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## **A multi-stage Bayesian modelling for building the chronocultural sequence of the Late Mesolithic at Cueva de la Cocina (Valencia, Eastern Iberia)**

Oreto García-Puchol, Sarah McClure, Joaquim Juan-Cabanilles, Alfredo Cortell-Nicolau, Agustín Diez-Castillo, Josep Lluís Pascual Benito, Manuel Pérez-Ripoll, Salvador Pardo-Gordó, Gianni Gallelo, Mirco Ramacciotti, et al.

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## A multi-stage Bayesian Modeling for building the chronocultural sequence of the Late Mesolithic at Cueva de la Cocina (Valencia, Eastern Iberia) --Manuscript Draft--

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<b>Abstract:</b>	<p>This paper presents a refined Mesolithic chronocultural sequence as result of matching data provided by the set of archaeological research conducted at Cueva de la Cocina in the 20th and 21st century and the new radiocarbon dates record. Because available data is of different quality, we apply a methodological framework based on Bayesian modeling approaches. To do this, we systematically order each one of the archaeological registers and then combine the information in a unitary general chronology. Our novel approach introduces Bayesian modelling from a double analytical procedure: using Bayesian chronological models applied to the stratigraphic sequence of Pericot's excavation in Cocina cave we build a general phase model using data from multiple years of archaeological fieldwork. One the most reliable layers have been defined, we use this information to define the rest of the sequence through a</p>

	Predictive Bayesian approach. This approach sheds light on evolutionary questions from a macroscale in regards to the socioecological dynamics of the last hunter gatherers and their role for explaining the subsequent agricultural spread.
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# 1 **A multi-stage Bayesian Modeling for building the chronocultural sequence of the Late** 2 **Mesolithic at Cueva de la Cocina (Valencia, Eastern Iberia)**

3  
4 García-Puchol, O.<sup>a\*</sup>, McClure, S.B.<sup>b</sup>, Juan-Cabanilles, J.<sup>c</sup>, Cortell-Nicolau, A.<sup>d</sup>, Diez-  
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## 27 28 **Abstract**

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30 This paper presents a refined Mesolithic chronocultural sequence as result of matching data  
31 provided by the set of archaeological research conducted at Cueva de la Cocina in the 20th  
32 and 21st century and the new radiocarbon dates record. Because available data is of different  
33 quality, we apply a methodological framework based on Bayesian modeling approaches. To  
34 do this, we systematically order each one of the archaeological registers and then combine the  
35 information in a unitary general chronology. Our novel approach introduces Bayesian  
36 modelling from a double analytical procedure: using Bayesian chronological models applied  
37 to the stratigraphic sequence of Pericot's excavation in Cocina cave we build a general phase  
38 model using data from multiple years of archaeological fieldwork. One the most reliable  
39 layers have been defined, we use this information to define the rest of the sequence through a  
40 Predictive Bayesian approach. This approach sheds light on evolutionary questions from a  
41 macroscale in regards to the socioecological dynamics of the last hunter gatherers and their  
42 role for explaining the subsequent agricultural spread.

43  
44 **key words:** Radiocarbon dates; Bayesian modeling; Late Mesolithic; Neolithic; Cueva de la  
45 Cocina; Eastern Iberia

## 46 47 **1. Introduction**

48  
49 In 1941 the first fieldwork campaign at Cueva de la Cocina began under Lluís Pericot's  
50 direction, just a year after Salvador Espí (member of Prehistory Museum of Valencia)

51 validated the preservation of archaeological deposits coinciding with their visit to the area for  
52 the exploration of a recent discovery of Levantine rock art at the *Cinto de La Ventana* and  
53 *Cinto de las Letras* sites (Pericot 1946). During four years, 1941, 1942, 1943 and 1945,  
54 Pericot and his team excavated for a total of 74 days. In all, approximately 60,5 m<sup>2</sup> of  
55 cultural deposits was removed, confirming the richness of the prehistoric archaeological  
56 deposits in a long sequence that included mainly forager occupations but also Neolithic,  
57 Chalcolithic and Bronze age levels. Lluís Pericot was a recognized Spanish archaeologist that  
58 previously had worked at Cova del Parpalló (Gandia, Valencia) discovering one of the most  
59 impressive Upper Paleolithic portable art collections in Europe (Pericot, 1942). In 1946 Lluís  
60 Pericot published the only paper focused on the primary results at the site of Cocina  
61 according to the 1945 campaign, a seminal work which provided evidence about the sequence  
62 and chronology, centered between the final Paleolithic and the Holocene times in the region.  
63 Consequently, Pericot's explanation linked the beginning of the human occupations with the  
64 Magdalenian, and identified a total of 3 levels that also encompassed the Epipaleolithic and  
65 Neolithic periods (Juan-Cabanilles et al., this issue). Furthermore, the discovery of a  
66 particular graphic expression episode through the recovery of "35" engraved plaquettes with  
67 lineal motifs highlighted the singularity of the site in terms of social and symbolic practices.  
68 Concurrently, Pericot mentioned the identification of possible painting traces in the southern  
69 wall of the cavity. This assertion triggered the controversy about the chronology of the  
70 Holocene graphic expressions sequence in the Mediterranean Iberia that remain until today  
71 (including Levantine, Schematic and Macroschematic horizons) (García Puchol et al., 2004;  
72 Cruz Berrocal and Vicent, 2007; McClure et al., 2008; Villaverde et al., 2016; Ruiz et al.,  
73 2022; López Montalvo et al., in press).

74 Despite the preliminary character of his report, different researchers understood the novelties  
75 that Cocina provided in order to organize the archaeological sequence at the regional level,  
76 particularly Javier Fortea, who in the 70s was working on his doctoral thesis. As a result, his  
77 influential book (1973) presented the bases for systematizing the sequence of the last hunter  
78 gatherers in the area. He classified the Holocene sequence in two main technocomplexes:  
79 "Microlaminar Epipaleolithic" and "Geometric Epipaleolithic" (he preferred the term  
80 Epipaleolithic to Mesolithic). Unlike Pericot, Fortea argued that Cocina had a short  
81 chronological sequence. Accordingly, he sorted the Pericot excavation information into four  
82 levels including two attributed to the Geometric Epipaleolithic of Tardenoisian tradition.  
83 Firstly, he emphasized the impressive richness of the lithic record produced by forager  
84 dwellers in the site, reflecting a diachronic succession of levels. These industries are  
85 characterized by regular blades and geometric projectiles, trapezes at the beginning, and  
86 "Cocina type" triangles subsequently. Since that publication, Cueva de la Cocina became the  
87 referential site for the Late Geometric Epipaleolithic in Iberia. Secondly, he centered his  
88 interest on the subsequent Neolithic levels and the "transitional process" that he believed was  
89 evident in the site. As a consequence, the site was considered the main proof for explaining  
90 the acculturation process from foragers to farmers in the Mediterranean Iberia (Fortea et al.,  
91 1987). This was described in the "dual model", aimed to explain the neolithization process in  
92 eastern Iberia (Fortea and Martí, 1984-1985; Fortea et al., 1987; Bernabeu, 1997).

93 He began a new fieldwork project at Cueva de la Cocina that involved several excavations  
94 between 1974 and 1981. For this purpose, he selected a central area near the north wall of the  
95 cave. Unfortunately, only three specific papers were published, two of them related to the  
96 sedimentary history of the site (Fumanal, 1978, 1986). The third one consists of a preliminary  
97 summary including new data from the faunal record (Fortea et al., 1987). Fueled by this first  
98 detailed zooarchaeological approach, the paper pointed to a transitional character of the site  
99 relating to the arrival of the Neolithic, including the presence of domesticated sheep or goats  
100 in levels with Late Mesolithic stone tools technologies. However, and probably due to the

101 new research challenges attached to his incorporation at the University of Oviedo (northern  
102 Iberia) the final results remained unpublished.

103 Based on these pivotal questions about the chronology and nature of hunter-gatherer lifeways  
104 as well as the evidence for acculturation of the last hunter-gatherers to farming, we decided to  
105 open a new window to the archaeological record of Cueva de la Cocina. Several research  
106 projects, started in 2013 until now, have allowed us to build an interdisciplinary research  
107 team that involves different Spanish and international institutions. Thanks to this  
108 collaborative approach we revisited the archaeological site and organized several  
109 archaeological excavations (from 2015-2018) that have provided new data for understanding  
110 this impressive prehistoric deposit. Not less important, one of the fundamental objectives has  
111 consisted of studying the older record recovered during the excavations from Pericot and  
112 Fortea. In fact, it has been a huge challenge considering the magnitude of the entire  
113 collection, particularly the access for the first time to the bulk of Pericot's remains. Thanks to  
114 this collaborative effort, more than 70,000 lithics, close to 7,000 faunal remains, and 2,000  
115 pottery fragments, among others, have been analyzed and provide the current database.

116 Our interest in Cueva de la Cocina was motivated by several questions. The general issues try  
117 to shed light on evolutionary questions from a macroscale approach in regards to the  
118 socioecological dynamics of the last hunter gatherers and the models for explaining the  
119 subsequent agricultural spread. Specifically, we focus on a) defining the archaeological  
120 sequence at Cueva de la Cocina with a new high resolution radiocarbon record; b) exploring  
121 cultural transmission processes and scenarios of cultural change from archaeological record;  
122 c) building land use behavior and palaeoeconomical patterns in a diachronic view; d)  
123 recovering new data about paleoclimate and paleoenvironmental dynamics; and, e) trying to  
124 reveal some aspects on social practices and symbolic behavior at the site level and at regional  
125 scale.

126 In this paper we focus on a refined chronocultural sequence as a result of matching data  
127 provided by the set of archaeological investigations conducted at the site and the new  
128 radiocarbon dates record. To do this we rely on different quality data that we will sort and  
129 combine through a methodological approach based on Bayesian modeling and statistical  
130 analysis procedures in order to present the best model for characterizing the particularities of  
131 this archaeological record.

## 132 133 **2. General description**

134  
135 Cueva de la Cocina is located in the municipality of Dos Aguas (Valencia province, Eastern  
136 Iberia), opened in a pronounced meander of the La Ventana ravine. The site is surrounded by  
137 an abrupt landscape forming part of the Southeastern Iberian range, limiting at the North and  
138 the West with the cretaceous formations of Sierra de Martes and Sierra del Caballón, to the  
139 East with the València plain, and to the South, with the canyon conformed by the Xúquer  
140 river before its arrival to the Valencian plain, where it flows into the Mediterranean (Fig. 1).  
141 This special situation would explain its continental climate character as it is reflected by the  
142 mean temperature, with a maximum in August (31), and a minimum in January, when it can  
143 drop to freezing. The annual rainfall fluctuates between 400-550 mm with a maximum in  
144 autumn. Recurrently affected by fires, the immediate natural landscape is dominated by a  
145 vegetation of shrubs and some residual pines.

146 The cave (20 meters wide by 30 m long) (Fig. 2) was formed by the drainage system of the  
147 Barranco de la Ventana until the beginning of the accumulation of sediments that constitute  
148 the base of the Holocene deposits (Fumanal, 1978, 1986). The particular position in regards  
149 with the course of the ravine explains sporadic entrances of water and the subsequent silt  
150 depositions. This kind of episodes was documented in 1977, when a flash flood reopened a

151 lateral sink at the cavity showing a long sequence of Pleistocene natural deposits. Fumanal's  
152 study (1987) points to the process formation of the cavity and the reading of the current  
153 natural and archaeological deposit. She highlighted another important trait previously  
154 described by Pericot: the cavity offers a sedimentary accumulation in the center, and a  
155 pronounced slope from this part to the southern wall, forming a great basin when the  
156 Holocene accumulation started to occur. This aspect has been demonstrated by the recent  
157 fieldwork conducted affecting the surrounding areas (García Puchol et al., 2018b).  
158 The mountainous landscapes around the site and the particular "cul de sac" conformed by the  
159 area, currently only accessible through a "stimulating" rural track, are in accordance with the  
160 several uses and activities carried out at the site from a long durée perspective, from the  
161 Mesolithic to the contemporary period. As an example, a Koran book was hidden in the  
162 cavity and discovered in 1821, as documented by the Real Academia de la Historia (1821),  
163 and has been linked by some historians with the last episodes of Valencian "moriscos" before  
164 the expulsion ordered by Felipe III at the beginning of 17th century. On the other hand, at  
165 least from modern times, the cavity has been used as an animal pen. Oral histories also  
166 inform us of its use as a refuge during the Spanish Civil War.  
167 Natural and anthropogenic factors explain the sedimentary episodes formed by a complex  
168 accumulation that must be understood from a taphonomic perspective. From the middle  
169 Holocene period, human activities are the most important agent, although it is possible to  
170 determine some natural events also affecting the stratigraphy. Of particular importance would  
171 be the extraction of manure in modern times for agricultural purposes. Following the site  
172 owners' oral communication, we could identify a particular moment of extraction of manure  
173 between Pericot's and Fortea's works, although this would be recurrent in previous times.  
174 These activities have affected particularly the top of the sequence, from the Neolithic to  
175 modern times. Water entrances from the nearby ravine have also sporadically affected and  
176 disturbed the sedimentary deposits at different moments.  
177 As consequence, focusing on prehistoric levels, we can say in advance that major  
178 postdepositional episodes have disrupted the upper stratigraphy at the cavity, particularly the  
179 Neolithic and Bronze age levels. The presence of pottery decorative motives belonging to the  
180 Early Neolithic (cardial and gradina impressions) confirms the evidence of Early Neolithic,  
181 followed by middle Neolithic, Chalcolithic, and Bronze age occupations, covering a period  
182 between the last centuries of the 8th to the 4th millennium cal BP. At the bottom, late  
183 Mesolithic levels reveals a complete sequence showing different degrees of intensity and  
184 activity starting at the first half of the 9th millennium until the middle of the 8th millennium  
185 cal BP.

### 187 **3. Excavation campaigns, sedimentary data, and radiocarbon record**

#### 188 *3.1 Archaeological excavations and material and biological remains*

191 The different seasons carried out at Cueva de la Cocina have yielded unequal documentation  
192 regarding archaeological levels. According with the current dataset we can say that Pericot's  
193 campaigns encompass the main occupational levels preserved at the site (Table 1). As a  
194 result, the bulk of cultural and palaeoeconomical materials correspond to this first fieldwork.  
195 This confirms that the majority of anthropic remains was preserved at the Southwestern area  
196 of the cavity, reaching at this point its maximum depth (4.5 m) (Fig. 2). In contrast, at the  
197 Northeast corner of the 1943 pit the natural sediment appears at 30 cm, indicating a  
198 pronounced gradient from the Northeast to the Southwest. Fortea's work was centered in an  
199 area of about 25 m<sup>2</sup> in the Northern central part, reaching close to 1 m in depth in sector E  
200 and in a test pit in the south (sector U). Finally, between 2015 to 2018 our team has been

201 working in a total of 6 sondages, some of them surrounding Pericot's excavation (sondage 1,  
202 2 and 4), and the others (sondages 3, 5, 6 and including sondage 2) around Fortea's sector U.

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204 3.1.1. Pericot's excavation (1941, 1942, 1943 and 1945)

205

206 As aforementioned, Pericot's excavation encompasses the most fertile archaeological deposit  
207 (around 60,5 m<sup>2</sup> resulting on 116,13 m<sup>3</sup> of archaeological sediments). The primary current  
208 information comes from the personal journals written by Pericot and collaborators. It is  
209 worthy to say that they described, in a veritable meticulous manner for that time, the main  
210 characteristics in regards with the minimum archaeological units removed. The area  
211 excavated varied between 9 m<sup>2</sup> to 1,31 m<sup>2</sup>, and the layer depth oscillated between 0,15 and  
212 0,30 m. From this information we were able to build the spatial volumes with the goal to  
213 better approximate horizontal and vertical values (Fig. 3). We also had access to a small  
214 number of sketch plans with some notes in regards with the maximum depths (including a  
215 draft of the largest stones), some drawn profiles, and a small number of photographs.  
216 Interestingly, the authors also recorded the main archaeological findings including lithics,  
217 pottery, ornaments and plaquettes through schematic drawings. At the same time, they also  
218 offered a general description pointing to the presence of hearths and the main sedimentary  
219 traits. From the 1942 campaign, the depth information accounts for the vertical distance  
220 according with the position of the possible painting located between the sectors B and C  
221 (1942).

222 At the beginning of their work (1941), the cave was being used as an animal pen and thus  
223 was closed by a wall which constituted the first exterior boundary relating to the 1941, 1942  
224 and 1943 sectors. Deposits of dung covering the ground of the cavity offered testimony of  
225 this use. Once these seasons finished, Pericot and his team decided to excavate at the exterior  
226 part of this stonewall, which was consequently dismantled. A new outer wall that limited the  
227 recently opened area from the Southern wall in the North direction (1945 E-I, and 1945 E-IIb  
228 and E-IIa) was immediately rebuilt. In regards with 1945 E2b sector, the data is restricted to  
229 the first 0.5 m, when a human skeleton of historic chronology was discovered and, at least  
230 apparently, caused the stoppage of the dig.

231 A summary of the main archaeological record recovered at Cocina is reflected in Table 2. In  
232 brief we can point to two general issues:

233 1) We have observed a selection factor bias: The most impressive record corresponds with  
234 lithic remains, more than 70,000 pieces (materials from cleaning activities or without clear  
235 context have not been recorded). They include mainly flint knapped remains but also  
236 limestones and quartzite objects. A painstaking recovery of this materials was clearly carried  
237 out (including very small items, less than 1 cm). Similarly, Pericot's interest in portable art  
238 objects stimulated the recovery of the engraved plaquettes. As for the faunal remains,  
239 although there are nearly 4,700 bones recovered, there was clearly a selection biases towards  
240 the largest and most identifiable of medium to large mammals and, to a lesser extent,  
241 leporids. The terrestrial and marine malacofauna resources recovered consist mainly of the  
242 better-preserved remains.

243 2) A differential preservation factor affects the archaeological sequence: The significant  
244 decrease of Neolithic record is observed from the East to the West, in such a way that pottery  
245 is concentrated in the sectors close to the Southern cavity wall and in the 1945's excavation.  
246 The same can be indicated for other prehistoric materials related to the top of the sequence,  
247 such as polished stone axes or domestic animals remains. Conversely, the Mesolithic deposit  
248 is better preserved in the wide area excavated by Pericot although a general Northeastern to  
249 Southeastern gradient is detected (from 0.3 m depth at the Northeastern corner of 1943 A to  
250 the 4,5 m depth in the Southwestern corner of 1945 E-I).

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### 3.1.2. Fortea's excavation

Prof. J. Fortea started his excavation project at Cocina in 1974. After his previous study, he decided to explore the central part of the cavity, assuming that the deposit would be better preserved (Fortea et al., 1987; Fumanal, 1986). To do this he selected a square area near the Northern wall (sector E). He used a grid that divided the site in square meters, where horizontal and vertical lines were named by letters and numbers, with a 0 crossing point (Fig. 2). The initial area (25 m<sup>2</sup>) was dug conforming a stepped area (the maximum depth achieved is around 1 m) from the superficial levels to the natural clay deposit. This information confirms the slimming of deposits towards the inner and Northern part of the cavity. The methodology applied was in accordance with modern procedures at the time including systematic record of spatial data for the amount of archaeological remains, and photographic documentation using artificial layers and/or livings floors (Pardo-Gordo et al., 2018). Other exploratory excavations were conducted at the same time. One trench was opened starting from the Pericot's excavation to the central area with the objective to understand the continuity of the deposit towards the interior part of the cave (5×1 m). A second trench located South of sector A was dug for investigating sedimentary processes. A third test pit was opened affecting the central Southern part of the cavity (sector U), mainly squares A'8' and B'8'. After reviewing Fortea's documentation, available at the Prehistory Museum of Valencia, we have currently detailed the information for sectors A and U. The information about the trenches is restricted to some profile drawing (South trench), so we relied primarily on the summary annotated in the excavation report (Labor del SIP).

The stratigraphical units described by Fortea account for natural and anthropical episodes of different intensity. The top of prehistoric archaeological units corresponds to the G unit, assigned to the Chalcolithic and Bronze age periods. Separated by a natural calcareous crust, he defined the formation of the H living floors (H1 to H4). For him, these deposits were a reflection of the transitional acculturation process revealed by Cocina and confirmed by the presence of cardial pottery fragments. At the bottom, the J archaeological unit is defined as the first Mesolithic episode. The archaeological materials remained unpublished except for a first appraisal of the faunal remains (Fortea et al., 1987). In the framework of our current research we analyzed the entire assemblage, first by compiling the spatial information data, on a *per object* basis, through the documentation in the database created for the project, and then studying in detail the archaeological record. Nearly 10,000 findings (cultural material and biological remains) have been studied. A first paper, published in 2018, focused on the stratigraphic problems revealed after studying the archaeological record (mainly faunal remains and pottery; Pardo-Gordó et al., 2018). The results of the statistical analysis applied confirm the taphonomical problems affecting the H level. Consequently we can highlight the following aspects: a) The stratigraphy in this area preserves evidence of Late Neolithic, Chalcolithic and Bronze age periods, some dismantled rests of Early Neolithic occupations and a short deposit formed by Mesolithic occupational episodes, b) The taphonomical problems concern not only natural aspects (mudflow revealing flows episodes), but also anthropic agents (ancient pits that caused percolating problems and mixed record), c) The living floors distinguished by Fortea must in fact be considered artificial constructions for methodological purposes, d) H1 to H4 archaeological units seem to better correspond with a continuous and less intense deposit of different Mesolithic events that encompasses a great part of the chronological development of the hunter-gatherers occupations at the cavity.

### 3.1.3. The 2015-2018 excavation

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Triggered by some intriguing questions concerning Pericot's and Fortea's excavations we revisited the cavity with a new excavation program. In 2014 we performed a three-dimensional map of the cave (Fig. 2). The new plan serves as the basis for situating the old excavation sectors with the aim to reconstruct archaeological units for implementing spatial analysis. The metallic grid assembled by Fortea allowed us to extend this same grid to the entire area, in order to plan the new excavation pits. For practical purposes we used coordinates that increase from the North and the South and from the East to the West given Fortea's XYZ 0 point. During the 2015 season we worked in 6 test pits (named 1 to 6) around Pericot's excavation (Fig. 2). At the same time, we emptied the Southern trench dug by Fortea with the goal to obtain a profile between his Southern excavated area and 1941 Pericot's sector. We also tried to find the Northern and Eastern Pericot's profiles, currently blurred both by posterior anthropic refills and timing. The results obtained helped us to offer a new reevaluation of the previous and currently preserved archaeological deposits. The methodology applied included refined spatial registering and digital orthophotographic methods within a rigorous protocol for recovering fieldwork data (Diez Castillo et al., 2017; García Puchol et al., 2018b).

Due to the cleaning activities developed in Pericot's area we observed the great dismantling of the remaining archaeological levels. As a consequence, test pits 1 and 4 have rapidly shown (particularly test pit 1) the appearance of natural red clays. After cleaning Fortea's Southern trench we could see in one hand the high degree of disturbance of the upper stratigraphy, and in the other the pronounced slope of natural red clay. The presence of two accumulations of ashes and charcoal at the Northern profile triggered us to open two test pits (2 and 5) with the goal to describe possible preserved prehistoric deposits. While the first (test pit 5) has been revealed as contemporary in chronology, we have proved that the amount of charcoal visible at the test pit 2 corresponds with the rest of a Mesolithic hearth partially preserved. Test pit 3 was open from the top of the current sedimentary deposits close to Fortea's Southern test pit U (Fig. 2). At this point we have excavated more 0.5 m<sup>2</sup> from the current surface to the natural deposits, recovering a sequence of a total of 1m depth with remains of Mesolithic, Early Neolithic and posterior accumulations attributed on top to the Bronze age. The stratigraphy seems broadly uniform, without clear shifts from the bottom to the middle segment of the profile (work in progress).

Finally, we focused our work in test pit 4 (5,5 m<sup>2</sup>). From the first season, the discovery of the based wall corresponding with the old animal pen closure of the cavity predicted good expectations in regards with the potential of preserved archaeological remains. This aspect was confirmed in the next seasons when we excavated Mesolithic deposits (a silty-clay grey level) formed since the natural red clay based in advance, when they were cut by modern human activity. The characteristic cultural material and the radiocarbon dates obtained reveal their adscription to the Late Mesolithic (phase B).

The majority of archaeological remains was mainly concentrated in test pit 4 and includes lithics, faunal remains, mollusks (terrestrial and marine shells), and ornaments, among others. One plaquette with several engraved lines was also recovered (another plaquette was discovered in test pit 1 from a superficial level). Not less important, for the first time the bulk of sediments were water sieved, collecting by flotation charcoal, seeds and fruits remains. The results presented contribute to reconstructing palaeoeconomical behavior and paleoenvironmental conditions from vegetation resources. This procedure allows us to obtain a complete record that serves also for comparing with the previous excavation gathering protocols.

### *3.2 Sedimentary analysis and Paleoenvironmental conditions*

351

352 As it has been previously noted, the first analysis of Cueva de la Cocina sediments was  
353 conducted in the 70s by Prof. Pilar Fumanal (1978). The particular conditions behind the  
354 formation of sedimentary episodes between the Pleistocene and the Holocene periods are in  
355 the base of our current understanding of the archaeological deposits. Pericot already signaled  
356 the concentration of archaeological sediments in the Southwestern area of the cavity, at a  
357 short distance of the “current level of the ravine”. Despite this feature, he excavated also at  
358 the exterior area of the closed pen when he reached the deepest archaeological levels.  
359 Through the diaries we know how he annotated the appearance of the natural clay level  
360 whenever he advanced in depth. In fact, after we cleaned the Pericot’s sector and conducted a  
361 test pit in the Northern profile we were able to understand a particular profile draft of his  
362 1943 excavation (Fig. 2).

363 The questions about the situation of the ravine at the entrance of the cavity are also present in  
364 Fortea’s reflections. The mudflow of 1977 was the starting point to investigate the entire  
365 sedimentary sequence exposed as consequence of the drain reopened in the right corner of the  
366 entrance. This natural drainage system confirmed the past functioning of the cave (Fumanal,  
367 1986). This episode flooded the cave during several days and left a 3-4 thick silt layer  
368 covering. The reading of drain profile allowed to describe close to 4 m of sedimentary levels  
369 formed by recurrent Pleistocene floods. The presence of detritus materials from the slopes  
370 supports strong episodes of flooding with a high charge capacity (visible in lower levels). At  
371 the top of the Pleistocene sequence a stalagmitic concretion was formed (level X: C-468:  
372  $27,466\pm 2,398$  and C-469:  $26,733\pm 2,181$ ) (Fumanal, 1986). The documentation of this  
373 concretion in the central-Northern area reveals that the basin should have been formed later,  
374 probably caused by a drain opened at the Southern wall of the cavity. After a cutting episode  
375 in the Pleistocene sedimentation, the Holocene levels were formed. Other flooding episodes  
376 have been identified through several means. Three of them were described by Fumanal, one  
377 forming the base of the Holocene anthropic sequence (IX sedimentary level), a second  
378 affecting Upper/Bronze age and Chalcolithic deposits, and the third corresponding to the  
379 1977 flooding event. While the last episode is described as a slow charge, the others showed  
380 a high capacity.

381 From Pericot’s excavation we have indirect data that confirm the effect of some flooding  
382 episodes. The description of gravel levels at the base of the archaeological stratigraphy could  
383 be one of them (maybe linked with the IX level described by Fumanal). Current laboratory  
384 work allows us to obtain other evidence from the study of the mollusk record. Despite the  
385 bias selection problems associated with the oldest materials, the distribution pattern of a  
386 particular species, *Melanopsis tricarinata*, a mainly aquatic taxon, allows us to hypothesize  
387 how its presence was caused by a flooding event affecting at the top of the Mesolithic  
388 sequence. Their presence could be directly related with the water entrance and subsequent  
389 stagnation, particularly due its vertical concentration in specific locations (Fig. 3). We have  
390 realized how this event was identified in the last of Pericot’s layers at the interior of the old  
391 closed animal pen, in particular, 1941 layer 2, 1942 RS layer 1, and 1943 A and C sectors  
392 layer 1. Confirming this assumption, the last layers excavated recently at sector 4 indicate the  
393 identification of this kind of event affecting recent Mesolithic episodes. As a consequence,  
394 we can confirm that the water of the ravine constitutes one of the natural agents affecting  
395 anthropic deposits from the top of the Mesolithic sequence.

396 In addition, we have analyzed current archaeological test pits by geochemical means  
397 (Gallello et al., 2021). The obtained results serve to address several questions concerned with  
398 methodological and archaeological purposes. At this point we tested how major and minor  
399 elements constitute a good sign for distinguishing anthropogenic and natural factors relating  
400 to the new exposed profiles. The interesting results obtained show different signatures

401 between anthropic activities as we could expected according to the domestic activities related  
402 to hunter-gatherers (especially in test pit 4), and more blurred Neolithic actions (only tested  
403 in current test pit 3).

404 Fumanal's sedimentary analysis had pointed to some major climatic events in regards with  
405 the last Wurm episodes. She hypothesized how the unstable postglacial episodes stopped  
406 sedimentary deposits after level IX. Since then, anthropogenic levels began at the cave during  
407 Holocene times. From Fortea's sector E she noted a specific climatic episode according with  
408 an extended concretion on top of H level. She correlated theirs with other similar Subboreal  
409 crusts documented in several caves at the region. The wetter conditions associated to the 4.2  
410 event (or Bond 3 event) in Mediterranean regimes could be behind these recurrent episodes.  
411 Paleoenvironmental conditions were also approached for the first time through charcoal  
412 remains. The identified flora at Cocina is dominated by species from the thermo-  
413 Mesomediterranean forest, dominated by Aleppo pine (*Pinus halepensis*) and Holm oak or  
414 kermes oak (evergreen *Quercus*), with the presence of some *Prunus* and junipers (*Juniperus*).  
415 The scrub would be composed of heathers (*Erica*), legumes and rosemary (*Rosmarinus*  
416 *officinalis*). Some thermophilic elements such as mastic (*Pistacia lentiscus*) and wild olive  
417 (*Olea europaea*) are also present (Carrión-Marco and Pérez-Jordà, this issue).

418

### 419 3.3 Radiocarbon dates

420

421 In the last few years we conducted several radiocarbon programs. Until now we have  
422 published a total of 18 radiocarbon dates (Juan-Cabanilles and García-Puchol, 2013;  
423 Marchand and Perrin., 2017; García-Puchol et al., 2018a, b, and Pardo Gordó et al., 2018,  
424 Olalde et al., 2019). Currently, we have of 40 radiocarbon dates from the different excavation  
425 seasons based on a careful sampling protocol (Table 3). The sample selection was managed  
426 by an accurate filter of samples considering their nature and the accumulated information  
427 data of archaeological levels. All samples come from short lived species, including charcoal  
428 remains (Table 3). Whenever possible, we preferred bone samples to plant charcoal due to the  
429 absence of domestic seeds preserved in direct relationship with anthropic remains for  
430 Neolithic and Bronze age levels. In the case of animal samples, we selected bones with  
431 anthropic marks (cuts or fractures) when possible. Only three samples do not meet this  
432 criteria, due to low levels of preserved collagen detected in bone samples recovered at the  
433 upper layers and the subsequent bias introduced in the resampling.

434 Considering Neolithic levels first, we dated domestic animals identified by Prof. Pérez  
435 Ripoll, although they are scarce in the faunal record. From his selection we obtained  
436 radiocarbon ages belonging to Chalcolithic and Bronze age periods (excluding some failed  
437 attempts affecting 2 domestic samples from Pericot's excavation (Pericot 1945 E-I layer 4  
438 and Pericot 1942 layer 1 RS). We also dated samples of fruits, such as acorns and, above all,  
439 pine cones particularly from upper layers where bone samples were problematic (e.g.,  
440 Pericot's sectors and 2015-2018 test pits). A coprolite of *Ovis/Capra* was dated with the aim  
441 to determine the age of the use of the cavity as an animal pen. And finally, 5 remains of  
442 human bone were dated. The anthropological study effectuated and the radiocarbon results  
443 confirms the minimum number of individuals found (5), unfortunately without any clear  
444 archaeological context (McClure et al., this issue).

445 Samples were sent to three radiocarbon laboratories: University of California Keck  
446 Laboratory (UCIAMS), The Pennsylvania State University's Institutes of Energy and the  
447 Environment Radiocarbon Laboratory (PSUAMS), and Beta Analytic. Samples for AMS  
448 radiocarbon dating at UCIAMS and PSUAMS were prepared using standard procedures for  
449 collagen extraction at The Pennsylvania State University Human Paleoecology and Isotope  
450 Geochemistry Laboratory (McClure et al., 2010; 2020; Zavodny et al., 2014; Kennett et al.,

451 2017). Specifically, dry bone samples (ca. 500mg) were crushed and washed in NanoPure  
452 water and demineralized in 0.5N HCL at 5°C for several days. Samples were then prepared  
453 for collagen extraction using a modified Longin (1971) method with ultrafiltration (Brown et  
454 al., 1988; Kennett et al., 2017) and extracted collagen was gelatinized at 110°C in 1ml 0.02N  
455 HCL for 24 hours, then pipetted into a precleaned 10ml disposable syringe with an attached  
456 precleaned 0.45µm Millex Durapore polyvinylidene difluoride (PVDF) filter and put into a  
457 thick-walled culture tube. Samples were hydrolysed in 1.5ml 6N HCL for 24 hours at 110°C  
458 before being driven through a SPE column with 10ml 6N HCL and dried under UHP N2 gas  
459 while being heated at 50°C for 12 hours. Samples sent to Beta Analytic, Inc. were treated  
460 following their standard protocols.

461

#### 462 **4. Methodology**

463

464 In order to build a refined chronological framework, we have used a multistage approach  
465 based on combining Bayesian methods. Differences in the accuracy of archaeological data  
466 provided the basis for separating Pericot's and Fortea's fieldwork campaigns (García-Puchol  
467 et al., 2018a; Pardo-Gordó et al., 2018). Here we correlate the set of archaeological data  
468 provided by each campaign and include 2015-2018 fieldwork. To do this, we order each of  
469 the archaeological records and then combine the information in a single general proposal.  
470 Our new approach introduces Bayesian modelling from a double analytical procedure. First,  
471 we will work with Bayesian chronological models applied to the stratigraphic sequence of  
472 Pericot's excavation in Cocina. Then, after the most reliable layers have been defined, we use  
473 these as prior information to define the rest of the sequence (Armero et al. 2021; Pardo-Gordó  
474 et al., 2022). The focus on Pericot's sectors stems from the fact that they preserve most of the  
475 Mesolithic sequence and a wide segment of the Neolithic evidences.

476

##### 477 *4.1. Bayesian chronological modeling*

478

479 Beginning with the Bayesian chronological modelling, the preliminary proposal was  
480 published in 2018 based on Pericot's excavation (García-Puchol et al. 2018a). There is a  
481 general bias produced by the minimum excavation unit excavated (layers of 15-25 cm) and  
482 the pronounced slope observed in E-W direction that affected all Pericot sectors, so we have  
483 chosen 1945 E-I and 1941 sectors as the starting point. To do this, we used archaeological  
484 units grouped statistically by considering densities of basic types of lithic projectiles and  
485 general lithic and pottery records (García Puchol et al., 2018a). We also took into account the  
486 radiocarbon dates available at the time from these sectors in addition to a considered *Ante*  
487 *Quem* date provided by trench 3 that could be related with Early Neolithic occupations at the  
488 site.

489 Here we run new models by introducing new dates that could be directly associated with the  
490 archaeological units proposed (Table 4). These new models have been built following similar  
491 criteria using Oxcal 4.4 software (Bronk Ramsey, 2009a) and intCal20 curve (Reimer et al.,  
492 2020). First, we have modeled stratigraphic models for 1941 and 1945 sectors. All of the  
493 models include the outlier model function (t-student at a significance level of 0.05). Once  
494 they were detected and evaluated, they were deemed as outliers in the models according to  
495 the information available of the date, and modelled again. This is in accordance with the  
496 stepping procedure used for Bayesian chronological modelling frameworks. The modelled  
497 dates were used in the next round steps as *priors*. After analyzing the results, we modeled a  
498 phase model including both *prior* dates produced by the stratigraphic models conducted and  
499 added the new radiocarbon dates from other sectors that could be more clearly associated  
500 with the units considered. Due to the fact that most of them corresponded to Mesolithic

501 contexts, the focus on discussing the subsequent occupational episodes is evaluated here only  
502 considering the first Neolithic evidences. From the results we estimated the timing of the  
503 units described in a diachronic view. The model is useful to assess the potential  
504 presence/absence of a hiatus event between last Mesolithic and early Neolithic occupations.  
505 The results will permit a higher accuracy in the explanation of diachronic Mesolithic  
506 occupations.

507

#### 508 *4.2 Predictive Bayesian approach for the 1942 and 1943 sectors*

509

510 A smaller number of radiocarbon dates are available for the 1942 and 1943 Pericot's sectors  
511 (close to the half of the excavated area). As a result and in order to avoid in that way the  
512 economical and sample destruction cost, we have decided to employ a Bayesian  
513 methodological procedure designed initially to get an estimate chronology for dating  
514 archaeological collections (Armero et al., 2021; Pardo-Gordo et al., 2022). The goal in this  
515 case consists of proposing an archaeological sequence for Pericot's 1942 and 1943 sectors  
516 based on the posterior probabilities defined by the existing material in such sectors.  
517 The work proposed here consists of an *intrasite* application of the method developed by  
518 Armero and colleagues (Armero et al., 2021; Pardo-Gordo et al., 2022). Essentially, this  
519 method consists of a multinomial-Dirichlet process where the response variable is a multi-  
520 level categorical variable (in this case, each potential chronological period is considered a  
521 category) and the predictors are the counts of the different artefacts involved. To construct  
522 the prior probabilities, we used assemblages from the better-defined layers (1941, 1945),  
523 which constitute our training set. After the data has been trained, the artefacts present in the  
524 sectors 1942 and 1943 were used to develop a prediction for the chronological classification  
525 of each of the layers in those sectors. For this work, we have adapted the scripts developed by  
526 Pardo-Gordó et al. (2022) using R (R Core team, 2022).

527 The count by layer of 1941 and 1945 E-I sectors includes 8 types conformed by the basic  
528 geometric projectiles morphologies, bifacial points and pottery (Supplementary material 2).  
529 Each one of the layers considered has been approximated from a defined archaeological unit  
530 tested through different statistical procedures (García Puchol *et al.*, 2018a). These units  
531 correspond to the minimum accurate temporal windows (archaeological subunits) proposed  
532 by us from Pericot's 1941 and 1945 excavation. In this analysis we exclude A0 due to the  
533 scarce cultural material associated. For practical purposes they have been named in the scripts  
534 from I to VIII from the bottom to the top of the sequence. Archaeological units I to V include  
535 A1, A2, B1, B2, B3 Mesolithic units, VI correspond to the unit C1, and the units VII and VIII  
536 group Neolithic, Chalcolithic and Bronze age record. These last units, because we only use  
537 detailed typologies for geometric projectiles, cannot be approximated more accurately.  
538 The methodological procedure consists of: 1) firstly, to calculate the estimated likelihood  
539 from these types by each archaeological unit considered (informative procedure), 2) to  
540 calculate for the unknown 1942 and 1943 layers the predicted likelihood to belong to each  
541 unit. For the acceptance of results, we selected a threshold of  $\geq 25\%$  probability for any  
542 single unit. If the results presented bimodal or multimodal distributions, they are rejected and  
543 were not considered for temporal assignment function. Taking into account the stratigraphic  
544 relationship among layers, we discuss the results including the potential inconsistencies  
545 considering a diachronic view.

546

## 547 **5. Results**

548

### 549 *5.1. Stratigraphical Bayesian chronological modeling*

550

551 The chronocultural subunits built from the different archaeological fieldwork conducted at  
552 Cueva de la Cocina can be understood at the moment as our proposal of the minimum  
553 temporal windows. The subunits deemed and the correlation with the different archaeological  
554 projects carried out are described in table 4. Taking into account the problems that affect the  
555 upper layers of the sequence, the chronological models offer a better evaluation of the  
556 Mesolithic evidence. According to the methods described, we have firstly obtained the results  
557 for the stratigraphic models applied to 1941 and 1945 E1 campaigns (Table 5 and  
558 Supplementary materials 1). For 1941 we modelled the dates according with their  
559 stratigraphic order. To do this we added a new date from layer 1. This date, from a bone of  
560 *Capra pyrenaica* (PSU5323, 6590±25 BP), constitutes the more recent radiocarbon result that  
561 we would associate with the last Mesolithic occupations. Some considerations are necessary,  
562 starting from the nature of the sample, a cervical vertebrae without anthropic marks and  
563 associated to a layer with a few number of artefacts (140 lithics and 4 pottery fragments). The  
564 assumption of linking it with the last Mesolithic relies on the assumed date related to the  
565 Early Neolithic evidence at the cavity, although we could also dismiss it due the lack of  
566 anthropic manipulation. The earlier pottery at Cueva de la Cocina would be coincident with  
567 the decoration techniques present at the “classic” cardial developed in the last centuries of the  
568 8th millennium cal BP. This aspect is confirmed by the only radiocarbon date that could be  
569 associated with these first Neolithic occupational events obtained from a branch of *Pinus sp*  
570 (Beta-426849, 6350±30 BP). The first rounded model shows a low A-model index (52.5)  
571 and an outlier (PSUAMS-4429: 7135±25 BP). The date corresponds to a fragment of cranial  
572 bone from a human individual clearly not associated with the cultural assignment. Deemed as  
573 an outlier, we run again the model and the results achieve an acceptable Amodel index  
574 (102.2). The model run for 1945 E1 uses the same dates that past attempts initially obtaining  
575 a low agreement index (Amodel: 33) affected by an outlier (Beta 267439: 6760±40 BP),  
576 clearly in disagreement with the archaeological context (layer 12). Consequently, we consider  
577 it as an outlier and we run the model again. The result obtained offers now an acceptable  
578 Amodel (93.4).

579 The modelled dates obtained from the stratigraphic models have been used as priors to build  
580 a new phase model correlating 1941 and 1945 E1 sectors. In addition, we include new  
581 radiocarbon dates from other sectors that could be merged with the temporal windows  
582 established through specific criteria. To do this we choose dates from the archaeological units  
583 with presence of cultural material data and/or stratigraphic relationships that easily permits us  
584 to determine their belonging to the temporal windows considered. This is the case of a date  
585 from a bone of *Capra pyrenaica* with anthropic fracture from 2015-2018 sector 6 (Beta-  
586 512549: 6760±30 BP, UE 1126) associated to a crescent with abrupt retouch that we assign to  
587 subunit B3. UCIAMS-174945 (6705±35 BP), on *Capra pyrenaica* without anthropic marks,  
588 has also been incorporated to this same temporal. Despite this problematic aspect we consider  
589 that the most probable scenario is its relationship with anthropic activities relating to the last  
590 Mesolithic episodes (B3). The model is complemented with the dates provided by 2015-2018  
591 sector 4. The radiocarbon dates obtained from pine cones (faunal remains failed repeatedly)  
592 show consistency considering their stratigraphic position and cultural material associated,  
593 while also being consistent with a date provided at the bottom of the stratigraphy from a  
594 *Capra pyrenaica* bone with anthropic marks. They have been associated to the B2 and B1  
595 temporal windows. In addition, we introduced within the model a date from Fortea’s A  
596 sector, a *Capra pyrenaica* bone with anthropic mark from the H4 level (UCIAMS-145197:  
597 7710±30 BP) that we associated with A0. The general lithic record is scarce, although blade  
598 technology is well represented (without geometrics). Finally, we introduce a terminus *ante*  
599 *quem* (TAQ) through the command (*before*) based on the unique date that we could associate  
600 to the Early Neolithic pottery at the cavity obtained from a branch of *Pinus sp* (Beta-426849,

601 6350±30 BP). This is used as a constraint to the Mesolithic last occupations. The resulting  
602 model offers a lower Amodel (57.9) and an outlier date affecting to the modelled date (Prior  
603 B2\_45\_Beta267436) from 1945 E1 campaign. Considering the scarce resolution of the data  
604 we run again the model considering it as an outlier. The new model presents an acceptable  
605 result (Amodel: 83.5) (Fig. 4).

606 The modelled dates estimate the duration of each archaeological subunit as a result of the  
607 constraints assumed step by step, from sample strategy to the archaeological resolution of *a*  
608 *priori* information and decision-making. Table 6 and figure 5 show the results by units  
609 expressed as modelled dates. The starting date starts at the first centuries of the 9th  
610 millennium cal BP (A0: 8850-8380 cal BP), involving units that cover the 9th millennium  
611 (A1 and A2) and the first half of the 8th millennium cal BP (B1, B2 and B3). In our proposal,  
612 the last subunit considered (B3) would arrive to the half of the 8th millennium cal BP.

613

#### 614 *5.2. Bayesian approach through informed phases likelihood*

615

616 Figure 6 informs us in a graphical manner of the results obtained by each layer in 1942  
617 season (Supplementary material 3 for 1943 season) about their chronological expectancy  
618 expressed as the likelihood to belong to different temporal windows (archaeological units). In  
619 a general view, the preliminary check reveals how the results show enough confidence  
620 considering a diachronic dimension from the bottom to the top of the sequence. More  
621 frequently, the probability up to 25 % is centered only in one temporal interval underpinning  
622 the robustness of the analysis conducted and the good diagnostic approximation provided by  
623 the selected types. Only in two cases (1943 D layer 1, 1943 A layer 2 and 1943 E layer 4) the  
624 results show two separated intervals above the accepted threshold. In other case (1942 B  
625 layer 5) there are three intervals above the threshold and, consequently, it is not conclusive. If  
626 we evaluate the results by sectors, it is possible to observe similar problems and also  
627 particular disruptive aspects.

628 1942 sector reflects several problems in regards with upper layers for all subsectors (A to D).  
629 Layer 1 (RS), is a general layer without minor divisions. The presence of pottery introduced  
630 the discussion about the preservation of a neolithic layer, as its temporal window would  
631 indicate. The results of dating the human bone recovered (frontal bone) emphasize its  
632 character as a palimpsest. From layer 2 it is possible to appreciate the different subdivisions,  
633 while we can also observe diverse kinds of parceled problems. The weight of temporal  
634 window III (subphase B1), could be another signal of disturbances due the lacking of the last  
635 Mesolithic subphases (B2 and B3). This effect also is visible in layer 3, particularly for A, B  
636 and C subsectors. The high concentration of "*Melanopsis tricarinata*" could be related, at  
637 least in part, to the degree of inconsistencies observed as consequence of the ravine flooding  
638 events. From layer 4 in advance (and including 1942 D, layer 3), the adscription provided  
639 seems to be more consistent. At this point the general observances help to refer some relevant  
640 features. First, we can say that at the Eastern part (subsector A), the natural layer appears  
641 before as it is noted in the diaries, although the maximum depth is achieved at layer 7 (of a  
642 total of 9). Considering the information from 1941, the basin slope had to be very  
643 pronounced. From layer 4 the coherence is largest reflecting the development of the  
644 subsequent subphases from temporal window I (A1) to IV (B2). Nevertheless, the two  
645 radiocarbon dates available inform us of the general problems persisting mainly caused by  
646 the coarse excavation method but also related with the proximity of the wall and the presence  
647 of particular accumulation of stone blocks that can be related with specific disturbance  
648 episodes.

649 The concluding relevant aspects in regarding the 1943 sector appear more clearly, maybe  
650 because Pericot applied a more controlled digging plan and took a great number of pictures

651 by layers, and specially for the profiles, that serve to give a more general view (Fig. 7). From  
652 them, we know that the natural clay layer appeared very early from the South and the  
653 Northern profiles, preserving the maximum depth to the center and the Southwestern part.  
654 We can conclude how the upper sequence is cut off in a gradient that affects particularly  
655 subsector A. In this case we observe how the first layer of subsector A could be approached  
656 from the results of the B1 subphase. It appeared immediately after cleaning dung remains and  
657 the superficial layer. Towards the South, we observe a more complete Mesolithic sequence  
658 (subsectors B and C) involving B2, B1, A2 and A1 subphases. The presence of *Melanopsis* is  
659 documented mainly in layer 1 although it is present also in layer 2 (C and D) (Fig. 3). From  
660 these layers, the sequence shows quite good consistency from the bottom (subphase A1).  
661 Other kind of issues can be noted from subsectors D and E, coinciding with the presence of  
662 Neolithic ceramic (subsector E). In accordance, the first layer of 1943 subsector E could be  
663 related with subphase VI, coinciding with the presence of pottery. The general description of  
664 this assemblage can be assigned to the regional Middle Neolithic (characterized by the  
665 presence of “peinada” treatment of surfaces (Molina-Balaguer et al., this issue). Interestingly,  
666 the Bayesian estimation reveals a cut off between the subsequent layer, related to the  
667 subphase B2. Based on the prior data, at this point we can note a breakup in the Mesolithic  
668 sequence. Since then, the likelihood obtained displays their association with the subsequent  
669 late Mesolithic subphases. In contrast, the radiocarbon dates from subsector E indicate  
670 inconsistencies with this attribution and among them. The most ancient one came from a  
671 human bone (cranial). Considering the profiles reading we could hypothesize that the  
672 pronounced slope of the Northern basin base could affect the sampling selection by layers.

## 674 **6. Discussion: Chronostratigraphy and cultural sequence**

675  
676 The result of combining Bayesian modeling and chronocultural data through an accurate  
677 revision of archaeological and sedimentary information allows us to propose a renewed  
678 archaeological sequence for Cueva de la Cocina. Figure 8 summarizes the correlation  
679 between each excavation considering the current dataset. As we can see, the proposal takes  
680 into account the revised Pericot’s sequence because it reveals the widest and most intensively  
681 occupied prehistoric levels from the bottom to the top. On one hand, the analysis carried out  
682 for the entire data collection has provided the diagnostic classification of cultural material  
683 components, particularly lithic projectiles. On the other, the radiocarbon dates program has  
684 introduced the necessary chronological data to approximate temporal windows through  
685 Bayesian modeling procedures with the aim to refine the reading of the prehistoric  
686 occupations. For a more comprehensive proposal we have used this same nomenclature in  
687 regards with general archaeological units considering the 2015-2018 excavation, whereas we  
688 have maintained Fortea’s names for practical purposes. The recent campaigns along with the  
689 top of Fortea’s excavations provide the necessary information for drawing a historic sequence  
690 until the 20<sup>th</sup> century. As result, we have built the minimum archaeological subunits that  
691 conform the proposal explained (subunits 1 to 18 from the top to the bottom).  
692 Focusing on prehistoric times we can say that the analyses conducted have provided a more  
693 accurate reading, particularly in regards with the Mesolithic sequence. We can approximate  
694 them from the bottom to the top as follows:

695  
696 1) The start of the sequence corresponds with the so-called A0 archaeological unit (unit  
697 18) (8850-8380 cal BP). It has been defined from the data provided by radiocarbon dates  
698 from the first archaeological layers (1941/layer 13, Fortea B4/level H4/layer 6). The scarcity  
699 of materials recovered here does not currently allow for detailed characterization, although  
700 the cultural material can be assigned to the Late Geometric Mesolithic according with the

701 technological blade knapping documented. The presence of macrolithic tools using limestone  
702 raw material is also associated to the immediate upper units as was described by Pericot  
703 (1945 layers 12 to 16). As a consequence, at the moment we do not have enough elements to  
704 disassociate this first ephemeral occupations with the Geometric technocomplex in part due  
705 to the small number of lithic remains. This issue is shortly to be explored properly.

706 2) The next Archaeological unit A1 (subunit 17) (8475-8230 cal BP) corresponds to the  
707 extended development of the blades and trapezes technocomplex, including asymmetric  
708 trapezes with concave sides among others, with scarce presence of microburin technique.  
709 This archaeological subunit shows, in general, a less intensive presence in the 1945 sector  
710 and a high concentration the 1941 dig. This aspect confirms differential activities in a spatial  
711 view. Current information reveals the first burial practices at the cavity.

712 3) Archaeological unit A2 (subunit 16) (8291-7929 cal BP) also shows differential  
713 intensive areas between the different sectors. This phase is also represented in current  
714 campaigns (test pit 2). The lithic composition contains a great number of geometric  
715 projectiles and the documentation of microburin technique.

716 4) Archaeological unit B1 (subunit 15) (8046-7720 cal BP) is characterized by the  
717 appearance of “Triangles Cocina Type Triangles”, a characteristic projectile of triangular  
718 morphology and concave edges, similar to Muge triangles, accompanied in this case by a  
719 significant number of trapezes. The buried children remains and the frontal bone belonging to  
720 an adult can be attributed to this period. The distribution of engraved plaquettes in Pericot’s  
721 sectors, together with the plaquette recovered at pit 4 (UE 1409), should confirm the first  
722 appearance of this graphic expression in the cave.

723 5) Archaeological unit B2 (subunit 14) (7781-7615 cal BP) shows a more general  
724 intensive occupation in the cavity as it is deduced from the largest densities recovered of  
725 cultural and biological materials. A flooding episode has been detected through the  
726 characteristic malacological record that proliferates associated to water presence. This species  
727 appears in the uppers layers throughout the Pericot’s sector, excluding 1945 campaigns. We  
728 can hypothesize its beginning from this moment. This level offers also some particularities  
729 that may be point to the remarkable activities conducted in the site in a more extensive social  
730 dimension (aggregate site function?). From a cultural diagnostic view, Cocina type triangles,  
731 made using microburin technique, dominate the assemblage. The knapping activities were  
732 focused on blades made from a wide diversity of flints, reflecting distant raw materials  
733 sources (Ramacciotti et al., 2021 and this issue). And not less important, the observed variety  
734 in regards to food resources, including now the higher concentration of marine resources like  
735 *Cerastodema glaucum*, would also indicate a greater diversity in landuse dynamics.

736 6) Archaeological unit B3 (subunit 13) (7660-7465 cal BP) is identified from a more  
737 blurred record, affected by the increase of postdepositional episodes that have eliminated the  
738 greater part of upper prehistoric sequence as long at the cavity. New radiocarbon dates  
739 contribute to supply a last temporal interval for the last Mesolithic activities at the site  
740 (PSU5323, 6590±25). At an lithic industrial level we hypothesize to its association with a  
741 great concentration of circle segments with abrupt retouch.

742 7) Archaeological unit C1 (subunit 12) corresponds with the Early Neolithic occupation  
743 of the cavity confirmed through the presence of “cardial pottery”. Only a charcoal date can be  
744 associated with this temporal window (Beta426849: 6350±30 BP). The appearance of a small  
745 number of “cardial” diagnostic decoration is revealing enough. As we noted before, this  
746 episode is widely altered. The sampling of domestic animals has revealed their relation with  
747 the upper prehistoric sequence of the cavity (Chalcolithic and Bronze age). In addition, the  
748 lack of domestic seeds does not support agricultural practices for the inhabitants of Cocina.  
749 Consequently, current data are not conclusive in order to characterize economical practices of  
750 the events associated with the Early Neolithic potteries, maybe linked with hunting activities.

751 In Fortea's E sector, the crust that covers the layer with these Early Neolithic remains  
752 separates it of an upper layer associated to the Chalcolithic and Bronze age indicating the  
753 lacking sediments between them. Some early pottery fragments appear concentrated in a  
754 supposed hearth structure that we consider a probable Neolithic pit. The analysis undertaken  
755 confirms the problems that affect the stratigraphic levels that preserve these kinds of  
756 evidence, particularly visible in Fortea sector E.

757 8) Archaeological unit C2 (subunit 11) has been identified through the evidences  
758 recovered at the entrance of the cavity consisting of a set of pottery remains that share  
759 characteristic "peinado" treatment attributed to the Middle Neolithic sequence in the region  
760 (Pericot 1945 E-I layers 3 and 4 and 1943 E layer 1). At the moment we do not dispose of  
761 any radiocarbon dates. The only remains of domestic animal (*Ovis*) recovered in this context  
762 (1945 E1 layer 4) failed in the results due to the low level of collagen preserved.

763 9) Finally, Archaeological unit D (subunit 10) refers the last prehistoric episodes at the  
764 cave that show the unique domestic evidence dated (sheep and cattle). Despite the problems  
765 affecting the integrity of the stratigraphy, radiocarbon dates and cultural material support  
766 their assignment to the Late Neolithic, Chalcolithic and Bronze Age periods  
767 (UCIAMS174145: 4425±25; UCIAMS: 3725±20; UCIAMS-174144: 3590±20)

768 10) The upper subunits (from 9 to 1) complete a sequence with important diachronic  
769 hiatuses. Some evidences of cultural material allows attribution of occupational episodes to  
770 the Iberian Culture (Iron Age), Medieval and Modern times and, finally, contemporary  
771 activities (Beta453589: 180±30).

772

## 773 **7. Concluding remarks**

774 The socioecological dynamics of the last hunter-gatherers have revealed adaptative  
775 evolutionary behaviors that show interesting patterns of resilience. Triggered by the changing  
776 environmental conditions, the last Western Mediterranean foragers exhibit driving forces that  
777 can be mainly appreciated by shifts in the landuse strategies and consequently in social  
778 networks. This reorganization has been demonstrated by the rise of the open-air sites  
779 involving the exploitation of aquatic resources from inner lacustrine areas and coastal areas,  
780 and through the increasing evidences of burial practices. The demographic changes also took  
781 place showing a visible and regionally diverse rise, according with several diagnostic proxies  
782 (García-Puchol et al., 2017, Fernández López de Pablo et al., 2019). These major shifts began  
783 around 10.200 cal BP linked to the Notches and Denticulated technocomplexes recognized  
784 from that moment in coastal and interior areas at the Mediterranean region and far away  
785 (Aura et al., 2011; Perrin et al., 2022). From the first half of the 9th millennium cal BP, the  
786 irruptive appearance of Blades and Trapezes technocomplex is recognized along the  
787 Mediterranean region (Marchand and Perrin, 2017). This reordering of the sequence has  
788 required a renewed interpretation in contrast with the first proposals described during the 20<sup>th</sup>  
789 century (Alday, 2006; Utrilla and Montes, 2009; Aura et al. 2011). In this regard, Cocina  
790 provides some of the oldest radiocarbon dates for blades and trapezes technocomplexes in the  
791 western Mediterranean, adding more questions to the debate of the cultural transmission  
792 processes explaining their appearance.

793 Based on the pioneering work conducted at the cave, and applying new methodological  
794 procedures, we propose a renewed interpretation of Cueva de la Cocina sequence. The  
795 obtained results have exceeded the initial expectations regarding intrasite dynamics and  
796 regional evolutionary perspectives. Concerning the first issue, we have presented a more  
797 refined view the chronocultural units as a result of a better understanding of natural and  
798 anthropogenic agents that affected the formation processes of the palimpsests that usually  
799 form archaeological deposits. The richness of the archaeological record of the cave provides  
800 new insight into economic behaviors, technological knowledge, and social practices,

801 including burial remains. These last spheres allow us to hypothesize about the remarkable  
802 role of Cocina as a microregional social network hub, at least affecting the last Mesolithic  
803 phases (Subphase B1 and B2). From that moment, ancient and recent disruptive processes  
804 have contributed to remove and largely dismantle the upper prehistoric and historic deposits.  
805 Consequently, and considering our current data, it is not possible to identify and characterize  
806 a “transitional phase” in Cocina, as was initially defined. Current radiocarbon dates indicate a  
807 short time between these occupational events. In parallel, the extended last Mesolithic  
808 occupations demonstrate the interaction processes that would act at regional level as the “dual  
809 model” had described. The artistic Holocene sequence, and its associated evidence for  
810 painting evidences, recognized on the Southern wall of the cavity, will in time be object of a  
811 specific discussion (work in progress). In this respect we can say in advance that this issue  
812 will be approached considering current evidence and postdepositional processes affecting the  
813 accumulation sequence described. Unquestionably, we have confirmed that the engraved  
814 plaquette graphic expression is associated with the last Mesolithic episodes (López Montalvo  
815 et al., 2022).

816 In conclusion, we would like to point to the recently published results from ancient DNA  
817 analysis to remark the role played by last hunter gatherer populations in the spread and  
818 consolidation of the Neolithic way of life in the Western Mediterranean, depending on  
819 variable regional situations (García-Puchol et al., 2017; Olalde et al., 2015; 2019; Arzelier et  
820 al., 2022; Perrin and Manen, 2021). The Mesolithic sequence of Cueva de la Cocina offers  
821 remarkable evidence of the richness of the last foragers regarding social practices and landuse  
822 dynamics. Although the data from Cocina does not permit to describe a proper acculturation  
823 context, the evidence, particularly temporality, would point to the participation of the last  
824 Mesolithic groups in the advance and consolidation of the Neolithic from coastal pioneers  
825 bearing the new economic practices and social challenges.

826

## 827 **Author contributions**

828

829 **Oreto García-Puchol:** Conceptualization, writing – original draft, investigation, formal  
830 analysis, methodology, funding acquisition, data analysis (lithics), project administration,  
831 visualization.

832 **Sarah B. McClure:** Writing – review & editing, investigation, formal analysis, funding  
833 acquisition, project administration, data analysis (faunal remains and human remains,  
834 isotopes).

835 **Joaquim Juan-Cabanilles:** Writing – review & editing, investigation, funding acquisition,  
836 data analysis and curation (lithics).

837 **Alfredo cortell-Nicolau:** Writing – review & editing, investigation, formal analysis, data  
838 curation (lithics), visualization.

839 **Agustín Díez-Castillo:** Writing – review & editing, investigation, data analysis (spatial  
840 analysis), databases design and maintenance, formal analysis, research team, visualization.

841 **Josep Lluís Pascual-Benito:** Investigation, data analysis and curation (marine and terrestrial  
842 mollusk, bone industry, Personal ornaments), research team.

843 **Salvador Pardo-Gordó:** Investigation, spatial analysis, research team.

844 **Gianni Gallelo:** Investigation, sedimentary analysis, funding acquisition, research team.

845 **Mirco Ramacciotti** Investigation, data analysis (chert raw materials)

846 **Lluís Molina-Balaguer:** Investigation, data analysis (pottery), research team.

847 **Esther López-Montalvo:** Writing – review & editing, Investigation, data analysis  
848 (plaquettes), research team.

849 **Joan Bernabeu-Aubán:** Investigation, data analysis (pottery), funding acquisition, research  
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851 **Martina Basile:** Investigation, data analysis (plaquettes), research team.  
852 **Cristina Real-Margalef:** Investigation, data analysis (faunal remains).  
853 **Alfred Sanchís-Serra:** Investigation, data analysis and curation (faunal remains).  
854 **Ángela Pérez-Fernández:** Investigation, data analysis (human remains).  
855 **Teresa Orozco-Kölher:** Investigation, data analysis (polished stone tools), research team.  
856 **Yolanda Carrión-Marco:** Investigation, data analysis (charcoal analysis).  
857 **Guillem Pérez-Jordà:** Investigation, data analysis (seeds and fruits analysis).  
858 **María Barrera-Cruz:** Investigation, data analysis (lithics), research team.  
859 **Pilar Escribá-Ruiz:** Investigation, data analysis (pottery), research team.  
860 **Joaquín Jiménez-Puerto:** Investigation, data analysis (pottery), research team.

## 861 862 **Data availability**

863  
864 All data discussed are presented in the manuscript or in the Supplementary files.  
865

## 866 **Declaration of competing interest**

867  
868 The authors declare that they no known competing financial interests or personal  
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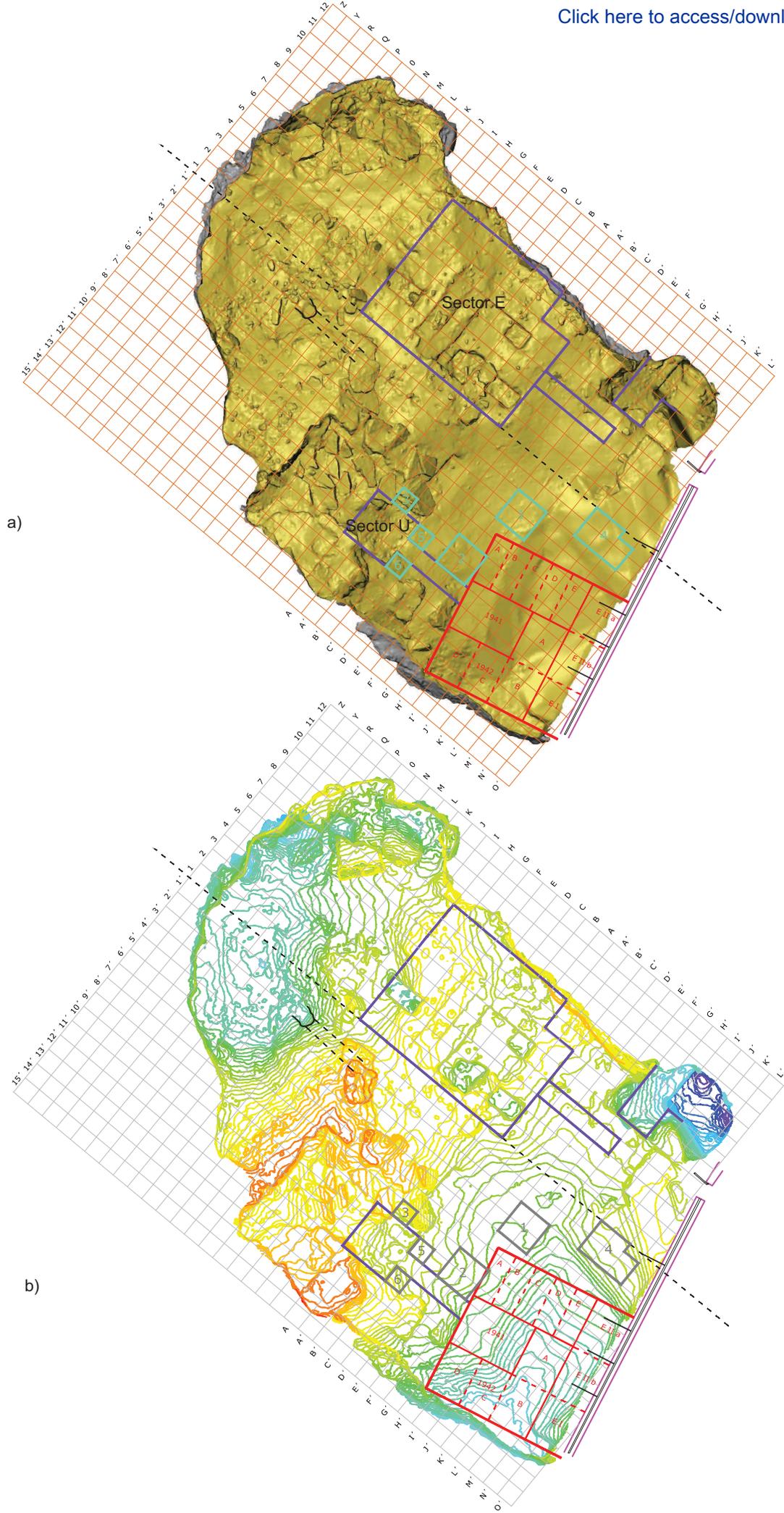
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1081  
1082 Figure captions  
1083  
1084 Figure 1. Location of Cocina cave at the eastern Mediterranean region and the main Late  
1085 Geometric Mesolithic sites (maps made with in QGIS 3.16 over SCUAM 2013 map).  
1086  
1087 Figure 2. Site map of the cavity with indication of archaeological fieldwork, a) 3D model  
1088 with indication of the different seasons (red=Pericot -1941:1945), purple= Fortea –  
1089 1974:1981, green=2015:2018), b) same with contour lines (made by Global Geomática).  
1090  
1091 Figure 3. Spatial volumetric reconstruction of Pericot’s sectors.  
1092  
1093 Figure 4. General Bayesian phase model plot. The models have been built using Oxcal 4.4  
1094 software (Bronk Ramsey, 2009a) and intCal20 curve (Reimer et al., 2020).  
1095  
1096 Figure 5. Bayesian modelling Dates plot. The models have been built using Oxcal 4.4  
1097 software (Bronk Ramsey, 2009a) and intCal20 curve (Reimer et al., 2020).  
1098  
1099 Figure 6. Predictive probability results from Bayesian approximate approach by units of 1942  
1100 and 1943 campaigns.

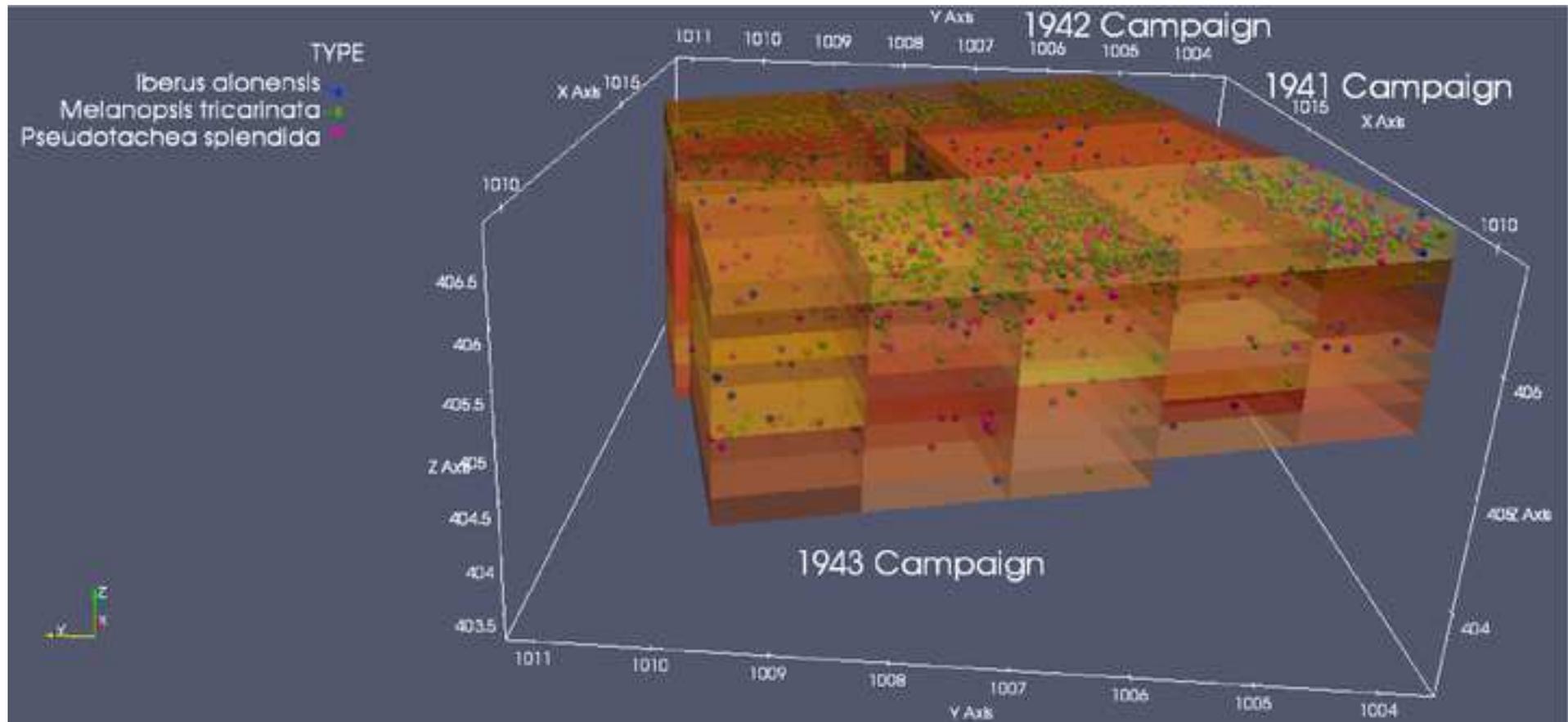
1101  
1102 Figure 7. 1943 Pericot's pictures (Prehistory Museum of Valencia).  
1103  
1104 Figure 8. Current proposal of Archaeological sequence at Cueva de la Cocina. General  
1105 correlation by archaeological units and subunits considered.  
1106  
1107 Table captions  
1108  
1109 Table 1. Surface and volume data from Pericot's seasons.  
1110  
1111 Table 2. Summary of archaeological remains recovered at the Pericot's fieldwork.  
1112  
1113 Table 3. Table with the current radiocarbon dates from Cueva de la Cocina. The dates have  
1114 been calibrated using Oxcal 4.4 software (Bronk Ramsey, 2009a) and intCal20 curve (Reimer  
1115 et al., 2020).  
1116  
1117 Table 4. Data for building Bayesian chronological analysis from 1941 and 1945 E1.  
1118  
1119 Table 5. Bayesian model results.  
1120  
1121 Table 6. Modelled duration dates from general phase modelling results using Oxcal 4.4  
1122 software (Bronk Ramsey, 2009a) and intCal20 curve (Reimer et al., 2020).





a)

b)



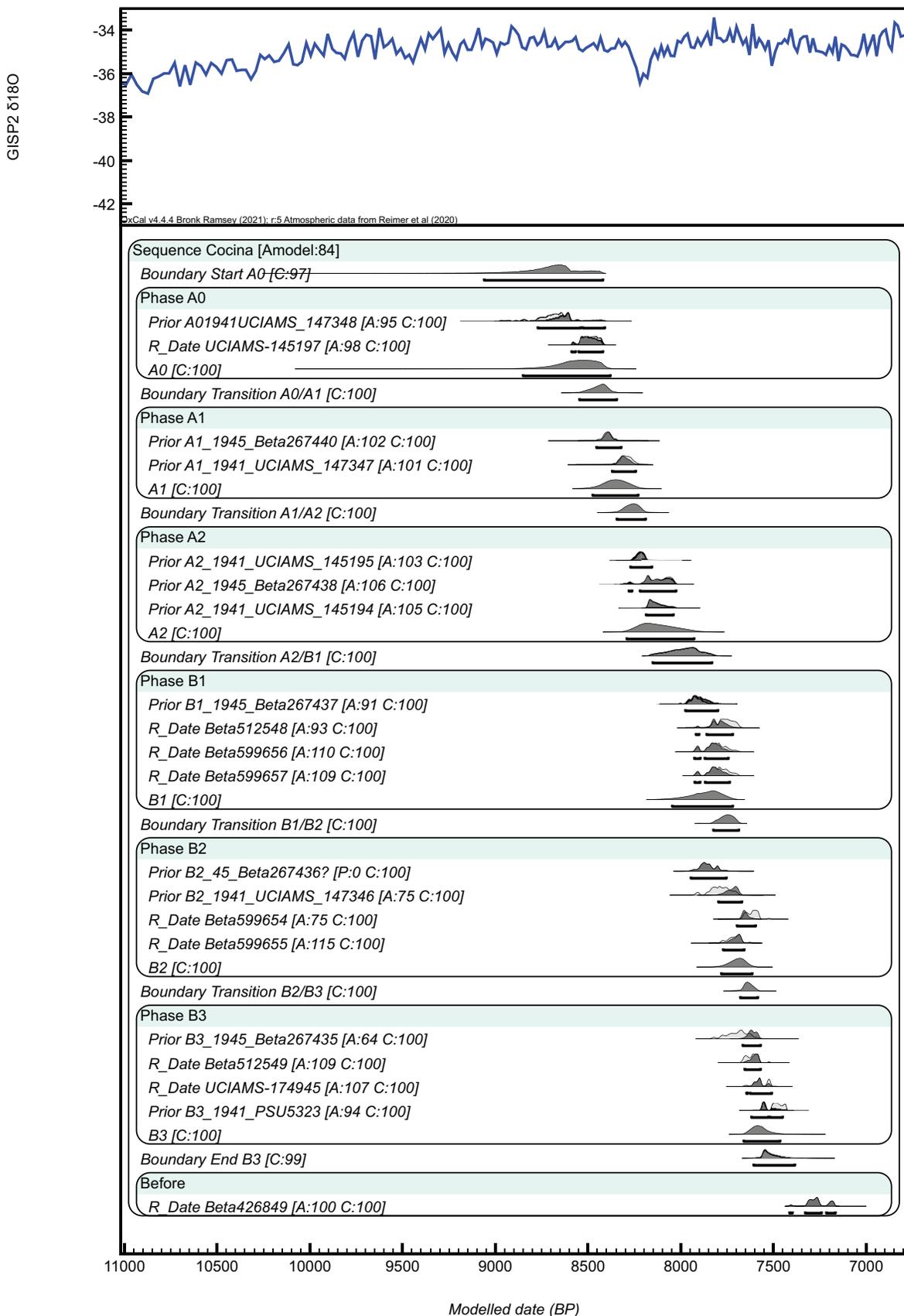
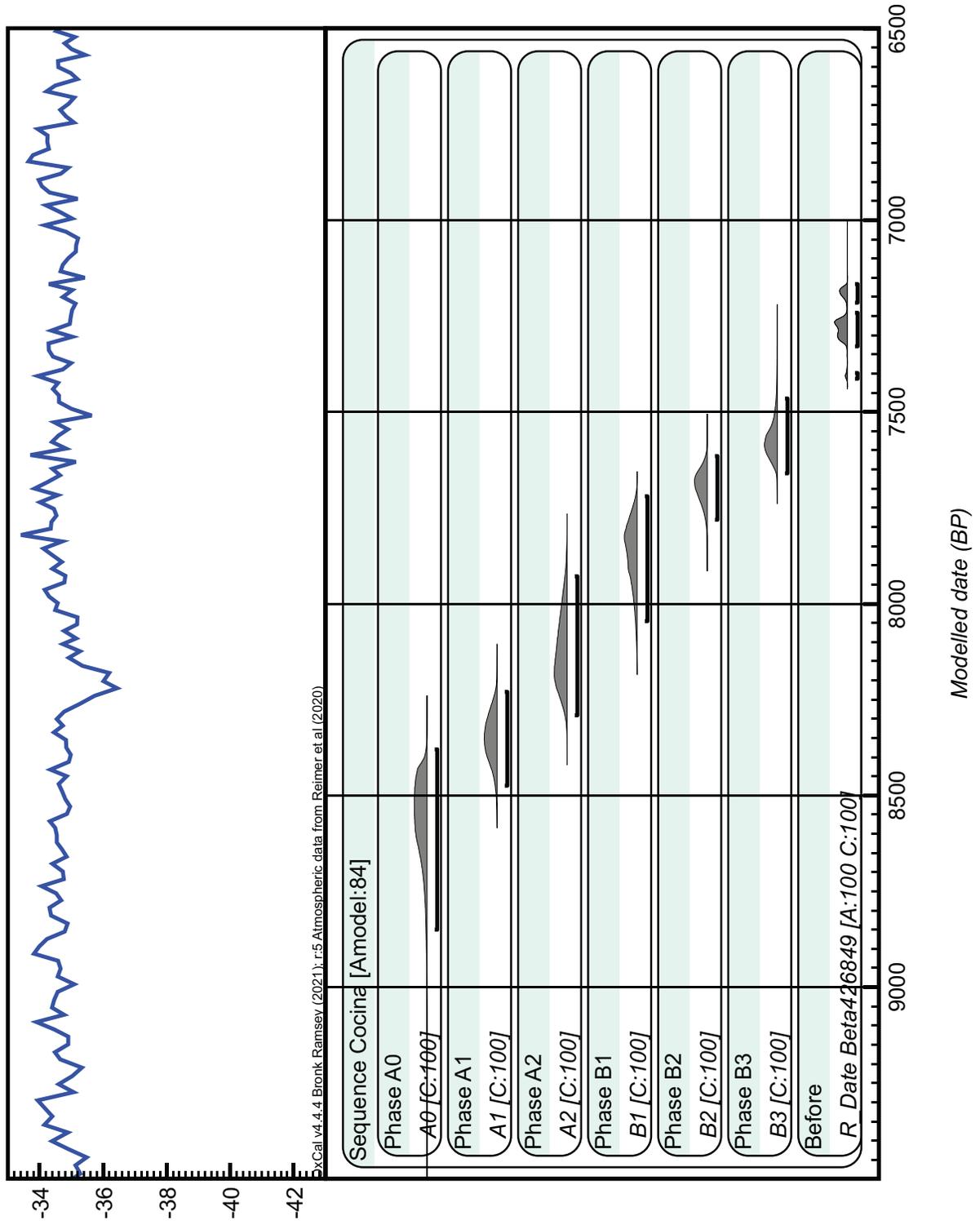
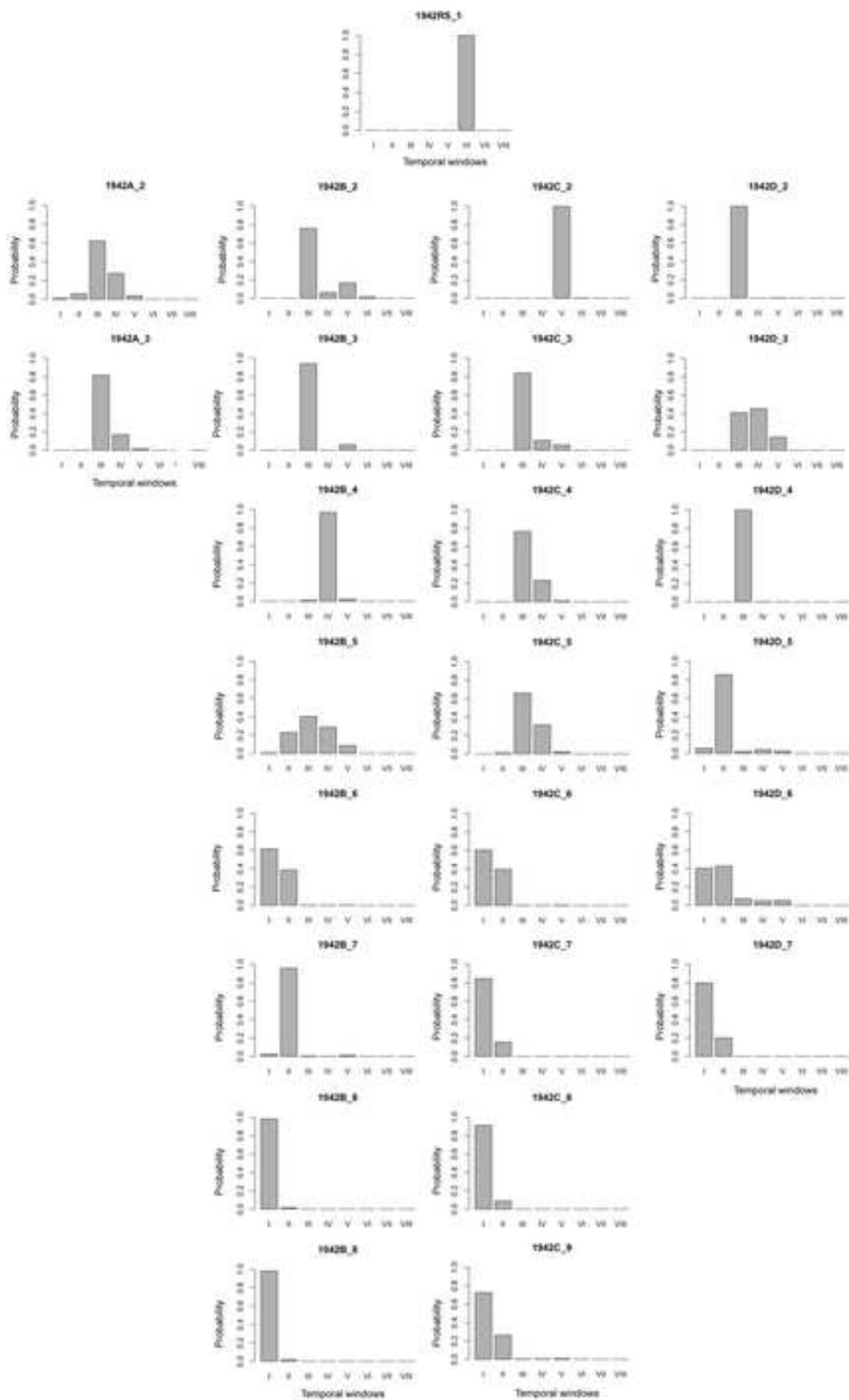
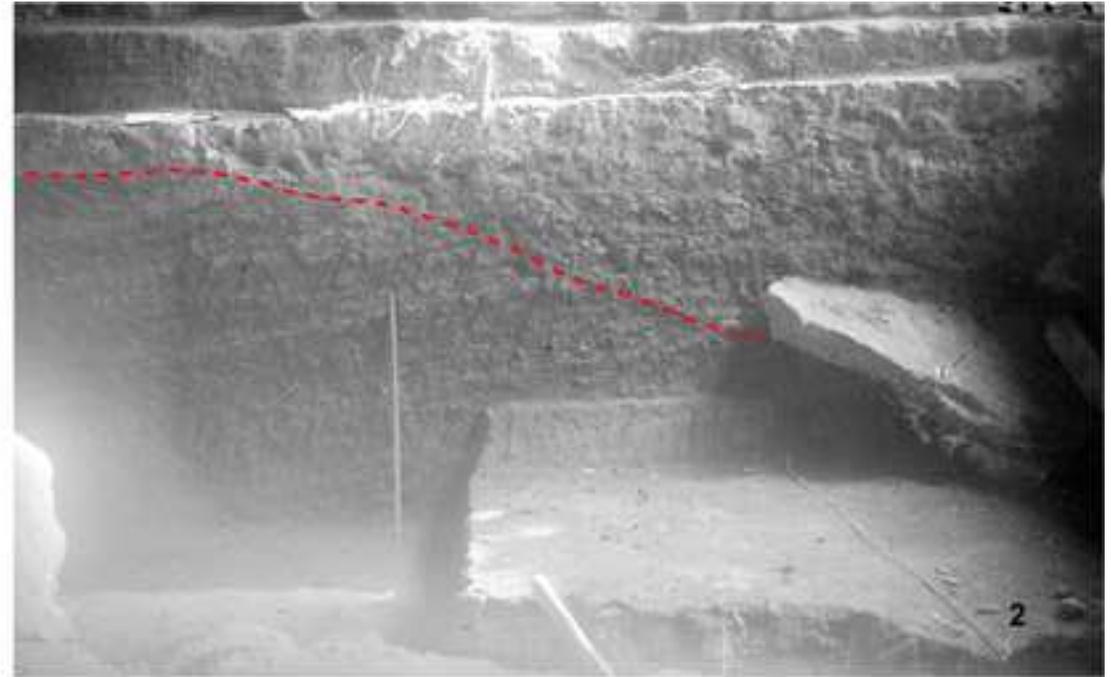
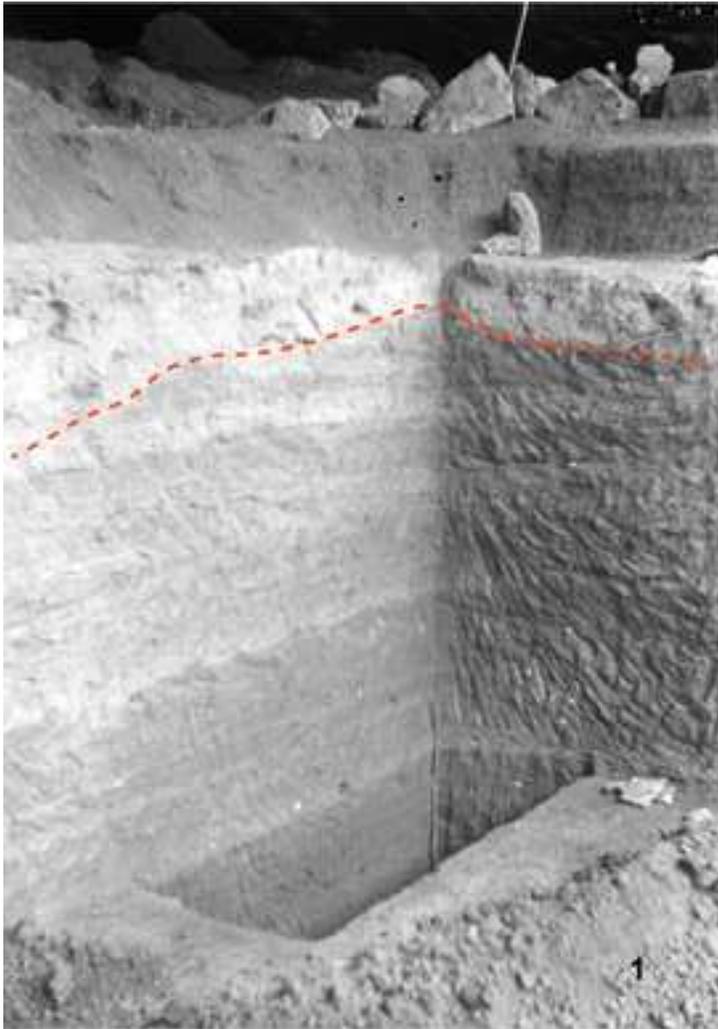


Figure 5

[Click here to access/download;Figure;Fig\\_5.eps](#)







1. 1943. A sector, Northeastern corner.
2. 1943. B, C, D, sectors, North side.
3. 1943. E sector, Western side.

\* Red dashed line: approximate limit between natural and anthropic sediments. Images from Prehistory Museum of Valencia (Spain).

Figure 8

Archaeological units			Archaeological subunits	Description	2015-2018 excavation detail						
PERICOT revisited	FORTEA excavation	2015-2018 excavation			Test pit 1	Test pit 2	Test pit 3	Test pit 4	Test pit 5	Test pit 6	
Sup	A, B, C, D, E	Contemporary	Surface	Surface	S1_1	S2_1	S3_1	S4_0	S5_1	S6_1	
			1	Contemporary hearth	S1_2						
			2	Pit 1						S6_2	
			3	Contemporary pen level		S2_2				S5_3/2	S6_3
			4	Pit 2				S4_1			
			5	Contemporary coal			S3_2			S6_4	
			6	Modern fill				S4_2			
			7	ancient close pen				S4_3			
		Medieval/ Modern	8	Base close pen fill			S4_4				
			Hiatus								
			9	Iberian level							
			Hiatus								
	F		Flooding	Flooding							
D	G	D	10	Late Neolithic / Chalcolithic / Bronze Age			S3_3				
			Crust	Crust							
C2		C2	11	Middle Neolithic							
			Hiatus?								
Mixed	H layer 2	C1	12	Early Neolithic			S3_3				
			Hiatus								
B3			13	Late Geometric Mesolithic B3							
B2	H1	B2	14	Late Geometric Mesolithic B2			S3_4	S4_5a			
B1	H2	B1	15	Late Mesolítico Geométrico B1			S3_4	S4_5b		S6_5	
A2	H3	A2	16	Late Geometric Mesolithic A2	S2_3		S3_4				
A1	H4		17	Late Geometric Mesolithic A1							
A0	J		18	Late Geometric Mesolithic A0							
			Natural base		S1_3	S2_4	S3_5	S4_6	S5_4	S6_6	

Pericot's Sectors	m <sup>2</sup>	m <sup>3</sup>	Max. Depth	Min. Depth
1941	9	18,45	2,50	1,60
1941 exp	1,50	3,75	2,50	2,50
1942 A	1,31	1,37	1,05	1,05
1942 B	3,15	9,18	3,37	2,46
1942 C	2,79	8,52	3,37	2,74
1942 D	5,04	10,68	2,12	2,12
1943 A	3,75	2,77	1,28	0,2
1943 B	3,75	4,36	1,28	1,05
1943 C	3,75	5,23	1,53	1,26
1943 D	3,75	5,23	1,53	1,26
1943 E	3,75	5,73	1,53*	1,53
1945 EI	3,36	15,12	4,5	4,5
1945 Ellb	9,62	4,81	0,5**	0,5
1945 Ella	5,98	20,93	3,90	3,10
TOT	60,5	116,07		

Pericot's sector:	Lithics*	Pottery	Fauna	Fish	Terrestrial Molusck	Marine molusck
1941	8771	4	510	2	763	220
1941 amp	2699	0	298	-	205	-
1942RS	2796	33	638	3	600	203
1942A	519	0	14		31	8
1942B	5760	2	454	15	282	94
1942C	4805	1	381		459	215
1942D	4348	0	376		225	91
1943A	3646	0	240	-	397	2
1943B	8422	0	310	-	242	8
1943C	8703	0	534	-	788	-
1943D	7361	8	523	-	379	126
1943E	7223	34	351	-	149	15
1945 E1	4502	656	149	1	29	94
1945 E2	*	145	*	-	2	8
<b>TOTAL</b>	<b>69555</b>	<b>883</b>	<b>4778</b>	<b>21</b>	<b>4551</b>	<b>1084</b>

Plaquettes	Ornament	Bone tools		
1	97	3		
-				
2				
-				
2				
2	152	4		
3				
9				
2				
1				
2	107	15		
2				
-				
5				
1				
56	56	10		
1				
30			412	32

Trench/Layer	Sample	Species	Lab. Ref	<sup>14</sup> C age bp	sd	Cal BP 95.4 %
Pericot 1941 Layer 3	Animal bone	Cervus elaphus**	UCIAMS-147346	6970	35	7924 7696
Pericot 1941 Layer 6	Animal bone	Cervus elaphus***	UCIAMS-145194	7300	30	8175 8027
Pericot 1941 Layer 8	Animal bone	Capra pyrenaica*	UCIAMS-145195	7475	25	8368 8195
Pericot 1941 Layer 11	Animal bone	Capra pyrenaica*	UCIAMS-147347	7415	35	8345 8061
Pericot 1941 layer 13	Animal bone	Capra pyrenaica*	UCIAMS-147348	7905	40	8981 8596
Pericot 1945 layer 6	Animal bone	Capra pyrenaica*	Beta-267435	6840	50	7780 7583
Pericot 1945 layer 8	Animal bone	Capra pyrenaica**	Beta-267436	7080	50	8010 7792
Pericot 1945 layer 10	Animal bone	Capra pyrenaica	Beta-267437	7050	50	7972 7752
Pericot 1945 layer 12	Animal bone	Capra pyrenaica*	Beta-267438	7350	40	8313 8026
Pericot 1945 layer 13	Animal bone	Capra pyrenaica**	Beta-267439	6760	40	7676 7522
Pericot 1945 layer 17	Animal bone	Capra pyrenaica*	Beta-267440	7610	40	8519 8345
2015 fieldwork Trench 3 UE1036	Charcoal	branch pinus sp	Beta- 426849	6350	30	7414 7167
Fortea, D6, level G	Animal bone	Ovis aries	UCIAMS-174145	4425	25	5269 4874
Fortea, D5, level H, layer 4	Animal bone	Ovis aries	UCIAMS-174146	3725	20	4149 3985
Fortea, B5, level H, layer 2	Animal bone	Capra pyrenaica**	UCIAMS-145198	6985	25	7929 7731
Fortea, B4, level H3, layer 5	Animal bone	Cervus elaphus**	UCIAMS-145196	7455	25	8345 8190
Fortea, B4, level H4, layer 6	Animal bone	Capra pyrenaica**	UCIAMS-145197	7710	30	8585 8416
Pericot 1943 zone E, layer 4	Animal bone	Cervus elaphus****	PSU5320	7040	20	7936 7796
Pericot 1943 zone E, layer 9	Animal bone	Capra pyrenaica*	PSU5321	7160	25	8019 7937
Pericot 1942, zone D, layer 4	Animal bone	Cervus elaphus*	PSU5608	7285	25	8171 8024
Pericot 1942, zone C, layer 8	Animal bone	Capra pyrenaica*	PSU5322	7310	25	8176 8032
Pericot 1941, layer 1	Animal bone	Capra pyrenaica****	PSU5323	6590	25	7562 7428
2018 fieldwork, trench 4 UE1424	Animal bone	Capra pyrenaica*	Beta-512548	6940	30	7843 7681
2015 fieldwork Trench 6 UE1126	Animal bone	Capra pyrenaica*	Beta-512549	6760	30	7669 7574
2015 fieldwork Trench 6 UE1147	Animal bone	Capra pyrenaica*	Beta-512550	6910	30	7830 7673
2015 fieldwork Trench 5 UE 1136	Coprolito	ovis/capra	Beta-453589	180	30	295 ...
2015 fieldwork Trench 3 UE1021	seed/fruit	acorn	Beta-453590	6930	30	7836 7680
2015 fieldwork Trench 2 UE 1154	Charcoal	evergreen quercus	Beta-426850	7380	30	8325 8037
Fortea A'8' layer 1, EI	Animal bone	Bos taurus	UCIAMS-174144	3590	20	3971 3836
2015 fieldwork Trench 5 UE 1078	Animal bone	Capra pyrenaica****	UCIAMS-174945	6705	35	7663 7505
Pericot 1943 zona E, capa 8/9	Human bone	Human	UCIAMS-174943	7400	30	8334 8051
Pericot 1942, rincón SE layer 1	Human bone	Human	UCIAMS-174147	7375	25	8320 8036
Pericot 1941 layer 2	Human bone	Human	PSUAMS-4429	7135	25	8013 7875
2016 fieldwork trench 4 UE1223 KE2S seed/fruit		pine cone	Beta-599654	6760	30	7669 7574
2016 fieldwork trench 4 UE1230 KE2S seed/fruit		pine cone	Beta-599655	6880	30	7790 7623
2018 fieldwork trench 4 UE1404 KE2S seed/fruit		pine cone	Beta-599656	6980	30	7927 7706
2018 fieldwork trench 4 UE1416 KE2S seed/fruit		pine cone	Beta-599657	6970	30	7922 7700
2015 fieldwork trench 3 UE1020 AE7S seed/fruit		pine cone	Beta-599658	6770	30	7671 7576
Sarrión1974	Human bone	Human	Beta-618257	7090	30	7975 7842
Sarrión1974	Human bone	Human	Beta-618258	7120	30	8012 7868

$\delta^{13}\text{C}$	$\delta^{15}\text{N}$	C:N	Reference
-19.5	4.0	3.25	García Puchol <i>et al.</i> 2018
-20.3	3.9	3.20	García Puchol <i>et al.</i> 2018
-20.4	4.2	3.18	García Puchol <i>et al.</i> 2018
-19.5	3.8	3.22	García Puchol <i>et al.</i> 2018
-19.0	4.5	3.24	García Puchol <i>et al.</i> 2018
nd	nd	nd	Juan Cabanilles & García Puchol 2013
nd	nd	nd	Juan Cabanilles & García Puchol 2013
nd	nd	nd	Juan Cabanilles & García Puchol 2013
nd	nd	nd	Juan Cabanilles & García Puchol 2013
nd	nd	nd	Juan Cabanilles & García Puchol 2013
nd	nd	nd	Juan Cabanilles & García Puchol 2013
-25.3			Pardo Gordó <i>et al.</i> 2018
-22.4	4.2	3.47	Pardo Gordó <i>et al.</i> 2018
-20.3	4.5	3.41	Pardo Gordó <i>et al.</i> 2018
-19.2	4.4	3.16	Pardo Gordó <i>et al.</i> 2018
-20.2	4.8	3.17	Pardo Gordó <i>et al.</i> 2018
-19.1	4	3.15	Pardo Gordó <i>et al.</i> 2018
-20.1	4.7	2.9	Unpublished
-20.2	4.3	2.9	Unpublished
-20.2	4.4	2.8	Unpublished
-20.7	3.9	3	Unpublished
-19.8	3.8	2.9	Unpublished
-19	4	3.3	Unpublished
-20.2	4	3.3	Unpublished
-19.6	4.6	3.3	Unpublished
-25.7			Unpublished
-23.3			Unpublished
-26.4			Unpublished
-20.1	7.6	3.39	Unpublished
-20.5	3.1	3.23	Unpublished
-18.1	8.6	3.3	Unpublished
-19.3	8.2	3.26	Unpublished
-18.8	9.3	3.27	Olalde <i>et al.</i> 2019
-27.9			Unpublished
-24.3			Unpublished
-20.7			Unpublished
-27.8			Unpublished
-21.9			Unpublished
-18.2	10.6	3.2	Unpublished
-18.8	10.8	3.3	Unpublished

<b>Trench</b>	<b>1941</b>				<b>Units</b>
41_1	layer 1	PSU5323*	6590	25	B3
41_2	layer 2	PSUAMS-4429	7135	25	B2
41_3	layer 3	UCIAMS-147346	6970	35	B2
41_4	layer 4				B1
41_5	layer 5				B1
41_6	layer 6	UCIAMS-145194	7300	30	A2
41_7	layer 7				A2
41_8	layer 8	UCIAMS-145195	7475	25	A2
41_9	layer 9				A1
41_10	layer 10				A1
41_11	layer 11	UCIAMS-147347	7415	35	A1
41_12	layer 12				A1
41_13	layer 13	UCIAMS-147348	7905	40	A0
<b>Trench</b>	<b>1945</b>				<b>Units</b>
45_1	layer 1				D
45_2	layer 2				D
45_3	layer 3				C2
45_4	layer 4				C2
45_5	layer 5				C1
45_6	layer 6	Beta-267435	6840	50	B3
45_7	layer 7				B2
45_8	layer 8	Beta-267436	7080	50	B2
45_9	layer 9				B1
45_10	layer 10	Beta-267437	7050	50	B1
45_11	layer 11				A2
45_12	layer 12	Beta-267438	7350	40	A2
45_13	layer 13	Beta-267439	6760	40	A2
45_14	layer 14				A1
45_15	layer 15				A1
45_16	layer 16				A1
45_17	layer 17	Beta-267440	7610	40	A1

Model results	Amodel
Stratigraphic model 1941 All dates	52.5
Stratigraphic model 1941 Outlier	102.2
Stratigraphic model 1945 E1 All dates	33
Stratigraphic model 1945 E1 (outlier)	93.4
Phase model all dates and priors	57.9
Phase model (outlier)	83.5

Units	From	to	%	C
A0	8850	8380	95.4	99.7
A1	8475	8230	95.4	99.9
A2	8291	7929	95.4	99.8
B1	8046	7720	95.4	99.8
B2	7781	7615	95.4	99.9
B3	7660	7465	95.4	99.9