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## Reconstructing human-environment interactions in the western Messara Plain (Phaistos, Crete, Greece) from the emergence of city states to Byzantine times

Matthieu Ghilardi, Jordi Revelles, Arthur Glais, Tatiana Theodoropoulou, Katerina Theodorakopoulou, Laurent Lespez, Fausto Longo, Amedeo Rossi, Olivier Bellier, Lucilla Benedetti, et al.

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1           **Reconstructing human-environment interactions in the western Messara Plain**  
2           **(Phaistos, Crete, Greece) from the emergence of city states to Byzantine times**

3  
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7           **Abstract**

8           Landscape evolution from the Early 1<sup>st</sup> millennium BCE to the mid-1<sup>st</sup> millennium CE is poorly  
9           documented around major archaeological sites in Crete. In a previous publication, the general  
10          landscape configuration in the vicinity of ancient Phaistos was reconstructed using a  
11          palaeoenvironmental approach, from the Proto-Palatial period (*ca.* 2000 BCE) to the Late-Proto  
12          Geometric period (*ca.* 8<sup>th</sup> cent. BCE). However, the physiography of the landscape, its hydrology and  
13          vegetation history remained uncertain for the later archaeological periods. In the present study,  
14          additional radiocarbon dates (8) together with pollen, mollusc and sedimentological analyses (CM  
15          diagram) were conducted on previously documented sediment cores. These new results enable us to  
16          reconstruct in greater detail the landscape history from the Early Archaic period to Late Byzantine  
17          times. The results indicate the continuous presence of swampland from the Proto-Geometric period  
18          (10<sup>th</sup> cent. BCE) probably until the initial stages of the Classical period (5<sup>th</sup> cent. BCE). Subsequently,  
19          during the Classical and Hellenistic periods, there was a short interval of alluvial input of terrigenous  
20          sediments (not exceeding two centuries in duration) which is directly linked with the complete drying  
21          up and drainage of the swampland. We address the issue of the possible climatic origin of this abrupt  
22          hydrological change, especially in relation to regional climate change and the sedimentary history of  
23          adjacent rivers and streams. Tectonic activity in the area is also an important factor and can be  
24          invoked as a potential environmental influence. Anthropogenic factors are also considered, even  
25          though there is no direct archaeological evidence of drainage in the western Messara Plain during the  
26          Archaic and Classical periods. Finally, from Roman times to the Early Byzantine period, floodplain  
27          development prevailed in the area and ponds formed locally, in particular from the Late Hellenistic to  
28          Early Byzantine periods; this was related to the climatic conditions of the Roman Warm period.  
29          Pollen analysis reveals an open forested landscape during the time interval under investigation, within  
30          which domesticated plants such as *Olea* (olive) were present. However, the representation of *Olea*

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31 decreases continuously from the Late Geometric period to Byzantine times, probably indicating much  
32 lower intensity of land use than during Minoan times and possibly also related to the generally colder  
33 climatic conditions in Crete from the 8<sup>th</sup> cent. BCE until the 1<sup>st</sup> Cent. CE. During this latter interval,  
34 there is also the first pollen analytical evidence of *Vitis sp.*

35

36 **Keywords:** Crete; geoarchaeology; palaeoenvironments; boreholes; Archaic and Classical periods;  
37 Roman and Byzantine times; pollen identification

38

39 Research highlights:

- 40 • Swamplands around Phaistos lasted until the Classical period (6<sup>th</sup>-5<sup>th</sup> Cent. BCE)
- 41 • A detrital input is recorded from ca. 450 to 200 cal. BCE
- 42 • representation of *Olea* decreases continuously from the Late Geometric period to Byzantine  
43 times
- 44 • Scarce representation of *Olea* during the Classical period and Byzantine times

45

## 46 1. Introduction

47

48 Reconstructing Holocene palaeoenvironments in Crete, the fifth largest Mediterranean  
49 island, is a challenging task since continuous sedimentary archives are scarce due to the  
50 paucity of permanent lakes and rivers, especially on the southern side of the island. Thus,  
51 both the landscape configuration and land-use in Crete, within an archaeological context,  
52 remains largely unexplored (Moody, 2000) and little is known about the geomorphological  
53 context around the major archaeological sites of the island during Minoan times and later  
54 cultural periods from the 1<sup>st</sup> millennium BCE and CE. In particular, at the end of the  
55 Geometric period (8<sup>th</sup> Cent. BCE), there is the political affirmation represented by  
56 independent city states (called *Polis* or *Poleis* in Greek; see, for example: Lefevre-Novaro,  
57 2007); examples are Gortyn and Phaistos (Lefevre-Novaro, 2007; Longo 2015) in the  
58 Messara Plain, Priniàs (between Gortyn and Cnossos), Lyttos and Dreros (Eastern Crete),  
59 Eleutherna and Axos (in the Rethymno area; Van Effenterre, 1985; Nielsen, 2002). These city  
60 states represent a major political, social and economic turning point in the history of Crete,  
61 following the demise of the Minoan Kingdom and the so-called “Dark Ages” (see, for  
62 example: Lefevre-Novaro, 2007 and 2008). This transition is largely undocumented from a  
63 palaeoenvironmental perspective and the effects of anthropogenic activity on landscape  
64 configuration and vegetation histories are unclear. Recent attempts to reconstruct both past  
65 landuse activities and the agricultural landscape, based on archaeological survey and  
66 excavations, have been made (Rossi, 2018) but these are restricted both in time and in space  
67 and need to be more documented from a palaeoenvironmental perspective.

68 The Messara Plain (South Central Crete; Figure 1) hosts several important archaeological  
69 sites dating from the Minoan Kingdom until Early Byzantine times (Watrous et al., 2003). It  
70 can be considered as one of the most important political and economic centres in the history  
71 of Crete. The most important sites include Phaistos (Bredaki et al., 2009) (Figures 1 and 2),  
72 one of the former capitals of the Minoan Kingdom, and Gortyn (Figure 1), which was an  
73 important city-state from the Geometric to the Hellenistic periods and became the capital of  
74 the Province of Crete and Cyrene during Roman times (Francis and Harrison, 2003). The two

75 major sites of the Western Messara Plain were probably already benefiting from the  
76 occurrence of fertile soils during the 2<sup>nd</sup> half of the 1<sup>st</sup> millennium BCE.

77 A palaeoenvironmental research project, conducted at the foot of ancient Phaistos,  
78 revealed the existence of a freshwater lake, extant from *ca.* 2000 to 1200-1100 cal. BCE  
79 (Ghilardi et al., 2018). Subsequently, after the 3.2 kyr cal. BP Rapid Climate Change (RCC)  
80 event, the lake became swampland. This palaeoenvironmental feature had not been  
81 documented previously and it was postulated that its investigation by the project might help  
82 to elucidate further the archaeology and palaeoeconomy of the area, not only Phaistos, but  
83 other sites from the central and western parts of the Messara Plain, such as Gortyn and Aghia  
84 Triada. The existence of the palaeo-lake, and adjacent fertile land would have played a major  
85 role in the economy and in the socio-political situation in Messara and the surrounding areas,  
86 from the late third millennium BCE to the opening centuries of the 1<sup>st</sup> millennium BCE. The  
87 exact timing of the drainage of the swampland remains unclear (though it may have occurred  
88 around the 7<sup>th</sup> Cent. BCE -the early phases of the Archaic period- according to Ghilardi et al.,  
89 2018); the subsequent input of detrital sediment has not been dated accurately (though it was  
90 dated earlier than the late Hellenistic period according to Ghilardi et al., 2018). Previous  
91 palaeofluvial studies conducted in western Messara (of the Gria Saita River; Pope, 2004;  
92 Figure 2) have revealed an important phase of sedimentation, probably covering most of the  
93 Hellenistic period (300-150 BCE; Pope, 2004). However, the complete history of alluviation  
94 has not been documented and there is no information available about the total thickness of  
95 these deposits or the coeval fluvial regime. This event was of regional extent and  
96 significance, also occurring for example in the Ayiofarango valley (south of the Messara  
97 Plain; Figure 1; Doe and Homes, 1977); however, details of the volume of sedimentation and  
98 the hydrological history of this former river have not been reconstructed. In addition, the  
99 interpretations of both these studies were based solely on the general stratigraphy of a number  
100 of different sedimentary profiles that contained reworked Hellenistic pottery sherds in the  
101 lower-most parts of the sequences. The chronology of the initial phases of alluviation remain  
102 uncertain and further palaeoenvironmental studies are needed to elucidate the fluvial history  
103 of Western Messara and the possible role played by the dessication of the palaeo-lake at the  
104 foot of ancient Phaistos. Moreover, the synchronous record of alluvial sedimentation during  
105 the Hellenistic period had led to questions regarding a possible regional climatic control on  
106 fluvial dynamics. Until now, palaeoclimatic reconstructions for Crete have been scarce and  
107 reliable data have only been available from other areas of southern Greece, between Crete  
108 and the Karpathos Islands (Rohling et al., 2002) and the south central Peloponnesus (Finné et  
109 al., 2014; Boyd, 2015).

110 Based on the palaeoenvironmental study of boreholes, drilled at the foot of ancient  
111 Phaistos and previously studied in detail only in their lowermost part (Ghilardi et al., 2018),  
112 this paper extends the knowledge base for the region by reconstructing the landscape  
113 evolution for the period covering the 1<sup>st</sup> millennium BCE and the mid-1<sup>st</sup> millennium CE.

114

115 **2. Study area and the history of human occupation from the Geometric period to**  
116 **Early Byzantine times.**

117 Located in south central Crete, Messara is the largest plain of the island (Figure 2). It  
118 corresponds to an elongated tectonic depression (graben) oriented W/E that has been infilled  
119 by clastic sediments during the Neogene and Quaternary (Peterek and Schwarze, 2004;  
120 Fytrolakis et al., 2005; Amato et al., 2014). Major fault lines border the Messara depression  
121 area to the north and south and are responsible for the steep relief of the Ida and Asteroussia  
122 mountain ranges. Several of these major fault lines are reported to be active and could have  
123 produced earthquakes during historical times (Monaco and Tortorici, 2004; Mouslopoulou et  
124 al., 2011) even if the identification of the potential fault responsible for the destruction of the  
125 Minoan palace of Phaistos is still under investigation and the focus of debate (Mouslopoulou  
126 et al., 2012). The Aghia Galini, Klima and Aghia Triada fault lines are all located around  
127 Phaistos (Fytrolakis et al., 2005; Mouslopoulou et al., 2014; Figure 2) and are invoked to  
128 explain the present-day morphology of the area: the archaeological site of Phaistos is located  
129 on an uplifted block (horst), called the Phaistos ridge (Fytrolakis et al., 2005; Figure 2) and  
130 overhangs the plain to the east. Today, there is no permanent river in the area and the  
131 Geropotamos River (Figures 1 and 2) only drains the Messara Plain towards the Tymbaki  
132 Gulf, but only during times of high rainfall (mainly spring and autumn). The headwaters of  
133 this river mainly drain the Psiloritis mountain range and several of its tributaries, such as the  
134 Lethaios River in the area of Gortyn, were especially active during historical times (Bondesan  
135 and Mozzi, 2004; Figure 1). Despite major wetland reclamation of the plain, there is some  
136 evidence for palaeochannels, in particular at the foot of ancient Phaistos where the bed of the  
137 Gria Saita river (dry for most of the year; Figure 2) has deeply incised through floodplain  
138 deposits.

139 The Messara Plain contains two major archaeological sites separated by a distance of  
140 *ca.* 12 km: Phaistos was a great Minoan political and economic centre (palatial site) during  
141 the 2<sup>nd</sup> millennium BCE, which subsequently declined during the Early 1<sup>st</sup> millennium BCE;  
142 and Gortyn, which played no major role during Minoan times but was considered as a key  
143 settlement in Crete during the 1<sup>st</sup> millennium BCE and the first centuries of the 1<sup>st</sup>  
144 millennium CE. Today, between these two major archaeological sites, excavated by the  
145 Italian School of Archaeology in Greece since the 19<sup>th</sup> Century CE, fertile land exists,  
146 however the character of the landscape was unclear for the 1<sup>st</sup> millennium BCE and the first  
147 half of the 1<sup>st</sup> millennium CE.

148 At Phaistos, Protogeometric and Geometric phases (10<sup>th</sup>-8<sup>th</sup> centuries BCE) have been  
149 recognized on the hill of Christos Effendi (Figure 2), on the Palace hill, and along the eastern  
150 slopes (Chalara; Figure 2). The area of Aghia Fotini, on the northern slopes of the Palace hill  
151 (Figure 2) – once occupied by Pre-, Proto- and Neopalatial buildings – has yielded burials  
152 dated to the Protogeometric and Geometric periods (Rocchetti, 1969-70; Longo, 2015a and  
153 2015b). Other burials, to the southwest of the plateau, indicate that one or more settlement  
154 clusters of one of the 90-100 Cretan cities mentioned by Homer were located there (*Il.* II,  
155 649; *Od.* XIX, 172-174). The archaic and classical phases of Phaistos are still poorly  
156 documented, apart from the materials unearthed in the area of the Palace and from the  
157 settlement of Chalara downhill (Figure 2). The epigraphic documentation (collected in  
158 Bredaki *et al.*, 2009, Marginesu, *in press*) and the numismatic evidence (Carbone, 2017 and  
159 *in press -1 and 2-*) bear witness, in any case, to the presence of a flourishing community.  
160 Only the Hellenistic period (323-150 BCE) can be partly reconstructed on the basis of

161 excavation records and the interpretation of aerial photographs. Some sectors of the city are  
162 known (on the Palace hill, on Christos Effendi, on the plateau, and at Chalara), as well as a  
163 numerous wells or cisterns which supplied potable water to houses (Longo, *in press*). The  
164 city limits in the Hellenistic period can be deduced by two lines of evidence: on the one hand,  
165 from remains of perimeter walls – some already in plain sight, others excavated – northwest  
166 of Aghios Ioannis (Figure 2), on the hill of Christos Effendi, and at Chalara; and on the other,  
167 by the distribution of burial grounds (Rocchetti, 1969-70; Longo, 2015a; Longo, 2015b;  
168 Greco and Betto, 2015; Longo 2017 and Longo, *in press*). There is archaeological evidence  
169 that the city was destroyed around the mid 2<sup>nd</sup> century BCE. This evidence confirms the  
170 passage in the work of Strabo (X.4.14) mentioning the occupation of the Phaistian territory  
171 by the Gortynians and the end of Phaistos as a city (Bredaki *et al.*, 2009). After a period of  
172 abandonment, the hills and the plateau were resettled (2<sup>nd</sup>-4<sup>th</sup> century CE; Bredaki and Longo,  
173 2011; Rossi, 2018). An especially important find from the Byzantine phase (from the 5<sup>th</sup>  
174 century CE) is a farm established at Chalara in the 10<sup>th</sup> century CE, overlying the (barely  
175 visible) ruins of earlier buildings.

176 Gortyn was inhabited by the end of the Neolithic period. The settlement continued in  
177 Minoan times, as evidenced by the Minoan farmhouse located in the area of Kannia near the  
178 village of Mitropoli, just below Gortyn (Dietrich, 1982; Cucuzza 2011). From the middle of  
179 the 1<sup>st</sup> millennium BCE and thereafter, Gortyn succeeded Phaistos as the dominant power in  
180 the Messara Plain. In Hellenistic times, it was one of the largest cities in Crete and the first  
181 city to issue a currency on the island. Gortyn needed access to the Libyan Sea, and the nearest  
182 port was Lebena or Kaloi Limenes (Figure 2), which was probably under the domination of  
183 Phaistos during this period, and also controlled the western part of the Messara Plain and the  
184 port of Matala (Perlman, 1995; Figure 1). Therefore, friendly relations with Phaistos were  
185 necessary, and perhaps these were achieved via a treaty which was marked by the two cities  
186 cutting their first alliance coins (Perlman, 2004; Stefanakis, 1997; Carbone, 2018).

187 The economic nature of the relationship between the two cities is indicated by a second  
188 series of silver coins issued around 380 BCE. Their currencies are the only evidence of their  
189 relationship in the second half of the 5<sup>th</sup> and the beginning of the 4<sup>th</sup> cent. BCE (Sanders  
190 1982).

191

### 192 **3. Climatic conditions in Crete from the Geometric period to Byzantine times:** 193 **evidence from palaeoenvironmental proxies and contemporary texts**

194

195 Specific climatic conditions in Crete during the 1<sup>st</sup> millennium BCE and CE remain uncertain  
196 due to the lack of local palaeoclimatic and palaeoenvironmental studies. In particular, there is  
197 neither a detailed, well-dated pollen record for this time, nor is there stable isotope evidence  
198 from speleothems that can identify local climatic oscillations (including the RCC events  
199 reported in Mayewksi *et al.*, 2004 and Finné *et al.*, 2011). However, a marine sediment core  
200 drilled NE of Crete, between it and the Karpathos Island (LC21; Rohling *et al.*, 2002; Figure  
201 1), indicates general climatic trends for the southeast Aegean. In addition, two palaeoclimatic  
202 records from speleothems (Finné *et al.*, 2014; Boyd, 2015; see Figure 1 for location) have  
203 provided significant information for the central and south Peloponnesus (~350 km from  
204 central Crete); and local OSL-dated sediment bodies deposited in the Anapodaris (Macklin *et*

205 al., 2010; Figure 1) and Istron (Theodorakopoulou et al., 2012; Figure 1) river systems (both  
206 situated to the east of the Messara Plain) help us to reconstruct past climatic conditions and to  
207 assess their effects on the local fluvial dynamics. Comparison of all of the available records  
208 reveals a large degree of intra-regional variability, as previously noted by Finné et al. (2011),  
209 which makes comparison between records potentially difficult. However, in Crete, several  
210 climatic phases can be identified based on these records and they are described below.

211 For the 1<sup>st</sup> millennium BCE, valuable general information is provided by Macklin et  
212 al. (2010) who reported a phase of incision in the Anapodaris gorge from *ca.* 3 to 2.07 kyr  
213 BP. Their palaeoclimatic interpretation is based on the record of marine core LC21 that  
214 indicates increasing sea-surface temperatures in the southeast Aegean during the entire 1<sup>st</sup>  
215 millennium and relatively high  $\delta^{18}\text{O}$  values in the southeast Mediterranean, reflecting  
216 enhanced evaporation and drier conditions in the region. Little is known in detail about the  
217 climatic conditions in Crete during the Geometric, Archaic and Classical periods (from the 8<sup>th</sup>  
218 to the 4<sup>th</sup> Cent. BCE). However, it appears that cold and dry conditions prevailed regionally,  
219 with a pronounced peak around the 6<sup>th</sup> Cent. BCE (Moody, 2016), which is indicated by other  
220 studies conducted in central Peloponnesus (Finné et al., 2014; Unkel et al., 2014) and  
221 northern Greece (Psomiadis et al., 2017). Concerning flood events, one is clearly reported in  
222 the central Peloponnesus around 500 BCE (Finné et al., 2014) and in north central Crete  
223 (Kournas Lake) around the mid-5<sup>th</sup> Cent. BCE (Vannière and Jouffroy-Bapicot, unpublished  
224 material cited in Walsh et al., in press). Ancient writers also document the occurrence of  
225 human-induced regional floods in the years 418 BCE and 385 BCE caused by the blocking of  
226 sinkholes (Finné et al., 2014). Dendrochronological results indicate that growth rings in the  
227 5<sup>th</sup> century BCE were especially thick compared with previous centuries and the two  
228 afterwards (Lamb, 1997). This suggests the occurrence of hotter summers and more rainfall  
229 in the 5<sup>th</sup> century BCE compared with the periods before and after. In Attica, Demosthenes  
230 mentions torrential rains, which caused problems for farmers around Eleusis, recalling the  
231 winter with heavy rainfall at the beginning of the Peloponnesian War. In addition, Diodoros  
232 writes that there were heavy rains in the winter of 427 BCE and that the grain harvest was  
233 poor (Sallares, 1991).

234 During the Hellenistic period (mid-4<sup>th</sup>-2<sup>nd</sup> Cent. BCE), climatic conditions in Crete  
235 seem to be characterized by a peak in cold and dry conditions (Moody, 2016), which is also  
236 well attested to in the Peloponnesus (Unkel et al., 2014; Finné et al., 2014). An interesting  
237 issue concerning the climatic conditions in southern Crete during Hellenistic times is derived  
238 from the unique literary source of the 4<sup>th</sup> Cent. BCE writer Theophrastus in his work "De  
239 ventis" (Book II, 47). He reported that, in Crete, "nowadays the winters are more severe and  
240 more snowy, resulting in the abandonment of agriculture in most of the plains among the  
241 mountains of Ida (situated just north of the Messara Plain) and in the other Cretan  
242 mountains..." In earlier times, the mountains there were more fertile, and the island was more  
243 populous (e.g. during the Archaic period according to Kardulias and Schutze, 1997); none of  
244 the plains were cultivated because they were infertile. Notably, Theophrastus reports that  
245 snow lasted on the Ida Mountains for the entire year (HP 4.1.3.). These descriptions of the  
246 climate of Crete during the Hellenistic period are in good agreement with a regional  
247 palaeoclimatic reconstruction based on palaeoenvironmental proxies (Rohling et al., 2002;  
248 Finné et al., 2014; Moody et al., 2016), which indicates cold conditions at the time. Finné et

249 al. (2014) suggest that wet conditions prevailed in southern Greece during the period 400-100  
250 BCE, as may also have been the case for Crete, according to the description of Theophrastus.

251 In contrast, Roman times (from approximately the 1<sup>st</sup> Cent. BCE to the 2<sup>nd</sup> Cent. CE)  
252 are regarded as a warmer and wetter period (Rohling et al., 2002; Moody, 2016) and are  
253 known regionally as the ‘Roman Optimum’ (RO) (Lamb, 1997), also called the ‘Roman  
254 Warm Period’ (Finné et al., 2011; Theodorakopoulou et al., 2012). This climatic event, also  
255 recorded elsewhere in the Mediterranean (Lamb, 1997), is characterized by intense sediment  
256 deposition at Istron (Eastern Crete) (vertical accretion at the Istron River was around 60-70  
257 cm/cent. during Early Roman times -2<sup>nd</sup> to 1<sup>st</sup> Cent. BCE-; Theodorakopoulou et al., 2012).  
258 By contrast, in the Anapodaris river system, fine-grained sedimentation, dated to *ca.* 100 CE,  
259 suggest minor, low-energy, floods, possibly coupled with changes in land use upstream  
260 (Macklin *et al.* 2010). Similar low energy fluvial dynamics with limited sediment  
261 accumulation are reported in the Ayiofarango gorge (Doe and Holmes, 1977), located south  
262 of the Messara Plain (Figure 1).

263 Finally, during Late Roman times and the Early Byzantine period (3<sup>rd</sup>, 4<sup>th</sup> and 5<sup>th</sup>  
264 Cent. CE), in the south Aegean Sea and in Crete in particular, colder and drier conditions  
265 occurred; notably, the 5<sup>th</sup> Cent. CE can be considered as the peak of aridity on the island  
266 (Besonen et al., 2011; Moody, 2016).

267 In summary, in Crete, the period covering the 1<sup>st</sup> millennium BCE and the mid-1<sup>st</sup>  
268 millennium CE was characterized by a long phase of cold, arid conditions, only interrupted  
269 by the warm and humid conditions of the RO (1<sup>st</sup> Cent BCE-2<sup>nd</sup> cent. CE). In general, no  
270 major phase of alluvial sedimentation is recorded for the abovementioned period across Crete  
271 and only fine-grained sediments, associated with low energy deposition, are recorded with a  
272 peak around 100 CE. In the latter case, land use, rather than climate drivers may explain the  
273 processes of erosion and deposition.

274 Only in the Western Messara Plain was there a major input of detrital sediment  
275 recorded in the vicinity of Phaistos (Ghilardi et al., 2018); however, this event was not  
276 accurately dated and was poorly characterized from a sedimentological perspective. In the  
277 present study, we refine the chronology of landscape evolution, erosion and sedimentation  
278 patterns to provide a greater understanding of this region.

279

#### 280 **4. Vegetation of Crete from the Early First Millennium BCE to the mid-1<sup>st</sup>** 281 **millennium CE**

282

283 In Crete, a small number of sites allow the reconstruction of the Holocene vegetation  
284 history based on pollen analyses (see Figure 1 for locations). The relevant research has been  
285 conducted over the last few decades and mainly focuses on the interval spanning the  
286 Neolithic, the Minoan period and the Post-Roman period; there is a hiatus between the post-  
287 Minoan period and Roman times. The sampling sites used for vegetation reconstruction are  
288 situated near or on the coast as well as inland: e.g., Aghia Galini (South Central Crete;  
289 Bottema, 1980; Figure 1), the Akrotiri Peninsula (Moody et al., 1996; Figure 1), Malia (North  
290 Central Crete, Lespez et al., 2003; Figure 1) and Palaikastro (Eastern Crete; Cañellas-Boltà et  
291 al., 2018; Figure 1). Some of the pollen sequences obtained from inland are from lake  
292 environments (see Bottema and Sarpaki, 2003 for Kournas Lake; Figure 1 and Ghosn et al.,



293 2010 for Omalos pond) in addition to the palaeolake investigated here (western Messara  
294 Plain; Ghilardi et al., 2018), and some include peat deposits (Asi Gonia; Atherden and Hall,  
295 1999; Jouffroy-Bapicot et al., 2016; Figure 1). However, despite their geoarchaeological  
296 value, few of these studies attempt to reconstruct the vegetation history of Crete from the  
297 Early Iron Age to the Byzantine epoch.

298 The pollen reconstruction of Bottema and Sarpaki (2003) indicates that between 3500  
299 and 1000 BP, around Kournas Lake (North Central Crete; Figure 1) an open, forested  
300 landscape was present, dominated by deciduous and evergreen oaks. This study also reveals a  
301 decrease in *Olea* (olive) slightly after the Santorini eruption (*ca.* 1630 BCE; however, the  
302 chronostratigraphy remains uncertain due to the lack of radiocarbon dating) from *ca.* 20% to  
303 less than 5% (Bottema and Sarpaki, 2003). Similarly, in a pollen diagram from Delphinos,  
304 *Olea* is poorly represented; it decreases to 6.1% just after the Santorini tephra layer, and  
305 finally reaches 2.8% during the 1<sup>st</sup> millennium BCE (Bottema and Sarpaki, 2003). To explain  
306 this phenomenon, Bottema and Sarpaki hypothesize that olive trees were felled after the  
307 Santorini eruption because of the reduced demand for olive oil. However, it appears that olive  
308 cultivation was still important during Late Minoan times elsewhere in Crete, such as around  
309 Phaistos (Ghilardi et al., 2018). Indeed, a pollen sequence obtained in the vicinity of the  
310 Minoan Palace (Ghilardi et al., 2018) reveals that *Olea* is highly represented from the 12<sup>th</sup>  
311 Cent. BCE until the 8<sup>th</sup> Cent. BCE, with percentages ranging generally from 10-40% with  
312 highest values (20-45%) during the Late Post-Palatial and Sub-Minoan periods (12<sup>th</sup> to 11<sup>th</sup>  
313 Cent. BCE). Such high values are only reported in Crete for Late Neolithic and Early Minoan  
314 times in the Akrotiri Peninsula (western Crete, Moody et al., 1996), at Istron (central Crete;  
315 Theodorakopoulou et al., 2012) and at Palaikastro (eastern Crete; Cañellas-Boltà et al., 2018).  
316 Notably, despite the demise of the Minoan Kingdom, *Olea* was still cultivated in the area of  
317 Phaistos during the later cultural periods, such as the Proto-Geometric and Geometric (10<sup>th</sup>-  
318 8<sup>th</sup> Cent. BCE), with a slightly lower representation than during the Late Post-Palatial and  
319 Minoan periods (Ghilardi et al., 2018). Nevertheless, the high representation of *Olea* in the  
320 vicinity of Phaistos can be explained by its expansion during a period of increasing aridity,  
321 corresponding to the 3.2 kyr BP RCC event, and in the context of socio-political instability  
322 following the demise of the Minoan Kingdom. Shortly after the early stages of the Geometric  
323 period (8<sup>th</sup> cent. BCE), the representation of *Olea* in the vicinity of Phaistos decreased to a  
324 low level (<10%), suggesting a substantial change in the vegetation landscape. However,  
325 neither for the Kournas Lake sequence (Bottema and Sarpaki, 2003) nor for the Phaistos  
326 sequence (Ghilardi et al., 2018), is a well-dated pollen record available for the period  
327 covering the Archaic, Classical and Hellenistic periods.

328 The only pollen data, with a robust chronostratigraphy and covering the first half of  
329 the 1<sup>st</sup> millennium CE, is from the Asi Gonia peat deposit (north central west Crete; Jouffroy-  
330 Bapicot et al., 2016). The pollen record covers the period from early Roman times onward.  
331 For the period of 0-300 CE, the vegetation was dominated by *Quercus coccifera*-type (50-  
332 80% of TPL) followed by *Erica*-type (up to 30% of the TPL) and *Cistus*-type. Nevertheless,  
333 *Olea* is poorly represented (1-5%) with only a single peak at *ca.* 5% around 150 CE (this date  
334 also corresponds to the peak of the warm and wet Roman Optimum). A similar situation for  
335 *Olea* is reported during the early phases of the Byzantine period. Notably, *Vitis* is not

336 identified during Roman times, while there is a clear record during early Byzantine times  
337 (Jouffroy-Bapicot et al., 2016).

338 A challenging task is to reveal the vegetation configuration during the time interval  
339 from the 8<sup>th</sup> cent. BCE to the 4<sup>th</sup> Cent. CE and to evaluate the significance of cultivated  
340 species such as *Olea* and *Vitis* within the vegetation record. In general, *Vitis* is barely  
341 represented in all pollen sequences obtained in Crete, in particular those spanning Neolithic  
342 times to the Late Minoan period.

343

## 344 5. Methods

345

346 The boreholes discussed herein are all situated at the foot of ancient Phaistos (Figure 2)  
347 with the exact geographic coordinates reported in Ghilardi et al. (2018). For the present  
348 study, several cores were reinvestigated, in particular their uppermost stratigraphy (cores  
349 Phaistos (Ph) 2, 3, 4, 5, 6 and 9); detailed descriptions of each can be found in Ghilardi et al.  
350 (2018).

351 The new laboratory work comprised mollusc identification for cores Ph 1, 2 and 6 and  
352 laser granulometry of the sediments. In total, 148 samples were analyzed using the protocol  
353 described in Ghilardi et al. (2008 and 2012). The deposits were classified using two  
354 granulometric parameters, the coarsest percentile (C) and the median grain-size (M). These  
355 data were extracted from the cumulative grain-size distribution curves following the method  
356 of Passega (1957 and 1964) and refined by Bravard and Peiry (1999) for floodplain deposits.  
357 C and M for the alluvial deposits are plotted on a log–log scale and the C–M pattern (Fig. 5)  
358 is used to evaluate the processes and dynamics of sediment transport and deposition.

359 Molluscan samples were identified with the help of general atlases for Europe and  
360 checklists available for Greece, more specifically Crete (Bank, 2006; Kerney & Cameron,  
361 1999; Locard, 1893; Tachet et al., 2000; Welter-Schultze, 2012). Identification was in most  
362 cases pushed to species level.

363 Pollen samples from cores Ph 2, 3 and 9 were processed following standard methods  
364 (Goeury and de Beaulieu, 1979; Girard and Renault-Miskovsky, 1969): treatment with HCL,  
365 NaOH, flotation in dense Thoulet liquor, HF and final mounting in glycerine. Pollen grains of  
366 terrestrial taxa were identified using an Olympus Bx43 microscope fitted with ×10 oculars  
367 and ×40/60 objectives. Hygrophytes (Cyperaceae, *Typha latifolia* and *Typha/Sparganium*)  
368 were excluded from the pollen sum to avoid over-representation by local taxa. Due to the  
369 poor quality of pollen preservation, only 10 samples provided reliable results and were  
370 plotted in a pollen diagram covering the period 1350 cal. BCE to 800 CE (Figure 6), with a  
371 focus on the interval ranging from the Archaic period (8<sup>th</sup> Cent. BCE) to Late Byzantine  
372 times (ca. 8<sup>th</sup> Cent. CE).

373 In addition, eight new radiocarbon dates (Table 1) from samples of organic matter  
374 were obtained from the radiocarbon dating laboratory in Poznan (Poland), with calibration  
375 provided by Calib 7.1.0 software (Stuiver and Reimer, 1993; Reimer et al., 2013; Table 1).

376

## 377 6. Results

378

### 379 6.1. Chronostratigraphy and mollusc identification

380 In Ghilardi et al. (2018), the main sedimentary units and environments for the period from ca.  
381 2000 to 800 cal. BCE were characterized using diatoms and pollens, as well as laser  
382 granulometry and magnetic susceptibility analyses. This included the lake sediments of Unit  
383 L (identified in the lowermost part of cores Ph 2, 3 (Figure 3) and 9 (Figure 4). In addition, a  
384 robust chronostratigraphy was obtained for Unit L (Ghilardi et al., 2018; Figures 3 and 4).

385 In this study, we use the same cores as described by Ghilardi et al. (2018) in order to  
386 provide a more detailed analysis of the sedimentary units in the uppermost part, dated from  
387 ca. 800 cal. BCE to 600 cal. CE. The units are described below.

388 - Unit S1 was identified in cores Ph 2, 3 and 6 (Figure 3). It consisted of gray silty  
389 clays with a mollusk assemblage typical of freshwater environments: *Planorbis planorbis*,  
390 *Planorbis corneus*, *Viviparus viviparus*, *Oxyloma elegans* and *Myxas glutinosa*. The last  
391 species lives mainly in still and clear freshwater in rivers, lakes and swamps. The age of  
392 deposition of this swampland sequence ranges from the 10<sup>th</sup>-9<sup>th</sup> Cent. BCE (cores Ph 2 and 6)  
393 to 537-203 cal. BCE (median probability of 394 cal. BCE; Reimer et al., 2013) in core Ph 2;  
394 and 542-381 cal. BCE (median probability of 446 cal. BCE after Stuiver and Reimer, 1993)  
395 in core Ph 3. In the uppermost part of Unit S1 in core Ph 6, the mean and modal grain sizes  
396 gradually increased: for Unit S1, the mode was generally around 5-10  $\mu\text{m}$ , while in the  
397 uppermost part it increased to 30-40  $\mu\text{m}$ , reflecting a detrital input from a source closeby.

398 - Unit F1 was observed in all cores and was composed of yellow to white  
399 heterogeneous material, ranging from fine sands to pebbles. It can be divided in two distinct  
400 parts. Sub-Unit F1a consisted of coarse deposits, a mixture of fine to coarse sands with  
401 gravels and rounded pebbles, and is only recorded in the lowermost part of cores Ph 4 and 5.  
402 Sub-Unit F1b comprised finer deposits (fine to medium yellow sands) which were identified  
403 in cores Ph 2, 3, 4 and 6. However, the lack of organic material in F1b prevented the robust  
404 dating of this subunit. Nevertheless, the dating of the uppermost part of Unit S1 and the  
405 lowermost part of Unit S3 (360-169 cal. BCE) provides an approximate age estimate of ca.  
406 450-400 cal. BCE. Notably, the complete thickness of unit F1 was not recorded and further  
407 coring is needed to identify this.

408 - Unit F2 was recorded in all cores and consisted of coarse silts to fine sands (the  
409 mode ranges from 50-100  $\mu\text{m}$ ). However, the deposits are not homogeneous and three minor  
410 peaks in mean grain-size are evident. The organic matter content was low (2-3%) and the  
411 carbonate content was around 20%. Absolute dating of the uppermost part of Unit F2 was  
412 only possible for core Ph 3 and 5, where the uppermost part of Unit F2 was dated to 379-285  
413 BCE (core Ph 3) while the lowermost part of unit S3 in core Ph 5 (overlying unit F2) was  
414 dated to 360-169 cal. BCE (median probability of 286 cal. BCE; Stuiver and Reimer, 1993).  
415 Combining the radiocarbon dating results for the uppermost part of Units S1 and F2 and the  
416 lowermost part of Unit S2 enables the robust dating of Units F1 and F2 (from ca. 450-400 CE  
417 to 250-200 BCE). Since Unit F1b was short in cores Ph 2, 3 and 6 (0.2-0.5 m, mainly  
418 consisting of fine sands) and directly overlies Unit S1, its age can be estimated at around 450-  
419 400 BCE. Unit F2 was about 1.5-2.0-m thick and despite its fine grain size, it was deposited  
420 rapidly from ca. 400 to 200 BCE.

421 - Unit S2 overlay Unit F2 and consisted of gray to white clay. The organic matter  
422 content was around 3-5% while the carbonate content was similar to that of Unit S1,  
423 generally around 20%. In general, the sedimentological parameters are very similar to Unit

424 S1. Notably, a peat deposit was recorded in cores Ph 2, 3, 5 and 6 with its thickness ranging  
425 from 0.10 m (core Ph 6) to 0.40 m (core Ph 2), indicating a gradually increasing trend from  
426 east to west across the Phaistos lowlands. The mollusc identification reveals the presence of  
427 freshwater species (the same as described for Unit S1): e.g. *Planorbis planorbis*, *Planorbis*  
428 *corneus*, *Viviparus viviparus* and *Pisidium* sp. (only recorded in the peat deposits). Only  
429 *Thebana pisana* (Helicidae) and *Rumina decollata* (Subulinidae), associated with terrestrial  
430 environments, are identified in the lowermost part of Unit S1. In core Ph 2, the peat deposit  
431 has been accurately dated to between 207-52 cal. BCE (median probability of 153 cal. BCE)  
432 for its initial development, and an age of 715-940 cal. CE for its final stages (median  
433 probability of 824 cal. CE). The central part of the peat is dated 410-546 CE. Notably, at the  
434 base of Unit S2 in core Ph 2, a fragment of mortar (white in colour and 0.20 m thick), was  
435 identified. It cannot be linked to any fluvial sedimentation and is likely to be of  
436 anthropogenic origin. Between Units F2 and S2, in core Ph 6, colluvium was identified, with  
437 a mean grain-size of ~80 µm and a multimodal distribution indicative of poor sorting. This  
438 stratum was about 30-cm thick, but is not accurately dated. However, it occurs in the same  
439 stratigraphic position as the mortar found in core Ph 2, located 85 m further east. Due to the  
440 proximity of the village of Aghios Ioannis, where Hellenistic archaeological structures have  
441 been uncovered, this mortar and associated sedimentation may have been anthropogenically  
442 influenced. A large piece of charcoal found directly overlying the mortar provides an age  
443 estimate of 107 BCE-129 CE, corresponding to early Roman times.

444 - Unit S3 was only identified in cores Ph 4 and 5. It consisted of white to yellow  
445 compact clay with intercalated layers of silt and fine yellow sand. Unit S3 has almost the  
446 same sedimentary characteristics as Unit S2. Whilst the basal part of core Ph 5 core has been  
447 dated to the Hellenistic period (360-169 cal. BC), no dating was possible of the central and  
448 uppermost parts of the unit due to the paucity of organic matter.

449

## 450 6.2. CM diagram

451 Grain-size classification based on the CM diagram has enabled the identification of five  
452 distinct sedimentary deposits (Figure 5), which are described below.

453

### 454 6.2.1. Group (A)

455 This group is the coarsest, indicating relatively high energy fluvial deposition  
456 (M=400-600 µm; C=1230-2000 µm). The sediments were composed of coarse sands and  
457 gravels, transported during a phase of high energy floods and probably transported mainly by  
458 rolling as bedload. Group A forms a cluster with a distribution parallel to the CM line,  
459 indicating that turbulent flow was able to remove the finest sediments in suspension (Passega,  
460 1967; Houbrechts et al., 2013). These detrital sediments are mainly recorded in Unit F1 from  
461 cores Ph 4 and 5 and they indicate a former channel of the Gria Saita river.

462

### 463 6.2.2. Group (B)

464 This group again corresponds to Unit F1 (fluvial sediments) from cores Ph 4 and 5  
465 (belonging to the upper F1b and lower F1a sub-units), both from the central part of the  
466 alluvial plain, a short distance from the Gria Saita river. The group is composed of fine to

467 medium sands, which were transported by rolling and bottom suspension processes (M=140-  
468 380  $\mu\text{m}$ ; C=1080-1550  $\mu\text{m}$ ), indicating transport along the bed of the river.

469

#### 470 6.2.3. *Groups (C) and (C')*

471 Group (C) is distributed along the CM line, representing varying proportions of the  
472 coarse and medium-grained deposits and indicating materials moved in graded suspension  
473 (M=50-170  $\mu\text{m}$ ; C=150-890  $\mu\text{m}$ ). All of the analyzed samples are between 31 and 32 m  
474 a.m.s.l. and were present in three cores. The sediments comprise fine and medium sands,  
475 mainly from Unit F1 (core Ph 2) and Unit S2 (core Ph 5). They are interpreted as sand bar  
476 deposits on the edge of a riverbed, or sheet deposits in a proximal floodplain setting,  
477 deposited during a gradual decrease of turbulent flow. The light-gray rectangle, situated  
478 above group C, denotes an additional group C', which also shows a parallel trend with groups  
479 C and the CM line but which contains coarser particles. These sediments are poorly-sorted  
480 and were deposited during a phase of aggradation corresponding to highly turbid flows from  
481 an ancient channel of the Gria Saita River, reaching cores Ph 3, 4 and 5 during phases S3 and  
482 S2.

483

#### 484 6.2.4. *Group (D)*

485 This group comprises most of the samples (62 in total) and shows the predominance  
486 of a uniform suspension during a long period of alluvial accumulation in the western Messara  
487 Plain (M=8-50  $\mu\text{m}$ ; C=140-400  $\mu\text{m}$ ). The sediments are floodplain sediments representing  
488 relatively low flow and turbulent flow velocities. These silty and fine sandy sediments were  
489 deposited during the overbank flooding of the Gria Saita River at different times, even though  
490 they are mainly composed of sediments from Unit F2, which is the thickest sedimentary  
491 layer.

492

#### 493 6.2.5. *Group (E)*

494 This group is divided into two subgroups (Ea and Eb), which respectively represent  
495 sediments with and without the characteristics of decantation processes with additional low  
496 energy alluvial inputs: Ea (M=3.5-14  $\mu\text{m}$ ; C=48-160  $\mu\text{m}$ ) and Eb (M=3.5-10  $\mu\text{m}$ ; C=18-  
497 60  $\mu\text{m}$ ). The sediments of subgroup Ea are present across the entire period of study, while  
498 those of subgroup Eb mainly comprise Unit S1. These deposits consist predominantly of  
499 samples from cores Ph 2, 3 and 6, and indicate an environment relatively distant from the  
500 main channel. The Ea subgroup, recorded in Unit S2 and as topsoil in cores Ph 2, 3 and 6,  
501 indicates predominantly low energy deposition with some higher-energy fluvial inputs.  
502 However, in core Ph 2, some of the coarsest grains correspond to post-depositional carbonate  
503 precipitation (concretions) derived from the progressive illuviation of Unit S2. Subgroup Eb  
504 represent decantation deposits lacking fine fluvial sand input and can be interpreted as distal  
505 deposits in the ancient lake (Ghilardi et al., 2018).

506

### 507 6.3. *Pollen analysis*

508

#### 509 6.3.1. *Core Ph 9*

510 The pollen record from core Ph 9 (Fig. 6a) comes from a phase of limnic clay  
511 deposition, dated to Late Minoan times. It provides information about vegetation composition  
512 and ecological conditions at a local scale. In most of the samples, NAP were dominant, with  
513 high percentages of grassland indicators, mainly Poaceae, with Asteraceae liguliflorae in the  
514 lowermost samples (490-550 cm, Figure 6a), and suggesting an open landscape during the  
515 whole period. Sclerophyllous taxa predominate amongst the arboreal vegetation, with high  
516 values of *Olea* and the presence of *Quercus ilex-coccifera*, *Phillyrea* and *Pinus*, which are  
517 characteristic trees in thermo-Mediterranean landscapes. The scarce values of mesic  
518 vegetation (only documented in the stratigraphically lowest sample) suggest a phase of  
519 dryness during the last centuries of the 2<sup>nd</sup> millennium BCE. At a local scale there is a clear  
520 vegetation change between samples at 490 cm and 470 cm, with the transition from the  
521 dominance of Cyperaceae (550-490 cm; ca. 1345-1162 cal BCE) to high values of  
522 *Typha/Sparganium* (470-430 cm; ca. 1102-982 cal BCE). This could be due to changes in  
523 water availability, with probable seasonal episodes of desiccation from 490 cm onwards, as  
524 shown by the high values of *Pseudoschizaea* (Pantaleón-Cano et al., 1996). The occurrence in  
525 these samples of fern spores (monoletes, *Isoetes*, *Ophioglossum*-t, Fig. 6a and type UAB-46)  
526 also points to subaerial conditions (Revelles et al., 2016).

527

### 528 6.3.2. Core Ph 3

529 In core Ph 3, the samples from Unit S1 (520-490 cm; ca. 713-524 cal BCE) yielded  
530 reliable pollen spectra. The pollen diagram (Figure 6b) indicates an open landscape (AP  
531 around 20-30%) dominated by grassland, mainly with Asteraceae liguliflorae, and with *Olea*  
532 and *Pinus* among the tree types. The presence of the pollen of hygrophytes (Cyperaceae and  
533 *Typha/Sparganium*) suggests the existence of swampland at the local scale. Nevertheless, the  
534 low values of hygrophytes, compared with the results for Ph 2, suggests either a dry phase or  
535 that core Ph 3 reflects the signal of a marginal area of the swampland concentrated around Ph  
536 2 (deeper). Decreasing values of *Olea* in Ph 3 (ca. 713-524 cal BCE) complete the trend of a  
537 decline in *Olea* that started in Ph 2-580 cm (ca. 700 cal BCE, Ghilardi et al., 2018) and  
538 culminated in Ph 2-178/135 cm (see below).

539

### 540 6.3.3. Core Ph 2

541 In core Ph 2, only samples from the top part (178-135 cm; ca. 464-797 cal CE)  
542 contained reasonably well-preserved pollen (Figure 6c). The samples from 835-520 cm  
543 contained very poorly preserved pollen and vegetation reconstruction was not possible for  
544 this section. The pollen results from P2 (Figure 6c) show an open landscape (AP values <15-  
545 20%). Among the tree pollen types, *Pinus* predominates with *Corylus*, *Quercus ilex-*  
546 *coccifera*, *Olea* and *Pistacia* also represented. The pollen spectra of core Ph 2 indicate  
547 grassland, mainly composed of Asteraceae liguliflorae. The existence of swampland at a local  
548 scale is attested to by high values of *Typha/Sparganium* and the occurrence of Cyperaceae  
549 and *Spirogyra* (freshwater algae). High values of *Pseudoschizaea* suggest episodes of  
550 desiccation, which were probably seasonally. The pollen results are consistent with previous  
551 studies of this core (section 700-580 cm) (Ghilardi et al., 2018), as in the predominance of  
552 Asteraceae and Poaceae and high values of hygrophyte plants.

553

## 554 7. Discussion

### 555 7.1. *Palaeogeographic reconstruction*

557 The sedimentological data, mollusc identifications, and results of new radiocarbon age  
558 estimates presented here allow the palaeogeographic reconstruction of the landscape around  
559 ancient Phaistos for the period covering the 8<sup>th</sup> Cent. BCE until the 6<sup>th</sup> Cent. CE.

560 - Previously published results (Ghilardi et al., 2018) revealed that during the Proto-  
561 Geometric and Geometric periods, swampland still existed at the foot of Phaistos, in the  
562 context of increasing aridity following the 3.2 kyr BP RCC event. In the present study, we  
563 dated the uppermost part of the wetland sequence and the radiocarbon dates obtained for  
564 cores Ph 2 and 3 reveal ages of 537-203 cal. BCE ( $2\sigma$ ) and 542-381 cal. BCE ( $2\sigma$ ),  
565 respectively. Thus, the last phase of the swampland environment can be reasonably assigned  
566 to the 6<sup>th</sup> and 5<sup>th</sup> Cent. BCE (Late Archaic to Classical period). The exact spatial extent of the  
567 landform feature remains uncertain due to the lack of additional records for boreholes located  
568 further east (cores Ph 4 and 5). However, Ghilardi et al. (2018) revealed that 750 m eastward,  
569 the swampland (Unit S1 described above) still existed for a short interval after 896-791 cal.  
570 BCE, probably until the Classical period. It is likely that the swampland (Unit S1) covered  
571 most of the area during the Geometric, Orientalizing, Archaic and Protoclassical periods,  
572 close to the course of the modern Gria Saita River.

573 - During the 5<sup>th</sup> and 4<sup>th</sup> Cent. BCE (the Classical period), the input of detrital material is  
574 clearly identified in cores Ph 2, 3, 4, 5 and 6 (and it was also identified in the easternmost part  
575 of the study area: see Ghilardi et al., 2018). The first stages of this detrital input by fluvial  
576 processes is well dated in cores Ph 2 and 3 and clearly corresponds with the Classical period.  
577 This phase of deposition did not exceed two centuries, according to the dating of the  
578 lowermost part of the swampland unit S3: to 366-166 cal. BCE (from the Late Classical to  
579 the Hellenistic period) in core Ph 5, as well as in core Ph 2 where a similar age can be  
580 inferred. Sedimentological data clearly indicate that the first phase of this coarse detrital input  
581 was associated with high energy processes, probably dating from the 5<sup>th</sup> Cent. BCE. A second  
582 phase of floodplain deposition (overbank alluviation), dated from the 4<sup>th</sup> Cent. BCE and  
583 characterized the sedimentation pattern across the Phaistos lowlands until the Late Hellenistic  
584 period. Finally, the results enable us to date, to the Classical period, the early stages of  
585 activity associated with of the Gria Saita River in the lowlands of Phaistos. It is possible that  
586 at this time the Gria Saita River was the main drainage artery to the Tymbaki Gulf and can be  
587 considered as a palaeochannel and forerunner of the Geropotamos River, which today flows  
588 further north (Rossi et al., 2013 and 2018; Amato et al., 2014).

589 In the nearby Anapodaris catchment, where human occupation was relatively limited  
590 during the entire 1<sup>st</sup> millennium BCE, compared to the western Messara Plain (area of  
591 Phaistos), Macklin et al. (2010) only recorded phases of incision with no major episodes of  
592 aggradation. Our results clearly differ from the fluvial history of the Anapodaris drainage  
593 basin as recorded by Macklin et al. (2010), but they agree well with previous research  
594 conducted on the Gria Saita River (Pope, 2004) and in the Ayiofarango valley (Doe and  
595 Homes, 1977) that highlight an interval of high energy fluvial activity during the Hellenistic  
596 period. This last period corresponds to a peak in cold and dry conditions (Moody, 2016) in  
597 the context of increasing temperatures that commenced around the 1<sup>st</sup> millennium BCE. In

598 southern Greece this was followed by an abrupt return to wet conditions during the 5<sup>th</sup> Cent.  
599 BCE (Finné et al., 2014). Around Lake Kournas, recent research has indicated a major peak  
600 in flooding at ~450 cal. BCE (Vanniére and Jouffroy-Bapicot, unpublished data cited in  
601 Walsh et al., in press) and it is probably the highest energy event recorded during the entire  
602 Holocene (Walsh et al., in press). At ~500 BCE in the Peloponnesus, a flood event is also  
603 clearly recorded at Kapsia Cave (Finné et al., 2014) and similar high-energy deposition is  
604 observed elsewhere in the central Peloponessus (Unkel et al., 2014).  
605 Following the interval of detrital deposition that started during the Classical period and lasted  
606 until the Hellenistic period, there was a new phase of swampland development to the west,  
607 together with peat accumulation, which commenced during Early Roman times and lasted  
608 until the 8<sup>th</sup> Cent. CE (confirmed by the high values of *Typha-Sparganium* in Ph 2 from 464-  
609 797 cal CE). The peat sequence is only recorded in the cores drilled in the westernmost part  
610 of the Phaistos lowlands. In the central part (cores Ph 4 and 5) swamps are affected by  
611 occasional detrital input, as confirmed by the granulometry data and the CM diagram. It is  
612 probable that due to increased humidity at a local scale, shallow ponds developed. At a  
613 regional level, the predominance of sclerophyllous trees among the scarce arboreal vegetation  
614 suggests dry Mediterranean climate conditions. The RO, which is characterized by warm and  
615 humid conditions starting from the 1<sup>st</sup> Cent. BCE and lasting until the 2<sup>nd</sup> to the 3<sup>rd</sup> Cent. CE,  
616 can be invoked to explain peat formation.

617 During the Early byzantine period, the landscape remained stable and the swampland,  
618 its associated peats and other floodplain deposits completely dried out, shaping the  
619 subsequent morphology of the Phaistos lowlands. This scenario is in good agreement with the  
620 interpretation of Ghilardi et al. (2018) concerning the landscape configuration of the lowlands  
621 situated around Phaistos during the last millennium.

622

## 623 7.2. *Vegetation history during the Archaic and Classical periods and Late Roman* 624 *to Early Byzantine times*

625

626 The pollen results obtained for cores Ph 2, 3 and 9 (Figure 7) reveal an open forested  
627 landscape with the predominance of *Olea*, *Pinus* and *Quercus ilex-coccifera* among the  
628 arboreal taxa. This predominance of sclerophyllous trees at a regional scale, and the very low  
629 percentages of deciduous woodland (*Quercus*, *Corylus*, *Carpinus*, *Alnus* cf. *suaveolens* and  
630 *Salix*), suggest a Mediterranean climate with marked seasonality and pronounced summer  
631 drought. Ruderal herbs (Poaceae and Asteraceae) are the major component in a highly  
632 anthropogenic landscape and, at local scale, hygrophyte communities (Cyperaceae and  
633 *Typha/Sparganium*) dominate in phases of shallow lake and freshwater swamp deposition.  
634 Despite the lake decline associated with drought conditions during the 3.2 cal ka BP event,  
635 swampland would have persisted in the lowlands until the early stages of the 5<sup>th</sup> century  
636 BCE, although there were seasonal droughts as evidenced by high values of fern spores and  
637 *Pseudoschizaea*.

638 The weak representation of *Pinus* indicates its presence at a regional scale, probably  
639 in the uplands of the Ida and Asteroussia mountain ranges, rather than in the immediate  
640 vicinity of Phaistos. Notably, from ca. 700 to 400 cal. BCE, *Olea* representation continuously  
641 decreases with a sudden fall around 650-600 cal. BCE. This decrease coincides with a decline



642 in sclerophyllous trees and a short period of expansion of mesic vegetation, suggesting wetter  
643 climatic conditions (Figure 8); this represents the final maximum occurrence of mesic  
644 vegetation before the drying up of the swampland due to increasing aridity. Conversely, *Vitis*  
645 is represented for the first time ca. 650-600 cal. BCE and it is also identified during the mid-  
646 5<sup>th</sup> cent. BCE, probably reflecting either its cultivation, or perhaps associated with an increase  
647 in mesic vegetation (*Vitis vinifera* subsp. *sylvestris* could have developed along riparian  
648 environments). Due to the poor pollen preservation in the sediment cores, we have no  
649 information about the vegetation composition for the time interval from the Hellenistic period  
650 through Roman times. The poor pollen preservation may reflect drier conditions at a local  
651 scale, consistent with a cool and dryer climate during the 3<sup>rd</sup> and 2<sup>nd</sup> centuries BCE (Moody,  
652 2016). During the Early Byzantine period, the vegetation around Phaistos was dominated by  
653 herbs, and a much-reduced forested landscape is attested to by the presence of pine on the  
654 slopes of the Ida and Asteroussia mountain ranges. Cultivated plants are scarcely represented  
655 at this time: *Olea* was almost absent during the Early Byzantine period, while a low  
656 representation of *Vitis* is attested to. The period covering the Early Byzantine period has the  
657 lowest percentage of cultivated plants around Phaistos. In northern Crete (the Asi gonia peat  
658 bog sequence), the pollen study of Jouffroy-Bapicot et al. (2016) also revealed the very low  
659 representation of *Olea* from Roman to Late Byzantine times. Meanwhile, in southern Italy  
660 (Apulia, Campania and Sicily), a similar situation was reported with a sharp decrease in *Olea*  
661 following a peak around the 1<sup>st</sup> millennium BCE (Sadori and Narcisi, 2001; Di Rita and  
662 Magri, 2009). From ca. 500 BCE to 500 CE, *Olea* is poorly represented in most of the pollen  
663 diagrams from southern Italy (Grüger and Thulen, 1998; Di Rita and Magri, 2009) and both  
664 climatic (increasing aridity) and anthropogenic factors (selective exploitation and  
665 management of wild olive trees for fruit production) may explain the surprisingly low  
666 representation of *Olea* during Roman times in southern Italy (Di Rita and Magri, 2009).  
667 In summary, the pollen results for the Phaistos area presented here (Figure 7), together with  
668 those of Ghilardi et al. (2018), indicate that *Olea* cultivation was linked to warm and dry  
669 climatic conditions, combined with shifts in social and economic strategies. This is because at  
670 around the 3.2 kyr BP RCC dry event, *Olea* was dominant in the pollen spectra, with high  
671 percentages (10-40%) only recorded during Late Neolithic times and the Early Minoan period  
672 elsewhere in Crete. The peak in representation around 3.2-2.8 kyr BP is clearly related to a  
673 period of warm, dry conditions (the 3.2 kyr BP RCC event) which favoured the growth of  
674 *Olea*. Nevertheless, the high percentages of *Olea* could also be interpreted as the legacy of  
675 olive cultivation during former periods (i.e. the Minoan period) and the continuation of  
676 favourable climatic conditions maintained the predominance of *Olea* in the landscape. From a  
677 social and cultural perspective, this period was characterized by high political instability  
678 following the demise of the Minoan kingdom and potential conflicts with the so called Sea  
679 People (Cline, 2014). Conversely, during the subsequent periods, ranging from the Early  
680 Archaic period to Early Byzantine times, *Olea* is almost absent from our pollen records  
681 (Figure 8), as is also the case in northern Crete (Jouffroy Bapicot et al., 2016). This may  
682 correspond to a long period of cold and dry conditions in south central Crete. Such conditions  
683 are clearly unfavourable for the development of olive cultivation, as it is also suggested for  
684 southern Italy (Di Rita and Magri, 2009). Thus, the increasing aridification affecting the

685 Mediterranean basin during the Late Holocene could have caused the decline of *Olea* in  
686 Crete, as well as much of the forest vegetation.

687 The occurrence of *Vitis* in our pollen records, only attested to after the 8<sup>th</sup> Cent. BCE (Early  
688 Archaic period) and until at least the Early Byzantine period, could reflect its cultivated form,  
689 probably imported from the Greek mainland or from elsewhere in Crete, during the Early  
690 Archaic period. As was the case for *Olea*, due to unfavourable climatic conditions (cold and  
691 dry), vineyard development could have been limited around Phaistos. The presence of *Vitis*  
692 may also reflect the riparian form associated with the development of the Gria Saita River,  
693 which commenced during Early Archaic times.

694

695 7.3. *On the possible origin of the alluvial deposition observed during the second*  
696 *half of the 1<sup>st</sup> millennium BCE (Classical and Hellenistic periods)*

697

698 The phase of significant detrital input noted in the sedimentological record and dated  
699 from the Classical and the early Hellenistic periods could be directly associated with regional  
700 climatic change. Indeed, it correlates well with regional alluvial dynamics related to a short  
701 phase of intense wet climate that lasted for a maximum of one to two centuries in southern  
702 Greece (Kapsia and Alepotrypa caves in Peloponnesus) around the mid-1<sup>st</sup> millennium BCE  
703 (Finné et al., 2011 and 2014; Boyd, 2015; Figure 8). Climate control on river dynamics has  
704 been observed elsewhere around Crete, such as in the Peloponnesus during the early stages of  
705 the Classical period (Finné et al., 2014; Unkel et al., 2014; Figure 8). Moreover, arguments  
706 for a regional climatic control on fluvial dynamics are reinforced by evidence for this alluvial  
707 event recorded by multiple rivers (e.g. in the Ayiofarango valley; Doe and Homes, 1977 and  
708 the western Messara; Pope et al., 2004; Figure 8) and lake deposits (Vannière and Jouffroy-  
709 Bapicot, unpublished material cited in Walsh et al., in press).

710 A direct human origin of this sudden detrital input cannot be excluded, even if there is  
711 neither archaeological or documentary evidence for events. The swampland could have been  
712 drained in order to reclaim the area for agriculture and to allow the flourishing settlement of  
713 Gortyn to gain access to the Tymbaki Gulf; and in doing so, a river diversion could have been  
714 engineered. In the Aegean, there are examples of anthropogenic attempts to modify the  
715 courses of rivers: in central south Euboea island, the courses of small streams were diverted  
716 and channelized during the 7<sup>th</sup> Cent. BCE in order to aid the development of the city state of  
717 Eretria (Krause, 1985). Indirectly, humans may have changed the catchment hydrology and  
718 could be linked to the major changes in land use associated to global climatic cooling in the  
719 1<sup>st</sup> millennium BCE. Our pollen results, combined with those previously published in  
720 Ghilardi et al. (2018), clearly reveal that around Phaistos cultivated plants such as *Olea* were  
721 present, within the context of an open forested landscape, from the Late Minoan period to  
722 Geometric times (Figures 6a and 8). The climatic conditions of this period are characterized  
723 by the 3.2 kyr BP dry event that lasted until ca. 700 BCE with a pronounced peak in aridity  
724 observed around 1100 BCE. At the end of Late Geometric times (ca. 700 BCE), colder  
725 conditions prevailed and there was an abrupt decrease in the representation of cultivated  
726 plants (such as *Olea*, together with only the limited presence of forest taxa; Figure 8). At this  
727 time, the slopes were poorly forested and less cultivated, increasing the risk of soil erosion  
728 associated with precipitation and runoff. In the Mid-1<sup>st</sup> millennium BCE there was an abrupt

729 return to wetter conditions in southern Greece (Finné et al., 2011 and 2014; Figure 8), which  
730 triggered intense runoff and erosion around Phaistos and probably within the whole of the  
731 western Messara Plain. The development of the Gria Saita River (a possible former course of  
732 the Geropotamos R.) was important to landscape evolution and detrital sediment input since it  
733 resulted in a short but intense phase of alluviation during a period of wetter climatic  
734 conditions around the mid-1<sup>st</sup> millennium BCE.

735 Local tectonic activity is another possible cause of the abrupt detrital input. According to  
736 Fytrolakis et al. (2005), western Messara is subject to active faulting resulting in violent  
737 earthquakes, some of which were recorded during the Prehistorical and historical periods  
738 (Monaco and Tortorici, 2004). Several studies conducted along the shoreline of Crete have  
739 revealed evidence for uplift related to a number of seismic events (Pirazzoli et al., 1992). One  
740 of the most studied seismic events, the “Early Byzantine Tectonic Paroxysm” (EBTP),  
741 occurred in *ca.* 365 CE (maximum uplift of 9 m associated with magnitude  $M > 8.5$ ) west of  
742 Crete and resulted in the general uplift of western Crete (Pirazzoli et al., 1996). Although  
743 detailed and -accurately- dated coastal evidence for this violent seismic event is available  
744 (Pirazzoli et al., 1992), until now there was no associated sedimentological or  
745 geomorphological evidence for it identified inland. The boreholes drilled in the lowland of  
746 Phaistos do not allow us to identify any geomorphological or sedimentological event related  
747 to the EBTP, probably because the uplift did not significantly affect the area of Phaistos-  
748 Gortyn (Stefanakis, 2010); the landscape was stable during the 4<sup>th</sup> Cent. CE as evidenced by  
749 the presence of ponds containing an undisturbed sedimentary record. The main question is:  
750 did an earthquake occur during the Late Archaic to the Classical periods in south central  
751 Crete, and if so did it have a major impact on the hydrological configuration of the Messara  
752 Plain? Archaeo-seismological evidence of possible mid-1<sup>st</sup> millennium BCE seismic activity  
753 is not reported for the Messara Plain (Ambraseys, 2009). Only Pirazzoli et al. (1992) and  
754 Dominey-Howes et al. (1998) report that shoreline uplift occurred at Phalarsana (Western  
755 Crete) around 728-358 cal. BCE, but the intensity seems to have been much less than that  
756 associated with the EBTP event and would probably not have affected the Messara Plain. In  
757 the western Messara Plain, around Phaistos, Monaco and Tortorici (2004) report earthquakes  
758 during the Minoan period, while at Gortyn, several seismic events are reported during the  
759 Roman and Byzantine periods. Further archaeo-seismological investigations should be  
760 conducted in order to identify major earthquakes and to determine whether there was tectonic  
761 control upon the hydrological network of the Messara Plain during the 1<sup>st</sup> millennium BCE.

762

## 763 **8. Conclusions**

764

765 The combined use of different palaeoenvironmental proxies has enabled us to reconstruct the  
766 landscape evolution in the vicinity of Phaistos from the Late Geometric period to Byzantine  
767 times. Our study is an example of palaeoenvironmental reconstruction for Crete during  
768 Ancient Greek and Early Byzantine times, within an archaeological context. The results make  
769 clear that swamplands existed in the Phaistos lowlands (western Messara Plain), since at least  
770 the late 3<sup>rd</sup> millennium BCE and dried up around the 5<sup>th</sup> Cent. BCE. In this study, we have  
771 determined the timing of the final drying up phase of the wetlands. We have also identified  
772 and precisely dated a large input of coarse detrital material, which contributed to the silting

773 up of the westernmost part of the Messara Plain during the Classical and Hellenistic periods.  
774 A climatic control of this sudden phase of sedimentation, which is associated with fluvial  
775 processes around the first millennium BCE, is the most plausible explanation and it is in good  
776 agreement with regional fluvial research (conducted to the south of the Messara Plain) and  
777 with palaeoclimatic studies conducted in Peloponnesus that reveal major flood events around  
778 the 5<sup>th</sup>-4<sup>th</sup> Cent. BCE; this followed a period of increasing aridity that started around the 3.2  
779 kyr BP RCC event. However, human intervention, within the cultural context of emerging  
780 city states, cannot be excluded as an alternative explanation for this major landscape shift: in  
781 order to drain the swamplands and to reclaim the area, a river diversion (anthropogenic  
782 forcing) of the Gria Saita could have been undertaken. One of the direct impacts would have  
783 been the transformation of the landscape and land-use by the local people from Phaistos. New  
784 geoarchaeological perspectives are offered and reinterpretation of the literary sources and  
785 inscriptions should be considered in order to elucidate the strongly contrasting economic and  
786 socio-cultural evolution of the two sites. This study has for the first time investigated the  
787 vegetation composition of Crete from the Late Geometric period to Early Byzantine times, in  
788 the vicinity of a major archaeological site, while the period covering the Hellenistic period  
789 and Roman times remains little documented. The results indicate that an open forested  
790 landscape prevailed with limited land-use: cultivated plants such as *Olea* drastically  
791 decreased following the Late Geometric period and were barely present during Greek and  
792 Roman times. Conversely, *Vitis* was first identified around Phaistos during Greek and Roman  
793 times. The decline of *Olea* can be related to climatic conditions (aridification) observed in  
794 Crete from Late Minoan to Early Byzantine times and to major changes in socio-economic  
795 strategies during ancient Greek and Roman times.

796

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798

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814

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1163 **Figure and table captions**

1164

1165 Figure 1: Location map of the study area and of previous regional palaeoenvironmental  
1166 investigations. Red stars indicate the location of the main archaeological sites cited in the  
1167 paper. Yellow squares represent speleothem studies; 1: Kapsia cave (Finné et al., 2014) and  
1168 2: Alepotrypa cave (Boyd, 2015). Yellow circles refer to terrestrial records (coring and  
1169 fluvial stratigraphic profiles): 3: Akrotiri Peninsula (Moody et al., 1996); 4: Kournas Lake  
1170 (Bottema and Sarpaki, 2003); 5: Asi Gonia peat (Atherden and Hall, 1999; Jouffroy-Bapicot  
1171 et al., 2016); 6: Malia swamps (Lespez et al., 2003); 7: Istron River (Theodorakopoulou et al.,  
1172 2012 and 2017); 8: Palaikastro (Cañellas-Boltà et al., 2018); 9: Aghia Galini (Bottema,  
1173 1980); 10: Anapodaris River (Macklin et al., 2010). Blue circle refers to marine core: 11  
1174 (Rohling et al., 2002). Phai.: Phaistos; Pelopon.: Peloponnesus

1175

1176 Figure 2: Local map of tectonic features and drill corings in the lowland of Phaistos (adapted  
1177 from Fytrolakis et al., 2005 and Ghilardi et al., 2018). Only cores Ph 2, 3, 4, 5, 6 and 9 were  
1178 re-analyzed for the present study. Black dash line indicates buried fault line.

1179

1180 Figure 3: Chronostratigraphy of cores Ph 2, 3, 4, 5 and 6. Granulometric parameters and  
1181 calibrated ages expressed in italics are derived from Ghilardi et al. (2018). Cores Ph 2, 3 and  
1182 6 contain 8 unpublished radiocarbon dated samples.

1183

1184 Figure 4: Chronostratigraphy of core Ph 9. In red: section studied for pollen identification for  
1185 the present paper. See Ghilardi et al. (2018) for further details concerning the full  
1186 stratigraphic sequence.

1187

1188 Figure 5: CM diagram of late Holocene deposits derived from cores Phaistos 2, 3, 4, 5 and 6.  
1189 M: median, C: one coarsest percentile

1190

1191 Figure 6: Percentage pollen diagrams established for cores Ph 9 (Fig. 6a), Ph 3 (Fig. 6b) and  
1192 Ph 2 (Fig. 6c). Values <2% are represented by dots and occurrence of taxa in pollen-poor  
1193 samples are represented by crosses.

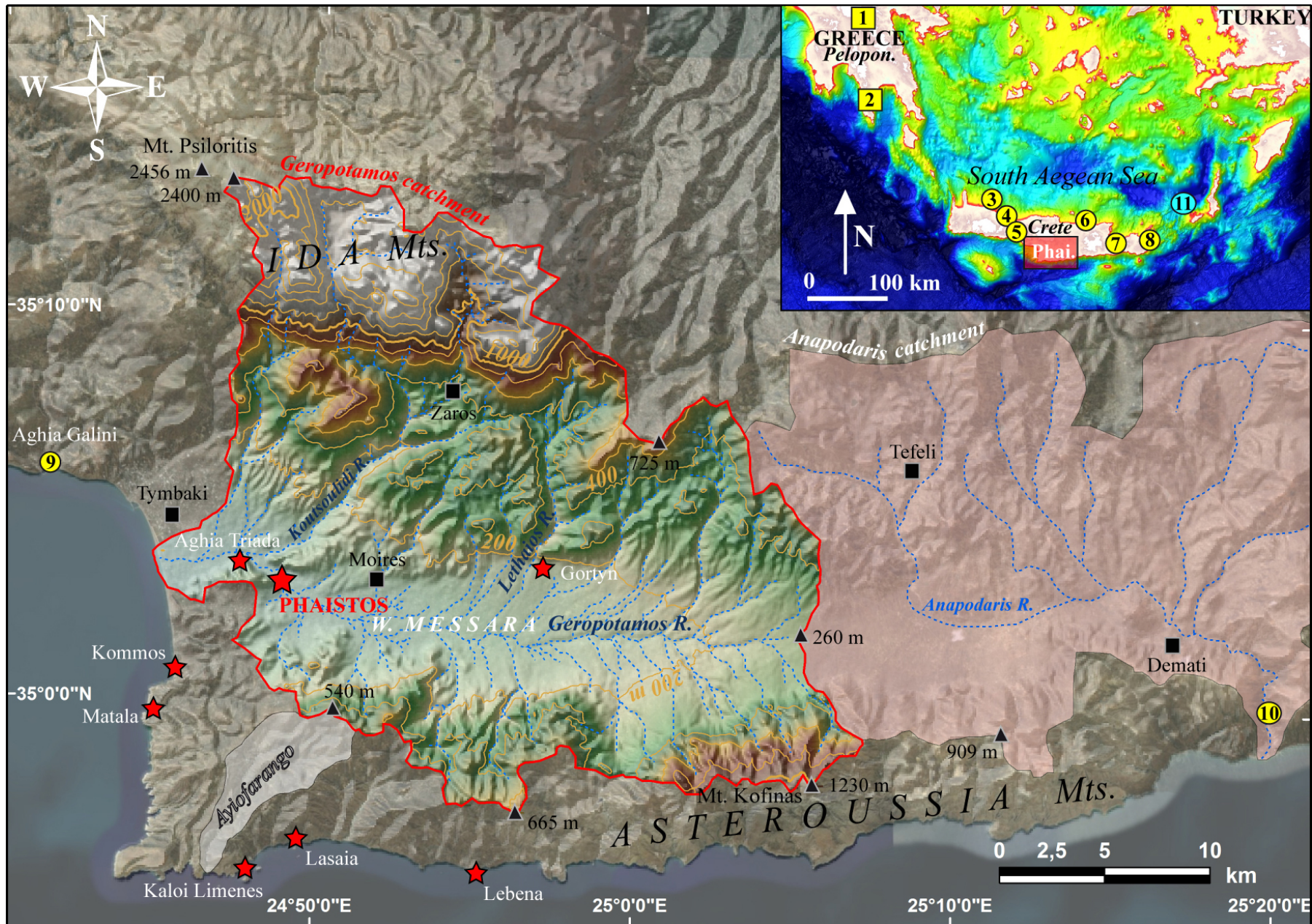
1194

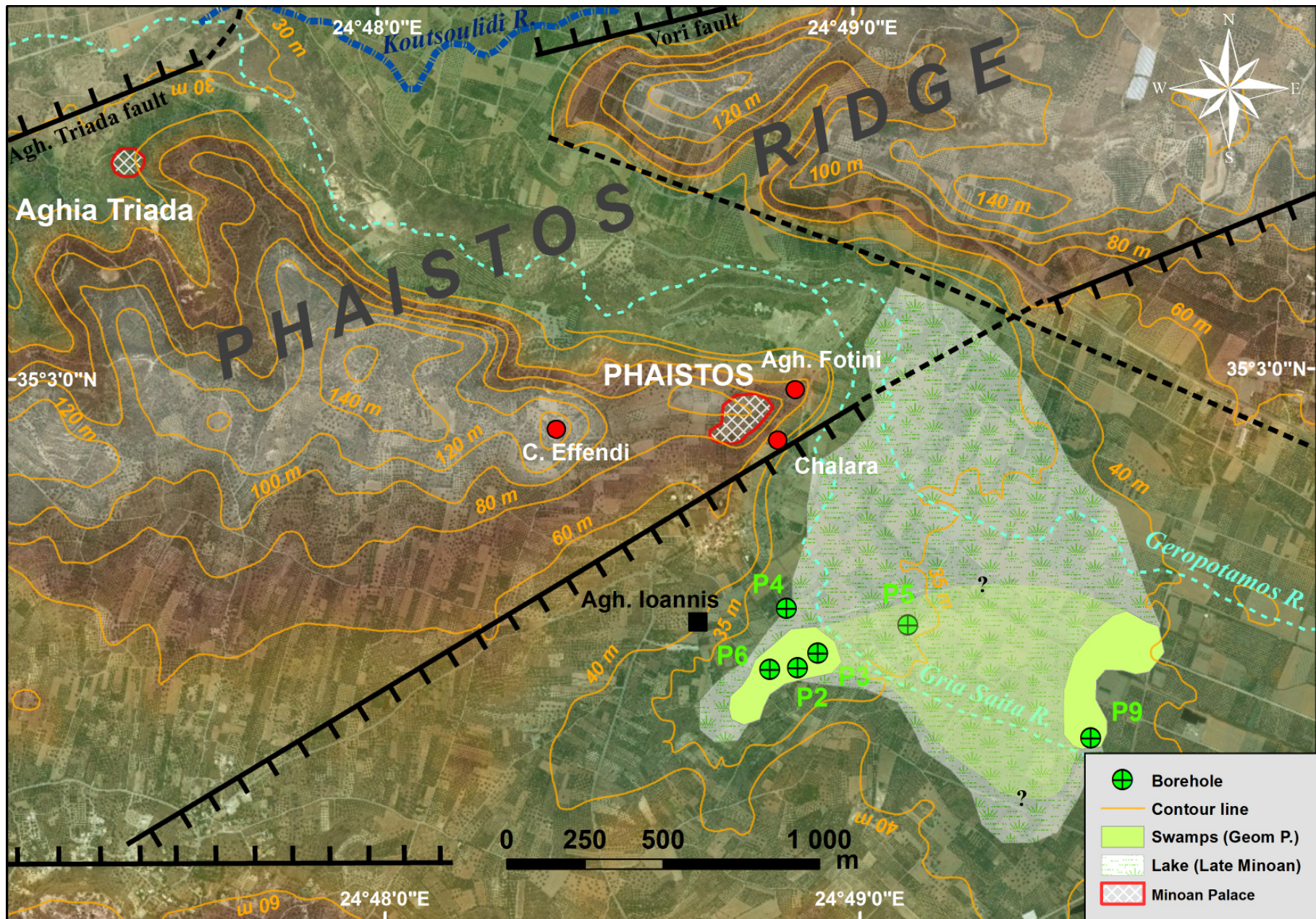
1195 Figure 7: Percentage synthesis pollen diagram based on reliable spectra from cores Phaistos  
1196 2, 3 and 9. Values <2% are represented by dots.

1197

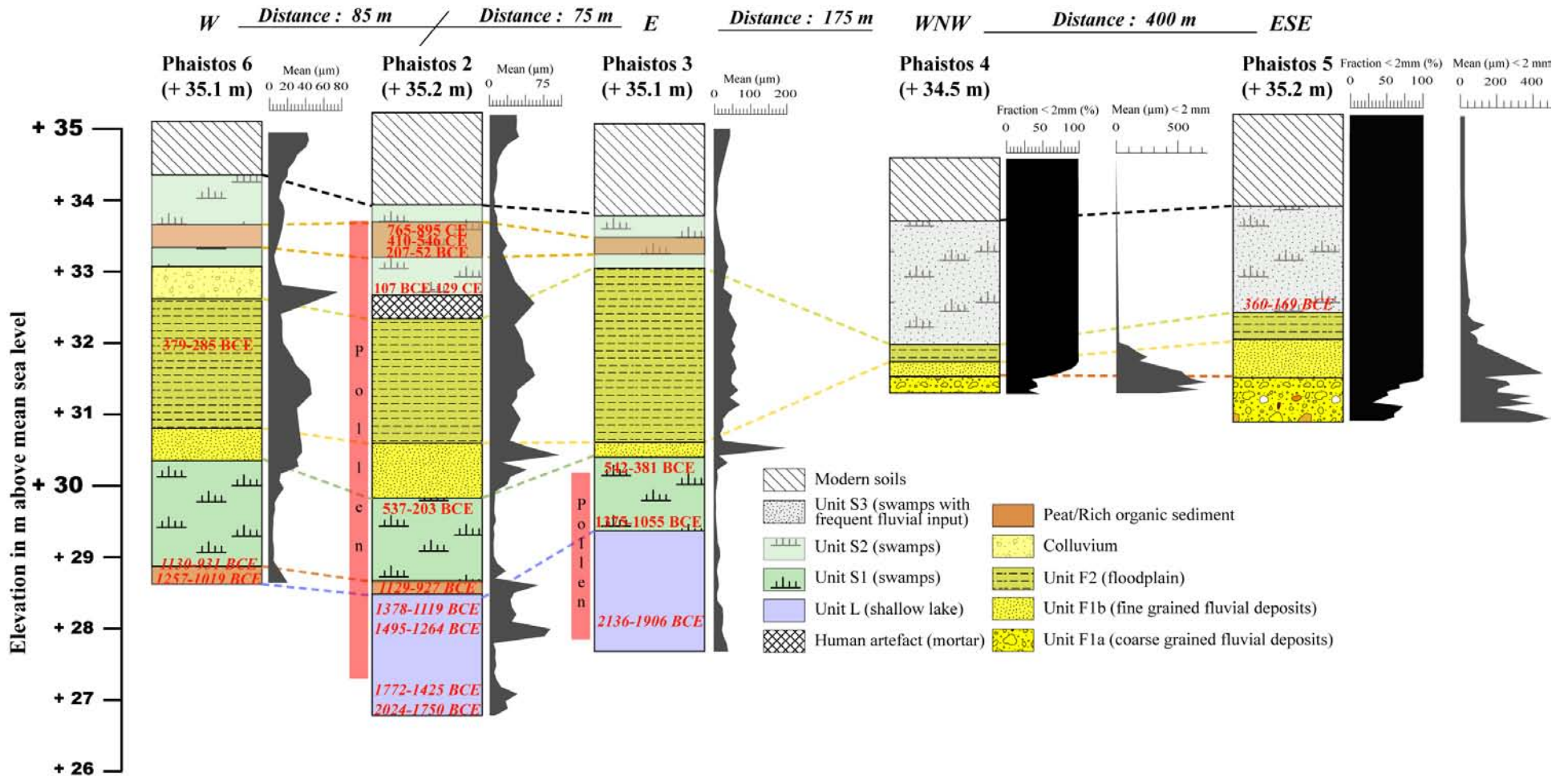
1198 Figure 8: Comparison of regional palaeoclimate reconstruction with the sedimentary history  
1199 of some rivers (that includes the present study) for the last 3000 years in the southern Aegean  
1200 (Peloponnesus and Crete). Summary of the Holocene palaeoclimate records for: a) South  
1201 Aegean Sea (relative abundance (%) of Aegean core LC21 planktonic foraminiferal species  
1202 with warm-water affinities; Rohling et al., 2002) and b) Peloponnesus (b1:  $\delta^{18}\text{O}$  record from  
1203 Kapsia Cave, central Peloponnesus; Finné et al., 2014 and b2:  $\delta^{18}\text{O}$  record from Alepotrypa  
1204 Cave, south Peloponnesus; Boyd, 2015); c: Evolution of the vegetation composition for the  
1205 Mesic and sclerophyllous taxa together with the cultivated plant *Olea* sp. (present study); d:  
1206 main phases of alluvial aggradation/incision reported for the south Peloponnesus (Finné et al.,

1207 2014), eastern Crete (Theodorakopoulou et al., 2012 and 2017) and south central Crete (Doe  
1208 and Homes, 1977; Pope et al., 2004; Macklin et al., 2010; the present study).  
1209  
1210 Table 1: Radiocarbon dating results. \* indicates previously published dates in Ghilardi et al.,  
1211 (2018).  
1212

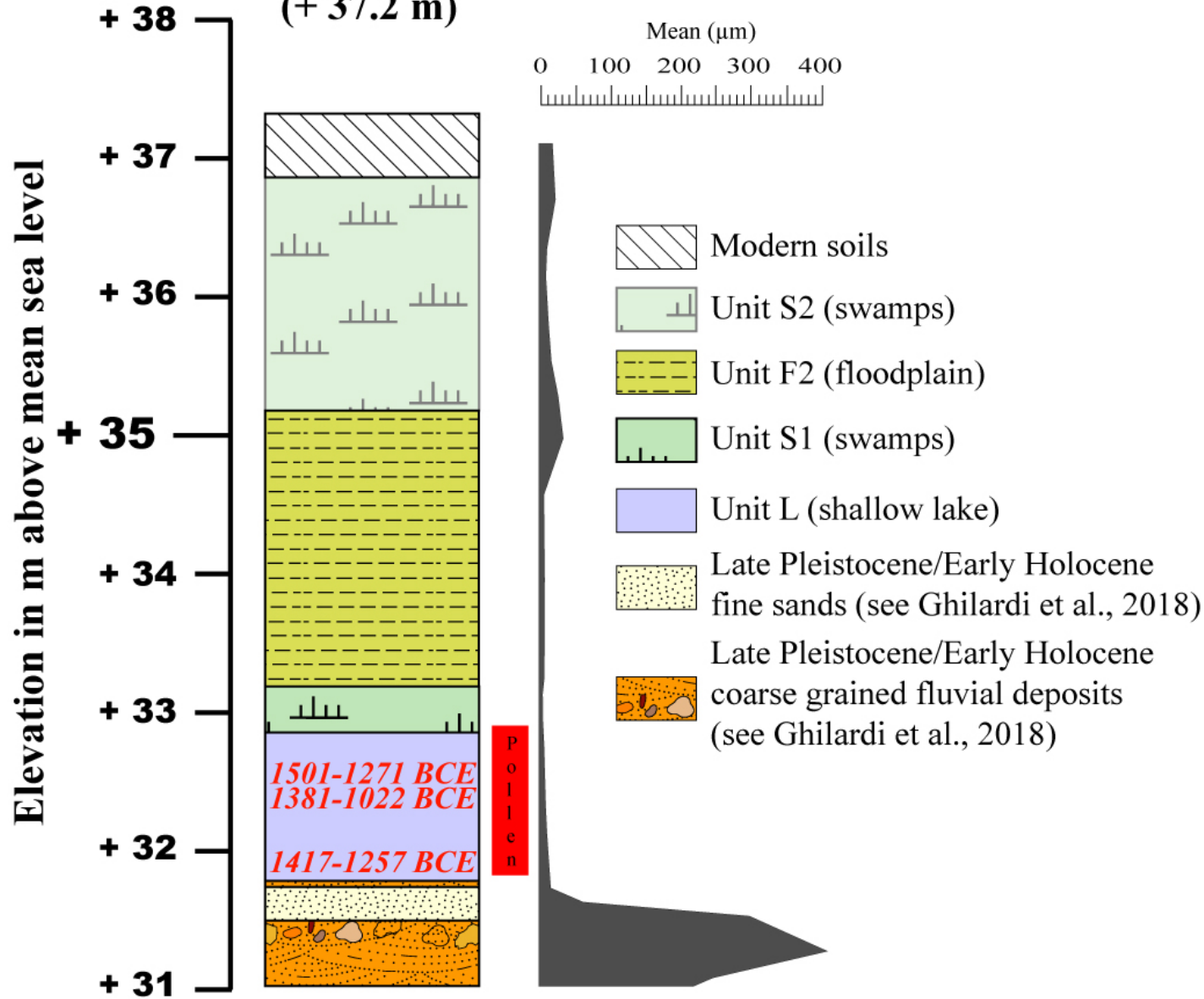




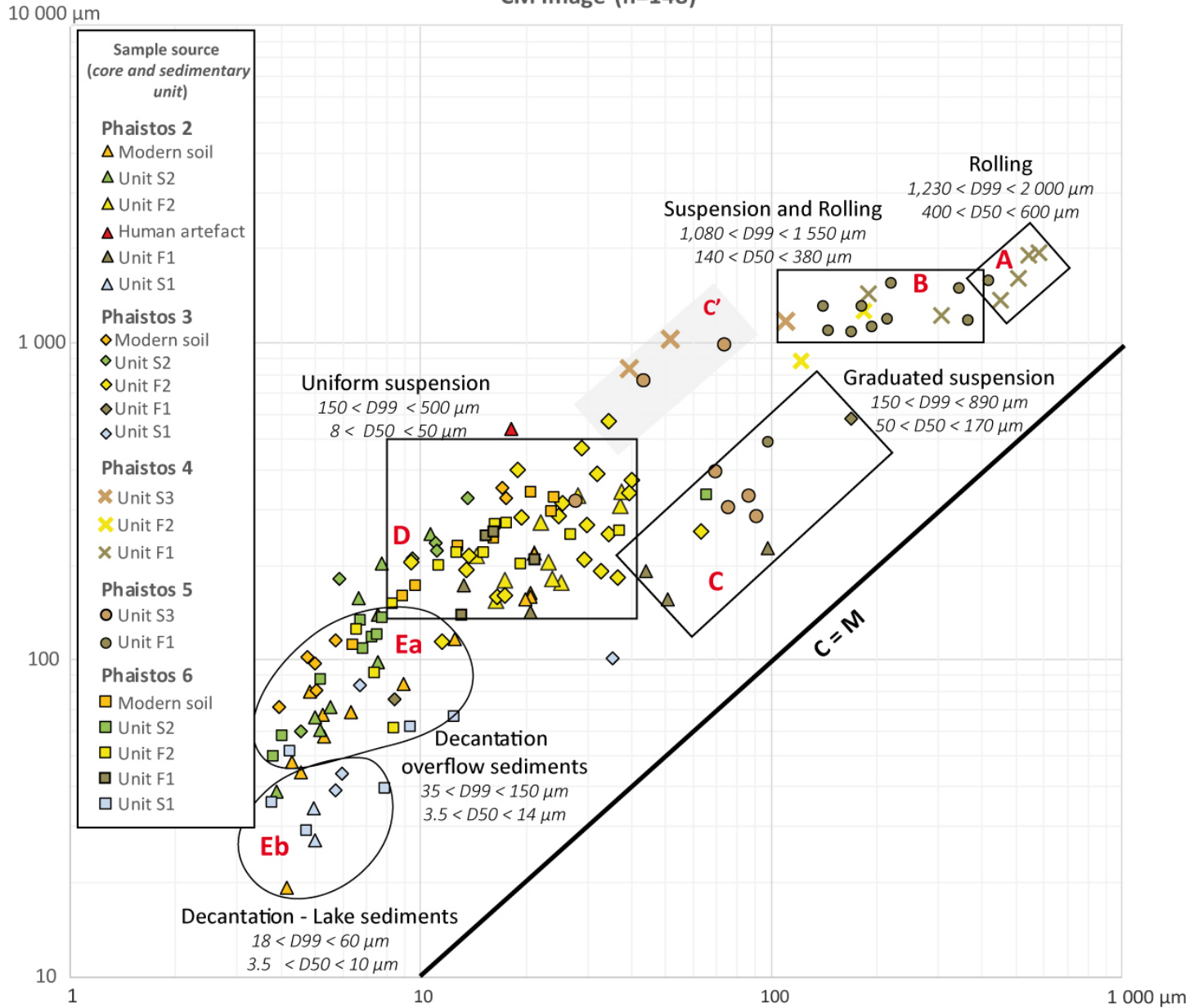


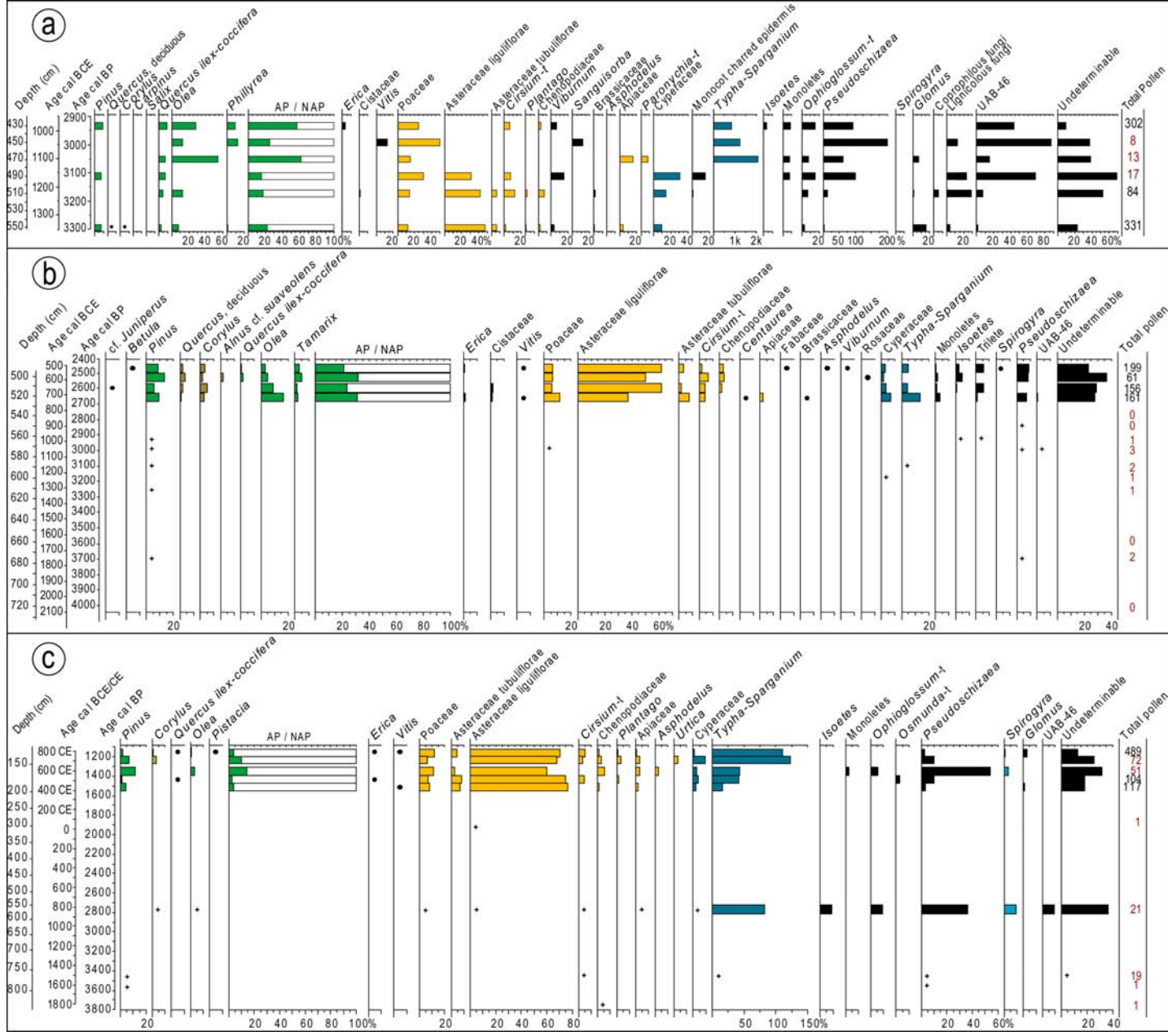


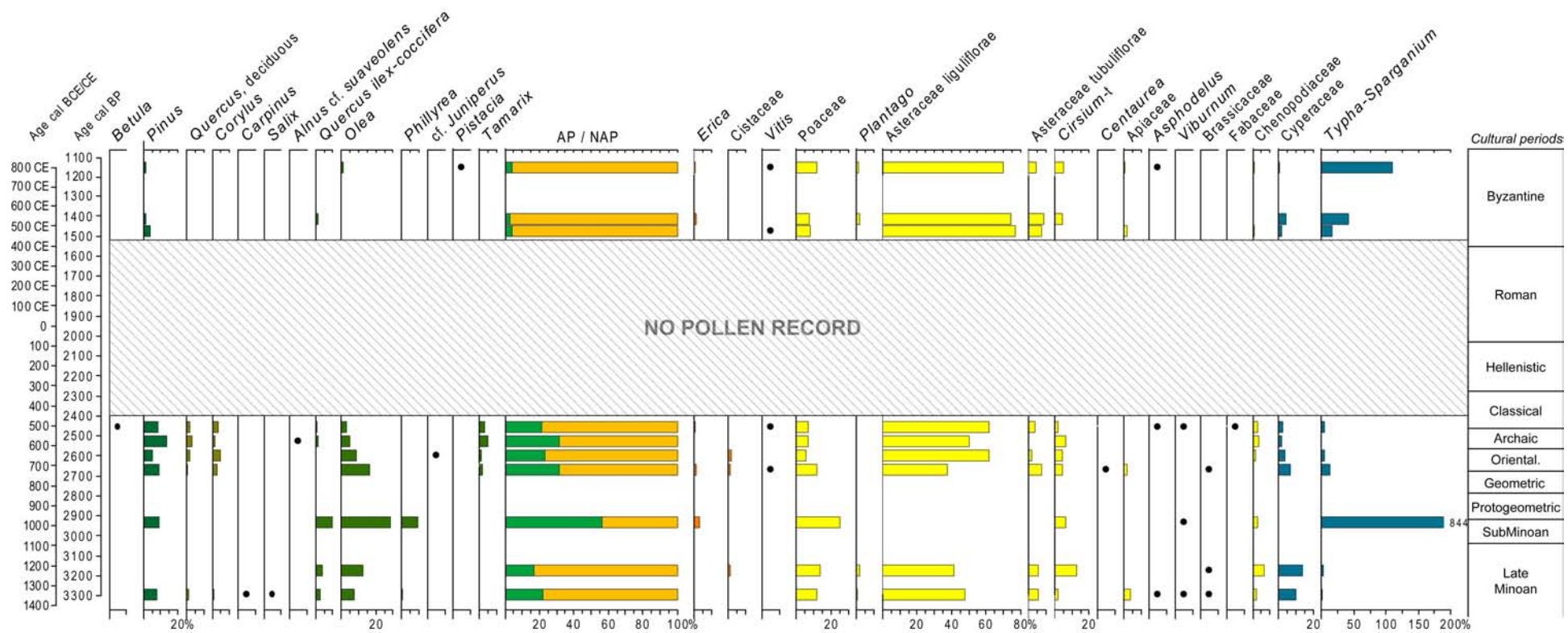
# Phaistos 9 (+ 37.2 m)

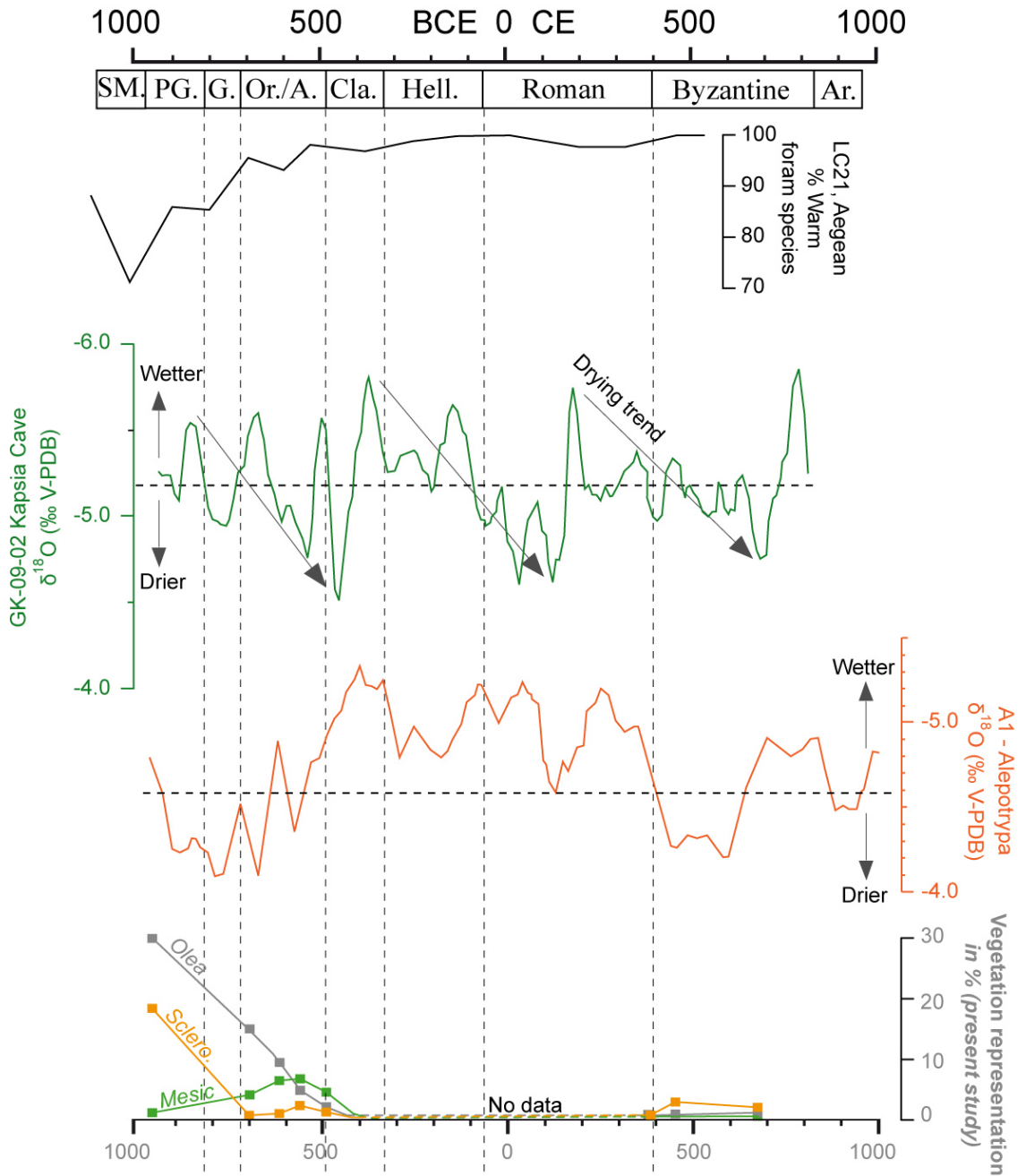


CM Image (n=148)









**River regime**

Kapsia cave - Pelop.  
(Finné et al., 2014)

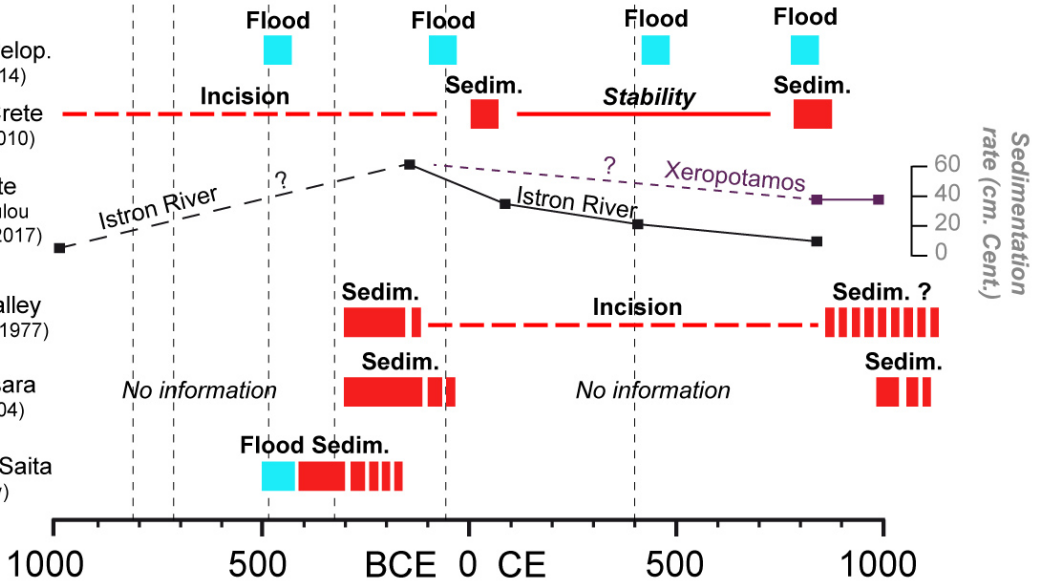
Anapodaris - Crete  
(Macklin et al., 2010)

Eastern Crete  
(Theodorakopoulou et al., 2012 and 2017)

Ayiofarango Valley  
(Doe and Homes, 1977)

Western Messara  
(Pope et al., 2004)

Messara - Gria Saita  
(present study)



<b>Coring reference</b>	<b>Latitude (WGS 84)</b>	<b>Longitude (WGS84)</b>	<b>Depth (m)</b>	<b>Sample elevation above mean sea level (m)</b>	<b>Material</b>	<b>BP</b>	<b>Error ±</b>	<b>Cal. 2σ</b>	<b>Laboratory reference</b>
Phaistos 2	35°2'38.61''N	24°48'58.05''E	1,45	33,72	Peat	1200	30	765-895 CE	Poz-105074
			1,6	33,57	Organic sediment	1580	30	410-546 CE	Poz-110204
			1,75	33,42	Organic sediment	2125	30	207-52 BCE	Poz-103362
			2,57	32,6	Charcoal	1980	50	107 BCE-129 CE	Poz-110205
			5,4	29,77	Charcoal	2310	110	537-203 BCE	Poz-105073
			6,55	28,62	Plant debris	2865	30	1129-927 BCE	Poz-49261*
			7,00	28,17	Plant debris	2990	35	1378-1119 BCE	Poz-49263*
			7,20	27,97	Plant debris	3110	50	1495-1264 BCE	Poz-58147*
			8	27,17	Plant debris	3310	80	1772-1425 BCE	Poz-58104*
			8,40	26,77	Plant debris	3550	50	2024-1750 BCE	Poz-49264*
Phaistos 3	35°2'40.24''N	24°49'0.63''E	4,85	30,22	Charcoal	2365	35	542-381 BCE	Poz-102145
			5,93	29,14	Charcoal	2980	40	1375-1055 BCE	Poz-110203
			7,05	28,02	Charcoal	3640	40	2136-1906 BCE	Poz-49266*
Phaistos 5	35°2'42.81''N	24°49'13.08''E	2,67	32,58	Charcoal	2180	30	360-169 BCE	Poz-49268*
Phaistos 6	35°2'38.46''N	24°48'54.82''E	3,15	31,90	Charcoal	2210	35	379-285 BCE	Poz-110201
			6,20	28,85	Peat	2870	30	1130-931 BCE	Poz-46522*
			6,22	28,83	Peat	2925	30	1257-1019 BCE	Poz-46523*
Phaistos 9	35°2'31.74''N	24°49'34.37''E	4,8	28,8	Charcoal	3130	50	1501-1271 BCE	Poz-70961*
			4,94	28,66	Charcoal	2970	50	1381-1022 BCE	Poz-70962*
			5,47	28,13	Charcoal	3070	35	1417-1257 BCE	Poz-73607*