

Earth building materials on pre-historic domestic architectures in the south of Portugal

P. Bruno*

UNIARQ/Universidade de Lisboa, Lisboa – Portugal

P. Faria**

Universidade Nova de Lisboa, Caparica - Portugal

ABSTRACT: Pre-historic architectures reveal a profound knowledge of building materials and their selection and application. Depending on each geographical context or functional needs, pre-historic man developed and applied different building techniques.

Archaeological vestiges from several pre-historic settlements of southwest Iberia has shown that stone, wood and earth were the main materials used on domestic structures. Earth mortars seem to be the most frequently used, probably due to the abundance of clayish materials in most geographical contexts and the facility on handling them.

Several earth building techniques were identified in settlements located in south of Portugal. Some of them are being object of detailed studies, based on material traces obtained in *habitat* places of Defesa de Cima 2 (Évora), Alto do Outeiro (Beja) and Alcalar (Faro).

The analysed materials are composed by samples of earth mortars from the covering/ filling of vegetable structures, stacked earth walls, renderings and mudbricks.

1 INTRODUCTION

The present text intends to synthesize the first results of a research project with the main objective of deepen the knowledge of earth constructive use on pre and proto-historic domestic architectures in the south of Portugal.

Based on available archaeological information about excavated *habitat* places, different earth building techniques were identified, from Ancient Neolithic to Copper age:

- shaped/ molded earth, used on walls;
- stacked earth, used on walls;
- earth mortar covering and filling vegetable structures;
- earth mortar binding stone masonry;
- earth mortar rendering storage bins;
- mudbricks masonry.

The analysed materials are composed by different types of vestiges: small clayish daub fragments coming from the renderings of two neolithic storage bins of Defesa de Cima 2 (Évora); big fragments of a hut wall, probably made of stacked earth, obtained in Alcalar calcolithic settlement (Faro); manual and perhaps moulded mudbricks, probably from a wall adjacent to a surrounding moat of the calcolithic settlement of Alto do Outeiro (Beja). Earth materials were burnt by fire, which permitted their conservation until nowadays.

* PhD student in Pre-history, Universidade de Lisboa; FCT scholarship holder.

** PhD in Architectural Heritage Rehabilitation, Assistant Professor, Universidade Nova de Lisboa.

2 TERRITORY

The study area sets in the south of the Portuguese territory and is limited north by Tagus river, east by Spain border, west and south by the Atlantic Ocean.

Plain landscapes are dominant, mostly less than 400 m, with punctual elevations. Geologically, the territory is generically characterized by the presence of metamorphic and eruptive rocks from Hesperic Massive (in interior Alentejo) and sedimentary accumulations (in littoral areas and Sado and Tagus basins). Tagus, Sado and Guadiana are the main rivers of the region.

Climate is typically mediterranean: high temperatures and insulations on summer, with the absence of rain. In the atlantic coast, relative humidity is higher and temperature moderate. The warm and luminous weather goes until the autumn, despite temperature coolness and the occurrence of some rain. Generally, rain falls strongly from December to March.

Plant life, conditioned by climate, is mainly composed by mediterranean species: trees and bushes of green leafs like cork trees, holm oaks, pine trees (specially stone pines), arbutus trees, heathers, laurels, lentisks, butcher's brooms, oleanders, canes, rock roses; aromatic plants from dry soils like rosemary, lavender and thyme; planted trees and bushes like almond trees, fig trees, carob shrubs, orange trees, olive trees and vineyards.

3 EARTH CONSTRUCTIVE VESTIGES

3.1 *Neolithic settlements*

In most neolithic *habitat* places of southwest Iberia survived only vestiges of underground structures, some of them probably related with domestic occupations: ditches, storage bins, post holes and, punctually, big cavities of anthropic origin, interpreted by archaeologists as *hut bottoms*¹.

Consequently, most investigators believe that Neolithic houses were made of ephemeral materials (like ramifications and daub), pointing the probable seasonality of some occupations as an explanation for those poor architectures (Diniz 1993, Gonçalves & Sousa 2000, Gonçalves 2002).

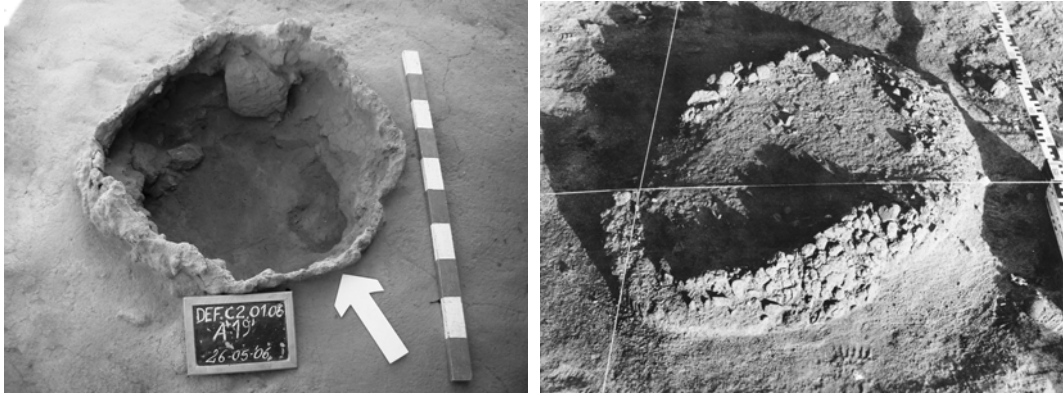
With regard to earth constructive use in the studied settlements, only in two types of neolithic structures earth mortars were securely applied: storage bins and ovens.

Generically, neolithic storage bin vestiges² are composed by ditches excavated in sand or rock, depending on each type of soil; they have circular or oval plans, with diameters between 50 and 90 cm and depths until 1.30 m. Frequently, inside this structures, archaeologists find clayish daub fragments (very similar to pre-historic ceramic pastes) coming from the interior rendering of storage bins.

For the time being, to this chronology, only in two cases among the studied settlements, the renderings were conserved *in situ*: Defesa de Cima 2, in Évora district (Santos & Carvalho 2006); Salema, in Setúbal district (Silva & Soares 1981) (figures 1-2). These renderings, with around 2 to 3 cm of thickness, were exposed to combustion by fire, after application in the ditches walls and bases. This proceeding seems to be intentional, with the objective of waterproof the bins interior, like archaeologists of Defesa de Cima 2 support (Santos & Carvalho, in press).

¹ The word is used in archaeology to designate big ditches (larger than storage bins and fire places), with small depths, usually associated with domestic functions.

² According to archaeological information about neolithic settlements, not all referred in the present bibliography.



Figures 1 and 2. Storage bins vestiges from Ancient Neolithic settlements: left, Defesa de Cima 2 (photo by Filipe Santos/ Arqueohoje); right, Salema (Silva & Soares 1981).

With regard to ovens, it seems that construction involved earth walls modeling. This technique was applied in two settlements in interior Alentejo: Carraça 1 and Xarez 12, in Évora district (Gonçalves 2000, 2001, 2003).

In both places, archaeological interventions showed numerous of these structures, with circular and oval plans, constructed upon ditches. Walls were made of clayish mortars, incurving to the interior of the structures. The base of some structures was also surfaced with the same materials.

With regard to measures: ovens of Xarez 12 had diameters between 30 and 60 cm; Carraça 1, between 22 and 86 cm; walls had thickness between 2 and 30 cm in Xarez 12 and between 2 and 7 cm in Carraça 1 (Gonçalves 2000, 2001, 2003).

Xarez 12 structures contained large quantities of fauna vestiges³ and combustion evidences; this enforced to interpret them as culinary ovens (Gonçalves 2003).

The technique used in the walls of Xarez 12 consisted, according to Victor Gonçalves, in the previous execution of clay “plaques” applied *in situ*, by pressure (Gonçalves 2003); in Carraça 1, the building technique seem to be similar (Gonçalves & Sousa 2000).

3.2 Copper Age settlements

For 3rd millennium B.C. *habitat* places, elevated structures vestiges are numerous. Archaeological interventions show the abundant utilization of stone structures, mostly in wall bases. Many of these masonries were laid with clayish mortars, binding stone blocks. Constructions of this kind were found in the following *habitat* places, among others: São Pedro (Mataloto et al, in press), Porto das Carretas (Silva & Soares 2002), Monte Novo dos Albardeiros (Gonçalves 1989b), Monte do Tosco 1 (Valera 2000b), all in Évora district; Monte da Tumba, Torrão, Setúbal district (Silva & Soares 1987); Porto Torrão, Ferreira do Alentejo, Beja district (Valera & Filipe 2004); Cerro do Castelo de Santa Justa, Faro district (Gonçalves 1989a).

Related with stone structures (and sometimes with post holes), there were also detected, in several calcolithic settlements, numerous fragments of daub with negative prints of ramifications, burned by fire. These fragments seem to come from the covering or filling of vegetable structures (walls, and eventually, roofs). They were found in several *habitat* places: São Pedro (Mataloto et al, in press), Monte da Ponte (Hock & Kalb 1997), Porto das Carretas (Silva & Soares 2002), Torre do Esporão 3 (Gonçalves 1991), Monte Novo dos Albardeiros (Gonçalves

³ The vestiges founded in the interior of the ovens were: river cockle-shells; bovine, pig, sheep and deer bones.

1989b), Mercador (Valera 2002), Moinho de Valadares 1 (Valera 2000a), Évora district; Monte da Tumba, Torrão, Setúbal district (Silva & Soares 1987); Porto Torrão, Ferreira do Alentejo, Beja district (Valera & Filipe 2004); Cerro do Castelo de Santa Justa, Cerro do Corte João Marques (Gonçalves 1989a) and Alcalar (Morán 2001), Faro district.

Punctually, there were also detected fragments of daub with negative prints of ramifications, related with *hut bottoms*, in *habitat* places of Torre do Esporão 3 (Gonçalves 1991) and Alcalar (Morán 1999). The vestiges were located in the filling layers of the ditches, and could come from the covering of superior vegetable structures; however, in none of these cases were detected post holes or stone structures in the *hut bottoms* areas.

Mudbricks were also used since calcolithic, at least in two *habitat* places: Monte da Tumba, Setúbal district (Silva & Soares 1987) and Alto do Outeiro, Beja district (Grilo, in press).

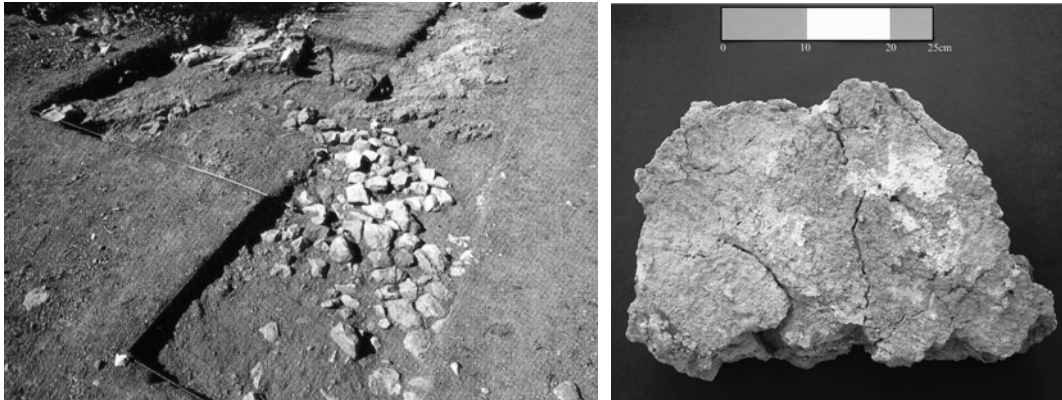
In Monte da Tumba, mudbricks were used on the superior layers of a defensive wall and in the walls of a circular house. The house was formed by a stone base, laid with clayish mortar, with 0.80 m thickness and 0.60 m height. According to the investigators, above the base, the house walls should be made of mudbrick masonry, due to the great number of burned mudbricks found in the interior ground. There were not found any vestiges of daub with negative prints of ramifications in the interior of the house; for that reason Joaquina Soares and Tavares da Silva think that the covering should be a mudbrick dome (Silva & Soares 1987).

In its turn, in Alto do Outeiro, the mudbrick fragments were found above and laterally a stone base, adjacent to one of the settlement's moat. It is possible that mudbricks belonged to superior layers of that stone base. The studied fragments came from different parts or different constructive phases of that wall, due to their characteristics (color, composition, dimensions).

Earth was also probably used on the construction of massive walls, as it seems in Alcalar (figures 3-4). Above a hut stone base (with 1 m of thickness) and the interior pavement, archaeologists found a high quantity of big fragments of earth mortar, without ramifications traces.

The technique used in Alcalar hut seems similar to *bauge* or *cob* (stacked earth), probably used in the south of Portugal, before rammed earth diffusion.

During calcolithic period, earth was also used on rendering mortars of underground structures, like storage bins and water tanks of Alcalar (Morán 1999) and Alto do Outeiro (Grilo, in press).



Figures 3 and 4. Alcalar vestiges: left, part of the excavated hut of Corte 5 (photo by Rui Parreira, 2004); right, a fragment of the wall, found above the stone base.

4 CASE STUDIES

4.1 Methodology

Chosen materials are related with architectonic structures vestiges like stone bases, ditches, post holes, etc. On a first stage, they were measured, design and photographed; the second stage, still running, consist on laboratorial analyses (microstructural morphology, granulometry and mineralogy). The vestiges characterization and analysis document the architectonic structures, consolidate the interpretation of the used technologies and, if necessary, turn possible a technologically correct reproduction of the settlements (obviously not over the original remains).

4.2 Defesa de Cima 2 (São Manços, Évora)

Chosen samples belonged to the renderings of two neolithic storage bins, both excavated in the granitic substrate.

Bin 5 (figures 5-6) had circular plan, with 80 cm of diameter and maximum preserved depth of 83 cm; inside, close to the basis, contained imbricate stones with combustion vestiges.

Clayish renderings were continuous, surfacing the lateral walls of the ditch.

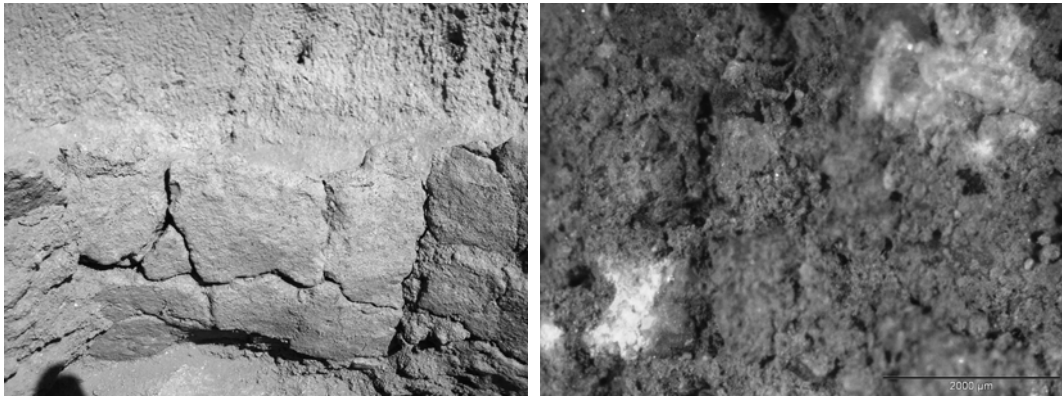
Bin 16 was too much destroyed. It had circular plan, with 80 cm of diameter and maximum preserved depth from 40 to 50 cm. Only part of lateral renders was preserved.

Morphologically, all vestiges are composed by small nodules and plaques of various dimensions, with 3 cm of maximum thickness. Concave faces of the plaques are smoothed and some of them had finger prints.

Pastes have brown-reddish colors and homogeneous compositions. As to the proportion between aggregates, fine elements are predominant (ilithic clays). Larger aggregates (mostly sands) seem to have diameters until 1000 μ (1 mm); it is observable the presence of quartz and feldspar.

There were not detected different layers on the renderings, negative traces of organic materials, animal or vegetable fibers.

Pastes have little porous, with small dimensions, diameters until 1000 μ (1 mm); microfissures are also rare, with apertures until 200 μ (0.2 mm).



Figures 5 and 6. Bin 5, Defesa de Cima 2: left, detail of interior renderings (photo by Filipe Santos/ Arqueohoje); right, photo of a sample, with binocular glass, 20x amplified.

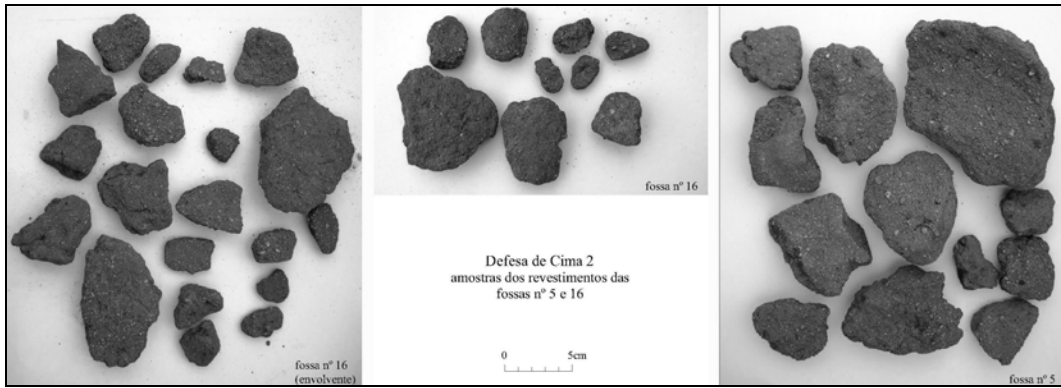


Figure 7. Defesa de Cima 2 materials (fragments of renderings from bins 5 and 16).

4.3 Alto do Outeiro (Baleizão, Beja)

Mudbricks from Alto do Outeiro were found above a stone base, adjacent to a moat. They probably belonged to a mudbrick masonry wall, constructed above that base. Materials were chosen from units 90 and 101, due to mudbrick fragments dimension and conservation state.

Mudbrick 729, from unit 101 (figure 8), has round edges. This is probably a hand-made brick. One of the faces presents four parallel ruts, oblique to the mudbrick edges. These incisions could be from mudbricks counting or the mark of the worker; less probable is the creation of a rugous surface, because they only exist in a small area of the face. The fragment measures 16 cm x 9 cm x 7 cm and weights 2.476 kg.

Mudbrick 706, from unit 90 (figure 9), has flat faces and sharp edges, which show that it was probably made using some kind of mold. One of the faces present two finger prints, possibly resulting from handling the mudbrick. The fragment weights 2.832 kg and measures 17 cm x 14 cm x 6.5 cm.

Binocular glass observation revealed substantial differences between pastes of mudbricks from units 90 and 101, proving that they were made using different techniques and probably on different moments.

Paste from unit 101 is more orange colored. As to aggregates, samples from both units have big quantities of fine elements, specially the ones from unit 101. Aggregates seem similar (mostly calcareous), though aggregates dimensions are different: pastes from unit 90 have aggregate dimensions until 2000 μ (2 mm) and the ones from unit 101, only until 100 μ (0.1 mm).

All pastes have some porosity, of two kinds: aspheric and more elongated. Pastes from unit 101 have more fissures, of small dimensions – apertures with 200 μ (0.2 mm).



Figure 8. Mudbrick 729, from Alto do Outeiro.

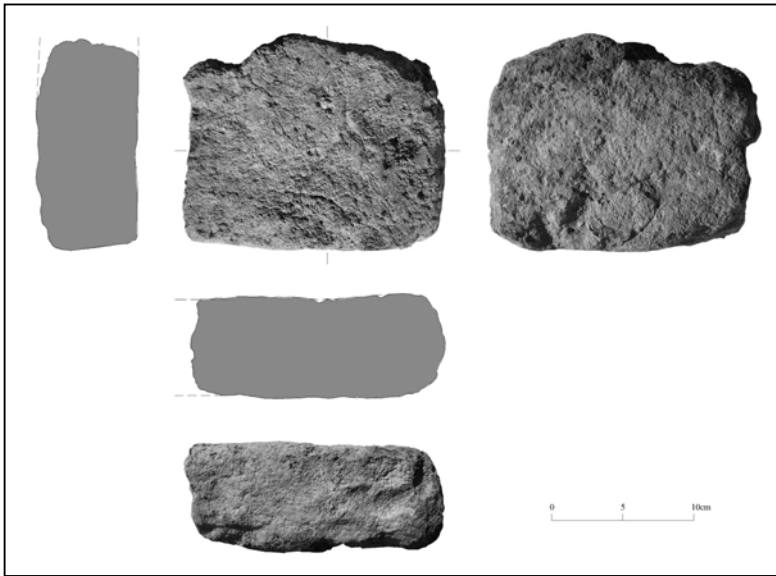


Figure 9. Mudbrick 706, from Alto do Outeiro.

4.4 Alcalar (*Mexilhoeira Grande, Faro*)

Earth vestiges from Alcalar were associated to a big hut, located in the central area of the calcolithic settlement. They were found above the stone base of the hut (figures 3-4).

These vestiges have big dimensions and no ramification traces. Pastes have orange colors and higher quantities of fine elements than larger aggregates; still, comparatively to other observed materials, they have higher quantities of aggregates - sands, calcareous and shell fragments with measures until 4000 μ (4 mm) and also larger aggregates; pastes seem more heterogenic than others.

Materials observation at binocular glass didn't show traces of compression, like on rammed earth technique. This was probably stacked earth, a technique more similar to cob.

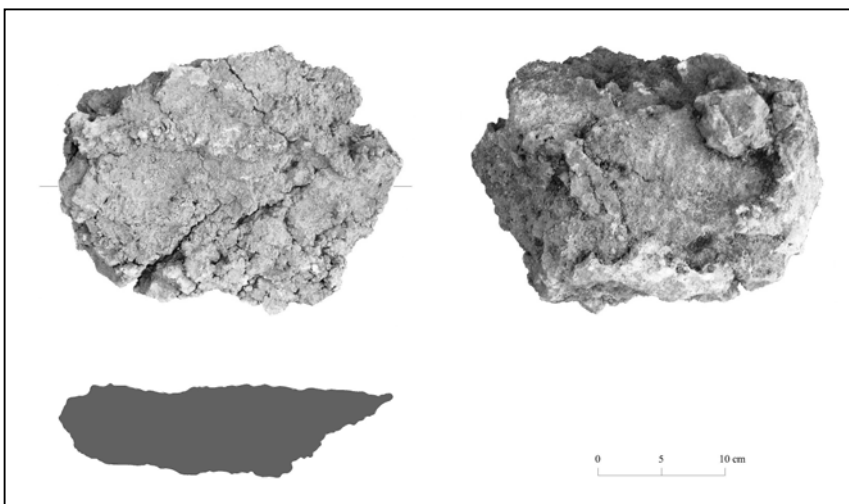


Figure 10. Fragment ALC_5_11, from Alcalar hut.

Samples don't have negative traces of organic material or fibers. Observation on binocular glass revealed some porosity - aspheric and elongated porous - with diameters no larger than 500 μ (0.5 mm). Calcareous concretions were observed, probably due to water infiltration and percolation in the interior of the materials. This phenomenon caused large fissures, with apertures until 500 μ (0.5 mm).

5 DISCUSSION

Archaeological materials exhumed in several pre-historic settlements in the south of Portugal show that earth mortars were largely used on domestic structures.

In fact, the abundance of clayish materials in most geographical contexts and the facility on handling them, made earth mortars use being extremely frequent in pre-historical communities.

In a first stage of sedentariness - Neolithic -, clayish pastes were used for rendering underground structures and build modeled walls. For the moment, there are no evidences of other earth building techniques.

Later, on Cooper Age, the presence of earth vestiges showing negative prints of ramifications is dominant. These materials probably come from the covering or the filling of vegetable structures. Could that be the most applied technique on house building, judging by the larger quantities of that kind of vestiges, comparatively to others (mudbricks or probable stacked earth)?

Anyhow, only earth vestiges exposed to combustion survived until nowadays, which strongly limit the identification of other possible construction techniques.

6 CONCLUSIONS AND FUTURE DEVELOPMENTS

The absence, on Portuguese context, of studies specifically directed to earth constructive use before the Roman Period, as well as the relative abundance of archaeological materials, justify this investigation.

From a data base which includes all the main excavated *habitat* places, the authors think it will be possible to identify some of the techniques and typologies used on the construction of domestic structures, since Ancient Neolithic to Bronze Age. They also believe that the development and analysis of the case studies, among with the archaeological and territory information (geography, geology, etc) will help to understand the technologies of extraction, manufacture and application processes of earth building materials on Pre-history.

ACKNOWLEDGMENTS

The authors would like to thank to the following archaeologists, who ceded materials and information to this work: Dra. Elena Morán, Dr. Rui Parreira, Dra. Carolina Grilo, Dr. Filipe Santos; and also thank Professor Ondina Figueiredo (INETI).

REFERENCES

- Diniz, M. 1993. O Neolítico. In J. Medina (dir), *História de Portugal*. Lisboa: Ediclube, 1, p.181-212.
- Gonçalves, V.S. 1989a. *Megalitismo e metalurgia no alto Algarve oriental, uma aproximação integrada*. Lisboa: INIC/ UNIARQ, 2 vols.
- Gonçalves, V.S. 1989b. A ocupação pré-histórica do Monte Novo dos Albardeiros (Reguengos de Monsaraz), *Portugália*. Porto: Nova Série, Vol. IX-X.
- Gonçalves, V.S. 1991. TESP3: o povoado pré-histórico da Torre do Esporão (Reguengos de Monsaraz), *Portugália*. Porto: Nova Série, 11-12, p.53-72.
- Gonçalves, V.S. 2000. *Intervenções na área da barragem do Alqueva (2000). Bloco 3. Habitats Sítio: Carraça 1*. (IPA/ proc. S-16242 Carraça 1).
- Gonçalves, V.S. 2001. *Intervenções na área da barragem do Alqueva (2001). Bloco 3. Povoados. Sítio: Carraça 1*. (IPA/ proc. S-16242 Carraça 1).
- Gonçalves, V.S. 2002. Lugares de povoamento das antigas sociedades camponesas entre o Guadiana e a Ribeira do Alamo (Reguengos de Monsaraz): um ponto da situação em inícios de 2002, *Revista Portuguesa de Arqueologia*. Lisboa: Instituto Português de Arqueologia, Volume 5, número 2, p.153-189.
- Gonçalves, V.S. 2003. Comer em Reguengos, no Neolítico. As estruturas de combustão da Área 3 de Xarez 12, *Muita gente, poucas antas? Origens, espaços e contextos do Megalitismo. Actas do II Colóquio Internacional sobre Megalitismo* (dir. V.S. Gonçalves). *Trabalhos de Arqueologia*. Lisboa: Instituto Português de Arqueologia, 25, p.81-91.
- Gonçalves, V.S. & Sousa, A.C. 2000. O grupo megalítico de Reguengos de Monsaraz e a evolução do megalitismo no Ocidente peninsular (espaços de vida, espaços da morte: sobre as antigas sociedades camponesas em Reguengos de Monsaraz), *Muitas antas, pouca gente? Actas do I Colóquio Internacional sobre Megalitismo* (dir. V.S. Gonçalves). *Trabalhos de Arqueologia*. Lisboa: Instituto Português de Arqueologia, 16, p.11-104.
- Gonçalves, V.S., Sousa, A.C. & Marchand, G., in press. *Na margem do grande rio. 1. Os últimos caçadores recolectores e as primeiras sociedades camponesas na Baixa do Xarez – Guadiana*.
- Grilo, C., in press. *O povoado pré-histórico do Alto do Outeiro, Baleizão, Beja*.
- Guillaud, H. & Houben, H. 1989. *Traité de construction en terre*. Marseille: Parenthèses.
- Hock, M. & Kalb, P. 1997. O povoado fortificado calcolítico do Monte da Ponte, Évora, *Actas do 2º Congresso de Arqueologia Peninsular, Zamora, 1996*. Zamora: Fundación Rei Afonso Henriques, Tomo II, p. 417-423.
- Mataloto, R., Estrela, S. & Alves, C., in press. *As fortificações calcolíticas de São Pedro (Redondo, Alentejo Central, Portugal)*.
- Morán, E. 1999. *Relatório dos trabalhos arqueológicos efectuados em Março-Abril de 1999 no povoado calcolítico de Alcalar. Parcela nº 16-L propriedade de Uta Tackenber*. (IPA/ proc. S-2781 Alcalar – povoado central).
- Morán, E. 2001. *Conjunto Megalítico de Alcalar (Portimão). Povoado de Alcalar. Parcela 15L. Campanha 3(2001). Relatório preliminar dos trabalhos de terreno efectuados no corte 04*.
- Morán, E. & Parreira, R. 2004. *Alcalar 7: Estudo e Reabilitação de um Monumento Megalítico*. Lisboa: Instituto Português do Património Arquitectónico.
- Ribeiro, O. 1945. *Portugal, o Mediterrâneo e o Atlântico*. Lisboa: Livraria Sá da Costa.
- Santos, F. & Carvalho, P. 2006. *Minimização de impactes sobre o património cultural decorrentes da construção do canal de adução da ligação Loureiro - Monte Novo. Habitat Neolítico da Defesa de Cima 2 (Torre de Coelheiros, Évora). Trabalhos arqueológicos. Relatório Final (Agosto 2006)*. Arqueohoje.
- Santos, F. & Carvalho, P., in press. *O sítio neolítico da Defesa de Cima 2 (Torre de Coelheiros, Évora). Primeiros resultados*.
- Silva, C.T. 1989. Novos dados sobre o Neolítico antigo do Sul de Portugal, *Arqueologia*. Porto: Grupo de Estudos Arqueológicos do Porto, 20, p.24-32.
- Silva, C.T. & Soares, J. 1981. *Pré-História da Área de Sines*. Lisboa: Gabinete da Área de Sines.
- Silva, C.T. & Soares, J. 1982. Des structures d’habitat du Neolithique ancien au Portugal, *Le Neolithique ancien Mediterranéen. Actes du Colloque International de Prehistoire. Montpel-*

- lier 1981. *Archeologie en Languedoc*. Lodeve: Imprimerie des Beaux Arts, nº especial, p. 17-28.
- Silva, C.T. & Soares, J. 1987. O povoado fortificado calcolítico do Monte da Tumba I - Escavações arqueológicas de 1982-86 (resultados preliminares), *Setúbal Arqueológica*. Setúbal: Museu de Arqueologia e Etnografia do Distrito de Setúbal, 8, p.29-79.
- Silva, C.T. & Soares, J. 2002. Porto das Carretas - um povoado calcolítico fortificado do vale do Guadiana, *Al-madam*. Almada: Centro de Arqueologia de Almada, 2ª série: 2, p.176-180.
- Valera, A.C. 2000a. Moinho de Valadares e transição Neolítico final/ Calcolítico na margem esquerda do Guadiana: uma análise preliminar, *Era Arqueologia*. Lisboa: Colibri/ Era Arqueologia, 1, p.24-37.
- Valera, A.C. 2000b. O Monte do Tosco I: uma análise preliminar no contexto do povoamento calcolítico e do início da Idade do Bronze na margem esquerda do Guadiana, *Era Arqueologia*. Lisboa: Colibri/ Era Arqueologia, 2, p.32-51.
- Valera, A.C. 2002a. A ocupação pré-histórica do sítio do Mercador (Mourão): a campanha de 2000, *Era Arqueologia*. Lisboa: Colibri/ Era Arqueologia, 3, p. 42-57.
- Valera, A.C. & Filipe, I. 2004. O povoado do Porto Torrão (Ferreira do Alentejo), *Era Arqueologia*. Lisboa: Colibri/ Era Arqueologia, 6, p. 28-61.