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New geosite candidates from Urla (İzmir, Western Anatolia, Turkey): a list of geological assets nested with antique and modern cultural heritage

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Abstract: The Urla Basin is an approximately 20 km wide and 30 km long N-S-trending strike-slip basin, located in the westernmost part of the Western Anatolia Extensional Province. Although the basin-fill units are generally composed of sedimentary and volcanic rocks of Miocene to Recent, Triassic and Late Cretaceous-Paleocene sedimentary rocks are also exposed in the middle and western part of the basin. In addition to this geological diversity, the basin hosts many ancient settlements due to its geographical position and close contact with the Aegean Sea. This study mostly focuses on the northern part of the basin with a concentration on the possible geological heritage sites from the Urla and surroundings and its cultural heritage assets with respect geotourism. Klazomenai and Liman Tepe, one of the best examples of archaeological sites in the area, have a respectable Earth-science importance. Some other cultural heritage assets are also very valuable, such as the Yıldız Tepe Martyrdom Monument, Karantina Island, traditional vineyards of Urla, Urla Art Street and fellow-townsman that are well-known figures of literature and popular culture (e.g., Yorgo Seferis, Necati Cumalı and Tanju Okan). We present seven new geosite candidates, which are evaluated in the geological framework category groups B, C and E of the geosite framework list for Turkey. These sites have quite important geological meaning and value for the Earth-science education and geotourism potential.

Key words: Candidate geosites, cultural heritage assets, geotourism, Urla Basin, Western Anatolia

1. Introduction

The study and documentation of geosites, places where geological peculiarities can be observed, are important first steps towards the application of strategies useful for geoconservation and evaluation of inexhaustible natural resources (cf., Wimbledon 2011), and these efforts help to raise awareness among governmental administrations to plan and manage future actions relative to the urban development and protection (cf., Bentivenga et al. 2017 and Palladino et al. 2013; Bentivenga et al., 2019). The concept of "geotourism" was actually first introduced as "geological tourism" by Hose (1995) for touristic usage of geological structures and scenery. This concept has been broadened and described by Newsome et al. (2012) as a sustainable tourism form that focuses on geological subjects for environmental education and development. Geological experience is directly related to cultural development (e.g., Panizza and Piacente, 2009; Lubova et al., 2013; Necheş and Erdeli, 2015). Considering this aspect, some late studies combine geotourism, archaeological tourism and cultural tourism topics with respect to human-environment and environment-geology relations (e.g., Cahyadi, 2016; Rapidah et al., 2018; Chakrabarty and Mandal, 2019). The study and protection of geosites may be followed by an evaluation of the geotourism potential combining the geological heritage assets with the other natural and human resources (cf., Bentivenga et al., 2019). Hence, the preparation of local and national inventories of geosites is an essential first target of future projects on sustainable development. A provisional inventory of the geological heritage of Turkey has been prepared by the Turkish Association for the Conservation of the Geological Heritage (JEMİRKO; cf. JEMİRKO 2002), which is a nongovernmental organization (NGO) and a member of UNESCO National Committee of Turkey and the European Association for the Conservation of the Geological Heritage (ProGEO). Additional potential geosites have been documented and suggested in later studies (e.g., İnaner et al., 2019). In Turkey, other than this list prepared by JEMİRKO, scientific studies that focus on the geological heritage, geosites and geotourism are relatively limited relative to their counterparts worldwide.

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Moreover, such studies within western Anatolia are even more limited (e.g., İnaner et al., 2019; Gürer et al., 2019). With this background and motivation, an exemplary study from the Urla Basin, which includes geological and cultural richness at the westernmost end of the Western Anatolia, will be presented in this paper.

Urla is located on a northwest orientated bulge next to the joint of the Karaburun Peninsula and the mainland prolongation at the southern flank of the İzmir Gulf (Figure 1). The town is founded over the northeastern segment of the N-S elongated Urla Basin, which is bounded by strike-slip fault zones to its west and east. The basin fill includes volcanic and sedimentary rocks and structural elements that present good examples for geoscience education. Besides these, the region had also been an important cultural centre starting from antiquity and it includes remnants of the ancient Ionian city of Klazomenai. Moreover, modern Urla has been home for several modern cultural assets and personalities, making it a popular cultural tourism focus on the Aegean coast. It is also a beautiful all-season vacation spot for native and foreign tourists.

Although the geological setting of the Urla region presents geological assets that are valuable for Earth-science education, they have not yet been addressed from the perspective of the geoheritage concept, and the geotourism opportunities have not been evaluated. In this study, we address seven of the potential geosites at the northern termination of the Urla Basin, and additionally summarize some examples of the cultural heritage assets at the Urla region. By this study, we hope for the first time to exemplify a combined cultural and geotourism inventory list for Urla.

2. Geological setting and stratigraphy of the study area

Urla region is located in the Mediterranean part of the Alpine-Himalayan Orogenic Belt, at the junction of the Eurasian, African and Anatolian plates (Figure 1a). The region is located at the westernmost part of Anatolia, and is included in the West Anatolian Extensional Provence (WAEP) (e.g., Ambraseys, 1988; Jackson and McKenzie, 1988; Taymaz et al., 1991; Bozkurt, 2001) which in the recent studies are tectonically considered in two main parts, having different deformational styles (Sümer, 2015): (1) the Western Anatolian Grabens (WAG), and (2) the NE-SW-trending zone of weakness, named the İzmir–Balıkesir Transfer Zone (İBTZ) (Figure 1a). The Urla Basin is located in this latter segment (İBTZ) and forms a N-S trending strike-slip depression that lies between the Karaburun Uplift in the west and Seferihisar Uplift in the east, in the westernmost segment of Anatolia that meets the Aegean Sea (Figure 1b). Two main strike-slip fault zones, that are named Gülbahçe Fault Zone (GFZ) and Seferihisar Fault Zone (SFZ), border the western and eastern ends of the basin, respectively.

In this study, we simplified the pre-Miocene basement lithologies and gave only a brief description of them. The exposed Palaeozoic to Mesozoic lithostratigraphy of the Urla Basin consists of rocks of the Karaburun Belt in the west and the Bornova Flysch Zone in the east (Figure 1b). The study area is located in the northern part of the Urla Basin and it presents all the basement rocks at the western border, and includes almost all varieties of rock units within the basin (Figure 2). The formations of the Karaburun Belt within the study area consists of carbonate-dominated lithologies of Triassic and Jurassic ages. These formations, from bottom to top, are the Gerence, Güvercinlik and Nohutalan formations (Figure 3). These, mainly platform type carbonate formations of Mesozoic age, are unconformably overlain by Miocene. The Miocene sequence within the basin dominantly consists of clastics, lacustrine carbonates, and volcano-sedimentary successions. These may be summarized, from bottom to top, as the Bozavlu Formation, Çankurtaran Formation, Urla Limestone, İskele Volcanics, Yarantepe Basalt and the Plio-Quaternary basin fill-units (Figure 3). A detailed description of the geological formations is beyond the scope of this paper, and readers are referred to Sümer (2001), Çakmakoğlu and Bilgin (2006), Helvacı et al. (2009), Göktaş (2014) for further reading.

3. Material and methods

The geological data from and around the proposed geosites summarized in this study have been collected by qualitative and quantitative observations and measurements of the field elements and structures. These interpreted geological elements have then been evaluated for their geoheritage value and categorized in several groups within the Geosite Framework List for Turkey, that is previously suggested by Kazancı et al. (2015).

The terminology and framework of the concepts that we use here under the main topic of geological heritage follow the standards given in Wimbledon et al. (1995), ProGEO Group (1998), Brilha et al (2005), De Lima et al. (2010), and Wimbledon and Smith-Meyers (2012). The original geosite framework list (FL) outlined by ProGEO includes 10 basic categories (groups) for convenient description of geosites, however, this rough categorization is not a final grouping (cf., Kazancı et al., 2015 and the references therein, İnaner et al., 2019). Commonly, every country creates its framework list in concordance with neighbouring countries' framework lists (cf., Kazancı et al., 2015; İnaner et al., 2019). Hence, in order to categorize the potential geosite types, we followed the geosite framework list for Turkey, which is also followed by JEMİRKO. This FL includes 85 titles in 10 categories (Groups A to J) and

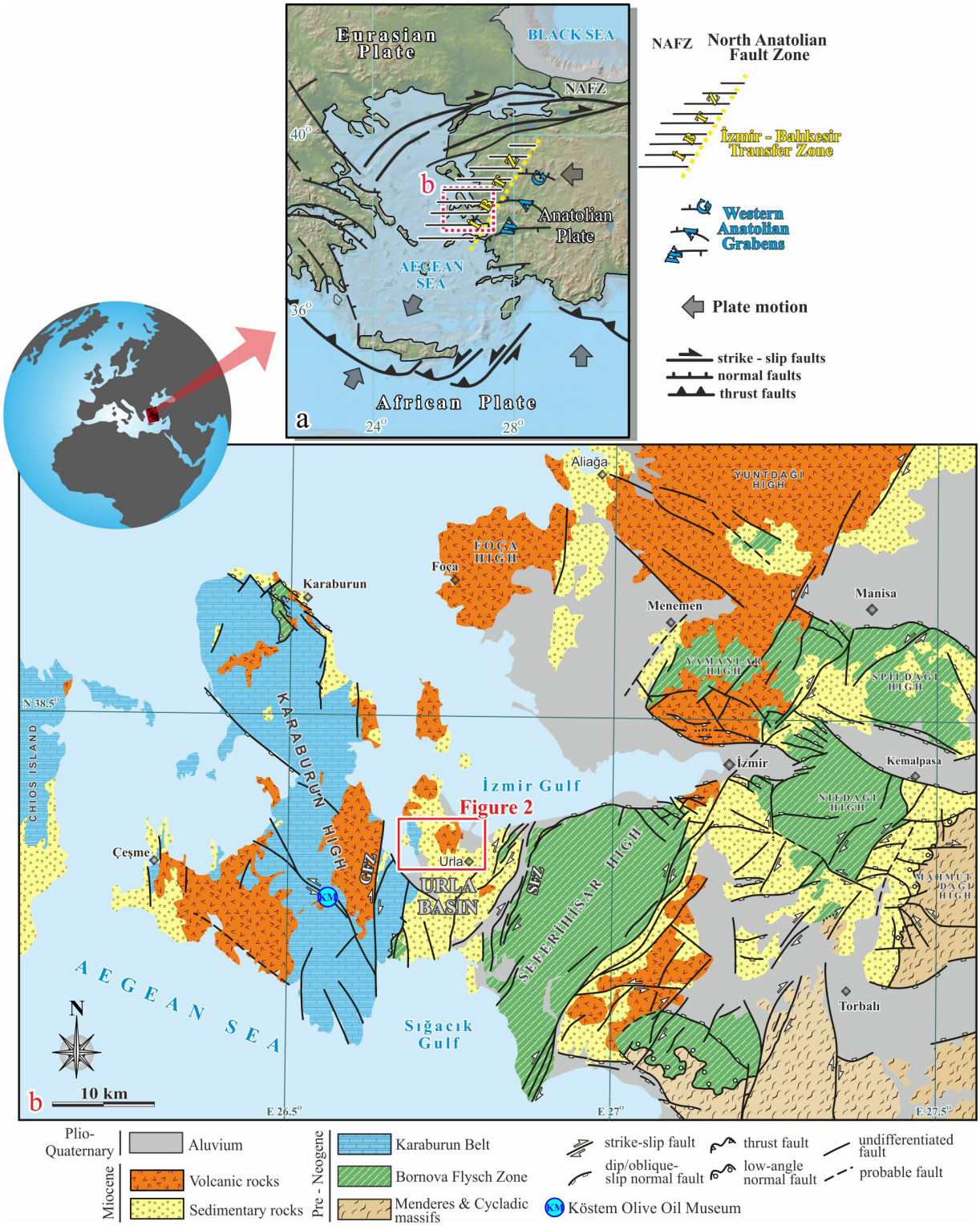

Figure 1. Location of the study area on global and regional scale. (a) Simplified tectonic map of the Aegean region and western Turkey. Major neotectonic structures complied from Şengör et al. (1985); Jackson and McKenzie (1988); Barka (1992); Sözbilir et al. (2003); Taymaz et al. (2007); Kaymakcı et al., (2007) and Sümer (2015). (b) Geological map of İzmir and its surroundings simplified from 1/500 000 scale geological map İzmir sheet published by General Directorate of Mineral Research and Exploration of Turkey, Konak (2002). The map also complied from Çakmakoğlu and Bilgin (2006); Sözbilir et al. (2011); Özkaymak et al. (2013) Uzel et al. (2013) and this study. GFZ: Gülbahçe Fault Zone, SFZ: Seferihisar Fault Zone.

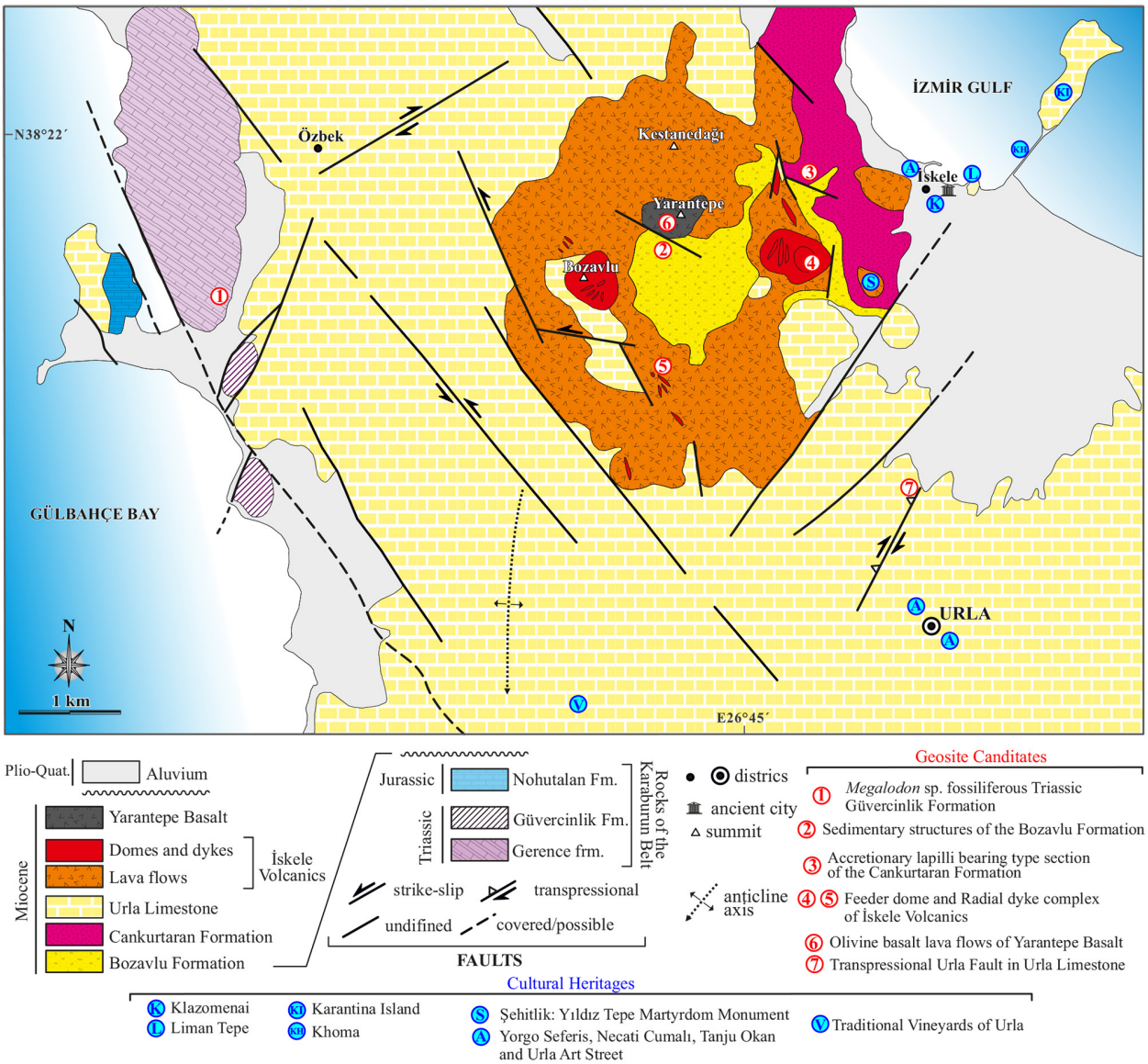

Figure 2. Geological map of the study area and potential geosites (PG) and cultural heritages (CH) of Urla surroundings. The Map is modified from Sümer (2001) and Çakmakoğlu and Bilgin (2006). See text and Table for further explanation of PG and CH.

is based on the FL by ProGEO (1998) and Theodossiou-Drandaki et al. (2014).

The groups in the FL for Turkey encompass a broad range of geological topics. In summary, Group A includes 3 subgroups of different geological eras (stratigraphic group, A1-Quaternary, A2-Phanerozoic, and A3-Proterozoic), Group B includes palaeoenvironmental geological assets, Group C comprises volcanic, metamorphic and sedimentary textures, stuctures, events and provinces, Group D is focused on mineralogical-economical assets. Structural geosites are grouped in Group E. Group F includes geomorphological characteristics. Group G is named Astroblemes and includes assets related to astronomic phenomena. Group H encompasses large-scale geological/geotectonic features, Group I includes submarine occurrences, and finally, Group J includes historical and cultural elements related to geology. The assessment method used for categorizing the defined geosites around Urla and the surroundings in this study is purely qualitative and based on definitions and examples given in the Geosite Framework List for Turkey by Kazancı et al. (2015).

4. Geosite candidates around Urla

We propose 7 potential geosites covering different geological categories from the north of the Urla Basin.

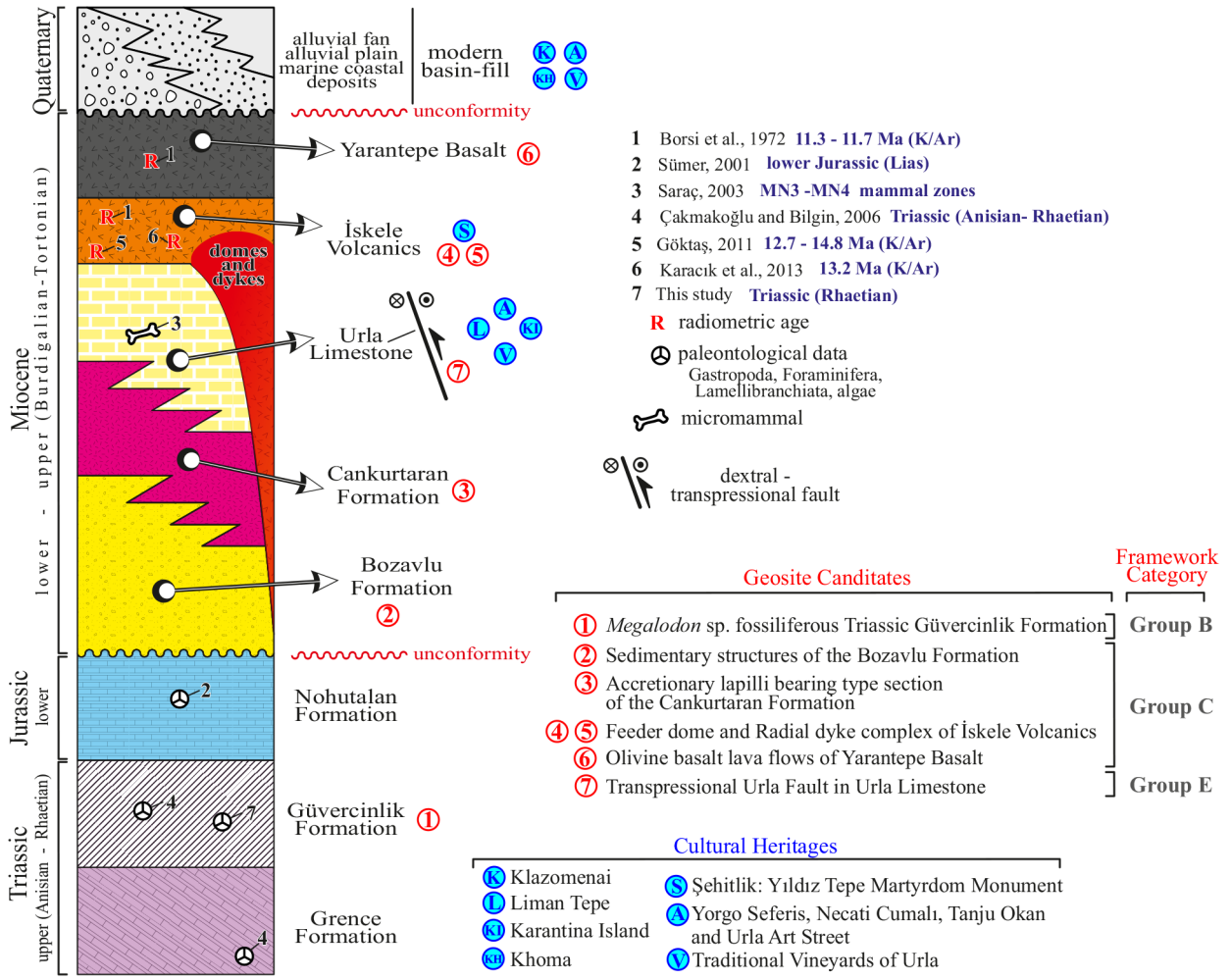

Figure 3. Generalized stratigraphic columnar section of the study area (modified and combined after Sümer, 2001 and Çakmakoğlu and Bilgin, 2006). Radiometric and paleontological age data according to previous studies attached the section. All of the PG and some CH are also located to the geological units on which they are exposed.

In addition to their geological values, availability for geological education and geotourism potential, all of them have good accessibility - being located in a crowded area and having public and pedestrian transport opportunities in order to make a one day trip.

4.1. Geosite 1 (megalodon sp. fossiliferous Triassic Güvercinlik Formation)

Brinkmann et al. (1967) were the first to recognize the presence of pelagic Triassic carbonates in the Karaburun Peninsula, and they divided this geological unit into subformations, consisting of Güvercinlik unit as light-coloured dolomite with reddish/yellowish siltstone and gravelly sandstone. Çakmakoğlu and Bilgin (2006) reported that the western part of the Gülbahçe Bay is covered by Mesozoic carbonate rocks belonging to the Karaburun Belt, that contained the Güvercinlik Formation. The formation, which is exposed to an area of approximately 2 km^2 in the east of Gülbahçe Bay in the study area (Figure 2), is composed of partly recrystallized dolomitic limestone with stromatolite layers (Figure 4a). Çakmakoğlu and Bilgin (2006) dated the unit as being Triassic (Anisian-Rhaetian) in age, according to the rich gastropod, foraminiferan and bivalvia faunal assemblages. This first candidate geosite comprises many perfect forms of *Megalodon* sp. bivalve fossils, which reach up 17 cm in length and which are observed in several levels in the section (Figures 4b and 4c). At this point, the thickness of some fossiliferous units varies between 0.5 and 1.2 m. It is one of the best fossil localities for the Triassic in the Urla Basin.

Karaburun Belt in western Turkey is one of the few areas that present evidence of Palaeotethyan events with nonmetamorphic rocks in the middle segment of the Anatolian Block. Kozur (1995) stated that the substratum of the Anatolian passive margin is observed

only in very few places and one of them is the Karaburun area. The Middle Triassic to Lower Jurassic part of this belt is characterized by a continuous stratigraphy that is carbonate dominated (Löwen et al., 2017). Moix et al. (2008) placed the Karaburun on the northwestern edge of the Pindos Ocean, which opened at the western end of Palaeotethys at the end of the mid Triassic times. Löwen et al. (2017) also relate the Karaburun belt to the northern edge of the Palaeotethys at the beginning of the Triassic. Hence, the proposed geosite is the best possible location in the Urla Basin for understanding mid Triassic geological events and the evolution of this part of the Palaeotethys.

4.2. Geosite 2 (sedimentary structures of the Bozavlu Formation)

The name "Bozavlu Formation" was given by Sümer (2001). The formation consists mostly of a fining-upward sequence of conglomerates, gravelly sandstones, sandstones, and mudstones. This candidate geosite demonstrates all of the sedimentological properties of the formation. The total thickness of the section, where perfect sedimentary structures are visible, is approximately 30 metres (Figure 4d). Conglomerates are massive-to moderately bedded, clast and matrix-supported, moderate to well rounded, moderately sorted, well consolidated, and blocky in the lowermost part of the unit. Some of the sedimentary structures in this location are amalgamated channelized large-scale cross-bedding (Figure 4e), laminations, syn-sedimentary deformational features, normal and reverse grading, imbricated clasts, sole marks, flute casts and current ripples. This geosite is also useful for understanding the relationships between Miocene volcanic and sedimentary rocks exposed in the Urla Basin. A geologist can easily take a quick geological field excursion to see a section starting at Yarantepe Hill in the north and extending to Bozavlu Stream in the south. Another substantial feature of this geosite, in terms of Western Anatolian Miocene palaeogeography, is its visual attributes being one of the rarest and best exposed outcrops that show the geological relation between the Urla volcanic rocks and detrital fluvial deposits.

4.3. Geosite 3 (accretionary lapilli in the type section of the Cankurtaran Formation)

The Cankurtaran Formation was first described by Sümer (2001) as a volcanoclastic rock series. The formation is mainly represented by block and ash flows. This candidate geosite covers all such volcanic facies in a 50 m-long unique geological type section (Figure 5a). The volcanic facies are characterized by debris flows (Figure 5b), mass flows and accretionary lapilli-bearing pyroclastic flow and fall deposits. Fully formed, spherical lapilli clasts are visible and reach up to 5 millimetres in size (Figure 5c). Some of the ash layers also include very visual examples of (formerly) molten volcanic bombs (Figure 5d). This geosite is an excellent example for geologists and others, becasue it is possible to observe how a phreatomagmatic volcanic eruption evolved step by step. Especially in the context of Western Anatolia, this is one of the shortest excursion profiles to observe the development of a Miocene explosive volcanism in terms of volcanic facies development. A detailed description of this locality is beyond the scope of this paper, and readers are referred to Sümer et al. (2003) for further information.

4.4. Geosites 4 and 5 (feeder dome and radial dyke complex of İskele Volcanics)

The İskele Volcanics occur in the middle and western segments of the study area and outcrop over an area of approximately 7 km^2 (Figure 2). They are generally composed of lava, dome and dyke facies. The main unique feeder dome of the complex is located in Örenkayalar. This volcanic structure is characterized by an exhumed outcrop that is 300 m in width and 350 m in length (Figures 6a and 6b). Both the internal structure and emplacement mechanism of the feeder dome can be observed. Hexagonal cooling joints reach up to 1.3 m in width and 80 m in height (Figures 6 c and 6d). Another unique volcanic feature in this unit is exposed 1 km south of the Bozavlu Hill, where there is a radial dyke complex (Figure 2). This complex is 200 metres in width and 400 metres in length, and it comprises several trachytic dykes striking NE–SW, E–W and NW–SE, following the structural trends (Figure 7a). Agostini et al. (2010) described the main geochemical character of the İskele Volcanics as shoshonitic. In addition, Borsi et al. (1972) and Karacık et al. (2013) reported K/Ar ages from the İskele region 11.9 Ma and 13.2 ± 0.3 Ma, respectively. Feeder dome and radial dykes complex are valuable tools for understanding fundamental volcano-tectonic processes, and in general, internal volcano growth, under a stress field resulting from the inflation of a shallow magma chamber (Bistacchi et al., 2012). Therefore, it is necessary to understand better and investigate these two geologically unique features presented as geosites in this study.

4.5. Geosite 6 (olivine basalt lava flows of Yarantepe Basalt)

The products of the later phase of volcanic activity in the study area, which are represented by black-coloured olivine basalt lava flows, were identified by Borsi et al (1972) and Innocenti and Mazzuoli (1972) as having a hawaiitic composition. Later, Savaşçın and Erler (1994) mapped these volcanic successions separately, in detail, as basalt, alkali-rhyolite and trachyte. The name "Yarantepe Basalt" was applied to the entire latest phase of the volcanic products by Sümer (2001). The lateral equivalent of these volcanic rocks is exposed in the middle part of the Urla Basin and was named the Ovacık Basalt by Kaya (1979).

These basalts are dated at 11.3 Ma by Borsi et al (1972). The 50 metres long and 20 metres wide outcrop,

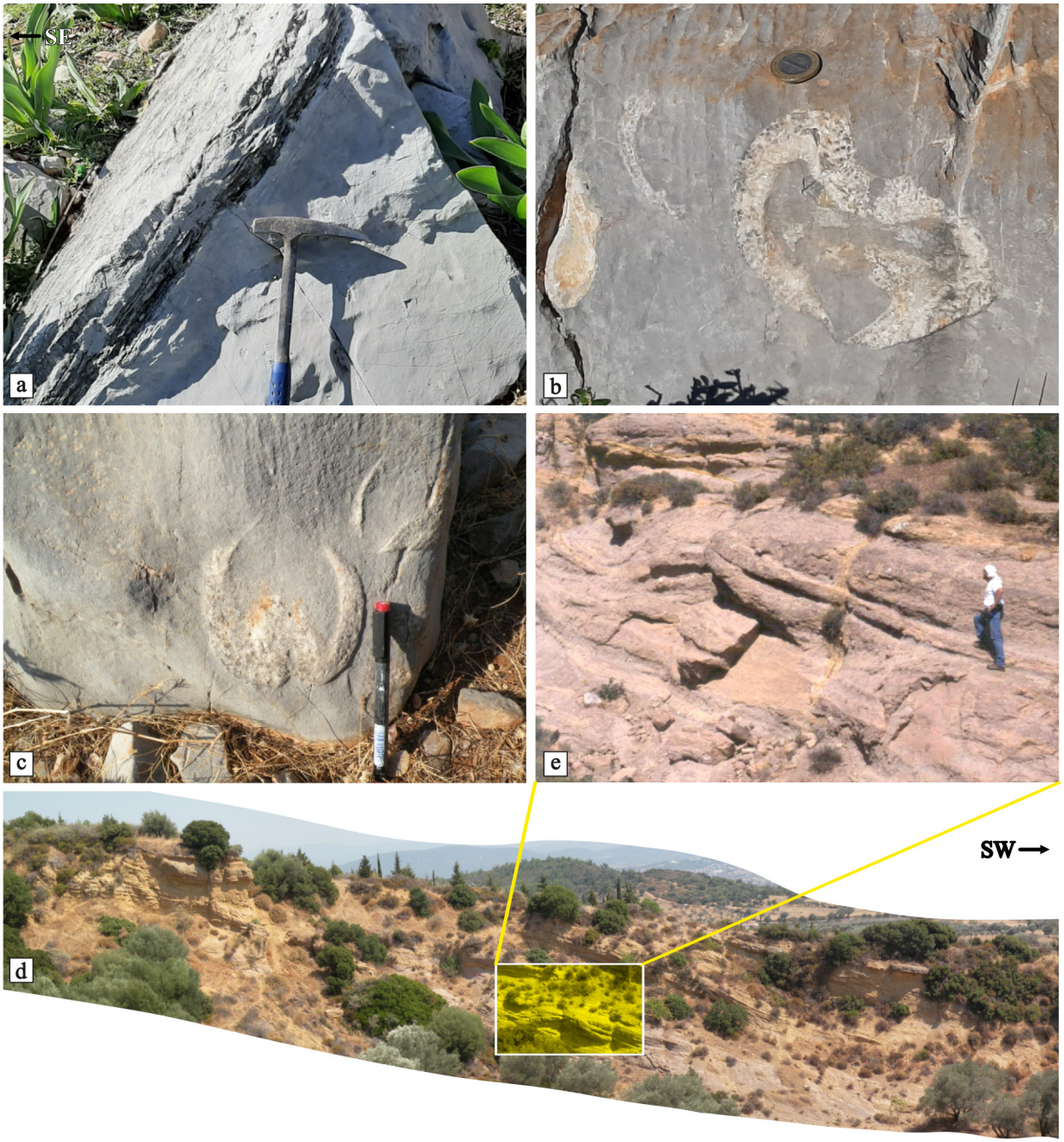

Figure 4. Field photographs of PG. (a) algal laminations within grayish cream-colored Güvercinlik Formation, (b and c) various size *Megalodon* sp. fossils in the formation, (d) Panoramic view of the candidate Geosite 2, (e) close-up view of the Miocene river channel with in the Bozavlu Formation. The geologist is 177cm, and the coin is 2.5 cm, the pencil is 14 cm.

our candidate geosite 6, is located on the southern slope of the upper part of the Yarantepe (Figure 7b). The site is represented by columnar-jointed olivine basalt lavas. This outcrop provides an excellent geological visual locality, and it is the only place where Tortonian age K- rich alkaline basaltic volcanics can be clearly seen in the Urla Basin. The Yarantepe Basalt is also significant for being the product of the last event of Miocene volcanism at İzmir and its surroundings.

4.6. Geosite 7 (transpressional Urla Fault in Urla Limestone)

Although Western Anatolia is especially known for its extensional graben and horst structures, studies of fault kinematics that started in the 2000s indicate that the

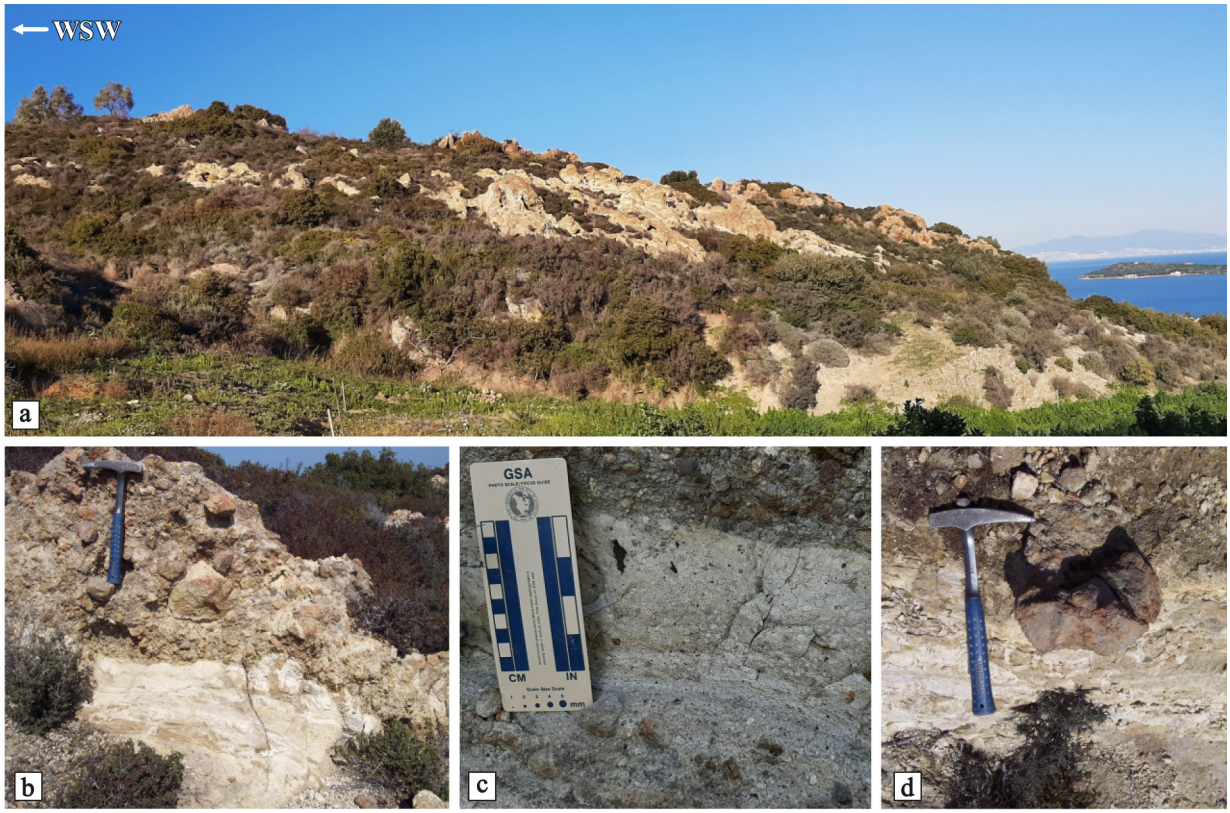

Figure 5. (a) Panoramic field photographs of candidate Geosite 3, (b to d) volcanic facies structural elements observed in the type section within the in Cankurtaran Formation. (b) block and ash flow deposits, (c) full spherical lapilli clasts in accretionary lapilli bearing pyroclastic fall deposits, (d) molten volcanic bomb. The hammer is 30 cm, the scale is 15 cm.

western part of the region is characterized by a strike-slip dominant zone. The western termination of Western Anatolia is characterized by a zone of weakness of dominant NE–SW-trending strike-slip zone, the İzmir-Balıkesir Transfer Zone (İBTZ), which is approximately 120 km long and 60 km wide (Sözbilir et al., 2003). The Urla Basin is located in this crustal-scale geological structure which presents a unique Miocene transpressional fault exposed in the northern part of the basin. The best-observed fault surface is located at the main road junction of the Urla County centre (Figure 7c). We suggest this point as another candidate geosite. The reactivated fault is approximately NNE–SSW-trending and NW-facing, with dip angles ranging between 48° and 60° NW. Phase 1 (D_1) is represented by strike-slip lineation with rakes changing between 12°–14° SW, kinematic indicators, such as corrugations, slickensides and chatter marks indicate right-lateral movement. The younger Phase 2 (D_2) is characterized by oblique-slip lineation with rakes changing between 60° and 65° SW, and the last phase is represented by a dip-slip movement with a reverse component. The fault shear zone includes clay gouge ranging between 15 cm and 30 cm in thickness. This candidate geosite is one of the clearest and most accessible locations for the Miocene transpressional deformational features in Western Anatolia.

5. Cultural heritage assets in Urla

5.1. Klazomenai (K)

Strabo mentioned Klazomenai, which covers 7 islands lying off-shore and the city lands, as suitable for agriculture (Strabo; Jones, 1923 translation). Klazomenai was one of a political federation of 12 Ionian city-states, located on the south coast of the İzmir Gulf (Figure 8a). Pausanias stated that Klazomenai was a lonesome place, first occupied by Greek migrants who migrated from Kolophon (Pausanias; Jones, 1933 translation). However, the settlement of the city dates back to the 4th millennium B.C., and the city has been investigated archaeologically in 2 main parts, on the mainland and on the small island of Karantina (Ersoy and Koparal, 2012). These 2 locations were occupied at different times; the settlement was on the mainland throughout the Bronze Age, and on the island during the Hellenistic and Roman periods (Ersoy and Koparal, 2012). The city is located in a very noteworthy province due to its geographical and geological location. The

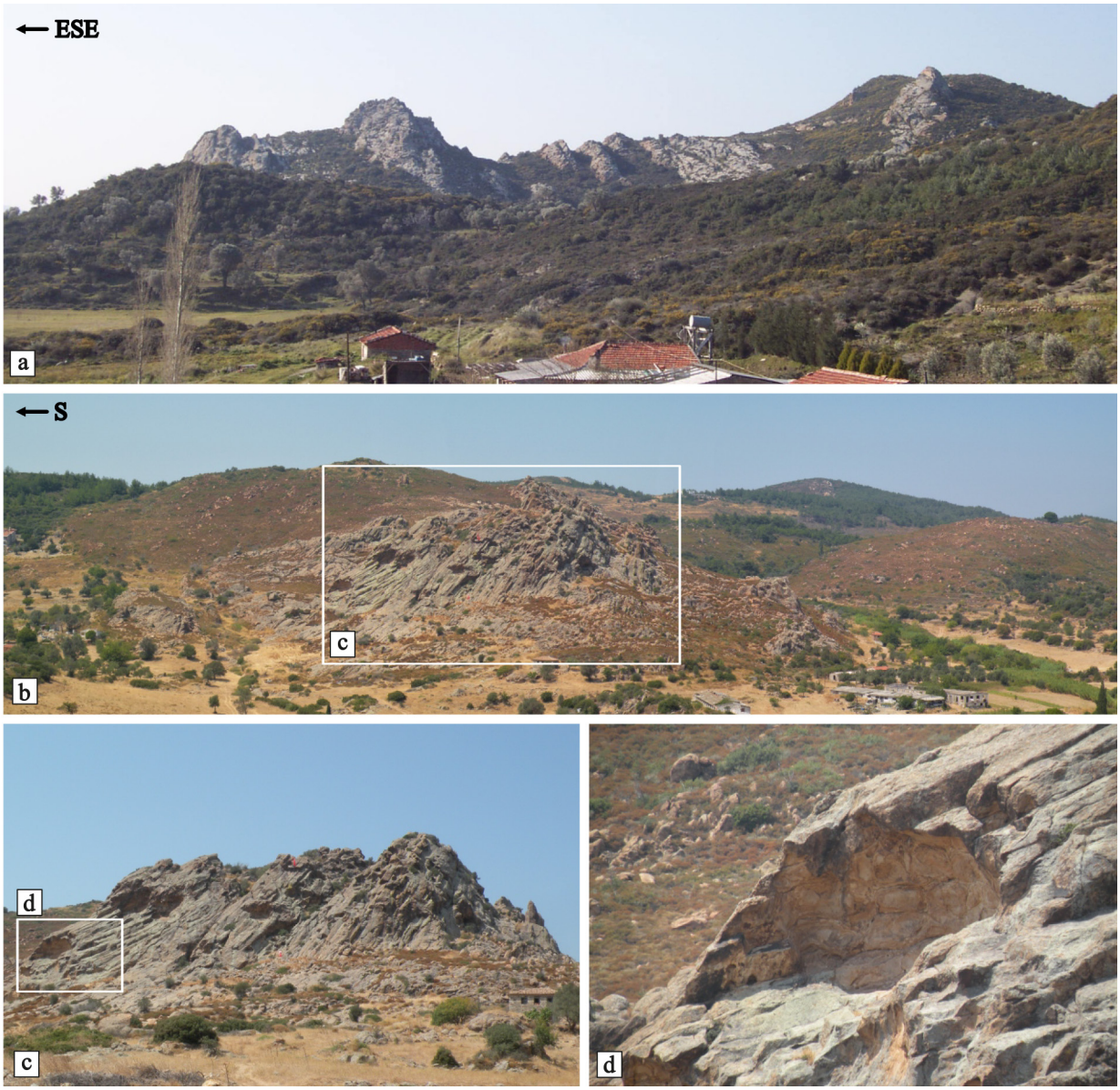

Figure 6. (a and b) Panoramic field photographs from different perspectives of candidate Geosite 4, feeder dome belonging to İskele Volcanics, (c and d) hexagonal cooling joint structures.

palaeogeographical position of the city and the Holocene coastline shifting was lately discussed in a recent study by Kayan et al. (2019).

Anaxagoras's hometown

The factor that makes Klazomenai an important spot for geology and enthusiasts of history, is that Anaxagoras, the natural philosopher, was born in the city (Strabo; Jones, 1923 translation). in 500 B.C. The works of Anaxagoras discussed astronomy, biology, and the constitution of matter. He tried to explain elementary physical phenomena rationally, and the Earth's processes in the light of observations on natural philosophy. He was perhaps the first literate person to attempt to explain the idea that the various processes through an internal circulation of waters, which we know in modern times as the hydrological cycle. He had also asserted that various water processes were involved in a closed cycle involving both movement and storage (Fairbridge and Alexander, 1999; Dooge, 2001).

5.2. Liman Tepe (L)

Liman Tepe is located in the easternmost part of the study area, within the Urla County-İskele town, just to the west of the highway connecting to the Karantina Island, and situated to the east of the modern harbour.

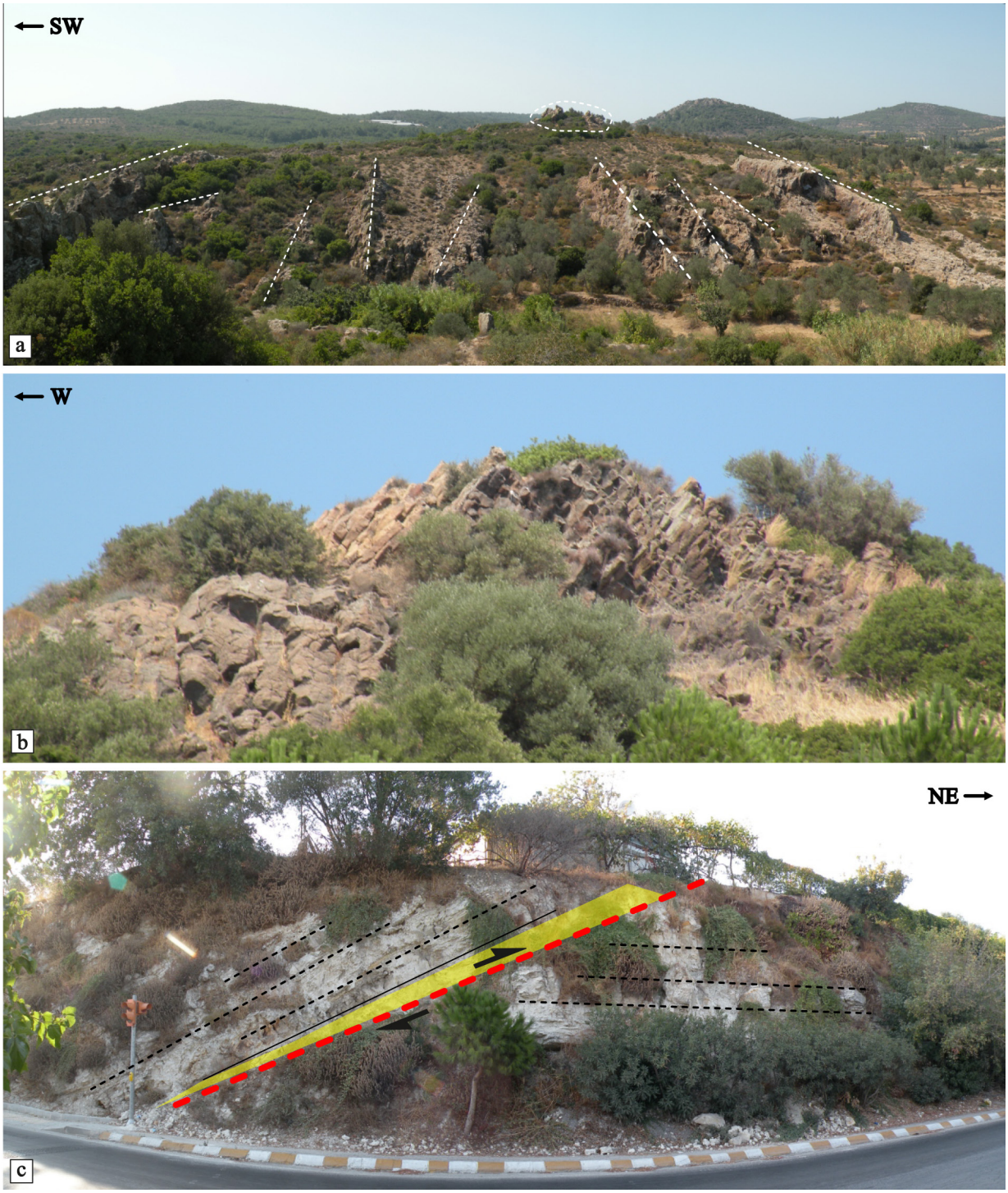

Figure 7. (a, b, and c) Panoramic field photographs of candidate Geosite 5, 6 and 7, respectively. White dashed lines indicate dyke strikes belonging to radial dykes complex of İskele Volcanics, black dashed lines show bedding of Urla Limestone, bold red dashed line indicate the transpressional Urla Fault, yellow shaded area show shear zone, black arrow indicate movement of the hanging wall.

This archaeological site in the harbour and surroundings is also defined as prehistoric Klazomenai (Figures 8a and 8b). Excavations which have continued uninterruptedly since the 1940s have revealed cultural layers of Liman Tepe which extend from the Middle Chalcolithic Age to the Roman Period (Erkanal and Şahoğlu, 2012). Liman Tepe

is one of the most important port cities of Anatolia opening onto the Aegean Sea, especially with its monumental buildings and magnificent walls from the Early Bronze Age (Erkanal and Şahoğlu, 2012). Also, it has the oldest ancient pier (mole) known (Figures 8a and 8c) its use in the 4th and 6th centuries B.C. has been proved during underwater excavations (Erkanal and Şahoğlu, 2012). The scientific archaeological data obtained from this site contains significant evidence relating to the boat- and shipbuilding techniques. The reproduction boats that have been made with this data are unique in this sense. Erkanal and Şahoğlu (2012) indicate that a wooden anchor find made during the underwater excavations of the 6th century BC port base is one of the earliest examples of its kind,being discovered so far.

5.3. Karantina Island (KI) and Khoma (KH)

Karantina Island is a tiny island, which is 1200 m in length and approximately 630 m in width at its largest extent (Figures 8a and 8d), connected to the mainland by a causeway (Khoma) (Güngör, 2004). Evidence of intensive human activity starting from the ancient period has been revealed, likely due to its close proximity to the mainland. This causeway was built in the reign of Alexander the Great (Pausanias; Jones, 1933 translation). Strabo described this geographical change as: "*the Klazomenai, an important city on the Gulf of Smyrna once an island but now, in a sense, a peninsula*". Some parts of this antique road are overlapped by the current modern road or lay parallel to the western part of the modern one (Figures 8a and 8e). The most prominent ancient structures of the island are the temple of Athena and the theatre complex that are located on top of the plateau on the northern hill and at the northern flank of the island, respectively. Archaeological finds on the island identified show Roman and Hellenistic periods settlement between the 5th and 4th centuries B.C. (Van Beek and Beelen, 1991; Güngör, 2004; Egeci, 2014).

5.4. Some examples of modern cultural heritage in the Urla County

Şehitlik: Yıldız Tepe Martyrdom Monument (S)

Yıldız Tepe, looking towards the İzmir Inner Bay at the central north segment of the Urla Basin, is a remarkable landmark for both its panoramic view of the basin and its place in the liberation of Izmir, which had great importance in the history of the Republic of Turkey. The monument located here is dedicated to Captain Kemal and Corporal Baki, who lost their lives due to the artillery fire by an English battle cruiser retreating from the bay, and all the martyrs that shed blood in liberation of Urla during the Turkish War of Independence.

Karantina Island: during the exchange period (KL)

In the 1850s, the Karantina Island was selected as a substitute for the first Quarantine Centre of İzmir, mainly due to its rapid expansion as one of the most important harbour cities of the Ottoman Empire (Yılmaz, 2018). The island was a prominent location during the population Exchange Period as a first stop for the Turkish exchanges that had immigrated to Anatolia according to the Lausanne Treaty (Yılmaz, 2018). Current accessible locations in the island are the showers and giant cylindrical ovens for the disinfection of personal possessions of the people under quarantine, and the rail systems that were used for transportation of goods from ships docked in the island's harbour. Urla Quarantine Centre is one of the 3 quarantine locations in the world that is well-preserved (Yılmaz, 2018).

Traditional vineyards of Urla (V)

Anatolia has been a significant landmass as the home for many vine varieties and Klazomenai has always been one of the notable loci for wine production and trade (Kalelioğlu, 2018). In late years, Urla wine producers have constructed the "Urla Wine Route" with the support of the İzmir Development Agency (İZKA) and are hopeful of reestablishing the Roman-era splendour of the Urla wines (Kalelioğlu, 2018). According to the data of the Department of Tobacco and Alcohol of the Ministry of Agriculture and Forestry of the Republic of Turkey, the local producers within the Urla Wine Route, one of the several legs of agricultural tourism worldwide, provide 2% of the national wine production.

Yorgo Seferis, Necati Cumalı, Tanju Okan, and Urla Art Street (A)

Urla is also of considerable importance for modern literature and culture. It is the birth place of Yorgo Seferis, a world-renowned Nobel Prize Winner poet and author, and the hometown of Necati Cumalı, one of the significant personalities of Turkish literature. Tanju Okan, a famous singer of Turkish pop music, also resided in Urla until his death. Urla Art Street is a relatively new occurrence based on a series of a street-aligned old Urla houses. The location serves as a new cultural attraction in the city. Besides, several high-quality restaurants present traditional cuisine in and around this street. In particular, the traditional "Urla Artichoke Festival" that displays a part of the Aegean culinary culture around western Anatolia, is held in the last week of the March and carried out around the Urla Art Street.

Köstem: the largest olive oil museum of the world (KM)

This interesting museum lies 20 km west of Urla County centre (Figure 1b). It is dedicated to presentation of olive cultivation and culture in the Aegean region and Urla. Köstem Olive Oil Museum is notable as the world's largest olive oil museum and Turkey's second industrial museum[1]. The museum, at 5000 m^2 indoors and 20,000 m^2 outoors, has a collection that includes stone presses, scales, animal-, water-, wind- and steam-powered antique and modern

[1] http://kzmurla.com/muze-kompleksi/muze-hakkinda

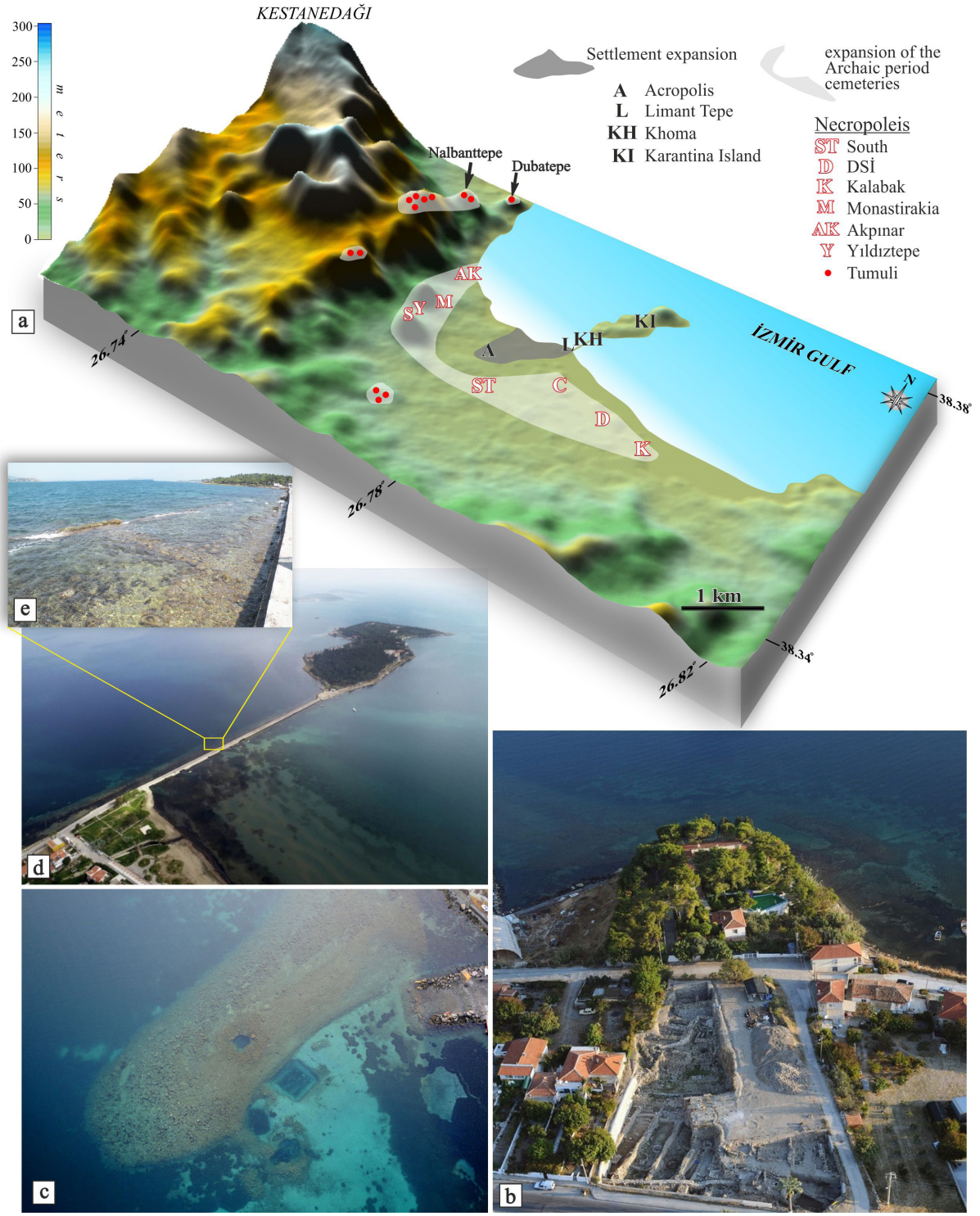

Figure 8. (a) Digital elevation model of the Klazomenai (K) and surroundings (archeological site location are taken and combined from official web site of Klazomenai excavation[1] and Ulus 2010). Drone footage pictures are taken from[1, 2, 3] (b) Liman Tepe (L) excavation area, (b) now undersea ancient pier (mole) of Liman Tepe, (d and e) Karantina Island (KI) and Khoma (KH) respectively.

[1] Website https://www.klazomeniaka.com/ [accessed 11.02.2020]

[2] Website http://ankusam.ankara.edu.tr/limansualti/ (photo by Hakan Çetinkaya) [accessed 15.02.2020]

[3] Website https://www.ensonhaber.com/seyahat/urla-karantina-adasi (photo by Cem Öksüz – Anadolu Ajansı) [accessed 11.02.2020]

Table. Potential geosites and cultural heritages of Urla. * To find on map (Figure 2) please use geosite no and marks of other cultural heritages. Only Köstem Olive Oil Museum (KM) location shows in Figure 1b. You may also find these locations in the KML file given supplementary material.

Geosite no *	Potential geosites introduced in this study	Coordinates (Long/Lat)	Framework category (cf., Kazancı et al. 2015)
1	*Megalodon* sp. fossiliferous Triassic Güvercinlik Formation	38°21'12.90"N / 26°41'34.11"E	GROUP B
2	Sedimentary structures belonging to Bozavlu Formation	38°21'28.92"N / 26°44'29.91"E	GROUP C
3	Accretionary lapilli bearing type section of the Cankurtaran Formation	38°21'51.28"N / 26°45'30.75"E	
4	Feeder dome of İskele Volcanics	38°21'22.24"N / 26°45'27.95"E	
5	Radial dykes complex of İskele Volcanics	38°20'45.67"N / 26°44'27.75"E	
6	Olivine basalt lava flows of Yarantepe Basalt	38°21'37.25"N / 26°44'29.22"E	
7	Transpressional Urla Fault in Urla Limestone	38°20'7.78"N / 26°46'6.50"E	GROUP E

Marks*	Other cultural heritage description	Location
K	Klazomenai Ancient City (Hometown of Anaxagoras)	İskele town and surroundings
L	Liman Tepe (the oldest known harbour of the Western Anatolia)	
KH	Ancient Island Road: Khoma	
S	Şehitlik: Yıldız Tepe Martyrdom Monument	
KI	Karantina Island (particularly was important during the exchange period)	
V	Traditional vineyards of Urla	Distributed in the middle and southern part of the Urla Basin
A	Houses of Yorgo Seferis, Necati Cumalı, Tanju Okan and Urla Art Street	İskele town and Urla County centers
KM	Köstem Olive Oil Museum (The Largest of the Wold)	38°17'23.69"N / 26°33'20.10"E

cold and hot press equipment. This museum also played a considerable role in the construction of the Klazomenai olive oil workshop.

6. Concluding remarks

Urla and its surroundings attract attention especially due to the presence of Klazomenai antique city and other cultural heritage assets. However, the region also has a very important geological heritage value due to the dense occurrence of geological formations rich in remnants of the volcanic, tectonic, sedimentary processes and paleontological data in a very limited area. These geological sites listed above, and evaluated in the framework category groups B, C and E (Table), may be considered as candidate geosites. We believe that these candidates are very useful not only for their scientific importance, but also for educational value to the Earth sciences. Locations in table are also given as a separate KML file in the supplementary data, to enable an easy follow-up in the field for visitors.

These geosites, nested within the cultural heritage and vacation potential of Urla, further encourage us in the evaluation of the geotourism potential of the region. Urla city and its abovementioned surrounding assets are located in the middle of the Aegean coastline of the Anatolian landmass. The Aegean coastline is mainly famous for its cultural/seasonal tourism spots (national parks, protected areas and holiday facilities, etc.). However, its geotourism potential has only started to be explored in recent years (e.g., Gürer et al., 2019; İnaner et al., 2019). Preparation of such a combined geosite and cultural inventory specific for the Urla region and surroundings is thus an important step so as to invoke further studies evaluating geotourism potential throughout the Aegean coast of Turkey. We think that the list presented in this work will speed-up efforts in the comprehensive utilization of the cultural and geoheritage assets of Western Turkey.

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Supplementary Data

Supplementary data can be accessed at the following link: https://dx.doi.org/10.3906/yer-2002-6-sup

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