Title: Analysis and reproduction of the techniques of perforation of quartz and amethyst beads from the Ceramic period in the Antilles.

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Reviewer: Stefano Viola (15th October 2022)

General remarks

The article describes a very well structured and applied research in a geographical area that is practically devoid of techno-functional studies on ornamental elements. To my knowledge, techno-functional studies of Central and South American parures are very few and recent (the last 20 years), although they do lead to the knowledge of exceptional cultural contexts. I find this contribution extremely brilliant for several reasons:

- The research question is original.
- The methodology is well described and well applied,
- The iconographic apparatus is definitely beautiful and very evocative.
- The analytical techniques used are very effective and powerful.

The research group not only presents very beautiful and extremely well-documented material (I stress that all the figures are very beautiful, well-focused and in high definition), but also uses a set of observation and analysis techniques (optical, electron and 'replication techniques' with elastomers and digital) that is heterogeneous, complementary and well coordinated in the different levels of study (low and high power approach). This is not insignificant, as the *parure* is often not studied so comprehensively from a methodological point of view.

The depth of the regional scientific project should also be emphasised. This contribution follows on from previous works that deal with both the issues of raw materials (by through archaeometric analysis) and aspects of the contexts and manufacture of the objects. In clear continuation of these is the main topic of the present work: the understanding, no longer of general manufacturing sequences, but of a more specific aspect related to the perforation of hard stone beads.

For prehistoric times (better said in societies without writing), the use of organic materials in everyday life is a known fact, but these are 'visible' objects. The present work deals with something that is invisible, or almost invisible, to archaeological investigation. Convincingly demonstrating the use of such ephemeral tools is uncommon and, in my opinion, the strength of the contribution lies in the methodology followed: rigorous in its analysis as in its experimental section.

One of the shortcomings of this field of study is that it is very differentiated according to the individual researchers (different terminology and conventions, documentation and analytical techniques that are not always easy to compare, few databases for comparison of technological and functional aspects, etc.). The present contribution seems to me to be a decisive step towards the explication of a research programme that has as its focus the study of ancient ornaments in their multiple cultural aspects.

The other comments are listed below and represent some minor issues (suggestions) that may be considered at the time of publication of this document. The article is brilliant and very interesting. The sole purpose of my comments is to improve it (if some of my comments are not adequate, do not hesitate to explain it).

In the end, I have to say that I would have described some aspects very differently, but I don't think it is right to get into matters of personal style even when they concern more technical and operational aspects. The different contributions must be written to represent the logical-scientific choices and styles of each particular research group.The reviews in which I have been involved have always tried to make me write the paper in the style of the reviewers and according to their technical convictions, thus deeply affecting my final message. By trying to communicate within a unified methodological framework shared by colleagues, the reader should be able to read your specific approach to the study of *parure*.

If requested in the future, I remain at the authors' disposal for any requests or suggestions.

Title

It seems to me a good title because it describes the content exactly and localizes well the space and chronological period of the research topic. Perhaps I would add a final sentence such as: ...*through a technological and experimental approach* (or something similar), to be clear about the method of analysis to readers

Abstract (L10)

The abstract is synoptic and comprehensive. It precisely addresses all the different themes found in the work and suggests, without affecting the reader`s curiosity, the interesting final results.

Introduction (L11-81)

It seems clear to It seems clear to me and summarizes the issue well. In particular, we understand the knowledge gap, especially in drilling techniques, and therefore the originality of the contribution.

L.22-23. I feel that the "value" of technological analysis is somewhat minimized and is reduced to more practical than cultural characters. I feel I can say that technical gestures (and finished products) incorporate and materialize symbolic-cultural aspects. Technology is such a basic aspect of a society's daily life that it is not just the totality of the various stages in the life of objects (acquisition of raw material, production, use and/or exchange) but a tangible manifestation of the construction and dissemination of certain constituent elements of society, in a view that considers the creation and transformation of technologies within social contexts as a true social phenomenon (eg. see: Dobres 2010, Archaeologies of technology). In particular, technical choices regarding drilling may have a strong cultural significance that may reflect an evolution over time or a mechanism of individualization among groups (Granger, Lévêque 1997, *Parure castelperronienne et aurignacienne: étude de trois séries inédites de dents percées et comparaisons*).

L24-. 41. Not being a native English speaker myself, I do not comment on the writing of the text (grammar, spelling, etc.) and the chrono-cultural aspects of the Antilles region. My personal impression is that the text is well written as well as the 'archaeological' synthesis is clear, effective and precise.

NOTE 1. I completely agree with the approach that sees the chemical-physical characteristics of the worked material as the real discriminator for technological analysis (and not secondary

qualitative characteristics such as colour, which are more important for cultural and typological interpretation).

L54. I would better specify that it is a lithic point fragment (Cody 1991, p. 595, fig. 5??).

L63. Cody 1990 is wrong citation, not present in bibliography.

Personal suggestion: in the future test the possible use of coral drill bits in drilling activities because I have the impression that perhaps for speeding up certain drilling stages or for not very long drillings they could be a good auxiliary tool. *"In addition to stone, coral material was also collected to be used as tools (table 4.5). Among the collected pieces, a small portion displayed evidence of use-wear, predominantly in the form of abraded areas present on restricted parts of the often fragmented items. Identified species exhibiting such use-wear are in the majority Acropora palmata, Acropora cervicornis, and Porites sp. In addition, only a single Montastrea annularis artefact was identified. The cylinder-shaped branches with a slightly pointed top of the Acropora cerviconis coral almost all display parts with abraded areas completely surrounding the branch, suggesting that the tools were used as drilling devices. Rare pieces, however, exhibit abraded surfaces on one side only, suggesting use as an active abrading tool, e.g. a rasp (see also Steenvoorden 1992)"* (after Knippenberg S. 2006, *Stone artefact production and exchange among the northern Lesser Antilles*, pp. 135-136; 142).

Material and Methods (82-160)

L90. the crystal flakes are 6 (in the table) but 5 in the text.

L93, fig. 1. Very beautiful and very successful table. Very successful HD photo assemblages, the typological, technological details and the characteristics of the raw materials are clearly visible. Perhaps in the case of the finds with a through-hole (e.g. GD-01-016 and GD-01014) the shape of the perforations could be indicated in some way. I also find the schematic drawings of the pieces very well done, but they have some slight inaccuracies (GD-05-002, GD-05-001) and do not correspond perfectly with the photos of the originals. I suggest making explicit somewhere the graphic conventions followed (e.g. fracture, abrasions, etc.) in order to try to disseminate a uniform methodology for representing the *parure/jewellery*, which, at present, is still a very differentiated field of investigation according to the styles and personal choices of the researchers.

L94, fig. 2. As in fig. 1. Some slight inaccuracies in the schematic drawings (GD-02-012, GD-02-034, GD-02-035) that do not correspond perfectly with the photos of the originals. In particular for GD-02-035, the schematic graphical representation of the upper face does not seem to give the same information as on the photo. In my opinion, there is a chamfer/bevel missing along the left edge and a chip towards the top edge.

L95, fig. 3. As in fig. 1.

L96, fig. 4. As in fig. 1.

L99. I suggest indicating the type of elastomer used and with which technique it was used (I assume with a dispenser gun).

L114. Somewhere in the methodology I suggest you put the bibliographic reference for the descriptive criteria of the perforations: e.g. regular contour, sub-regular etc. (e.g. see Hoareau, Beyries 2022, *Insight into use-wear development on shell beads.* p.118, fig. 3; Bonnardin 2009, *La parure funéraire au Néolithique ancien dans les Bassins parisien et rhénan*).

L108. For X-ray microtomography, I think it is worth mentioning the very few studies in the field of *parure* that are applying this set of techniques (eg: Yang et al 2011, *A new 3D information acquisition method of micro-drilling marks on ancient perforated stone bead through micro-CT*) .

L117. I apologise but do not know the cultural context so I have a question; can you rule out the use of the pump drill? on hard stones, the weight of the flywheel stabilises the drilling operation well (eg.: Groman-Yaroslavski, Bar-Yosef Mayer 2015*, Lapidary technology revealed by functional analysis of carnelian beads from the early Neolithic site of Nahal Hemar Cave, southern Levant*). Rotation speed is also an important factor, particularly when machining hard stone (of course I agree with the arc drill experiment). In certain objects (eg.: GD-02-034, GD-02-035), the morphology of the margins of the hole appears quite circular. This may suggest a fairly low rotation speed even if the perforated thickness is significant.

Fast reciprocating motion (arc drill) produces an ovalised drill cone (Ricou, Esnard 2000, *Utilisation des galets ouvragés du site de Ponzhezières à Saint-Georgesd'Oleron (Charente-Maritime)*). The same opinion is held by J. A. Gwinnett and L. Gorelick, who believe that during the use of an arc drill, even the mere vibration of the rod without the axis moving produces a hole that is wider at the top, conical and slightly oval (Gwinnett, Gorelick 1990, *Rounded traingles in flavian coiffures reconsidered*) - L263, also for this quotation I consider your statement to be correct. It should be noted, however, that any drill used non-vertically tends to produce ovalised contours (Bessac 1986, *L'outillage traditionnel du tailleur de pierre. De l'Antiquité à nos jours*).

L124, fig. 5. The locking system is certainly effective, but it is not compatible with antique systems. I criticise it not because it is modern (in many cases certain variables are irrelevant) but for two reasons: if you clamp the pieces in the manner illustrated, you tension the piece in a way that is completely different from any hypothetical locking system (I imagine you have encountered a fair amount of fracturing). Furthermore, a very interesting phase is when the drill pierces the last diaphragm on the opposite side (critical phase). For this reason, there are various systems to avoid fracturing the worked object. For example: in thin objects, bipolar drilling (SM-02-087) is still applied; or the artefact is placed on a soft surface (wood) to support the face under the tension of vertical and roundabout forces (maybe in SM-02-091).

Regarding the drill rod, in the future, I suggest you select and possibly straighten (with steam) the wooden support better. A very relevant diagnostic feature to distinguish the different types of motion (and therefore mechanism) is the degree of ovalisation of the hole as it is related to the speed of drilling. Now, a shaft that is not perfectly vertical (but also an imprecise blocking of the stone drill) can deform the hole and make interpretation more difficult.

L130.The lubricant issue is more complex but extremely elusive. Lubricants can be various (water, oil, grease, etc.) and are the most ephemeral aspect of the whole manufacturing sequence as their traces are almost impossible to find archaeologically. By their nature, they are generally liquid substances, forming a thin layer between the tool and the worked material. The subject is closely interconnected with the theme of abrasives and perforation to reduce the friction and wear of the instrument. In the interests of your contribution, I would not change what you have written as it would take you too far off topic.

L133. Personally, I would add pressure force.

L137. I would add an example that is morphologically consistent, the perforators created with burin spall. For example, at the Italian site of Benefizio, Structure 11 - archaeological example, dating from the Middle Neolithic, a production site for steatite ornaments. The drill tips are made from elongated flakes, lamellae or on *coup de burin*. Drilling was probably carried out

with the use of bow or pump drills (Mazzieri et al. . 2007, *Parma-Benefizio, struttura 11: remains of a workshop for the production of steatite necklace ornaments from the Middle Neolithic*).

In the micro-point version, something similar can be found (points with a quadrangular or polygonal cross-section) in North America and used on semi-hard and hard stone (eg. Cahokia, USA, Mississipian period, Linder, Folb 1998, *Lopuch 3 and microdrills: site report and use-wear analysis*).

L139. I also suggest sea urchin spines. In general, provide a minimum of bibliographic comparison to motivate your choice. The concept is that we cannot test indefinitely and, therefore, experimental tests should be carried out as far as possible in a manner compatible with the local archaeological and cultural record.

L147-160. I find the experiments carried out, in a very controlled style, are interesting and well explained (which allows comparison between colleagues).

Results (161-190)

L167-175. The sequence of manufacture is clear and well summarised. I suggest inserting some reference (even if only photographic) to justify the statements. That is to say, what technical character suggests to you that perforations always occur after the *mise en forme*?

You deal with several morphological types together (in theory for each type the sequence should be described), so it seems to me that your intention is to give a general theoretical sequence. If that is the case, that is fine, but I would still add some details that refer to the specifics of some finds in your local corpus. In alternative even just refer to your older work (e.g. Queffelec, et al. 2018, p. 279, fig. 8; Queffelec, et al. 2020, p. 32).

Discussion (291-377)

L193-217. I would put in one or two lines a minimum of comparison between the two analytical techniques (X-ray and SEM associated with elastomers).

L214. I would also put a reference to the photograph of the face of the object illustrated in Fig. 1. If you look at the morphology of the edge of the hole, you can see a small asymmetry typical of the use.

L222. Figure 11. Another indicator of use (or light reaming!) could be the isolated, long, narrow stripes running along the axis of perforation seen in the upper right image.

L234. there are 10 perforation axes. It may be useful to know that with the pump drill it is easier to continue working even when changing the drilling angle (this is a characteristic of the pump drill). Obviously, the result is a change in the hole with at least half of the margin becoming elongated (i.e. half oval).

(SM-02-077) Perhaps a slight inclination can also be seen by looking at the margins of the hole (Fig. 3, top face). The outline (there are two non-concentric half-arcs) is quite asymmetrical and ovalised in the lower left quadrant.

L237-241- For the sake of completeness at least a bibliographical citation could perhaps fit.

L242-246. I appreciate the comparison test, but it must be said that even the characteristics of the striations on the hole walls do not correspond to the use of a lithic point (they are very fine and thin). I find the image showing the fragmentation pattern of lithic tips with an elongated active part interesting. They are a first criterion for the functional recognition of the object.

L261. is the abrasive powder amethyst or quartz? In figure 16 it is written quartz and seems more correct to me. Perhaps recheck lines 257-263 for more correspondence with the legend in Figure 16.

L331-333. From an experimental point of view, your statement is very significant. I think you are right when you point out that your test does not have a high degree of compatibility with antique procedures (industrial vice). I think that to be more sure of the statement you should also determine the type of abrasive used in antiquity and test only with that (See the work of Emiliano Melgar, eg. Melgar Tisoc, Solis Ciriaco 2009, *Caracterización de huellas de manufactura en objetos lapidarios de obsidiana del Templo Mayor de Tenochtitlan*). Different abrasive sands have very different wear resistance and this greatly influences the way the drill bits advance.

Another aspect, which ties in with the system and the difficulties of blocking, concerns the succession of steps in the *chaine operatoire*. That is, it is one thing if you finish the shaping and then drill, it is another if you drill a pebble and then perform the shaping. Or you produce a thick plate, drill and then perform the shaping. The 3 different sequences have very different difficulties and locking systems and can greatly affect the regularity of the drilling. If you drill a small plate (or a short discoidal, or a cylindrical one), maintaining the same angle of incidence is very easy, but if you drill a spheroidal bead it changes a lot.

Parallel to your hypothesis of the reuse of the amethyst, as pure methodological speculation, it could indicate that semi-processed artefacts arrived at the site but had already been shaped.

I would remind you that drilling is the most risky moment of the whole process. Thus, often in thin discoid beads or cylindrical beads the perforation occurs early, while in pendants or thick discoid beads it is postponed.

Finally, in the specifics of parures, the mobility of raw materials and their circulation system is much studied and may hold surprises touching the symbolic and 'value' sphere (I point out as a recent example: Ahola et al 2022, *Materialising the social Relationships of Hunther-Gathers*).

L356. the subject of reuse is very interesting and vast. Little investigated but there are studies on the subject. I suggest you cite at least one bibliographic source. Your work is really good but written like this it seems you have shed light on a lot of issues which is not always true (my personal impression). For example, reuse in ornament production has been dealt with by others before (e.g. Gazzola 2007, *La produccion de cuentas en piedras verdes en los talleres lapidarios de La Ventilla, Teotihuacan*; Vidale, Shar 1990, *Zahr-Muhra: soapstone-cutting in contemporary Baluchistan and Sind*).

Conclusion (378-406)

I find that the conclusions are very clear.

References

See L63