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## **The Early and Middle Pleistocene archaeological record of Greece : current status and future prospects**

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## 7– Synthesis

### 7.1 INTRODUCTION

In the beginning of this book, chapters two and three outlined the main aspects of the Lower Palaeolithic (LP) period and the earliest hominin movements between Africa and Eurasia (and/or within Eurasia itself). Specifically, the overview of key-sites of the circum-Mediterranean region in chapter three focused chiefly on patterns regarding the existing regional chronological schemes, the nature and credibility of the archaeological evidence, and the geomorphological settings and depositional environments in which the latter is attested. In turn, this review provided the framework against which the Greek testimony was put under scrutiny in chapter four. Here, a critical re-appraisal of the LP data-set was given –the first to appear in the literature after the discovery of the Petralona cranium and the handaxe from Palaeokastro in the 1960’s, which provoked the earliest claims for a pre-Mousterian human presence in Greece. As in chapter three, the guiding principle for this comprehensive evaluation was that ‘stratigraphy is the only truth’ (*cf.* Dincauze 2000). To ‘work’ this motto, fieldwork was carried out in the two most important sites; although limited by practical constraints and permit issues, the results from my revisits of Kokkinopilos and Rodia enhance our understanding of those sites and highlight their role as promising targets for future investigations. Fieldwork-based experience was used also in chapter five, where preliminary results from survey projects in Macedonia and Zakynthos were presented; here, it was demonstrated that the difficulty in finding material stratified into Early and Middle Pleistocene deposits is mostly due to geological biases, rather than research-related issues (*e.g.* research intensity, designs and objectives, or expertise of participants). Thus, chapter five bridged the conclusions from the examination of the Greek LP record with the exploration presented in chapter six: the evolution of

the Greek landscape during the Quaternary, and how it might have affected the preservation of the archaeological record.

Below, a synthesis of these results is presented in four sections, which cover equivalent thematic categories, in turn related to the primary research questions of this study: the first section (7.2) refers to the evaluation of the Greek LP record, both in its own right and in juxtaposition with patterns emerging from the rest of the Mediterranean; the second section (7.3) explains the status of the record on the basis of the geo-archaeological and geomorphological approach advanced throughout this study, emphasizing at the same time how geomorphic factors constrain what we should expect for Greece to yield in the future. Elaborating in this latter point, section 7.4 brings in conjunction specific proposals that were put forth for specific cases in Greece (*e.g.* Kokkinopilos/Epirus and Rodia/Thessaly) with conclusions distilled from the examination of the other LP Mediterranean records, aspiring to put in prospect the future of Lower Palaeolithic investigations in Greece, by suggesting not only methodological strategies but also places that emerge as promising targets for future research. Finally, the last section (7.5) provides a brief account on alternative and/or complementary research questions that were not elaborated here due to space limits, and outlines potentially wider implications of the perspective expanded in this study.

### 7.2 IDENTIFYING THE CURRENT STATUS OF THE GREEK LOWER PALAEOOLITHIC

On the most solid age estimates that we have so far, namely the dating evidence for the Petralona cranium in Macedonia and the finds from Kokkinopilos in Epirus, the earliest peopling of Greece occurred sometime between *ca.* 350-200 ka. In Thessaly, Ro-

dia provides sound artefactual evidence for a core-and-flake typo-technological facies in which Mousterian traits and the Levallois technique are absent; as such, this assemblage could be attributed to the Lower Palaeolithic. Yet, the chronological bracketing of the site relies on relative dating, based on a fossil occurrence (*Archidiskodon meridionalis*) and a U/Th date (<210 ka), both of which are not directly related to the context of site FS 30 at Rodia. On the other hand, my re-evaluation of the site confirms the proposed correlation between the Rodia gravels and those of the highest (and hence oldest) river terrace in the area. Moreover, following the suggestions of R. Caputo, who has defined the locally exposed Rodia Formation, I pointed out the possibility that the FS 30 gravels are part of this late Pliocene-Early Pleistocene Formation. If the Rodia artefacts are indeed associated with the upper part of the Rodia Fm, then it is Rodia that has yielded the oldest human traces in Greece, most likely dating to the Early Pleistocene. Until this is confirmed, *there is no unequivocal evidence for an Early Pleistocene human presence in Greece*.

However, the fossil remains from Petralona and Megalopolis (and, in all probability, also those from Apidima) demonstrate the presence of humans in the late Middle Pleistocene, and *most likely even before ca. 200-300 ka*, if we account for the morphology of the Petralona cranium (e.g. affinities with the Sima de los Huesos material; Harvati 2009) and the age of the Marathousa Member at Megalopolis (>300 ka; van Vugt *et al.* 2000). The late Middle Pleistocene is a period of significant biological developments in hominin lineage(s), notably with regard to important steps in the 'Neanderthalization' process (Hublin 2002; 2009). While the phylogenetic assessment of the Megalopolis tooth is pending, the Petralona specimen shows that *H. heidelbergensis* was certainly present in Greece, whilst the Apidima fossils may be pointing to representatives of (other?) 'early' or 'pre-Neanderthals', if they are not *H. heidelbergensis* (*sensu stricto*), too. Currently, the latter species can be considered as the most probable maker of the existing non-Mousterian Middle Pleistocene material remains in the Greek Peninsula, although I have already stressed how tentative such associations usually prove to be. Exactly because we need to be cautious before equating hominin species with cultural

periods/artefactual taxonomies, we cannot *a priori* assume that the hominins of Petralona and Megalopolis were using a lithic tool-kit that we would conventionally ascribe to the Lower Palaeolithic. *In this sense*, and as we have to exclude Rodia for a most conservative assessment (see 4.6.4), the only secure Lower Palaeolithic evidence from Greece is so far restricted to the handaxe (and associated artefacts) found by Runnels and van Andel in Kokkinopilos. The stratigraphic position of the latter, the age estimate based on the TL-dated paleosol capping the entire sequence, and the absence from the artefact-bearing layer of any specimens indicative of prepared-core technological features (in a site with a strong Levallois signal), altogether support this conclusion. Refinement of the local chronostratigraphic framework, further confirmation of the stratigraphic integrity of the site and more systematic collection of stratified artefacts, will corroborate whether there is indeed a Lower Palaeolithic component at Kokkinopilos (as suspected and argued here), *or* whether we have been looking at an early Middle Palaeolithic facies with handaxes.

Besides the general lack of stratigraphic control, the fact that the earliest best-dated human and material remains in Greece date to between *ca.* 350-150 ka complicates even further any attempts to ascribe undated surface assemblages to either the Lower or the Middle Palaeolithic. This is the time-span during which the transition between the two periods appears to occur in most of Europe. Apart from noting the complexity in identifying, assessing and comparing 'transitional' industries, it is not possible to discuss here the character of this transition in Europe (which still remains largely enigmatic), much less to compare it with the limited evidence from Greece or the Balkans (*cf.* Reisch 1982). Likewise, the nature of the material from Greece (small sample, undated surface collections) obscures the identification of any meaningful pattern with regard to the Mode I versus Mode II spatio-temporal distribution. Taking the Lower Palaeolithic of Greece at face value, it emerges with Mode I tool-kits; in that respect, it follows what some researchers opt to recognize as a general pattern for the earliest circum-Mediterranean sites. In fact, when adopting a less strict perspective for ascribing material to the Lower Palaeolithic, then, all assemblages from Greece thus far attributed to

this period are ‘core-and-flake’ industries (*i.e.* Rodia, Nea Skala, Alonaki, Petralona, Doumbia, Milos). On the other hand, the specimen that *chronostratigraphically* provides the best ‘Lower Palaeolithic’ evidence is a handaxe. Rough cores and choppers have been found also in later contexts (*e.g.* Panagopoulou 1999) and it is overall not clear whether Mode I industries truly precede the earliest Acheulean in Greece. The fact that all of the Greek assemblages mentioned above are of Mode I type may partly reflect the biased notion that morphologically simple tools are of early age. Considering the finds from Kokkinopilos (Runnels and van Andel 1993a; Tourloukis 2009) and perhaps also those from Crete (Strasser *et al.* 2010), it is now beyond doubt that (Acheulean) handaxe manufacture was practiced in Greece most probably already in the Middle Pleistocene, persisting well into the Middle Palaeolithic. Accounting for the small sample of Lower Palaeolithic finds and the harsh preservation conditions, the presence or absence of bifaces in Greece cannot be as yet adequately explained and it apparently varies regionally for reasons other than ‘cultural’ (see *e.g.* Runnels 2003b for an environmental explanation of the distribution of core-chopper versus handaxe-dominated assemblages in SE Europe and Turkey). Industries dominated by core-choppers are being found in western Greece alongside handaxes (the latter being, though, mostly solitary finds), as for example in the area of Alonaki. All in all, we can envisage the earliest inhabitants of Greece using non-specialized tool-kits in employing subsistence strategies within a highly diverse and mosaic landscape; and there would have been room for both Acheulean and core-like implements to be alongside (or, interchangeable) in these tool-kits, without the need to assume different populations.

Apart from the caves of Apidima and Petralona (see below), the geomorphological setting of Kokkinopilos is that of a tectonic depression (a polje), whilst Rodia is situated in the margins of the Larissa basin, at the point where the Pineios river enters a gorge. The sedimentary sequence of Kokkinopilos accumulated in the environment of an ephemeral lake, whereas the fluvial gravels of Rodia most likely represent river-bar deposits. The rest of the sites with possible Lower Palaeolithic material are associated with fluvial/alluvial settings (Aliakmon localities,

Higgs’ handaxe from Palaeokastro and Doumbia in Macedonia, and the findspots on the terraces of the Peiros in Peloponnesus); whilst Alonaki and other findspots of Epirus (Ayios Thomas, Ormos Odysseos) are in solution basins with fills of redeposited *terra rossa*, or in coastal plains; the marine terraces of Nea Skala and the Triadon Bay of Milos also belong to coastal settings. In terms of both geomorphological settings and depositional environments, the Greek evidence matches exactly the pattern deduced from the rest of the Mediterranean records: the vast majority involves open-air sites, found within topographic depressions at low elevations and with low gradients, such as drainage catchments, former lakes and coastal areas; hence, the archaeological material is commonly associated with fluvial, lacustrine or fluvio-lacustrine contexts. The location of FS 30 at the Rodia Narrows and close to the point where the Titarissios river meets the Pineios, brings to mind the patterned association of Iberian sites with river confluences and valley entrances. Within the karstic, rugged landscape of Epirus, Kokkinopilos documents repeated visits of hominins at an ephemeral lake close to the river Louros and reminds us of the mosaic environments in which the Italian sites are located, in the Apeninnic basins, whilst from the perspective of its geomorphological setting, it would not be very dissimilar to that of Ambrona (Spain). The Early and Middle Pleistocene basinal setting of Megalopolis would be comparable to that of Isernia and Notarchirico (Italy), the sites of the Guadix-Baza basin (Orce, Spain) or the Levantine sites of ‘Ubeidiya and Gesher Benot Ya’aqov. Importantly, Middle (and occasionally Upper) Palaeolithic evidence from the poljes of Epirus (*e.g.* Kokkinopilos, Karvounari, Morphi), and from other depressions, such as the Thessalian basin or that of Mygdonia, indicate that hominins continued to exploit the rich resources of those basins also in the Late Pleistocene (*cf.* Runnels and van Andel 2005) – a pattern that was stressed with regard to the Italian record as well.

The scarcity of Lower Palaeolithic cave sites is as conspicuous in Greece as it is in the other Mediterranean records; exceptions such as Petralona, Yarımburgaz (Turkey) or Kozarnika (Bulgaria) only serve to confirm the norm. The age estimate for Petralona follows the general trend of cave use being a rather late phenomenon. The cave of Apidima and other

cave sites with younger material in southern Peloponnesus (Lakonis, Kalamakia) are here to remind us that, if coastal caves were as important in the Early and Middle Pleistocene as they appear to have been in the Late Pleistocene, then we have certainly lost a lot due to marine inundations of the present or earlier interglacials; let us recall here the assertion by Pitsios (1996) that less than 5% of the original volume of Pleistocene deposits remain today in Apidima. Although the submergence of coastal caves is the most dramatic demonstration of preservation biases, there is another issue to consider in this direction: some Lower Palaeolithic cave sites and cavities have infillings with sediments washed in from the surroundings (allochthonous deposits), as it is the case with Sima de los Huesos and Sima del Elefante in Atapuerca, Pirro Nord in Italy and Le Vallonet in France; for those, it is hard to make an argument for hominin preference for caves. In contrast, if we accept that the half-lives of caves average about 250 ka (Wrangham 2009, 88)<sup>65</sup>, and that coastal caves would have been preferred over upland ones; then, it is reasonable to argue that the observed rarity of cave use before the late Middle Pleistocene partly reflects preservation biases. Moreover, there are a number of behavioral factors that could have constrained the use of caves: for instance, control of fire may have been a prerequisite for cave dwelling (*cf.* Mussi 2001, 85), while lack of appropriate weaponry would have limited confrontational success in encounters with carnivores. Combined, these factors alone would have replaced a high risk level for the use of caves. Hence, both the 'late' dates for Petralona and Apidima and the overall scarcity of caves with pre-Late Pleistocene deposits in Greece is not a surprise.

But the overall results from the re-evaluation of the Greek Lower Palaeolithic evidence are indeed a surprise, and a negative one, considering what the rest of the Mediterranean records should let us expect from the Greek Peninsula. Hominins were certainly present in Greece in the late Middle Pleistocene, most probably before *ca.* 200-300 ka and in all likelihood

associated with a Lower Palaeolithic material culture. Yet, the soundest dating evidence from the best-studied sites, namely Petralona, Kokkinopilos, Megalopolis and Rodia, is still inadequate to confidently dismiss the question mark standing next to the 'Lower Palaeolithic' label. In a sense, Rodia exemplifies the problems with the status of the Greek Lower Palaeolithic: even when the dating combines different lines of evidence, such as biostratigraphic indications (the elephant fossil); radiometric results (U/Th); secure-enough geomorphological correlations (fluvial terrace stratigraphy); chrono- and lithostratigraphic evidence (Plio-Pleistocene Rodia Formation); and tectonic history (the age of the associated faults); even then, the desired degree of certainty is missing. Is this a 'technical' issue? Methodological constraints on dating techniques are undoubtedly at stake: a successful dating program at (most prominently) Kokkinopilos or Rodia would perhaps suffice to clear the picture. However, as I already argued, the scarcity of sites and the lack of stratigraphic control are more than technical issues and cannot be sufficiently explained by research-related biasing factors. As deduced from the conclusions of chapter three, the same (or very similar) dating-related problems that tantalize the late Middle Pleistocene record of Greece affect most of the Early and early Middle Pleistocene circum-Mediterranean key-sites as well. Obviously, in lack of excavated sites, the Greek evidence cannot be directly juxtaposed to that from the rest of the Mediterranean; that is, not in even terms. Having said that, I would still argue that the main issues that the Mediterranean sites are facing, are the same issues bearing on the Greek record, except in a different time-frame: if for the other Mediterranean sites chronological data and context-related arguments become increasingly problematic the further we reach back in the Early Pleistocene, the same applies to Greece, but in this case the problems start already from the lowermost end of the Middle Pleistocene, if not the Late Pleistocene. For instance, why is it that Upper Palaeolithic sites in Greece are so few (see *e.g.* Runnels 1995), with only a handful of open-air find-spots yielding mostly non-stratified material? And how do we explain the fact that, apart from the five main excavated caves, the Middle Palaeolithic open-air sites remain in their majority undated and largely comprise of surface material (see above 4.1), which is found commonly mixed with artefacts from later

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65. Note, however, that a recent dating study of cave sediments in Slovakia showed that deposits in caves (both clastic and chemogenic) can be up to several millions of years old (Hanja *et al.* 2010, 49).



periods? Very little is known even for the Greek Mesolithic, with inland open-air sites being extremely scarce (see *e.g.* Tourloukis and Palli 2009). Below I will discuss how the role of geomorphic processes explains this fragmented geo-archaeological archive, keeping the focus on the Early and Middle Pleistocene and using the Italian and Iberian records as case-studies for informative juxtapositions.

### 7.3 EXPLAINING THE CURRENT STATUS OF THE GREEK LOWER PALAEOLITHIC

‘Ice Age’ is a popular term to describe the Pleistocene Epoch, but it is not far from the truth if we consider that temperate stages account for only about 10% of the Pleistocene. Hence, for most of the last 2.5 myr, relatively harsh climatic conditions prevailed, and it has been shown that during these cold periods, plant, animal and probably also human European populations would retreat to refugial areas in the southern parts of the continent, Greece being certainly one of them (*e.g.* Blondel 2009). At around and after *ca.* 400-500 ka, *i.e.* exactly when the European (including the Mediterranean) archaeological records become more substantial (both quantitatively and qualitatively), large lakes were formed in the Aegean, between extensive landmasses, which emerged during sea-level low-stands of glacial spells. Before *ca.* 400-500 ka and until an Early Pleistocene datum-line that is yet to be resolved, those lakes and the emerged land would most likely have persisted also during interglacial stages. Based on recent data (Lykousis 2009), I estimated that the Aegean and Ionian subaerial land of MIS’s 10-12 would amount to *ca.* 140,000 km<sup>2</sup>, *i.e.* to a total area comparable to the continental extent of Greece. The land emerged during MIS 8 was only slightly less than that of the preceding glacial(s) and only from MIS 6 onwards there would have been a significant difference in emerged aerial exposure. In brief, from most likely about the early-middle Early Pleistocene until (a cautious) MIS 8 but essentially until MIS 6, extended landmasses (in total, almost equaling what is today continental Greece) were exposed in the Aegean and Ionian Seas during both glacials and interglacials (pre-MIS 10 period), or during only glacial sea-level drops (post-MIS 10 period). Put differently, *an aerial extent that fluctuated around the size of today’s mainland*

*Greece lies now submerged; or, archaeologically speaking, half of what would have been ‘the Greek record’ is currently underwater, virtually forever lost.* This is the first point to consider in explaining the status of the Greek Lower Palaeolithic archive.

Besides lakes as large as -and even larger than- the size of Crete (*e.g.* in northern and central Aegean during MIS 8), we can envisage the emerged land being dotted with numerous moors, ponds, marshes, lagoons, littoral zones and, of course, rivers and ephemeral streams, which are overall not shown in the reconstruction of Fig. 6.18. In those times of ‘land emergence’, what we know today as the Aegean islands are the peaks of mountains. Although continental conditions are accentuated during marine regressions, it is mainly the water bodies setting the ecological tone of those landscapes, with freshwater, brackish and marine resources allocated in rather small distances and alternating during the emergence-submergence cycles. Due to time-constraints, it was not possible to include in this study an examination of the potential ecological productivity for those landscapes. Yet, most scholars would likely be ready to attribute a high ecological value to environments combining a strong marine influence with most beneficial features of terrestrial ecosystems (freshwater lakes, rivers, etc). Exactly such an environmental structure would have constituted the most efficient buffer to the effects of glacial climatic extremes. Spatially and temporally variable marine incursions in the short-term and the cyclic alterations of regressions-transgressions in the long-term would most probably have enhanced also topographic complexity, which in turn serves as a spatial buffer to acute climatic conditions (Loarie *et al.* 2009). Discussing the ecological importance of the poljes of Epirus, Runnels and van Andel (2003, 77) note that “If the resource potential of an environmental zone is assumed to be roughly equal to its area, most of the time [in their case: over the past 130 kyr] the coastal plains were at best equal in potential to the combined area of all poljes”. Assuming the same for the emerged Aegean and Ionian landscapes, their ecological significance becomes immediately obvious. In short, those landscapes would have served as:

1. Refugia during periods of increased climatic stress

2. Corridors for animal, and, most notably, hominin population movements
3. Super-ecotones (*cf.* Bailey *et al.* 2008), hence ideal habitats for hominins, and, generally, areas of broader archaeological and palaeoanthropological significance, as potential sources of evidence for biological adaptations and behavioral innovations.

Considering all the above, I would argue that those areas would have been the best places to be exploited by hominin groups arriving in the wider Aegean region. A marine control on sedimentation together with the influence of the rivers of Asia Minor and Northern Greece debouching thick alluvia would have created extended low-gradient terrains of coastal lowlands, deltaic and lacustrine depositional settings and geomorphological flatlands. Hence, both of the two most important factors for today's archaeological investigations are essentially met here: hominin habitat preferences and a high degree of geomorphological preservation potential. In this sense, the fact that this part is now lost suggests that we are missing not only half of the record, but most probably *the best half of it*. This is the second point to consider in explaining the status of the Greek evidence, and it carries an extra, qualitative value: *the best chances that we would potentially have in recovering a Greek Isernia or 'Ubeidiya have been drowned by the sea – and in more than one episodes of interglacial transgression.*

In chapter six, I examined landscape dynamics as expressed in various interrelated processes between vegetation, lithology, soils, topography and land use, all of which are more or less conditioned by the ongoing tectonic activity and the seasonality of a Mediterranean climate. On the grounds of this examination, and following basic principles and empirical applications of large-scale erosion studies in tectonically active landscapes, I presented a slope-map of Greece as a morphological measure to assess biases in archaeological preservation/visibility, assuming slope angle as a surrogate for mean local relief and a proxy for evaluating long-term erosion at the landscape-scale. From a geoarchaeological perspective, it was argued that the best cases for Lower Palaeolithic material to have survived up to the present in a primary and/or secondary context are to be sought in the

low-gradient, low-altitude areas of Greece, namely in *ca.* 30–40% of the country's total surface extent. With this line of reasoning, and by accounting for the role of the emerged landmasses discussed above, as well as considering the aerial coverage of Quaternary Formations, I suggested that: assuming a hypothetical initial spatial extent of the Lower Palaeolithic geoarchaeological archive in mainland Greece and the Aegean and Ionian Seas, what is left today as 'promising' (and/or simply 'available') target for investigations is a mere two to five percent (2–5%) of the country and of the 'initial record'. The latter value essentially coincides with lowland areas of low relief and, using the nine-unit land-surface model as a heuristic tool, I proposed that it is in those areas where material is most likely to be found in a primary and/or secondary archaeological context.

This extremely small percentage-value explains vividly the status of the Greek Lower Palaeolithic record as identified above, namely the very small number of sites and the fact that the related material is commonly non-stratified and/or it is very difficult to either associate it with a geological context or demonstrate its non-reworked character. The potential for the preservation and recovery of the geoarchaeological archive (and the qualitative status of this preserved archive) depends mostly on the available geological opportunities. This is what is ultimately reflected in the assessment elaborated in chapter six and summarized above: in spatial terms, the geological opportunities in Greece allowed for only a meager 2–5% of the record to have been preserved, and, in this portion, much of the potentially preserved material is likely to be found in a reworked (secondary) context, whereas material in primary contexts may be lying deeply buried. The reasons why geological opportunities are limited and unpropitious for stratified material refer to landscape dynamics and their spatio-temporal specifics. Quaternary landscape evolution in Greece was primarily controlled by four main driving mechanisms: (1) a *tectonic activity* with rates of vertical and horizontal deformation that are among the highest in the entire Eurasia; (2) a markedly *seasonal climate* in which the seasonality of precipitation is the most important parameter, being accentuated mostly during glacials, and, in turn, affecting river flow fluctuations; (3) *sea-level oscillations* exposing and submerging large areas, at the same time

controlling sedimentation in many parts of the country (e.g. recall the case of Zakynthos); and, last but not least, as the land-surface manifestations of all of the above, (4) *slope processes* on a predominantly high-relief terrain with spatially restricted drainage basins, erodible lithologies, skeletal soils and an effectively strong slope-channel coupling. Rather than temporally continuous, landscape disturbance occurred in an episodic fashion and in the form of extreme erosional events of low duration but high amplitude and high frequency of recurrence, in time-windows that were pre-conditioned by the combined forces of some (or all) of the four above-mentioned factors. Changes to the thresholds at which a disturbance-event became effective could be due to climatic transitions (mostly cold-to-warm ones) at millennial, centennial or decadal scales, and/or associated sea-level changes (e.g. affecting base-levels of rivers); if not climate, tectonic movements would have been equally efficient as triggering factors. As a working hypothesis, I suggested that the overall landscape instability of Greece during the Quaternary can be attributed to the transient (*i.e.* unstable) behavior of the landscape over periods of 100 to 10,000 years (*cf.* Brunsden 2001). If transient landforms prevailed over periods of  $10^2$ – $10^4$  for most of the Early and Middle Pleistocene, then sites of those times would have had less chances for surviving their first 10,000 years of existence (and hence improving thereafter the possibility of survival until the present (*cf.* Surovell *et al.* 2009). A landscape dominated by transient, erosional landforms explains well not only the overall scarcity of Lower Palaeolithic sites but also the difficulty in recovering stratified material.

Landscape dynamics in a tectonically active setting, affected by the Pleistocene climatic periodicities, might also explain an apparent dichotomy in the degree of fragmentation of the geoarchaeological archive before and after the penultimate glacial-interglacial cycle. In 2002, Macklin and colleagues presented for the first time a correlation of Late and Middle Pleistocene alluvial sequences in the Mediterranean, based on 54 securely dated alluvial units, including Greek data. Is it a methodological bias (e.g. dating constraints) that “both the number of alluvial units, and the precision to which they are dated, decrease significantly prior to the OIS 6/5e

boundary”, as the authors note (*ibid.*, 1636), and that their oldest-dated aggradation event is identified within MIS 6? A major MIS 6 alluviation episode is documented also in the Voidomatis glacio-fluvial record, represented as the thickest and most extensive of all local units; but fluvial sediments predating MIS 6 (the latter correlated with the ‘Vlasian Stage’ of the local glacial record), have been either not preserved or buried below ‘Vlasian deposits’. My own field-work-based observations (*cf.* assessments for the Thessalian fluvial sequence, or the observed general lack of terrestrial deposits before the last interglacial in Zakynthos) suggest that such a phenomenon appears to be rather widespread in Greece. In contrast to the indications for significant terrestrial responses to climatic events during MIS 6 (which was the most extreme glacial in Greece after MIS 12; Tzedakis *et al.* 2003b) and within the MIS 5 complex (e.g. river aggradation at MIS 5d and the 5b/a boundary; Macklin *et al.* 2002; extreme phase of open vegetation during 5b; Tzedakis 2005); MIS 8 displays the least extreme Arboreal Pollen minima of the last 450 ka in the Tenaghi Philippon record. Future research may test if the subdued glacial conditions of MIS 8 and both the preceding and following interglacial complexes of MIS 9 and 7 altogether comprised a time-window for a successful hominin colonization event and/or demographic growth in the Greek peninsula. After all, the scarce dating evidence that we have at the moment for a Middle Pleistocene human presence in Greece, fall into this time-span. Alternatively, any future proof for a ‘clustering’ of sites within this period (MIS 9 to 7/6), may also serve to remind us how much filtering of the archaeological signal occurred due to the erosional processes active during MIS 6 and/or 5d to 2. In other words, it is not unreasonable to assume that very little Lower Palaeolithic material may have managed to survive more than one or two full glacial-interglacial cycles –and much less to continue to be in an *in situ* position until today.

Without such *in situ* occurrences and lacking information that can be extracted from excavated sites (e.g. data for environmental reconstructions), it is not easy to explain the association of Greek sites with areas related to water bodies (rivers, lakes, coastal zones): it probably reflects both geological preservation and hominin preferences. If it is difficult



to assess the exact importance of these two factors for records as well-studied as the Italian or the Iberian (see above 3.2, 3.3 and 3.7), this is even truer for the scanty Greek archive. However, I already emphasized how specific aspects of tectonic evolution and topographic configuration adequately explain the preservation and recovery of sites in Epirus (*e.g.* Kokkinopilos, Alonaki), and how the tectonic history of Thessaly explains not only the preservation of the 'Hochterrasse'/Rodia fluvial gravels, but also how exceptional this preservation is within the Thessalian basin. At this point, it is fruitful to address another question: if landscape dynamics, disfavoring preservation of material throughout multiple climatic cycles, elucidate the scantiness of the Greek record in both quantitative and qualitative terms, how could we explain the richness of other circum-Mediterranean records, considering the similarities in climatic trends and overall geomorphic processes in the Mediterranean? Due to limited space here, I will only briefly outline how specific differences, mainly in topography and tectonic history, can explain the disparity between the records. To this end, I will use as examples the Iberian and Italian peninsulas.

Compared to the high relief of Greece, Iberia is characterized by a low relief with mean slopes of 7.1 degrees (Benito-Calvo *et al.* 2009). According to a morphometric classification (*ibid*), the most extensive class represents intermediate plateaus and plains, which occupy 23% of the Iberian surface. Coastal lands, valleys and plains of low altitude and low gradients (mean: 2.9°) occupy 15% (unit 1); the plains and valleys with gentle slopes (mean: 2.8°) cover 16.3% (unit 2), and hillsides and valley slopes with a mean 9.8° represent 11.4%. In other words, 42.7% of the peninsula comprises of low relief with low-to-medium gradient slopes (units 1 to 3), whilst the plateaus and plains of the interior (essentially: the Iberian Meseta) add another 23% of areas with very low topographic roughness and gentle slopes (mean: 2.7°); overall, the low-relief areas reach a total of 65% of the peninsula. Although the latter values are not straightforwardly comparable to those derived from the slope-map of Greece (Fig. 6.24 and Table 6.4), they give us a first-order appreciation of the differences in relief (and gradients) between the two peninsulas: as a general trend, the percentage of low relief areas in Iberia almost equals the percentage of

high relief areas in Greece. As described in section 3.3, most of the Lower Palaeolithic sites of Iberia are located in those low-relief/low-gradient terrains, with the majority of them situated on the high elevated flat surfaces of the 'Iberian Meseta', in the interior of the peninsula. The low relief of the Meseta was developed already before the Quaternary (Casas-Sainz and de Vicente 2009); hence, anthropogenic material was to be discarded (and potentially buried) on low-gradient terrains. The causes and timing of the uplift of the Meseta is debated, but a recent study (*ibid*) suggests that it probably had two main components: 1) Alpine compressional tectonics 2) a recent, Plio-Pleistocene stage of uplift. Most likely related to the latter (Plio-Pleistocene uplift) is a major transition affecting the Meseta: the plains and basins (*e.g.* the Duero, Ebro and Tagus basins), which were until that time endorheic (internally drained), were captured by the fluvial systems and changed to exorheic. The transition from endorheism to exorheism marks the onset of drainage reversal, river incision and hence dissection and erosion of the basins and plains. The precise timing of this transition is not resolved with regard to specific stages within the Quaternary and it probably differed regionally. Yet, strong incision observed in some basins (*e.g.* parts of the Duero) is described as occurring in 'recent times' (Casas-Sainz and de Vicente 2009). I would thus point out the possibility that well-preserved Lower Palaeolithic sites in Iberian basins and plains remained buried and protected from erosion for most of the Early and Middle Pleistocene, and were only recently (Late Pleistocene to the present) exhumed by river incision, the latter providing the necessary degree of archaeological visibility. An example of such a case can be given with respect to the sites near Orce.

The intramontane Guadix-Baza (G-B) basin is situated on a plateau with a mean elevation of 1000 m, now intensely dissected by the river network. A >600 m-thick sequence of fluvio-lacustrine sediments (>2500 m-thick in the centre near Baza) accumulated in the enclosed, endorheic depression of G-B (Scott *et al.* 2007). Activity along the Baza normal fault since *ca.* 8 Ma provided accommodation space for continuous sedimentation in the Baza sub-basin, which was formed in the hanging-wall of this fault (Alfaro *et al.* 2008). A large lake occupied the depocentre of the latter area, and the archaeological and

palaeontological sites (*e.g.* Barranco León, Fuente Nueva 3) are located at the margins of this palaeo-lake (Barsky *et al.* 2010: fig. 2). Alluvial fans on the borders of the basin were gradually connected with the central lake (Pérez-Peña *et al.* 2009). Besides the gently sloping fans, the fluvio-lacustrine sediments of Baza lie horizontally and the entire depression is described as an “essentially flat, elevated region” (Pérez-Peña *et al.* 2009, 206; Díaz-Hernández and Juliá 2006). The central Betic Cordillera, where the G-B basin is located, is currently subjected to regional uplift (Alfero *et al.* 2008), but the Pliocene-Pleistocene evolution of the basin was dominated by sedimentary processes largely undisturbed by significant tectonic events (Pérez-Peña *et al.* 2009). At a certain point, the former, endorheic drainage was captured by the Guadalquivir river system due to uplift (Díaz-Hernández and Juliá) and the drainage of the basin changed from endorheic to exorheic; from that point on, lacustrine and fluvial sedimentation ended and erosion predominated in the area (Alfaro *et al.* 2008; Pérez-Peña *et al.* 2009). While the exact age of this change is debated, the most recent study regards it as younger than *ca.* 43 ka (Pérez-Peña *et al.* 2009). Since the basin was captured by the Guadalquivir, the level of the sea, *i.e.* about 1000 m lower than the river’s level, became the base level of erosion; for the river to adjust its profile to the new conditions, it had to erode the poorly consolidated Neogene-Quaternary sedimentary fill and the incision wave propagated headward very rapidly, but its intensity decreased over time (*ibid.*, 214). Most of the erosion has since been concentrated in the Guadix sub-basin, because it is close to the capture point (Pérez-Peña *et al.* 2009). The Baza fault delayed the propagation of erosion into the Baza sub-basin, and this explains the large differences in erosion rates between the two sub-basins (*ibid.*).

In translating this picture into geoarchaeological terms, two points need to be stressed:

1. During the Early and Middle Pleistocene sedimentation was continuous and with high rates (~10 cm/ka; Scott *et al.* 2007). It largely consisted of fine-grained material and it essentially formed a flat-lying terrain. Hence, the most important prerequisites for a good preservation potential were in place: fine-grained material
2. Erosion started only late in the Late Pleistocene (after *ca.* 43 ka), it was probably vigorous in the beginning (*i.e.* upon capture of the drainage by the Guadalquivir) but it gradually slowed down. The incision/erosion wave affected mainly the Guadix area, whilst its propagation to Baza was buffered by the Baza fault<sup>66</sup>. Encroachment of the drainage in Baza only served as to expose the Early and Middle Pleistocene sediments, instead of severely eroding them, as it is the case with the badlands directly adjacent to the S/SW of Orce (*cf.* Díaz-Hernández and Juliá 2006: fig. 1). Therefore, for the Orce sites, the most important requirement for today’s good archaeological visibility was there, too: erosion starting only late in the Pleistocene, stripping off uppermost sediments and exposing lower layers and associated artefacts without disturbing them.

The case of Italy is also instructive, because, in contrast to Iberia, its topography is much more similar to that of Greece, with alluvial plains and flatlands covering about ¼ of the peninsula (Mussi 2001). The majority of the Lower Palaeolithic sites are associated with the fluvial and/or lacustrine depositional settings of the Apeninnic basins (see section 3.2). The Late Pliocene and Early-Middle Pleistocene of Italy are characterized by lacustrine environments of low relief in most intramontane depressions, which hosted swamps and floodplains of mainly fine-grained sediments (Bartolini 2003; Bartolini *et al.* 2003). These closed and semi-closed drainage systems were chiefly internally drained (endorheic), because the low relief prevented streams from eroding divides and capturing the drainage (Bartolini 2003). After the Middle Pleistocene, lacustrine sedimentation was significantly reduced, continuing only in a few basins that maintained internal drainage (Bartolini *et al.* 2003, 214). It is during the Middle and Late Pleistocene that a major rearrangement occurred in the depositional settings of the Apeninnic depres-

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66. In contrast to the wealth of well-preserved palaeontological and archaeological sites of Baza, the Guadix is almost devoid of sites; this would reinforce the ‘preservation argument’ advanced here.

sions: the fluvio-lacustrine environments changed to fluvial-alluvial sequences “in a regionally correlated phase of basin fill incision and drainage integration” (ibid). The change from internally-drained lacustrine systems to through-going fluvial networks is related to the uplift of the Apenninic chain and the creation of the necessary relief that provided the streams with the required energy to capture the drainages (ibid). As a result, the older (Early-Middle Pleistocene) fluvio-lacustrine units were being incised and eroded, and they are now overlain by units transitional from low-gradient lacustrine and fluvial environments to coarser deposits of alluvial fans. The uplift that occurred from the Middle Pleistocene onwards was time-transgressive and the drainage-change did not affect all basins, but, as a general pattern, it involved most of them (Bartolini *et al.* 2003). For those basins that were captured later in the Pleistocene (Late Pleistocene), we can envisage the low-gradient lacustrine palaeo-surfaces being covered and thus protected throughout the Early and Middle Pleistocene; as with the case of the Iberian example mentioned above, this would have offered better chances for associated archaeological material to attain a high degree of preservation and relatively good visibility after dissection and erosion due to uplift. This is exactly what happened at Isernia: human activity is recorded in low-energy, flat-lying lacustrine sediments that were subsequently covered by high-energy stream deposits, generated by a considerable increase in gradient due to the Middle Pleistocene tectonic movements (Mussi 2001, 24).

The examples from the Iberian and Italian peninsulas demonstrate that the disparity between the Lower Palaeolithic records of the latter areas with that of Greece can be explained by differences in topography and tectonic history. What emerges as a key-factor is *the timing of uplift and the intensity of erosion accompanying the inversion of basinal settings*. In rather ideal situations (*e.g.* Orce sites), Early and Middle Pleistocene sediments of low-gradient settings (*e.g.* lacustrine) are being protected by burial until the late Pleistocene; then, uplift signals the onset of dissection, erosion and exposure, but, in such cases, the exposed sediments are subjected to the erosional effects of ‘only’ one full glacial-interglacial cycle, and have therefore better chances to be preserved. I would argue that such an ‘advantageous

timing of uplift’ (Late Pleistocene) was rather exceptional for the lowlands of Greece; in contrast, most basins were affected by uplift already in the Early and Middle Pleistocene. This had important consequences in the tecto-sedimentary evolution of the depressions and the preservation potential for sediments and associated archaeological material. When uplift occurs in the Early Pleistocene, there is limited sedimentation in the uplifted area in the Middle Pleistocene, whilst already deposited (Early Pleistocene) sediments are subjected to dissection and erosion throughout multiple glacial-interglacial cycles from the Early Pleistocene to the present. Likewise, when uplift starts in the Middle Pleistocene, (Middle and) Late Pleistocene sedimentation is reduced in the uplifting block, hence any Middle Pleistocene sediments have very low chances of being covered and protected -instead, soon after their deposition they are subjected to the erosional effects of stream dissection, throughout more-than-one climatic cycles; any Early Pleistocene sediments (pre-dating the uplift) have essentially the same fate, too. In section 6.3, I examined in more detail the consequences of this timing of uplift with respect to the Megara basin and the Gulf of Corinth, for which no Lower or Middle Palaeolithic evidence has been reported so far. The case of the Thessalian basin, where the site of Rodia is situated, was also discussed in this respect, because parts of it were uplifted during the Late Pliocene-Early Pleistocene and then again in the Middle Pleistocene (section 4.6.2, 4.6.5 and 6.3); as a result of this uplift, Early and Middle Pleistocene sediments in Thessaly (the greatest lowland area of Greece) occupy today a meager *ca.* 0.8% of the basin. Similar to the endorheism-exorheism transition discussed for the Iberian and Italian basins, the Thessalian drainage changed from an internally-drained Pliocene lake to a through-going fluvial network (the Pineios river drainage); in contrast to the basins of the Iberian Meseta or the Apennines, this transition occurred in Thessaly in the Early Pleistocene, due to uplift related with the first major tectonic phase affecting the region. Earlier, I stressed how the site of Rodia exemplifies most of the major archaeological issues of the Lower Palaeolithic record of Greece (notably, the dating problems). In light of the discussion above, I would add now that Thessaly and Rodia exemplify also the limited geological opportunities for the preservation and/or visibility of early Pleistocene sediments in

Greek basinal settings, as well as the reasons accounting for this picture (a disadvantageous ‘timing of uplift’). In contrast, the small basin of Kokkinopilos appears to have been inverted relatively recently and the intensity of erosion has accelerated also in geologically very recent times; if the soils of Kokkinopilos were not acidic but alkaline, favoring the preservation of fossils, this site could have been a miniature of the situation seen at Orce.

To sum up, in the model that I suggest as central for explaining the scarcity of the Lower Palaeolithic record of Greece -as compared to those of other Mediterranean regions (*e.g.* Spain, Italy)- *basin inversions and drainage diversions occurred already in the early rather than the late Pleistocene*. While most of the Iberian and Italian basins were experiencing a period of relative quiescence during the Early Pleistocene, (parts of) the Greek basins changed from ‘sediment-receiving’ to ‘sediment-producing’ areas, in which erosion predominated over deposition. In turn, this can be explained by the fact that *the last tectonic paroxysm in Greece seems to have begun in the early and middle Pleistocene*. In section 6.3 it was pointed out that in the Early and early-middle Pleistocene, a compressional regime invaded the broader Aegean region, separating the extensional regimes that prevailed before and after that time-span. During this intense compressional phase (*ca.* 1.0–0.7 Ma), the entire Hellenic arc was uplifted and convergence rates increased at its outer circumference from 1 to 3 cm/year (Schattner 2010, 545). In the early-middle Pleistocene (locally better resolved as in the Middle Pleistocene), a reorganization of stress trajectories occurred in the southern and northern Aegean, and in the north (Florina-Vegorit-Ptolemais graben) as well as central mainland Greece (Thessaly); a third phase of opening affected the Gulf of Corinth; whilst some basins and coastal areas in Peloponnesus were being uplifted. As a whole, these developments are probably related to *a major tectonic event that occurred across the entire eastern Mediterranean during the early-to-middle Pleistocene*, manifested by a series of synchronous structural deformations that accentuated the topography (Schattner and Lazar 2009; Schattner 2010).

#### 7.4 PROSPECTING THE FUTURE OF LOWER PALAEOLITHIC INVESTIGATIONS IN GREECE

Asking for more -and, ideally, radiometric- dates to bracket the Greek Lower Palaeolithic would sound as a cliché, if not because a more precise dating is needed for the regional Middle and Upper Palaeolithic records as well. Yet, the examination of the Early and Middle Pleistocene archaeological evidence from Greece as a whole (chapter 4), along with the zoomed-in fieldwork-based investigations of specific case-studies (Thessaly, Epirus; Aliakmon and Zakynthos survey projects), altogether demonstrated that the necessity for building regional chronostratigraphic frameworks is currently the number one priority. Contributing in this direction, sediment samples that I collected from Kokkinopilos have been submitted to the Netherlands Center for Luminescence (results pending). In one of my revisits at Rodia, together with R. Caputo (Professor of Structural Geology, University of Ferrara), we were able to assess that the fluvial gravels at FS 30 are probably about a million years older than previously thought. On the other hand, my own experience at, for instance, the ‘red-bed sites’ of Epirus or Rodia in Thessaly, suggests that even the very same assessment of ‘what to date’ is by no means an easy task: considering the erosional and/or reworked character of most (Early/Middle Pleistocene) preserved landforms and land-surfaces, great care must be taken not only when targeting sampling points, but also in interpreting the dated event (be that depositional or, even worse, erosional). Paleosol chronosequences have already proved to be significantly helpful in relative dating, providing *post* or *ante quem* estimates for artefacts resting on or buried within paleosols. Paleosol stratigraphy has been successfully integrated in Palaeolithic investigations in Epirus, Thessaly, Macedonia and Peloponnesus, but the complex soil sequences and depositional histories of the Greek landscapes call for attention when using pedostratigraphy for dating purposes. Furthermore, we still lack a confirmed model to explain the incorporation of artefacts inside paleosol horizons (*cf.* van Andel 1998), although some explanatory suggestions have already been presented with regard to the paleosols formed on redeposited *terra rossa* (Runnels and van Andel 2003); these need to be further elaborated



and tested in other depositional contexts, preferably along with the application of micromorphology. Biochronology can also be of much help in relative dating and in calibrating other dating techniques, especially when considering the constraints in absolute dating methods applied to the Early and Middle Pleistocene. Unfortunately, areas as rich in Palaeolithic finds as Epirus are blanketed with acidic soils, offering a very low potential for the preservation of faunal and hominin fossils; regions of southern Greece or Macedonia are most promising in that respect.

In order to establish a solid chronostratigraphic framework, we need not only more dating assays, but also more stratified material. Although this is an obvious prerequisite, it is not always a straightforward objective in research designs, mainly due to a reality of ‘low returns’ attached to this aim. In discussing the results of the Aliakmon Survey Project, I emphasized that the search for *in situ* material was the proper way to pursue the project’s goals, even if –in retrospect– this choice did not yield the desired outcome. As is obvious from the assessment of the Greek data-set, the crux of the problem in deciding over the existence of a Greek Lower Palaeolithic lies principally in the shortage of stratified remains. Thus far, there are no reports of horizontally extensive Lower Palaeolithic surface scatters (as in the case of, for instance, the Iberian Meseta), and my research indicates that such instances will hardly ever be found: it is not so much a matter of research intensity, it is more an issue of geomorphic controls. If exposed surfaces with ‘veils of handaxes’ are chiefly ‘wishful thinking’ for Greece, a great number of new surface finds would be needed if we are to say anything more than echoing the results presented here; at best, surface material from new areas would extend the mapped distribution of Lower Palaeolithic human presence –provided that the material is indeed able to do so (e.g. on the grounds of typo-technological criteria combined with geomorphological observations, if the collection is not mixed with younger material, etc). In contrast, *in situ* remains may acquire an importance much wider than that of mere data points in distribution maps. For the rudimentary status of the Greek Lower Palaeolithic, these will be the primary building blocks for a reference framework towards a regional culture-stratigraphic sequencing of surface

collections, save that the excavation of *in situ* material is the only means in unraveling hominin behavioral traits. This is not to undermine the value of non-stratified artefacts; rather, it is to emphasize that only with such reference-frameworks can surface material be used in a most fruitful manner. Far from being pessimistic, one is forced to expect that surface finds will continue to dominate the Greek Lower Palaeolithic collections of the future, at least in as much as they dominate the rest of the circum-Mediterranean records.

Where should we look for this highly-prized, potentially undisturbed and preferably stratified Lower Palaeolithic material? As has been repeatedly underlined throughout this book, low-gradient palaeosurfaces in basinal settings provide the best potential for a high quality of preservation; when inverted due to uplift, they may also offer the other main prerequisite for successful recovery: exposure, and hence archaeological visibility. The site of Kokkinopilos was emphasized (section 4.5.5) as providing such a ‘window of opportunity’, which combines both aforementioned parameters (preservation and visibility). Kokkinopilos was a closed depression (a *polje*), in which *terra rossa* has been redeposited in the low-gradient, low-energy depositional environment of an ephemeral lake; fault activity and uplift changed the drainage from endorheic to exorheic, initiating dissection, gully formation and exposure of long stratigraphic sections. ‘Absolute’ dating of this transition is lacking, but the intense erosion creating the badland morphology is most probably a recent phenomenon (Late Pleistocene but, mostly, Holocene). However, in contrast to what happened in e.g. the Guadix-Baza basin, erosion has not slowed down at Kokkinopilos; rather, it has been accelerated, most likely in very recent times. As a consequence, Kokkinopilos exemplifies also the latent drawbacks associated with such drainage transitions: excavating the badlands of Kokkinopilos will be a very difficult exercise, during which much attention will have to be paid to distinguishing between gully-reworked and non-reworked parts of the site<sup>67</sup>. Relatively better opportunities for

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67. Such a recent but intense erosional history indicates how the pace of geomorphic disturbance may be set by sub-millennial, even decadal-scale climatic fluctuations, as well as



subsurface investigations are offered by the current morphology and sedimentary preservation of another red-bed site of Epirus, namely Morphi. Lower Palaeolithic artefacts have not been reported yet from Morphi, but the site has a strong Middle Palaeolithic component and a thick tephra deposit to serve as an invaluable stratigraphic marker. The tephra at Morphi dates to *ca.* 374 ka and underlies a 12 m-thick red-bed zone, which is marked by paleosol horizons and is similar to zone B of Kokkinopilos (*i.e.* the zone where the Micoquian handaxe was found). Should artefacts occur immediately above the tephra (as my own, preliminary observations indicate), their typo-technological analysis could shed light to technological variability within this enigmatic time-frame (*ca.* 350–150 ka), potentially assisting in sketching for the first time a regional culture-stratigraphic ‘boundary’ between the Lower and the Middle Palaeolithic. Moreover, I would expect the red-bed sequence to continue also under the tephra; although the site is largely covered by recent (Holocene) alluvial deposits of unknown thickness, trial-trenches at selected locations could test the possibility of finding artefacts stratigraphically below the tephra.

The basin of Megalopolis in Peloponnesus would be another primary target for future research. Here, there is an essentially continuous Early and Middle Pleistocene lacustrine sequence of fine-grained sediments, accumulated in an internally-drained lake; at some point, most probably in the late Pleistocene, the drainage was captured by the Alfeios river, which eventually emptied the palaeo-lake. Therefore, Megalopolis experienced an advantageous –for today’s investigations– timing of drainage diversion, as in the case of the Spanish and Italian examples mentioned earlier. Flint artefacts have already been documented from locations that would have been at the margins of this lake (see section 4.7.2). Moreover, a hominin tooth that was found there in the 1960’s was reported as associated with a Biharian fauna (Sickenberg 1975) and is currently being re-studied (Harvati *et al.* in prep.). In this light, Megalopolis can be re-

garded as the most promising candidate for the recovery of an ‘Isernia-type’, primary-context Lower Palaeolithic site in Greece. Nonetheless, the exploitation of the lignite seams of the basin in opencast mines poses immense problems to the realization of archaeological excavations, as large parts of the basin have been significantly disturbed and reworked due to the quarrying operations –let alone the administrative issues that any research team would have to face. On the positive side, many sectors of the basin’s circumference have not been affected by quarrying. I would expect traces of hominin activity to be found at the margins of the palaeo-lake and this is where any surface or subsurface investigations should start with. Although Megalopolis has been extensively studied by geologists and palaeontologists, a great deal of original work is needed before and/or upon launching an archaeological research. Geomorphological mapping along with a small-scale dating project would be some of the first steps towards pinpointing locales for further investigation. On the basis of my personal observations and as a general strategy, I would also suggest the targeting of natural outcrops of lacustrine/fluvio-lacustrine deposits of the Early-Middle Pleistocene that were later exposed by streams, since the establishment of the Alfeios river network. In future investigations, priority could be given to deposits of the Choremi Formation and particularly its fossiliferous Marathousa Member, from which the hominin tooth is considered to be derived, but also to the early Pleistocene Apiditsa Formation. Overall, exposed sediments of the aforementioned formations should first be sought in the western part of the basin and preferably at locations that would have been at the margins of the palaeo-lake.

Not far from Petralona cave, the basin of Mygdonia in Macedonia (section 4.3.2) offers a depositional setting similar to that of Megalopolis, with lacustrine and fluvio-lacustrine sequences that extend back to the Early Pleistocene. A rich Pleistocene fauna has been discovered here, whilst unpublished results from an archaeological survey project note the presence of quartz artefacts that have been preliminary attributed to the ‘Early Palaeolithic’. Moreover, the saber-tooth *Megantereon whitei*, possibly related to hominin arrival(s) in Europe and found also in Dmanisi (Georgia) and Venta Micena (Orce, Spain), is in-

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Holocene anthropogenic influences; as a result, the infill of Kokkinopilos will not survive not even half a glacial-interglacial cycle.

cluded among the fauna of the important Early Pleistocene palaeontological locality of Apollonia. Examining outcrops of the Gerakarou and Platanochori Formations, with which many Villafranchian localities are associated (Koufos *et al.* 1995), would be a starting point for investigations in this basin. Notably, Mygdonia includes also Plio-Pleistocene volcanics (Mendrinou *et al.* 2010), which can be used not only as stratigraphic markers for regional correlations, but also for dating purposes.

The examples of Megalopolis and Mygdonia could be seen as representing some of the most prominent cases for recovering *in situ* Lower Palaeolithic material from fine-grained, lacustrine primary contexts. They also refer to depressions that are not *terra incognita* in terms of geological and geomorphological studies, archaeological investigations or palaeontological findings – a fact that adds extra advantages for any further research. In the same line, other basinal settings that can be pointed out would be, for instance, parts of the Florina-Ptolemais-Kozani basin complex, in which lakes that formed in the middle Miocene might have persisted into the Pleistocene, and from which Early Pleistocene proboscidean fossils have been reported (*e.g.* Doukas and Athanassiou 2003). The exact timing in the Pleistocene, when this basinal complex was fractured into the Florina, Ptolemais and Kozani (Servia) sub-basins is not well-resolved, but, if it occurred in the Late Pleistocene, the uplifted blocks of the sub-basins may prove to offer good visibility due to stream dissection. The depressions of eastern Macedonia and Thrace would have hosted highly productive habitats, conditioned by the combined and/or alternating existence of lakes, marshes, lagoons and shallow beaches (Psilovikos and Syrides 1984). Moreover, those complex and diverse drainage systems would have served as natural routes for animal and hominin movements, connecting the regions of the Near East with the Balkans and Europe<sup>68</sup>. However, these areas have been affected by marine transgressions and fluvial sedimentation, the latter resulting in the accumulation of 10- to 100-m-thick deposits overlying the Early and Middle

Pleistocene sediments. For instance, large parts of the Serres-Drama basin were covered by lakes (Echinos-Philippi), which were later filled with sediments debouched by Strymonas River (*ibid.*, 111). As a consequence, preservation potential may have been high here, but archaeological visibility is overall low at present. Nonetheless, the documentation of palaeontological localities (*e.g.* Tsoukala 1991; Athanassiou and Kostopoulos 2001; Doukas and Athanassiou 2003) indicates that there still exist possibilities for investigating out-cropping deposits.

The rest of the remaining key basinal settings of Greece are characterized by environments where either limnic deposits occur chiefly intermixed with fluvio-terrestrial sediments or where a preponderance of basically fluvial and/or alluvial/torrential deposits is documented. As a general trend, fluvial fines (*e.g.* overbank loams) are commonly under-represented in those sequences, occurring mainly in vertically restricted facies. Alternatively, wherever preserved and exposed, such fine-grained layers can serve as ‘marker beds’ that are easily visible and can be followed laterally. Nonetheless, the potential for recovering artefacts from primary contexts is reduced here, compared to the possibilities provided by former lake-settings, because of the highly dynamic environments of river systems and their ability to repeatedly rework older deposits (*cf.* section 6.2). The fluvial settings of Thessaly and Western Macedonia (Aliakmon basin) have already been discussed in some detail. Here, it is sufficient to emphasize two main points: (1) the new observations on the stratigraphy at Rodia (Thessaly), presented in this study, can be regarded as stimulating points of departure for further investigations: a lot of uncertainties may remain, but now we have at least some rough, new indications on the age of the deposits, and we can narrow-down the focus of investigations, *e.g.* in spatial terms (Middle Thessalian Hills and the area around the Rodia Narrows) or in terms of the lithic material to be targeted (quartz); (2) similarly, the Aliakmonas Survey Project paved the way for further research: apart from the new lithic and fossil collections, large areas were mapped and the first steps towards resolving the terrace-staircase system have been made, whilst radiometric dates are pending. In short, the results of this research and of previous projects may not be as impressive as originally

68. To put it in an archaeological scenery, they would connect the cave of Petralona with that of Yarımburgaz (which were almost contemporaneously in use).

hoped, but they are encouraging enough to suggest that there is still a lot to be researched in both of these two major river basins of Greece. Other important drainage networks remain virtually unexplored with regard to systematic investigations of Early and Middle Pleistocene deposits. Included in those are the greatest parts of the Axios river-Thessaloniki basin in northern Greece and those of Pyrgos-Kyllini basins in Peloponnesus; early Pleistocene fauna has been recorded in both of them (*e.g.* in the lower Axios valley for the former, and at Pyrgos and Kaifas for the latter; van der Meulen and van Kolfschoten 1986; Tsoukala and Melentis 1994; Koufos 2001; Doukas and Athanassiou 2003). Smaller-scale river basins, such as those of the Kalamata, the Kardamyli and the Oitylo in Peloponnesus, are by no means negligible, although they are mostly filled with conglomerates and sandstones deposited in alluvial fan and deltaic environments (*e.g.* Zelilidis and Kontopoulos 1999). Along the southern margin of the Gulf of Corinth (section 6.3), Early and Middle Pleistocene fan-deltas are exposed in outcrops of km-scale (both vertically and horizontally), which remain also unexplored; high-energy conglomeratic units predominate here, but lacustrine-lagoonal facies and floodplain fines are also interbedded. High Early to Middle Pleistocene sedimentation rates and a ‘good timing’ in the uplift of the depositional sequences (late Middle to Late Pleistocene until present), resulting in fan abandonment and stream dissection, place this case among the aforementioned group of inverted basinal settings; but, although there is a lot of potential for recovering *in situ* remains, there are equally lot of hindrances, most notably the fact that these are in essence massively bedded, unreachably high profiles of dominantly coarse-grained calibre.

Last but not least, caves and rockshelters should not be overlooked, despite the fact that cave use is an overall marginal and late phenomenon in the entire European Lower Palaeolithic record. Caves are indispensable sediment-traps that can potentially provide high-resolution geo-archaeological archives, and this is one of the reasons why they have so far been the dominant target in systematic investigations on the Palaeolithic of Greece. Certainly, there still remains a significant number of caves and rockshelters to be examined, while in some of those which have al-

ready been or are still being investigated, the excavations did not or have not yet reached the bedrock.

Section 6.4 highlighted the potential and the constraints for both subaerial and submarine research in the Aegean and Ionian islands. Similar to the above-suggested directions for fieldwork in mainland Greece, insular investigations could start with targeting basinal settings, especially those of islands with already documented palaeontological and/or archaeological findings (*e.g.* Crete, Rhodes, Mytilene, Milos). Earlier above (7.2), I stressed that the ‘best half’ of the Greek record (*i.e.* the once-emerged Aegean/Ionian landmasses) is now submerged. Yet, this could also be translated to a prediction that the likelihood of recovering here an Early/Middle Pleistocene primary-context site could be reversely related to the quality potential of this site: the surprises that the Aegean region can yield may be of such an exceptional character that we are still unable to foresee.

## 7.5 SUGGESTED RESEARCH SUBJECTS FOR FUTURE EXAMINATIONS

What we can indeed already anticipate is that the improvement of the Greek Lower Palaeolithic data-set is going to be a painstaking process: conditioned by a highly dynamic Quaternary landscape, the geological opportunities for the preservation of the Early and Middle Pleistocene archaeological archive are limited, and -as a general assessment- they seem to be significantly more limited than that of, for instance, the Iberian or the Italian peninsulas. This is not to undermine the potential for future discoveries in Greece: the more we realize and apprehend the effects of geomorphic biases, the more we armor our methodologies with analytical tools capable of unveiling those biases and hence locating new sites to unearth. It is in this direction that the research presented here aspired to contribute, and, as this direction follows the paths of earth-science disciplinary fields, my study was structured along a geoarchaeological axis. Other parallel and/or convergent lines of analysis towards examining the present status and future prospects of the Greek Lower Palaeolithic record could not be included here due to space limitations. The following issues could be considered as points of departure for such alternative (but also, complementing) lines of analysis:

1. A distinct biogeographical pattern appears to emerge with regard to glacial floral populations (and their range contractions/expansions) between eastern and western Greece (*cf.* section 6.2). How would this pattern be differentiated during interglacials, what was its contribution to the erosion/preservation potential and how is it associated with the apparent abundance of Palaeolithic sites in western Greece as compared to the eastern parts of the peninsula? In which ways could it have affected animal (and human) population distributions?
2. Considering the latest palaeogeographical reconstruction of the Pleistocene Aegean and Ionian Seas, it could be argued that Greece functioned not only as a refugium, but also as a 'transit area' (instead of a 'cul de sac') for animal and human movements in an east-to-west biogeographical and/or climatic transect. At least for the middle Pleistocene, "massive immigrations of new species from Asia" have been assumed (Mussi 2001, 19), and a rapid increase in faunal diversity observed in all three Mediterranean peninsulas (Greece, Italy, Iberia) is thought to be related to a progressive diffusion of taxa from Eastern and Central Europe (Kostopoulos *et al.* 2007). Let us recall here that South-East Europe and the area around the Black Sea is the region where "the humid faunas of Europe and Northern Asia intergrade with the faunas that lived in the arid area that extends from N. Africa to Central Asia" (van der Made and Mateos 2010). In extent, as soon as new hominin fossils are discovered in Greece, it will be of no great surprise if they also prove to belong to species originating from areas to the east of Greece. Overall, faunal and hominin biogeographical patterns and natural routes for large-scale movements are still under-studied in the broader Aegean region, much more with regard to east-west trending events.
3. Climatic fluctuations, intense tectonic activity and a complex topographic configuration would have increased environmental heterogeneity of Pleistocene Greece to levels probably even higher than those at present. Hominin forms within the hypodigm of *H. erectus* (*s.l.*) are assumed to have been generalists in their diet and to have used an unspecialized technological tool-kit; by all accounts, and following similar suggestions put

forth for the Italian record (*cf.* Mussi 2001), it is relatively safe to assume that early hominins would have been attracted by the mosaic habitats of Greece. In fact, it has been argued that *H. erectus* was a 'weed' taxon that profited from habitat fragmentation and ecosystem instability, being adapted for environmental and long-term habitat disturbance (Cachel and Harris 1998). Earlier in this study, the same parameters (climate oscillations and marked seasonality, ever-present tectonism and a 'broken-up' topography) were called upon to explain landscape instability and the limited preservation potential of the geoarchaeological archive. In other words, the same factors and processes that would have created conditions of landscape disturbance, allowing weed-like taxa to "thrive in disrupted environments" (*ibid.*, 119), are the ones also responsible for constraining the potential for hominin cultural and fossil remains to be preserved. As a working hypothesis for future research to test, I suggest here that there may be an inverse relationship between the degree of geo-climatic mosaicism and preservation potential. The approach advanced here sketched out possible means of assessing preservation potential for low-resolution data-sets in a large-scale spatio-temporal perspective; for records of higher resolution and for smaller scales of analysis, a more fine-grained modeling can be achieved. The 'degree of geo-climatic mosaicism' can be modeled by use of applied analytical tools, such as that of geodiversity<sup>69</sup>. Geodiversity assesses "the constituent elements within the physical environment that participate in the richness of biotopes, ecosystems or landscapes" (Reynard and Coratza 2007, 138); with a combination of morphometric, geological and morphoclimatic maps, and with the use of metric indices and spatial statistical analysis, the study of geodiversity allows researchers to quantify, describe and compare different land-

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69. Geodiversity is defined as "the natural range (diversity) of geological (bedrock), geomorphological (landform) and soil features, assemblages, systems and processes. Geodiversity includes evidence of the past life, ecosystems and environments in the history of the earth as well as a range of atmospheric, hydrological and biological processes currently acting on rocks, landforms and soils" (Zwolski 2004)

scapes, which can be either coeval in separate locations or throughout time (Benito-Calvo *et al.* 2009); as such, it provides “an objective and useful tool to understand the singularity and geocomplexity of landscapes” (ibid, 1433).

So far, the early colonization of Europe/Eurasia has been approached by focusing on a combination of various parameters, such as environmental constraints and climatic variability; behavioral capacities of the hominin agents (*e.g.* technological repertoires, hunting *vs.* scavenging, use of fire, etc); life history features and social organization; biogeographical and zooarchaeological proxies (*e.g.* mammal expansions, contractions and renewals, such as that of the carnivore guild); as well as a whole array of lines of evidence from multi- and inter-disciplinary domains, most of which are included in Life Sciences. This study elaborated on a hitherto largely neglected aspect of a Eurasian Early-Middle Pleistocene record: the biasing effects of geomorphic processes. The role of landscape processes in biasing archaeological records is commonly approached within the small-scale of individual sites. Choosing the scanty record of Greece as a case-study, this examination set forth to explore the first steps towards integrating geomorphic biases into approaches that consider wider temporal and spatial scales. If we are to ‘get the pattern right’ in *identifying* spatio-temporal models of

human presence/absence (Roebroeks 2006), then we need to develop analytical tools which will shed light on what geomorphic biases conceal or have already erased. Besides research biases, it is time to consider other possibilities when *explaining* the identified patterns: for example, the marked difference between the early Palaeolithic archaeological record of Greece and that of Italy or Spain, was suggested here to be more an artefact of Earth-Sciences-related matters (geomorphic biasing), than a reality explained in terms of Life-Sciences-related trajectories (*e.g.* hominin preferences). It can be argued that analogous examinations are needed before assessing ‘first’ and ‘last appearance dates’ of hominins in regions such as those of Asia, for which -likewise Greece- very little is known (*cf.* Dennell and Roebroeks 2005). Similarly, the ‘500 m. altitudinal threshold’ that has recently been proposed as one of the decisive criteria of the Lower-to-Middle Palaeolithic transition (Hopkinson 2007; *cf.* section 2.2 and Mussi 2001), may in fact be -according to the results presented here- a geomorphological threshold reflecting geomorphic biases, rather than hominin behavioral constraints: at least for landscapes like those of Greece, the 500/600 m contour defines the upland-lowland boundary (*cf.* Macklin *et al.* 1995), as well as the boundary between ‘areas of erosion’ and ‘areas of sedimentation’ in river basins (*cf.* Pinet and Souriau 1988).



