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Pleistocene Palaeogeography and Palaeolithic Archaeology: The Tectonically Active North Aegean Sea Case Study

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Introduction

The Aegean area was part of the Hellenic orogenic system throughout the early Tertiary with continuous landmasses between mainland Greece and Western Anatolia. This continental status, known by Philippson as "Agaeis" (Philippson, 1901), lasted until the late Miocene, when mammal migrations of the 'Pikermi' fauna (*Hipparion* as characteristic fossil) occurred. At this period, the last Tethyan oceanic remnant of the Ionian Basin entered the Hellenic subduction zone and resulted in the acceleration of the African plate subduction (from 1 to 5 cm/year) and created the individualization of the Aegean microplate, south of the North Aegean Basin (e.g., Royden and Papanikolaou, 2011). The above geodynamic change gradually produced a thinning of the Aegean continental crust causing subsidence, which became more extensive during the Quaternary. Data based on lithoseismic profiles in the North Aegean (Skyros Basin) indicate that towards the Skyros and Limnos Platform there is no sedimentary cover or a very thin cover (e.g of several tens of meters) resting on top of the Alpine basement. According to published sedimentation rates obtained from coring, the older sediments might extend back to 400-500 Ka in extended areas of the Central - North Aegean Sea (Papanikolaou *et al*., 2019). The availability of high resolution bathymetric and seismic reflection data revealed that several of North Aegean islands would be connected by stretches of land allowing terrestrial animals to travel between them. The existence of such land passages would have affected connectivity and thus biodiversity and colonization rhythms. The overall aim of this study is to provide a synthesis of the North Aegean palaeogeography during the Pleistocene and examine its role as a southeastern entrance to hominin movements out of Asia and into Europe and subsequent occupations and migrations.

State-of-the art

New high resolution bathymetric and seismic reflection data, bolstered with tectonic data on active faults have enriched our understanding of the palaeogeography of the North Aegean. Regional subsidence rates at the Aegean margins during the last 400 Ka have been investigated using high-resolution seismic reflection profiles, indicating a gradual process, based on successive glacial sea-level lowstand systems of Marine Isotope Stages (MIS) 2, 6, 8, 10 and probably 12 (Lykousis, 2009). Higher subsidence rates were calculated for MIS 12–8 at the North Aegean margins (1.46–1.88 m/Ka) whereas sedimentological and mineralogical analyses in commercial boreholes in the northern Aegean revealed sediment deposition under riverine-lake conditions throughout the Pliocene and the Early Pleistocene.

In world prehistory, the questions of geography and process of the first penetrations to Europe by late Early Pleistocene hominins and later colonization by Middle Pleistocene hominins remain wide open. In Iberia, several pre-1 Ma and post-1 Ma archaeological sites indicate a very early presence of hominin groups. By comparison, the very sparse and contested Balkan archaeological record from the same periods meant that, until recently, the role of the Balkan Peninsula as a gateway to Europe has been unclear. The question became all the more pressing by the discovery a *Homo erectus* skull near Kocabaş in the province of Denizli, Aegean Turkey, dating to around 1.1 Ma.

Results and Discussion

More recently, archaeological work at Rodafnidia, Lisvori, near the Gulf of Kalloni on the island of Lesbos, ~300 km to the west of Kocabaş, returned absolute dates and evidence of Middle Pleistocene hominin activity from ~500 ka (Galanidou *et al*., 2013). The archaeological variability has indicated repeated hominin occupations on Lesbos over long periods of time from at least the early stages of the Middle Pleistocene. The stone tools from the site belong to the Acheulean and have close industrial affinities with material excavated at Gesher Benet Y'aaqov on the bank of the Jordan River in northern Israel, which dates to 800 Ka and the lower strata at Kaletepe Deresi 3 on a seasonal drainage in the Göllüdağ area near Cappadocia. The verterbrate palaeontology of Lesbos (Villanfrancian fauna) suggests that animal crossings from Anatolia to the Aegean began much earlier. Two possible, though not mutually exclusive, routes for early hominin dispersals from Anatolia to Europe therefore emerge: through the, inadequately explored, northern Balkan territories, or through a southern route in the North Aegean. Thus, the extensive submerged landscapes of the Aegean hold clues to understanding the early Pleistocene hominin expansions 'Out of Asia' into Europe.

A second issue concerns the situation after the submergence of the N. Aegean, when migrations depended on land connections exposed during glacial sea-level lowstands. These coastal landscapes may have provided relatively fertile and productive refugia for plants, land mammals and hominins. The Palaeolithic sites discovered in the last 20 years on the islands of Crete, Thasos, Limnos, the Inner Ionian Archipelago and Lesbos suggest that land-bridge crossings become more frequent in the late Middle and Late Pleistocene, as glacial lowstands reached ~120 m below present.

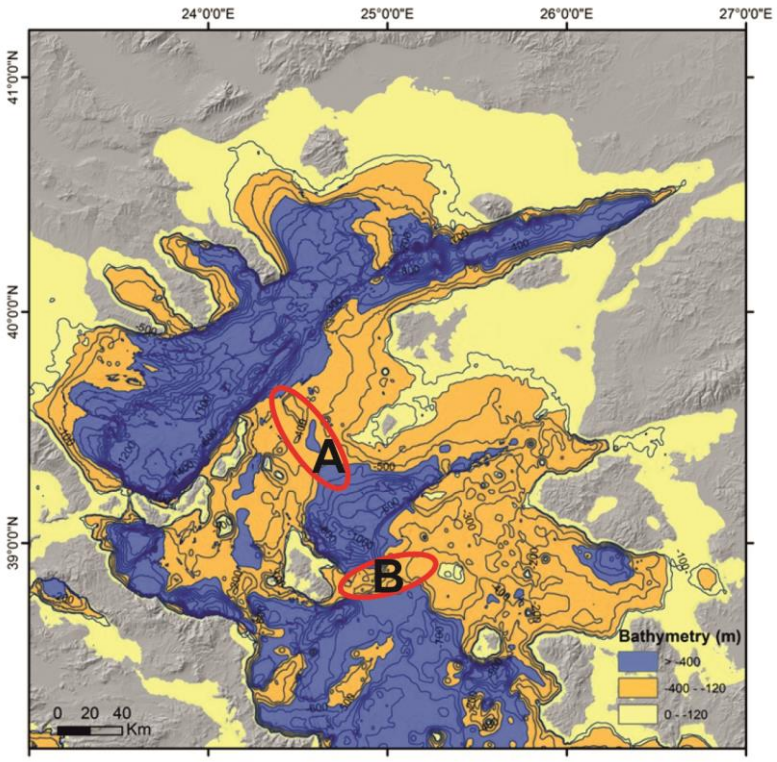

Fig.1 Bathymetric map of the North Aegean area showing the areas: 0-120 m depth, where the paleocoastline was located 20 Ka ago during MIS 2, 120-400 m depth, where palinspastic tectonics show the existence of land bridges during MIS 4, 6 and 8, and depths more than 400 m, where palinspastic tectonics show the existence of marine basins.

Some answers related to the questions on the evidence for land bridges during glacial sea-level lowstands of the late Middle and Late Pleistocene and their importance for human migrations may be obtained from the study of the North Aegean Sea and especially of the Northern Sporades - Limnos platform, which might serve as a major land bridge from Northwestern Anatolia to southeast Thessaly (Fig. 1, area A). Here the maximum depth is about 350 m, between the islands of Aghios Efstratios and Kyra Panagia - Youra. Another probable land bridge might have been south of the Skyros Basin, between Lesbos and Skyros – Evia, where the maximum depth is around 250m (Fig. 1, area B). The study of the active faults surrounding this area of the two North Aegean platforms has shown that the fault throws are several hundred m or even more than 1.0 –1.5 km. Especially in the case of area B the NW-SE faults forming a graben structure with fault lengths more than 8–11 km east of Skyros Island have probably caused the tectonic subsidence of the platform to 250 m depth. Taking into account the available chronological data in combination with the available sedimentation rates we may conclude that several active faults have been activated during the last 200–400 Ka, with slip rates ranging around 3mm/yr. Thus, the presently maximum depths within the North Aegean platforms did not exist during the previous lowstands in MIS 4, 6 and 8.

In conclusion, land bridges between the western coastlines of Minor Asia and the eastern coastlines of continental Greece probably existed during the lowstands of MIS 4, 6 and 8, due to the regional subsidence combined with the tectonic subsidence caused by the normal/oblique faulting especially of the NW-SE trending faults within the platform areas (Papanikolaou *et al*., 2019). Thus, hominin migrations were possible through the North Aegean until the late most Middle Pleistocene around 140 Ka.

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