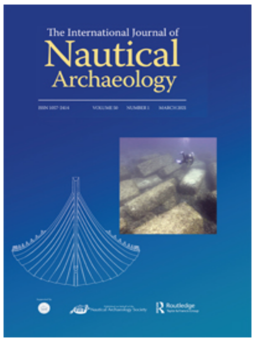

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Did the Minoans have Storage Shipsheds? A Palaeogeographic Perspective

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NOTE

Did the Minoans have Storage Shipsheds? A Palaeogeographic Perspective

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In our recent publication on the palaeogeographic reconstruction of the Messara Gulf in Crete during prehistoric and historic times (Mourtzas & Kolaiti, 2020), solely based on geoarchaeological evidence, we posed the question of whether the building P at Kommos could have served as shipsheds, as suggested by the excavators of the site (Joseph and Maria Shaw). To our question, Joseph W. Shaw and David Blackman immediately responded by submitting a note to the *IJNA*, in which they repeat their opinion about the role of 'the civic, shore-side building P' (Shaw & Blackman, 2020, p. 406). In support of their thesis that the six galleries of building P served as 'storage shipsheds' during the LMIII period of Kommos, they mention two – in their opinion – parallels, at Katsambas (Vasilakis, 2007, 2010) and Gournia (Watrous, 2010, 2012), thus opening up a debate about this issue. Despite their unfounded allegation that these 'articles were not included, as if they were discarded' in our bibliography (Shaw & Blackman, 2020, p. 408) and following their exhortation to 're-examine our argument with the new evidence at hand' (sic) (Shaw & Blackman, 2020, p. 409), we submit this note. Acting in the spirit of a creative interdisciplinary dialogue, with all due respect for the significant work of the two authors, creditable in their specific field of knowledge, we clarify our position from a geoarchaeological – and not archaeological – point of view regarding the arguments given in their recent note (Shaw & Blackman, 2020) and in previous publications (Blackman, 2011; Shaw, 1990, 2019). *Inter alia*, we make a brief reference to the likelihood of ships having been able to approach, moor and be drawn up along the NE coast of Crete (Katsambas, Amnisos, Nirou Chani, Malia, Gournia and Mochlos) based on the paleogeography of each particular site and its exposure to the prevailing weather conditions (Figure 1).

Sea-Level Rise Curves

Based on intertidal geomorphological markers of the relative sea-level change (henceforth rsl) from 83 locations throughout the Cretan coast, including the data presented by Pirazzoli et al. (1982) for the westernmost part of Crete, Mourtzas et al. (2016) suggested a curve of the rsl rise (Figure 2). The dating of the deduced six sea-level stands was achieved by archaeological rsl indicators of prehistoric and historic times from 47 locations scattered all along the coast of Crete. The study of this plethora of information led to the determination of a rsl stand at 3.95 ± 0.25 m below mean sea level (henceforth bmsl), which remained stable throughout the Protopalatial period (*c.*1900 BC to 1600 BC), and a subsequent rsl stand at 2.70 ± 0.15 m bmsl, which formed after the Thera eruption of *c.*1600 BC and lasted until *c.*1200 BC. The paleogeography studies of the coastal Minoan centres of Kato Zakros and Kommos that were published thereafter (Mourtzas & Kolaiti, 2017, 2020) relied on these sea-level stands and the authors further analysed the particular underwater geomorphological features of each location. In fact, in the latter publication on the Messara Gulf and Matala Bay, the curve of the rsl rise for the past 5000 years was updated according to geoarchaeological findings from the Kommos and Matala survey.

In contrast, Gifford's (1995, p. 80) 'hypothetical reconstruction of coastal evolution' of the Minoan Kommos is not deduced from geomorphological and archaeological rsl change indicators that determine and date the past sea levels on the coast of Messara and Kommos. Despite his own statement that there is no evidence ('no trace remains') to support his hypothetical scenario, he suggests that 'Papadoplaka islet was joined to the coast by a sand tombolo deposited in the lee of the dominant wave fetch', which 'drowned and was dissipated by wave energy' (Gifford, 1995, p. 78). He attempts 'to explain the known geological and archaeological facts in terms of a sea-level rise that fits them' although he admits that this is not 'an adequate approach', since 'the argument is very *ad hoc* and borders on circularity' (Gifford, 1995, p. 77). Nevertheless, 'in the absence of more field work' he generates a local curve of sea-level rise 'conceivable', which 'cannot in any sense be

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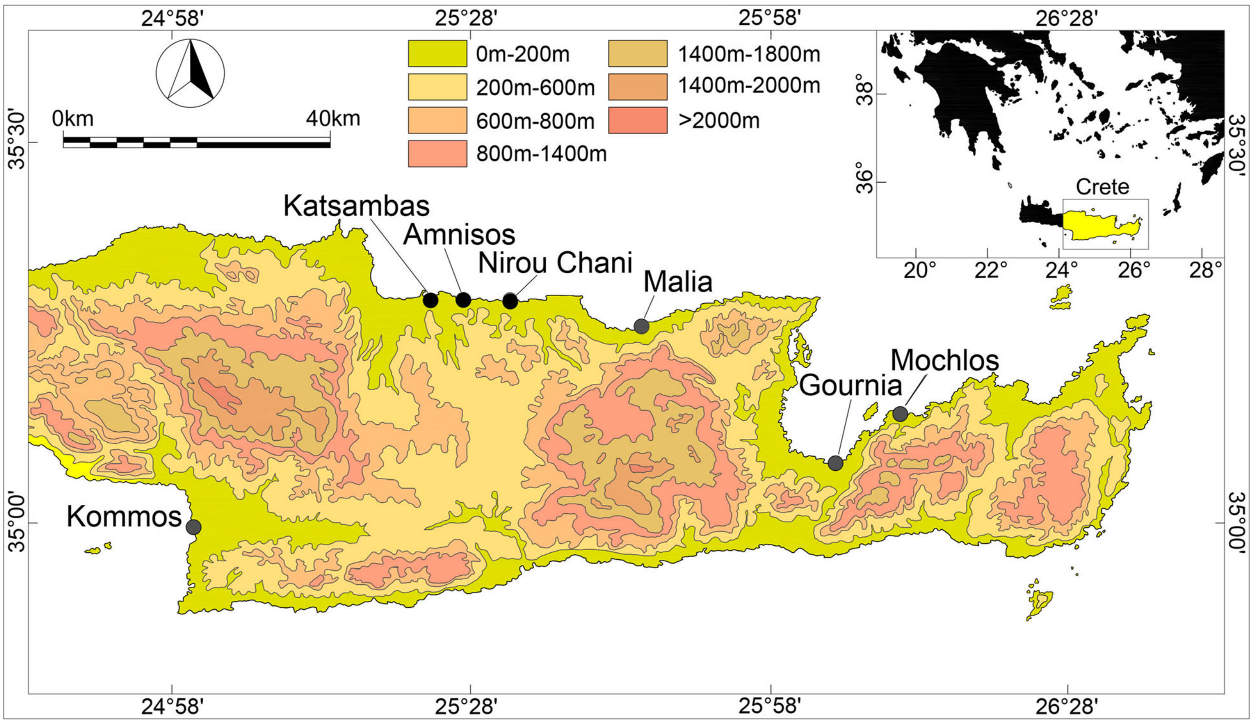

Figure 1. Location map of the Minoan sites of East Crete discussed herein (Nikos Mourtzas).

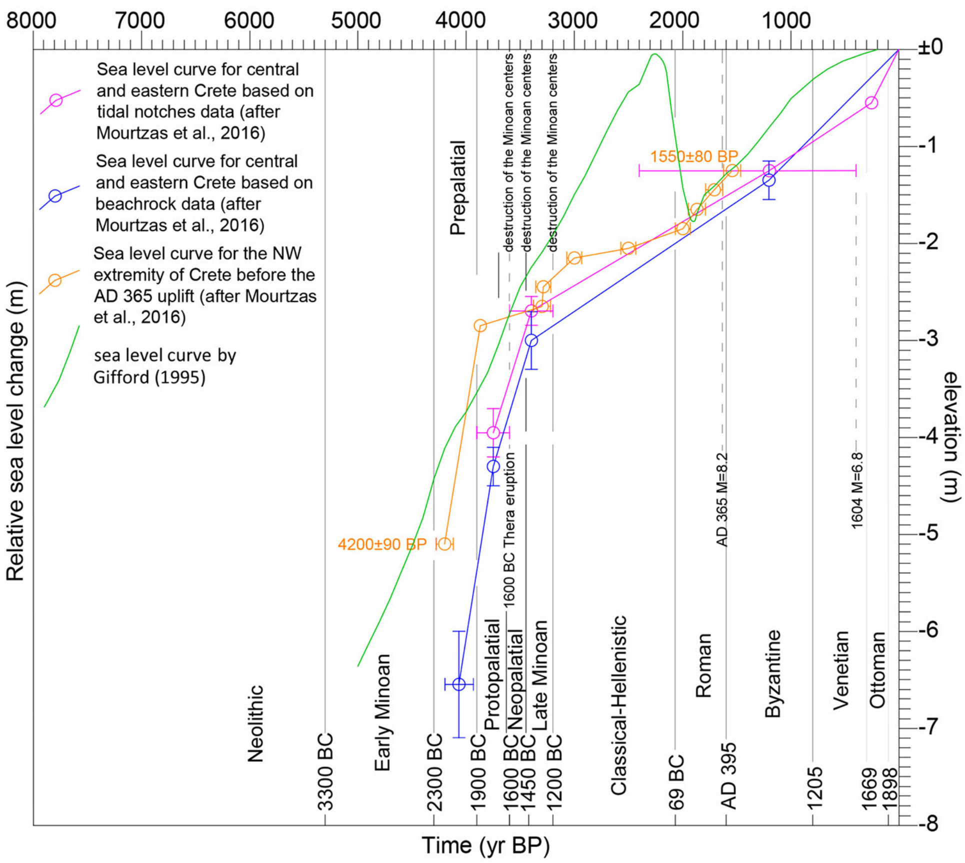

Figure 2. Curve of the rsl change for the Messara Gulf and Matala Bay for the past 5000 years (after Mourtzas & Kolaiti, 2020).

considered an attempt at constructing a "true" curve' (Gifford, 1995, p. 80).

The curve suggested by Mourtzas and Kolaiti (2020) differs radically from that suggested by Gifford (1995, p. 601), in terms of not only methodological approach but also produced results (Figure 2). Therefore, the former sea-level stands suggested by Mourtzas and Kolaiti (2020) and the palaeogeographic reconstruction of the coast of Kommos during a *c.*700 yr-period that it was operating as a harbour-side settlement are anything but 'complementing John Gifford's introduction', as Shaw and Blackman (2020, p. 406) somewhat injudiciously claim. After all, Gifford's (1995) chapter on the Physical Geology of the Western Messara and Kommos had been preceded by a publication and a PhD Thesis by Mourtzas (1988, 1990) in the same field, both of which were not considered by the author.

Geoarchaeological Approach

Kommos

Although Shaw and Blackman (2020) quote the excerpt from our article (Mourtzas & Kolaiti, 2020) referring to the building P at Kommos, their comment distorts its meaning, claiming that we 'have expressed differing opinions from them about the roles of at least one of the civic, shore-side buildings, P' (Shaw & Blackman, 2020, p. 406). However, at no point in our manuscript do we express our personal interpretation of the use of building P. In fact, after serious consideration of the new geoarchaeological evidence, mainly 'the great distance of the galleries from the then coastline and the substantial difference in height between their floor and the then sea level', we underline the necessity for them 'to reconsider the interpretation of their function as shipsheds' (Mourtzas & Kolaiti, 2020, p. 22). As supporters of Shaw and Blackman's (2020, p. 406) view that 'prehistoric Mediterranean nautical history and archaeology is still in its early, formative phases', and accepting the phrasing of Shaw (1990, p. 427) concerning the explanation of shipsheds 'while this is the best proposal made so far, however, substantiating evidence remains to be discovered', we introduce the parameter of the palaeogeomorphology of the site to the equation of interpreting these buildings as storage shipsheds that were used during the winter months.

Our concern is simple: why were these special monumental storage buildings built within the residential area, thus limiting its vital space, while another location closer to the shore and at a much lower altitude could have been chosen, given that Papadoplaka Islet would have protected the then shore from the strong NW winds and waves? Moreover, why were the ships hauled up on land at an altitude of *c.*6 m above the then sea level at a distance of 120 m from the then shoreline, necessitating their crossing the Central Court in order to be stored in the galleries of building P located behind it?

We know that the ancient people, including the Minoans, would cut and transport 'extremely heavy building blocks' (Shaw & Blackman, 2020, p. 408) from quarrying sites to building sites even in mountainous and rough landscapes far away from the sea (for example Kolaiti & Mendoni, 1992, 1993; Papageorgakis et al. 1992, 1994; Papageorgakis & Kolaiti, 1992). The point that the authors may be ignoring is that building blocks were transported only once and were often reused later *in situ*, whereas haulage of ships for storage would have needed to be repeated at least twice a year. This would arguably have been a laborious procedure.

Even if we accept the hypothesis that ships were actually transported to the roofed galleries of LMIII building P for winter storage, another question arises: what was the need for transportation and winter storage outdoors at the earlier Middle Minoan (MMIIB) platform, which was located at a greater distance and altitude than the later galleries? Shaw (2019, p. 3) argues that the ships would have been brought up from the shore along a paved slipway equipped with a channel, where wooden beam/s were inset with their top projecting above the pavement. The ships would have been pivoted on the beam/s and driven to their storage position in the open air. In fact, the difficulty of the haulage procedure would have increased, if we consider that in order for ships to be stored on the MMIIB platform, they would have to have been rotated 90° to the north within the limited area of the platform. If a slipway was required for drawing up the ships from the shore to the storage yard, and it actually seems that it was needed, then it would also have been required in the later periods when the galleries of buildings T (MMIII) and P (LMIII) were constructed. But no traces of a similar later slipway have been found. The hypothesis of Shaw (2019, pp. 3–4) is that 'the use of the slipway was ceased' and upon it 'an attractive court' was formed with 'masses of pebble packing' brought from the shore. Moreover, in the absence of any findings, he goes on to describe a method by which ships were now transported to the galleries, a 'simpler technique, most likely wooden rollers and sleepers, which, if used without stone slabs, would disappear with time'. However, it is a paradox that while building facilities were improving over time, from open-air storage areas to monumental roofed galleries, at the same time haulage procedures were deteriorating, from an elaborate slipway to ephemeral transport techniques.

Katsambas

Vasilakis (2007, p. 109) reported the discovery of six walls, which 'define parts of five rooms on a N-S axis: the fullest preserved are two at the W'. Each rectangular elongated room 'measures at least 21–23 m l. by 6 m w.', while 'their full lengths are unknown'. This finding led Vasilakis (2007, p. 109) to state that these 'structures further confirm the existence of the Minoan harbour-town in this region, at the mouth of Kratairos river that flows down from Knossos'. In the very next sentence, Vasilakis (2007, p. 109) named the structures 'shipsheds' that 'lie about 100 m from the present course of the river and 150 m from the original seashore'. Three years later, the author presented the preliminary results of the excavations at Katsambas in the years 2005, 2006, and 2007 (Vasilakis, 2010, pp. 285–286). He repeated the uncovering of six walls, each 1 m wide and of visible length 25 m, which now define at least six rooms (note: impossible in geometrical terms) in two wings, with a seventh narrower (1.5 m w.) room, probably a corridor, between them. Although Vasilakis (2010, p. 285) admits that he does not know the length of the walls, he assumes that it might be about 45–50 m, while the number of rooms should be at maximum ten, five on each side of the corridor. He interprets without any further explanation that these rooms are identified as a roofed 'Minoan Neorion' (Greek, meaning: shipshed/dockyard) dated to between LMII and LMIIIA2 periods (1450–1300 BC), with the corridor between them a staircase leading to their roof. Moreover, he argues that they are similar to those unearthed at Kommos by Shaw and Shaw (2006, pp. 70–85, 850–853), unfortunately without providing any detail about how he reached this conclusion and without (yet) publishing a plan view of the structures.

Vasilakis's (2007, 2010) description inspired Shaw and Blackman (2020, p. 409, fig. 4, Table 1) to give a hypothetical plan view of the termed 'Kairatus port installations' at Katsambas, consisting of 'shore-side ship storerooms' which 'were set back of an estimated shoreline' by about 150 m.

A schematic plan of the walls at Katsambas as they now stand is shown on the detail square of Figure 3. As can be seen, the archaeological excavation is confined between modern buildings and limited to an area of about 700 m^2. Five parallel stone walls, about 1 m wide, and a small section of a sixth to the east have been unearthed. The maximum visible length of the walls is 24 m, while the ends of the walls on both sides have not yet been revealed to conclude whether they were open toward the sea or the land. The walls are oriented NNW-SSE at an angle of 57° to the shoreline of the year 1936.

The modern maritime installations at the port of Heraklion have radically altered the morphology of the seafront at Katsambas (Figure 3). From the Admiralty chart of Candia (Heraklion) published in 1897 and the urban plans of Heraklion city from the years 1936, 1958, and 1967 (all before the construction of the Heraklion new port facilities), it can be deduced that the NE-SW oriented sandy coast at Katsambas was fully exposed to the strong NW winds and waves (Figure 3, see wind rose in detail). The isobaths of 4 and 2.70 m were offshore, 275 and 198 m, respectively (Figure 3). The prevailing wind on Heraklion coast is NW, the average annual wave height is 0.91 m, the maximum

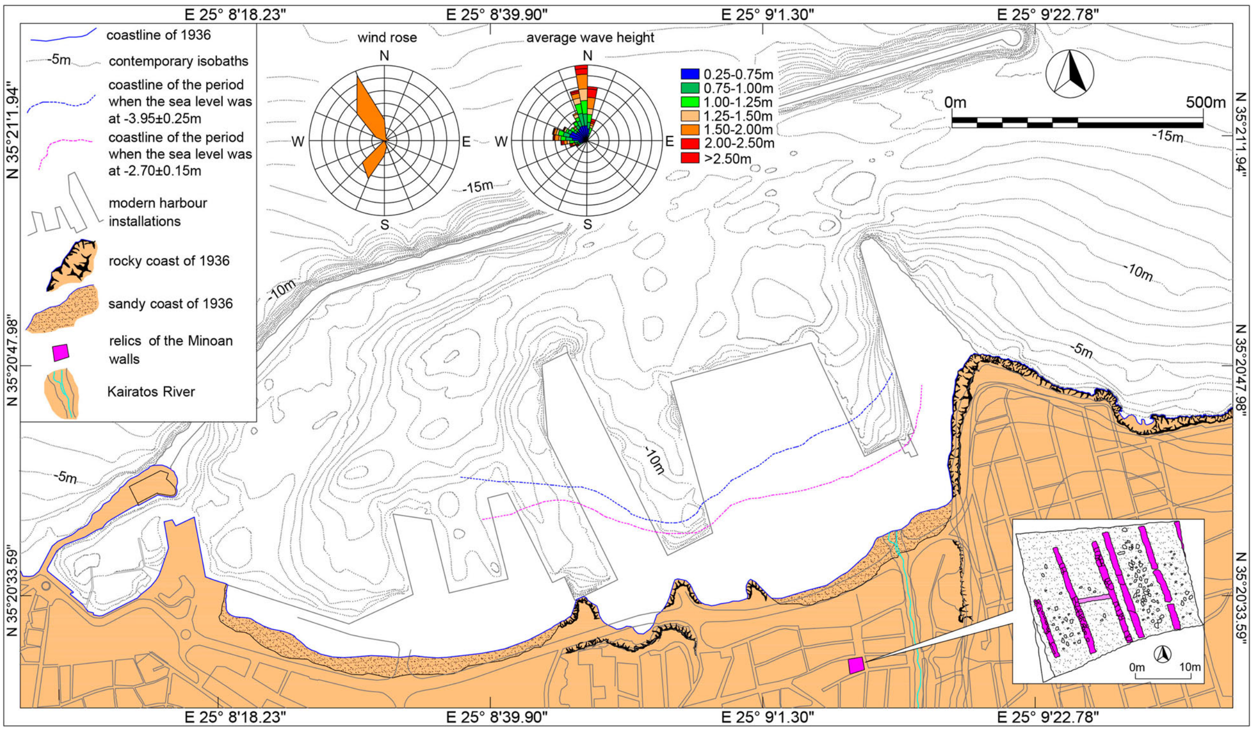

Figure 3. Plan of Katsambas area, where the modern port facilities of Heraklion are located. The isobaths as in 1897 shown on the Admiralty chart. The position of the coastline when the sea level was at 3.95 ± 0.25 m and 2.70 ± 0.15 m bmsl results from the depths given in the Admiralty chart of 1897. Top centre: wind rose diagram showing the average monthly wind speed and direction frequencies and a wave diagram showing the average annual wave height and direction frequencies. Bottom right: In detail a schematic plan of the relics of the Minoan walls, as they now stand (Nikos Mourtzas and Eleni Kolaiti).

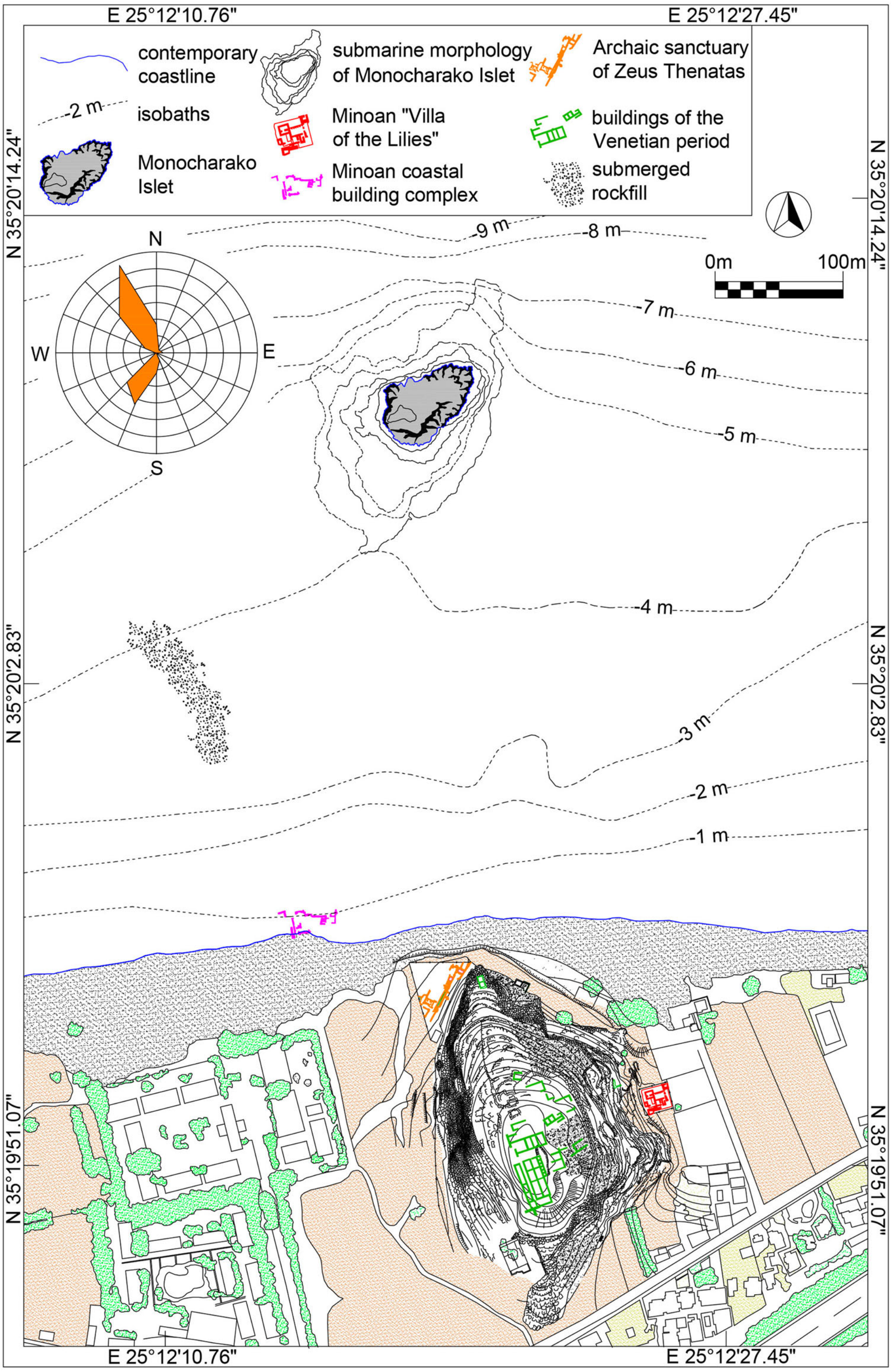

Figure 4. Plan of Amnisos coast as it now stands. Top left: wind rose diagram showing the average monthly wind speed and direction frequencies (Nikos Mourtzas and Eleni Kolaiti).

recorded wave height comes from the NNW reaching 5.09 m (Figure 3), and the maximum wave energy is 225 kW/m (source: European Centre for Medium-Range Weather Forecasts, ECMWF). Given the specific weather conditions, the approaching of ships to such an exposed coast would have been extremely difficult for most of the year. This fact is ascertained by the numerous depictions of Heraklion coast dated to between 14th and 17th centuries: no harbour installation, and neither mooring nor ship approach is shown. On the coast of Katsambas, there is no port work, or mooring, or ship approach. In stark contrast, many ships are depicted mooring in the Venetian port to the west and Amnisos Bay to the east.

Based on the isobaths of 1897 shown on the Admiralty chart, the Minoan walls at Katsambas, so-called shipsheds, should be at a distance of 430 m to 350 m from the then coast (Figure 3), completely exposed to the adverse weather conditions. Some 3.5 km to

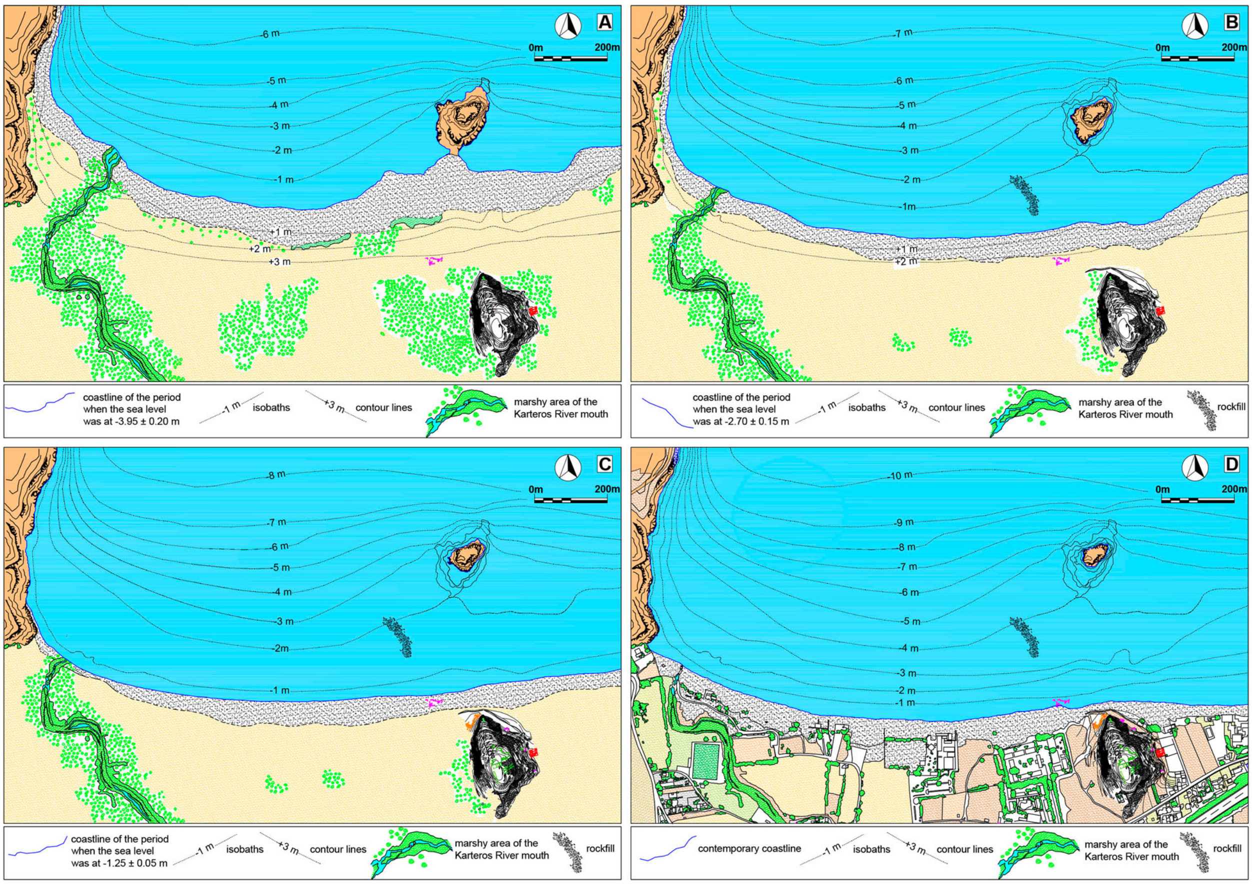

Figure 5. Palaeogeographic reconstruction of Amnisos coast: (A) during the Protopalatial period (MM IA to LM IA, *c.*2000–1600 BC), when the sea level was at 3.95 ± 0.25 m bmsl and (B) between the Neopalatial period (LM IB, *c.*1600–1425 BC) to the end of the Postpalatial period (*c.* 1200 BC), when the sea level was at 2.70 ± 0.15 m bmsl, (C) from the end of the Postpalatial period (*c.* 1200 BC) to 1604 AD, when the sea level was at 1.25 ± 0.05 m bmsl. (D) the coast at Amnisos as it now stands (Nikos Mourtzas).

the east of Katsambas, contrarily, Amnisos provided protection against NW winds and waves, allowing ships to approach and moor.

Amnisos

The bay of Amnisos is located some 4 km east of Katsambas. It is bounded on the west by the high and steep cliff of New Alikarnassos, where the airport of Heraklion is located, and on the east by the rocky extension of Kako Oros into the sea. The sandy beach of the bay, about 2 km in length, is oriented E-W and at its westernmost end the Karteros River flows into the sea. About 1200 m east of the Karteros mouth, just opposite and in line with Monocharako Islet 370 m offshore toward the north, there is a rocky hill (Palaeochora) (Figures 4 and 5D). At the eastern side of the hill have been found the ruins of the Minoan 'Villa of the Lilies' and at its NW edge the Archaic sanctuary of Zeus Thenatas, which remained in use until the 2nd century AD (e.g. Marinatos, 1938; Schäfer, 1991). On the top of the hill, there are ruins of a fortified Venetian village (Mesovouni). Submerged walls of at least three Minoan house-type buildings were also reported (Shaw, 1990, p. 425). They lie on the contemporary coastline and seawards up to a depth of 1.20 m bmsl. A slightly curved rockfill, made of sizeable stones, 130 m in length and 30 m wide, has been found submerged below the water between the islet and the coast (Figures 4 and 5D).

The palaeogeographic reconstruction of Amnisos Bay revealed that during the Protopalatial period, when the sea level was at 3.95 ± 0.25 m bmsl, the sandy beach was 330 m wider than at present and was connected to the opposite rocky islet, thus providing protection against the winds and waves on both sides depending on the prevailing wind direction (Figure 5A). When the sea level rose to 2.70 ± 0.15 m bmsl, after *c.*1600 BC, the coastline receded by about 200 m and the islet separated from the coast, with the depth of the seafloor between the islet and the coast not exceeding 1 m. It was then, probably, that the rockfill was constructed, in order to restore the coastal protection lost after the retreat of the coastline (Figure 5B).

Nirou Chani

The small sandstone peninsula of Agioi Theodoroi at Nirou Chani, 3.5 km east of Amnisos, has been

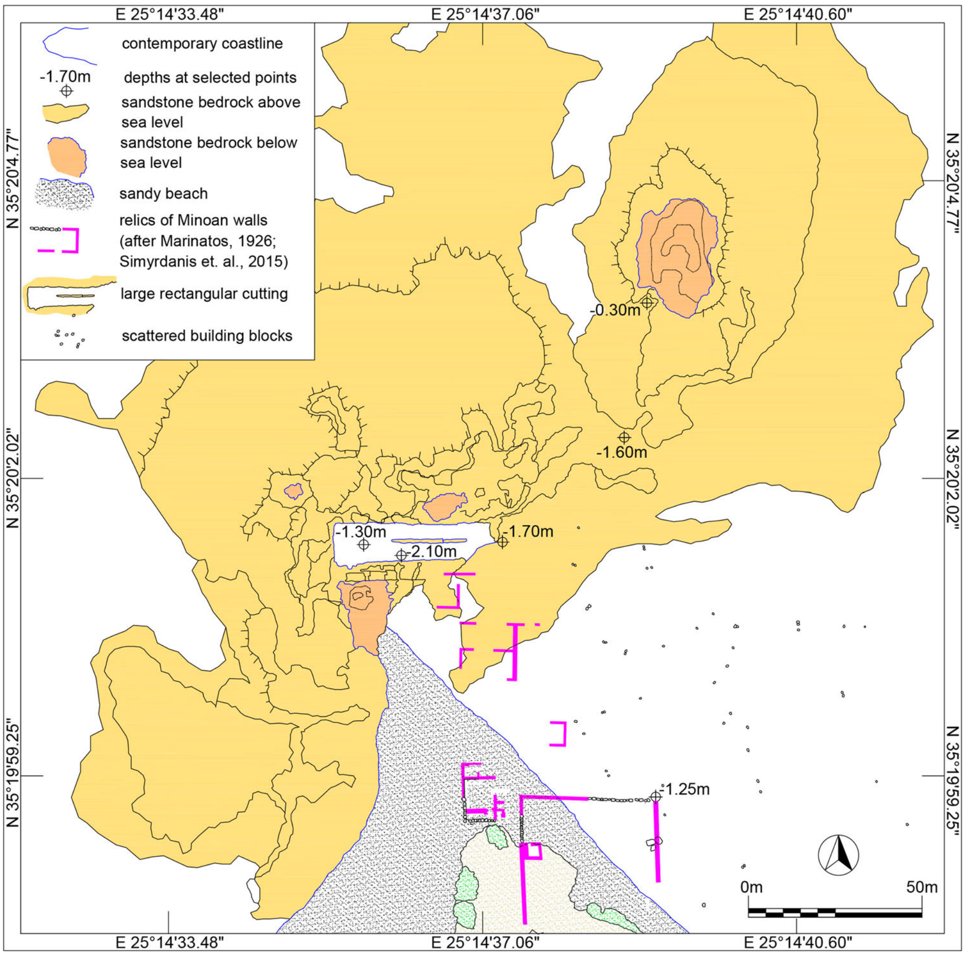

Figure 6. Plan of the coast at Nirou Chani as it now stands (Nikos Mourtzas).

extensively quarried in the area defined between its northern tip and the small islet 110 m offshore to the NE (Figures 6 and 7D). A large rectangular cutting has been shaped there, which the excavator of the Minoan buildings found on the coast (Marinatos, 1926), and who characterizes it as shipsheds. Shaw (1990, p. 425, 427) reproduces this view, but Mourtzas (1990) and Blackman (2011) reject it, the latter suggesting that they could be Minoan docks but not slipways.

The palaeogeographic reconstruction of the small peninsula leaves no doubt that this was a quarry, today submerged at a maximum depth of 2.10 m bmsl, with visible traces of carving, quarrying, and detachment of blocks throughout. Although quarrying activities and in general rock cuttings cannot be dated, the amount of submergence refers to a possible rock exploitation during Minoan times. After all, the maximum depth of the last visible trace of the building walls is at 1.25 m bmsl. It can also be inferred that the coast in Minoan times was far wider than the present and the rectangular cutting was located at least 300 m inland from the Minoan coastline (Figure 7A, B). When the sea level rose to 1.25 ± 0.05 m bmsl during Roman times (e.g. Mourtzas et al., 2016), the rock-cutting flooded and the peninsula was further shrunk (Figure 7C).

Malia

Further east, on the coast of Malia, on the eastern side of Mylos Bay, there have been reported the partially submerged remains of a large rectangular building consisting of at least four parallel walls, forming three narrow galleries, probably of the Minoan period, that might be the remains of storerooms associated with maritime trade (Guest-Papamanoli & Treuil, 1979, 1980). Shaw (1990, p. 428) welcomes this view and argues that this building is 'quite analogous with that described at Nirou Chani and Amnisos to the west and Mochlos to the east'. Raban (1991, p. 139) provides a depth of 1.30 m for the submerged building and repeats that it may well have been a 'boat house of the Minoan period', while underlining that 'there are potential parallels for this type of installation at nearby Nirou Chani and at Kommos'. Blackman (2011, p. 7, Fig. 13) clearly rejects this view, claiming that 'these are remains of a storage building on land, not directly connected with the shore'. The building relics, now submerged up to a maximum depth of 1.90 bmsl, lay behind a sizeable beachrock slab. Its seaward end is

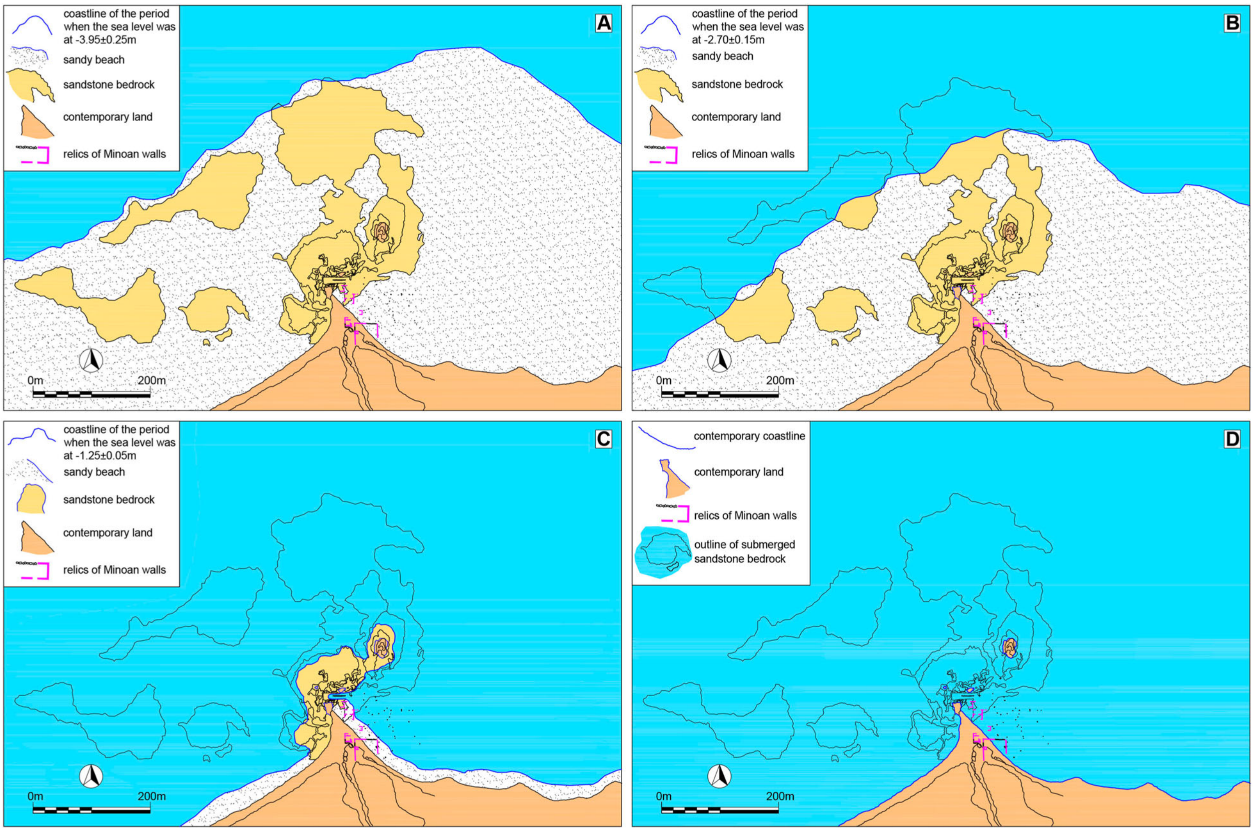

Figure 7. Palaeogeographic reconstruction of the coast at Nirou Chani: (A) during the Protopalatial period (MM IA to LM IA, *c.*2000–1600 BC), when the sea level was at 3.95 ± 0.25 m bmsl; (B) between the Neopalatial period (LM IB, *c.*1600–1425 BC) to the end of the Postpalatial period (*c.*1200 BC), when the sea level was at 2.70 ± 0.15 m bmsl; (C) from the end of the Postpalatial period (*c.*1200 BC) to 1604 AD, when the sea level was at 1.25 ± 0.05 m bmsl; (D) the coast at Nirou Chani as it now stands (Nikos Mourtzas).

between the depths of 2.50 and 2.90 m bmsl, thus signalling the shoreline of the Neopalatial and early Postpalatial period (Figure 8).

Raban (1991, p. 140, fig. XXXV) suggests that the Minoan harbour basin of Malia was inland, in the area of the contemporary marsh. On the then sandy beach in front of the harbour basin and today buried below the sand, he assumes that there was a 'retaining wall', which was used to protect the marsh from silting. He also argues that two rock-cut channels were used for both navigation of ships into the basin and sufficient water circulation within it (Figure 8). In fact, the NE-SW rock-cut channel (Figure 8), starting from two successive circular basins coated with mortar and communicating with each other, ends at the sea (Mourtzas, 1990). A small bridge between the two basins secured passage. The channel is 50 m long, 1.50 m wide and its floor slopes at 1.5° toward the sea. The 23 m-long seaward section of the channel is gradually sinking, with its northernmost end to be at 1.10 m bmsl. Moreover, it is at the same depth as the base of the marine tidal notch incised on the rocky ridge. This evidences that the channel was cut before the AD 1604 earthquake, and probably dates to the Byzantine or Venetian period (Mourtzas, 1990; Mourtzas et al., 2016).

When the sea level was at 3.95 ± 0.25 m and 2.70 ± 0.15 m bmsl during the Minoan period, the marsh was at an elevation of +3 m to +4 m above the then sea level and clearly could not have served as a harbour basin. Sedimentary data and radiocarbon ages from the Malia marsh (Dalongeville, 2001) mainly indicate terrestrial depositional processes, without lithostratigraphic signatures of a brackish or marine lagoonal environment which would justify a harbour basin. The first sedimentary sequence (6400–4700 BC) corresponds to the filling up of the basin, the second (4700–1500 BC) to the formation and evolution of the marsh, the third non-dated sequence reveals a short marine event that might be related to the tidal wave/tsunami caused by the Thera eruption, the fourth (190 BC–414 AD) denotes the abrupt reestablishment of the marsh and the fifth sequence (from 414 AD up to date) indicates that the marsh's surface is evolving in relation to the changes in the shoreline.

Gournia

On the rocky and largest promontory of the coast at Gournia (Figure 9), there is a building complex called Shore House (Boyd Hawes, 1908, p. 20). It consists of

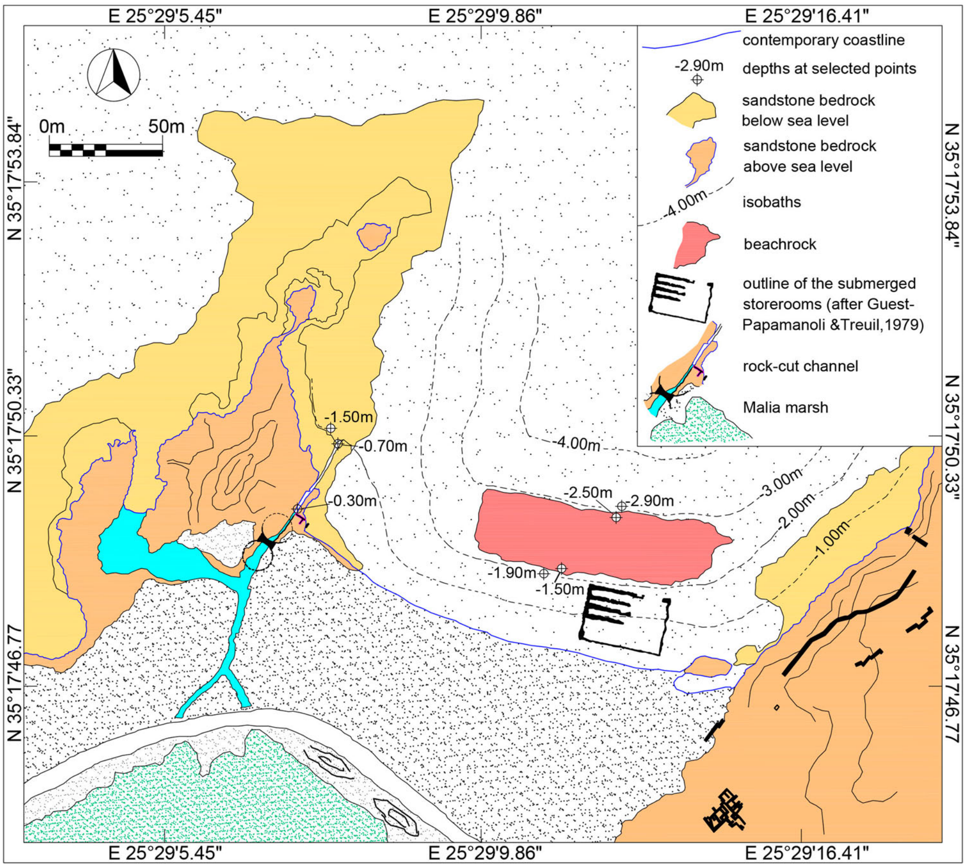

Figure 8. Plan of the coast at Malia as it now stands (Nikos Mourtzas).

two large rooms running northward along the promontory toward the sea. The visible length of each room is 14.50 m, while the visible width of the western room is 5 m and of the eastern 4.50 m. To the south landward wall of these rooms, three smaller rooms are attached. The north seaward side of the building is greatly eroded, and therefore it is not possible to ascertain whether or not it was open toward the sea. The building dates back to the MM IIIA period and its catastrophe was caused by a tsunami following the LM IA Thera eruption, as evidenced by the 'cyclopean blocks of the walls fallen into the rooms' (Watrous, 2012, pp. 527–528).

Watrous (2012, p. 527) finds that the Shore House at Gournia resembles the Neopalatial shipshed (Building T) at Kommos, even though only the width of the western room at Gournia is similar, since the number and length of rooms or galleries differ substantially and no evidence of roofing was reported. Although Blackman (2011, p. 8) seems hesitant in this regard ('Minoan parallels for the later "covered slipway" have not been found, unless one accepts some remains on the shore at Gournia', 'It remains a rather exposed site, which leaves me with some lingering doubts'), in the latest co-authored note (Shaw & Blackman, 2020, p. 408, 410) both fully accept it ('Moreover, a similar structure, but with only two galleries partly preserved, has been identified at Gournia' … 'for a Minoan parallel for the later shoreline "covered slipways" one may consider some remains on the shore at Gournia').

The building complex is today located at a distance between 5 and 24 m from the irregular coastline of the rocky promontory, at an altitude of +3 m. The conglomeratic bedrock gradually slopes down toward the sea at an average slope of 5° and sinks under the sea for at least 70 m northward (Figures 9 and 10D). Two erosional holes formed in the submerged portion of the rocky promontory have been interpreted by Watrous (2012, p. 523) 'as tie holes for ships desiring moorage', without considering them to be eroded potholes, easily shaped in this type of rock in such an exposed coastal environment. Further expanding his assumptions, Watrous (2012, p. 523) suggests that the tidal notches and erosional features incised on the rocky cliff of the peninsula, and now partly eroded, are the four rock-cut steps of a staircase leading down to a lower level at 2.50 m bmsl which 'was probably the ancient level of the sea'. Instead, the bases of the three uppermost notches identified throughout central and eastern Crete are at 0.55 ± 0.05, 1.25 ± 0.05 and 2.70 ± 0.15 bmsl (Mourtzas et al., 2016) and could give the false impression that these are rock-cut steps.

Nevertheless, the rough and craggy morphology of the underwater part of the promontory, with rocky

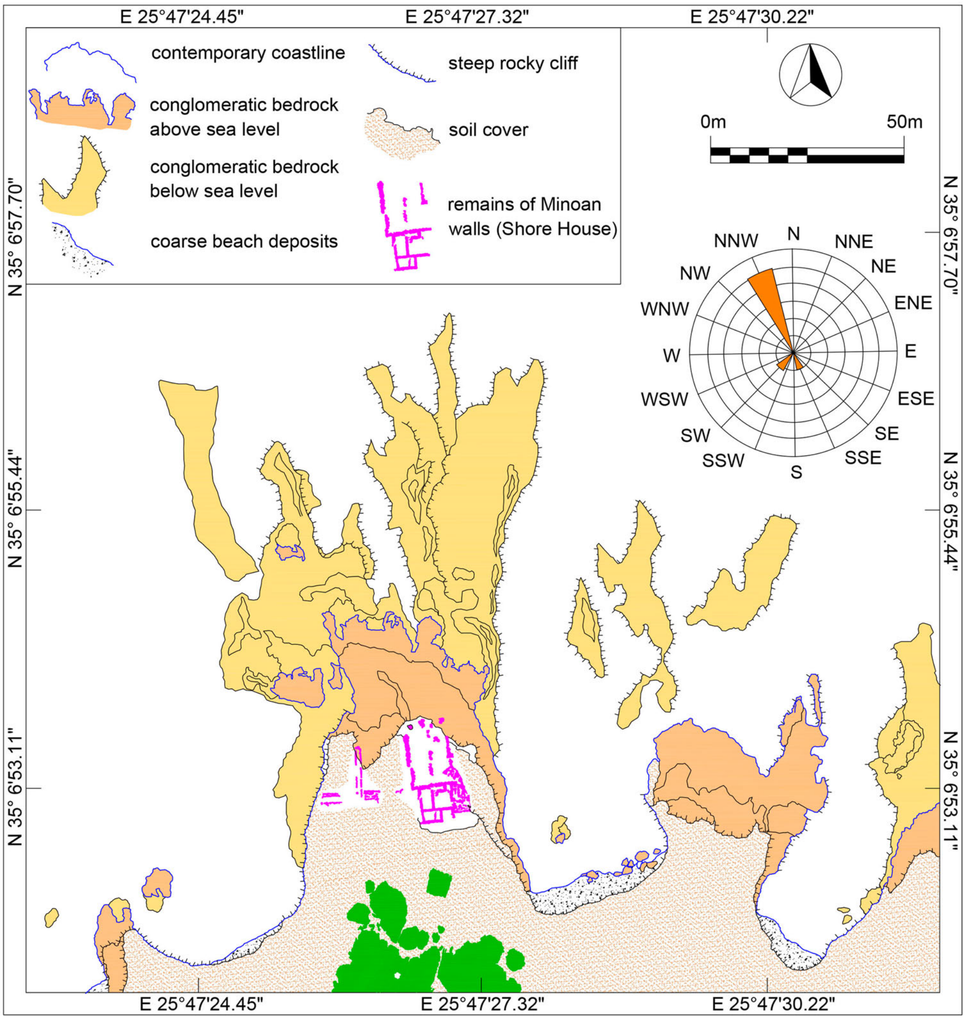

Figure 9. Plan of the coast at Gournia as it now stands. Top right: wind rose diagram showing the average monthly wind speed and direction frequencies (Nikos Mourtzas and Eleni Kolaiti).

ridges and steep cliffs, combined with the exposure of the coast for most of the year to the strong NW winds and waves (Figures 9 and 10D), was anything but favourable for drawing up ships from the coast to their supposed storage place. Moreover, in terms of palaeogeography, when the sea level was 3.95 ± 0.25 m bmsl and 2.70 ± 0.15 m bmsl during Minoan times, the coast was wider than the present by 130 and 80 m, respectively (Figure 10A,B). This result does not match Watrous's hypothesis (2012, p. 527) that the shipshed building was 'situated on a shoreline'.

Mochlos

The ancient settlement at Mochlos is mainly located on an islet off the coast of the homonymous modern village, but also in the coastal plain (Figures 11 and 12D). Multiple occupation phases have been identified, dated to from the Prepalatial period to Hellenistic times (Soles & Davaras, 2010). Excavations from the Minoan period in Mochlos revealed residential remains, workshops, the cemetery and, *inter alia*, a significant amount of imported pottery (Soles & Davaras, 1996). The imported pottery of LM III includes vessels from other regions of Crete, the Cyclades, and Syria-Palestine (Brogan & Smith, 2011, p. 151). However, Minoan harbour installations at Mochlos have not been reported so far.

Many geomorphological indicators of past sea levels found at Mochlos, such as two beachrock generations on the NE coast of the modern village with the seaward end of the deepest at 3.80–4.00 m bmsl and of the shallowest at 2.60–2.70 m bmsl, a beachrock slab at 3.90 m bmsl formed between the NE coast and the islet and another one on the south coast of Mochlos Islet at 1.60 m bmsl, as well as the marine tidal notches at respective depths, robustly confirm the Minoan sea-level stands determined and dated for central and eastern Crete (Mourtzas et al., 2016; Mourtzas & Kolaiti, 2017, 2020).

The palaeogeographic reconstruction of the coast in the area of Mochlos is shown on Figure 11. When the sea level was at 3.95 ± 0.25 m bmsl during the Protopalatial period (*c.* 1900–1600 BC), the islet was linked to the shore by an isthmus, about 100 m wide

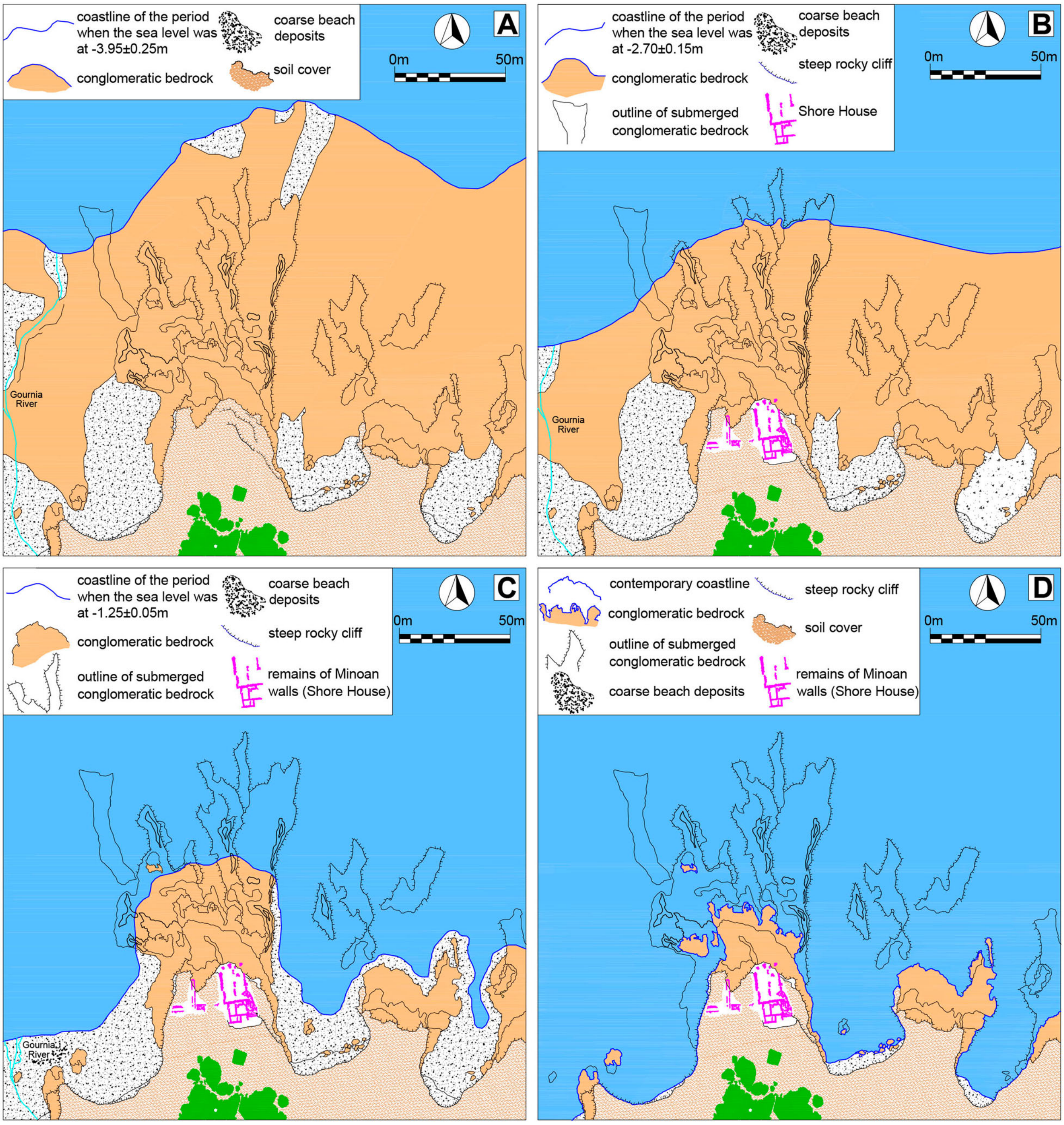

Figure 10. Palaeogeographic reconstruction of the coast at Gournia: (A) during the Protopalatial period (MM IA to LM IA, *c.*2000–1600 BC), when the sea level was at 3.95 ± 0.25 m bmsl; (B) between the Neopalatial period (LM IB, *c.*1600–1425 BC) to the end of the Postpalatial period (*c.*1200 BC), when the sea level was at 2.70 ± 0.15 m bmsl; (C) from the end of the Postpalatial period (*c.* 1200 BC) to 1604 AD, when the sea level was at 1.25 ± 0.05 m bmsl; (D) the coast at Gournia as it now stands (Nikos Mourtzas).

(Figure 12A). The change in the sea level by 1.25 m around 1600 BC resulted in the isthmus shrinking by 30 m, but it still existed and joined the islet to the opposite coast (Figure 12B). The subsequent sea-level rise by 1.45 m to 1.25 ± 0.05 m bmsl, *c.* 1200 BC, probably caused the abandonment of the Minoan settlement, as the isthmus submerged at 2 m bmsl and the islet cut off from the mainland (Figure 12C). Therefore, during Minoan times, the eastern side of the isthmus was protected against the prevailing strong NW winds and waves. Ships could approach and find a safe place either to anchor or be dragged out of the water on the sandy beach. This interpretation is in line with the view of Simpson and Betancourt (2004) that Mochlos was the most ideal harbour on that side of Crete.

Discussion

In this note, solely based on the geomorphological features of each location, we examine the possibility that the various Minoan structures could have served as shipsheds, slipways, or in general maritime installations connected to harbours, and we try a different approach to their use, in particular when the buildings have not been excavated in their

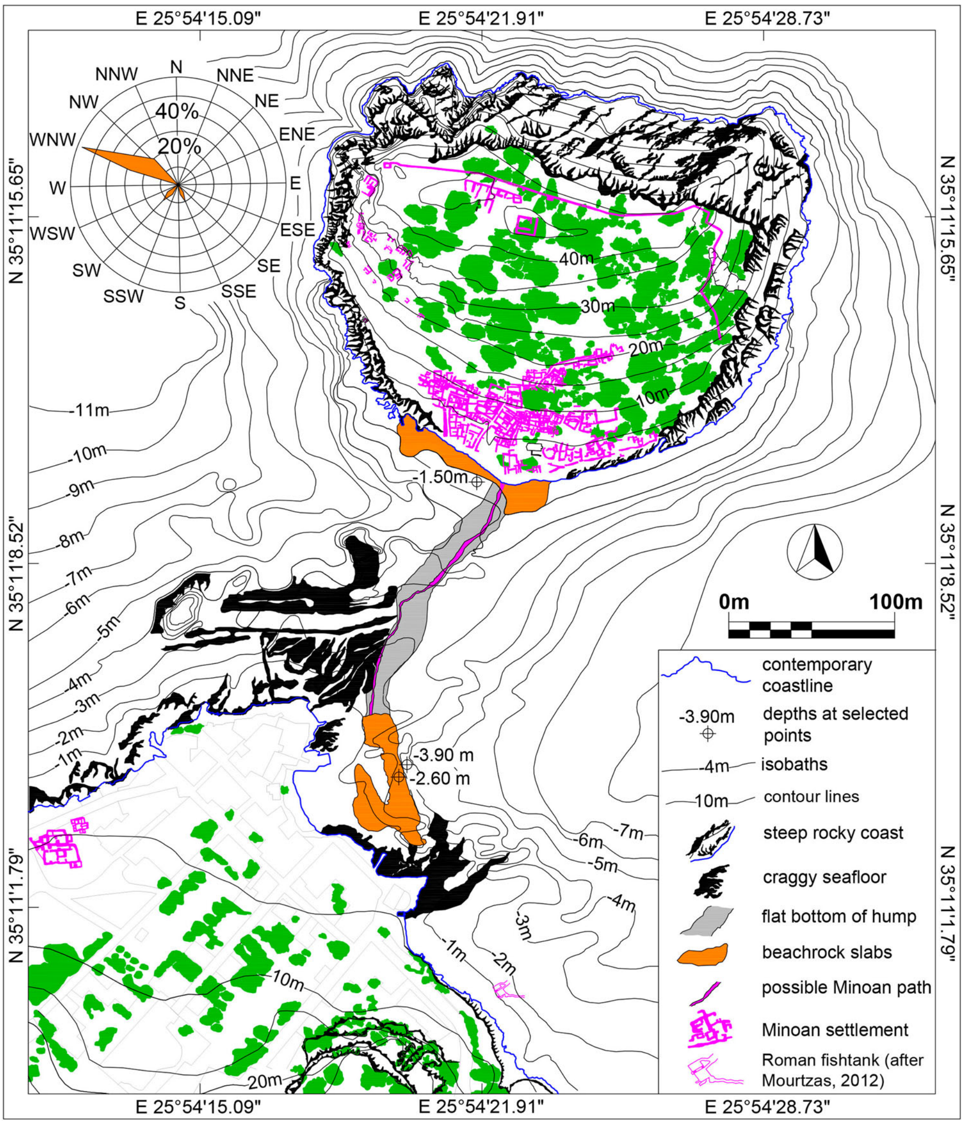

Figure 11. Plan of the coast at Mochlos as it now stands. Contour lines, isobaths and ancient remains from Soles (2007, 2009). Top left: wind rose diagram showing the average monthly wind speed and direction frequencies (Eleni Kolaiti and Nikos Mourtzas).

entirety or their poor condition makes it difficult to interpret their use.

The exposure of the ancient open coast at Katsambas seems to exclude the possibility that Minoan ships could approach and moor there, preferring the sheltered coast of Amnisos as the epineion (harbourtown) of Knossos. The rectangular cutting in the peninsula of Agioi Theodoroi at Nirou Chani, which is a topographic depression caused by the exploitation of the quarry that later sunk, was interpreted as shipsheds without taking into account the palaeogeography of the coast. At Malia (Mylos Bay), the suggestion of a harbour basin in the marsh has been rejected not only because of the amount and direction of the sea-level change but also the evolution of the marsh environment. The rough and craggy underwater morphology of the promontory at Gournia, fully exposed to weather conditions, does not support the interpretation of the Shore House as 'shed for ship storage' (termed by Shaw & Blackman, 2020, p. 410). Finally, the isthmus that ensured the communication of the islet and the settlement of Mochlos with the mainland and protected the coast from the winds and waves throughout the Minoan period justifies the characterization of Mochlos as a major trading post of the Late Bronze Age (Soles & Davaras, 1996) (Figure 1).

All the sites considered herein were Minoan trade centres for exchange and distribution of products and organic goods across the entirety of Crete, the Aegean, and the eastern Mediterranean. It would, therefore, have been necessary to have warehouse buildings in protected environments for storage of imported and exported goods, rather than sheds for ship storage.

At Kommos, inside building P, thousands of fragments have been found of either local transport jars (from western Messara area, south-central Crete) or imported transport vessels from West Crete, Gavdos, Egypt, Cyprus, Syro-Palestine and from various

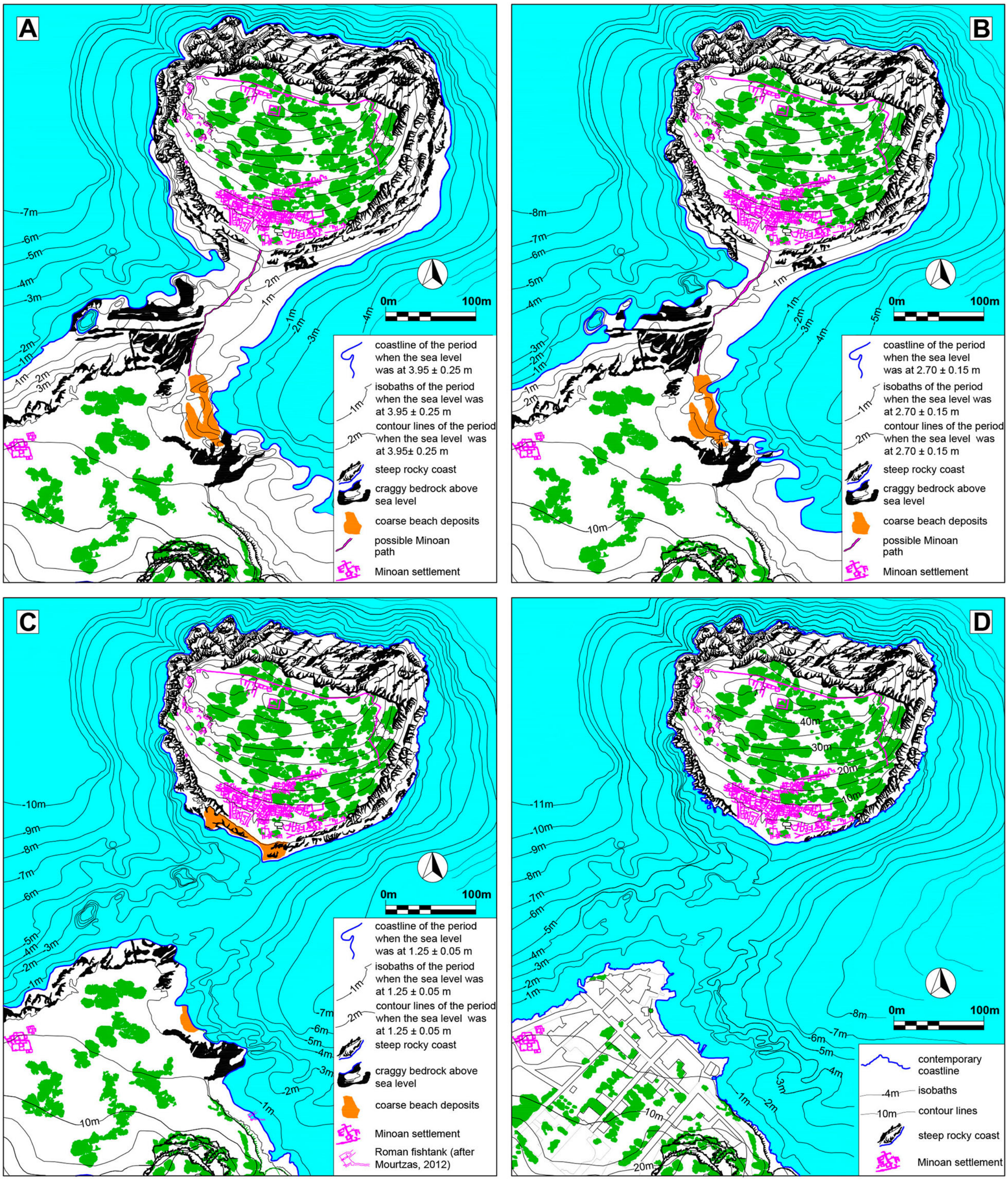

Figure 12. Palaeogeographic reconstruction of the coast and the islet of Mochlos: (A) during the Protopalatial period (MM IA to LM IA, *c.*2000–1600 BC), when the sea level was at 3.95 ± 0.25 m bmsl; (B) between the Neopalatial period (LM IB, *c.*1600–1425 BC) to the end of the Postpalatial period (*c.*1200 BC), when the sea level was at 2.70 ± 0.15 m bmsl; (C) from the end of the Postpalatial period (*c.*1200 BC) to 1604 AD, when the sea level was at 1.25 ± 0.05 m bmsl; (D) the coast at Mochlos as it now stands (Nikos Mourtzas).

locations along the Levantine coast (Day et al., 2011; Rutter, 2006a, 2006b, 2006c). These findings led Day et al. (2011, p. 516) to suggest that the monumental LMIII Building P 'might have served as a warehouse in which to stockpile SNAs (Short-Necked Amphorae)'.

Additionally, many fragments of cooking and other vessels were found in the galleries of building P (Rutter, 2006a), as were characteristic burnt areas on its earthen floors, with hearths and ovens set in some of them (Shaw & Shaw, 2006, p. 851).

Abundant fragments of different vessel types (mainly stirrup jars but also cups, jugs, amphoras, and tripod cooking pots), bone and bronze pins, clay weights for fishing, significant amounts of raw materials (obsidian, steatite, and pigments) and lead damaged by the fire were found in the destruction layer of the rooms at Katsambas (Vasilakis, 2007, 2010, pp. 287–288). In addition, at the eastern wall of the westernmost room, there has been found almost intact, a built rectangular hearth, inside which were many cooking and other utilitarian vessels (Vasilakis, 2010, p. 286).

Many fragmented vessels, such as pithoi and large jars, amphoras, cups, cookpot and tripod legs, dishes and pots, fine ware jugs, basins, a kalathos, the base of a vat, and loom-weights were also found inside and outside the rooms of the Shore House at Gournia (Watrous, 2012, pp. 528–529).

The use of haematite on ships, either as a colouring or as a possible antifouling agent, is one of the main arguments of Blackman (2011) and Shaw and Blackman (2020) to prove that the monumental building at Kommos served as shipsheds, after it was found at the 5th-century shipsheds at Naxos in Sicily (Lentini, Blackman, & Pakkanen, 2008, 2013). However, the mineral haematite (Fe_2O_3) is a natural pigment found in several shades of black, grey, brown, and red. It was broadly used since the Palaeolithic for many different purposes, such as for body decoration and sun protection, medical purposes, manufacturing cosmetics, for decoration and staining of ceramics, clothing, and other objects, wall painting, as an adhesive, in burial rituals, etc. (e.g. Baraldi et al., 2013; De Faria & Lopes, 2007; Pomis et al., 1998; Pomiès et al., 1999; Siddall, 2018 and references; Kostomitsopoulou-Marketou et al., 2019). For example, Baraldi et al. (2013, pp. 54–55) examined 210 samples from the phoenician-punic settlement of Mozia (Sicily) and in many cases detected haematite in red powders, which were used to give colour to the cheeks and lips. Consequently, the storing of a multi-purpose substance in amphoras, which were stored in warehouses, does not automatically make these buildings 'sheds for ship storage'. It is striking, however, that such weak reasoning is accepted, while the palaeogeography of the sites is disregarded, if not ignored.

We consider that the comparison of the buildings at Kommos, Katsambas, and Gournia interpreted as prehistoric shipsheds with the known and well-documented shipsheds of Classical, Hellenistic, and Roman times (e.g. Shaw (2019) and Shaw and Blackman (2020)) is highly inappropriate, based as it is on certain structural features, while overlooking the most significant functional component: the sloping floor ending at the shoreline for hauling up ships from the sea and vice versa. Moreover, the absence of evidence and lack of knowledge about the dimensions and models of the Minoan ships in contrast to the later vessels renders this comparison meaningless, only allowing the formation of hypotheses for the possible use of these prehistoric buildings.

Finally, it should be stressed that the main argument supporting the hypothesis that all excavated Minoan structures/building walls were maritime installations that served as shipsheds or *neosoikoi* is that they bear some resemblance between them, mostly in dimensions, even if excavations were not completed and all their actual features were not revealed (e.g. Katsambas). For example, Vasilakis (2010, p. 286) bases his hypothesis for the buildings at Katsambas on the hypothesis of Shaw and Shaw (2006, pp. 70–85, 850–853); for the buildings at Kommos, Shaw and Blackman (2020, pp. 407–408) base their hypothesis on the hypothesis of Vasilakis (2007, 2010) for Katsambas and of Watrous (2010, p. 13; 2012, p. 527) for Gournia, and in turn Watrous (2012, p. 527) bases his hypothesis for Gournia on the hypothesis of Shaw and Shaw (2006, pp. 845–878) for Kommos. Undoubtedly, this argumentation borders on circularity.

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