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An archaeological investigation of Sira Bay, Aden, Republic of Yemen

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Introduction

In December 1993, Yemen's Aden Governorate initiated a cultural resources survey of Sira (Front) Bay, Aden (Figs 1 and 2). The intention of the survey was to confirm the location and to investigate any physical remains of Aden's pre-British-Colonial seaport, historically a strategic and commercially active harbour. Today, Aden is the principal southern port in the Republic of Yemen.

The city of Aden is decentralized in nature and consists of several distinct sub-centres, spread about the base of the extinct volcanic escarpment that dominates the Peninsula of Aden (Fig. 3). Aden, or Crater, located on the eastern side of the Peninsula, is the oldest and largest of these. Sira Bay fronts Crater. Other population hubs include Khormaksar, located on the isthmus; Sheikh Othman, on the mainland; Ma'alla, on the northern side of the Aden Peninsula; and Tawahi, or Steamer Point, situated on the western side of Peninsula, and the site of the modern port of Aden developed by the British in the 19th century.

The survey occurred amidst the planned development of Sira Bay into a recreational and leisure centre. Within the past two years developers have plugged the western portion of the Bay with thousands of cubic metres of fill, and the process continues on a daily basis. Contractors are building an amusement park and restaurants, and are drawing up plans for high-rise buildings above the remains of the port of antiquity.

The specific aims of the archaeological project were to locate an ancient breakwater (mole), to identify potential remains of the ancient port, and to pinpoint any shipwreck sites in the Bay itself. The survey was undertaken by a research team composed of the author, a fellow graduate and a student of East Carolina University's Program in Maritime History and Nautical Archaeology, a military diver, and a liaison officer associated with the Yemeni Department of Antiquities. Throughout the project, security concerns hampered research and key sections of Sira Bay could not be investigated. Raw sewage discharge, multiple-source water pollution, and recurrent dysentery complicated research. In addition, Yemen is one of the least developed countries in the Middle East and the process of obtaining most necessities and research tools there, such as compressed air, presented difficulties.

Site history

Aden has played an important role in world trade since before the era of the *Periplus*, an Indian Ocean seafaring guide written by an anonymous Graeco-Egyptian mariner around AD 50 (1989: 26). According to the writer, Aden had served as the commercial intermediary between East and West, 'when ... vessels from India did not go on to Egypt and those from Egypt did not dare sail to places further on.' By the *Periplus*' era, however, Aden had degenerated into a miserable village, and supposedly Roman troops had sacked the port during the reign of the Emperor Caligula (AD 37–41) (Miller, 1969: 14–15).

Aden rose again to prominence as a port during Yemen's Ayyubid and Rassulid dynastic eras (AD 1174–1454), and continued to flourish well into the 16th century. According to Ludovico di Vartema (N.D.: 59), an Italian who visited the city early in the 16th century:

'Aden is the strongest city that was ever seen on level ground. It has walls on two sides, and on the other sides

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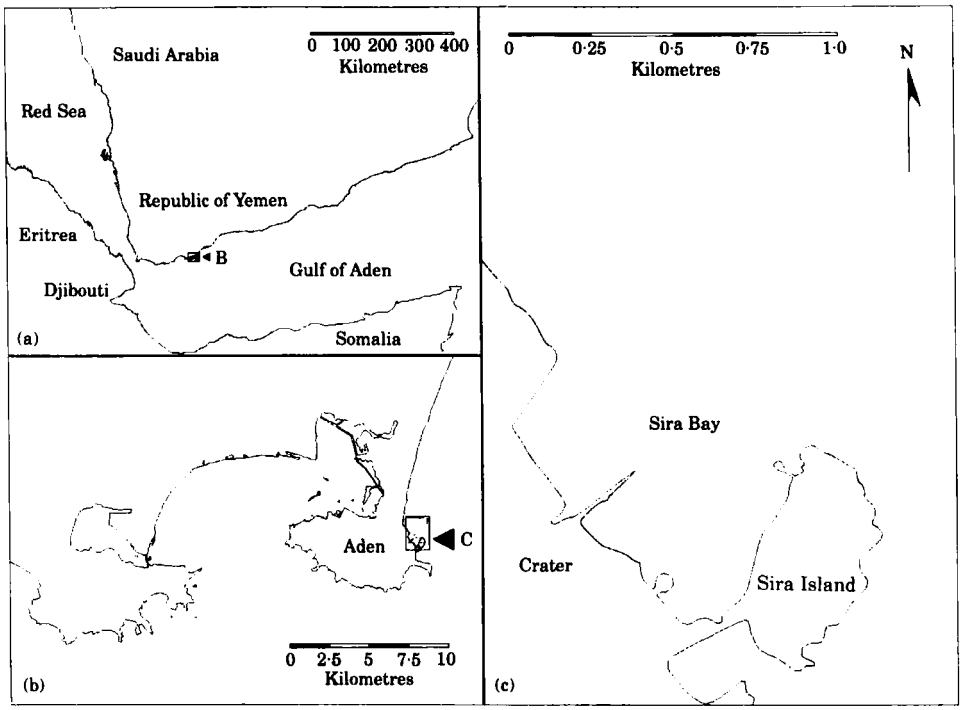

Figure 1. Map of Aden with the location of Sira Bay. (All figures by the Author.)

Figure 2. View of Crater and Sira Bay.

there are very large mountains . . . It is the rendezvous for all the ships which come from India Major and Minor, from Ethiopia and from Persia'.

In 1513, the Portuguese Governor of India, Alfonso de Albuquerque, mounted an ambitious assault on Aden and its walls; the effort was a complete failure. Subsequent Portuguese attempts to capture the port also proved unsuccessful. It was at this time that the Portuguese were seeking to consolidate their hold over the maritime trade of the Indian Ocean littoral region. That Portugal failed in this attempt was due, in part, to that nation's inability to control Aden, and, by extension, the Red Sea/Egyptian route to the Mediterranean (Prados, 1992).

Aden's fortunes continued to fluctuate, with a period of eclipse beginning in the 17th century when the Red Sea port of Mocha—renowned

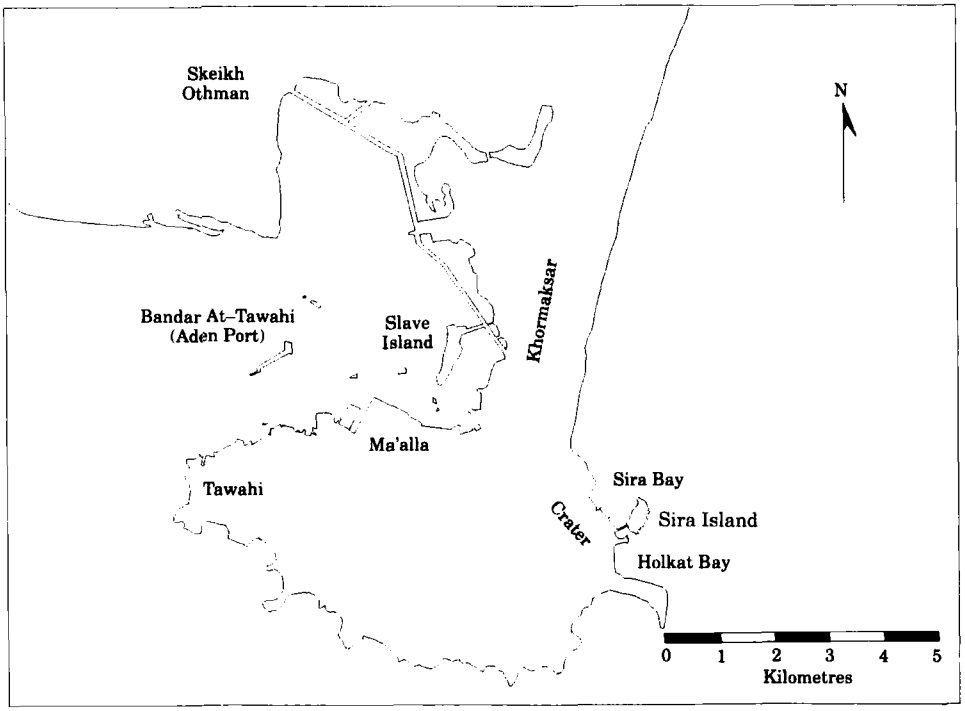

Figure 3. Sub-centres of Aden.

for its coffee exports—displaced Aden as a preeminent regional trading centre. The Ottomans, who had successfully taken Aden in 1538 and subsequently re-fortified it, relinquished their hold over the port in order to focus on their more prosperous Red Sea holdings (Little, 1968: 9). Aden had degenerated into a ramshackle fishing village when, in 1839, the British captured and eventually fashioned it into a bustling city and a major port.

Topography and site formation processes

The city of Aden is situated on a peninsula moulded by volcanic activity. Aden was originally an island; today it is joined to the mainland by an isthmus formed as the shallow seabed between Aden and the mainland gradually silted up (Playfair, 1859 [1970]: 5; Serjeant, 1988: 163). On the Peninsula, steeply-sloping volcanic mountains lead directly into the sea; consequently flat land has consistently been a scarce resource. The British built large portions of the districts of Khormaksar, Ma'alla, and Tawahi upon reclaimed land.

Crater alone boasted some level ground; nevertheless, landfill activity has been extensive at this sub-centre. Initial observations made it clear that within the last decade there have been huge reclamation activities. Today, Victorian seawalls lie behind both a major thoroughfare and an amusement park.

In addition to landfill activities, sediment deposition has affected and altered the extant, submerged portion of Sira Bay. The rate of sedimentation is difficult to predict, and, undoubtedly, it has changed over time (Duncan, 1994). Presently, tidal flats, which are exposed at low tide, characterize the coasts of Crater and Khormaksar. While no perennial streams or rivers empty into Sira Bay, infrequent but violent rainstorms drive quantities of material from Aden's mountainous backdrop into flood channels, known as *sailas*, that empty into the Bay. Currently, most of the Bay is so shallow that it dries at low tide.

In 1839, it was possible to wade to Sira Island (Kirkman, 1975). Subsequently, the British built a causeway from the mainland to Sira Island, which resulted in an accelerated

sedimentation rate in the Bay by deflecting the southerly waves that previously scoured it. Today, this area is used as a soccer field at low tide, suggesting that at least 0·5 m of sediment has accumulated since then.

It is probable that the tidal flats that currently characterize Sira Bay also existed in earlier eras. A wide expanse of tidal flats before the old coastline would not have hindered commerce at Aden, as it is the practice of dhow captains at Ma'alla to beach their vessels for off-loading, careening, and repairs. Even large dhows have a shallow draft and nautical charts show that the channel of Ma'alla's dhow harbour is dredged to only 2·7 m. Historical sources indicate that Sira Bay's mud flats have existed for at least four hundred years.

It appears that Aden's ancient (pre-7th century AD) and Medieval (pre-16th century) maritime features do not lie underwater or below the seabed, but are covered by 5–10 m of successive habitation levels and landfill. In 1859, a British Officer, Capt. Playfair, noted ancient South Arabian inscriptions 6 m below the level of the present town, in an era that preceded modern landfill in Crater (1859 [1970]: 13). At the same depth, Brian Doe, director of the Aden Department of Antiquities in the 1960s, unearthed four ancient column capitals (1974: 176–179). He also located the remains of buildings 4–4·5 m underground in the area of the Holkat Bay Road.

Earlier archaeological research

Little terrestrial archaeological research work has been conducted at Aden. R. B. Serjeant (1988) and Brian Doe (1965) identified Chinese ceramics found during surface surveys of Holkat Bay and other areas around Crater. Doe also conducted several test excavations that revealed the remains of buildings in the Holkat area. The Cisterns of Tawila, a Medieval system of water-catchment tanks for Aden's waterless Peninsula, have received some archaeological attention (Norris and Penhey, 1955). UNESCO environmental assessment specialists have studied the cisterns more recently, following damaging floods in early 1993.

Buildings and streets occupy almost every square metre of land, and intensive construction and development have destroyed archaeological information. According to Serjeant: 'the British Engineers cleared the area without regard to archaeology . . . Modern Aden is practically entirely a British creation' (1974: 210).

The survey

This survey was the first formal, underwater archaeological project to be conducted in Aden, or in Yemen itself. This resulted in difficulties, as the discipline is new to the country. Officials were unsure of the proper jurisdictional placement of activities such as SCUBA diving and underwater archaeology, and were worried about the safety of these activities. Supporting facilities and equipment were non-existent.

Cartographic reconstruction

The survey was designed to be implemented by means of a four-phase process: cartographic reconstruction, visual searches, remote-sensing searches, and intrusive investigation. The first phase, cartographic reconstruction, began with a study of primary sources and charts, designed to allow project members to define the parameters of the search area. Following initial familiarization, a map of shoreline change at Crater and Sira Bay was constructed depicting the current shoreline in relation to the shorelines of previous eras. As no up-to-date map was available, the current shoreline was mapped with a transiting compass and a 30 m chain in December 1993. It was then digitally plotted using AutoCAD (Release 12). A 1990 US Defense Mapping Agency nautical chart and a 1954 British chart were digitized as overlays on the map to provide recent, comparative data.

Next, the Medieval shoreline was projected in the following manner. An inspection of the slope of Crater revealed a positive (upward) slope leading to the remains of the sub-centre's seawalls. On the Aden Peninsula, a positive slope leading to the sea is artificial, given the topographical characteristics of the landmass, a volcanic escarpment whose lava mountains often plunge directly into the Indian Ocean. Where natural beaches exist, they are limited in extent, and descend (albeit far more moderately) to the sea. One of Crater's few remaining Medieval structures, the Aden minaret (*c.* AD 1050), was observed to be directly behind this positive gradient (Fig. 4). Additionally, an aerial photograph revealed that building and

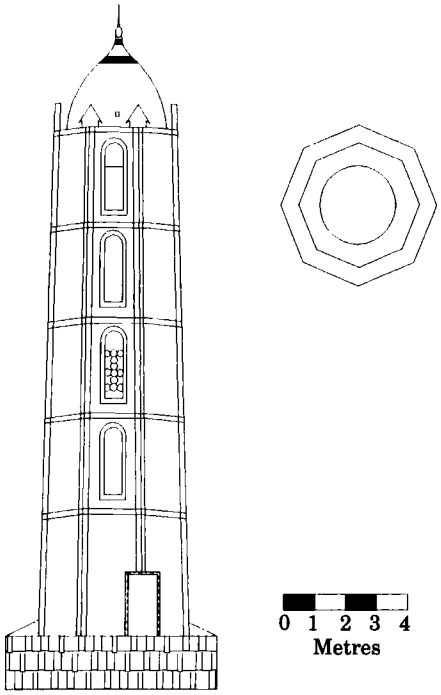

Figure 4. Sketch of the Aden minaret.

road orientation differed distinctly before and after the gradient, indicating two distinct phases of construction activity. It was, therefore, presumed that Post-Medieval developmental activities had formed the landfill that comprises the positive slope. Thus, the appropriate Medieval shoreline lay along a rough arc coinciding with the beginning of the upward incline. Periodic readings were taken along this arc using a Magellan 5000D differential global positioning system (GPS) unit. The GPS waypoints, along with the position of the Medieval structure commonly believed to have been a minaret—but which may have served as a signal tower or lighthouse—were plotted. Close scrutiny of the minaret's base confirmed that the structure had, at one time, fronted the sea. On its eastern side the base's mortar was noticeably eroded, and salt deposits were identified in the north and south faces. An arc was drawn through all of the plotted positions, completing the projection of the Medieval shoreline.

The final task in the cartographic reconstruction was to calculate the ancient and earliest shoreline. Behind the positive slope of the Medieval era, there is a long stretch of land that exhibits minimal slope as it slowly rises inland. The slope increases dramatically as the town ascends to meet the Jebal Shamsan range that encircles Crater and rises over 600 m above sea level. Comparison with natural shorelines on the Peninsula would suggest that the original interface between land and sea can be found where the land begins its rise to the mountains. In addition to slope and feature analysis, the absence of observable rock formations in building pits over 4 m deep seaward of the rise suggested the extent of early landfill. The ancient shoreline was computer-plotted in a manner similar to the Medieval shoreline. Based on information generated from the map, the projected maximum distance from the ancient shoreline to the current shoreline in Crater is 845 m. The estimated area of landfill coverage for Crater alone is 600,000 m^2 or 0·6 km^2. The completed map demonstrates the gradual transformation of Sira Bay from a large, well-sheltered, and fortified natural harbour into a small, shallow bay suitable only for fishing and leisure activities (Fig. 5).

The phase of data-gathering and landscape analysis also allowed the team to investigate Aden's few, surviving pre-Colonial structures. The function and existence of these structures strengthens the probability that Sira Bay was the site of Aden's ancient harbour. Included among the structures were the Cisterns of Tawila. These water-tanks, whose earliest origins remain the topic of some debate, may date back to a Persian occupation in the 6th century AD (Norris and Penhey, 1955). They would have been essential in supplying the port city and in provisioning visiting ships with water, and indispensable at times of siege. Another composite structure is the defensive works of Aden. Two 16th-century prints depict predecessors of these defensive installations (Naval Intelligence Division, 1946: 259; Serjeant, 1963: Pl. 2).

A final structure, the Aden minaret, demanded closer investigation (Fig. 4). Commonly held to be a minaret, but lacking an associated mosque, the structure's positioning makes it an ideal light or signal tower. Small windows placed at the top of the building would have permitted signals to reach the fortification on the highest peak of Jebal Shamsan

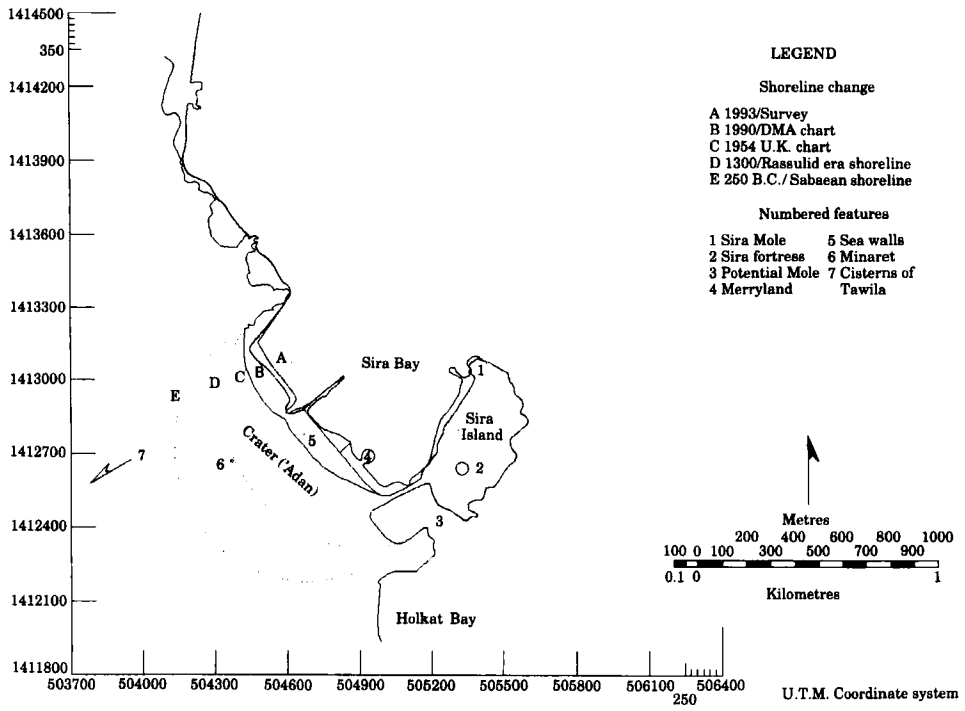

Figure 5. Shoreline change at Sira Bay. The causeway to Sira Island did not exist in the pre-Colonial era.

to the west, the observation post of Jebal Mansour to the north, a fortification to the south, and ships at sea to the east. The location of the internal platform, flush with the main windows, would have made it impracticable for the Muslim caller-of-prayer, the muezzin, to perform his five-times-daily ritual. Notably, the minaret is not currently used for religious purposes, despite Aden's dearth of minarets following twenty years of socialist rule. No formal study of the minaret was permitted, but through the cooperation of construction workers repairing a fence, the interior of the structure was visited. Its brick construction, octagonal siding, and decorative brick patterns display Seljuq Turkish influence (Bloom, 1989: 157–158); it is likely that the tower dates to the 11th century AD. Regrettably, little effort has been expended to conserve and restore this unique, historic structure.

Visual searches

This second phase of the project commenced in January 1994 with walking searches of Sira Bay at low tide, and continued with diving searches in deeper water. No significant anomalies protruded through the 1·5 m overburden of the exposed tidal flats. Those cultural remains discernible on the surface proved to be of modern origin.

A diving search did disclose more information about the deeper, submerged portion of the Bay. Activity during this phase of the survey was directed primarily in the vicinity of a mole or breakwater, found at the extreme end of the harbour on the northern side of Sira Island. The mole's location makes it extremely effective in blocking the swell generated by the easterly waves of the north-east monsoon. The proper positioning of such a mole would have been crucial during Aden's tenure as a world-class entrepôt. Capt. Haines' 1836 chart of Aden confirms the mole's usefulness by depicting a fleet of vessels anchored in the feature's lee.

Underwater examination of the mole and its surroundings revealed that the feature once extended a further 25 m and that the mole was not a natural formation (Fig. 6). A regular, sloping, stone wall at its submerged end

Figure 6. Sira mole.

which ends abruptly at the seabed confirmed its artificial nature and indicated that its builders were able to operate efficiently in 10 m of water. That the mole's builders could conduct work underwater has implications for the survival of submerged cultural remains in a shallow bay fronting a heavily-populated area. Although locals did not seem to know the age of Sira mole, pictorial sources show it as early as the 16th century, and it is likely that the mole dates to well before that period. Only modern surface material was located in the diving search. Three distinct construction layers underlying the breakwater's modern surface were briefly noted at a break in the wall, but officials prevented the team from recording and investigating this, the seaward, side of the mole.

Remote sensing searches

In the third phase of the project, a SCUBA King underwater metal detector and an EG & G Geometrics G-866 proton precession magnetometer were utilized in detecting subsurface metallic and magnetic anomalies. The metal detector proved to be of limited value. The seabed, dark in colour and rich in igneous, magnetic minerals such as magnetite, caused the metal detector to register almost continually as it was walked along a preset grid.

Greater success was obtained with the magnetometer, as it was trawled during high tide at least 1 m above the seabed, thereby reducing sensor interference. Magnetometer tow lanes were randomized, varying according to transit availability on shore, but the team succeeded in its objective of intensively sampling what was probably the most active area of the Bay in the pre-Colonial era (Fig. 7). Several gaps in magnetometer lane coverage were caused by obstructions, such as fishing boats and nets located in the harbour. Unfortunately, the team and local officials were not able to have the obstructions removed prior to the conclusion of the magnetometer search.

A traditional, Yemeni *huri* towed the magnetometer sensor at a relatively constant speed. The huri had a shallow draft, making it ideal for surveying in the shallow bay. However, there were no enclosed spaces aboard the craft. The lack of a protected cabin area precluded the use of an EG & G Geometrics RS-232 communications cable that would have permitted automatic transferal of data from the magnetometer to the project's notebook computer. Instead, thousands of magnetometer readings had to be input manually into the computer. The magnetometer values were then matched with their respective x–y coordinates, which were calculated by a team-designed QBASIC locational control programme. Team members plotted and investigated all significant anomalies.

The volcanic composition of the Aden peninsula imposes limits on any magnetometer's effectiveness. Small rocks, less than 10 cm in

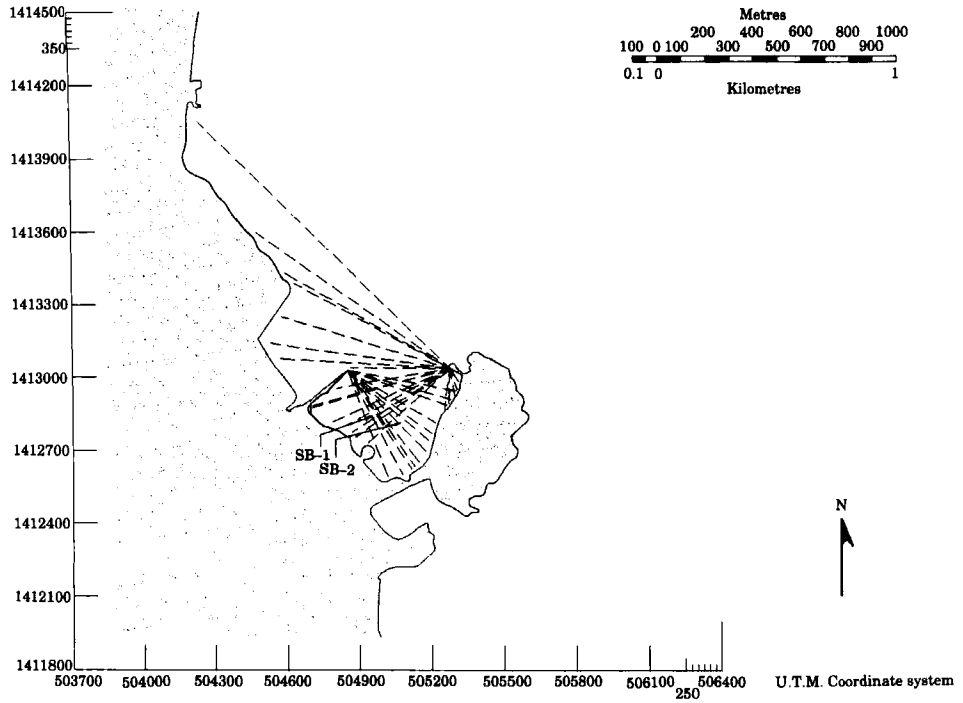

Figure 7. Magnetometer tow patterns.

diameter, could produce readings of 40 to 50 gammas above the background magnetic field. Such readings made it necessary to filter out smaller anomalies. The disadvantage of this screening process was that the detection of small ferrous objects, as well as ceramics and fired bricks, which exhibit thermoremnant magnetism, was not possible due to background magnetic noise (Breiner, 1973: 46). Nevertheless, a shipwreck with iron fittings might still have been detectable. Figure 8, produced with the aid of Surfer, a computerized plotting programme, graphically represents the complex magnetic contours of Sira Bay.

Larger anomalies, registering 200 to 20,000 gammas were also detected. These anomalies, however, turned out to be contemporary iron and steel surface debris. Figure 9 displays the anomalies and the strength of their readings. No significant patterns or signatures typical of a wooden shipwreck with iron fittings were detected in the magnetometer print-outs or in this three-dimensional representation.

However, shipwrights in the Indian Ocean littoral did not use iron fastenings prior to European contact in the 16th century (Moreland, 1939; Bowen, 1949: 19–21). Rather, they stitched their craft together with coir rope, derived from the husks of coconut. Even today, sewn-boat construction continues on a limited basis in the region. Furthermore, there is no historical or archaeological evidence that shipboard ordnance was used in the Indian Ocean before direct European contact. Thus, a magnetometer could not detect a sewn, Arabian vessel unless the craft were carrying fired ballast and did not lie in an area with a noisy magnetic background. The use of a sub-bottom profiler and the digging of sondages are the only means to find a vessel with limited iron fittings or magnetically thermoremnant components.

Intrusive investigation

The fourth and final phase of the survey involved calibrated probing and test excavation in selected areas of anomaly detection. Probing at and around each anomaly revealed a scatter of items 1·25 to 1·5 m below the surface. Two sondages, SB-1 and SB-2 were dug at the sites

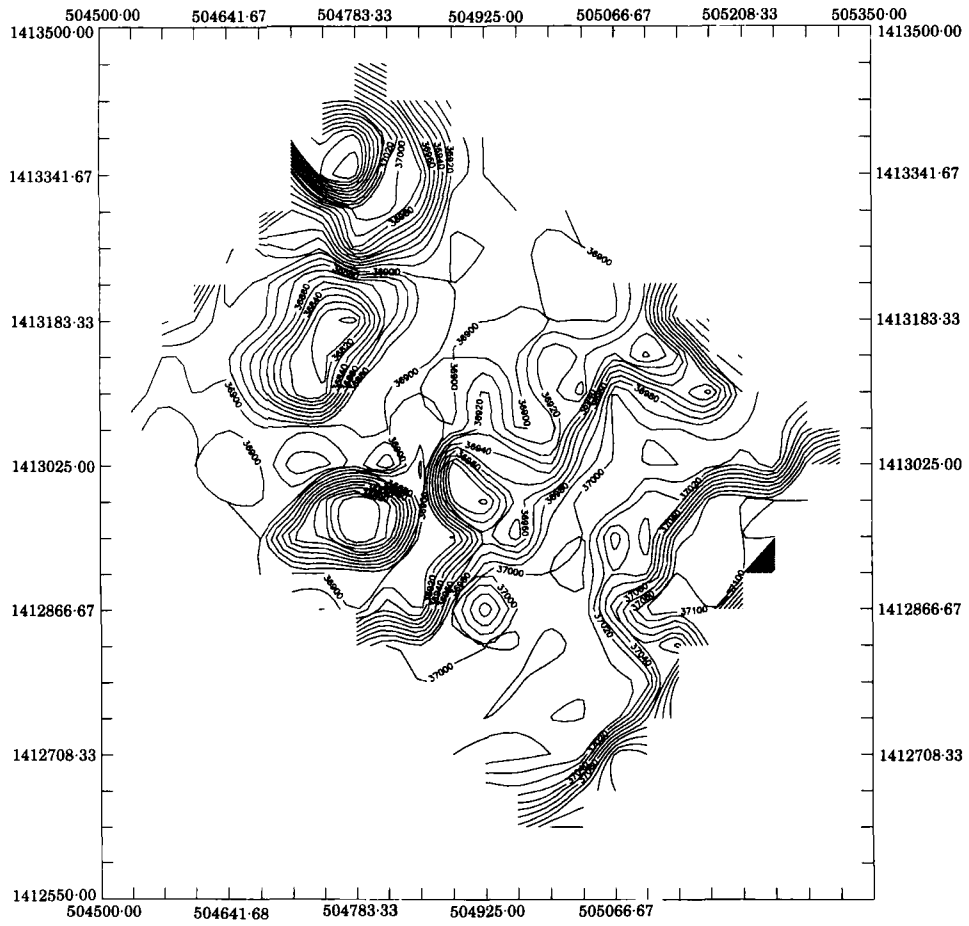

Figure 8. Magnetic contour map of main portion of Sira Bay. 10-gamma contour interval.

of fifty-gamma anomalies (Fig. 7). No air-lift or dredging equipment was available, and team members dug the pits using bare hands and shovels. Excavation proved difficult as the sediment was hard-packed, there was a 30 cm depth of water above the surface of the hole, and surge caused the pits to silt-up as quickly as they could be dug. Excavation revealed the sediment to be of uniform colour and density. In both sondages, small fragments of wood, less than 3 × 1 cm, were found. Conservation was initiated on the wood fragments; however, it is more likely that these fragments are from construction debris and run-off than from archaeological sites. Each sondage also yielded one igneous rock, always placed squarely at the end of the probe. Examination with the metal detector and magnetometer revealed that these rocks were magnetic and were responsible for generating the anomalies detected by the magnetometer.

The work was completed on 28 January 1994, following six weeks of preliminary analysis and actual survey. No significant anomalies or cultural remains were detected during the underwater portion of the survey of Sira Bay. Team members were not, however, allowed to examine several areas where a greater potential for ancient sites exists. Internal security considerations forbade additional investigation.

Conclusions

The survey team confirmed the location of Aden's pre-Colonial harbour. Additionally, the site of an ancient and Medieval breakwater was identified. The team was not able to locate the

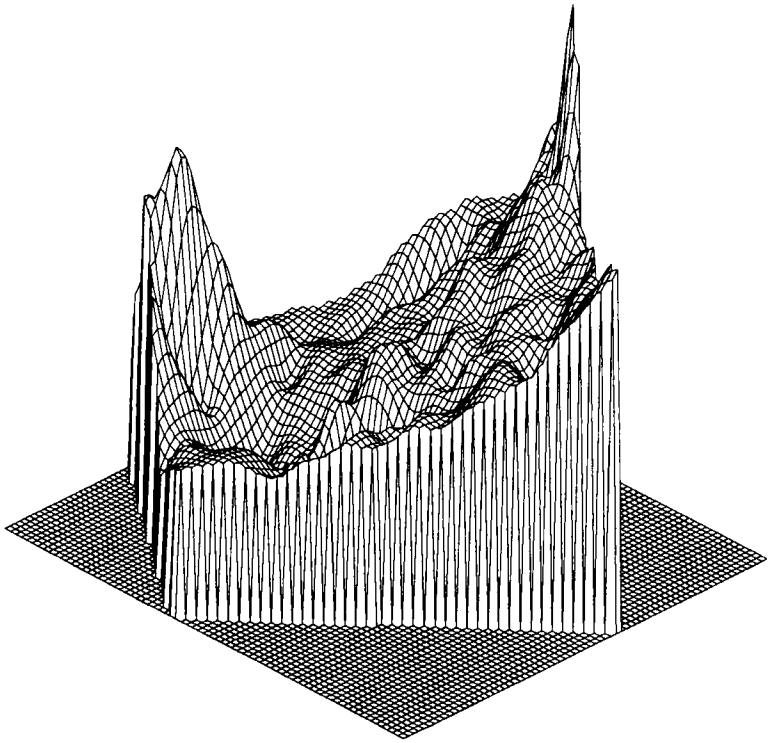

Figure 9. Magnetic anomaly map of Sira Bay. 10-gamma contour interval. Orthographic projection rotated 225 degrees clockwise for viewing purposes. Highest peaks represent contemporary surface debris.

remains of any port facilities or shipwreck sites in the harbour.

The reason for the lack of observable port facilities is made clear by the cartographic reconstruction: any extant remains of the ancient port would be located several hundred metres inland from the current shore, and under perhaps 10 m of landfill. Shipwreck sites were not located for other equally valid reasons. Wood is an extremely scarce commodity in Yemen. In timberless South Arabia, it would have been senseless to allow such a resource to deteriorate in a shallow harbour. Conversations with an elderly fisherman suggested that builders had incorporated ships' beams into buildings in the area. In a similar fashion, the principal government and population could have easily retrieved ships' cargoes and ballasts. Observations of several older, dilapidated buildings revealed that they were constructed not out of indigenous rock, but of fired brick, probably brought to the port city as ballast. Fired brick is not a traditional architectural material in Yemen, a country renowned for its stone and mud-brick architecture.

Thus, it is unlikely that there are buried features or sites within the Bay itself. If any remain they are buried under sediment, and the exact rate and depth of sediment accumulation in the Bay can only be accurately predicted with a coring programme. Sira Bay must have been deeper in the past than it is currently, or the Bay would have afforded no anchorage for ships waiting to unload their cargoes or seeking shelter from the seasonally heavy monsoon swells. In the project's two sondages, team members uncovered indigenous, volcanic rocks at 1·25 to 1·5 m below present seabed level. Probing through the sand overburden also revealed rocks and gravel clusters at a 1·5 m depth. Areas of Sira Bay, then, were at least 1·5 m deeper when it originally served as a harbour.

Only full-scale investigation can confirm the assumption that little material of archaeological significance remains in Sira Bay. It is important to recognize that no survey can achieve total coverage of any area. A well-equipped team, outfitted with dredging equipment and appropriate financial resources is needed to investigate the possibility that cultural remains lie buried underneath the harbour's silt. Survivability of remains must also be considered, for Aden's waters are warm and teredo-infested. Terrestrial testing should accompany the maritime survey, and several areas that were off-limits because of security considerations need to be investigated. These include a small portion of Sira Bay where another breakwater may have been located to shield vessels from the waves generated by the south-west monsoon (Fig. 5, No. 3); the seaward side of Sira Island where previously unrecoverable remains may exist; and Holkat Bay, which was also used as a port in Medieval times. Landfill and construction continue daily at the site, and unless a large, well-equipped team investigates the area soon, little may ever be known about what was formerly one of the most important ports in the world.

Author's note

On 4 May 1994, civil war broke out in Yemen. The city of Aden was under siege for over 2 months, until resistance ceased on 7 July. All construction and landfill projects have temporarily halted, as the city and its population attempt to recover from weeks of almost daily shelling and scarce supplies of food and water. The extent of the damage, as well as the future of archaeological work in the area, is unclear.

Acknowledgments

The Fulbright Committee and the Leigh Douglas Memorial Foundation provided funding. Richard Mannesto and Sabrina Faber, two members of East Carolina University's Program in Maritime History and Nautical Archaeology assisted in all phases of this project. ECU's Program also furnished a magnetometer for the survey. In Yemen, the Aden Branch of the Department of Antiquities granted research permission for the project and provided a liaison officer and a qualified diver. Thanks are due to Ron Andrews of Canadian Occidental Petroleum, who furnished our team with compressed air, and finally, to Yemen Hunt Oil Company for its evacuation assistance from the war-torn country.

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