Precious Stones and Bronzes in Jade Age and Bronze Age of China

Kin Sum (Sammy) LI
Department of History, Hong Kong Baptist University, Hong Kong, China
kinsumli@hkbu.edu.hk

Abstract

This article aims to revisit the terms ‘Jade Age’ and ‘Bronze Age’ in respect to Chinese archaeology and history. It argues that the active exchanges of techniques, ideas, and tools between the bronze and stone producers have blurred the definitions of these periods and proposes that we focus more on the concrete agents in history. This article adopts evidence from the cold mechanical treatments of precious stones and bronzes. It presents and analyzes traces of polishing and chiseling on bronze surfaces and argues that some of the traces may have been left by abrasives as practiced in the lithic industry. This demonstrates that lapidary skills and the post-casting treatments of bronze objects were interrelated.

Keywords
jade – bronze – China – abrasive – producer

Introduction

The start of the Bronze Age in different regions varies, but the Bronze Age is generally defined as the period immediately after the Stone Age or the Neolithic period.¹ The academic consensus is that the Bronze Age of China (BAC) refers to the period from approximately 2000 BCE and ending about

¹ For a discussion of Christian Jürgensen Thomsen’s foundational work of classifying the three ages, ‘Stone Age, Bronze Age, and Iron Age,’ see Trigger 2008:121–9.
500 or 100 BCE when the Iron Age began. Scholars argue that the BAC is a useful term referring to the last two millennia BCE in China because one of the most prominent types of material records from China during this period was bronze (Chang 1983:30). The bronzes produced during the BAC illustrate how the ancient Chinese bronze casters acquired some of the most precious mineral materials, mastered the improved technologies, mobilized large labor forces, and became affiliated with the most powerful political elites. But as we understand more about the different material records from the BAC, we come to realize that the prominent status of bronze may not capture the variegated industrial reality of the time. Bronze is a permanent material that can be preserved for a long time; products made of other materials may have been as prominent as bronze, but they could not be preserved for a long time, leaving little or no trace. Moreover, the prominence of the bronze industry may have been shaped by other industries as well. Ignoring the contribution from other industries and the exchanges of ideas and technologies between various production communities may not do justice to the historical study of the BAC. This article will focus on the close interactions between bronze producers and workers of precious stones. It first presents evidence of how precious stones were processed before the Bronze Age. It then argues that bronze producers learned from the stone workers during the BAC. By doing so, we will be able to understand a fuller picture of the BAC, evaluate the usefulness of the term BAC, and propose new ideas for the study of material records from the BAC.

### Working on Precious Stones

Human beings have processed and used stones for a long time. The earliest identifiable lithics are believed to date to roughly 3 million BP (Harmand et al. 2015). Lithic technology had been developed for millions of years when the Bronze Age began. Some lithics were treated as ordinary tools, but some were designed and processed with the finest workmanship. The treatment of precious or rare stones, including jades (mainly nephrites in ancient China) and turquoises, was often carefully controlled. One reason was that these stones were valuable in terms of the cost of their acquisition, rarity, and distinct features. For example, their colors are rarely seen on other stones, or they are harder than others and require special treatment. People may have developed

---

2 The beginning time of the Iron Age of China is subject to debate. Max Loehr (1968) ends his selection of Bronze Age ritual vessels with a Han period (202 BCE–220 CE) item. K. C. Chang (19831–30) dates the end of the Bronze Age of China to 500 BCE.
an artistic sense and an inclination to acquire objects of beauty and rarity by the Neolithic period (Henshilwood et al. 2004; Holden 2004; Derevianko et al. 2008:24). They specifically selected these precious and rare stones and invested tremendous efforts in designing and processing them. Slicing them into desired shapes was merely the beginning of the production process after great resources had been expended to acquire them. Depending on how delicate the workers wanted their products to be, the following steps of the process could be time-consuming and laborious.

Creating forces of fracture and friction is the key when working on stones. Given the relatively high hardness of jades and turquoises, the two kinds of precious stones this article focuses on, friction was applied more often than fracture. The latter was not desired as it could break the precious stones easily in an uncontrolled manner. Appropriate force of friction could slice the precious stones into pieces of desired shapes and cut them open in a predictable and controlled way. The friction force, if well controlled, could also dent, drill or perforate, file, abrade, grind, and polish the stones without causing unnecessary cracks.

Abrasives were widely used in creating the force of friction. Sand grits, which can be easily obtained in nature, are an ideal abrasive because they are harder than most precious stones ancient Chinese producers wanted to process (Table 1). In modern industrial engineering, the Mohs scale is used widely to measure the hardness or scratch resistance of materials. Diamond is the hardest material on earth and its level is 10. Only harder materials could

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Hardness (scratch resistance) of materials found in ancient China</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mohs scale</td>
<td>(Diamond: 10)</td>
</tr>
<tr>
<td>Silicon dioxide (SiO₂) /quartz/sand grits</td>
<td>7</td>
</tr>
<tr>
<td>Nephrite</td>
<td>6–6.5</td>
</tr>
<tr>
<td>Turquoise</td>
<td>5.5</td>
</tr>
<tr>
<td>Bone (certain types)</td>
<td>5</td>
</tr>
<tr>
<td>Iron and steel</td>
<td>4–5.5</td>
</tr>
<tr>
<td>Cast bronze</td>
<td>3 (copper: 3, tin: 1.5, lead: 1.5)</td>
</tr>
</tbody>
</table>

3 Personal communication with Tang Chung, 2009.
4 Marshak 2004:94–6; Rothschild et al. 2013:1; Rumble et al. 2017:4–127 to 4–133, 12–222 to 12–223. The numbers in the table are not absolute but imply the relative range of hardness.
be used to scratch on softer materials, thus sand grits can be used to scratch on nephrites and turquoises, but iron and bronze could not cause a scratch on nephrites. Cutting open the nephrites or turquoises with sand grits implies scratching on them numerous times. Whetstones of higher hardness, another type of abrasive, can be used to slice or cut nephrites and turquoises as well; alternatively, they could be used as platforms for grinding.\footnote{For a study of whetstones dating to about the second millennium BCE, see Song Xueming 2020.}

When using sand abrasives, workers would additionally need water and the materials to which the sand grits could be attached. It is hard to grasp numerous, tiny sand grits; however, attaching them to strings, bamboo tubes, hemp, or other materials by soaking them with water created some of the best tools of friction. The movement of these materials is easier to control, and so is the direction of the force of friction. The strings soaked with water and sand can saw open a stone. Rubbing a stone with hemp fibers soaked with water and sand can abrade unnecessary protruding parts of the stone. Rotating the tubes can drive the sand underneath to dent or drill a stone. Water can also help reduce the heat generated from friction, prolong the life of the tools used to carry abrasives, and protect the surface of the stones.

These techniques and knowledge were generated and developed at the latest during the period from 40,000 BP to 8,000 BP in East Asia. A cave at Denisova in the Altai Mountains in Siberia, Russia, has provided some of the earliest examples, dating to approximately 40,000 BP, of how stones were processed in ways similar to those described above (Derevianko et al. 2008; Douka et al. 2019; Shunkov et al. 2020a; Shunkov et al. 2020b). Archaeologist A. P. Derevianko and colleagues have conducted a detailed analysis of the manufacturing technology of a green chloritolite bracelet from the Denisova Cave (Derevianko et al. 2008). Techniques of slicing, boring/drilling, rubbing and polishing, and scraping were used in processing this bracelet. Lithic tools made of ordinary stones did not receive the same kind of sophisticated treatment. The bracelet was produced with artistic designs and the most sophisticated techniques available at that time. The artistic and technical practices were inherited and re-invented by workers of later generations.

Jades and other precious stones from Northeast and Central China, dating to around 6000-5000 BCE, resemble the stones from the Denisova Cave in their shapes and decorative features, although many missing cultural links await...
One of the important discoveries was made at the Xinglongwa site in Chifeng, Inner Mongolia, China (Yang Hu et al. 2007:124). The beautifully designed stones from Xinglongwa are identified as nephrites. The rings and the crescent-moon-shaped pendants resemble those from the Denisova Cave, although there is not enough evidence to validate a connection between them. However, workers may have shared similar concerns in production techniques, avoiding the application of facture forces to jades and relying instead on the friction force that could be used to break them in a controlled manner without further damage. The slit rings and the drilled holes are clear evidence of that.

Turquoises unearthed from the Jiahu site in Wuyang county, Henan, China are also evidence of the high-standard production techniques during the period from 7000 to 5000 BCE (Chen Xingcan 2005:57–73). Tiny turquoise beads were formed by slicing the raw ones into a roughly circular shape and perforated. The beads were not perfectly round. The striations on the beads, however, give evidence that they were ground on harder stones. Grinding the roughly circular-shaped beads could help smoothen the edge of the irregularly shaped beads, but it would leave striations on their surface. Drilling the beads required the use of abrasives and a rotating pole to drive the movement of the abrasives. The rotation of the pole would make the abrasives penetrate through the beads.

Turquoises and nephrites are much harder materials and there are not many stones in nature that could be used to work on them. The Denisova Cave chloritolite is much softer, but the processing techniques demonstrated in this discovery are already well-established. The Denisova Cave workers might have inherited their techniques and knowledge from earlier lithic workers. After over 30,000 years, entering the last six millennia BCE, similar stone-working techniques, knowledge, and designs were applied onto much harder materials. The knowledge of stone mines was also significantly enriched. Workers knew
where and how to acquire new varieties of stones to broaden their repertoire of raw materials. New colors and novel stone types were introduced, but their properties also brought new challenges. Workers in Northeast and Central China in the last six millennia BCE elaborated on and refined the designs and techniques provided by these long-established traditions.

Entering the last three millennia BCE, workers kept producing jades of new shapes and decorative features. From approximately 3300–2000 BCE, the Hongshan 紅山 culture jades represented one of the most distinct jade products in Northeast Asia. Figure 1 shows a large and bulky jade in the shape of a coiled “dragon” collected from Yangchangxiang E’ergenwusu 羊場鄉額爾根勿蘇 in Balinyouqi 巴林右旗, Inner Mongolia (Gu Fang et al. 2005, 2:22). It was first sliced into a rough shape. The central, large hole was drilled subsequently.

**Figure 1**  Jade dragon from E’ergenwusu. Height (H.) 16.3 cm. Ca. 3300–2000 BCE. After Gu Fang et al. 2005, 2:22
Afterwards, striations were sawed on the edge of the jade dragon to represent its face and mouth. Near its mouth a large gap is seen, which was about to join with the central hole. However, for unknown reasons, the workers stopped there and left the last part unfinished.

The edge of the large, bulky jade dragon was so smooth that it was hard to set a string soaked with water and sand to cut into the jade. The workers needed to first stabilize the string on a specific place of the edge and subsequently saw it until the breakage joins with the central hole. If no stabilizing mark was provided, the string could go astray and damage neighboring areas. This was also the process employed in the creation of slit rings. A stone disc from Wengniuteqi Danangou in Inner Mongolia, dating to about 3000 BCE, shows four stabilizing marks (Fig. 2). Stabilizing a string soaked with water and sand on one of the marks, one could obtain a slit ring by sawing the jade along with the mark. The Danangou workers also left an unfinished product.

To create the striated stabilizing mark, one could use a smaller whetstone that was harder than the jade to first scrape a trench or a groove on the jade. The act of scraping a line or trench on the jade is called “filing.” Filing a long, straight trench was not easy because the whetstone could at any time stray from the desired moving direction on the smooth surface of the jade. A purported
Hongshan culture jade yields a clue to one of the methods the worker used to create a longer, straighter trench (Fig. 3). On the right of the object in Fig. 3, two dented dots were created, which were about to be joined with the longer trench on the left. We may postulate that the worker of this unfinished jade may have begun by denting a series of dots in a line. Subsequently he could join two neighboring dented dots by filing. Since any two neighboring dots were so close to each other, the filing would not go off the desired track. By joining more dots, he could create a longer, straighter trench. In this way he could well control the moving direction of the filing and the depth of the trench.

If the method of creating the long striation/trench described above can only be used on the outer area of the jade, jade workers also devised methods to create long, curved line within the jade. A Hongshan culture jade pendant, unearthed from M1 of Burial Mound No. 1 at the 5th location at site Niuheliang (牛河梁), Chaoyang (朝陽) city, Liaoning (遼寧), provides clues to how a long, curved line within the jade could be created (Fig. 4; Gu Fang et al. 2005, 2:133). One could not start by creating a stabilizing mark from the outer area. Instead, the worker could begin by drilling two tiny holes, as indicated by the arrows in Fig. 4. The front and back sides of the jade pendant show these two holes and the direction of the curved line. The worker could have inserted a string through one of the holes and started sawing out the line with the string. By using the methods similar to the ones employing stabilizing marks described above, the worker could carefully control the sawing direction and join the line with the other hole.

A jade hairpin finial, inlaid with turquoise, was unearthed from Xizhufeng (西朱封), Linqu (臨昫), Shandong, dating to about 2500-2000 BCE (Fig. 5; Gu Fang et al. 2005, 4:19–20). Its worker combined a variety of processing methods.
while producing it. Traces of drilling holes, denting, setting stabilizing marks, and connecting the marks by filing or sawing can be found on the hairpin finial, thanks to some of the unfinished processing marks. Unlike a perfectly-processed jade that would not reveal many production traces, a jade like the Xizhufeng hairpin finial provides a good study example. We can also see that the turquoises inserted onto the jade finial were delicately processed. They were ground to circular shapes and fitted perfectly into the holes drilled on the jade finial. Such grinding skills that made the turquoises fit into the pre-set holes represented high technical standards and laborious efforts, considering the coarse forms in which raw turquoises were probably extracted.

Raw turquoises can appear in very irregular shapes. When they were broken into tiny pieces for detailed processing, they would appear in shapes like those found in the site Erlitou 二里頭, Yanshi 偃師 city, Henan, dating to about
1800–1500 BCE (Fig. 6; Tang Chung et al. 2007:120–32). These irregular-shaped turquoises needed to be ground. If a workshop needed to produce a turquoise dragon, thousands of turquoise pieces would have to be ground into regular cuboidal or trapezoidal shapes of a similar size. The tiny striations on these processed turquoise pieces are also evidence of multiple grinding on whetstones. Eventually they were assembled to form a dragon, mounted on bronze shields, or inserted into other items to strengthen the visual effect (Qin Xiaoli 2016).

These sophisticated designs and techniques of jade products, one of the most precious art types at the time, demonstrate the tremendous social and economic resources that were invested in the jade industry. From the acquisition of raw materials, to the processing of stones with a variety of techniques and tools, the incorporation of the most advanced technologies, and the distribution of the products to their commissioners or consumers, jades, turquoises, and other precious stones during this period represented the highest artistic and technical achievement. This observation led a number of scholars to postulate the existence of the Jade Age of China (jac) (Childs-Johnson 1998; 2001–2002; 2021; An Zhimin 2000). The rationale of proposing the term jac relies on the available evidence of art items that represented the investment of tremendous efforts and resources. Since not many artifacts from the last six millennia BCE have been preserved, it is not surprising that jades, for contemporary scholars, became the most representative art items from about 6000–2000 BCE. But we have to realize that this perception may be caused by the durability and preservation of stones as opposed to perishable materials. At
the advent of the BAC, bronzes had become one of the most representative art items, but jades and other precious stones did not fade out. Instead, numerous sophisticatedly processed jades and turquoises were still produced during the BAC. Most importantly, the knowledge and techniques of processing jades were adopted by bronze producers, who used what they learned from the lithic industry on bronze products. These instances of the borrowing of knowledge and techniques from the lithic industry and their impact on the bronze industry should have important bearings on how we understand the BAC.

**Working on Bronzes with Methods Learned from the Lithic Industry**

The knowledge and techniques of jade and turquoise processing by no means vanished at the onset of the BAC. Instead, such techniques as stabilizing of work tools, sawing, denting, drilling, chiseling, abrading, filing, grinding, and polishing were embodied in a number of cast bronzes. Most of the bronzes from the BAC were cast (Bagley 2009), but freshly cast bronzes were subjected
to complicated post-casting procedures, which were of utmost importance for the final appearance of bronze products. The techniques of processing jades and turquoises represented types of cold mechanical treatments that were used on the bronzes at this stage. Similar to working on precious stones, force of friction, but not of fracture, was desired, as bronze was also an expensive material. There are not many studies of how bronze producers applied stone-working techniques on their products; the evidence is scattered and comprehensive studies would be desirable in the future.9 Due to the limited samples collected by the author and his colleagues, in this article, we will have to roam throughout the centuries in search of evidence.10

When a bronze was freshly cast, the surface was coarse, with many undesired protrusions. Casters needed to scrape off the protrusions and smoothen the surface, probably by using whetstones (Hua Jueming 2007:401–6; Liu Yu 2019:158–62; Song Xueming 2020:22–6). Removing protuberances by striking was not desired as it may have cracked neighboring parts. Repeated friction force was probably exerted to scrape off the protuberances. Extant bronzes from the BAC are usually corroded; the corrosion covers the surface that was processed long ago. But there are exceptions, showing well-preserved original processed surface, with the ancient marks of grinding and polishing still visible.

Fig. 7 shows a bronze mirror excavated from Changsha 長沙 city, Hunan 湖南.11 It is a silverish high-tin bronze that shows almost no signs of corrosion, thus its traces of grinding and polishing are well preserved. Its decorated back side is significantly different from its reflective front side, which was heavily polished and thus appears in a smooth, lustrous form. All tiny protrusions and coarse surfaces were removed. Its decorated side can be divided into two parts: the one containing the main motifs and the one containing background

---

9 For a brief discussion of the post-casting processing techniques of bronzes in the last two millennia BCE, see Yue Zhanwei et al. 2012:66–7; Yang Huan and Yang Jian 2020; Zhao Shaodong et al. 2020. Burnished ceramics may show that techniques learned from the lithic industry, such as burnishing and polishing with the assistance of stones, were probably applied on the surface of ceramics. See Wu Rui et al. 2007:114; Zhang Xiaolei 2010:30–1.

10 The author of this article has attempted to cite objects that were archaeologically excavated but is hindered by limited access to these material records and the scant evidence. Of the evidence discussed in this article, only a few pieces came with unclear archaeological provenance. Other cited artifacts are all archaeologically excavated and clearly provenanced. The art historical, if not the archaeological, field may welcome such discussions.

11 This mirror is housed in the Changsha Municipal Museum, whose accession number, zongzhanghao 總帳號, is 4817, and fencelihao 分類號 is 1B313. See also Changsha shi bowuguan 2010:10.
patterns. The background patterns were not delicately treated, only the protuberances were removed, while the coarse surface was left mostly untouched. The main motifs were, however, carefully ground and polished (Fig. 8). Within the inner contours of the slanting-T-shaped motif, there are many striations, traces of multiple times of grinding. The more grinding was applied, the smoother the surface became. A smoother surface can also reflect light easily, as we can see from Fig. 8. These traces of grinding and polishing have made the main motifs significantly stand out from the background in terms of their
texture. The main motifs are much smoother and more lustrous, inviting the mirror handlers to touch them. Visual effect was also taken care of since the lustrous main motifs are much more evident than the background patterns. For such visual and tactile effects, the mirror producers must have spent tremendous efforts grinding the mirror. Similar effects can be seen on many well-processed jades and precious stones. Both the bronze and jade producers were attentive to the visual and tactile effects of their products.

Abrasives must have been used in grinding the surface of the bronze mirror. To grind the inner contours of the slanting-T motifs, strings were not the appropriate tools for the sand grits to be attached to. Instead, these abrasives may have been attached to wet bark, hemp-woven fabric, or other fabrics composed of cheaper materials. Soaked with water, these fabrics would make ideal grinding tools to drive the movement of abrasives within limited areas, that is, the inner contours of the slanting-T and other motifs. Similar grinding marks are also seen on the smooth, lustrous, circular edge of the mirror (Fig. 9).

There might have been a tube specifically designed for grinding the edge of the mirror. The grinding traces on the edge are long and curved, which do not resemble the long, straight striations made by moving abrasives back and forth in a linear direction. Instead, the curved grinding traces on the edge seem to be created by a circular tube, whose size in cross-section is close to the edge of the mirror. The tube could be made of bamboo, wood, or other perishable material. Rotating the tube by adding water and abrasives into the contact area between the tube and the mirror edge would make it easy to grind the edge. The neighboring areas, such as the background patterns, were not ground at all. Such application of tubes driving the movement of the abrasives could be seen
in earlier processing traces left on jade objects. A cylindrical piece was ready to be drilled out from a raw jade attributed to the Qijia 齊家 culture, dating to about 2200–1500 BCE (Fig. 10). This unfinished cylindrical jade was drilled by a tube by adding water and abrasives. It would appear that the bronze mirror producers obtained inspiration from jade workers.

The bronze producers seem to have borrowed other techniques from jade workers. On a bronze container in the collection of the Shanghai Museum.
(Fig. 11), dating to about 221 BCE, there are many traces of denting/drilling, chiseling, filing, and stabilizing the work tools, which were techniques often used by jade workers. We know that to engrave a long straight line on a bronze surface by using an iron knife is very difficult. Bronze is softer than iron (Table 1), but it is not like talc that can be engraved freely and smoothly. The author of this article conducted a simulation experiment by using a modern iron knife to engrave grooves on a bronze plate, which is composed of 80% copper and a certain ratio of tin and lead (Fig. 12). The first difficulty was that it was not easy to engrave a straight line. The iron knife could stray off course very easily. The same difficulty made it impossible to engrave a curved line too. The fact that an iron knife can make unwanted skids across a bronze surface means that the neighboring areas can be damaged. In this experiment, the desired grooves appeared very shallow and faint, unless engraved repeatedly. But still, the traces of repeated engravings were left at the inner sides of the grooves (Fig. 12). The producers of the Shanghai Museum container engraved lines to make inscriptions on the container, but they adopted different methods. They first made dented dots on the container for stabilizing the work tools. The two arrows in the top-left sub-image in Fig. 11 point to two abandoned dented marks. They were not used eventually, probably because the inscribers were not happy with their positions. Yet, the inscribers left these dented dots.

---

12 Accession number of this container in the Shanghai Museum collection is 44331. See Guojia jiliang zongju et al. 1984:44–5.
marks in specific positions intentionally. When all of the dented marks were connected, they formed the strokes of the characters. The inscribers connected all other dented marks, except the two abandoned ones, probably by chiseling with an iron knife. The neighboring dented marks were very close to each other, so that the iron knife that was used to connect them would not stray from its intended path. This prevented the knife from creating undesired grooves next to the character strokes. Curved lines could be created because the distance between any two neighboring marks was significantly shortened. The inscribers needed only to chisel bit by bit and they could eventually create a long, curved line, which retained the beauty and smoothness of each stroke. The traces of the dented marks and chiseling within the strokes are still visible. In this way, the inscribers managed to avoid some of the crucial problems mentioned above and achieved the beauty and clarity necessary for the inscriptions.

The producers of another bronze item attempted to remove these working traces inside the grooves. This is the Yangpingjia 阳平家 bronze lamp support, dating to 38-34 BCE (Fig. 13), also in the Shanghai Museum collection (Xu Zhengkao 1999:273; Wu Xiaoping 2007:103). Its producers probably used the same methods in creating the strokes of each character of the inscriptions by setting up the dented marks for stabilizing the work tools and other dented marks in pre-determined positions for chiseling when joining them together. They, however, wanted to remove the working traces inside the grooves, probably with sand grits. We can see that while traces were left in some grooves, other grooves are much smoother and cleaner. There are some sand grits
remaining in certain smoothened grooves. We cannot ascertain whether the sand grits were left there because the support was buried in a sand-filled environment, or they were remnants, accidentally left in situ, of the sand grits used to smoothen the inner sides of the grooves. If the latter scenario were true, it would be no surprise that some grooves appear much smoother and cleaner. Repeatedly engraving the grooves would not produce this effect, as shown by the author’s simulation experiments. On the other hand, inserting sand grits into the grooves and using a knife to drive the movement of the sand grits to scrape and polish the grooves would achieve the desired effect. Water was added constantly too. In this way the grooves could be ground and polished even when they were very tiny and narrow.

It is now clear that the bronze producers obtained a variety of techniques and knowledge from the workers of jade, turquoise, and other precious stones. To be sure, the bronze producers devised their own metallurgical knowledge and techniques to cast bronzes, but the cold mechanical treatments of the post-casting process of bronze production necessitated the use of the knowledge, techniques, and tools from the lithic industry. The bronze producers learned how to scrape away the unnecessary protuberances on freshly cast bronzes. They acquired the lithic workers’ experiences of preferring force of friction, but not of fracture as the cold treatments of bronze and precious stones were similar. They probably shared the use of whetstones and sand abrasives and learned the advantages of using harder stones to work on softer stones or bronzes. Grinding and polishing were essential skills to create

13 See also Yang Huan and Yang Jian 2020:105; Zhao Shaodong et al. 2020:105.
smoother surfaces of both bronze and jade objects. The use of tubes to drive the movement of abrasives to grind and polish was originally the stone workers’ invention, but it was subsequently adopted by the bronze mirror producers. Other techniques of denting marks for stabilizing work tools on smooth surfaces, chiseling to join dots to shorten the working distance, and filing or engraving longer and deeper grooves were originally adopted by stone workers, but they were transferred to the bronze industry to create decorations on the bronze surface and inscriptions. It is therefore evident that the knowledge, experiences, techniques, and actual practices of the lithic industry did not fade out of existence in the BAC. Instead, they became more prominent with the booming of the bronze industry when cold mechanical treatments were applied to the bronzes. We have to note also that the knowledge, techniques, and tools used in the lithic industry could be applied to the bone and shell-processing industries. Evidence of clusters of workshops processing jades and other stones, bones, and shells were found in the famous Shang period (ca. 1500-1046 BCE) site, Yinxu in Anyang city in Henan (Du Jinpeng 2022). It would not be surprising if the bone and shell workers interacted closely with the lithic workers.

Conclusion

The BAC is a convenient term for periodization, but we should be careful of using this term when it does not capture the essence of production during that particular period. The appropriateness of the term JAC should also be subjected to similar skeptical scrutiny. Although bronzes were one of the most prominent product types during the BAC and remain one of the most well-preserved ancient materials in current material records, one cannot rule out the possibility that other less well preserved or well-studied materials such as jades, bones, and textiles were also actively produced and used as important ritual paraphernalia. Other industries transmitted from the Stone Age did not necessarily disappear. Jades are still widely produced and used in China. Consider quartz, an abrasive employed during the JAC and BAC, which is widely used today as an industrial material in the processing of glass, ceramics, optical fiber, and semiconductor chips (Gong Mengtao et al. 2021). The continuous use of quartz certainly does not prove that we still live in JAC or BAC, likewise, the continuities of techniques in processing stones and bronzes suggest that there was no clear-cut boundary between the BAC and the preceding period.

Speaking of the present age (2023 CE), it seems that it would be inaccurate to apply such terms as Steel Age, Plastic Age, or Digital Age to capture its...
pluralistic features. The same can be said of all other periods in history. The use of these terms depends on our ultimate research agenda. Defining a period with a certain predominant material is a convenient way to stress the prominence of a particular industry. However, the method definitely fails in accounting for the presence of other production phenomena, especially in the BAC when the exchanges of technologies and ideas occurred frequently between the jade, bone, shell, and bronze producers. The BAC, JAC, or the Iron Age of China are artificially constructed terms by later generations’ historians (An Zhimin 2000:33; Trigger 2008:45–7, 121–9).

Perhaps we should focus more on the concrete human agents, materials, actions or practices in the actual production. The roles of humans and materials in historical industrial production are easy to deduce, but the actions and other ephemeral conditions are not conspicuous in any material or textual records. These actions, such as the practices of grinding, polishing, chiseling, and abrading, played important roles in producing the finest bronzes and precious stones. In the future, more attention should be paid to the factors of hand, material, and action in industrial production, for they will help us to better define the production history of any period.

Acknowledgment

The work described in this paper was partially supported by grants from the Research Grants Council of the Hong Kong Special Administrative Region (HKSAR), China (Project No. HKBU 12618422, 14600118, and 22601019).

Bibliography


