# EGYPTIAN METALWORKING AND TOOLS. pdf

## 1: Advanced Machining in Ancient Egypt

*Egyptian Metalworking and Tools This book gives a comprehensive description of Egyptian metalwork from the earliest times to the Late Period.*

New Articles Ancient Mesopotamian Tools Mesopotamia has always been the centre of awe and amazement for historians and scholars worldwide. The immense promise of development that this civilization showed years from now is indeed a source of inspiration for times to come. Mesopotamia was credited with many a unique advancements in the fields of art, architecture, technology , etc. The development of better and modern tools was one amongst the many developments. Here is a small account of the tools of Mesopotamia. Stone was one of the main raw materials for many uses in the ancient times. Heavy tools were first made out of stones coz metals were yet to be discovered. Sculptors used stone told to chip through stones to give them the beautiful shape of statues. None of the excavated stones seem to have handles on them and hence historians and scholars find it difficult to specify their usage. Some detail which seems evident is the use of flint forarrowheads, ploughshares and sickles. Bones were also widely used for tools in Mesopotamia. Different bones were brought to different uses in the ancient civilization. Larger bones served as awls for working on leather where as smaller ones were used as needles. Bone knives have also been found to be common in Mesopotamia. Many people also used utensils composed of bones. The excavations have recovered several metallic tools in Mesopotamia. Tools like knife blades, awls, chisels, copper axes, etc have been found in various sites of excavation. Copper was also used for the manufacture of other tools like chains, sickles, hammers, daggers, etc. The ornaments and jewellery found in the excavations also have marks of the work of metallic tools on them. Other tools have also been recovered from the excavation sites. The kilns seem to have been made of clay like material. The potters wheels found here also were either of baked clay or rarely of stone. Farming tools have also been discovered in Mesopotamia.

## 2: Ancient Egyptian Metal working | Yahya Zaki - www.enganchecubano.com

*Voice is given to the ancient smiths by letting the Ancient Egyptian depictions of their metal-workings speak for themselves, in private tombs stretching from the Old Kingdom to the New Kingdom, as well as the informative accompanying hieroglyphic inscriptions.*

An Ancient Metal Humans Meet Metal Between seven and ten thousand years ago, our early ancestors discovered that copper is malleable, holds a sharp edge, and could be fashioned into tools, ornaments, and weapons more easily than stone, a discovery that would change humanity forever. This meeting of humans and metals would be the first step out of the Stone Age and into the ages of metals: Thus began the increased movement of elements and minerals out of their parent geological formations and into the air, soil, water, and living organisms by way of smelters, furnaces and mine tailings. The first several thousand years of copper production contributed little to global or even local pollution. Copper is not very toxic in comparison to other metals and early humans used too little of it to begin concentrating it in soil, air, or water to the extent that it would affect human health or ecosystems. It appears that during the first few thousand years of its use, humans experiment with and learned techniques to utilize copper. As they got better at working with it, civilizations became more complex, which in turn often enabled better copper-working technology. With this came expanded use of copper and a greater movement of copper into our everyday environment. There is disagreement among archaeologists about the exact date and location of the first utilization of copper by humans. Archaeological evidence suggests that copper was first used between 8, and 5, B. Archeologists have also found evidence of mining and annealing of the abundant native copper in the Upper Peninsula of Michigan in the United States dating back to 5, B. Native copper was likely used first, as it did not require any process to purify it. It could have been hammered into shapes although it would have been very brittle. Annealing was the first step toward true metallurgy, when people discovered that copper became more flexible and easy to work with when it was heated before hammering. Next, casting of molten copper into molds was developed. This lent more flexibility to copper crafting; no longer was native copper the only kind of useful copper if copper could be extracted from ores. Hood Museum of Art, Dartmouth College; Gift of the Estate of Harold Goddard Rugg, Class of The Sumerians and the Chaldeans living in ancient Mesopotamia are believed to be the first people to make wide use of copper, and their copper crafting knowledge was introduced to the ancient Egyptians. The Egyptians, famously fond of personal beautification, made mirrors and razors out of copper and produced green and blue makeup from malachite and azurite, two copper compounds with brilliant green and blue colors. By comparing the purity of copper artifacts from both Mesopotamia and Egypt, scientists have determined that the Egyptians improved upon the smelting methods of their northern neighbors in Mesopotamia. Most copper items in Egypt were produced by casting molten copper in molds. Put simply, wax is formed into the shape of the end product, then covered in clay. The wax is melted out leaving a clay mold, which is then filled with molten copper. The mold is broken off when the metal is cool. Bronze is Better The Egyptians may have been the first group to discover that mixing copper with arsenic or tin made a stronger, harder metal better suited for weapons and tools and more easily cast in molds than pure copper. Since copper ore often contains arsenic, this may have been the unintentional result of smelting copper ore that included naturally occurring arsenic. This alloy of copper with arsenic or tin is called bronze, and there is archeological evidence that the Egyptians first produced bronze in 4, B. Bronze may have also been developed independently in other parts of the Middle East and other parts of the world. Regardless of where it originated, bronze metallurgy soon overtook copper in many parts of the globe, thus ushering in the Bronze Age. In parts of the world that lacked deposits of tin, copper was used alone or alloyed with other metals until iron was introduced. The smelting process for bronze made with arsenic would have produced poisonous fumes. People may have preferred tin-based bronze or found that it was easier to control the amounts of tin added to copper than it was to control the amount of arsenic, which often occurred naturally in copper ore. Whatever the reason, bronze made with tin soon became the bronze of choice throughout the Middle East. Tin deposits were more confined to certain geographical areas than copper, which was readily available in many parts of the

Middle East as well as other parts of the world. As people began using bronze instead of pure copper to make weapons and tools, trade in tin developed. The availability of bronze led to more advanced tool and weapon making, and with better weapons, armies could better conquer neighboring societies and plunder their tin and copper resources. Cyprus was the major supplier of copper to the Roman Empire. Copper Crafting and Spirituality As copper helped humans to advance warfare, it also has played a role in the religious and spiritual life of people around the world through time. Using native copper, Andean artisans made religious items from pounded copper foil and gilded copper. Hood Museum of Art, Dartmouth College; Gift of Arnold and Joanne Syrop In many pre-colonial sub-Saharan cultures as well, coppersmiths were believed to have powers as shamans, magicians, and priests because of their intimate knowledge of earth, minerals, and fire and their ability to produce metal from ore. In some parts of the continent coppersmithing was an inherited position with master smiths passing secret knowledge on to their sons. Mining, smelting, and casting of copper ore were preceded by elaborate ceremonies to ensure that the endeavors were safe and fruitful. Copper also plays a role today in many New Age beliefs. In some modern religions, it is seen as having healing powers, both spiritually and physically. Some people wear copper to help alleviate the symptoms of arthritis. Manheim The people of the Indian subcontinent have been using copper and its alloys as long as anyone. Bronze casting was extensive in ancient times and bronze was used for religious statues and artwork. This practice also spread to Southeast Asia where copper and its alloys are used extensively even today in Buddhist artwork. Copper was first used in China around BC. The Chinese quickly began using bronze as well, and used different percentages of tin in bronze for different purposes. They used copper and bronze extensively for coinage. Copper production was now reaching almost industrial proportions in some civilizations, though probably nowhere more than in ancient Rome. Precocious Polluters Although iron and lead were in use by the era of the ancient Romans, copper, bronze, and brass an alloy of copper and zinc were used by the Romans for coins, aspects of architecture such as doors, and some parts of their extensive plumbing system although pipes were made of lead. They also developed pipe organs made with copper pipes. Roman copper coin in the denomination of "As", from the reign of Caligula, c. Scientists analyzing copper isotopes and trace metals present in Roman copper coins have determined that Rio Tinto, Spain still a working copper mine , Cyprus, and to a lesser extent Tuscany, Sicily, Britain, France, Germany and other parts of Europe and the Middle East were sources of copper for the Empire. Increased purity of Roman copper coins over time also shows that their smelting methods improved quickly. The Romans in their heyday produced nearly 17, tons of copper annually, more than would be produced again until the Industrial Revolution in Europe. With this enormous output of copper came pollution that would be unsurpassed for almost two thousand years when the Industrial Revolution began. Did polluted air from early copper smelting affect the health of humans living in ancient times? Early smelting methods at that time were crude and inefficient by the standards of today. Copper smelting and to a lesser degree copper mining produced ultra-fine particle dust that was carried into the atmosphere on air currents created by the intense heat from smelting operations. Most of the pollution would have fallen near the smelting sites, causing health problems and contaminating soil and water. Roman Bronze waterspout from 2nd century A. Marantz, Class of Scientists in the s discovered that copper contamination is present in 7,year-old layers of ice in the Greenland glacial caps. A layer of ice is deposited on glacial caps annually, allowing a year-by-year analysis of the ice composition. As copper smelting became widespread at the beginning of the Bronze Age, enough copper was released into the air to contaminate ice thousands of miles away. Peaks in copper concentrations in ice layers correspond to the era of the Roman Empire, the height of the Sung dynasty in China c. The copper pollution of the Roman days still haunts us today. Researchers have discovered that vegetation and livestock in Wadi Faynan today have high copper levels in their tissue. Copper ore from Cornwall and other areas and coal deposits throughout the country fueled the smelting of copper. The copper industry drove the economy of this town. Wealthy English people often owned smelters, while local Welsh people worked as laborers in the industry. Just as in ancient Rome, copper smelting had its price. The town and once lush countryside surrounding Swansea was stripped of vegetation by noxious copper smoke that billowed from the smelter stacks and settled on the surrounding town and fields. Topsoil on denuded hillsides succumbed to erosion. Livestock developed strange new ailments like swollen joints and rotten teeth. Farmers blamed the smoke. The smoke also reportedly caused shortness of breath, decreased appetite, and other complaints in humans. The Cornish copper ore purified in the Swansea smelters was high in arsenic, sulfur, and fluorspar a compound of the element fluorine. The smelters emitted fumes from these compounds along with exhaust from the coal that fired the operations. The sulfur and fluorspar from the smoke mixed with water and oxygen in the atmosphere to produce sulfurous, sulfuric and hydrofluoric acids which rained down on Swansea as acid rain. Copper slag and other waste covered the landscape near the smelters. Historic print of 18th century copper smelting in the lower Swansea Valley In , a fund was set up in Swansea, with contributions from some of the smelter owners, that would go to whomever could develop the technology to reduce the level of poisons being emitted from the smelters. The industrialists were likely more concerned with economics and aesthetics than the health of workers and local people. Although several groups of people came up with ideas to purify the smoke, none succeeded. Eleven years later, a group of Welsh farmers from outside Swansea sued one of the major smelter owners for public nuisance, claiming that the smelter smoke was damaging their farms. The farmers lost the suit. Conductive Copper Copper played a central role in the technologies developed during the industrial revolution. One of the most important uses of copper at that time was in electrical engineering. Early scientists experimenting with electricity chose copper as a transmitter because it is highly conductive can transmit electrical current easily. The electrical engineering industry today is the second largest consumer of copper. The Price of Industrialization Although production methods have improved since the time of the Romans and the Industrial Revolution, today copper production makes a hefty contribution to global pollution. Butte, Montana is home of an abandoned copper mine once owned by the now defunct Anaconda Copper Mining Company, established in Butte in  Until the major Butte mine operations closed in the s, the mine produced 20 billion pounds of copper. The former mine is now the largest Superfund site in the country. The main open pit has filled with water since the termination of mining activities, forming a acre lake. Sulfur, a mineral that is commonly a component of copper ore, reacts with air and water, producing sulfuric acid, which fills the pit. Mine runoff and fallout from the smelter once owned by Anaconda cover the landscape. A 1,acre tailings pond sits near the main pit.

## 3: Ancient Egyptian Stoneworking Tools and Methods: Stone vase making

*56 Egyptian Metalworking and Tools 1 Tools and their uses 57 Agricultural tools.. Egyptian agricultural workers used only a limited range of metal tools. Cast bronze hoes were used from the New Kingdom and sickles with edges made of steel are known from Roman Egypt.*

Land of the Pyramids and a vast collection of evidence that, like a taciturn teenager, is begging for understanding. Contrary to conventional thought, for decades there has been an undercurrent of speculation that the pyramid builders were more advanced. The speculation is well placed. When attempts have been made to build pyramids using the theorized methods of the ancient Egyptians, they have fallen considerably short. The great pyramid is feet high and houses 70 ton pieces of granite lifted to a level of feet. Theorists have struggled with stones weighing up to 2 tons to a height of a few feet. One wonders if these were attempts to prove that primitive methods are capable of building the Egyptian pyramids or the opposite? Executing this theory to practice has not revealed the theory to be correct. Do we need to revise the theory, or will we continue to educate our young with erroneous data? With each visit I leave with more respect for the industry of the ancient pyramid builders. An industry, by the way, that does not exist today. While in Egypt in , I visited the Cairo museum and gave a copy of my article, along with a business card, to the director of the museum. He thanked me kindly, threw it in a drawer to join other sundry material, and turned away. Another Egyptologist led me to the "tool room" to educate me in the methods of the ancient masons by showing me a few cases that housed primitive copper tools. I asked my host about the cutting of granite, for this was the focus of my article. He explained how they cut a slot in the granite and inserted wooden wedges which they soaked with water. The wood swelled creating pressure that split the rock. Splitting rock is vastly different than machining it and this did not explain how copper implements were able to cut granite, but he was so enthusiastic with his dissertation, I did not wish to interrupt. To prove his argument, he walked me over to a nearby travel agent encouraging me to buy airplane tickets to Aswan, where, he said, the evidence is clear. I must, he said, see the quarry marks there and the unfinished obelisk. Dutifully, I bought the tickets and arrived at Aswan the next day. After learning some of the Egyptian customs, I got the impression that my Egyptologist friend had made that trip to the travel agent many times. The Aswan quarries were educational. The obelisk weighs approximately 3, tons. Drill hole at the Aswan Quarries However, the quarry marks I saw there did not satisfy me as being the only means by which the pyramid builders quarried their rock. Located in the channel, which runs the length of the obelisk, is a large round hole drilled into the bedrock hillside, measuring approximately 12 inches in diameter and 3 feet deep. The hole was drilled at an angle with the top intruding into the channel space. The ancients may have used drills to remove material from the perimeter of the obelisk, knocked out the webs between the holes and then removed the cusps. While strolling around the Giza Plateau later in the week, I started to question the quarry marks at Aswan even more. I also questioned why the Egyptologist had deemed it necessary to buy an airplane ticket to look at them. I was to the South of the second pyramid when I found an abundance of quarry marks of similar nature. The granite casing stones which had sheathed the second pyramid were stripped off and lying around the base in various stages of destruction. Typical to all of the granite stones worked on were the same quarry marks that I had seen at Aswan earlier in the week. This was puzzling to me. If these quarry marks distinctively identify the people who created the pyramids, why would they engage in such a tremendous amount of extremely difficult work only to destroy their work after having completed it? It seems to me that these kinds of quarry marks were from a later period of time and were created by people who were interested only in obtaining granite, without caring from where they got it. The hammer is probably the first tool ever invented, and by hammer working metals, relatively unsophisticated tools have forged some elegant and most beautiful artifacts. Ever since man first learned that he could effect profound changes in his environment by applying force with a reasonable degree of accuracy, the development of tools has been a continuous and fascinating aspect of human endeavor. Quarry marks on the Giza Plateau The Great Pyramid leads a long list of artifacts that have been incredibly misunderstood and misinterpreted by Egyptologists. They have postulated theories and methods based on a collection of tools that are, at best, questionable. For the most part, primitive tools that have been uncovered would be considered contempor-aneous with the artifacts of the same period. This period in Egyptian history, however, resulted in artifacts being produced in prolific number with no tools surviving to explain their creation. The ancient Egyptians left artifacts behind that are unexplainable in simple terms. The tools that have been uncovered do not fully represent the "state-of-the-art" that is physically evident in these artifacts. There are some intriguing objects surviving this civilization which, despite its most visible and impressive monuments, has left us with only a sketchy understanding of its full experience on planet Earth. We would be hard pressed to produce many of these artifacts today, even using our advanced methods of manufacturing. The tools displayed as instruments for the creation of these incredible artifacts are physically incapable of reproducing many of the artifacts in question. Along with the enormous task of quarrying, cutting and erecting the Great Pyramid and its neighbors, thousands of tons of hard igneous rock, such as granite and diorite, were carved with extreme proficiency and accuracy. After standing in awe before these engineering marvels and then being shown a paltry collection of copper implements in the tool case at the Cairo Museum, one comes away with a sense of frustration, futility and wonder.

## 4: Tools Used by Artists in Ancient Egypt | Synonym

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South of the second pyramid I found an abundance of quarry marks of similar nature. The granite casing stones that had sheathed the second pyramid were stripped off and lying around the base in various stages of destruction. Some of the stones were still in place, though sections had been split away from them, and there I found the same quarry marks that I had seen earlier in the week at Aswan. This was puzzling to me. If these quarry marks distinctively identify the people who created the pyramids, why would they engage in such a tremendous amount of extremely difficult work only to destroy their work after having completed it? It seems to me that the quarry marks found at Aswan and on the Giza Plateau were from a later period of time, and they were created by people who were interested only in obtaining granite without caring about the source from where it came. The hammer was probably the first tool ever invented, and hammers have forged some elegant and beautiful artifacts. Ever since man first learned that he could effect profound changes in his environment by applying force with a reasonable degree of accuracy, the development of tools has been a continuous and fascinating aspect of human endeavor. The Great Pyramid leads a long list of artifacts that have been misunderstood and misinterpreted by archaeologists, who have promoted theories and methods that are based on a collection of tools that they struggle with to replicate the most simple aspects of the work. Their axes and chisels were made of copper hardened by hammering. Yet during this period in Egyptian history, artifacts were produced in prolific number with no tools surviving to explain their creation. The ancient Egyptians created artifacts that cannot be explained in simple terms. These tools do not fully represent the "state of the art" that is evident in the artifacts. There are some intriguing objects that survived after this civilization, and in spite of its most visible and impressive monuments, we have only a sketchy understanding of the full scope of its technology. The tools displayed by Egyptologists as instruments for the creation of many of these incredible artifacts are physically incapable of reproducing them. After standing in awe before these engineering marvels, and then being shown a paltry collection of copper implements in the tool case at the Cairo Museum, one comes away bemused and frustrated. William Flinders Petrie, recognized that these tools were insufficient. He explored this anomaly thoroughly in "Pyramids and Temples of Gizeh," and expressed amazement about the methods the ancient Egyptians used to cut hard igneous rocks. He credited them with methods that " I do not have much interest in who died when, whom they may have taken with them and where they went to. No lack of respect is intended for the mountain of work and the millions of hours of study conducted on this subject by intelligent scholars professional and amateur , but my interest, thus my focus, is elsewhere. When I look at an artifact to investigate how it was manufactured, I am not concerned about its history or chronology. Having spent most of my career working with the machinery that actually creates modern artifacts, such as jet-engine components, I am able to analyze and determine how an artifact was created. I have also had training and experience in some non-conventional manufacturing methods, such as laser processing and electrical discharge machining. Having said that, I should state that contrary to some popular speculations, I have not seen evidence of laser for cutting on the Egyptian rocks. Still, there is evidence for other non-conventional machining methods, as well as more sophisticated, conventional type sawing, lathe and milling practices. Undoubtedly, some of the artifacts that Petrie was studying were produced using lathes. There is also evidence of clearly defined lathe tool marks on some "sarcophagi" lids. The Cairo Museum contains enough evidence that will prove that the ancient Egyptians used highly sophisticated manufacturing methods once its properly analyzed. For generations the focus has centered on the nature of the cutting tools used by the ancient Egyptians. Some even speculate that the builders used lasers to cut the masonry and then levitated the stones into place in the pyramid. Although the laser is a wonderful tool with many uses, its function as a cutting tool is limited to economically viable applications, such as cutting small holes in thin pieces of metal and refractory material. As a general purpose cutting tool, it cannot compete with the machining methods that were available before its inception. The methods used to cut the masonry for the

Great Pyramid can be deduced from the marks they left behind on the stone. While there are some interesting points to be made concerning the limestone that encased the pyramid, and they will be addressed later, these stones do not offer the same information about the methods that were used to produce them as the thousands of tons of granite. At the expense of considerable time and effort by the original creators, the granite artifacts found in the Great Pyramid and at other sites in Egypt offer the clues we are looking for. Before we investigate the granite that was included in the Giza pyramids, there are several artifacts that indicate machinery power being used by the pyramid builders. These artifacts, scrutinized by William Flinders Petrie, are all fragments of extremely hard igneous rock. These pieces of granite and diorite exhibit marks that are the same as those resulting from cutting hard igneous rock with modern machinery. It will probably surprise many people to know that evidence proving that the ancient Egyptians used tools such as straight saws, circular saws, and even lathes has been recognized for over a century. Even so, there is a persisting belief among some Egyptologists that the granite used in the Great Pyramid was cut using copper chisels. Having worked with copper on numerous occasions, and having hardened it in the manner suggested above, this statement struck me as being entirely ridiculous. You can certainly work-harden copper by striking it repeatedly or even by bending it. However, after a specific hardness has been reached, the copper will begin to split and break apart. This is why, when working with copper to any great extent, it has to be periodically annealed, or softened, if you want to keep it in one piece. Even after hardening in such a way, the copper will not be able to cut granite. The hardest copper alloy in existence today is beryllium copper. There is no evidence to suggest that the ancient Egyptians possessed this alloy, but even if they did, this alloy is not hard enough to cut granite. Copper has predominantly been described as the only metal available at the time the Great Pyramid was built. Consequently, it would follow that all work must have sprung from the able use of this basic metallic element. We may be entirely wrong, however, even in the basic assumption that copper was the only metal available to the ancient Egyptians. For another little known fact about the pyramid builders is that they were iron makers as well. The Small Relics Found Inside The Pyramids - DE49 In proposing more primitive methods of manufacture, it has been demonstrated that copper charged with quartz sand can also be used to wear away the granite. Also, small balls made of dolorite, a stone that is harder than granite, have been found in the granite quarries which have led Egyptologists to suggest that granite artifacts were created by bashing the material. Unforbidden Geology explores the more simple approach to working granite. While there may be some who are satisfied with believing that these simplistic methods were adequate in creating the artifacts I have seen and measured, I am not. This is because they do not explain the full scope of the work. Without going back in time and interviewing the craftsmen who worked on the pyramids, we will probably never know for sure what materials their tools were made of. Any debate of the subject would be futile, for until the proof is at hand, no satisfactory conclusion can be reached. However, the manner in which the masons used their tools can be discussed, and, perhaps if we compare current methods of cutting granite with the finished product i. The wire is a continuous loop that is held by two wheels, one of the wheels being the driver. Between the wheels, which can vary in distance depending on the size of the machine, the granite is cut by being pushed against the wire or by being held firmly and allowing the wire to feed through it. The wire does not cut the granite, but is designed to effectively hold the silicon carbide grit that does the actual cutting. By looking at the shapes of the cuts that were made in the basalt items 3b, and 5b, one could certainly speculate that a wire saw had been used and left its imprint in the rock. The full radius at the bottom of the cut is exactly the shape that would be left by such a saw. John Barta, of the John Barta Company informed me, that the wire saws used in quarry mills today cut through granite with great rapidity. Barta told me that the wire saws with silicon-carbide cut through the granite like it is butter. Out of interest, I asked Mr. Barta what he thought of the copper chisel theory. Barta, possessing an excellent sense of humor, came forth with some jocular remarks regarding the practicality of such an idea. If the ancient Egyptians had indeed used wire saws for cutting hard rock, were these saws powered by hand or machine? With my experience in machine shops and the countless number of times I have had to use a saw both handsaws and power saws , there appears to be strong evidence that, in at least some instances, the latter method was used. Once again, Petrie provides a clue: The following concerns the coffer inside the Second Pyramid: The bottom is left rough, and shows that it was sawn and afterwards dressed down to the intended height; but in sawing it the saw was run too deep and then backed out; it was, therefore, not dressed down all over the bottom, the worst part of the sawing being cut. This is the only error of workmanship in the whole of it; it is polished all over the sides in and out, and is not left with the saw lines visible on it like the Great Pyramid coffer. If we agree with these estimates as well as with the methods proposed by Egyptologists regarding the construction of the pyramids, then a severe inequity can be discerned between the two. So far, Egyptologists have not given credence to any speculation that suggests that the builders of the pyramid might have used machines instead of manpower in this massive construction project. In fact, they do not give the pyramid builders the intelligence to have developed and used the simple wheel. It is quite remarkable that a culture, which possessed sufficient technical ability to make a lathe and progressed from there to develop a technique that enabled them to machine radii in hard diorite, would not have thought of the wheel before this. Petrie logically assumes that the granite coffers found in the Giza Pyramids were marked prior to being cut. The workmen were given a guideline with which to work. The accuracy exhibited in the dimensions of the coffers confirms this, plus the fact that guidelines of some sort would have been necessary to alert the masons of their error. While no one can say with certainty how the granite coffers were cut, the saw marks in the granite have certain characteristics, which suggests that they were not the result of hand sawing. If there was not evidence to the contrary, I might agree that the manufacturing of the granite coffers in the Great Pyramid and the Second Pyramid could quite possibly have been achieved using pure manpower, and a tremendous amount of time. It is extremely unlikely that a team of masons operating a 9-foot handsaw would be cutting through hard granite fast enough that they would pass their guideline before noticing the error. With these experiences, plus those observed in others, it seems inconceivable to me that manpower was the motivating force behind the saw which cut the granite coffers. While cutting steel with handsaws, an object that has a long workface, and certainly one with such dimensions as the coffers, would not be cut with great rapidity, and the direction the saw may turn can be seen well in advance of a serious mistake being made; the smaller the workpiece, naturally, the faster the blade would cut through it. On the other hand, if the saw is mechanized and is cutting rapidly through the workpiece, the saw could "wander" from its intended course and cut through the guideline at a certain point at such a speed that the error is made before the condition can be corrected. This is not uncommon. This does not mean that a manually operated saw cannot "wander," but that the speed of the operation would determine the efficiency in discovering any deviation that the saw may have from its intended course. Another interesting point to consider is that the saw was run too deeply, backed out, and then proceeded to cut again. Anyone who has been faced with the problem of drawing a saw-blade out of a cut and then making a restart on only one side of the cut, which is essentially what was done with the granite, knows that excessive pressure on the saw-blade would force it back into the original cut. To make a restart of this type it is necessary that very little pressure is put on the blade. Making a restart in the middle of a cut, especially one of such dimensions as the granite coffer, would be more easily accomplished with machine sawing than it would be with hand sawing. With hand sawing there is little control over the blade in a situation like this, and it would be difficult to accurately gauge the amount of pressure needed. Also, the blade of the handsaw would be moving quite slowly; a fact that would question further the suggestion of a handsaw being used. At such a slow speed and with very little pressure, accomplishment of such a feat would be almost, if not completely, impossible. With the power driven saw, on the other hand, the blade moves rapidly, and control of the blade is possible.

## 5: Composition and development of ancient Egyptian tools

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The earliest metals found and used were quite probably what is termed free or native metals; nuggets found in the metallic state. Such nuggets of native iron or copper, for instance, were rare and the Egyptians had to learn to mine metal-bearing ores and the smelting processes used to extract workable metal. Copper was the first metal to see extensive use in Egypt. Soft, malleable, and with a relatively low melting point of 1, degrees Celsius, copper tools, weapons, and ornaments are found beginning approximately BCE. Generally, mines of all types were placed as near as possible to rivers to facilitate travel and provisioning. Deposits of copper ore mined were almost always on the surface, and extraction was usually of the distinctive green malachite ore which was also used as a pigment , but also of chrysocolla, and the somewhat rare bluish azurite. Smelting to extract metal from the ore was almost always done on-site, no matter what was being mined. Copper ore was extracted and broken into small pieces and mixed with charcoal fuel in a fire on the ground or in a shallow pit. This method produced temperatures of between and degrees Celsius, enough to separate the metal from the rock, but not hot enough to reduce it to a truly molten state. After sufficient time had passed, the fuel was removed and the resulting bits of freed copper were gathered up. Later, smelting operations utilized furnaces and bellows, causing the copper to become truly molten and allowing casting of the copper into ingots for easier transportation and measurement. This harder, easier to cast metal eclipsed copper as the major material for tools in Egypt after its introduction from western Asia. Placer gold, found in river deposits of silt, was simply extracted by washing the lighter silt away with water, picking out any particles of gold, and setting aside whatever was found for later melting into ingots. Gold-bearing veins of quartzite were also exploited in the eastern desert and in Nubia. Quartzite is a harder stone than the stone bearing copper ores malachite could be mined with flint tools, which it was during early periods , so greater effort had to be used to extract it. A Greek account from the 2nd century BCE describes the Egyptian miners lighting fires over deposits of gold-bearing quartzite to make the stone more brittle and smashing the stone with hammers and picks. The broken rock was then reduced to dust by a series of mortar and pestles and hand mills. Gold was separated by hand from the resulting powder. Trenches along the surface were what characterized the typical Egyptian gold mining operation, though particularly promising veins were followed underground vertically or horizontally into mountainsides for as long as was practical, with one especially deep shaft recorded as extending cubits straight down. Gold is typically found in native form, but it usually contains some sort of metallic impurity, in Egypt this impurity was usually one of iron, copper, or silver. Ironically, the chief impurity of the gold found by the miners of Egypt was silver, which was considered much more valuable than gold due to its comparative rarity. Varying amounts of silver impurity is encountered in Egyptian gold. Gold that was diluted with a high enough impurity of silver was called electrum, and was highly prized for its durability and sheen. Refinement of gold for greater purity did not occur until sometime around the age of Persian hegemony over Egypt, though it was graded by purity by the twelfth dynasty. Gold was refined by the Egyptians using salt to extract the silver, which was lost during the process. Iron production in Egypt lagged behind the rest of the Middle East, not being produced internally until around BCE. The 18th Dynasty saw a gradual increase of the amount of iron products and by the 26th Dynasty bronze was falling into disfavor as a metal for tools. By the time of the Ptolmaic Dynasty, iron had replaced bronze as the metal used in tools. The Egyptian word for iron was biat or bia n pet, which literally means ore of the heavens. The small amounts of Egyptian iron artifacts found before the widespread use of the metal are either imported from other areas of the Middle East or, in the case of older ceremonial and decorative items, betray the tell-tale nickel impurity that is characteristic of meteorites. This lateness in the production of iron cannot be traced to a lack of materials. Iron-bearing minerals, such as hematite, ochre, sienna, and umbers were fairly common and used for decorative and cosmetic purposes from a very early time period. The temperatures needed to work it were high: Iron must also be worked while hot, something not needed for the other metals that the Egyptians and other Bronze-Age cultures were familiar with. Although Egypt was not the originator of metalworking, the exploitation of the mineral resources under its control assisted in its rise to power and craftsmanship. Bibliography Ancient Egyptian Materials and Industries. JOM, 49 3 pp

## 6: TheProcessHistory

*In addition, this article reviews the effect of Egypt on the Greek metalworking industry. The Greeks learned about metallurgical materials and techniques, and about the design and production of monumental stone architecture and sculpture from the Egyptians.*

The oldest examples are found in Lower Egypt at the settlement of Merimde Beni Salamais, dating to the Merimden period over years ago, and exhibit a low level of technical competency in their manufacturing Hoffman During the rest of the Predynastic period c. The late Predynastic period of Upper Egypt was generally characterized by an increasing shift away from pottery of fine craftsmanship to stone vessels for use in tombs. This may reflect a shift in the direction of consumer demands of the elite, with an emphasis on exotic luxury goods for the afterlife, and the increasing economic difference between the ruling class and the rest of the populous Hoffman As a result stone vessel manufacturing reached a high level of technical competency during the Early Dynastic c. After the Old Kingdom, stone vessels continued to be made, but on a much lesser scale. A wide variety of different rocks and mineral were employed in their manufacture, and these materials often varied over time as availability and aesthetics changed Fig. These raw materials were either collected as eroded debris or quarried from rock outcrops. The majority of vessels were made of carbonate rocks, such as travertine Egyptian alabaster , limestone , limestone breccia, and dolomite, smaller numbers were made of other rocks and mineral. The more exotic rocks and minerals, as well as the harder and more expensive to work material were restricted mainly to royal tombs. Although, more common and easier to work rocks like limestone, travertine, and alabaster were used for great numbers of vessels in royal tombs, they were by far the main materials used in non-royal tombs. The range of stylistic forms were quite varied. Many are original in design Fig. UC , to basket-work e. Others appear to be fantasies on the part of the craftsmen Fig. Stone vessel forms were sometimes imitated in pottery Fig 5b , such as that expressed in the spiral and zigzag line decorations Fig 5a representing the mottled appearance of limestone breccia Bourriau Many of these vessels are remarkable for both perfection of workmanship and purity of stylistic form, which is especially true in the case of hardrock vessels. Metasiltstone ornamental toilet tray and representation of missing center portion after El-Khouli , 1st Dynasty. Basalt footed jar with perforated handles from the Nagada I period and thought to be originally a Mesopotamian design common to pottery Adams height c. Theriomorphic vessel in shape of a bird made of limestone breccia, Late Predynastic-early 1st Dynasty c. This is characterized by the cutting the stone vessel into sections so that the interior could be easily hollowed and the sections then glued back together, this was continued to the 12th Dynasty Fig 6a ; cutting a hole through the bottom of the vessel to allow easy access to the interior for grinding, in which the hole was later plugged with a disk of rock Petrie c ; the manufacturing of imitation vessels made of blue glass paste to simulate lapis lazuli, and black mud with fragments of white limestone to simulate andesite porphyry Petrie c; c , and the ancient Egyptians sometimes did not hollow vessels out completely, or at all, which became more common later in their civilization Fig. The shapes of forms, as well as, the materials used for vessels changed over time, which makes stone vessels a useful tool for dating archeological sites Date range of cylindrical beakers. The size of stone vessels range from quite small, on the order of a few centimeters in height e. Predynastic period Nagada I basalt vase height: The places were stone vessels were made are dependant on the materials used. Many other quarry sites have little evidence of on site carving, suggesting that the rock was quarried or collected and transported to workshops, where it was transformed into vessels and other objects. Today, rock can be shaped to a fine scale by this method with the use of bush hammers, which are made of soft tool steel or cast iron Rich Stone hammers and other such tools will also work, as long as the stone being carved has a lower rock hardness than that of the tool, and the fracture toughness of the mineral grains in the rock being carved are not too high. Other types of tools made of flint, such as pecking hammers, work as a result of the combination of the indentation hardness of quartz and the brittle nature of the rock flint. The durability of stone tools is less than their modern equivalents made of metal, and as a result, more frequent replacement would be necessary during use. As a result of high impact stresses sustained by stone percussion tools during use, hardrocks of igneous, metamorphic, and sedimentary composition are preferable as the material of manufacturing of these tools. The ancient Egyptians routinely worked such rocks into axeheads e. UC , and adzes e. Many of the skills developed during early stone tools manufacturing could be used in the manufacturing of stone vessels, as well as other stone objects such as statues. For example, the similarities in the symmetrical shape and the hollowing of the center in both early maceheads and stone vessels is quite evident Fig. Percussion tools may consist of metal chisels hardened copper cold-worked and arsenic alloy or bronze, e. UC , pecking hammers, pounders e. Engelbach , Zuber , Stocks a; The process of working porous limestone and similar rocks is easily done with these tools, however, carving igneous rocks like granite is a slow process Stocks Examples of unfinished stone vessel exhibiting marks from percussion tools are also known Fig. Stocks conducted hieroglyphic carving experiments in granite using hammer-driven flint chisels and obtained a rate of 5 cm3 per hour of rock removal. Engelbach conducted granite quarrying experiments using diabase dolerite pounders at Aswan and obtained rates of cm3 per hour of rock removal. Small bronze chisel UC without handle for use as a hand graver, 19th Dynasty. Unfinished travertine vessel exhibiting tool marks from rough-shaping. The Petrie Museum , Photograph by Jon Bodsworth The Egypt Archive Lapidary tools such as hand- or bow-powered slabing saws and coring drills are very useful for the removal of waste rock, and in the shaping of complex and delicate shapes in stone. An example of a partially completed granodiorite porphyry vessel, on display in the Cairo Museum JE , demonstrates how a coring drill could be used to remove waste rock in the manufacturing of stone vessels Stocks , image 1 , image 2 , image 3 , image 4 , image 5. This method of removing waste rock reduces the effort necessary for the manufacturing of stone vessels from blocks of stone, and is a common timesaving technique still used today. An example of the faceting of a small unfinished statuette of vein quartz demonstrates the removal of waste rock and the rough shaping of the front and sides by the use of a small lapidary saw e. UC , Petrie c Stone rubbers and scrapers can also be useful grinding tools for shaping both hardrocks and softrocks. Turning has also been suggest as a method used to shape stone vessels by the ancient Egyptians Petrie , c Petrie , e-book section gives two examples as evidence of lathe-turned objects: UC , Drawing 15 Petrie c states that Predynastic stone vessels exhibit markings consistent with grinding in a up and down direction, and it is in the Early Dynastic that the circular tool marks that suggest turning in a block begin to appear Fig. The quality of early Predynastic stone vessels demonstrates the ability of the ancient Egyptians to produce symmetrical vessels in stone and that it existed prior to the development of a possible lathe-like tool Fig. The ability of the ancient Egyptians to produce symmetrical shapes without a lathe is also demonstrated in their ability to carve fine statuary in a variety of complex forms. However, the only prerequisites for a lapidary lathe and other simpler devices is that the object being worked and the grinding tools be held ridged as the object is rotated. This does not have to be a high-speed or high-pressure type tool, only enough pressure to cause abrasion between the grinding surface and the object being worked is needed. The object being worked could be placed on pivots and hand-rotated, or the bow drill could be modified into a partial rotary pole-lathe. Pole-lathes are tools that rotate the object back and forth rather than spinning it. All the rough shaping would be done by percussion and other types of lapidary techniques, since in most cases the removal of waste rock is more efficient and less time consuming by these methods. The lack of pivot holes on stone vessels is a problem Fig. Old Kingdom basalt cup UC exhibiting circular striations. The striations on such objects as the above basalt cup may also be explained by the rotation of the tool as the vessel is held in place. Modification of the end of a coring drill barrel into a tapered cone could be used to produce various shapes by lapidary grinding, while the end of the rotating tool is pressed down onto the stationary stone object being worked. As we see below Fig. A small 12 Dynasty lid e. A number of New Kingdom stool legs also show the possible use of a primitive lathe in their manufacture, although this may also be the result of other methods Manuelian For the copper barrel, this may be due to the wearing down of the copper tube to lengths that were no longer usable, at which point the remaining copper tube was recycled Stocks The use of bow- and hand-powered coring drills Fig. Traces of verdigris, either copper or bronze, as well as abrasive have been found in core holes in both Egypt Reisner and Crete Warren Representation of the ancient Egyptian coring drill used in the rock cutting experiments of Stocks , Before the introduction of the a bow- or hand-powered coring drill during the mid-Predynastic Period, holes in rocks were drilled by boring, a more time consuming practice due to the larger volume of rock that needed to be removed. In the case of a narrow-necked vessel i. A core hole would be cut through the center of the neck of the vessel to a depth that would allow access to the interior for the purpose of hollowing. This is similar to the methods used today by lapidist when making stone vessels Long , Can narrow-necked stone vases be made today? Unfinished travertine stone vessel marked with red paint for coring with drill, possibly 6th Dynasty height c. The sides of the core and core hole were generally kept as parallel as possible to reduce the risk of breakage of the neck, which is often the weakest part of the vessel. The core would then be snapped out of the vessel, presumably with the add of wooden wedges and a light taping of a hammer. Sometimes the core would not break cleanly at the base of the vessel, a number of unfinished vessel exhibit this Fig. The use of a material to coat the outer delicate surfaces of the vessel for the purpose of strengthening them, such as glue or resin soaked linen strips could also have been used, and this is also done today by modern Egyptian stone vessel makers El-Khouli  The ancient Egyptians carefully ground the groove away during the hollowing procedure. This changes by the middle of the 1st Dynasty where the ring is commonly shown e. UC , in later times the ring became a necessity Fig. Unfinished travertine stone vessel split longitudinally to reveal remaining drill core fragments partially attached, possibly 4th Dynasty height 6. Metasiltstone ornamental bowl with coring slot from the Step Pyramid, 3rd Dynasty. A tube cut from basalt Fig. This is a useful method of removing larger cores, since it reduces the amount of stress necessary to break the core from the base of the core hole. Another example of tube making by the ancient Egyptians is an Early Dynastic period metasiltstone ornamental bowl, the tube is left attached and the surrounding rock is removed Fig. Stocks demonstrated the ability of hand-powered coring drill to make a rock tube in limestone during a stone vessel manufacturing experiment see below. This is a method still used today by amateur lapidists for the making of cylindrical vessels and bracelets Long  Drill core waste fragment made of basalt UC , double cored to producing a tube, unknown date possibly 4th Dynasty. Rock tube in center of the metasiltstone ornamental bowl from the 1st Dynasty tomb of Prince Sabu Tomb Emery  These features could have been made with a number of lapidary coring bits of varying diameters to create the 3 outer ridges. To produce each of the raised ridges 2 coring bits would be needed. These bits can just be a single sheet of copper, which is attached to wooden dowels of the appropriate diameters. Partially coring the rock that occupies the needed groove area a number of times with bits of varying diameter could also be done, this makes this waste rock easy to removed by chiseling from the grooves. The use of a coring drill would actually be a faster and easier method then turning the object with a lapidary lathe, since less material needs to be ground away. Stone bores have been found from ancient Egypt, but the wooden shafts have not survived. In Egypt numerous representations of the apparent use of such a tool are known from scenes depicting stone vessel manufacturing Fig.

## 7: Ancient Egyptian technology - Wikipedia

*Egyptian Metalworking and Tools by Bernd Scheel starting at $ Egyptian Metalworking and Tools has 1 available editions to buy at Alibris.*

Their geometry was a necessary outgrowth of surveying to preserve the layout and ownership of farmland, which was flooded annually by the Nile river. The 3,4,5 right triangle and other rules of thumb served to represent rectilinear structures, and the post and lintel architecture of Egypt. Egypt also was a center of alchemy research for much of the western world. Paper and writing[ edit ] A section of the Egyptian Book of the Dead , which is written and drawn on papyrus The word paper comes from the Greek term for the ancient Egyptian writing material called papyrus , which was formed from beaten strips of papyrus plants. The establishment of the Library of Alexandria limited the supply of papyrus for others. According to the Roman historian Pliny Natural History records, xiii. However, this is a myth; parchment had been in use in Anatolia and elsewhere long before the rise of Pergamon. Egyptian hieroglyphs , a phonetic writing system , served as the basis for the Phoenician alphabet from which later alphabets, such as Hebrew, Greek and Latin were derived. With this ability, writing and record keeping, the Egyptians developed one of the â€”if not theâ€" first decimal system. Structures and construction[ edit ] Tools[ edit ] Some of the older tools used in the construction of Egyptian housing included reeds and clay. Buildings[ edit ] Many temples from Ancient Egypt are not standing today. Some are in ruin from wear and tear, while others have been lost entirely. The Egyptian structures are among the largest constructions ever conceived and built by humans. They constitute one of the most potent and enduring symbols of Ancient Egyptian civilization. Temples and tombs built by a pharaoh famous for her projects, Hatshepsut , were massive and included many colossal statues of her. In some late myths, Ptah was identified as the primordial mound and had called creation into being, he was considered the deity of craftsmen, and in particular, of stone-based crafts. Imhotep , who was included in the Egyptian pantheon , was the first documented engineer. In Hellenistic Egypt , lighthouse technology was developed, the most famous example being the Lighthouse of Alexandria. Alexandria was a port for the ships that traded the goods manufactured in Egypt or imported into Egypt. A giant cantilevered hoist lifted cargo to and from ships. This lighthouse was renowned in its time and knowledge of it was never lost. A drawing of it created from the study of many references, is shown at the right. Egyptian pyramids and Egyptian pyramid construction techniques The Nile valley has been the site of one of the most influential civilizations in the world with its architectural monuments, which include the pyramids of Giza and the Great Sphinx â€"among the largest and most famous buildings in the world. Pyramids functioned as tombs for pharaohs. In Ancient Egypt, a pyramid was referred to as mer, literally "place of ascendance. It is one of the Seven Wonders of the World , and the only one of the seven to survive into modern times. The Ancient Egyptians capped the peaks of their pyramids with gold and covered their faces with polished white limestone, although many of the stones used for the finishing purpose have fallen or been removed for use on other structures over the millennia. The Red Pyramid of Egypt c. The Great Pyramid of Giza c. Other uses in Ancient Egypt , [10] include columns , door lintels , sills , jambs , and wall and floor veneer. The ancient Egyptians had some of the first monumental stone buildings such as in Sakkara. How the Egyptians worked the solid granite is still a matter of debate. Archaeologist Patrick Hunt [11] has postulated that the Egyptians used emery shown to have higher hardness on the Mohs scale. Regarding construction, of the various methods possibly used by builders, the lever moved and uplifted obelisks weighing more than tons. Obelisks and pillars[ edit ] Obelisks were a prominent part of the architecture of the ancient Egyptians, who placed them in pairs at the entrances of various monuments and important buildings, such as temples. The word "obelisk" is of Greek rather than Egyptian origin because Herodotus, the great traveler, was the first writer to describe the objects. Twenty-nine ancient Egyptian obelisks are known to have survived, plus the unfinished obelisk being built by Hatshepsut to celebrate her sixteenth year as pharaoh. It broke while being carved out of the quarry and was abandoned when another one was begun to replace it. The broken one was found at Aswan and provides the only insight into the methods of how they were hewn. The obelisk symbolized the sky deity Ra and during the brief religious reformation of Akhenaten, was said to be a petrified ray of the Aten, the sun disk. The Egyptians also used pillars extensively. It is unknown whether the Ancient Egyptians had kites , but a team led by Maureen Clemmons and Mory Gharib raised a 5,pound, foot 4. A ramp is an inclined plane, or a plane surface set at an angle other than a right angle against a horizontal surface. The inclined plane permits one to overcome a large resistance by applying a relatively small force through a longer distance than the load is to be raised. An inclined plane is one of the commonly-recognized simple machines. Egyptian ship on the Red Sea, showing a board truss being used to stiffen the beam of this ship Navigation and ship building[ edit ] The Ancient Egyptians had knowledge to some extent of sail construction. This is governed by the science of aerodynamics. Egyptian ship with a loose-footed sail, similar to a longship. Note that the sail is stretched between yards. Loading Egyptian vessels with the produce of Punt. Shows folded sails, lowered upper yard, yard construction, and heavy deck cargo. Ancient Egyptians had experience with building a variety of ships. Irrigation and agriculture[ edit ] Irrigation as the artificial application of water to the soil was used to some extent in Ancient Egypt, a hydraulic civilization which entails hydraulic engineering. Before technology advanced, the people of Egypt relied on the natural flow of the Nile River to tend to the crops. Although the Nile provided sufficient watering survival domesticated animals, crops, and the people of Egypt, there were times where the Nile would flood the area wreaking havoc amongst the land. They were made by winding molten glass around a metal bar and were highly prized as a trading commodity, especially blue beads, which were believed to have magical powers. The Egyptians made small jars and bottles using the core-formed method. Glass threads were wound around a bag of sand tied to a rod. The glass was continually reheated to fuse the threads together. The glass-covered sand bag was kept in motion until the required shape and thickness was achieved. The rod was allowed to cool, then finally the bag was punctured and the sand poured out and reused. The Egyptians also created the first colored glass rods which they used to create colorful beads and decorations. They also worked with cast glass, which was produced by pouring molten glass into a mold, much like iron and the more modern crucible steel. Egyptian calendar and Archaeoastronomy The Egyptians were a practical people and this is reflected in their astronomy [32] in contrast to Babylonia where the first astronomical texts were written in astrological terms. In Lower Egypt, priests built circular mud-brick walls with which to make a false horizon where they could mark the position of the sun as it rose at dawn, and then with a plumb-bob note the northern or southern turning points solstices. This allowed them to discover that the sun disc, personified as Ra, took days to travel from his birthplace at the winter solstice and back to it. Meanwhile, in Upper Egypt a lunar calendar was being developed based on the behavior of the moon and the reappearance of Sirius in its heliacal rising after its annual absence of about 70 days. Day and night were split into 24 units, each personified by a deity. Key to much of this was the motion of the sun god Ra and his annual movement along the horizon at sunrise. Out of Egyptian myths such as those around Ra and the sky goddess Nut came the development of the Egyptian calendar , time keeping, and even concepts of royalty. An astronomical ceiling in the burial chamber of Ramesses VI shows the sun being born from Nut in the morning, traveling along her body during the day and being swallowed at night. During the Fifth Dynasty six kings built sun temples in honour of Ra. The temple complexes built by Niuserre at Abu Gurab and Userkaf at Abusir have been excavated and have astronomical alignments, and the roofs of some of the buildings could have been used by observers to view the stars, calculate the hours at night and predict the sunrise for religious festivals. For instance, from the Middle Kingdom onwards they used a table with entries for each month to tell the time of night from the passing of constellations. These went in error after a few centuries because of their calendar and precession, but were copied with scribal errors long after they lost their practical usefulness or the possibility of understanding and use of them in the current years, rather than the years in which they were originally used. Medicine[ edit ] The Edwin Smith Papyrus is one of the first medical documents still extant, and perhaps the earliest document which attempts to describe and analyze the brain: However, medical historians believe that ancient Egyptian pharmacology was largely ineffective. Parkins, sewage pharmacology first began in ancient Egypt and was continued through the Middle Ages, [38] and while the use of animal dung can have curative properties, [40] it is not without its risk. Practices such as applying cow dung to wounds, ear piercing, tattooing, and chronic ear infections were important factors in developing tetanus. Snoek wrote that Egyptian medicine used fly specks, lizard blood, swine teeth, and other such remedies which he believes could have been harmful. Once the practice began, an individual was placed at a final resting place through a set of rituals and protocol. The Egyptian funeral was a complex ceremony including various monuments, prayers, and rituals undertaken in honor of the deceased. The poor, who could not afford expensive tombs, were buried in shallow graves in the sand, and because of the arid environment they were often naturally mummified. Other developments[ edit ] Stained glass window from c. Some have suggested that the Egyptians had some form of understanding electric phenomena from observing lightning and interacting with electric fish such as Malapterurus electricus or other animals such as electric eels. Bolko Stern has written in detail explaining why the copper covered tops of poles which were lower than the associated pylons do not relate to electricity or lightning, pointing out that no evidence of anything used to manipulate electricity had been found in Egypt and that this was a magical and not a technical installation. Engineers have constructed a working model based on their interpretation of a relief found in the Hathor temple at the Dendera Temple complex. This sacred snake sometimes is identified as the Milky Way the snake in the night sky the leaf, lotus, or "bulb" that became identified with Hathor because of her similar association in creation. Later technology in Egypt[ edit ] Main articles: Ancient Greek technology and Roman technology Under Hellenistic rule , Egypt was one of the most prosperous regions of the Hellenistic civilization. The ancient Egyptian city of Rhakotis was renovated as Alexandria , which became the largest city around the Mediterranean Basin. Under Roman rule , Egypt was one of the most prosperous regions of the Roman Empire , with Alexandria being second only to ancient Rome in size. Recent scholarship suggests that the water wheel originates from Ptolemaic Egypt , where it appeared by the 3rd century BC. This is supported by archeological finds at Faiyum , Egypt , where the oldest archeological evidence of a water-wheel has been found, in the form of a Sakia dating back to the 3rd century BC. A papyrus dating to the 2nd century BC also found in Faiyum mentions a water wheel used for irrigation, a 2nd-century BC fresco found at Alexandria depicts a compartmented Sakia, and the writings of Callixenus of Rhodes mention the use of a Sakia in Ptolemaic Egypt during the reign of Ptolemy IV in the late 3rd century BC. Ancient Roman technology is a set of artifacts and customs which supported Roman civilization and made the expansion of Roman commerce and Roman military possible over nearly a thousand years. Inventions in medieval Islam , Muslim Agricultural Revolution , and Timeline of science and engineering in the Islamic world Under Arab rule , Egypt once again became one of the most prosperous regions around the Mediterranean. The Egyptian city of Cairo was founded by the Fatimid Caliphate and served as its capital city. At the time, Cairo was second only to Baghdad , capital of the rival Abbasid Caliphate.

## 8: [PDF Download] Egyptian Metalworking and Tools (Shire Egyptology) [Read] Online - Video Dailymotion

*The oldest Egyptian copper artefacts - beads and small tools - date to the early 4th millennium. It has been proposed that they were fashioned from native copper which can occasionally be found. According to this (unproved) theory working copper predated its extraction from ore.*

The plunder of war also enriched the treasury Lo, [they] slew In their inscriptions they used expressions like fine gold, gold doubly refined and gold of three times, white gold, green gold, native gold, ketem gold and many others. The inclusion of silver could result in a dullish, grey or green looking metal, and copper or iron made it look reddish. The standard of work of the Egyptian goldsmiths was high from the beginning of the pharaonic age. Only a small part of all the gold bracelets, diadems, pectorals, rings and other jewellery, ornamental weapons and tools, vessels and tomb equipment have survived the plundering by kings and robbers, and they belong to the most beautiful objects ever made. They were shaped by casting and hammering and embellished by engraving and embossing and by setting other materials like precious stones or even glass. By pounding, thin plates were made which were glued or riveted with gold rivets onto other, baser materials. These foils were often less than half a millimetre thick. They were applied to obelisks, columns, furniture, coffins and death masks, amulets and jewellery. Gold leaf less than a hundredth millimetre thin quite hefty compared with modern leaf which has only a hundredth of this thickness was applied to surfaces smoothed by gesso. I made its august shrine like the horizon of heaven, in thy barque in the midst of it, resting upon it The shrine was with a roof, two columns, and an upper [cornice] of the [roof]; they were of gold in [raised work], in real costly stone. I wrought upon its great carrying-poles, overlaid with fine gold, engraved with thy name. It was mostly reserved for the use of the gods, the kings and, to a lesser extent, the rich and powerful. Receiving it in the form of gold of valour , golden necklaces or ornaments in the form of flies, was an extraordinary honour for commoners serving in the army. Some gold must have circulated among the people at least from the late New Kingdom onwards, enough for robbers to run the risk of stealing gold from tombs and trying to sell it. Electrum is a gold-silver alloy which occurred naturally. It had a silver contents somewhat higher than twenty percent and its colour was a pale amber. It was mostly imported from countries south of Egypt: Punt, Emu, the south countries: Punt, 80, measures of myrrh, [6,] Silver Egypt had little silver which was not part of gold deposits. This scarcity caused the value of silver to remain high compared with gold and other commodities until the New Kingdom. By the 18th dynasty silver and copper had been established as a mostly abstract means of exchange , with silver being worth half its weight in gold and times its weight in copper. Under the 20th dynasty this ratio decreased, but grew again until it reached 1 to under the Ptolemies. With the introduction of coined money silver became the base of the system, small denominations were struck from copper. Silver was imported from western Asia, though it is unclear which were the supplying countries. On the other hand, the gifts of foreign kings, interpreted by the Egyptians as tribute, were meticulously recorded, but these were only small amounts and economically not very significant. I turn my face to the north, I work a wonder [for thee]. Seti I, Karnak reliefs J. The annals of Thutmose III: The ninth campaign J. The eighth campaign J. This niello was occasionally applied as decoration. Beaten into sheets, silver was used to plate copper and other materials, especially mirror surfaces. Bronze The introduction of bronze was a huge improvement in tool and weapon manufacture. Unlike iron which was a difficult material to work with, bronze technologies were similar to the techniques improved during the copper age: It could be cast, hammered cold, and annealing improved its toughness. It is harder than pure copper, melts at a lower temperature and is easier to cast. They may have been the result of the accidental mixing of tin and copper ores. While Egypt produced some bronze and copper-arsenic alloys of its own, it began to import significant amounts of bronze from Syria during the Middle Kingdom which reduced the use of arsenic bronze and eventually replaced it. Khikhet, the great seat of Amon, his horizon in the west; all its doors of real cedar, wrought with bronze. Inscriptions of Thutiy J. Tin for the production of bronze was imported, probably from western Asia. Although of great importance in the production of bronze, tin was only very rarely used on its own. A few objects made mostly of tin were found, the oldest the bezel of a ring dating to the New Kingdom.

Small amounts of tin oxide were added to glass to give it an opaque white colour. Tin was used as solder in the Ptolemaic Period. In the 25th Dynasty Tanutamen built a Palace in Napata: His majesty issued a command concerning it, to Nubia, to build for him a hall anew; it was not found built in the time of the ancestors. His majesty caused it to be built of stone, mounted with gold; its panel was of cedar incensed with myrrh of Punt. The double doors thereof were of electrum, the two bolts of [tin]. That and the lack of hardwood or coal needed to achieve high temperatures prevented any large scale iron production in Egypt. Much of the iron used for the manufacture of tools and weapons was therefore imported. Since pre-historic times iron compounds were used as colouring agents: Haematite, reddish-black ferric oxide, was made into small decorative items like beads and amulets. Native iron of meteoric origin with a high nickel content was the first metallic iron to be used during the pre-dynastic. According to the written records the first smelted iron reached Egypt from Tinay, an unknown country probably in western Asia [The tribute of the chief] of Tinay: The papyrus Harris, a very extensive and detailed inventory of items donated to temples by Ramses III mentions iron just once, in a listing of Nile god statues made of various metals: Iron, a statue of the Nile god, nusa. During the New Kingdom and the Third Intermediate Period no or little iron was produced locally, and finds are few. In the seventh century BCE Ionians began to settle in the Delta and seem to have brought with them the know-how necessary for working iron. Naukratis and Defenneh became the great Egyptian centres of iron tools manufacture. Once they got going it took only about a century for the production of iron implements to equal the manufacture of bronze tools and weapons. The result of this smelting process is useless as a material unless hammered hot. In antiquity, casting was not achieved anywhere but in China. When a workpiece had to be heated its temperature was not high enough to affect the bronze tools used to handle it. An additional problem was the fact that pure iron is barely harder than bronze. Repeatedly heating the iron in a charcoal fire and hammering it was probably the method used for carburizing. This seems to have occurred as early as the Late New Kingdom, probably as a fortunate by-product of shaping. Quenching was apparently introduced during the Third Intermediate Period. Iron, while the most utilitarian of metals, was still employed to fashion ornaments, but it was most important for making knives, the only metal tools most of humanity ever used and owned until the industrial revolution. Lead Lead was of minor importance. Too soft for making tools or weapons apart from slingshot it was still known since pre-dynastic times. It was mined in the eastern desert near the Red Sea coast and at Aswan. It was also frequently plundered or given as part of tribute. Thutmose III returned from his fifth campaign with Easily worked, it was employed in the manufacture of relatively cheap statuettes and jewellery.

## 9: Ancient Egyptian Stoneworking Tools and Methods: Copper coring drills

*The edges of Egyptian tools and weapons were made initially of stone, but over the centuries copper, bronze and, finally, iron were employed as their availability increased and their properties became understood.*

These coring barrels are generally thin-walled to reduce as much as possible the volume of rock that needs to be cut away. A coring bit is made by attaching the coring barrel to a wooden dowel, and the coring barrel can often exhibit a groove or gap along the length of the tube to allow new abrasive to more easily reach the cutting surface during use. Today, coring drills can be powered by an electric motor, but they can also be powered by hand, such as with a bow. In Egypt, a number of carpentry bowdrills have been found that were used by the ancient Egyptians Fig. The bow was much wider at one end to allow for a handhold, and the drill-stock was made of wood, and sometimes contained a discharge hole to help eject the drill bit Petrie a, image. The capstone bearing was of wood or hard stone, and had a hole in one end for the insertion of the drill-stock. An example of a modern experiment in fire making using a replica of a small ancient Egyptian bowdrill is presented in the following website. Ancient Egyptian bowdrill after Wilkinson  Many representations in Egyptian art of bowdrill usage is known Singer et. Examples of other depictions include a carpentry drill used for boring wood Fig. Hand-powered stone borers were also used by the ancient Egyptians for the hollowing of stone vases Petrie a, , Stocks , and representations are found in Egyptian art Fig. Both from a tomb at Thebes c. No tubular copper barrels or the wooden drill-shaft used for coring of rock have been found in the archeological record from ancient Egypt, or from Mesopotamia and Crete where rock coring was also employed Stocks , Warren  For the copper barrel, this may be due to the wearing down of the copper tube to lengths that were no longer usable, at which point the remaining copper tube was recycled Stocks  The use of bow- and hand-powered coring drills as a method of cutting rock is inferred from marks observed on ancient Egyptian stoneworks, finished and unfinished stone objects, and pieces of waste rock. Both cores and core holes are often observed to be striated e. These striations are observed to be of the concentric and also spiraling variety Fig. The diameter of the cores and core holes vary from about 0. Travertine Egyptian alabaster and limestone shows the smallest diameter cores, and igneous rocks are generally above about 5 cm in diameter Petrie  The largest diameter core holes are found in limestone and siliceous sandstone, with the largest being on the order of 45 and 70 cm Petrie ; a. The 45 cm coring bits appears to be used to dress down a platform of limestone, and the 70 cm bit could possibly have been used to cut a slab of rock, since the core could not be detached from the bottom of the core hole otherwise. The maximum length of the cores are restricted by friction forces generated by the rotation of the coring barrel, and clogging due to the build up of compacted tailings between the coring barrel and the walls of the core and core hole Stocks  Granite core UC from Giza of 4th Dynasty date. Unfinished travertine stone vessel split longitudinally to reveal remaining drill core fragments partially attached, possibly 4th Dynasty height. The ancient Egyptians began to make tools of smelted copper by cold-working and casting starting around BC Hoffman  The technique of cold-working copper into sheets by hammering existed in early dynastic Egypt, where thin-walled copper vessels have been found Petrie  The ability of the ancient Egyptians to make copper and bronze tubes, either with sheeting or by casting, is demonstrated in examples of cylindrical vessels Petrie b and pipes for plumbing Wilkinson  The thicknesses of the coring barrels are inferred from tubular slots left on the bottom of stone objects Fig. Casting of copper tubes with 5 mm thick walls can be accomplished with molds of sand Stocks  Metasiltstone ornamental bowl with coring slot from the Step Pyramid, 3rd Dynasty. A harder material than the metal itself is required as an abrasive in order to cut these rocks. This abrasive material could have been used as shards of rocks or crystals used as cutting teeth, charged copper or bronze abrasive impregnated into the metal , or as loose abrasive grains. It is unlikely that cutting teeth were used, since they would quickly loose their sharp edges, essential for efficient lapidary cutting of rock. It is unlikely that the ancient Egyptians had a ready source of mineral abrasives with hardnesses greater than that of quartz Lucas and Harris  An example of a 4th Dynasty basalt fragment can be found at The Petrie Museum, in which the saw cut still contains rock tailings and sand UC For examples of rock coring in ancient Egypt see: Core hole on the diorite gneiss statue of

Khafre, 4th Dynasty. Granite door post socket in the Sphinx Temple, 4th Dynasty. Bolt sockets in a granite door lintel near the pyramid of Pepi II, 6th Dynasty. Drawing 7 Granite drill core found at Giza Fig. Drawing 8 Part of a cast of a pivot hole lintel from a granite temple at Giza. In this example the core is not entirely removed, and remains to a length of 20 mm. Drawing 9 Travertine mortar UC found at Kom Ahmar, broken in course of manufacture, showing the core in place. Drawing 10 A small travertine core found with others at Memphis. Drawing 11 A marble eye for inlaying, with two core holes made with thin coring bits, one within the other. Drawing 12 Part of the side of a core hole in diorite UC exhibiting regular spaced grooves from Giza. Drawing 13 A limestone fragment UC from Giza, showing how closely holes were placed together to remove material by coring. An unfinished travertine vase, exhibiting a core and core hole with parallel sided walls, in which part of the core is still attached Fig. Cross-section of an ancient Egyptian unfinished travertine vessel with parallel core and core hole walls after Petrie a. A tube cut from basalt Fig. This is a method still used today by amateur lapidists for the making of cylindrical vessels and bracelets Long , Fig. Another example of tube making by the ancient Egyptians is an Early Dynastic period metasiltstone ornamental bowl, the tube is left attached and the surrounding rock is removed Fig. Drill core waste fragment made of basalt UC , double cored to producing a tube, unknown date possibily 4th Dynasty. Modern coring of cylindrical shaped stone vessels after Long  Rock tube in center of the metasiltstone ornamental bowl from the 1st Dynasty tomb of Prince Sabu Tomb Emery  Eight core holes can be observed with 7 closely spaced around the perimeter of the inner surface, and one in the center, for which the tubular coring slot is still visible. This method of removing waste rock reduces the effort necessary for the manufacturing of stone vessels, and is a common time-saving technique still used today. Stone borers and drills were also used by the ancient Egyptians. Lucas and Harris gives examples of drilling with copper or stone points, where the drill holes are still clearly visible. Many stone beads have been found with holes drilled for threading. Figure 16 presents a number of unfinished beads that contain holes from the Temple of Memeptah. Small flint drill-bits and borers, used in the manufacturing of beads, can be found at The Petrie Museum UC The Ashmolean Museum , Photograph by Jon Bodsworth The Egypt Archive A limestone block with 10 boring sockets with circular striations and ridges somewhat similar in appearance to those in a center cup of a 3rd Dynasty travertine ornamental dish from Saqqara: Objects such as these may represent an underlying block used to bore completely through a number of rock object that rested on top of it Arnold , or possibly a waste piece of rock used to practice bowl or other stone vessel boring skills. An example of these ridges can be observed in a sectioned alabaster vessel Fig. Another example of multiple bore holes is a fragment of limestone with four bore holes found in waste rock near the pyramid at Meydum Petrie b. It is described by Petrie as a possible pivot for wooden levers used to move large blocks of stone. Fragment of possible limestone pivot block UC used with levers of unknown date. Limestone fragment UC on which coring drills have been used of unknown date. The coring barrel was made of copper and was 8 cm in diameter, 1 mm in thickness, and was partially forced fitted to the wooden drill-shaft. A capstone bearing was carved out of a hard sandstone with flint chisels and punches, so that the rounded cone end of the drill-shaft could rotate with reduced friction when aided by grease, as well it acted as a weight. The wooden bow was made from a curved tree branch that applied enough tension to the bow rope to prevent slippage of the wooden drill-shaft during the coring experiment. Representation of the coring drill used in the rock cutting experiments of Stocks ,  A granite block from Aswan was used to test the coring drill. Initially, the surface of the granite was flattened by pounding with a diabase dolerite hammer. An outline equal to the diameter of the cutting edge of the coring bit was marked on the surface of the rock with red paint, and this outline was used to guide the carving of a shallow groove into the surface of the granite with a flint chisel and stone hammer. This was done to prevent the coring bit from slipping from the area being cut, during the initial stage of coring. This slippage was no longer a problem when the depth of the cut exceeded 5 mm. Unfinished travertine stone vessel marked with red paint for coring with drill, possibly 6th Dynasty height. Two workmen operated the bow at either end, and the third held the capstone. As the bow was drawn back and forth, the motion produced revolutions of the coring bit per minute 60 clockwise and 60 anticlockwise. This was easily obtained by the workman holding the capstone, however, some difficulty was noted in keeping the drill stable and perpendicular to the granite surface during the reciprocating motion of the bow. However, this effect was reduced as the core depth increased, and the overcutting of the core hole was kept symmetrical by changing the orientation of the bow during drilling. The dry sand abrasive quartz was added at the top of the core hole and some of it worked its way down to the cutting surface as the coring proceeded. Wet sand appeared to make the drilling more difficult than that of dry sand. When dry sand was used the tailings of the drilling process were removed by hand after extraction of the drill, and were found to be compacted on the sides of the copper tube. The rock core was removed from the core hole by hammering two chisels into the tapered groove, and the core was extracted in a single piece after breaking off near the bottom of the core hole. Stocks notes the presence of concentric horizontal striations. As in the case of the slabbing saw experiment , this may be the result of angular quartz fragments embedded in the copper coring barrel, or possibly the compacted tailings on the walls of the coring barrel. The striations were up to 2. The experiment took 20 hours to complete and generated a rock core 6 cm in length. A rate for cutting granite with dry quartz sand abrasive of 5. The ratios of volume, weight, and depth of removal between the copper barrel and the granite block are presented in Figure  Because of the inexperience of the work teams in these modern experiments, it was suggested by Stocks that the rate of cutting could be increased by a factor of 2 with gained experience. Stocks also conducted experiments on cutting limestone with bow-powered coring drills. The rate of cutting limestone with a copper barrel was 15 times greater than that observed in granite Stocks  The rate of copper loss would be expected to be very low, due to the similarity in hardness between the mineral calcite and copper. This was demonstrated by coring drill experiments conducted by Stocks , in which a ratio of length of copper barrel lost from the drill bit to stone depth penetrated was less than 1: Copper tube coring drills would be very effective in the working of most limestones, since quartz abrasive is about 5 times the indentation hardness of calcite.

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