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The manufacture of a small crystal skull purported to be from ancient Mexico

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Summary The small rock crystal skull (Am,St.420) was acquired by the British Museum in the 1860s and is possibly the earliest of several crystal skulls purchased by collectors in Mexico City between about 1850 and 1880, when interest in ancient Mesoamerican artefacts was high. To study the lapidary technology and authenticity of the Museum's carving, scanning electron microscopy was used to investigate the manufacturing techniques and compare these with Mesoamerican lapidary practices in the pre-Columbian period prior to 1519. In contrast to securely dated Mesoamerican artefacts that were carved with hand-held tools, the small skull was predominantly worked with lathe-mounted rotary tools. Furthermore, the perforation had been modified and the surface appears to have been chipped deliberately, probably in imitation of antiquities recovered from burial. These observations suggest that the small crystal skull is a relatively recent piece of Mesoamerican skull art, made in post-Columbian times, between the late sixteenth century and the mid-nineteenth century when it was acquired.

INTRODUCTION

Two crystal skulls were acquired by the British Museum during the second half of the nineteenth century. Both are carvings of human skulls worked from single crystals of quartz (the colourless variety, rock crystal). The first to enter the collections was a small damaged skull, 3 cm high, with a vertical perforation, Figure 1. It had been part of the Henry Christy collection and was bequeathed to the Museum by the family after Christy's death in 1865. Three decades later in 1897, the better-known, life-size carving (*c.*15 cm high, 13.5 cm wide and 21 cm deep: Am1898,-.1) was purchased from the New York jewellers Tiffany and Company. Human skulls worn as ornaments and displayed on racks (*tzompantli*) were known to have featured in Aztec art and iconography in Mexico at the time of first contact with the Spanish in AD 1519, and both crystal skulls were registered by the Museum as ancient Mexican pieces [1–3]. The subsequent development of systematic scientific excavation in Mexico and associated studies of archaeological finds have shown that human skulls were sometimes carved in basalt in bas-relief as architectural elements by Aztec and Mixtec craftsmen during the post-Classic period, AD *c.*1200–1519, and worked in limestone by the Maya during the earlier Classic period, *c.*200 BC–AD 900. However, no quartz crystal skulls have to date been recovered from well-documented archaeological excavations [4].

Despite this, crystal skulls of various sizes that are purported to have originated from pre-Columbian Mesoamerican contexts have come to light in increasing numbers in museum and private collections during the past century. The authenticity of the life-size British Museum crystal skull has been the subject of increasing speculation since the 1930s [5, 6]. Doubts arose concerning the methods of manufacture and the large size of this piece because ancient Mesoamerican hard stone carvings, such as jades, were typically worked from relatively small water-worn pebbles collected from alluvial deposits using hand-held tools made of natural materials such as stone, wood and cane [7].

The life-size crystal skull was examined in the Research Laboratory at the British Museum several times between 1950 and 1990 and, although the evidence from the techniques then available was not totally conclusive, the carving was included in the exhibition *Fake? The Art of Deception* [8]. In a recent collaborative study, optical microscopy and scanning electron microscopy (SEM) were used to investigate tool marks on the life-size skull and these were compared with the tool marks on pre-Columbian material from secure contexts [8]. In addition, optical microscopy and Raman spectroscopy were used to investigate solid and fluid inclusions in the quartz to provide an indication of its provenance. The results of these examinations were supported by the findings from archival research into

FIGURE 1. Damaged rock crystal skull with a vertical perforation, Am,St.420, British Museum, *c*.3 cm high, 2.4 cm wide, 3.5 cm deep

the early history of the carving, and clearly demonstrated that this life-size crystal skull was a product of nineteenth-century Europe [9]. Lathe-mounted rotary wheels had been used to work the quartz crystal, which was obtained from a source far from Mexico and ancient Mesoamerican trade links, most probably Brazil or Madagascar. These sources were first exploited by European merchants when the sources of quartz crystal in the Alps were exhausted around 1800. In addition, large blocks of quartz suitable for producing this skull were unlikely to have been available much before the final quarter of the nineteenth century and documentary evidence suggests that the carving was first acquired by Eugène Boban, a French antiquarian, collector, dealer and enthusiastic student of ancient Mexico, between 1878 and 1881 when he was based in Paris.

Smaller crystal skulls have attracted less public attention, but their origins are of no less interest to our understanding of the past. The small British Museum crystal skull was considered by Walsh to be one of the "first generation of crystal skulls" [4]. These skulls appear to have been acquired in Mexico City during the second half of the nineteenth century by various collectors and dealers. All are perforated, none are more than 4 cm high and the example in the British Museum is possibly the earliest. It was catalogued as part of the original Christy collection by Steinhauer, a curator from Copenhagen, in 1862 and may have been bought by Christy on a visit to Mexico City in 1856. Other small crystal skulls include two acquired by Eugène Boban when he was based in Mexico City (from 1850 to 1869) that were first exhibited at the Paris Exposition Universelle in 1867 and are currently in the collections of the Musée du Quai Branly, Paris. Another small crystal skull was bought in 1885 by the dealer William Blake from the collections of Augustin Fischer, who acted as secretary to Emperor Maximilian during the French intervention in Mexico (1863–1867); the following year Blake sold the carving to the Smithsonian Institution, Washington DC. Finally, the Museo Nacional de Mexico, Mexico City, purchased two further small crystal skulls, one in 1874 and another in 1880 [4].

These 'first generation' crystal skulls were acquired when interest in Mesoamerican antiquities was high. The Smithsonian curator, William Holmes, described the large quantities of ceramic, stone, wood and metal artefacts being forged or created in unknown Mesoamerican forms in 1886 in Mexico City and environs [10], while it has been suggested more recently that the first generation crystal skulls may have been reworked from pre-Columbian Mesoamerican beads in post-Columbian times [4]. Following the successful outcome of the recent study into the origin of the British Museum's life-size crystal skull, it was decided to investigate the lapidary technology of the small crystal skull (Am,St.420).

METHODS OF EXAMINATION

The fine detail preserved on the carved features of hard stone artefacts is ideal for the study of ancient lapidary technology. The use of tools and techniques can usually be recognized from the characteristic morphology of the tool marks of carved features. The approach adopted for the examination of the small crystal skull was similar to that employed to assess the technology of the life-size crystal skull. The approach, based on SEM examination of moulds of carved features and their comparison with moulded experimental standards, was used by Gwinnett and Gorelick to examine the internal surfaces of ancient drill holes [11], then developed by the present authors to identify techniques of engraving on quartz cylinder seals from the ancient Middle East [12, 13], and subsequently applied to investigate the technology of jade working in China [14].

First, optical microscopy was used at magnifications up to 60× to survey the small skull for tool marks; features that appeared to bear evidence of the carving technique were selected for more detailed SEM examination. To facilitate the examination of recessed features of interest, where important evidence for the carving techniques is often preserved, detailed impressions were made using a dental silicone moulding material that posed no risk of damage to the skull. Prior to moulding, a thin coating of soil was gently cleaned from the lower half of the perforation to reveal original tool marks on the internal surface. The moulds were mounted on aluminium stubs. Initially, the moulds were coated with a thin layer of gold for examination using secondary electron imaging in the high vacuum chamber of a JEOL JSM 840 SEM, but the recent acquisition of a Hitachi S-3700N variable pressure SEM (VP-SEM) permitted further moulds to be viewed without coating and the basically convex surfaces of the crystal skull to be examined directly at a chamber pressure of 30 Pa. The different modes of examination are indicated in the figure captions of the SEM micrographs.

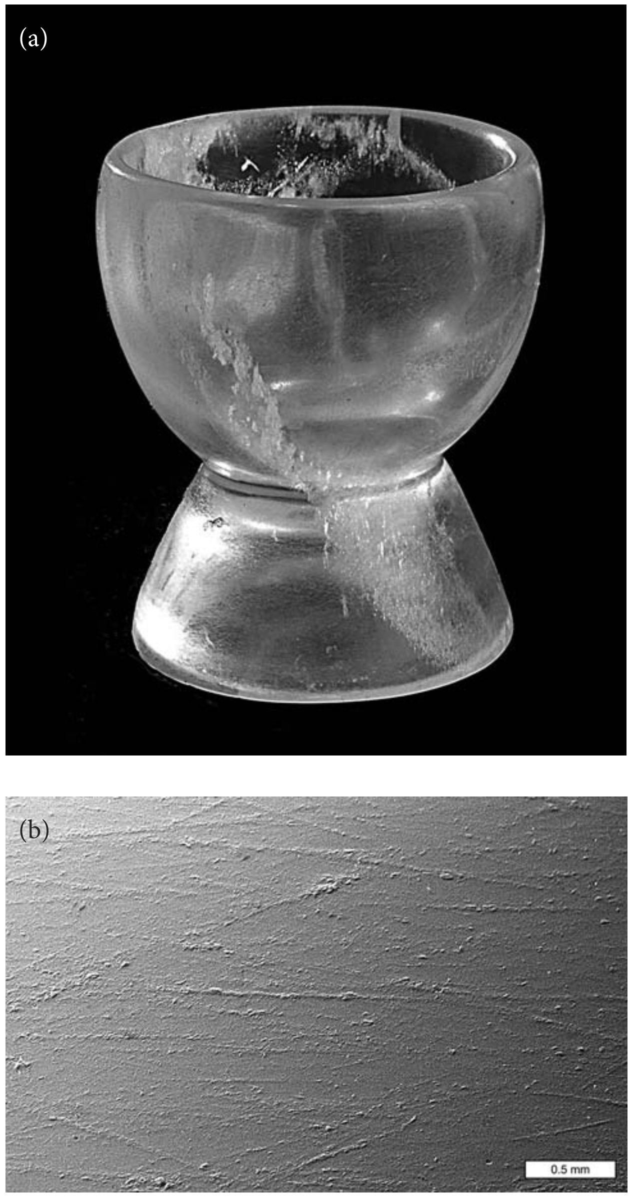

FIGURE 2. (a) Rock crystal goblet with cup-shaped hollow base, 10.105605 Museo de las Culturas de Oaxaca, Mixtec culture, AD *c*.1200–1521, 8.8 cm high; (b) electron micrograph of the moulded details of the internal surface of the goblet, showing single striations in random orientations that are consistent with non-rotary tools. Image: JEOL JSM 840 (b)

Following the criteria established by the authors, the use of various lapidary tools and techniques was recognized by comparing the moulded characteristics of the tool marks on the skull with the moulds from features produced experimentally on quartz using a range of non-rotary and rotary techniques, tools and abrasive materials [15]. By considering several characteristics, it is usually possible to distinguish between individual tools, for example, non-rotary saws and rotary disc-shaped tools (or wheels).

The evidence found on the skull was compared with that for pre-Columbian Mesoamerican lapidary practices presented previously [9], and summarized below. The information found in Codices recording Aztec and Mixtec histories in the early colonial period, when it is unlikely that traditional indigenous technologies had been significantly modified, was of particular help, as was the SEM examination of a securely dated Mixtec rock crystal goblet, Figure 2a. This goblet was recovered from Tomb 7 at Monte Albán, Oaxaca, which is a Zapotec tomb that was reused by Mixtecs in post-Classic times, AD *c*.900–1521; the goblet is now in the collection of the Museo de las Culturas de Oaxaca (No. 10.105605) [16].

PRE-COLUMBIAN MESOAMERICAN LAPIDARY TECHNOLOGY

No evidence for rotary lapidary wheels has been found in Mesoamerica prior to the Spanish conquest. In contrast to drills, which may have been hand-held, for example with a capstone and bow-driven, the use of wheels would have been dependent on devices similar in function to lathes: the attachment of a wheel to a spindle (or axle) fixed between bearings allows the tool to be rotated by some means [15, 17]. Mesoamerican lapidary methods were relatively simple by modern standards and relied on the use of hand-held tools. These included small rigid saws and broader files, pointed tools and drills made of stone or organic materials, such as wood and cane.

A painting in the *Codex Mendoza* (Figure 3), compiled between 1541and 1542, shows an artisan using a stone (possibly flint) tool to saw individual beads from a preformed jade/green stone tube [18]. Metal lapidary tools appear to have been introduced soon after the Spanish conquest, as discussed below and by Hosler [19].

FIGURE 3. A lapidary teaching his son uses a stone tool to saw individual beads from a preformed perforated column (*Codex Mendoza*). Image: reproduced by kind permission of the Bodleian Library, Oxford

Abrasive sands were sometimes applied in conjunction with the tools. In contrast to the views of Foshag [20], who considered that the use of abrasives considerably harder than quartz (Mohs' scale of hardness, H = 7) or jadeite (H = 6.5) was unlikely, Sax *et al*. have inferred that, prior to 1521, the range of abrasives may have occasionally included emery/corundum with H = 9 in addition to quartz and almandine garnet (H = 7–7.5) [9].

Rock crystal and amethyst were among the hardest stones to have been worked in Mesoamerica. The methods employed to carve these materials were documented by the Franciscan Fray Bernardino de Sahagún in the *Florentine Codex* (Book 9, Part II) between 1575 and 1577 [21]. At that time, "a piece of metal" was used to shatter the crystals then shape selected pieces to size. Carving experiments confirmed that rock crystal and amethyst may be shaped relatively easily by chipping/pecking techniques using, for example, pointed stone or copper-based tools [15]. In a second stage of working, abrasives were used to smooth the shaped surfaces. This was a lengthy process with the ultimate aim of providing a gleaming polish with wood or cane polishers (often containing natural opaline silica).

Observations on the Mixtec crystal goblet

Numerous tool marks are preserved on the external and internal surfaces of the Mixtec rock crystal goblet. Foshag referred to similar marks on other Mesoamerican artefacts as "ghosts" of the technique [20]. SEM observation of the fine detail on the goblet provided supportive evidence for the methods of smoothing and polishing described by Sahagún, although no tool marks remain on the goblet from the initial stages of shaping.

The moulded details of the tool marks are shown in the SEM micrograph, Figure 2b: single linear striations occur in random orientations. These irregular characteristics are consistent with a non-rotary technique of carving, involving the application of straight files in random directions. The internal concave surfaces of the goblet are occasionally characterized by single curved striations. Files with shorter working edges would have been needed to work these surfaces; the ends of straight files or files with curved working edges, similar to modern riffler files, would have been suitable. The notable, smooth shaping of the Mixtec carving is consistent with a soft tool material, such as 'hard' wood [15].

The variable cross-sectional thickness of the tool marks probably reflects the use of abrasive particles with different grain sizes, suggesting that increasingly fine abrasives might have been applied prior to polishing. Alternatively, the abrasives may have been poorly sorted with a single abrasive containing grains of different sizes. Comparison of the tool marks on the goblet with those of experimental carvings made on rock crystal using files separately charged with abrasives of different hardness suggests that the marks on the goblet were made with an abrasive harder than quartz, such as almandine garnet or emery/corundum [15]. The experimental use of quartz sand produced occasional coarse, often non-linear striations, and continued filing gave shorter, finer linear striations, unlike those on the goblet. Durán, a sixteenth-century priest, recorded that during the rule of Moctezuma (1502–1520), the Aztecs obtained lapidary sands from the Mixtec provinces of Quetzaltepec and Tototepec, now in Oaxaca [22]. Although the mineralogy of these sands is not known, sources of almandine garnet are found at San Sebastián Abasolo, Oaxaca [23], and sources of emery/corundum occur in Oaxaca and neighbouring Guerrero and Puebla [24].

The tool marks are recessed in the goblet and protrude upwards on the mould (Figure 2b), showing rough and unpolished surfaces that contrast with the remaining smooth and highly polished surfaces of the goblet. The combination of the two textures gives the artefact a softly polished overall appearance. Furthermore, as noted by Foshag [20] and Chenault [25], unpolished recesses are diagnostic of rigid polishing tools, such as the wood and cane polishers described by Sahagún [21]. Unlike soft felt or leather-covered tools charged with fine-grained polishing mixes in post-conquest times, rigid polishers would not have reached the recessed surfaces. It is against these Mesoamerican methods used in pre-Columbian times that the carving of the skull may be judged.

LAPIDARY TECHNOLOGY OF THE SMALL SKULL

The sides of the small crystal skull have a matt, apparently worn finish and parts of the carving are damaged: several surfaces are chipped and the lower jaw (mandible) is missing, Figure 1. Numerous tool marks are preserved within the polished surfaces as 'ghosts' of the technique [20]. Their characteristics provide evidence for several stages of working. The ways in which the various techniques and tools are recognized are described and illustrated below in the possible sequence of their application; the characteristics of the chipped surfaces are also discussed.

Shaping

An early stage of working appears to have been to saw flat surfaces at opposite sides of the quartz crystal. Using the VP-SEM to examine the skull directly, a well-defined linear profile was seen along the join of the upper surface and the proper left side of the cranium. Experimental experience suggested that the profile was consistent with sawing, rather than the Aztec method of pecking described by Sahagún in the 1570s. It seems that subsequent working erased other tool marks produced at this stage and it was not possible to determine whether a thin non-rotary straight saw or a thin rotary circular had been used.

Particularly well-defined linear tool marks remain from a subsequent stage of shaping, apparently unmodified by subsequent smoothing prior to polishing. They are preserved on a narrow surface (*c*.1.5 mm wide and 8 mm long) under the zygomatic bone, protruding from the proper right-hand side of the carving above the jaw, Figure 1. In the SEM micrograph in Figure 4a, a mould

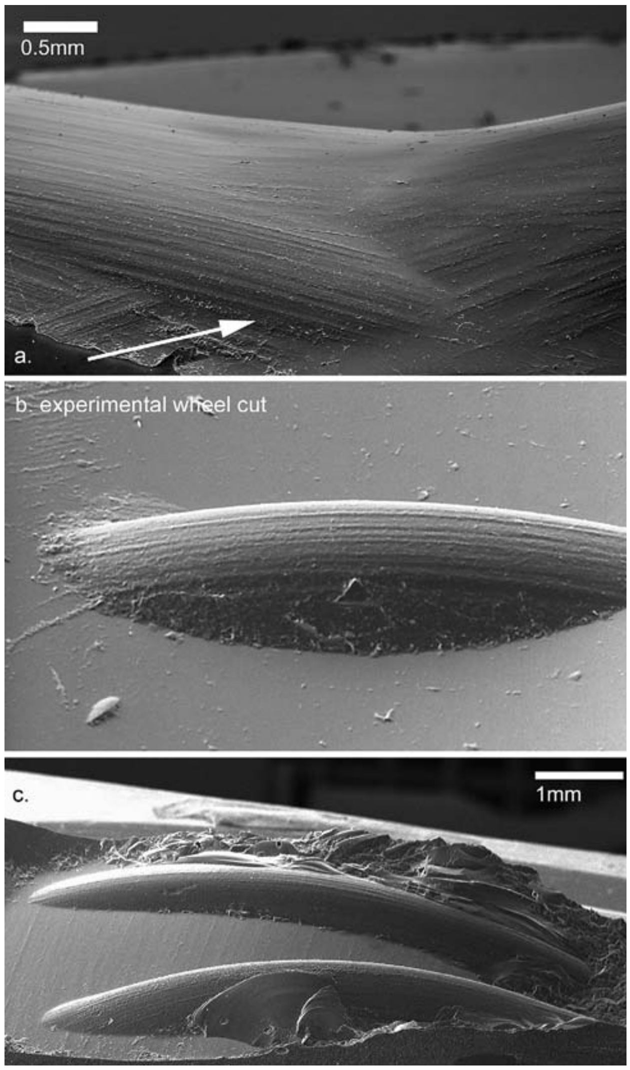

FIGURE 4. SEM images of moulds of carved features in the small crystal skull – in these oblique views, the recessed features on artefacts protrude upwards on the moulds (across the images): (a) the surface of the zygomatic bone at the side of the skull – the profiles and striations along the ends of cuts (for example, arrowed) are slightly convex, reflecting their concave depth in the skull, consistent with the use of a grinding wheel (see text); (b) experimental feature produced by wheel-cutting, for comparison with (a) and (c); and (c) the nasal apertures indicate the use of a smaller engraving wheel *c*.15 mm diameter. Images: Hitachi S-3700N (a) and JEOL JSM 840 (b) and (c)

of the underside surface is inverted. This oblique view of the mould shows a series of carved features protruding upwards across the image: a slight convex curvature is seen along the ends of individual features, for example, the feature at the bottom left indicated with an arrow. The moulded profiles reflect the slight concave depth of the features in the skull. Pronounced regular continuous parallel striations are present along each feature. These characteristics are consistent with the use of a rotary wheel. Similar features were produced experimentally on rock crystal using a metal disc-shaped wheel, charged with a loose abrasive mix such as emery/corundum, Figure 4b. The quartz was held in a stationary position against the rim of a rotating wheel mounted on the spindle of an electrically driven lathe [15]. Experimental experience suggested that in shaping the recess under the zygomatic bone, the small quartz crystal blank was repeatedly held in different, more or less stationary positions against a grinding wheel with a relatively large diameter. A similar approach appeared to have been used to shape other parts of the skull, such as the cranium (see *Smoothing* below). Large diameter wheels offered the benefit of a fast rim speed for a given rotational speed of the shaft.

Less pronounced and continuous striations are present on other parts of the skull that have a shallow concave depth, such as the *canine fossae* above the teeth. Carving tests showed that similar striations were produced on quartz when the material was moved against the rim of the rotating wheel, rather than being held in a stationary position as described above [15]. The use of lathe-mounted rotary tools for shaping the small skull contrasts with traditional Mesoamerican methods of pecking.

Perforating and shaping eye sockets

Previous investigations showed that circular features, such as the perforation and eye sockets in the skull, were produced by drilling [15]. The perforation, visible through the quartz crystal, was made by drilling two holes from the cranium and the base in the area of the *foramen magnum* to meet more or less centrally. Examination of the moulded details of the cleaned, lower half of the perforation (*c*.10 mm long) revealed two stages of working. Traces of the tool marks produced during the first stage were preserved towards the end of the moulded hole, adjacent to the central join and visible in the upper half of Figure 5. The tapered profiles here were consistent with a solid drill, *c*.2.5 mm diameter. The well-defined pronounced circumferential striations showed that an abrasive was used with the drill. Comparison of the striations with those produced experimentally on quartz with stone or metal drills charged with a range of abrasives indicated that an abrasive considerably harder than quartz, probably emery/corundum, was used with a metal drill [11, 15].

Elsewhere, the walls of the hole are predominantly smoother as, in a second stage of working, the well-defined characteristics of the first drill were largely erased; see the lower half of Figure 5. Faint longitudinal striations on the mould showed that the perforation was smoothed by filing, using a tool or an abrasive material of similar hardness to quartz.

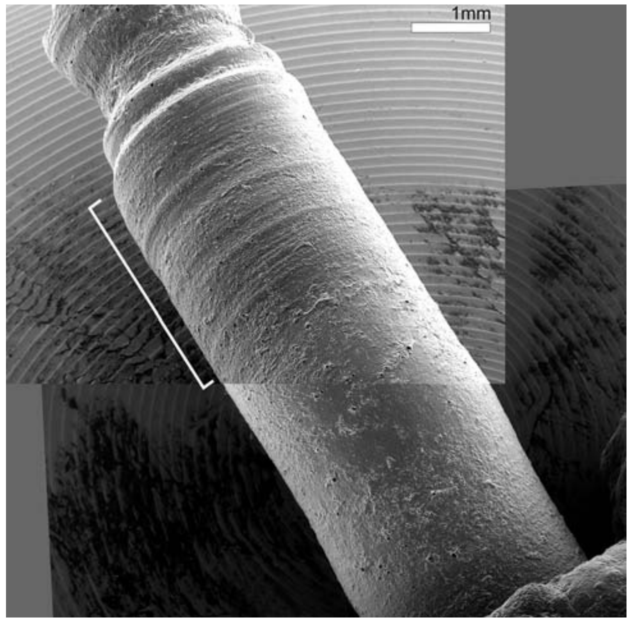

FIGURE 5. Composite SEM image of a mould of the lower half of the perforation in the crystal skull. First, the pronounced circumferential striations (indicated) were produced with a solid drill and a hard abrasive then, in a second stage of working, the surfaces were smoothed to resemble those of pre-Columbian Mesoamerican artefacts. Image: Hitachi S-3700N

The fine detail in the hemispherical recesses forming the eye sockets (8 mm diameter) provided further insight into the rotary tool used to shape and/or smooth these features. Groups of fine parallel striations indicated that the head of the tool had a curved working edge and was charged with an abrasive. These groups of striations occurred in various orientations. Circumferential striations were produced using the tool in 'drill' mode, rotating about an axis essentially perpendicular to the facial features, while tangential striations were produced using the tool in 'wheel' mode, rotating about an axis essentially parallel to the facial features. The use of the tool in both drill and wheel modes suggested that it was lathe-mounted. In contrast to hand-held drills, lathe-mounted tools such as spherical 'burrs' may easily be used in both drill and wheel modes.

Smoothing

In contrast to the curved sides of the Mixtec goblet (Figure 2a), which are evenly shaped and were painstakingly smoothed with hand-held files and abrasives, the convex surfaces of the skull, particularly those of the cranium, were not fully smoothed prior to polishing and have a faceted appearance, Figure 6. The surfaces of the facets

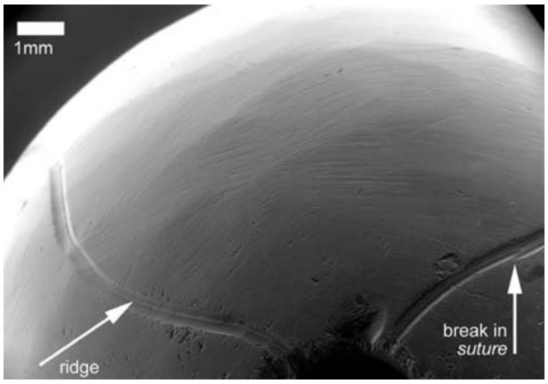

FIGURE 6. SEM image of the crystal skull showing the faceted upper surface of the cranium and details of two engraved sutures. The ridge (arrowed) along the sutures is consistent with the use of a worn wheel while breaks in their continuity (one is arrowed) reflect pauses in wheel-cutting. Image: Hitachi S-3700N

were flat or slightly concave and retained extensive traces of the abrasive striations produced by the grinding wheel (see *Shaping* above).

Engraving

Engraved details comprise three long narrow features (less than 0.5 mm wide) cut into the cranium to imitate sutures between the plates of an immature human skull (Figure 6), narrow features representing teeth and the upper lip, and wider (*c*.1.3 mm) features indicating nasal apertures, Figure 1. The features are curved or linear and fine, parallel striations are present along their length. In an oblique view of a mould of the nasal apertures (Figure 4c), the two features are seen across the image, their convex profiles on the mould reflecting their concave depth in the artefact. These engraved features have very similar characteristics to those produced experimentally using wheels (Figure 4b), as described above under *Shaping*. The curvature of the moulded nasal apertures (Figure 4c) indicates this wheel had a diameter of about 15 mm.

Further observations provide a fuller description of workshop practices. First, the surfaces of the sutures, upper lip and teeth are characterized not only by fine longitudinal striations but also by a pronounced continuous ridge (arrowed in Figure 6), apparently consistent with the use of a worn engraving wheel [26]. The defect was not present on the thicker wheel employed for working the nasal apertures. Second, frequent breaks in the shape and depth at intervals of 1–7 mm along the length of longer features (a break is arrowed in Figure 6), may indicate separate applications of the crystal surface to the wheel. An alternative explanation is that the wheel may have been mounted on the spindle of a lathe driven in a reciprocal motion with, for example, a simple bow or foot treadle.

Polishing

SEM observations of moulded surfaces at magnifications up to 100× show that the polish extends into the recessed tool marks and the sides, and occasionally the base of engraved features. As noted above, polished recesses are diagnostic of relatively soft polishing tools, such as the felt- or leather-covered wheels charged with fine polishing mixes in post-conquest times. The rigid polishing tools used in pre-Columbian times would not have reached these recessed surfaces.

Secondary chipping

The base of the mandible (16 mm deep) is characterized by large conchoidal fractures, Figure 7. These are not typical of normal handling wear and appear instead to have been worked by indirect percussion using manual tools [15]. Experiments to chip/peck rock crystal suggest that a suitably hard and tough pointed tool or chisel was held in several positions around the teeth and struck firmly with a hammer. Furthermore, the outer edge of the base is char-

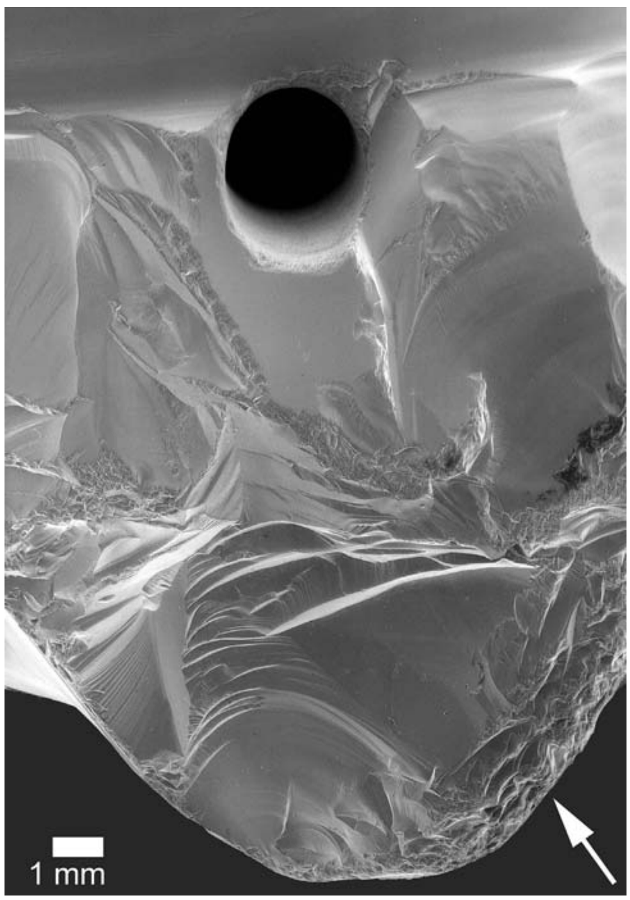

FIGURE 7. SEM image of the base of the jaw of the crystal skull showing a surface characterized by large conchoidal fractures and smaller cavities (arrowed) around the edge. These are not typical of normal handling wear, appearing instead to have been worked by indirect percussion using manual tools. Image: Hitachi S-3700N

acterized by fine conchoidal and angular cavities (arrowed in Figure 7), consistent with systematic pecking. Numerous conchoidal and angular cavities, for example on the zygomatic bones at opposite sides of the skull and around the nasal bone (Figure 4c), also appear to have been deliberately created with tools. SEM observation of the moulded interfaces between conchoidal fractures and adjacent features shows that surfaces were chipped mainly after the skull had been carved and polished.

DISCUSSION

Lathe-mounted rotary tools were used extensively in the manufacture of the small crystal skull: large diameter grinding wheels were used for shaping surfaces, smaller diameter wheels were used for engraving features and a spherical tool similar to a modern burr was employed for working the eye sockets. These tools were apparently metal and charged with an abrasive considerably harder than quartz, probably emery/corundum. Evidence was also found for the use of rotary polishing tools. To date, no evidence has been found in pre-Columbian Mesoamerica for lathe-mounted or metal lapidary tools or the regular use of abrasives as hard as emery/corundum, as illustrated by the working of the Mixtec crystal goblet excavated at Monte Albán. These innovations appear to have been European introductions in post-Columbian times, after 1519. Although Sahagún documented the use of metal tools between 1575 and 1577 [21], no mention was made of lathe-mounted rotary wheels, which appear to have been introduced sometime after 1577.

The perforation in the crystal skull was drilled with a metal tool and a hard abrasive, probably emery/corundum, rather than one of the natural tool materials and soft abrasives generally employed prior to 1519, indicating that the possibility that the piece was worked from a large pre-Columbian Mesoamerican rock crystal bead should also be discounted.

The lack of smoothing on the faceted surfaces of the crystal skull, and the use of a worn engraving wheel attest to a cursory approach within the workshop. Furthermore, modifications to the carved features suggest that the crystal skull may have been produced in imitation of a Mesoamerican artefact. After drilling, the walls at both ends of the perforation were smoothed and a thin, even layer of soil applied. Although perforations in pendants were commonly smoothed by secondary working to prevent the chafing of a suspension cord, this seems unlikely in the case of the crystal skull as the surface of the narrow central join between the two halves of the perforation remains unmodified by secondary working, Figure 5. Instead, it is notable that the smooth surfaces, which were visible under the coating of soil at both ends of the perforation, resemble those of perforations of comparable dimensions in securely dated Mesoamerican quartz and jade carvings, such as the tubes excavated at the Olmec site of La Venta, Tabasco (1000–600 BC), in the collections of the Smithsonian Institution [27, 28]. In addition, the external surfaces of the crystal skull were deliberately chipped, presumably in imitation of excavated antiquities. In 1886, William Holmes described the manufacture of large quantities of spurious antiquities in Mexico City, where the British Museum crystal skull and other small crystal skulls were acquired by various collectors during the second half of the nineteenth century.

The present investigation and the earlier programme of research show that the two purportedly ancient Mexican crystal skulls in the British Museum are both of more recent origin [9]. The place and purpose of their manufacture differ however. The small skull was probably made in Mexico City to satisfy a demand there for antiquities, while archival research by Walsh suggests that the large skull was worked in Europe [4,9], apparently as an *objet d'art*. The earliest extant reference to the life-size carving is in Eugène Boban's 1881 Paris sale catalogue, which provided no details of provenance or date, but described the crystal skull as a "chef-d'oeuvre de l'art du lapidair" [29]. Likewise, four years later in 1885, when the piece was displayed by Boban alongside human skulls from Mexico and other parts of the world in his shop, the Museo Cientifico, in Mexico City, no details of provenance or date were given and the crystal skull was termed a "pieza unica en el mundo" [9]. Later that year, having failed to sell the carving, Boban approached the Museo Nacional de Mexico, describing the life-size crystal skull as an ancient Mexican artefact for the first time.

CONCLUSIONS

The SEM investigation of lapidary technology indicates that the small perforated crystal skull in the collections of the British Museum is not ancient Mexican and was made at some time after the late sixteenth century, using rotary tools unavailable in pre-Columbian Mexico. No quartz crystal skulls are known from official excavations in Mesoamerica and the carving appears to be a more recent representative of Mexican skull art. The crystal skull was acquired by Henry Christy sometime before 1862 and is thought to have been bought by him in 1856 on a visit to Mexico City, where spurious Mesoamerican antiquities were manufactured. This suggests that the crystal skull is probably of mid-nineteenth century origin. It is hoped that ongoing investigation of the mineralogy of the quartz will provide an indication of the provenance of the rock crystal used for the carving.

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