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# Combined Zonation of the African-Levantine-Caucasian Areal of Ancient Hominin: Review and Integrated Analysis of Paleogeographical, Stratigraphic and Geophysical-Geodynamical Data

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## Abstract

The origin of the man at the Earth is directly associated with the determination of directions of the flow distribution of the ancient man migration to adjacent territories. In such studies traditionally mainly landscape and climatological changes are considered. We suggest that along with the above factors, regional tectonic-geodynamic factors played a dominant role in the character of migration. The considered African-Levantine-Caucasian region is one of the most complex regions of the world, where collisional and spreading processes of geodynamics converge. First is determined an essential influence of the Akchagylian hydrospheric maximum (about 200 m above the mean sea level) limiting the ancient men migration from Africa to Eurasia. We propose that the Levantine Corridor emerged after the end of the Akchagylian transgression and landscape forming in the Eastern Mediterranean. This corridor location was formed by the movements between the Dead Sea Transform and the boundary of the carbonate platform of the Mesozoic Terrane Belt. Further landscape evolution was largely determined by the geodynamic behavior of the deep mantle rotating structure occurring below the central part of the region under study. All the mentioned events around and in the Levantine Corridor have been studied in detail on the basis of the combined geodynamic, paleogeographic, and paleomagnetic analyzes performed in northern Israel (Carmel uplift and Galilee plateau). Careful studies of the Evron quarry geological section indicate that it is a unique one for the dating of the marine and continental archaeological sequences and sheds light on the movement of the ancient man along the Levantine Corridor.

**Keywords:** Hydrospheric events, tectonic-geodynamic zonation, paleogeographic reconstructions, ancient man migration, Levantine Corridor, paleomagnetic correlation, deep geodynamic factors

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## Introduction

The problem of origin, features of evolution, changes in the landscape and climatic conditions of habitation and migration of ancient hominin ultimately forced to formulate a number of promising methodological and theoretical studies (e.g., Bobe et al., 2007, 2010; Camps and Chaudan, 2009; Bar-Yosef and Belmaker, 2011) . Since this most important research program is associated with the Late Cenozoic history of the Earth (and not only with it, but also with its most active tectonic region), we consider it necessary to reveal the leading geological and geophysical factors of the appearance and development of ancient humans in the transition zone of Gondwana and Eurasia (Ben-Avraham et al., 2005; Eppelbaum and Katz, 2021).

In this regard, the Eastern Mediterranean is the central region through which, for many hundreds of thousands of years (and in general - according to radiometric and paleomagnetic data (Scardia et al., 2019) about 2.0 Ma), hominin moved from the primary East African range to the regions Eurasia (Figure 1).

The narrow Levantine Corridor was an important link in this route of movement (Bar-Yosef, 1987). It passed near the coastline of the Neotethys-Mediterranean basin in the epoch of mass migration of late hominins (Groucutt et al., 2021), which was changing its shape due to tectonic-eustatic and glacioeustatic factors of geodynamics (Eppelbaum and Katz, 2015a, 2022).

If we consider the migration path as a whole, then the paradox of the seemingly broken habitat of ancient hominin, which includes three habitats: (1) the East African Rift Belt, (2) the carbonate platform of the Mesozoic Terrane Belt, and (3) the Anatolian-Caucasian zone Alpine orogen. This topological paradox is well illustrated by numerous paleo-archaeological, anthropological, paleontological, paleomagnetic, radiometric and landscape-ecosystem research methods (e.g., Ronen, 1991; Heimann. and Braun, 2000; Goren-Inbar et al., 2004; Bobe et al., 2007; Camps and Chauhan, 2009; Belmaker, 2010; Guseinov, 2010; Leakey and Werdelin, 2010; Davis et al., 2011; Scardia et al., 2019; Trifonov et al., 2019; Ozherel'yev et al., 2020; Hershkovitz et al., 2021; Schelinsky, 2021). However, from the standpoint of regional geology and the evolution of terrestrial processes, it has not been systematically analyzed due to the fact that, in theoretical and practical terms, the data of global geodynamic mapping and zonation of this complex region became the subject of generalization only recently (e.g., Eppelbaum et al., 2021).

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To solve these problems, a variety of mapping methods were applied: paleogeographic, geomorphological, geophysical, paleomagnetic, structural-tectonic, and planetary-geodynamic. Together with them, both their own data (Katz, 1986; Eppelbaum and Katz, 2012, 2015a, 2015b) and literary sources in the field of historical planetology, cyclic stratigraphy, paleopedology, and ecological-stratigraphic analysis were widely involved in order to compare marine and continental formations. Along with this, numerous data on geological mapping were attracted (Hall et al., 2005; Krasheninnikov et al., 2005; Segev and Sass, 2010; Karcz and Sneh, 2011; Sass et al., 2013; Sneh, 2013, 2018; Sneh et al., 2014). The unique sections, where Pliocene marine and lagoon formations are replaced by continental ones, containing Acheulean artifacts with numerous remains of large mammals have been investigated (e.g., Braun et al., 1991; Tchernov et al., 1994; Heimann. and Braun, 2000; Ron et al., 2003; Trifonov et al., 2019).

The constructed maps and diagrams make it possible to shed light on the planetary-genetic reasons for the evolution of early hominin: landscape-geomorphological, paleoclimatic, geodynamic, and deep tectonic-thermal and hydrospheric factors of the development of their habitat. A description and analysis of the comparison of the obtained materials with anthropological data are given below in the relevant sections.

## Formulation of the Problem

The origin of Man on the Earth and the ways of his migration are, in fact, among the most important problems in the field of natural sciences. The discoveries of the latest decades have allowed for a significant breakthrough in the field of ancient ecosystems, where the way of life of ancient people, artifacts of that time, and elements of biotic and abiotic habitats were studied. Of the abiotic factors, only landscape and climatic features were usually considered. The factors of the regional geological-geophysical environment were used only partially (for example, Ben-Avraham et al., 2005).

It should be noted that the region of the Eastern Mediterranean and the adjacent regions of Eurasia and East Africa is one of the most complex in the world in geological and geophysical terms. Many of the most important features of its structure have been identified only in recent years (e.g., Bosworth et al., 2005; Hall et al., 2005; Krasheninnikov et al., 2005; Ben-Avraham et al., 2006; Reilinger et al., 2006; Stern and Johnson, 2010; Eppelbaum et al., 2021). Therefore, as the leading areas of research, we

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applied the method of analysis of hydrospheric disturbances, new aspects of plate geodynamics, and detailed integrated methods of geological mapping, paleogeography, and event stratigraphy.

We propose that the emergence of the noosphere (Vernadsky, 1945) was preceded by three main events that determined the emergence and development of Man. The first of them, the inception of the evolution of hominin, was caused by the Messinian crisis (Eppelbaum and Katz, 2021), a plate tectonic event (Lapkin and Katz, 1990) that caused the drainage of the residual Tethys ocean and vast shelf spaces and the development of climate aridization and a sharp change in ecosystems in the equatorial segment of the planet in the epoch of 5.8-5.3 million years ago. The second most important event was the Akchagylian hydrospheric maximum (3.6-1.8 Ma ago), which caused flooding of the shelf of southern Eurasia and, in part, high plateaus, and erosional valleys adjacent to the Mediterranean (Eppelbaum and Katz, 2022). The third event is associated with the regression of the end of the Pliocene - the beginning of the Quaternary period and the emergence of continental glaciation (0.9-0.8 Ma ago).

Let us go back to the second event. Climate humidification in the equatorial segment led to the intensification of glaciation at the poles and in the highlands (e.g., van Baak et al., 2019), and an abrupt change of landscapes in the primary habitat of hominin with the replacement of tropical forests by grassy savanna (Bobe et al., 2002, 2007; Rogers and Semaw, 2009; Dennel, 2010), and biotic communities (Leakey and Werdelin, 2010). Under these conditions, the nature of the evolution of primates dramatically changed towards the development of the stone industry (Bobe and Leakey, 2009), socialization, and mastery of fire (Goren-Inbar et al., 2004; Gowlett, 2009; Guseinov, 2010; Hlubik et al., 2019).

The maximum Akchagylian transgression of 2.6-2.1 Ma ago (up to +200 m above the modern mean sea level) (Eppelbaum and Katz, 2022) closed the migration route to the north, where there were vast bays, mountain ranges, and arid volcanic plateaus. Only in the epoch of the post-Akchagylian regression 2.0-1.8 Ma ago and in the process of activation of the deep mantle structure (Eppelbaum et al., 2021) with the formation of fault valleys and strike-slip basins, did the descending structure of the Levantine Corridor appear. Its favorable ecological niches served as multiple stopovers on the way of Man's movement to the east of the Forward Asia. At the end of the post-Akchagylian regression period (about

1.1-0.8 Ma ago), there was the development by Man (Hershkovitz et al., 2021) of southern Eurasia and northern Africa (e.g., Camps and Chauhan, 2009; Fleagle et al., 2010).

The subsequent epoch of human migration and evolution was qualitatively different (de Menocal, 2004) both in terms of planetary (meridian skew of the Earth's figure with the intensification of seismological and glaciotectonic movements), contrasting climate of the epoch of continental glaciations with sharp fluctuations in sea levels (Milankovitsch, 1941; Morner, 1980). The factors of changes in the abiotic environment contributed to fundamental changes in the composition of ecosystems (Behrensmeyer et al., 2007). From this point of view, the concept of the Quaternary period (or Anthropocene (Gibbard et al., 2021)) is planetologically specific and does not depend on regional factors and the professional arguments of certain research groups or schools. The change of the Neogene equatorial transgression to the polar one with a corresponding change in the shape and speed of the Earth's rotation in the Anthropocene (844 thousand years ago) is a natural physical and planetary boundary of the stratigraphic scale. Hydrodynamically, this boundary is marked by the Cassian-Türkian regression of the Tethys-Paratethys basin, corresponding to the mark of the sea-level drop to -200 m (Eppelbaum and Katz, 2021). And the geodynamical meridian skew of the Earth's figure was expressed in the movements of the Khovaling tectonic phase between the Kulyab and Kyzyl-Suu series of Central Asia (Dodonov, 1986).

**Paleogeographic and Geological-Geophysical Aspects**

The problem of origin, features of evolution, and settlement of ancient hominin is closely related to the evolution of the habitat, caused by geological and geophysical processes in various shells of the Earth, which form their dynamics and structure. The existence itself of the African-Levantine-Caucasian way of settlement of the ancient Man has a significant number of planetological analogies: geophysical, biotic, cultural-historical, socio-economic, etc. This is, of course, connected with the planetary-geophysical uniqueness of the region. Immediately to the east of the way, a step of the Ural-African geoid anomaly is developed, and in the north there is a critical parallel of 35$^{o}$ (Figure 2), which is an area of conjugate deformation of the Earth's rotation ellipsoid (Veronnet, 2012; Eppelbaum and Katz, 2021). And approximately in the middle of the migration path, at the interface between the collisional structures of the Mediterranean and rift-spreading structures of the

Red Sea system, there is a projection of the central zone of the deep mantle structure (Eppelbaum et al., 2020, 2021), which initiates the rotation of the overlying lithospheric formations in a counterclockwise direction.

The East African area of origin of ancient hominin (East African Rift Belt) (Figure 1) is located in the zone of the southern pericline of the deep mantle structure, where in the rift zone the Nubian, Arabian, Somalian, and Victorian lithospheric plates are articulated (Figure 2). Here, under the conditions of active modern rifting, a blocky relief of the volcanic plateau with landscapes optimal for the habitation of ancient people was formed.

The central Eastern Mediterranean region (carbonate platform of the Mesozoic Terrane Belt of the Levant) is insignificant in the area and is located near the projection of the uplifted zone of the mantle structure (Figure 2). This area was formed at the border of two lithospheric plates, Sinai and Arabian. And it is in this tectonically unstable zone that the Levantine Corridor runs (Figure 1), along which the migration of ancient people from Africa to Eurasia took place for many hundreds of thousands of years. Its features will be discussed below.

The fairly wide and diverse Caucasian range (Anatolian-Caucasian zone of the Alpine orogen) of ancient hominin (e.g., Belyaeva and Tesakov, 2020) is located in the northeastern pericline of the deep mantle structure (Figure 2). An area of active orogenesis is developed here, in which folded, volcanic areas and foothill and intermountain depressions filled with sediments are combined. As a result, active migration from south to north was carried out, bypassing mountain ranges along the coasts of the Caspian and Euxine basins (Figure 1). The area under consideration is located in the contact zone of the Eurasian, Aegean-Anatolian, and Arabian lithospheric plates. The population of the last two plates was probably insignificant due to the unfavorable nature of the ecosystems developed here.

Each of the three habitats with sites of ancient hominin (Table 1) differs in terms of the age of the development of the habitat. The age estimates presented are based on the data of the isotope-radiochronometric and paleomagnetic methods, taking into account the refinement by the methods of stratigraphic and paleogeographic analysis.

The East African range (East African Rift Belt) of the hominin with the oldest finds of artifacts of the Oldowan type of stone industry is 2.6-1.6 Ma old and belongs to the species Homo rudolfensis and H. habilis 2.6-1.9 Ma old and the younger species Homo

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erectus, industry 1.9-1-6 million years ago and then began to manufacture Acheulean artifacts and began to master fire and the manufacture of bone and other tools (Gowlett, 2009).

The Eastern Mediterranean range (carbonate platform of the Mesozoic Terrane Belt of Levant) of the hominin is located about 2000 km north of the previous range, and a migration route bypassing the high plateau of the Eastern Desert along the Nile Valley by an extensive estuary and along the valley-cut southeastern coast of the Pliocene Mediterranean and strike-slip basins of the Dead Sea Transform (DST) significantly increased the travel distance and travel time along the as yet undeveloped Levantine Corridor. On the other hand, the absence of ancient sites along the Nile Corridor (Camps and Chauhan, 2009) may be due to the widespread development of the younger Pleistocene alluvium of this extended river.

The oldest artifacts of the area under consideration are located on the Arabian Plate in western Jordan in the Zarqa River Valley north of Amman, in the northern block of the Negev Terrane shifted along the DST line (Figure 3). According to the data of paleomagnetic and radiometric analysis, continental Pliocene clastic rocks with remains of large mammals and numerous artifacts of the Oldowan type stone industry is 2.0-1.78 Ma and clearly correspond to the epoch of the Late Gelasian and the stage of the Late Akchagylian regression. This is a very well-defined narrow interval on the chronostratigraphic scale, not exceeding 250 thousand years. To the west of the DST, there are very important classical Levantine sites with the Acheulean stone industry and traces of the use of fire (Belmaker, 2010), with an age of 1.6 Ma and younger. The reason for the absence of sites with older age in the zone of the emerging Levantine Corridor will be discussed below.

The Caucasian area (Anatolian-Caucasian zone of the Alpine orogen) is located at a distance of more than 1000 km from the Eastern Mediterranean; if we do not take into account the East Anatolian sites, the age of which is insufficiently substantiated by radiometric methods. The most ancient site Dmanisi (Figure 1) reliably belongs to the Olduvai episode (Garcia et al., 2010) and has an age of about 1.85-1.78 Ma, which corresponds to the Gelasian and Calabrian boundary of the Mediterranean scale and Akchagylian-Absheronian of the Paratethys basin scale (Belyaeva, 2020).

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The more northern sites of the Greater Caucasus (Figure 1) (from Dagestan to Taman) have a younger age - about 1.1-0.8 Ma (Amirkhanov, 2020). However, according to other data (Trifonov et al., 2019), they are close in age to the Dmanisi site. In general, the problem of correlating rocks containing artifacts according to paleomagnetic data requires correction by more accurate research methods. Nevertheless, these data fit into the young radiometric age of sites with artifacts in remote regions of Eurasia and Africa.

The difference in the age of the described areas of ancient hominin sites with artifacts and the very isolation of areas sets the task of finding geological-geophysical and ecological-historical obstacles in relation to the formation of an extensive ecumene at the turn of the Pliocene and Pleistocene. It is most clearly manifested in relation to the geological structure and evolution of the Levantine Corridor – a transitional zone of settlement from closed basin ecosystems into the vast expanses of Eurasia.

**Tectonic-Geodynamic Aspects of the Formation of the Levantine Corridor**

The reasons that impeded the migration of ancient people from Africa to Eurasia were traditionally considered only in terms of changes in climate, landscape, and the nature of the evolution of biotic relationships. From the standpoint of historical planetary science, such an approach seems incomplete both in causal and physical-geographical and historical-evolutionary terms of changes in natural landscapes. In the region under study one of the most difficult ways to overcome natural obstacles was a narrow section of the Eastern Mediterranean - the Levantine Corridor, passing through a very complex geological structure of the Mesozoic Terrane Belt (Eppelbaum and Katz, 2015a) and the regional system of the DST strike-slip depressions. One of them is the Dead Sea depression, where the lowest (-430 m) point of the modern earth's relief is recorded. In the era of migration of ancient people, other depressions of this zone could have had a similar hypsometry.

The terrane belt is composed of a series of carbonate platforms - high plateaus covered with Cretaceous and Paleogene limestones. These plateaus are accompanied by the permanent processes of fault tectonics complicating the relief of the dry highlands of these platforms. Before the formation of ancient man, high carbonate plateaus came close to the Mediterranean coast. Erosional canyons of the great Messinian crisis and powerful terrigenous strata of the Late Cenozoic are not developed here, with the exception of the southern part of the Negev terrane (Hall et al., 2005).

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The coastal terranes, partly submerged in the Mediterranean Sea shelf, include Negev, Pleshet, Helez, and Galilee-Lebanon (Figure 3). To the east of them are the Judea-Samaria, Anti-Lebanon, Palmyrides, and Aleppo terranes, which are tectonically disrupted by the DST system; they are elevated desert plateaus and low mountains with periodic winter snow cover.

To the east of the terrane belt, within the Neoproterozoic shield of the Arabian plate, high plateaus (up to 1000-1200 m) are developed – Tabuk, Jordanian, Ard As Sawwan, Hauran-Jebel Drouze, Rutbah, and the Azraq-Sirhan depression (Figure 3) complicated by Late Cenozoic basaltic trap complexes. In the terrane belt, traps are developed mainly in the area adjacent to the DST.

It should be noted that the Cretaceous and partly Eocene limestones of the carbonate platform of the terrane belt contain horizons with siliceous nodules, which makes the Levantine Corridor an advantage as a source of raw materials for the stone industry.

The impassability of the Levantine Corridor by ancient people was also associated with a number of other geodynamic factors, in addition to the differentiation of movements in the DST zone and at the boundaries of terranes. Paleomagnetic mapping of the Mt. Carmel area and the Galilee region (coastal part of northern Israel) (Figure 4) also showed a significant differentiation in the direction of tectono-thermal processes from the Late Mesozoic to the Late Cenozoic. This indicates the extreme geodynamic instability of this region and the variety of manifestations of tectonic movements, magmatic processes, and relief with the formation of fault, strike-slip valleys, and rotational structures. The dominant direction of the isopachs of the Lower Cretaceous traps of the Halal-1 superzone corresponds to NNE-SSW. It is $60^{o}$ counterclockwise as opposed to the development field of the Upper Cretaceous volcanoes of the Halal-2 superzone – NNW-SSE. In turn, the direction of the trap field of the Upper Cenozoic, belonging to the paleomagnetic zone of Sogdiana, the largest in area in the Middle East, the Harrat Ash Shaam patch (covering a total area of about 40,000 $km^2$ (Weinstein et al., 1994)) has a length of WNW-ESE. It is 30 degrees counterclockwise compared to the long axis of the Late Cretaceous traps (Katz and Eppelbaum, 1999) of the Mt. Carmel. These data confirm the regional rotation of the deep mantle structure (Figure 2) over a long geological time, which could not but affect the instability of the structure and ecosystems of the Eastern Mediterranean, and the Levantine Corridor in particular. Diagonal and arc faults, mapped, oppose the boundaries of larger tectonic blocks (terranes) and in recent times have created fault and strike-slip valleys and

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coastal zones of marching and other landscapes within the Levantine migration corridor of ancient people. Horst uplifts with abundant vegetation, such as the present-day Mt. Carmel, could serve as an optimal ecosystem for them on their way to the north (e.g., Kübler et al., 2019).

Thus, on the basis of various geodynamic analyzes, for the first time, we draw the attention of anthropologists to the need to combine traditional methods with tectonic-geophysical research, complementing the understanding of the nature of the ecosystems and migration routes developed by ancient people.

**Mid Pliocene Hydrospheric Maximum as a Migration Barrier in the Early Hominin**

The duration of existence, from 0.5 to 1.0 million years, of the isolated East African range of early hominin against the background of opposing closely spaced vast and diverse landscapes and ecosystems of Eurasia, requires a logical explanation. Climatic and ecological features as a limitation of migration are significant, but unconvincing since the Pliocene epoch inherits the Miocene. It developed under conditions of equatorial transgression and with limited development of polar glaciations. There were no continental glaciations creating contrasting zonation of climate and ecosystems in the Neogene. Paleogeographically, the Pliocene seas covered, as in the Miocene, vast shelf spaces, and their hydrospheric maximums reached 200 m above the present-day sea level, and the area of the Paratethys shelf basin was as vast and uniform as in the Miocene. The data of the analysis of hydrospheric disturbances (Katz, 1986) show that the meridian skew of the Earth's figure with the development of polar transgressions, equatorial compression and continental glaciations occurred at the very end of the Matuyama epoch, about 844 thousand years ago. Therefore, the separation of some parts of the marine Pliocene and its assignment to the Pleistocene is incorrect from the standpoint of historical planetology.

The last Pliocene transgressive maximum was established on the platform in Eurasia, and the marks of the Akchagylian Sea were revealed, reaching +186 m (Vostryakov, 1964). In the Epipaleozoic platform area of Great Britain (Bennison and Wright, 1969), the same Pliocene transgressive maximum reached 180 m. Within the continental plates of Gondwana, similar studies were carried out only in Egypt (Chumakov, 1967). It was found that Pliocene ingressions in the Nile erosional valley reached in the south to the latitude of Sudan and reached elevations of about +200 m. An analysis of all

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these data with paleogeographic reconstructions of the Pliocene Tethys and Paratethys basins is given in our generalizing work (Eppelbaum and Katz, 2022).

The materials presented made it possible to carry out special studies indicating the development of marine formations on the Pliocene shelf of the Eastern Mediterranean in the area of the future Levantine Corridor.

For many years we have been engaged in regional and local mapping of various regions of Israel using geophysical methods for exploratory (e.g., Eppelbaum and Katz, 2011, 2015a) and engineering and geodynamic (e.g., Eppelbaum et al., 2007, 2012, 2015a, 2015b) and archaeogeophysical (e.g., Eppelbaum, 2010; Eppelbaum et al., 2010).

For the paleogeographic assessment of the Pliocene transgressions, extensive data of detailed geological surveys at a scale of 1: 50,000 by the Geological Survey of Israel and the materials of our research on geomorphology, ecostratigraphy, and paleoecological analysis of the Pleistocene marine of northern Israel were used. The description and analysis of the research results are given below.

The first structural and geomorphological map of Mt. Carmel and adjacent areas of the Galilee (Figure 5) showed that the tectonic uplift of Mt. Carmel in the Pliocene was an island composed of Cretaceous and partly Paleogene carbonate rocks. At the same time, the Galilee area was lowered and almost completely covered by the Pliocene Sea. By age and hypsometry, two terraces are distinguished: low – up to 100-110 m high, and high – up to 200 m high (Figure 5).

Justification of their stratigraphic sequence, age, conditions of formation, and relationship with the continental Pliocene, its artifacts, and remains of the fauna of large mammals became possible thanks to the study of the unique Pleistocene section in the Evron quarry and its environs (Figure 6). This area has been studied by many specialists: geologists, paleontologists, archaeologists, petrographers, paleomagnetologists, and researchers in the field of radiometric dating (Issar. and Kafri, 1969; Ronen and Amiel, 1974; Ronen, 1991; Tchernov et al., 1994; Porat and Ronen, 2002; Ron et al., 2003). There are no analogs of such a section in the world, since the combination of Pliocene marine formations underlain by the trap complex, overlapped by continental formations bearing artifacts and remains of large mammals, is an object of study of supreme importance.

The marine Pliocene occurs on the sediments of the Cretaceous-Eocene carbonate platform. Above these formations are two complexes of Miocene traps, which are the

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westernmost offshoot of the largest trap field, the Harrat Ash Shaam of the Arabian Plate, as can be seen on the paleomagnetic map (Figure 4). Two complexes are developed here - Middle Miocene Lower basalts with an age of 16.1 Ma (Evron-1) and 14.5 Ma (Evron-3) and Upper Miocene Intermediate basalts with an age of 6.3 Ma (Kabri-15). Early Pliocene Cover basalts are absent in this area, but they occur in the Galilee 17 km southeast of the Kabul area and have a radiometric age of 3.76 Ma, which corresponds to the end of the Early Pliocene or the Gilbert Paleomagnetic Epoch.

Thus, according to regional radiometric data, the age of the Pliocene marine strata in the Eastern Mediterranean corresponds at least to the Gauss and Lower Matuyama (Akchagylian) or Piacenzian and Gelasium stages of the Mediterranean scale. According to chronostratigraphic data, the Lower Akchagylian - Piacenzian is composed of marine formations approximately corresponding to the level of the modern ocean, and these formations are absent on the high plateau of Galilee. Middle Akchagylian forms terraces 100-200 m high and in the Evron section, we see only two strata corresponding to the Mediterranean Gelasium. At the base of the entire marine strata, both Piacenzian and Zanclean are absent, and at the top there are no regressive formations of Upper Akchagylian (Upper Gelasium), and continental analogues of Absheronian (Calabrian of the Mediterranean scale) are developed. It is in the upper part of this stage (according to paleomagnetic data, most likely in the upper part of the Matuyama zone) layers with artifacts are developed.

Thus, the data for the Evron section allows us to assert that in the Levantine Corridor in the epoch 2.6-2.0 Ma ago on the continental carbonate plateau of the Eastern Mediterranean, a high marine transgression was developed - up to +200 m above the modern sea level. It reached the foot of the carbonate platform of the Mesozoic Terrane Belt, rising to an altitude of 500-2000 m. East of the DST, within the high plateaus of the Neoproterozoic shield of the Arabian lithospheric plate, the Late Cenozoic marine transgressions did not reach (Gvirtzman and Buchbinder, 1969; Eppelbaum and 2015a).

To assess the climate of the Pliocene transgressive maximum epoch in the African-Arabian region, a paleoecological reconstruction of benthic communities in the Pliocene Sea of the Evron region was carried out (Figure 7). A warm-water association is developed here, in which attached, drilling, burrowing, wandering benthos, and bottom floating organisms are developed. This association is quite comparable with the coastal warm-water association of the modern Mediterranean Sea, which corresponds to the interglacial epoch when there is no continental glaciation. The development in the Pliocene section of carbonate sediments, sharply different from the coastal terrigenous formations of the modern Mediterranean Sea, indicates a milder warm climate. Consequently, the influence of transgressions on climatic zoning noted deep in the north, in Iceland (Einarsson, 1957; Gladenkov, 1978), in the African-Arabian region was probably not so significant. Here, migration restrictions during the movement of ancient hominin from Africa to Eurasia were determined rather not by the climate, but by the peculiarities of paleogeography. We tried to check this proposition on a specially compiled tectonic-paleogeographic map (Figure 8).

**Discussion and Conclusions**

According to tectonic-paleogeographic mapping data (Figure 8), the Levantine Corridor is a rather exotic landscape-geodynamic structure and a migration ecosystem of a narrowly channeled type. It is sandwiched between two linear zones, one of which is purely paleogeographic (from the northern part of the Nile estuary in the south to the Levantine coast in the north), and the second has a pronounced geodynamic character and is an extremely active planetary strike-slip zone. The echoes of the movements of this long-developing Eastern Mediterranean Nubian Belt (Eppelbaum et al., 2021) extend from the high plateaus of the Eastern Desert of Egypt, formed by the island-arc and ophiolite complex of the Neoproterozoic, extending far to the north, into the Alpine region of the Eurasian lithospheric plate. This belt forms the western part of the Caucasian-Arabian syntaxis (Sharkov, 2019). The latter is an arcuate zone of accretionary intrusion of the extended Indian plate into the Eurasian one. In the DST belt, intense seismicity and intense shear tectonics are developed with the formation of numerous rhomboid graben-like troughs (pull-apart basins) in the zones of the Gulf of Aqaba, Arava Valley, the Dead Sea area in the south, and basins of Kinneret (Sea of Galilee), Hula, and El Gab in the north (Hall et al., 2005; Krasheninnikov et al., 2005).

Thermal springs and active Pliocene-Quaternary trap magmatism and volcanism are developed in this zone (Figures 5 and 8) in the zone of intersection with the diagonal fields of tectonothermal activation of the Arabian Plate (Eppelbaum et al., 2004, 2007, 2021; Eppelbaum and Katz, 2015a, 2021). Obviously, such processes actively influenced the formation of the relief, hydrographic elements, and the nature of the microclimate and the dynamics of the landscape of this unique narrow zone, close to the coast of the Pliocene-

Quaternary Neotethys-Mediterranean basin. The DST area appears to be a significant constraint on the dispersal of ancient hominin (Ben-Avraham et al., 2005).

Here, only three Pliocene sites are known, Ubeidiya (south of Lake Kinneret), Gesher Benot Ya'aqov (south of Hula basin), and Maayan Baruch (north of Hula basin) (Kübler et al., 2019). And most of the younger Pliocene-Quaternary hominin sites are developed in the coastal plain of Israel. In the southern part of the Negev Desert, in the area of erosional-tectonic depressions (makhteshim), no sites of ancient hominin have been found. This circumstance requires further research. Data from paleogeographic and geomorphological studies confirm that the presence of erosional incisions of the Late Messinian canyon-type stretching from Beer-Sheva to the Mediterranean Sea (Buchbinder and Zilberman, 1997) limited the penetration of ancient hominin to the north, and were estuaries in the Middle Pliocene. To the north of the coastal plain and Mt. Carmel, on the coastal plateau of the Galilee, a marine basin was developed, whose narrow trough bays probably merged with freshwater streams along with the DST system. The presence of such a connection is evidenced by the finds in the terrigenous strata of the Pliocene of this region of shells of marine euryhaline foraminifera (Almogi-Labin et al., 1995).

The indicated limiter of hominin migration to some extent explains why the earliest finds of artifacts from the Levantine area of ancient hominin aged 2.0-1.78 Ma (Scardia et al., 2019) were found east of the Levantine Corridor in Western Jordan. We assume that this is due to the closure at this time of the Levantine Corridor in the south by the Beer-Sheva estuary, and in the east by the DST estuaries. This assumption is shown in Figure 8. It is possible that immediately after the end of the maximum flooding of the Middle Akchagylian - Middle Gelasian time; the tectonic subsidence of the carbonate platform of the Mesozoic terrane belt has already taken place, with the formation of the coastal plain of Israel. And here could be the sites of ancient hominin. Their absence could, in this case, be explained by the fact that they are buried under the younger formations of the continental formations of the Late Calabrian and the strata of the Quaternary terraced fossil dunes (Kurkar). However, such finds have not yet been found, although the sandy red-colored complexes of the Upper Pliocene (Calabrian), underlying the most ancient layers of the Kurkar, are widely developed in the Coastal Plain of Israel. We come to the conclusion that this plain was formed in the Quaternary time (in the epoch after 800-850 thousand years ago), as a result of movements associated with the meridian skew and hydroisostasy

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(Morner, 1980) due to a significant difference (100-120 m) sea levels during the rhythm of changes in the eccentricity of the Earth's orbit (Milankovitsch, 1941).

The fact that it was precisely at the boundary between Calabrian and Pleistocene (800-900 thousand years ago), that intensive movements took place in the marginal zone of the carbonate platform can be seen in the Gush Dan area (Big Tel Aviv, Israel), on the border of the Pleshet terranes and the raised plateau of the Judea-Samaria terrane (Figure 8). Here, north of the city of Rosh Ain, there are developed near-fault folds in Cretaceous limestones and fractured zones filled with Calabrian red sands. There are no such formations to the west of Mt. Carmel. The age of the terraces of the youngest fault step with marks up to 35 m does not exceed 300 thousand years, as evidenced by the marine terraces with the remains of mollusks and large foraminifera (Michelson, 1971).

The data of sin-sedimentation tectonics of the Neogene-Quaternary stage (Figure 9) of the Eastern Mediterranean region (Eppelbaum and Katz, 2015a) definitely confirm the uplift of the carbonate platform of the Mesozoic Terrane Belt adjacent to the coastline of the Mediterranean Sea. Equally uplifted were the terrane blocks located east of the DST, as well as the development areas of the Neoproterozoic belt of the Sinai and the Arabian plate, located south of the carbonate platform of the Mesozoic terrane belt. The areas of abrupt subsidence in the Late Cenozoic, judging by the drilling data, are the DST rhomboid troughs and the Mediterranean Sea basin, starting approximately from the coastline. A significant difference in thickness of the Late Cenozoic (up to 1,500-2,000 m) is developed here; magmatic manifestations and zones of tectonic faulting are recorded. Further on the shelf of the Mediterranean Sea, the subsidence increases rather smoothly, and the thickness reaches 3,000-4,000 m and more (Figure 9).

This indicates a clear stability of the high plateau of the carbonate platform massif in the Neogene. Discordant in relation to it and the Neoproterozoic belt, also elevated up to 1,000-2,000 meters and more in the areas adjacent to the rift zone of the Red Sea, the zone of deep troughs of the Dead Sea and Lake Kinneret is developed. Here, the thickness of terrigenous-saline Neogene-Quaternary formations penetrated by traps exceeds 4,000-6,000 m (Figure 9). Currently, most of the elevated carbonate platform and the Neoproterozoic belt is an arid rocky desert, excluding the lowered coastal plain and mountainous regions. Optimal landscapes for habitation are partly developed in the northern part of the DST. The analysis of sin-sedimentation tectonics leads to an unambiguous conviction about the complexity of the structure, the diversity of landscape, and the narrowness of the optimal

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ecological niches within the Eastern Mediterranean and the youth of the formation of the ecosystem of the Levantine Corridor. From the east and south, it was adjoined by an arid zone of a vast rocky desert. This factor cannot but be taken into account when analyzing the features of migration and settlement of ancient people.

Summing up the above, we come to the conviction that the Levantine Corridor in the era of the early hominin development in the area of East Africa had not yet formed as an optimal landscape-migration zone, either tectonically or paleogeographically. The dissection of the coastal high plateau of the Eastern Mediterranean with the formation of optimal land landscapes for the habitation of ancient people began after regression at the end of Middle Gelasian two million years ago when the sea level dropped by 200 m. This concept seems to be consistent with the age of the Pliocene artifacts. On the other hand, this concept sets out a new strategy for finding them. If new data is discovered, this approach can be confirmed or significantly adjusted. However, it is obvious that taking into account the diverse complex aspects of the migration of hominin from Africa to Eurasia in this complex region will have to be in a wider range.

Thus, the following main conclusions can be formulated:

1. For the first time, attention was paid to the discrete nature of the migration area of ancient people from Africa to Eurasia.
2. It was found that the meridional location of the Pliocene proto-area of ancient hominin, stretching from East Africa to the Caucasus, is associated with the planetary nature of the formation of landscapes and ecosystems, due to the deep-geophysical nature of geodynamics,
3. The dominant influence of changes in the shape of the Earth and hydrospheric fluctuations in the Late Cenozoic on the evolution of the landscape, climate and settlement of populations of ancient humans has been established.
4. The rotation of the deep mantle structure and its effect on the surface (near-surface) layers led to the emergence of the Middle Pliocene – Akchagylian hydrospheric maximum,
5. Revealed the reason for the late development of the Levantine Corridor, due to the development in the Middle Pliocene of the great Gelasian-Akchagylian transgression and the presence of a high coastal plateau of the carbonate platform of the Mesozoic Terrane Belt,

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6. The comprehensive study of the Carmel area, displaced at the main direction of the Levantine Corridor (during the Late Pliocene – Quaternary time), showed that during the exodus of the ancient man from Africa, this area was flooded.

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**Table 1.** Location and age of the well-studied Pliocene anthropological sites

| Name of site | Age, Ma | Geographic location | Coordinates | Author | Tectonic zonation (according to the authors of the article) |
|---|---|---|---|---|---|
| Koobi Fora | 2.1-1.6 | East of the Lake Turkana, Kenia | 3.9482° N 36.1864° E | Grine et al., 2019 | **East African Rift Belt** |
| Omo | 2.4-2.3 | Southern part of the Omo River, south-western Ethiopia | 4.4875° N 35.5886° E | McDougall et al., 2008; Rogers and Semaw, 2009 | |
| Hadar | 2.4-2.3 | Afar area, Ethiopia | 11.0960° N, 40.3760° E | Johanson, 2017 | |
| Mille-Logya | 2.43-2.1 | Afar area, Ethiopia | 11.435° N 40.753° E | Alemseged et al., 2020 | |
| Kada Gona | 2.6-2.0 | Awash River area, Ethiopia | 12.2333° N 39.2333° E | Semaw et al., 2005 | |
| Bizat Ruhama | 1.0-0.6 | Near kibbutz Ruhama, northern Negev, Israel | 31.502° N 34.705° E | Belmarker, 2010 | **Carbonate platform of the Mesozoic Terrane Belt of the Levant** |
| Zarqa | 2.0-1.95 | Northern-western Jordan | 32.3217 ° N 34.5444 ° E | Scardia et al., 2019 | |
| Ubeidiya | 1.6-1.4 | Kinneret Basin, Israel | 32.4124° N 35.3346° E | Belmarker and O'Brien, 2018 | |
| Evron | 1.1-0.9 | North of Carmel area, northern Israel | 32.5929° N 35.1167° E | Ron et al., 2003; Tchernov et al., 1994 | |
| Kovandzhilar | 2.0-1.7 | Kovandzhilar Mt., Taurus Mts., South-eastern Turkey | 38.4195° N, 39.5170° E | Ozherel'yev et al., 2020 | **Anatolian-Caucasian zone of the Alpine orogen** |
| Azykh | > 1.2 | Khojavend district of Azerbaijan | 39.6223° N 46.882° E | Guseinov, 2010 | |
| Karakhach | 1.85-1.78 | Lesser Caucasus, Armenia | 41.007° N 44.002° E | Belyaeva, 2020 | |
| Dmanisi | 1.85-1.77 | Dmanisi town, western Georgia | 41.190° N 44.210° E | Lordkipanidze et al., 2007; Garcia et al., 2010 | |
| Mukhkai | > 1.95 2.1-1.77 | North-eastern Caucasus, Dagestan, Russia | 42.1446° N 47.2131° E | Amirkhanov, 2020; Sablin, 2020 | |
| Kinzhal | Acheulian | Northern Caucasus, MinVody, Russia | 44.269° N 43.017° E | Belyaeva and Tesakov, 2020 | |
| Kermek | 2.1.-1.95 | North-western Caucasus, Taman Peninsula, Russia | 45.3575° N 37.1030° E | Schelinsky, 2021 | |

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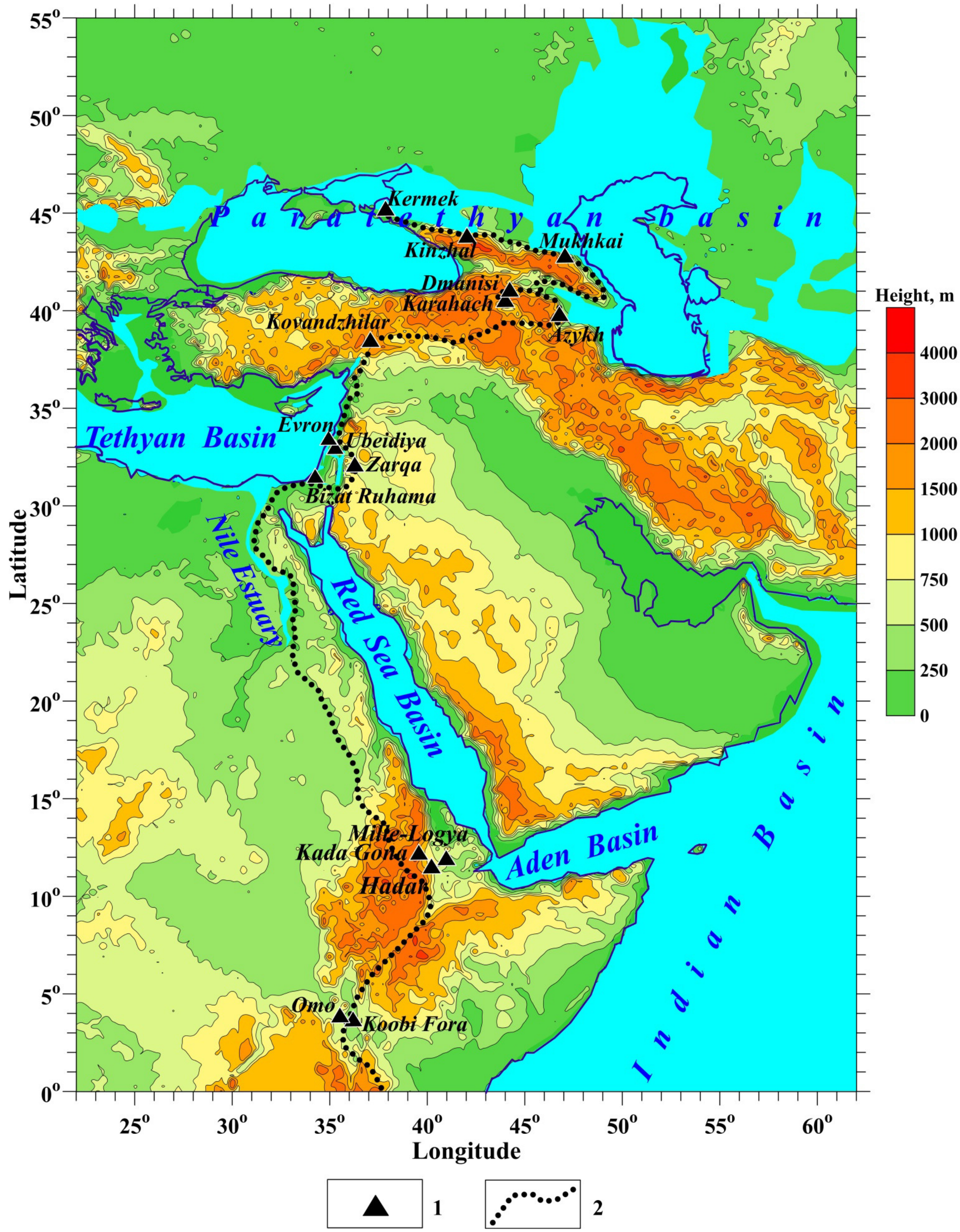


**Figure 1.** Geomorphological-paleogeographic map of the study area with the main tectonic elements and modern topography map.
(1) ancient hominin sites of 2.6 – 1.6 Ma, (2) reconstructed ancient hominin way from Gondwana to Eurasia

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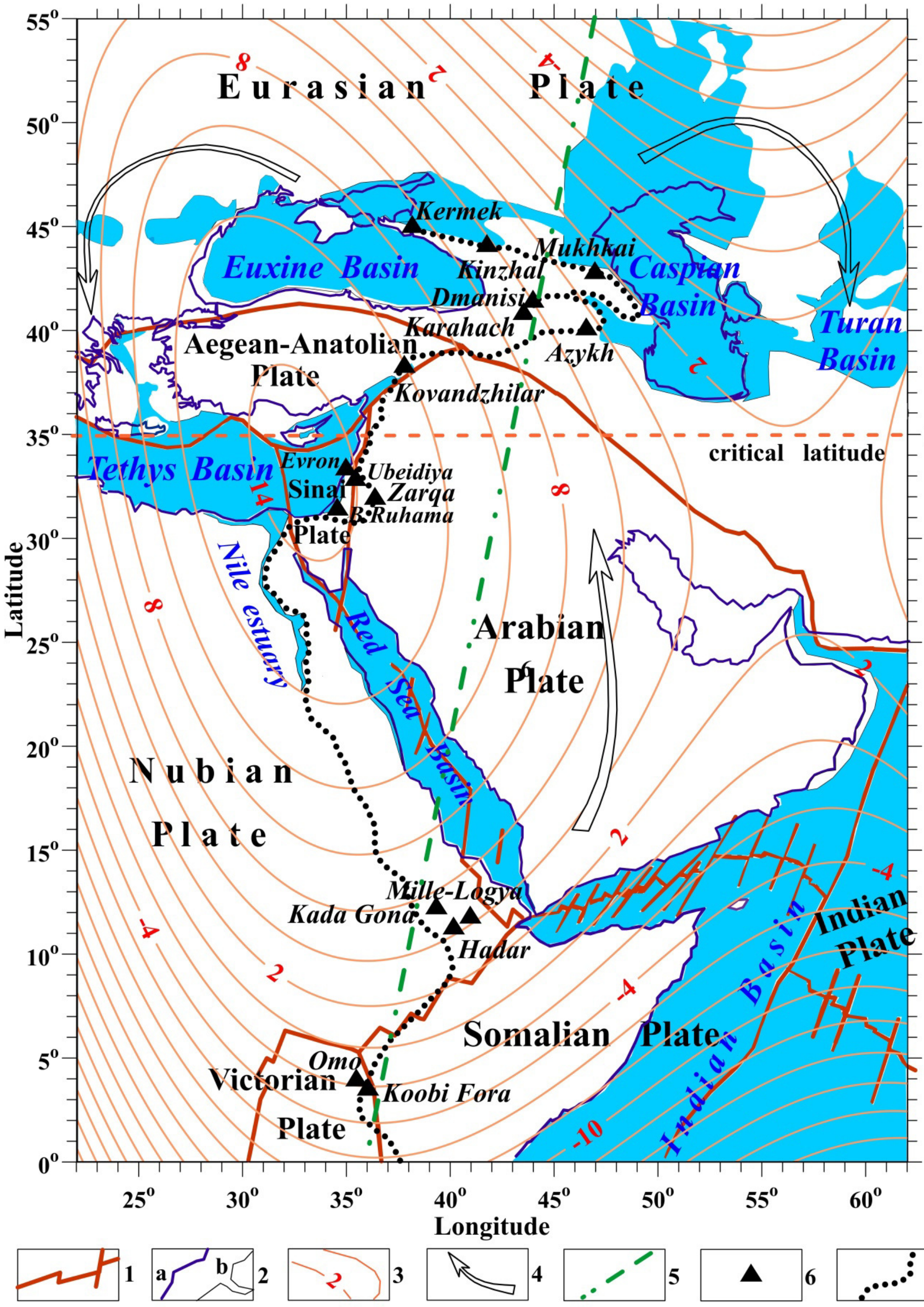


**Figure 2.** Satellite-derived gravity map with the paleogeographical, tectonic-geodynamic elements and anthropological features**.**

(1) interplate faults, (2) a: modern land-sea boundaries, b: land-sea boundaries during the maximum Pliocene transgression, (3) residual satellite-derived gravity map, (4) rotation of the Earth's crust according to the GPS observations, paleomagnetic and structural data, (5) averaged position of the Ural-African Step, (6) ancient hominin sites corresponding to the age of the Pliocene transgression, (7) reconstructed early hominin way from Gondwana to Eurasia ((3) and (4) according to Eppelbaum et al. (2020), and Reilinger et al. (2006) and Eppelbaum et al. (2021), respectively).

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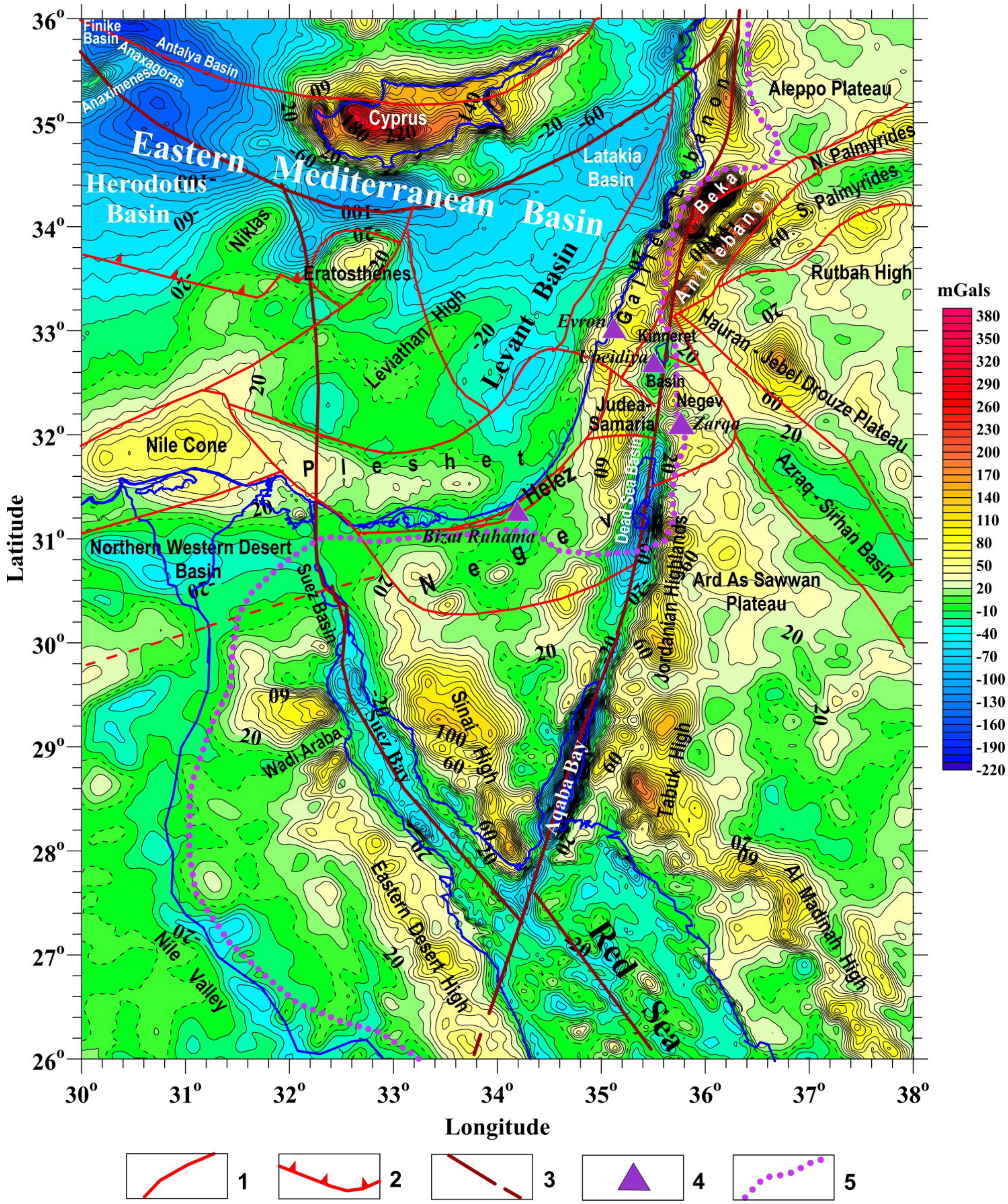


**Figure 3.** Geodynamic-paleogeographic map of the African-Arabian-European region with the main tectonic elements and ancient hominin sites.

(1) interplate faults, (2) Mediterranean Ridge, (3) intraplate faults, (4) ancient hominin sites corresponding to the age of the Pliocene transgression, (5) reconstructed early hominin way from Gondwana to Eurasia

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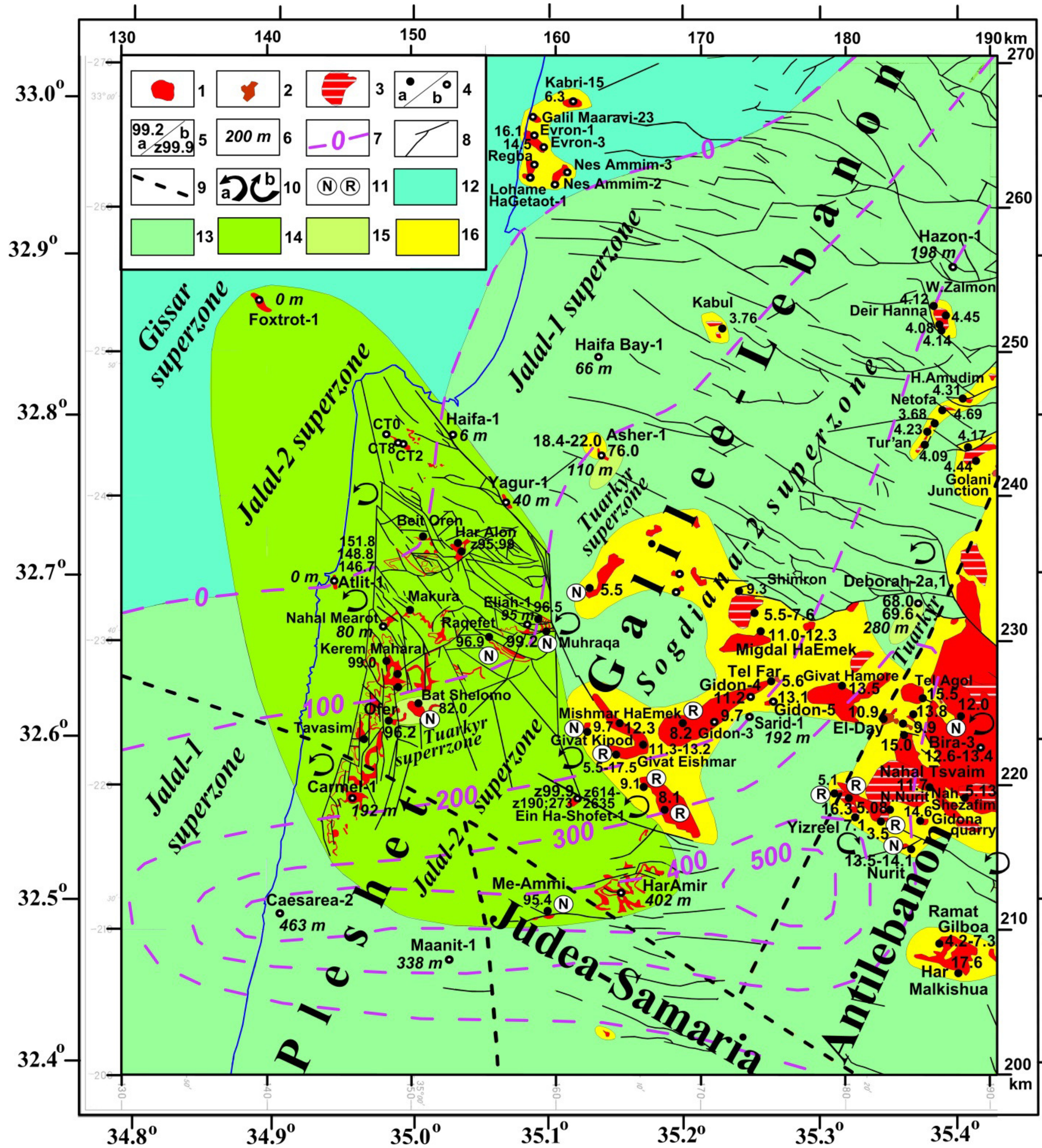


**Figure 4.** Geodynamic-paleomagnetic map of the Mt. Carmel – Galilee region. The following main works were used for this map construction: Nur and Helsey, 1971; Lang and Mimran, 1985;Lang and Steinitz, 1989; Nur et al., 1989; Shaliv, 1991; Mor, 1993; Heimann et al., 1996; Sneh et al., 1998; Katz and Eppelbaum, 1999; Segev, 2000, 2009; Segev et al., 2002; Ilani et al., 2005a, 2005b; Segev and Sass, 2009, 2010; Karcz and Sneh, 2011; Sass et al., 2013; Kaminchik et al., 2014; Dembo et al., 2015; Sneh, 2013, 2018; Sneh et al., 2014; Eppelbaum and Katz, 2015a, 2015b;Griffin et al., 2018.

(1) Cretaceous-Miocene basalts, (2) Miocene gabbroid intrusive, (3) Pliocene Cover basalts, (4) outcrops: (a) and boreholes, (b) with the Mesozoic-Cenozoic magmatic complexes, (5) radiometric age of magmatic rocks and minerals from K-Ar, Ar-Ar methods (a) and zircon geochronology (b), (6) thickness of the Lower Cretaceous traps (in m), (7) isolines of the Lower Cretaceous traps thicknesses (in m), (8) faults, (9) boundaries of terranes, (10) counterclockwise (a), and clockwise (b) rotation derived from tectonic and

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paleomagnetic data, (11) data of paleomagnetic measurements of magmatic rocks with the normal (*N*) and reverse (*R*) polarities, (12-15) paleomagnetic superzones: (12) Gissar, (13) Jalal-1, (14) Jalal-2, (15) Tuarkyr, (16) Sogdiana-2.

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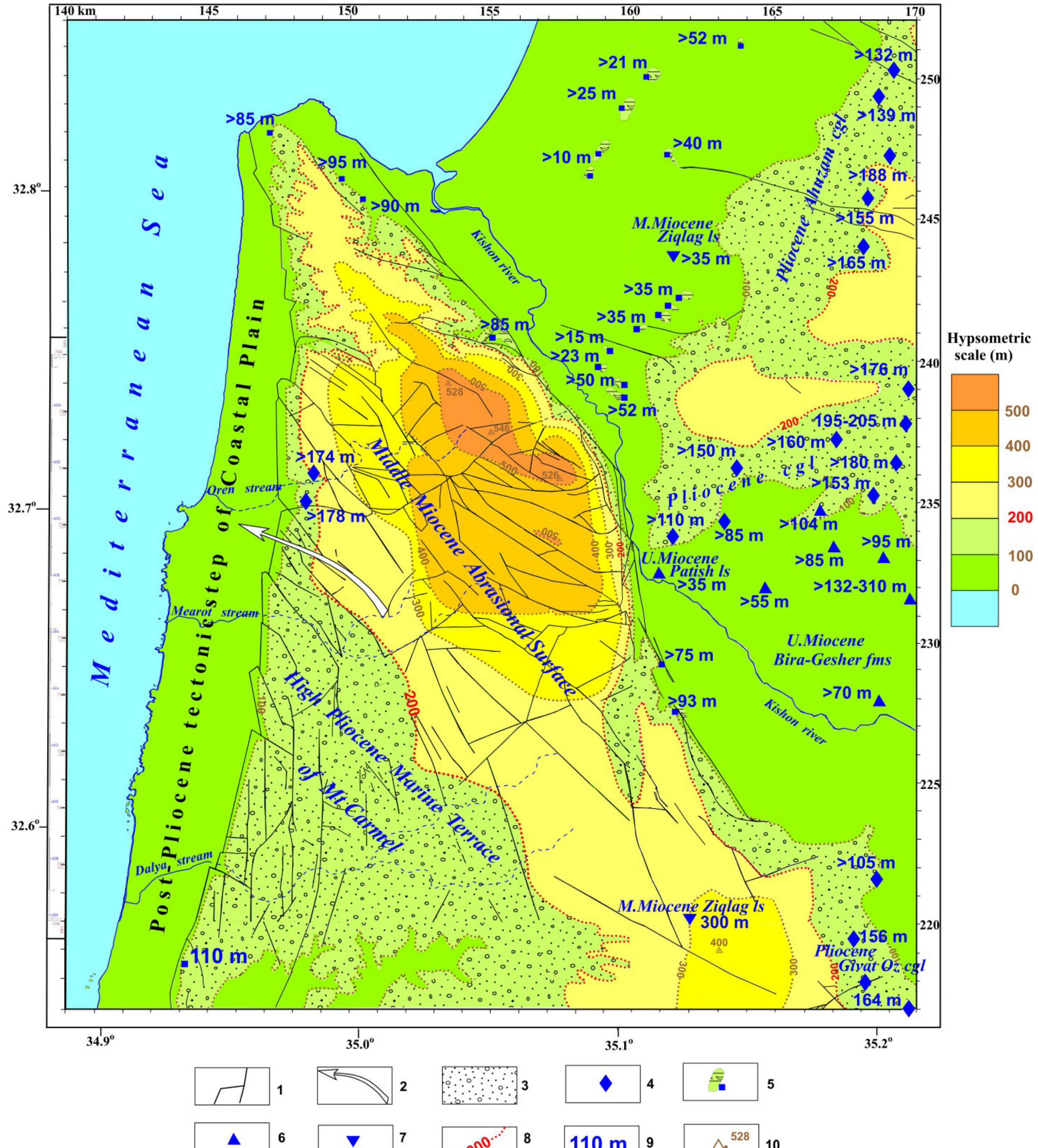


**Figure 5**. Structural-geomorphological map of the Mt. Carmel area (northern Israel). The following main works were used for this map construction: Segev and Sass, 2010; Karcz and Sneh, 2011; Sass et al., 2013; Sneh, 2013, 2018; Sneh et al., 2014.

(1) faults, (2) counterclockwise rotation of tectonic blocks, (3) high-level Pliocene marine terrace, (4) points with the Pliocene abrasion conglomerates, (5) Pliocene marine sediments of the Pleshet Formation, (6) Late Miocene marine sediments of the Bira and Patish Formations, (7) Middle Miocene marine sediments of the Ziqlag Formation, (8) most high level of the marine Pliocene transgression (boundary indicating the position of the Miocene islands within the Pliocene marine environments), (9) modern hypsometric data of the Miocene-Pliocene sediments, (10) highest hypsometric points of the tectonically uplifted Miocene marine terraces.

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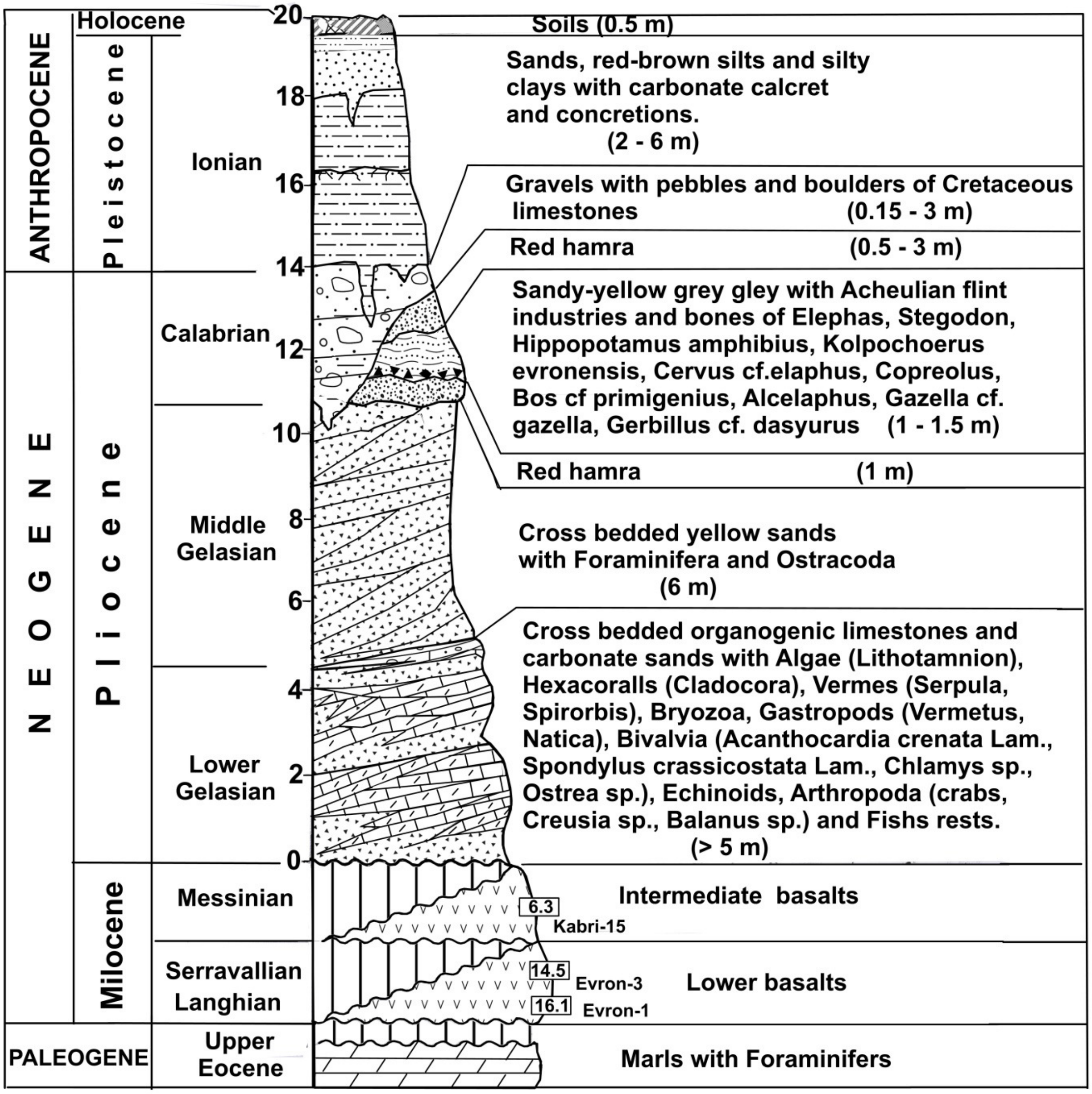


**Figure 6**. The stratigraphic sequence of the Upper Cenozoic sediments and traps of the Evron quarry area in northern Galilee (northern Israel). Besides the personal studies of the authors of this paper, the following main works were used for this section construction: Issar and Kafri, 1969; Ronen and Amiel, 1974; Ronen, 1991; Tchernov et al., 1994; Ron et al., 2003; Ilani et al., 2005a; Belmaker, 2010.

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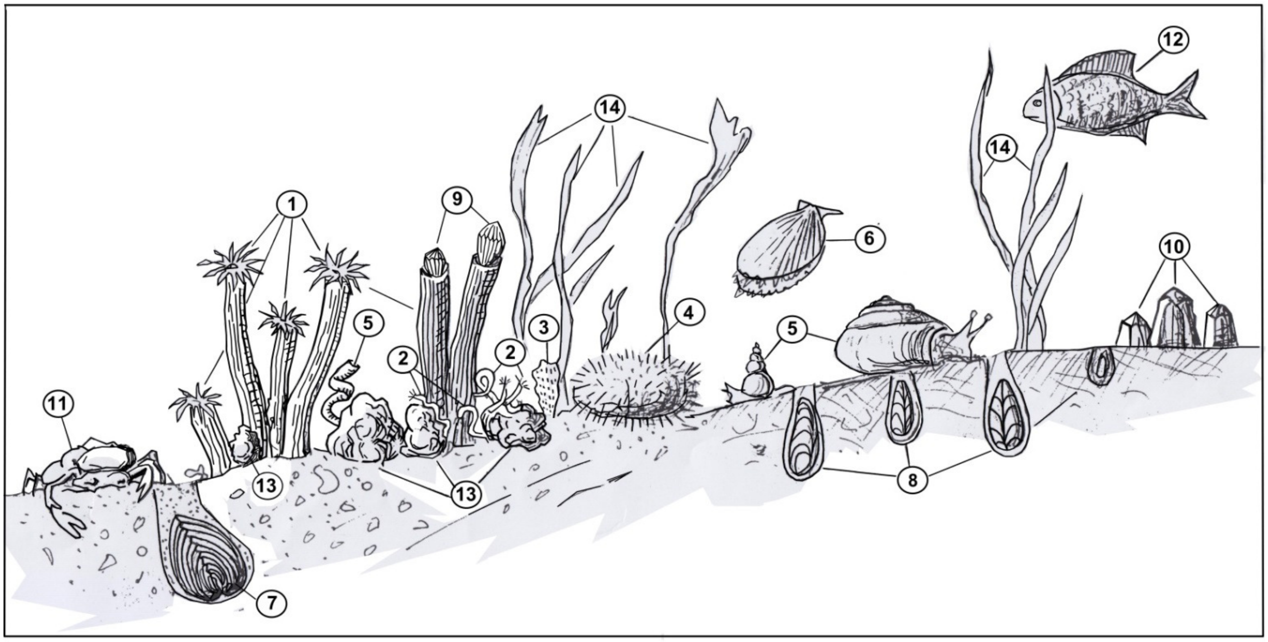


**Figure 7**. Paleoecological reconstructions of the Early Gelasian (Pleshet stage) marine benthic association of the Evron quarry in northern Galilee (northern Israel).

(1) Scleractinian corals (*Cladocora sp.*), (2) Polychaeta worms (Serpula, Spirorbis), (3) Bryozoa, (4) Echinoidea, (5) Gastropod mollusks (*Vermetus, Natica* and oth.), (6)–(8) Bivalvian mollusks: (6) *Pectinidae,* (7) *Cardiiidae,* (8) *Lithophaga*, (9)–(11): Arthropods: (9) *Creusia*, (10) *Balanus*, (11) Crabs, (12) Fishes, (13)–(14) marine Plants: (13) *Lithotamnion* biogenic carbonates, (14) thalloid *Chlorophycea.*

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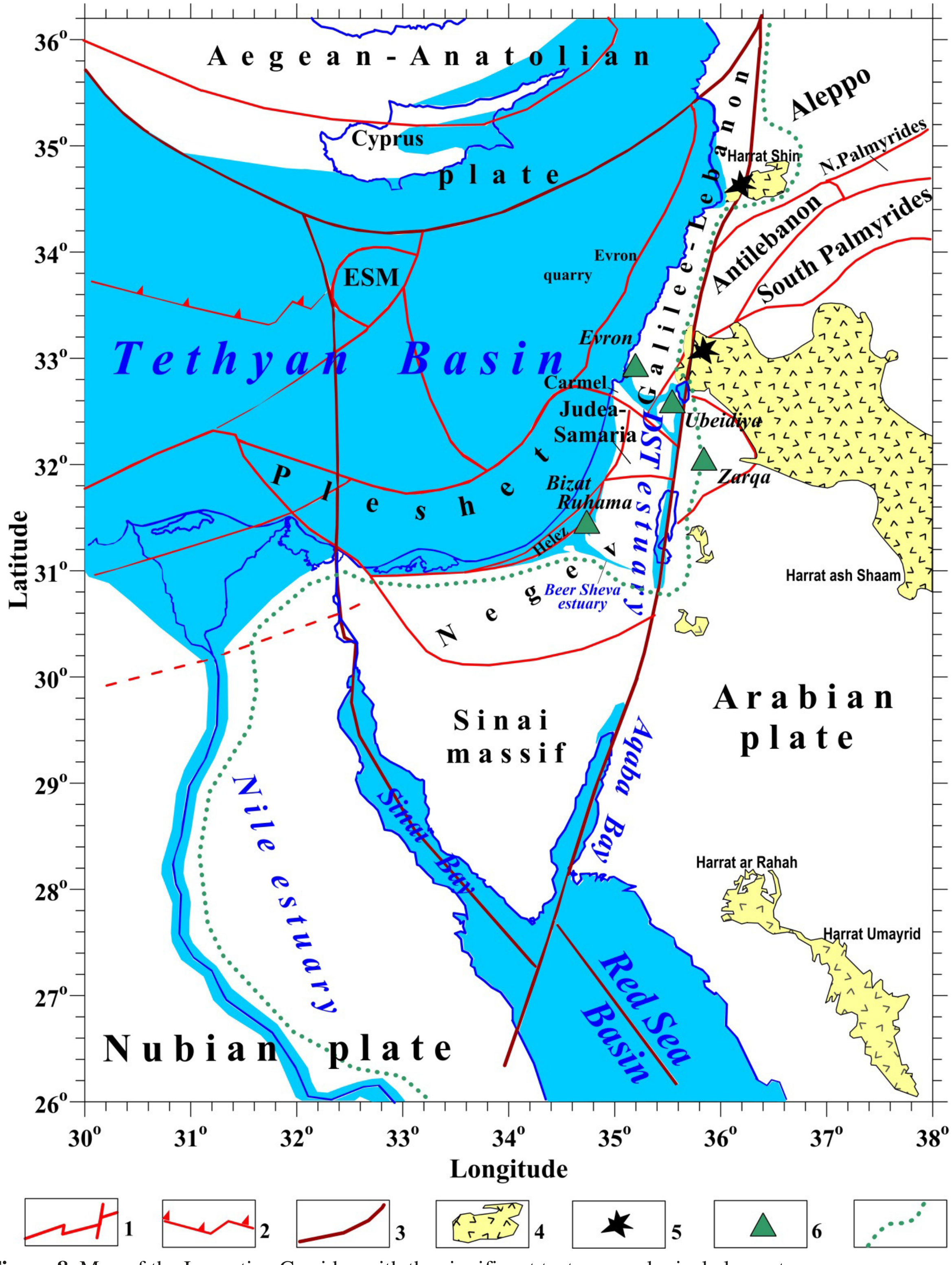


**Figure 8.** Map of the Levantine Corridor with the significant tectono-geological elements (1) interplate faults, (2) Mediterranean Ridge, (3) intraplate faults, (4) Pliocene trap fields, (5) Pliocene-Pleistocene volcanoes, (6) ancient hominin sites, (7) Levantine Corridor

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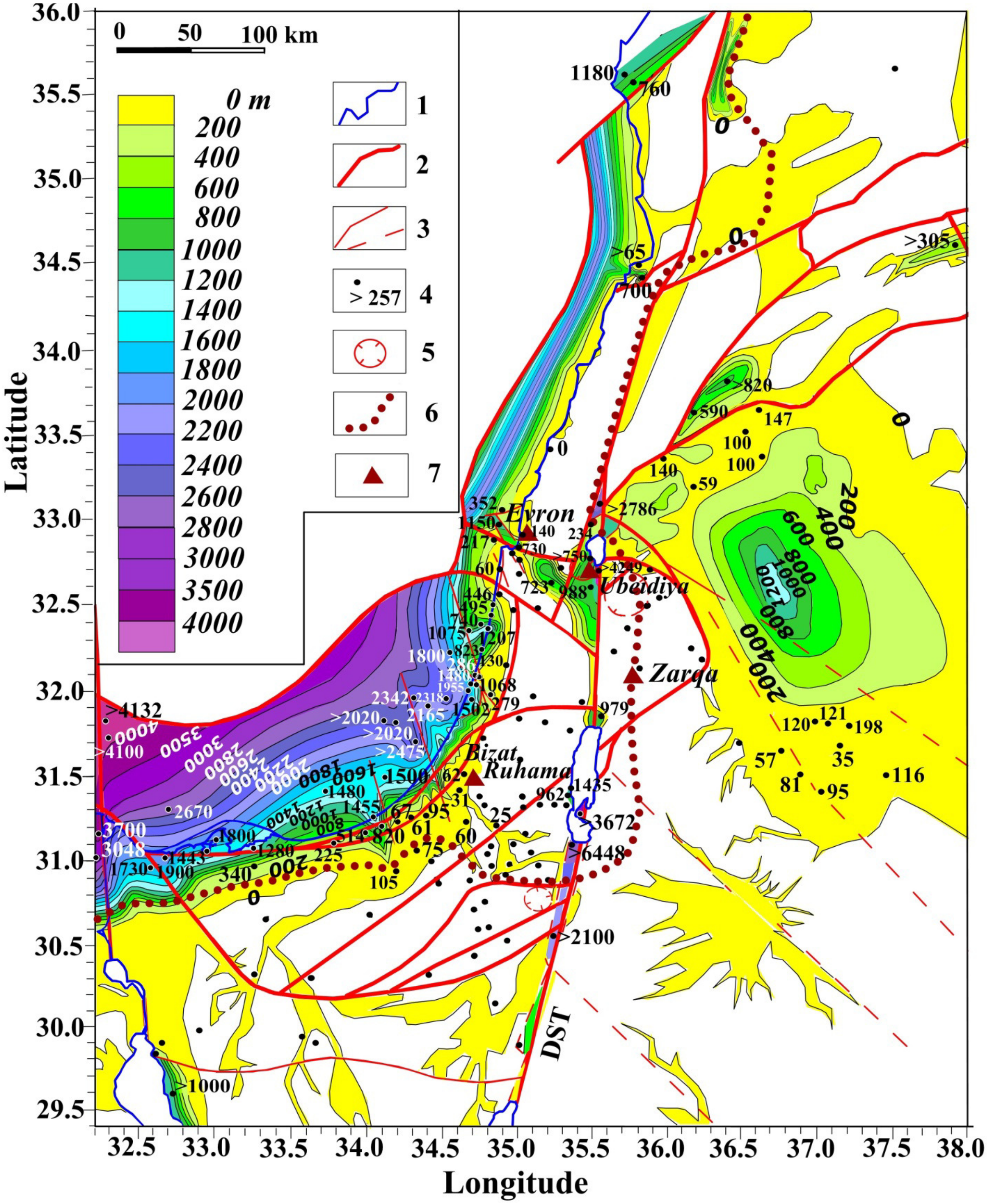


**Figure 9**. Map of the Neogene-Quaternary structural stage of the Eastern Mediterranean with some anthropological features (revised and supplemented after Eppelbaum and Katz (2015a)).

(1) coastline, (2) main faults, (3) secondary faults, (4) borehole (outcrop) location, (5) ring structures, (6) reconstructed early hominin way from Gondwana to Eurasia within the Levantine Corridor, (7) ancient hominin sites