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Coastal Prehistory in the Southern Red Sea Basin, Underwater Archaeology and the Farasan Islands [1]

Geoff Bailey
Abdullah AlSharekh
Nic Flemming
Kurt Lambeck
Garry Momber
Anthony Sinclair
Claudio Vita-Finzi

Summary

We explore the proposition that the Red Sea Basin was an attractive coastal habitat for human settlement in early prehistory and an important zone of cultural contact and population dispersal between Africa and Asia, rather than a barrier. We use the global record of sea-level change associated with the glacial-interglacial cycle to reconstruct the position of shorelines at different periods, taking into account isostatic and tectonic movements of the Earth's crust. We demonstrate that the Bab al-Mandab Straits would have been reduced to a shallow and narrow channel at the time of lowered sea levels that persisted for most of the glacial period, posing very little obstacle to human movement, even in the absence of watercraft. At the same time, the persistence of low sea levels means that any record of coastal settlement is mostly submerged and inaccessible without underwater exploration. Palaeolithic sites on the present-day coastline are difficult to evaluate because they are mostly surface finds of stone tools lacking stratigraphic context or absolute dates, and are in any case associated, at best, with earlier and short-lived episodes of high sea level. We have therefore begun archaeological survey and underwater exploration in the Farasan Islands. We have recorded approximately 1000 sites on land, mostly shell mounds formed during the past 6000 years. These sites are typically associated with wave-undercut coral platforms formed at the shore edge, and shallow embayments rich in molluscs and other marine life. We have shown that similar features can be found under water down to depths of at least 60 m, representing shorelines formed at periods of lower sea level, and that these features can be mapped, sampled and photographed by diving teams using mixed gas diving technologies. Future work will be extended to the search for archaeological sites associated with these submerged features.

Keywords: prehistory, Red Sea, sea levels, shell mounds, underwater archaeology

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Introduction

The context for this project is the renewed interest in the Red Sea Basin as a zone of contact and dispersal in early prehistory rather than a barrier to movement (Figure 1). Although several finds of stone tools of Lower and Middle Palaeolithic character have been found throughout the Arabian Peninsula (see Petraglia 2003; Petraglia & AlSharekh 2003; AlSharekh 2006), the rarity of radiometric dates and a lack of associated fauna or human fossils have tended to perpetuate the notion that the Arabian Peninsula was a geographical cul-de-sac of little importance for most of the Pleistocene epoch. Well-dated human fossils and stone tools show that the earliest humans outside Africa were present from around 1.8 million years ago at sites like Ubeidiyah in the Jordan Valley, Dmanisi in the Caucasus and the Sangiran Dome in Indonesia (Lordkipanidze *et al.* 2000; Bar-Yosef & Belfer-Cohen 2001; Swisher *et al.* 1994). Given that these early Asian sites were occupied by populations originating from Africa (but see Dennell & Roebroeks 2005), the question arises as to the major pathways of human movement and cultural contact between Africa and Asia. In this regard, the long-standing assumption is that the main lines of contact were to the north via the Nile Valley, the Sinai Peninsula and the Levant, and thence northwards to the Caucasus and eastwards via the Zagros arc to India and the Indonesian archipelago. Recently, opinion has begun to change and attention has focused on the southern dispersal route, that is to say a pathway from Ethiopia and the Horn of Africa across the Bab al-Mandab Straits to the Arabian Peninsula, southern Iran and the Indian Sub-continent, particularly for anatomically modern humans after about 150,000 years ago (Lahr & Foley 1994). This change of thinking is based on mostly indirect clues derived from the modelling of genetic histories (Templeton 2002; Macaulay *et al.* 2005) and the modelling of dispersal patterns (Mithen 2002), from similarities in Middle Stone Age artefacts in East Africa and southern Arabia (Rose 2004) and from a belief that coastlines and the exploitation of marine resources may have been an attractive option from the earliest period (Walter *et al.* 2000; Stringer 2000; Erlandson 2001; Flemming *et al.* 2003; Bailey 2004a; Bailey 2004b). An additional factor is the possibility that the major sea channels on this route that supposedly acted as barriers may have been dry land during the low sea levels that persisted for much of the Pleistocene period, and conceivably never presented a serious obstacle to movement. Nevertheless, arguments against the viability of a southern route continue to be advanced, principally the deterrent of supposedly arid climatic conditions (e.g. Derricourt 2005).

If coastlines were a significant environmental attraction in early human settlement and dispersal, we face a formidable problem in pursuing this line of enquiry. For most of the Pleistocene period, sea level has been substantially lower than the present in response to the expansion of the continental ice sheets. From the point of view of human dispersal, a large drop in sea level is advantageous in narrowing or eliminating sea crossings between adjacent landmasses. From the point of view of investigating early use of coastal resources, the drop in sea level is a major handicap, because, outside areas that have undergone rapid postglacial uplift, any evidence must necessarily be hidden from view on old shorelines that are now deeply submerged and many kilometres offshore.

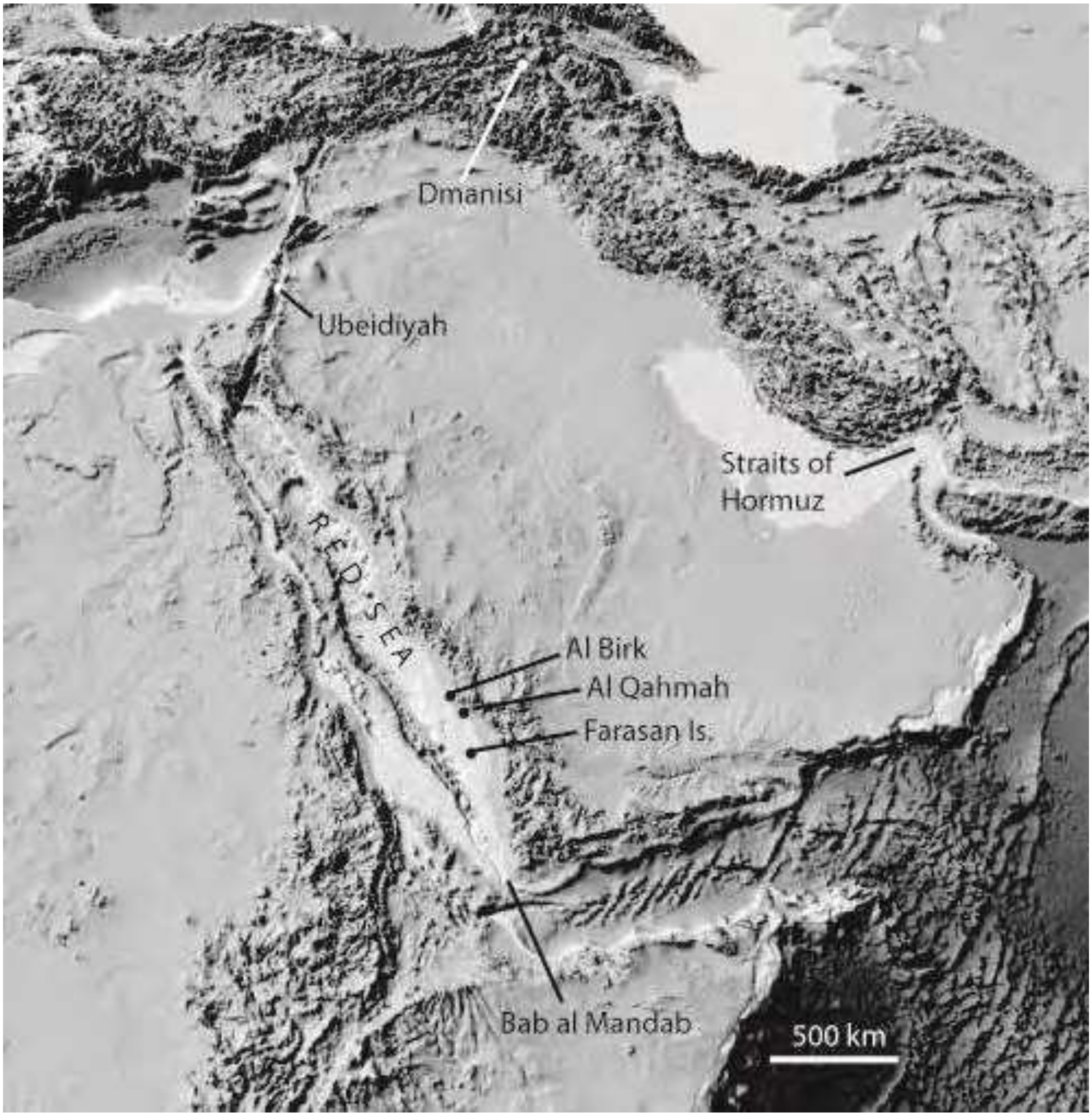

Figure 1. *Map of the Arabian Peninsula and adjacent regions, showing broad topography including submarine features and the extent of the continental shelf, with archaeological sites and other places mentioned in the text.*

Figure 2 shows the change in sea level over the past 140,000 years, encompassing two glacial maxima and two interglacial periods of high sea level (including the present "postglacial"). The sea level curve is actually a curve of variation in the oxygen isotope composition of seawater derived from measurements of foraminifera in deep-sea sediments, but since this reflects the amount of ice accumulated in the continental ice caps, together with a small contribution from temperature variation, it offers a reasonably good proxy measure of sea level change. The curve demonstrates very clearly that periods of high sea level were of limited duration, of the order of 5000–10,000 years, that for short periods at glacial maxima sea level dropped by as much as 130 m below its present position, and that for most of the intervening period sea level oscillated within a range of –40 to –60 m with occasional sea level stands of –20 m.

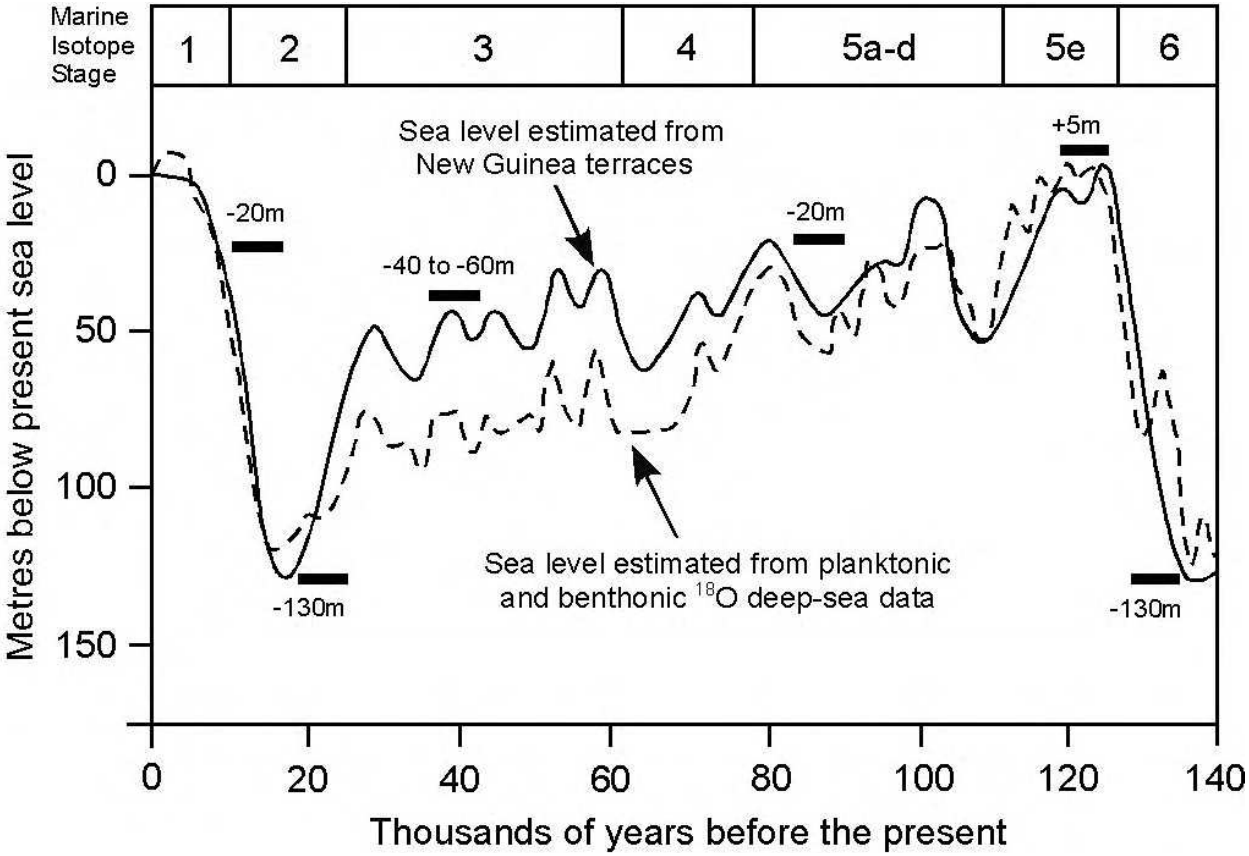

Figure 2. *Eustatic sea level change during the past 140,000 years. Data from Chappell & Shackleton 1986, Shackleton 1987, Van Andel 1989a, Lambeck & Chappell 2001. Chronology for the later part of the sea level curve is in uncalibrated radiocarbon years. Horizontal bars indicate approximate date and depth of submerged shorelines, which may be re-worked at successive sea level stands after initial formation.*

Against this background, it is no surprise that there is a worldwide "explosion" in the evidence of shell mounds and other maritime indicators at about 6–7000 radiocarbon years ago, because that is the time when sea levels stopped rising after the most recent deglaciation and established their present position. It is now considered unlikely that this evidence represents some expansion in human activities in response to rising population numbers or technological change, but rather an improvement in the visibility of coastal evidence. Similar comments apply to the coastal caves of South Africa, where long sequences that reach back to the last interglacial period show the appearance of mollusc shells and sea-mammal bones in deposits dated to Marine Isotope Stage 5, and particularly to the high sea level period of Stage 5e (Henshilwood *et al.* 2001, Klein *et al.* 2004). Although some authors have suggested that this evidence indicates new abilities and patterns of environmental adaptation associated with the emergence of anatomically modern humans (e.g. Klein 1999, Walter *et al.* 2000), there is no reason to suppose that what we see in the archaeological record at this time is anything other than an increased visibility of evidence during a period of high sea level: the lowered sea levels of Stage 4 and Stage 6 would have moved the coastline in South Africa up to 100 km out onto the continental shelf (Van Andel 1989b).

The glacial-interglacial cycle of sea level change is repeated in a fairly regular pattern back to about 800,000 years ago. Between 800,000 and 2 million years ago, sea level fluctuations were more irregular and had a smaller amplitude, but still include long periods when sea level was lower than the present. It follows that from the earliest period of human migration and contact beyond Africa, we face the problem that most of the evidence of coastal activity is likely to be missing, submerged and possibly destroyed completely, and that if we are to fill that large gap in the record, we will have to undertake underwater exploration. The growing numbers of prehistoric archaeological finds discovered under water during the past decade or so and improved techniques of submarine mapping and exploration (Fischer 1995; Werz & Flemming 2001) have strengthened the belief that such work is not only feasible but also essential if we are to avoid a seriously distorted view of world prehistory.

In the Red Sea Basin, our specific objectives are (1) to assess changes in coastal environments and the position of shorelines with regard to sea level change; (2) to investigate archaeological sites and environments on land for evidence of coastal exploitation and for clues to what to look for in underwater exploration; and (3) to explore underwater landscapes and their archaeological potential. In this paper we summarise some of our recent results, the sites that we have discovered on the Farasan Islands, and the approach that we are adopting to underwater exploration.

Sea level Change in the Red Sea

At the maximum of the last glacial in the Arabian Peninsula, substantial areas of the continental shelf were exposed as dry land (Figure 1). In our more detailed work we have paid particular attention to the effect of sea level change on the possibilities of transit across the Bab al-Mandab Straits.

A simple first approximation of shoreline positions at lowered sea level can be obtained by plotting bathymetric contours from marine charts, and using diagrams of eustatic sea level change such as the one in Figure 2 to delineate shoreline positions at different periods. For more accurate assessments in relation to specific questions, and especially in regions subject to movements of the Earth's crust, two additional effects need to be assessed: isostatic compensation in relation to the loading and unloading of ice or seawater, and tectonic movements, especially at plate boundaries. Both are relevant in the Red Sea.

Isostatic effects are most marked in high-latitude regions close to the ice sheets, where the crust is subject to local depression by the mass of overlying ice during glacial periods, with some compensating uplift of the unglaciated regions immediately adjacent to the ice sheets. When the ice sheets melt, the depressed crust undergoes slow uplift or rebound, with a time lag of thousands of years, and the uplifted bulge region sinks back again. These effects are obviously most marked in regions of glaciation (such as Britain and Scandinavia), where vertical crustal movements may be as much as 200 m or more, but the compensating adjustments of the earth's crust are distributed on a world-wide basis, and even regions remote from the centres of glaciation may register slight isostatic effects. In addition, regions far from the ice sheets undergo similar effects locally as a result of the loading of large masses of seawater during high sea level periods, with corresponding adjustments when sea level drops again. Both global and regional effects can be modelled (Lambeck 1995; Lambeck 1996; Lambeck 2004), and the maps of shoreline position shown in Figure 3 take account of isostatic adjustments for the Red Sea region.

The effects of sea level change on the Bab al-Mandab Straits are of particular interest (Figure 3). Here the present width of the sea channel is some 32 km, divided into two channels by Perim Island, the western channel 26 km across, and the eastern 3 km wide. The main channel would be a considerable crossing to undertake without sea craft of some sort. In contrast, the sea level reconstructions for the Last Glacial Maximum at 18,000 radiocarbon years indicate that the Red Sea may then have been isolated from the Indian Ocean for a brief period in the vicinity of the az-Zugur and Hanish al-Kabir Islands (Figure 3D). The land elevation at this crossing would have been only a few metres and would not have formed an effective barrier isolating the two water bodies or impeding human movements. Oxygen isotope measurements from deep-sea sediment cores from within the Red Sea demonstrate that water circulation with the Indian Ocean was never completely cut off at the maximum regression of sea level, or at any rate not for long enough to register in the deep sea record, and that a water depth of 15±6 m over the Hanish sill must have persisted during the glacial maximum (Siddall *et al.* 2003; Fernandes *et al.* 2006), which suggests a shoreline position closer to the reconstruction in Figure 3C. Since both the bathymetry and the isotope record are subject to small margins of uncertainty, it is not possible to be decisive on this point at present. Nevertheless, it seems likely that a sea channel of some sort persisted at the lowest sea level, but one that was sufficiently shallow and narrow that it would have posed little obstacle to human movements. Even at higher sea levels up to about –50 m, the channel would have remained long and narrow, with intervening islands to act as stepping-stones, and water crossings of no more than a few kilometres wide for the period between about 90,000 and 12,000 years ago (Figure 3B). The opposite shore would have offered a visible target extending for tens of kilometres. The probability of successful landfall in such circumstances is very high because there is no danger of failure when being carried sideways by water currents (cf. Birdsell 1977).

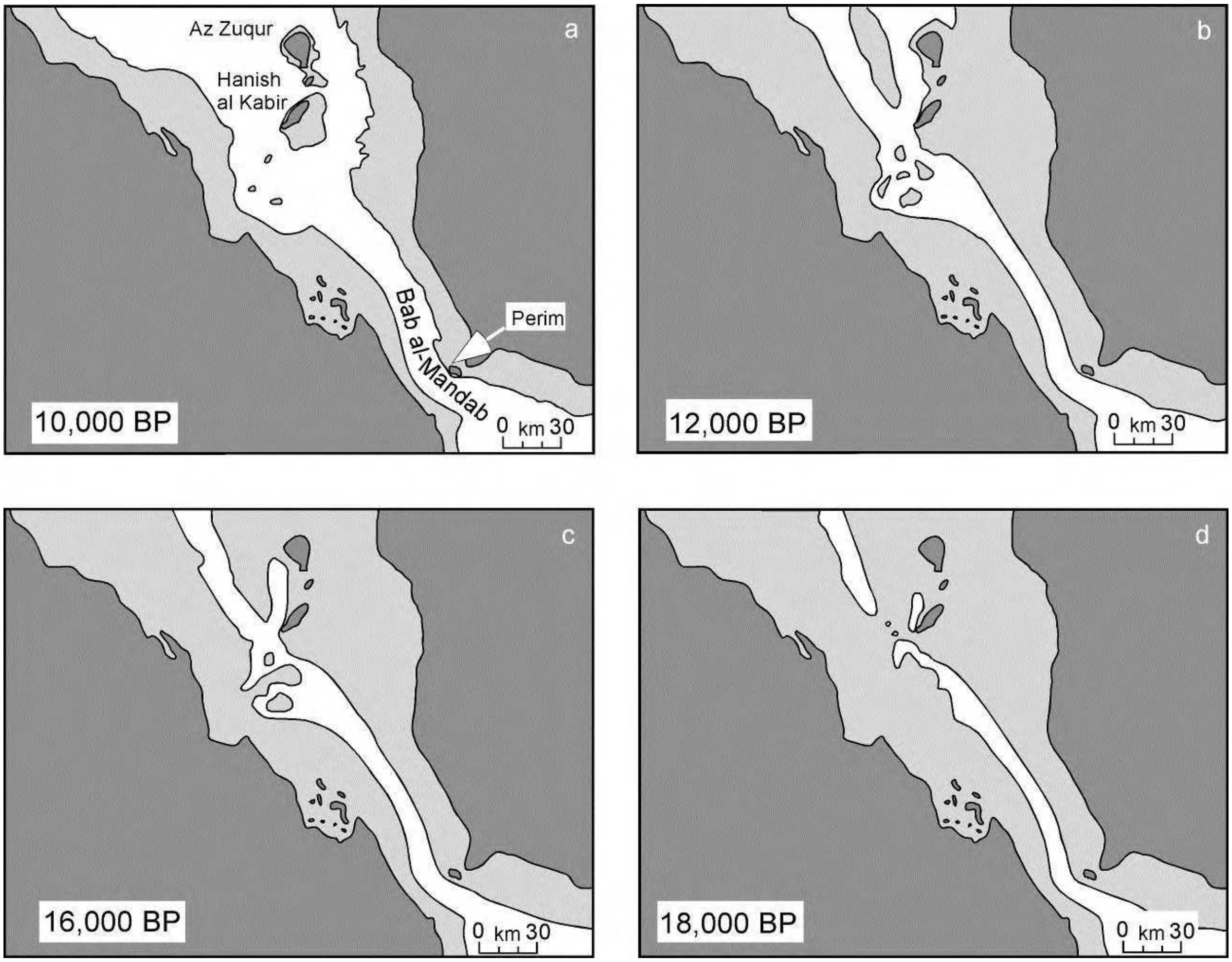

Figure 3. *Shoreline position in the region of the Bab al-Mandab Straits at four time periods during the most recent sea level cycle. Time periods are expressed in uncalibrated radiocarbon years and correspond to sea level positions ranging from c. –50 m at 10,000 BP to –130m at 18,000 BP. The darker shading indicates the modern coastline, the lighter shading the coastline at the dates indicated.*

As for tectonics, the Red Sea is a rift structure, which has undergone progressive widening and deepening, with associated volcanism and corresponding uplift of the rift flanks, over a period of as much as 13 million years since the original separation of the Arabian plate from Africa. The average rate of separation is believed to be as high as 16 mm per year. Extrapolated over a period of 2 million years, that would be sufficient to open up a gap the width of the present-day Bab al-Mandab Straits, the implication being that at the time of the first exodus of early humans out of Africa some 1.8 million years ago, it would have been possible to cross the southern end of the Red Sea on foot even without any depression of sea level. However, evaporites (salt deposits) would have formed when the Red Sea was isolated from the Indian Ocean, and the absence of such deposits younger than 6 million years suggests that the Straits could have remained open from that time onwards (Fernandes *et al.* 2006). Moreover, evidence from raised beach terraces associated with earlier periods of high sea level suggests that there has been very little vertical tectonic movement over the past 125,000 years, and chemical signals from deep-sea cores in the Red Sea show that horizontal spreading was sporadic and localised, with little activity during the past 40,000 years (Vita-Finzi & Spiro 2006). Thus, it is unwarranted to attempt any reconstruction of shoreline positions 1.8 million years ago by simple extrapolation of average rates of movement. The most we can say is that any effects of tectonic movements over this time span are likely to have facilitated crossing of the Bab al-Mandab by the earliest human populations in the region rather than to have inhibited it. A more prominent cause of tectonic movement, but on a localised scale, is salt diapirism, that is the mobility of thick salt deposits, which tend to rise upwards in relation to surrounding rock formations and also to undergo solution, creating both localised uplift and deep depressions (Bosence *et al.* 1998; Warren 1999). These effects are especially marked in the Farasan Islands.

Coastal Archaeology

From the general patterns of sea level change described above, it is clear that coastal sites preserved on land today are likely to be associated with periods of high sea level, either within the past 6–7000 radiocarbon years, or at earlier periods of high sea level, such as the high sea level stand at about 125,000 years ago.

The Comprehensive Archaeological Survey Program of Saudi Arabia, conducted in the late 1970s, recorded a number of Palaeolithic sites along the Red Sea coastline, which seemed to offer the prospect of information about early use of coastal resources, particularly in the vicinity of al-Qahmah and al-Birk (Zarins *et al.* 1981). Here finds of stone tools of Lower and Middle Palaeolithic type are associated with basaltic lava fields and lava cones, which provide the raw materials for stone tool manufacture. Tools are also found on a raised coral terrace some 3 m above the present shoreline, which is presumed to correlate with the high sea level stand dated to about 125,000 years ago. We have revisited these sites to assess their potential for more detailed work, and have obtained some new geochemical dates from the land surfaces on which the artefacts are placed. Our observations lead to the following conclusions:

1. All the sites and artefacts we have examined in the field are surface finds. None of them are embedded within the underlying deposits, and extensive inspection of exposed sections in marine beach deposits and alluvial sediments has so far failed to reveal any artefacts in a stratigraphic context that might provide some means of dating or associated biogenic evidence of palaeoenvironmental conditions and palaeoeconomic practices.

2. Some of the lava cones are very ancient. Two basalt samples from the lava cone at site 216-208 near al-Qahmah (Zarins *et al.* 1981: 18, fig. 5/A) gave K/Ar ages of 1.37±0.02 million

years (KSA 04/AR1) and 1.25±0.02 million years (KSA 04/017). They provide a maximum age for the Acheulean artefacts that have been found in the vicinity.

3. Similarly the Mousterian artefacts that occur on the 3 m beach terrace in this area are surface finds and may postdate the beach formation by an unknown interval. Pending the results of our dating studies, we take this 3 m beach deposit to correspond to the Stage 5e high sea level. Thus, the 3 m beach deposit provides, at best, a maximum age for the Mousterian artefacts of about 125,000 years, although their true age may of course prove to be much younger.

4. The difficulty of relating surface finds to underlying geological formations is illustrated by a small shell midden at al-Birk. Here a concentration of shells and non-diagnostic stone tools is distributed over an area of about 200 m^2 on the surface of a 3 m coral beach terrace. A radiocarbon date on some of the shell material of 5560±70 BP (Beta-191460) demonstrates that this site was used at about the time when modern sea level was established, or soon after, but the underlying coral terrace is too recrystallized for secure U-series dating and yields shell material too old for a finite ^{14}C age (BETA-191459: 38380 ± 1290 BP), consistent with formation at a high sea level 125,000 years ago..

These sites provide important information about the Palaeolithic period, but their potential to give more detailed insight into the early use of coastal resources is severely limited. For better information we will have to look elsewhere.

The Farasan Islands

The Farasan Islands are composed of cemented coral platforms that have been variously uplifted and deformed by salt tectonics, resulting in a characteristically scalloped shoreline and a complex offshore topography including some very deep depressions (Dabbagh *et al.* 1984; Macfadyen 1930) (Figure 4). We have chosen this area for more detailed work for three principal reasons. Firstly, previous discoveries of archaeological sites including shell middens and shell mounds (Zarins *et al.*1981, Zarins & Zahrani 1985) suggest the presence of a well-preserved record of postglacial settlement, which can provide insight into the nature of the coastal archaeology associated with the present-day coastline, and a guide to what to look for underwater. Secondly, experience elsewhere suggests that offshore islands and archipelagos, and heavily convoluted and embayed shorelines, often offer good marine conditions for the preservation and discovery of submerged landscapes and archaeology.This is because they provide some protection from the full force of wave action associated with straighter and more exposed coastlines, and are subject to relatively limited run-off and deposition of terrestrial sediments which may obscure the inundated land surface. Also, many parts of the Farasan coastline are unsuited to recent coral growth, which would otherwise obscure the surface of the underlying terrestrial landscape. There are also variable depths of water offshore with quite deep water in the near vicinity, offering the possibility of discovering submerged shorelines associated with different periods of the sea level cycle. Finally, the Farasan Islands, which today are some 40 km distant from the mainland, would have been attached to the mainland at sea levels lower than about –20 m, so that a human presence during the Palaeolithic era would not have depended on a technological capacity for sea travel.

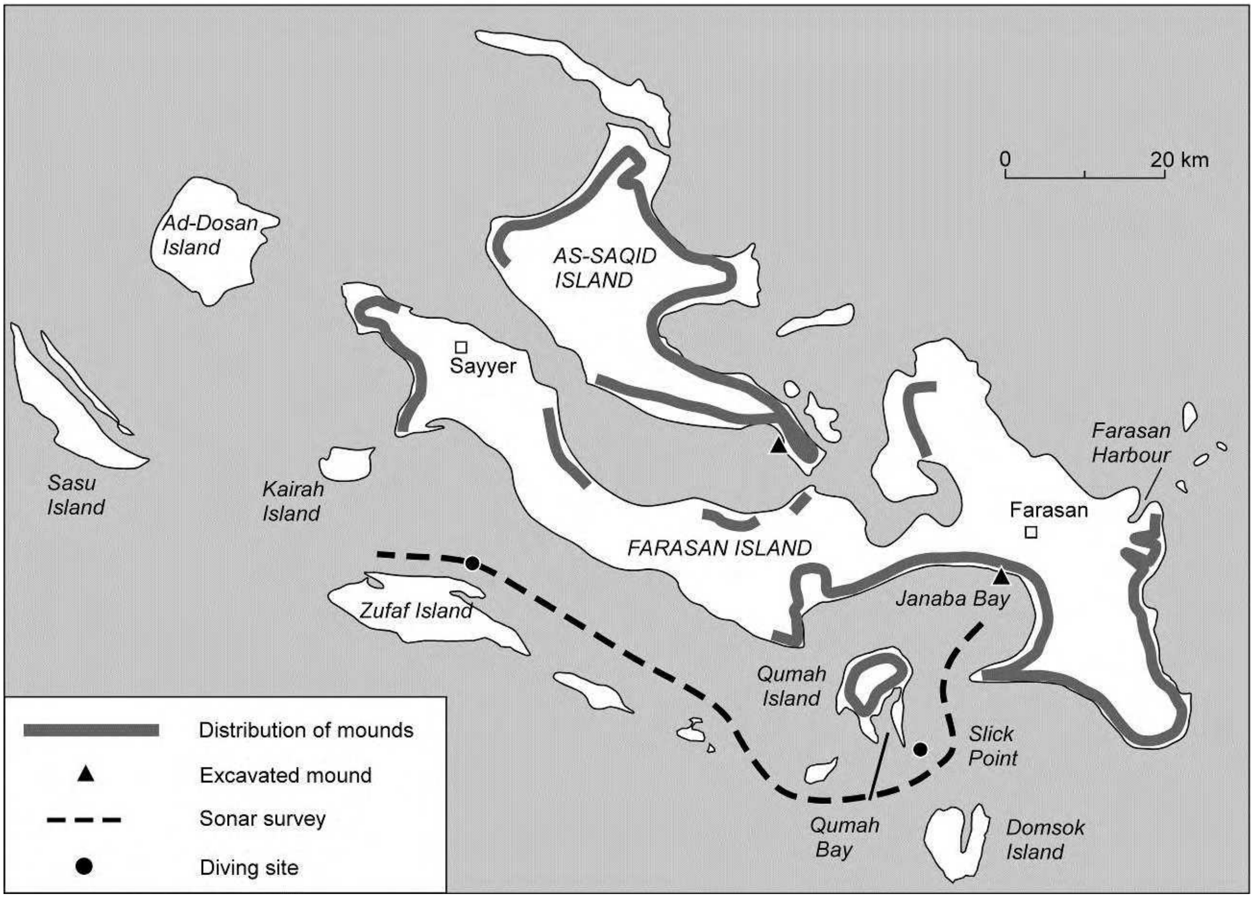

Figure 4. *Map of the Farasan Islands, showing the general distribution of shell mounds on land, location of mounds where test excavation took place, and location of underwater work. The distribution of shell mounds is not everywhere as continuous as suggested by the line on the map. Where the distribution deviates from the modern shoreline, this indicates areas where the shoreline has prograded seawards because of a shallow offshore profile and sediment infill.*

Accordingly, we are pursuing a joint strategy of archaeological investigation on land and underwater. Although the techniques of site survey in each domain are necessarily quite different, both address essentially the same issue: the nature of the prehistoric landscape and the human activities and archaeological materials associated with it. It is therefore important to integrate the two types of study so as to achieve, as far as possible, a seamless study of the ancient landscape across the present-day marine-terrestrial boundary, so that the results of investigation on land can inform the underwater work and *vice versa*.

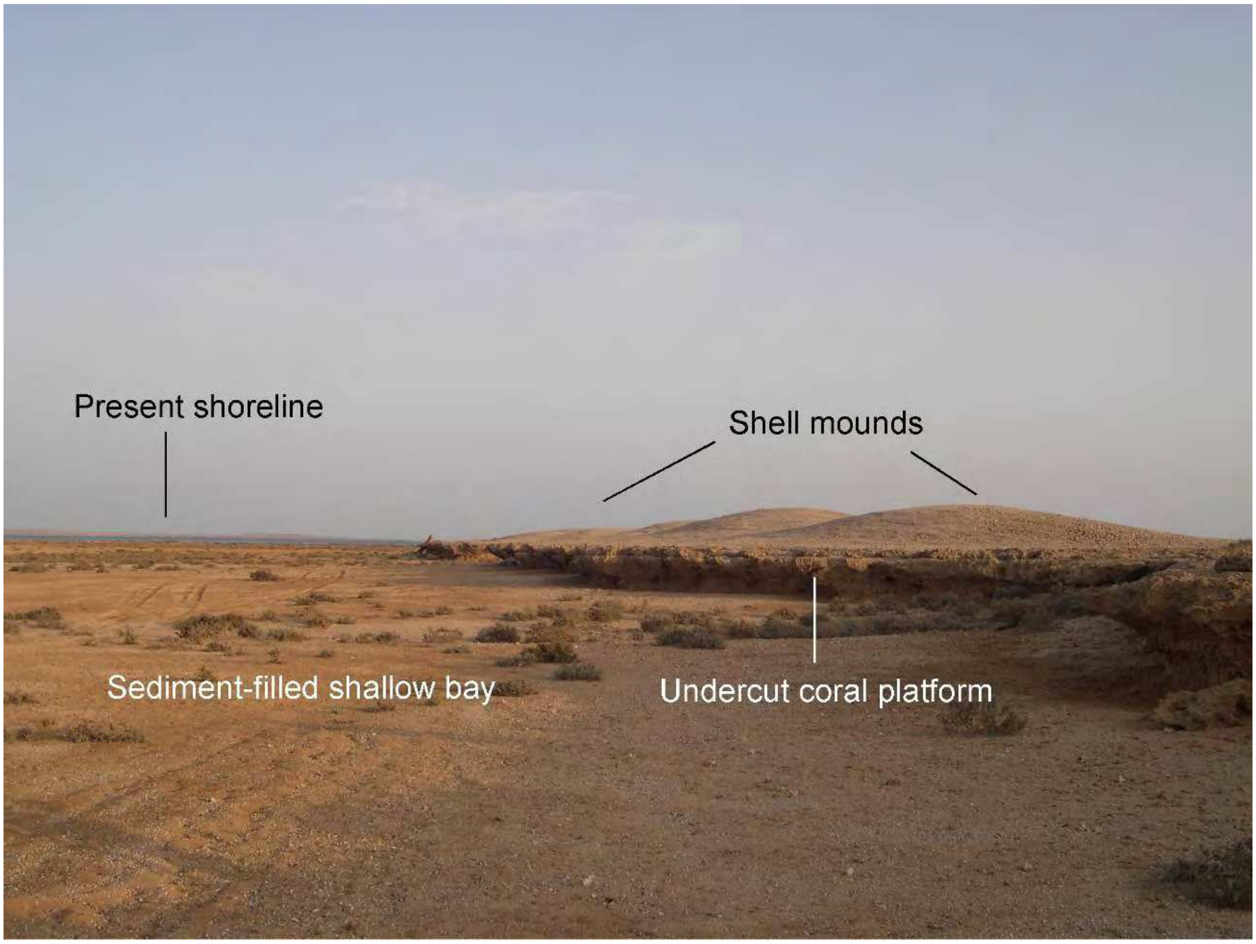

Figure 5. *View of shell mounds on the Farasan Islands. Five mounds are visible extending in a line along the edge of a coral platform that previously formed the shoreline of a shallow bay. Subsequently the bay was filled with sediments, which have displaced the present-day shoreline further seawards (photo by Abdullah AlZahrani).*

In the course of a survey conducted in May 2006, we have discovered some 1000 archaeological sites on land. Most have marine shells associated with them and many are shell mounds of substantial size, up to 4 m thick, sometimes forming a virtually continuous line of deposits along stretches of the shoreline (Figure 5). The sites often form clusters, with thicker mounds on the beachfront and shallow shell deposits or shell scatters situated further back from the shoreline. Some are associated with potsherds of Islamic and pre-Islamic type. Many shell mounds have no apparent association with potsherds or other artefacts, at least none that are visible on their surfaces, and may be of pre-ceramic age. Remains of structures built from blocks of coral are occasionally present both on mounds and in association with shell scatters.

We conducted a small test excavation at one of the larger shell mounds in Janaba Bay and a second large mound on the southern shore of As-Saquid Island, comprising in each case a 50 cm wide step trench (Figure 6). The sections show the characteristic structure and formation pattern of shell middens in other parts of the world. Stratified and compacted layers of marine shells with variable degrees of fragmentation are intercalated with ashy lenses representing the remains of fireplaces, indicating slow incremental growth of the mounds and repeated use over periods of centuries or more. Imported stone material and fish vertebrae have also been recovered from these test excavations, but no formal artefacts, probably due to the very small volume of midden deposit so far excavated.

Figure 6. *View of shell mound on As-Saquid Island with test trench (photo by Geoff Bailey).*

Zarins *et al.* (1981) and Zarins & Zahrani (1985) reported South Arabian ceramic material from the Farasan middens which were dated to about 2000 years ago, and ceramics similar to those found at the mainland shell midden of Sihi, where they are dated to about 3300 radiocarbon years BP. Excavation of a shell mound in Janaba Bay produced three radiocarbon dates: Level 3: 5235±225 BP; Level 3: 4810±170 BP; Level 2: 2410±100 BP (Deputy Ministry of Antiquities and Museums 1990). Another shell mound in Janaba Bay produced a date of 5400±250 BP (UCL 435) (Rashad Bantan, personal communication). We have collected a large number of dating samples of shell and charcoal during the recent survey. It is clear that there is a rich archaeological record extending back at least 6000 years, but more detailed information about the sequence and associated patterns of economy and land use must await the results of further dating and excavation.

Figure 7. *View of a shell mound in Janaba Bay, showing its position on the edge of a coral platform with a deep undercut caused by seawater action (photo by Hans Sjoeholm).*

In the meantime, the location of the shell mounds and their relationship to local geological and topographic features provide some important clues about the conditions in which mounds occur and the sorts of features to search for underwater. A characteristic feature is the association of shell mounds with a wave-undercut coral platform (Figure 7). The undercut is actually the result of solution of the coral by the chemical action of seawater rather than physical breakdown caused by wave action, but in any case it forms a distinctive feature of the modern shoreline, and we might expect to find similar features associated with submerged shorelines formed at periods of lower sea level. In some cases these undercut coral platforms on land are now separated from the modern shoreline by a shallow sand-filled embayment, which was formerly an extensive intertidal zone with productive conditions for the molluscs whose shells form the main constituent of the archaeological deposits. This infilling is the result of the cumulative deposition of sand deposits, accentuated in some cases by localised tectonic uplift caused by salt diapirism.

Figure 8. *Diving vessel (MV Midyan) anchored off Slick Point, with dive boat moored alongside and wave-cut shoreline in foreground (photo by Geoff Bailey).*

Underwater Survey

In combination with survey on land, we also conducted a preliminary underwater survey using a combination of diving, video and remote sensing. The objectives of the diving work were to establish the feasibility of prolonged and deep dives using mixed gas technology, to develop a general familiarisation with underwater conditions and topography, and to identify geomorphological features associated with submerged shorelines and with potential for the preservation and discovery of archaeological sites. The diving programme was facilitated by the use of a large vessel (the MV Midyan) as a mobile offshore base for a six-strong diving team, diving equipment and two small boats to provide access to dive sites (Figure 8).

Dives were concentrated in near-shore locations with relatively steep drop-offs with good potential for exposure of wave-cut coral platforms representing shorelines formed during periods of lowered sea level, and echo-sounding transects were conducted to identify breaks of slope elsewhere that might indicate similar features, and to help focus the selection of diving locations. Work was concentrated in particular on the southern side of Qumah Island in the vicinity of Slick

Point and on the north side of Zufaf Island. For short and shallow exploratory dives normal scuba tanks with compressed air were used. For prolonged diving at greater depth, we used nitrox (oxygen and nitrogen) and trimix (oxygen, nitrogen and helium), which enable divers to reach depths safely that would otherwise be inaccessible (Figure 9).

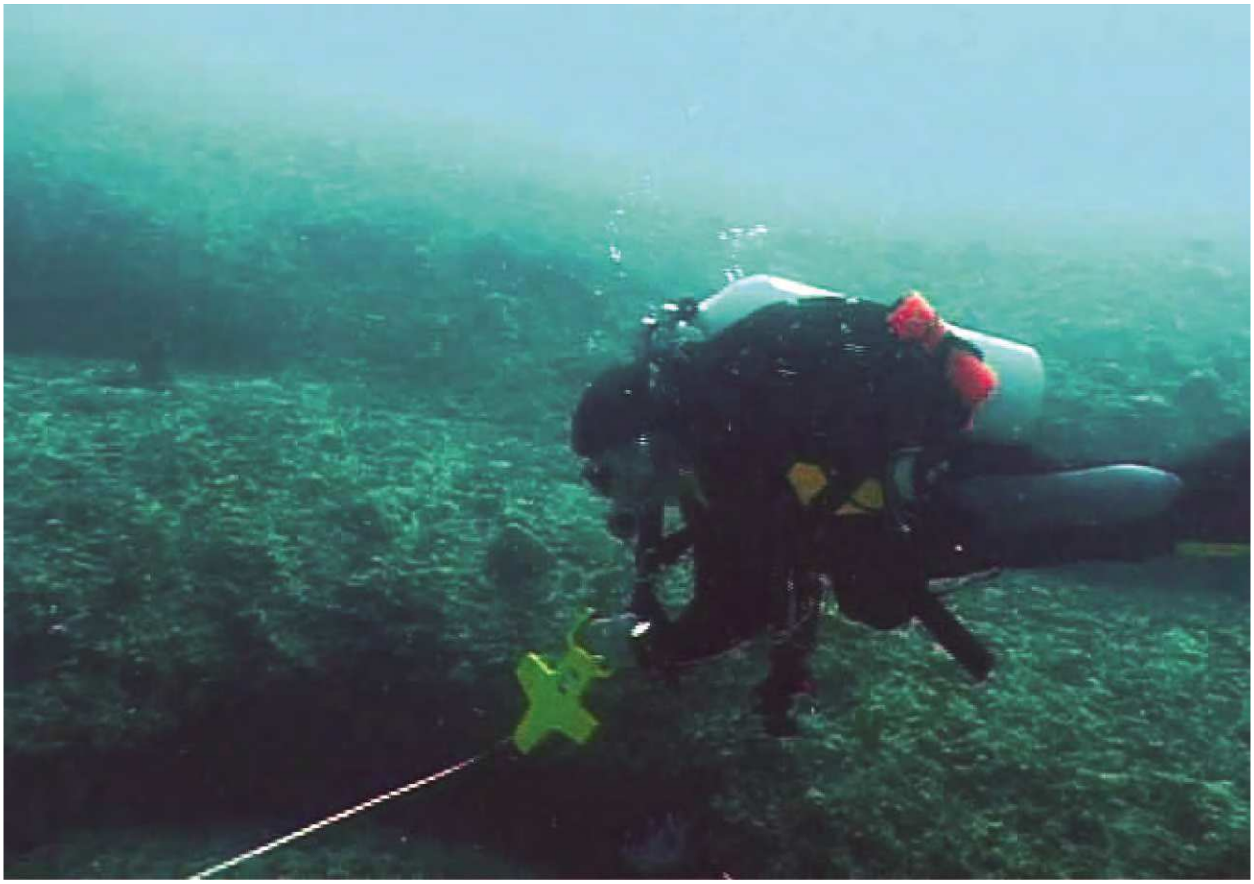

Figure 9. *Diver taking measurements on the submerged shoreline at Slick Point (photo by Trevor Jenkins).*

At Zufaf, well-defined coral terraces were examined at depths of 60 m and 6 m, but smothering of sand obscured detail. At Slick Point coral reefs representing old shoreline terraces were identified at approximately 6 m and 20 m depth. Here there was less sand covering and it was possible to undertake a more detailed examination. The 20 m reef has a west-facing vertical face up to 10 m in height and a series of notches and terraces etched into the cliff, running in a north-south direction. These features are typical of those associated with the present-day shoreline and represent a beach line at a sea level about 20 m below the present, which we believe was formed at about 80–90,000 years ago and probably re-worked when sea level reached the same level about 12,000 years ago during the sea level rise of the late glacial period (see Figure 2). We mapped, measured and photographed this submerged feature over a distance of about 100 m to the south of Slick Point, and also tracked this feature to the north within Qumah Bay. This former shoreline feature is now tilted in a north-south direction at an angle of about 1 in 20 as a result of salt-induced tectonic warping, and could be traced to a depth of 35 m to the south, where it could be seen dipping to greater depth beneath the present sea-bed, while to the north it rises to a level some 9 m below the present sea level within Qumah Bay.

Figure 10. *Large wave-cut notch associated with a submerged shoreline in Qumah Bay (photo by Trevor Jenkins).*

Within Qumah Bay, the modern shoreline has a number of shell mounds of presumed postglacial date located on top of wave-undercut coral platforms encircling a shallow basin with extensive intertidal mudflats rich in marine life including molluscs, fish and turtles. In the northwest corner of the bay, the old shoreline with its undercut coral platform and associated shell mounds is now located some hundreds of metres inland behind a flat sandy basin as a result of sediment accumulation and/or tectonic uplift. Underwater exploration on the east side of the bay shows that this same combination of features was associated with the submerged shoreline. The underwater shoreline is associated with some impressive undercuts, one of which is 3.5 m high and 4.5 m deep (Figure 10). Similar notches of almost cave-like proportions are found on the modern shoreline with shell mounds on top of them. Where they have been marooned inland because of recent shoreline progradation they make attractive, shady and sheltered spots used as modern campsites. Such features on the now-submerged shoreline would presumably have had similar attractions for prehistoric populations.

Conclusion

We have demonstrated that the southern end of the Red Sea offered relative ease of transit across the Bab al-Mandab Straits throughout most of the glacial period because of lower sea levels, with a mimimal sea barrier at the glacial maximum. Increased climatic aridity in the region at large may have acted as a deterrent to human occupation at such times, but set against this is the likelihood that local environments in the vicinity of coastlines would have offered springs and other localised water supplies, creating pockets of fertility on land, and an accessible shoreline rich in marine resources except for short periods at glacial maxima within the main body of the Red Sea Basin, when very high salinity would have destroyed most marine life. We have greatly exp;anded the onshore record of shell mounds and shell middens on the Farasan Islands dating to the past 6000 years; and we have shown how study of associated geological features provides clues on where we should look underwater in order to extend the record of human occupation further back in time. We have begun mapping submerged shorelines at a range of depths from 6 m to 60 m, which indicate continuity in geological and ecological features attractive to human settlement, and we will continue that work in search of associated archaeology, along with more detailed excavation and study of the more recent shell mounds on the present-day shoreline.

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List of Authors

Prof. Geoff Bailey
Department of Archaeology, University of York, the King's Manor, York, YO1 7EP, UK
Email: gb502@york.ac.uk

Dr. Abdullah AlSharekh
College of Tourism & Archaeology, King Saud University, P.O. Box 2456, Riyadh, 11451, Kingdom of Saudi Arabia
Email: asharekh@hotmail.com

Dr. Nic Flemming
National Oceanography Centre, Southampton, University of Southampton Waterfront Campus, European Way, Southampton, SO14 3ZH, UK
Address for correspondence: Sheets Heath, Sheets Heath Common, Brookwood, Surrey, GU24 0EN
Email: n.flemming@sheetsheath.co.uk

Prof. Kurt Lambeck
Research School of Earth Sciences, Building 61 Mills Road, The Australian National University, Canberra ACT 0200, Australia
Email: Kurt.Lambeck@anu.edu.au

Garry Momber
Hampshire & Wight Trust for Maritime Archaeology, Room W1/95, National Oceanography Centre, Empress Dock, Southampton SO14 3ZH, UK
Email: garry.momber@hwtma.org.uk

Dr. Anthony Sinclair
School of Archaeology, Classics & Egyptology, University of Liverpool, 12–14 Abercromby Square, University of Liverpool, Liverpool, L69 7WZ, UK
Email: A.G.M.Sinclair@liverpool.ac.uk

Prof. Claudio Vita-Finzi
The Natural History Museum, Cromwell Road, London, SW7 5BD, UK.
Email: CVitaFinzi@aol.com