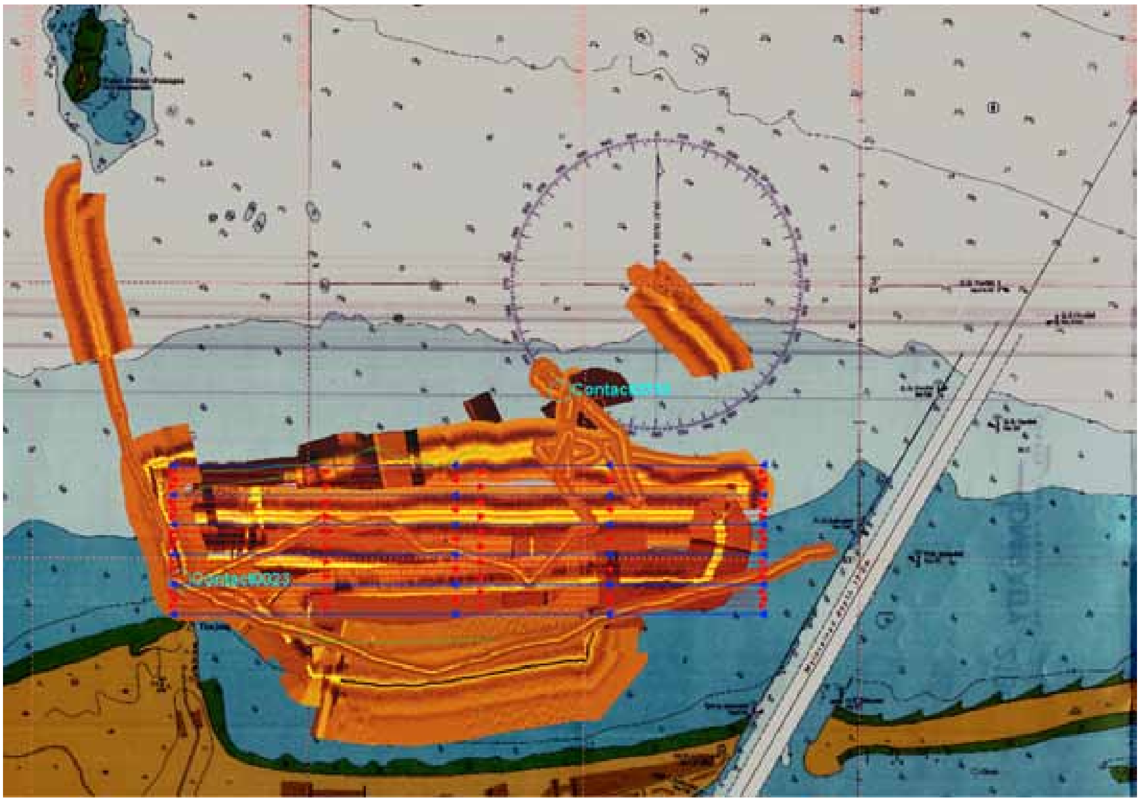
Preliminary Report on Maritime Archaeological Survey in Brunei Darussalam

Jeremy Green and Jun Kimura



Report—Department of Maritime Archaeology, Western Australian Museum, No. 300
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1 Executive Summery

1.1 Introduction

This report outlines the activities and intermediate results of the project of the "Shipwreck Survey within Brunei Waters: the use of Marine Magnetometer & Side-scan Sonar" led by the Maritime Museum Section, the Brunei Museum Department. While the underwater remote sensing survey in August in 2013 in Brunei Darussalam was preliminary-level sidescan sonar and marine magnetometer survey in the waters off the northern coasts of Marau District, we could obtain substantial outcomes and perspectives on future possibility. During the survey, numerous targets were identified, of which a few may be modern shipwrecks, and others need to be further investigated by visual survey techniques, as possible remnants from older watercraft whose hulls have disintegrated. This survey should be considered as reconnaissance, but it will allow a more comprehensive remote sensing survey strategy and underwater archaeological activities to be deployed in the future.

1.2 Aim

to make preliminary assessment for potential underwater sites in the Brunei Waters, in particular, in the areas surrounding Tanjung Batu, Muara, Brunei Darussalam.

1.3 Objectives:

1. to establish approximate locations of potential underwater sites through the implementation of underwater remote sensing survey.
2. to clarify the significance of the area in relation of the discovered ceramic shards to a potential wreck site off at Tanjung Batu.
3. to make recommendations about future investigation, monitoring, and management of the potential sites and its associated artifacts
4. to enhance the capacity of staff of the Brunei Maritime Museum through cooperative work

1.4 Personnel

Dr. Jun Kimura – Asian Research Center, Murdoch University, Australia
Jeremy Green – Department of Maritime Archaeology, Western Australian Museum
Maritime Museum Section, Brunei Museum Department Representatives
Matzin bin Haji Yahya – Brunei Museum Department

1.5 Timeline of project activities

Two weeks: 12–25 August 2013

Dates	Tasks
August 12	Arrival
August 13	Briefing and artifacts inspection in the Maritime Museum, Kota Batu
August 14	Project opening ceremony at the National Archives Building Welcome by Hajah Fatimah binti Haji Aji and presentation by Jeremy Green and
August 15	Preliminary site visit and fieldwork preparation
August 16-18	Underwater remote sensing survey
August 19	Data interpretation
August 20	Survey offshore the Tanjung Batu
August 21-22	Data interpretation and post data analysis
August 23	Tanjung Batu inspection with MWH
August 24	Preliminary report submission

1.6 Fieldwork outcomes

Extensive remote sensing survey from 16 to 18 August produced a large data set. The raw data of the sidescan sonar survey and an preliminary evaluation of the survey data has been presented to the Maritime Museum Section of the Brunei Museum Department. This report is the final assessment of the survey, together with other activities associated to the project, including site inspection at Tanjung Batu.

2. Remote sensing survey

2.1. Environment and background

The proposed area for underwater remote sensing survey was approximately 10km^2, located off the coast of Muara District around the mouth of Brunei Bay (). The survey area stretched from the northeast tip of Tanjung Batu to the deepwater shipping channel cut through Pelmpong Spit, which was constructed in 1968. The shipping channel extends to the west of Muara Island and the port facilities are located on the west side of the channel at Muara. Earlier maps and plans of the area show that the coastline has changed substantially. A previous study of the coastal morphology suggests that the Muara Island could have been once connected to the mainland: 'Growth rates of Pelmpong suggests that it is probably of the order of three hundred years' (Tate 1970: 242).

By the mid-1970s twenty-five archaeological sites had been found on land in Brunei Darussalam and full archaeological excavations had been completed on two major sites: Kota Batu, excavated between 1952–53 and Sungai Lumut, excavated in 1968 (Omar 1975). The various types of ceramics found at these two sites shows Brunei's past engagement in the South China Sea trading networks. The Kota Batu site is the most extensively studied and considered to be the centre of the ancient Brunei polity that had an extensive relationship with the Ming Dynasty. The recent discovery of the late 15th–early 16th century Brunei Shipwreck indicates that at that time Kota Batu was one of the important trading centers in the South China Sea region.

There are older period sites in Brunei that functioned as trading centres, Sungai Liamu Manis, for example, has been dated from ceramics to the Song Dynasty (960 to 1279 CE). The start of the involvement of Brunei in the South China Sea trade is a disputed subject involving the identification of the site of the so-called Po-li or Bo-ni (Nicholl 1983). By the Yuan Dynasty (1279–1368 CE), the polity of northern Borneo had been incorporated into the sailing route stretching

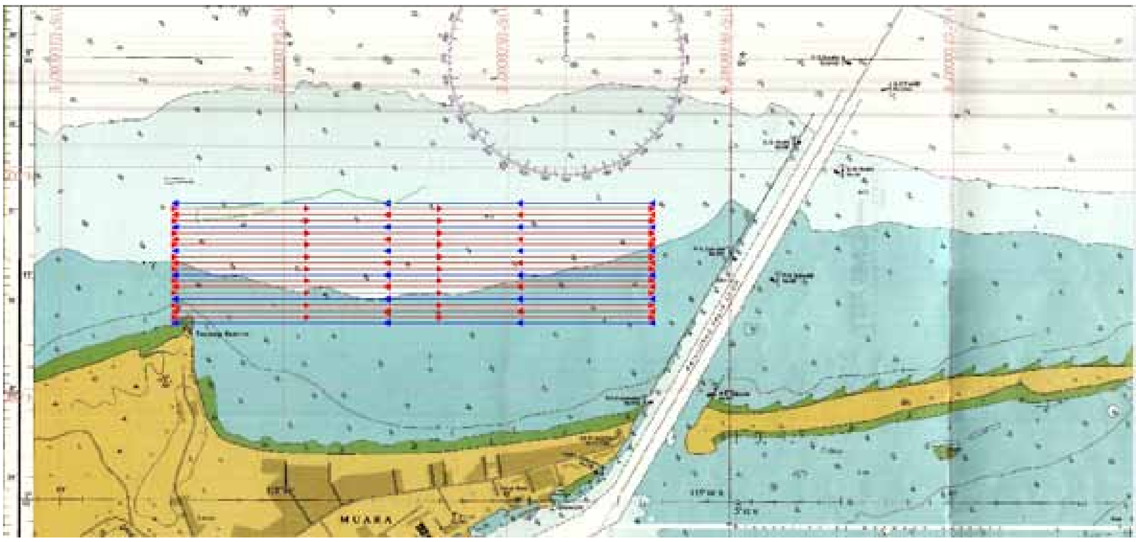

Figure 27. A proposed survey area.

from Quanzhou to the Southeast Asian archipelago (Ptak 1998). Ceramic shards found at Tanjung Batu, suggest that Borneo became more intensively involved in a trade to Fujian in China.

In 1974, Bob Hewitt of the Brunei Agricultural Department, reported finding ceramics on the eastern beach of Tanjung Batu and subsequently a survey was led by Metussin Omar which resulted in the recovery of 193 pieces of ceramics on a small area of the beach (Omar 1975). The ceramics were identified as Song Dynasty wares, the majority were small or large green glazed bowls with combed decorations on the interior and exterior of the body. This type of ware is known as Tongan greenware or celadon and the kiln site is located relatively close to Quanzhou in Fujian. There is evidence that Tongan wares were exported in the Song Dynasty as part of the South China Sea trade. The 12th century Jepara Shipwreck in Indonesia contained a number of Tongan wares, however substantial salvage operations appear to have destroyed the site.

Only a very few Song Dynasty shipwrecks have been found in Southeast Asian waters and the few that have been found have not been properly excavated or protected. Thus the discovery of the relatively large quantity of Tongan wares at Tanjung Batu is of great significance. Future identification of the shipwreck site will bring an insights into the 12–13th century trans-regional trading networks in Southeast Asia and what the kind of ships were engaged in the maritime trade.

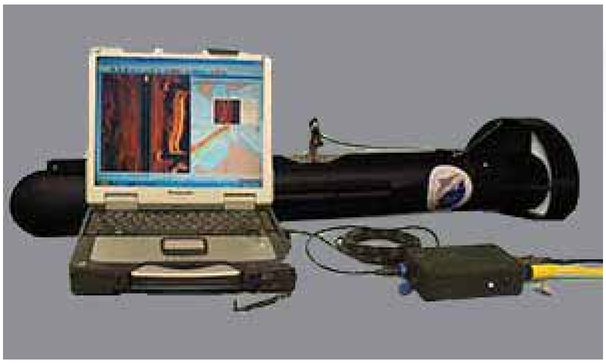

Figure 28. High definition sidescan sonar system (left) and the tow fish of a marine magnetometer (right).

2.2 Survey equipment

The equipment used for the underwater remote sensing survey consisted of four components together with a suite of software.

Hardware components:

i. Marine Sonic Sea Scan HDS (High Definition Sonar) (), consisting of a dual-frequency sonar (300/900KHz) which incorporates both low and high frequency transducers in a single tow fish, together with a 30 m cable, a Standard Topside Unit (STU) interface box and a power cable.

ii. Marine Magnetic Explore overhauser magnetometer (Figure 28) consisting of a tow fish, 50m cable, electronics box.

iii Trimble OmniStar Omnilight 132 DGP and Garmin GPS with antenna and control box.

iv. A 240 volt power supply provided by two 12 volt automotive batteries powering a 600w 12v DC to 240v AC inverter.

Computer software components:

v. SonarWiz5 is an acoustic mapping package designed to produce real-time mosaics from sidescan sonar data. In real-time mode, mosaics can be generated on-the-fly at any resolution and size. Visualization tools such as zoom, pan, measure, and on-the-fly image scaling are available to enhance mosaic production.

vi. Marine Magnetics BOB, underwater magnetometer data aquisition and control software.

2.3 Survey procedures and operations

2.3.1 Preparation

A 31ft diving boat, owned by the Maritime Museum, was used for the survey. The boat was powered by two Yamaha outboard engines. A davit with a snatch-block pulley deployed the sidescan sonar to port while the magnetometer fish was deployed 3 m from the stern of the boat.

Admirality Charts of the proposed survey area were obtained (No.1844 and No. 2134) ahead of the survey. These charts were digitized and then georeferenced using Esri ArcMAP, a GIS basis software package. The georeferenced charts were then used as an underlay in the SonarWiz navigation.

Prior to the commencement of the survey a survey grid was created in SonarWiz which outlined the lanes that the survey vessel would follow. For the 4 km^2 area to be surveyed, 21 parallel east–west lines 4 km long were set up in SonarWiz (Figure 27). The area covered relatively shallow water (3–7 m depth) and, using SonarWiz navigation window, it was quite simple to maintain the vessels course on the survey lines.

2.3.2 Survey operations

On the first day of the remote sensing survey (August 16), the survey team completed approximately 30 km of track operating the sidescan sonar system at 300 kHz at a range of 200 m. Areas of shallow water were encountered about 200 m off the northern beach of Muaru so it was impossible to continue the survey in this area. As a result the survey was extended north of the survey lines into deeper water.

The marine magnetometer survey encountered problems with irregular noise, possibly thunderstorm activity or electromagnetic radiation from the nearby port. Weather conditions in the afternoon were also not favourable for the magnetometer survey, with lightning flashes observed in the sky. As a result, the magnetometer survey was abandoned.

Sonar were recorded using a Garmin GPS linked to the SonarWiz program. All tracks were recorded in their entirety, and a list of Contacts was made of potential targets as they were encountered. The first sidescan sonar reconnaissance survey was successfully completed in a single pass using a 300 kHz frequency. In all, 15 Contacts were recorded (Contacts Nos 0–14) (Figure 29).

In the second day, the contacts were investigated in more detail using the

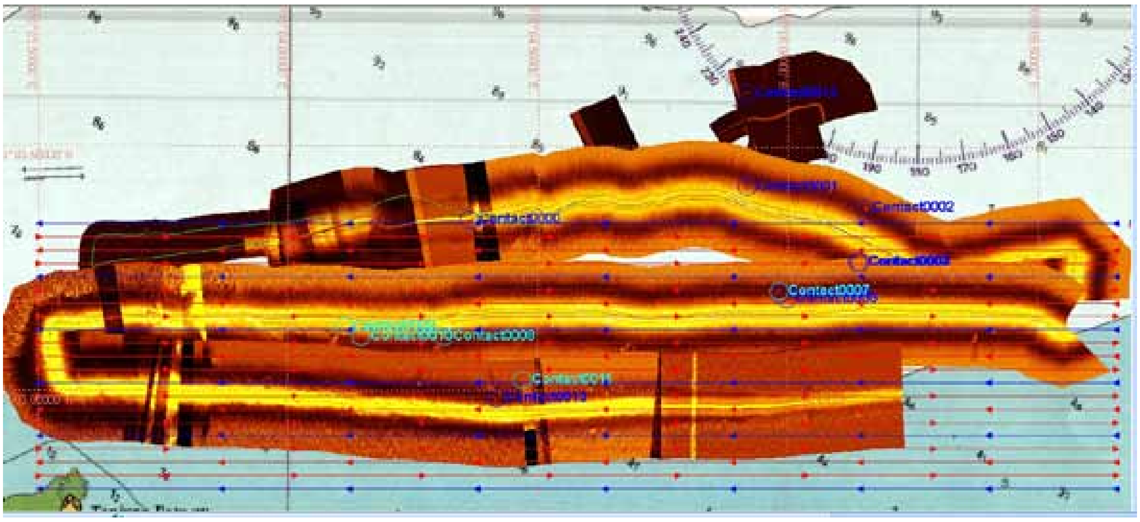

Figure 29. Day 1 outcome: acoustic images of the seabed produced by the sidescan sonar survey with Contacts in the 1st Day.

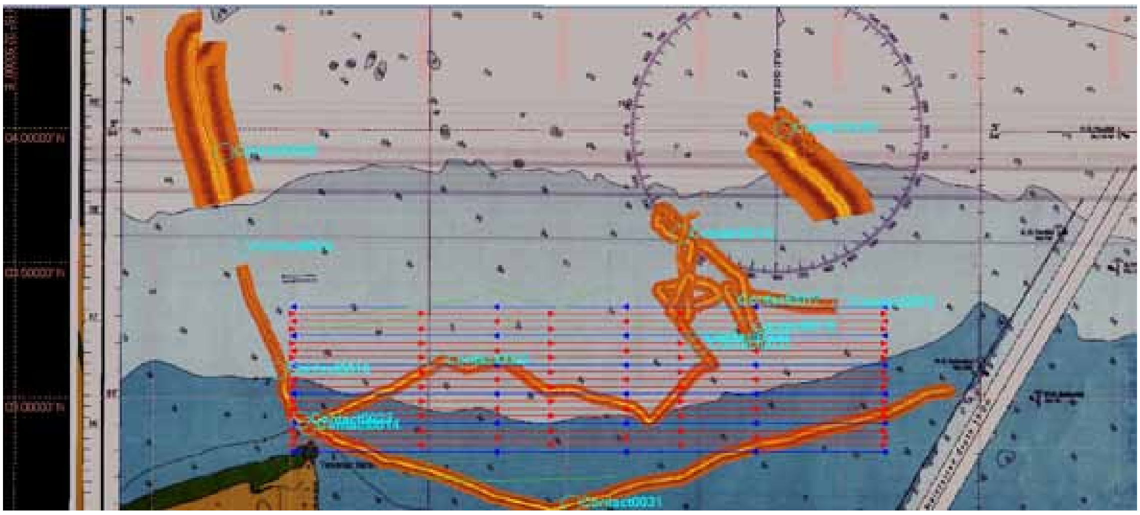

Figure 30. Day 2 outcome: track plot of the high resolution survey showing the sidescan acoustic images of the and the contacts.

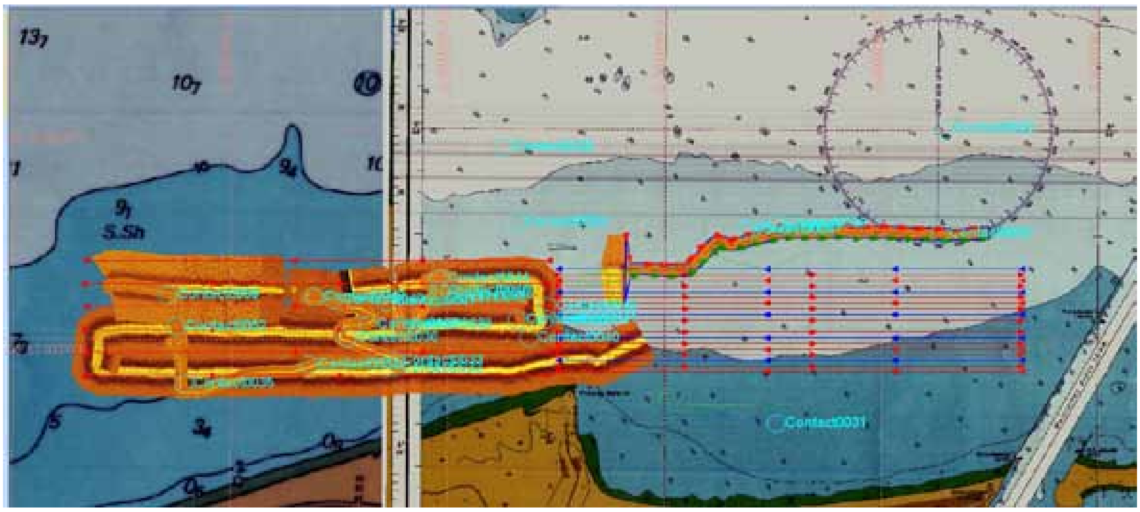

Figure 31. Day 3 outcome: acoustic images of the seabed produced by the sidescan sonar survey, both low frequency and high frequency and the contacts.

high frequency (900 KHz) that provides a high resolution image of the sea bed. The survey boat passed directly over each of the targets, thus obtaining better resolution images of the original contacts. A total number of both low and high frequency image of the contacts during the second day operation includes Contacts Nos 15–31 (Figure 30).

In the morning of the third day the survey area extended into the waters west of the tip of Tanjung Batu. The sidescan sonar survey used low frequency 300 kHz on a 200 m range. The reconnaissance survey of approximately 30 km track covered approximately 4 km^2 area. Following the identification of the interesting anomalies in this area, a further survey was conducted at the high frequency 900 kHz 50 m range. The low and high frequency recorded 21 Contacts (Contact Nos 32–52) (Figure 31).

3 Survey Results

3.1 Marine magnetometer survey

A marine magnetometer is an instrument to measure the Earth's magnetic fields and iron objects or ferrous material, such as anchors, cannon, iron fastenings and cargo disturbs this magnetic field. Thus by recording the Earths magnetic field intensity such objects disturb this field and are known as anomalies. The marine magnetometer survey, however, was limited in this project task by the occurrence of magnetic field disturbances of 5 nT probably the result of an unidentified electromagnetic disturbance.

The exact cause of the electromagnetic disturbance is currently being investigated for future reference. Possible reasons for the disturbance include the electromagnetic radiation from the Muara District industrial complex; effects of geological laterite deposits formed by tropical weathering of ultramafic (highly metamorphic) rocks, where iron is leached from the rock resulting in an overburden that has a high iron content; or thunderstorm activity.

Archaeologists have identified the locations of some modern sources of ferrous material, such as iron ships and cables that would affect the magnetic field readings, although the acoustic images from sidescan sonar survey would show this material in the acoustic record. All data sets are useful to be cross-checked for relevant correlations in future marine magnetometer survey in the areas.

3.2 Sidescan Sonar Survey

Within the scanned area 52 contacts were made using both low and high frequency surveys and are discussed further here. A list of these sidescan sonar acoustic images are submitted to the Brunei Museum Department. Their geocoordinate information is listed in the Appendix I.

Very few of these images are confirmed as shipwrecks at this stage and at least one of the contacts can be considered as a relatively modern shipwreck that was already located on the Admiralty chart (Contact No. 30) (Fig. 5). The side scan sonar survey revealed a few interesting objects that may relate relatively modern shipwreck Contacts No. 20 (Figure 32), and Contact 21 (Figure 33). The high-resolution acoustic images of these contacts clearly show some distinctive circular objects lie on the seabed. The diameter of each of these objects measures approximately 0.8 m in average, indicative of modern debris, such as vehicle tires.

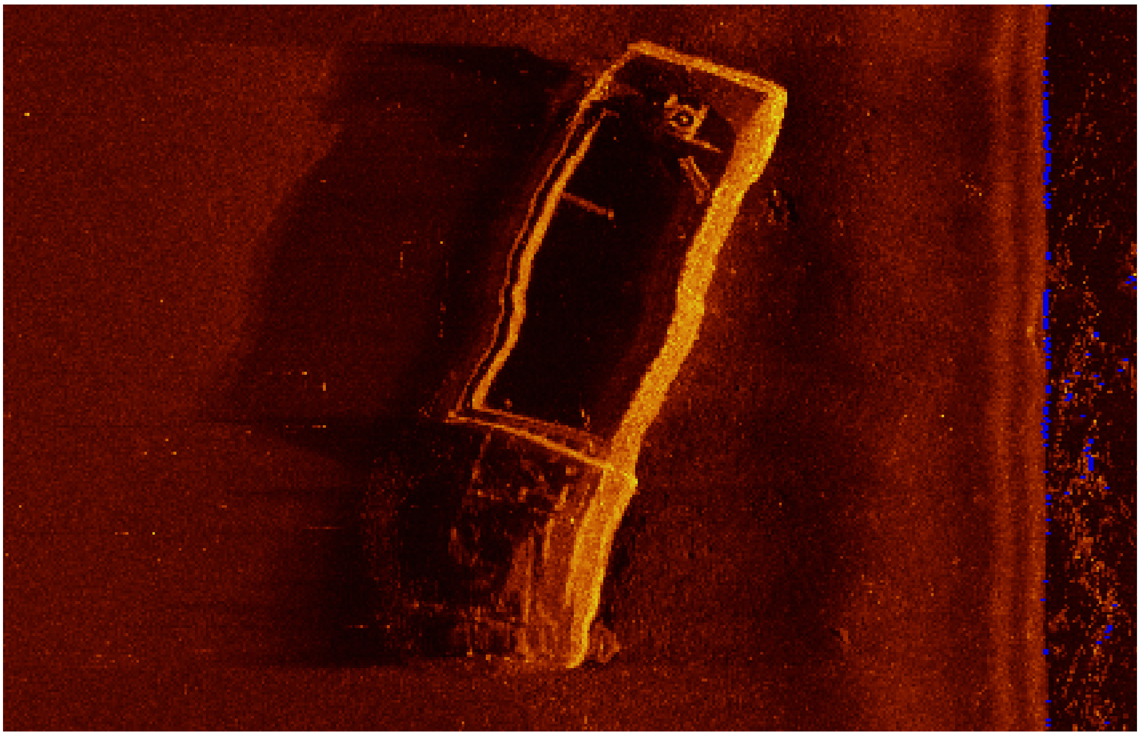

Figure 32. Wreck site target No 20.

The date of the above three contacts has not been determined. They are located in a depth of around 10 m and accessible by diving. In order to determine further details visual inspection need to be conducted.

Some of the contacts appear to be exposed rock or geological formations. However, of great interest are a number of contacts with one or more mounds on the sea floor. These mounds need to be further investigated, as they may be associated with remains of older periods and are shown in Contacts No. 14, 15, 18, 19, 20, 23, 24, 27, 28, 51, and 52. (Figure 32–Figure 18)

3.3 Seabed Classification Analysis on the Sidescan Sonar Images

Seabed classification is an analytical method to assort seabed features and geological sediment. It is used in a wide range of sonar mapping missions including marine biological habitat studies, dredging projects, pipes and cables laying projects, sea platform construction, and archaeological survey.

SonarWiz 5 has function to convert sidescan sonar acoustic images to a colour coded map which represents classes of sea floor material or aggregate. Each colour is corresponded to different class of sediments, such as silt, sand, gravel, and rock bed. The colour codes develop based on algorithm calculated in the Sonar Wiz5 system and are effectively used for the distinctiveness of the sediments. The featured colours represent seabed features composed of natural geological formation rather than cultural objects. This helps us with evaluating the identified Contacts on the sonar acoustic images whether these anomalies are natural formation or not; that is, it functions as a means to distinguish cultural objects from natural seabed features.

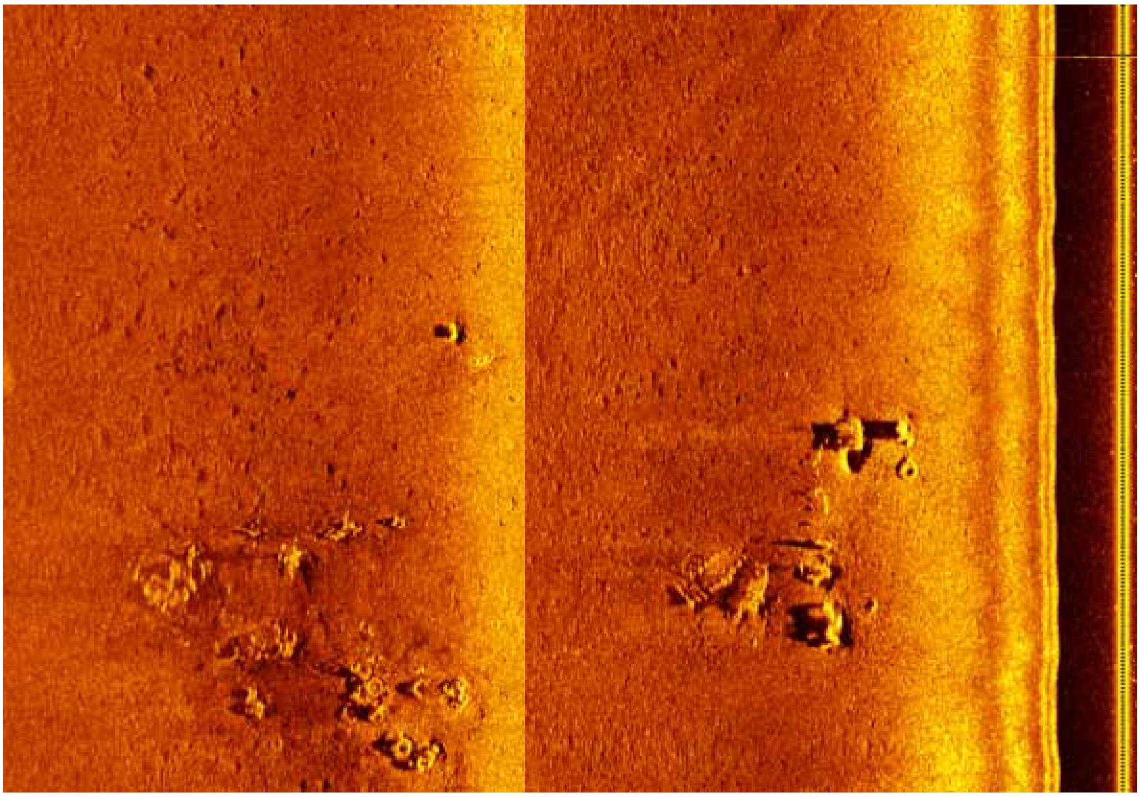

Figure 33. Contact No.21, considered to be relatively modern objects.

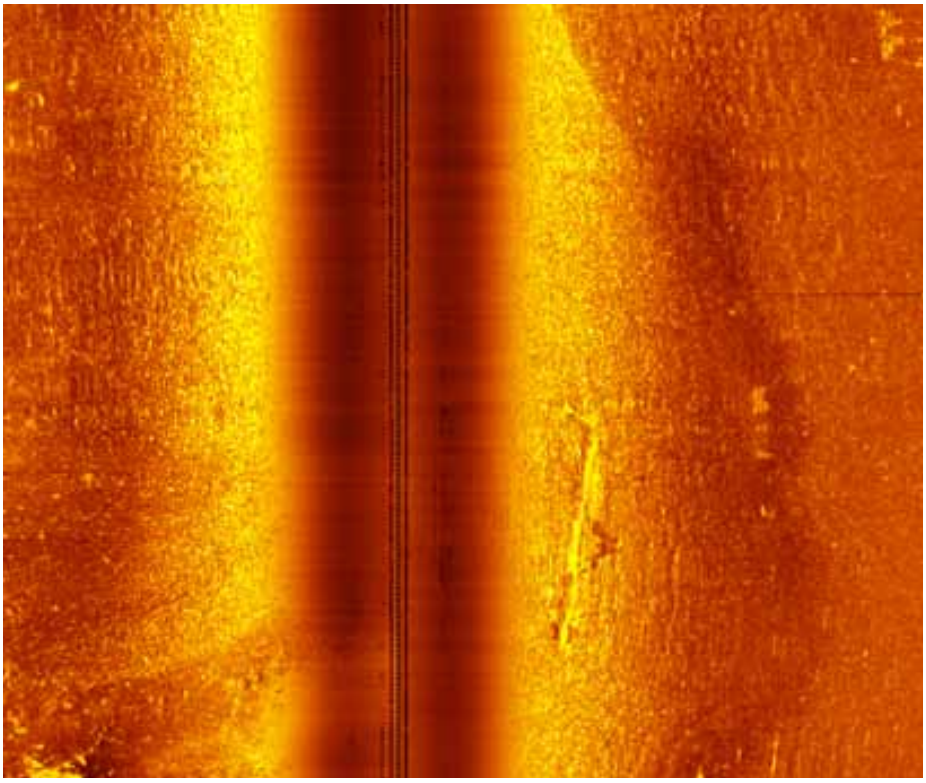

Figure 34. Contact No. 14, possibly a trawl warp or anchor chain.

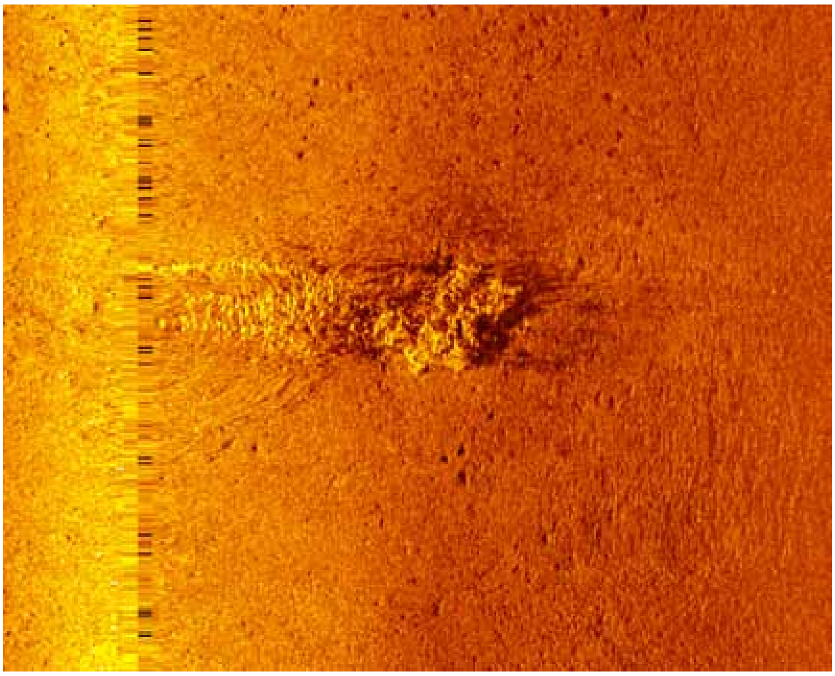

Figure 35. Contact no. 18.

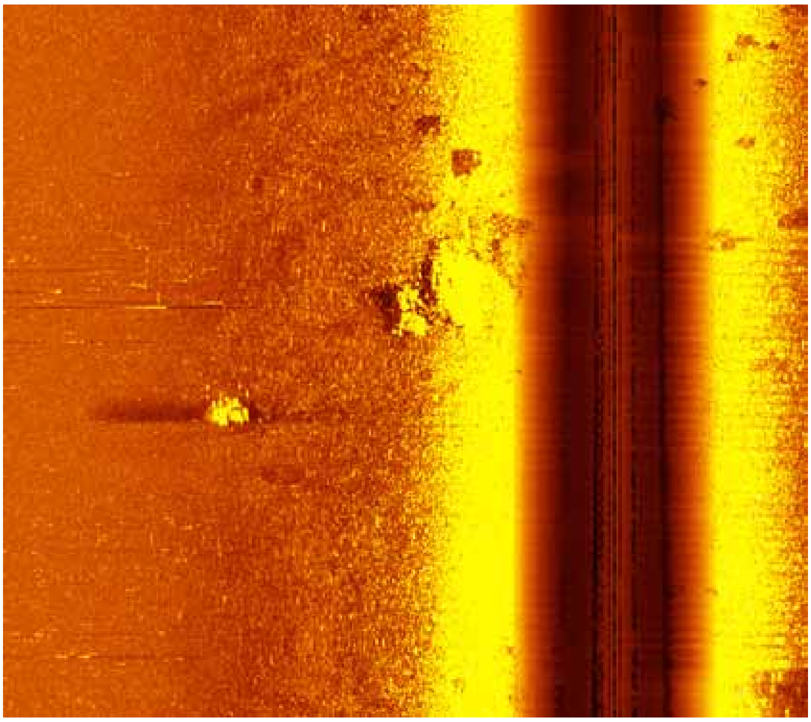

Figure 36. Contact No. 15. probably fish

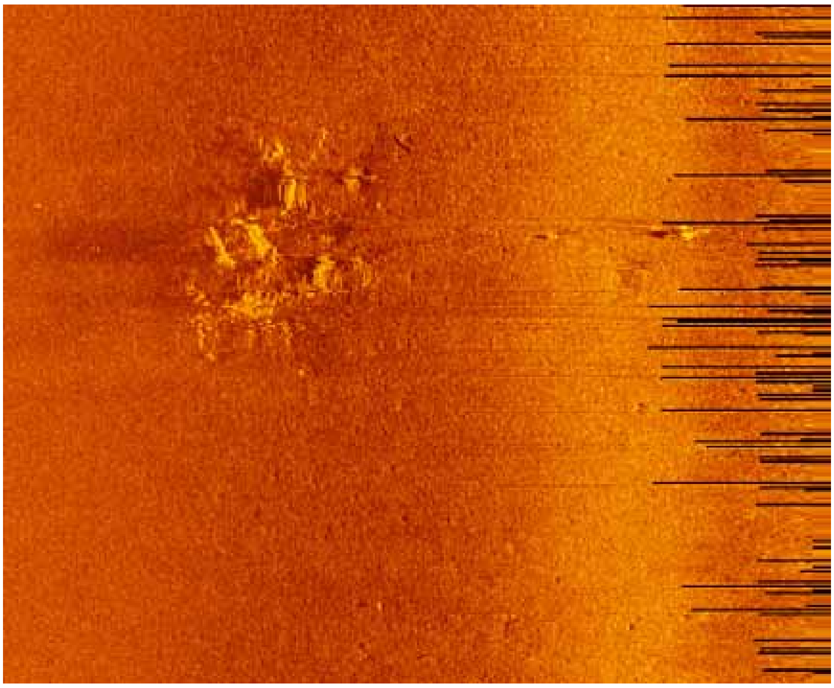

Figure 37. Contact No.19

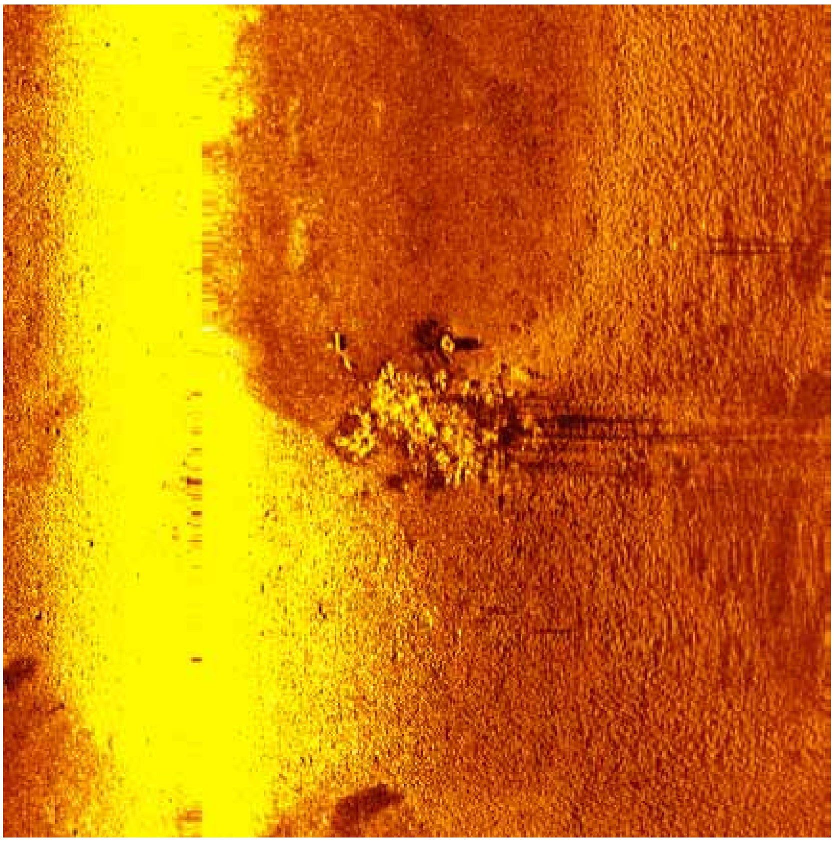

Figure 38. Contact No. 23

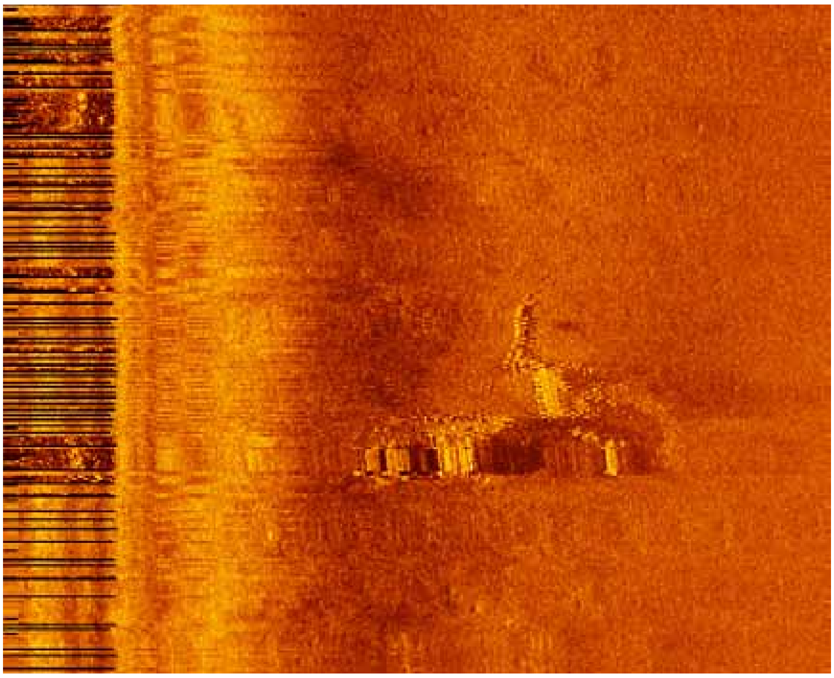

Figure 39. Contact No. 24

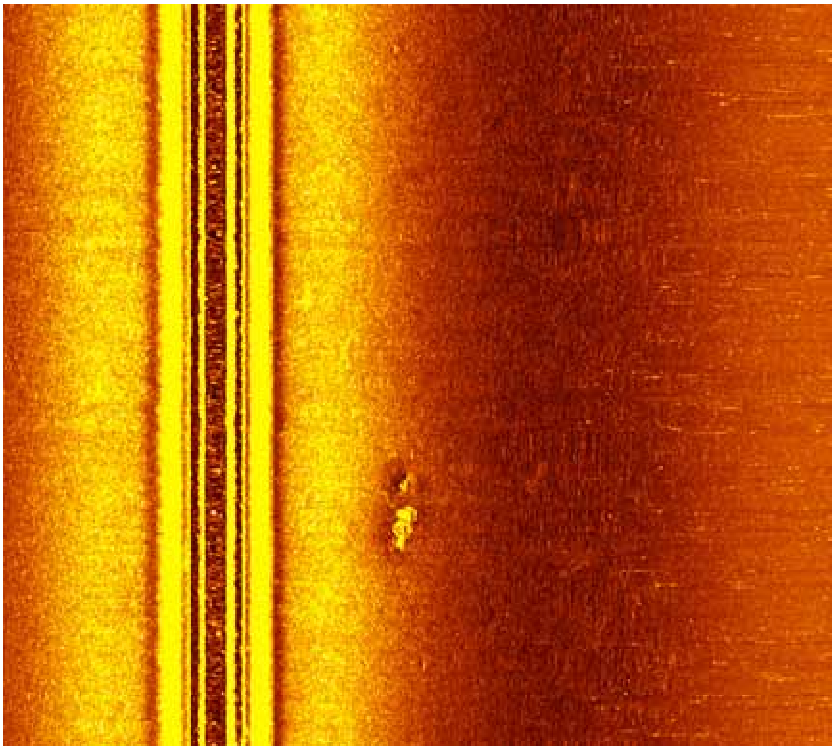

Figure 40. Contact No. 28

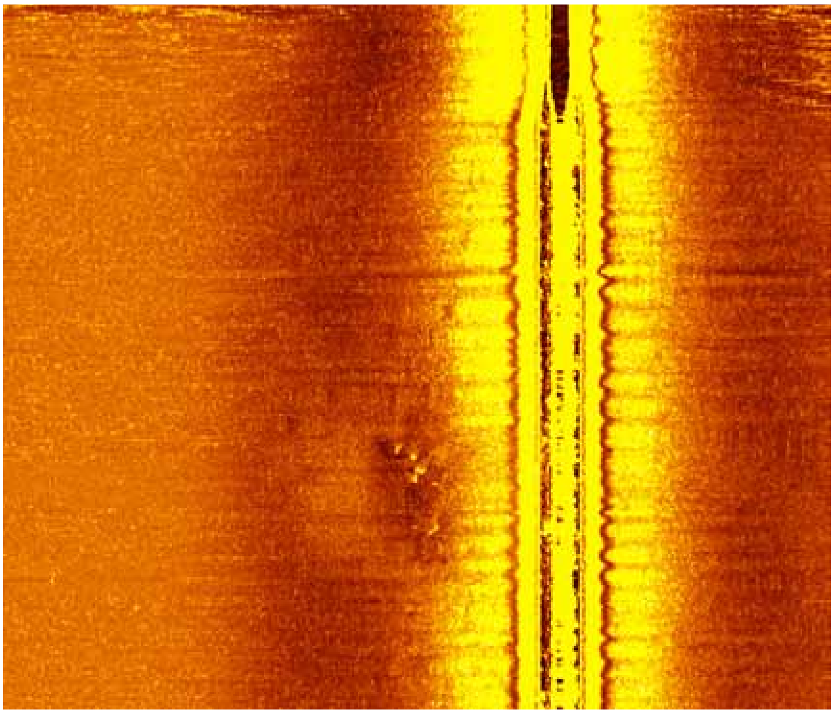

Figure 41. Contact No. 50.

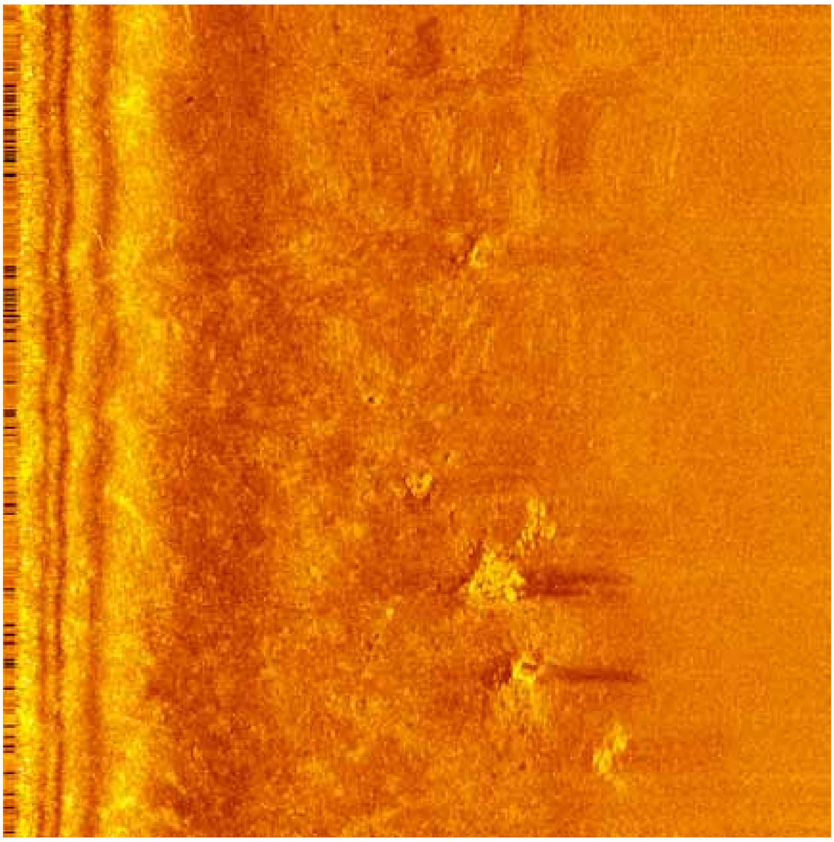

Figure 42. Contact No. 51.

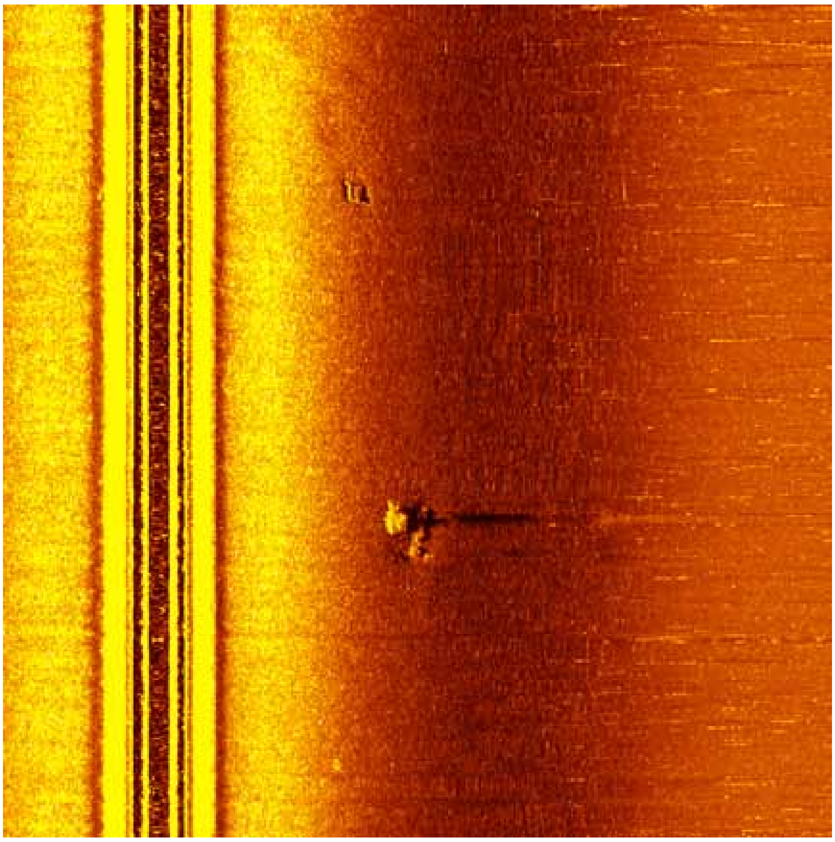

Figure 43. Contact No. 27.

Figure 45 shows the result of the Seabed Classification analysis on the acoustic imagery data from the sidescan sonar survey with high frequency (900 KHz). Six Contacts (Contact No. 17,18, 19, 32, 34,and No. 35) have been indentified on the top seafloor image (Figure 44). Of these, Contact No. 19 and No. 32 are identified on the Seabed Classification map (Figure 45). These two Contacts are likely to be distinctive natural sediment from sand seabed, possibly isolated rocks or some other solid composition, although it is suggested that the Contact No. 19 is still worth being inspected by diving operations. The rest of the Contacts include possible cultural objects but may be objects dating back to relatively modern period, according to what is visible on the sidesonar images. The Contact No. 18 remains as an interesting target and recommended to be further investigated.

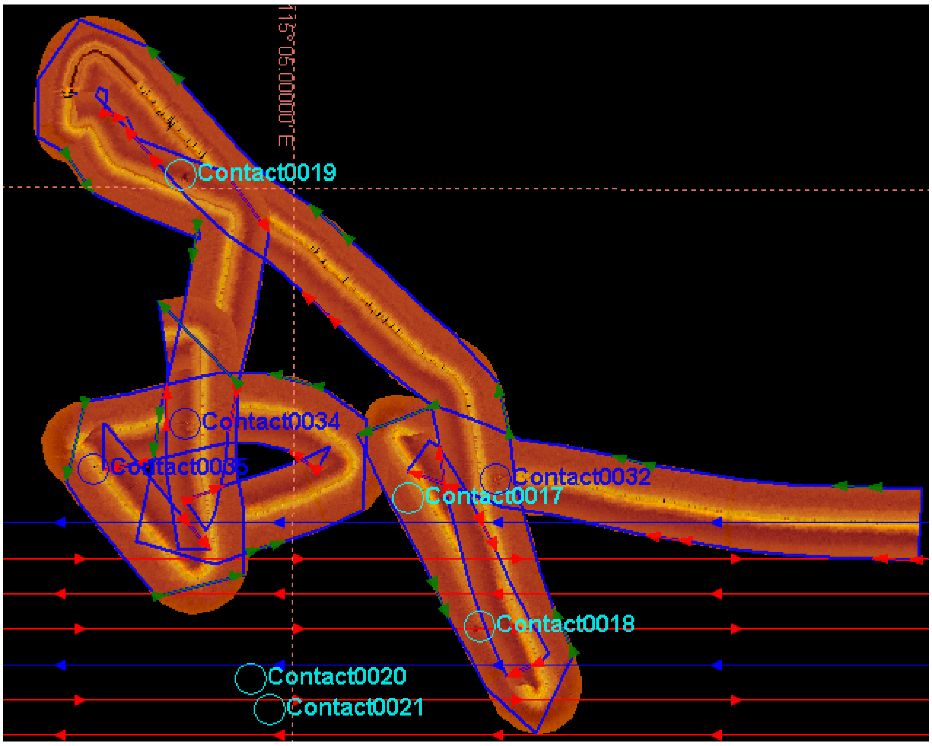

Figure 44. Survey area showing sonar track and targets.

Figure 45. Seabed classifications howing details of Contacts 19 and 32.

4. Site assessment at Tanjung Batu

4.1 Site inspection

The green-glazed ceramics discovered at Tajung Batu is a unique asset for the Maritime Museum. Detailed observation of the ceramic material has revealed calligraphy on the bottom of some of the Tangan style wares (Figure 17). Most of the ceramics shards found in 1974 have sharp edges and do not show the substantial damage from rolling. The condition of the broken indicates that they have not been exposed on the seabed. The only complete piece, a glazed shallow bowl, was also found in 1974. The edges of those ceramic shards found in 1975 onwards, however, tend to have polished edges.

During the remote sensing survey, it was noticed that some form of development was taking place on the eastern beach at Tanjung Batu. A site inspection was conducted to assess the impact of the on-going development on the beach and the current condition of search for a collecting of beach ceramic shards. The eastern area of Tanjung Batu has narrow shoreline stretching from north to south. The northern part of the shore is rocky with many gravel and sandstone boulders from the Tanjung Batu headland. The southern area consists of sand and sandstone boulders that are mostly located under the foot of headland. A rock long jetty associated with the beach development has been constructed around the segment of the two areas. The development work has already changed the topography of the southern shore where a large amount of sand was newly accumulated on the shore. There is currently no evidence of a ceramic scatter on the beach.

To inspect intertidal zones a swimline search was conducted. A bench mark was established at the corner of a foundation for one of the drains at the foot of the headland. A temporary datum for the swimline search was placed 10 m east from the bench mark (UTM 50N0284978, 05574988). Another datum was set in the position of 60 m south from this point; a 60m datum line was fixed between north and south. A line search was conducted along the datum line by a team of 6 members who spread out along a length of a rope at an interval of 5m. Three transverses were made, so that the area of $1.8km^2$ was inspected. Despite the systematic survey, the evidence of cultural remains was not found.

4.2 Consultancy meeting with developers

During the site assessment, we identified a developer of the Tanjung Batu area and a meeting with them. MWH Global, a global company in consulting business of wet environment infrastructures, is undertaking a coastal protection project of the shores under the foot of Tanjung Batu. The purpose of having the meeting with people from MWH was to exchange opinions on the potential impact of the development on the Tanjung Batu site and ensure the implementation of relevant actions and procedures to minimize the possible destruction of the site. Recommendations

5 Proposed future activities

5.1 Systematic investigation of anomalies and targets with SCUBA divers, underwater drop camera, or ROV (see Appendix II):

Each of these methods has advantages and disadvantages. For example, the visual inspection with divers is one of the most realistic options in terms cost and workload. However, there is a need to consider some issues; for example, the condition of the diving environment, such as low visibility requires extensive support from experienced underwater archaeologists working under similar conditions in Southeast Asian. Underwater drop camera and ROV are available with relatively reasonable prices these days; however, the operation workload and long term maintenance costs of these instruments need to be carefully considered.

5.2 Monitoring and extensive archaeological survey at Tanjung Batu

Consultative meeting with the MWH Global during the project enhanced a chance to make further mitigation actions to minimize the impact of development work on possible archaeological remains. Considering historical significance of the Tanjung Batu areas, regular visits to see the ongoing site condition is strongly recommended. Apart from the site monitoring, the Maritime Archaeology Section of the Brunei Museum may consider extensive archaeological survey on the shores and intertidal zones of Tanjung Batu, as well as in the waters vicinity to the shore by SCUBA Diving/Snorkelling (Line search) with the possible use of marine metal detectors (see Appendix II). These are recommended to be practiced before the completion of the construction, as afterwards more people would start to access to the beach.

5.3 Further underwater remote sensing survey in the northern waters of Tanjung Batu and other parts of the Brunei waters

In terms of the location and environment as well as what's been discovered so far, there is almost no doubt of the long term significance of Tanjung Batu in the history of Brunei. Based on this perspective, further remote sensing of the deeper waters of Tanjung Batu is recommended. There are fish farms in northern waters. The Maritime Archaeology Section of the Brunei Museum Department needs to select the next survey areas carefully. In order to determine accessible and potential survey areas, interviewing local people in fishery activities and professional divers ahead of the actual remote sensing survey is important.

5.4 Artefact inventory of the ceramic recovered from the Tanjung Batu beach

Apart from an introductory article, little information is available on the Tanjung Batu artefacts. It is recommended that an inventory of the artefacts is made. Museum research fellows can consider publications regarding the artefacts, including the analysis of site environment and formation processes of the Tanjung Batu areas.

6 Long term perspectives

6.1 Development of an Underwater Cultural Heritage management plan database

Brunei's waters probably contain a unique archaeological and heritage sites that record of national and international maritime activities of the past. Brunei faces the South China Sea that has been a highway, and sea and river voyaging must have been part of the cultural and social formations of the country. Such underwater cultural heritage can be diverse in terms of types, ranging from the prehistoric to World War period.

The UNESCO Underwater Cultural Heritage section has recently mentioned, 'The Centenary of the First World War will be commemorated in 2014'. Hence, the development of Brunei's national strategy on the protection and management of UCH should not be restricted to a narrow temporal focus.

6.2 Human capacity building on the National Maritime Museum

To nominate staff to research institutes and organizations is a training opportunity for Brunei underwater archaeology and for young fellows to work underwater on the site as part of their training, and gaining experience, in archaeological fieldwork.

i. Cooperation with the other sections of the Brunei Museum Department (e.g. Conservation and Archival Research Sections and Coastal Development Sections).
ii. Specialist training for Brunei Museum staff in the operation of remote sensing and maritime archaeological GIS.
iii. Historical Spanish, Dutch, and British maps and nautical charts, for example, are recommended to be obtained and studied extensively. Various digitized imageries of old Broneo are available online (See Appendix III) from the David Rumsey Historical Map Collection: http://www.davidrumsey.com

It is suggested that a two week workshop is developed for Brunei Museum staff to provide hands on experience in operating remote sensing equipment and to develop a Underwater Cultural Heritage GIS for Brunei.

Appendix I. List of Contacts

TargetName	Date Time	Latitude	Longitude
Contact0000	08/16/13 11:12:18	5.055814062	115.0727261
Contact0001	08/16/13 11:43:55	5.056943986	115.0819734
Contact0002	08/16/13 11:48:01	5.056251733	115.0858252
Contact0003	08/16/13 11:48:05	5.054400654	115.0856573
Contact0004	08/16/13 11:49:25	5.05441154	115.0857101
Contact0005	08/16/13 12:05:21	5.05332493	115.0830555
Contact0006	08/16/13 12:06:49	5.053127993	115.0832901
Contact0007	08/16/13 12:07:05	5.053397949	115.0830175
Contact0008	08/16/13 12:14:21	5.051837481	115.0718791
Contact0009	08/16/13 12:16:27	5.052169568	115.0685618
Contact0010	08/16/13 12:16:35	5.051819862	115.0691336
Contact0011	08/16/13 12:39:10	5.050351773	115.0744804
Contact0012	08/16/13 16:03:05	5.049121384	115.0803709
Contact0013	08/16/13 17:00:47	5.043098957	115.0752603
Contact0014	08/16/13 17:32:08	5.048212189	115.0593756
Contact0015	08/16/13 17:36:47	5.051662323	115.0575961
Contact0016	08/17/13 10:13:16	5.055964378	115.0916327
Contact0017	08/17/13 10:22:28	5.056032392	115.0847985
Contact0018	08/17/13 10:24:38	5.0543932	115.0857251
Contact0019	08/17/13 10:35:19	5.06014682	115.0818993
Contact0020	08/17/13 11:26:05	5.05372042	115.0828133
Contact0021	08/17/13 11:26:41	5.053322974	115.0830515
Contact0022	08/17/13 11:48:48	5.052250219	115.067205
Contact0023	08/17/13 11:58:35	5.04856956	115.0589623
Contact0024	08/17/13 12:12:03	5.059298671	115.0553145
Contact0025	08/17/13 12:19:09	5.065175687	115.0543193
Contact0026	08/17/13 13:06:56	5.058690289	115.0728612
Contact0027	08/17/13 13:07:05	5.058740574	115.0733853
Contact0028	08/17/13 13:09:26	5.059197938	115.0752772
Contact0029	08/17/13 13:23:26	5.058475498	115.0878889
Contact0030	08/17/13 13:38:38	5.066700251	115.0881236
Contact0031	08/17/13 15:40:34	5.043445667	115.0753105
Contact0032	08/18/13 10:36:04	5.047746289	115.0457619
Contact0033	08/18/13 10:36:16	5.048314016	115.0458607
Contact0034	08/18/13 10:43:47	5.047963376	115.0394023
Contact0035	08/18/13 10:53:19	5.046441363	115.0297556
Contact0036	08/18/13 11:27:41	5.050084508	115.042362
Contact0037	08/18/13 11:29:04	5.0511665	115.0439697
Contact0038	08/18/13 11:32:12	5.051123561	115.0464861
Contact0039	08/18/13 11:41:05	5.0515505	115.0553313

Contact0040	08/18/13 11:42:04	5.050140692	115.0562979
Contact0041	08/18/13 11:43:31	5.051647129	115.0576247
Contact0042	08/18/13 11:45:04	5.052619893	115.0576552
Contact0043	08/18/13 11:53:07	5.053567366	115.0497096
Contact0044	08/18/13 11:53:21	5.054801599	115.0493345
Contact0045	08/18/13 11:53:37	5.053869454	115.0494409
Contact0046	08/18/13 11:53:39	5.05328874	115.0491535
Contact0047	08/18/13 11:58:01	5.052980083	115.0453147
Contact0048	08/18/13 12:01:23	5.053073428	115.0412845
Contact0049	08/18/13 12:02:55	5.053378284	115.0398463
Contact0050	08/18/13 12:14:38	5.053441592	115.0285713
Contact0051	08/18/13 12:28:07	5.053438083	115.0285913
Contact0052	08/18/13 12:31:18	5.050959715	115.0291585

Note latitude and longitude is in decimal degrees and datum is WGS84

Appendix II. Background to Remote sensing survey work and subsequent investigation

Remote sensing equipment

Remote sensing for underwater cultural heritage (UCH) involves using equipment that is able to investigate what is on and under the seabed (see Green, 2004 and NAS, 2004). Conventionally this involves three different technologies: acoustic; magnetic; and optical. All of these techniques are backed up by the global positioning system (GPS) in its various forms. The information is usually displayed on a geographical information system (GIS). The use of the different technologies will be discussed briefly below.

Acoustic technology

Acoustic technology is divided into a number of different types of equipment that can be used to detect UCH, both on the surface and below the surface of the seabed. These include:

High Resolution Multibeam Sonar

High-resolution multibeam survey can be deployed over a range of seabeds and water depths and can provide fast collection of high quality bathymetric data that can form the core of the geophysical data set. Subsequent alternative geophysical techniques (listed below) will be used in targeted areas.

Side Scan Sonar

The side scan sonar is an instrument that is used to survey the surface of the seabed. It consists of a tow-fish that is trailed behind the survey vessel. Transducers are mounted on either side of the tow-fish and emit a narrow (in the fore and aft direction) fan-like sonar signal. The sonar beam 'illuminates' the seabed and the reflected echoes are received in time by the sonar transducer (the closest signals

Figure 46. Underwater metal detector.

Figure 47. A simple drop camera.

Figure 48. Small ROV.

arriving first). These time-dependent signals are displayed on a computer screen, which then essentially depicts images the seabed on either side of the tow-fish. The first return echo to the tow-fish is the seabed and from that point onwards, in time, the echoes are received from further and further distances, until the signal is too weak to be recorded.

The side scan sonar is best and most efficiently deployed in areas of sandy or muddy seabed, where the slightest disturbance will tend to show up clearly. Often the presence of an object creates a scour that again produces a tell-tale sign of something of interest. The side scan sonar is are not generally conducive to locating underwater cultural heritage in rocky areas.

Sub-bottom Profiling Systems

A Sub-bottom profiler enables vertical cross sections of the stratigraphy to be determined. It can be deployed in selected areas when an appreciation of the sub-surface vertical stratigraphy is required in order to analyse submerged palaeolandscapes, palaeochannels, geology and the material culture buried within it.

All sub-bottom profiling is subject to the reflectivity of the sediments that again effect the penetration. Sub-bottom profiling is particularly effective when examining submerged buried cultural landscapes or buried palaeolandscapes that may contain submerged cultural landscapes. It can also be used to provide more detail of buried sites that are identified on the broader survey.

Magnetometer

The magnetometer is used to locate magnetic anomalies in the Earth's magnetic field caused by iron or ferrous material. Thus large iron shipwrecks can be detected at great distances whereas small iron objects or objects with little ferrous material can only be detected at shorter ranges. Survey procedure in the marine or aerial environment is to run parallel lanes, preferably, but not necessarily, north–south, and to record the magnetic field intensity against the position that is recorded with a GPS. Post-processing allows sophisticated data manipulation to resolve small anomalies and to produce a magnetic field intensity digital elevation model (DEM) or a contour plot that can be projected onto a GIS.

All the above geophysical instruments can be part of the same survey.

Remotely Operated Vehicle (ROV)

A remotely operated vehicle (ROV) is a tethered underwater vehicle, highly manoeuvrable, operated from the surface by a person aboard a vessel and usually carrying a video camera. They are linked to the surface vessel by a tether, cables that carry electrical power, video and data signals back and forth between the operator and the vehicle. Equipment may be added to expand the vehicle's capabilities, including sonar, magnetometer, a still camera, a manipulator or cutting arm, or other instrumentation. Normally the Project would use an ROV with video for search and site recording.

Autonomous Underwater Vehicle (AUV)
The AUV is basically a small, unmanned submersible that can be programmed to carry out a survey of a predetermined area. The vessel is deployed, it commences its assigned survey and at the end of the operation it is recovered and the data downloaded (in some cases they visit the surface from time to time to download their data). In unsupervised missions most operators remain within range of acoustic telemetry systems.
Whereas remote-sensing can be instrumental in the search for sites, it is also very valuable once a site has been found. Deploying instrumentation over the site can be useful in terms of generating very rapid and detailed surveys of the site and its context.

Visual survey, ground truthing, closer more detailed site investigation
After cultural material is discovered and logged, closer examination and sampling may be required in order to determine the date, origin, significance and state of preservation of the site or cultural material. Underwater metal detectors (Figure 46) are often useful in this situation to help locate buried metal objects and to determine the extent of the site. For a shipwreck site, this would involve a pre-disturbance survey to assess and map the site and perhaps retrieve a very few key archaeological artefacts for dating or identification. Any artefacts lifted from the seabed require specialised conservation treatment and the necessary procedures would be carried out as part of the conservation training programme.

Visual survey
Diver survey
Divers can be deployed in a number of means—teams of divers usually four per team, can undertake swim line searches of stretches of the coastline. This involves divers swimming in line a fixed distance apart, generally parallel to the shore, over a designated area of the seabed (the exact area and line spacing is determined by visibility, nature of seabed, depth, area to be covered, etc.).

Depending upon the context divers can speed up the survey with the deployment of scooters. Scooters are only recommended if the conditions are favourable and divers are confident they will not miss any anomalies. If an archaeological sites or artefact is spotted each is marked with a location co-ordinate so that it can be mapped and entered into the GPS data base (either deployed by divers or located on the boat), so that is it possible to relocate and record in more detail.

Drop cameras
One of the simplest techniques not involving divers is to use a drop camera (Figure 47). This system only works well in reasonably shallow water because it is difficult to manoeuvre the camera in deeper water. The camera is lowered on a cable until it is close to the seabed and the vessel then manoeuvres around the site.

Remotely Operated Vehicles (ROV)
Alternatively ROVs can be deployed instead of divers—the objectives would be

the same but the advantage of ROV is that it can stay down longer and can go much deeper. However, they do not necessarily allow as complete coverage as diver survey or do not necessarily see everything that a diver and can be costly to deploy, but cameras mounted on the ROV can insure an instant record of sites and artefacts so that they may be identified. There are a number of compact and relatively cheap ROVs availabe (Figure 48), although they are not suitable in situations where there are strong currents.

Ground truthing

Once the targeted areas identified as part of diver survey and / or identified by remote survey have been noted, further ground truthing of any anomalies or targeted areas of seabed will be undertaken. The most appropriate method to undertake this survey again depends on the nature of the seabed and the material detected:

Diver survey

Divers can be deployed to make an assessment of anomalies identified as a result of geophysical data analysis, thereby further adding to our understanding of the sites identified.

Sub-bottom survey

As explained above, sub-bottom profilers are a form of acoustic instrument that allow penetration of the seabed to a fixed distance dependent upon the depth of water column above the seabed and the nature of the seabed topography. They allow anomalies buried beneath the seabed to be mapped. They are particularly useful to deploy in areas of high archaeological potential on a deep sandy bottom.

Detailed site recording

Once sites have been identified they will require more in-depth recording. This can be undertaken using a number of different methods:

i. Divers can record the site, photograph and draw any visible archaeological remains—this provides a basic level of detail.
ii. Divers can survey the site / artefacts in more detail using offsets and triangulation—this is a simple, low-tech method of mapping the visible remains of a site.
iii. Digital photomosaics—divers can create a single two-dimensional image from a number of more detailed photos of a site or large artefact.
iv. Record as above but using AUV (described above) in place of divers in greater depths.

Post-survey

Following the completion of the survey work each site should be subject to assessment, and diagnostic and prognostic reports for each site identified should be produced, in order to establish a comprehensive intervention plan.

Typical activities would be:

1. On sites identified through general survey samples may be taken to help

determine the significance and dating of the site. The identified sites will be assessed for their potential, prioritised and a plan developed for future work. There are several activities that could take place in this phase.

2. *In-situ* monitoring, where shipwreck remains would be left in place, it will need to be monitored to track its deterioration. In the case where preservation strategies are set in place, monitoring will be required.
3. Excavation of a site may occasionally be warranted. Because excavation and conservation of artefacts and ship remains are expensive, the value of a site or particular artefacts needs careful consideration. Excavation should not be undertaken without having secured funding to carry it through to completion. A research design needs to be carefully crafted.
4. Artefacts recovered in any sampling or excavation work need careful conservation to ensure long-term survival. A program of conservation should be developed, using initially the conservation facility at the Brunei Maritime Museum.

Training and Capacity Building

It is suggested that a programme for training and education should be developed over a three-years period. Training will target different key groups of professionals responsible for the management of the cultural heritage: professional archaeologists and students, museum professionals, sports divers and dive centres. Additionally, other groups such as fishermen, Marine Police, environmental researchers and other users of the sea are made aware of the unique importance of the UHC resource.

Initial training courses could provide a broad introduction to maritime archaeology, and the management and presentation of the UCH based on other successful courses run by the WA Museum. This could be accompanied by training courses for recreational divers and non-archaeological professionals based on the proven model of the Nautical Archaeological Society training programme. The training aims to raise awareness of the richness of the underwater and coastal cultural heritage, and the potential threats faced, to instil skills on a number of levels and to build capacity to manage, protect and promote maritime culture for the future in Brunei.

Training, Education and Capacity Building

Firstly, it is important to identify target audiences that vary from stakeholders in the maritime environment, developers and marine users, to school children and students of archaeology, to ministry employees and museum curators, and not forgetting the general public. There are numerous ways that awareness and training can be delivered, some more appropriate than others depending on the recipient parties. A Training Model as mapped out below is one that provides breadth in relation to this project. Outreach activities are also detailed however more formal educational and training workshops are considered to be the most effective way to reach the key stakeholders. A series of workshops are proposed as follows and the number of each activity recommended to be conducted over the course of a three-year project, is indicated:

Training Model

Ministry workshop (2 x one or half day)—this would to be delivered near the beginning of the Project over half or one day and targets high level staff of the Ministry of Heritage and Culture, Ministry of Foreign Affairs, Ministry of Tourism, Ministry of Education, Ministry of Higher Education, Royal Brunei Navy and other nominated government organizations to raise awareness of the key issues and challenges facing maritime and coastal heritage in the region. A second half-day workshop would be conducted towards the end of the Project to demonstrate progress and reinforce the message.

Developer workshops (1–3 x one day/ one per year of three-year Project)—targeted one-day workshops to raise awareness of the key issues and challenges facing maritime and coastal heritage in the region in the hope that developers will act more responsibly when undertaking coastal and offshore survey and development. NB. Aspects of best practise, current legislation, curator responsibility, process for development planning/EIA etc. could also be discussed at both of the above (they could run in tandem) in order to map out a mechanism of improving policy and practise in relation to the UCH.

Targeted day-meetings to engage Dive Centres and Dive Operations to raise awareness of significance of UCH (dependent upon demand predict 2 x one day meetings over course of three years).

Courses for trained divers (NAS training)—(2 x one to two-day NAS Introduction courses)—NAS Introduction courses are designed to engage Sports Divers and work and dive clubs in Brunei to raise awareness and provide basic training in UCH. This may encourage divers to further their interest in maritime archaeology and perhaps take further training NAS courses <http://www.nauticalarchaeologysociety.org/training/index.php>.

Conservation training workshops. One x five-day workshop. These workshops could have two separate but compatible goals. Firstly, creating awareness and an appropriate understanding among archaeologists of conservation principals, teaching archaeologists to appreciate the need for conservation, encouraging consultation with conservators and stressing the importance for conservator participation in archaeological projects. Maritime archaeologists could be trained in the proper recovery, initial storage, stabilization and transportation of maritime artefacts. Secondly, the programme could train conservators or science students in the theory, techniques and processes of maritime conservation. A Conservation Field School incorporating higher level tutorials and practicals for post- graduate maritime and terrestrial archaeology university students is also possible. For example, training students to determine the environmental conditions prevailing at, and within, an archaeological site in order to ascertain the condition of anticipated artefact materials and identify any potential problems prior to excavation, or for in-situ monitoring. This information, including any risk factors determined, can guide the archaeologist when the investigation of sites is being prioritized and indicate if urgent action is required.

Awareness raising courses—(3 x one day courses/one per year over three years) Awareness raising courses would be targeted at a range of marine stakeholders from marine scientists, to naval officers, to yacht and dingy sailors to heighten their awareness and interest in the UCH.

Workshops (two over three years)—Ten to fifteen-day workshops inviting Ministry employees, museum curators and students of archaeology and heritage (total number of participants for each workshop *c.* 15) NB this largely targets those working in culture but marine scientists and professionals working in the marine environment. The objective would be to provide basic skills and a much heightened awareness with regard to the issues and also the method and practise of maritime archaeology and coastal heritage management. This is a model that has been tried and practised on a number of occasions and would need to be conducted in a coastal location and would encourage (but not be restricted to) those who already dive. The outline below provides the basic idea:

Day	**Activity**
Day 1	Course Introduction Maritime Archaeology—History, Definitions and Practice Student and staff Country presentations
Day 2	Theory and method in Maritime Archaeology Skills-based pool session
Day 3	Underwater Survey/ boat handling and GPS, photographic survey/ terrestrial exercises
Day 4	Geophysical/ marine data interpretation Landscape/ shipwreck investigation, case studies Introduction to finds conservation Finds handling and ceramics
Day 5	Management of the cultural resource Legislation and role of UNESCO
Day 6	Coastal heritage assessment practical
	Break
Day 7	Boat recording and ethnography survey/interviews.
Day 8	Presentation and Outreach
Day 9	Museums and Collections- an introduction Museum and Similar Displays Museum Visit
Day 10	Project management, report production and student presentation.

Training of archaeologists and archaeology students in basic SCUBA. It is always easier to teach archaeologists how to dive rather than train divers to be archaeologists. Particular candidates who take part in the last workshop can be singled out to be more involved in the Project and/or education process.

Appendix III. Maps and plans of Borneo available on line

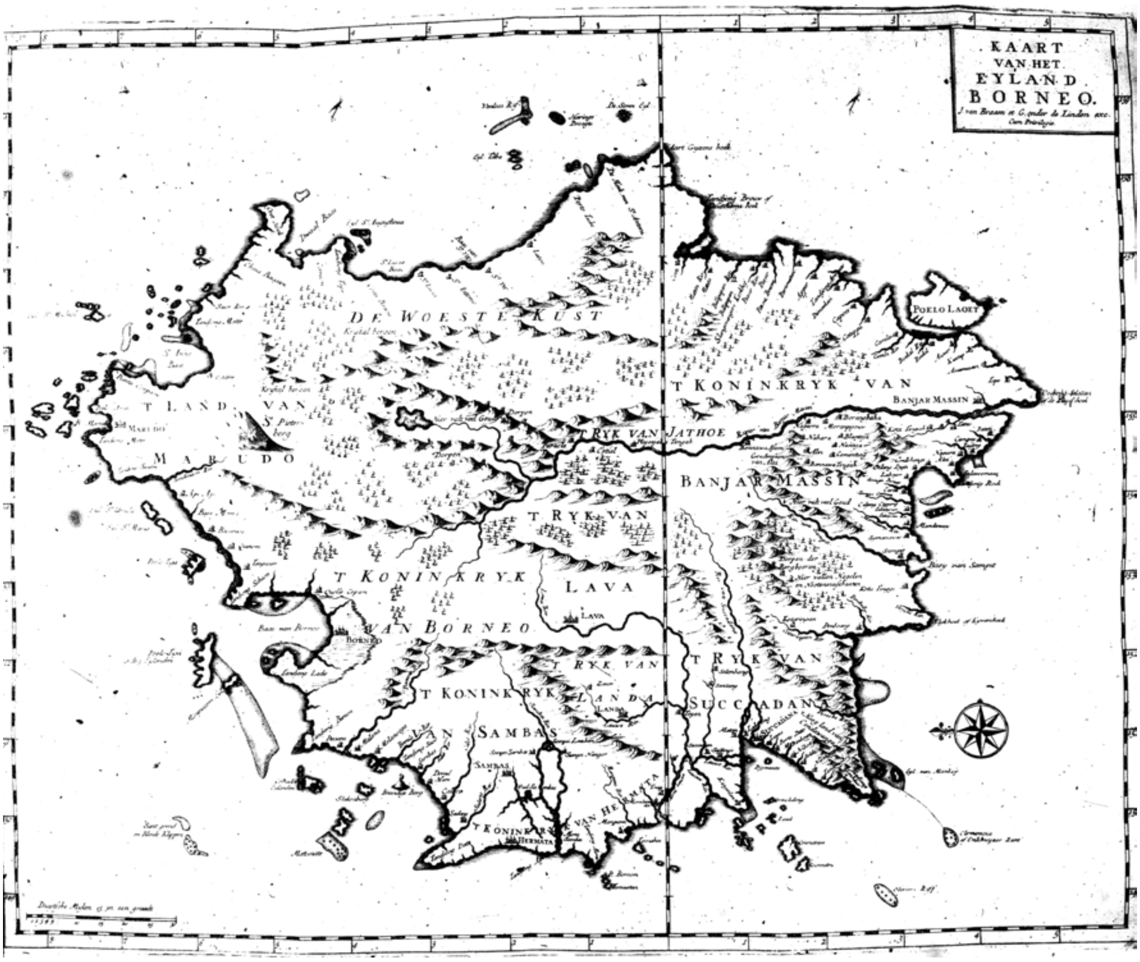

Figure 49. Valentijn, F., *Oude en Nieuw Oost-Indiën: Borneo*, 1724

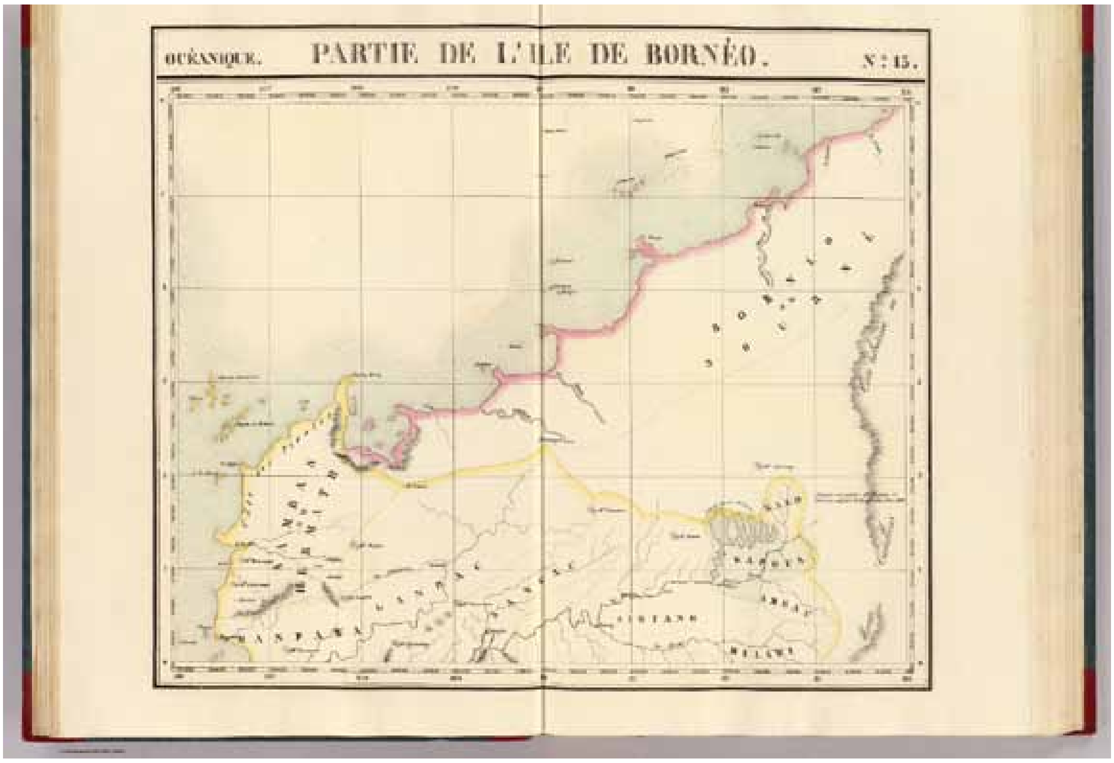

Figure 51. Vandermaelen, Philippe, 1795 Partie, Borneo. Oceanique no 1827 World Atlas. Note: this map describes the place what is known as Tanjung Batu, as Tanjong Datou.

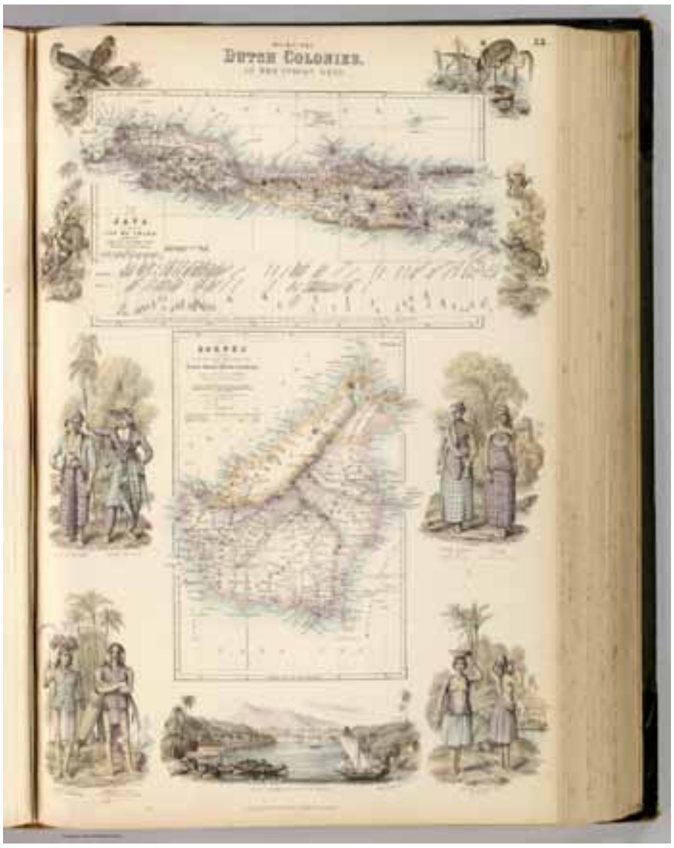

Figure 50. Fullarton, A. & Co. Principal Dutch Colonies in … 1872 World Atlas.

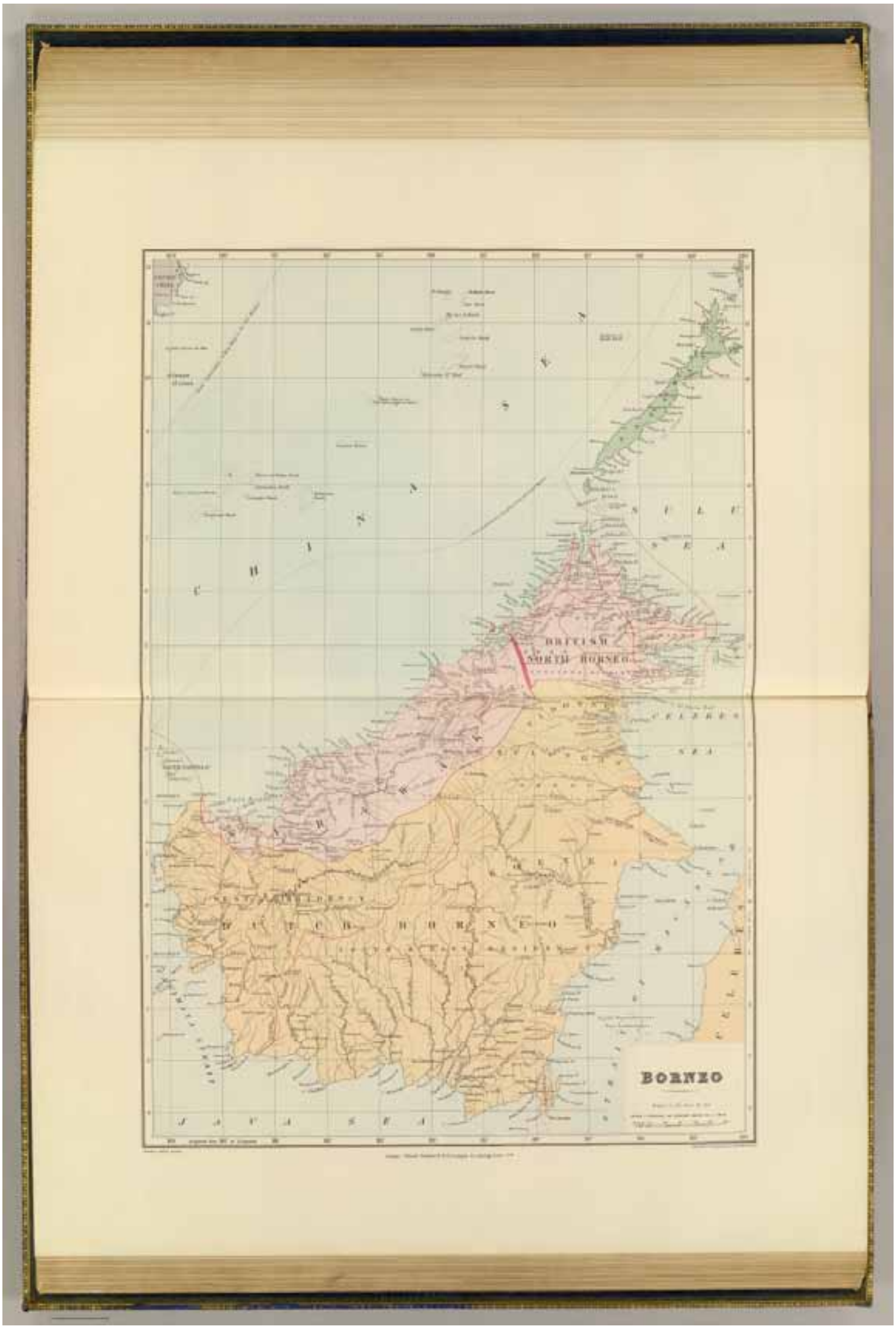

Figure 52. Cram, George, 1901, World Atlas: Borneo.

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*See also: Boni in Chinese Sources: Translations of Relevant Texts from the Song to the Qing Dynasties by Johannes L. Kurz