



# Constructing identities in Neolithic times: the variscite ornaments of Gavà (Barcelona)

Hala Alarashi, Ferran Borrell

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# L'ART DU PARAÎTRE

Apparences de l'humain, de la Préhistoire à nos jours  
*The art of human appearance, from prehistory to the present day*

sous la direction de  
HALA ALARASHI & ROSA MARIA DESSI

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from prehistory to the present day*

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*The art of human appearance : from prehistory to the present day*

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**Hala Alarashi, Rosa Maria Dessì**

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DANSER SES PEAUX

# CONSTRUCTING IDENTITIES IN NEOLITHIC TIMES

## The variscite ornaments of Gavà (Barcelona)

Hala Alarashi<sup>a</sup>, Ferran Borrell<sup>a</sup>

### Résumé

Les mines souterraines de Gavà ont été parmi les principales sources de variscite exploitées et distribuées dans le bassin occidental de la méditerranéen au cours du Néolithique moyen (1<sup>re</sup> moitié du 4<sup>e</sup> millénaire avant J.-C.). Les fouilles récentes de trois mines (83, 84 et 85) dans le secteur Ferreres ont apporté un nouvel éclairage non seulement sur les aspects économiques, mais aussi sur des pratiques rituelles et symboliques jusqu'alors inconnues. Cette étude présente les résultats des analyses technologiques, morphométriques et stylistiques de l'assemblage de variscite composé de perles, d'objets inachevés et d'ébauches découverts dans les mines 83 et 85. Elle confirme l'existence de deux qualités de production, l'une conventionnelle, standardisée, caractéristique des productions spécialisées et destinée à l'échange à plus ou moins longue distance, l'autre plus « expérimentale » et opportune. Ces qualités ont été examinées dans le contexte chrono-culturel de la région, mais aussi en considérant le contexte exceptionnel de l'exploitation minière et de la fabrication de perles à Gavà. L'étude prend également en compte les données anthropologiques concernant les individus enterrés dans ces mines, identifiés comme des artisans mineurs et bijoutiers. Elle s'interroge notamment sur leur rôle et l'influence de ces acteurs de la production sur la construction des codes culturels et la consolidation de l'identité des communautés de la culture des *Sepulcros de Fosa* au nord-est de la Péninsule Ibérique, et plus largement dans le bassin méditerranéen occidental.

### Mots clés

Variscite, parures, exploitation minière, spécialisation, Néolithique moyen, culture des *Sepulcros de Fosa*

### Abstract

The subterranean mines of Gavà were among the main sources of variscite exploited and distributed in the West Mediterranean basin during the Middle Neolithic (1<sup>st</sup> half of the 4<sup>th</sup> millennium BC). The recent excavations of three mines (83, 84 and 85) at the Ferreres sector shed new light not only on the economic aspects, but also on an unknown ritual and symbolic practices carried out in the mines. This study presents the results of the technological, morphometrical and stylistic analyses of the variscite assemblage of beads and unfinished items and blanks discovered in mines 83 and 85. It confirms the existence of two different types of production, one of them being conventional, standardized, characteristic of specialized crafts and destined for external exchange, while the other is more "experimental" and expedient. These qualities are discussed within the chrono-cultural context of the region, but also consider the exceptional mining and beadmaking context at Gavà. The results also consider the anthropological data regarding the buried individuals in these mines, identified as the miners and beadmakers, through questioning their roles and influence in the construction and consolidation of the identity of the *Sepulcros de Fosa* (Pit Burial culture) communities in the North East of the Iberian Peninsula and more largely in the Western Mediterranean basin.

### Keywords

Variscite, ornaments, prehistoric mining, specialization, Middle Neolithic, *Sepulcros de Fosa* culture

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## INTRODUCTION

Shaping and perforating stones to make beads is a crucial threshold for prehistoric people. In the Near East, the development of the craft of stone bead making took place at the same time as the emergence of the Neolithic way of life (MARÉCHAL & ALARASHI 2008; ALARASHI 2014, 2016a). The incorporation of stone beads within the ornamental traditions in North East Africa (ALARASHI 2017) and Western Europe is also associated with well established, fully Neolithic societies (RUBIO 1993; THOMAS 2011; MICHELI 2012; OLIVA 2015; ODRIOZOLA *et al.* 2017). Such an innovation does not emanate from a merely aesthetic choice, but it reflects “new” codified forms of expression for which the Neolithic communities have mobilized significant technical, economic and social means.

A wide variety of minerals and rocks of different qualities, colours and textures were exploited for beadmaking during the Neolithic. Common examples are serpentinite, steatite, amazonite, turquoise, variscite, muscovite, jadeite, chrysocolla, agate, carnelian, amethyst and obsidian. The sources are generally rare as they occur in specific geological conditions and mineral environments, making them highly sought-after, thus appositely considered Neolithic “gemstones”. Their acquisition, either as raw materials of finished products, was subject to a remarkable shift in the complexity and intensity of inter-regional social interaction and trade networks taking place in the Western Mediterranean basin, particularly those involving abiotic resources (*e.g.*, obsidian, Provençal flint, Alpine rocks, variscite, etc.) (*e.g.* PÉTREQUIN *et al.* 2012; LÉA 2012; TERRADAS *et al.* 2014; BORRELL, BOSCH & MAJÓ 2015, BORRELL *et al.* 2019).

Among the most emblematic gemstones of Western Mediterranean Neolithic cultures is variscite. Beads and pendants made from this mineral have indeed played a key-role in the sociocultural and economic life of the communities who produced and displayed them. Together with other raw materials such as obsidian and Barremian-Bédoulian flint, variscite constitutes significant chrono-cultural markers of the Middle Neolithic cultures in the Western Mediterranean.

Variscite is a secondary mineral formed by the deposition of phosphatic groundwater infiltrating along open fissures, which reacts with aluminum-rich rocks (LARSEN 1942). The colour depends on the formation process but also on the presence of chemical compounds other than P and Al such as chromium (Cr3p) and vanadium (V4p) (CALAS *et al.* 2005) which include multiple hues of yellow, grey and green. A turquoise-green colour with a waxy luster aspect is characteristic of what is described as “massive” variscite (*ibid.*).

In the Western Mediterranean basin, sources of variscite can be found in Italy, France, Portugal and Spain. Among the most known are those of Gavà (Barcelona),

located in the north-eastern Iberian Peninsula. There sources represent a unique example of a large subterranean complex of mines where ancient mining activities exclusively dedicated to the extraction of variscite (CAMPRUBÍ *et al.* 2003), which were then transformed into ornaments, were documented.

Mining activities at Gavà were concentrated in the first half of the 4<sup>th</sup> millennium cal. BC, although slightly earlier and later activity is also reported (BORRELL, BOSCH & MAJÓ 2015). In chrono-cultural terms, this timespan corresponds to the Middle Neolithic, precisely to the *Sepulcros de Fosa* (Pit Burial) culture in north-eastern Spain, contemporaneous with the Chasséen culture of southern France and North-western Italy (BINDER 2016).

In Gavà, the mines were dug using stone hammers, picks, and wedges in order to extract the variscite (VILLALBA *et al.* 1986; BOSCH & ESTRADA 1994; BOSCH & BORRELL 2009; BORRELL, BOSCH & MAJÓ 2015). After the complete extraction of the stone, some of these mines were used as burials. The mines vary greatly in complexity and size, from short, simple, vertical or semi-vertical shafts to complex structures that combine semi-vertical shafts, distribution chambers and horizontal tunnel-like galleries at different levels, reaching a total depth of up to 15 m. The surface area affected by the mining activities was quite large, probably several hectares. A dozen mines have been fully or partially excavated, while over 90 sections of shafts or galleries have been identified and left unexcavated for future research. Archaeological excavations started in Can Tintorer sector, north-east of Gavà, and are still on-going along with the exploration of new sectors such as the Ferreres sector, situated to the north-west of the city. Long-term research at Gavà has allowed understanding of how the variscite was mined and used, revealing a strong and long-lasting connexion between the mining community, the valued green stone (used in life and after death) and the subterranean landscape (a work place and a final resting place), which would not have been possible without the miners at Gavà exercising certain control over the landscape and the first stages of the manufacture and early distribution of variscite ornaments (BORRELL, BOSCH & MAJÓ 2015). This nexus, while having economic importance, was also likely charged with a highly symbolic significance through, as yet unidentified, social practices

This is an exceptional context in which the extraction of variscite and the production and consumption of beads took place. The variscite assemblage discovered in these mines and presented in this paper is therefore unique. Its study aims to elucidate the sociocultural identity of the actors who produced the variscite beads through investigating the technological know-how mobilized and the typological and aesthetic choices made by the miners and, by extension, the communities of the *Sepulcros de Fosa*.

## MATERIAL AND METHOD

The studied objects were recovered in two mines in the Ferreres sector, 83 and 85 (BORRELL & ESTRADA 2009; BORRELL, BOSCH & MAJÓ 2015). Mine 84, contemporary with mines 83 and 85 and very close to them, revealed no variscite beads but will also be taken into consideration in the subsequent interpretations as it offers significant data and insights for this study.

Mine 83 is a small simple mine that only reached a depth of 4m. The mine was re-used as a burial site during the peak mining period at Gavà to bury the body of one individual in a primary grave, which has been interpreted as that of a miner (BORRELL, BOSCH & MAJÓ 2015). Grave goods accompanying the body were abundant including Barremian-Bedoulian flint, variscite beads, an obsidian blade, eclogite axes, a square-mouth vessel, etc. Two concentrations of variscite items were found with the badly preserved human remains. The first concentration (83-A) is composed of 59 beads (fig. 1a-j, q-ff) that were reconstructed as a single row “necklace” and is currently exhibited in the Museum of Gavà. The second concentration (83-B) contains 61 polygonal, relatively flat blanks<sup>1</sup> (fig. 2a-r), two complete beads (fig. 1k-l) and three broken beads (fig. 2ll).

In mine 85, only the distal ends of two semi-vertical shafts were preserved and excavated, reaching a total depth of 4 m (*ibid.*). The lower shaft was filled with organic clay/silt-based anthropogenic deposits with a few faunal remains and shells. The upper shaft, which was filled with mining debris, contained an extremely rich deposit that included three complete pottery vessels, several bone tools, flint blades and arrowheads and abundant variscite items: 18 beads and pendants (fig. 1m-p, gg-rr) and 70 blanks (fig. 2s-kk).

Mine 84 is a medium-sized (10 × 14 m) T-shaped mine, combining narrow galleries (1 m in diameter) with wider chambers. In the deepest part of the mine (6.5 m deep), the remains of two adults (male and a female) were found along with grave goods (*ibid.*). The buried individuals and the associated artefacts were disturbed and had been moved from their original position. The absence of variscite items and other exotic materials (obsidian or Alpine rocks) contrasts with the grave goods from mine 83 and the deposit of materials in mine 85, and more generally with the funerary goods characteristic of the contemporary Sepulcros de Fosa culture in the region. The absence of items made of variscite and the evidence of post-mortem disturbance of both individuals in mine 84 is thought to have been caused by looting variscite objects and exogenic artefacts (*ibid.*).

A permit was obtained to bring the material stored at the Museu de Gavà to the laboratory of the Archaeology of Social Dynamics group (IMF-CSIC) in Barcelona for analysis in January 2019. All the objects, the beads and the blanks, were 2D scanned (Epson 4490) and measured with a digitally connected calliper. The necklace was dismantled, and each bead was examined individually. The typological identification of the finished objects was based on a classification protocol developed elsewhere (ALARASHI 2014). Morphometric characterization of the beads aims to determine any aesthetic trends and to check whether these choices had repercussions or influences on the technical procedures. The colour variability was also considered. The stones were differentiated by eye (H. Alarashi) according to the diversity of the green hues within the same stone: monochrome (one dominant hue of green), bichrome (two contrasting hues of green) or polychrome (three or more nuances of green).

All the objects were examined with the naked eye and with a stereo microscope (Leica 6x to 40x) in order to detect and distinguish microwear caused by technical procedures from those caused in use. The distribution and organization of traces were then mapped on sketches made of each object. A digital portable microscope (Dino-Lite Edge 5 M, ×20 – ×200) was used for capturing photographs. A reflected-light microscope (Olympus BX51 50× and 100×) was also used.

To characterize the morphology and types of perforations as well as the techniques employed for drilling, silicon moulds were made of the perforations of the long beads (using dental quality silicon (President MS 6002 Light Colten). This study also benefited from experimental replication, which was used to infer, through comparisons, the manufacturing techniques of the archaeological objects (ALARASHI 2014; PICHON & ALARASHI 2018).

Morphometric analyses were performed in order to evaluate the degree of regularity of the shapes and their calibration. Finally, the presence of items representing the manufacturing stages bearing diagnostic technical traces, including those broken during the manufacturing process, enabled us to reconstruct the *chaîne opératoire* of some types.

Use-wear analyses was conducted only on the beads from mine 83. These beads (a total of 59) had been gathered together as a necklace since their discovery and exhibited according to several scenarios at the Museum of Gavà. Because of this it was not possible to determine the origin of some traces that could have been produced by slight wear over a short period of time. Therefore, only diagnostic traces of heavy use-wear (intensive rounding, intensive polish, distribution of polish, restricted or generalized erasure of technical traces, notches, enlargement of perforation perimeters...) were registered.

1. The term « blank » here is defined as fragments of material bearing traces of manufacture. They range from working waste and debris to clear preforms of beads or pendants.



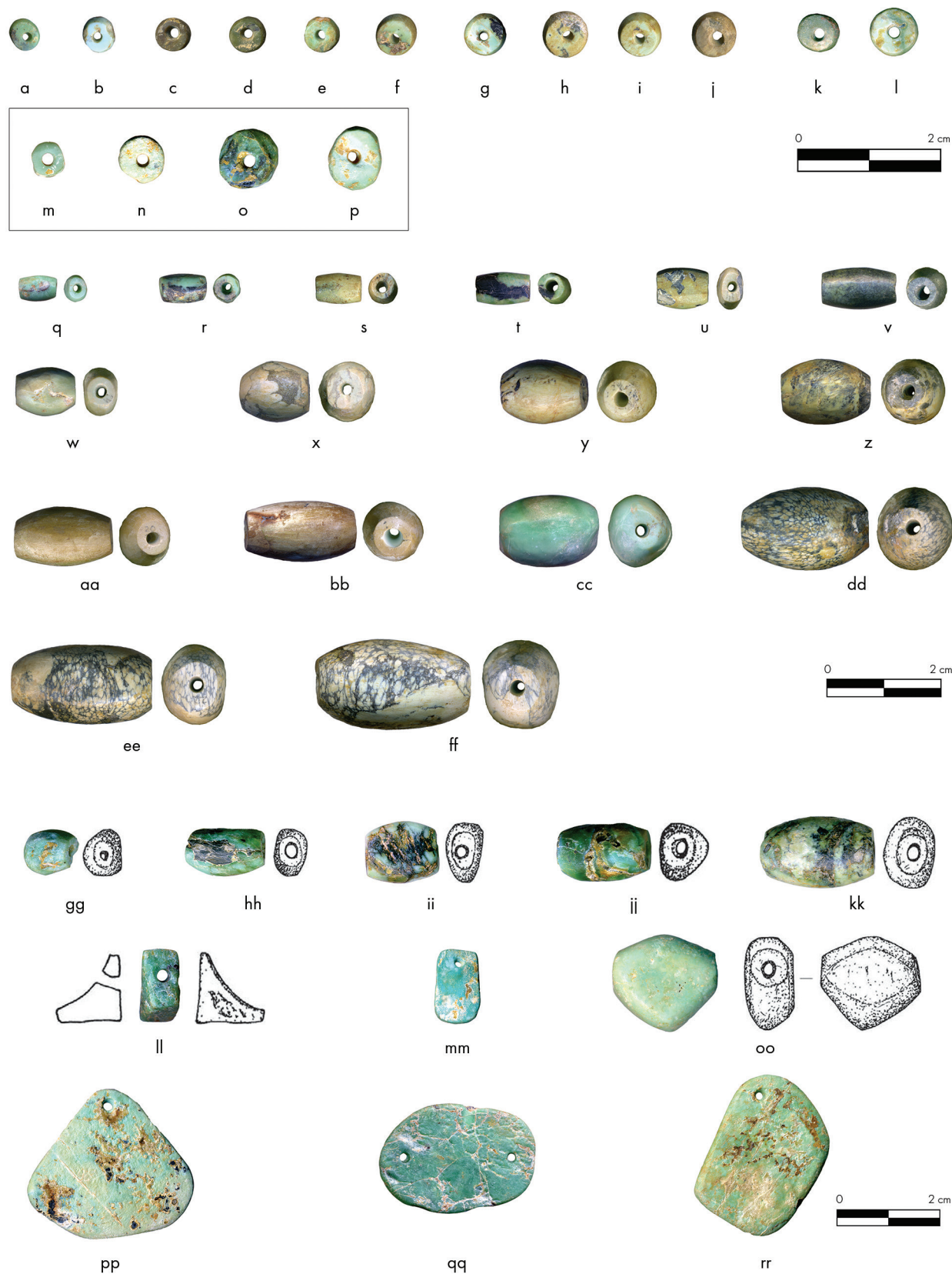


Fig. 1. Selection of variscite beads and pendants from mines 83 and 85 (Ferrerres sector Gavà). Mine 83: Short beads from concentration A (a-j) and B (k-l); Barrel beads concentration A (q-ff). Mine 85: Short beads (m-p); Barrel beads (gg-kk); Flat pendants (mm, pp & rr); Double perforated object (qq); L-shaped pendant (ll); Bead/pendant (oo). (Scan: H. Alarashi; drawings: F. Borrell).



Fig. 2. Selection of variscite fragments and broken beads from mines 83 and 85 (Ferrerres sector Gavà). Mine 83: Blanks (a-r); Three broken beads broken during the manufacturing process (II). Mine 85: Preforms of short beads (?) and broken short beads (s-w); Large worked exploitable blanks (x-kk). (Scan: H. Alarashi).

## RESULTS

### Morphotypes and metrical analyses

Beads (objects with centered perforations) from mine 83 are from two major typological families: short and long beads<sup>2</sup>. Specimens from both categories show regular shapes and are symmetrically proportioned. Short beads ( $n = 43$ ) correspond to short tubular shapes ranging subtly between cylinder and “barrel”, with rounded, generally circular, cross-section (fig. 1a-j). The long beads ( $n = 19$ ) are strictly barrel shaped with either circular (fig. 1r, s, y, x, y, dd, ff) or elliptical cross-sections (fig. 1u, w, aa). The three broken long beads seem to correspond to a barrel shape with an elliptical cross-section (fig. 2).

The blanks found in mine 83 are roughly angular and polygonal in shape (fig. 2a-r). Their dimensions and morphologies allow the making of relatively small objects with short perforations (disc, short beads, flat pendants, double perforated objects, etc.). Beads with long perforations would be hardly made from these blanks unless they were very small and flat. The smallest long beads in the assemblage are larger than these blanks.

In mine 85, the beads are typologically more diverse. In addition to the short ( $n = 4$ ) (fig. 1m-p) and long beads ( $n = 7$ ) (fig. 1gg-kk), objects with short lateral perforations ( $n = 5$ ), double lateral perforations ( $n = 1$ ) (fig. 1qq), and long lateral perforation ( $n = 1$ ) were recorded. The short and long beads are similar to those from mine 83 although the edges and shapes are less regular and symmetrical. Objects with short lateral perforations, more usually known as pendants, were separated into flat polygonal (sub-rectangular, sub-diamond and sub-triangular) shapes (fig. 1mm, pp, rr) and one unusual “L-shaped” (fig. 1ll) example. Another exceptional shape is the one provided by the object with long lateral perforation. It has hexagonal shape and a flattened oval cross-section and can be considered as a bead/pendant (fig. 1oo). Unlike the other objects from this mine, this item has a regular edges and shape.

The blanks from mine 85 are also diverse. Both polygonal and rounded shapes are present. The edges are worked, and the fragments are rarely angular (fig. 2s-kk). About 60 % of items can be considered preforms of flat polygonal pendants and short beads. Among the latter, four

have unsuccessful perforations and were broken during the process (fig. 2t-v).

The short beads are the smallest objects among the identified morpho-types. They fall into two groups when the ratio of the diameter/length of the bead is plotted (fig. 3). The first comprises the smallest beads ( $n = 42$ ) with averages of 4.60 and 3.66 mm respectively for the diameter and the length. Standard deviations calculated for the diameter (0.41) and the length (0.60) are low, which indicate homogenous sizes. The beads in the second group ( $n = 8$ ) are almost of the same length range as the first group but are differentiated by their diameters that are significantly larger (fig. 3). These differences in proportion are also correlated with the archaeological context. Indeed, the first group belongs to concentration A in mine 83, while the second correspond to concentration B in the same mine, and to the four short beads recovered in mine 85. Differences are even observed within the second group, those from mine 83 being longer than those from mine 85.

The distribution of long beads according to the ratio diameter/length shows that the majority are under 26 mm in length and 16 mm in diameter. Beads of larger dimensions are few and belong exclusively to mine 83. Long beads from mine 83 have different, yet progressive sizes. According to the coefficient of determination ( $R^2 = 0.9632$ ), the distribution of beads (short and long) from mine 83 is close to the linear regression (fig. 3), meaning that the proportions of objects from this mine are homogenous despite the typological difference (short *vs.* long beads) and the sizes (standardized *vs.* different). To illustrate the homogeneity of the sizes and their dynamics between and within the groups of short and long beads, the length and the diameter values were presented in a stacked bar histogram (fig. 4).

As observed previously, short beads have highly standardized proportions. For the long beads, despite the differences in size, an interesting trend is observed. For 15 specimens, the length appears to increase systematically by approximately 2mm. However, the last largest beads ( $n = 4$ ) increases by 4mm approximately - double the previous group. This means that the proportions of the beads of the whole series wear previously planned, likely with the intention to create an ornamental composition highly symmetrical. Another aspect perceptible in figure 3 and quite clear in figure 4 is that the increase in length occurs in pairs of beads each time. This trend of matching in beads can also be observed for the colours or the textures of the stones (in figure 1, see for example the similarities between “y” and “z”, “aa” and “bb”, or between “dd” and “ee”). The presence of pairs of matched beads within an ornament, a necklace for instance, can be interpreted as a deliberate and intended choice to create a homogenous and symmetrical composition. If we assume that this ornament was made of a single row

2. A bead is considered short, when the length of perforation (which is the same as the length of the bead) is shorter than the diameter of the bead. On the contrary, it is considered long when the length of perforation is greater than the diameter of the bead. When the length of perforation is equal to the diameter (or width) of the bead, the latter is classified as a “compact bead”. This type was not identified in this assemblage. In previous publications (e.g. BORRELL, BOSCH & MAJÓ 2015), the terms “discoidal” and “cylindrical” have been used to designate what here is defined as short and long beads, respectively.

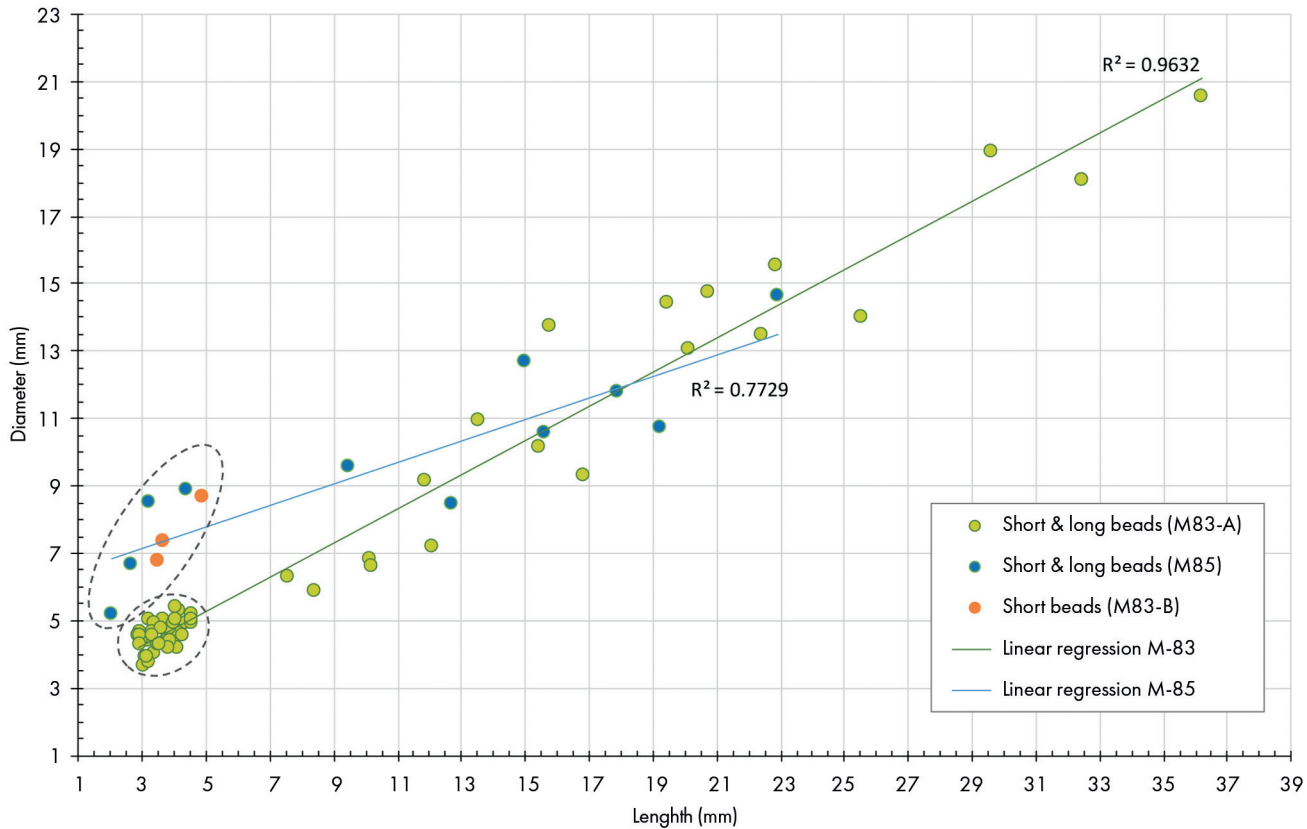


Fig. 3. Distribution of the short and long beads from mines 83 and 85 according to the ratio diameter/length of the bead. Short beads are surrounded with ellipses.

of beads, one of the scenarios of composition would be that the largest beads are placed in the center, with the beads gradually decreasing in size and culminating in the short beads. Comparisons with ornaments discovered in contemporaneous Sepulcros de Fosa sites confirm this scenario, which is in fact the reconstruction adopted for the “necklace” exhibited in a showcase at the Museum of Gavà.

### Variscite diversity of colour and aspects

Geochemical characterization of the beads and blanks from mines 83 and 85 is ongoing. The material used in both mines is very similar in colour and texture (natural combinations and contrasts in the colour's hues, veins, spots, etc.). These variables were examined in terms of the archaeological contexts and of the morpho-typological variability.

The stones used have colours ranging from very dark to very light green (figs. 1 and 2). The green colour corresponds mostly to hues of olive-green (fig. 1c, de, h, s, u, y, aa) and turquoise or blue green (fig. 1b, p, q, cc, gg, mm). In addition, some stones exhibit dark grey or black spots or veins giving an attractive marbled aspect to the surface (fig. 1r, t, v, hh, ii). In terms of colour homogeneity, three variations

were distinguished: monochrome (one homogenous hue), bi-chrome (2 contrasting hues) and polychrome (three or more hues). These three variations were recorded for all the objects from mines 83 and 85 (both finished products and the blanks). Figure 5 shows that proportions of colours of objects, both finished and blanks categories, are similar within one mine, but different between the two mines.

In mine 83, mono- and bi-chrome objects are well represented while polychrome objects are few. In the case of the beads, the observed trend is that the short beads and some of the long beads fall into the monochrome and bi-chrome groups, but that the long beads, particularly the large ones, fall into the polychrome group. However, in mine 85, there are significantly more polychrome and bi-chrome objects than monochrome ones.

The chromic configuration of the colours shows no clear correlation when they are compared with the morphotype variable except for the pendants and the double perforated object, which do not exist in monochrome variscite. On the contrary, the exceptional bead/pendant is made from a very homogenous monochrome turquoise green stone, which has been described by some researchers (CALAS *et al.* 2005) a massive variscite. Indeed, this item has a waxy and naturally lustered surface. Beads of similar material are very few within the assemblage. In mine 83, several long



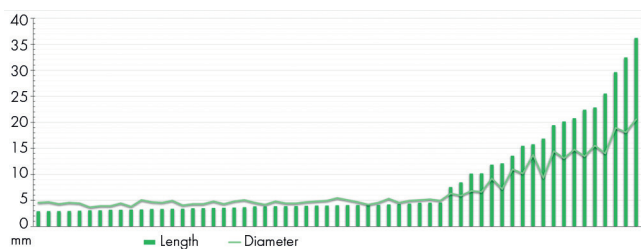


Fig. 4. Stacked histogram combining the lengths and the diameter values of the short and long beads (N = 59) from concentration A in mine 83.

beads were made from this material (fig. 1q, cc) and around six short ones. As in mine 83, polychrome stones were used to make relatively large long beads while mono- and bi-chrome varieties were used to make small long beads and short beads. These results should be considered carefully as they might be biased by the low number of pieces per morpho-type in mine 85.

Despite the lack of information regarding the physical proprieties of the variscite varieties exploited within the assemblage, some observations are worth further consideration. For instance, we wonder whether the turquoise green variscite (the so called “massive” variscite), is harder and more resistant than the other varieties. Indeed, the diameters of the perforations on this variety are among the smallest (fig. 6c) when compared to the diameters of the perforations on beads of similar sizes. This is probably due to the resistance of the variscite to the drilling action; the drill tip doesn’t wobble or oscillate freely as it does when the material is soft, and therefore produces perforations with small diameters. The correlation between the hard materials and small diameter of the holes were observed for perforations of long flat beads from the Near East made of carnelian and agate, which are microcrystalline varieties of quartz (ALARASHI 2016b).

### Technical marks and manufacturing methods

Except for the long beads from mine 83, the surfaces of most of the finished objects are partially covered with an orange-beige fine sandy layer, which could not be removed by gentle cleaning. The analysis of the chemical composition of this layer will determine whether its presence is related to the manufacturing process (abrasive?), or to a post-depositional phenomenon.

#### Short beads

Short beads exhibit parallel sub-straight and unidirectional striations of abrasion on the faces and on the lateral surface (fig. 6a, b). On the lateral surface, they are

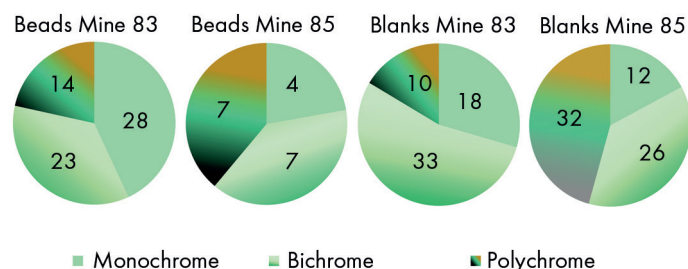


Fig. 5. Proportion of beads and blanks in mines 83 and 85 according to colour variations.

perpendicular to the intersections with the faces (fig. 6b), meaning that they were produced through a back-and-forth axial movement; parallel to the axis of the perforation. The distribution and orientation of the striations are similar on the rounded blanks and preforms of short beads (fig. 6d), except that the lateral surface is sometimes abraded obliquely (fig. 6d, red arrow) and small adjacent abraded facets are still visible. The presence of facets on the lateral surfaces is observed for all the beads from mine 85 (fig. 1m-p).

Another recurrent stigma ( $n = 18$ ) on the short beads are the irregular removals on the intersections between the lateral surfaces and the faces (fig. 6a, c). These were likely produced during the abrasion process, probably because of the heterogenous nature (mineral inclusions?) of some variscite varieties.

The perforations are bipolar, and their sections are bi-conical (fig. 6a) or bi-cylindrical (fig. 6c). Drilled from both faces, the meeting point is situated equidistantly from each end. The diameters of the meeting rim are smaller than the diameters of the outer rims<sup>3</sup> of the perforation. The outer rims have a quite regular shape, generally sub-circular, with sometime microchips (fig. 6c). The walls of the perforations show regular fine, concentric striations (fig. 6a) indicative of a rotative drilling technique. Based on experimental drilling of stones of varied hardness (Mohs scale 4.5 to 7.5), the regularity of the outer rims of the perforation and the continual concentric striations are diagnostic of fast drilling performed by a mechanical device such as bow or pump-drill. Experiments show also that the topography of the walls of the perforations mirrors the morphology of the drill tip used if the material of the latter is harder than the material of the drilled bead. The topographies of the perforation walls of the short beads (and the long beads) are flat. This indicates that drill tips used had rather smooth and regular edges, which is the case of the flint drill tips found in Gavà (fig. 7b).

3. The outer rim is the upper edge of the perforation located on the face of the bead. The junction rim corresponds to the edge created by the meeting of the opposite drillings (thus creating the light path) inside the bead.

A few beads ( $n = 7$ ) have irregular perforations, with accidental outer rims and damaged (?) areas on the walls. These irregularities are observed from one face (one drilling side) in five cases, and from both faces in two cases. They also can be explained by the heterogenous composition of some variscite (soft and hard components), which could have been one of the main causes of fracture during the manufacturing process. Despite the fragile nature of the variscite, the drilling process was mostly conducted successfully.

As shown previously, the short beads from concentration 83-A have a standardized small size differing from the sizes of the short beads pertaining to concentration 83-B or to mine 85. The short beads from concentration 83-A are also

characterized by a regular lateral surface and homogenous roundness suggesting batch treatment by abrasion. This consists of stringing the beads together and rubbing them all at the same time and in the same direction. According to the stigmata identified, the movement is axial, meaning that the string was actioned longitudinally, while turning it progressively and regularly in order to abrade the beads all around. The removals observed in the area of intersections (fig. 6a and 6c) would have been produced through batch grinding of the beads. They may have not been strung very tightly during the abrasion, which might also explain why the lateral surfaces are slightly convex. Experiments are needed to confirm this hypothesis.

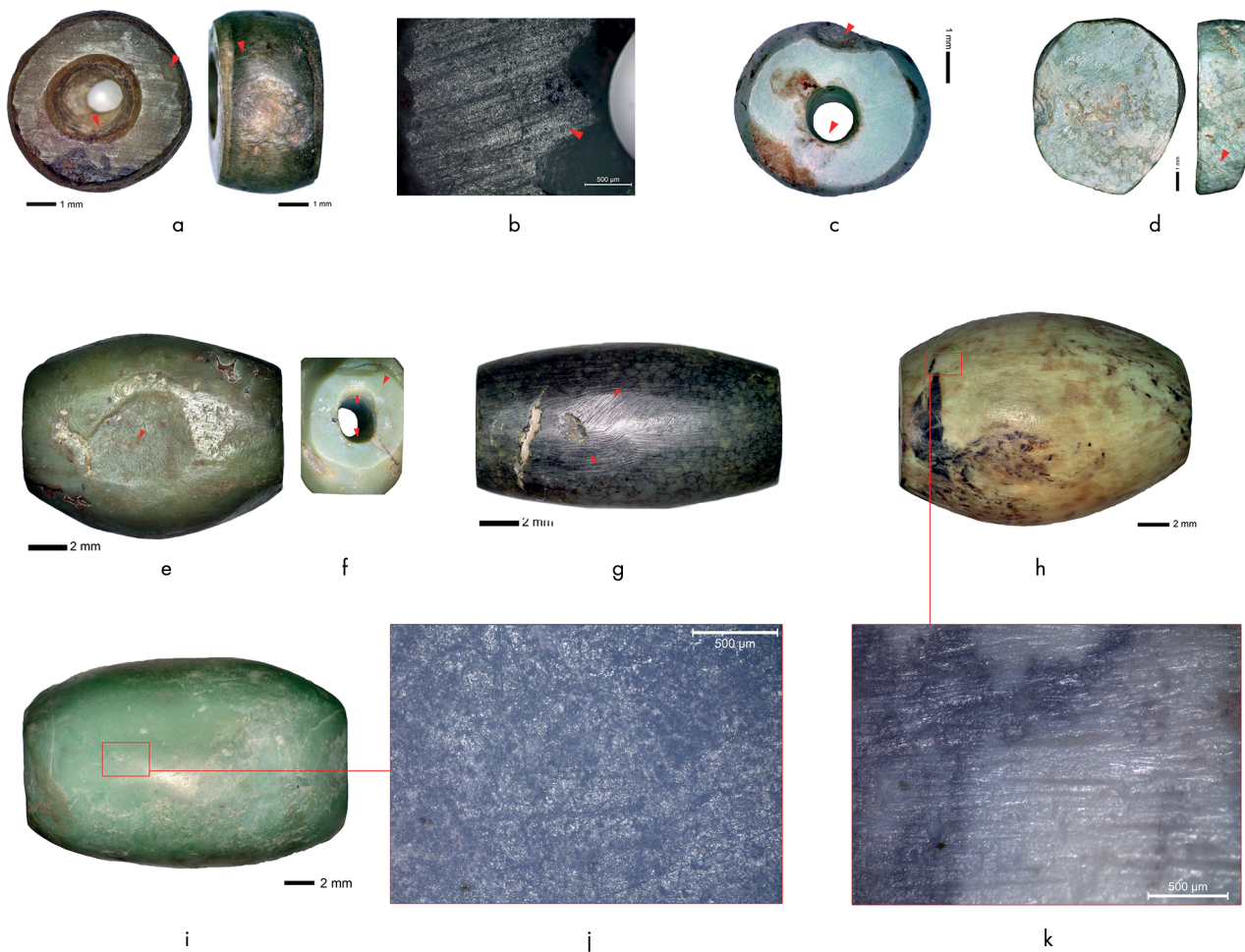


Fig. 6. Traces of manufacture and use. a. Short bead with rounded rim and concentric striations on the walls (red arrow). Removals on the intersection (photo to the left, red arrow) and the lateral surface (right). Axial striations on the lateral surface (red arrow); b. Parallel sub-parallel and marked striations. Fine circular striation of drilling cutting the abrasion striations (red arrow); c. Sub-cylindrical perforation, narrow regular outer rim (red arrow) and removals on the intersection; d. Preform of a short bead with unidirectional striations on the face and the lateral surface (oblique, red arrow); e. Barrel bead with removal on the lateral surface (red arrow) and a facet with striations; f. Rectified path of drilling (red opposite arrows inside perforation), and oblique striations on the face; g. Barrel beads with fine multidirectional striations; h. Regular unidirectional striations (k. detail); i. Erased technical stigmata; j. Detail of the barrel bead (i) with fine random striations (use-wear?). Photos: H. Alarashi.

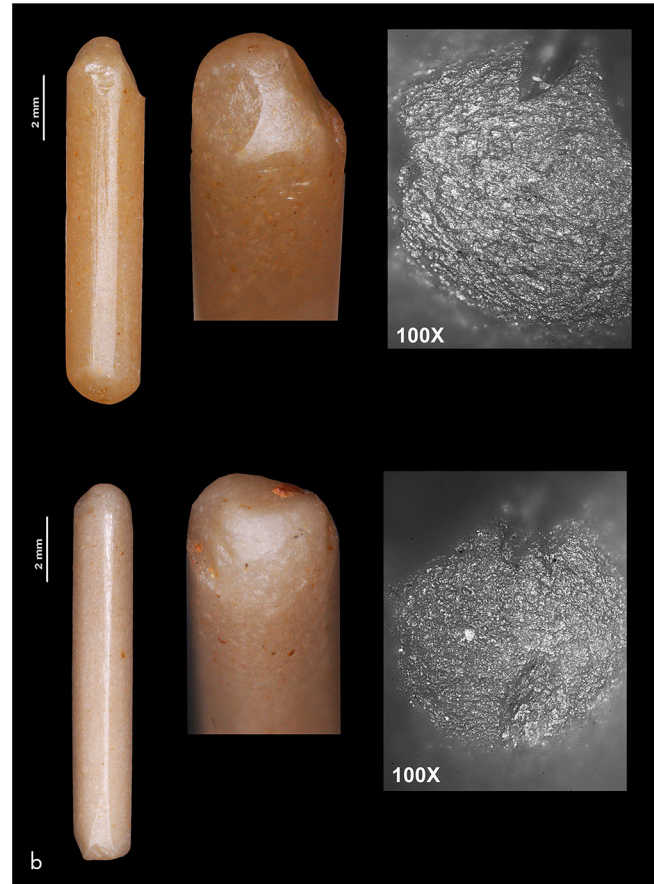
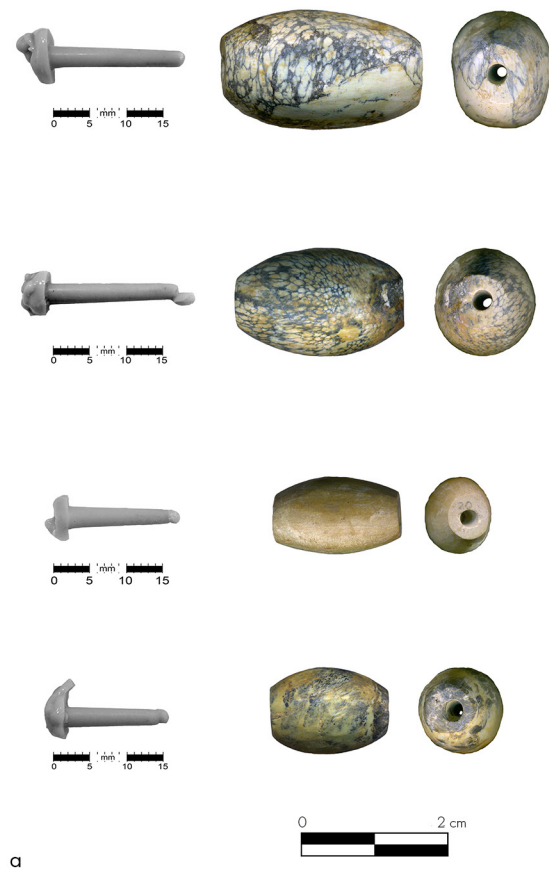


Fig. 7a. Selection of silicone imprints of one drilling side of barrel beads from mine 83 (photos: H. Alarashi); b. Examples of drilling tips from Gavà with microwear diagnostic of both drilling and pressure during the drilling (BORRELL *et al.* 2019, fig. 12).

### Long beads

Three unfinished beads from concentration 83-B (fig. 21l), of which two were broken during perforation, allow determination of the sequences of the main manufacturing stages. The shaping consists on an intensive abrading, generally in a longitudinal axial movement, of the selected piece of variscite until the approximate shape (and size) of the bead was obtained. At this stage, several juxtaposed facets with large and well-marked striations (fig. 6e) can be observed. Similar preforms of beads, either unperforated or bearing traces of started perforations, were recorded in mines (7, 8, 11, 21 and 28) from sector Can Tintorer (VILLALBA *et al.* 1986, fig. 84 and fig. 86). Although there is some hint at the intention of creating barrel-shaped beads, they are still asymmetrical with uneven proportions and edges. Actually, however, they are strongly reminiscent of the beads from mine 85 at sector Ferreres, meaning that these beads were not subject to a finishing stage; their manufacturing process has stopped after the perforation. This is clearly not the case for the beads from concentration 83-A for which the shapes are very symmetrical, and the striated facets are generally erased (cf. *infra*).

The regularity of the general shape was likely strongly conditioned by the hardness of the variscite variety used. It appears that the turquoise green waxy variscite, which seems to be a hard and resistant variety, is less manageable than the other varieties. The exceptional bead/pendant (fig. 10o) from mine 85, which has regular edges and relatively regular polygonal shape, though asymmetrical, could be the result of difficulties due to the resistance of the material to abrasion and might reflect the decision of the designer or craftworker to solve the problem by creating a long perforation near the center. This flexibility in design is also seen in another exceptional piece, the L-Shaped pendant (fig. 11l), that was probably also the result of an adaptation due to the raw material.

The perforations of the long beads are, like those of the short beads, bipolar. The outer rims on the faces are regular with rounded shapes, sometime almost perfect circles (fig. 1q-kk). In one case, the outline has a quite elongated oval shape. Examined carefully, it appears to be the result of two circular overlapped rims of two parallel paths of drillings (fig. 6f: opposite red arrows). The first drilling being off-center (or probably out of alignment with the opposite drilling), it was abandoned and a “new” one, this



time better oriented in order to join the other drilling, was created. This case of rectification of the drilling axis is the only one recorded for the category of long perforations. It concerns a small bead of around 14 mm long made of a light monochrome olive-green variety of variscite. On one lateral surface the negative of a removal of a small piece (flake?) of variscite is visible (fig. 6e) suggesting that the quality of the raw material used for this bead was not optimal. The incident related to the axis of the drilling could be explained by the quality of the variscite and its level of compactness.

Silicone imprints of one end of the perforation of 15 out of 27 long beads were made. They perfectly mimic the sections of the drillings: all are sub-cylindrical and taper towards the bottom (near the meeting area) (fig. 7a). As for the short beads, the walls have a straight topography, and are covered with fine, regular concentric striations and occasionally show a shallow polish on areas closer to the outer rim. Like the short beads, the perforations were made by a fast rotative technique using a mechanical device. The only difference is the size of the drill tip used in each category.

Perforations are made from two opposed surfaces and although aligned the drillings do not meet in the center; one is always longer than the other. Indeed, the silicone imprints enabled the measurement of the drilling length from one side, thereby allowing us to estimate of the length of the drilling from the other side. The ranges of lengths of both drillings were examined in relation to the total length of the beads and resulted in three categories (tb. 1).

Perforation length	Drilling 1 (based on silicone casts)	Drilling 2 (calculated)	N beads
10 - 22 mm	72 % - 66 %	34 % - 28 %	7
15 - 30 mm	64 % - 56 %	44 % - 36 %	6
< 35 mm	52 %	48 %	1

Tab. 1. Range of lengths of drillings given in percentages (rounded values) of the total length of the bipolar perforations of 14 long beads. One short specimen (> 10 mm) has approximately a ratio of 50 %.

Results in table 1 show that the longer the bead, the more equal the depth of the drilling from each side. While this could be explained by the length of the drill tip used, it could also be a technical strategy to prevent breakage. This hypothesis is supported by the fact that when some beads are made from non-optimal quality variscite, even if they are small, the ratio of the drillings is around 50/50 %. This is for instance the case of a bead which shows rectification of the drilling path (fig. 6e, f) (cf. *supra*).

Flint drill tips are occasionally recovered at Gavà (NOAIN 1996; BORRELL *et al.* 2019). One of them was even discovered inside a broken long bead from a mine in the sector of Can Tintorer (EDO, BLASCO & VILLALBA 1995, fig. 12). These drill tips are highly polished cylinders of rounded section (fig. 7b) which are generally short (5 to 15 mm length). Eleven of them were studied and measured by F. BORRELL *et al.* (2019) while the dimensions of other four have been given in the publication of EDO *et al.* (1995, Est. IX, fig. 9). The measurements of the drill tips were compared with those of the perforations (fig. 8).

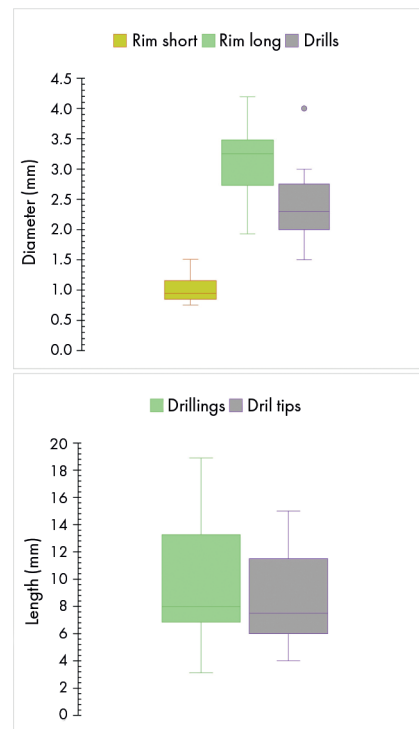


Fig. 8. Above, box plots comparing the diameters values of the short and long beads from Gavà sector Ferrers with the diameter of a collection of drill tips from several mines in Gavà (including those of Can Tintorer). Below, box plots comparing the lengths of the drillings of the long beads and the lengths of the same drill tips.

The box plots (fig. 8 above) show hardly any match between the diameter of the perforation of the short beads and the diameter of the drills. This observation is probably biased by the fact that short perforations are drilled by the distal end of the tip, which is often rounded or pointed and, subsequently, slightly thinner than the body of the drill bit (fig. 7b). In other words, the extremities of the drill tips would show a closer match to the diameter of the short perforations. The match between the rims of the long beads and the drills is much more significant. The cylindrical drills were therefore also suitable for drilling long beads.

The comparisons between the lengths of the drillings of the long beads and those of the drill tips also show significant matching in values and in the median (fig. 8 below). Nevertheless, bead perforations that are deeper than 15 mm remain without matching drill tips. The absence of the polished cylindrical drill tips longer than 15 mm could reflect their scarcity in the assemblage of lithic tools, which seems to be the case in Gavà.

Another aspect revealed by the silicon imprints is the degree of alignment of the opposite drillings that make up the perforations. The longest beads of the assemblage, those having drillings reaching deeper than 18 mm from one single side, are, surprisingly, those showing almost perfect alignment, or only a slight overlapping within the same axis. Experimental drilling (with a bow drill) of long beads made from similar rocks (ALARASHI 2014) shows that without a constant effort, and thoroughly modulated pressure together with a constant vigilance of the steadiness of the axis, long perforations are a very risky and challenging especially without a device to stabilize the bead during the process.

After the perforation, the beads from concentration 83-A have received a supplementary treatment in order to balance or even out the general shape, thus rendering the beads symmetrical. Abrasion striations are still visible, but they follow organized patterns. Most of the beads bear sub-parallel, sub-straight striations on the faces and the lateral surfaces. On the faces, striations are generally unidirectional (fig. 6f). On the lateral surfaces, striations are organized in all directions (fig. 6g), yet the most common are axial and long (fig. 6h, k). In the case of beads with flat oval cross-sections, axial or oblique short striations are ascribed to juxtaposed facets (fig. 6e). Beads with rounded sections show, on the contrary, no (fig. 6h) or very few facets (fig. 6g). The regularity of the shapes and organization of the striations indicate that the long beads from mine 83-A were very carefully finished through fine abrasion. The intentional polishing aimed at obliterating the manufacturing stigmata and providing smooth and shiny surfaces, similar in aspect to variscite beads from other Middle Neolithic sites in northern Spain (OLIVA 2018, fig. 1 and 2) or Late Neolithic in France (see for instance QUERRÉ, CASSEN & VIGIER 2019: Appendix I), was not documented within the assemblage. However, some beads do have shiny surfaces, but it is likely that they were caused by use-wear.

### Pendants and other finished objects

The manufacturing process of the pendants and the double perforated objects follows the general stages documented for the short beads, which are shaping by abrasion and perforation from both sides by a fast rotative mechanical

drilling technique. Some shapes show relative regularity and even proportions in regard to the location of the perforation (fig. 1mm, pp, qq) while others clearly lack symmetry (fig. 1rr). The hardness of the worked fragments may be the reason, or it may simply be that the objects were abandoned before they were finished. Planned use-wear analysis of these items will give clear answers to these questions. However, preliminary observations hint that the objects were not, or very little, used.

### Use-wear traces

As described earlier, the manufacturing stigmata on the objects are well-marked and quite diagnostic of the techniques employed. Straightaway, this rules out the possibility that the beads were heavily worn. We have, however, some doubts about one instance that could represent a unique example of intensive use, or at least clearer evidence of use than that on the other beads. It concerns a barrel-shaped (fig. 1cc; fig. 6i) long bead<sup>4</sup> with a rounded cross-section and of green-turquoise colour. When detected, striations from abrasion appear faint and intercepted (interrupted) by multidirectional unorganized but very fine sub-straight striations (fig. 6j). At 50x magnification, areas with strong polish are delimited by these fine striations which in contrast, appear not to have been affected by the polish (at least at the magnification used). While doubts concern the origin and the pattern of the fine striations (*i.e.* whether they were produced by intentional polishing), the completely rounded and dulled edges of the bead confirm its prolonged use. Its lateral surfaces are also very smooth and reflect polish at the point of maximum diameter near the center of the bead.

## DISCUSSION

The characterization of the variscite artefacts discovered in mines 83 and 85 has revealed similarities and differences that are summarized in table 2. Unsurprisingly, common points between both groups are numerous as they are ascribed to the same context of variscite extraction and transformation, which employed a technological background that was shared by the mineworkers and beadmakers.

The differences concern typo-morphological choices, which have consequently conditioned the technological (differential) management of the objects. This in turn might have been partially influenced by the capricious/variable nature (friability, hardness) of some variscite varieties, and the morphology and size of the extracted raw material.

4. Two other small specimens of long barrel beads and five short beads also appear to have been heavily used but they need further microscopic analysis.

Characteristics	Mine 83 (Burial context)	Mine 85 (Intentional deposit)
<i>Typological families</i>	Two: 1 type short beads/2 types barrel beads	Five: 1 to 2 types per family, some unusual
<i>Sizes</i>	Small, short beads/small to very large, barrels	Large, short beads/varied, other types
<i>Size control</i>	Standardized, short beads/ Paired for barrels	Random
<i>Colour(s)</i>	Mono & bichrome dominant	Polychrome & bichrome dominant
<i>Surface aspects</i>	Marbled, largest beads	Marbled, largest beads/Non-marbled, pendants
<i>Stages (Tech. over-investment)</i>	Shaping, drilling & finishing (yes)	Shaping & drilling (no)
<i>Level of technicity</i>	High: very small to large barrel/Material variability	Material variability
<i>Techniques involved</i>	Abrasion, fast mechanical drilling & fine abrasion	Abrasion & fast mechanical drilling
<i>Specificity of tools</i>	Common in Gavà, restricted long polished drill tips	Common in Gavà
<i>Use intensity</i>	Low or not used except one bead heavily worn	Low or not used
<i>Colours of blanks</i>	Mono & bichrome are dominant	Polychrome & bichrome dominant
<i>Technical investment of blanks</i>	Rough shapes, little or & worked (small)	Rounded shapes, preforms frequent (larger)
<i>Potential of blanks</i>	Disc, short beads & pendants	Disc, short beads, very small barrel, & pendants
<i>Broken elements</i>	Long & short beads (concentration B with blanks)	Short beads

Tab. 2. Synthesis of the main characteristics of the finished and unfinished products from mine 83 and 85, sector Ferreres, Gavà. Light blue shading: criteria used to identify types of production.

By considering the variable characteristics of the colour of the variscite together with morphometrical variability and technical criteria relating to the beads it has been possible to distinguish two levels of quality among the finished beads. The first corresponds to the beads from mine 83 which are characterized by regular and symmetrical shapes and are nicely and well finished. The sizes of the beads, and likely their numbers too, were standardized and controlled suggesting that the finished object was visualised prior to its making and that production was preceded by a plan and that a design was followed during the manufacture of the individual pieces, with the obvious intention of composing an ornament. The second level of quality is the one seen in the beads and pendants from mine 85, some of which have quite intriguing morpho-types. The shapes are generally irregular and asymmetrical while the sizes, even within each type, are random. These elements were probably destined to integrate different ornaments in combination with items made from other materials. Some of them may also have been attached to garments.

To sum up, the beads from mine 83 are of a quality associated with prestige goods, while those of mine 85 are rather rough, with the appearance of experimentation and aspiration to creativity. Interpreting the qualities of the variscite items from Gavà requires, naturally, understanding the intention/function of the product, which is generally indicative of its status, *sensu* C. PERLÈS (2012). It is essential, therefore, to interpret them within their archaeological context and to consider the technological systems and cultural practice of the period.

### The variscite ornaments of Gavà: the mining context and beyond

The state of preservation of the human remains in mine 83 did not permit the identification of the position of the beads on the skeleton, thereby, the type of ornament these beads were used for was not identified. However, comparisons with finds in burials of adults and children from contemporaneous sites in the region show that beads were used to compose three types of ornaments: necklaces, bracelets and anklets. Short beads were used in all these types while long beads (barrels but also cylindrical), especially the large specimens, were used in the composition of necklaces (RIPOLL & LLONGUERAS 1963; MUÑOZ 1965; OLIVA 2015). Information on whether this mirrors their position on the human skeletons is not systematically given. But, based on photographs of buried individuals from some sites such as Can Gambús 1 (ALLIÈSE *et al.* 2014, fig. 6a, 8a, 11b, 12a) and Bóbila Madurell (GIBAJA 2004, fig. 8), it seems that these combinations are the most recurrent. It appears also that ornaments were made from a single row of beads. We therefore conclude that the concentration of beads from mine 83 were elements of an impressive necklace, remarkably designed and extremely attractive from an aesthetical point of view (fig. 9).

As in the case of the burial in mine 83, a significant number of blanks and variscite fragments, this time quite exploitable, were deposited in mine 85 along with a range of beads and pendants and other unusual objects. For these latter, especially the L-shaped pendant and the hexagonal

bead-pendant, no parallels have been found so far in the literature related to the same chrono-cultural horizon apart from the flat, double-perforated object. Similar examples (though smaller) of the latter occur in burials from Bòbila Madurell and Masia Nova (OLIVA 2015, fig. 305).

A number of publications dealing with the diversity of body ornaments during the Middle Neolithic in the region (e.g. OLIVA 2015, 2018; GIBAJA *et al.* 2016; MOLIST & OLIVA 2019) was consulted. Accordingly, it seems that the communities of the Sepulcros de Fosa culture had a conventional ornamental tradition and highly regulated ornamental practices. If the necklace from mine 83 can be easily ascribed to this tradition, the unusual types from mine 85 are, on the contrary, to be considered as individual expressions, particular creations or experimental types, or simply a way of overcoming technical difficulties.

In previous studies, the typological differences observed between the variscite artefacts from mines 83 and 85 were interpreted as indicative of a “double production line”, one oriented to the production of standardized and conventional products destined for external exchange, though not exclusively as they were also used by the miners, while the other was only for “local use” of the miners themselves, thus not to be exchanged (BORRELL, BOSCH & MAJÓ 2015: 88). The results of the technological approach point in the same direction and, in addition, suggest that only the standardized production from mine 83 fulfils the requirements of what could be considered a specialized activity (table 2: cells shaded light blue) for which the technicity, the over-investment and the access to tools are determining factors. During the manufacture, the heterogeneity of the material between and even within some fragments



Fig. 9. Hypothetical reconstruction of the ornament found in mine 83, proposed in previous publications (e.g. BORRELL, BOSCH & MAJÓ 2015; BOSCH 2019). (Scan: H. Alarashi)

represents a significant level of technical difficulty which is compounded by the challenge of creating the beads according to predetermined standardized sizes and shapes. In this sense, the beadmakers were very skilled as they were able to produce all the sizes, including tiny ones, despite the difficulties of holding during the manufacture. They were also capable of creating long perforations of perfectly aligned drillings for the largest specimens of barrel beads. The technical over-investment (in time and energy) is also evidenced by the high-quality finish of the beads. This is actually a pre-requisite for increasing the value of the product (COSTIN 1991), thereby for determining its status as item for circulation and exchange (PERLÈS 2007, 2012). The conventional types of variscite beads made at Gavà were indeed intensively distributed within 40 km of Gavà. Long-distance distribution is, for example, also evidenced by variscite beads found in the contemporary site of Feixa del Moro in the Pyrenees mountains (OLIVA 2018). Access to the appropriated tools and devices, such as the flint drill bits (absent in other Middle Neolithic contexts except for Gavà) also hints specialized activities (COSTIN 1991). However, among the tools, polished drills long enough to perforate the impressive central beads, those placed in the front of the necklaces, are rare. They were probably kept carefully or collected after their use. The access to tools might have been controlled or restricted to certain beadmakers. Moreover, the long polished drills were certainly valuable as their manufacturing requires a considerable effort, particularly the polishing process (EDO, BLASCO & VILLALBA 1995; NOAIN 1996; BORRELL *et al.* 2019).

### Constructing identities: the role of the miners and beadmakers of Gavà

The osteological study of one adult female and male buried in mine 84 has revealed pathological traumas and marks of physical activity related to repeated movements involving muscular force that are consistent with typical mining work. Based on these results, but also on the associated funerary goods, the individuals buried in mines 83 and 84 of sector Ferreres at Gavà are considered to be representative of the mining community, the variscite extractors and beadmakers (BORRELL, BOSCH & MAJÓ 2015). Diversity of material cultural (lithic, variscite, bone industry, pottery, etc.) belonging to mines 83 and 85 reflects the cultural affiliation of the mining community of the Sepulcros de Fosa culture (GIBAJA *et al.* 2016; MOLIST *et al.* 2016; TERRADAS *et al.* 2016) and more widely to the North West Mediterranean Middle Neolithic sphere (PERRIN *et al.* 2016). However, the presence in the same context of piles of variscite fragments, finished standardized products and mining tools is exceptional. These intentional depositions

customize meaningfully the exceptional context of Gavà and more importantly, they seem to symbolize the identity of the buried individual and the range of activities he or she accomplished in their lifetime.

Mining activities and beadmaking in Gavà lasted several centuries during the first half of the 4<sup>th</sup> mill. BC (BORRELL, BOSCH & MAJÓ 2015). Interestingly, in Western Mediterranean, this period falls exactly between the decline of jade in the 5<sup>th</sup>-4<sup>th</sup> mill. and the uptake of copper, ivory and amber by the end of the 3<sup>rd</sup> millennium (ODRIOZOLA *et al.* 2016). In Gavà, the sustainability in the exploitation and production systems of variscite was ensured not only by transgenerational transmission of knowledge in mining labour and beadmaking, but also by the constant demand of the consuming sites. This synergy between producers and consumers was rooted in a symbolic and social substratum shown in the funerary practices of the Sepulcros de Fosa. The codification or ascription of things to a meaningful frame empowers their symbolic expression and allows, through the body as a mediator, not only the affirmation but would even intervene in the definition of a determined identity (Benz *et al.* this volume). In this sense, the variscite ornaments appear as powerful symbols that have legitimized the role of the actors of production, and reciprocally claimed the cultural identity of the consumers, including the producers of Gavà.

All this indicates the strong control exercised by the community of Gavà over the variscite production and distribution (BOSCH & BORRELL 2009; BORRELL, BOSCH & MAJÓ 2015; BOSCH 2019). Archaeological documentation, geological and technological studies indicate that this community had a deep knowledge and understanding of variscite (structure, transformability and qualities) and that mining operations required high technical skills, work organization, constant production of tools and devices, etc. (CAMPRUBÍ *et al.* 2003). Such a complex system has led some authors to advocate that Gavà was a specialized mining community (VILLALBA 2002), even though nothing is known about the settlement/s (or their permanency?) that must have existed near the mines during the period. However, whether mining was, apart from bead production, a specialized activity or not, there is little doubt that the community of miners and beadmakers from Gavà were determinant actors in the configuration and adjustment not only of the cultural codes and the conventions in matters of body appearance. They also played a key role in the construction of identity in the Sepulcros de Fosa culture.

The necklace found in the burial of mine 83 exemplifies what could be the ideal of the production line in Gavà. This is of course the quality of the beads themselves but also the way that they can be paired to create an extraordinarily balanced composition albeit it in a simple way using only a single row (fig. 9). The regularity, symmetry, play of colours and textures and the visual dynamism in the



design are characteristics of the ornaments displayed by the miners and beadmakers who were probably representative or ambassadors of the of Sepulcros de Fosa culture within a context of intensive and overlapping networks of circulation in which variscite had a crucial role.

## CONCLUSION

The mines of Gavà provide an ideal context to scrutinize the entanglement between the technical system and the symbolic expressions of the past societies. The characterisation of the variscite ornaments found at the Ferreres sector of the Neolithic Mines of Gavà allowed us to confirm the specialized character of part of the production and thereby confirm the important role of the actors of production, the variscite extractors and beadmakers of Gavà. These qualified craftsmen most likely were the producers of one of the strongest symbols and hallmarks of the Sepulcros de Fosa culture, the variscite ornaments, thus clearly involved in the construction and consolidation the cultural identity.

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