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COMPLEX FACETED AND OTHER CARNELIAN BEADS FROM THE VARNA CHALCOLITHIC NECROPOLIS: ARCHAEOGEMMOLOGICAL ANALYSIS

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ABSTRACT. Among the metal (gold and copper) and non-metal (minerals, rocks, pottery, pigments, bioobjects) artefacts in the Chalcolithic graves from Varna in Bulgaria are numerous beads of chalcedony (carnelian and agate) composition. To the three morphological types of beads already described (type 1 – elongated barrel-shaped; type 2 – elongated with trapezohedral facets; type 3 – short cylindrical; Kostov et al., 2004), a rare forth type – elongated cylindrical, has been added. Measurements of almost all the chalcedony beads have been performed including weight and size. Mean values of weight and size are given for beads of all the studied graves as well as for the whole necropolis. The detailed study confirmed the complex "constant" number of 32 facets among the morphological type 2 carnelian and agate beads (16x16 on both sides on the elongation of the bead; the form is a truncated 16-fold trapezohedron). This is considered as the earliest complex type of faceting on a hard mineral as quartz (chalcedony is 6.5-7 on the Mohs scale). The mean weight of the type 1-2 carnelian and related beads is 0.4 g (or 2 carats), in close correspondence to the mean value of the gold short cylindrical beads – thus a Chalcolithic weight unit has been introduced called *van* (from ***Va****rna* ***n****ecropolis*) supposedly relating mineral and metal artefacts in an early weight system. The position in the graves and all the processes of manufacture (including tumbling) of the faceted chalcedony beads were shortly discussed as part of the archaeogemmological analysis.

Introduction

Among the metal (suggested as the largest and oldest gold treasure; copper) and non-metal (minerals, rocks, pottery, pigments, bioobjects) artefacts in the Chalcolithic graves from Varna in Bulgaria (Ivanov, 1974; 1978; Ivanov, Avramova, 2000; *The First Civilization…,* 1982; *Die Erste Gold…,* 1986; *Macht, Herrschaft und Gold*, 1988; *Varna Archaeological Museum,* 2002) are found numerous beads of a chalcedony (carnelian and agate) composition considered as the first complex and 'constant' faceted beads cut of a hard gemmological material (Kostov et al., 2003; Kostov, 2005; 2007).

New detailed study and measurements of the carnelian beads provided new data for the early stages of carnelian and agate beads manufacture and their significance in the history of gemmology (Fig. 1-4). Among the carnelian beads are observed most of the main techniques for cutting and polishing of gem minerals.

The social and symbolic meaning of the chalcedony beads has been studied – in the Durankulak necropolis they are distributed equally among male and female graves and in the Varna I necropolis they are typical only for the symbolic graves (cenotaphs). In both cases the chalcedony beads are associated with golden and copper objects, as well as with pottery and bone or shell artefacts – they are considered as prestigious jewellery objects. The origin and trade routes of carnelian and its deposits at the Balkan Peninsula and more remote places are under discussion.

Carnelian is a red to pinkish or yellow-orange colour variety of cryptocrystalline quartz (variety chalcedony). It owns its colour usually to impurity iron oxide phases – goethite and hematite (Barsanov, Yakovleva, 1984). It has a wide distribution in nature (Kostov, 2003) with the most important deposits in India, which have been exploited since the time of the Harappan culture. This chalcedony variety has been also reported from the territory of Bulgaria (Petrussenko, Kostov, 1992; Kostov, 2007). The nearest to the Balkan Peninsula sites with probable agate and carnelian deposits are the Crimea Peninsula, the Caucasus region, Asia Minor, the Arabian Peninsula (Yemen) and Egypt.

Several contemporary methods of study have been applied for distinguishing carnelian raw material or carnelian beads from different deposits or origin as well as for investigation of different stages of cut of boring. Among them are scanning electron microscopy (Gwinnett, Gorelick, 1981), electron paramagnetic (spin) resonance (EPR; ESR) spectroscopy (Plyusnina, Kostov, 1988), ultraviolet-laser ablation inductively coupled plasma mass spectroscopy (UV-LA-ICP-MS) (Insol et al., 2004).

Position of the carnelian beads

Carnelian and related agate beads (with a total number of 479) were found among the graves richest in gold and other artefacts (Table 1). The largest number (314) of such beads was found in symbolic graves (in 13 graves – 65.6%), followed by graves with extended imhumation of skeletons (144 beads from 3 graves – 30%) and contracted imnumation' graves (18

beads in 4 graves – 3.8%). The remaining number of beads (3) is from destroyed graves or without stratification, in both cases with gold anthropomorphic amulets and other artefacts (grave N190 and group 013a – 0.6%).

Carnelian beads were found as part of necklaces often with gold beads and gold spirals (such are the cases for symbolic graves N3, 4, 5, 24, 35, 36, 41 and 63). In certain cases the carnelian beads are found together with anthropomorphic amulets (symbolic graves N3, 26, 71, 97 and 195). In graves with normal straight position of the skeleton there are a few cases of carnelian bead position (graves N43, 67, 143): as necklace with other beads including gold beads at the upper part of the chest (graves N43, N143), on the wrists of the hands with lignite beads (grave N143), in two pottery vessels with gold beads (grave N43), on the left part of the chest and under the bracelet at the left hand with gold beads (grave N43), near the left thigh bone together with gold biconical beads (grave N43), at the feet with gold beads (grave N43).

Among the hocker graves carnelian beads were found on the bones of the left hand together with two anthropomorphic amulets (grave N48), in a necklace on the neck or on the chest together with gold and *Spondylus* beads (grave N90) or with *Spondylus* and all other kind of mineral or metal (gold, serpentinite, carbonate, lignite coal) beads (grave N154) and on the chest with an anthropomorphic gold amulet – with two beads on each side (grave N254). Since there was no reason to produce facets other than to create addition brilliance, the carnelian beads are an excellent illustrations of climax Chalcolithic Age aesthetics in mortuary context (Chapman, 2007, 69).

Morphometry

To the three morphological types of beads already described: type 1 – elongated barrel-shaped; type 2 – elongated with trapezohedral facets; type 3 – short cylindrical (Kostov et al., 2004), a 4th cylindrical type can be added (Fig. 1-3). According to the classification of stone beads by G. G. Laemmlein, the described morphological types 1 and 3-4 can be listed in the group of curvilinear beads, and those of type 2 – in the group of flat faceted beads with trapezoidal faces (Laemmlein, 1950; 168, 171).

Mean values (weight, length, diameter) for chalcedony (carnelian; w – whitish agate) elongated beads among different type of graves have been calculated (Table 2). The mean dimensions (length to width) for the types 1-2 beads is 1.29 and for type 3 – 0.54, and weight – 0.40 g and 0.14 g correspondently. In the hole of a single carnelian bead a golden mini-cylinder (~2x1 mm) has been found, probably with the purpose to tighten up some sort of band or strip (Fig. 4).

A revised list of values for the morphometry of short cylindrical carnelian allows presentation of better data for morphological type 3 beads (Table 3). The newly measured mean values for length and diameter for the chalcedony beads from the Varna necropolis are in close concurrence (Table 4) with the same values for beads from the Durankulak necropolis (Kostov, Dimov, 2003; Kostov et al., 2004), located near the Black Sea coast to the North of Varna. The type and cut of the chalcedony beads is similar in both cases thus they have to be of the same unknown so far origin.

Table 1

Distribution of chalcedony (carnelian and as agate) beads among different type of graves (m – male; f – female) from the Varna Chalcolithic necropolis and relation to other metal and non-metal artefacts (Kostov et al., 2004; Kostov, 2007; with additions)

Grave, N	Type	Chalcedony beads	Metallic artefacts		Non-metallic artefacts				
			Au	Cu	Flint; rock	Mineral beads	Bone	Shell	Pottery
3	cenotaph	4	+	+	+	+	+	+	+
4	cenotaph	71	+	+	+	+	+	+	+
5	cenotaph	5	+	+	+	-	+	+	+
24	cenotaph	34	+	-	+	+	+	+	+
26	cenotaph	8	+	+	+	-	+	+	+
35	cenotaph; +m	60	+	-	-	-	-	+	-
36	cenotaph	2	+	+	+	-	+	+	+
41	cenotaph	66	+	+	+	+	+	+	-
43	m	134	+	+	+	-	+	+	+
48	hocker/f?	1	+	-	-	-	-	-	+
49	cenotaph	6	+	-	+	-	-	+	+
63	cenotaph; +m	35	+	-	+	+	+	+	+
67	m	4	+	-	+	-	+	-	+
71	cenotaph; +f	2	+	-	-	-	+	+	+
90	hocker/child/f	7	+	-	+	-	-	+	+
97	cenotaph	13	+	+	+	+	+	+	+
143	m	6	+	+	+	+	+	+	+
154	hocker/f?	6	+	-	+	+	-	+	+
190	destroyed	1	+	-	-	+	-	-	+
195	cenotaph	6	+	+	+	-	-	+	+
254	hocker/f?	4	+	-	-	+	-	+	-
013a	-	2	-	-	-	-	-	-	-

Fig. 1. Chalcedony (carnelian) elongated beads of all observed shapes and colours: upper row – orange faceted 16x16 bead; red broken faceted bead; dark red faceted bead; red cylindrical bead; second row – orange-red asymmetric barrel-shaped bead; dark red barrel-shaped bead; red cylindrical bead (grave 35; photo R. Kostadinova)

Fig. 2. Chalcedony (carnelian) elongated complex faceted bead with cut and polished ends (grave 35; photo R. Kostadinova)

Table 2

Mean values (weight, length, diameter) for chalcedony (carnelian; w – whitish agate) elongated beads among different type of graves (m – male; f – female) from the Varna Chalcolithic necropolis (nd – not determined)

Grave, N	Type	N of beads	Weight, g	Length, cm	Diameter, cm
3	cenotaph	4	nd	nd	nd
4	cenotaph	62 (71)	0.40	0.79	0.60
5	cenotaph	5w	0.24	0.75	0.54
24	cenotaph	34	nd	nd	nd
26	cenotaph	8	0.43	0.80	0.62
35	cenotaph; +m	59 (60)	0.39	0.80	0.57
35	cenotaph; +m	1 (60)	nd	0.68	0.56
36	cenotaph	2	nd	nd	nd
41	cenotaph	61 (66)	0.41	0.80	0.59
43	m	134	0.41	0.81	0.58
48	hocker/f?	1	0.49	0.89	0.61
49	cenotaph	6w	0.41	0.85	0.58
63	cenotaph; +m	35	nd	nd	nd
67	m	4	0.46	0.88	0.62
71	cenotaph; +f	2	0.50	0.84	0.64
90	hocker/child/f?	7	0.37	0.74	0.60
97	cenotaph	12 (13)	nd	0.66	0.59
143	m	6	0.50	0.85	0.63
154	hocker/f?	6w	nd	0.75	0.54
190	destroyed	1	nd	0.79	0.63
195	cenotaph	6w	0.43	0.84	0.62
281	cenotaph	1w	0.55	0.91	0.59
013a	-	2	0.38	0.82	0.56
Mean values, N4; 35; 41; 43		316	0.40	0.81	0.58

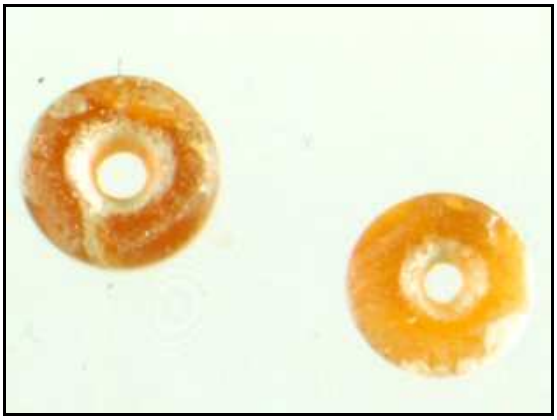

Fig. 3. Short cylindrical beads – morphological type 3 (grave 97; photo V. Alexeev)

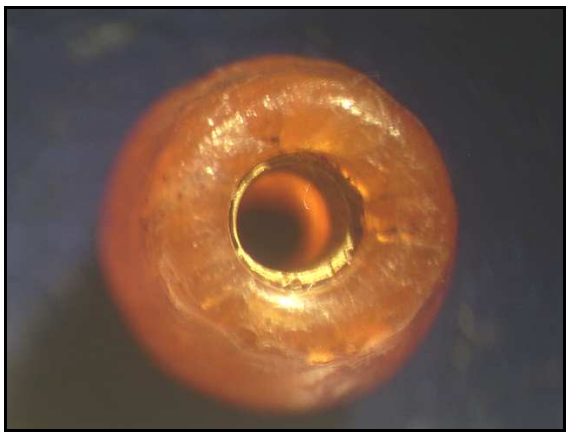

Fig. 4. Barrel-shaped chalcedony bead with a gold 2x2 mm microcylinder in the drilled hole (grave 35; photo Y. Dimitrov)

Table 3

Mean values (weight, length, diameter) for chalcedony (carnelian) short cylindrical beads among different type of graves (f – female) from the Varna Chalcolithic necropolis (nd – not determined)

Grave	Type	N of beads	Weight, g	Length, cm	Diameter, cm
4	cenotaph	9	0.12	0.28	0.53
41	cenotaph	5	0.17	0.32	0.54
97	cenotaph	1	nd	0.22	0.45
254	hocker/f?	4	0.18	0.34	0.58
Mean values		19	0.15	0.30	0.54

Table 4

Mean values (length, diameter) and length/diameter ratio for elongated chalcedony (carnelian; whitish agate) beads from the necropolis at Durankulak (Kostov et al., 2004) and Varna

Necropolis	Length, cm	Diameter, cm	L/D ratio
Durankulak	0.79	0.61	1.295
Varna I	0.81	0.58	1.396

Complex 16x16 faceting

The complex (16x16 facets along the elongation of the bead) and 'constant' faceting among the carnelian and related chalcedony beads of morphological type 2 is the earliest known faceting of such kind on a hard mineral as quartz (chalcedony is 6.5-7 on the Mohs scale). From a crystallographic point of view the form is a truncated 16-fold trapezohedron, which is considered as probably the earliest in Chalcolithic times complex type of faceting (Kostov, 2007). The complex facets require at least some primitive technical means in the different stages of bead manufacture.

Colour

Three main types of colour have been distinguished visually among the carnelian beads: orange, red and dark red. It has been suggested that the uniform dark red colour may have resulted from a process of heating of pale red or pinkish coloured carnelian beads (Kostov, 2007). Such technique for improving the colour of gemstones is known even today for carnelian in the Asia Minor, Iran Pakistan and India (*mekke tasi* – Savascin, 1986, 43-44). Data for such improvement of colour of carnelian beads have been reported from Armenia with artefacts from the III-I mill. BC (Seiranyan, 2005, 79).

Archaeological data and bead-making techniques

In Pre-dynastic Egypt carnelian beads are known since the Badara (~4400-4000 BC) and Naqada (~4000-3100 BC) periods. The dimensions and morphology of some of the carnelian beads from the Neolithic and Chalcolithic in Ancient Egypt is similar to those from the described Chalcolithic necropolises in Bulgaria. From the Badara period are known small short cylindrical beads with rounded edges, but also tiny (under 1 cm) carnelian amulets with a complex crescent or cross shape. From the Naqada period together with the short cylindrical beads are known barrel shaped carnelian beads (with two morphological varieties – symmetrical and asymmetrical according to the position of their maximum width) (c. Petrie Museum of Egyptian Art, London; N-UC4450). Probably to the Pre-dynastic period can be dated also carnelian beads with cylindrical form or amulets in the shape of a drop-like pendant.

During the I dynasty small (1-2 cm in size) zoomorphic carnelian amulets appear, and later, since the time of the VI-VIII dynasties – small carnelian amulets in the shape of hand or leg. Faceted bypiramidal and prismatic carnelian beads of unidentified age and site are known from the Petrie Museum of Egyptian Art in London (N-UC74540), but the earliest report points back even to the Badara period (N-UC9586) (Kostov, 2007). In the Nile delta, at the village Maadi near Cairo, carnelian beads have also been found together with basalt vases, dated to the Pre-dynastic period (~3200 BC) (Hoffman, 1979). In the later periods of Ancient Egypt carnelian was extensively used as incrustation for rings and other jewellery artefacts, as well as for small items and scarab amulets (Lucas, Harris, 1962).

Carnelian and *Dentalium* shell beads were found in a female grave from the Early Neolithic site Khirokitia in Cyprus. Quartz (including carnelian) short cylindrical beads are known from Canhashan and other Chalcolithic sites in Anatolia (Savascin, Ture, 1985).

In Asia carnelian beads are known from the Harappian sites (3300-1900 BC) Chanjuho-daro and Lothar, where the whole sequence of the processes on bead manufacture has been reconstructed: nodules of raw material of a ~8-9 cm size → spread on the sun → fired in shallow pits in earthenware pots with covered mouths and packed with cow or goat dung for a slow burning process → pecking, drilling, polishing (Mackey, 1937; Allchin, 1979; Kenoyer, 1997). The Indian carnelian beads known from Harappa and Mohendjo-daro (including the unique ~12 cm in size long pseudo-cylindrical beads; Yule, 1985, 25, Taf. 12) are traded to the west (Mesopotamia) and Central Asia about the III mill. BC and from there further to the Mediterranean region. Special technique is applied for the white pattern carnelian beads (see Mackay, 1933). Some types of faceted elongated carnelian beads have been reported from the excavations at Ur (III mill. BC), a style which is supposed not to be used in the Indus region (Kenoyer, 1997).

Several operations of manufacture have been suggested for the described carnelian beads – pecking, shaping, faceting, polishing, drilling and tumbling. These are the main standard operations used for most of the gemmological materials: from a piece of carnelian raw material a more or less cylindrical piece has been pecked; next is the shaping of cylindrical elongated pieces; they are sawed in larger (morphological types 1-2 and 4) or shorter (morphological type 3) cylindrical pieces; barrel shaping; complex faceting (probably with the help of some mechanical instrument and abrasive – the fridges of the facet faces are in one and same direction); drilling (from both sides of the bead); tumbling (this operation has been identified as very important and the level of polish of the curvilinear surfaces points to the application of fine abrasive powder; both ends of the longer beads seam to be rounded very well at this last technological stage). The short cylindrical carnelian beads have almost mirror polished cylindrical surface.

Weight system

The golden objects from the Middle and Late Chalcolithic necropolis found at Varna are assumed to be the "oldest gold of humankind" according to their number and quantity. Analysis of the measured weight of the different types of golden artefacts (beads, appliqués, rings, bracelets, pectorals and diadems) has revealed at least two minimal weight units of 0.145 and 0.415 g (Kostov, 2004; 2007). The second one has been suggested as a basic "Chalcolithic unit" with the name *van* (from the first letters of **Va**rna **n**ecropolis). Three groups of golden objects have been described according to their weight: up to 10 g (golden beads and appliqués); between 10 and 20 g (golden pectorals); above 20 g (golden diadems and bracelets) – all with related to the *van* and common multiples measured values. Early forms of exchange can be considered – an average 0.40-0.41 g weight has been found as well as for the carnelian type 1, 2 and 4 beads (twice the weight of carat).

The easier for manufacture faceted carnelian beads with a small number of facets are known from artefacts in the Northern Fore-Caucasus region (IV-V c. AD), as well as for the whole territory of South-Eastern Europe (during the next centuries), in both cases with suggested Indo-Iranian origin (Deopik, 1959; 1961). The rounded ellipsoid carnelian bead shape has been preserved as a form up to the Early Medieval period, as observed from finds in a number of European countries (Mastikova, 2001).

Conclusion

The carnelian beads are known only from the Varna I and Durankulak Chalcolithic necropolises (Kostov et al., 2004), but not from the earlier and small Varna II necropolis (Kostov et al., 2003). Thus, their distribution has to be assigned to a narrow time interval. Their origin is under discussion. To the three morphological types of beads already described (type 1 – elongated barrel-shaped; type 2 – elongated with trapezohedral facets; type 3 – short cylindrical; Kostov et al., 2004), a rare 4th type – elongated cylindrical, has been added. Measurements of the chalcedony beads have been performed

including weight and size. Mean values of weight and size are given for beads of all the studied graves as well as for the whole necropolis: weight – 0.40 g; length – 0.81 cm; diameter – 0.58 cm (for morphological type 1-2 and 4); weight – 0.15 g; length – 0.81 cm; diameter – 0.58 cm (for morphological type 3). The study confirms the complex "constant" number of 32 facets among the morphological type 2 carnelian and agate beads (16x16 on both sides on the elongation of the bead; the ideal form is a truncated 16-fold trapezohedron). This form is considered the earliest complex type faceting on a hard mineral. The mean weight of the type 1-2 and 4 carnelian and related beads is 0.4 g (or 2 carats) in close correspondence to the mean value of the gold short cylindrical beads – thus a Chalcolithic weight unit has been introduced called *van* supposedly relating mineral and metal artefacts in an early weight system.

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