THE SURVEY of the V.O.C. FLUIT RISDAM 1727 MALAYSIA

by

JEREMY N. GREEN

and

E.V. GANGADHARAM

1985

REPORT DEPARTMENT MARITIME ARCHAEOLOGY
WESTERN AUSTRALIAN MUSEUM : No. 25

The Survey of the V.O.C. *fluit Risdam* (1727), Malaysia

Jeremy N. Green
Department of Maritime Archaeology
Western Australian Maritime Museum
Fremantle

with
A Geological Report on the Wrecksite

by
E.V. Gangadharam
University of Malaya and Muzium Negara
(A report submitted to the Muzium Negara)

Report Department of Maritime Archaeology
Western Australian Maritime Museum: No. 25
1985

GEOLOGICAL REPORT ON THE WRECKSITE OF THE DUTCH SHIP *RISDAM* (1727), PENINSULAR MALAYSIA

E.V. Gangadharam

FIGURE CAPTIONS

The Survey of the V.O.C. *fluit Risdam* (1727), Malaysia

Jeremy N. Green

A. INTRODUCTION

On 6 May 1984 a vessel was intercepted by the Royal Malaysian Customs while engaged in looting a wreck site near Mersing, State of Johore, Peninsular Malaysia. This was the first public announcement relating to the wreck site which is now thought to be the *Risdam*. There followed a brief expedition to the site by the Muzium Negara and a Royal Malay Navy diving team, which recovered over 110 tin ingots, 40 elephant tusks and other material. Later, material recovered by the looters and impounded in Singapore, was returned to Malaysia by the Singapore authorities (five tin ingots and 61 elephants tusks).

In September 1985, this author was invited by the Muzium Negara to carry out a survey of the wreck site in order to confirm that the wreck was that of the *Verenigde Oostindische Compagnie* (V.O.C.) ship *Risdam* and to make recommendations regarding future work on the site. The expedition included staff of the Muzium Negara, divers and naval personnel from the Royal Malaysian Navy, commercial contract divers, together with Jo Buckee, Warren Blake and the crew of the *Four Friends* and Dr E.V Gangadharam, a geologist-geochemist of the University of Malaya in his capacity as Honorary Curator of the Muzium Negara. The survey, initially scheduled for a week, was subsequently extended to a fortnight. Professor Jaap Bruijn of Leiden University briefly joined the expedition for two days.

The objective of the project was not to carry out any major excavation work, but simply to determine the extent of the site, its state of preservation and its identity.

B. HISTORICAL BACKGROUND

The *Risdam* was built for the Chamber of Hoorn in 1713. She made two voyages to the Indies. The first departed for the Chamber of Amsterdam on 27 September 1714, arriving at Batavia 22 April 1715, with a total complement of 119 people. The *Risdam* returned to the Netherlands for the Chamber of Enckhuisen on the 16 January 1717, arriving in the Netherlands on the 30 July 1718, with a complement of 87. She again departed on 16 November 1718 and arrived 31 August 1719 in Batavia with a complement of 162 (Bruijn et al, 1979).

The vessel is described as a *fluit* of 130 *voet* (36.8 m) long and 100 *last* in the *Uitgezeilde schepen 8 November 1673 - 23 February 1796*. According to the records the vessel loaded tin at Ligor and then went to Ayutthaya on 29-30 November 1726(?) where she loaded sappanwood, barrels of ginger, 40 pots of *achar*, 30 pots of *klak* (possibly *kalk* or lime the "a" and "1" having been transposed, or alternativly *lak*) and 150 empty glazed pots (see below). The vessel left Ayutthaya in a leaking condition on 8 December. It was intentionally run aground on 1 January 1727, near Pulau Batu Gajah, to save the lives of the crew when the leak became substantial.

C. LOCATION OF THE SITE

The site is located 500 m north of Pulau Batu Gajah, near Mersing on the east coast of Malaysia (Fig. 1). Initially, some difficulty was encountered in relocating the site, because it had not been charted correctly and the buoy marking the site was not in the correct position. As a result, once the site was located, a number of methods of precisely fixing the position were made. These are described and illustrated below and should ensure that the site can be relocated easily in the future.

1. Topographical map

A copy was made of the topographical map of the area of Mersing (Series L8010, Sheet 119a, Scale 1:25,000) (Fig. 2), onto which this has been plotted the sextant and compass locations of the wreck site. Unfortunately, the Admiralty chart of the area (No. 769, 1:200,000) was not at a large enough scale to be of any great use in locating the position (Fig. 3).

2. Photographic transits

The most efficient method of relocating the site is to use transits. A visual transit is the coincidence of two features separated by a distance. In the area around the site there are a number of excellent transits including features of Palau Batu Gajah against Pulau Setindan (Fig. 4A, B, C, D, E, F, & G), Pulau Setindan against hills and features on the mainland, and Tanjung Selantai against other coastal features. Some of the offshore islands make good transits against Pulau Tioman, but the haze caused difficulties and therefore have not been included.

3. Compass bearings

Compass bearings were made to five points A, B, C, D and E (see Fig. 4A & B)

Point	Location	Magnetic
A	E side of P.Batu Gajah	171°
B	W side of P.Batu Gajah	194°
C	NW side of P.Setindam	235°
D	SW side of Tg Selantai	291°
E	E side of Tg Selantai	325°

4. Horizontal Sextant angles

A series of horizontal sextant angle measurements were made to the same features used in compass survey. These are expected to be more accurate than the compass angles since it is possible to read sextant angles to 1.0' of arc, whereas compass accuracy is only about 1°. The position was determined using an overlay tracing to give the most accurate fix. The angles observed are as follows:

AC	64° 14'
BC	41° 24'
CD	56° 21'
CE	83° 52'

5. Photo angle measurement

Using a specially callibrated 24 mm camera lens, a series of photographs of the coastal topography were taken. These were used to construct a photo angle plot which was then used to resection the site.

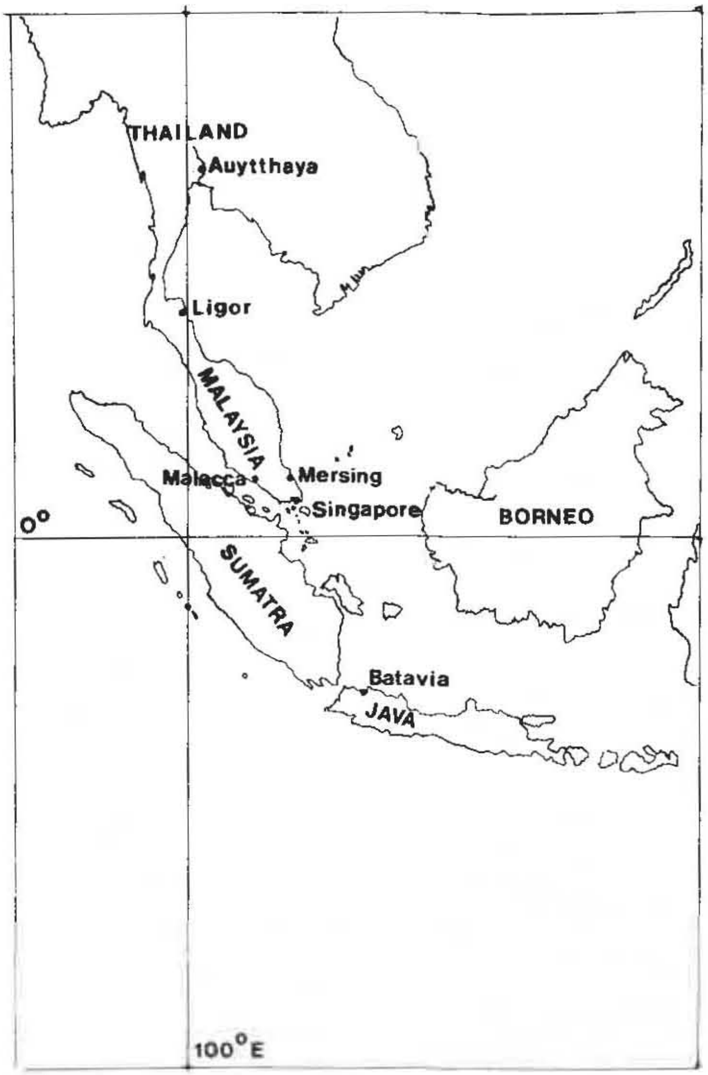

Fig. 1 Map of Southeast Asia

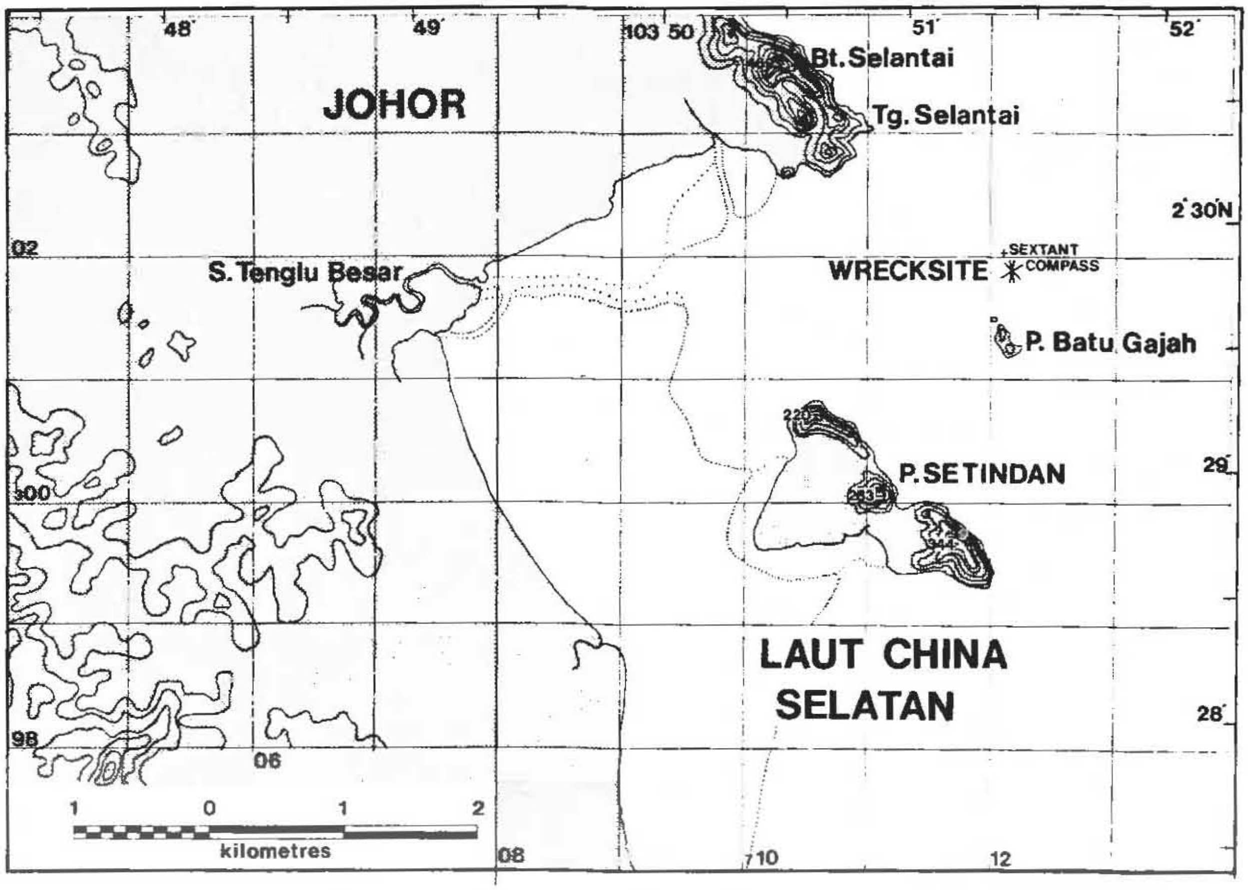

Fig. 2 Chart of wreck site area

6. Satellite navigation

During the two week period on the site, Warren Blake, master of the yacht *Four Friends* took a series of satellite navigation fixes. Whilst these are less precise than the angle measurements, the average of the readings gives an approximation to the latitude and longitude. A total of 28 fixes were made between 25 September and 4 October, the average of the latitude readings was 2° 29.72' N with a standard deviation of 0.24' and the longitude was 103° 51.25' E with a standard deviation of 0.33'. The instrument was a Magnavox MX4102 single channel SATNAV.

D. OUTLINE OF SURVEY WORK

Inspection of the area of seabed around the yellow spar buoy marking the site indicated that there were no visible traces of a shipwreck on the muddy bottom. Extensive probing in the area indicated that there was no buried remains up to a depth of 3 m below the surface in the general area up to 50 m around the buoy. Discussions with Navy personnel suggested that the site was further to the north. Therefore, systematic probing was started in an area well to the north of the anticipated position, along 400 m jackstays, running E-W. Probes were made every 3 m and the jackstay lines were separated by 20 m. Four jackstays were laid and probed, progressing southward toward Pulau Batu Gajah.

At 1700 on the second day (25 September) a local fisherman from Tanjung Selantai came and indicated the position of the site. Navy divers confirmed a positive probe contact and timber samples were found at about 1 m below seabed surface.

Because the survey yacht *Four Friends* (with the airlift) was only available for 2 more days, it was decided to airlift a shallow trench across the site. The objective was to expose the archaeological layer and investigate the nature of the site. Detailed survey work would then follow after the departure of *Four Friends*. A jackstay (pegs 1, 2 and 3, see Fig. 5) was laid across the site to indicate the extent of the initial probe contact. A narrow trench was run across the site from 3 to 2 and then from 2 to 1. Some structural timber was revealed notably Area A, see Fig.5.

Meanwhile, a systematic probe survey recorded the western extremity of the hull (pegs 4, 5, 6, 7, 8, 11, 14, 15, 16, 17, 18 and 19), Fig. 5. It was noted that there were a number of iron stakes, possibly left by looters, in the northern region of the site. Initially, the pegs were surveyed using a compass and tape to get an initial plan of the site. Later, a more accurate survey was made of all the survey pegs using three tape trilateration.

An exploratory airlift trench was made along the west side of the site. The airlift was used to uncover the top of the hull structure which had been found by probing between peg 4 and peg 14. This revealed part of the hull of the ship, with the tops of the frames, outer planking, sheathing and ceiling. The sheathing was 30 mm thick, the outerplanking 120 mm thick, the frames were 250 mm thick by 200 mm wide and the ceiling was 100 mm thick. It was noted that the ceiling lay at an angle of 60° to the horizontal. Heavy riders or chocks were noted in some places lying on top of the ceiling.

At this point (27 September) the *Four Friends* departed for Singapore. However, it was decided that she should return two days later to continue the survey. Meanwhile the pegs and exposed outline

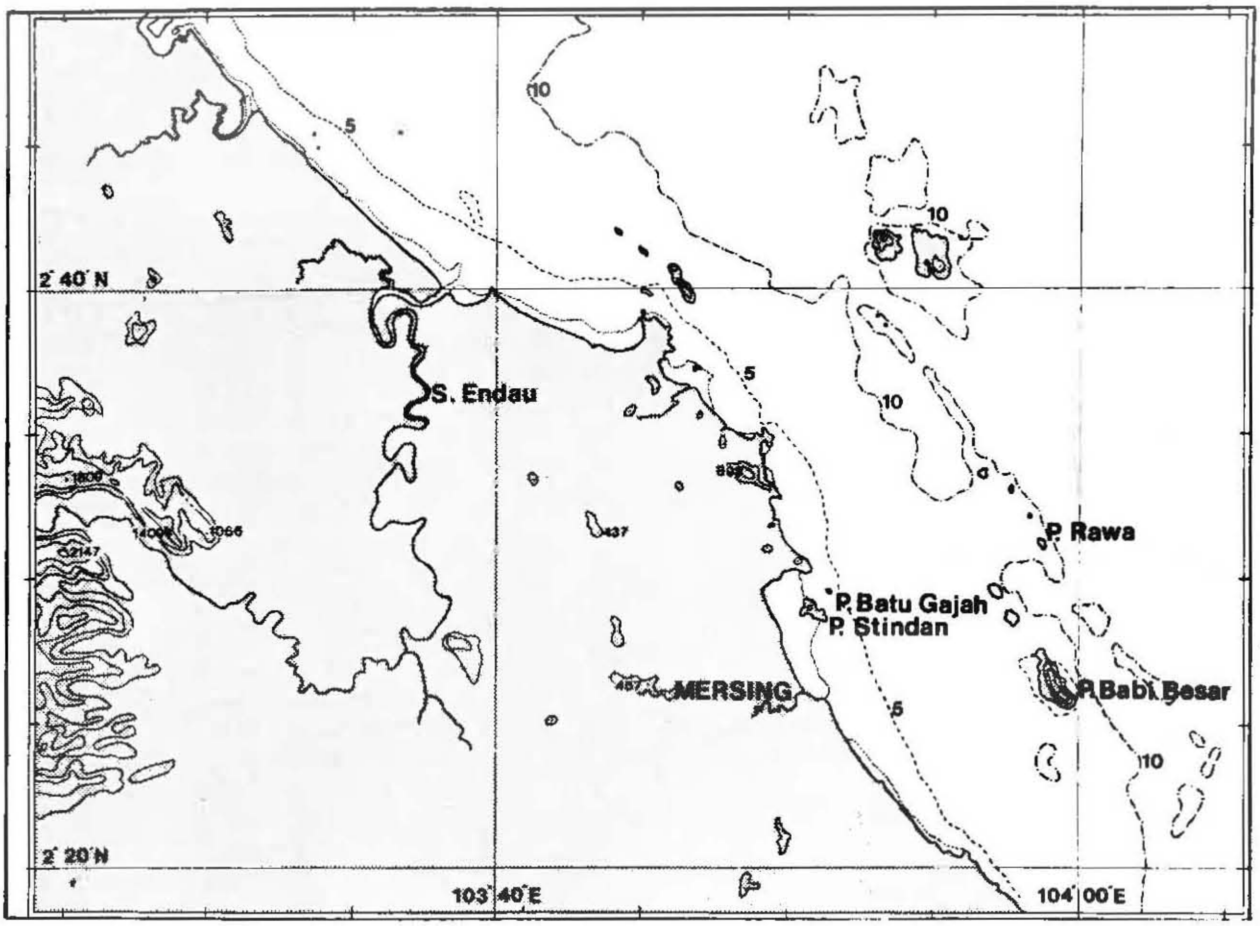

Fig. 3 Admiralty chart of Mersing area

Fig. 4A Photo transit S end P. Batu Gajah

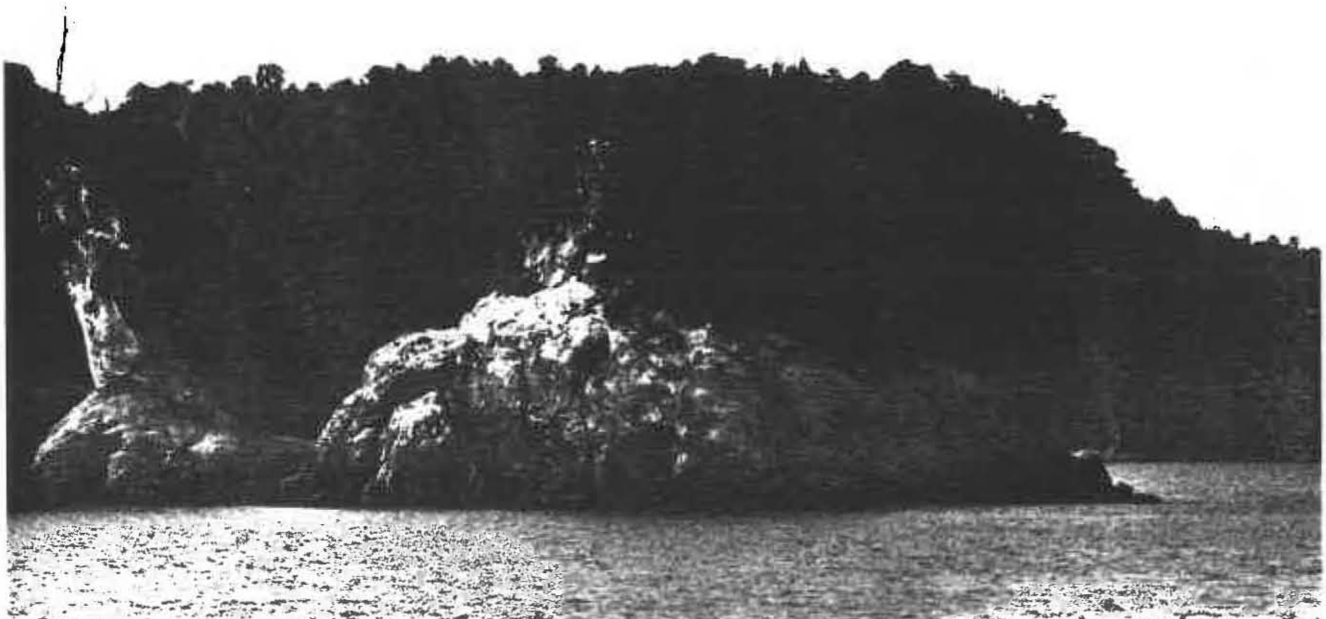

Fig. 4B Photo transit N end P. Batu Gajah

Fig. 4C Photo transit N end P. Setindan

Fig. 4D Photo transit E end Tg Selantai

Fig. 4E Photo transit coastal features N of Tg Selantai

Fig. 4F Photo transit coastal features N of Tg Selantai

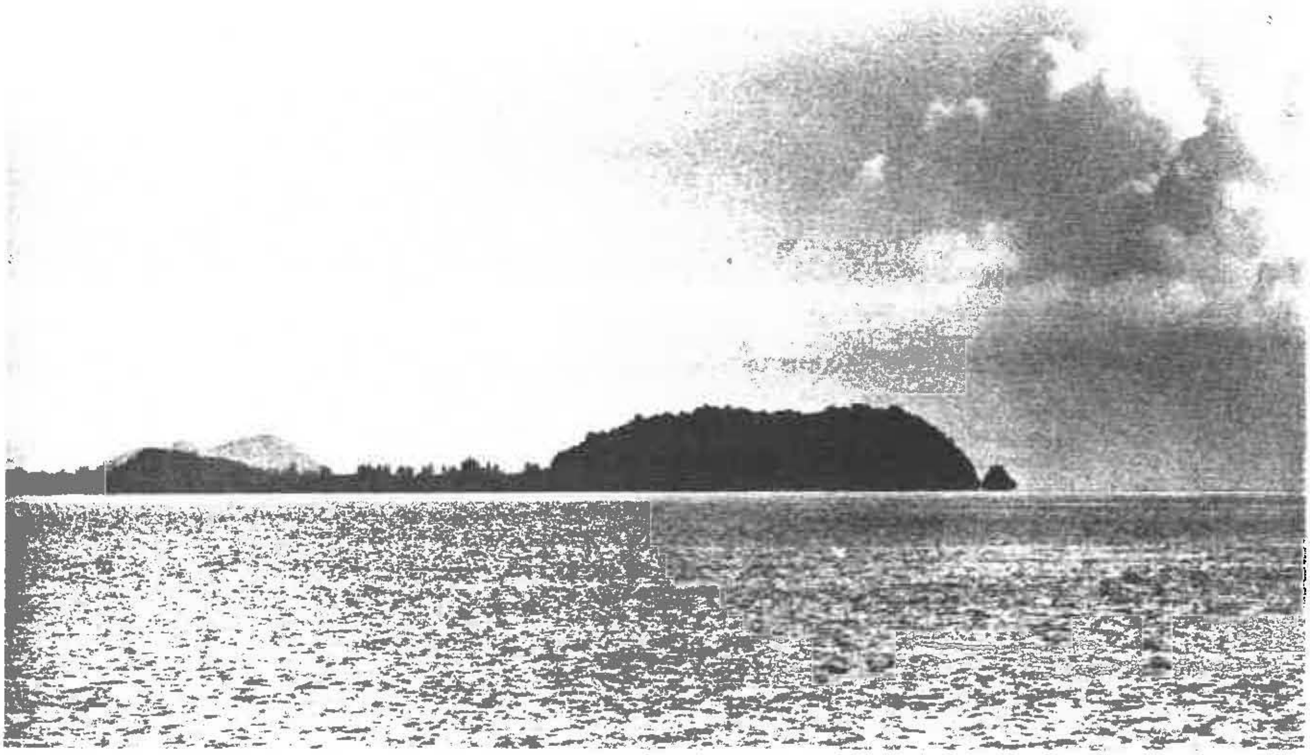

Fig. 4G Photo transit coastal features N of Tg Selantai

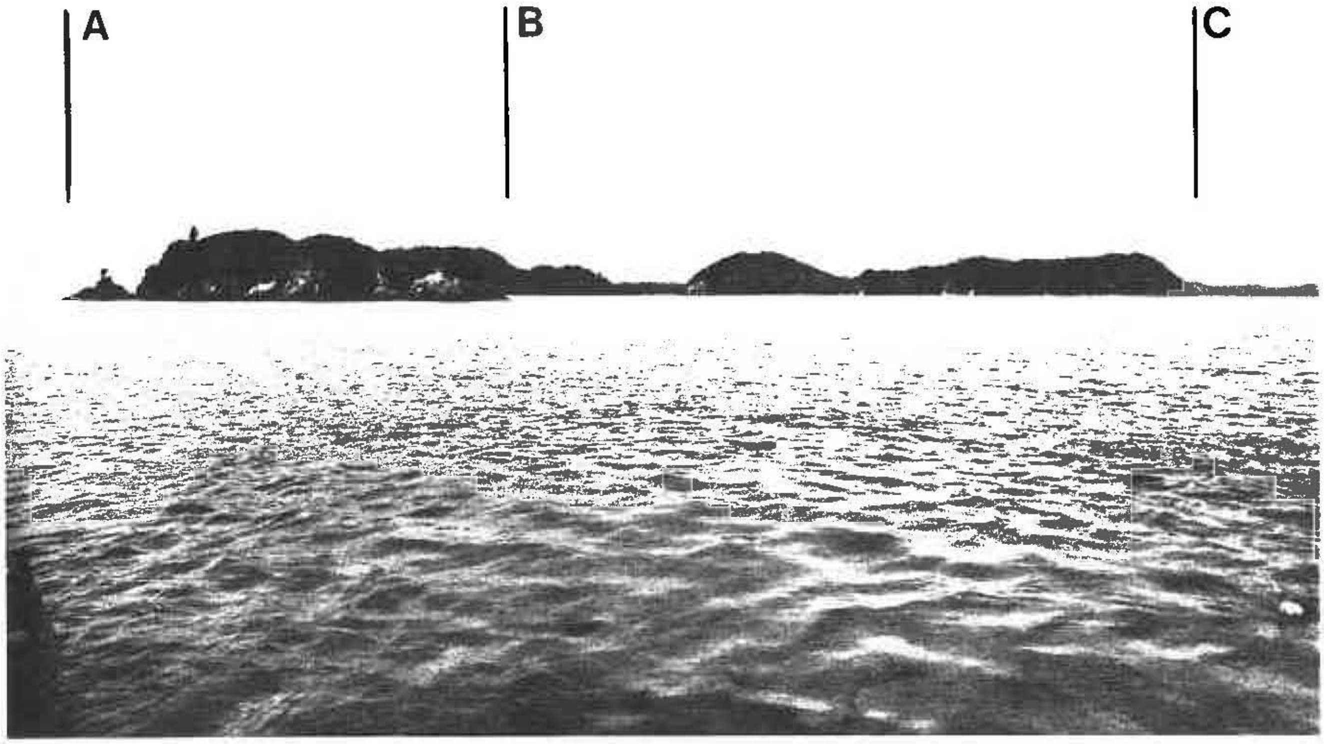

Fig. 4H Photograph showing sextant and compass marks

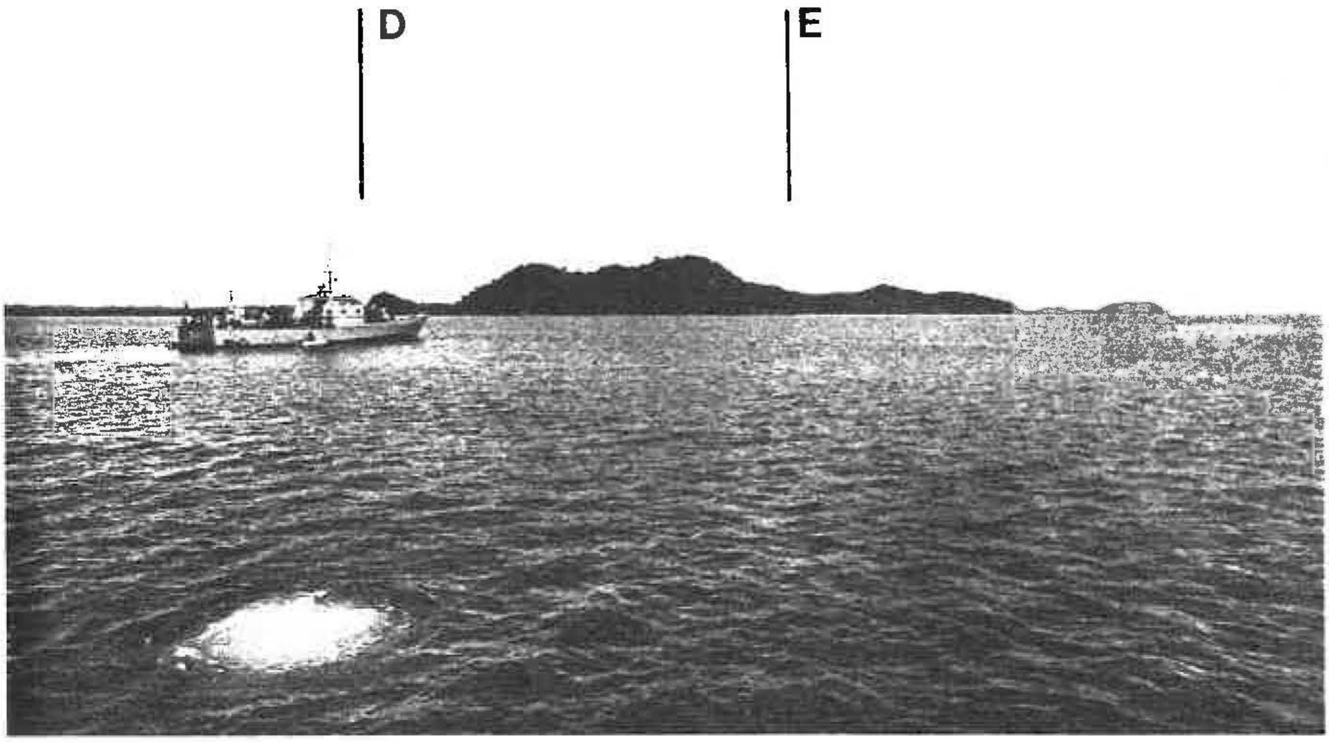

Fig. 4I Photograph showing sextant and compass marks

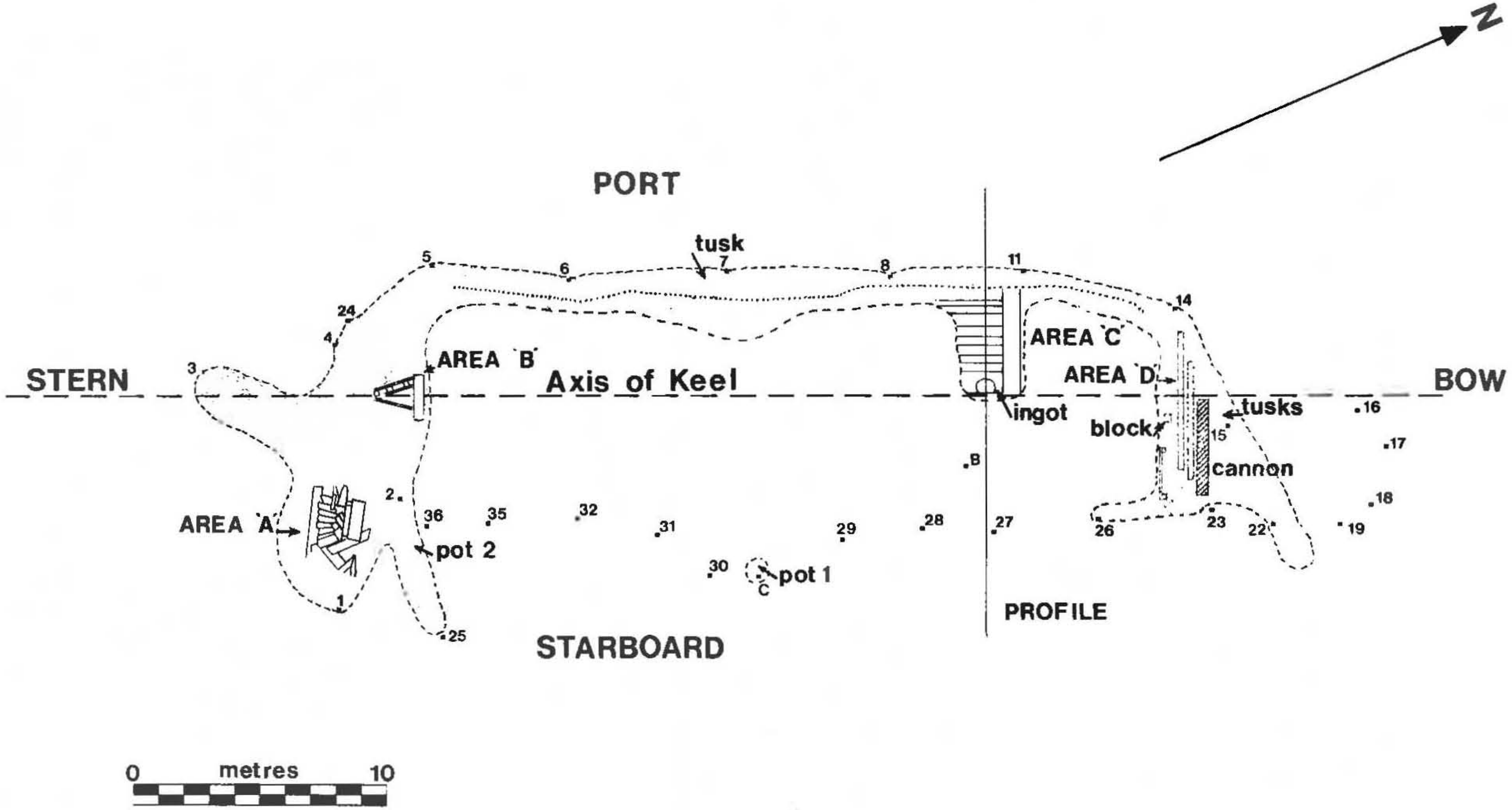

Fig. 5 Plan of *Risdam* site

of hull were surveyed using three point trilateration. The next objective, after the return of the *Four Friends*, was to determine the location of the bow and stern and the depth that the hull was buried under the surface of the seabed. Up to this point all excavation had been confined to removing the inert or sterile mud overburden to reveal the surface of the archaeological level.

Three test trenches were delineated. In the south a jackstay was laid from peg 24 to peg 25. In the middle of the site, near peg 11, heavy riders had been found; these served to guide an approximate midship trench. In the north a jackstay was laid from peg 14 to peg 23. Some airlift work was continued in area A to uncover hull structure.

Area A (Fig. 6)

Area A proved to be a section of hull structure that had collapsed and separted from the main hull. It is extremely complex and badly eroded. Whilst it is not exactly certain what part of the ship it belongs to, it may be connected with the stern structure.

Area B (Fig. 7)

Excavation of this area revealed two sets of frames converging to a point towards the south. It is thought that this represents the dead wood of the stern, very close to the sternpost. It is possible that the structure of Area A is closely associated with this area. The centre line of Area B gives the stern axis of the site.

Area C (Fig. 8)

A trench 5 m long by about 2 m wide was made across the site at the position of the rider-chock complex near peg 11. The objective was to excavate a profile across the site up to the keelson. The trench proved to be difficult to excavate because of the large quantity of wooden logs, presumably sappanwood, in the layer 1 m below the sterile mud. The keelson was located and a profile of the trench was made using a spirit-level and ruler to establish the levels across the ceiling. Individual ceiling planks were also measured, together with the thickness of the keelson and the details below the ceiling at the keelson (see Fig. 8). Next to the keelson a round hole mm in diameter was found. This is thought to be a pump hole which allows access to the bilge below the ceiling. The hole facilitated measurements below the ailing planking of the thickness of the ceiling planking frames and keelson; timber holes were noted in the frames next to the keelson, but were not measured. The depth of the keelson below the seabed was just less than 3 m. The thickness of the riders and chock have been indicated on the profile. In an attempt to estimate the amount of buried structure, the mirror image of the profile is shown on the other (eastern) side of the keelson. Projections of the amount of structure extending to the same depth on the starboard side are shown in Fig. 8. It was not possible to measure the width of the keelson at this point.

The survey clearly shows that the vessel is leaning at an angle of 15° to the starboard and suggests that the starboard side

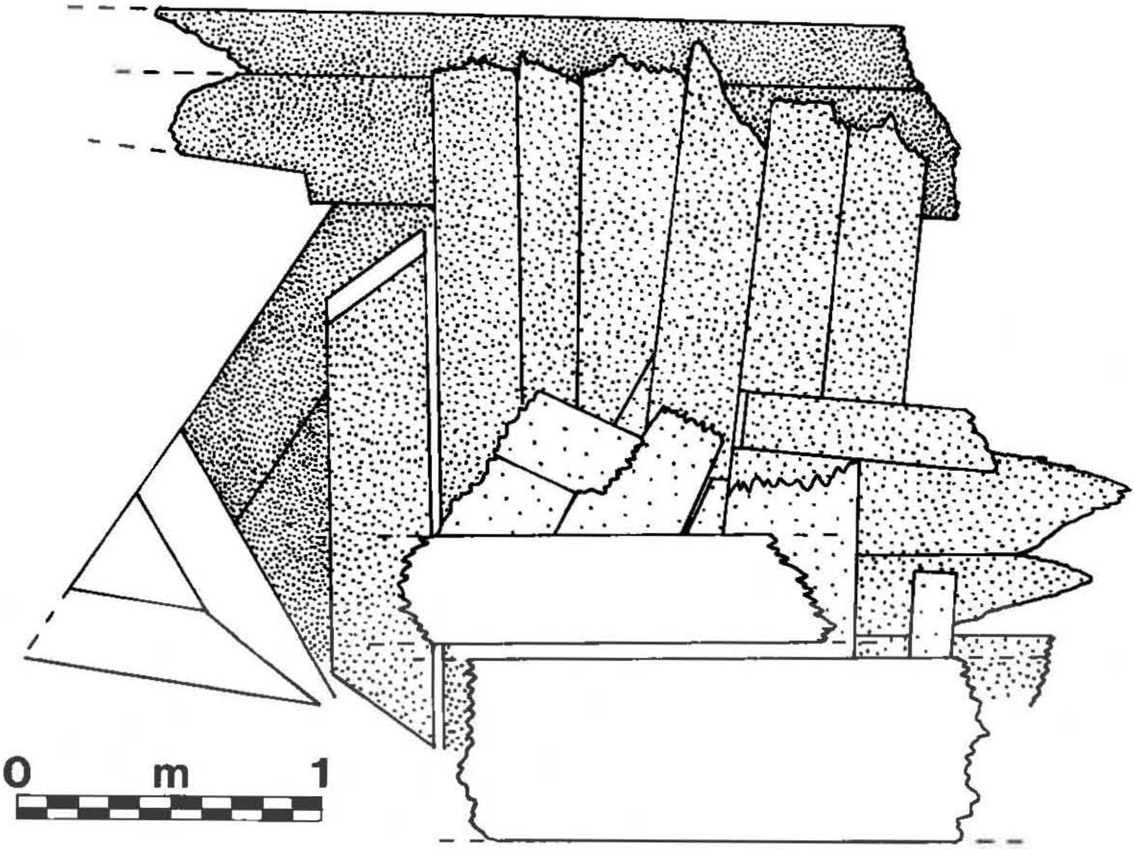

Fig. 6 Area A

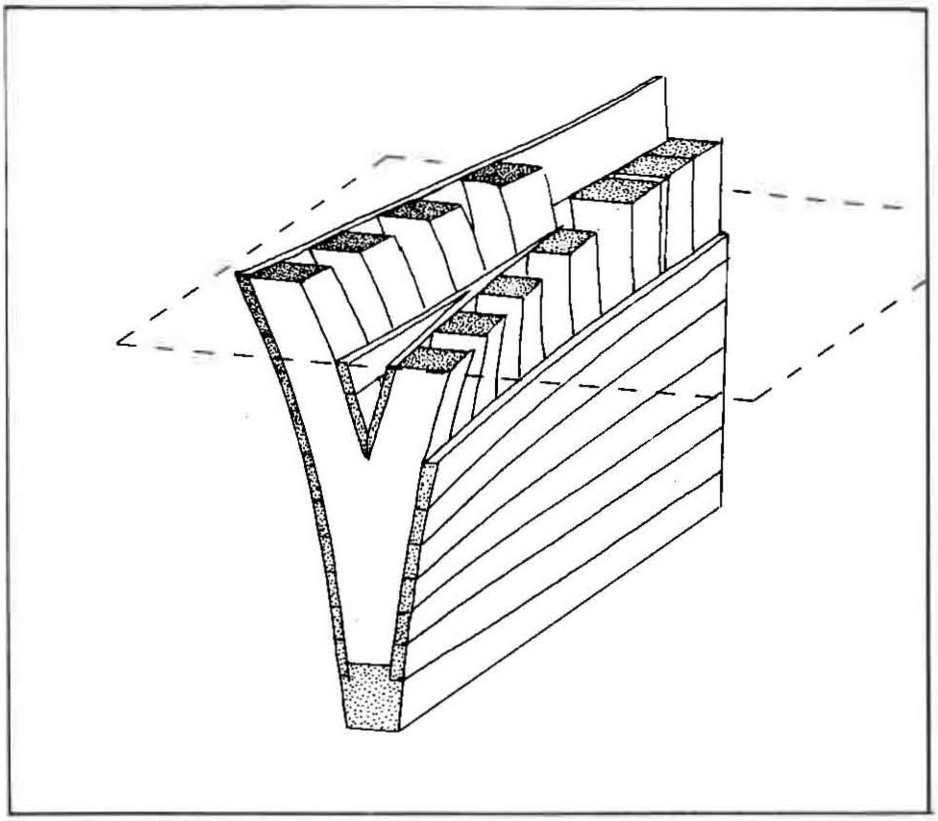

Fig. 7 Area B

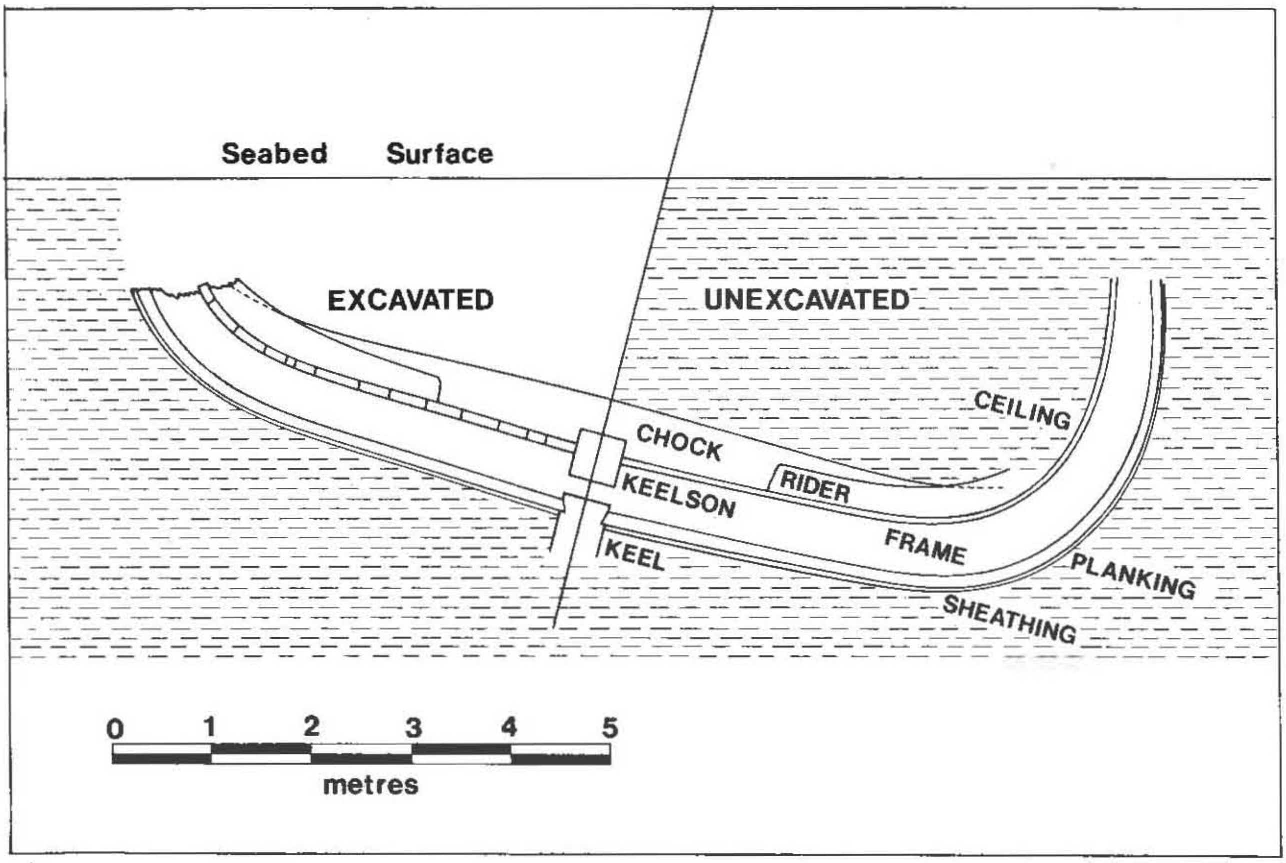

Fig. 8 Area C - cross section of hull structure

will be better preserved to a depth of about 3.5 m. During the excavation, a tin ingot was found close to the keelson.

Parallel to the keelson was a vertical partition made up of clinker laid planks supported by a vertical beam. This may be some form of hold partition to contain the cargo.

Area D

Excavation work in Area D indicated that the trench was slightly aft of the bow. A large concretion which included elephants tusks and possibly a cannon, lay across the main axis of the hull. Two large beams possibly breast hooks were surveyed, together with a bulkhead. A large three sheave pulley block (Fig. 12) was found at the bottom of the trench in the position indicated in Fig. 5. On one of the large beams on the starboard part of the hull in this area, possibly a hanging knee or rider, were the letters SB1 carved onto the forward face. The significance of this is at present not clear. On the southern side of the excavation face, a partition was noted. This could be part of the lateral partitioning of the hold of the vessel.

E. DISCUSSION

From the site plan it appears that the site is about 37 m long which corresponds closely with the known length of the vessel of 130 Amsterdam *voet* (1A.*voet* = 0.283 m) giving 36.8 m. It seems that the width, 10.8 m, as estimated from Fig. 8, is a little large against the figures from van Dam of a *fluit* in 1696 of 130 *voet* with a width of 33 *voet* 6.5 *duim*. which gives a value of 9.5 m (Staple, 1927). This may represent the fact that there has been a certain amount of outward collapse of the hull structure or alternatiely that the width of the vessel was measured at the main deck, and due to the tumblehome the width at the waterline is slightly greater. However, the figures are generally consistant with the *Risdam*.

The survey indicates that there is more than 500 cubic metres of internal hull which may contain archaeological material. There may well be collapsed material on either side of the vessel. Above the archaeological horizon there is about 1.5 m of sterile overburden.

The vessel has been strongly constructed with regular sets of riders and chocks set on top of the ceiling. This is consistant with Witsen (1690) who states that *fluits* that went to the Indies were strongly built.

F. ARTEFACTS

During the course of the survey and excavation a number of artefacts were raised. It was not the objective of the project to excavate artefacts. However, decisions to raise an object were made either, because the object may have been damaged if left in situ, or that it was hindering the progress of test excavation trenches. In all cases the position of the object was recorded before the object was recovered.

1. Storage Jars (Fig. 9)

Two stoneware storage jars were recovered (Fig.9). Jar A was found near peg C (see Fig. 5 marked Pot 1) during the probe survey. The jar was extremely distorted with a collapsed neck and shoulders. The height of the jar was about 350 mm, body diameter 320 mm and base 172 mm. The body was Munsel colour 2.5 YR 5/2 with a glaze of Munsel colour 2.5 R4/1. The body had dark grits in it and was reasonably high fired stoneware. The second jar B (Pot 2 Fig. 5), had a slightly distorted neck, with a height of 373 mm, body diameter 325 mm, base 190 mm, neck external diameter 175 mm. The ceramic body was fine, low fired stoneware, with a Munsel colour 10YR 6/4. The slip or glaze was eroded, with a Munsel colour of 2.5 YR 5/4, it was poor quality, fine low fired stoneware with an eroded glazed slip.

These jars are commonly found in the Southeast Asian region and associated with kiln sites in north central Thailand. Originally, it was thought that this material came from the kilns around Sawankhalok and Sisatchanalai. However, recently it has been suggested that the material may have come from Bang Rachang (Harper, personal communication). There can be little doubt that these particular jars were used for a long period of time. They have been found on 16th century wreck sites in Thailand (Green & Harper, 1983), and have also been found on the 17th century sites of the VOC ships *Batavia* (1629) and *Vergulde Draeck* (1656), (Green, 1977). To date, this is the most modern site to have this type of material. Interestingly, the jars do not have the distinctive ridge associated with (although not certainly from) Sawankhalok. It is possibly a reflection of the poor quality of the material bought by the VOC in Ayutthaya. Possibly these were containers for *achar*, *kalk*? or part of the consignment of glazed pots mentioned in the records of goods loaded on board the *Risdam*.

2. Tin Ingots (Fig. 10)

It is known that a number of tin ingots were recovered by the looters from the site. Some were recovered by the previous expedition to the site and at present the Muzium Negara holds about 125 ingots. Only one ingot was recovered during this expedition and this was located close to the keelson.

A total of 28342 *pont* tin in 459 *Ligoorse baren* were loaded in the vessel. This represents 12.8 tons of tin, each bar weighing 61.75 *pont* or 27.79 kg. Each ingot was 402 mm long by 182 mm wide by 80 mm high. The ingots are tapered towards the base with two flanges at the narrow end which would help in the handling. The top surface was stamped with the VOC mark with L above. Bruijn has suggested that the L represents Ligor. It is likely that the tin, because it was a heavy cargo item, was placed along the keelson of the vessel in order to add to the stability of the ship and to act as paying ballast.

3. Elephant Tusks (Fig. 11)

There were a number of tusks recovered by the original looters and by subsequent expeditions to the site (the Museum holds 90 tusks). Two loose tusks were recovered during the survey

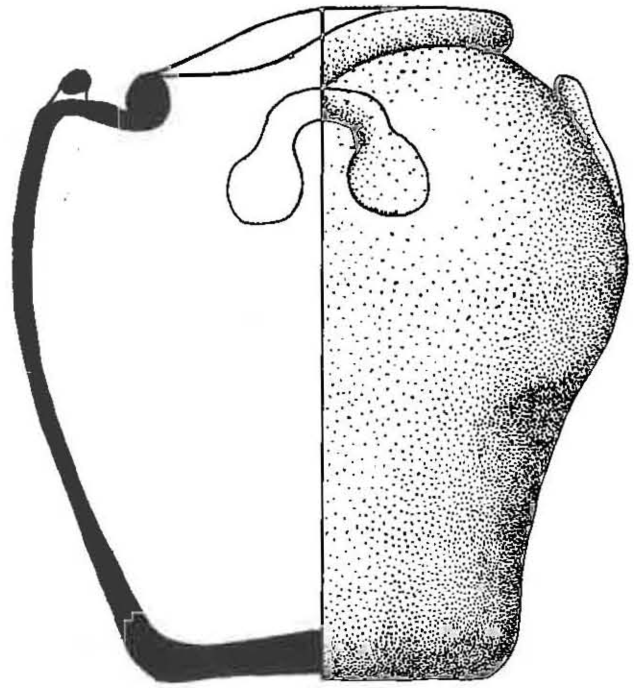

Fig. 9A Storage jars scale 1:4

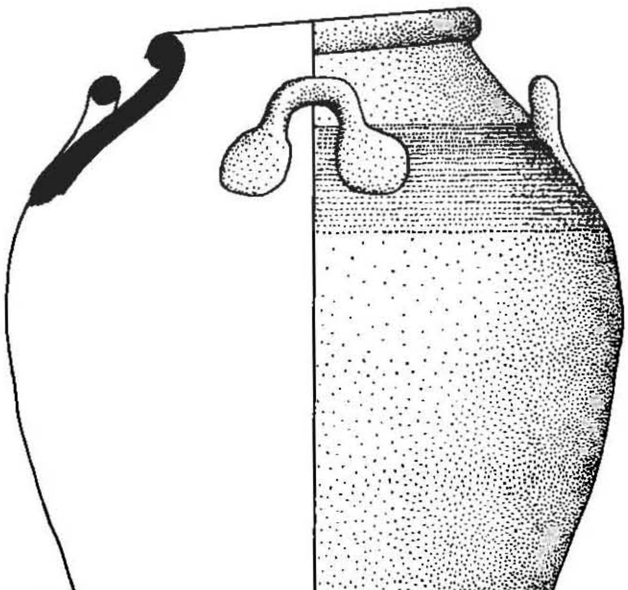

Fig. 9B Storage jars scale 1:4

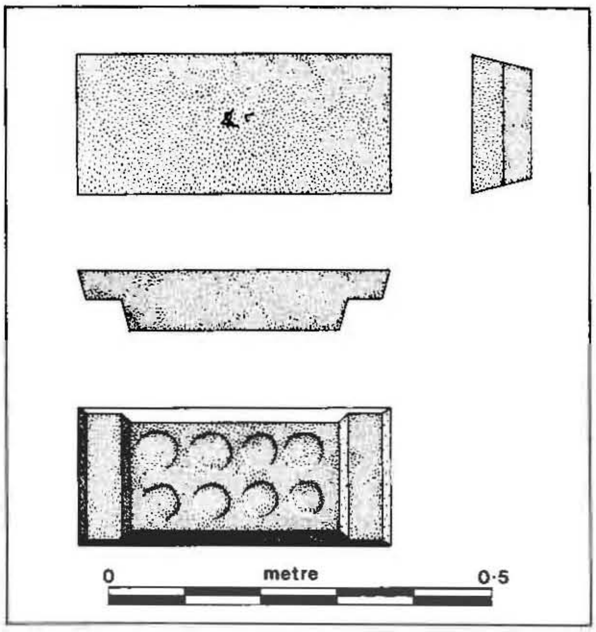

Fig. 10 Tin ingots

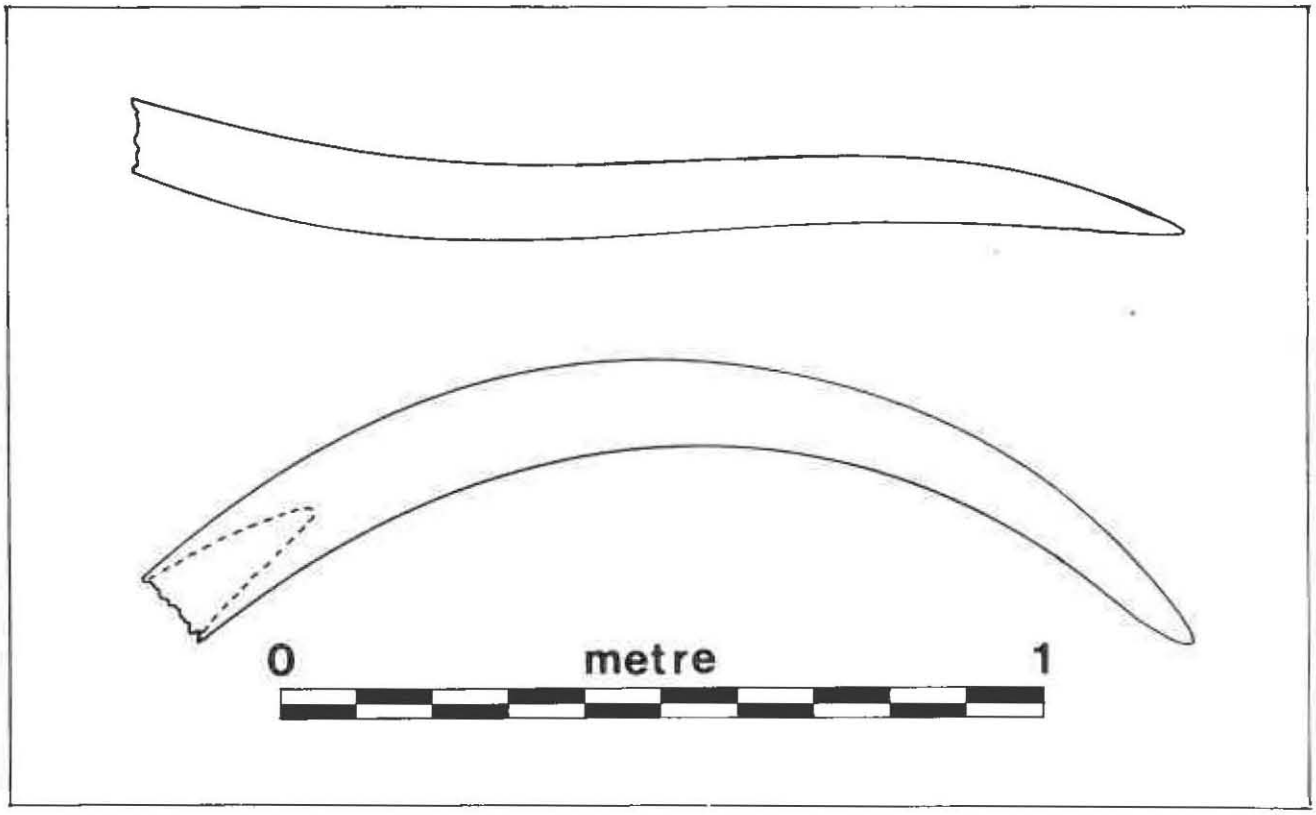

Fig. 11 Elephant tusk

and a large concretion was noted, in Area D (Fig. 5), containing a number of tusks. These were not possible to remove without damage, so were left in situ and covered up at the end of the expedition. A sample tusk was measured and photographed. It was one of the larger tusks, 1.3 m long with a root diameter of 123 mm and a bow of 256 mm at the mid point. The tusks have a noticeable skew or twist in their longitudinal axis. It is not certain if these are tusks from African or Southeast Asian elephants. Certainly some African elephant tusks are generally much larger, and have no twist, so it is possible they are from Southeast Asian elephants.

4. Sappanwood

Throughout all the site, short logs about 500 mm long by about 10 mm in diameter were noted. These were roughly hewn, with some external shaping. They are thought to be part of the cargo of 37199 pieces of Sappanwood, which was stated to be 461300 *pont* (209 tonnes) which gives an average weight per piece of 5.63 kg.

5. Lead Ingots

A number of small conical-shaped lead ingots were recovered from the site. These are not recorded in the inventory of the site but are known to be a common cargo on shipwreck sites in Thailand (Green & Harper, 1983).

6. Dutch Bricks

Several small yellow Dutch bricks were noted on the site. These are Overijselsteen and are commonly found on VOC ships of the 17th century (Green, 1977). They were brought by the Company from the Netherlands as ballast and generally unloaded in the East where they were utilised for building. Their approximate dimensions were 176 x 76 x 34 mm.

7. Pulley Block (Fig. 12)

In the bow section of the vessel a large, three-sheave block was found. This was raised and carefully drawn. It is not certain what purpose it served. It may have been for raising the anchor on the cat-head or possibly part of a lift for one of the yards of the vessel's mast.

8. Miscellaneous Items

A number of miscellaneous items were recovered. These included a green glass bottle neck similar to one found on the *Zeewijk* (Ingleman-Sundberg, 1977); porcelain fragments of Chinese blue and white wares; saltglaze stoneware fragments of jugs, possibly beardman jugs; fragments of Chinese storage jars of the Martiban type; and the remains of a leather shoe.

G. DISCUSSION

The artefacts are all consistent with the vessel being the *Risdam*. The only item known to be loaded, but not noted on the site, was the consignment of candied ginger (12431 *pont*, 5.64 tons) in 35 *aamen* barrels marked VOC. It is likely that these will be located somewhere in the hold of the ship. The only questions are the presence of elephant's tusks and the small quantity of lead ingots. The latter may have been ballast or the remains of a previous cargo. The elephant's tusks possibly were not recorded on the manifest and were probably loaded after the cargo list was completed, more than a week before the vessel departed. It is unlikely that these were illegal cargo since they were found in such large numbers and were a common export from the region.

H. CONCLUSIONS

The site of the *Risdam* is an extremely well preserved example of an 18th century Dutch East Indiaman. It is the only known example of a *fluit*, and represents the second best preserved Dutch East Indiaman found to date (the *Amsterdam* being the best (Gawronski et al, 1985)). Because of the shallow depth of water (5-6 m) and the well preserved nature of the hull, the site is extremely interesting and important.

I. RECOMMENDATIONS

The recommendations for management of the site fall into four parts. Immediate, pre-excavation, excavation and hull recovery. It should be emphasised that this report is the result of a brief survey and examination of the site, and the following are suggestions based on this work. It is possible that, as the result of future work, alternative and more attractive possibilities may become apparent. The question of the feasibility and advisability of raising the hull of the ship can only be properly addressed at the end of the excavation of the main interior of the hull.

J. IMMEDIATE RECOMMENDATIONS

1. It is recommended that in order to protect the site from looters, some form of watchkeeping be established. Serious damage to the site can not occur without a vessel being moored over the site for several hours. It is appreciated that the employment of a watchkeeper on Palau Batu Gajah or Pulau Setindan would be an expensive and difficult operation. However, since the site can be seen from Pulau Rawa, an official approach should be made to Tengku Ibrahim Alang that he and his staff be requested to keep watch on the site.

2. That historical research be carried out to gather together all available documentary information, both from contemporary records and from newspaper articles relating to the looting.

3. That a catalogue of all artefacts from the site be set up immediately. All material should be stored together in a suitable storage area and conservation treatment carefully documented. A

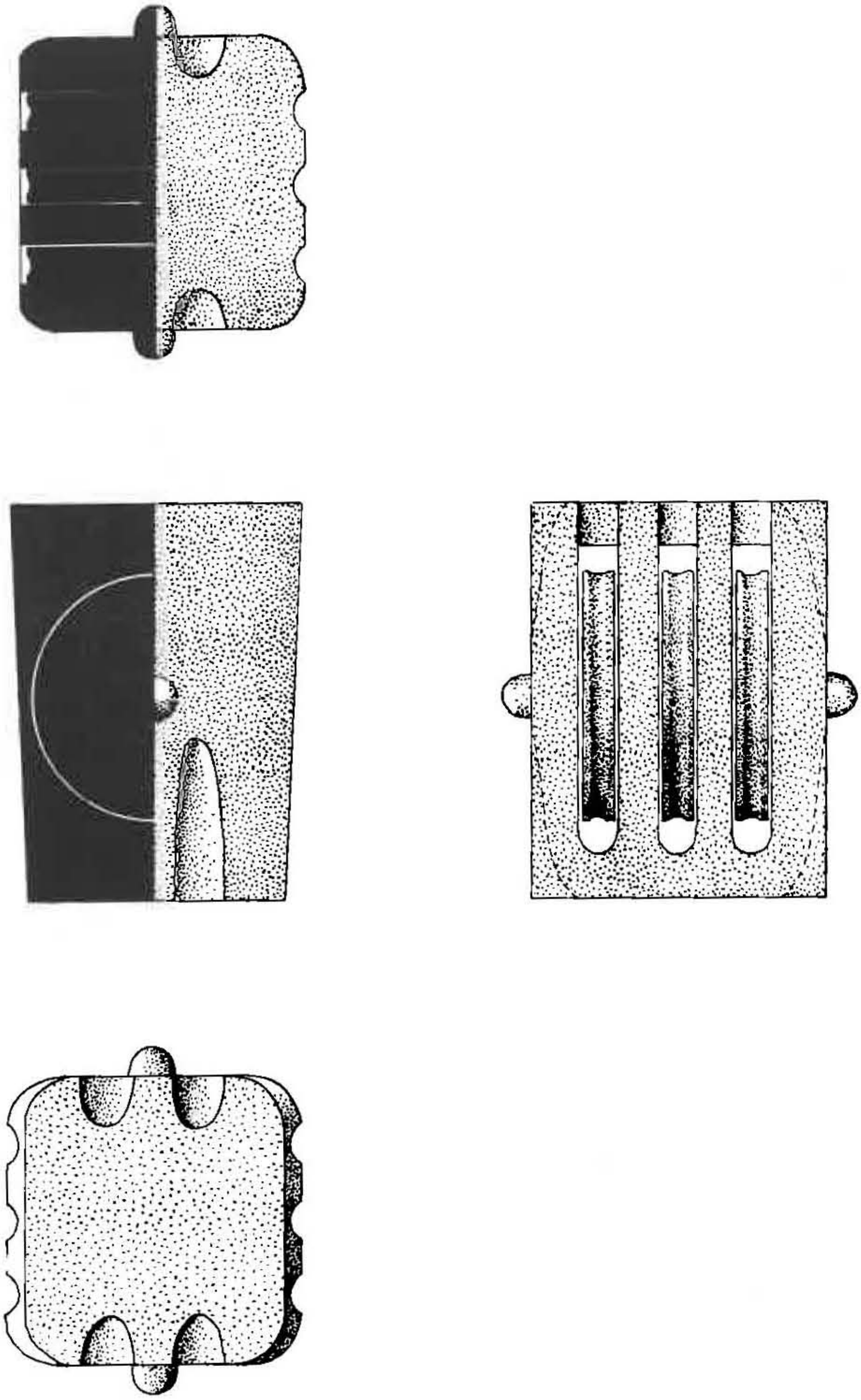

Fig. 12 Pulley Block scale 1:4

review of all material should then be made to determine its present condition and recommendations be sought for conservation treatment.

4. Research into the composition of the tin and lead should be made through material analysis to determine if the ore sources can be identified. Dr E.V. Gangadharam has indicated that he would be interested in doing this analaysis at the proposed Centre for Conservation of Cultural Property.

5. It is suggested that the proposed Centre for Conservation of Cultural Property be strongly supported. Such a Centre would be important for any future work in this field. It is well known that such centres are essential for proper conservation of material from the marine environment. It is suggested that Dr E.V. Gangadharam, honorary curator of the Muzium Negara may be albe to visit the Western Australian Maritime Museum where he would be able to study conservation techniques used in the treatment of maritime archaeologiacl material.

K. PRE-EXCAVATION RECOMMENDATIONS

In order to determine as much as possible about the site prior to excavation, it is recommended that a number of survey projects be undertaken. These projects could be carried out at any point prior to the main excavation, either as a separate 2 week operation, or as a prelude to the main work.

1. Close Plot Magnetometer Survey

A close plot magnetometer survey over the wreck site up to a distance of 50 m from the site is a high priority. This survey would locate concentrations of iron objects, both inside the main hull and in the area around the site. This would take 3-4 days to complete and should not be technically difficult. It should be conducted by individuals trained in archaeological magnetometer work. This survey would locate cannon and anchors and indicate the extent of collapsed structure. It is expected for example, that any guns would have fallen out on the starboard side of the vessel after it sank. The main anchor should not be difficult to find either. Warren Blake of the *Four Friends* has a proton magnetometer which could be hired or, alternatively, it may be possible to loan the magnetometer belonging to the Department of Maritime Archaeology of the Western Australian Museum.

2. Probe Survey

Further probe survey work is required around the exterior of the hull to outline the extent of collapsed structure. Also, core samples of the mud both inside and outside of the hull should be taken to determine the sedimentation and conditions of the site and environs.

3. Grid Frame

Prior to excavation, it may be of advantage to establish a rigid frame work around the exterior of the main hull structure. This could be constructed out of steel scaffolding pipe, forming a 40 x 10 m rectangle, levelled to just above the seabed, and held in place with vertical piping driven into the ground. This framework can be graduated for use in survey work, locating divers in poor visibility, attaching airlifts to and for deliniating excavation trenches. The structure would be permanently placed over the site for the duration of the excavation.

4. Training

It is suggested that the Muzium Negara addresses the problem of training staff to carry out maritime archaeological work. The *Risdam* excavation would be an ideal training ground for Malaysians to learn and develop expertise in maritime archaeology. However, prior to the start of the excavation it is important that at least some form of training and experience in diving should be obtained. In January 1986 the Fine Arts Department in Thailand is conducting a workshop in Maritime Archaeology under the SPAFA Program. It is suggested that some staff could be seconded to take part in this program, as prior training for any future *Risdam* excavation.

L. MAIN INTERIOR HULL EXCAVATION

The objective of this part of the excavation is to excavate the interior of the hull of the ship and record the interior hull structure. It will be essential to have a permanent working platform anchored over the site, on which airlift compressors and other excavation plant and machinery can be based. Whilst there are a number of possible alternatives for this, the most attractive would be in my opinion, to charter Warren Blake and the *Four Friends*. Warren Blake has an impressive record working on archaeological projects, including recently, a four month contract with the Philippine Government. The advantage of this approach is that the vessel would have both the plant and accommodation available on the spot. The diving team could live on board the boat and operate during the whole day without having logistic problems travelling to and from hotels in Mersing, and as a result be cheaper.

Estimates indicate that it would be possible to excavate the interior of the hull in 6-8 weeks. This would depend on a number of factors and would be subject to no unforeseen circumstances arising. Because of the shallow depth, it is not necessary to have a large team of divers. A team of about 10-12 diving personnel should be adequate, but at least half should be experienced in archaeological excavation work. The first phase of the operation, after the grid has been placed around the site, would be to remove the sterile overburden. This would be an ideal project for the Navy divers. The overburden would be excavated down to the archaeological layer.

It would be necessary to run two separate excavation areas so that up to four divers and two airlifts could be in operation at any one time.

All objects would be plotted using a three tape survey and tagged on the site prior to raising. In view of the anticipated 200 tons of sappanwood, it would seem sensible to collect a sample of this, but to dispose the material off the site. I would suggest that a number of large holes are dug, some distance off the site, in which the sappanwood could be placed. In this way it will be preserved should it be required for future study. These large holes could be excavated by the Navy diving team.

One of the most important problems is on-site storage. Most of the material will need to be immediately stored in fresh water. This storage will have to be in Mersing and it is anticipated that quite large quantities of material will be involved. Provided space is available, it should be possible to build large steel storage tanks in which some form of plastic stacking trays could be used to store material. These tanks could subsequently be drained and transported to Kuala Lumpur at the end of the expedition. If this was done reasonably quickly, material could be replaced in the tanks in Kuala Lumpur.

On site registration will also be necessary, involving recording of all material and its location on the site. This will need to be cross-referenced later with material in the storage tanks.

Additional problems include how to deal with large iron cannon. The pre-disturbance magnetometer survey should indicate the number of guns or large iron objects. However, it may be difficult to unload these at Mersing since there is no access for a crane at the Shabandah jetty. Obviously, these problems will have to be resolved on site, and it may be able to store the large iron objects and then transport them en mass via a Naval vessel to a more convenient unloading point.

It will be essential that during the excavation, Malay staff, preferably archaeologists, obtain training in underwater archaeological techniques. This training would be integrated in the excavation program and would ensure that at the end of this phase of the work there were at least a nucleus of trained staff.

The final phase of the work would be to accurately record the interior hull structure. This would be done both photogrammetrically and using three dimensional trilateration methods. The hull plan would enable a feasibility study to be made of the possibility of raising the hull structure.

At the end of the operation, the timber should be covered with polythene sheeting and covered with mud. This will help to preserve the ship's timbers.

M. RAISING THE SHIP

There are two basic ways of raising the hull, either it can be raised in one piece or it can be dismantled. Either way will be an expensive operation. The raising process would not necessarily take very long, but the preservation and conservation will be extremely time consuming, taking up to 10 years or more. Serious consideration will have to be given to the advisability of raising the hull. It may be that it would be better to leave the site for the moment, and investigate and record other sites in Malaysian waters. In this way, a number of choices may be available, some of which may be of more interest than the *Risdam*.

Realistically, at present it is not possible to accurately assess the costs of raising the hull. This decision would be better left until after the interior hull excavation. The relative merits of raising in one piece or dismantling are however fairly clear. In order to raise the hull in one piece it will require a prefabricated steel cradle to be constructed and placed under the vessel.

Heavy lifting equipment on a vessel with suitable draft will be required to lift the hull and support structure. It is anticipated that the lift will be in excess of 100 tons. The hull and support structure will then have to be placed on board a barge and towed to some location where it can be unloaded and housed. It may be possible to incorporate the support structure into some building close to the edge of the water, where it can be removed from the barge and a structure built over the top to protect it. As an interim measure the hull could be regularly sprayed with water to prevent drying. In the long term, a full time conservator will be required to supervise the dehumidification of the hull structure. The alternative of dismantling the hull does not require large cranes or barges, but presents an enormous logistic problem both with storage and reconstruction. The process of dismantling and reconstruction takes a long time and it is often difficult to put the pieces back together due to distortion.

Thus, the first option is probably more expensive in the short term, but the later method costs more in the long term.

N. ACKNOWLEDGEMENTS

I would like to thank the following people for their help and assistance with this project: Warren Blake, Nguyen Hung and Jaji Biri, skipper and crew of the *Four Friends*; Dr E.V. Gangadharam of the Geology Department of the University of Malaya; Professor J.R. Bruijn of the Rijksuniversiteit te Leiden; Ms J. Buckee student volunteer from the University of Western Australia; Mr. Patrick Cheah and his associates from Cheah Marine Engineering; the commander and crew of the Royal Malasin Navy vessel *Jab Laut*; the master and crew of the Customs boat *Taujune Labuan*; Mr. Charles Arputham and the film crew from Media Master.

I would like to thank the Western Australian Government and the Director and Trustees of the Western Australian Museum for granting me permission to work on this project. Finally I would like to thank the Director of the Muzium Negara for inviting me to take part in this project. I would also like to particularly thank Dr. Adi Haji Taha and his staff for all their help and assistace given to me during my stay in Malaysia.

O. REFRENCES

Bruijn, J.R., Gaastra, F.S. and Schoffer, I., (1979)
Dutch Asiatic shipping in the 17th and 18th centuries.
RGP 166 and 167, Martinus Nijhoff, 's-Gravenhage.

Gawronski, J., Heide, G.D. van der, Jutte, B.A., Kist, B.J., Marsden, P.R.V., Paul, C. & Giorgi, R. san, 1985
Report of the VOC-ship *Amsterdam* Foundation, 1984.
VOC ship *Amsterdam* Foundation, Amsterdam.

Green, J.N. (ed.), (1977)
The AVOC jacht Vergulde Draeck *wrecked Western Australia 1656.*
BAR Supplementary Series 36, Oxford.

Green, J.N. and Harper, R., (1983)
The Excavation of the Pattaya wreck site and survey of three other sites in Thailand, 1982.
Australian Institute for Maritime Archaeology Special Publication No.1.

Ingleman-Sundberg, C., (1977)
Relics from the Dutch East Indiaman Zeewijk *foundered 1727.*
Western Australian Museum Special Publication No.10,Perth.

Staplel, F.W., (1927)
Pieter van Dam Beschryvinge van de Oostindische Compagnie (Book 1, Part 1).
RGP 63, Martinus Nijhoff, 's-Gravenhage.
Witsen, N., (1690)
Architectiera navalis et regimen nauticum otle aalouden hedendaagsche scheeps-bow en bestier.
Amsterdam.
Yk, C. van, (1697)
De Nederlandische Scheeps bow Konst.
Amsterdam.

GEOLOGICAL REPORT ON THE WRECKSITE OF THE DUTCH SHIP *RISDAM* (1726), PENINSULAR MALAYSIA

E.V. GANGADHARAM

Department of Geology, University of Malaya, 59100 Kuala Lumpur
Honorary Curator, National Museum of Malaysia

1. INTRODUCTION

This is an interim report on the geological studies being carried out on the shipwreck located off Mersing on the east coast of the state of Johor, Peninsular Malaysia. It is based on the field and laboratory studies carried out on the geological and other kinds of samples collected by the author and the sediment samples collected with the help of the divers, during the first (May-June 1984) and second (September-October 1985) expeditions to the wrecksite conducted by the National Museum, Kuala Lumpur. Laboratory investigations are being carried out at the Department of Geology, University of Malaya as a part of the author's research project (F 4/85) funded by the University.

It is of interest to note that during the second of the two expeditions, the wreck has been confirmed as that of the V.O.C. (*Verenigde Oostindische Compagnie*, or the United East India Company of the Netherlands) *fluit* type of ship named *Risdam* which is reported to have sunk at this location on January 1, 1727 (Green, 1985, this report; Professor Jaap Bruijn of Leiden University, 1985, personal communication).

2. DESCRIPTION OF THE WRECK

2.1. LOCATION

The shipwreck is located about 7.5 km N 15° E of Mersing (Long. 103° 50'E, Lat. 2° 25'N), a major town on the northeastern coast of the state of Johor, Peninsular Malaysia. The site is also 0.5 km from the northern tip of Pulau (= island, abbreviated P.) Batu Gajah, a small rocky island about 7 km from Mersing in the same direction. P. Batu Gajah itself is about a km northeast of a larger island P. Setindan, and about 1.5 km from Tanjung (= promontory, abbreviated Tg.). The wrecksite location is given by the grid reference wH 121017 on the Peninsular Malaysia Topographic Sheet 119a (Series L8010, Edition 1-PPNM, 1970). The locality is also covered by the British Admiralty Maritime Chart No. 769 (1960 edition).

2.2. THE WRECKSITE

The wrecksite is at a depth of about 10 m of water, and is relatively flat, consisting of soft mud, underlain by harder clay as per the divers' initial reports. The wreck itself lies under at least 3 m of sediment, with no part of the ship visible above the seabed.

The divers reported that visibility can be 3 - 4 m under conditions of bright sunshine between 8 am and 2 pm. However, once the diving operations started, the divers' work was hampered by very poor visibility, of less than a metre. One diver reported that the sea currents at the site, which change rapidly with the tides, could be up to 1.5 knots.

2.3. THE WRECK

It is only during second expedition (September-October 1985) under the direction of Jeremy Green of Western Australian Maritime Museum, that the first full details of the actual conditions of the *Risdam* wreck came to light (this report). The ship is lying apparently tilted about 15° to the right (starboard) side, the front (bow) pointing northwards, and with the axis of the ship oriented approximately N25°E. The preliminary probe survey by the diving team established the central wreck are to be about 50 m long and 15 m wide.

2.4. ARTEFACTS

Artefacts recovered during the first expedition (Gangadharam, 1984) consisted of about 120 numbers 29 kg tin ingots with the VOC emblem on them; about 40 elephant tusks in various states of preservation, from perfect (except blackening) to severely damaged by marine organisms; and a number of heavy metallic objects in thick sand concretions (some of which, on x-radiography appear to be firearms). Cargo timber (sappan wood logs), wooden planks (ship timbers), and other miscellaneous objects including wooden shipparts, ropes, small lead pieces and broken pottery were also recovered during the first expedition.

Additional objects recovered during the second expedition (Green 1985, this report) include a large pulley block, large earthenware jars, part of a Dutch ("onion") glass bottle and "Dutch bricks".

3. GEOGRAPHY OF THE LOCALE

The geological environment of the wrecksite is strongly influenced by the topography, drainage and climate of the landmass immediately near to it, besides its geology. These factors are therefore briefly examined here.

3.1. TOPOGRAPHY

The coastal part of the nearby landmass, namely the area immediately W of Mersing, consists of low topography not rising above 100 m. The highest point nearest the wrecksite, however, is the Bukit (= hill, abbreviated Bt.) Selantai, 140 m, on Tg. Selantai. P. Batu Gajah is less than 30 m above MSL while P. Setindan rises to about 100 m above MSL. The beach boardering the landmass west of the site is 1 - 4 km wide, and is bordered by a broad tidal flat up to one km wide, with tombolos connecting the P. Setindan with the mainland and the P. Batu Gajah with P. Setindan.

3.2. DRAINAGE

The major drainage channel of the coast west of the wrecksite is the east-flowing Sungai (= river, abbreviated S.) Mersing, about 100 km long which opens into the South China Sea about 7.5 km southwest of the wrecksite. The other smaller rivers and streams are the S. Tenglu Besar, S. Tenglu Kecil and S. Selang Bani. These three rivulets flow through the "old" beach of sand ridges and disappear into the tidal flats.

3.3. CLIMATE

The climate prevailing in the area has a direct bearing on the nature, intensity and rapidity of weathering of the rocks of the landmass and the islands nearest to the wrecksite. This in turn dictates the nature of the sediments that were deposited on the shipwreck in the last 260 years. For this reason the climate of the area is briefly dealt with here.

The region is described as having a typical tropical-equatorial climate, with long hot and humid periods alternating with poorly defined monsoonal rainfall periods. Mean daily temperature variation is 23-28°C (averaging 26°C) while the mean annual rainfall ranges from 298 cm to 317 cm (averaging 303 cm). Relative humidity is estimated to range from about 43% to about 66%.

The monsoon periods of the region control the direction, intensity and duration of the near-shore currents which affect the movement and rate of accumulation of the sediments at the wreck site. The northeast monsoon from the South China Sea prevails from December to March resulting in heavy rains and moderately strong winds. The southwest monsoon from the Indian ocean as active from May to October bringing in moderate rainfall and strong winds. The monsoon rains bring in very large sediment load from S. Mersing to the sea which gets spread out by the near-shore currents, as described later.

4. STUDIES ON THE COAST AND THE ISLANDS

4.1. PREVIOUS STUDIES

Mersing area is covered in several studies by the Geological Survey of Malaysia which focused on the general geology, stratigraphy and mineral resources of the northeastern Johore, the last amongst which is by Suntharalingam (1968). Geomorphological studies of northeastern Johore coast are carried out by Nossin (1961) and Nossin (1962), dealing with the development of the coast and the coastal sedimentation. Hill (1966) studied the changes in the beach from just north of the mouth of S. Mersing and suggested coastal erosion during the north-east monsoon and accretion during the southwest monsoon. Tjia (1970) described the monsoon control of the eastern shoreline of the Malayan Peninsula, including the area of interest to this report. A comprehensive account of the geology, stratigraphy and the geological history of the Mersing area is given by Lee (1972).

4.2. CURRENT STUDIES RELEVANT TO THE SHIPWRECK SITE

Studies on the geology of the immediate environs as well as on the artefacts of the shipwreck are commenced, and are continuing. The aspects being examined include coastal geology, river and beach sediments from Mersing to Tg. Selantai, the outcrops on P. Batu Gajah and P. Setindan, the sediments, encrustations and coatings associated with the recovered artefacts, the sediments from the wrecksite as well as detailed chemical and x-radiographic studies of the artefacts. (Gangadharam, 1984 and 1985).

4.3. GEOLOGY OF THE COAST AND THE ISLANDS

Handspecimens and thin sections of the rocks of the coast and the islands were examined and the following is a brief account of the petrography and mineralogy of the rocks. The stratigraphic aspects are based on the previous studies mentioned above. (Fig.13)

The major rock formation of the coast immediately northwest of Mersing is termed the "Mersing Beds" which is made up of metamorphic rocks consisting of quartz-phyllite, metaquartzite and black slate, which have been assigned the age of Carbo-Permian (225 to 345 million years). These rocks examined in thin section show fine-grained quartz, felspar, muscovite/sericite, clay minerals and carbonaceous matter. Accessory minerals include sillimanite, andulasite, staurolite and pyrite. The next major rock formation is named "Jasin volcanics" which is a group of rock types produced by volcanic activity in the area during the Triassic period, 195 to 225 million years ago. The rock types on this group include: a) volcanic agglomerate which is a fragmental rock consisting of valcanic ash, lapilli and rock fragments, making up the hill region just northwest of Tg. Selantai; b) Rhyolite or acid volcanic lava, with flow textures occupying the major part of the P. Setindan and making up the P. Batu Gajah; c) "Tuff" or consolidated volcanic ash with other fragmental volcanic material, occupying Tg. Selantai. A study of thin sections of these rock types shows quartz, felspar and lithic fragments in a matrix of glass or cloudy devitrified glass. Iron oxides, zircon and fine grained pyrite are also quite common.

Another geological formation in the area is Chawang conglomerate, but as this does not outcrop in the vicinity of the wrecksite, it is ignored.

Quarternary alluvium consisting of land-derived clay, sand, some organic-rich layers such as carbonaceous clay and peaty material occupies near-shore swampy areas of the landmass just northwest of the wrecksite. The border of the landmass southwest of the P. Setindan is covered with sand ridges which are conspicuous in the aerial photographs of the area. the southwestern portion of P. Setindan grades into sandy alluvium. The area between the landmass and P. Setindan is a broad tidal flat consisting of swampy, organic-rich muddy zone, which exhibits bars, spits and tombolos.

4.4. THE WEATHERING OF ROCKS

High humidity, tropical temperatures and monsoonal rainfall makes rock weathering intense, deep and rapid in the area of interest. The topographically high regions show thick soil cover which at times moves downslope in massive landslides periodically, especially during the monsoons. A cursory examination of the weathering products shows the following. The metamorphic rocks of the area weather to a relatively fine grained material consisting of quartz, muscovite, sericite and clay minerals. The volcanic rocks yield, on weathering, medium to coarse grained, angular quartz sand and some minor amounts of feldspar, glassy fragments and possibly sericitic mica. the swampy clay and the marine beach sand ridges also move downbeach to contribute to the offshore sediments. the large deposits of peaty material of the swamps also on weathering reaches the sea in the form of finely divided organic carbon.

4.5. RIVER AND STREAM SEDIMENTS

The river and stream courses constitute channels by which sediment load from the hinterland catchment area is brought to the sea. Samples of sediments collected from the Mersing river at its mouth during the months of May 84 and October 85 did not show much difference, and found to consist of abundant well-rounded quartz grains and minor amounts of feldspar and mica with traces of ilmenite, zircon and garnet. Some samples however, consisted of up to 64% clay fraction indicating the mature stage of the river. Three minor streams S. Tenglu Besar, S. Tenglu Kecil and S. Bani are largely muddy and sluggish-flowing, and have 18 - 27% medium to coarse fraction consisting of quartz, feldspar and mica. These streams disappear into the swampy tidal flat opposite the P. Setindan. Results are shown in Fig.14 and Table 4.

4.6. BEACH SEDIMENTS

Several samples of the beach sands were examined by sedimentological methods and microscopy. They mostly consist of medium to fine sand, moderately well-sorted, subangular to rounded, with about 12 - 16% shell fragments. The sand fraction consists of over 72% quartz, with some feldspar and mica. Heavy minerals include ilmenite, zircon, tourmasline, staurolite, andalusite and sillimanite. Results are showin in Fig. 2 and Table 4.

5. STUDIES ON THE WRECK SITE

5.1. TOPOGRAPHY

The wreck site is under about 10 m of water. The divers and the diving archaeologist reported that the area is relatively flat with no part of the shipwreck showing above the seabed. During the first expedition (April-May 1984) the divers reported a small mound about a meter high and three shallow ditches 2-3 m in diameter each, in a rough north-south direction, approximately 10 m apart. These are obviously the result of illegal salvaging operations which were in progress until halted by the Malaysian authorities in April 1984. At the start of the second expedition (September/October 1985) the divers reported the seabed to be nearly flat, indicating that the ditches were filled up with sediments during the two preceeding monsoons.

5.2. LONGSHORE CURRENTS

Tjia (1970) discussed the monsoon control of the eastern shoreline of the Malayan Peninsula. The predominant direction of movement of long-shore currents in the region of Mersing is northwest. This implies that a bulk of the sediment discharged by the river Mersing would be travelling in the direction of P. Setindan and gets deposited in its vicinity, especially south and southwest of it. Even though P. Batu Gajah itself lies in the "shadow zone" of P. Setindan in the path of the longshore currents, the sediments encircling the P. Setindan from the south would ultimately reach the vicinity of P. Batu Gajah and get deposited at the wrecksite The sandy southwestern edge of P. Setindan and the sandbars and tombolos in that direction confirm the above.

5.3. AERIAL PHOTOGRAPHS

Aerial photographs of the Mersing river mouth and the vicinity of P. Setindan and P. Batu Gajah are examined. These include the photographs produced on a scale of approximately 1:125,000 by the Lockwood Survey Corporation of Canada in 1958 under the Canadian-Malaysian Cooperation Agreement as a part of the Colombo Plan (Agocs, 1959): Line 104-S, Roll C-47, Photos 154, 155, 156; Line 105-S, Roll C-58, Photos 11, 12 & 13.

Also studied are the British Royal Air Force photographs of the area (Nossin, 1962). The photographs clearly show the manner of distribution of the sediment plume from the S. Mersing to the south and west of the P. Setindan, and yet some of it reaching the P. Batu Gajah and its vicinity.

5.4. MERSING COAST IN THE 18TH CENTURY

The southrn half of the eastern coast of Peninsular Malaysia appears to have undergone considerable change during the last three centuries. This is attributed primarily to the progradation (accretion) of the coast brought about by at least three major factors: large sediment load brought in by five major east-flowing rivers (viz., S. Mersing, S. Endau, S. Rompin, S. Pahang and S. Kuantan); strong northwest longshore currents for five to six months a year during the southwest monsoon; and the postulated eustatic withdrawal of the sea resulting in a fall of the sea level by about 6 m (Nossin 1961).

Nossin (1964, 1965) for example, noted that the coast at the mouth of S. Pahang, about 100 km north of Mersing, had at one time a deep bay with some islands, as per maps dated 1700 AD. The size of this bay was shown successively diminished in maps published up to and including 1825, and it is no longer shown in maps published from 1855 onwards. Nossin postulates, based on the evidence of the ancient maps and other arguments, that the coastal progradation was fairly rapid and resulted in the seaward shifting of the shore by about 13 km during a period of 300 years, brought about by the eastatic fall of the sea level by about 6 m.

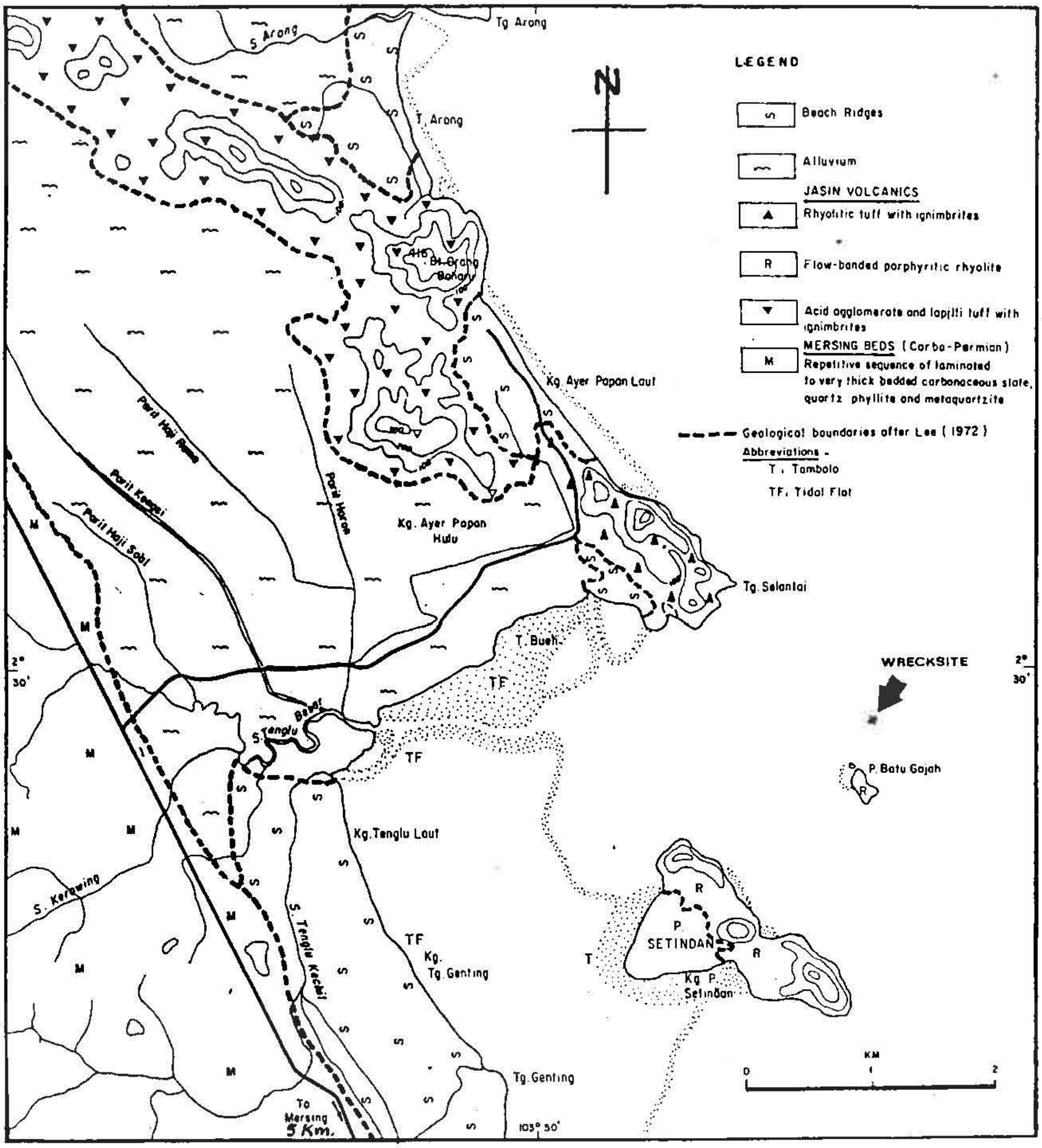

Fig. 13 Geological map of the immediate environs of the wrecksite of the V.O.C. ship *Risdam*

Progradation on a rapid scale is apparently not uncommon in the context of the Malayan Peninsula. Evidence for similar progradation of the coast on the opposite (west) coast of the Peninsula, namely at the Kalng Strait which is a part of the Malacca Strait, has been presented by Coleman et al., (1970). By comparing the coastal photographs of 1926 and 1957, a coastal accretion rate of about 6 m per year was determined by the authors.

It is conceivable that this kind of rapid progradation of the coast at Juantan could have affected the coast at Mersing, about 100 km south of Kuantan. The fact that the area between T. Selantai and the "main land" shows recent allurvium and that the area between P. Setindan and the mainland is occupied by modern sand ridges, tidal flats, tombolos and sand bars, suggests that this part of the coast is of recent origin (Nossin, 1961).

It is possible that at the time of shipwreck (1727), the area of present Tg. Selantai is an island, that there was a deeper channel between P. Setindan and the mainland, and probably P. Batu Gajah and P. Setindan were connected as one larger island. This conjecture, however, needs to be verified. A detailed examination of maps of this part of the coast dated about and after 1700 AD and aerial photographs of the last fifty years is presently being carried out.

6. SEDIMENTOLOGICAL STUDIES

The *Risdam* shipwreck lay in its oceanic grave for about 160 years and obviously the ship timbers, cargo, and the other artefacts belonging to it have established an equilibrium with the sedimentary environment of the site over this period. Thus, a detailed study of the mechanical properties, mineralogy and chemistry of the sediments at the wrecksite would prove valuable when carrying out further studies on the artefacts and when deciding procedures for conserving them. With this in view deliberate sampling of the wrecksite sediments was carried out, in addition to "opportunity samples" that were obtained when artefacts were salvaged during the first and second expeditions. The sedimentological studies are described here and the chemical studies are not completed at the time of preparation of this report.

6.1. GRAB SAMPLES

Five grab samples were collected with the help of the divers from the wrecksite during the two expeditions. Exact locations could not be determined because of lack of reference points during the first expedition and due to poor visibility at the time of collection during the second expedition. Approximate positions of samples, however, were ascertained from the divers, and all of them constitute near-surface samples from within the area of the hull of the ship. The following are the general observations (Table 1).

6.2. SEDIMENT CORE

During the second expedition, a core of sediment was collected from the wrecksite with the help of the diving archaeologists. A PVC tube 80 mm in diameter and about 2 m long was driven into the site, just outside the "hull area" of the *Risdam* wreck, at a point about m from the stern. When the tube was raised, only about 70 cm of the tube from the bottom was filled with the sediment. The tube was cut off with wooden discs and tape, and the tube with core was sent to Kuala Lumpur via Singapore.

Some seven weeks after the sampling, the tube was cut into 7 segments each 10 cm long from the bottom, and each segment was cut open in half lengthwise. Table 2 presents a description of the sediment core (Fig. 15). An attempt to collect a similar core from inside the "hull area" of the wreck was not successful on the last day of the expedition, and no further attempts could be made.

TABLE 1

Description of grab samples of sediments from the *Risdam* wrecksite

Sample No.	Description by the divers	Nature of the sediment	Comments
G 21/84	"Dark soft clay from undisturbed area"	Greenish grey, fine clay with about 10% coarser fraction and 10% shell fragments; sulphurous smell	Probably represents the present day sediment from the surface of the sea bed
G 22/84	"Fine sandy clay from disturbed area"	Brownish-grey and greenish grey clay with 16% sand and about 20% shell material	Probably represents a deeper layer, disturbed by the illegal salvaging operations prior to the first expedition
G 23/84	"Hard layer"	Very fine greenish-grey clay with less than 5% coarse fraction and 5% shell fragments. Also present man-made debris such as nylon fibres and plastic float pieces	Diver description at variance with sample. Probably represents more recent sediment
Grab 2A/85	"Highly shelly layer"	Slimey greyish green clay with a very large shell content, perhaps 40%, with complete shells such as a turritella (35 mm) and a 65 mm long tusk shaped shell	Probably represents an active biological horizon with considerable activity of living organisms. The shells are many and varied
Grab 2B/85	"Dark clay from the unexcavated area" of "Area C" (Fig. 8, Green 1985, this report)	Grey-greenish clay with 10% coarse fraction and 5% shells; sulphurous smell	Similar to Grab sample G 21/84. Recent surface sediment

(Results of sedimentological analysis given in Table 4 and showin in Fig. 14

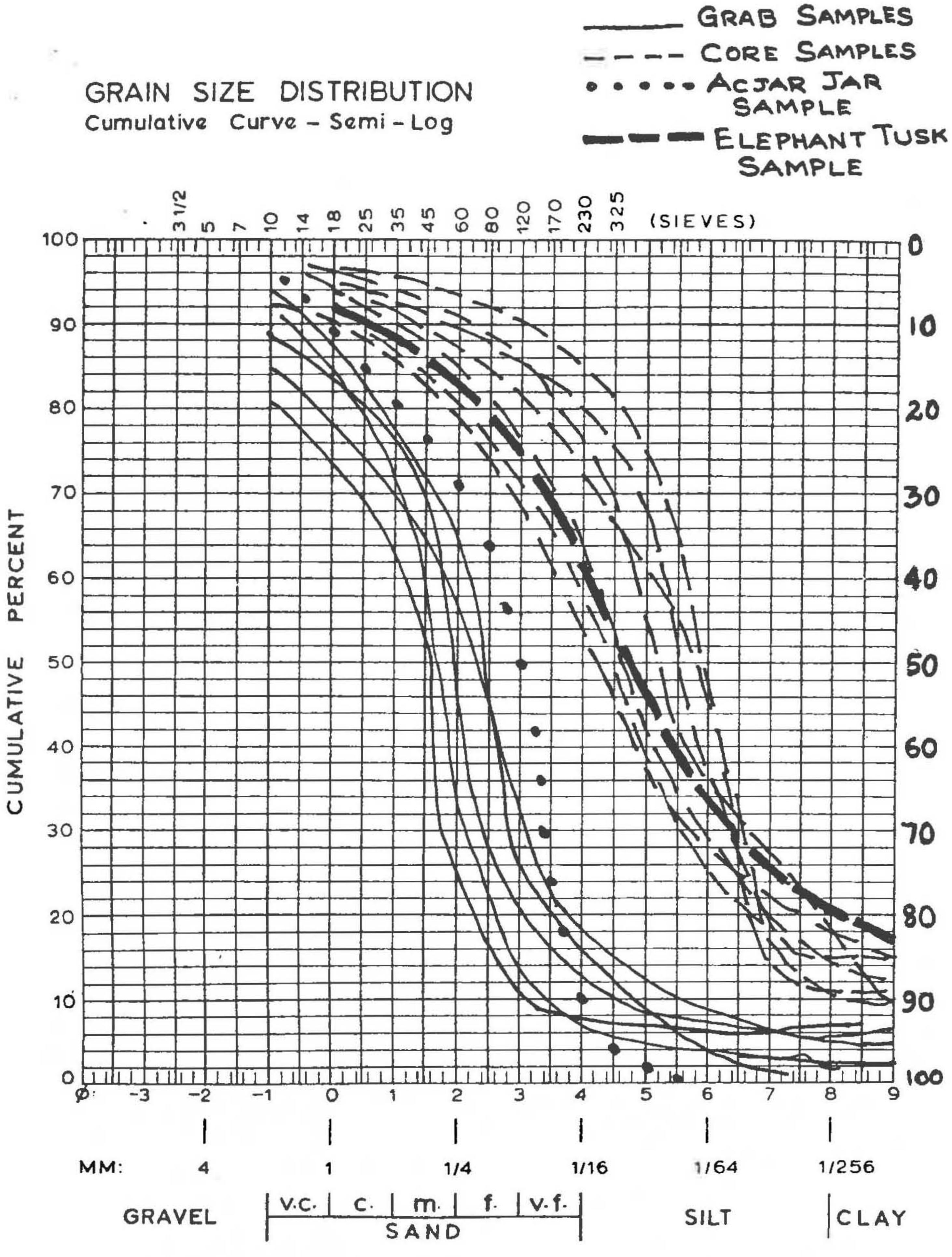

Fig. 14 Sedimentological analysis of *Risdam* sediments

TABLE 2

Description of the sediment core from the wrecksite of *Risdam* (Fig. 3)

	Core Section	Depth from Surface	Description of the sample
TOP	A	0 - 9 cm	Soft, fine, brown and grey clay; shell content about 5%
	B	9 - 19 cm	Soft, fine, brown and grey clay; shell content very low
	C	19 - 23 cm	Tight, fine, brown, grey and black clay; not filling the tube wall-to-wall
		23 - 29 cm	Air gap, no sediment
	D	29 - 31 cm	Air gap, no sediment
		31 - 33 cm	Tight, fine, brown and grey clay; shell content about 5%
		33 - 37 cm	Tight, fine, brown and grey clay
	E	39 - 43 cm	Tight, fine, brownish grey clay; very low shell content
		43 - 49 cm	Soft, black and grey clay; shell content about 20%
	F	49 - 59 cm	Soft, black and grey clay; shell content about 20%; including very large shell fragments
BOTTOM	C	59 - 69 cm	Soft, black and grey clay; shell content about 20%

(Results of sedimentological analysis given in Table 4 and Fig. 14

Each half of the seven sections were systematically sampled. The samples were subjected to standard sedimentological analysis and mineralogical examination (Table 4). Clay identification and chemical analysis is in progress at the time of preparation of this report.

7. STUDIES ON THE ARTEFACTS

7.1. SEDIMENTS ASSOCIATED WITH THE ARTEFACTS

"Opportunity samples" of sediments were obtained from the artefacts during the first and second expeditions. Studies on these samples are expected to provide information on the nature of the sediment which accumulated during the early decades of the *Risdam*'s existence as a wreck off the Mersing coast.

7.1.1. Sediments in the elephant tusks. Sediment was obtained from the hollow end of an elephant tusk (Field Catalog 1984 Number: JM/DL.PBG 84/Gading 3) which was recovered during the first expedition. The tusk itself was 1.5 m long and up to 15 cm in diameter at its widest. The proximal end of the tusk had a cavity about 12 cm in diameter and about 14 cm deep, which was half-filled with sediment. The sediment was recovered when the first examination was made by the author in June 1984 at the Mersing Police Station where the artefacts were temporarily stored in water tanks. It was thought that a chemical analysis of this sediment would be of interest to indicate the nature of sediments deposited about 300 years ago. Three aliquots of the sediment, each about 25 gm were dried at about 50°C, gently disaggregated and sieved to pass 120 mesh. The + fraction constituted about 8% of the whole sample by weight, and consisted of medium to fine sand, shell fragments and fragments of ivory flaked off from the inside of the tusk due to its deterioration in the marine environment. The averaged values of the analysis of the minus fraction of the three samples is given in Table 3.

TABLE 3

Chemical composition of the sediment recovered from an elephant tusk, from the *Risdam* shipwreck

SiO_2	60.1%	
MgO	7.7	
K_2O	11.2	
Na_2O	4.3	
$CaCO_3$	1.9	
SO_2	1.2	
Fe_2O_3	6.7	
Sub Total	95.1	
Undetermined, by difference	4.9%	includes organic carbon

TABLE 4. Mineraological analysis of sediments from the *Risdam* wrecksite

Sample	MEDIUM %		FINE %clay/	Percentage of heavy minerals in fine fraction								
	Qtz	Flsp	silt	Ilm	Zir	Gar	Rut	And	Sil	Sta	Tou	Other
Beach Sands												
1. Bch 16/84	61	27	12	27	21	3	3	6	10	14	10	7
2. Bch 17/84	66	20	14	21	19	6	4	3	12	10	8	17
Mersing River mouth												
3. Mer 18/85	57	20	23	32	28	8	11	1	3	6	11	0
4. Mer 19/85	54	32	14	29	27	10	13	2	1	3	17	-
Grab samples from wrecksite												
5. G 21/84	15	10	75	31	14	8	10	11	9	6	10	-
6. G 22/84	22	14	64	28	16	10	9	8	3	11	8	7
7. G 23/84	19	17	64	22	8	14	11	10	8	6	15	6
8. Grab 2A/85	19	17	64	22	8	14	11	10	8	6	15	6
9. Grab 2B/85	24	20	56	21	10	8	15	3	2	8	22	11
Core samples from wrecksites												
10. CA/85	32	21	47	35	21	11	8	1	3	8	10	4
11. CB/85	28	24	47	30	20	14	9	3	2	0	15	7
12. CC/85	20	17	63	41	18	13	10	0	0	11	3	4
13. CD/85	24	24	52	33	12	18	9	6	10	0	10	2
14. CE/85	18	17	65	42	10	18	12	3	3	8	0	4
15. CF/85	17	22	61	38	18	14	10	3	5	4	4	4
16. CG/85	20	21	59	30	17	10	10	8	0	8	15	2
"Opportunity" samples												
17. Sediment from elephant tusk	31	28	41	30	11	14	11	7	3	2	10	12
18. Sediment from "Acjar" jar	42	37	21	20	18	8	10	8	7	6	10	12

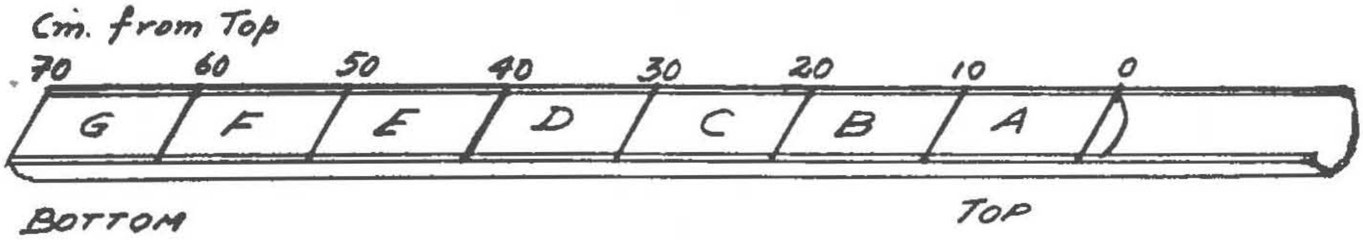

Fig. 15 Sediment core from *Risdam* wrecksite

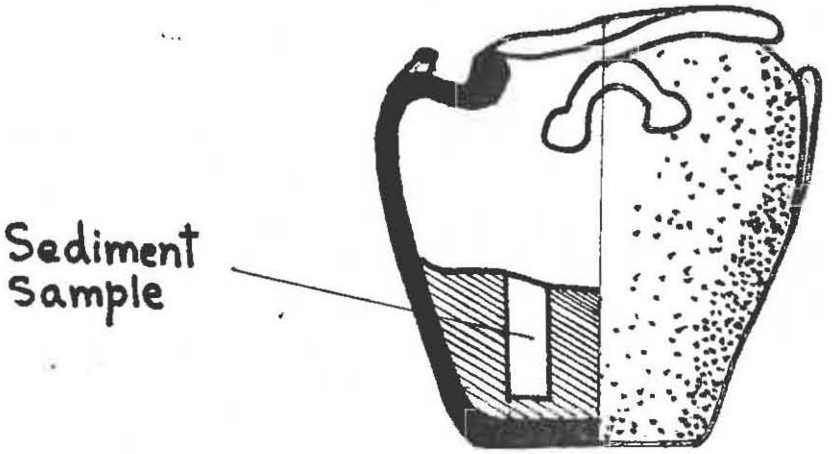

Fig. 16 Sample from Tempayan (Storage jar)

7.1.2. Sediments in the "Acjar" jars (Fig. 16)

"Opportunity sample" was provided during the second expedition when the diving archaeologist recovered large earthenware jars about 35 cm high and about 17 cm at its widest (Green, 1985, this report). these were referred to in the *Risdam*'s cargo list as "Acjar" (pickled foods, originally of Indian origin, subsequently widely adopted in Southeast Asia; *Achar*=Hindi for pickle; *Acjar*=Indonesian and Dutch, for pickle) jars. The sediment was found to contain unusually coarse material, with considerable shell fragments and some organic mud. If the jar was empty at the time of the wreck and was open to receive the marine sedimentation within the very early period of the wrecking of the *Risdam*, it is possible that it was filled with this coarser sediment in the early period of sedimentation. Detailed chemical studies of this and other similar samples from a second jar will be carried out.

7.2. ENCRUSTATIONS ON THE ARTEFACTS

An important group of artefacts recovered during the first expedition consisted of 27 heavy objects, most probably metallic, with encrustations ranging from a few millimetres of sand to several centimetres of very hard concretion. During studies on these objects a 5 cm x 7 cm fragment of encrustation came off loose from a concretion, and the opportunity was taken to study the encrustation in detail. The data obtained is expected to help in understanding the nature of interaction of the artefacts with the marine environment for about 3 centuries. The information would also help at the time the artefacts, presently stored under water, would be treated for restoration and conservation.

The fragment of encrustation was mounted in epoxy resin, sectioned and polished following procedures standard for ore specimens, and examined under the ore (reflectance) microscope. The outer layers clearly consisted of grains of quartz, shell fragments, organic material and some clay. Besides these, distinct ore minerals which are identified as having been deposited in the marine environment, include haematite (Fe_2O_3), Pyrite (FeS_2), Siderite ($FeCO_3$) and Calcite ($CaCO_3$), in that order of abundance. Detailed chemical analysis will be undertaken in the future.

7.3. X-RADIOGRAPHY OF THE CONCRETIONS

Selected specimens of heavy artefacts from *Risdam* with a thick concretion were x-rayed by the author in August 1984 at the Mersing District Hospital, in order to try and identify the objects inside the encrustations. The pictures were taken using a medical x-ray unit of 200 kV power, with no prior experience in archaeological applications of x-radiography! After a number of exposures to deterime the optimum definition of the shadows, pictures were taken, of which some show poorly defined objects. These include shapes of a long fire-arm, a small fire-arm, a long, narrow strip tube of metal and a corrugated object similar to a hand-grip of hilt. Figures 17, 18 & 19 show some of these x-ray pictures as positive prints.

7.4. ENCRUSTATIONS ON THE TIN INGOTS

The large number of 29 kg tin ingots are, undoubtedly, amongst the heaviest cargo on board the *Risdam*. Though tin is a soft metal, it is relatively inert and the ingots are not expected to be heavily corroded despite the 260 years of exposure to the marine environment. The VOC emblem on the ingots is by far the most direct proof yet uncovered that the shipwreck is related to the Dutch trading of the period, if not owned by the Dutch.

The surface coatings from four ingots were scraped gently using non-metallic scraping tools (in order to avoid metallic contamination) improvised from broken fragments of plastic dinner plates. In the laboratory, the scrapings were homegenised, gently disaggregated while still in solid form, sieved and the arbitrarily graded coarse, medium and fine fractions and examined under the microscope and by using chemical spot tests. The yellowish-white flakes in the +60 mesh fraction were found to contain tin, manganese and sodium. The -120 mesh fraction consisted of marine clays and calcium carbonate. The medium grain-size fraction between these two grades contained greyish calcite, greenish marine clay materials, and yellowish white tine oxide or hydroxide, also called "tin-pest".

8. RESULTS OF INVESTIGATIONS

The Sedimentological and mineralogical studies of the sediments from the wrecksite and from the artefacts constitute the major part of the research reported in this paper. Table 4 presents the mineralogical data while Fig. 16 gives a graphic representation of the sedimentological data in the form of cumulative frequency curves.

X-ray diffractometric studies of the clay minerals and chemical analysis of the sediments for major, minor and trace elements are not completed at the time of preparation of this report.

9. DISCUSSION OF RESULTS

1. An examination of the pertinent geographical aspects of the locale of the wrecksite of *Risdam* indicate that the site is likely to be strongly influenced by the sediments from the Mersing river, the monsoon and the proximity to the tidal flat environment.

2. Geological examination of the rocks and the weathering products form the nearby mainland and the islands, the sands from the Mersing river and the beach, suggest that the total sediments at the wrecksite are likely to consist of not only the fine-grained mineral matter derived from the nearby rocks but also considerable quantities of clay minerals common in the weathering/marine environment of humid tropical climate, and considerable amounts of organic material, and marine precipitates such as calcium carbonate, sodium chloride and exoskeletal remains of marine organisms.

3. An examination of previous studies by other workers on the area suggests the possibility of a different configuration of the Mersing coast at the time of the shipwreck.

4. Sedimentological examination of a limited number of grab samples and a single core sample gives a range of cumulative frequency curves suggesting highly variable grain size, sorting and statistical distribution. The clay content is also high, as also the shell content of the sediments is highly variable.

5. Examination of some of the artefacts as well as the sediments, encrustations and coatings associated with them give very useful information on the nature of these products of interaction of the artefacts with the marine environment. This data, though at the moment very limited in nature and scope, will be extended, and is expected to be of great use at the time of the systematic examination of the artefacts and when procedures are considered for their restoration and conservation.

6. Preliminary X-ray photography of metallic objects with encrustations showed possible small arms/hand weapons inspite of inadequate resolution of the pictures.

Fig. 17 X-ray of concretion from *Risdam* (positive print)

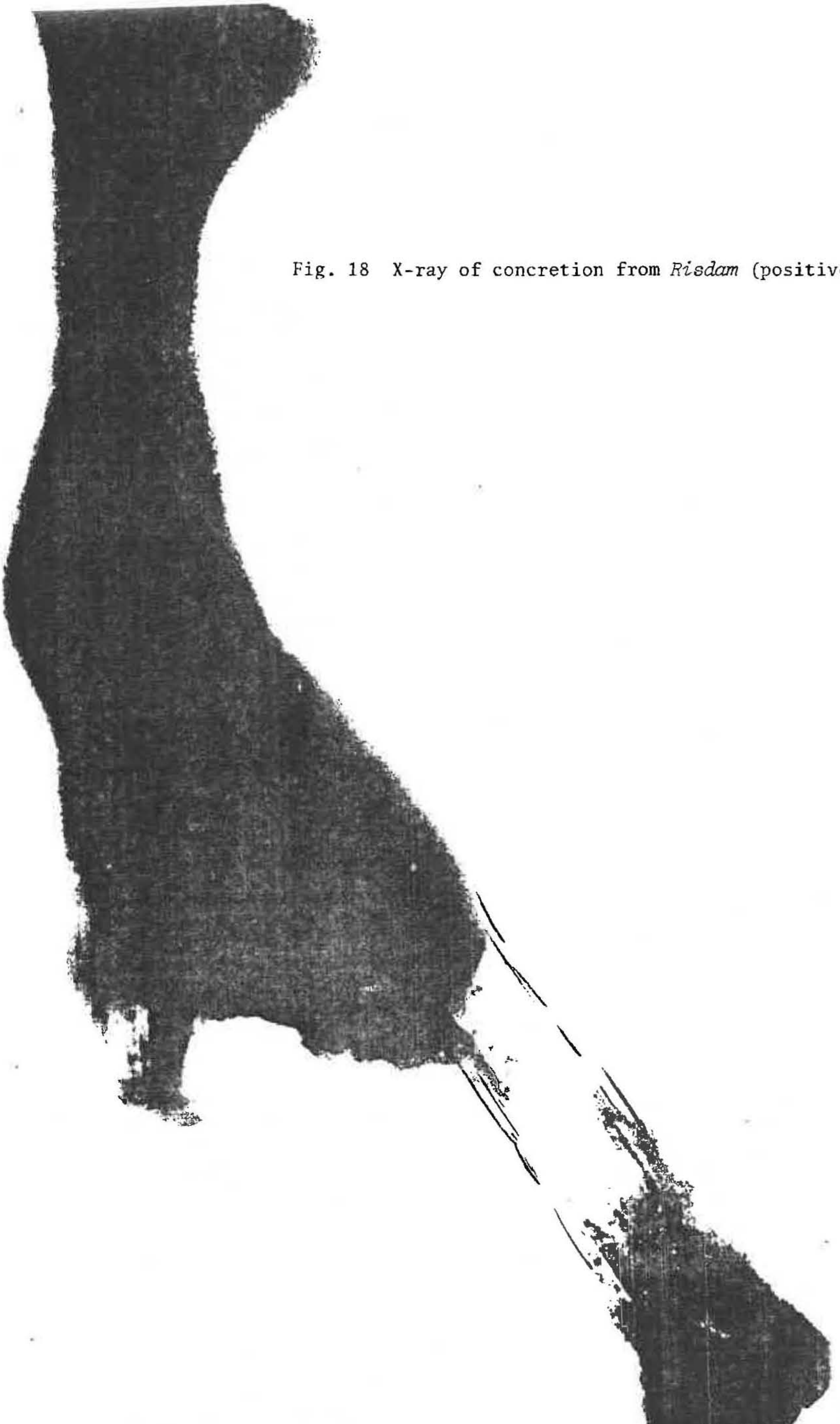

Fig. 18 X-ray of concretion from *Risdam* (positive print)

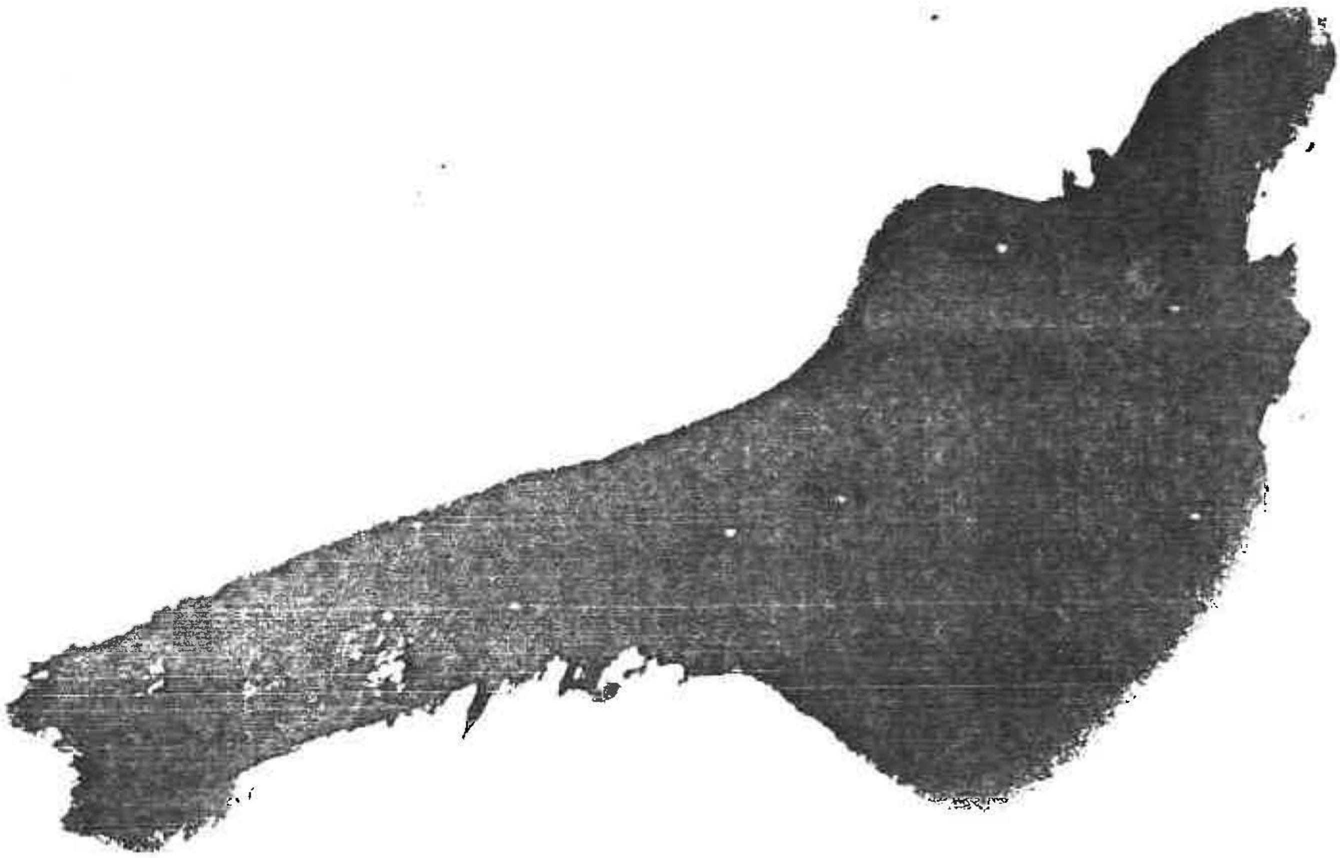

Fig. 19 X-ray of concretion from *Risdam* (positive print)

10. ON-GOING STUDIES AND RECOMMENDATIONS

Studies being carried out but which have not yet been completed at the time of writing this report include the following: i) detailed work on the sedimentological parameters of the sediments; ii) clay mineral determinations by X-ray Diffraction; and iii) major, minor and trace element studies of sediments by AAS, XRF and ICP methodologies.

10.2. STUDIES PLANNED FOR THE FUTURE

Sectioning and sampling of a tin ingot will be carried out for detailed metallographic microscopic analysis and trace element studies. This facilitates an understanding of the status of tin-refining techniques of the period, possible source region of the tin ore by comparison with ingots of Malaysian and Thai origin. Carefully controlled X-radiography of the iron objects encrusted with sand will be carried out to deterime the nature of objects.

10.3. TWO RECOMMENDATIONS

10.3.1. During the first expedition it was observed that there is a great amount of information on the *Risdam* wreck, which was widely scattered. The first expedition itself gave rise to a large amount of archaeological material and there was a strong need for documentation of all the artefacts recovered and their comprehensive description. In view of this a recommendation was made to the Muzium Negara in the present author's "First Quarterley Report" as Honorary Curator, (Ref. No. EVG/MN/QRI dated August 1984) to prepare a comprehensive "LAPORAN SEMENTARA -1" ("Interim Report - 1") documenting everything relating to the *Risdam* and the wreck. Unfortunately, however, it has not yet been possible for Muzium Negara to undertake this activity in view of (i) lack of staff devoted exclusively to this project, and (ii) the preoccupation of all of Muzium's staff in other duties, responsibilities and activities required of them. However, in view of the fact the Jeremy Green 1985, (this report) made a similar recommendation, this present author renews his earlier offer made in his report cited above, to initiate and actively participate in the preparation of such a comprehensive report. This is especially urgent in view of the new data and artefacts generated during the second expedition, and during the on-going research on the site and artefacts. There is also a strong need for such a comprehensive document which is essential before any kind of planning required or any decision-making on the part of the Muzium Negara in respect of the next steps recommended by Jeremy Green (1985, this report).

10.3.2. It is also felt that the absence of geophysical data on the structure of sediments at the site, the extent of the shipwreck and its exact dimensions, the lie and scatter of its artefacts etc had considerably reduced the efficiency of the second expedition (September/October 1985) in its early stages. For example, two valuable days at sea were lost in "relocating" the wreck site and in preliminary "probe survey" to determine extent of the wreck. Attempts in September 1984 to get PETRONAS to carry the survey did not succeed because of some communication problems at the Johore end. Attempts to organise a geophysical survey preceding or parallel with the second expedition also did not materialise for various "logistic" reasons. Again, in view of the recommendation made by Jeremy Green (1985) it is also recommended by this author to undertake this survey without further delay. It can be done very inexpensively compared to a contract to a commercial company, if expertise available at Universiti Sains Malaysia, Universiti Malaya, PETRONAS and some local organisations is utilised. As was offered last year, this author once again offers his time and effort to help initiate this phase of research on *Risdam* and actively participate in it.

10.4. ACKNOWLEDGEMENTS

The author wishes to acknowledge the cooperation of the Muzium officials, especially Encik Kamarul Buyong, Encik Adi Taha, Encik Paiman Keromo, and Encik Mat Nasir Baba as also Encik Jaleel. It is a pleasure to place on record the excellent help received from Mr Jeremy Green, Mr Warren Blake and Professor Jaap Bruijn. The assistance of the following laboratory and general staff of the Department of Geology is thankfully acknowledged: Mr Lee Kok Eng, Mr Koh Tuck Wai, Mr Chong Boon Siong, Mr Lee Meng Chong, Mr Sreenivas, Mr Rosly, Puan Zaimah, Puan Fauziah and Cik Asmaliah.

Dr E.V. Gangadharam

2 Decemember 1985
Kuala Lumpur

REFERENCES

Agocs, W.B., et al, (1959)
Airborne magnetometer and scintillation counter survey over parts of Johore and Malacca.
Geol. Survey, Red. of Malaya, Econ. Bulletin, 1:5.

Coleman, J.M., Gagliana, S.M. and Smith, W.G., (1970)
Sedimentation in a Malaysian High-Tide Tropical Delta.
In: *Deltaic Sedimentation, Modern and Ancient.* J.P. Morgan (Ed.), Soc. Econ. Palaeo and Min., Special Publication No.15:185-197.

Keller, G.H. and Richards, A.F., (1967)
Sediments of the Malacca Strait, Southeast Asia.
Journ. Sed. Petrol, 37:102-127.

METEOROLOGICAL DEPARTMENT, (1978)
Ministry of Transport, Govt. of Malaysia. Climatological Summary, Kuala Lumpur.

Hill, R.D., (1966)
Changes in beach form at Sri Pantai, northern Johore, Malaysia.
J. Trop. Geogr., 23:19-27.

Lee, Soon Chiong, (1972)
Geology of the Mersing area, Johore, West Malaysia.
Unpublished B.Sc(Hons) thesis, Department of Geology, University of Malaya, Kuala Lumpur.

Nossin, J.J., (1961)
Relief and coastal development in north-eastern Johore (Malaya).
J. Trop. Geogr., 15:27-39.

Nossin, J.J., (1962)
Coastal sedimentation in north-eastern Johore (Malaya).
Zeitschrift fur Geomorphologie, 6 (new series):296-317.

Nossin, J.J., (1964)
Geomorphology of the surrounding of Kuantan.
Geologie en Mijnbouw, 43:157-182.

Nossin, J.J., (1965)
The geomorphic history of the northern Pahang delta.
J. Trop. Geogr., 20:54-64.

Suntharalingam, T., et al, (1968)
Geology and mineral resources of the Melaka-Mersing area "C", North Johore-South Pahang: Concluding Phase.
Ann. Rep. Geol. Surv., Malyasia:82-93.

Gangadharam, E.V., (1984)
The sunken Dutch Trading vessel off Mersin Coast, Johor: A Preliminary study of the geological environment of the Shipwreck, its artefacts and their initial preservation. Collequium volume on Dutch Trade and Shipping in the Malay Archipelago before the year 1900.
Department of History, University of Malaya, Kuala Lumpur:1-10.

Gangadharam, E.V., (1985)
Geological and chemical studies on the wrecksite of and artefacts from *Risdam* (1726), off Mersing Coast, Johor, Peninsular Malaysia.
J. of Southeast Asian Studies, (in press).

Green, J.N., (1985)
The Survey of the V.O.C. fluit Risdam *(1726), Malaysia.*
Report to the National Museum, Kuala Lumpur.

Tijia, H.D., (1970)
Monsoon control of the eastern shoreline of Malaya.
Bull. Geol. Soc. Malaysia, 3:9-15.