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NEW EVIDENCE OF CHALCOLITHIC AGE STEATITE BEADS FROM İNÖNÜ CAVE: TYPOLOGY AND TECHNOLOGY ASPECTS WITH ARCHAEOMETRIC TECHNIQUES

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ABSTRACT

During the excavations conducted at level V of İnönü Cave, which is located on the western Black Sea coast of Anatolia, 10.198 beads were found in a small pot above the bedrock. While 93 of the beads, the vast majority of which were produced from steatite, were produced from agate, 27 of them were produced from gold, 1 of them was produced from electrum, and 1 of them was produced from radiolarite. C14 analyses that were performed to obtain the absolute dates of this level, which bears the traces of the first settlers of the cave, and to date this group of finds, revealed that this level belonged to the last quarter of the 5th millennium BC (cal. 4260-3976 BC).

The SEM-EDS analyses of 7 beads selected from among the steatite beads in İnönü Cave were performed to understand steatite bead production techniques in the Chalcolithic Age. Furthermore, their detailed images were obtained with a polarization microscope. These studies revealed that steatite beads consisted of two sections, including the inner main body/core and the section covering the outer part of the bead, and produced by heat treatment. Based on these data, beads were attempted to be experimentally produced in the laboratory environment. The definition, analogical and chronological evaluation of these steatite beads and SEM-EDS analyses and experimental practices are comprehensively presented in this study.

KEYWORDS: Chalcolithic Age, Steatite Bead, Bead Production, Pyrotechnology, İnönü Cave

1. INTRODUCTION

Beads, which are among the frequently encountered objects in archaeological studies, have been among the impressive finds with their eye-catching designs and forms. Contrary to popular belief, it is considered that beads that are ignored in terms of their aspect of understanding the past and society and are usually defined as ornaments or jewellery are not just objects that make a visual impact. Moreover, they have an major potential in understanding the past and societies (Bar-Yosef Mayer et. al., 2004; Baysal, E. and Miller, 2016). New studies and analyses on beads, which are defined as small finds, pierced objects, or centrally pierced coloured ornaments in the literature, provide significant clues about the production technologies and raw material sources of these finds and what they mean (Bednarik, 2015; Damick and Woodworth, 2015, Perlès, 2018). Increasing knowledge brings along new questions and provides the diversification of perspectives (Baysal, E., 2015b). The importance of archaeometric studies, as well as archaeological evaluations in understanding the above-mentioned issues related to beads, is gradually increasing (Liritzis et. al., 2020). Therefore, these small objects are no longer the eye-catching materials of the past, and they are transformed into data that provide more information than their dimensions in terms of understanding the past, the individual, and the society.

There is a considerable amount of studies on some issues such as the production techniques and origins of beads, which are the main ornaments of the prehistoric period found in the Near East (Damick and Woodworth, 2015; Wright et. al., 2003; Wright et. al., 2008; Bar-Yosef Mayer et. al., 2004, Tite and Bimson, 1989; Horn, 2015), in the Aegean (Perlès, 2018), the Egypt (Helmi and Abdel-Rehim 2016) and the Indus Valley (Bouquillon, et. al., 1995; Vidale, 1995; Margaret and Miller, 2008), and circum Aegean (Dietz et al., 2018), and their place in commercial and social relations. Although there is a more limited number of studies on the ornaments of the prehistoric period found in Anatolia, it is observed that especially studies on bracelets and beads have gained momentum in recent years (Bains et. al., 2013; Baysal, E., 2013; Baysal, E., 2014; Baysal, E., 2015a-b; Baysal, E., 2016a-c; Baysal, E., 2017; Pickard and Schoop 2013).

During the excavations conducted in 2018 in İnönü Cave, which is located on the western Black Sea coast of Anatolia, 10.198 beads made of different materials were found in a small pot at level V, which is located just above the bedrock. It is quite difficult to determine how tens of thousands beads, which were found together in a pottery cup in the in-situ at level V, are arranged. Moreover, there are insufficient data to show what this group of finds means.

The relative dates obtained by the analogical evaluation of other archaeological materials found at level V were confirmed by C14 analyses of the carbon and bones taken from this level. Accordingly, it was understood that level V belonging to the first settlers of the cave belonged to the last quarter of the 5th millennium BC (cal. 4260-3976 BC).

The description of steatite beads in this collective finds and the determination of their production techniques were among the main aims of this study. The supply of the raw material from which the beads were produced, their place in trade relations, and their comparison with the samples in contemporary settlements constituted other aims of the study. Accordingly, the SEM-EDS analyses of seven beads with appropriate features selected from among the beads were performed. Furthermore, the beads were also examined under the polarization microscope. Based on the information provided by these studies, experimental practices were conducted in the laboratory environment for a better understanding of the production stages of beads. As a result of these analyses and evaluations, it was revealed that the beads are produced in two stages, the body/core and the section covering the outer part. The pieces of evidence, which indicate that the roughly shaped steatite core in the inner part was coated with the paste, which was formed with steatite/talc powder, and then, it could probably be fired by placing on a copper stick, were obtained.

2. THE SITE

İnönü Cave, which is located in the southwest of the village of Alacabük in Ereğli district of Zonguldak province (**Fig. 1**), is on average 235 meters above sea level. İnönü Cave, which is situated in a location dominating the Gülüç Creek (Ekinci, 2011), which creates a natural route that provides the connection and transportation between the coastal and inner parts in the mountainous geography of the Western Black Sea, has quite favourable characteristics for life due to its location and natural equipment. While the width of the cave, which consists of three chambers called A, B, and C (**Fig. 2**), reaches approximately 25 meters in its inner section, its height reaches 10 meters locally. Even the extreme points of the cave, the mouth of which faces west (**Fig. 3**), can remain bright from sunrise to sunset. Nevertheless, the areas formed by the Gülüç Creek and its small tributaries provide significant advantages in terms of meeting freshwater and various nutritional needs. Furthermore, the forestland where the cave is located and its rich vegetation are home to many hunting animals.

The intensive surveys carried out before the excavations that started in 2017 in İnönü Cave, which was used for the last time as the temporary living space of the shepherds of the village of Alacabük, indicated that the finds were concentrated in chamber C of the cave. As a result of the excavations conducted in trench H/7 until the bedrock in this section between the years 2017 and 2018, and it was found that there were five levels in a fill ranging from approximately 1.20 to 1.40 meters (**Fig. 4**) (**Table 1**).

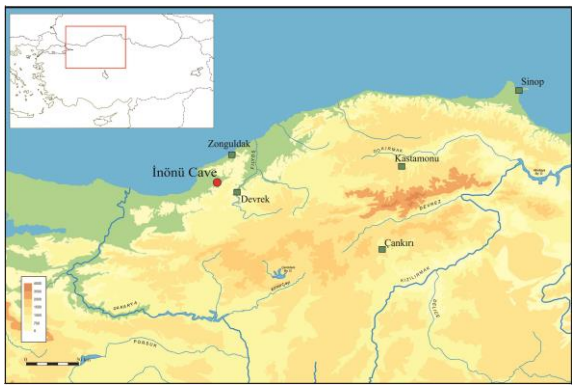

Figure 1: Location of İnönü Cave.

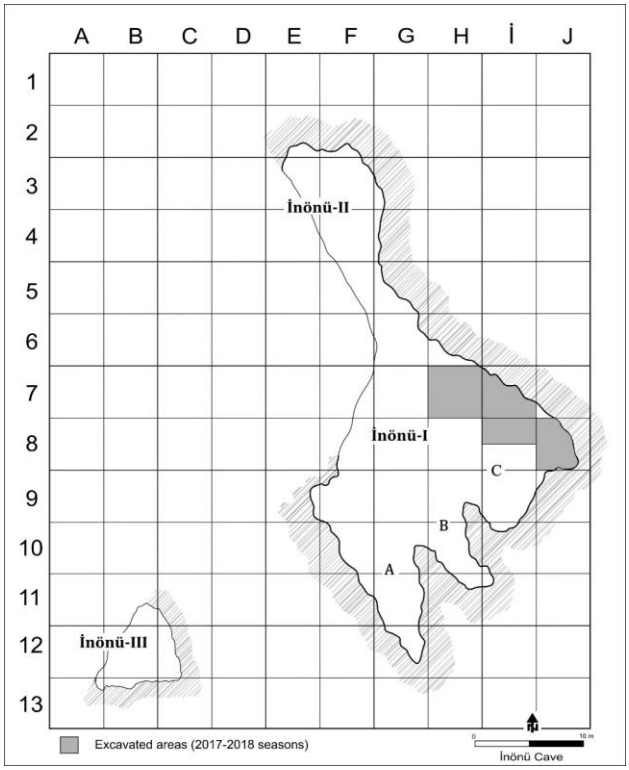

Figure 2: Plan of the cave and the areas excavated in 2017- 2018.

Figure 3: Southwestern view of İnönü Cave. (Photo: Archive of İnönü Cave Project)

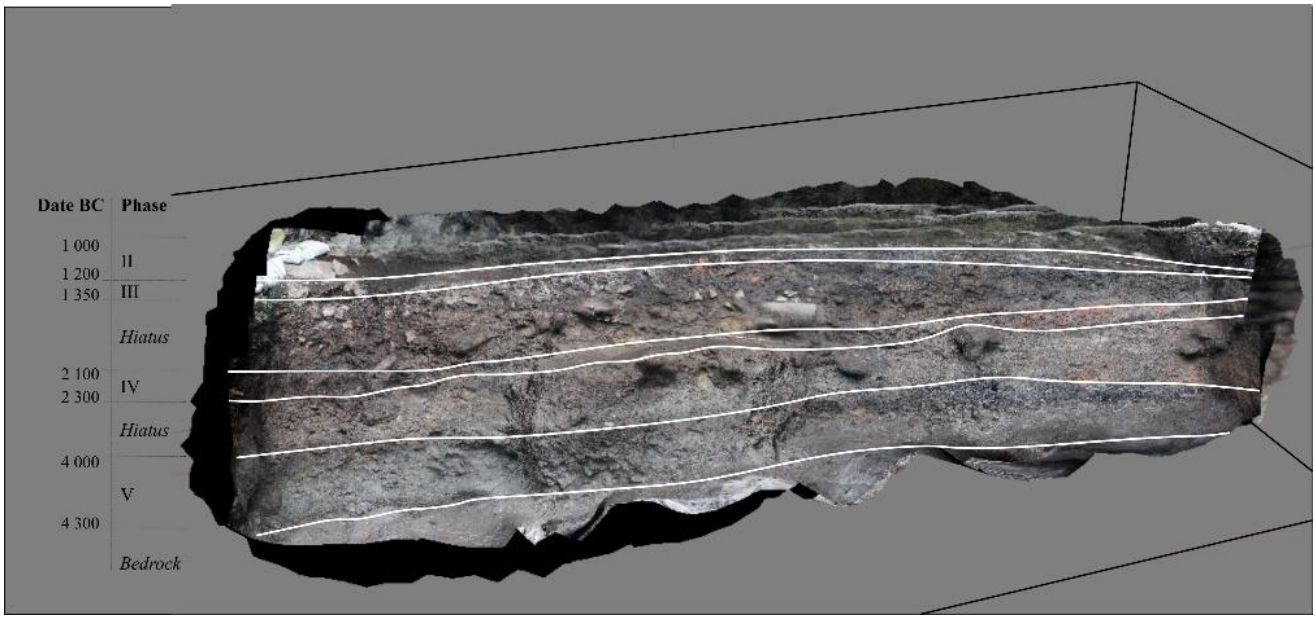

Figure 4: East Section of the Trench H/7 is made by Photogrammetry. (Photo: Archive of İnönü Cave Project)

It was observed that the bedrock of the cave, which was also found in some sections of trenches İ/7 and J/8 apart from trench H/7, had a sloping structure in the east-west direction, in other words, from the bottom of the cave to the mouth. As a result of the studies conducted in these areas, it was found out that the sloping bedrock was filled with gravel and grit and levelled by plastering with gray-clay mortar. Level V, which is located just above this ground and includes the oldest traces of life in the cave, contains findings of the 5th millennium BC. The findings remaining from the inhabitants of the Chalcolithic Age, who lived in İnönü Cave in small groups and possibly at certain times, provide significant information about the coastal cultures of the Western Black Sea, which is one of the least investigated regions of Anatolia, and the interregional relations of these cultures.

Table 1. Stratigraphy of İnönü Cave.

Level	Age	Characteristic Finds	Approximate Dates
I	Medieval Age	Glazed Pottery	1000-1200 AD.
II	Early Iron Age	Coarse Ware and Buckelkeramik	1200- 980 BC.
III	Late Bronze Age	Metal Weapons and Tools	1350-1200 BC.
IV	Early Bronze Age	Yassıkaya Type Pottery	2300-2100 BC.
V	Chalcolithic Age	Dark Burnished Pottery and Idols	4300-3900 BC.

During the excavations conducted in trench J/8 located in the northeast of chamber C in 2018, a small pot at a depth of 120 cm was found just above the bedrock, which was reached in a limited area, and next to the water source inside the cave (**Fig. 5**). Ten thousand one hundred and ninety-eight beads, twenty-seven of them were produced from gold, one of them was produced from electrum, one of them was produced from radiolarite, ninety-three of them were produced from carnelian, and the rest of them (10. 076) were produced from steatite, and two teeth of *Cervus elaphus*, which were possibly used as pendants, were found in the small pot with opposing vertical pierced lugs on its shoulders (**Fig. 6**).

All of the beads made of steatite were found in a small pot at level V, in the same context (**Fig. 5-6**). It is impossible to determine how the beads are arranged according to the status of the find. While the outer diameter of the beads, a few of which were found in broken condition, varies between 2 to 3 mm, their length varies between 1 and 3 mm (**Fig. 7-8**). According to Beck's typology (Beck, 1928), these beads were named disc, standard, and short beads by their dimensions (**Fig. 8A**). While disc beads are cylinder-shaped, standard and short beads are of three different types: barrel-shaped, cylinder-shaped, and those with a truncated bicone body.

While traces in shades of yellow and orange are observed due to exposure to heat on the outer surfaces of some of the beads, which are generally white and in shades of white, stainings ranging from brown to gray that apparently occurred over time in

their environments are observed on some of them (**Fig. 7-8**).

It is known that bead production became increasingly widespread in various parts of the Near East since the 5th millennium BC (Pickard and Schoop, 2013). However, as the researchers emphasize, there are many issues, from the supply of the raw material required for the production of beads to production technologies and from its place in trade relations to its intended uses, which have not been fully clarified (Bar-Yosef Mayer et. al., 2004; Baysal, E. 2015b; Damick and Woodworth, 2015). In this study, steatite beads, which numerically constitute the largest group of the bead collection found in İnönü Cave, will be introduced, and the bead production stages obtained as a result of the analyses and examinations performed on these beads will be emphasized.

Figure 5: In-situ of the beads in the pot. (Photo: Archive of İnönü Cave Project)

Figure 6: Steatite and carnelian beads lined up on the rope. (Photo: Archive of İnönü Cave Project)

Figure 7: Details of the steatite beads. (Photo: Archive of İnönü Cave Project)

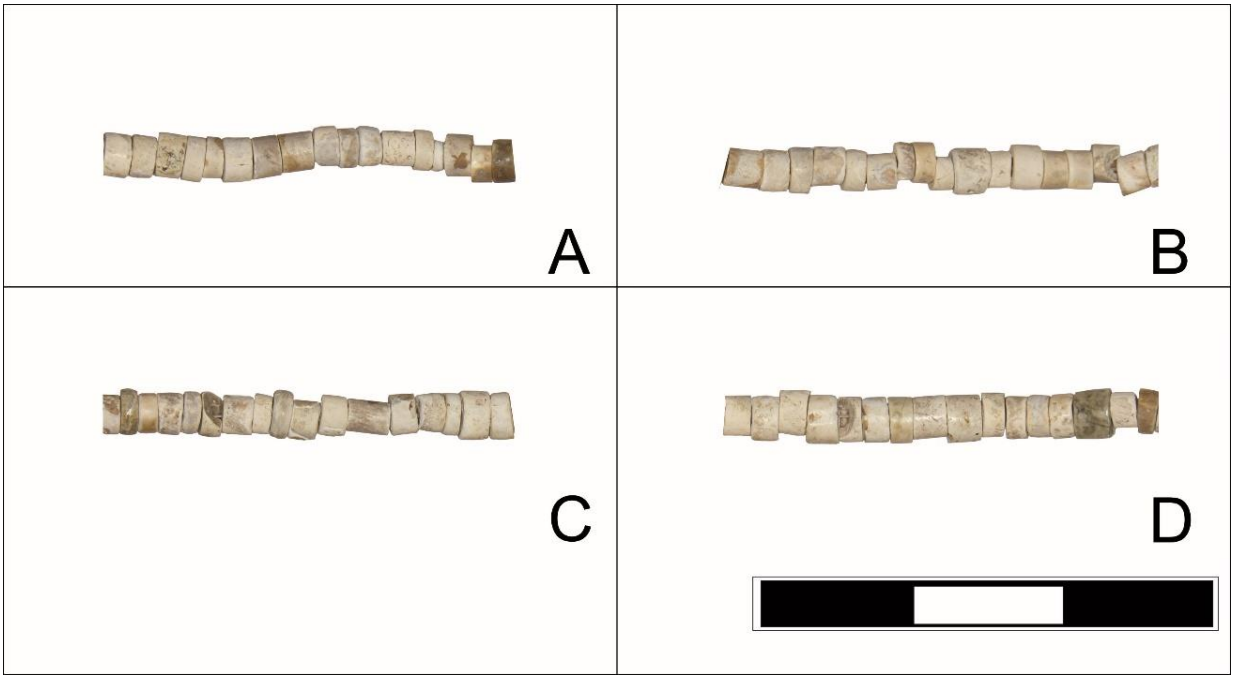

Figure 8: Details of the steatite beads. (Photo: Archive of İnönü Cave Project)

3. SEM-EDS ANALYSIS AND POLARIZATION MICROSCOPE

Seven beads were selected from among the broken and solid samples of the beads. Quantitative chemical analyses were performed on these selected beads with a Scanning Electron Microscope (SEM) and Energy Dispersive Spectrometry (EDS) to find out their texture, structural properties, and chemical components. Furthermore, thin sections of the beads were examined in detail under a polarization microscope.

It is applied two stepped analyses on bead samples. In the first step, to obtain the images and mineral micro analyzes of the exterior and drillhole part, bead specimens were placed on the aluminium plate and coated with thin film of a conductive material carbon using EMS 5000 SC (Sputter Coater) coating device and the first analysis was carried out. In the second part, analysis of the interior part that is not visible from the outside. Therefore, the same bead samples were placed in Epofix resin and polished using different hardness levels pads in accordance with SEM-EDS analysis. Afterwards, the same coating process has been applied.

The Everhart-Thornley secondary electron (Secondary Electron) detector integrated with the Carl Zeiss EVO 50 EP Scanning Electron Microscope was used in both imaging. 5-15 kV accelerating voltage and 50-150 pA beam current conditions were applied during this process. To obtain mineral content, micro analyses were performed using Bruker-Axs Xflash 3001 Silicon Drift X-Ray Energy Distribution Spectrometer (EDS) integrated with SEM; 15 kV accelerating voltage, 5-10 nA beam current were performed during the operating.

The outer side of all selected bead samples is white. Some of the broken parts are greenish-yellow, and some of them are colourless and white. The texture of the sample of beads can be stated as a very fine serpentine-like texture (**Fig. 9**). There is also one exception in one of the beads that show a fine-grained quartzite texture.

The EDS results (**Table 2**) show that the coated material on the beads has the same major oxide per-

centages of steatite (Mg3Si4O10(OH)2) (talc group mineral) and the coated material is clearly visible under the polarized microscope (**Fig. 10**). However, it is observed in the EDS and backscatter images that there is an abundant growth of enstatite crystals and scattered copper particles in the part of the drill hole coat (**Fig. 11**). However, Cu particles were not found abundantly in the outer part of the beads (**Fig. 11c**). According to another result of EDS analysis, copper particles are observed in the glazed layer, especially in the drill hole part of all beads. No any other crystals are found in the beads, except enstatite.

SEM-EDS analyses and polarization microscope images (**Fig. 9-11**) provide information about the production process and techniques of the beads in İnönü Cave. According to the polarization microscope images taken from the broken beads, two separate sections were observed in the beads. The first of them is the glazed part, which is approximately 75-100 µm, and the other one is the core part with cracks. In some of the beads, the glazed outer surface appears to be destroyed and removed (**Fig. 8C**). In the EDS analyses, it was observed that the material covering the outer part of the beads had the same chemical content as the material from which the bead was made. However, it was observed in the EDS and backscatter images that there was a large number of enstatite crystals and copper particles in the part with the hole (**Fig. 11a, d**). In some samples (**Fig. 9/B1**), the observance of a high rate of calcium in the outer part of the beads provides clues that a material similar to calcium carbonate (CaCO3) obtained from SiO2-rich tuff or limestone might have been used as a binder to make steatite into a paste.

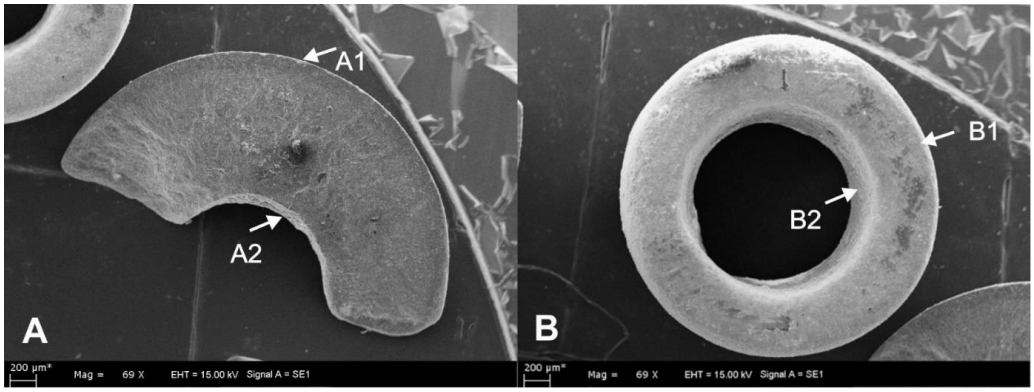

Figure 9: SEM-EDS analysis of the outside (A1,B1) and inside (A2,B2) A:Bead 1 B: Bead 2. Outer part of pieces is covered by talc (Mg3Si4O10(OH)2) mineral. Iron (Fe) and Aluminium (Al) elements are detected in B1 which may include a small amounts of residual elements from ultramafic rocks before hydrothermal alteration process. Copper ratio has been found as irrelevant result the drill hole of all beads.

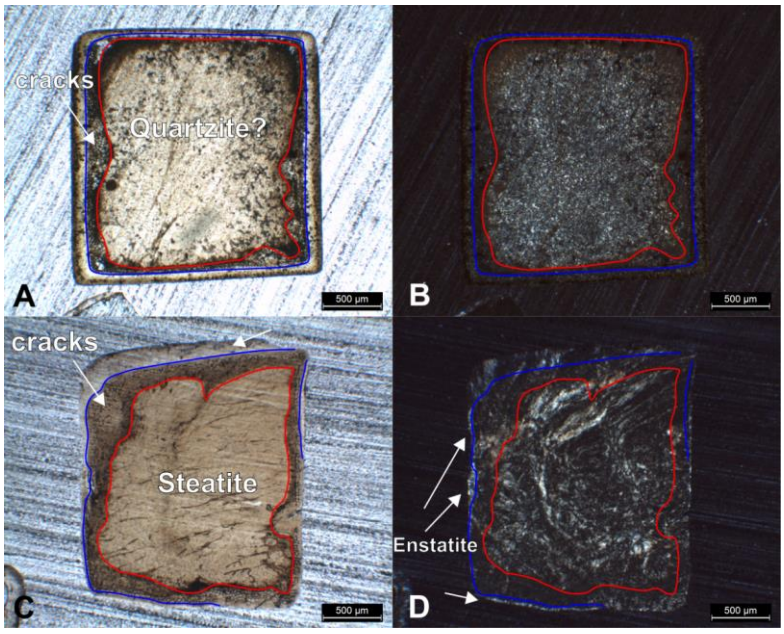

Figure 10: Thin sections images of two different pieces of necklace (A, C are plane-polarized; B, D are cross-planed images) under polarized microscopy show at least 2 different material (A: quartzite, C: talc) they used to create the necklace. Edges of pieces have a different texture from its core which contains enstatite with talc according to EDS analysis

4. EXPERIMENTAL STUDY

Based on the data presented above, steatite beads were attempted to be produced under laboratory conditions. In this experimental study, steatite/talc powder, which was made as paste (mold) by mixing with water, was applied to some surface of a rock sample like a plaster. However, when it was dried, it did not fix well on the surface of the sample. In the second attempt, limestone paste (CaCO3) was first applied to the rock sample surface, and then it was coated by burying into steatite powder. In this way, the steatite powder with carbonate mineral, could be fix on to the surface. Finally, the beads coated with steatite mineral were fired for a short time with a blow torch that could reach 1000°C in couple of minutes. After firing process, it was observed that heat-related cracks developed in the carbonated parts of the beads and they were a little glazed in the section where the steatite paste was found. Carbonate mineral has succeeded in fixing of steatite in to a paste.

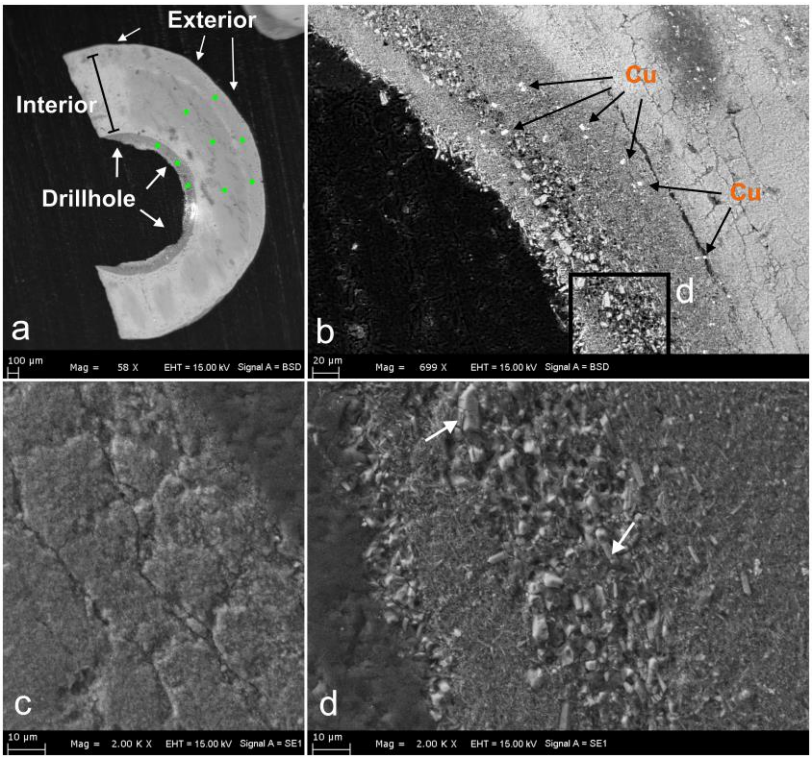

Figure 11: SEM images of a necklace bead thin section (Backscatterd image: a and b, SEM images: c and d). EDS analysis has been performed on green spots to five selected beads (a) and results are given in Table 1. b: Scattered copper particles have been identified in ceramic zone and also rarely observed in inside the bead. Heat cracks appeared on drillhole part (b) as well as outer part (c) of the bead. This result shows heating process have been applied from inside as well. About 8-10µm sized Enstatite minerals (d: white arrows) have been observed in drillhole of the bead.

Table 2. EDS result shows major oxide percentages of selected whole and broken beads. Two whole samples (Bead 1 and Bead 2) has directly analysed and broken samples (Bead 3 to 7) have been made thin sections to analyse interior of elemental content. Explanation of dh: drilhole wall, int: interior and ext: exterior wall is shown in Figure 11.

	Major Oxide (%)									
	Na_2O	MgO	Al_2O_3	SiO_2	K_2O	CaO	FeO	Cl	Cu	Total
Bead 1 (Fig 9a)										
1 (dh)	0	11,23	3,74	33,68	0	3,86	2,42	0	45,07	100
2 (ext)	0	34,16	0	65,84	0	0	0	0	0	100
Bead 2 (Fig 9b)										
1 (dh)	0	27,12	0	57,34	0	1,78	0	13,76	0	100
2 (ext)	0	14,54	7,05	29,45	0	47,48	1,48	0	0	100

Bead 3 (Fig. 11)										
1 (int)	1,69	28,38	0	67,14	0	0	4,84	0	0	100
2 (int)	0	22,81	0	71,47	0	0	5,72	0,63	0	100
3 (int)	0	23,27	0	71,56	0	0	5,17	0	0	100
4 (dh)	0	39,13	0	60,87	0	0	0	0	0	100
5 (crystal) Enstatite	0	41,44	0	58,56	0	0	0	0	0	100
6 (dh) Cu particle	0	0	0	0	0	0	0	0	100	100
Bead 4										
1 (int)	0	25,70	0	74,30	0	0	0	0	0	100
2 (int)	0	25,49	0	74,51	0	0	0	0	0	100
3 (int)	0	26,22	0	73,78	0	0	0	0	0	100
4 (dh)	0	34,63	0	65,37	0	0	0	0	0	100
5 (ext)	0	32,76	0	67,24	0	0	0	0	0	100
Bead 5										
1 (int)	0	24,19	0	75,81	0	0	0	0	0	100
2 (int)	0	24,61	0	75,39	0	0	0	0	0	100
3 (int)	0	25,50	0	74,50	0	0	0	0	0	100
4 (dh)	0	38,21	0	57,06	0	0	0	0	4,72	100
5 (ext)	0	24,19	0	75,81	0	0	0	0	0	100
Bead 6										
1 (int)	0	23,04	0	73,96	0	0	0	0	0	100
2 (int)	0	25,16	0	73,28	0	0	0	1,56	0	100
3 (int)	0	24,81	0	75,19	0	0	0	0	0	100
4 (dh)	2,69	32,64	0	63,17	0	0	0	1,51	4,72	100
5 (dh)	0	33,43	0	49,69	0	0	0	0	16,88	100
6 (dh)	1,30	32,65	0	56,88	0	0	0	0	9,17	100
Bead 7										
1 (int)	0	25,92	0,73	71,94	0,85	0	0	0,57	0	100
2 (int)	0	28,44	0	71,56	0	0	0	0	0	100
3 (int)	0	26,12	0	73,88	0	0	0	0	0	100
4 (dh)	0	32,65	0	67,35	0	0	0	0	0	100

According to SEM-EDS analyses, in addition to the homogeneous steatite, enstatite, and copper particles observed in the beads, the traces of aluminum (Al) and iron (Fe) elements were also detected in the glazed parts of the beads, which can be explained by the fact that steatite was not found homogeneously in the place where it was unearthed. In other words, the observation of a certain amount of aluminum and iron in steatite is a condition observed in ultramafic rocks, which are source rocks (Turekian and Wedepohl, 1961).

5. TYPOLOGICAL COMPARISONS

It is known that the early beads dating back to the Paleolithic Age in Anatolia were commonly produced from land and sea crustaceans (Özdoğan, E., 2016; Bednarik, 2008; Bar-Yosef Mayer, 2013; Baysal, E., 2015b). It is remarkable that the production and use of stone beads with an aesthetic and exotic appearance of various colors made of different raw materials with the Neolithic Age became increasingly widespread (Baysal, E., 2015a; Baysal, E., 2016c). The early samples of beads made of stone of different colors and types in Anatolia are known from Körtiktepe (Özkaya and Coşkun, 2011), Caferhöyük (Cauvin et. al., 2007), Gusir Höyük (Özdoğan, E., 2016), Domuztepe (Belcher, 2011), Pınarbaşı, Boncuklu Höyük (Baysal E., 2013), Çatalhöyük (Hamilton, 2005), Aşıklıhöyük (Esin and Harmankaya, 2007), Yumuktepe (Caneva, 2007; Caneva and Köroğlu, 2010), Köşk Höyük (Öztan, 2007) and Çukuriçi Höyük (Baysal, E., 2015b; Baysal, E., 2017a).

The beads made of stone belonging to the Chalcolithic Age, which have similar features with the beads in İnönü Cave, were also unearthed in Barcın Höyük (Baysal E., 2014). A large number of beads made of limestone and other raw materials were found in Aktopraklık, which is located at a distance close to Barcın Höyük (Özdoğan, E., 2016). The pottery decorated with white, disc-shaped limestone beads found in Aktopraklık provided information that beads were also used in the decoration of pottery in addition to personal ornaments in the early periods (Baysal, E., 2016c; Özdoğan, E., 2016). Moreover, serpentine and quartzite beads, which are among beads made with a wide variety of materials and in different types found in Canhasan, are closely similar to the samples in İnönü Cave (Baysal, E., 2017b). The beads belonging to the Late Chalcolithic Age found in Çamlıbel Tarlası are similar to the samples in İnönü Cave with respect to both their types, production technique, and raw materials (Pickard and Schoop, 2013).

There are various opinions about the importance of choosing different colors and their meaning in daily life in the use of ornaments along with the Neolithic and Chalcolithic Age (Baysal, E., 2015a; Baysal, E., 2015b; Bar-Yosef Mayer and Porat, 2008). Nevertheless, the fact that especially the use of white color was attached significance to during those periods is an issue to which researchers pay attention (Özdoğan, E., 2016). Due to the presence of the imitations of ornaments made of Spondylus and Glycymeris, which became a common fashion in the Neolithic Age and especially in the Chalcolithic Age, and made of different raw materials in some settlements (Baysal, E., and Erdoğu, B., 2014; Özdoğan, E., 2016), some researchers indicate that there was an increase especially in the number of white bracelets. As mentioned previously, the steatite beads in İnönü Cave, the number of which is over ten thousand, constitute the largest group of a collection consisting of a small number of gold, carnelian, and one radiolarite. The gold and carnelian beads in the collection are exactly parallel to the gold and carnelian beads unearthed in the Varna I cemetery (Leusch et. al., 2015). The beads in the Varna I cemetery and the beads in İnönü Cave are also chronologically compatible with each other. In addition to the gold and carnelian beads found in the Varna I cemetery, there are many Spondylus beads. In this regard, it is possible to consider that the beads made of steatite in İnönü Cave were produced by imitating Spondylus beads in accordance with the fashion of the period.

6. CHRONOLOGY AND RADIOCARBON DATES OF THE CAVE

In order to evaluate the chronology of the period of the beads found at level V of İnönü Cave, it is necessary to briefly mention the other findings found at this level.

Level V located on the ground, which was formed by filling the sloping bedrock of the cave with gravel and grit and leveling it with gray-clay mortar, is the oldest level of the cave. The dark burnished ceramics unearthed just below a rubble-filled hiatus along with the sudden disappearance of the pottery with a red paste of level IV, which represents the Early Bronze Age, are the most significant indicators of level V.

Among the ceramic repertoire found at this level where architectural remains are very limited, some groups come to the forefront in terms of dating. Among these ceramics, the group which is high in number is dark-coloured in the includes of grayish-black, black, dark gray, or dark brown. The pottery in this group of paste is generally well burnished. It is considered that the surface color and bright appearance of the pottery in this tradition were obtained depending on burning conditions in a reduced environment during firing. Furthermore, it is also known that the outer surfaces of pots were burnished with carbon, coal, or graphite before full cooling took place after firing in order to achieve this appearance (Dzahanfezova et al., 2014). The researchers think that the use of graphite for burnishing or pattern purposes on pots, which began to appear in the Neolithic Age and continued throughout the Chalcolithic Age, was closely associated with metal production, especially the emergence of gold and copper metallurgy (Radivojević and Rehren, 2015).

The detail, which indicates a much clearer and narrower range in terms of dating the relevant level among the ceramics of level V, is the ceramics with the polished/pattern burnished tradition. The pattern burnished samples, similar to the pieces found in İnönü Cave, are known from the Thrace, Aegean, and Marmara Regions (Çayır-Böyükulusoy, 2014). This tradition, which is known from the Early and Middle Chalcolithic Age in Western Anatolia (Erdoğu and Çevik, 2015) and from the Late Neolithic-Chalcolithic Age in the Aegean Region (Günel, 2014), is also one of the general characteristics of the culture, which is contemporary with the cemeteries such as Varna I and Durankulak and defined as Kodjadermen–Gumelnita–Karanovo VI (KGK VI) in northeast Bulgaria and Muntenia region (Boyadziev, 1995; Özdoğan, 2000). Among the pottery forms of level V, the most important forms for dating are car-

inated and long-necked pottery with a biconical body. The counterparts of carinated pottery of a similar type are known from the settlements of the Western Anatolia, Thrace and South Marmara Region (Özdoğan et. al., 1991; Parzinger, 2005; Efe, 2001; Schoop, 2005; Derin, 2011; Caymaz, 2013). The small pot with a simple rim, a flat bottom shoulder, and a broad body found among the beads, which constitute the subject of this study, also helps dating. This little pottery cup has two opposing vertical pierced lugs on its shoulders. These types of lugs are a tradition known from Western Anatolia and Lakes Region since the Neolithic Age (Duru, 2008). Their samples of the Chalcolithic Age were found in Ulucak III, Aegean-Gübre 2, Yeşilova II (Derin, 2011), Baklatepe, Limantepe VII (Caymaz, 2013), Ilıpınar (Thissen, 2008) and Hocaçeşme (Özdoğan, 2013).

Most of the above-mentioned close counterparts of the characteristic types among the pottery in İnönü Cave are dated to the Middle Chalcolithic Age. However, when the general repertoire and diversity of these compared sites are compared with the pottery in İnönü Cave, it is remarkable that the samples in İnönü Cave are very limited in terms of their form and decoration diversity. This is a proof that some traditions known from the Western Anatolia, Thrace, and South Marmara Regions in the Middle Chalcolithic Age were sustained in the Western Black Sea Region in the Late Chalcolithic Age, and also, this limited repertoire can be considered as the local character of the region.

When the small finds belonging to this level, except for the ceramics found at this level, are examined for the dating of level V, two idols made of terracotta stand out. The woman standing in both of them is depicted in a stylized form abstracted from her natural appearance. The separation of the waist and neck in their bodies and the chin protrusion on their faces are not depicted (Ekmen, F. G., 2020). The fact that women were depicted in a stylized form and without details during the periods, especially after the middle of the Chalcolithic Age, was a common tradition, and the counterparts of these types of idols are known from the other regions of Anatolia (Bilgi, 2012).

Pottery and idols unearthed at level V, where steatite beads were found, are the pieces of evidence indicating that this level belongs to the 5th millennium BC. This evidences are supported by C14 dates. C14 analyses for the present project carried out in the TUBİTAK Marmara Research Center on seven samples consisting of tooth, charcoal and horn that were taken from different contexts of Level V provided dates for the last quarter of the 5th millennium BC (**Fig. 12**). Analysis number TUBITAK_0405 was obtained from the tooth of Cervus Elaphus found in the small pot where the beads were hidden. This tooth yielded a date of 4200-4000 BC which indicates the serving date of the pot and of the beads either. The charcoal sample number TUBITAK_0402 was collected from the spot, right next to the pot. While both analyses results are exactly compatible with each other, they also comply with the results of the other five analyses.

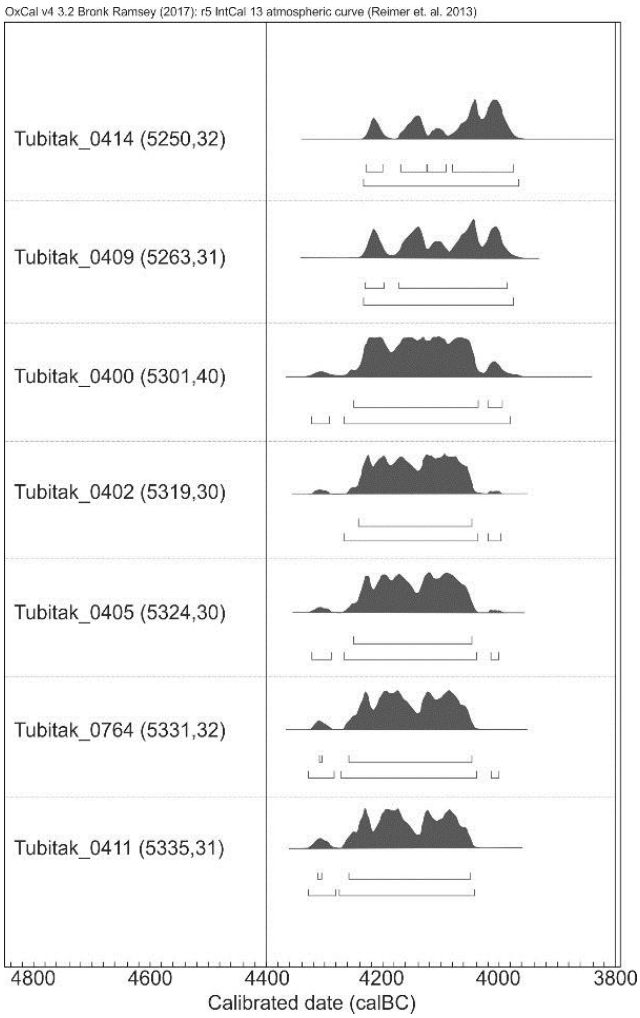

Figure 12: The results of 14C analysis of İnonu Cave level V. (Ekmen, F.G. 2020)

7. DISCUSSION

7.1. *Origin*

As mentioned above, beads, which were commonly used within the ornaments of the Prehistoric Age, are among the personal ornaments frequently encountered in the Near East and Indus Valley. The studies on beads provide significant information about issues such as the raw material from which beads were produced, and production techniques. Therefore, the roles of these objects in understanding the past become more important (Baysal, E., 2015b). The determination of the raw

material from which the bead was produced provides important clues for understanding cultural and commercial relations. For example, due to the absence of steatite in the region for the production of beads made of steatite belonging to the Chalcolithic Age found in the Peqi'in Cave, it is considered that this raw material points to Turkey's relations with its southeast, Northern Mesopotamia and Egypt (Bar-Yosef Mayer et. al. ,2004). Pickard and Schoop indicated that the steatite used in the production of beads belonging to the Late Chalcolithic Age found in Çamlıbel Tarlası was obtained from local sources (Pickard and Schoop 2013). The raw material of the steatite beads in İnönü Cave is found abundantly in the river sediments located near the cave, on the coastline of the Western Black Sea. Furthermore, a large number of quartzite banded rocks were found in the field studies carried out by our team together with K. Çakır, one of the experts of the General Directorate of Mineral Research and Exploration, in the village of Ebegümeci, which is located approximately 3 km east of İnönü Cave.

Steatite occurs on hydrothermally modified ultramafic rocks (dunite, lherzolite, harzburgite). The closest rocks with these lithological characteristics are located in the Almacık massif between Bolu and Düzce at a distance of approximately 90-100 km (Tüysüz et. al., 2004). Serpentinized ultramafic rocks with the same characteristics were also found in the Sünnice massif located 40-50 km south of the region. Therefore, it is possible for the inhabitants of İnönü Cave to obtain the raw material they needed to produce beads from local sources, in other words, from a distance that cannot be considered too far. Undoubtedly, source analyses are needed for the exact determination of the sources of raw material from which the beads were produced. However, it is, of course, possible that these beads were brought to İnönü Cave as finished products. Since no finds and remains of the production stage have been found yet, it is difficult to comment on whether these beads were locally produced or brought as finished products.

7.2. *Production*

Apart from the raw material and supply of beads, the other stage emphasized by the researchers is the bead production technology. Expertise and skills are the main virtue needed by masters for the production of these small objects, which are not only simple ware but also contain aesthetic and exotic values. The studies on bead production in recent years have increased our knowledge of this issue. For example, it is known that the beads of the same type found in Çamlıbel Tarlası were produced with different techniques, which can be explained by many factors, such as the fact that beads were produced by different masters, and economic reasons or preferences. Although such a difference is clearly visible, archaeometric studies and experimental practices on how beads of a similar type with the beads in İnönü Cave were produced describe two main methods. According to the first method, beads were obtained by carving from steatite core and firing. However, in the second method, beads were shaped and exposed to fire with powdered steatite or talc-based paste (Pickard and Schoop, 2013; Damick and Woodworth, 2015). It was determined that beads with the same appearance found in different contexts in Tel Fadous-Kfarabia (Pickard and Schoop, 2013), Peqi'in Cave (Bar-Yosef Mayer et. al., 2004), Ra's al Hadd (Panei et. al., 2005) and Çamlıbel Tarlası (Pickard and Schoop, 2013) had different production techniques and different raw materials.

In the polarization microscope observations of the broken steatite beads in İnönü Cave, it was observed that the beads had a steatite and quartz-like texture in their core part (**Fig. 10**). It is difficult to comment on how the beads cores were cut in the stage that represents the first step of the production of beads in İnönü Cave. However, it is considered that cross striations observed on several samples occurred while cutting or smoothing the bead. Emphasis was also put on the fact that the irregular cross-striations on the sides of the Tel Fadous-Kfarabia beads and not continuing out of the bead could be related to cutting (Pickard and Schoop, 2013). On the other hand, it was indicated that the striations observed on the sides of some of the beads found in Çamlıbel Tarlası continued towards the outer sides and that these striations could be the spaces between a squeezed paste (Pickard and Schoop, 2013). According to another opinion, similar traces on the beads of the Predynastic and First Intermediate periods in Egypt were caused by coarse smoothing (Beck, 1934; Damick and Woodworth, 2015).

Another important step for the bead production technology is the drilling of beads. Although there is no adequate information on how the bead cores in İnönü Cave were drilled, it is possible to put forward an idea about in which stage of the production they were drilled. Since glazed was observed on the hole walls of the beads, as on the outer surface, and based on the copper remains observed in some samples on these hole walls, it is understood that a hole was drilled by firing the beads on a copper stick after steatite was made into a paste (**Fig. 11**). It is stated that the beads in the Peqi'in Cave were shaped along a thin long stick after the talc was made into a paste, and then, they were shaped by firing at high temperatures (Bar-

Yosef Mayer et. al., 2004). Apart from this method, it is known that some of the other contemporary beads were drilled with a spring drill. The flakes observed on both sides of the Tel Fadous-Kfarabia beads were interpreted as the traces indicating the two-pole drilling. It is stated that the wider ring on the outer line of the hole walls of the beads was the traces of the ground prepared before drilling in order to prevent the spring drill from slipping during its use (Pickard and Schoop, 2013). It is indicated that the spiralities observed in the holes of the beads in Çamlıbel Tarlası also indicate that a spring hand drill was used (Pickard and Schoop, 2013).

As mentioned above, SEM-EDS analyses revealed that a type of carbonate group mineral was applied as a binder material inside and outside in the production of the beads in İnönü Cave. A similar situation was also mentioned in the study by Bar-Yosef Mayer et al. In that study, it was indicated that since steatite is a material that does not fuse, fusion could be ensured by adding some feldspar to it (Bar-Yosef Mayer et. al., 2004). In their study on the beads found in Ra's al Hadd, Panei et al. stated that the beads could be shaped from talcum powder by using or not using a binder material (Panei et. al., 2005). The analyses performed on the beads in İnönü Cave showed that enstatite minerals and crack marks (**Fig. 11A-D**) on the inner and outer parts of the beads were caused by the exposure of beads to heat inside and outside. Therefore, it can be considered that the steatite paste prepared to produce the bead was fired after it was placed on a copper stick with good heat conduction. The traces of heat treatment/pyrotechnology were found in many of the beads made of steatite found in parallel sites. The researchers suggest that these heat-treated beads may have been fired at temperatures between 700-1100 oC (Melekhova et. al., 2006; Hedge, 1983; Bar-Yosef Mayer et. al., 2004). It was observed that the elemental order of steatite was disrupted at a temperature of approximately 600 to 750 oC under atmospheric conditions and turned into enstatite and quartzite, which is a more stable structure (Kitahara et. al., 1966). However, we do not have adequate pieces of evidence on whether there were special furnaces for this process or how the firing process may have occurred (Damick and Woodworth, 2015). It is stated that the technology required for the heat needed in the production of steatite beads in Çamlıbel Tarlası is known due to the mining furnaces in the settlement. However, it is difficult to say that these furnaces may have also been used in bead production (Pickard and Schoop, 2013). Bar-Yosef Mayer et al. also indicated that microbead production technologies were closely associated with the development of extractive metallurgy that improved at the beginning of the 5th millennium BC (Bar-Yosef Mayer et. al., 2004).

8. CONCLUSIONS

The fact that ten thousand one hundred and ninety-eight beads made of different materials were found in a small pot at level V of İnönü Cave belonging to the Chalcolithic Age is an extraordinary situation that is rarely encountered in archaeological studies. This assemblage provides significant data on the condition of the Western Black Sea region during the prehistoric periods and the comprehension of bead production technologies of the Chalcolithic Age. The similarities of the gold and carnelian beads, which are relatively few in number among the assemblage, with the gold and carnelian beads in the Varna I cemetery (Leusch et. al., 2015), which is well-known in the world of archeology, are remarkable. Therefore, it was initially considered that the white beads found in İnönü Cave could also be produced from Spondylus due to their similarity with a large number of beads produced from Spondylus, which was found together with the gold and carnelian beads in the Varna I cemetery. Therefore, B. A. Gümüş, who has studies on Spondylus, was asked for her opinions on the beads. As a result of the examinations, B. A. Gümüş clearly stated that the beads were not produced from Spondylus. Furthermore, one of the broken beads was sent to the TÜBİTAK-MAM laboratory for radiocarbon (C14) dating. T. Doğan, who conducted the study, indicated that radiocarbon dates could not be obtained since the material does not contain carbon and therefore is not an organic material. Thus, it was decided to select a group from among this assemblage and to examine them through SEM-EDS analysis and a polarization microscope.

As a result of the SEM and EDS analysis and Polarization Microscopic examinations, it was understood that the beads in İnönü Cave were made into a paste by mixing with liquid after powdering the steatite, and after this stage, they were shaped around a long thin metal (copper?) stick. Enstatite minerals and crack marks on the inner and outer parts of the beads indicate that the beads were exposed to heat inside and outside. Therefore, it is predicted that the steatite paste was fired after it was placed on a metal stick (copper?) with good heat conduction during the production of beads. While enstatite minerals are homogeneously visible in the inner part where the bead is glazed, they are observed less due to abrasion in the outer part. The fact that enstatite minerals in the inner part are in a certain order is a consequence of the natural formation of enstatite with high temperature (Bose and Ganguly, 1995; Chernosky et al., 1985;

Melekhova et al., 2006). The presence of copper (Cu) pieces, the crystal shape of which could not be observed along with enstatite, was also determined. These studies demonstrate that the steatite in a paste form was first placed on a metal stick and then fired at a high temperature, and some of it turned into enstatite and quartzite. It is predicted that calcium carbonate was used as a binder material to hold the steatite powder before this process.

Although there are stainings of different colors on the outer surfaces of the beads, which are of three main types: cylinder, barrel, and bicone, the main color is white. It is difficult to say something clear whether this color was related to preferences or whether it was preferred by imitating Spondylus beads in accordance with the fashion of the period. With respect to this issue, E. Baysal indicated that imitation products were commonly observed in bead production during and after the Neolithic Age, and in some cases, imitation beads had good workmanship to deceive the person who looked at them (Baysal, E., 2015b).

When the amount and production process of these beads, which were found in İnönü Cave and introduced in detail here, are considered, it is not difficult to think that this process is quite complicated. However, we do not have enough data yet to state what the detection of this assemblage that was found at level V, which was investigated in a limited area and where there were almost no architectural elements, at the bottom of the cave, next to the water source and without depending on the architecture, means. This brings to mind a situation related to rituals for now. We hope that the excavations to be carried out at level V in the next years will also contribute to what the assemblage, which constitute the subject of this study, means and why they were found there.

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