27 GEOARCHAEOLOGICAL AND GEOCHRONOLOGICAL INVESTIGATIONS OF PALAEOLITHIC OPEN-AIR SITES IN EPIRUS, GREECE

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27.1 INTRODUCTION

The province of Epirus in north-west Greece hosts the largest Middle Palaeolithic record in Greece (Elefanti and Marshall, 2015). Most of the known Palaeolithic sites in Epirus belong to a particular type of open-air sites, which consist of *terra rossa* deposits and are known as 'red-bed sites' (Fig. 1). Since the 1960's, it has been established that, wherever these red-beds occur, they are almost always associated with Palaeolithic artifacts –in fact, some of these sites are littered with thousands of chipped-stone tools (Dakaris et al., 1964; Higgs and Vita-Finzi, 1966). The interpretation of this association has generated a long and intense controversy (Bailey et al., 1992; Runnels and van Andel, 1993; King and Bailey, 1985; King et al., 1997; Papakonstantinou and Vassilopoulou, 1997; Papagianni, 2000; Runnels and van Andel, 2003; van Andel and Runnels, 2005; Tourloukis, 2009; Tourloukis et al., 2015). For a long time, those sites have been regarded as a fortuitous admixture of archaeological remains from different periods: sites with reworked deposits that essentially provide no context for the artifacts and are, therefore, of little archaeological value.

Mostly as a result of this view, extremely few of these sites have so far been examined with subsurface investigations (e.g., Dakaris et al., 1964). Recently, geoarchaeological work at the site of Kokkinopilos showed that, contrary to this old view, the red-bed sites can indeed yield artifacts from

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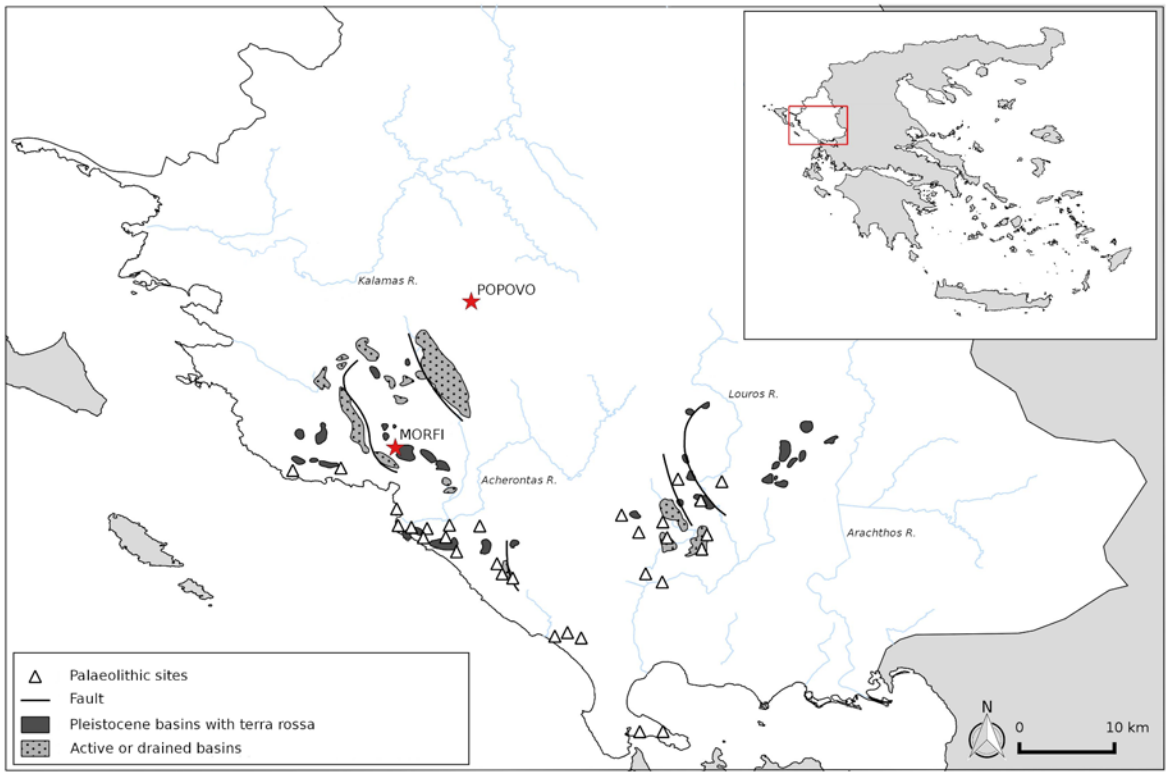

Figure 1: Map of Epirus showing the distribution of Palaeolithic sites in relation to the locations of Pleistocene basins with *terra rossa* and the active or drained poljes (modified after Runnels and van Andel, 2003). The sites of Popovo and Morfi, discussed in this study, are marked with a star.

in situ, geologically undisturbed –and hence datable– contexts (Tourloukis et al., 2015). Following on this work, we conducted a two-year geoarchaeological project (2016-2017) aimed again at red-bed sites, for two main reasons:

1) While most of the evidence from the red-beds is attributed to the Middle Palaeolithic, there are also specimens of potentially Lower and Upper Palaeolithic morphotypes. The high density of artifacts indicates an intensive and/or 'persistent' occupation during certain periods, as seems to be the case with the Middle Palaeolithic. Evidently, the lacustrine/marshy settings of those sites must have played a significant role in the Palaeolithic economy of the region (Runnels and van Andel, 2003). Yet, a focus on caves has created an unbalanced picture, biased towards Upper Palaeolithic cave contexts.

2) The collections of surface material from the red-beds comprise the bulk of the Middle Palaeolithic record of Epirus. Considering that Epirus has the largest Palaeolithic record in Greece, it becomes obvious that the investigation of those sites will have implications for our understanding of the Palaeolithic of Greece as a whole.

27.2 METHODOLOGY

Our investigations focused on the site of Morfi, which is known from the 1960s, and Popovo, which is a new site that we discovered in 2015 (Kourtessi-Philippakis et al., 2019a, b). A double intensive surface survey was conducted at both sites. At Popovo, we employed a near-total collection strategy, picking up all specimens with knapping attributes. At Morfi, however, the sheer amount of surface finds dictated a judgmental/representative collection strategy focusing mainly on cores, blanks, retouched tools and, occasionally,

knapping debris. At both sites, test trenches were opened at selected locations, with spits of 5 to 10 cm following the stratigraphy, while all finds were piece-plotted with a differential GPS device.

Designated profile sections were cleaned, logged and described following standard pedological and lithostratigraphic criteria. At geoarchaeological contexts of interest, and especially at stratigraphic boundaries, monolith-type samples of intact sediment were removed as blocks of ca. 10 x 10 x 15 cm, stabilized with plaster, for micromorphological analyses through the study of thin sections. Geological sampling included also bulk samples for isotopic, geochemical and microfossil analyses, which are still on-going.

Additionally, sediment samples were collected for radiometric dating with the methods of post infra-red infra-red stimulated luminescence (pIRIR), optically stimulated luminescence (OSL) and cosmogenic nuclides dating. Sediment samples for dating with the $^{40}Ar/^{39}Ar$ method were collected from the layer of tephra at Morfi (see below). Whether it was for geoarchaeological analyses or dating purposes, our sampling strategy sought to not only cover most of the stratigraphic sequences (vertical dimension), but also address issues of lateral variation in context (horizontal dimension).

27.3 RESULTS

27.3.1. POPOVO

The site of Popovo is located at an altitude of ~500 m in a shallow polje that is surrounded by low mountains (Fig. 2a). The geological sequence is composed of clay and silt, and is about 15 m. thick. We collected lithic artifacts from almost the entire extent of the site, but our evaluation of surface distributions showed that, rather than representing undisturbed, *in situ* concentrations, most surface aggregates essentially result from erosion and re-deposition. Small streams and gullies that run through or cut across the depression have significantly disturbed the site. The Popovo lithic assemblage includes artifact classes from all stages of the reduction sequence, namely cores, blanks, retouched tools, and waste products (Thompson et al., this volume).

The Popovo deposits have been affected by tectonic activity, but erosion and slope-washed sediments have obliterated or obscured the original geometry of the faults, some of which could be of syn-sedimentary origin. Additionally, the present-day badland landscape has been shaped by extensive recent and/or older episodes of sediment re-deposition by mass-wasting and other erosional processes, such as runoff, slope wash and colluviation. Another significant problem is the widespread presence of soft-sediment deformation structures, produced by processes such as slumping, which are triggered by seismic events or by chemical processes related to karstification; such deformations may affect the deposits at a small scale, but they also affect entire hillslopes and, in this case, have resulted in substantial slope alterations that complicate the understanding of the stratigraphy. In view of the lack of fresh geological exposures, much of our efforts focused on cleaning slope profiles at selected locations across the site, where the stratigraphic sequence was considered locally intact. Eventually, it was evident that only with heavy machinery (bulldozer) it would be possible to remove all of the slope-washed sediment and reveal intact section profiles, but this option was not covered by our research permit. The excavation of test trenches yielded only two undiagnostic artifacts; unfortunately, more stratified artifacts that were collected during the cleaning of the profiles are also typologically undiagnostic and cannot be used for attributions to specific techno-complexes. In sum, due to the combined effects of all the above-mentioned geological processes affecting

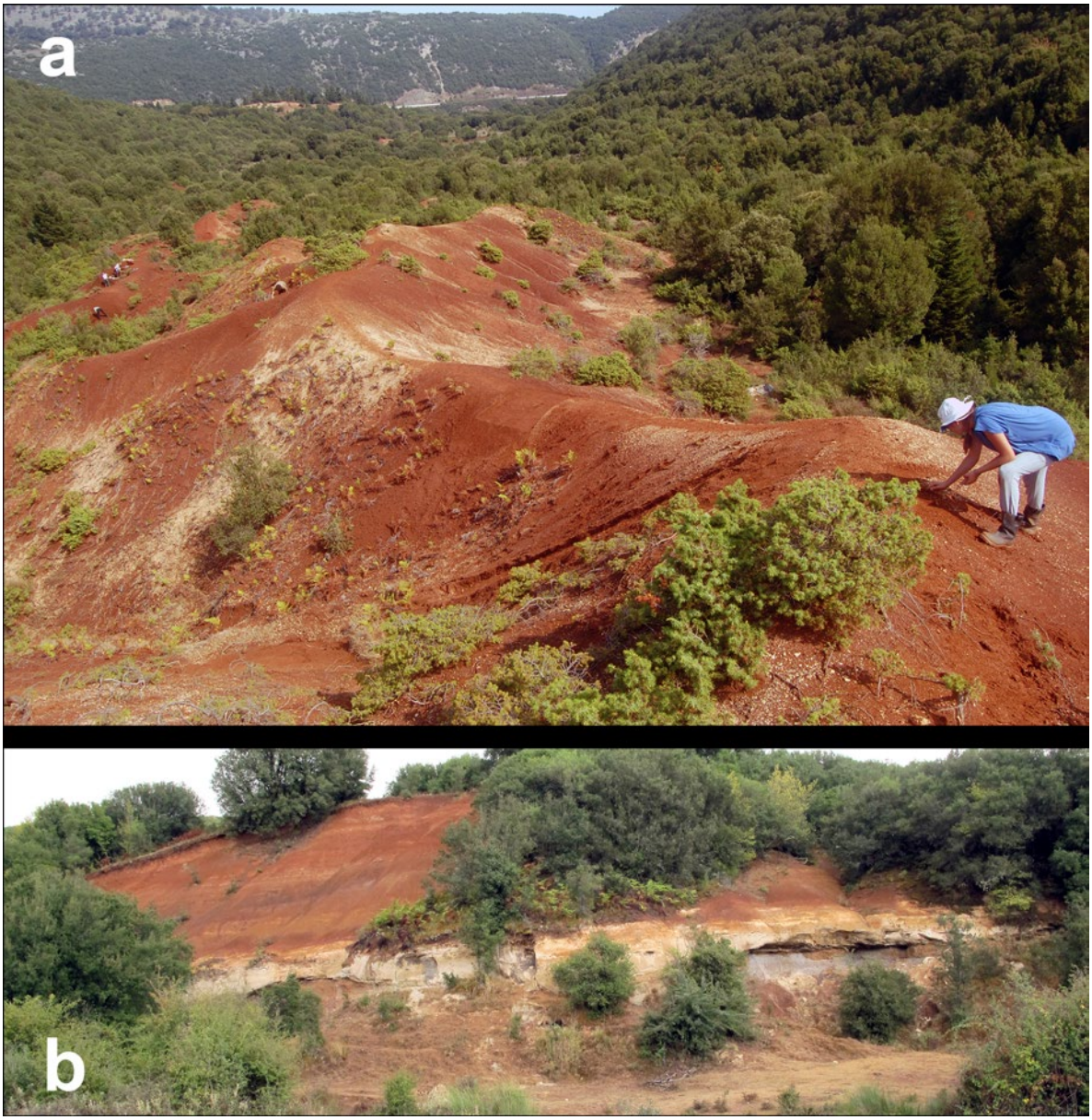

Figure 2: a) Panoramic view of the site of Popovo; b) general view of the site of Morfi, showing the layer of tephra and the overlying artifact-bearing zone of *terra rossa* deposits.

the stratigraphy, it was not possible to construct a stratigraphic scheme for the site, and the finds (stratified and/or surface) could not be placed in the local geological sequence.

27.3.2. MORFI

The raised and dissected polje near the village of Morfi (Fig. 2b) is known as a rich Palaeolithic site since the investigations of E. Higgs and S. Dakaris in the 1960s (Higgs, 1965; Higgs and Vita-Finzi, 1966). More recently, it was revisited in the framework of the Nikopolis Project (Runnels and van Andel, 2003). The site has yielded thousands of lithic artifacts, but none of the previous teams conducted test trenches, and any artifacts potentially found stratified were not documented as such or placed in a stratigraphic profile (Papayianni, 2000). Moreover, the aerial extent of the site

was never assessed or mapped. Our investigations suggest that Morfi is one of the most extensive and artifact-rich open-air sites in Epirus and includes areas with extremely dense concentrations of finds.

The geological sequence at Morfi begins with a paleosol overlying the karstic bedrock and underlying yellowish red silty clays; the latter are overlain by leached, grey clays, which are in turn overlain by a ca. 2.5-m-thick layer of tephra deposit (Pyle et al., 1998; Runnels and van Andel, 2003). The deposit of volcanic ash is exposed at three locations in the polje and so it is used as a stratigraphic marker for lithostratigraphic correlations across the site. Above the tephra layer lies a 10- to 15-m-thick zone of *terra rossa* deposits (detrital red silty clays), which includes three or four intercalated units of sand and flint gravels. The latter probably represent distal alluvial fan deposits such as debris flows, and crop out at several locations, hence they are also used for correlation purposes. This zone of *terra rossa* is currently being exposed by headward alluvial erosion, it includes artifact-rich horizons and was therefore the focus for cleaning profile sections and opening test trenches. Distinct, thin layers rich in iron and manganese oxides that form hardpan-horizons and can be followed laterally were also used as stratigraphic markers to help correlate the stratigraphy in different areas of the site.

Artifact-bearing layers occur at various levels throughout the zone of red clays (Fig. 3). This can be interpreted as indicative of repeated hominin visits during the Middle Palaeolithic. Stratified finds were retrieved from mainly three different kinds of geological contexts:

1) artifacts in gleyed sediments indicate low-energy sedimentation under wet conditions, probably related to ephemeral wetlands; drab halo root traces, mottles and iron-manganese pedo-features are redoximorphic traits, which resulted from changes in the redox conditions of the soil in response to fluctuation in water saturation (Ashley et al., 2013).

2) artifacts stratified in bedded sands and gravels; these can be considered as finds in secondary positions, associated with sheet-floods or the distal parts of dilute debris flows.

3) artifacts embedded inside paleosol horizons indicate intervals of dry conditions with subaerially exposed surfaces.

By definition, paleosols indicate breaks in the sedimentation, and in Epirus, these have been estimated to be in the order of a few to tens of thousands of years old (cf. Runnels and van Andel, 2003). Besides the paleosols, there are no major hiatuses in the sequence, as we did not observe any geological unconformities. Unfortunately, so far none of the samples from the *terra rossa* have yielded adequate quantities of mineral grains of quartz or K-feldspars for conducting the necessary measurements for luminescence dating with the methods of OSL or pIRIR. Similar problems affected the samples from Popovo, which also failed to yield any results. The overall scarcity or total lack of the desired minerals is attributed to the bedrock lithology of the area, which is dominated by limestone and evaporites (Ntokos, 2017).

In the location of Morfi, our efforts with the method of cosmogenic nuclides faced the problem that, after cleaning the samples, the remaining material was a microcrystalline quartz. This material was not suitable for cosmogenic burial dating, with *in situ*-produced ^{26}Al and ^{10}Be, most likely due to the incorporation of a substantial amount of meteoric ^{10}Be.

Nevertheless, the samples from the layer of tephra at Morfi appear to work quite well and there are already very promising first results from the on-going analyses of the $^{40}Ar/^{39}Ar$ dating method: the tephra was deposited in the polje at around 200 ka, which is considerably younger than the age obtained by Pyle and colleagues (1998). Major and minor element compositional data from the Morfi tephra are now being processed for geochemical fingerprinting and will be compared to known

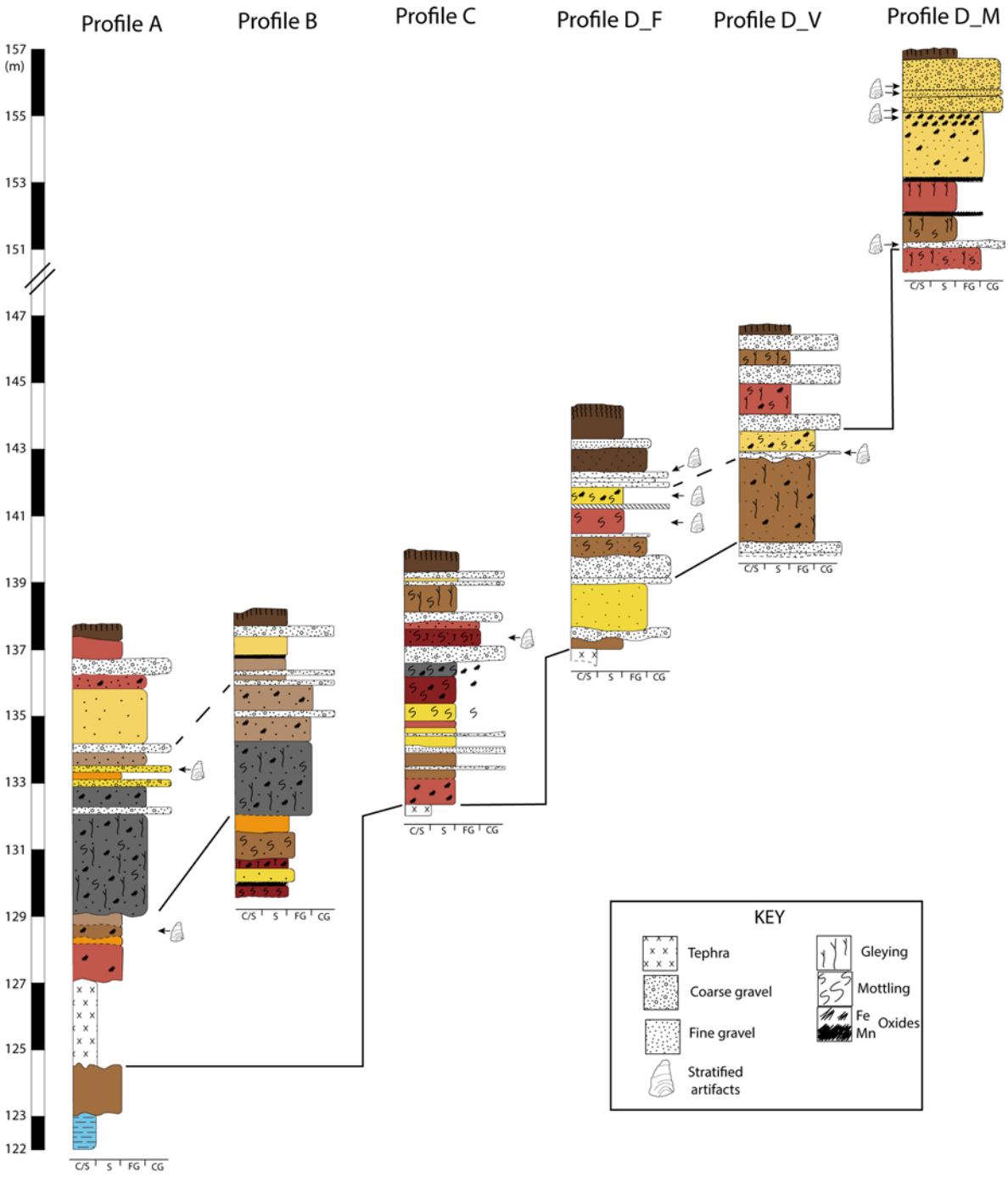

Figure 3: Preliminary stratigraphic correlations between the logged profiles at Morfi, showing the artifact-bearing horizons. Note the presence of the tephra layer at the base of the studied sequence.

late Middle/Late Pleistocene volcanic glass datasets from Mediterranean and Balkan localities, in order to determine the volcanic source.

As the tephra directly underlies the entire artifact-bearing zone of *terra rossa*, its dating provides a useful *terminus post quem* for the archaeological record of Morfi. On the grounds of macroscopic pedo-sedimentary and lithostratigraphic analyses,

there does not seem to be any considerable hiatus separating the volcanic ash from the first *terra rossa* deposits. While the final results from the micromorphological analysis are pending, if the aforementioned observation is further confirmed, then the artifacts retrieved from the lower layers just above the tephra should date to somewhere close to 200 ka.

27.4 DISCUSSION AND CONCLUSIONS

At both Popovo and Morfi, sedimentary facies with evidence of gleying and mottling attest to sedimentation under wet conditions and/or periodical waterlogging, while paleosols, bands of oxidations and desiccation surfaces mark depositional breaks and designate subaerially exposed surfaces. Stratified artifacts that have been found inside paleosols indicate the presence of hominins when the marshy setting of the poljes was mostly dry, while artifacts found in sediments deposited within the zone of water-table fluctuation, point to exploitation of the sites when the water was more abundant in localized ponds.

Both sites can be considered as including mainly cumulative but also erosional and spatial palimpsests of varying resolution (Bailey, 2007). Yet, in both cases there is a remarkable consistency in the typo-technological composition of the assemblages, the raw materials used and the intra-site range of chemical weathering; the bulk of the assemblages can be attributed to the Middle Palaeolithic, followed by an Upper Palaeolithic component. Preliminary as it may be, this assessment matches evaluations made by previous studies for Morfi and other coastal sites (e.g., Papayianni, 2000). Retouched tools diagnostic of the Neolithic or the Bronze Age occur only in extremely few numbers, pottery fragments were not observed, and ground stone-tools were not encountered at all (see also Thompson et al., this volume). As the composition of the assemblages is reported elsewhere (Thompson et al., this volume), suffice it here to note that toolkits with clear Mousterian typo-technological characteristics and the full range of Levallois flake cores are well-represented at both sites. Tool-type frequencies are overall similar, including Levallois, pseudo-Levallois, Mousterian and bifacial leaf-points. Scrapers occur in higher frequencies at Popovo than at Morfi, where there are also large single platform blade cores that are absent at Popovo, even though Middle Palaeolithic blades are similar in frequencies at both sites (Thompson et al., this volume). The study of core reduction sequences is on-going, and no particular chrono-cultural patterns can be discerned at this point.

Notwithstanding such an 'internal consistency' evident in both sites, attributing lithic assemblages to discrete chronostratigraphic units requires provenanced material as well as an adequate understanding of the stratigraphy on which this material will be eventually anchored. This was not the case at Popovo, where the combined effect of tectonics, slumping events, and contemporary erosion and re-deposition, coupled with a scarcity of stratified occurrences, altogether prevent the development of a chrono-cultural scheme framed by stratigraphy. Future investigations at this site would require a research permit for large-scale profile cleaning with heavy machinery and extensive excavation trenches. In contrast, the presence of the tephra and pedo-sedimentary features that can be used as stratigraphic markers at Morfi allow for placing different artifact-bearing deposits into a chrono-stratigraphic scheme, albeit tentative and lacking the number of radiometric dates that was originally expected. The age of the tephra at ca. 200 ka prompts us to hypothesize that the lowermost artifact-bearing layer(s) potentially date to Marine Isotope Stage 6; if confirmed, such a finding would give further support to the hypothesis that some of the red-bed sites of Epirus contain

a Middle Palaeolithic component that pre-dates the last interglacial (Tourloukis et al., 2015).

The differences in the context and preservation of finds between the two sites (e.g., frequency of stratified vs. surface occurrences) can be most likely attributed to differences in local site formation processes. The site of Morfi is located inside a basin that is larger than that of Popovo and apparently involved a more gentle, flatter terrain with low slope angles; the envisioned mass-wasting processes here include runoff, dilute debris flows and sheet-floods that may have produced archaeological palimpsests but have not altered substantially the original geomorphological configurations and the stratigraphic integrity of the site at present: geologically *in situ* artifact-bearing horizons can still be discerned and assessed. In contrast, Popovo is a relatively small, inland basin, where hominin activities occurred at places close to the mountain flanks and were likely affected by more catastrophic erosional processes (syn- and post-depositional), such as slope failures, landslides and slumping, triggered by tectonics (as faults have been identified) and accelerated by the steeper relief and the proximity to the mountain front.

The red-bed sites are known from the 1960s and they have produced thousands of artifacts, which make up the bulk of the record from Epirus, a region with probably the largest Palaeolithic record in Greece. The work presented here for the first time combined the opening of test-trenches, a dating program that included every method that could be applied on the available materials, extensive sampling for micromorphological studies and palaeoenvironmental proxies, and a stratigraphic approach in order to support chronological/cultural attributions. Our investigations led to the discovery of Popovo, a new site with a difficult stratigraphy, but still very important finds (Thompson et al., this volume). The re-dating of the volcanic ash at Morfi is expected to have major implications for research on the critical period around 200 ka in the Southern Balkans, and, in the future, it may even allow us to compare archaeological records on the two sides of the Adriatic.

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REFERENCES

Ashley, G.M., Deocampo, D.M., Kahmann-Robinson, J., and Driese S.G., 2013. Groundwater-fed wetland sediments and paleosols: it's all about water table. New Frontiers in Paleopedology and terrestrial paleoclimatology: paleosols and soil surface analog systems, SEPM Special Publication, 104, pp. 47–61.

Bailey, G., 2007. Time perspectives, palimpsests and the archaeology of time. Journal of Anthropological Archaeology, 26, pp. 198–223.

Bailey, G., Papakonstantinou, V., and Sturdy, D., 1992. Asprochaliko and Kokkinopilos: TL dating and reinterpretation of Middle Palaeolithic sites in Epirus, north-west Greece. Cambridge Archaeological Journal, 2, pp. 136–144.

Dakaris, S.I., Higgs, E.S., and Hey, R.W., 1964. The Climate, environment and industries of Stone Age Greece: Part I. Proceedings of the Prehistoric Society, 30, pp. 199–244.

Elefanti, P., Marshall, G., 2015. Late Pleistocene hominin adaptations in Greece, in: Coward, F., Hosfield, R., Pope, M., Wenban-Smith, F. (Eds.), Settlement, society and cognition in human evolution. Cambridge University Press, Cambridge, pp. 189–213.

Higgs, E.S., Vita-Finzi, C., 1966. The climate, environment and industries of Stone Age Greece: Part II. Proceedings of the Prehistoric Society, 32, pp. 1–29.

King, G., Bailey, G., 1985. The palaeoenvironment of some archaeological sites in Greece: the influence of accumulated uplift in a seismically active region. Proceedings of the Prehistoric Society, 51, pp. 273–82.

King, G., Sturdy, D., Bailey, G., 1997. The tectonic background to the Epirus landscape, in: Bailey, G.N. (Ed.), Klithi: Palaeolithic Settlement and Quaternary Landscapes in Northwest Greece, Klithi in its Local and Regional Setting, vol. 2., McDonald Institute for Archaeological Research, Cambridge, pp. 541–558.

Kourtessi-Philippakis, G., Pomonis, P., and Sakkas, D., 2019a. Archaeological survey research in the Middle Kalamas river basin of Thesprotia, 2011-2015: first results, in: Chouliaras, I. and Pliakou, G. (Eds.), Thesprotia I, Proceedings of the 1st Conference on the Archaeology and History of Thesprotia, Ioannina 2019, pp. 1–20 (in Greek).

Kourtessi-Philippakis, G., Tourloukis, V., Sakkas, D., and Michos-Rammos, F., 2019b. The survey research of the University of Athens in the Middle Kalamas River basin. Archaeologiko Deltio, 70, Chronika 2015, Athens, pp. 833–838 (in Greek).

Ntokos, D., 2017. Synthesis of literature and field work data leading to the compilation of a new geological map–a review of geology of northwestern Greece. International Journal of Geosciences, 8, pp. 205–236.

Papagianni, D., 2000. Middle Palaeolithic Occupation and Technology in Northwest Greece: The Evidence from Open-Air Sites. British Archaeological Reports, 882, Oxford.

Papakonstantinou V., Vassilopoulou, D., 1997. The Middle Palaeolithic industries of Epirus, in: G.N. Bailey (Ed.), Klithi: Palaeolithic Settlement and Quaternary Landscapes in Northwest Greece, vol. 2: Klithi in its local and regional setting, McDonald Institute for Archaeological Research, Cambridge, pp. 459–80.

Pyle, D.M., van Andel, T.H., Paschos P., and van den Bogaard, P., 1998. An exceptionally thick Middle Pleistocene tephra layer from Epirus, Greece. Quaternary International, 49, pp. 280–86.

Runnels, C., van Andel, T.H., 1993. A handaxe from Kokkinopilos, Epirus, and its implications for the Palaeolithic of Greece. Journal of Field Archaeology, 20, pp. 191–203.

Runnels, C., van Andel, T.H., 2003. The Early Stone Age of the Nomos of Preveza: landscape and settlement, in: J. Wiseman and K. Zachos (Eds.), Landscape Archaeology in Southern Epirus, Greece I, Hesperia Supplement, 32, American School of Classical Studies at Athens, Athens, pp. 47–133.

Thompson, N., Kourtessi-Philippakis, G., Giusti, D., Harvati, K. and Tourloukis, V., this volume. The preliminary analysis of lithic assemblages from the archaeological survey and test-trench excavations at Popovo and Morfi, Greece.

Tourloukis, V., 2009. New bifaces from the Palaeolithic site of Kokkinopilos, Greece and their stratigraphic significance. Antiquity, 83(320), Project Gallery.

Tourloukis, V., Karkanas, P. and Wallinga, J., 2015. Revisiting Kokkinopilos: Middle Pleistocene radiometric dates for stratified archaeological material in Greece. Journal of Archaeological Science, 57, pp. 355–369.

van Andel, T.H., Runnels, C., 2005. Karstic wetland dwellers of Middle Palaeolithic Epirus, Greece. Journal of Field Archaeology, 30, pp. 367–384.