*Ancient Pakistan*, Vol. XXX, 2019: 1–22
ISSN: 0066-1600(print)/ 2708-4590(online)

# Stone Beads from Taxila

Akinori Uesugi*

**Abstract**: This paper explores a connection between Taxila and North India by examining stone beads from Taxila. Morphological and technological features of the beads from Bhir Mound and Sirkap point to close similarities to the examples from North India, which indicate the introduction of stone bead tradition from North India during the late first millennium BCE and early first millennium CE. Further studies on the archaeological remains from Taxila must be oriented to reveal understanding better how the connection with North India developed and examining different types of artefacts to reveal the strategic position and dynamic nature of the sites of Taxila connecting not only with North India but also with different parts of South Asia and Central Asia using scientific analyses.

**Keywords**: Taxila, North India, stone beads, trade, technological transfer.

## Introduction

Taxila is one of the most important archaeological sites of the Early Historic South Asia (Fig. 1). The several series of excavations since the 1910s (Marshall 1951) revealed three cities and a number of Buddhist monasteries of the time period between the late first millennium BCE and the early first millennium CE, which fully demonstrated the significance of this site in the political, economic and religious milieus of the society in the northwestern part of South Asia. This site or the Northwest is also important for connecting South Asia with Central Asia, West Asia and the Mediterranean world as is exhibited by the developments of the Gandharan Buddhist art that has a diverse range of traits derived from these connected regions.

However, it should be admitted that very few studies have been conducted on various elements of material culture to fully understand the socio-cultural developments in this region, regardless that a diverse range of archaeological remains have been unearthed in the excavations conducted at this site so far. As Taxila, among a number of archaeological sites in this region, can be regarded as representing the prominent importance of the Northwest, further detailed studies on the material culture of this site can lead to better understanding of the socio-cultural developments in the region and its relations with the surrounding regions.

This article attempts to examine some aspects of the socio-cultural developments in the Northwest based on the stone beads unearthed at Taxila.

## Ceramic chronology of Taxila

A diverse range of archaeological evidences retrieved from excavations at this site plentifully exemplifies the importance of this site, especially the dynamic socio-cultural developments that happened at this site and in the Northwest. Stone beads that are dealt with in this paper are also one of the socio-cultural products of this dynamic nature of the region. In order to better understand the dynamism of this region, the ceramic evidence is essential for any kind of studies on the material culture, as it can provide us with many insights for understanding the long-term socio-cultural developments of this region. This section briefly overviews the ceramic sequence in the Northwest to see the historical backgrounds for understanding the significance of stone beads (Fig. 2).

It has been well revealed by a number of excavations that the Gandhara Grave culture or the Northwestern Iron Age[1] culture spread over a wide area of this region (Dani 1968; Antonini and Stacul 1972; Stacul 1969; Wheeler 1962; Allchin 1982; Khan 1979). This cultural tradition appeared in the region around the mid-second millennium BCE and continued to the mid-first

*Centre for Cultural Resource Studies, Kanazawa University, Japan. ✉ southasia.ua@gmail.com

millennium BCE, and the ceramic evidence from Bala Hissar (Wheeler 1962) exhibits that the ceramic style of this culture started changing in the mid-first millennium BCE as represented by the appearance of the Afghanistan-Iran (Dittmann 1984) and North Indian elements, followed by the widespread emergence of North Indian elements during the late first millennium BCE. Although researches have not fully revealed how the preceding Gandhara Grave ceramics contributed to the developments of ceramics in the Northwest towards the end of the first millennium BCE, it is not unlikely that the ceramic style of this culture played an important role in the ceramic developments as a local element. It appears that both the local elements and the penetrations of elements from the surrounding regions including North India and the west made crucial contributions for the emergence of the Northwestern ceramic tradition around the beginning of the Christian Era.

Among the ceramic evidence retrieved at Taxila, North Indian elements can be identified at Bhir Mound from its lowest level dating to around the third century BCE upwards (Khan *et al.* 2002)[2]. Although the exact nature of the emergence of the North Indian elements around the third century BCE must carefully be examined and interpreted, it is apparent that the connection between the Northwest and North India became stronger than ever by this period. The ceramic evidence from the sites of the following period also indicates that the Northwestern ceramic style had a connection with that of North India.

This overall ceramic sequence in the Northwest can help assess other archaeological evidence from the region including stone beads.

## Morphological features of the stone beads from Taxila

In this section, the morphological features of 30 stone beads (Table 2, Fig. 4) that are stored in the Museum of Archaeology and Anthropology (hereafter MAA), University of Cambridge, are examined. These stone beads of the MAA collection are part of the stone and glass beads handed by J.H. Marshall over to H. Beck in the 1930s for study, which was published by Beck as '*The Beads from Taxila*' (1941). This publication of Beck can be regarded as a pioneering work on the beads from Taxila. In the excavation report published by J.H. Marshall in 1951, the beads unearthed in his excavations at Taxila were briefly described along with a material- and context-wise lists of beads, in which the details of the morphological features of beads were not included. Table 1 tabulates the period- and material-wise numbers of stone beads based on the information provided by Marshall.

This article deals with only 30 beads that the author examined at the MAA in 2016 and 2017, but it should be noted that there are many specimens included in these, which cannot be matched with the illustrated specimens published by Beck and whose excavated contexts cannot be confirmed.

While beads of the Iron Age and Early Historic South Asia can generally be classified into geometric and figurative groups, the 30 specimens examined by the author belong to the geometric group, which can be subdivided into various forms based on the combination of plain shapes and side elevation shapes (Fig. 3)(Uesugi *et al.* 2018; Uesugi and Rienjang 2018). Adding size categories to these forms, the morphological classification of stone beads can be established.

Based on this classification system, the specimens from the MAA collection include Type Aa (seven in number), Type Ac (13), Type Ad (one), Type Dc (one), Type Ea (two), Type Ed (one), Type Fa (one), Type Hj (three) and Type Ib (one).

Among the specimens of Type Aa (nos. 1 - 7) having a circular plan and a truncated lenticular side elevation, nos. 1 and 2 measure 8.20 - 8.33 mm in length and 9.80 - 10.65 mm in diameter. The ratio of the diameter of ends to the body diameter varies from 0.93 to 0.95. No. 1 is made of banded carnelian and no. 2, of banded agate. On both specimens, the bands of stone run in a horizontal direction perpendicular to the main axis of beads, suggesting that the natural bands were incorporated into the design of beads. Nos. 3 - 5 have a range of 13.07 - 23.20 mm in length and 6.87 - 13.73 mm in body diameter. The ratio of the diameter of ends to the body diameter varies from 0.37 to 0.61. Especially, no. 5 has a bulging

**Table 1.** Material- and period-wise occurrences of stone beads in Taxila (Marshall 1951)

| | Bhir Mound | | | | Sirkap | | | | Dharmarajika |
|---|---|---|---|---|---|---|---|---|---|
| | Str. IV | Str. III | Str. II | Str. I | Pre-Greek | Greek | Early Saka | Saka-Parthian | |
| Carnelian | 37 | 143 | 232 | 21 | 1 | 4 | 21 | 223 | 4 |
| Agate | 16 | 64 | 108 | 13 | | 1 | 10 | 111 | 4 |
| Jasper | | 3 | 9 | 1 | | 2 | 2 | 20 | 3 |
| Onyx | | 2 | 3 | | | | 1 | 2 | |
| Amethyst | | 2 | 31 | | | 1 | | 10 | 1 |
| Garnet | | 2 | 3 | 1 | | | 3 | 24 | 5 |
| Rock crystal | 3 | 7 | 15 | 1 | | 2 | 41 | 91 | 9 |
| Aquamarine | | | | | | | 2 | 1 | |
| Beryl | | 2 | | | | | | 2 | 2 |
| Chalcedony | 2 | 2 | 9 | | | 1 | 2 | 2 | |
| Lapis Lazuli | 7 | 4 | 6 | 2 | | 1 | 3 | 28 | |
| Malachite | | 1 | | | | | 7 | 40 | |
| Turquoise | | | | | | | | 1 | |
| Serpentine | | | | | | | | 6 | |

profile. Nos. 6 and 7 also have a profile similar to these specimens, their exact size and metrical values are uncertain due to their broken condition. No. 7 seems to have had a length of around 35 mm and no. 6 also appears to have had a longer size. Nos. 3, 6 and 7 are of carnelian, no. 4, of greyish jasper and no. 5, of black jasper. Nos. 6 and 7 have beautiful bands indicating that the aesthetic value of bands were incorporated into the design of beads. No. 5 was applied with a white honeycomb pattern by the bleaching technique.

Type Ac (nos. 13 - 25) has a spherical form. Nos. 13 - 17, 20 - 22 and 24 were exquisitely finished in a smooth surface, while nos. 18, 19, 23 and 25 are distinctly irregular in shape. It is not certain whether this difference in the final form was intentional or accidental due to the skill of bead makers. Examinations of more samples from more sites would reveal the cause for this difference. In terms of their size, the specimens have a size of 4.91 - 13.34 mm in length and 5.90 - 13.57 mm in diameter, among which the ones with a size of 9.0 - 13.50 mm are dominant. Nos. 13 - 15 are made of carnelian with no band. No. 24 is of banded agate of black and white colours. No. 25 is likely of garnet. The stone used for no. 16 with a whitish surface is unidentifiable. Nos. 13 - 16 are applied with a dotted pattern in white or black. No. 23 has a serrated pattern in white.

Type Ad (no. 8) has a circular plan and a hexagonal side elevation. The specimen has a length of 18.17 mm and a body diameter of 8.60 - 8.89 mm. The ratio of the diameter of ends to the body diameter is 0.36 showing a proportion similar to no. 5 mentioned above. It is made of carnelian decorated with a honeycomb pattern in white.

No. 26 of Type Dc, which is a disc shape, has a length of 16.21 mm, a width of 17.05 mm and a thickness of 7.76 mm. The sides are slightly rounded. It was applied with a white pattern on both sides, which consists of a row of U-shapes along the edge and dots in the centre. It is of carnelian.

Type Ea (nos. 9 and 10) comprises of a hexagonal plan and a side elevation of a truncated lenticular profile. The specimens made of rock crystal measure 12.19 - 18.69 mm in length and 8.28 - 9.20 × 6.99 - 7.74 mm at the body.

Type Ed (no. 12) has a hexagonal plan and hexagonal side elevation, but its shape is not completely symmetrical. It measures 7.50 mm in length and 8.04 × 7.28 mm at the body. It is of carnelian.

**Table 2.** List of the samples analysed in this article

| No. | MAA Acc. no. | Material | Form code | Drilling technique | Hole profile | Dimension | Hole nos. 1/2 diam | Direction of drilling | Beck's number |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | L/W/Th/Wt (mm/g) | | | |
| 1 | 1927.876 C | carnelian | Aa | 4a | straight | 8.33/9.80/9.89/1.40 | 1.03-1.06/1.03-1.03 | two ends | |
| 2 | 1927.876 C | jasper | Aa | 4a | straight | 8.20/10.65/10.62/1.7 | 1.17-1.22/1.17-1.17 | two ends | |
| 3 | 1927.876 C | carnelian | Aa | 4b | tapered | 13.07/7.36/6.87/1.00 | 0.92-1.40/- | two ends | |
| 4 | 1927.876 C | jasper | Aa | 4a | straight | 16.42/8.12/8.11/1.30 | 1.31-1.45/1.31-1.31 | two ends | |
| 5 | 1927.875 E | jasper | Aa | 4a | straight | 23.20/13.73/13.61/5.10 | 1.50-1.54/1.50-1.50 | two ends | |
| 6 | 1927.876 C | carnelian | Aa | 4a | straight | 18.94/12.11/12.54/3.60 | 1.21-1.40/1.21-1.21 | two ends | |
| 7 | 1927.876 C | carnelian | Aa | 4a | straight | 23.95/12.95/12.73/5.50 | 1.04-1.15/1.04-1.04 | - | |
| 8 | 1927.875 D | carnelian | Ad | - | - | 18.17/8.60/8.89/1.50 | - | - | |
| 9 | 1927.876 C | rock crystal | Ea | 4a | straight | 12.19/8.28/6.99/1.00 | 1.13-1.16/5.75-6.44 | two ends | PL. VI-3?/ BM |
| 10 | 1927.876 C | rock crystal | Ea | 4a | straight | 18.69/9.20/7.74/2.00 | 0.84-0.92/1.02-1.03 | two ends | |
| 11 | 1927.876 C | carnelian | Fa | 4b | tapered | 5.36/3.24/3.25/0.10 | 0.85-0.96/1.04-1.04 | two ends | |
| 12 | 1927.876 C | carnelian | Ed | 4a | straight | 7.50/8.04/7.28/0.50 | 1.16-1.17/1.16-1.16 | two ends | |
| 13 | 1927.875 A | carnelian | Ac | 4a | straight | 13.34/13.57/13.20/3.10 | 1.45-1.45/1.45-1.45 | two ends | PL. II-26 or 29/SK or DH |
| 14 | 1927.875 A | carnelian | Ac | 4a | straight | 11.85/12.00/11.95/2.20 | 1.40-1.40/1.40-1.40 | two ends | PL. II-26 or 29/SK or DH |
| 15 | 1927.875 A | carnelian | Ac | 4a | straight | 12.43/12.66/9.47/1.80 | 1.32-1.43/1.32-1.32 | two ends | |
| 16 | 1927.875 G | carnelian | Ac | 4a | straight | 9.49/9.75/9.92/1.20 | 1.39-1.43/3.11-3.11 | two ends | PL. II-27/ SK |
| 17 | 1927.876 A | carnelian | Ac | 4a | straight | 10.68/10.68/10.64/1.60 | 1.61-1.82/1.59-1.59 | two ends | |
| 18 | 1927.876 A | carnelian | Ac | 4a | straight | 9.09/10.22/10.19/1.20 | 1.95-2.03/3.11-3.11 | two ends | |
| 19 | 1927.876 C | carnelian | Ac | 4a | straight | 10.00/10.64/11.12/1.70 | 1.62-1.66/1.62-1.62 | two ends | |
| 20 | 1927.876 C | carnelian | Ac | 4a | straight | 9.66/9.87/9.69/1.20 | 1.33-1.54/1.33-1.33 | two ends | |
| 21 | 1927.876 C | carnelian | Ac | 4a | straight | 10.46/10.91/10.82/1.60 | 1.43-1.53/1.89-1.89 | two ends | |
| 22 | 1927.876 C | carnelian | Ac | 4a | straight | 10.84/10.98/11.04/1.80 | 1.45-1.45/1.21-1.24 | two ends | |
| 23 | 1927.875 F | carnelian | Ac | 4b | tapered | 8.30/9.16/8.89/1.00 | 1.12-1.46/- | one end | PL. II-10 /BM |
| 24 | 1927.876 C | jasper | Ac | 4a | straight | 8.87/9.60/9.65/1.10 | 1.49-1.54/1.49-1.49 | two ends | |
| 25 | 1927.876 C | garnet? | Ac | 4a | straight | 4.91/5.90/5.55/0.30 | 1.16-1.20/1.20-1.20 | two ends | |
| 26 | 1927.875 C | carnelian | Dc | 4a | straight | 16.21/17.05/7.76/3.50 | 1.90-2.01/1.91-1.91 | two ends | PL. II-31/ unknown provenance |
| 27 | 1927.876 C | rock crystal | Ib | 4a | straight | 16.38/15.79/9.60/4.60 | 1.03-1.07/1.03-1.03 | two ends | |
| 28 | 1927.875 B | jasper | Hj | 4a | straight | 12.85/11.50/4.86/1.20 | 1.25-1.25/1.25-1.25 | two ends | PL. II-30/ unknown provenance |
| 29 | 1927.876 C | amethyst | Hj | 4a | straight | 18.41/16.24/6.22/2.80 | 1.16-1.21/1.16-1.16 | two ends | |
| 30 | 1927.876 A | agate | Hj | 4a | straight | 17.50/16.64/8.10/3.30 | 1.43-1.65/1.43-1.43 | two ends | |

* This table tabulates basic information on the specimens that the author examined at the MAA. There are many other elements that should be examined, but the other elements will be discussed in the articles that the author is preparing.
* In the case of being drilled from two ends, the holes are named no. 1 and no. 2.
* The abbreviations in the Beck's number are BM=Bhir Mound, SK=Sirkap and DH=Dharmarajika.

**Table 3.** Morphological parallels of the stone bead types from Taxila

| | Aa | Ac | Ad | Bc/Dc | Ea | Ed | Fa | Hj | Ib | Reference |
|---|---|---|---|---|---|---|---|---|---|---|
| Ahichchhatra | ○ | ○ | ○ | | ○ | ○ | ○ | | | Dikshit 1952 |
| Hastinapura Period II | ○ | | | | | | | | | Lal 1954 |
| Hastinapura Period III | ○ | | | | ○ | ○ | | | | Lal 1954 |
| Hastinapura Period IV | | ○ | | | | ○ | | | | Lal 1954 |
| Atranjikhera Period III | ○ | ○ | | | | | ○ | | | Gaur 1983 |
| Atranjikhera Period IV | ○ | ○ | ○ | | ○ | | | | | Gaur 1983 |
| Narhan Period II | ○ | | | | | | | | | Singh 1994 |
| Narhan Period IV | ○ | ○ | | | ○ | | | | | Singh 1994 |
| Narhan Period V | ○ | | | | | | | | | Singh 1994 |
| Sonkh Period II | ○ | ○ | | | | ○ | | | | Härtel 1993 |
| Sonkh Period V | ○ | ○ | | | | | | | | Härtel 1993 |
| Nagardhan | ○ | | | ○ | ○ | ○ | | | | Uesugi et al., in press |
| Kanmer | ○ | ○ | | | ○ | ○ | | | | Endo et al. 2012 |
| Sannathi | | ○ | ○ | ○ | | ○ | | | | Howell 1995 |
| Siruthavur | ○ | | | ○ | | | | | | Badhreenath 2011 |
| Porkalam | ○ | ○ | | ○ | | | | | | Thapar 1952 |
| Niramakulam | ○ | | ○ | ○ | | | | | | Ajit Kumar and Ambily 2014 |

Type Fa (no. 11) consists of a triangular plan and a rectangular side elevation. The specimen has a length of 5.36 mm, 3,24 mm in width and 3.25 mm in thickness. It is made of carnelian.

Type Hj (nos. 28 - 30) has a plano-convex plan and an oval side elevation. No. 28 was crudely finished showing chipped surfaces and abrasions that are derived from the modelling process. The convex side has a white pattern consisting of a circle along the edge and dots in the centre. It measures 12.85 mm in length, 11.50 mm in width and 4.86 mm in thickness. It is of red jasper. Nos. 29 and 30 are the specimens that were exquisitely finished. The sides are slanting. They measure 17.50 - 18.41 mm in length, 16.24 - 16.64 mm in width and 6.22 - 8.10 mm in thickness. No. 29 is of amethyst and no. 30, of agate. Their slanting sides suggest that these specimens were inlaid on some other part made of other material like gold to make a composite jewellery.

Type Ib (no. 27) has a flat hexagonal plan and a square side elevation. The sides are slanting like Type Hj. The specimen has a length of 16.38 mm, a width of 15.79 mm and a thickness of 9.60 mm. It is made of rock crystal. It is not unlikely that this type was also inlaid on some other part to make a jewellery.

These types examined above, which do not cover the entire morphological variations in beads from Taxila that Beck illustrated in his report, have been reported from various sites of the Iron Age/Early Historic periods in South Asia (Table 3). Type Aa, which is a common shape throughout time and across space, includes some specimens that have a peculiar shape, such as nos. 1, 2 and 5. Further metrical examination on this type may reveal tempo-spatial variations in its morphology. Type Ac, which also has been reported at a number of sites, is quite peculiar to the Iron Age/Early Historic periods in South Asia, not so common in the Indus period. Type Ad, which can be regarded as a variant of Type Aa, has been reported in less number compared to Type Aa. Types Bc and Dc, which have a similar shape, has been reported more abundantly in South India and is rare in North India. Especially, South Indian megaliths yield this type quite widely and abundantly, many of which have white decoration made by the bleaching technique. No. 28 of Type Hj from Taxila may have been genealogically related to this Types Bc and Dc. Types Ea, Ed and Fa, which can be categorised as faceted beads, are widely known at a number of Iron Age/Early Historic sites in North India. No parallel of Types Hj and Ib have been found in published reports, but their peculiar shapes, especially its slanting sides and large size, indicate that they were used to make a composite jewellery and that they were rare types of beads.

This brief examination on the morphological parallels of the beads from Taxila clearly demonstrates that many types in Taxila have connections to the other parts of South Asia.

## Drilling technology used on the stone beads from Taxila

This section examines the drilling technology used in making holes through beads (Fig. 4). Highly skilful technology is needed to make a straight hole through hard stones such as carnelian, agate, rock crystal and so on. Especially in the case of beads longer than 10 mm, suitable tools and skills are necessary. Highly skilful drilling technology developed and specialised production system was established during the Indus Civilization period of the late third millennium BCE.

Although it is also well known that stone beads were widely produced and used across South Asia during the Iron Age/Early Historic periods, very few studies have been conducted on the beads of this period to understand the production system and technologies used. Regarding the drilling technology, it has been suggested by Gwinnett and Gorelick (1986, 1988) and Kenoyer and Vidale (1992) that a drill called 'diamond drill' was used on the beads of this period. This 'diamond drill' seems to have been more efficient than the stone drill used during the Indus period to make a hole suggesting that technological innovation happened some time after the decline of the Indus urban society around 1900 BCE. However, as the samples analysed so far are limited in number, it has not been well understood when and where 'diamond drill' appeared and how this new drill and drilling technology spread across South Asia.

The author conducted Scanning Electron Microscopy (SEM) examinations on 29 beads from Taxila in order to identify the drilling technology used. Twenty-six samples (nos. 1, 2, 4 - 7, 9, 10, 12 - 22, 24 - 30) exhibit straight hole profiles and parallel striations running perpendicular to the main axis of holes. This surface pattern can be identified as Surface pattern 4 that the author discussed in previous articles (Uesugi *et al.* 2018; Uesugi and Rienjang 2018). The rest of the samples (nos. 3, 11 and 23) are distinctive in having hole profiles tapering towards the proximal end, while they also exhibit parallel striations in a direction perpendicular to the main axis of the holes. The former surface pattern is called the Surface pattern 4a and the latter, the Surface pattern 4b. Regarding the Surface pattern 4a, it can be presumed that the drill used had a tip with a projection(s), which creates parallel striations throughout the hole. The Surface pattern 4b suggests that the drill of a tapering profile would have had multiple projections on the entire surface of the drill; otherwise parallel striations would not have been created on the entire surface of the hole. Although it is uncertain how such projections were made on the surface of a thin drill, it is apparent that different types of drills were used in these two types of surface patterns. Further examinations on more samples are needed to understand these two different types of drills, but they indicate that there were different types in the so-called 'diamond drills'.

Some remarks are to be made on the samples analysed. Among the samples with the Surface pattern 4a, nos. 1, 2, 4, 5, 7, 9, 10, 13 - 22 and 24 - 30 exhibit parallel striations running perpendicular to the main axis of holes and irregularly rugged surfaces. It appears that the rugged surface was a result of the use of abrasives. The differences in the conditions of striations, their intervals and depth, and in the conditions of rugged surfaces may have been due to the various factors, such as the different conditions and shapes of the projections on the tip of drills, the different skills of craftsmen to use a drill, the different speeds of the rotation of a drill and so on.

Among the samples in which the juncture of two holes are observable, nos. 2, 9, 10, 17 and 29 show irregularly cracked surfaces, which were caused at the time of the second hole reaching to the proximal end of the first hole. Nos. 5, 13 and 16 have a relatively smooth surface while some cracked surface can be observed. The subtle striations running parallel to the main axis of the hole visible on the images of higher magnifications indicate that some additional action was conducted to make the hole smooth using a rod. No. 15 has a part thinner than the drilled holes having a surface pattern different from the Surface pattern 4a, at the juncture of two holes. Subtle striations in both directions perpendicular and parallel to the main axis of the hole can be observed on this part. No. 22 also exhibits a tool different from the 'diamond drill' to connect two drilled holes. On no. 18, two different types of drills were used. While parallel striations can be observed on one hole, a very smooth surface is visible on the other suggesting that the drill used for this hole had a tip different from the drill used for the first hole.

Nos. 4, 7 and 10 have a shallow ledge in the middle of the holes, which may have been created at the time of resuming the drilling process after some time gap. On no. 10, two drills with different sizes were used. No. 21 has a ledge near the distal end indicating that a shallow hole was drilled in the beginning of the drilling process and then the main part of the hole was drilled. It seems that the shallow hole was made to fix the position of the hole to make the drill stable.

No. 5 shows both rugged surfaces and smooth surfaces in places at a higher magnification. This example indicates that different surface patterns can happen even in the case that one drill was used. While they show a smooth surface on the image of a low magnification, nos. 6 and 12 exhibit rugged surface at a higher magnification. Their surface patterns differ from the typical Surface pattern 4a, but the thin size of the drill and the rugged surface pattern indicate that the drilling technology identical to the case of the Surface pattern 4a was used in this example. Nos. 10, 20 and 21 show striations running parallel to the main axis of the hole along with the striations in the perpendicular direction suggesting that the former striations were made at the time of moving the drill in and out. It is uncertain how the bulging profile of the proximal end of the hole on no. 14 was created.

Among the samples having the Surface pattern 4b, nos. 3 and 23 exhibit parallel striations running perpendicular to the main axis of the hole across the surface. The intervals of striations are denser than the examples having the Surface pattern 4a. No. 11 has a relatively smooth surface on most part of the hole while clear striations or ledges can be observed near the proximal end of the hole and shallow striations on some part of the hole.

## Significance of the stone beads from Taxila

In this section, the stone beads from Taxila analysed above are to be discussed in a wider context to better understand their significance.

In terms of the morphological features, a diverse range of forms including Types Aa, Ac, Ad, Dc, Ea, Ed, Fa, Hj and Ib have been identified even in the samples analysed. Adding the different types reported by Beck, a diverse range of morphological variations can be confirmed among the beads from this site. In the Marshall's report (1951), the details of contexts of stone beads are not available making it difficult to examine these diverse variations in contexts of the complex stratigraphy of Bhir Mound and Sirkap. As the morphological variations of beads may reflect diachronic changes in beads or the different contexts in which beads were retrieved, it may be that the morphological variations that have been observed are just by an appearance. This overall morphological diversity must be further examined by conducting excavations in future, in which context-wise documentation and examination of beads are needed.

In relation to the contexts of beads, the stone beads unearthed in stupas at the Dharmarajika (Fig. 5) are noteworthy (Uesugi and Rienjang 2018). The examples from stupas at this site also include a diverse range of forms suggesting that beads of various forms were in use in Taxila. The figurative beads including lion-shaped beads in the stupa assemblages may indicate that these figurative beads were given some special value and meaning in connection with the Buddhist monastery, which were different from geometric beads, although some specimens were reported from Bhir Mound and Sirkap.

It is apparent that beads were intended to compose ornaments such as necklaces, bracelets and so on and that there were different styles and variations in the compositions of ornaments. There may have been some stylistic rules to compose ornaments using different types of beads, and different values and meanings behind the different compositions. Therefore, it is not unlikely that the morphological variations observed in the beads from Bhir Mound and Sirkap are indicative of the presence of different modes and styles of ornaments and different values and meanings. Future studies must be oriented towards disentangling the diversity in beads by examining them context-wise and revealing the different modes of use and values of ornaments that were composed by different types of beads.

This morphological diversity in beads can also be seen at other sites in South Asia. The evidence from the urban site of Nagardhan in Maharashtra (Fig. 6; Uesugi *et al.*, in press), which dates to the early to mid-first millennium CE, slightly later than Taxila in chronology, exhibits a diverse range of forms including Types Aa, Ac, Ai, Bi, Cd, Dc, Dd, Ea and Ed, some of which are common to Taxila.

In contrast, the beads from Kanmer, a small settlement site in Gujarat are characterised by a simpler morphological variation consisting of Types Aa, Ac, Cd, Ea and Ed (Fig. 7; Endo *et al.* 2012). Their morphological varieties simpler than Taxila and Nagardhan may have been due to the different natures of these sites; Kanmer is a small settlement while Taxila and Nagardhan are extensive urban centres. As stated above, there seems to be a diverse range of ornament styles and modes of use, and different values and meanings in ornaments as well as in beads. The difference in types of archaeological sites also seems to be another factor that causes the diversity in beads and ornaments, which must be taken into consideration in future studies and researches on beads.

Although the lack of information on the contexts of beads at sites makes it difficult to examine the beads from Taxila in details, it is quite apparent that the beads from Taxila have morphological features identical to the examples from various parts of South Asia. The presence of bleached decorations is also an element common in other parts of the region. These elements clearly suggest that the beads from Taxila belong to the South Asian bead tradition. Especially, the location of Taxila is suggestive of its strong connection to North India or the Ganga valley. The discovery of similar beads in Afghanistan indicates that South Asian beads were widespread across the Northwest (Rienjang *et al.* 2017).

The question to be solved by future researches is where the beads found in Taxila were produced. No detailed report on ancient bead workshop has been available at any sites in the Northwest, but Taxila, as an extensive urban centre in the region, may have played a significant role in producing and supplying beads. It seems that the penetration of North Indian ceramics in the late first millennium BCE was accompanied with the introduction of bead production technology and system of the North Indian origin to Taxila or to somewhere in the Northwest.

In relation to this question, the drilling technology examined in the previous section is relevant. The predominance among the samples from Taxila of the Surface pattern 4a, which have been identified as the trace made by the 'diamond drill', is a technological feature commonly seen across South Asia during the Iron Age/Early Historic periods (Figs. 5-7). The earliest occurrence of this surface pattern or the origin of the 'diamond drill' is still uncertain, but it seems that this drilling technology emerged in North India by the early first millennium BCE and became widespread across South Asia by the late first millennium BCE. The Northwest seems to have been one of the regions to which the North Indian beads and technology were transplanted. Further analysis on beads from more sites in the Northwest may reveal the process of this technological transplantation and the bead production and distribution system in the region.

Another point to be highlighted is the presence of the Surface type 4b. This surface type can broadly be categorised in the Surface type 4 or 'diamond drill', but its different profile of drill indicates that it belonged to a drilling technology group different from the one represented by the Surface type 4a. Only three samples from Taxila have this surface type. While no example of this surface type has been observed in the sample set from North India examined by the author, many samples from South India, especially from the context of the South Indian Megalithic culture (Uesugi *et al.* 2019; Uesugi and Jenee 2019), exhibit this surface pattern. It is premature to conclude that the beads with the Surface pattern 4b from Taxila were derived from South India, but the presence of this surface pattern among the samples from Taxila indicates that the production and distribution system of stone beads in South Asia during the Iron Age/Early Historic periods may be wider and more complex than we imagine.

The discussions made above have revealed that the beads from Taxila have morphological and technological elements common to those in various parts of South Asia, especially North India. It is highly likely that the beads or the production system of beads was transferred to the Northwest. Although many questions must be solved to better understand the historical developments and significance of stone beads in the Northwest, it has become clear that the beads in Taxila and in the Northwest must be studied in connection with the other parts of South Asia. In this sense, it can be well understood that stone beads have vital implications in the socio-cultural developments and its dynamics in the Northwest.

## Summary

The discussions made on the beads from Taxila in the previous sections can be summarised in the following points.

1) The ceramic evidence from Bhir Mound demonstrates the predominance of North Indian elements from its lowest level dating to the late first millennium BCE. The stone beads analysed also exhibit the North Indian elements suggesting that they belong to the time periods from the later first millennium BCE onwards. Although the stone beads predating the late first millennium BCE in the Northwest is not yet clear, it appears that the late first millennium BCE was an epoch in the developments of stone beads in Taxila or even in the Northwest as the North Indian beads started being in a wide use.

2) The morphological diversity in beads at Taxila is a feature common to the other parts of North India during this time period. The nature of Taxila as an extensive urban centre appears to have been the background of the diversity not only in the bead forms but in the ornament compositions and their different values and meanings. Future studies must be oriented towards revealing the meaning of this diversity by examining beads in context-wise.

3) Although it is uncertain where the beads found in Taxila were actually produced, the drilling technology identical to that of the other parts of South Asia is noteworthy. As the hilly regions surrounding Taxila are likely to have sources of different stones suitable for bead productions[3], it seems likely that Taxila played a significant role in bead productions as well as in bead supply to the surrounding regions. Further excavations at Taxila is expected to yield the evidence of bead production to better understand the role of this site in the Northwest. It is also noteworthy that the presence of the Surface type 4b in Taxila, which is different from the Surface type 4a of the typical 'diamond drill', may be indicative of multiple sources of beads to Taxila or of the existence of workshops with different technological traits in the region. In order to answer this question, systematic analyses on beads from different parts of South Asia are needed.

4) Thus, the stone beads from Taxila point to its strong connection with North India as the ceramic evidence indicates. However, this does not mean that the material culture at Taxila was comprised only of North Indian elements, and the material culture elements exhibiting the connection with the region to the west of Taxila must also be examined to better understand the socio-cultural dynamism of Taxila and the Northwest, and the examination of local elements also needs further researches. Systematic comprehension on the material culture in the region must be made based on the individual examinations on various material culture elements to better understand the complex history and importance of this region.

These remarks made based on the examination of some samples of stone beads from Taxila are hypothetical ones for future research. Fresh excavations are needed to provide different kinds of evidence to test the hypotheses proposed above. Also examinations are expected to be conducted on stone beads from different sites in the Northwest. This article aimed at give new perspectives and information on the archaeology in the region.

## Acknowledgements

This article is based on the author's examination of the stone beads stored in the Museum of Archaeology and Anthropology, University of Cambridge in 2016 and 2017. The author expresses his gratitude to Ms. Imogen Gunn, the curator of the museum, for providing her help to the author's work. The author is also grateful to Dr Kay Rienjang for helping him conduct SEM analysis at the McDonald Institute for Archaeological Research. It is noted that this article is a part of the research project 'Establishing Chronology of the South Indian Prehistory' funded by the Grant-in-Aid for Scientific Research, the Japanese Society for the Promotion of Science (Principal investigator: Akinori Uesugi; Project number: 15H05164).

## Notes

1. Recently the term of 'Protohistoric Culture' or 'Protohistoric graves' is preferably used by scholars for denoting the archaeological manifestitation, which was termed 'the Gandhara Grave Culture' by Dr. A.H. Dani in the 1960s, but the present author still prefers the latter term or the 'Northwestern Iron Age', because the term of 'Protohistoric Culture' does not include the spatial concept of this culture in its terminology.
2. Regarding the chronology based on the ceramic evidence from Bhir Mound, the presence of NBPW, neckless carinate handis, 'pear-shaped vases' (short-necked pots or jars with an elliptical body, some of which have paddle impressions on their external surface), flat-based small bowls and so on, can be well paralleled with the North Indian Iron Age Period IV (Uesugi 2002), while it should be admitted that the samples from the site are still limited in number and no 14C dates have been avilable from the site so far. As the North Indian Iron Age Period IV can be safely dated to the late first millennium BCE (c. third - first centuries BCE), Periods II-IV of Bhir Mound (Khan *et al.* 2002) can be paralleled to the same ceramic phase. In relation to the issues of the chronology, the numismatic evidence has widely been used for establishing the chronology of Taxila, but it cannot solely be used for determining the absolute dates of the occupations at the site, as coins can be in circulation for a long period of time between their production and discard. Although much more work is needed for refining the chronology and cultural sequence of the site using different kinds of evidence such as ceramics, 14C dates, numismatic evidence and so on, the chronological parallel between Bhir Mound Periods II-IV and the North Indian Iron Age Period IV is apparent based on the ceramic evidence available to date.
3. The stone sources in the northwestern part of the South Asian subcontinent have widely been examined by Randall Law (2011), although his study focused on identifying the stone sources that were exploited during the Indus period. Still extensive surveys must be conducted, especially in the region around Taxila, to identify possible stone sources that may have been exploited during the Iron Age and the Early Historic period.

## References

Allchin, F.R.
1982. How Old Is the City of Taxila? *Antiquity* 56: 8-14.

Antonini, C.S. and Stacul, G.
1972. *The Proto-historic Graveyards of Swat (Pakistan)*. Rome: IsMEO.

Beck, H.C.
1941. The Beads from Taxila. *Memoirs of the Archaeological Survey of India* 65. Delhi: Archaeological Survey of India.

Dani, A.H.
1968. Timarghara and the Gandhara Grave Culture. *Ancient Pakistan* III: 1-407.

Dittmann, R.
1984. Problems in the identification of an Achaemenian and Mauryan Horizon in North-Pakistan. *Archaeologische Mitteilunggen Aus Iran* 17: 599-616.

Endo, H., Uesugi, A. and Meena, R.
2012. 'Chapter 7: Minor Objects' in J.S. Kharakwal, Y.S. Rawat and T. Osada eds. *Excavations at Kanmer 2005-06 - 2008-09*. Kyoto: Indus Project, Research Institute for Humanity and Nature.

Gorelick, L. and Gwinnett, A.J.
1988. Diamonds from India to Rome and Beyond. *American Journal of Archaeology* 92: 547-552.

Gwinnett, A.J. and Gorelick, L.
1986. Evidence for the use of a diamond drill for bead making in Sri-Lanka c. 700-1000 A.D. *Scanning Electron Microscopy* 11: 473-477.

1987. The Change from Stone Drills to Copper Drills in Mesopotamia. *Expedition* 29(3): 15-24.

Kenoyer, J.M. and Vidale, M.
1992. 'A New Look at Stone Drills of the Indus Valley Tradition', in P.B. Vandiver, J.R. Druzik, G.S. Wheeler and I.C. Freestone eds. *Materials Issues in Art and Archaeology* III. Pittsburgh: Materials Research Society, 495-518.

Khan, G.M.
1979. Excavations at Zarif Karuna. *Pakistan Archaeology* 9: 1-94.

Khan, M.B., Hassan, M., Khattak, M.H.K., Rehman, F. and Khan, M.A.
2002. *Bhir Mound: The First City of Taxila (Excavation Report 1998-2002*. Lahore: Government of Pakistan, Department of Archaeology and Museums / National Fund for Cultural Heritage.

Law, R.W.
2011. *Inter-Regional Interaction and Urbanism in the Ancient Indus Valley: A Geologic Provenience Study of Harappa's Rock and Mineral Assemblage*. Occasional Paper 11: Linguistics, Archaeology and the Human Past. Indus Project, Kyoto: Research Institute for Humanity and Nature.

Marshall, J.H.
1951. *Taxila: an illustrated account of archaeological excavations carried out at Taxila under the orders of the Government of India between the years 1913 and 1934*, 3 vols. London: Cambridge University Press.

Rienjang, W.K., Kenoyer, J.M. and Sax, M.
2017. Stone Beads from the Relic Deposits: a Preliminary Morphological and Technological Analysis, in E. Errington ed. *Charles Masson and the Buddhist Sites of Afghanistan: Explorations, Excavations, Collections 1833-1835*. London: The British Museum, 52-57, 231-234.

Stacul, G.
1969. Excavation near Ghaligai (1968) and Chronological Sequence of Protohistorical Cultures in the Swat Valley (W.Pakistan). *East and West* 19(1-2): 44-91.

Uesugi, A.
2002. Re-evaluation of the pottery sequence in north India during the first millennium B.C., in C. Margabandhu, A.K. Sharma and R.S. Bisht ed., *Purāratna - Emerging Trends in Archaeology, Art, Anthropology, Conservation and History*. New Delhi: Agam Kala Prakashan, 182-196.

Uesugi, A., Kumar, M. and Dangi, V.
2018. Indus Stone Beads in the Ghaggar Plain with a Focus on the Evidence from Farmana and Mitathal, in D. Frenez, G.M. Jamison, R.W. Law, M. Vidale and R.H. Meadow eds. *Walking with the Unicorn: Social Organization and Material Culture in Ancient South Asia, Jonathan Mark Kenoyer Felicitation Volume*. Oxford: Archaeopress, 568-591.

Uesugi, A., Ambily C.S., Kumar, A., Abhayan, G.S. and Rajesh S.V.
2019. Stone Beads from Megalithic Burial at Niramakulam, Kerala, in Rajesh S.V., Abhayan G.S., P. Nayar and E.R. Ilahi eds. *Human and Heritage: An Archaeological Spectrum of Asiatic Countries (Felicitation to Professor Ajit Kumar)*. New Delhi: New Bharatiya Book Corporation, 1-22.

Uesugi, A. and Peter, J.
2019. Stone Beads from Kunnukara Urn Burial in Kerala. *Heritage: Journal of Multidisciplinary Studies in Archaeology* 7: 29-69.

Uesugi, A. and Rienjang, K.
2018. Stone Beads from Stupa Relic Deposits at the Dharmarajika Buddhist Complex, Taxila. *Gandharan Studies* 11: 53-80.

Uesugi, A., Sontakke, V., Vaidya, S. and Ganvir, S.
in press. Drilling technology on stone beads from Nagardhan, in V. Sontakke, S. Ganvir and S. Vaidya eds. *A Preliminary Report on the Excavations at Nagardhan, Nagpur District*. Pune: Indian Society for Prehistoric and Quaternary Studies.

Wheeler, R.E.M.
1962. *Charsada: a metropolis of the North-West Frontier being a report on the excavations of 1958*. London: Oxford University Press.

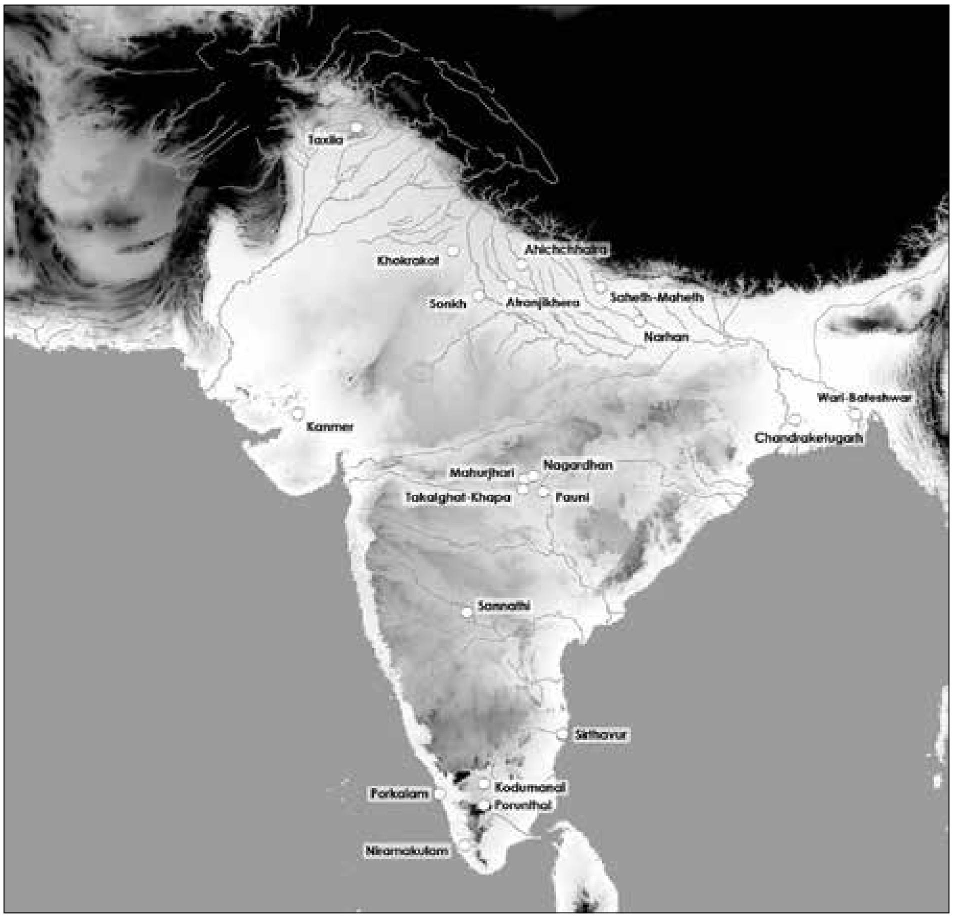


Figure 1. Map showing the location of Taxila and relevant sites

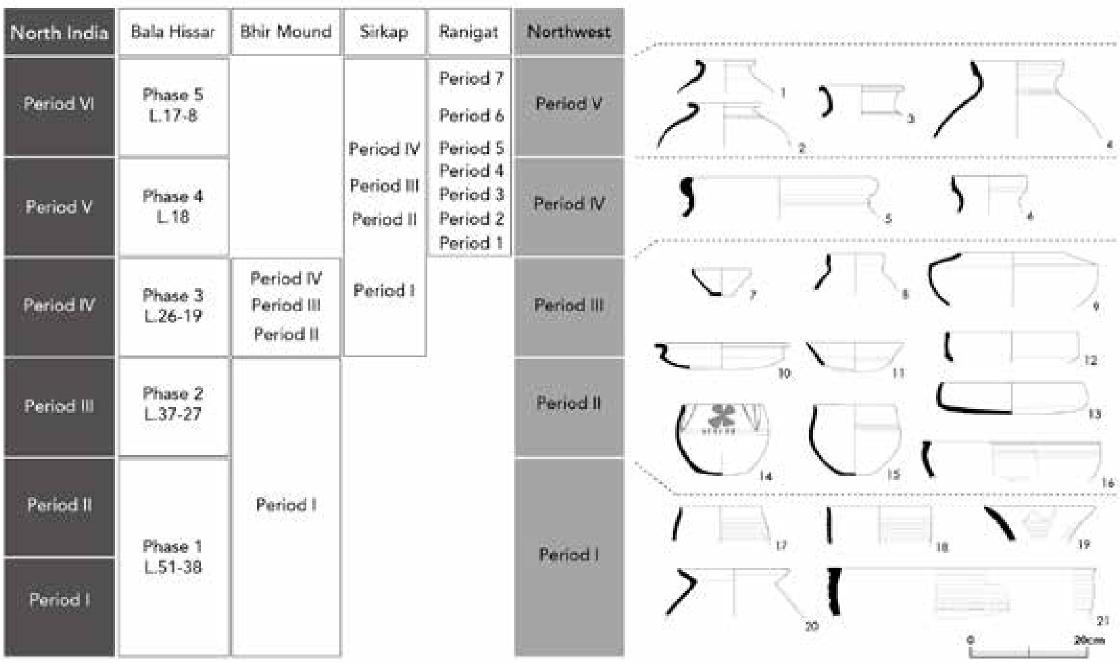


Figure 2. Ceramic sequence in the Northwest

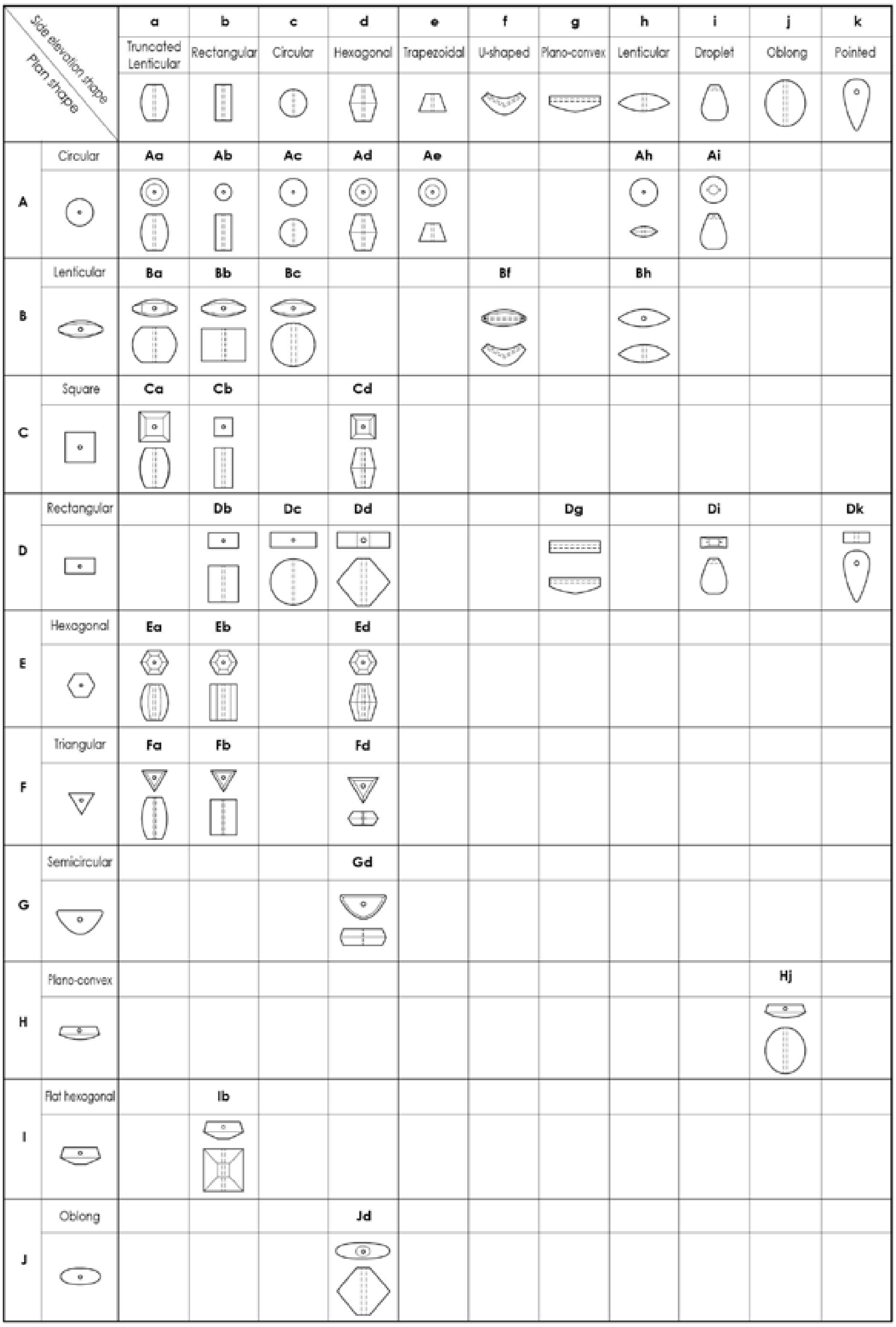


Figure 3. Morphological classification of stone beads from South Asia (produced by the author)

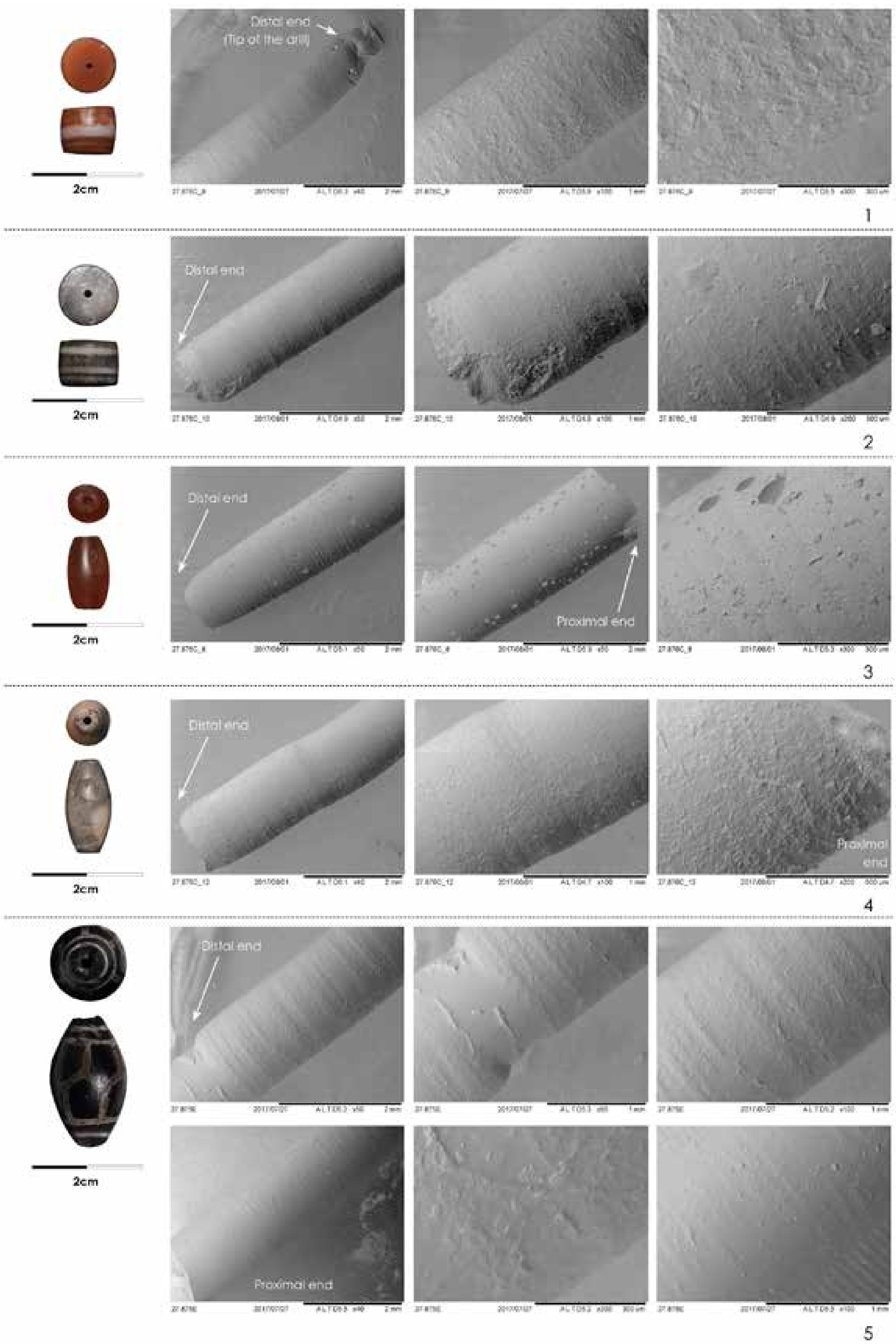


Figure 4. Beads from Taxila (SEM images produced by the author and Dr. Kay Rienjang)

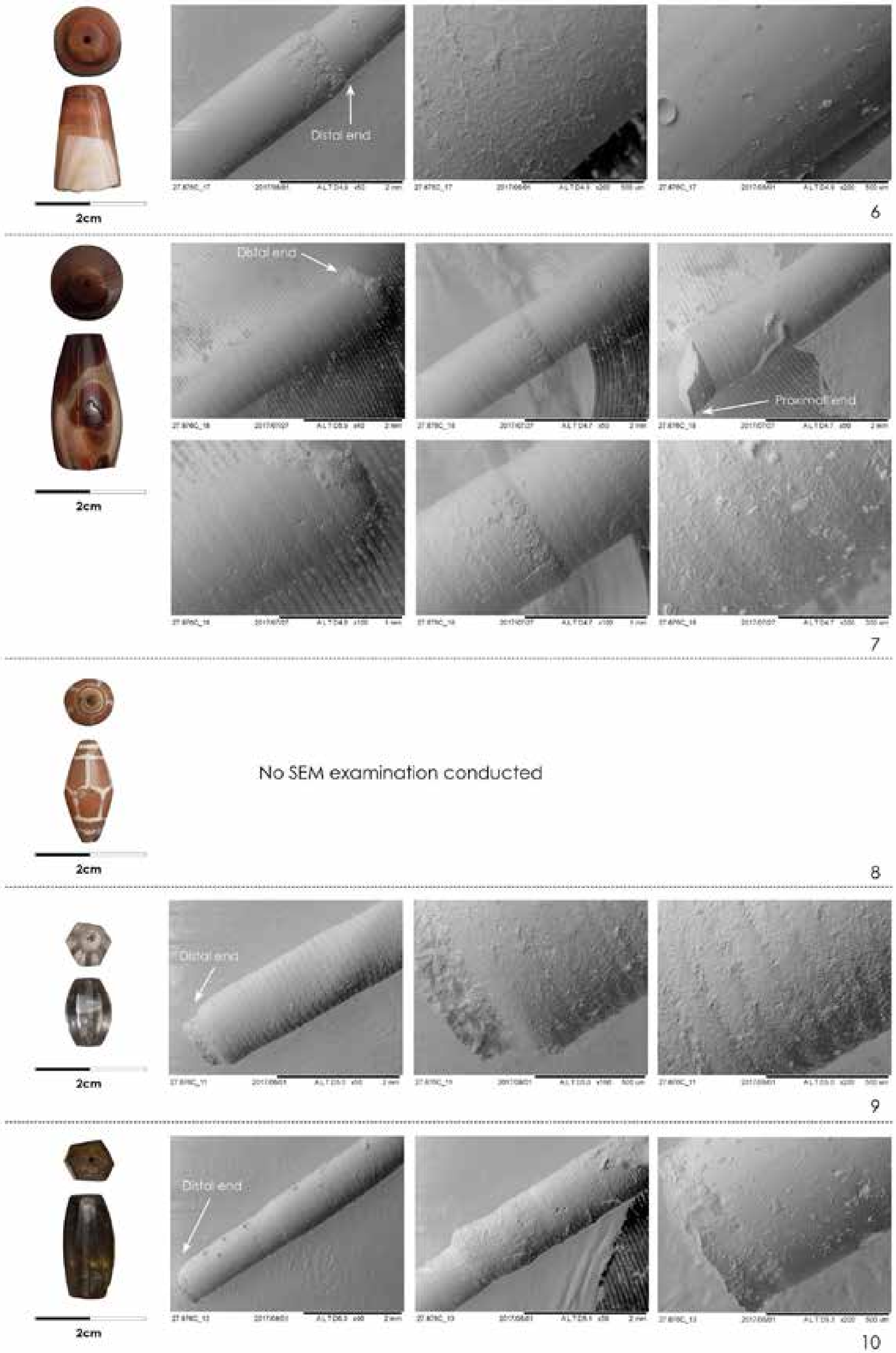


Figure 4 (contd.). Beads from Taxila (SEM images produced by the author and Dr. Kay Rienjang)

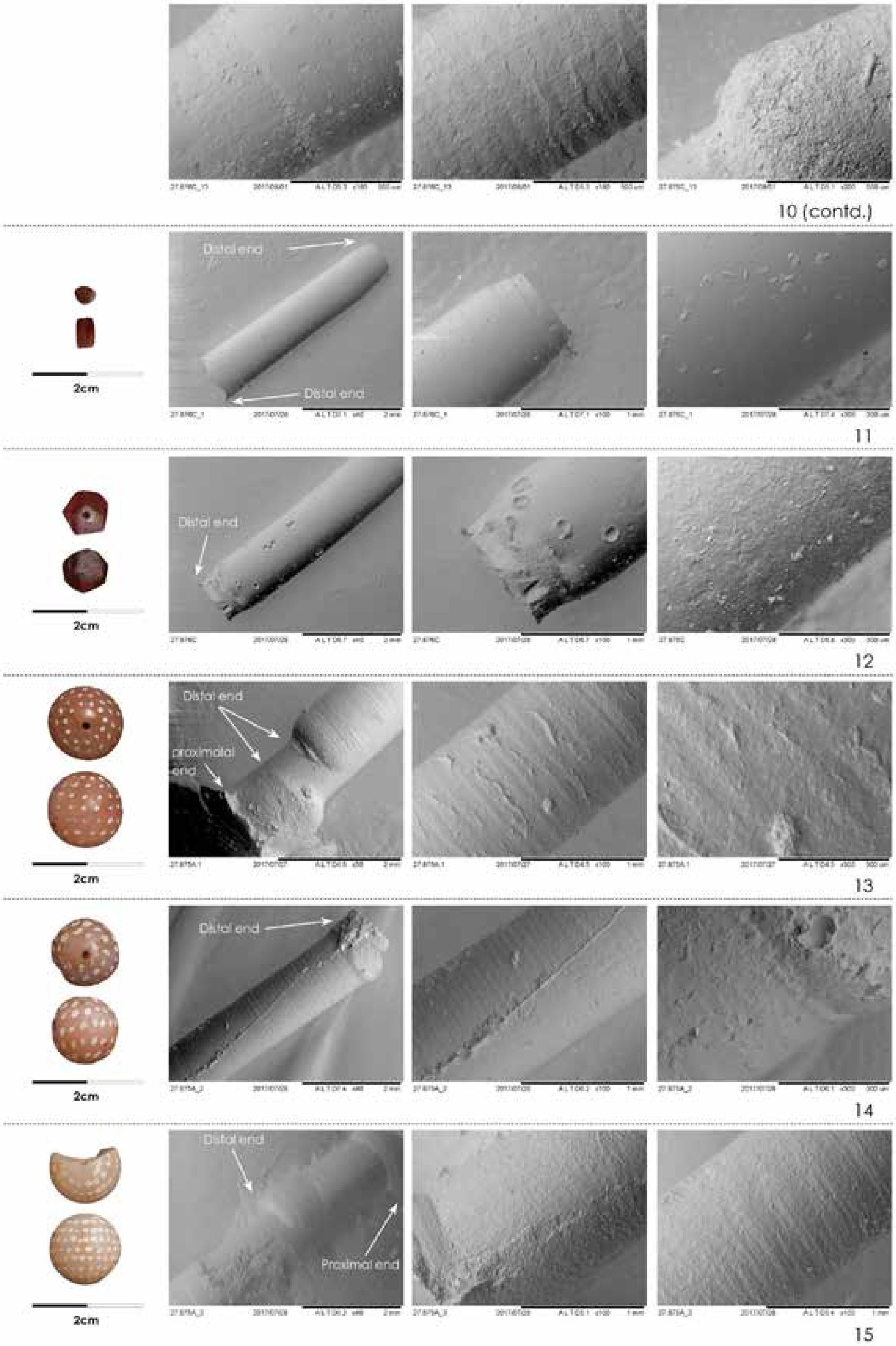


Figure 4 (contd.). Beads from Taxila (SEM images produced by the author and Dr. Kay Rienjang)

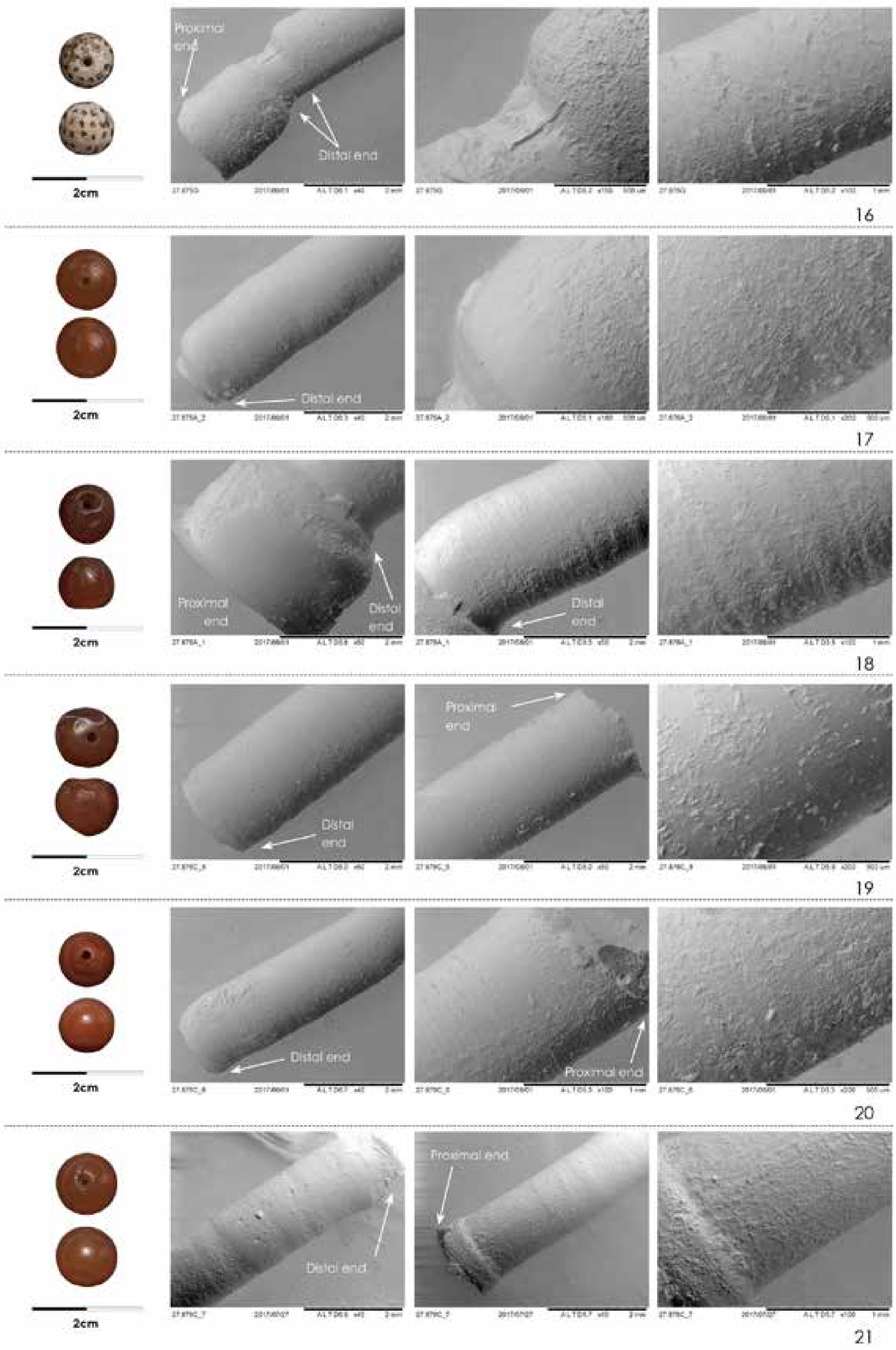


Figure 4 (contd.). Beads from Taxila (SEM images produced by the author and Dr. Kay Rienjang)

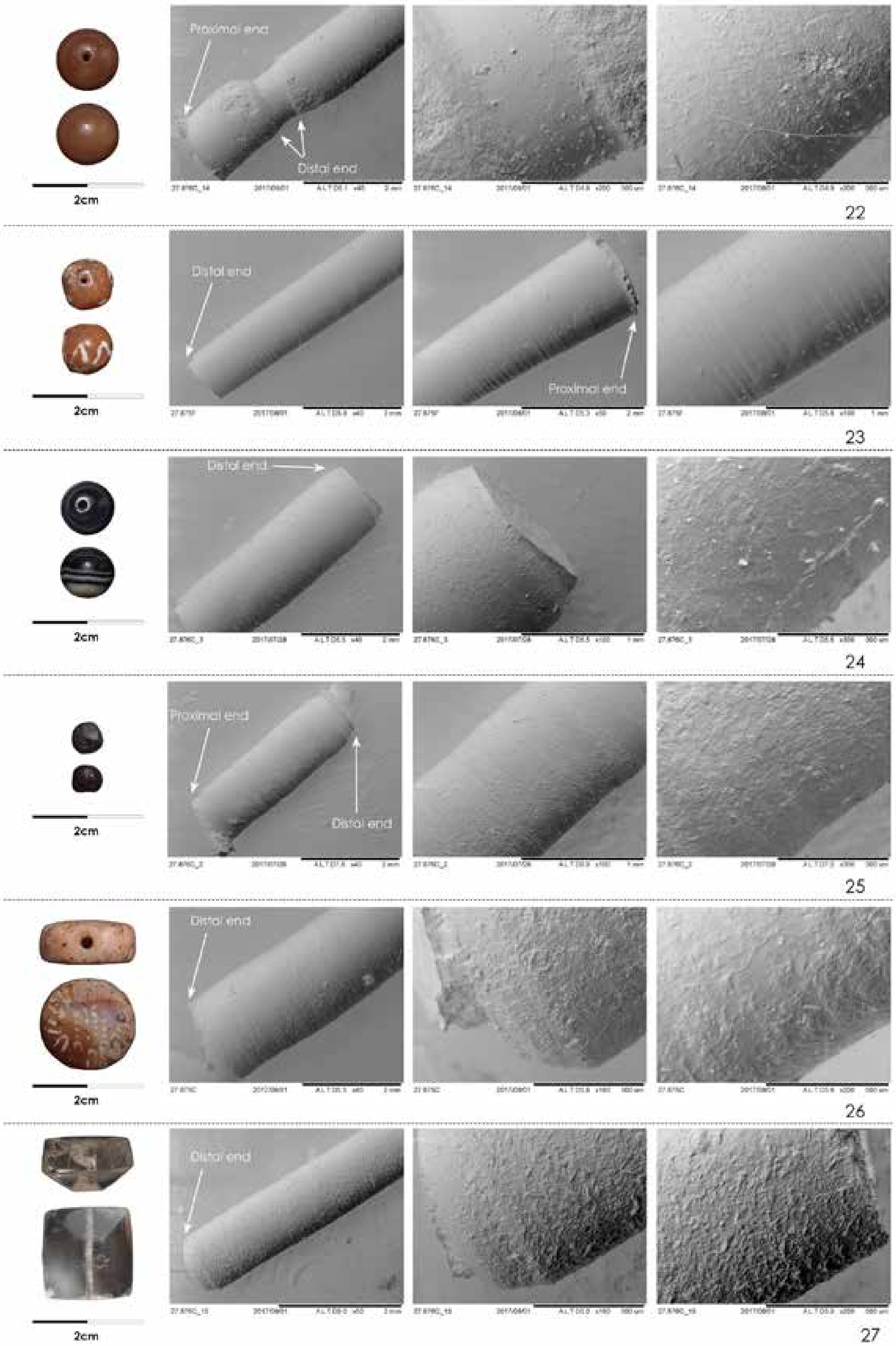


Figure 4 (contd.). Beads from Taxila (SEM images produced by the author and Dr. Kay Rienjang)

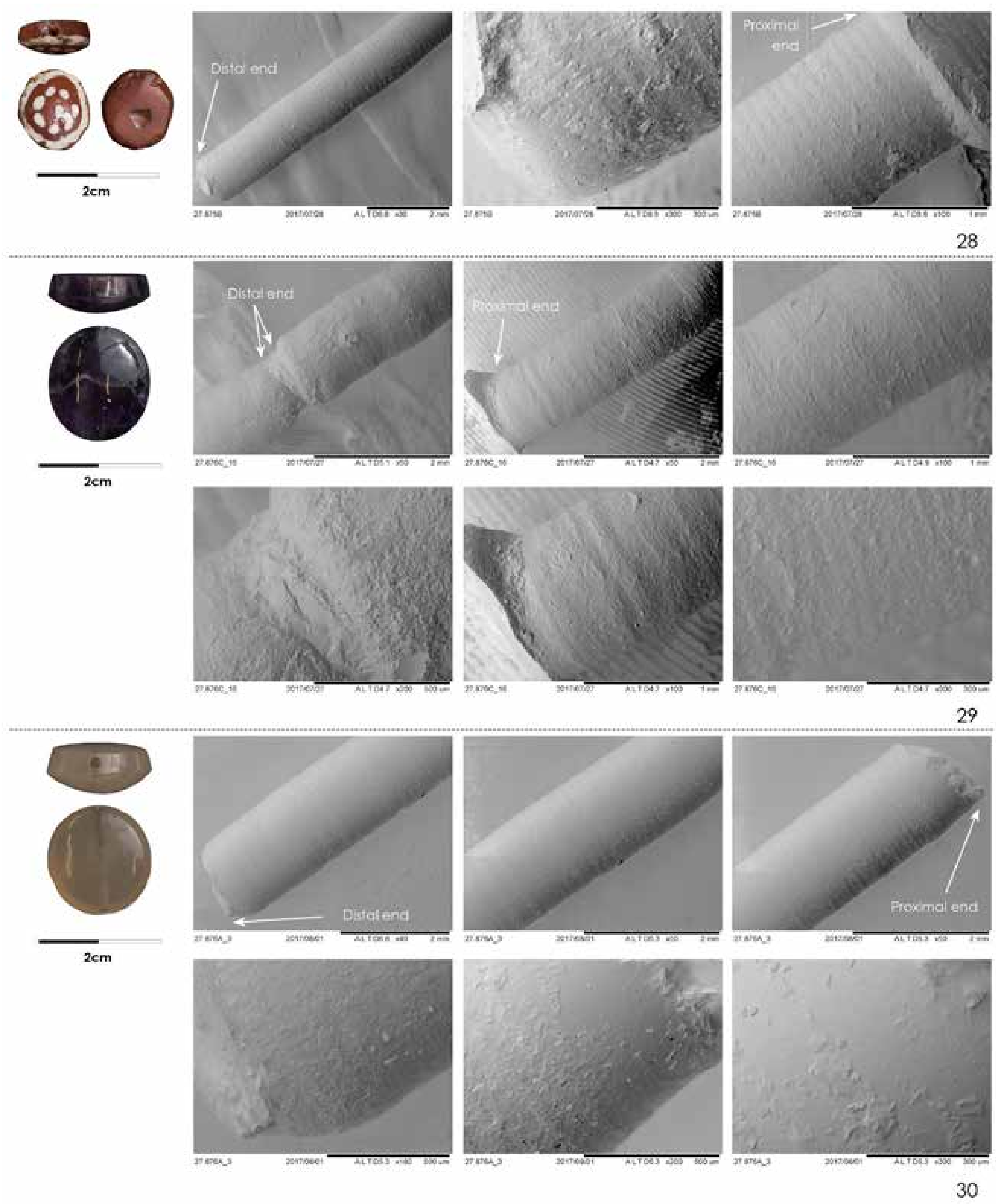


Figure 4 (contd.). Beads from Taxila (SEM images produced by the author and Dr. Kay Rienjang)

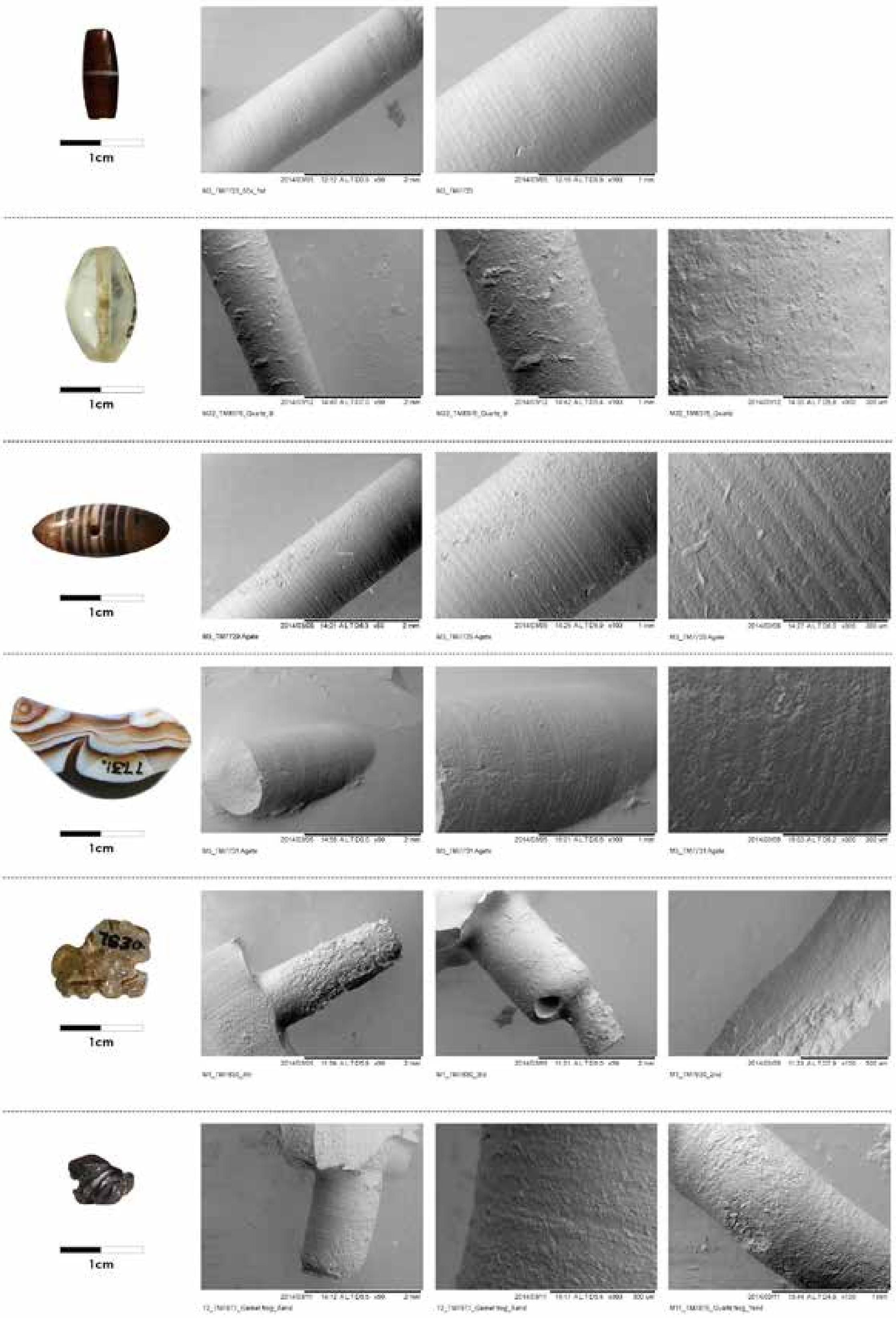


Figure 5. Representative examples of beads from the Dharmarajika (after Uesugi and Rienjang 2018)

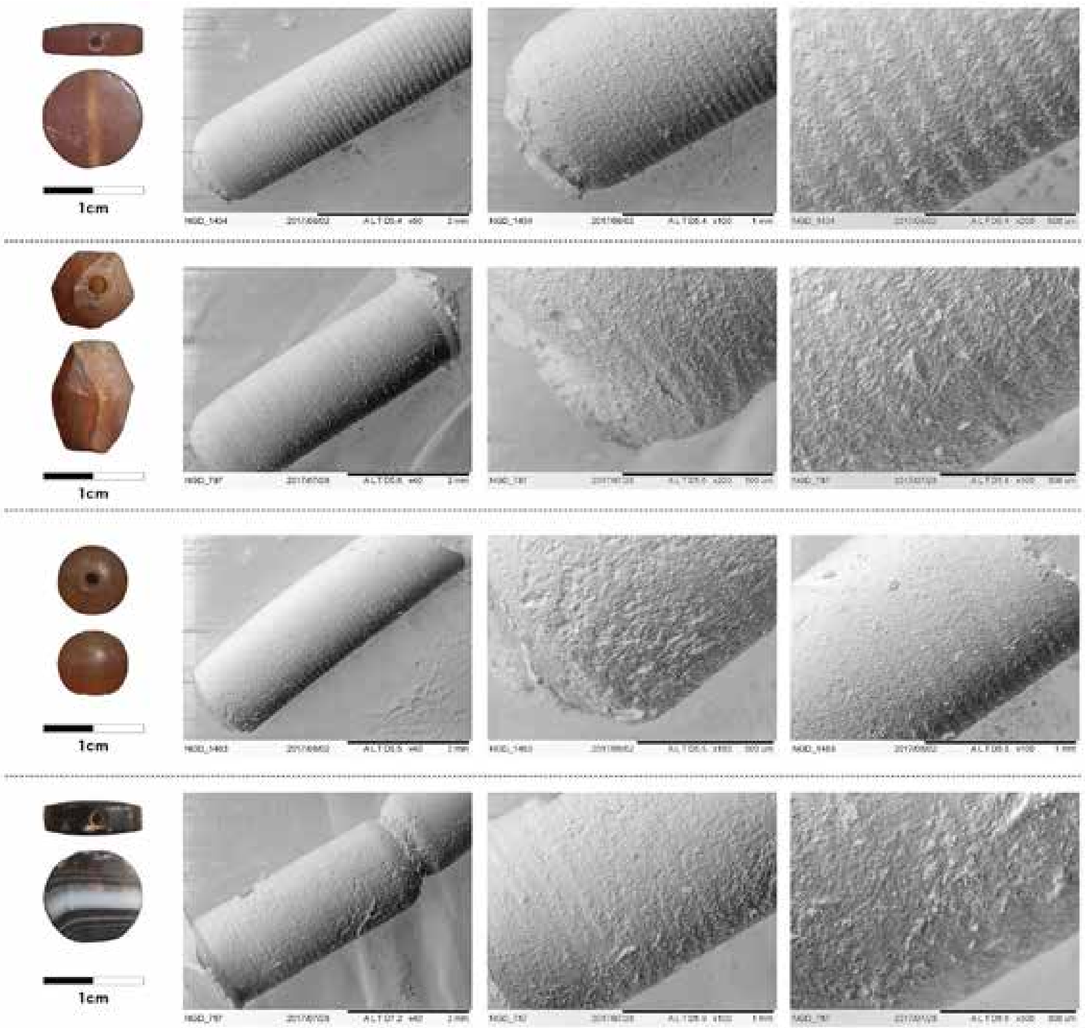


Figure 6. Representative examples of beads from Nagardhan (after Uesugi *et al.*, in press)

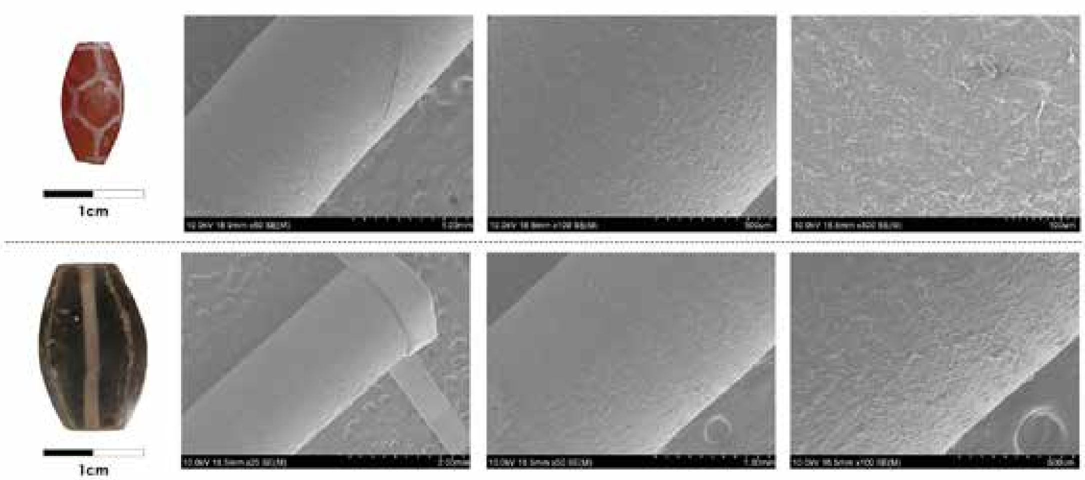


Figure 7. Representative examples of beads from Kanmer (SEM images produced by the author)