

Identifying stone carving and stonemasonry techniques in the dating and authentication of built heritage and artefacts

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Abstract: *This article aims to underline the importance of understanding traditional stone processing techniques in order to better approach the authentication and dating of historic structures and cultural objects. The constructive methods employed, the chosen materials and the tool marks are in themselves historic documents which communicate information regarding individuals, groups and societies from the past. While it is well established that craftsmen in antiquity and the middle ages travelled to different regions, their origin and identities are not always known. Moreover, by correlating specific stone finishes with their respective tools, it is possible to trace different aspects which are essential to the preservation of cultural heritage.*

Key Words: *stone carving, tools, techniques, authentication, monuments.*

1. INTRODUCTION:

It is sometimes the case that even a well-known monument is later re-examined and a different time period is attributed to it. This applies to monuments whose construction is not documented, leaving archaeologists to date it based on physical characteristics such as the type of masonry employed, architectural style, materials, inscriptions. However, some elements can be misleading. Funerary monuments may bear a certain year or date, but one also has to consider it may have been constructed or re-constructed at a later time. Also, large edifices may have been built over a long time period, bearing traces of different architectural styles. Furthermore, up until more recent times, around the 19th century, when the notions of conservation and restoration started to be outlined in their current sense, it was always a common practice for older building materials to be re-used. This involved dismantling stone blocks from abandoned constructions and using them for building new ones. A particularly well-known example can be the Basilica Cistern in Istanbul. It is a large underground vaulted construction built under the Christian emperor Justinian I, considered a marvel of Byzantine engineering and architecture. Among its distinguishing features are two large heads representing the Medusa at the base of two of its pillars. Although the reasoning behind this is not yet confirmed, most likely these were re-used from a heathen temple simply because they are large and solid, ideal for supporting a heavy load.

2. ANALYSIS:

Types of stone masonry

Stonemasonry can be loosely categorized into rubble stone masonry and carved stone masonry. These are also found in different varieties and are categorized differently according to different languages. Rubble stone masonry employs mostly stone as extracted in its natural state, having a more irregular shape, usually slightly adjusted during work with a hammer. However, the stone is usually sorted according to its size and shape, the purpose being to have stability in the wall regardless of what mortar is used. While modern rubble stone masonry is still used, often it involves the use of concrete backfilling and cement mortar to assure its solidity. Traditionally, this building technique relied on mastering the craft in order to create solid structures solely using a strong bond, without mortar having a significant structural role. A variety of this uses no mortar at all, usually referred to as dry stone masonry.

Carved stone, or ashlar masonry as it is often referred to in English, can be divided into different types, depending on the shape, size and finish of the stones. However, understanding the specific process of their making is more important, as it will aid in their correct assessment.

Stone quarrying and rock splitting techniques

Stone blocks are traditionally extracted in quarries using natural fault lines, creating new fissures and applying the principle of leverage. The size of the blocks depends on the nature and quality of the rock. The most efficient method of rock splitting utilizes metal wedges. The process starts by tracing and carving a series of narrow rectangular holes along a line, using a sharp point or a flat chisel. After completion, the wedges are fixed into these holes and struck repeatedly until a fissure is formed. Additionally, narrow trenches may be cut into limestones using a quarry pick, in order to better control the break. The marks left by this process (long narrow grooves) are some of the most frequently found in historic quarry sites.



Fig.1 – Plugs and feathers (stone splitting wedges)

Another variety of stone-splitting wedges are composed of three pieces: two feathers (reverse wedge shaped) and a plug fitted between them (Fig.1), forming a cylindrical shape. For utilizing it, a series of holes are drilled, the feathers are introduced, then the wedges are driven between them until a fracture forms. Although hand drilling has existed since prehistory, it wasn't until the 19th century that this method gained favour due to the introduction of the pneumatic drill. Engineers G.Betea, I.Albu, I.Lazarescu (1) and G.R.Thiladze (2) suggest the ideal distance between perforations to be between 7 and 11 cm, respectively 7 and 20 cm, according to the type of rock. These distances may also need to be adjusted to the size and shape of the material, measuring and tracing the first and last holes, then dividing the resulting distance according to the closest and most efficient number.

Table 1

Author	Type of stone	Distance between perforations
G.Betea et al.	Hard rocks (granite, andesite, labradorite)	7-9 cm
	Marble, limestone	10-11 cm
G.R.Thiladze (Тхиладзе Г. П.)	Hard rocks	7-9 cm
	Marble, semi crystalline limestones	10-11 cm
	Limestone	12-13 cm
	Tuff and other soft stone	15-20 cm

Stone carving tools

Stonemasonry is a craft that involves the use of a great variety of instruments, beginning with the quarrying phase, followed by the rough shaping and finishing. The following represents a selection of tools frequently used in Europe, the Middle East and the Mediterranean, although some of them are universal:

- The pick. Shaped like a pick-axe except with a sharp pyramidal point on both ends, it's used in the roughing out stage by striking the stone at an inclined angle. It is ideal for removing large quantities of stone and approaching the next stage of carving as much as possible. Weight: 3-4 kg.
- The square sledge-hammer. This tool is either used for striking larger stone splitting wedges or for striking stone blocks directly. The hardness of the steel utilized may give indication to its intended use. By striking slightly inclined, it is possible to split some smaller stones directly. Weight: 4-9 kg.
- The mash hammer (Fig.2). Despite its name in English, this is what is properly known as a stonemason's hammer and has existed in a similar shape since antiquity. It bears a flat face on one side, and a vertical peen on the other, being wedge-shaped. It is used for adjusting masonry stones: trimming, breaking or splitting. Weight: 1-2 kg.



Fig.2



Fig.3

- The pointed stonemason's hammer (Fig.3, left). Along with the mash hammer, it is a traditional tool. One striking end is flat or concave, often rectangular (used for pitching). The other end is pointed, like the pick. Its use was widespread throughout continental Europe and the Mediterranean. Weight for masonry: 1-1,5 kg. For quarry work 3-4 kg.
- The stone axe (Fig.3, right). There are several varieties, the most common ones being with two flat blades, another one has both blades with sharp teeth, and another one has flat teeth. All varieties are used for flattening the surface of softer limestones and sandstones. This tool was widely used throughout the Roman Empire and the Mediterranean.
- The toothed stone hammer. Similar to the toothed stone axe, except the blade is horizontal instead of vertical.
- The bush hammer (Fig.4). The striking faces of this tool have rows of pyramidal points. For versatility, the two have a different number of points (for example 16 and 25). The number of points on each side ranges from 9 to 81, although they can have 100 points or more. The most common numbers are 16, 25, 36, 49. The tool is used by striking flat onto the surface of the stone. By striking repeatedly, it pulverizes high points and creates a rough but even surface with a pleasant aspect. It is often used as a final finish of the stone. The bush hammer was introduced in the early 19th century for use on hard stones such as granite, but soon became preferred for use on limestone and sandstone. Viollet-le-Duc (3), one of the earliest renowned architects specialized in medieval buildings, suggested it was used beginning with the late 15th century, although he stated at that time the tool most likely resembled a toothed stone axe.
- The bushing chisel (Fig.5). A metal shaft with a square tip like the bush hammer. It is used mostly on marble and decorative stonework for creating texture.



Fig. 4 – Bush hammers



Fig. 5 – Bushing chisels

- The point chisel (Fig.6). This is one of the basic tools of the stone carver and it is used the most, mainly for removing stone in the roughing out stage. It is usually a cylindrical piece of steel with a sharp pyramidal point on one end. The angle of its sharpness, its length and diameter depend on the type of stone being worked.
- The flat chisel. Used for straightening the margins of stone and for refining surfaces. It comes in a variety of sizes but its cutting blade is always straight. For ornaments, letter-cutting and details, narrow chisels are used. For masonry stone margins, it's usually 20 mm wide (between 15-25 mm).
- The rounded chisel (also called a bullnose). Same as the flat one, but with a rounded cutting edge. Used on soft stones only, for creating concave grooves.
- The tooth chisel. A very widespread tool, extensively used from antiquity. Its cutting edge has sharp teeth or flat teeth, similar to the toothed stone axe. Used for removing high points and flattening the stone surface, leaving a number of specific grooves. Often its marks are left as a final finish.
- The wide chisel. Also called a bolster or a drove. Despite its aspect, it is not used for splitting stone, even though bricklayers sometimes use a similar chisel for splitting bricks. It is used similarly to the stone axe with the flat blade, for flattening surfaces. It is normally left for the final finish. This tool is used on softer limestones and sandstones and its cutting edge is between 4 and 10 cm, usually around 5-7, depending on the hardness and surface size of the material.

- The pitcher (Fig.7). A thick, heavy chisel with a square tip. Unlike other chisels, it doesn't have a sharp blade tip. Its cutting edge is usually very close to a 90-degree angle (around 80). Its width is around 38-40 mm, although some wider ones exist for softer stones. It is struck with a hammer at a slight inclined angle along the line of the desired stone edge to break off any excess and create a straight margin.
- The mallet (Fig.8). The stone carver's or stonemason's traditional mallet is used for striking chisels, is cup-shaped or bell-shaped and entirely made of wood. Its weight and diameter depend on its intended purpose: lighter for ornamental work or heavier for masonry stones. Usually from 600 g to 2 kg, on average around 800g – 1 kg. Wood is used to prevent deformation to the chisel's striking end but it also dulls vibration and reduces noise during work. More modern mallets replace the wood with a synthetic striking head, most commonly nylon.



Fig. 6

Fig. 7

Fig. 8

3.CONCLUSIONS:

In order to properly assess historic monuments and establish the most suitable restorative interventions, the analysis of tool marks is essential. These may give clues not just to the building methods, but even to the presence of migrating craftsmen or other socio-economic phenomena. Advanced crafts have always depended on continuity, tradition, relative prosperity as well as the balance of supply and demand in one society or another.

While inspecting a statue, a funerary altar or a carved architectural element, its level of craftsmanship gives us information about context. For example: What type of finish does it have? What tools were used? Are there any visible defects in its making? By simple observation, we can draw informed opinions, based on which we can make estimates and deduct further information.

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