

## A Stone Bead Production Complex from the Beginning of the Indus Civilization at Chanhudaro (Sindh, Pakistan)

Florine Marchand<sup>1</sup>, Aurore Didier<sup>2</sup>, David Sarmiento-Castillo<sup>3</sup>, Zakir Khan<sup>4</sup>,  
Ali K Lashari<sup>5</sup>

<sup>1</sup> Université de Liège, Belgium

<sup>2</sup> CNRS-UMR7041 – Archéologies et Sciences de l'Antiquité, Nanterre, France

<sup>3</sup> IRD UMR208-Patrimoines Locaux, Environnement et Globalisation, MAFBI–Mission Archéologique Française du Bassin de l'Indus

<sup>4</sup> Department of Archeology and Museums, Government of Balochistan, Pakistan

<sup>5</sup> Culture, Tourism, Antiquities & Archives Department, Government of Sindh, Pakistan

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### Abstract

Between 2016 and 2020, a massive stone bead workshop associated to dwelling units was discovered at Chanhudaro site (Trench 2 and 3) and dated to the first period of the Indus Civilization (2600/2500-2300 BCE). A huge amount of different raw materials (e.g. flint, steatite, agate, carnelian, jasper, erenite) was processed and debitage wastes of both knapping and cutting activities were identified. Tools for manufacturing, perforating or polishing the stone beads (e.g. blades, drills/borers, polishers, hammers, pressure flaker) - some of them unique and exceptionally preserved – were found together. Several beads roughouts, preforms, and finished products were also documented. For the first time (so-far) contextualized data about an intensive craft production from the first Indus period will be discussed. The evidence found at Chanhudaro site will help reconstructing the whole stone beads manufacturing processes and investigating the related technical system.

**Keywords:** Chanhudaro, Indus Civilization, Lapidaries, Lithic technology, Specialization.

### Introduction

Chanhudaro is located between the modern cities of Sakrand and Nawabshah, 20 kilometers from the banks of the Indus River. It was discovered and briefly investigated in 1931 by N.G. Majumdar from the Archaeological Survey of India<sup>1</sup>, then excavated during one field-season in 1935-1936 by the first American Archaeological Expedition in India under the supervision of E.J.H. Mackay<sup>2</sup>. Several 'Harappan' levels with buildings in fired brick were uncovered as well as craft quarters, which evidenced bead, seal and metal working<sup>3</sup>. Since then, Chanhudaro is considered in the archaeological literature<sup>4</sup> as one of the main craft centers of the Indus Civilization between 2500 and 1900 B.C. Since 2015, the French Archaeological Mission in the Indus Basin (MAFBI), directed by Aurore Didier, has resumed extensive excavations on this major site in cooperation with the Culture, Tourism, Antiquities and Archives Department, Government of Sindh, with the aim of better documenting the architectural and craft developments during the early centuries of

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<sup>1</sup> Majumdar 1934.

<sup>2</sup> Mackay 1943.

<sup>3</sup> Ibid.

<sup>4</sup> Wheeler 1968; Fairservis 1975; Allchin and Allchin 1982; Kenoyer 1999; 2014; Shar and Vidale 1985; Vidale 1989a; Miller 2005; Wright 2010

the Indus Civilization or first Indus period dated between 2500 and 2300 BCE<sup>5</sup>. In the Lower/Middle Indus Valley, the study of the first Indus period was indeed substantiated by limited field-data. For many sites, those earlier phases are indeed deeply buried beneath more recent occupations dated to the subsequent second (2300-2100 BCE) and third (2100-1900 BCE) Indus periods like in Mohenjo-daro, or to post-Indus periods. Other excavated sites were too eroded or seriously damaged by agricultural and/or industrial projects to provide substantial data on architecture and material culture from this period, while many sites buried beneath the sediments of the massive floodplains remained unidentified or inaccessible to excavation. At Chanhudaro, the levels under the city in fired brick excavated in the 1930s were reached without being excavated<sup>6</sup> or barely documented<sup>7</sup>. The site was therefore an ideal place to undertake large-scale excavations, to study the first Indus period occupation thoroughly, and to bring fresh data on the models of gradual evolution of urbanism in the Lower/Middle Indus Valley. Two areas were selected for excavations: the southern slope of Mound 3 located in the north-western part of the site (Trench 3) and the eastern part of Mound 2 (Trench 2) where numerous indicators of crafting activities associated with lapidary working had been found during the previous excavations and survey collections<sup>8</sup>. The MAFBI excavations of Trench 2 and Trench 3 in 2016, 2017, 2018, 2019 and 2020 provided the remains of mud brick architectures over a vast surface of about 4200 square meters<sup>9</sup> (Fig. 1). They date from the first Indus period (2500-2300 BCE) based on pottery studies and radiocarbon analysis<sup>10</sup>. The city has a general plan characteristic of an Indus Civilization urban center including a subdivision of space in several quarters or blocks delimited by narrow lanes and larger streets. At least 7 blocks were identified and largely excavated on both sides of a 'Main Street' (Street 1) measuring 5 to 7 meters wide (from north to south). Overall, they provided an exceptional contextualized testimony regarding the bead manufacturing from the beginning of the Indus Civilization. In particular, the eastern quarters (Block 2 and Block 3) yielded a vast crafting complex formed of: 1) a large building (A) including 12 storage cells and larger rooms used as workshops; 2) a smaller building (B) also involved in crafting activities; 3) joined craftsmen's houses and workshops (D-H) composed of quadrangular or L-shaped courtyards, small rooms, storage cells and waste areas; and, 4) a pyro technological area (C) dedicated to specialized firing activities. The crafting quarters as well as the residential quarters of Trench 2 located west of Street 1, and those of Trench 3 provided a voluminous quantity of contextualized artifacts illustrating all the steps of bead manufacturing ranging from the knapping, the cutting, the preforming of the different materials to the perforating or polishing of the objects. The raw materials are extremely diversified: steatite, different types of chalcedonies such as agate, jasper or carnelian, chert, sandstone, erenite, lapis-lazuli, ribboned calcite, serpentine with calcite ribbon, quartz, amazonite or alabaster. We discuss here the main results of the stone bead production by type of materials and tools used for their manufacture discovered in 2017-2020.

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<sup>5</sup> Didier 2018; Didier et al. 2017.

<sup>6</sup> For Mound 2 excavation, Mackay indicates that the 'Harappa II' buildings were settled on massive mudbrick structures described as "*solid platforms [...] such as these are well known at Mohenjo-daro, where they were expressly constructed to raise buildings beyond the reach of floods*" (Mackay 1943: 37). A massive mudbrick 'platform' was also identified in the 'Harappa III' level excavated in the Cutting dug in the southwestern slope of Mound 2 (*Ibid.*: 12-22, Pls. IV-VII).

<sup>7</sup> Only the structures in fired brick (walls, drains and wells) have been reported.

<sup>8</sup> Mackay 1943; Shar and Vidale ; Vidale 1989.

<sup>9</sup> This surface has been extended to 6500 square meters during the 2022 field-season as it is shown in Fig. 1.

<sup>10</sup> Didier *et al.* 2021.

## Chalcedony Products

Chalcedony, which is sedimentary rock composed mainly of quartz crystals<sup>11</sup>, occurs in a wide range of varieties among which agate, carnelian, jasper, and other varieties of stones worked by the Indus craftsmen. Agate and carnelian are translucent or semi-translucent varieties<sup>12</sup> characterized by yellow to yellow-brown and red-orange tones, and white veins of milky aspect. Carnelian is a very fine-grained variety naturally found as pebbles with a rust coloured cortex. Once the material is heated, its red orange colour turns to a deep red colour. The material collected at Chanhu-daro also includes ribboned agate – a dark brown stone with white ribbons (calcite) which is fine grained and translucent, and jasper, an opaque variety of microcrystalline silicates with a variety of tones (red, yellow-brown and green). We will focus in the next lines on the carnelian assemblage and the green jasper artefacts.

## Carnelian Assemblage (Fig. 2)

The manufacturing processes of the carnelian beads have been the subject of various studies<sup>13</sup> substantiated by ethno-archaeological or experimental approaches. The numerous and various crafting remains found in Chanhu-daro gives an opportunity to shed a new light on the production of these ornaments. Complete carnelian pebbles were discovered in different blocks of Trench 2. Impact traces are visible on their cortical part indicating percussion. They can be used as hard stone hammer, or the cortex can be withdrawn by percussion; both activities are possible. Most of the pebbles are opened, flakes were extracted, or the pebbles are split. When they are proper to bead manufacture, they are knapped to obtain three types of roughouts: (1) long thick quadrangular type; (2) short thick quadrangular type; (3) short square type. Each roughout is dedicated to a precise bead type: the first one for the long cylindrical/biconical beads, the second one for the short biconical/cylindrical and tubular beads, the third one for the ellipsoidal bi-truncated, polyhedral, discoidal and quadrangular beads. To obtain preforms, the roughout are worked by invasive retouches. Once the preforms are ready, beads were manufactured according to two different processes: In the first one, the short and long biconical or cylindrical/tubular beads are polished to erase the crest due to the preforming, after that lengthwise bipolar perforated and finally polished. In the second one, the discoidal beads are pegged to ease the central perforation, after that they are bipolar perforated and polished. As we said earlier, the different heating steps should procure the deep red coloration of the carnelian beads, but it can also ease their preforming and polishing as identified by Inizan and Lechevallier in Mehrgarh during the Neolithic and Chalcolithic periods<sup>14</sup>. Some of the ellipsoidal, polyhedral, quadrangular or tubular beads are decorated with white or black lines forming circles or concentric elements.

## Green Jaspers Artefacts (Fig. 3)

The most represented jaspers in Chanhu-daro are the green jasper and the heliotrope also called 'bloodstone' because of the red inclusions inside the material. The green jasper pebbles and the heliotrope blocks are both knapped by direct percussion. The purpose of the jasper *débitage* is obtaining thick bladelets to manufacture beads. The roughouts are trihedral or quadrangular. The preforming of the roughout is possibly made by pressure as many scars were found during the flotation. The bead preforms are first polished, after that lengthwise perforated and finally repolished. Usually found in small quantities, it is almost over 200 artifacts discovered in 2020. Of course, this raw material is known from other sites, but we would like to emphasize this

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<sup>11</sup> Law 2008

<sup>12</sup> *Ibid.*

<sup>13</sup> See, for example, Kenoyer 2005b, 2017; Kenoyer and Vidale 1992; Kenoyer *et al.* 1991, 1994; Prabakhar 2016, 2018; Roux 2000; Roux and Pelegrin 1989; Roux *et al.* 1995;

<sup>14</sup> Inizan and Lechevallier 1996

exceptional discovery because normally beads are found without traces of their manufacture. In our case, the assemblage shows the presence of both beads and *débitage* wastes. The technical pieces in general demonstrate for the green jasper that the material arrived raw and was knapped by Chanhu-daro craftsmen on the site. To our knowledge, this is one of the unique cases of green jasper and bloodstone workshop.

#### **Ernestite (Sillimanite) Assemblage (Fig. 4)**

Three types of ernestite are found in the assemblage (dark grey, kaki-grey, orange-grey colored). Two types of perforating tools in ernestite are researched: short drills manufactured with short roughout and preforms, and long drills manufactured with long roughout and preforms. Both type of preforms are worked with invasive retouches made by pressure. The short drills showed a polished extremity while the opposite extremity is rarer with a polyhedral form probably to ease the handling. One of the results of the perforation is a shouldered section between the perforation zone and the handled part. In the case of the long drills specifically designed to drill the long carnelian biconical beads, a lengthwise polyhedral polishing is used to obtain a cylindrical form, but no specific arrangement was made to handle the pieces. It seems that two handle processes were used for the drills. We were able to observe on both types' circular striae due to the perforation. The extremities of the drills, after the perforating activity, can be circular convex, can show a small concavity in the center of the convex part or can be flat with a nipple.

#### **Steatite Assemblage (Fig. 5)**

Steatite is a metamorphic rock composed of mineral talc and chlorite that has been substantially worked in the Indo-Iranian Borderlands since the Neolithic period. Whether the production of steatite beads has been the subject of numerous published studies<sup>15</sup>, several aspects of the manufacturing processes of beads have yet to be further documented and elucidated. Thousands of steatite pieces including entire and fragmentary blocks or chips showing cutting marks and/or fractures were discovered inside the assemblage. Hundreds of disc-shaped beads (large, medium and small sizes) have been collected in the different quarters. The assemblage also includes ring, circular, tubular and biconical beads, as well as hundreds of disc micro-beads and few tubular microbeads. For the manufacture of the different beads, the first step is to obtain bars and chips. Quadrangular bars are especially used to obtain disc beads but also spherical or circular ones. Two *chaîne opératoire* can be distinguished for the disc type: in one case, the bars are first bipolar perforated and seems to be polished, incised and finally heated; in the other case, the steatite bar body was polished by a polyhedral transversal movement while the extremity by an horizontal one. After that the cylindrical bar is pre-incised to mark the disc beads. The perforation and the heating occurred later. The steatite micro beads are of two types: micro-discs and micro-tubes. Both types are obtained from chips specifically cut in that purpose or from quadrangular bars or seals cutting wastes. The micro discs are manufactured from cut and fractured quadrangular micro-chips as showed by stepped pieces. Two processes are used to preform the micro-discs: (1) micro-chips can be first perforated, pre-incised and fractured; (2) micro-chips can be first pre-incised, fractured and finally perforated. The micro-preforms are probably stringed to be polished. In the micro-tube case, they are obtained from micro quadrangular bars. They are perforated, stringed and after polished. The bars are pre-incised to mark the tubes and finally fractured. The different type of beads and micro-beads are heated to obtain a white coloration. Moreover, disc and micro-tube beads were found in a powdery agglomerate. Those testimonies reinforce the hypothesis of steatite beads cooked in a steatite powder or a steatite paste to prevent cooking accidents.

<sup>15</sup> Barthélémy de Saizieu 2001, 2003, 2020; Barthélémy de Saizieu and Bouquillon 1994, 1997; Bhan *et al.* 1994; Kenoyer 1997, 2005a, 2005b, 2017; Miller 2008a, 2008b; Vanzetti and Vidale 1994; Vidale 1987a, 1987b, 1989a, 1989b, 1995, 2000; Vidale and Miller 2000; Vidale and Shar 1990.

### Chert Assemblage (Fig. 6)

The chert varieties found at Chanhu-daro have colours ranging from light grey, grey-brown to light brown or dark brown. Some have inclusions such as orange bands, white lenses or grey spots. Most of the chert is medium grained, even if fine grained and more rarely coarse-grained examples exist. The cortex is beige coloured. Sometimes milky or white patinas covered the cherts: those types of patinas are resulting of water infiltration that changed the chemical properties of the soil which reacts with the silica of the chert and create the patina<sup>16</sup>. The chert is not heated on technical purpose (neither for knapping nor retouches), rather by accident. Thousands of pieces in chert were found including blades, bladelets, laminar flake, flakes. Lately in 2020, three cores were discovered shedding a new light on the lamino-lamellar industry of the site. The cores were not found together, two of them come from Trench 2, the third from Trench 3. The cores share commonalities. Their striking platform are flat, showing a 90° angle with no specific preparation. The sides are prepared by flake extractions (preliminary flaking) but in the second case not any more visible because of the rotating extraction. The back of the core is not showing a specific management. The *débitage* is unipolar. The regularity of the negative of removals, highly straights, the very small convexity of the bulb negatives indicates the pressure technique.

In the core 1 case, impacts are visible on the central part of the striking platform, the edge between the striking platform and the *débitage* surface are blunted, the bottom of the core is impacted, the back of the core show posterior scars going against the bladelets direction. The pyramidal morphology of the piece and the different clues of a percussion activity can indicate the recycling of the core for metal battering<sup>17</sup>. In the core 2 case, we can say it is a typical bullet shape core usually made by pressure extraction. In the core 3 case, the negatives of removal are larger, more blade type but a bladelet knapping started as we can see on the right side where a plunging bladelet negative of removal cut the other removals. The plunging is a type of common accident that cause a wrong curvature of the core. It is probable that after the plunging accident the knapper try to shape the left side to continue the bladelet *débitage* but didn't obtained the desired result and finally abandon the core. Formerly, we assumed the blades and bladelets were knapped inside Chanhu-daro site and not that the *plein débitage* products came in a finished form from Rohri Hills mines. This hypothesis was based on the technical pieces studied from the previous excavations. In term of the *chaîne opératoire* and *débitage techniques* we found comparison with Briois and Pelegrin study<sup>18</sup>. With the discovery of the cores, the chert material surely arrived on the site as raw blocks or sparsely preformed blocks, but the knapping of the chert is practiced inside Chanhu-daro workshops. For the laminar production, the extreme straightness of the blades is wanted, that's why they are segmented to obtain rectilinear pieces. The proximal and distal parts are withdrawn, if needed, only to keep the mesial section most regular. The cutting edges of the blades are shaped with very fine semi-abrupt invasive retouches to regularize the edges. When the blades are retouched, they are used as "knives" for the steatite cutting. After the cutting, the edges are glossed and blunted. In certain cases, the blunted retouches are still visible under the gloss. The gloss is extended and can be seen as bands on the upper and lower surfaces of the blades. Several blades artifacts have darker spots on their surfaces. In the absence of SEM analyses, we can just assume it might be a type of glue if the blades were hafted to be used. When the flint 'knives' are not any more suitable for cutting, it seems that blade segments are recycled to make either drills with double shoulders, either axis burins or "*déjetés*" dihedral burins. The bladelets are also recycled to manufacture double pointed micro-drills with double shoulders and a triangular body.

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<sup>16</sup> Rottlander 1975a and 1975b

<sup>17</sup> Caricola 2020

<sup>18</sup> Briois and al. 2005

### **The Composite Tool, the Organic and Metallic Artifacts**

In 1989, Michel Pernot identified metallic residues on a blade butt from Nausharo<sup>19</sup>, but no metallic or composite tool was discovered then. In 2017, a unique composite tool was discovered near many micro-beads on the floor of a room of a building with massive walls in the artisanal complex of Trench 2. The handle is made of antler, probably polished, perforated at one extremity while a cupreous metal point was inserted in the other extremity. This type of tool is generally used in experimental archaeology by knappers to reproduce invasive retouches by pressure or punch techniques of the metal ages. However, the perforated extremity could indicate other uses. We can imagine a use as perforating tool: a shaft can be inserted in the perforated extremity to realize a manual rotation or a mechanic one with a bow. The indirect percussion technique was already considered but the composite tool can be part of a pressure system like a crutch or even a lever. It is also possible that such an important tool inside a knapper kit was involved in different tasks for the bead manufacture. From 2017, different pieces of antler were discovered again. Their implication or not inside the lapidary industry needs to be defined. Among the metallic artifacts, several rods are visible remembering the copper rod of the composite tool.

### **Macro-tools Collection**

The macro-tool assemblage is composed of numerous pebbles in chert, carnelian, Ernestine and undetermined hard stone used for percussion and polishing activities or a combination of both activities. A series of sandstone tools of various grains and colors were identified including hammers, polishers, grinders and anvils. Especially in the case of sandstone polishers, some of them show shallow grooves on one or several faces corresponding to beads or to Ernestine drills width (0.3 to 0.5 cm).

### **Contribution of Contextual Data**

A preliminary examination of the spatial distribution of craft indicators shows that certain categories of materials, tools or wastes related to specific stages of ornament manufacturing were evidenced in higher quantities in some parts, rooms or cells of the eastern craft complex (Blocks 2 and 3), what may reflect a specialization of production sectors by type of activities. For example, carnelian pebbles and flakes are more numerous in room 52 in Building B (Block 2) and in rooms 30 and 43 in Building E (Block 2). More than 10 kg of steatite blocks have been collected in rooms 44, 51, 52 in Buildings D and E (Block 2). Most of the tools have been found in the deposits of the largest quadrangular or L-shaped courtyards and rooms in the same buildings. Numerous polishers with grooves were collected in Block 3. Preforms of steatite microbeads were found in Building A in Block 2 and in the western house in Block 3.

In 2020, the lapidary industry associated to the contextualized data in the residential areas of Trench 2 and Trench 3 gave us more information on the material distribution. In Trench 2, the steatite-chalcedony combo is highly represented and followed by the chalcedony-steatite combo. It appears clearly that the two raw materials are principally treated in the area. Especially for the carnelian, the area is dedicated to the shaping of the blocks rather than the retouching of the bead preform. The chert, very well represented here too, is probably related to the important work of the steatite requiring proper tools (knives, drills and burins). Sandstone macro-tools are represented in small number in nearly all the units certifying the mix of artisanal activities but also of a dwelling context. The ernestine artefacts are found in small numbers in many of the units testifying the preforming of the ernestine drills and their use in the perforation of hard stone materials. The other types of stone are rare for Trench 2 even if most of the lapis-lazuli was discovered there. The principal materials worked in Trench 3 are carnelian and other types of stone, especially green jaspers obviously treated there because few flakes were sparsely found in Trench

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<sup>19</sup> Anderson-Gerfaud and al. 1989

2. The steatite is not well represented but steatite beads are always found when steatite wastes are found too. The chert is numerically smaller comparatively to Trench 2. The steatite work, less practiced in that area, is probably linked to the inferior number of chert tools in Trench 3. Sandstone and Ernestine are scattered in the units for the manufacture of the drills, the drilling activities, the polishing or the grinding.

### Conclusion

Our preliminary observations established a strong link between the manufacture of steatite beads, macro-tools for polishing activities and flint tools. We were able to see that the manufacture of carnelian beads (perhaps more widely agate-carnelian), macro-tools for polishing and Ernestine drills for perforating hard materials had a tight relationship as well. We believe that the artifacts reflect the uses of one material for the complex shaping of another material. Even if the technical skills of the craftsmen of Chanhu-daro are no longer to be proven, the indisputable attestation within the site of a chert *débitage* and the shaping of green jasper confirms the image of increased specialization and specialists with various skills, adapting to each raw material worked with an extremely well mastered technique. This is the case, for example, with pressure techniques, which are used both for the knapping and for the retouching of different types of preforms. In general, the raw material is exogenous so Chanhu-daro is showing the dynamism of a long-distance exchange network from the beginning of the Indus Civilization. The quantities of documented materials also challenge previous calculations on the time required to produce the ornaments. Furthermore, the spatial distribution of the artefacts along with data on urbanism and architecture, not presented here, seems to point towards a non-hierarchical organization at Chanhu-daro during the early centuries of the Indus Civilization, the model of a heterarchical society being currently favored.<sup>20</sup> It appears very clearly that Chanhu-daro site, due to the quantity, the diversity of its materials and the technological quality of its assemblage already allows and will still allow us in the future to bring capital results on the lapidary industry of the first period of the Indus Civilization.

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<sup>20</sup> Didier 2018.

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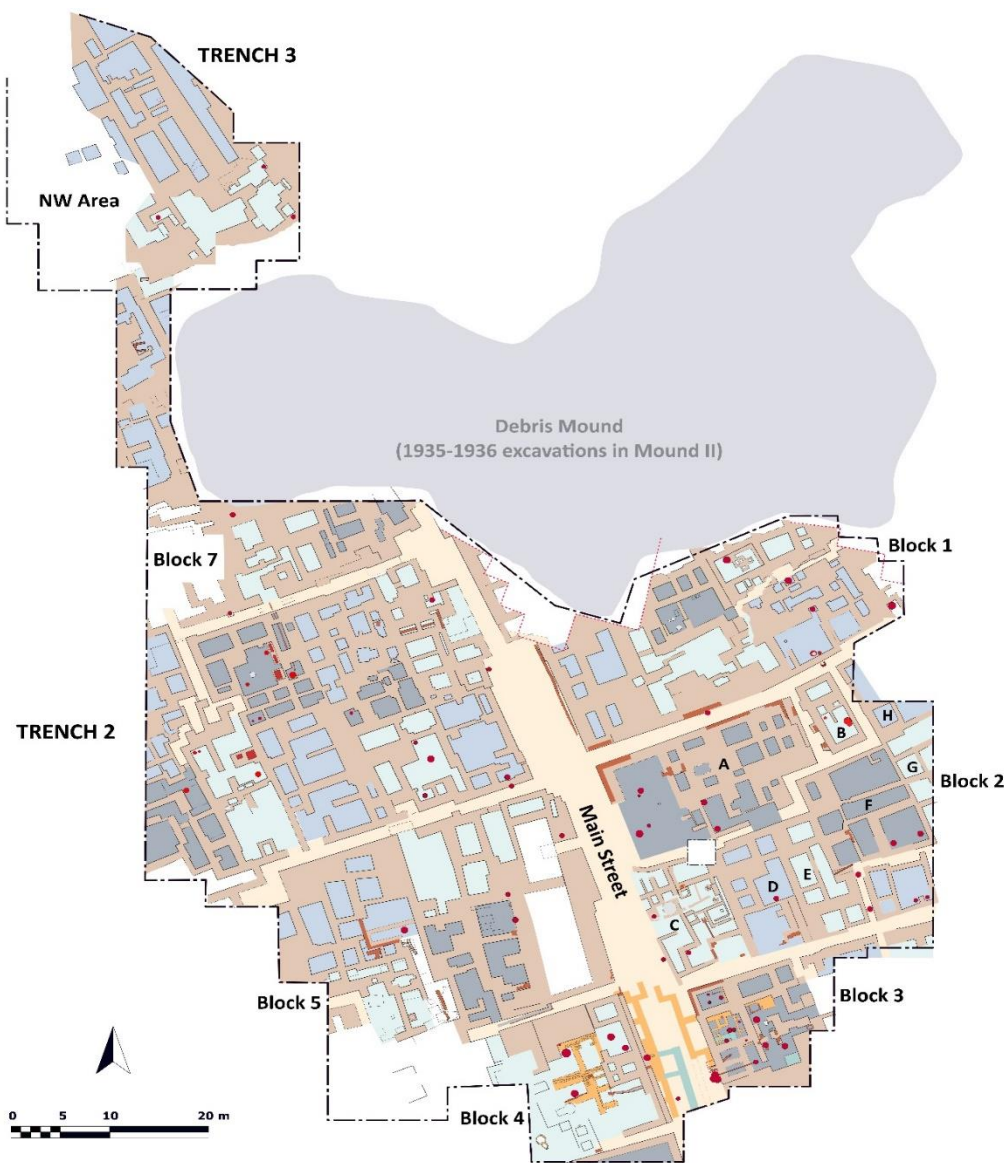


Figure 1: Plan of the Trench 2 and Trench 3 showing the different mudbricks architectural units excavated at Chanhu-Daro, © MAFBI.



*Figure 2: Examples of carnelian pieces depicting the whole manufacturing process from the pebbles to finished beads, © MAFBI.*



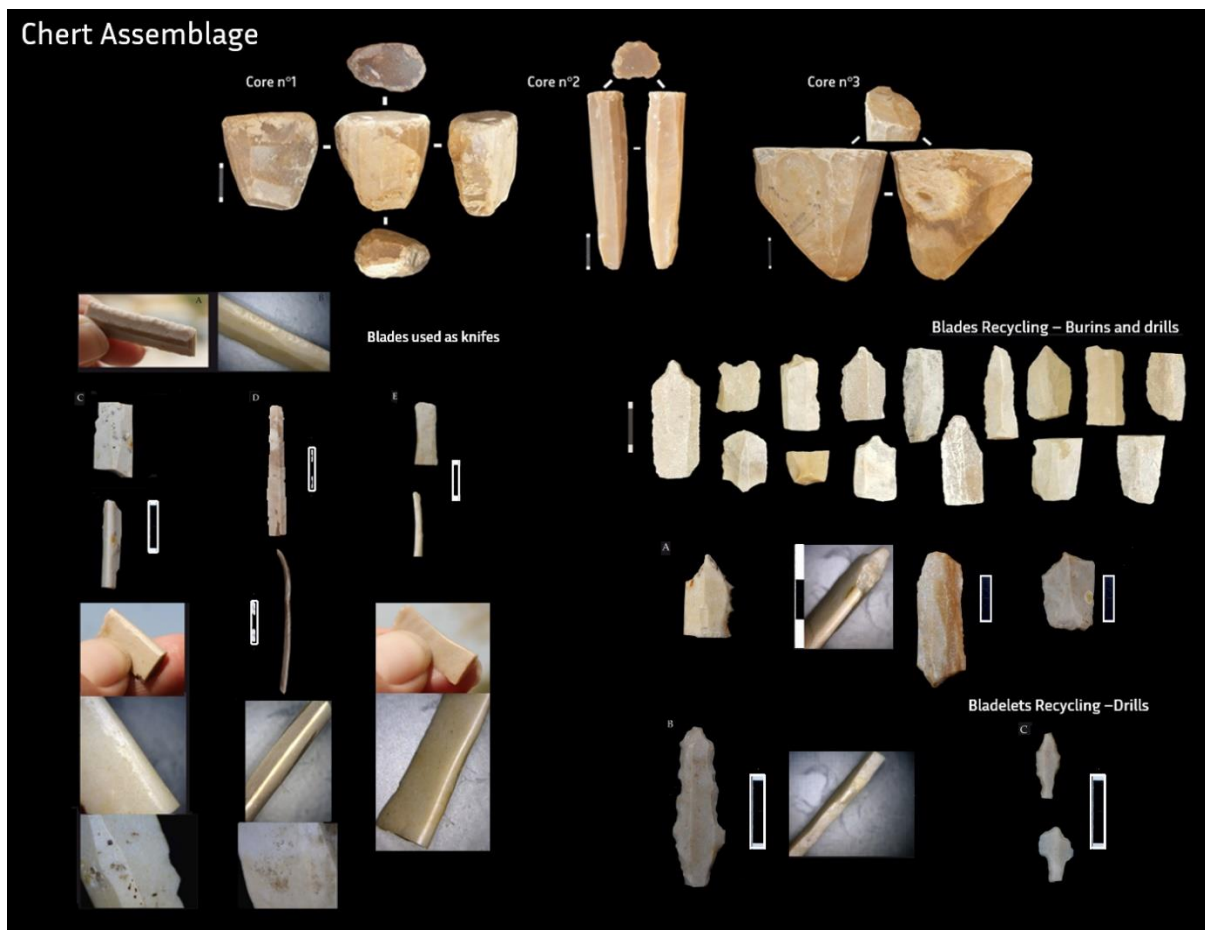
*Figure 3: Examples of débitage wastes, a roughout, a preform and a bead made of green jaspers*  
© MAFBI.



*Figure 4: Examples of ernestite artefacts showing the pebbles, the débitage wastes, the preforms, the roughouts and the drills used for carnelian bead perforations © MAFBI.*



Figure 5: Examples of steatite cutting wastes, bead products, schematization of the steatite beads and micro-beads processing, © MAFBI.



*Figure 6: Examples of chert cores, polished blade knives and recycled chert blades and bladelets in burins or drills © MAFBI.*