This collection presents state-of-the-art approaches to the use of inorganic raw materials in the period known as prehistory. It focuses on stone tools, adoptions, colorants, and pottery from Europe, America, and Africa. The chapters interwoven archaelogy, anthropologists, ecologists, and social complexity. The book represents a framework of raw material investigation for those working in isolation, regardless of the time period, region of the world, or materials they are studying.

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The Exploitation of Raw Materials in Prehistory
The Exploitation of Raw Materials in Prehistory: Sourcing, Processing and Distribution

Edited by
Telmo Pereira, Xavier Terradas and Nuno Bicho

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TABLE OF CONTENTS

Foreword .................................................................................................................. xi
Telmo Pereira, Xavier Terradas, Nuno Bicho

Contributors ....................................................................................................... xiii

Chapter One ........................................................................................................... 1
Flint Outcrops and Behavioral Flexibility: Testing the Hypothesis
of Recycling Acheulian Handaxes at the Middle Paleolithic Workshop
Giv'at Rabi East, Lower Galilee, Israel
Alla Yaroshevich, Maayan Shemer

Chapter Two ......................................................................................................... 15
Raw Material Diversity, Availability and Sourcing in the River Lis Basin,
Central Portugal
Telmo Pereira, Eduardo Paixão, Vânia Carvalho, Susana Carvalho,
Telmo Gomes

Chapter Three .................................................................................................... 30
Quarrying as a Socio-Political Strategy at the Mesolithic-Neolithic
Transition in Southern Norway
Astrid J. Nyland

Chapter Four ....................................................................................................... 46
An Analysis of the Use of Quarries and Workshops by Late Prehistoric
People in Western Pennsylvania
Beverly A. Chiarulli

Chapter Five ...................................................................................................... 62
Identifying Iron-Rich Raw Material Sources with a Multi-Technique
Approach: Some Analytical Problems Detected in the Case Study
of a Prehistoric Mine-Cave From Southern Italy
Luca A. Dimuccio, Ana M. Amado, Luís A. E. Batista De Carvalho,
Felice Larocca
Chapter Six ................................................................................................................. 77
Neolithic Flint Quarries on Montvell (Catalan Pre-Pyrenees, NE Iberia)
Xavier Terradas, David Ortega, Dioscorides Marín, Alba Masclans,
Carles Roqué

Chapter Seven ........................................................................................................... 90
Domoszló: Grinding Stone and Millstone Production Centre in Hungary
Bálint Péterdi, Katalin T. Biró, Zoltán Tóth

Chapter Eight ............................................................................................................ 98
The Use of Non-Destructive Energy Dispersive X-Ray Fluorescence
Analysis (EDXRF) for Sourcing Flint in Northern Europe:
Progress to Date and Prospects for the Future
Deborah Olausson, Anders Högberg, Richard E. Hughes

Chapter Nine .............................................................................................................. 113
Near Infrared Imaging Spectroscopy for Raw Materials Characterization:
The Example of a Mesolithic Dwelling Site in Northern Sweden
Claudia Scuito, Johan Linderholm, Paul Geladi

Chapter Ten ................................................................................................................. 121
Siliceous Raw Material Sources at La Sierrita De Ticul, Yucatan, Mexico:
A First Approach of Lithic Procurement During Late Pleistocene
and Early Holocene in the Maya Lowlands
Maria Alejandra Espinosa, Gabriela Armentano

Chapter Eleven ......................................................................................................... 134
Terrain Difficulty as a Relevant Proxy for Objectifying Mobility Patterns
and Economic Behaviour in the Aurignacian of the Middle Danube
Region: The Case of Stratzing-Galgenberg (Austria)
Luc Moreau, Guido Heinz, Anja Cramer, Michael Brandl,
Oliver Schmitsberger, Christine Neugebauer-Maresch

Chapter Twelve ...................................................................................................... 148
Chert Chemical Composition Analysis for Geoarchaeological Application
Liga Zarina, Valdis Seglins

Chapter Thirteen ..................................................................................................... 161
Preliminary Geochemical Results (ICP-MS) of Flint Debitage from
an Extensive Paleolithic and Neolithic/Chalcolithic Extraction and
Reduction Complex in the Eastern Galilee, Israel
Meir Finkel, Ran Barkai, Avi Gopher, Ofir Tirosh, Erez Ben-Yosef
The Exploitation of Raw Materials in Prehistory

Chapter Fourteen ................................................................. 174
The Zambujal’s Arrowheads: A Petroarcheologic Approach to Flint’s Provenance Determination
Patricia Jordão, Nuno Pimentel

Chapter Fifteen ................................................................. 191
Testing a New Methodological Approach to Define the Use of Dolerite Outcrops for Prehistoric Tools Production in Mediterranean Iberia
Teresa Orozco Köhler, Gianni Gallello

Chapter Sixteen ................................................................. 205
“What does your Saddle Quern come from?” Grinding in the Contemporary Province of Limburg (BE) during the Iron Age
Else Hartoch, Tatjana Gluhak, Roland Dreesen, Eric Goemaere

Chapter Seventeen ............................................................ 222
What For These Blades? Flint Blades Production and Circulation in Final Neolithic Sardinia
Barbara Melosu, Carlo Lugliè

Chapter Eighteen ............................................................. 234
Siliceous Raw Material Exploitation at Hort De La Boquera Site (Margalef De Montsant, Tarragona, España): First Results from La-Icp-Ms Analysis
Maria Rey-Solé, Anders Scherstén, Tomas Naeraa, Deborah Olausson, Xavier Mangado

Chapter Nineteen ............................................................. 250
Compositional Analysis on Lithic Beads: The Case of the Lower Paraná Wetland, Argentina
Natacha Buc, Romina Silvestre, Alejandro Acosta, Daniel Loponte

Chapter Twenty ............................................................... 265
Flint Variability in a Cardial Context: A Preliminary Evaluation by Portable X-Ray Fluorescence of Artefacts from Cerradinho do Ginete (Portugal)
António Faustino Carvalho, Telmo Pereira
Chapter Twenty One................................................................................ 284
Flint Procurement and Transportation in the Middle Paleolithic in the North-Eastern Coast of Azov Sea (Preliminary Results)
Ekaterina V. Doronicheva, Andrey G. Nedomolkin, Marianna A. Kulkova, Marina V. Gerasimenko

Chapter Twenty Two................................................................................ 305
Long Distance Obsidian Distribution and the Organisation of Palaeolithic Societies
Theodora Moutsiou

Chapter Twenty Three............................................................................. 320
Raw Lithic Material Reservoirs or “Cache” Record in the Ecotonal Humid Dry Pampean Area, Argentina, as a Strategy for Supply and Territorial Marking
Fernando Oliva

Chapter Twenty Four............................................................................... 336
Chert Acquisition in the Final Upper Palaeolithic and Mesolithic: Territory Contraction in Southwestern France?
Guilhem Constans

Chapter Twenty Five ............................................................................... 354
Alpine Jades: From Scientific Analysis to Neolithic Know-How
Pierre Pétrequin, Anne-Marie Pétrequin, Estelle Gauthier And Alison Sheridan

Chapter Twenty Six.................................................................................. 368
Site Catchment Analysis and Human Behaviour during the Upper Palaeolithic in the Cantabrian Region. Coimbre Cave (Asturias, Spain) as a Case Study
María De Andrés-Herrero, David Álvarez-Alonso, Álvaro Arrizabalaga, Daniel Becker, Gerd-Christian Weniger, José Yravedra

Chapter Twenty Seven.............................................................................. 382
A Spatial Approach to the Study of Competition between Toolstones in Specific Regional Contexts
Gustavo Barrientos, Luciana Catella
Chapter Twenty Eight ................................................................. 400
Distinguish the Similar: The Chemical Composition of Mineral Inclusions in the Ceramic Pastes as Tracer of the Source of Raw Materials
Benjamin Gehres, Guirec Querré

Chapter Twenty Nine ............................................................... 414
The Technology of Neolithic Pottery North and South of the Western Carpathians
Slawomir Kadrow, Anna Rauba-Bukowska

Chapter Thirty ................................................................. 432
Technological Diversity of the Early Neolithic Pottery of the Muge Shellmiddens (Portugal): The Case Study of Cabeço da Amoreira
Ruth Taylor, Daniel García Rivero, João Cascalheira, Nuno Bicho

Chapter Thirty One ............................................................ 449
Pottery for the Dead: Exploring Raw Material Exploitation in the Pottery of Can Gambús-1 (Sabadell, Catalonia)
Miriam Cubas, Miguel Angel Sánchez Carro, Jordi Roig, Joao Manuel Coll Rieratt, Juan Gibaja

Chapter Thirty Two ............................................................. 463
Raw Materials and their Use in the Making of Pottery from Basagain (Basque Country, Spain): Archaeological and Experimental Research
Judit López De Heredia, Javier Peña Poza, Juan Félix Conde Moreno, Fernando Agua Martínez, Manuel García-Heras

Chapter Thirty Three .......................................................... 477
Technological and Functional Identification of Cooking Slabs: Evidence from the Bronze Age Pile Dwelling Settlement of Grotta di Pertosa (Salerno, Southern Italy)
Delia Carloni, Felice Larocca, Levi Sara Tiziana, Valentina Cannavò

Chapter Thirty Four ............................................................ 492
Investigating the Source of Blue Color in Neolithic Beads from Barcin Höyük, Nw Turkey
Ayşe Bursali, Hadi Özbal, Rana Özbal, Gülsu Şimşek, Barış Yağci, Ceren Yılmaz Akkaya, Emma Baysal
Table of Contents

Chapter Thirty Five .................................................................................................................. 506
Neolithic Materials and Materiality in the Foothills of the Zagros Mountains
Amy Richardson

Chapter Thirty Six .................................................................................................................... 520
The Bead-Maker’s Toolkit: The Circulation of Drilling Technologies and Gemstones in the “Middle Asian Interaction Sphere”
Federica Lume Pereira, Giuseppe Guida, Ulrike Müller, Massimo Vidale

Chapter Thirty Seven .............................................................................................................. 538
The Sources of Some Obsidian Beads Found at Kish, Southern Iraq
Stuart Campbell, Elizabeth Healey

Chapter Thirty Eight .............................................................................................................. 549
Prehistoric Pigments in the Hungarian National Museum
Katalin T. Biró, Tamás Vácz

Chapter Thirty Nine ............................................................................................................... 560
The Geo-Mineralogical Approach in Ochre Provenance Studies
Giovanni Cavallo, Maria Pia Riccardi, Roberto Zorzin

Chapter Forty .......................................................................................................................... 572
Iron Oxide Artefacts in Late Prehistoric Corsica: Towards a Physico-Chemical Characterisation
Marylyne Lambert, Robin Skates, François-Xavier Le Bourdonnec, Stéphan Dubernet, Kewin Peche-Quilichini, Hélène Paolini-Saez, Jean Louis Milanini, Yannick Lefrais

Chapter Forty One .................................................................................................................. 587
Finding Chemical and Physical Evidence of Heat Treatment of Ochre by Using Non-Destructive Methods: A Preliminary Study
Marine Wojcieszak, Tammy Hodgskiss, Lyn Wadley

Chapter Forty Two .................................................................................................................. 601
Experimental Implications for Flint Heat Treatment at Hasankeyf Höyük
Osamu Maeda

Chapter Forty Three .............................................................................................................. 613
Mechanical Experiments to Test Quartzite vs Chert Edge Reduction
Telmo Pereira, João Marreiros, Eduardo Paixão, Rui Martins
CHAPTER THIRTY TWO

RAW MATERIALS AND THEIR USE
IN THE MAKING OF POTTERY FROM BASAGAIN
(BASQUE COUNTRY, SPAIN):
ARCHAEOLOGICAL AND EXPERIMENTAL
RESEARCH

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Abstract

Basagain is an Iron Age fortified site located on the north-eastern side of the Basque Country (Spain). As is common in other Iron Age sites of the region, evidence has been found of the coexistence and complementarity of two types of pottery production, which can be differentiated by their own
modes of production and use, even though both were made with the same basic raw materials but with different preparation processes.

This contribution presents the results derived from an archaeometric study carried out to determine the clay sediments and the tempers probably used in the making of mainly hand-made pottery from Basagain. A representative set of raw materials from the surroundings of the Basagain site was prepared in the laboratory, with the aim of comparing them with the archaeological material. The same characterization techniques used with archaeological items were applied: petrographic analysis by thin section and X-ray diffraction (XRD). The resulting data suggest that the clays used by Basagain potters were quite similar to clay sediments sampled in this study, as the main characteristics of these clay sediments are shared with archaeological ceramic potsherds previously analysed.

**Keywords:** Pottery, Iron Age, Archaeometry, Raw materials, Clay, Temper

**Introduction**

It is well known that, within the process of ceramic production, the catchment and selection of raw materials and their conditioning to make recipients are important steps in the production sequence of the ceramic material. The choice of the clay and/or the non-plastic materials (tempers) is an aspect that has a decisive influence on the development of artefacts. The use of different clays determines the time of drying and the degree of plasticity of the material, as well as the final properties of this material once fired.

As far as inclusions are concerned, on Basque Iron Age sites the only deliberately added temper is calcite (López de Heredia 2015; Olaetxea 2000). This calcium carbonate provides a higher mechanical and thermal resistance to the vessels, thereby reducing, in addition, the drying time. However, a well-known post-depositional process causes calcite dissolution, leaving only marks or voids due to its previous presence.

The aim of this contribution is to present the results derived from an archaeometric study carried out to determine the clay sediments and non-plastic materials possibly used in the making of the pottery recipients coming from Basagain (Basque Country, Spain). In a previous project several aspects such as typology, decoration, or the raw materials used were studied (López de Heredia and García Heras 2015). Therefore, the next phase in the research was to fix which could be the possible resources of these raw materials.
The Archaeological Site of Basagain

This site represents the ideal fortified site at the top of a hill from the Oria valley in Anoeta, Basque Country (Spain). It is located at an altitude of 295 m above sea level, and about 650 m away from the Oria River and has an area of 2.81 ha. Basagain was settled during the Iron Age, from the sixth to fourth centuries BC, and during the early Roman period. Its visual control is remarkable, it is in a line of three other sites which allows the control of the entire Oria valley from the coast to inland (fig. 32.1).

Fig. 32.1. Basagain location on the geological map from the IGME (Spanish Mining Geological Institute) and clay sediment samples taken in the vicinity of the site.

The site has two areas: the habitat zone and the other in which numerous stela have been found. Both areas are surrounded by a stone wall of approximately 720 m. Basagain shows different economic activities, such as farming (with evidence consisting of seeds, mills and a plough), or metallurgy (with elements made by iron and the appearance of some slags). On the other hand, the product of some exchange has been also attested by the appearance of a glassy paste bracelet, a possible necklace, and a denarius.

A single archaeological level has been identified (Peñalver n.d.; Peñalver 2008), which is in conjunction with the ceramic material found
(López de Heredia and García Heras 2015). On the whole, this material presents a notable homogeneity in terms of production.

**Geological Background**

Regarding its geological context, Basagain sits on Jurassic sediments: dolomites, dolomitic limestones and nodular limestones, being close conglomerates, ophites, sandstones and red clays (fig. 32.1).

On the other hand, as is usual in this region, a conservation problem of calcium carbonates, such as calcite, also occurs in Basagain. Those ceramics that contain this type of temper lose these carbonates during burial and even part of the surfaces of the vessels.

Due to the acidity of the soils (the average pH is 6.4) and the action of the water (it is a very rainy region), the dissolution of calcite and its disappearance from the pottery usually occurs. However, their traces with the characteristic shapes of the calcite inclusions remain, thereby allowing their identification (Berducou 1990: 91; Olaetxea 1995: 95–96; Quinn 2013: 207)

**Pottery at Basagain**

There were many types of pottery production in the Iberian Peninsula during the Late Iron Age. Nevertheless, in this region, two types of pottery coexist, differentiated by their own modes of production. The differences are very noticeable in morphology and decoration, and also in their fabric, with the use of calcite as the sole temper in hand-made pottery and the clean clays of the wheel-made pots. Both types of pottery wares share some uses.

In Basagain, the percentage of wheel-made pottery is much lower than hand-made pottery (less than 1%) (López de Heredia and García Heras 2015). On the other hand, it was possible to identify common potsherds of Roman pottery, probably a product of exchange.

The pottery found has functions relating to storage, handling and consumption, either in hand-made or wheel-made pottery. With regard to the decorations found, for hand-made pottery there are many decorated potsherds: fingertip impressions on the walls, applied cordons with fingertip impressions, and so on. However, due to the almost lack of wheel-made pottery, only one potsherd was decorated consisting of a moulded straight line.

The clays used are illitic-kaolinitic and montmorillonitic, with crushed calcite deliberately added for hand-made pots (in fact, the only highlighted
difference between petrographic groups was the percentage of calcite), and a highly levigated clay for wheel-made pots (López de Heredia and García Heras 2015). The hand-made pottery was mainly fired in a heterogeneous atmosphere, while the wheel-made pots were fired in a predominantly oxidizing atmosphere. The firing temperature was quite low in both types of ware, at around 700°C in hand-made pottery and 700-800°C in the wheel-made pottery, since neoformed phases, such as gehlenite, were not detected in XRD analysis.

**Methodology and the Experimental Part**

As previously mentioned, product acquisition and the selection of raw materials and their preparation are some of the most important variables that influence the making of a ceramic pot.

With the aim of understanding the production processes, a representative set of raw materials obtained in the surroundings of this site was prepared and experimentally fired in the laboratory, following the same sequence of production as that determined for the archaeological ceramic materials, which had been previously assessed (López de Heredia and García Heras 2015). This work is focused on hand-made pottery as it is the main type of pottery production at Basagain. Wheel-made pottery will be analysed in future research. In addition, archaeological adobe or sun-dried bricks from Basagain were also analysed.

The selection of possible raw materials was carried out from sheets numbered 64 and 89 of the Geological Map from the Geological and Mining Institute of Spain (IGME) and after prospecting the area in situ. Due to the characteristic lithology of the region and its accessibility, a total of 5 clay sediment samples (fig. 32.1) were collected to assess and determine their potential in the elaboration of pottery. The election of a collection perimeter of approximately 2 km responds to previous experimental experiences carried out in other similar and close sites, such as Santiagomendi, Los Castros de Lastra and La Hoya (López de Heredia 2015). The main lithological characteristics of these 5 samples are as follows:

- Sample 1: Clay, dolomite, limestone-dolomite and nodular limestones;
- Sample 2: Massive sandstones and red clays;
- Sample 3 and 4: Dolomites, nodular limestone-dolomite and limestone. These samples are treated together as their proximity implies that they belong to the same sediment;
- Sample 5: Ophites.
Samples were sieved and later prepared with different mixtures of sediments and non-plastic materials. A total of ten briquettes per sample were prepared: 4 briquettes were vegetable tempered, another 4 were tempered with calcite and the remaining 2 were without any temper (Tab. 1). The calcite used in this experiment came from a source 40 km away. It was used because it is similar to that found in pottery from other archaeological sites, since calcite is not conserved in potsherds from Basagain. 4 briquettes per sample (table 32.1) were eventually fired in an electric kiln in an oxidizing atmosphere up to a maximum temperature of 750°C.

Table 32.1. Mixtures of clay and temper used in the experimental briquettes.

<table>
<thead>
<tr>
<th>Sample number</th>
<th>Vegetable tempered number of briquettes</th>
<th>Calcite tempered number of briquettes</th>
<th>Non tempered number of briquettes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Raw</td>
<td>Fired</td>
<td>Raw</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
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<td>4</td>
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<td>2</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

An important point to be highlighted is that the dissolution of carbonates has been taken into account in the simulation of archaeological sherds in the laboratory. In some fired briquettes the dissolution process has been accelerated using diluted hydrochloric acid (HCl). Thus, it is possible to observe how, by means of its dissolution, the inclusions of calcite leave their characteristic rhombohedral shape.

Finally, the same characterization techniques used with archaeological sherds and adobe sun-dried bricks were applied: petrographic examination by thin section and X-ray diffraction (XRD).

The microscope used in the petrographic analysis was a Kyowa BioPol 2 transmitted light optical microscope with a polarization device, with four lenses (2x, 4x, 10x, 20x) and an eyepiece lens (10x). Micrographs were obtained with the digital camera Moticam 2500. Measurements have been carried out through the software ImageJ, which works on these same micrographs.

X-ray diffraction (XRD) analyses were carried out at the Science and Technology Park (PCT), at the Centre for I+D+I of the University of Burgos (UBU). The diffractometer was a Davinci D8 Discover with a tube.
of copper with radiations $K\alpha (\lambda = 1.54060 \, \text{Å} \text{ and } \lambda = 1.54439 \, \text{Å})$ under working conditions of 40kV and 30mA. Diffractograms were recorded in the range $2\theta = 5-60^\circ$. The evaluation of such diffractograms was accomplished by a comparison of the standardised patterns from the Joint Committee of Powder Diffraction Standards (JCPDS), by using the EVA software supplied by Bruker.

Results

From all the samples collected, only sample 5 did not show appropriate characteristics for making vessels. The rest of the samples display some similarities with the archaeological material.

Sample 1
It was taken near the site. In terms of mineralogy it is mainly composed of quartz (0.47-0.52 mm in size), quartzite (1.54-1.58 mm in size), and epidote (1.31-1.48 mm in size). This sample is very similar to adobe or sun-dried bricks Bas.adb.285 and Bas.adb.695. In all likelihood, the sediment used to prepare the adobes was probably gathered near the place where they were needed (fig. 32.2).

Sample 2
It contains quartzite (0.48 mm on average size), authigenic quartz (0.28 mm on average size) and epidote (0.52 mm on average size). This sample is slightly similar to potsherd Bas.535 from Basagain. During the general analysis of archaeological potsherds, this specimen was assigned as an outsider because of its different fabric: more sorted and with less temper added (fig. 32.2).

Samples 3 and 4
The mineralogy observed in thin section is mainly authigenic quartz (0.19 mm on average size) and epidote (0.53 mm on average size). It is similar to Group 3 (potsherds Bas.244, Bas.300 and Bas.332) of the archaeological analysis (López de Heredia 2015) carried out at the site. In addition, the diffractogram of potsherd Bas.447 is significantly similar to sample 3 (fig. 32.3).
Fig. 32.2. Upper micrographs: comparison of experimental sample 1 and adobe or sun dried brick BAS.adb.285. Lower micrographs: comparison of experimental sample 2 and archaeological ceramic BAS.535. Similarities are indicated by squares.
Fig. 32.3. Micrographs of experimental sample 4 and archaeological potsherd Bas.244. Comparison of diffractograms from sample 3 and archaeological potsherd Bas.447: M: Montmorillonite; I: Illite; Q: Quartz; FK: Potassic feldspar; P: Plagioclase (sodium feldspar); H: Hematite. Similarities are indicated by squares.
Experimental samples

In any case, samples 3 and 4 are the most similar to archaeological potsherds since the sediment shows practically the same characteristics.

Another point worth mentioning is the presence of authigenic quartz. It is important to note that some Jacintos de Compostela have been found in all the samples (fig. 32.4). This is consistent with the potsherd fragments analysed from the site in which the typical authigenic quartz of the Triassic Keuper sequence is well represented (Olaetxea 2000: 47; Ortega et al. 2001: 59, 63).

Finally, and regarding the wheel-made pottery, none of the samples collected relate to sediments used in this type of ceramic. This may be due,
however, to the preparation of the clay pastes, which gives rise to a well sorted and levigated ceramic fabric.

**Discussion**

Previous research carried out on pottery from Basagain has clearly distinguished the use of calcite as a temper (López de Heredia 2015). Nevertheless, sometimes it is difficult to know when a temper has been deliberately added or, on the contrary, whether it is a natural inclusion of the sediment, such as the quartz sand. The mineral angularity has been commonly employed to determine if the temper is natural or added to the clay paste. The lack of weathering in the crystals can be very often indicative of a voluntary addition instead of a previous presence in the sediment (Olaetxea 2000: 33; Quinn 2013: 159–68; Reedy 2008: 129–33). For that reason, the angularity of their morphology leaves no doubt that calcite is deliberately added.

The results obtained in this study suggest that the clays used by Basagain’s ancient potters were quite similar to those sampled in this study, since the main characteristics of these clay sediments are shared with the analysed archaeological ceramic potsherds. The clay was illite, sometimes mixed with montmorillonite clays. Illite is formed from the alteration of mica and feldspar, and has a variety of compositions. As a result of its formation, it has very small crystals, which makes them very plastic and refractory and therefore very suitable for making pottery (Cubas 2013: 22). This clay paste is tempered later with calcite, one of the most common minerals in pottery-making. The wide dissemination of calcite is understandable if its technical advantages are considered, especially in the use or function of the vessel, which would make it the best temper for cooking and storage pots. Besides, it is important to remember that this temper, calcite, is always added in Iron Age Basque pottery (Olaetxea 2000). This fact suggests that calcite could have had a cultural significance, as it is commonly used instead of choosing other elements (Gosselain and Livingstone Smith 2005: 43).

The raw materials chosen and their collection in the vicinity of the sites are in conjunction with data obtained from other archaeological sites of the same region (e.g., Santiagomendi, Los Castros de Lastra and La Hoya), in which the same pattern has been recognised. The results derived from this research showed that the sediments (illite, kaolinite and/or montmorillonite, and calcite) were collected within a 2-7 km radius of the settlements studied (López de Heredia 2015). In the case of Basagain, ceramic
resources come from a maximum distance of approximately 2 km in easily accessible areas, which confirms their local origin.

The use of local clays is not a strange issue. There are numerous ethnological cases where the clay used comes from very near the workshops, such as the vicinity of the settlements or the gardens of the potters themselves (Bazzana et al. 2003: 53–55; González Urquijo et al. 2001: 58). In most places clay sediments are used from a radius of 5 km (Arnold 1985: 77 and following). There are few cases which exceed 10-20 km. Logically, practical aspects, besides the type of clay, must be considered such as the distance or proximity of raw materials or transport used (Arnold 1985: 32).

Conclusions

This study has been useful to assess and determine the types of clays and non-plastic materials used to make pottery by Iron Age communities who inhabited the settlement site of Basagain, as well as the technology employed to produce it. Comparison with experimental samples reflects a local source of clay for both pottery sherds and adobe or sun-dried bricks. Such experimental samples have allowed the simulation in the laboratory of the processes of production, including firing, and the later dissolution of carbonates. The resulting technological data enable a more solid approach to socio-economic aspects of the communities who produced and used these ceramic materials. Finally, overall results obtained in the present work show the same pattern recognised in other sites of the region with a similar chronology, typology, and function.

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