SPAL 30.2 (2021)
20-46
ISSN: 1133-4525
ISSN-e: 2255-3924

FECHA RECEPCIÓN
16/9/2020

FECHA ACEPTACIÓN
27/10/2020

A closer look at the forgotten bones of the Dolmen of Pedras Grandes (Odivelas, Portugal). Examining old human remains 7

UN RECORRIDO POR LOS HUESOS OLVIDADOS DEL DOLMEN DE PEDRAS GRANDES (ODIVELAS, PORTUGAL)

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Abstract The Dolmen of Pedras Grandes (Odivelas, Lisboa, Portugal) was discovered and excavated at the end of the 19th century by Carlos Ribeiro. In 2004, this monument was re-excavated by Rui Boaventura and a complete study was conducted. The Dolmen of Pedras Grandes presents a polygonal chamber and a very short passage and may have had a short period of burial activity in the 4thmillennium as indicated by the radiocarbon dates and the "archaic" artefacts. The relative and absolute dating enable us to assign this monument to the initial phase of megalithic funerary monumentality in south-central Portugal. Moreover, the recovery of human skeletal material offers an opportunity to obtain data on the biological profile and the health status of the human community who buried their dead in this megalithic tomb.
In this paper are present new radiocarbon dates and isotopic analyses obtained from human bone samples from this tomb and also a complete anthropological study of the human skeletal material recovered in this monument. At least 13 individuals are represented in the skeletal assemblage, including 8 adults (> 16 years) and 5 non-adults, although this is certainly an underestimate due to the poor preservation of the bone assemblage. Young children, under the age of three years, are missing. A small number of pathologies were observed, including cranial trauma, degenerative joint disease and oral pathologies. The high frequency of stress indicators, more specifically linear enamel hypoplasia, is a notable feature of this assemblage. The new data are discussed in the context of the problem of the origin of megalithic monumentality in Central and Southern Portugal.
Key-words Late Neolithic; Western Iberia; Dolmen; Old documentary sources; Biological profile; Health status.

Resumen El Dolmen de *Pedras Grandes* (Odivelas, Lisboa, Portugal) fue descubierto y excavado a finales del siglo XIX por Carlos Ribeiro. En 2004, este monumento fue re excavado por Rui Boaventura donde se realizó un estudio completo del sitio. El Dolmen de *Pedras Grandes* presenta una cámara poligonal y un pasaje muy corto, y puede haber tenido un corto periodo de actividad funeraria en el IV milenio, como indican las fechas de radiocarbono y los artefactos "arcaicos". Las dataciones relativas y absolutas permiten asignar a este monumento a la fase inicial de la monumentalidad funeraria megalítica en el centro-sur de Portugal. Además, la recuperación de material óseo humano ofrece la oportunidad de obtener datos sobre el perfil biológico y el estado de salud de la comunidad que enterró a sus muertos en tumbas megalíticas.

Silva, A.M., Sousa A.C. y Scarre C. (2021): "A closer look at the forgotten bones of the Dolmen of Pedras Grandes (Odivelas, Portugal). (Examining old human remains 7)", *Spal,* 30.2, pp. 20-46. https://dx.doi.org/10.12795/spal.2021.i30.16

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En este trabajo se presentan nuevas fechas de radiocarbono y los análisis isotópicos obtenidos a partir de muestras de huesos humanos de esta tumba y, también, un estudio antropológico completo del material humano recuperado en este monumento. Al menos 13 individuos están representados en el conjunto óseo, incluyendo 8 adultos (>16 años) y 5 no adultos, aunque esto es, sin duda, una subestimación debido a la mala conservación del material osteológico. Faltan niños pequeños, menores de tres años. Se ha observado un pequeño número de patologías, entre ellas traumatismos craneales, enfermedades articulares degenerativas y patologías orales. La alta frecuencia de indicadores de estrés, más concretamente de hipoplasia lineal del esmalte, es una característica notable de este conjunto. Los nuevos datos se discuten en el contexto del problema del origen de la monumentalidad megalítica en el centro y sur de Portugal.
Palabras claves Neolítico Tardío; Iberia Occidental; Dolmen; Fuentes documentales antiguas; Perfil biológico; Estado de salud.

1. INTRODUCTION

The construction of megalithic monuments, particularly those intended for funerary deposition, was a characteristic practice of Neolithic societies along the whole of the Atlantic façade, including the Iberian Peninsula (Guilaine, 1999; Joussaume, 1985; Scarre, 2002). These monuments have long exerted a great fascination, raising questions about their origin, the dyary purposes (Silva, 2003a; 2012). Within present-day Portugal, many of these tombs have no preserved human remains owing to previous disturbances and/or taphonomic factors (Boaventura *et al.,* 2014). Moreover, even when human remains are present, the high degree of fragmentation, the level of disturbance and the commingled nature of these deposits have frequently discouraged any attempt at their analysis (Boaventura *et al.,* 2014; Evangelista, 2019; Silva, 2012; 2017; Silva and Ferreira, 2007; Silva *et al.,* 2014; 2019). This is unfortunate since skeletal remains are a valuable archive of evidence about the lifestyles and living conditions of past populations (Silva, 1993; 1996; 1999; 2012; 2018; 2019). They provide information about demography (Carvalho *et al.,* 2012; Díaz-Zorita *et al.,* 2017; Evangelista, 2019; Silva, 2003a), population affinities (Cunha, 2015; Irish *et al.,* 2017), diet (Beck *et al.,* 2018; Carvalho and Rocha, 2016; Carvalho *et al.,* 2016; Fernández-Crespo and Schulting, 2017; Guiry *et al.,* 2016; Waterman *et al.,* 2016) diseases, lesions and stress markers (Curate *et al.,* 2011; Díaz-Zorita *et al.,* 2017; Fidalgo and Silva, 2020; Silva, 2005; 2011; Silva and Ferreira, 2008b; Silva and Silva, 2010; Silva and Wasterlain, 2010; Silva *et al.,* 2018; 2019; Wasterlain and Silva, 2012), activity patterns and mobility (Carvalho *et al.,* 2016; Díaz-Zorita *et al.,* 2018; Fidalgo *et al.,* 2020; Waterman *et al.,* 2014), medical practices (Tomé *et al.,* 2017; Silva, 2003c; Silva *et al.,* 2017), incidence of violence (Silva, 2003b; Silva and Ferreira, 2008a; Silva and Marques, 2011), and social care (Fidalgo and Silva, 2020). Therefore, skeletal remains when present in any quantity always have a story to tell about the individuals to whom they once belonged. The difficulty is how to access these data. This can be achieved, however, through the use of appropriate anthropological methodologies, besides the application of biochemical techniques such as radiocarbon dating, ancient DNA analysis and stable isotope analysis (Silva, 2017). In sum, these apparently "low-informative" human skeletal assemblages can still reveal new and valuable data about past communities (Díaz-Zorita, 2017; Fernández-Crespo, 2015; Silva, 2017; 2018; 2019; Silva *et al.,* 2019). It was in this context that, in the late 1990s, two of the authors of the present work (AMS and RB), began the exhaustive re-analysis of Late Neolithic skeletal collections from megalithic monuments in the Lisbon region, long forgotten in museums and/or private collections (Boaventura *et al.,* 2013; Silva *et al.,* 2004; 2013; 2014; 2019).

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The aim of this research was to gain unique insights into the lives of these prehistoric individuals through an interdisciplinary approach, including documentary sources relating to earlier work, new radiocarbon dates, and the complete anthropological study of the human skeletal remains recovered from this monument, that is, of those who found their final resting place in the Dolmen of Pedras Grandes.

The present manuscript is the seventh published under the scope of the above mentioned project to re-analyse long forgotten human skeletal collections.

2. THE MONUMENT

The Dolmen of Pedras Grandes (or *Anta de Pedras Grandes*) is located in the outskirts of the village of Odivelas (Lisbon district), with geographical coordinates (WGS84): N-38°,806707; W-9°,218636. Classified as a National Monument since 1944, the Dolmen of Pedras Grandes has the National Code Site 648 (CNS 648; Endovelicus System Information General Directorate of Cultural Heritage, Portugal Government agency). The monument is also known as the Dolmen of Caneças or Fojo (Ferreira, 1959; Leisner, 1965; Ribeiro, 1880).

Pedras Grandes is situated in an area where the geological substrate changes from Middle to Upper Cenomanian within the Cretaceous limestone (SGP, 1981; Leisner and Ferreira, 1961; Zbyszweski, 1964). Immediately to the north, about 20 metres distant, white limestone emerges, which offers the possibility of extracting stone blocks similar to the slabs used in the dolmen.

This dolmen is located in Portuguese Estremadura, a narrow strip of territory limited to the West by the Atlantic Ocean and to East and South by the Tagus River basin. This region is characterized by a mosaic geological substrate, with limestone bedrock punctuated by volcanic occurrences, which provides excellent conservation of organic material: the best indeed for prehistoric remains within the whole of Portugal. Estremadura is characterized by the diversity of funerary practices in the 4th and 3rd millennia BC, with the frequent use of natural caves alongside dolmens, hypogea and tholoi (Figure 1) (Boaventura, 2009; Boaventura *et al.*, 2014; Silva, 2012; 2003a). In a study dedicated to the dolmens of the Lisbon region, Rui Boaventura identified a cluster of monuments in the Belas region (Dolmens of Pedra dos Mouros, Belas, Monte Abraão, Estria); another concentration in the Trigache area (Trigache 1, 2, 3, 4); and an area between the two clusters, in which Pedras Grandes is located. The Dolmen of Conchadas and the Batalhas site were in the same vicinity, but their location is unknown today (Boaventura, 2009).

2.1. History of research

As with most of the megalithic monuments in the Lisbon region, the Dolmen of Pedras Grandes has a long history of research, which creates difficulties and limits to its interpretation. Rui Boaventura conducted a detailed study of all the available sources, not only from a historiographical perspective but, above all, in an attempt to recover the maximum amount of information from the archaeological record. In this endeavour, the Leisner Archive constituted the core basis of information (Boaventura, 2009; Sousa *et al.*, 2015).

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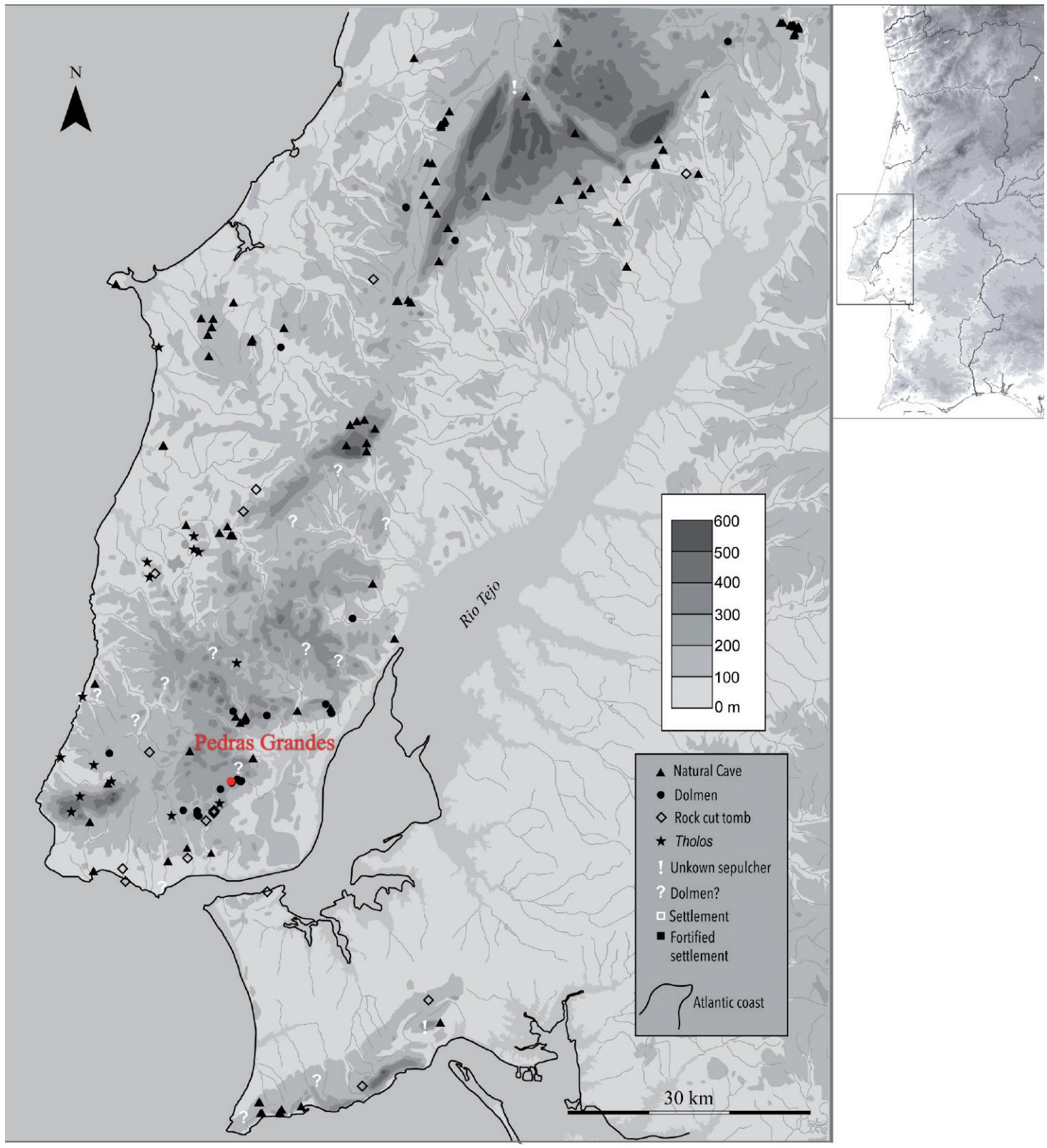

Figure 1. Burial sites of the 4th and 3rd millennia BC in Portuguese Estremadura, showing the location of Pedras Grandes. (Cartography by Maia Langley and Rui Boaventura, adapted by Cátia Delicado).

The discovery of this monument and the first archaeological investigations took place in 1875, with the excavations by Carlos Ribeiro (1813-1882), later published in the monograph *Estudos Prehistoricos em Portugal: Noticia de algumas estações e monumentos prehistoricos. II - Monumentos megalithicos das visinhanças de Bellas* (Ribeiro, 1880, p. 69). The archaeological material recovered in these excavations is currently deposited at the Geological Museum (*Museu Geológico)* in Lisbon. Between, 1920 and 1925, Francisco Carlos Ribeiro excavated several monuments near this location, and the notes of that work were later handed over to Octavio Veiga Ferreira and Vera Leisner who transcribed and partially published them (Leisner and Ferreira, 1961). Transcripts are held in the Leisner Archive (German Archaeological Institut). They make no direct reference to the Dolmen of Pedras Grandes, but the archive does include a photo of the monument, so there is a possibility that some material was collected from the site.

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Figure 2. 1. Removal of the fallen orthostats in 2004; 2-3. Eastern and western views of the dolmen at the end of the 2004 fieldwork; 4. Orthostats restored and re-erected in the sockets identified in 2005 (Photos Rui Boaventura).

The first plan of the monument was made on 1st December 1943 shortly after the Leisners moved to Portugal, and was subsequently published in the third volume of the *Megalithgraber der Iberischen Halbinsel: Der Westen* with details of the finds deposited at the Geological Museum (Leisner, 1965).

Since the 19th century there have been several references to the poor condition of this dolmen, a problem that was aggravated by the pressure of urban development around the monument in the second half of the 20th century. This situation improved only after 2001, when the City Council of Odivelas commissioned archaeological excavation and consolidation (2001, 2004 and 2018 campaigns). Despite the significant damage that the monument had suffered, we should note that the surviving remains still corresponded closely with the first description of the monument in 1880: two of the orthostats were still complete although they had fallen into the chamber, and four fragmented orthostats were also lying inside it, as well as a further five stone blocks (some of them probably belonging to the broken orthostats). One of the orthostats was missing but the excavation showed its position and the socket in which it had stood (Boaventura, 2009).

The 2004 campaign was led by one Rui Boaventura in collaboration with Maia M. Langley and bioarchaeologist Álvaro Figueiredo (Boaventura, 2009). This was the most significant recent fieldwork, since it included the removal and replacement of the architectural components that had fallen into the chamber, allowing a deeper understanding of the architecture and use of this monument (Figure 2).

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2.2. Architecture and Artefacts

Pedras Grandes has a polygonal chamber with 6 orthostats still surviving (probably 7 originally), measuring approximately 3.50 metres wide by 3.20 metres long, reaching 3 metres in height, on which a large capstone would most probably originally have rested. There is a short passage, around 1m wide x 1m long, consisting of a pair of small pillars about 0.50 m tall (Figure 3).

For the erection of the orthostats of the chamber and the passage, sockets were cut in the bedrock according to the size and shape of the individual blocks. The interstices between the orthostats were filled with stones larger than those used in the packing of the sockets, almost like small pillars. The Pedras Grandes backstone is of special interest: a large, unbalanced slab with a base measuring only half the total width of the block. The choice of this block probably represents a conscious intention on the part of the builders. The possibility that a *tumulus* covered the stone skeleton of this tomb has not been fully confirmed, as is the case with most dolmens in the region.

The material recovered during the various archaeological campaigns is limited, but includes polished stone (two axes and an adze), knapped stone (hammers and one quernstone) and abundant flaked stone. Ceramics and symbolic artefacts (schist plaques or limestone votive artefacts) are completely absent, which is typical of the first phase of megalithic tombs in western Iberia (Boaventura, 2009; Gonçalves, 1992; Leisner and Leisner, 1951). The lithic industry is abundant, both inside and outside Pedras Grandes, including the various components from every stage of the *châine operatoire* of flint working, which were recovered locally on the surface. Even within the tomb, dozens of flint artefacts were recovered and these could belong to the same flint working activity (Figure 4).

In the 2004 campaign, after the removal of the fallen orthostats and displaced blocks, human remains associated with grave goods were found, especially next to the surviving *in situ* orthostats U8 and U9.

Distinguishing between the debitage from local flint working and the flint artefacts that accompanied the funeral deposits proved to be complex. In order to understand this accumulation of lithic material, a series of seven survey test-pits was excavated in the area surrounding the monument. The work was carried out in 2004, but no type of structure or stratification was detected that could be associated with the flintwork, and there was little stratigraphic depth. It can be suggested, however, that here, or in the vicinity, was an a "atelier" for working local flint, possibly a palimpsest covering an extensive area that had been disturbed by agricultural activities. The Cenomanian substrate would have supplied the raw material for local debitage, following a model of surface exploration documented in the surrounding region although only known from surface scatters, as for example at Pedreira do Aires (Andrade and Cardoso, 2004) or Monte das Pedras (Andrade, 2011). In the Lisbon region, only at Casal Barril at Mafra have mine-like production contexts been discovered with a charcoal-filled pit. These have been dated to the Chalcolithic period (Sousa and Gonçalves, 2011). The chronological relationship between the megalithic tomb of Pedras Grandes and this area of debitage remains to be understood. The flint-working probably pre-dated the tomb but it is also possible that sediment from outside the tomb was introduced to cover the funerary deposits, as proposed for example for the dolmen of Santa Margarida 3 (Gonçalves, 2003).

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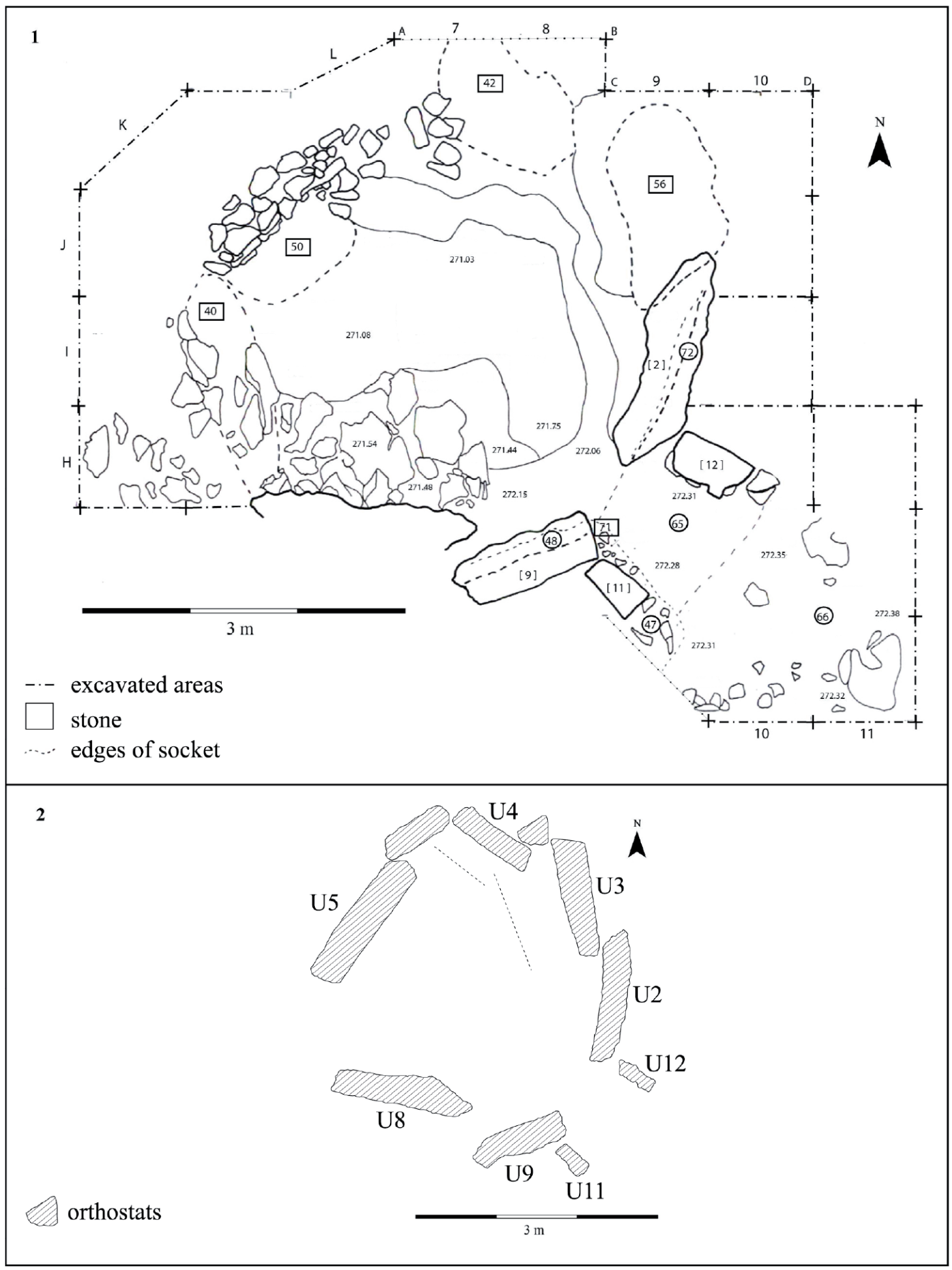

Figure 3. 1. Final plan of the 2004 campaign, showing the sockets and the stone packing supporting the backstone (U5); 2. Reconstructed plan of the dolmen, assuming the existence of an orthostat in socket U40 (adapted by Cátia Delgado from Boaventura, 2009, p. 44).

The identification of the lithic funerary assemblage was based on the association of artefacts and human skeletal material in stratigraphic units within the chamber that were visibly reminiscent of mortuary activity. The series includes fragments of small blades, with and without retouch, a geometric trapezoid and flake, some scrapers, and an awl.

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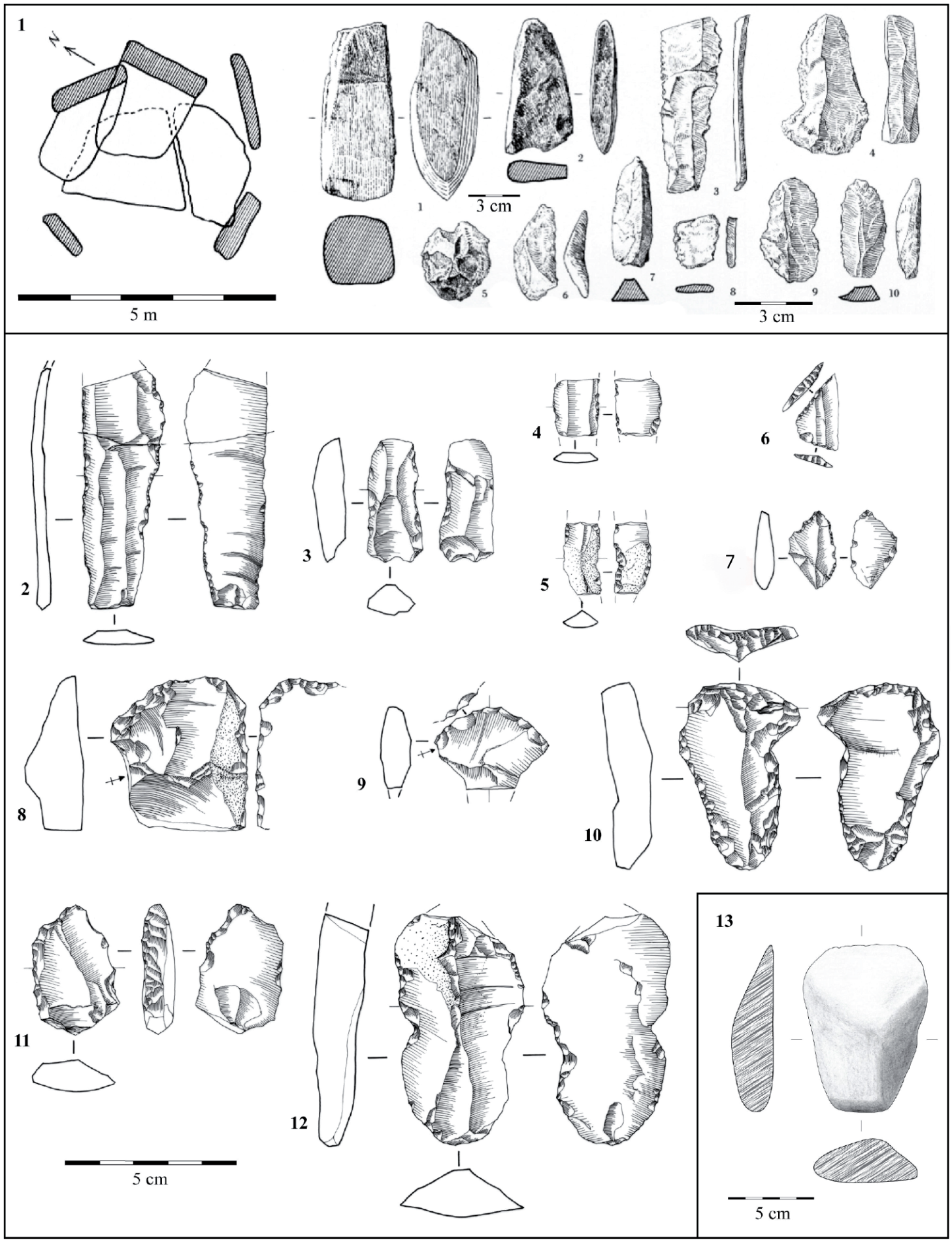

Figure 4. 1. Plan and recovered artefacts according to V. Leisner (1965); 2-5. Blades; 6. Geometric trapeze; 7. Retouched flake; 8-10 & 12. Scrapers; 11. Awl; (drawing by F. Sousa); 13. Limestone adze (drawing by C. Pereira) (adapted from Boaventura, 2009, p. 41).

3. PREVIOUS ANTHROPOLOGICAL STUDIES

The human remains from Pedras Grandes were recovered during two separate series of excavations. The first, directed by Carlos Ribeiro took place during the second half of the 19th century. The remains were deposited in the Geological Museum (*Museu*

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Geológico: MG) at Lisbon, and according to Ribeiro (1880, p. 69) included fragments of long bones and human teeth, from young individuals as well as adults.

In the 21th century, two further excavations were conducted at this monument. In 2001, a team from Era, Arqueologia Lda. undertook fieldwork to confirm the heritage potential of the tomb and its state of preservation, as part of the project for the restoration and valorisation of the monument commissioned by the Odivelas municipality. This led to a second intervention in 2004 under the direction of Rui Boaventura, archaeologist of the Odivelas municipality (for detailed descriptions see Boaventura, 2009: pp. 112-123). The material recovered was curated at the Câmara Municipal de Odivelas (CMO). Álvaro Figueiredo, member of the team, prepared a preliminary report on the human remains (Figueiredo, 2004 *in* Boaventura, 2009). According to the field records, the human remains were mainly recovered next to orthostats U8 and U9 (Figure 3 and Boaventura, 2009, p. 121).

In the summer of 2007, Maria Hillier and David Boutilier, within the PortAnta program *MegaOsteology*, re-analysed the bone and dental remains, respectively, under the scientific supervision of one of the present authors (AMS) and Rui Boaventura. Archival documentation, radiocarbon dating, stable isotope analyses and detailed study of the archaeological material from this dolmen were presented by Boaventura in his 2009 PhD thesis. Lastly, in 2018, AMS undertook a detailed study and revision of the complete osteological collection, including the human remains unearthed in 2004 and housed in CMO. Further radiocarbon dates were obtained at the same time. It is the results of this study that are the subject of the present paper.

4. MATERIAL AND METHODS

The human skeletal assemblage housed in the *Museu Geológico* was cleaned, labelled and marked. The assemblage unearthed in 2004 and curated at the *Câmara Municipal de Odivelas* was studied during February 2017, and the data added to the previously prepared excel database.

The minimum number of individuals was estimated following the method of Herrmann *et al.* (1990) adapted by Silva (1993), and for non-adults, maturation was also taken into account, as recommended by Silva (1996; 2012). Sex was determined through observation of morphological features of the mandible, according to Ferembach *et al.* (1980). The age-at-death of non-adults was estimated using the dental mineralization standards proposed by AlQahtani *et al.* (2010) and the epiphyseal union of the long bones (recommendation of Scheuer and Black, 2000; Stloukal and Hanáková, 1978). For adult individuals only, observation of cranial sutures (Masset, 1982) gave insights about age at death. A more detailed study of the mortality profile of non-adults was performed by comparing their mortality coefficients to those expected according to the mortality tables provided by Ledermann (1969). Morphological analysis included estimation of the platimeric and platicnemic indices (Martin and Saller, 1956) to provide data about the flatness of lower long bones, and thus inferences about the daily behaviours of these individuals. 25 non-metric morphological crown and root traits were recorded. With the exception of the hypotrophic root (Cunha *et al.*, 2012) and the mandibular molar pit tubercle (MMPT; Marado and Silva, 2016), all other traits are part of the Arizona State University Dental Anthropology System (ASUDAS; Turner *et al.*, 1991). Non-metric postcranial traits were scored following the definitions of Saunders (1978) and Finnegan (1978) to assess the

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morphological variability of these individuals. For insights into the oral health status of these individuals, cariogenic lesions (Buikstra and Ubelaker, 1994; Lukacs, 1989), presence of calculus (Buikstra and Ubelaker, 1994), hypercementosis and evidence of deposition of secondary dentine were registered. Dental wear was scored according to Smith (1984), adapted by Silva (1996). Other dental alterations, such as chipping and notching, were scored according to Bonfiglioli *et al.*, 2004. All bone fragments were carefully examined for signs of palaeopathological alterations. To evaluate the childhood health of these individuals, the presence of macroscopically visible linear enamel hypoplasia (LEH), a permanent marker of childhood physiological stress, was recorded.

Due to the unknown extent of bone loss from this assemblage it was not possible to use the bone weight methodology proposed by Silva (2012; Silva *et al.*, 2009) to evaluate dental and bone representation in order to gain insights into burial practices.

5. RESULTS

The human remains recovered by Carlos Ribeiro in 1875 are housed in the Museu Geológico (Figure 5a). The bone remains are labelled as Moinho do Baeta (code MG 638) and the dental remains as Dolmen de Caneças (code MG 637). Fragments of cranium, clavicle, scapula, humerus, radius, ulna, femur, tibia, fibula and calcaneus are represented in this assemblage. Only 3 of the 65 bone fragments belong to non-adult individuals. Three fragments (fragments of left and right femur; left tibia), still have the original Carlos Ribeiro label with information about their provenience: "*22/2/1875, 300m S70'E do M' do Baeta, Caneças*" (22/2/1875, 300 metres south, 70 metres east of the Baeta Mound, Caneças – authors' translation) (Figure 5b).

The dental remains include 5 deciduous teeth (5/55). Of the 50 permanent teeth, 7 are still in process of mineralization (non-adults). One tooth, a left upper central incisor, besides displaying severe taphonomic alteration, had a brown substance along its incisal line that may result from a previous conservation process (Figure 6).

The sample housed in the Museu de Odivelas (Odivelas Municipality: CMO) consists of 17 dental remains and around 438 small bone fragments. Bones from all parts of the skeleton are present, excluding phalanges and small carpal and tarsal bones. The dental sample includes only permanent teeth, although 3 are still in formation, and thus belonged to non-adults. Within the bone assemblage, 34 fragments could be assigned to non-adults.

In sum, the complete assemblage of human remains from the Dolmen of Pedras Grandes is composed of around 503 bone fragments and 72 teeth (Table 1). No complete bone was recovered from this tomb.

Table 1. Human remains preserved from the Dolmen of Pedras Grandes.

	MG	MO	TOTAL
Dental fragments	55	17	72
Bone fragments	65	438	503

MG – Museu Geológico, Lisbon; MO – Museu de Odivelas.

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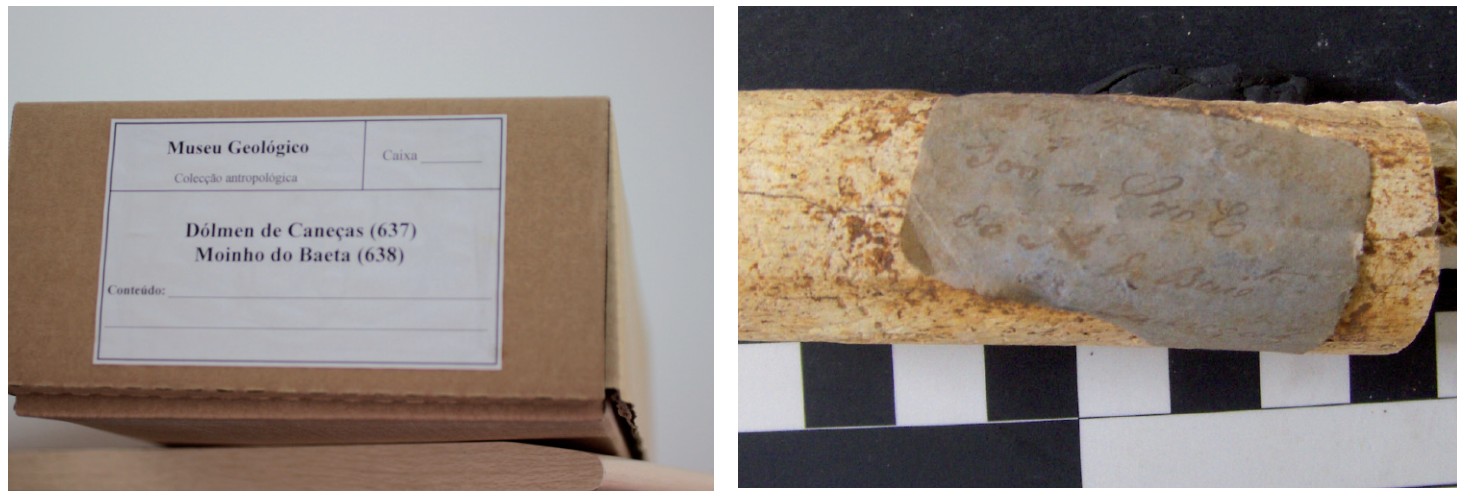

Figure 5. a. Box containing the human skeletal remains recovered from Pedras Grandes in the second half of the 19th century by Carlos Ribeiro and stored in the Museu Geológico (Lisbon); b. Fragment of proximal diaphysis of right femur (0638.0005.2) from the Dolmen of Pedras Grandes still with the original label from the excavation by Carlos Ribeiro.

Figure 7. Root marks visible on the right-hand fragment of proximal diaphysis of femur (0638.0005.1).

Figure 6. Lingual view of left upper central incisor (637.40.25.3). Note the brown substance along the incisal line. This tooth also displays a hypotrophic root.

https://dx.doi.org/10.12795/spal.2021.i30.16

Preservation is better for the assemblage recovered in the 19th century. Heavy erosion of the bone surface is visible in all the fragments recovered from the 2004 excavation. Among the observed taphonomic alterations are the presence of black stains on fragments of long bone diaphysis, probably due to precipitation of manganese oxides; orange or red-coloured stains due to the use of pigments (all from the 2004 excavation); and root (Figure 7) and animal gnawing marks (possible rodents).

The skeletal remains from the Dolmen of Pedras Grandes correspond to a minimal of 13 individuals: 8 adults (>16 years) and 5 non-adults (38,5%). This, however, is certainly an underestimate, especially since the remains recovered from the more recent excavations had mostly been reduced to tiny fragments of bone.

For the non-adult remains, the level of dental calcification allowed a more detailed age-at-death profile to be produced (Figure 8). The youngest individual would have been around 3 years old at the time of death.

For the adults, the different stages of suture obliterations that were observed allow the presence of several adult age groups to be suggested.

The mortality profile of the non-adults was analysed in more detail, through the comparison of their mortality coefficients to those expected according to the mortality tables by Ledermann (1969). Demographic analysis revealed a clear under-representation of infants less than 1 years old in comparison to the theoretical mortuary curve based on mortality frequencies of pre-industrial populations. The following age group (1- 4 years) fell at the lower end of variation. By contrast, the remaining age groups are

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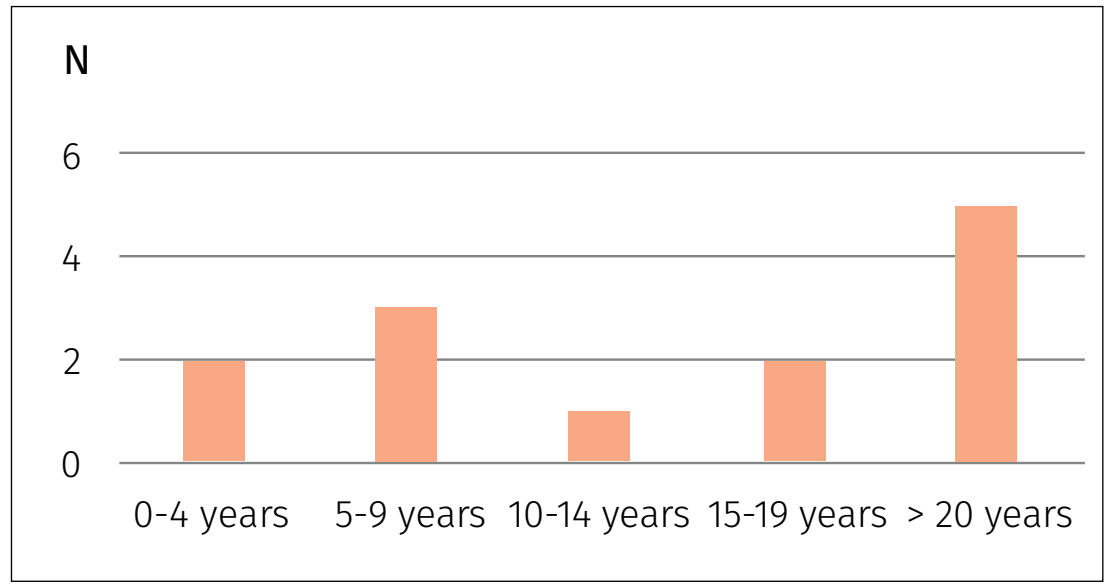

Figure 8. Age-at-death profile of the preserved assemblage from the Dolmen of Pedras Grandes.

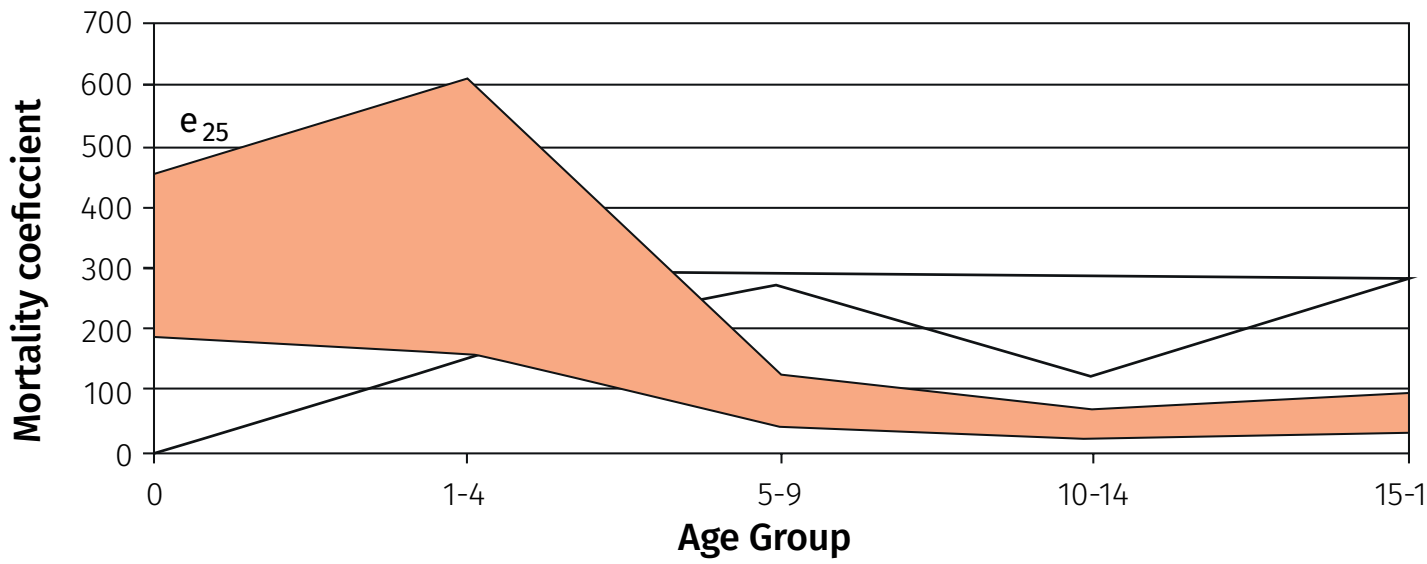

Figure 9. Comparison of the mortality coefficients for the non-adult sample recovered from Pedras Grandes with 95% confidence interval upper limit of e^o = 25 years and lower limit of e^o = 30 years, according to the life tables of Ledermann (1969).

over-represented when compared to the expected mortality rates but, simultaneously, the outline (trend) of the mortality curve is closer to that expected for natural populations (Cunha *et al.*, 2015; Ledermann, 1969; Silva, 2003a; 2012) (Figure 9).

The presence of adults of both sexes is suggested by differences in the robustness of long bone fragments, since no metrical method could be applied owing to the high fragmentation of the assemblage.

The only morphological metrical analysis possible was the estimation of the platycnemic index in one right tibia fragment, which expresses no flatness (73.07). Robustness could only be confirmed macroscopically through the presence of several robust long bone fragments, and three fragments of proximal diaphysis of femur display a thick cortical layer (Figure 10).

Among the analysis of non-metrical skeletal traits, a right femur fragment lacked evidence of the hypotrochantic fossa, and a septal aperture was observed on the only left distal humerus that was preserved. The results of the dental non metric traits are presented in Table 2. The presence of a left upper central incisor with hypothropic root (Figure 6) and a right lower canine with two roots (Figure 11) stands out.

Evidence of disease or lesions are scarce in this assemblage. Evidence of an old trauma was observed above the nuchal line of an occipital bone fragment (Figure 12).

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Figure 10. A thick cortical layer observed in a fragment of proximal diaphysis of right femur (0638.0005.1).

Figure 11. Right lower canine (637.40.25.11) with two roots recovered from Dolmen of Pedras Grandes.

The depressed area has a long axis of 20mm (medial-lateral direction) and a 13mm short axis. The lesion is completely remodelled and no signs of complications, such as infection, are visible. Some cranial fragments exhibit slight porosity probably related to healed lesions of porotic hyperostosis. Among the post-cranial material, signs of mild osteoarthrosis were observed on a left glenoid fossa.

Table 2. Dental non metric morphological traits observed in the assemblage from the Dolmen of Pedras Grandes. Traits were scored using ASUDAS protocol (Turner *et al.*, 1991), Cunha *et al.* (2012) and Marado and Silva (2016).

Dental trait (scoring value)	Observations
Labial curvature UL1 (+ = ASU 2 – 4)	0/1
Shoveling UI1 (+ = ASU 2 – 6)	1/1
Hypotrophic root UI1 (+ = root length equal or shorter than crown)	1/2
Interruption Groove UI2 (+ = ASU +)	0/1
Tuberculum dentale UI2 (+ = ASU 2 – 6)	0/1
Hypocone UM1 (+ = ASU 3 – 5)	3/3
Cusp 5 UM1 (+ = ASU 2 – 5)	1/2
Carabelli trait UM1 (+ = ASU 2 – 7)	0/3
Parastyle UM3 (+ = ASU 1 – 5)	0/3
Enamel extension UM1 (+ = ASU 1 – 3)	0/3
Root Number UM1 (+ = ASU 3 +)	2/3
Distal Accessory Ridge LC (+= ASU 2-)	1/2
Lingual Cusps LP2 (+ = ASU 2+)	1/1
Anterior Fovea LM1 (+ = ASU 2-4)	0/2
Groove pattern LM2 (+ = ASU Y)	0/6
Cusp Number LM1 (+ = ASU 6+)	0/6
Cusp Number LM2 (+ = ASU 5+)	0/8
Deflecting wrinkle LM1 (+ = ASU 2 – 3)	0/2
Protostylid LM1 (+ = ASU 1-6)	0/3

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Dental trait (scoring value)	Observations
MMPT LM1 (6 grades of presence)	0/3
Cusp 7 LM1 (+ = ASU 2-4)	0/5
Root Number LC (+ = ASU 2+)	1/3
Tome's Root LP1 (+ = ASU 3-5)	0/3
Root Number LM1 (+ = ASU 3+)	0/3
Root Number LM2 (+ = ASU 2+)	2/4

Legend: ASU rank scale trait breakpoints from Scott and Turner (1997).

The mean dental wear is low (2.8; n=51) (Table 3), ranging between absence of wear to grade 5 (from a maximum of 8). Dental pathologies were observed, in the form of calculus deposits, in 28% of the permanent teeth, all at low level. One left upper first premolar and one left lower third molar exhibit small cariogenic lesions at the level of the enamel-dentine junction and the occlusal surface, respectively. Hypercementosis was observed in 10 teeth, all belonging to the posterior dentition (two upper premolars and 8 molars, 4 of each arcade). In several teeth (10/16; all posterior teeth with the exception of one lower incisor), it was possible through post-mortem root fractures to observe an extensive deposition of secondary dentine. Natural physiological ageing tends to promote deposition of secondary dentine which starts to form once a tooth erupts and is in occlusion (Johnstone and Parashos, 2015). The majority of affected teeth, however, display low dental wear (with the exception of one molar, all other teeth display dental wear lower than grade 4), suggesting that they belong to young individuals. According to clinical literature, pathological factors can also modify the deposition of dentine, such as occlusal trauma, periodontal disease, carious lesions or deep restorations (Lee *et al.*, 2011). Although the available data for Pedras Grandes does not allow us to infer which factor(s) may have been the mechanism responsible for the early pulp space reduction due to deposition of dentine, the last two, at least, can be excluded.

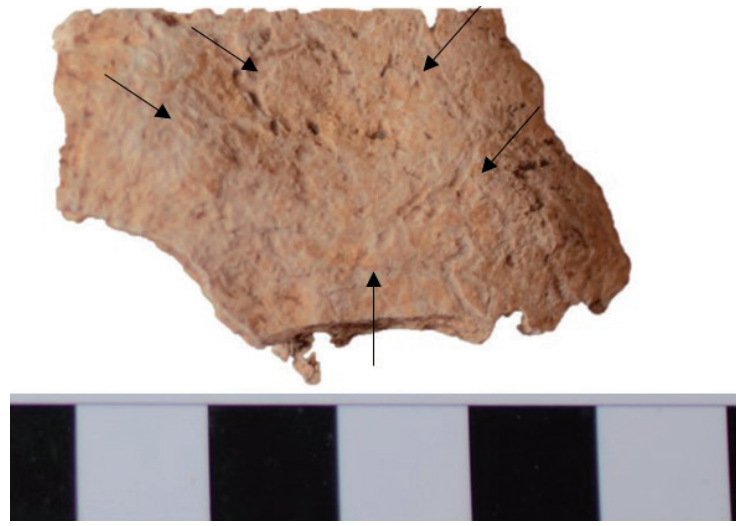

Figure 12. Depression observed above the nuchal line of a small occipital bone fragment (0638.0008.1) recovered from the Dolmen of Pedras Grandes. The arrows indicate the limits of the depression (exocranial view).

Figure 13. Lingual view of a right first lower premolar (637.40.25.18) with a marked lineal enamel hypoplasia.

13 teeth (13/55) reveal linear enamel hypoplasia (Figure 13). All tooth express one line with the exception of one right upper first premolar with three lines, and one right and one left lower canine (not symmetrical), each with two lines.

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Chips were scored on 10.5% of the teeth, 22.2% of the anterior (2/9) and 6.9 % of the posterior ones (2/29). Notches were not observed (Table 4).

Table 3. Oral pathologies, dental wear and enamel hypoplasia observed in the assemblage recovered from the Dolmen of Pedras Grandes.

	Results
Dental wear	Mean = 2.8 (n=51)
Calculus	14/50 = 28%
Cariogenic lesions	2/50 = 4 %
Hypercementosis	10/32 = 31%
Linear enamel hypoplasia (Permanent teeth)	13/55 = 24%
Linear enamel hypoplasia (Deciduous teeth)	0/5 = 0%

Legend: Presence/Number of possible observations.

Table 4. Dental alterations observed in the assemblage recovered from Dolmen of Pedras Grandes.

CHIPS	%	%
Anterior and upper teeth	2/4 = 50%	3/17 = 17.7%
Posterior and upper teeth	1/13 = 7.7%	—
Anterior and lower teeth	0/5 = 0 %	1/21 = 4.8%
Posterior and lower teeth	1/16 = 6.25%	—
TOTAL	4/38 = 10.5%	—

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6. ABSOLUTE DATES AND PRELIMINARY STABLE ISOTOPE ANALYSIS

In the course of the osteological analysis, three further samples were selected for radiocarbon dating by the Oxford Radiocarbon Accelerator Unit (ORAU) (Table 5). These can now be added to the two dates previously available (Boaventura, 2009; see also Guiry *et al.*, 2016). All five dates are for right femurs and hence correspond to different individuals.

Diaphysis samples were selected from right femurs, taken both from Carlos Ribeiro's nineteenth-century collections and from the new 2004 excavations. Given the NMI of 13 individuals (with 5 individuals being dated; 38.5% of the NMI) and the homogeneity of the grave goods, this sampling can be considered highly representative of the whole assemblage. There is also a level of agreement between the dates for material from the old excavations (Beta-234136 OxA-35898; OxA-35899; OxA-36001) and the recent excavations (Beta-205946), which confirms the value of retrieving information from previously excavated material. While the first published dates (Boaventura, 2009), fell into the third quarter of the 4th millennium (Beta-205946; Beta-234136), the new dates push that back to the end of the second quarter of the 4th millennium, particularly OxA-35898 and OxA-36001 (Figure 14).

The isotope values obtained with the radiocarbon dating varied between -19.9 and -19.1 for δ13C, and between 8.4 and 9.2 for δ15N. These values are very homogenous between the individuals that were analysed. Moreover, they are within the range of other coeval samples

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recovered from Portuguese sites, including from assemblages recovered from other types of tombs (Cubas *et al.*, 2019; Guiry *et al.*, 2016; Waterman *et al.*, 2016), allowing to suggest C3 plant terrestrial diet consistent with animal husbandry and farming (Guiry *et al.*, 2016).

Table 5. Results of radiocarbon dating and isotopic analysis of fragments of right femurs from the Dolmen de Pedras Grandes (adapted from Boaventura, 2009; Guiry *et al.*, 2016), including new data. Calibration: OxCal v4.3.2 Bronk Ramsey (2017); r:5 IntCal13 atmospheric data from Reimer *et al.* (2020).

Sample number	Sample type	Laboratory reference	Radiocarbon date (BP)	Calibrated date (2s) (cal BC)*	Isotopic analysis
U58,PG(04)H6-28	Right femur	Beta-205946	4590 ± 40	3510-3100 cal BC	δ 13C = - 19.9 δ 15N = 8.4
MG638.0005.2	Right femur	Beta-234136	4530 ± 40	3370-3100 cal BC	δ 13C = - 19.6 δ 15N = 8.6
MG638.0005.3+0006.16	Right femur	OxA-35898	4796 ± 30 BP	3640-3530 cal BC	δ 13C = - 19.5 δ 15N = 8.4
MG638.0007.1-2	Right femur	OxA-35899	4671 ± 29 BP	3520-3370 cal BC	δ 13C = - 19.2 δ 15N = 8.6
MG638.0005.1	Right femur	OxA-36001	4812 ± 28 BP	3650-3530 cal BC	δ 13C = - 19.1 δ 15N = 9.1

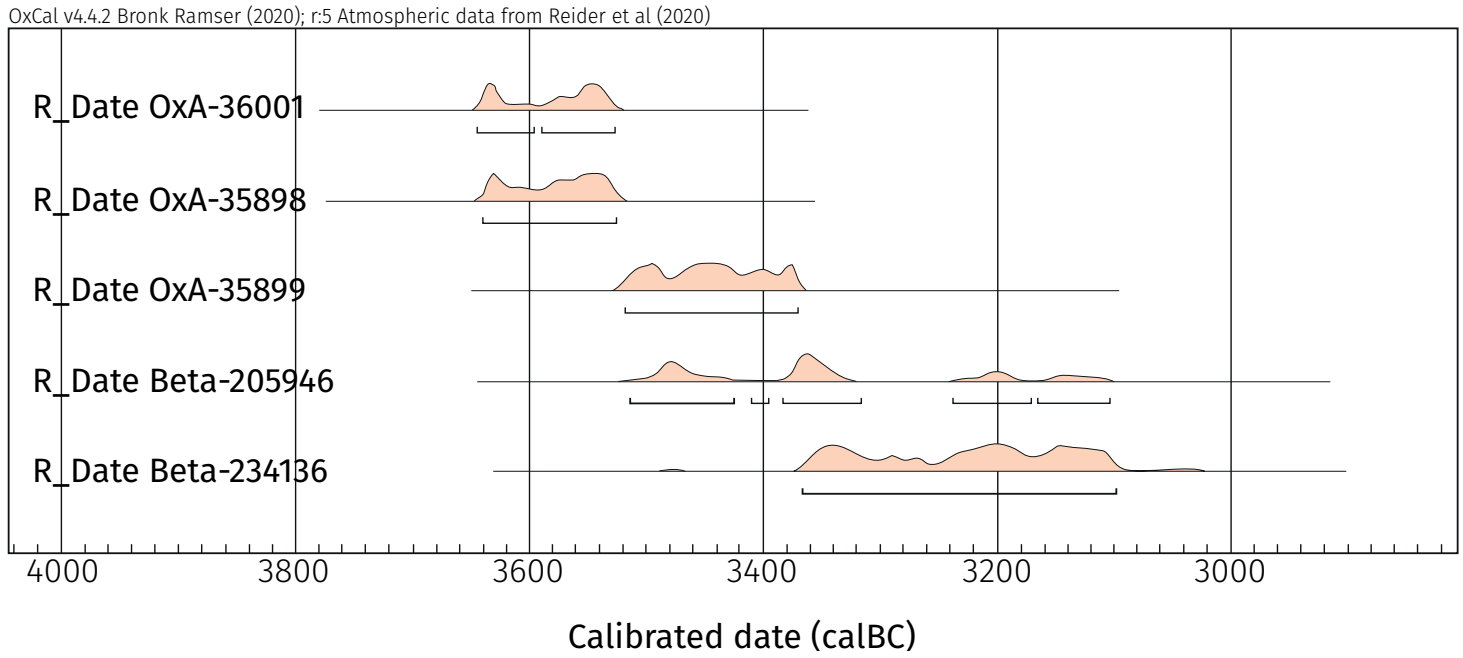

Figure 14. Calibrated radiocarbon dates (2s) from the Dolmen of Pedras Grandes (see Table 5).

7. DISCUSSION

The Dolmen of Pedras Grandes belongs to the megalithic tomb type most frequently encountered among the dolmens of the Lisbon region (Boaventura, 2009): it has a polygonal chamber (3.5m x 3m) with an internal area of around 10m^2, in which a minimum of 13 individuals were deposited. The anthropological data may be compared with the samples of the same period from the *Dolmen do Carrascal* (Silva *et al.*, 2019) and the *Dolmen de Ansião* (Silva, 2012). These three tombs belong to the same type of funerary monument, although the Dolmen de Ansião is located at some distance, around 200km north of Lisbon, near the city of Coimbra. The data from the *Tholos de Agualva* (Boaventura *et al.*, 2016) were also included in this comparison, coming from the same geographic region although around 600 years later in age.

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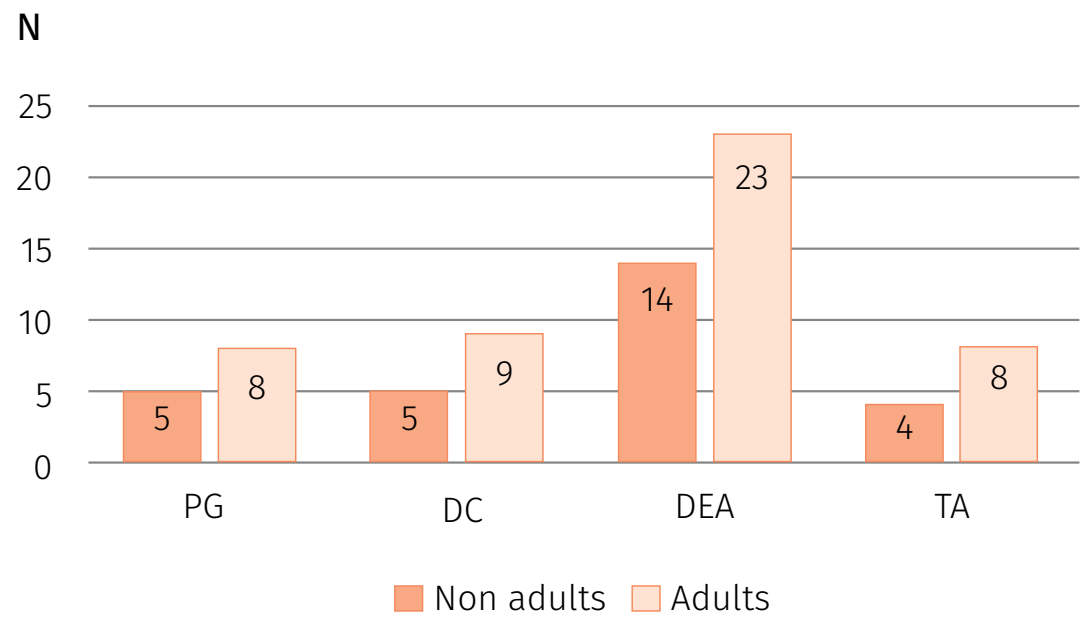

Figure 15. Demographic profile of the skeletal assemblages from four tombs. Legend: PG – Pedras Grandes; DC – *Dolmen do Carrascal*; DEA – *Dólmen de Ansião*; TA – *Tholos de Agualva*.

All four tombs contain the remains of adults (both sexes) and non-adults, the latter ranging between 33.3% (4/12; TA) and 38.5% (5/13; PG) (Figure 15). This in accordance with the expected non-adult ratio of 36 % to 50 % in archaic populations (Acsádi and Nemeskéri, 1970) that has been observed in many coeval archaeological samples of the Iberian Peninsula (Díaz-Zorita *et al.*, 2017 ; Cunha *et al.*, 2015; Fernández-Crespo and De-la-Rúa, 2016; Silva 2003a; 2012). Yet, as in other Iberian assemblages of this period, individuals who died before the age of one year are under-represented (Cunha *et al.*, 2015; Fernández-Crespo and De-la-Rúa, 2016; Silva, 2003a, 2012). This under-representation has been attributed variously to age-related mortuary practices, to differential preservation caused by taphonomic agents, or to incomplete archaeological recovery resulting from excavation techniques (Saunders and Barrans, 1999). The available data do not allow us to confirm which of these factors may have influenced the observed under-representation, but all of them may have contributed.

Among rarely encountered dental traits, the presence of one lower canine with two roots is the most noteworthy feature in the Pedras Grandes assemblage. According to Lee and Scott (2011), this is a typical European dental trait, although its actual frequency in Iberian prehistoric assemblages is only now beginning to be recognised (Cunha, 2015). It was not observed in the other three assemblages. Among the postcranial elements, the only non-metrical morphological trait observed was the presence of a septal aperture in a humerus fragment, a trait frequently registered in prehistoric Portuguese samples (Silva, 2003a).

The presence of a thick cortical layer was observed on a fragment of proximal diaphysis of a femur, suggesting high levels of loading. Unfortunately, the poor state of bone preservation prevented the estimation of flatness indexes for the femurs which could have sustained that observation. Robustness of several long bone fragments was also a feature observed at Carrascal together with a thick cortical layer on a fragment of proximal diaphysis of a femur. These observations strongly suggest that these individuals were subject to significant daily mobility, as documented for other assemblages of this period (Silva, 2003a; 2012; Silva *et al.*, 2019).

Mean dental wear is medium-low in these individuals and a low frequency of cariogenic lesions characterizes the samples recovered from all three tombs of dolmen type (Carrascal, Pedras Grandes and Ansião), which also share the same chronology

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(Table 6). The dental material from Agualva exhibits a much higher frequency of these lesions. That may in part be biased by the small sample size, but changes in the dietary habits of the Agualva individuals, who lived around 600 years later, and the inclusion of more cariogenic foods such as sweet fruits, cannot be excluded.

The Pedras Grandes material stands out on account of the frequency of linear enamel hypoplasia: 23% of the dental remains, that is 13 teeth, display this non-specific stress indicator. These teeth belong to a minimum of three individuals: one non-adult (age at death around 9.5 years) and two adults. The non-adult displays two lines, confirming that this individual survived two periods of enamel growth disruption. The tooth with three lines belongs to an adult individual exposed to three severe stress periods during childhood. It is important to emphasise that these individuals survived these episodes, revealing some immunological competence. Moreover, these data allow us to infer that the individuals from Pedras Grandes were exposed to a higher level of physiological stress than the other three groups. This difference is not, however, reflected in the mortality data: although Pedras Grandes includes the highest percentage of non-adults, this mortality profile is not significantly different from those obtained for the other assemblages (Cunha *et al.*, 2015; Silva, 2003a).

Table 6. Dental wear and pathologies from the dolmens of Pedras Grandes, Carrascal and Ansião, and the *Tholos* of Agualva.

	Pedras Grandes	Carrascal	Ansião	Tholos de Agualva
Dental wear	2.8 (n=51)	2.1 (n= 117)	4.0 (n= 41)	3.77 (n=22)
Calculus	28% (14/50)	34% (40/117)	—	40% (8/20)
Cariogenic lesions	4% (2/50)	1.7% (2/117)	2.6% (1/40)	30% (6/20)
Linear enamel hypoplasia (permanent dentition)	24% (13/55)	8.2% (8/97)	1.2% (6/506)	0% (0/20)

Despite the poor preservation that characterizes these assemblages, cranial trauma was observed in all three dolmens (no evidence was observed in the *Tholos de Agualva* assemblage) (Table 7). The majority of the lesions were depressed fractures, followed by 2 perforations and 1 trepanation. All lesions were remodelled with the exception of the depressed fractures observed in the Carrascal sample. Intriguingly, no evidence of trauma was detected in post cranial bones in these assemblages. At present, the available data do not allow us to confirm whether this trauma pattern is genuine, or only a reflection of the pattern of bone preservation in these assemblages, since increasing evidence of traumatic injuries is emerging in studies of prehistoric assemblages from Portugal (Curate *et al.*, 2011; Silva, 2017; Silva and Ferreira, 2008a; Silva *et al.*, 2014; 2018).

Non-masticatory use of teeth can be inferred from the presence of alterations such as chipping and notches (Table 8). Evidence for these alterations is only available for Pedras Grandes and Carrascal, which display the same tendency for chipping: more chipping in anterior than posterior teeth, and more in upper than lower teeth. This mixed pattern probably reflects a combination of non-masticatory activities (performed mostly with anterior teeth) with the ingestion of hard food, such as hard fruits (posterior teeth) (Silva *et al.*, 2019). Only two teeth (n=13) with notches were scored for Carrascal, and none for Pedras Grandes.

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Table 7. Summary of the pathologies observed in the assemblages here discussed.

Pedras Grandes (Present study)	Carrascal (Silva et al., 2019)	Ansião (Silva, 2012)
— 1 depressed fracture on occipital bone	— 2 depressed fractures on right parietal bone — Trepanation in a right parietal bone fragment (remodelled)	— depressed fractures; 2 frontal, 3 parietal and 1 occipital bones — skull perforations on frontal bone

Table 8. Chipping pattern observed in the Pedras Grandes and Carrascal assemblages.

	Pedras Grandes	Dólmen do Carrascal
Anterior teeth	22.2% (2/9)	19.5% (8/41)
Posterior teeth	6.9% (2/29)	11.3% (7/62)
Upper teeth	17.7% (3/17)	20.5%
Lower teeth	4.8% (1/21)	8.5%

The results of the preliminary analysis of stable isotopes for the individuals sampled from Pedras Grandes, along with those from Carrascal and Agualva, suggest that these individuals had a C3 plant terrestrial diet consistent with animal husbandry and farming. They present δ13C δ15N values (Table 9) that are also similar to other assemblages of the same period from the Iberian Peninsula (Beck *et al.*, 2018; Cubas *et al.*, 2019; Fernández-Crespo and Schulting, 2017; Guiry *et al.*, 2016; Waterman *et al.*, 2016).

Table 9. Mean of δ13C and δ15N values of individuals from three megalithic tombs in the Lisbon region.

	N	Mean δ13C	± 1 s	Mean δ15N	± 1 s
Pedras Grandes	5	-19.4	0.3	8.6	0.3
Carrascal	4	-19.2	0.1	9.2	0.4
Tholos de Agualva	3	-19.5	0.1	8.1	0.8

The new dates for the Dolmen of Pedras Grandes make a significant contribution to improved understanding of the periodization both of this specific monument and the monuments of the Lisbon region as a whole. With five absolute dates, Pedras Grandes is currently the best-dated orthostatic tomb in the Lisbon region.

The grave goods, the absolute dates and the restricted number of individuals buried in the Dolmen of Pedras Grandes place it within an early phase of the megalithic tradition of western Iberia. Analysis of the chronology of megalithic monuments in central and southern Portugal by one of the authors (RB) identified an initial phase of megalithic tomb construction between the third and second quarters of the 4th millennium BC (Boaventura, 2009). Bayesian analysis carried out in that study assigns to this initial phase all of those tombs that have a limited grave assemblage of an 'archaic' character (geometrics, small blades, no decorated ceramics). Tombs of this phase are marked furthermore by the absence of engraved schist plaques, flint arrowheads, halberds and daggers. In megalithic tombs, the limited number of buried individuals is also considered an indicator of relatively early date. In Estremadura, dolmens such as Pedras Grandes, Carrascal and Trigache 4 can be attributed to this initial phase, along with a number of natural caves: Algar do Bom Santo, Algar do Barrão, Feteira, Salemas and Porto Côvo. Some of the later, notably Algar

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do Bom Santo (Carvalho *et al.*, 2012), reveal a higher minimum number of individuals, but that may result from continued funerary deposition over an extended period.

The evidence suggests that in central and southern Portugal the large-scale collective burials began in natural caves in the first quarter of the 4th millennium. Only at a later stage, in the last quarter of the 4th millennium, do funerary assemblages containing large numbers of individuals appear in dolmens. The first dolmens and cists seem to have been reserved for the burial of small numbers of individuals, perhaps families of related kin (Gonçalves, 1999).

These burial practices will only be effectively understood through a more systematic study of the sequence and chronology of the funerary deposits, supported by rigorous field recording and larger series of AMS dates. The megalithic monument of Alto de Reinoso is of special importance in understanding these dynamics: despite a relatively high number of burials (at least 47 individuals), the tomb was in use for only around 100 years and the mitochondrial DNA study revealed a pattern pointing to a closely related local community with matrilineal kinship patterns (Alt *et al.*, 2016). Burial of close kin has also been suggested for megalithic tombs in northern and northwestern Europe from analysis of ancient DNA (Sánchez Quinto *et al.*, 2019; Cassidy *et al.*, 2020).

The upper limit of this early phase of megalithic tombs in central and southern Portugal was initially placed between 3760 and 3550 cal BC, and the lower limit between 3320 and 3030 cal BC (Boaventura, 2009; 2011). Today, almost ten years later, the series of available dates has been expanded with new dates for the Dolmen of Carrascal (Silva *et al.*, 2019) and the new dates for the Dolmen of Pedras Grandes reported here. There are also new dates for the burial caves of Lugar do Canto (Carvalho and Cardoso, 2008) and Algar do Barrão (Carvalho *et al.*, 2019).

The new dates from Pedras Grandes represent an important contribution to the chronology of megalithic monuments in Western Iberia, building upon the existing model (Boaventura, 2009; 2011). In particular, they support the evidence from Carrascal that the construction of orthostatic passage tombs in the Lisbon region began in the second quarter of the 4th millennium BC.

To understand the significance of the Pedras Grandes dates they must be placed within the broader context of megalithic tombs not only in the Lisbon Peninsula but also in Alentejo, south of the River Tagus. In cultural terms, there are strong connections between the two regions, which are reinforced by physical geography (Gonçalves, 2003). Alentejo has the most impressive concentration of megalithic monuments (*c.* 1600) in southern Portgal, far more than the Lisbon area.

In the Lisbon region, the dates from Pedras Grandes and Carrascal place them within the earliest phase of megalithic tombs in south-central Portugal. This early phase is characterized by funerary assemblages containing geometric microliths, unretouched flint blades and ground stone tools, but little pottery. It pre-dates the widespread deposition of engraved schist plaques (the “pre-idol-plaques” phase: Boaventura, 2009; 2011). Many of the same tombs continued to be used over the following centuries, into the third quarter of the 3rd millennium BC, but it is possible that very few new megalithic tombs were built in the region after the 4th millennium BC (Boaventura, 2011). This seems to be confirmed both by absolute and relative chronology. In fact, in south-central Portugal there are very few dolmens with no ‘archaic’ elements in their assemblages, or with dates that fall exclusively in the 3rd millennium: the exceptions being the Estria and Trigache dolmens in the Lisbon region (Boaventura, 2011) and the Dolmen de Santa Margarida 3 in the Alentejo (Gonçalves, 2003).

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To confirm this chronology, much larger numbers of dated samples and more diversified dating strategies will be required. Recent work on the megalithic cemetery of Panoria in southern Spain has illustrated the complexity of funerary practices that the archaeological record may contain (Aranda *et al.*, 2020), including the deliberate and systematic removal of the oldest burial deposits, and the introduction of new bodies.

8. FINAL REMARKS

The dolmen of Pedras Grandes, a monument known since the 19th century, continues to offer an interesting case study both for the genesis of megalithic funerary architecture and for the funerary practices and late Neolithic populations of the Lisbon region.

The interdisciplinary approach developed for this dolmen must necessarily be understood within the regional and supra-regional context. Earlier research on the megalithic monuments of the Lisbon region (Boaventura, 2009) established a frame of reference both for stable isotope analysis and chronology. Despite the fragmentary nature of the evidence surviving from old excavations in the Lisbon region, the skeletal assemblages of Pedras Grandes and other dolmens in this region are crucial since the monuments with organic material is very rarely preserved in the of the Alentejo despite their much higher numbers.

The series of five radiocarbon dates, two from the end of the second quarter of the 4th millennium BC, indicate that Pedras Grandes may be placed within the early phase of orthostatic tombs in central and southern Portugal, along with the dolmen of Carrascal (Lisbon region) or the orthostatic tombs of Alentejo with similar early dates (Sobreira 1, Cabeço da Areia, Cabeceira 4a). Current research indicates considerable architectural variability among the earliest megalithic monuments. By contrast, grave assemblages and funerary practices are similar in all monuments from this phase, including small orthostatic tombs, natural caves and rock cut tombs (hypogea). The origins of megalithic monumentality hence present a great diversity that we cannot yet explain.

The high degree of fragmentation of the human remains from Pedras Grandes unfortunately precludes the recovery of significant information about the biological profile and health status of the individuals buried in this tomb. The osteological evidence nonetheless indicates that both adult and non-adults were buried here, although no individuals under the age of three years were identified. With the exception of remodelled depressed cranial fractures, no relevant pathological changes were detected in the bone assemblage. The dental remains were more informative: besides evidence of dental alterations and pathologies, the frequency of LEH revealed that some of these individuals had experienced systematic physiological stress during their childhood, but had also demonstrated resilience by surviving various health problems. The new radiocarbon dates for Pedras Grandes confirm other evidence for the 4th millennium BC chronology of the earliest megalithic funerary monuments in this region.

Acknowledgements

The authors express their gratitude to the Director of the Museu dos Serviços Geológicos, Dr. Miguel Ramalho, for access to the collection, and to the museum curator José

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António Moita for his assistance during our research. The municipality of Odivelas supported the recent archaeological fieldwork and allowed access to the excavated material and the fieldwork documentation. We thank Cátia Delicado for assistance in the preparation of the maps and plans and Néstor Hernández Canales for the Spanish abstract. The authors wish also to thank the Oxford Radiocarbon Accelerator Unit and NERC award NF/2015/1/1 for AMS dates OxA 35898, OxA 35899 and OxA 36001; and the CIAS for financial support (PEst-OE/SADG/UI0283/2020).

This manuscript is the seventh published under the project launched by one of the authors (AMS) and Rui Boaventura to re-analyse a series of long-forgotten skeletal assemblages housed in museums and private collections.

This work is dedicated to Rui Boaventura, mentor and participant of this work until his premature death, and Álvaro Figueiredo, member of the 2004 field intervention and author of a preliminary report on the skeletal assemblage recovered in this intervention, who passed away during the preparation of this paper.

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ISSN: 1133-4525
ISSN-e: 2255-3924

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Contribución Autores

Todos los autores han contribuido por igual en la elaboración de este trabajo.