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Learning to Recreate, Recreating to Learn. Experimental Archaeology

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This paper aims to present and discuss ongoing activities that combine Experimental Archaeology and Ethnoarchaeology developed in the scope of a master's degree, a post-doctoral and other research projects at the University of Vigo (Galicia, Spain), in collaboration

with regional open-air museums and educational centres. Actions have focused on teaching about material properties and transformations, as well as on the design and application of experimental protocols, specially focused on archaeometallurgy. Within this framework, we have promoted the interest of archaeology students in this subject, and other specialised members of the public. As a result, a richer transfer of acquired knowledge from academia to the more general public has been reached.

> The role of experimental archaeology in academic research is to place models that have been proposed in theory into actual practice, with the goal of validating or modifying the premises tested, as well as to explore and obtain new ideas; at the same time, they bring significant information of a sensory and technical nature to the archaeological research projects.

Introduction

Between 2011 and 2017, members of the Group of Study for Archaeology, Antiquity and Territory (GEAAT) from the University of Vigo (UVigo) (Galicia, Spain) have been rolling out an entire series of activities linked to prehistoric archaeometallurgy and experimental archaeology, carried out with the goal of encouraging both academic research and teaching in these areas, within the context of regulated and non-regulated education. These activities initially arose as a logical development in more conventional research into metallurgical activities in prehistory, where the theory about the technological processes generally left more open questions than answers. In this way, the activities incorporated the experiential factor as a route for exploration, until making the jump to experimentation. With these activities, the aim is to provide participants with the basic theoretical and empirical tools for the understanding of the metallurgical processes in Prehistory, through learning based on technological recreation, and at the same time to offer active participation in the processes and experiential acquisition. As part of the members from *GEAAT* that have been driven the experimental path, below we propose making a number of reflections on the origin and development of these activities.

The Context. Experimental Archaeology in the Galician University System

Experimental archaeology as a teaching path in regulated archaeological education has presence in the study plans of various universities. In the context of the British Isles, there are specific master's degrees in the area, such as the one at the University of Exeter, or the one recently inaugurated at University College Dublin. Both focus on the study of the principles of experimental archaeology and on the tools for research into archaeological materials, and also on cultural heritage's management and communication, stressing the important role both play as a tool in the analysis and enhancement of that heritage. Other European

Universities have also included experimental archaeology in their degree plans, but as one semester course, as for example Leiden University.

In Spain, experimental archaeology had a recent emergence. The interest of this subject within archaeology is clear with the development of initiatives such as the publications, of the *Boletín de Arqueología Experimental* (since 1997), the periodic holding of the *Congreso Peninsular de Arqueología Experimental*, linked to the creation in 2004 of *Experimenta*, the Spanish association concerned with this subject (Ramos et al., 2007).

This growing importance is apparent also in its ever-greater presence as a discipline in university centres dedicated to the training of archaeologists and in its inclusion in the principal archaeological manuals (Reeves and Paardekooper, 2014).

Within the sphere of the Spanish universities, and specifically in experimental archaeometallurgy, is the example of the Universidad de Granada, with a specific mining and prehistoric metallurgy workshop. Moreover, experiments performed by Salvador Rovira at the Universidad Autónoma de Madrid (Rovira, 2011-12) has set out the need to carry out experiments, recreating the theoretical processes on peninsular metallurgy in the simulated working conditions of the metal worker, as opposed to studies in laboratory conditions.

In the map of degree qualifications in the Galician University system in Spain, there is not a specific degree in Archaeology. Related degrees, are generalist in scope. Experimental Archaeology has had no express formal presence, even though various activities have indeed been undertaken with the intention of finding synergies in the sphere, both by the Study Group for North-Western Iberian Prehistory (GEPN) at the University of de Santiago de Compostela (USC), and by the Study Group for Archaeology, Antiquity and Territory (GEAAT) at the University of Vigo (UVigo).

GEAAT organised the First Experimental Metallurgy Workshop Days, May 2012 in Taramundi (Asturias, Spain), in collaboration with Ceder Oscos-Eo, the Town Council, Taramundi Museo de Cuchillería (Museum of Traditional Knives), the "Consejo del Hierro" (“Iron Council”) of the Asociación de Herreros (Association of Metalsmiths), and the Conjunto Etnográfico (Ethnographic Group) of Os Teixois (See Figure 1). These groups were oriented to experimentation in the production of bronze. The Second Experimental Metallurgy Workshop Days were held in December 2014, oriented towards the production of iron (See Figure 2).

The members of the GEAAT also took part in various open workshops, including the First *Jornada de Recreació Prehistòrica Jaciment Arqueològic dels Closos de Can Gaià* (Recreation of the Closos de Can Gaià Prehistoric Archaeological Site Workshop Day) at Portocolom, Felanixt, Majorca, August 2013 (See Figure 3), the *Jornada Prehistórica de Arqueología Experimental* (Experimental Archaeology Prehistoric Workshop Day) at Fuentes de León, in the province of Badajoz, December 2013 (See Figure 4) and the organisation of the course

entitled *Transforming Materials, an interdisciplinary approach to the production of bronze objects* (October 2013) within the framework of an European Funded Project GestART- Artistic Gestures Revisiting Artistic Diversity and Convergence with the collaboration of Parque Arqueológico de Arte Rupestre de Campo Lameiro (PAAR – Campo Lameiro Rock Art Archaeological Park) (See Figure 5).

From the start of these activities, it became clear there was interest both from the university students and from the public, with assiduous and reiterated participation from those attending. Based on these prior experiences, the commission that designed the Inter-University Master's Degree in Archaeology and Sciences of Antiquity (University of Santiago de Compostela, University of Vigo, INCIPIT-CSIC) academic year 2013-14, was responsible for the introduction of an optional subject of Ethnoarchaeology and Experimental Archaeology. Since its beginning in the academic year 2014-15, activities are carried out in relation to this formal teaching context, to further the undertaking of supervised academic research projects.

Thus, in the academic year 2014-15, three experimental workshops were held, one in Santiago de Compostela in the Monte da Condesa experimental space of the South Campus of the University of Santiago de Compostela and through the GEPN (See Figure 6), and two on the Ourense Campus of the University of Vigo through GEAAT, with the support of the vice-rectorate (See Figure 7). The quality of the results obtained this year even lead to the proposal of the creation of an archaeo-experimental space on the Ourense campus (EACO) as an educational resource (See Figure 8).

In the academic year 2015-16, the activities were undertaken through the GEAAT, in collaboration with the Campo Lameiro PAAR (See Figure 9), and through the Museum of Traditional Knives in Pardiñas and the Taramundi Town Council (See Figure 10). These were organised as workshops open to the public (first) and as a course (second), with great success as regards attendance. Illustrating the potential of this type of events. Finally, in the academic year 2016-17, the activities were undertaken again through the GEAAT, in collaboration with the Campo Lameiro PAAR, as an open workshop day entitled “Una giornatta al sole” (See Figure 11).

A reflection on the repercussion of these activities is the dynamism of the workshops organised by the university students. Likewise, the *Asociación Cultural de Arqueoloxía e Ciencias da Antigüidade* (ARCIAN: Cultural Association of Archaeology and Sciences of Ancient History) organised an experimental workshop day in 2016 with public demonstrations on the USC campus. In turn, the Young Researcher Workshops organised by the Delegation of Students of the Faculty of History of the Ourense Campus of the Universidad de Vigo included public demonstrations and re-enactment activities in their programmes.

The experimental actions received a high social visibility, and as a result, some primary and secondary schools have begun to request the university to create specially designed activities for these junior students. In academic terms, this was understood as the high cross-curricular teaching potential of experimental archaeology. Thus, as an example, the GEAAT and the GEPN took part together in the day of experiments organised at the request of the Marco do Camballón Secondary School in Vila de Cruces (Pontevedra) (See Figure 12).

The outcome is very satisfactory, given that it shows us not only the students' interest, with promotion of new groups for experimentation, and there is also still a long way to formalize this discipline, as well as creation of the exact institutional synergy to back up this type of training.

Exploration in the Sphere of Experimental Archaeology

We must set off from the premise that not everything done under the label of experimental archaeology is actually just that, or that it cannot be categorised in the same way. Javier Baena (1997) distinguishes between non-rigorous experimental models or know-how models, rigorous models with little or low control of variables, and rigorous models with a high control of variables.

Despite the fact that the experiential path is usually reviled, in favour of the experimental, our starting point consisted of various pilot experiences or pre-experiences, by way of an exploratory path, for the acquisition of skills or testing equipment. Experimentation also has a heuristic role, although only those clearly adopting a scientific approach should use the term experiment (Morgado and Baena, 2011). There is always, of course, an element of experience in an experiment, but not always an experiment in an experience (Cunningham et al., 2008)

In the case of our experiments, we tended to carry out the experimental workshop days, conceived as public demonstrations with didactic goals oriented towards showing different processes relating to prehistoric technologies, and assuming the premise of the didactic capacity of errors (Flutsch, 1994).

Experimental Archaeology and Academic Research

The role of experimental archaeology in academic research is to place models that have been proposed in theory into actual practice, with the goal of validating or modifying the premises tested, as well as to explore and obtain new ideas; at the same time, they bring significant information of a sensory and technical nature to the archaeological research projects. The rolling out of the research is structured around the concept of the *Chaîne Opératoire* (CTO: Technical Operatory Chain), as defined by Andre Leroi-Gourham, and used in archaeology to outline the sequence of actions involved in the production of an artefact (See Figure 13). The anthropology of technique studies, the processes involved in human productions, and the

difference between technique and technology is fundamental, although both are related, since they determine both the process and the result obtained. As M. Martinón-Torres (2002) has pointed out, it is more a matter of a combination of complementary approaches that are aimed at a holistic understanding of the role of technologies in past societies, and is indeed a useful tool from an analytical point of view. We can take on the study of the archaeological register through characterisation by type, but the technological approach to the processes involved is widely enriching, and a link is established through ethnoarchaeology.

In archaeometallurgy, readings about the manufacture of archaeological objects are very difficult, since, as a general rule, the metallic archaeological object has been produced through a succession of independent processes, the development of which is not traceable by setting out just from one artefact. As a general theoretical model, for its study we adopt a biographical approach that presupposes one phase of production, one phase of circulation, and another of amortisation or consumption.
To obtain information about the CTO of an artefact, the archaeological context and evidence detected about the productive process are fundamental. Through the varied techniques available nowadays and the knowledge acquired in the area of materials science (archaeometallurgical studies), some information about the CTO can be inferred although it is not possible to give a full sequential reading. For instance, on the basis of analyses of elemental characterisation, the standard of metal or of alloy used can be established; from metallographic analyses, the micro-structure of the objects can be observed, thus obtaining information about the final processes in achieving the shape of the objects; through the analyses of isotopes, indications can be achieved on the identification of the origins of the metal in relation to the mineral deposits. It is not, however, possible to determine with certainty how the alloy was obtained: by addition of different metals or simultaneous reduction of different minerals? It is not possible to establish the intended efficiency of use of an object nor its lifespan, and on occasions it can be difficult to distinguish if minerals from different origins would have been mixed, whether the metals would have been recycled frequently or not, and what the advantage of recycling over repairing a broken or defective piece would be.

Based on this information and of ethnoarchaeology, theoretical models of metallurgical production are proposed, taking into account the evidence available in the archaeological context. These models constitute the basis for the design of the archaeometallurgical experiments that we carry out. Taking these premises as our starting point, we have promoted the development of these research projects either in relation to university teaching activity and in particular in the framework of academically supervised work, or in the development of a research network.

Related to the phase of extractive metallurgy, we have not developed experimental proposals dealing with extraction of metallic minerals, although we have tried to introduce minerals that

we ourselves have obtained in the north west of our peninsula, either directly from the spoil heaps of historic mines, or through collaboration with geologists or amateur mineralogists. In the case of copper, we have been working with malachite from the zone of Valdeorras (Ourense) (Lackinger et al., 2013) (collected by ourselves from historical heaps), and in the case of tin, we have worked with cassiterite from the mines at Penouta (Viana do Bolo, Ourense) (provided by and amateur mineralogist) and Gondiães (Portugal) (collected by ouselves with collaboration of a geologist) (Figueiredo et al., 2016) (See Figure 14).

In the same way, within the scope of the activity of the Early Iberian Tin Group, we have presented the experimental route as a fundamental element of research, which has already allowed us to unwrap scientific research in the sphere of reduction of tin alone, as well as in conjunction with copper (Comendador et al., 2015; Comendador et al., 2017).

With regard to the experiments relating to the reduction of copper-based minerals, at a theoretical level, it has been proposed that there are three possible ways of manufacturing bronze, and that all of them were used in the Iberian Peninsula between Prehistory and Protohistory. The first of these, known as co-reduction, consists of obtaining bronze from a mixture of copper minerals and tin minerals, which are smelted (reduced) together in a metallurgical structure. From this kind of process, metallic prills of various compositions were obtained which had afterwards to be melted together to manufacture bronze with a specific tin content. The second, known as cementation, consists of obtaining the bronze alloy through the reduction of tin minerals directly on metallic copper. The last of the possible formulas for obtaining bronze is to perform the reduction of copper and the reduction of tin minerals separately, and afterwards melt the two metals together to obtain an alloy. The activities we developed have explored these three possibilities experimentally with positive results, allowing us to delve deeper into extractive metallurgy from an empirical perspective (Figueiredo et al., 2016; Lackinger et al., 2013; Lackinger, 2015).

With regard to the production of artefacts of a prehistoric type, we have explored different materials and techniques. Ceramic moulds, both bivalve and lost wax (Lackinger and Comendador, 2013) has been tested, and of bivalve stone moulds, both sandstone and steatite (Lackinger, 2014). These experiments help us improve our understanding regarding the materials and techniques used to manufacture bronze objects during Prehistory. Also, one of us has undertaken a study on the different shapes and forms of putting wood handles on flat copper axes (Comendador and Méndez, 2007).

More recently, we have begun the first experiences relating to the reduction of iron. Although these attempts can be classified as a preliminary approach, with modest results and still in process of evaluation, we hope to extend them further in the future.

In the experiences of an experimental nature, measurements are made on the quantities of minerals used, times and temperatures. The temperatures are checked by means of a K type

thermocouple, fitted onto Pico TC-08 equipment, monitored by a portable computer, using the team's own software. The logistic support of a team of researchers, specialists in archaeometallurgy, is fundamental for the task carried out, allowing us to implement analytical results after our experimental research. For the analysis of the materials involved in the process of reduction, both the earlier ones (coal, minerals and fired ceramics) and the later ones (tin, copper, bronze, slag), after their quantification, representative samples are taken of each one of the products. Subsequent analysis include elemental (composition), mineralogical, and micro-structural analyses performed by X-Ray Fluorescence Spectrometry (XRF), X-Ray Diffraction (XRD), Optical Microscopy (OM), and Scanning Electron Microscopy (SEM-EDS) (Figueiredo et al., 2016). Tin isotopic analysis has also been conducted in the scope of an international collaboration with the project “Bronze Age Tin - Tin Isotopes and the Sources of Bronze Age Tin in the Old World” (ERC project) (Berger et al., 2016).

It is important to point out that all these activities have been being carried out in the Iberian Peninsula without a specific funding obtained by any national call. The work has been performed based in work synergies, collaboration between researchers and institutions, and a desire to opening up this path of research, in the hope that future specific funding will be possible to support and further develop the activities just described.

Dialogues between Disciplines

In our contemporary day-to-day living, the undertaking of activities that involve heating/high temperatures, translates almost exclusively into cookery, despite the fact that not many kitchens are equipped with solid fuel these days. The current historic moment, described by some as the technological era is, to a large extent, distanced from the technological implications of the products consumed, which is due to the disappearance of traditional lifestyles, where artisan activities used to make that link clear. Today, the separation of production into areas of maximum specialisation, hinders the individual from assimilating the whole process which is hidden behind any artefact. Therefore, the recreation of those same processes, such as for instance, a possible CTO to obtain metal from the mineral, or the production of a metallic artefact, nowadays causes great impact and even generate interest among the younger generation (See Figure 15).

At the same time, it becomes clear that there is need to promote knowledge of artisan activities, besides boosting the exchange of experiences, resulting in a broadly enriching dialogue between disciplines. The transfer of ideas about the processes experienced by individuals, at a variety of events (public experimental demonstrations, thematic workshops, specific conferences), has generated not just interesting conversations, but also tested the complementarity between the languages of different spheres: the language of archaeology through paying greater attention to the register and the archaeological evidence; the physical-chemical and archaeometric language, greater attention to materials science phenomena; and finally the artisan language, that includes the relation of human contact with

the material and experiential facets, which should be considered as a vital perspective. The result of such complementary work, is the ethnoarchaeological research undertaken with regard to traditional methods to obtain tin in Galicia (Lackinger et al., 2014) (See Figure 16).

In addition, anthropology is fundamental not only for the interpretation of archaeological remains in their widest cultural dimension and to help establish experimental archaeology protocols in the archaeometric study, but also for the teaching and socialisation of knowledge generated by archaeological research.

Finally, the objective is to make people aware of the necessary cross-disciplinary and dialogical relationship which experimental archaeology is able to deliver, outstretching the spread of archaeological knowledge, and the creation of a critical awareness of the value of cultural heritage and its social use.

To Communicate and Transfer

We believe that in recent years, Archaeology and the sphere of Cultural Heritage have reflected on their social repercussions in a way that few other disciplines have done. This is related to the diffusion of knowledge, not only between more restricted and specialised groups (e.g. academic groups), but also to a whole community or public. The profession's new paradigms demonstrate there is no excuse for not attending to this type of tasks through informative magazines, the press, and other series of events directed at society as a whole. However, this task lacks recognition in the academic sphere, where it is considered a secondary activity and given little value. In addition, the hierarchical paradigm, based on the model of first researching and publication of results, is still the predominant one, although things are beginning to change through the growing processes of empowerment of civil society over archaeological and cultural heritage in general, and the growing of thematic touristic programs that are also assumed to valorise cultural heritage and cultural development.

Lately, living history events have multiplied, some of them have very scant didactic capacity, stressing props and focusing on free-form activities under the label of experimental archaeology, although they are actually not that at all. It is a matter of a simple conversion to social/didactic archaeology of something that is not so dressed up as something didactic, when it is more practically considered a play in a historic setting. This practice means a kind of modern theatre, although we do not wish to cast aspersions on the role of theatre, given that on most occasions it is the most significant form in which our discipline interacts with people.

As a discipline which can join two worlds, that of the specialist academic, interested in analytical/scientific/archaeological studies, and that of the man on the street, what is fundamental is to pitch for awareness raising in the more academic and scientific media

about the importance of experimental archaeology and its role as an activity of social and educational transfer. As a result, in the medium to long term experimental archaeology will bring benefits for more detailed and scientific heritage studies, both in the form of funding, and in the form of greater capacity to retain human resources specialising in cultural heritage.

Finally, it would enable us to cover gaps such as the use of new languages of communication, despite the technological facilities or the development of specific materials for didactic use.

Final Remarks

Carrying out this type of activities enables us to hold a dialogue with different spheres of society, in which learning is reciprocal. Without doubt our knowledge grows with each experience. Generally speaking, the set of developed activities have transcended from a theoretical, a practical, and an experimental level, which allows us to:

1. Explore the sphere of experimental archaeology and distinguish between complete experiments, pilot-experiences, pre-experiences, experimental activities, public demonstrations and hobby projects;
2. Introduce experimental archaeology into academic research;
3. Improve communication between the academic experimental archaeologists and artisans;
4. Communicate experiments for the academic community to the general public.

Keywords metallurgy
experience
archaeological open-air museum
didactics
education

Country Spain

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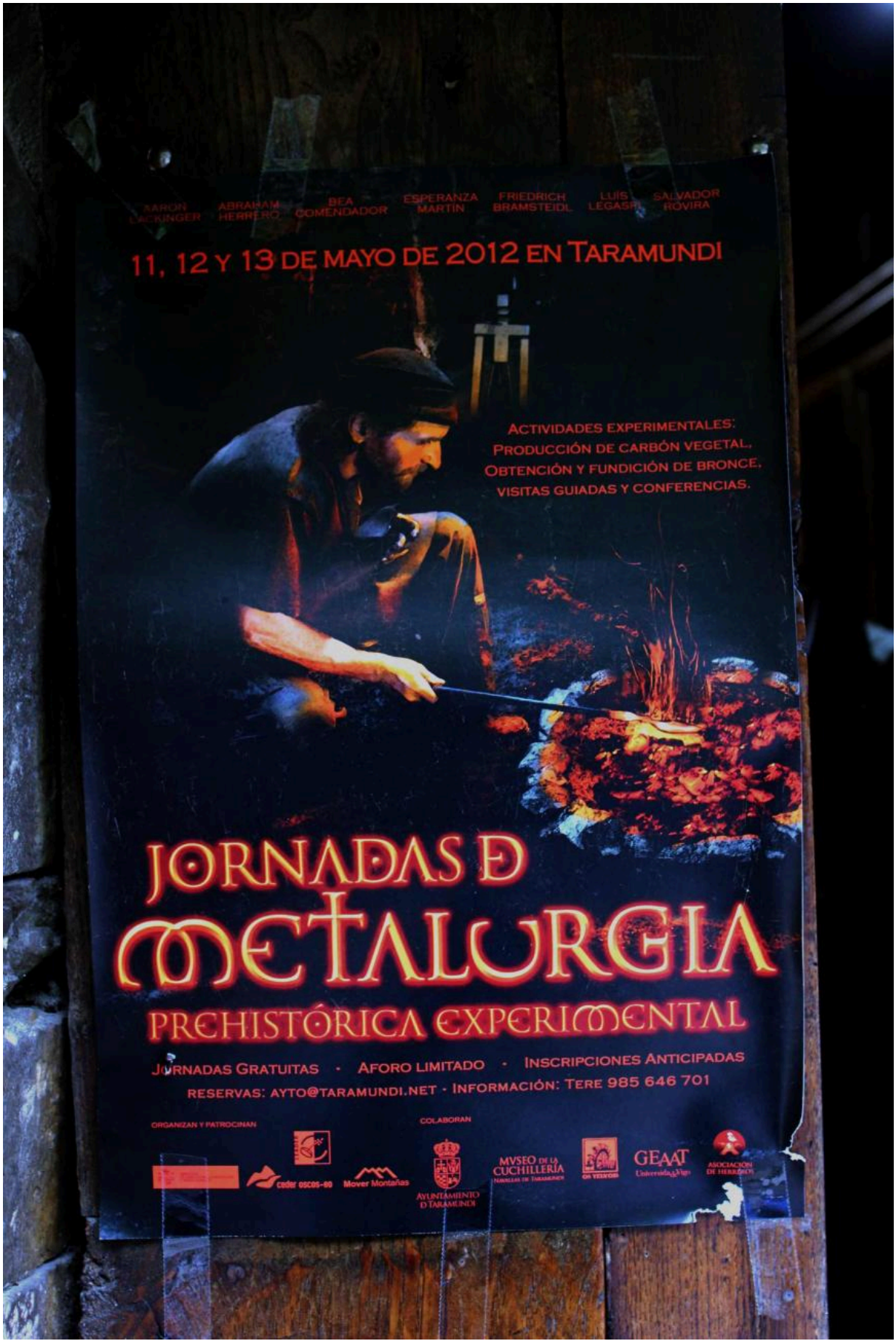

FIG 1. EXPERIMENTAL ARCHAEOMETALLURGY WORKSHOP DAYS, TARAMUNDI, (ASTURIAS, SPAIN), MAY 2012. COPYRIGHT: BEATRIZ COMENDADOR

FIG 2. EXPERIMENTAL METALLURGY WORKSHOP DAYS, TARAMUNDI (ASTURIAS, SPAIN), DECEMBER 2014

FIG 3.COPPER-TIN SMELTING IN THE CLOSOS DE CAN GAIÀ PREHISTORIC ARCHAEOLOGICAL SITE, WORKSHOP DAY AT PORTOCOLOM, FELANIXT, MAJORCA, AUGUST 2013. COPYRIGHT: BEATRIZ COMENDADOR

FIG 4. EXPERIMENTAL ARCHAEOLOGY PREHISTORIC WORKSHOP DAY, FUENTES DE LEÓN (BADAJOZ, SPAIN), DECEMBER 2013. COPYRIGHT: BEATRIZ COMENDADOR

FIG 5. COURSE “TRANSFORMING MATERIALS, AN INTERDISCIPLINARY APPROACH TO THE PRODUCTION OF BRONZE OBJECTS”, ROCK ART ARCHAEOLOGICAL PARK (CAMPO LAMEIRO, SPAIN), OCTOBER 2013. [PHOTOGRAPH] (DARÍO PEÑA 2013). COPYRIGHT: DARÍO PEÑA

FIG 6. EXPERIMENTAL WORKSHOP, MONTE DA CONDESA, CAMPUS OF THE UNIVERSITY OF SANTIAGO (SPAIN), 2014-15. COPYRIGHT: BEATRIZ COMENDADOR

FIG 7. WORKSHOP ON COPPER-TIN METALLURGY, OURENSE CAMPUS, UNIVERSITY OF VIGO (SPAIN), 2014-15. COPYRIGHT: BEATRIZ COMENDADOR

FIG 8. WORKSHOP ON DECORATED POTTERY, OURENSE CAMPUS, UNIVERSITY OF VIGO (SPAIN), 2014-15. COPYRIGHT: BEATRIZ COMENDADOR

FIG 9. EXPERIMENTAL WORKSHOP, ROCK ART ARCHAEOLOGICAL PARK (CAMPO LAMEIRO, SPAIN), APRIL 2016.

FIG 10. IRON EXPERIMENTAL WORKSHOP, MUSEUM OF TRADITIONAL KNIVES, TARAMUNDI (ASTURIAS, SPAIN), APRIL 2016. COPYRIGHT: BEATRIZ COMENDADOR

FIG 11. EXPERIMENTAL WORKSHOP “UNA GIORNATTA AL SOLE”, ROCK ART ARCHAEOLOGICAL PARK (CAMPO LAMEIRO, SPAIN), APRIL 2017. COPYRIGHT: BEATRIZ COMENDADOR

FIG 12. DAY OF EXPERIMENTS ORGANISED AT THE REQUEST OF THE MARCO DO CAMBALLÓN SECONDARY SCHOOL, VILA DE CRUCES (SPAIN), MAY 2015 . COPYRIGHT: BEATRIZ COMENDADOR

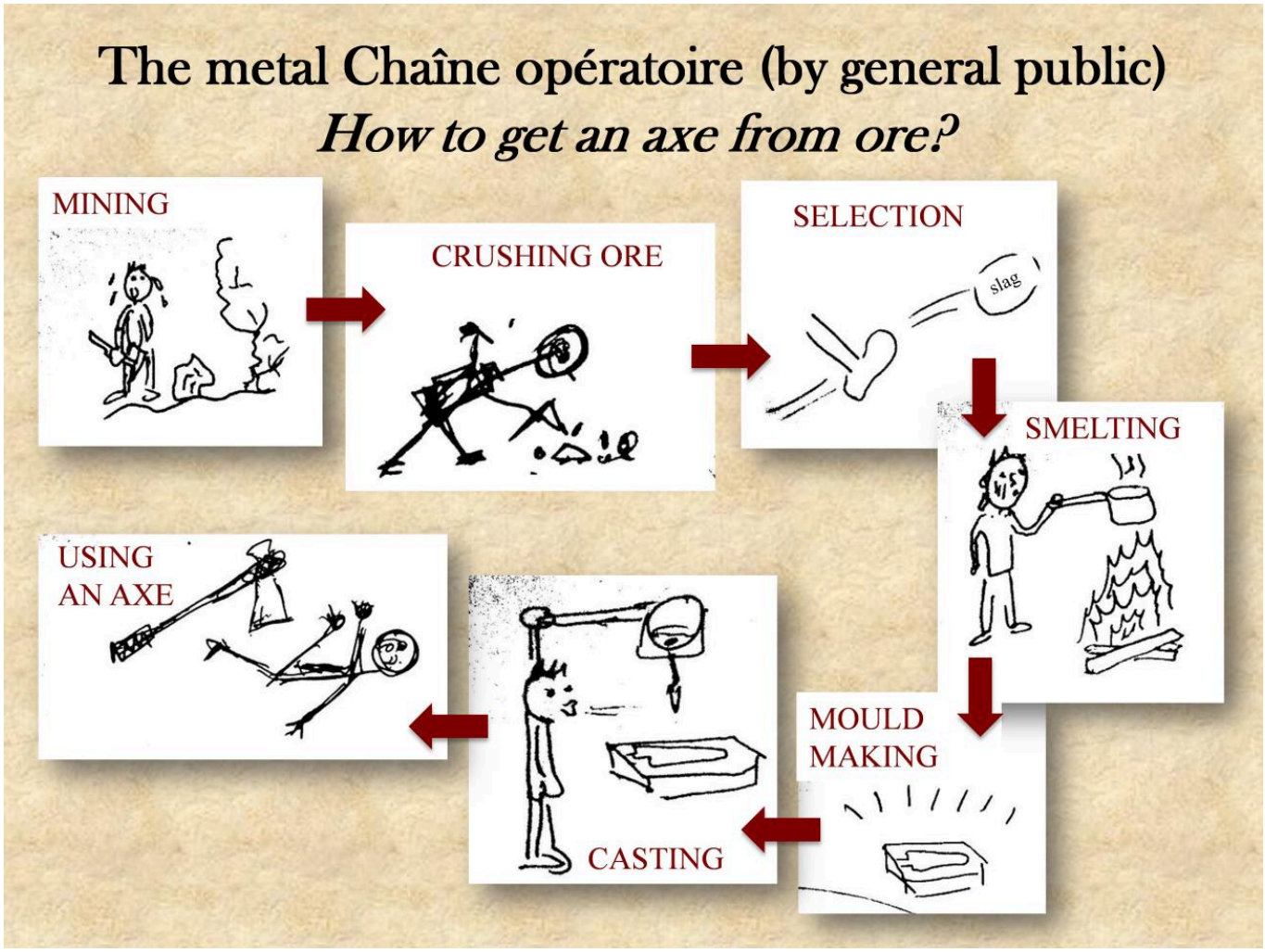

FIG 13 THE METAL CHAÎNE OPÉRATOIRE (BY GENERAL PUBLIC). COPYRIGHT: BEATRIZ COMENDADOR

FIG 14. MALACHITE FROM THE ZONE OF VALDEORRAS (OURENSE, SPAIN) AND CASITERITE FROM THE MINES AT PENOUTA (VIANA DO BOLO, OURENSE, SPAIN) . COPYRIGHT: BEATRIZ COMENDADOR

FIG 15 OBTAINING METAL FROM THE MINERAL OR THE PRODUCTION OF A METALLIC ARTEFACTS RECEIVED A LOT OF INTEREST. COPYRIGHT: BEATRIZ COMENDADOR

FIG 16. MR. MAMEDE GARCÍA IN HIS TRADITIONAL FORGE (PENTES, OURENSE). SMELTING CASSITERITE AND CASTING A TIN INGOT IN AN TURNIP MOULD, APRIL 2013. COPYRIGHT: BEATRIZ COMENDADOR