their form and structure. According to Viktor Matura, starfish are rarely found in paleontologists' collections – organisms that lacked a hard shell and are only found in rock formations as imprints on stone (Skavron, 2013). A unique fossil of a starfish was found in a curb at 6 Akademika Hnatyuka Street in Lviv (Fig. 1). Given the natural fragility of such objects (Tuzak, Kurchanova, 2022), it becomes necessary to develop methods for copying and replicating geological monuments. The accuracy and reliability of these methods are crucial, as they determine the preservation of information about our planet for future generations and the scientific community.

At the request of colleagues from the Department of Geology at Ivan Franko National University of Lviv, we have presented and described the main methods by which students from the Department of Restoration at the National University "Lviv Polytechnic" can copy fossils that cannot or are difficult to remove from various rocks or objects of exploitation.

Creating a mold from plaster

The original, previously coated with a soap solution or petroleum jelly, is covered with plaster up to a thickness of 3 cm. The mold can be made from one or several pieces, depending on the complexity of the object being copied. Once the plaster hardens, the mold is removed from the original. If it is made of multiple pieces, the parts are assembled and fixed together using thick string or wire (Viktor Melnyk, Olena Stasyuk, 2017). The mold can then be filled with artificial stone to create a copy with different textures, colors, etc.

Creating a mold from plaster

The original is isolated, coated with a soap solution, and then covered with silicone to a thickness of 2 to 5 mm. Silicone can be either two-component or single-component (Jerzy Ciabach, 1998). For additional strength and durability, the mold is reinforced with gauze. The gauze is soaked in silicone and applied in several layers to the object. Once the silicone hardens, a plaster shell is made for additional fixation. After the plaster hardens, the mold is removed from the original—first the plaster shell, then the silicone. As a result, a double mold is obtained, which can also be reused multiple times. Silicone has proven to be an excellent material for copying, as it is highly flexible and perfectly captures all textures and nuances of the form.

3D Scanning and Printing

The sculpture can be 3D-scanned to create a digital model, which can then be reproduced using 3D printing. This method allows for the creation of precise copies in three-dimensional space and is used in various fields, including art, design, and manufacturing. A significant number of photographs are taken with a camera from different angles and perspectives, which are then processed using specialized software to create a computer model. It is important to note that during the photography process, additional lighting must be provided to the object to ensure that shadows do not affect the quality of the image (Remondino, Fabio, 2011).

Wax Casting

Wax casting is used to create a wax pattern, which is then used for casting a metal copy. Hot wax is poured onto the object and left to cool until the casting can be removed from the original. The wax mold is then filled with plaster, allowing the mold to be reused (Dick Parry, 2006).

Each of these methods has its own advantages and limitations, and the choice depends on the specific needs and characteristics of the original object.

In November 2023, the Faculty of Geology at Ivan Franko National University of Lviv requested the copying of a geological monument – a fossil of a starfish located in the curb at 6 Akademika Hnatyuka Street in Lviv. The copying of this monument was carried out using the method of creating an impression from plasticine.

A similar method was used for copying petroglyphs in the historical and cultural reserve "Tustan" (Natalia Harkot, 2016). In Tustan, petroglyphs are carved on rocks, and these rocks are both a geological and architectural monument. The rock petroglyphs represent significant cultural and historical value and require protection. The images are carved in hard-to-reach locations, making them impossible to remove. Copying the petroglyphs using plasticine was chosen as the method for museum preservation of the monuments.

The process of copying the Lviv fossil was carried out in the following sequence:

1. Initially, the surface of the fossil was treated with hot water to safely remove surface contaminants—dust and dirt.
2. The next step was filling the impression with plasticine and removing this mold from the curb (Fig. 2).
3. After that, a plaster mold was created for further copying of the impression.
4. Once the mold dried and was given an exhibition appearance, it was toned to match the color of the curb.

Fig. 2. Plasticine mold of the fossil. *Photo by O. Stasyuk, 2024*

Fig. 3. Plaster copy of the fossil. *Photo by O. Stasyuk, 2024*

Thus, we obtained an exact copy of the geological monument. The copy is currently housed in the geological museum of Ivan Franko National University of Lviv (Tuzyak, Ivanina, Hotsanyuk, 2021).

Unfortunately, the original fossil, which remains on the streets of Lviv, is in a situation that poses a threat to its preservation and even its existence. In addition to the natural conditions, which in our city are quite harsh for stone (such as autumn and spring rains and winter temperature fluctuations), the location of the monument, effectively underfoot and subjected to the wheels of cars, is also unfavorable.

Conclusion

The preservation of geological monuments, which are part of architecture, such as fossils, is an important task for science and society. Since some objects cannot be removed from their natural environment or from architecture, various methods of copying are applied. This study demonstrated the effectiveness of different approaches, including plaster, silicone, and plasticine. Each of these methods has its advantages, but the choice depends on environmental conditions, the state of the original, and the purpose of creating the copy. In the case of the starfish fossil found in Lviv, using a plasticine mold was the optimal choice, which confirms the necessity of adapting methods based on circumstances to ensure accurate preservation and reproduction of objects.

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Kopiowanie reliktów geologicznych w procesie ochrony i restauracji zabytków architektury

Streszczenie: Lwów jest historycznym miastem znanym ze swoich zabytków architektury. Historyczna część Lwowa, wpisana na listę światowego dziedzictwa UNESCO, składa się głównie z budynków wykonanych z kamienia. Ta architektura – mury, wieże, kamienice na Rynku, budowle sakralne itp. – wymaga zachowania, stałej troski, a często także restauracji. Aby profesjonalnie i dokładnie restaurować kamienne obiekty, istotne jest zrozumienie natury materiału, z którego wykonano dany zabytek. W tym aspekcie nieocenioną okazuje się współpraca z Wydziałem Geologii Uniwersytetu Lwowskiego. Wykładowcy i studenci geologii badają materiał geologiczny, z którego zbudowano Lwów, wyjaśniają jego dokładne datowanie oraz pochodzenie. Takie informacje są szczególnie cenne w przypadku konieczności uzupełnienia uszkodzonych detali lub wykonania replik elementów utraconych.

Równocześnie, podczas szczegółowego badania materiałów geologicznych na ulicach Lwowa, studenci geologii odkrywają skamieniałości, które są cennymi obiektami naukowymi. Najczęściej są to różnorodne muszle, czasami liście roślin. Prawdziwą perełką odkrytą na kamieniu w krawężniku ulicznym pod adresem ul. Akademika Hnatiuka 6 we Lwowie jest skamieniałość rozgwiazdy. Jest to unikatowy i wyjątkowy zabytek geologiczny, który bez wątpienia zasługuje na zachowanie. Jednocześnie ten zabytek geologiczny jest częścią ulicy miasta, a więc także częścią jego architektury, i obecnie nie można go usunąć.

W ramach współpracy pomiędzy Uniwersytetem Lwowskim a Politechniką, Katedrą Geologii i Katedrą Architektury i Restauracji, wykonano formę od reliktu, a następnie kopię skamieniałości rozgwiazdy. Obecnie obiekt znajduje się w muzeum geologicznym uniwersytetu i jest jego cennym eksponatem. W artykule przeanalizowano metodykę kopiowania zabytków geologicznych oraz przedstawiono kolejne etapy wykonania kopii na przykładzie rozgwiazdy z miasta Lwowa.

Słowa kluczowe: architektura, kamień, geologia, ochrona zabytków, kopiowanie