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Response to the Workshop Analysing Rock Crystal and Other Hard-stone Craftmanship in Medieval and Early Modern Muslim Societies, From Raw Material to the Final Product

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I have written some responses below to the workshop entitled, 'Analysing Rock Crystal and Other Hard-Stone Craftmanship in Medieval and Early Modern Muslim Societies'. These responses are inevitably brief and only intended to give an overview of the methods that I use in cutting and carving stones. Writing this piece has enabled me to reflect on how the methods that I use in my work today are firmly rooted in the past; such as which grits may have been used by craftsman. This is poorly documented, and so I examine the use of grits briefly below. As Ben Gaskell stated, it is important to respect the Makers' Legacies, and indeed their techniques are still in use in lapidary workshops worldwide in the 21st century. Apart from the use of modern ultrasonic machines and modern materials for tools to improve the cutting and polishing processes, thereby making these processes easier and quicker, the techniques that I use in my workshop, set out below, are little changed from the time of the early modern Muslim Societies.

Several different skills and techniques must be employed, by experienced craftsmen to produce items such as The Rock Crystal Fatimid Ewers. Stone is a very unforgiving material, and any slip or mistake may result in a chip, crack or worse the breaking of the stone being worked on. This means that there must be a respect for the material and a knowledge of its limitations. This knowledge was only learnt by a combination of experience in handling and working stone. Modern craftsmen however have the additional benefit of being able to study photographs, texts and modern media. It is remarkable that the craftsmen in the Fatimid Workshops were able to produce such a high standard of workmanship on these large delicate items, given the simple tools that they employed.

It is likely that several specialist craftsmen would have collaborated to produce the Ewers. In a workshop it is usual to find that different craftsmen work on different aspects of the production

process; for example, there would have been carvers, cutters, polishers and so on. In my work, where I am a sole worker, it is important to understand as many of the production skills as possible. Much of my work is done purely by hand and eye, very much like how craftsmen through the ages have worked; the only major difference would be the use of electric power and some simple motors. If only a small run of one type of work is required, it is quicker and more cost effective to use simple tools rather than sophisticated machines to do the same job.

Lapidaries have always been creative in their art, use of tools, and production methods needed to create a final product. Invariably the ideal tool does not exist. Craftsmen would often adapt their tools in inventive ways to perform the task required. This is as true today as it was thousands of years ago. As tools wear down they become less useful for one job; this tool is not discarded but remodelled to perform another function. One example of this could be, as grinding wheels wear down they become less useful for one job, so may be employed for another. Another example of this could be that the waste grit can also be collected, and then used as an abrasive slurry for another job. This principle applies to both lapidaries and glass engravers.

Quartz

Clear quartz is a valued rare material, so it is important to achieve the best yield (i.e. the most gem quality and the least waste) from the rough crystal. In the case of the Ewers, rough crystals would have been studied first to avoid any flaws or imperfections. In contrast coloured stones need to be similarly studied, to take account of the optical properties of these stones. This ensures that in the finished item they are shown off to their best.

Equipment

Early saws may have been wire bow saws, strips of metal or thin metal discs; the most likely metals would have been copper, bronze or iron.

A flat rough stone surface is one of the tools which may be used to grind flats onto crystals. This can be improved by shaping the grinding stone into a disc, with a hole placed in the centre, this disc then becomes a useful grinding wheel. If the wheel is mounted (vertically) onto a spindle of wood or metal, this becomes a lathe. The wheel's performance, however it is mounted, is improved by the application of power (hand, treadle or water) to turn the wheel. The Germans in the past used water power to turn their grinding wheels, at their workshops in Idar Oberstein. In modern workshops electric motors are used to turn the wheels.

Many grinding wheels in modern workshops are electroplated diamond wheels, or sintered diamond wheels.

The wheels may be different sizes, shapes or materials (see below), which would result in more detailed carving effects being applied to the crystal or rough stone.

Manufacturing Process

Chipping – The chipping process involves carefully hitting the rough stone with a stone or metal tool, to remove unwanted material.

Preforming - The preforming process for small pieces, consists of holding the stone in the fingers. For larger pieces, the stone is held in the hand and rubbed on the rough surface of a harder material.

Sawing – Sawing removes unwanted material quickly, thereby blocking out a rough shape. The discarded pieces from the original crystal would then be used for producing other objects. Sawing saves time and energy which would otherwise be spent grinding the crystal. An abrasive grit would be applied to the saw blade, water would also be used in the process. Sawing rough crystals produces heat, so water is used to cool the crystals, act as a lubricant and carry the slurry away.

Cutting – The process of cutting involves moving a stone across a rough flat surface, so that abrasion takes place, resulting in a flat surface appearing on the crystal. (This process is known as lapping). If

the principles of flat lapping are reversed, by employing power to move the grindstone, rather than the crystal, the process may be speeded up.

Much of the cutters' work is done by simply holding stones in the fingers and then working the stone on the grinding wheel. This method produces simple ground surfaces on a stone.

This allows unskilled workers to be employed in the production process under a skilled and knowledgeable craftsman, enabling the formation of production lines for efficient working.

Faceting – Smaller stones need to be 'stuck up' on sticks to be worked on. The stone is held so that the facets can be accurately placed on the stone. The material used to attach the stone to the stick is called shellac. It is a readily available material derived from the insect secretions of the female lac bug. This material melts with heat and can be easily shaped.

One disadvantage of this material is that heat is generated while the stone is worked on, potentially causing the stone to move and fall off the stick; but this problem may be overcome by the addition of powdered glass and clay, creating a higher temperature cement than the original shellac material. This cement is ideal for working stones, particularly small ones.

This enables the craftsman to perform delicate, detailed and accurate placing of the facets on the stones, which would not be possible if the stones were held in the fingers. This allows the production of various types of cut stones such as cabochons and faceted stones, to be produced for specific pieces of jewellery. This method also enables tiers of facets at different angles to be placed on a rough stone, which brings the stone 'to life', when polished. Facets enable light to reflect around the stone internally and back out of the front of the stone. Early faceted gemstones had simple, polished, faces, but over the years cutting techniques have improved to allow more complex shapes of cut gemstones to evolve.

Polishing – Polishing is a simple process, involving the rubbing together of two surfaces. It can be thought of as a very fine grinding process. Different grinding stones produce different surface

effects. Various materials may be used for carrying the polishing compounds, and may include tin, lead, pewter, copper, felt, leather or hard woods. In modern workshops, as in the past, a variety of different polishing wheels are used, as the materials have very different properties. Flat simple facets on stones or cabochons can be polished on a range of these wheels.

To achieve a true polish, the surface of the stone needs to be 'melted', but on a microscopic level. When harder stones are polished with fast moving wheels combined with the application of lubricants and polishing compounds, the resultant friction of this process generates heat. This process of polishing results in the melting of a microscopic layer of the stone, which then re crystalizes on the surface. This layer is called the Beilby layer, after Sir George Thomas Beilby who discovered this process in the early 20th Century.

Polishing compounds are often oxides, such as tin oxide, aluminium oxide, but rouge, rottenstone, Tripoli and clay powders may also be used. These compounds are hard and grind into a powder and combine well with water. Heat is generated from the friction that occurs during polishing, so a lubricant is essential during this process to lubricate the wheel and ensure the stone does not become hot or it will crack. Different stones require different lubricants, such as oil or water.

This polishing process results in a high gloss look without which the piece would have a dull greasy appearance.

Grinding Grits and Polishing Materials for Carving and Polishing – For every good quality gemstone mined, there is a huge amount of near gem (poor quality material) and an even larger amount of low-grade material. Sapphires and rubies derive from the same family of gemstones, known as the corundum group. In the early workshops it is possible that the rough pieces of corundum would have been smashed on an anvil, and the resultant pieces would then have been ground up in an agate pestle and mortar, to form the abrasive grit used in the grinding of quartz carving. Corundum would have been mined and traded throughout the ancient world. This then would have been processed to form emery, which would have been used by craftsmen in their workshops. In modern

lapidary workshops corundum has now been replaced by a combination of diamond and carborundum abrasive powders. Carborundum is composed of Silicon carbide, and is harder than corundum, and therefore is the modern alternative to corundum. The resultant slurry is composed of grinding grit, quartz grindings and water. The grinding grits in this slurry have a higher specific gravity than quartz and could easily be separated by simple panning methods. This panned grit, once dried, could be separated by sprinkling it into an oil column. The coarse larger grains of grit would sink quickly to the bottom and the finer grains would remain in suspension nearer the top of the column. The top of the oil column is drained off, and the finer grains separated from the oil. This process is then repeated many times to refine the grits into different sizes for different uses. These fine grains could then be reused to achieve a finer surface on the stone, in preparation for the polishing process.

Grinding and polishing grits can be incorporated into grinding wheels by heating the shellac with the abrasive grit. This compound is spread onto a wood wheel or stick which is slowly spinning, ensuring the surface of the wheel or stick is fully coated with the compound. Whilst the wheel or stick are spinning, the surface may be shaped by pressing a hot blade to achieve a perfect surface. Any sized wheel or stick may be treated in this way, as it is a simple and quick way to make the perfect tool for the job.

It is likely that the Ewers and other quartz carvings of the time were carved with emery abrasive. The carving process generates heat because of the friction occurring between moving surfaces. Water is used in carving and grinding to prevent heat from friction building up and damaging the stone and subsequently the carving. Water also acts as a lubricant and reduces the amount of dust given off during the polishing process. Quartz and other stones, despite their hardness, can be cracked by heat and especially when exposed to extremes of temperature, either cold or heat.

Use of Diamonds - It is not exactly known whether the early craftsmen would have used corundum or diamond grits or both, however it is in my opinion that this would have been the case. In my work as a modern lapidary, I use both diamond and carborundum grits, for different processes.

The same rule applies for rough diamond crystals; for every gem quality rough diamond mined, there is a huge amount of poor-quality material around it, where the diamonds are mined from host rock. Diamond extracted from alluvial deposits have less poor-quality material surrounding them.

One of the many properties of diamonds is their hardness. It is however possible to pulverise them into a grit, which then can be used as part of the carving process. Another of the properties of the diamond crystal is that it possesses perfect cleavage. A simple explanation of the cleavage process is, if the cutter hits the crystal parallel to one of the crystal's faces it will split, cleaving along a flat plane, leaving sharp crystal flakes or larger pieces. These pieces or chips could be mounted on simple drills which could possibly have been used as part of the carving process.

Carving and Engraving Stones – simple engraving may be achieved by stippling a surface, using a hard point to scratch or chip at a surface to produce a pattern or picture. Carving implies that a more 3D effect is required and achieved than engraving.

Small flat stones may be stuck onto a small block of wood, so the stones are easier to hold and manipulate. Small grinding tools/wheels would be mounted on simple wooden lathes to enable detailed patterns/pictures to be engraved.

Cylinder seal stones would have been engraved by holding the cylinder in the fingers, using small grinding wheels. This is a technique which would also be used by glass engravers.

Detailed carving effects are achieved by using small wheels and tools. If grits are applied to a wheel made of soft metal the grit is pushed into the surface of the metal. The grit becomes embedded in the metal and this wheel is therefore an effective tool for carving fine details.

Small engraving and carving tools are made of copper or iron. In the case of copper, this is a soft metal, and because of this property it wears away quickly with constant use. These tools do have their place for specific detailed engraving work. Iron is generally a better choice for small tools, as the metal retains its shape better than copper.

In conclusion I have attempted to give a basic outline of the production methods that might have been used by craftsman in the production of the Rock Crystal Fatimid Ewers, in medieval and early modern Muslim societies. I have tried to show how a modern workshop, such as mine, in the 21st century has very similar methods, tools and materials.

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