

# Exploration of a Portuguese shipwreck in Goa waters, western coast of India

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## Abstract

Maritime archaeological explorations have been initiated in Goa waters since 1997 for locating port installations and shipwrecks both in coastal waters and riverbanks. Exploration off Sunchi reef in 3 to 6 m water depth brought to light a barrel of a hand gun, guns, Chinese ceramics, sherds of Martaban pottery (stone ware), elephant tusks and hippopotamus teeth, a number of dressed granite blocks, a cast iron cannon ball, lead pieces, copper vessel and strip, stone and clay bricks, pieces of glass bottles, etc. These findings suggest that the ship might have arrived from Portugal via African countries to Goa and grounded due to lack of knowledge of the topography of the area. Thermo-luminescence dating of Martaban pottery (stone ware), the radiocarbon dating of ivory and comparative study of the 'Admiralty Pattern Long Shank' type of iron anchor indicate that the wreck could be dated to the early 17th century AD. The findings of Sunchi Reef show the evidence of the Indo-Portuguese maritime trade and are the oldest wreck observed so far in the nautical archaeology of India.

**Keywords:** Shipwreck, Marine trade, Portuguese, Goa, Findings, Shipbuilding, Dutch

## Introduction

In recent times, thousands of shipwrecks have been located both in marine and fresh water as well as on land around the world. Shipwrecks are important to maritime archaeologists, historians, scholars and the general public to enhance their knowledge of maritime history, trade and cultural contacts from the material remains of the shipwreck sites. They are often referred to as 'time capsules'. In general terms, 'shipwreck' means 'material remains of the ship'. Exploration, excavation and research of a shipwreck, reveals the history of the ship, interactions with people, construction pattern and other achievements made before the accident. Shipwrecks are nothing but maritime casualties. After sinking, the deterioration of the cargo and ship starts, due to the presence of natural forces and marine organisms in the sea. However, it continues for a certain duration then diminishes slowly till it is disturbed by the researchers or amateur divers; then further deterioration starts once again. Countries bordering the seas and oceans have attempted to locate and excavate shipwreck remains with a view to reconstructing their maritime history, trade and cultural contact with other countries. Shipwrecks are the part and parcel of the underwater cultural heritage of the country. India is not lagging behind. The Marine Archaeology Centre at the National Institute of Oceanography (NIO), Goa has made considerable progress in this field. Shipwrecks have been discovered to date in Goa (Sila Tripathi, *et al.*, 2004; Sila Tripathi, *et al.*, 2003a), Lakshadweep (Sila Tripathi, *et al.*, 2001) and Tamil Nadu (Sila Tripathi, *et al.*, 2003b; Gaur *et al.*, 1997).

The Portuguese records housed in Goa State Archives, Panaji and India House, Lisbon, indicate the wrecking of numerous Portuguese shipwrecks in shallow waters off Goa with its treacherous reefs and sand-bars; in prevailing storms; or due to enemy fire.

Marine archaeological surveys to locate and document these shipwrecks have taken place in Goa waters since 1997.

A survey off Sunchi Reef unveiled the remains of what seems to be a Portuguese shipwreck and the findings include a brass barrel of a handgun, iron guns, an anchor, Chinese ceramics, Martaban pottery (stoneware), bases of glass bottles, elephant tusks, hippopotamus teeth, lead pipe fragments, a copper vessel and strip, stone bricks and dressed granite blocks.

Thermoluminescence dating of Martaban pottery, radiocarbon dating of ivory and comparative study of the iron anchor indicates that the shipwreck dates to the early 17th century. Artefacts from the Sunchi Reef shipwreck and other Portuguese shipwrecks such as the *Nossa Senhora dos Mártires* (1606) that sank off Lisbon, Portugal and the *Santo António de Tanna* (1697) that wrecked near Mombasa, Kenya, also showed similarities. The Sunchi Reef shipwreck is the oldest wreck found in Indian waters to date and its artefacts are representative of the Indo-Portuguese maritime trade.

### **Portuguese shipbuilding and shipwrecks in Goa waters**

After the arrival of Portuguese in India, a number of changes were noticed in the design and construction of ships along the western coast of India, e.g. the introduction of nails in joints and increased use of caulking (Deloche, 1996). Likewise, the Portuguese borrowed wood joinery technology from the traditional shipwrights of India. Originally, the Portuguese used oak and pine in the construction of their ships. These oak and pine ships were constantly subject to the attack of teredo and other marine organisms, resulting in the deterioration of the ship's timbers and relatively high maintenance costs compared to their longevity. However, the native shipbuilders of India used teak, which proved to be excellent timber for shipbuilding. Subsequently, the Portuguese understood the superiority of teakwood for ship construction and used teak extensively in the shipbuilding industry.

One of the objectives of Alfonso de Albuquerque who captured Goa in 1510 was to gain control of Goa's shipbuilding industry, which was one of the most prominent in India (Danvers, 1984). The Portuguese established several shipyards in Bassein (Maharashtra), Cochin (Kerala), Goa and Daman on the western coast of India. Goa alone had three shipyards situated on the bank of the Mandovi River. Well-known ships that were built in Goa are the *Santo António de Tanná*, *naus Cinco Chagas* and *São João Baptista*, and galleons *Bom Jesus* and *Madre de Deus*. Portuguese records related to shipping and navigation mention that a number of ships were wrecked off the Indian coast between 1497 and 1612 en route from Portugal to Goa due to storms, shallow water, perilous reefs and lack of proper maintenance (Mathew, 1988). The exact location of these wrecks cannot be retrieved from the historic records.

In 1648, twelve Portuguese ships, en route from Goa to Calcutta (Kolkata), sank near Aguada Bay due to a fierce storm. In 1651, five Portuguese sailing ships namely *Santa Helena*, *Santa Joan*, *Evangelista*, *São Francisco* and *São Thomé* set sail from Portugal to Goa, but only two ships reached the coast of Goa and they were also wrecked in a storm on 10 March 1651. A Portuguese Pataxo (ship with two masts) *Santa Tereza de Jesus* was ready to sail to Bassein and Chaul in Maharashtra but wrecked in the sand-bar off Goa on 18 May 1658. Some cargo was salvaged and the other remains were robbed. A small bag containing precious stones, royal money and other goods

onboard the *Manoel Dias* went down in the sea. Majority of records indicate that a number of ships have been wrecked in the sand-bar of Aguada Bay (Gudigar, *et al.*, 1992; Gudigar, *et al.*, 1995–96).

### **The topography of Sunchi Reef**

Sunchi Reef lies in between Marmagao harbour and the promontories of Cabo headland (Fig. 1), which extends in north-south direction and separates Marmagao Bay from the Arabian Sea. The seafloor in the area is characterised by prominent submerged laterite rocky bed with prominent flat surfaces with sandy patches. At places the height of the laterite shoal is more than 3 m. In the Sunchi Reef region the ebb current is 3 knots whereas the spring tide is 1.5 knots.

The river Zuari flows into the head of Marmagao Bay through a constricted passage and discharges a huge quantity of sediment especially during the South-west monsoon. During the South-west monsoon (rough weather) the wave height reaches up to 2–3 m in the Sunchi Reef region. The comparison of the bathymetric charts of 1881 and 1976 show that Sunchi Reef and the adjoining area are not very conducive for sediment deposition. The sediments collected from the sand patches represent coarse-grained shelly sand. Big boulders also occur in the area and their height is about 4 m; crevices of various sizes are noticed on the laterite boulders. Archaeological artefacts are found in the crevices of the laterite. Visibility of the working site depends upon the tide and state of the sea conditions.

### **Location of wreck site, survey and exploration**

The Sunchi Reef shipwreck was discovered in 1988 by local divers, and followed by a preliminary survey the same year. Subsequent archaeological investigations have taken place from 1997 onwards. The Sunchi Reef shipwreck is not shown on hydrographic charts nor has any reference been found to the ship's wrecking in the Portuguese archives. The wreck remains are scattered over the reef in a large area roughly 800 m<sup>2</sup> where water depth ranges from 3 to 6 m depending on tidal variations. During ebb tide, the velocity of currents on the reef is stronger which hinders survey work and reduces visibility. The shipwreck remains are overgrown with white and orange coloured gorgonians and green mussels, and at places covered with a fine layer of silt and coarse sand. The surveys in Goa waters were usually performed between November to March because of favourable sea conditions and clear visibility. Diving and survey documentation, such as shooting underwater footage with a video camera, were carried out from a fishing trawler or big canoe that was rented. Due to the shallow depth of the site, all diving was done by using regular scuba while surveying, each dive lasting for more than one hour. Sometimes the duration of diving was extended depending upon the nature of the work and weather conditions.

During visual survey specific attention was paid to the distribution of artefacts, ceramic sherds, granite blocks and other cargo remains on the seabed. Sometimes, hand-fanning was used to expose the buried artefacts in the sediment. The artefacts were mapped by taking their positions with a GPS, and the smaller artefacts were recovered from the seabed for study and analysis. However, more emphasis was put on a non-invasive survey than an archaeological excavation because of the complicated nature of the site and widespread remains of the shipwreck over the reef. In addition, investigation of the rock outcrops, the natural topography of the seabed in the region,

movement of sediments, direction and strength of currents on the reef were ascertained. After a preliminary investigation of the artefact distribution, they were mapped and documented.

## Findings

The archaeological surveys of Sunchi Reef yielded iron guns, an iron shot, a brass barrel of a handgun, an iron anchor, elephant tusks, hippopotamus teeth, storage jar fragments, sherds of Chinese ceramics, bases of glass bottles, a door knocker, lead piping material, a copper vessel, and strip and dressed granite blocks. They were recovered after an extensive and thorough search. The guns and anchor were lying on the laterite and a prolific growth of marine organisms was noticed on them. The descriptions of the finds are as follows.

### ANCHOR

A spindly iron anchor with a long shank, presumably belonging to the ship, was observed on the north side of the guns. This type of anchor was used extensively by the Portuguese both in naval and merchant ships from the 16th to 18th centuries. The discovery of the anchor excludes an Indian origin for the ship. Generally, ships carry a number of anchors but only one anchor has been found to date on the Sunchi Reef shipwreck. It is not known whether the ship carried more than one anchor at the time of her sinking.

The anchor is 3.10 m in length and its shank is fully exposed, whereas its arms are partially covered by laterite boulders. The anchor's stock is not preserved and its wood is likely to have decomposed over time. In addition, the anchor ring, used for securing the cable, is no longer present. One fluke is exposed and measures 1.10 m in length. As the anchor is heavily concreted and overgrown with barnacles and other marine organisms, it is not possible at present to conclude whether the anchor was coated with a film of lime to prevent corrosion and activity of marine organisms. A lime coating did preserve a similar type of anchor found in the Aguada Bay. The size and shape of the Sunchi Reef anchor are similar to those of the anchors found in Aguada Bay, and two examples on display in the Archaeological Museum in Old Goa (Sila Tripathi *et al.*, 2003c).

### ARMAMENTS

From the early 17th century onwards, numerous naval battles were fought among the European powers to gain control over resources in the Indian Ocean. Most of the ships were armoured to counter pirate attacks, hostilities by local rulers and other unforeseen dangers.

Four muzzle-loading iron guns were found during the Sunchi Reef shipwreck survey in close vicinity of one another (Fig. 2). The length of each gun is approximately 200 cm. The muzzles of two guns are facing towards the seabed in a slanted position whereas the other two are lying parallel to the seabed. The guns are heavily concreted and overgrown with barnacles and mussels, hence the monogram, symbols and other identification marks cannot be determined. These guns have trunnions on each side of their bore, a cascable on their aft end and no dolphin-shaped handles or rings. It appears that the guns have two reinforcements and the chase. It was observed during

exploration that all four guns are identical and belong to the 17th and 18th centuries. More thorough study may be conducted in the future if these guns are raised from the seabed and conserved.

To the west side of the guns, cast iron shot was found and subsequently brought up. This shot has a flat base, is slightly conical at the top, and its surface texture irregular. The diameter and weight of the shot are 0.095 m and 1.218 kg respectively. Using the radius of the shot (4.77 cm) the original weight would be roughly 3.3 kg. The iron shot could have been a four pounder.

Further explorations in the region revealed a brass barrel of a handgun (Fig. 3), which was trapped and partially buried underneath the dressed granite blocks. The gun is partly concreted and overgrown with marine organisms. It measures 0.56 m in length and weighs 2.2 kg. The diameter of the gun's calibre is 0.04 m. It has a muzzle astragal 5 cm from the forward end of the muzzle moulding. The thickness of the gun tapers slightly from the cascabel towards its muzzle. Its vent, at the aft end of the gun, is threaded for attaching a firing mechanism. The barrel has two fastening holes to which the gun was once attached. The trigger, firing mechanism and other parts attached to the barrel are missing and have not been found in the vicinity of the gun.

A small chip was cut from the aft portion of the barrel to know whether the handgun was made of either brass or bronze. This flat piece was cleaned in the Oscar Ultrasonic for removal of dirt then analyzed using Energy Dispersive X-ray Analysis (EDS) equipment attached with a Scanning Electron Microscope. The chemical analysis showed dominantly, copper and zinc (Table 1 and Fig. 4) with minor varying amounts of iron (Fe), lead (Pb) and also small quantities of chromium (Cr). The presence of a higher percentage of copper (Cu) and zinc (Zn) indicates that the barrel is made from brass.

While copper and zinc dominated the composition, even in this small piece of metal, the contents of iron, lead and chromium varied considerably indicating that the process of manufacturing this alloy was not perfect, homogenization of the entire gun could not be achieved. The lead could also have been material introduced from the gunpowder used in the barrel.

Oxide	Spot 1	Spot 2	Spot 3	Spot 4	Spot 5
Cr <sub>2</sub> O <sub>3</sub>	01.08	n.d.	n.d.	n.d.	n.d.
Fe <sub>2</sub> O <sub>3</sub>	20.41	07.33	02.35	0.74	0.90
CuO	46.56	52.72	52.99	55.55	55.55
ZnO	31.95	39.95	40.12	39.97	39.09
PbO	n.d.	n.d.	04.54	03.75	04.47
Total	100.00	100.00	100.00	100.00	100.00
n.d.=not detected					

Table 1. Chemical composition of the barrel of the handgun found in Sunchi Reef.

## CAULKING

Caulking is an important addition that needs to be applied with utmost care, in particular to vessels destined for overseas maritime trade and naval activities. The traditional shipwrights of India generally would caulk the planking of their vessels with oakum. Nonetheless, Ludovico Varthema (1470–1510), who visited India, mentions that the shipbuilders of Kerala, on the western coast of India, did not use oakum but had a manner of joining planks so skilfully that water did not seep through (Mookerji, 1912).

The Sunchi Reef shipwreck survey has brought to light a flat shaped copper strip, three fragments of lead and part of a lead pipe that measures 0.375 m in length and 0.36 m in diameter (Fig. 5). Out of these fragments, two are 'L' shaped and the other one is plain. These small sheets do not have any holes meant for nailing. However, they have teeth-like projections at one side only, which suggests they were probably used for pipe joinery. Marine growth is present on all of them. These are in a very fragile and worn condition. The lead pieces are used as cladding material. The lead sheets are used on the hull to protect the vessel from the attack of teredo, leakages and to prevent damage after hitting rocks and coral reefs. Only one flat-shaped copper strip has been found to date, which is twisted and has a cut, probably from a nail that was fixed on it. The surface of the strip is uneven and the thickness is not uniform throughout. Copper strips might have been placed at some joints of ships. The lead pipe has some square holes, which are twisted and worn. Probably lead pipes are used to drain the water away from the decks. Lead sheets and strips have been recovered from the *Nossa Senhora dos Mártires* 1606 off Lisbon (Castro, 2001).

## CARGO OF THE WRECKED VESSEL

### *Elephant tusks and Hippopotamus teeth*

Eight elephant tusks of different sizes ranging from 0.65 to 0.32 m in length have been recovered from the site. These tusks were buried in the coarse sand and covered with dead shells. Only small portions were visible in the seabed. Out of eight tusks two are inscribed: one has 3 letters namely 'ICM', out of which 'CM' is visible clearly and the first letter 'I' has been eroded (Fig. 6). This could possibly be an acronym for a firm and/or a business man. The second tusk has some geometrical designs. These tusks, having been underwater for a long duration, have become soft, brittle, flaky and highly degraded.

Similarly, nine different sizes of hippopotamus teeth (0.535, 0.385, 0.205, 0.16 and 0.125 m in length) (Fig. 7), partly buried in the seabed, were recovered near the guns. All the hippopotamus teeth are canines and hence they are curved. No incisor teeth, which are straight, were found in the exploration. The glazed coating, which is present on the outer surface, is the enamel and the hard substance (ivory) on the inner side is the dentine. Originally the teeth are white but due to the length of time underwater have turned brownish. Marine growth is also present on these teeth.

## CHINESE CERAMICS

The exploration yielded Chinese ceramic sherds consisting of bases, rims and a lid, which are of medium fabric. Blue on white paintings are present both on the inner and outer sides of these sherds. A base and a sherd with green decoration on white, on

the inner side, have also been recovered. A number of bases have been collected. Among them, a few are plain and the rest have blue on white decoration. Chinese characters are present on two base sherds: on one sherd the character reads as 'lucky jade' but the age is not specific; whereas on the other, the Chinese characters are present (Fig. 8 a-b), but the character is illegible (Roxanna Brown, 2005, pers. comm.). The other sherds have paintings on both inner and outer surfaces. Base sherds belong to jars, plates and bowls. Some bases of jars have a raised ring (footrim) and others are without footrim. Besides, a small broken lid has been recovered which has blue on white decoration on the outer surface and a plain inner surface. The knob of the lid has floral designs (Fig. 9). Marine growth is present on all sherds. The majority of Chinese ceramic that have been collected are broken and not a single intact jar, bowl or a plate have been found during exploration. They resemble types of Chinese ceramic sherds that have been found in Old Goa. The decoration on these sherds includes lotus flowers, pomegranates, pine trees, hills and mountains. The symbols painted on the ceramics generally belong to the Chinese traditions, folklore, mythology and history.

## STORAGE JARS

The survey brought to light a number of storage jar sherds, which were lying in the crevices of laterite. The shapes include rims, bases, lids and body parts belonging to jars of different shapes and sizes. These sherds are well fired and are comprised of medium to thick fabric. Due to long exposure to seawater, the paint and glaze has been washed out on some sherds while other sherds still have the dark brown glaze coat. Further, they do not show any spalling, cracking or other defects despite a long burial time in the marine environment. Recent exploration yielded a shoulder fragment of a brown-glazed storage jar stamped with Chinese character (Fig. 10) but it is illegible. Most of the storage jar bases have distinct string marks (Fig. 11).

Some of the rims have horizontal and other have vertical loop handles. The recent exploration has brought to light a high neck jar with vertical loop handles and linear designs around the neck. This type of rim was found for the first time from the Sunchi Reef (Fig. 12). Vertical loop handles are bigger and more prominent than the horizontal loop handles. Some horizontal loop handles are smaller and prominent whereas others are thicker and less prominent. Besides rims and bases, body sherds were recovered that show dark brown glaze and linear designs. From the shape and size of the rims it appears that these jars were made for different purposes, or manufactured by different makers. On the basis of the findings, the pottery bases, rims and body sherds can be classified into two groups: (i) stoneware; and (ii) low-fired stoneware.

The exploration has so far yielded three types of rims namely:

(a) low-fired stoneware with dark brown glaze, horizontal prominent loop handles, without raised dots, without neck, medium mouth and large size jars;

(b) raised dots, small horizontal loop handles, with small mouth, high neck, medium size jars; and

(c) raised dots, prominent vertical loop handles with dark brown glaze, wider mouth, high neck, and medium size jars.

Among the collected sherds the majority belong to stoneware having raised dots around the neck and body. Ropes are tied to the loop handles during transportation, which provides greater balance and stops breakages of the jars.

#### COPPER VESSEL

The exploration brought to light a very fragile copper vessel (Fig. 13), which is trapped in the laterite. The vessel has been twisted and some portion is missing. It is made out of a very thin sheet of copper without using any rivet, and it does not have designs or marks on its surface. The distinctive carination is present below the neck. It has a wider mouth and small height. Its particular use on board is yet to be ascertained but it could have been used for various purposes.

#### BASES OF GLASS BOTTLES

A number of broken glass bottle bases (Fig. 14 a–b) found scattered over the wreck site were recovered. All the bases and pieces of glass bottles are extremely dark green in colour. Out of these bases, sixteen have a conical shaped push-up, are round in shape, with a base diameter of 0.28 m; and twenty, square-shaped bases were recovered, measuring 0.085 x 0.085 m, all identical in shape and size. The recent explorations have yielded stamped square bases: one base is stamped on the inner side and is illegible, whereas on another a geometrical design is on the outer side. The majority of the square bases have distinct pontil marks. None of the round bases have pontil marks. Some of the round bases have a deep push-up while in others it is shallower. Marine growth is present on the pieces. The square bases are thinner in section compared to the round ones. Similarly, previous exploration has yielded a full bottle with broken rim having a round base stamped with 'A 0751' inside the push-up. This could be either the maker's mark or the serial number of the concerned firm. On the basis of the stamped mark this bottle appears to be of later period and possibly from a later shipwreck. Unbroken, square-based ('case') glass bottles *have* so far not been recovered from the site. It appears that olive oil, spirits and wine were being imported in these glass bottles. However, the greatest quantity of wine was imported in wooden casks.

#### BRICKS

The underwater exploration yielded three well-fired clay and four stone bricks which are square and rectangular in shapes (Fig. 15 a–b). These are nicely trimmed from all four corners. All are intact but profuse numbers of holes are present on the clay bricks. The clay bricks measure 15 x 10 x 3 cm, 11 x 11 x 4 cm and 10 x 10 x 3 cm respectively. Out of four stone bricks, two are intact and the other two are broken. Of two intact, one is square (10 x 9.5 x 6 cm) and other is rectangular (22 x 8.5 x 5 cm). The raw material appears to be sandstone. The two broken bricks are flat, thin and different in size; the raw material appears like slate. All these bricks belong to a metamorphic group of rock. One of the possible uses of bricks could be for furnaces for cooking on board.

#### GRANITE STONE BLOCKS

A large number of rectangular and square finely dressed granite blocks of different in sizes were found lying at random on the seafloor (Fig. 16). It appears that there could have been about 250 granite blocks, which probably served both as cargo and ballast.



Some blocks are more than 2 x 0.40 x 0.10 m in size. Most blocks have fallen in the crevices of the laterite boulder and are concentrated in and around the guns. These blocks can be categorised under four groups based on their sizes: 200 x 40 x 10 cm (232 kg); 190 x 35 x 15 cm (289 kg); 125 x 35 x 15 cm (190 kg); and 75 x 35 x 12 cm (91 kg). The estimated weight of the above granite blocks have been calculated on the value of 1 cubic metre of granite equals 2 900 kg. The X-ray diffractometry (XRD) (Philips PW 1840) analysis of the rock sample shows the presence of quartz and feldspar as dominant minerals and corresponds to granite.

## Discussion

No documentary evidence has so far been found on the Sunchi Reef wreck which could have provided some more information on the ship. The information on this wreck was provided by the local fishermen. During the Portuguese regime, Old Goa was the capital, port and main trade centre of Goa. Ships coming to Old Goa used to cross the River Mandovi to reach Old Goa port. The sand-bar near Aguada Bay at the confluence of the River Mandovi has caused a number of Portuguese ships to ground. Sunchi Reef is not far away from the sand-bar of Aguada Bay. The captain of the ill-fated ship might have thought of sailing the ship into the River Mandovi through Sunchi Reef instead of following the normal route. Though the cause of the wreck still remains mysterious, the possible reasons for the shipwreck of Sunchi Reef could be due to either of the following: (i) inadequate knowledge about the sea bottom topography of the region; (ii) the non-availability of navigational charts of the region showing the submerged rocks, shoals and reefs; and (iii) grounding of the vessel on the shallow submerged rocks because of human error in navigation.

The height of the laterite cliff near the gun is less than 4 m and the current action during low tide in the region is very strong. Except for a thin layer of silt and sand not much deposit of sediment was noticed on the guns, granite blocks and iron anchor; however growth of green mussels was noticed on them during recent exploration. The potsherds, glass bases and other remains are preserved as these were lying either below the laterite boulders or within the crevices, and sometimes buried in the silt and sand.

As the ship wrecked in rocky and shallow waters, the perishable material may have decomposed and subsequently disintegrated. The light material such as glass bottles, tusks, ceramics etc. was scattered over the region, and some of these artefacts have been retrieved for study and analysis. Heavy material, however, namely the guns, granite blocks and iron anchor are lying *in situ* in their original location.

The stoneware sherds raised from Sunchi Reef shipwreck are remnants of jars that could contain both solid and liquid contents. All the rims of the jars have loop handles to tie a rope and the base has a distinct ring (footrim), which gives greater balance during transportation. Oils, water, food grains and other perishable material were transported in these jars. Similar kinds of sherds and jars have been reported from *Nossa Senhora dos Mártires* off Lisbon (Francisco, *et al.*, 1998), *Santo António de Tanná* off Mombasa (Willoughby, 1991; Piercy, 1981; Sassoon, 1981; Moore, 1970) and the VOC *Risdam* wreck off Malaysia (Green, 1986). For better preservation of eatables wooden or clay lids were sometimes provided to close the mouth of the jars (Desroches, 1998). Even, the square glass bottle bases resemble the glass bases found on the *Santo António de Tanná*.

Comparatively, the quantity of stoneware sherds found outnumber the Chinese ceramics. The Chinese ceramics appear to have been used daily on board because if they had been part of the cargo then a larger quantity of sherds would have been found in the course of exploration. The glass bottle bases indicate that olive oil, spirits and wine were imported from Portugal to Goa and other places India. The hippopotamus teeth and ivory were either imported from Mozambique and other African countries to Goa, and from Goa they were sent to Gujarat for carving sculptures and making handles, chess pieces, dice, and so on. Finally, the finished artefacts were sold in Portugal and her colonies. The marks on the ivory could be the dealer's mark. These were items of trade, hence these could be a small part of the cargo of the ill-fated ship. The size and shape of the iron anchor resembles the anchors kept in the Archaeological Museum in Old Goa and found in Aguada Bay. Generally these iron anchors used to have wooden stocks, however the stock of the anchors of Sunchi Reef and Old Goa are missing. The iron anchor, which was retrieved from Aguada Bay has a wooden stock. The anatomical analysis of wood indicates that it belongs to the *Tectona grandis* species for which the trade name is teak (Sila Tripathi, *et al.*, 2005). These anchors are datable to the 16th–18th centuries and resemble the 'Admiralty Pattern Long Shanked' type of iron anchor (Sila Tripathi, *et al.*, 2003c). Granite blocks are lying randomly on the seabed. It appears that these dressed granite blocks initially fell on the rock and in the course of time slipped down and fell into the crevices of laterite. These blocks could be the main cargo of the ship and also served as ballast.

The exploration has yielded a limited quantity of glass bottles, elephant tusks and hippopotamus teeth, pottery, Chinese ceramics etc.; hence the mystery remains as to what could be the main cargo of the ship? It appears that the granite blocks could be the main cargo and the other findings are the part of secondary cargo. The granite blocks might have been brought to Goa for various constructions such as making the steps, facades and flooring of the churches, buildings and decorative objects, and art pieces. On the basis of the weight of the granite blocks the carrying capacity of the ship could be around 600 tons. Probably, further research on this wreck would be able to provide more information on the issues unknown at present. However, on the basis of the radiocarbon date of ivory, thermoluminescence date of a storage jar (360± 40 years old), and date for the iron anchor, it would appear that the wreck could be dated to the early 17th century and belongs to the Portuguese period. Furthermore the shipwreck findings are the evidence of maritime trade between India and Portugal.

During recent exploration a highly eroded an iron anchor, an iron rudder, timber affected by teredo, some wine bottles, roof tiles, including iron pieces were noticed in the adjoining area belonging to a later period wreck. These appear to be contaminants of another wreck which certainly affect the dating the original wreck findings.

The question arises as to why the Sunchi Reef shipwreck could not be a Dutch shipwreck? The probable answer, could be 'no' because during the 17th century several naval battles had been fought between the Portuguese and the Dutch either outside the Aguada Bay or at the entrance of the River Mandovi, but not at Sunchi Reef. Both nations had lost their ships in the naval battles. Generally, battles were fought at such locations where the attacker could flee after damaging the enemy ships, and for this purpose Sunchi Reef is not at all an ideal place. Secondly, if it was a naval ship, it would have carried more armament than simply four guns, one iron shot, a handgun and granite blocks. Further, if the ship had been wrecked in a naval battle it would have sunk either off Aguada Bay or in Mandovi River, not at Sunchi Reef. Ships cannot come from

either of these sites to Sunchi Reef because the adjoining area is full of rocks. Our arrival at the conclusion that this wreck was a Portuguese ship is based on the fact that it was carrying granite blocks and very few guns, portraying the fact that it was not a naval ship. If it was a Dutch ship as some would perceive than what would a Dutch ship be doing so far away from her port and fighting in enemy water? The Dutch had absolutely no trade dealing in Goa; the only place of refuge for the Dutch was Vengurla in the north of Goa and Cochin in the extreme south of India.

## **Conclusion**

Due to non-availability of archival information, it is not possible to state whether the ship was built in India or not, so too its name, name of the captain, whether all the crew on board died or survived. Similarly, no timber remains of the wrecked ship have so far been noticed, hence its construction pattern and other details remain obscure. The exact cause of the loss of the ship remains unidentified, but the results of the survey leave a number of possibilities open, which can be taken into consideration. The findings indicate that the ship was a cargo vessel rather than a naval ship, and it could be the one of the Portuguese ships that were wrecked in Goa waters.

Sunchi Reef wreck is the oldest wreck in Indian waters and the first Portuguese wreck to be explored and detailed. The wrecked ship of Sunchi Reef was a wooden-hulled cargo sailing ship. As the ship was wrecked in the rocky area survival of perishable and light material is ruled out. The waves and currents might also have washed out the timber, other parts of the ship and some antiquities. Except for the granite blocks, hippopotamus teeth and elephant tusks no other cargo has so far been found.

The Sunchi Reef shipwreck findings are the indicative of the trade and commerce between Goa and the Portuguese empire as mentioned in the literature. Shipwrecks prior to the Portuguese period have not been located in Goa waters, hence the present findings are breaking new ground in the field of nautical archaeology of India in general and Goa in particular. Further, the Sunchi Reef explorations have opened a wide scope to undertake explorations of unknown wrecks because Goa has a rich potential for shipwreck archaeology in India. If further investigations could shed new light on the origin and date of the wreck this would be an additional step forward.

## **Acknowledgements**

The authors are thankful to the Director of the National Institute of Oceanography and K.H. Vora, Scientist-in-Charge for their encouragement in this field. Sincere thanks go to Prof. Roxanna M. Brown, Southeast Asian Ceramic Museum, Bangkok University for identifying the Chinese sherds. Thanks are also due to our colleagues namely to Vijay Khedekar for EDS analysis and to S.N. Bhandodker, S.B. Chitari and G.R. Desai for their co-operation in the field and completing the paper, to Sheikh Ali for digital photographs. This is NIO's contribution No: 4082.

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Fig. 1

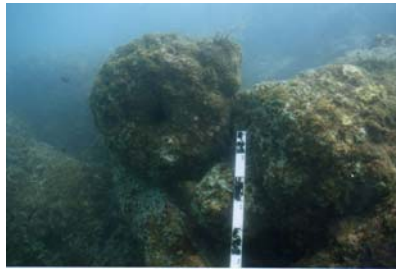


Fig. 2



Fig. 3

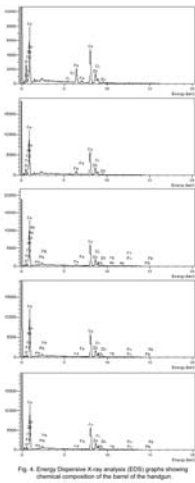


Fig. 4 Energy Dispersive X-ray analysis (EDS) graphs showing chemical composition of the sample of the handgun.



Fig. 5



Fig. 6



Fig. 7



Fig. 8a



Fig. 8b



Fig. 9



Fig. 10



Fig. 11



Fig. 12



Fig. 13



Fig. 14a

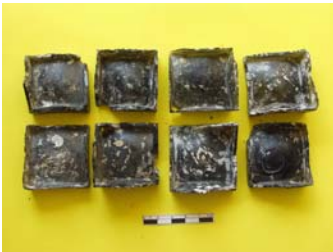


Fig. 14b



Fig. 15a



Fig. 15b



Fig. 16