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Reviewed Article:

Mining at Pozarrate: Applying Experimental Approaches to Understand the Neolithic Extraction of Flint in the Sierra de Araico (Treviño, Spain)

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The aim of this paper is to introduce the scientific works performed in the Sierra de Araico Neolithic Mining Complex, mainly located in the Treviño enclave of Spain, in the Basque-Cantabrian Basin, between Burgos and Álava provinces. Archaeological works were focused on the Pozarrate quarry, dated to the Neolithic period (6000-5600 BP). This site is unique since it has been used recently to intensively dig out high-quality flint cores. This type of flint, called Treviño, has had wide circulation in archaeological sites of the Cantabrian Mountains and Western Pyrenees. The interdisciplinary research applied to Pozarrate site involves LiDAR analysis and geological, procurement, typological, technological and functional research related to flint blanks and different mining tools manufactured on the local flint. The research also includes the study of other raw materials, such as dolerite hammer stones and antler picks. Different experiments, related to the comprehension of mining processes, have been carried out in order to clarify the archaeological findings of the site. Particularly, we present the results of an experiment on flint changes produced by contact with fire and an experiment on the replication, utility and use-life of hammer stones used to dig out the flint cores.

> The main aim of this experiment was the replication and use of hafted dolerite hammer stones, in order to understand the archaeological dolerite sets: both the surface finds around Sierra de Araico-Cucho and the archaeological finds recovered at Pozarrate. Unlike the surface collection, the Pozarrate dolerite set shows simple technological modifications to adapt lithic blanks to hafting and mining work.

Introduction

Sierra de Araico is one of the only two prehistoric flint mining complex in the Iberian Peninsula that have provided dates associated to the Neolithic period. Pozarrate archaeological quarry has eight structures classified as crescent-shaped dumps. The archaeological excavation focused on the inferior dump. The two dates were obtained from an antler (5640±30 BP uncalibrated) and from a charcoal (6050±40 BP uncalibrated) (Tarriño et al., 2011a, p.25). During excavation, thousands of artefacts made in Treviño flint have been collected, including several mining tools such as antler picks and dolerite hammer stones.

Sierra de Araico Neolithic Mining Complex: a long-term flint procurement area and Archaeological works at Pozarrate

Estavillo Villambrosa (1975) described around 50 surface finds of dolerite-quarry-hammers in the Sierra de Araico-Cucho, that are similar to the archaeological material subsequently discovered, and were taken as an indicator of intense mining activities. After a preliminary analysis, some of these items were reclassified as loom-weights or undefined objects, leaving the total of 30 surface finds of

hammer stones (Tarriño et al., 2011b, p.176). This is the point of departure for the whole mining complex research.

Since 2011, different works at Sierra de Araico were developed to understand and delimit the mining area. The principal raw material is Treviño flint. It's a frequent type of flint usually detected in many archaeological sites of the Cantabrian region (from Asturias to the Basque Country, Spain), the Western Pyrenees and the south of Aquitanian Basin (France), from the upper Pleistocene to the Holocene.

An experiment on Treviño Flint changes by thermal stress

This experiment was done due to the considered hypothesis of a "fire-setting" procedure to weaken limestone rocks where Treviño flint cores are included, as seen in some quarry front excavated areas of Pozarrate. Thus, our main aim was evaluating flint damage caused by thermal stress that was created by this extraction method, both by direct contact with fire and indirect heat, over varying time scales.

We were able to take advantage of an ethnographic experiment on Basque traditional coal production performed on June 2018 during a week in Bernedo, Álava (Basque Country, Spain). Despite not being an experiment focused on our goals, we believe that the conditions of time and temperature would be similar to those used in the extraction of flint nodules from Pozarrate. Due to the long duration of the experimental process, the temperature of several areas of the charcoal pile was checked with a laser thermometer at intervals. Therefore, several Treviño and similar Botorrita flint flakes (n=21) were placed on the surface at an initial stage of the experiment and recovered by archaeological methodology after the charcoal pile was dismantled (n=13).

It was not possible to recover several pieces in the most external area due to trampling activity that occurred while maintaining the charcoal pile during rekindling and earth-covering procedures. In addition, high temperatures in the central area of the charcoal pile could totally destroy some pieces in internal positions. As a result of spatially varying temperatures, sooty and fractured surfaces and thermal edge damage were common features among experimental pieces situated in the internal area of the charcoal pile (the area covered by the charcoal pile) (see Figures 4b, 4c, 4d). On the contrary, all the pieces buried at the geometric centre of the charcoal pile showed no features related to thermal stress: only PT12 (on Treviño flint), half-buried, shows light variation of colour (see Figure 4a)

An experiment on the replication, utility and use-life of dolerite hammer stones to dig out the flint cores

The main aim of this experiment was the replication and use of hafted dolerite hammer stones, in order to understand the archaeological dolerite sets: both the surface finds around

Sierra de Araico-Cucho and the archaeological finds recovered at Pozarrate. Unlike the surface collection (with evidence of standardization and much more polishing features), the Pozarrate dolerite set shows simple technological modifications (generally notches) to adapt lithic blanks to hafting and mining work. The morphotechnic similarities of other prehistoric and metalliferous mining environments (e.g. Blas Cortina, 2007-2008; Delgado Raack et al., 2014) make us think that these surface maces may belong to a post-Neolithic period. Therefore, we chose to reproduce the archaeological set, taking into account its weight and technological improvements, and designed different mining tools accordingly with three extractive strategies: a rigging device, a single-end hammer of medium weight and a double-end hammer of light weight (Blas Cortina, 2007; Timberlake and Craddock, 2013 p. 44-45).

The designed experiment was focused on logically reproducing all phases of hammer stones production:

- procurement of the lithic raw material from the nearest outcrop;
- technological conditioning, including pecking, direct knapping -for flaking purposes-and polishing;
- a hafting process, involving wood sticks, hemp cords of different thickness and a natural glue made from resin, ash and wax;
- a controlled use in a similar environment to Pozarrate site, by direct hitting of limestones and indirect hitting and levering-off with an intermediate antler pick.

Experimental piece	Origin (distance to pozarrate)	Maximum dimensions (cm)	Weight (kg)	Technical conditioning	Hafting	Use
EP1	Payueta (10 km)	26.5 x 17.5 x 14.5	8.1	Direct knapping. Picketing	Ridding device	Direct hitting on limestones
EP2	Payueta (10 km)	22.5 x 16 x 14	6.1	Direct knapping (break)	X	X
EP3	Payueta (10 km)	20 x 12.5 x 12	5.6	Direct knapping	Single-end hammer	Direct hitting on limestones
EP4	Payueta (10 km)	15 x 12.5 x 10	3.6	Direct knapping (break)	X	X

EP5	Payueta (10 km)	15.5 x 11 x 6.5	2.1	Direct knapping. Picketing. Polishing	Double-end hammer	Contact surface A: direct hitting on limestones. Contact surface B: indirect hitting, levering-off with an intermediate antler pick

TABLE 1. DOLERITE MATERIALS USED DURING THE EXPERIMENT. EP2 AND EP4 WERE DISCARDED DUE TO INTERNAL FRACTURES DURING KNAPPING.

The experiment was carried out during the first quarter of 2019, involving 12 people. The comprehensive technological management of dolerites and their hafting took seven hours. The field experiment took two hours. The successful use of experimental hammer stones allows us to affirm that the mechanical extraction of flint is possible, and the use-wear generated will be used for their comparison with those from the archaeological samples, in order to determine their use and function.

Conclusions

Two experiments, related to the comprehension of mining processes at the Pozarrate site, have been carried out in order to interpret its archaeological findings from a functional perspective. On one hand, the experiment related to flint changes due to heating show that only the direct contact with fire produced typical evidences of thermal stress (dome-like fractures, edge damage, micro-abrasions...). However, pieces with a non-direct heating did not show any visible taphonomic feature (mainly colour changes), even after a long period of time. Thus, a “fire-setting” mining strategy is feasible, since it is possible to avoid thermal stress on flint cores by non-direct heating. On the other hand, the experiment based on the replication and use of dolerite hammer stone for quarrying allow us to confirm (1) the difficulty of technological management of this sort of very hard lithic raw material; and (2) the efficacy of the three hafting methods on mining activities, in order to conduct some technical gestures, such as hitting limestones directly or by levering-off with an intermediate antler pick.

Future Research

The next step in our research will be to do new research to establish a reference collection that includes a catalogue of prehistoric mining activities. This experimental collection will enable us to compare it with the archaeological record and also allow the development of a functional analysis of tools from Pozarrate.

Acknowledgments

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Keywords flint
mining

Country Spain

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Gallery Image

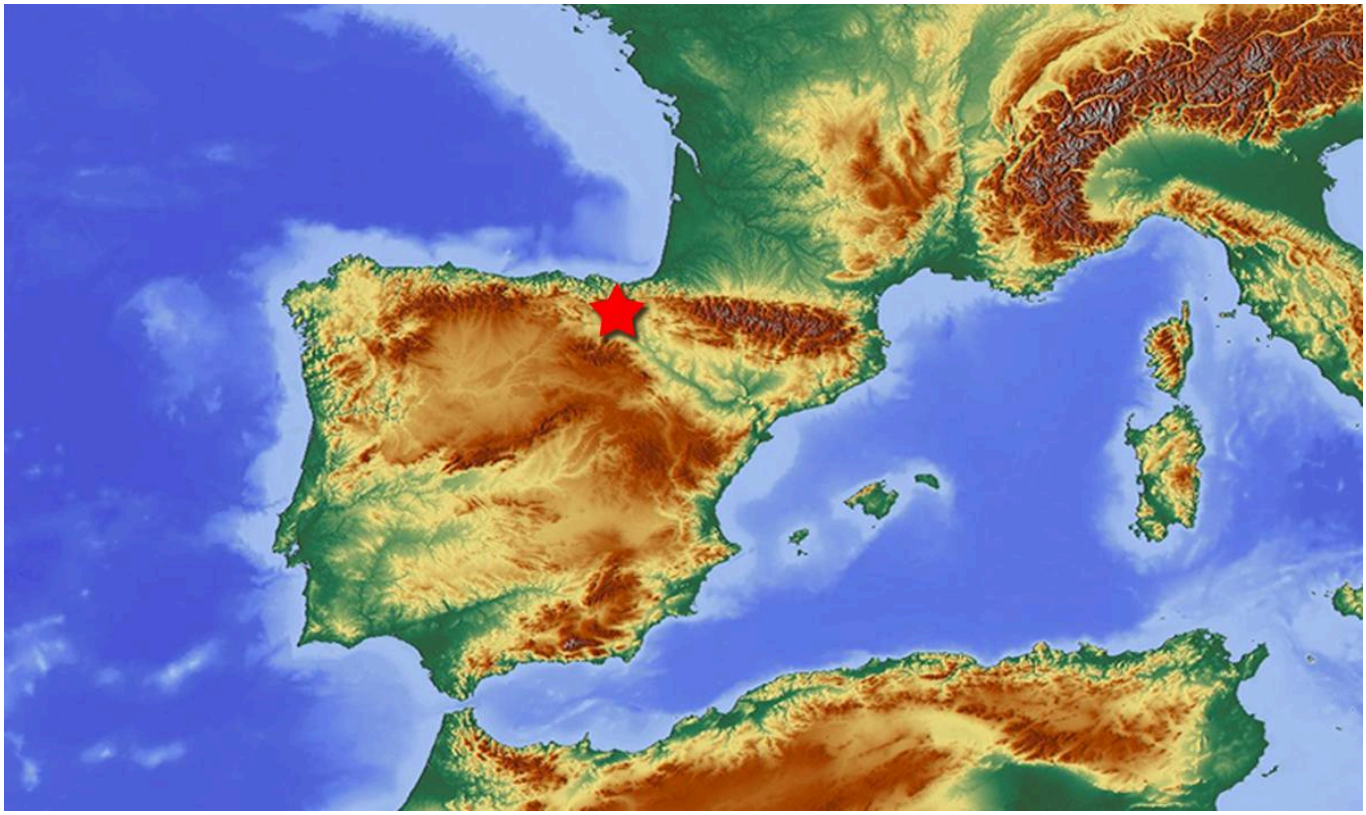

FIG 1A. LOCATION OF POZARRATE ARCHAEOLOGICAL SITE (SIERRA DE ARAICO NEOLITHIC MINING COMPLEX) WITHIN THE IBERIAN PENINSULA (RELIEF MAP MODIFIED FROM HTTPS://MAPS-FOR-FREE.COM/).

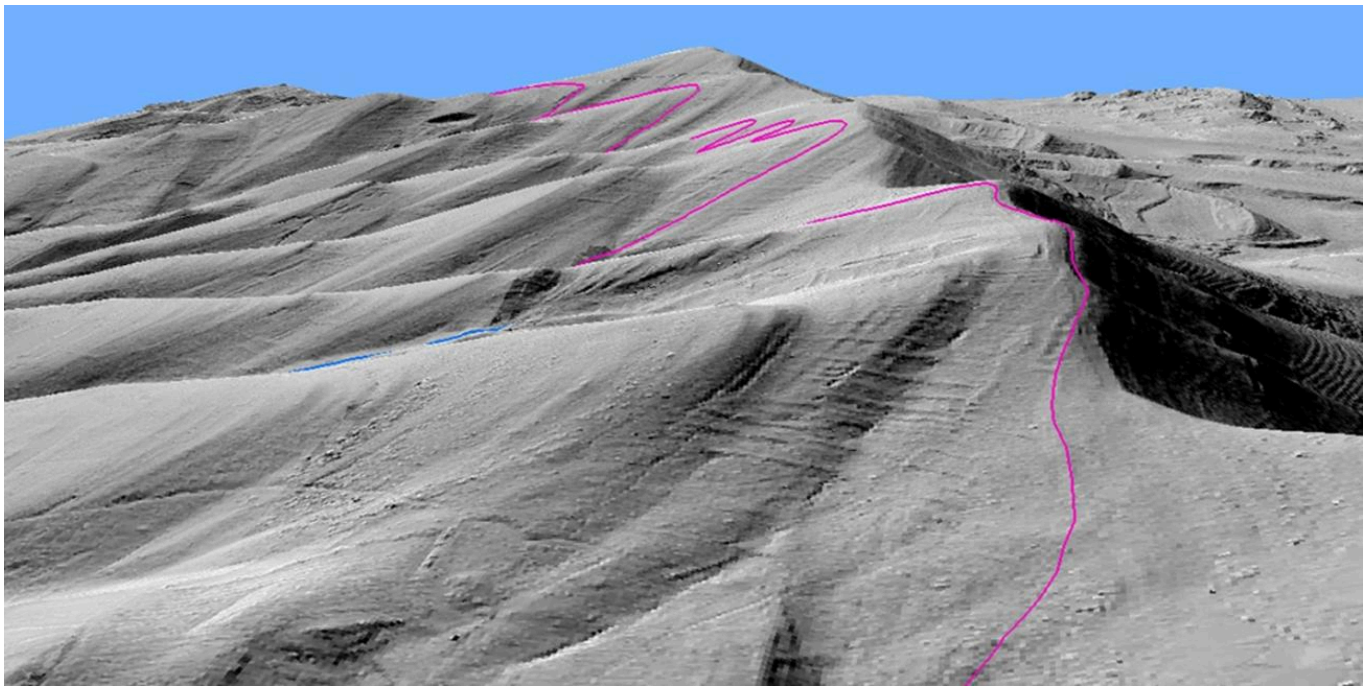

FIG 1B. 3D MODEL OF SIERRA DE ARAICO BASED ON A LIDAR IMAGE. VIOLET LINE: NODULAR FLINT LAYER. RED SQUARE: LOCATION OF POZARRATE WITHIN A CRESCENT-SHAPED DUMP (TARRIÑO ET AL., 2014, P.132, FIGURE.2).

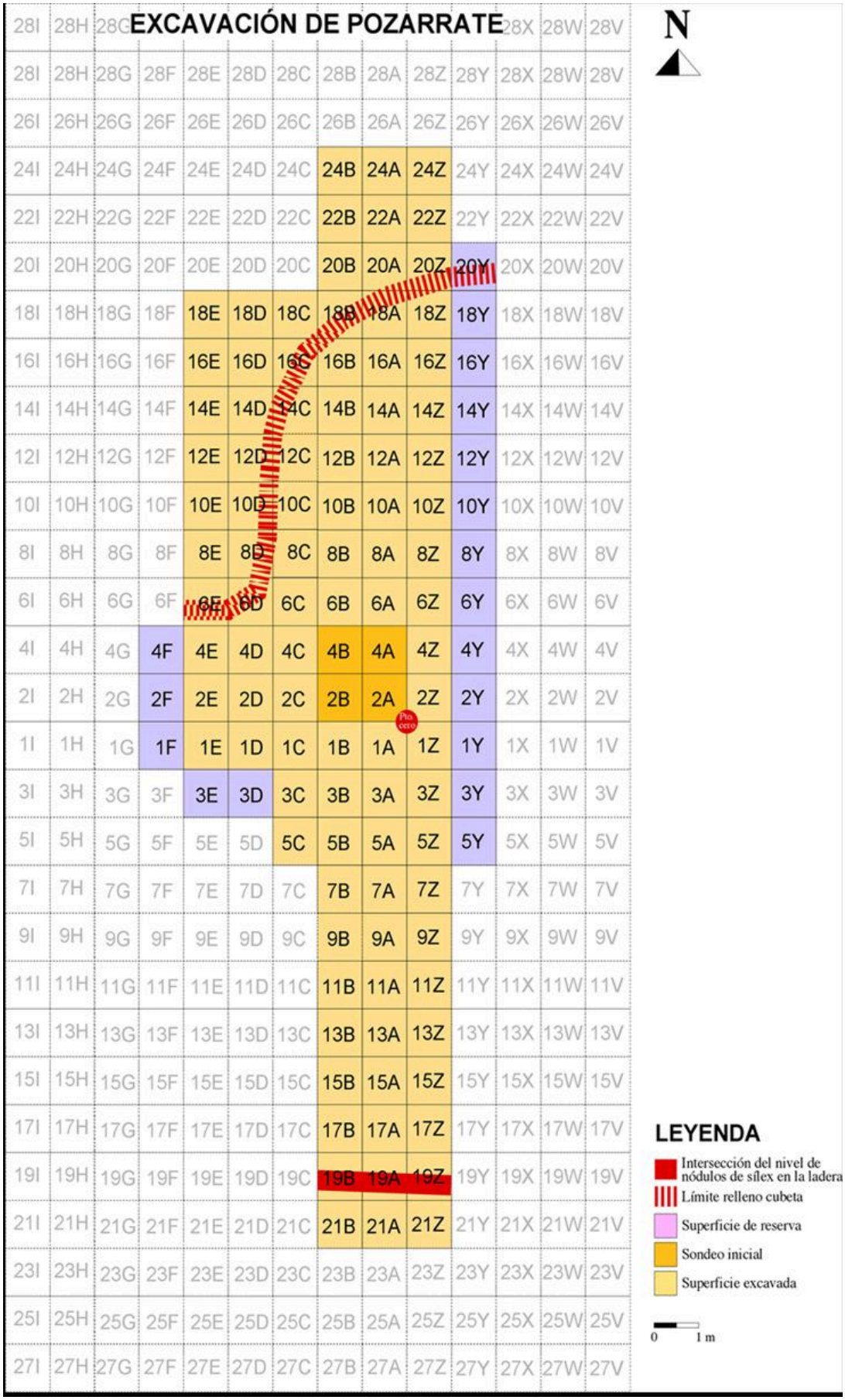

FIG 1C. PLAN OF POZARRATE 2018 EXCAVATED AREA.

FIG 1D. GENERAL VIEW OF POZARRATE DURING THE LAST ARCHAEOLOGICAL CAMPAIGN.

FIG 2A. ARCHAEOLOGICAL DOLERITES FROM POZARRATE. THERE IS AT LEAST A DOZEN OF RECOVERED DOLERITE ITEMS WITH SIGNS OF HAVING BEEN DELIVERY WORKED.

FIG 2B. ARCHAEOLOGICAL ANTLER FROM POZARRATE. AT THE MOMENT, THERE IS EVIDENCE OF 8 ANTLER ELEMENTS, MAINLY SITUATED CLOSE TO THE QUARRY FRONT.

FIG 3A. PHASES OF THE EXPERIMENT: STACKING LOGS, AND COVERING WITH GRASS AND BRANCHES BEFORE LIGHTING, AND AERIAL VIEW AFTER COAL COLLECTION. PHOTOS BY P. RODRÍGUEZ-SIMÓN

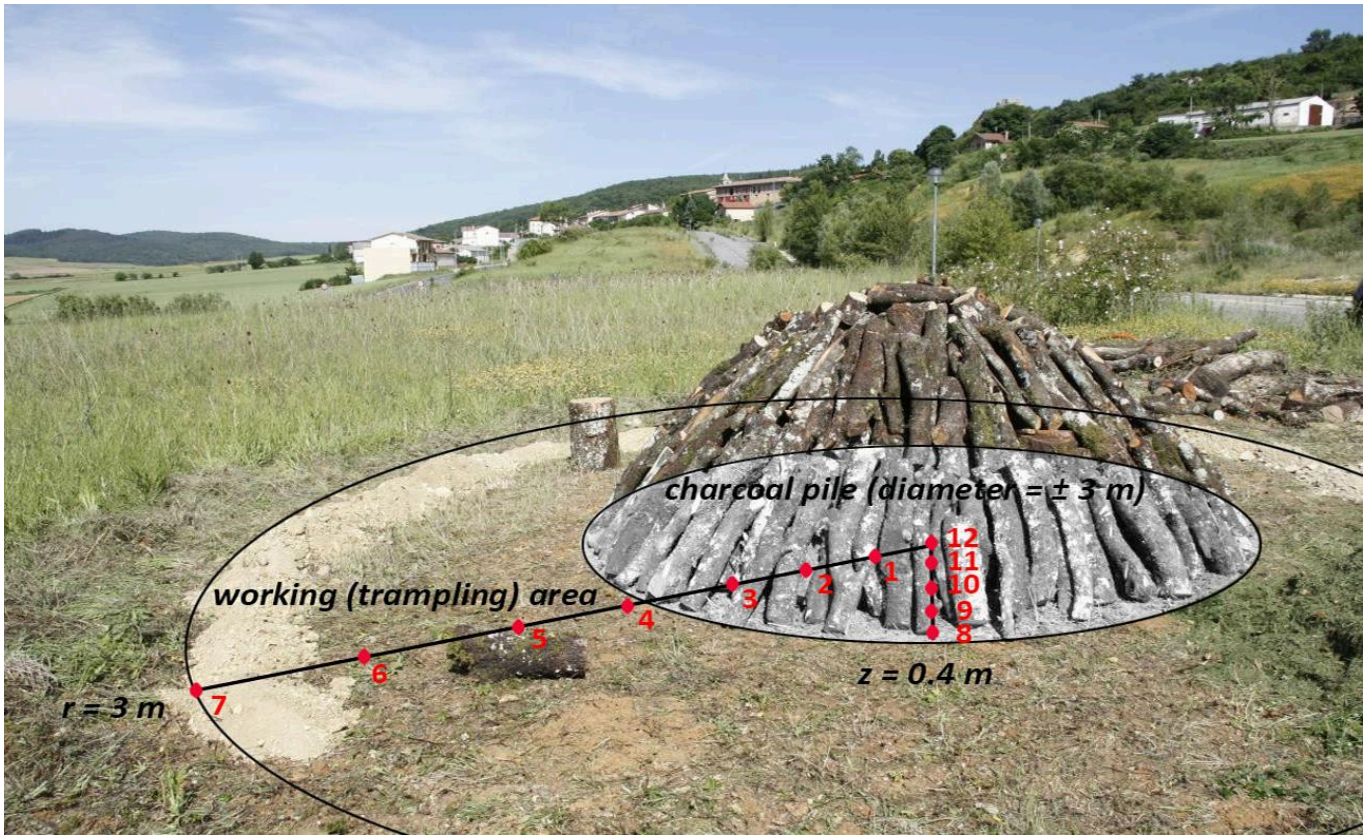

FIG 3B. GENERAL DIMENSIONS OF THE EXPERIMENTAL CHARCOAL PILE AND THE WORKING SURFACE. RED DOTS REPRESENT THE INITIAL POSITIONS OF THE EXPERIMENTAL FLINT FLAKES.

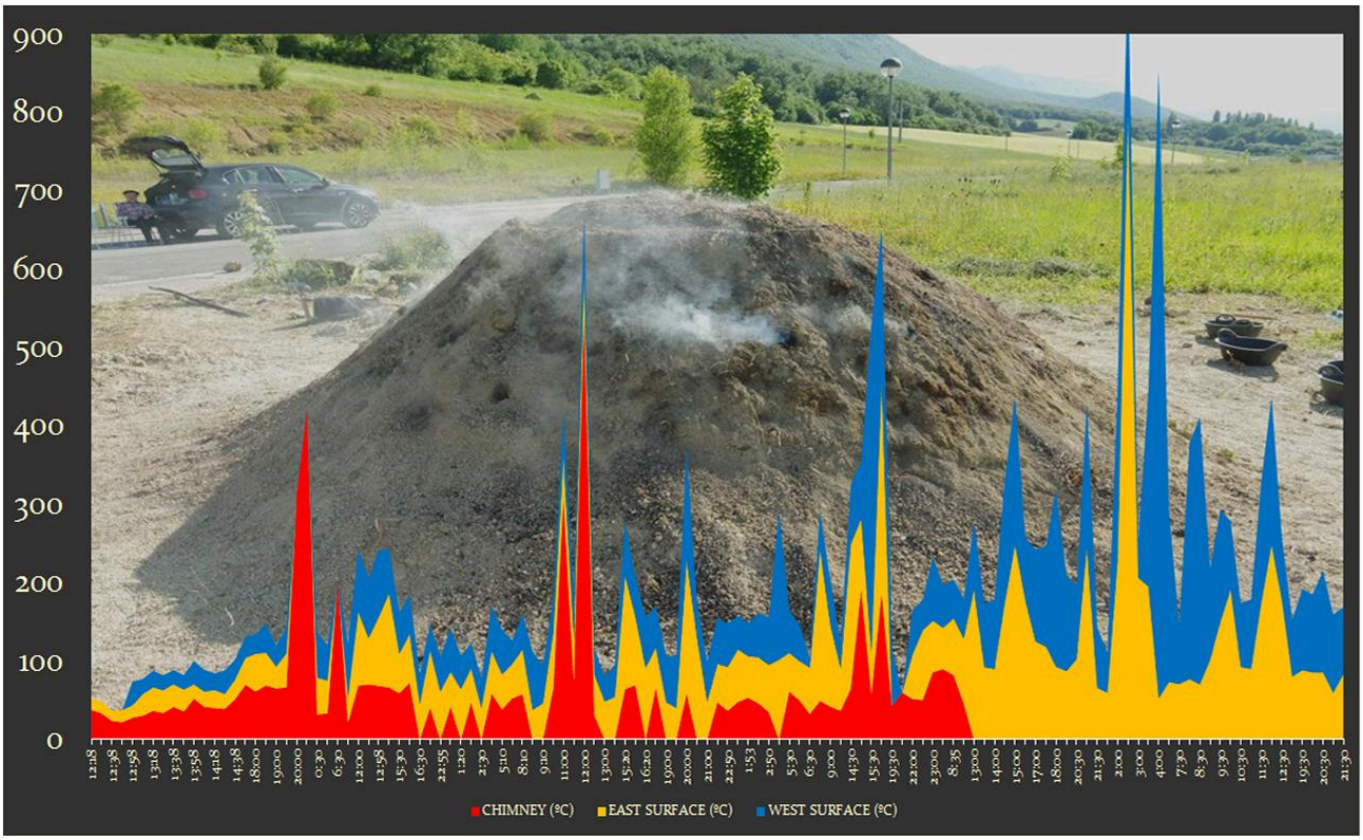

FIG 3C. SURFACE TEMPERATURES ON THE CHARCOAL PILE DURING EXPERIMENT. HEATING PEAKS OCCURRED DUE TO THE APPEARANCE OF GAPS DURING THE REKINDLING PROCESS OR BETAGARRI.

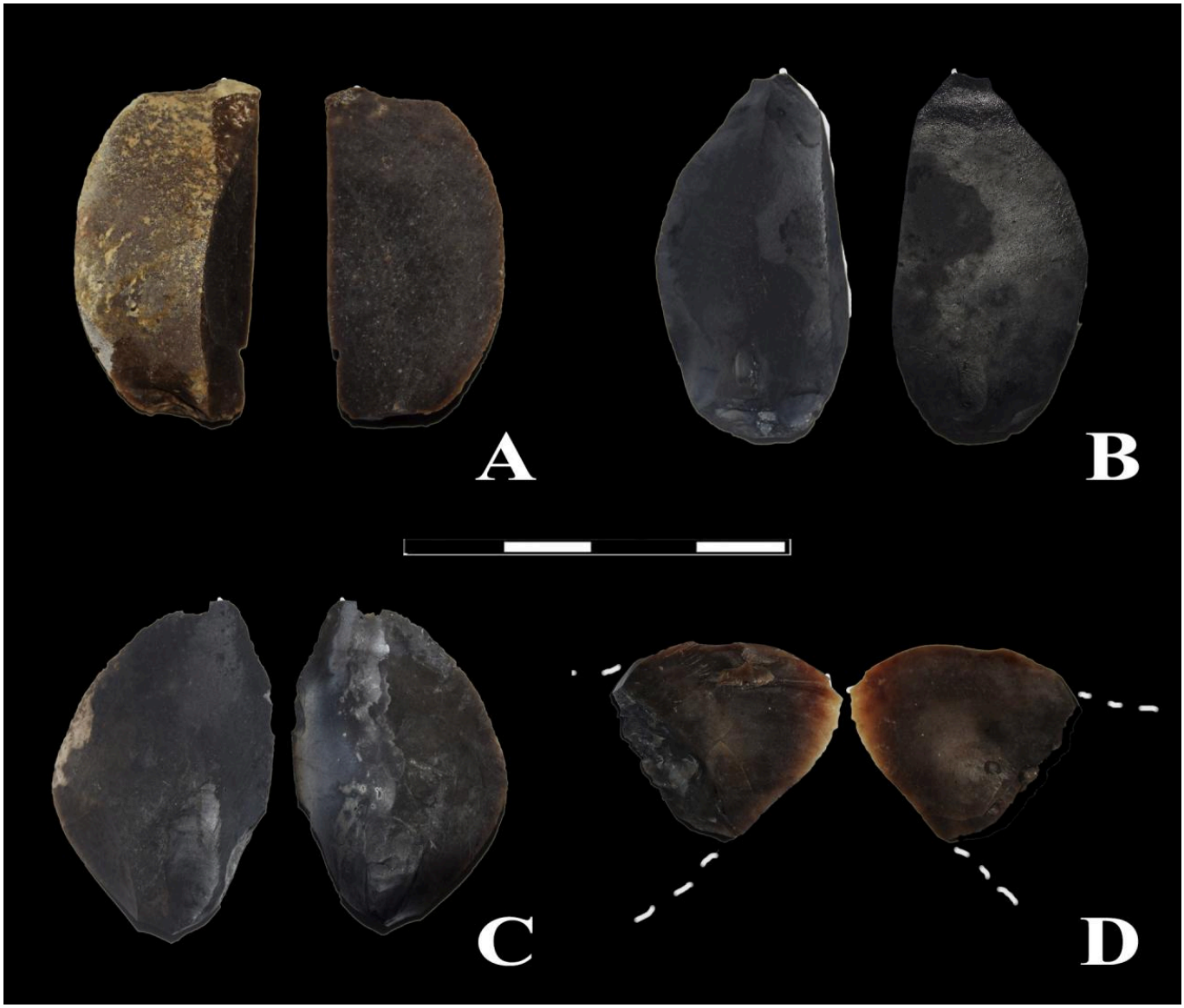

FIG 4. DOCUMENTATION OF FLINT FLAKES AFTER THE EXPERIMENT (SELECTED IMAGES): (A) PT12-TREVIÑO; (B) PT2-TREVIÑO; (C) PT2-BOTORRITA; (D) PT3-BOTORRITA.

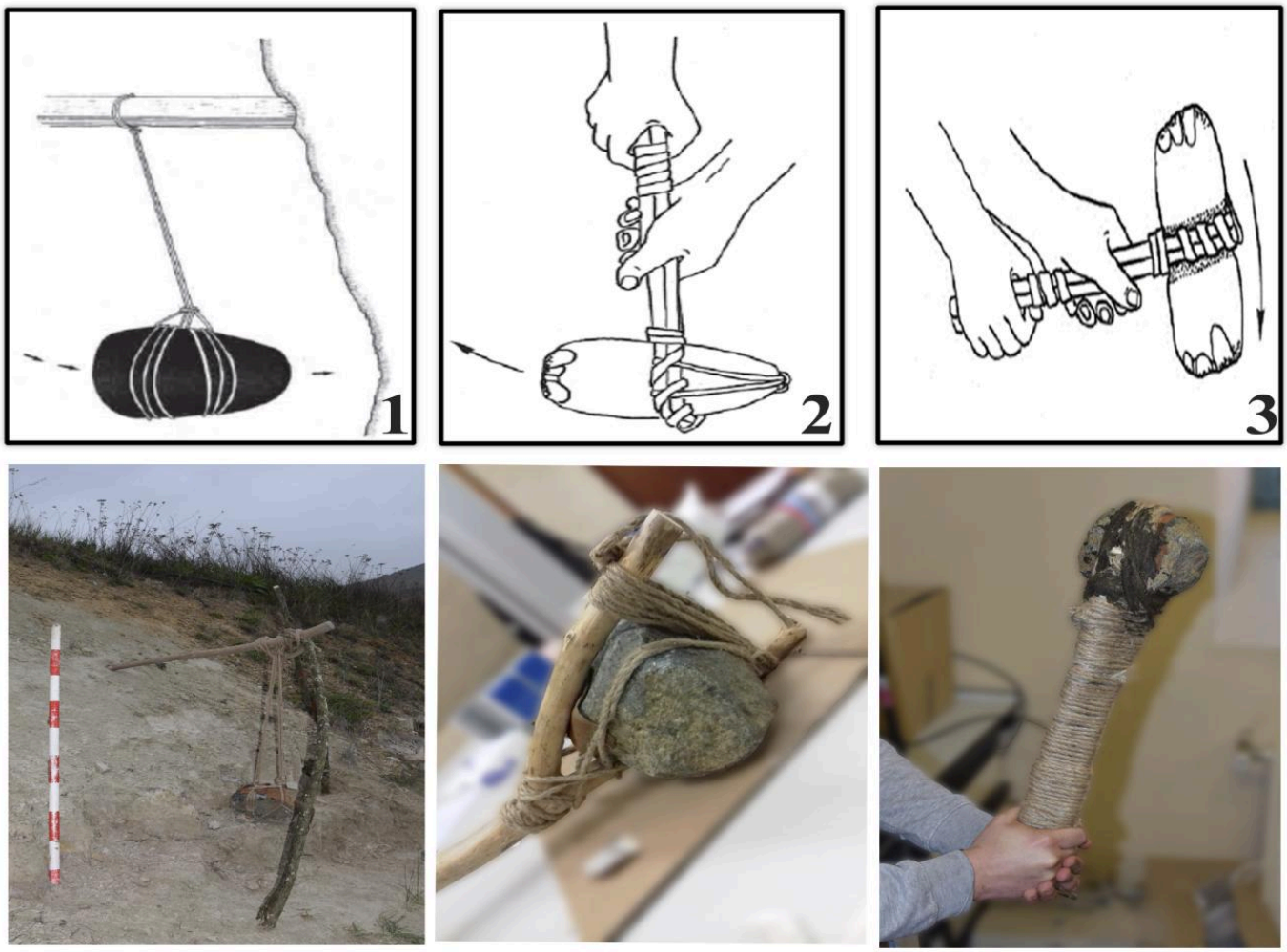

FIG 5. (1) RIGGING DEVICE, HEAVY WEIGHT (BLAS CORTINA, 2007) AND EP1 DEVICE ON THE FIELD; (2) SINGLE-END HAMMER, MEDIUM WEIGHT (TIMBERLAKE & CRADDOCK, 2013, P.45) AND EP3; (3) DOUBLE-END HAMMER, LIGHT WEIGHT (TIMBERLAKE & CRADDOCK, 2013, P.45) AND EP5.

FIG 6A. ADDING NATURAL GLUE TO EP3 HAFTING.

FIG 6B. USE OF EP5 WITH AN INTERMEDIATE ANTLER PIECE.

FIG 6C. USE OF EP3.

FIG 6D. USE OF EP1 ON ITS REMOVAL DEVICE.