IN THE UNITED STATES DISTRICT COURT
FOR THE WESTERN DISTRICT OF MICHIGAN
Northern Division

GREAT LAKES EXPLORATION GROUP LLC Plaintiff, v. The Unidentified, Wrecked and (For Salvage-Right Purposes), Abandoned Sailing Vessel, her tackle, apparel, appurtenances, cargo, etc. located within a circle having a radius of 3.5 statute miles, whose center point is at coordinates 45° 32.8′ North latitude and 86° 41.5′ West longitude, *In Rem* Defendant,	)	Civil Action No. 1:04-CV-375 HON. ROBERT HOLMES BELL

v.

STATE OF MICHIGAN DEPARTMENT OF HISTORY, ARTS, AND LIBRARIES AND MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY,

Intervenors.
____/

SECOND AFFIDAVIT OF WAYNE LUSARDI IN
SUPPORT OF MOTION FOR SUMMARY JUDGMENT

STATE OF MICHIGAN)
)
COUNTY OF ALPENA)

Wayne Lusardi, being first duly sworn, states as follows:

1. I am employed by the Michigan Department of History, Arts and Libraries as State Maritime Archaeologist stationed at Thunder Bay National Marine Sanctuary in Alpena.

2. I have previously filed three other affidavits in this matter, including an affidavit dated December 19, 2008 filed in support of the State's motion for summary judgment.

3. I have reviewed the materials submitted by Great Lakes Exploration Group, L.L.C. (GLEG) in response to the State's motion for summary judgment.

4. I strongly disagree with the assertion that some excavation tools would not be required and/or recommended to gain access to the portions of the alleged Defendant shipwreck that are indisputably below the surface of the bed of Lake Michigan. As indicated in my earlier affidavit, the one artifact located in the target areas that was at least partially visible is so firmly embedded in the lakebed that it has not moved in the four years since it was first photographed by GLEG. Whether this is because the stick itself is deeply buried, or attached to the hull of a sailing ship as asserted by GLEG, some tools would be required to gain access to the lower parts of this artifact. This is particularly true if as GLEG asserts, the timber is attached to a large object that is completely buried in the lake bottom. Even if it were possible to dig down the sides of this object so that it could be viewed, there would be no way to dig *underneath* the object to gain access to its bottom-most exterior without the use of some tools to lift it or prop it up. Otherwise, as soon as the sediment underneath it were excavated by hand fanning (it is also true that hand fanning will not work underneath large, heavy objects because the weight of the object compresses the

sediments so the fanning motion is ineffective), the weight of the object would cause it to fall back into the hole that had been hand excavated. All this would accomplish would be to cause the object to be buried lower and deeper into the lakebed.

5. GLEG's filing (Docket #146-8 and #146-6) indicates that it would expect to use liftbags (also characterized as "airbags") to assist it with the excavation of the Defendant. Liftbags are considered tools of underwater archeological excavation.
6. GLEG also indicates that "probing" of the site would be required to excavate it. Probing is done with a metal or similar rod (sometimes with water pumped through it to assist in penetrating sediments) pushed into the lakebed until it strikes a solid surface, at which point the depth and position of that surface is recorded. Such probes are considered tools of underwater archeological excavation.
7. I also disagree with the statements in GLEG's filings that it would be imprudent to use excavation tools to gain access to any artifacts in the target areas, and that the use of such tools could destroy archeological data. I have attached excerpts from two standard treatises from the field of underwater archeology, Marine Archeology, A Technical Handbook by Jeremy Green (2d ed.) ("Handbook") and Underwater Archeology The NAS [Nautical Archeology Society] Guide To Principles and Practice, edited by Amanda Bowen (2d ed.) ("Guide"). Both the Guide and Handbook make it clear that standard practice for investigating and excavating shipwrecks is to use some tools. In fact, these treatises make it clear that the use of an airlift or water dredge to clear sediments that would otherwise obscure the site and/or be deposited elsewhere on the site, is standard practice, at least on significant sites. It would be unthinkable to excavate the entire hull of a ship, as suggested by GLEG,

merely using hand fanning, even if there were currents to carry sediments. Such currents cannot be controlled and more than likely will carry the sediments to other areas of the archeological site. The air lift and/or water dredge can be controlled so that any spoils are immediately removed so that visibility is impaired as little as possible, and so that the spoils are directed to an area off-site. GLEG's suggestion that visibility is so poor in this area that the use of an airlift or water dredge would make no difference is inaccurate. As can be seen from the photographs and video submitted with my December 19, 2008 affidavit, the water is very clear here. This is in large part due to the impact of zebra mussels that have filtered impurities out of the water increasing visibility markedly.

8. The declaration of Kenneth Vrana filed under seal by GLEG claims that it is impossible to determine whether an object is embedded without the use of "remote sensing technologies" to "characterize sub-bottom features." The other declarations also suggest that some kind of remote sensing survey must be done. They also state that several remote sensing surveys have in fact been done. Yet, they attach no data from these surveys to support their claims that the objects are not embedded. If such data proved that the objects in question were not embedded, why is it not provided to aid in the determination of embeddedness? In fact, the statements concerning these surveys don't prove that the objects are not embedded, but rather that most or all of the objects they claim are on this site are below the surface of the lake bed. Furthermore, none of the remote sensing technologies they discuss could be used to determine whether something could be excavated without the use of tools. At best,

these technologies may reveal the possible existence of objects below the surface of the lakebed and not much more.

9. GLEG's various filings in response to the motion for summary judgment repeatedly assert that I did not use scientific instruments to determine whether the Defendant was embedded. As noted above, there is no tool that is used by archeologists for the express purpose of determining whether an artifact is "embedded" as that term is used in the Abandoned Shipwreck Act. This issue arises, not as part of a typical archeological investigation, but rather as a question under the Abandoned Shipwreck Act. Although archeologists typically use tools to excavate a significant artifact that is partially or fully buried, the purpose of the tools is to perform the excavation, not to make a determination as to whether the object is embedded. In any event, I did make a scientific record of the site in question and provided that to the Court in the form of photographs and a video that support a determination that the Defendant is embedded in the lake bottom.

10. The Declaration of Steven Libert states that carbon dating studies have confirmed that the "age" of the timber embedded in Lake Michigan is "correct," apparently meaning that the artifact was created at the time the Griffin was built. I have reviewed all carbon dating studies provided by GLEG to the State, and at best they establish that there is less than a 50-50 chance that this timber even dates from the time of the Griffin and provides no evidence what so ever that the timber originated from that vessel. If there is some other study that supports this claim, it has not been provided to the State or to the Court.

11. GLEG asserts in its response to the motion that I determined that objects other than the timber could not be associated with the Griffin "based on reading the verbal descriptions of the Michigan State troopers who performed the dives." This is incorrect. My previous affidavit submitted in support of this motion did not reference Michigan State troopers in any way. As indicated in my previous affidavit, the only other object in the target areas that was visible above the lakebed was a dumbbell shaped metal object. As stated in my previous affidavit, I personally inspected this object and concluded based on that inspection that it could not have come from a 17th century sailing vessel.

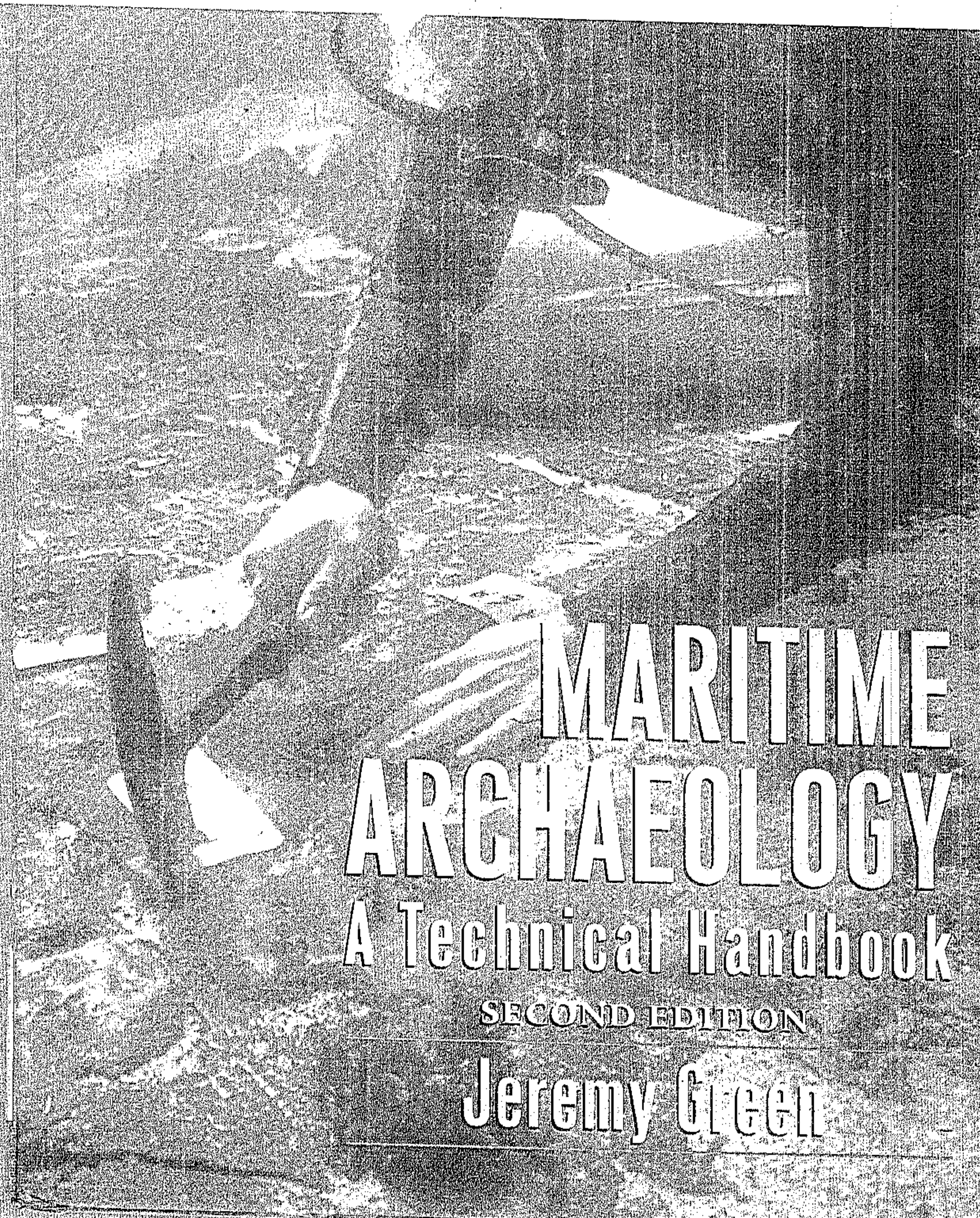
12. I state the matters asserted herein of my own first-hand knowledge and if called upon to testify concerning these matters, I would so testify.

Wayne R Lusardi
Wayne Lusardi

Subscribed and sworn to before me
this 20 day of February, 2009

Brandi L Laundry, Notary Public
Alpina, County, Michigan
My Commission Expires: 02-15-2011

Brandi L. Laundry
Notary Public
Alpena County, Michigan
My Comm. Exp. 2/15/2011


MARITIME
ARCHAEOLOGY
A Technical Handbook
SECOND EDITION
Jeremy Green

VII. VIDEO CAMERAS

Underwater video cameras are widely used on archaeological wreck sites. On the archaeological excavations of the *Mary Rose*, the video was described as "probably the most important single piece of equipment loaned to the [*Mary Rose*] Trust during the excavation" (Rule, 1982). During the excavation it was used as a briefing tool for new divers and as a method of recording the ship's structure (see also Cederlund, 1981).

There is obviously a great advantage in using a video camera to monitor the progress of an excavation, particularly where the site is deep and it is impossible for the archaeologist to inspect the site at will. Additionally, the video system can be used to provide important educational and training programs. At present the normal resolution of the best commercially available systems (mini-DVD format with three-chip set) is not nearly as good as conventional black and white film resolution nor the high-end digital cameras. With the advent of the digital camera, it is unlikely that the video system will be used for photogrammetric recording.

When the video camera is used as a method of recording a site, a great deal of thought needs to go into the process. Just as it is easy to take huge numbers of meaningless or poorly documented still photographs, it is also possible to accumulate hours of meaningless video footage. It is essential that planning goes into video recording and a decision should be made as to the need for video footage. Where the video camera is an observation point for the surface operators, it is probably not necessary to keep a record of what is happening. Where site recording is taking place, it is probably better to use still recording rather than video. However, where complex operations are occurring it is possible that video recording will be useful. This is a decision that needs to be made depending on the circumstances. The most important aspect of video recording, and possibly the most difficult with which to achieve good results, is the use of the video camera to produce instructional, educational, or semi-commercial videos. In this case, some understanding of film techniques is essential.

Chapter 9

Excavation

I. GENERAL CONSIDERATIONS

This chapter deals with the techniques of excavation. The question of the surveying techniques that can be used to survey a site during an excavation is discussed in Chapter 4, the recording of the excavation work is discussed in Chapter 10, and the excavation and the archaeological interpretation of an excavation is dealt with in Chapter 13. It is difficult to generalize about excavation. Each excavator will have a different approach to a site, and no two sites are ever alike. It is therefore impossible to give more than the broad outlines of methods and techniques of excavation. Because an archaeological site contains unique records of the past which the process of excavation will dismantle, it is essential to understand that excavation can only be justified in certain circumstances. The excavator must have a clear understanding of reasons for undertaking the excavation, of the techniques and methods that will be used, and the effects these techniques and methods will have on the archaeological record. Adequate storage, conservation, and work facilities, together with trained archaeological staff to handle the material, are absolutely essential before excavation can be considered.

Archaeologists undertaking an excavation must not only be experienced in excavation work but must also be used to directing the excavation. It is, for example, possible to be a good archaeologist and yet not be able to direct an excavation; this can result in poor archaeology. However, the converse is not true; one cannot be a good director of people and, without any archaeological skills, direct an archaeological excavation. This may have been true 20 or 30 years ago when there were no archaeologists who were able to work under water and no proper understanding of excavation techniques. The subject was then in a learning phase. Today, the ordinary techniques of archaeological excavation under water are well understood, and research and development is tending toward highly sophisticated methods and strategies of excavation and recording. It is essential that archaeologists who excavate sites are thoroughly conversant with these techniques and methods, and this can only be achieved through experience.

Excavation is the process of uncovering a site by removing spoil or intrusive material, observing and identifying the archaeological material, and then recording and recovering it. The most difficult aspect of excavation is identifying what is archaeological material and interpreting its significance; this is again where experience is essential. In the past, many maritime archaeological excavations have suffered from inadequate excavation techniques. This was partially due to the fact that maritime archaeology was in a developmental phase and it is easy to criticize the mistakes of the past. The mistakes formed part of a learning process which now makes it inexcusable for the same mistakes to be made. Cousteau (1954) described the early days on the Grand Congloué site (one of the early excavations of a site using the aqualung, to remind us of how long ago this was). The article was entitled "Fish Men Discover 2,200-year-old Greek Ship." In the following he describes the use of the air lift:

> Sometimes we got astride it and felt it vibrate like a spirited horse's neck as we turned on the compressed air. And like a browsing horse, the mouth went forward into the pasture munching shells, sand, shards and things too big for it to eat such as heavy hunks of wine jars. When an amphora neck jammed in the pipe mouth, another diver with a hammer pulverized the obstacle.

This practice would be deplored today, but at the time, when archaeology under water was only a vague possibility, many mistakes were made. Today, after the experience of countless exemplary excavations, it is no longer acceptable to use this type of approach.

Although high standards of excavation are expected on all maritime archaeological projects, it must be remembered that excavation alone is not archaeology, but part of a process whereby information is obtained which allows archaeological interpretation. Excavation is therefore carried out in a systematic manner across the site in both the horizontal and vertical directions. All the artifacts and their associations are recorded along with their three-dimensional coordinate location. Subsequently, the archaeologist has the responsibility, which is no less demanding, of interpreting this information and then publishing it. It is therefore important to emphasize that minimum archaeological standards include publication. An excavation that is not published means that the information is lost and this is bad archaeology, probably worse than excavating with inadequate techniques.

Throughout the process of planning an excavation, it is necessary to evaluate what is to be done and what the implications will be as the excavation proceeds. There must be good predisturbance information on which to base this planning process, so the predisturbance work is critical for subsequent planning as the predisturbance survey will not tell you what *is* going to happen as the excavation proceeds. However, it should provide one with an insight as to what *might* happen. The extent of the sight will be known and probably the depth of overburden and some indication of the potential depth of the archaeological material. The physical constraints of the sight will be known so that estimates of how efficiently one will be likely to proceed will also be known. The nature of the archaeological material, its likely fragility, material, and size should be at least anticipated. Armed with this information and the knowledge of the operational conditions on the site and the final destination of the material, some serious planning can be started. This will include a variety of contingency plans for various possible scenarios. It is almost impossible to predict the totally unexpected. It should, however, with good planning, be possible to anticipate most likely problems.

II. EXCAVATION TECHNIQUES

There are two simple approaches to excavation: one is to excavate over large areas of the site, layer by layer; the other is to work the site in small sections (either grid squares or trenches), layer by layer, repeating section by section across the site. The former approach is usually taken where the site lies in relatively calm conditions, there is a large staff available, and there are no time constraints. The latter method tends to be utilized where conditions are difficult, there is a limited number of staff, or where budget constraints restrict the length of excavation. In the latter case, excavation can be rapidly terminated without danger to the site.

In planning excavation work it is important to refer to the predisturbance survey. The information from this survey will play an important part in the planning of the excavation. The survey will provide information on the area of the site, the depth of the overburden, and the extent of the archaeological material and its nature. Some form of exploratory excavation may be needed to complement the predisturbance survey. For example, it may be necessary to determine the exact periphery of the site prior to the main part of the excavation. This process may simply be to excavate the overburden at the periphery until the archaeological layer is exposed. Alternatively, it may be necessary to excavate a test pit in order to determine the depth of the archaeological material. A great deal of caution is necessary when carrying out this form of exploratory work; however, provided the work is done carefully, it will provide essential information in planning the excavation strategy. Until the extent of the site is fully understood, it will be impossible to plan how long the work will take or the necessary storage and conservation facilities that will be required. There will be a great deal of difference between the excavation of a site which has an average archaeological depth of 0.5 m and that of a site which has an archaeological layer 4 m thick.

The use of grid frames to assist with excavation needs to be carefully considered. There are a number of advantages and disadvantages attached to using grid frames. On extensive sites with a large staff, grid frames are often used to help define excavation areas and to orientate staff who may be unfamiliar with the site (Figure 9.1). Novice archaeological divers inevitably require some form of coordination and, at times, the grid frame may be the best solution. Otherwise, when left to their own devices, it is not uncommon to find inexperienced staff excavating totally unsystematically in some far off area.

With the grid frame system, one is confined. Grid frames can also be useful supports for the excavators while they are working over a site that has a large quantity of extremely fragile material exposed and, as previously mentioned, are particularly helpful when working with novice divers. Proper buoyancy control and coordination of the excavation using more

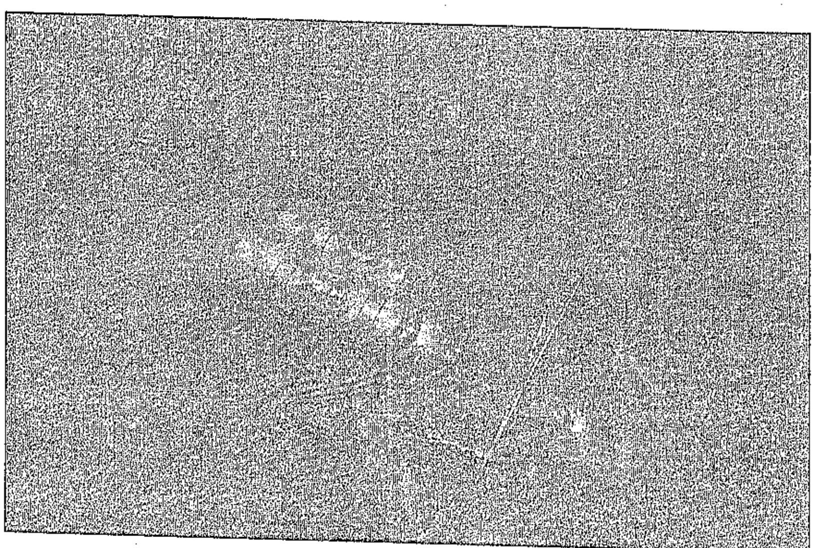


Figure 9.1 Excavating using a grid frame, Ko Kradat wreck site, Thailand.

experienced staff may be a better approach to the situation. On many sites it is a requirement that fins are removed because they tend to stir up the sediment, thus reducing the visibility.

The use of grid frames also introduces a danger of damaging fragile objects. There are varying types of grid frames ranging from rigid frames that are set up and fixed to the seabed (scaffolding-type situation), to semi-flexible frames (made of plastic tubing), to string grid frames attached to small stakes. Completely rigid grid frames have been used on many occasions (for example Bass and van Doorninck (1982) at Yassi Ada in Turkey, Henderson (1977ii) on the *James Matthews* and Gesner (2000) on the *Pandora* site (Figure 9.2)) where they were used as the basis for a measuring system. Semi rigid grid frames made of PVC water piping were used in Kyrenia by Katzev (1970) (Figure 9.3) and by Piercy (1977, 1978, 1979, 1981) on the *Santo Antonio de Tanna* in Mombasa Kenya and in this situation they are used to control excavation work and are not used for measuring. Recently, Bass (2002) used string grid lines to delineate the excavation areas on the Tektas Brunu site as they are less cumbersome and more flexible to use (Figure 9.4).

The choice will depend on the circumstances and if the archaeologist wishes to use the grid frames for survey work. In general, grid frames are not used for reference purposes in survey work, because it requires that they are firmly attached to the seabed. Unless the frames are really firmly

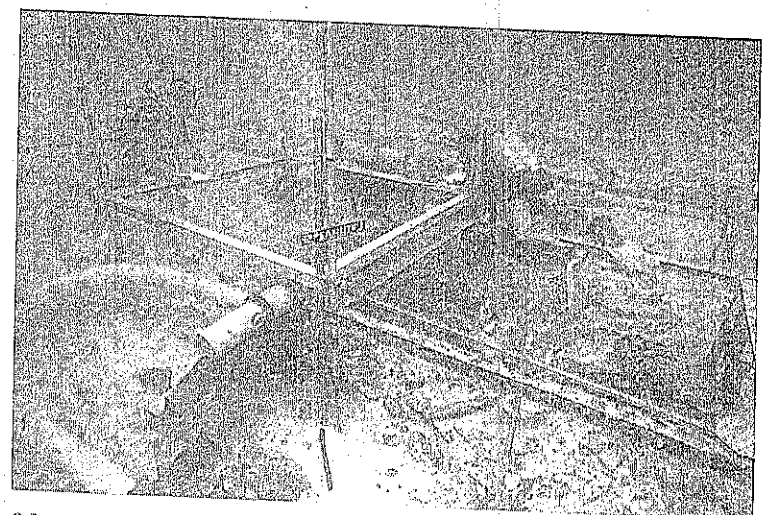


Figure 9.2 Rigid grid frames used on the *Pandora* wreck excavation as a basis for survey and photogrammetric work. (Courtesy of Brian Richards, Department of Maritime Archaeology, Western Australian Maritime Museum.)

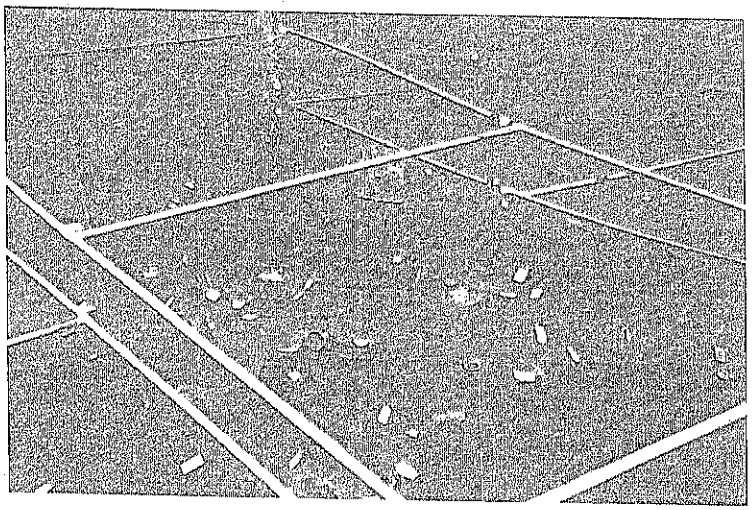


Figure 9.3 Large complex grid frames made of plastic water piping in use on the Kyrenia wreck. (Courtesy of Kyrenia Wreck Excavation.)

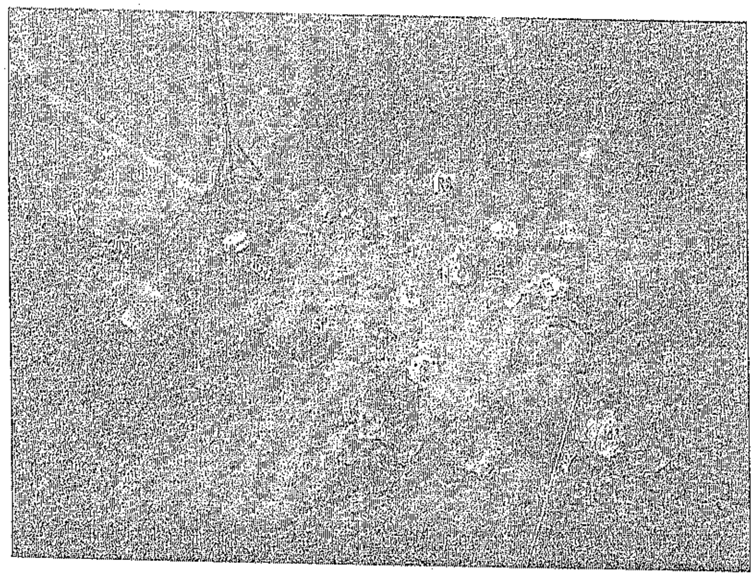


Figure 9.4 String grid lines used at Tektas Brunu, Turkey, to delineate excavation areas. (Courtesy of Jeremy Green, Department of Maritime Archaeology, Western Australian Maritime Museum and the Institute of Nautical Archaeology, Bodrum, Turkey.)

attached to the seabed they will inevitably move if bumped by divers or equipment. Ideally, grid frames would be dispensed with altogether. The problem is they get in the way of the excavation, particularly when one has to work around the framework in order to get excavation equipment into a grid frame. If the excavation is deep, the grid frames will cause the edges of the excavation to slope down toward the center of the grid, because it is often impossible to get excavation equipment into the edges of the frame. As a result there will be slumping at the sides of the grid and a site can often look like a series of holes centered on each grid square. In such situations the use of grid squares cannot really be justified. If it is necessary to use a grid, it should be made as large as possible, ideally at least 4 m^2.

In many cases the grid frame plays some role in recording, however, it is usually not possible to use the grid frame for accurate recording. Such a system requires a rigid grid frame firmly attached to the seabed. Henderson (1975) used a rigid structure with great success to record and excavate the *James Matthews* wreck site, however, this approach is generally difficult to implement and to maintain. It is more likely that the grid will be used for approximate location and that important artifacts and structures will be recorded using a more reliable control. Thus, loose finds and fragments can be approximately located within the grid square, which will have some relationship with the site grid. Possibly, some objects, which do not require precise location can be registered within a subdivision of the main grid, giving a more precise location. Thus the grid can be very useful for recording purposes and allows the distribution of loose finds to be easily and quickly recorded.

One alternative to the grid frame is the trench system (Figure 9.5). Instead of square frames, a series of parallel lines or bars can be laid across the site. The lines marking the edges of the trench can be scaled so that the relative position in the trench may be determined.

In some cases it is possible to backfill from one grid square to the previously excavated square, or from one trench to the previously excavated trench. This simplifies excavation techniques considerably, particularly where spoil is too large to be removed with suction devices. The heavy material or even light spoil can be removed quite simply to the adjacent square (Figure 9.6). Naturally, such a system can never show the whole site completely excavated. This can be a disadvantage where there is a structure that would be best displayed completely excavated. This may be partially resolved by making a section by section photomontage or photomosaic of the site.

An excavation without frames has a number of problems, partially because it is difficult to control the excavation. It has already been noted that there is a danger that excavation will progress in random directions

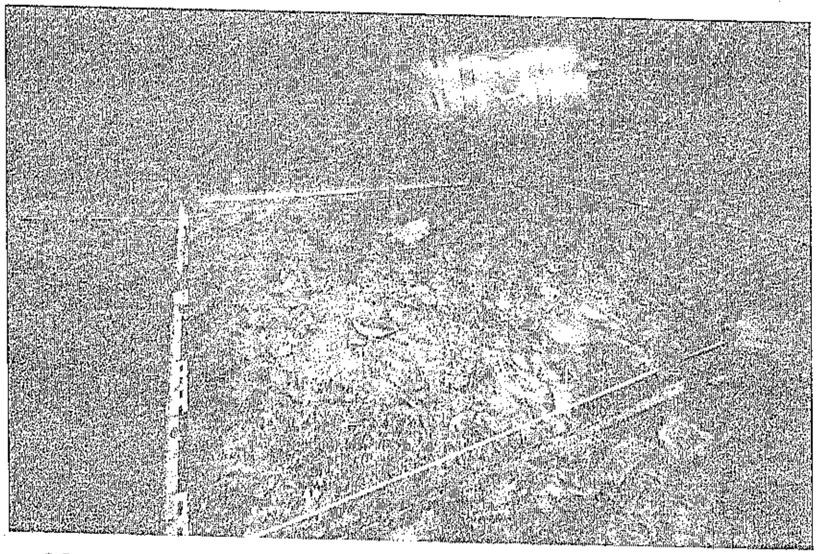


Figure 9.5 Excavating a trench and showing excavated square. Once the square is completed the grid is moved to the next position in the trench and the excavation continues.

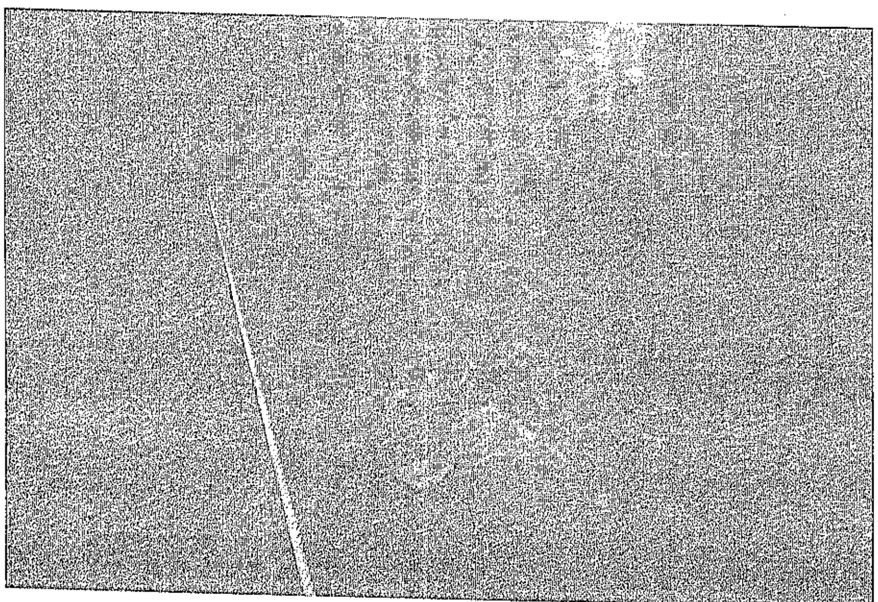


Figure 9.6 Backfilling on Ko Kradat site showing the baskets used to recover ceramic shards. (Courtesy of Brian Richards, Department of Maritime Archaeology, Western Australian Maritime Museum.)

unless there is some form of control. However, if a start is made at one end of the site and excavation proceeds forward across the site, with experienced staff it is possible to excavate quickly and efficiently. A bar or tape can be used to help keep the excavation moving evenly across the site. The great advantage of this technique is that complex structures can be excavated in one piece.

When excavating in localized areas, a grid or defined trench is essential to confine the extent of the excavation. Excavation proceeds downward, layer by layer. The process is repeated grid by grid. However, it is often difficult to correlate grid square layers, as structures sometimes extend through several squares creating serious problems. On a site with little vertical component, the trench system works well.

One ingenious method of excavating a hole in order to make a test pit in loose sand or mud is to use an open-ended 200-L fuel drum as a caisson (Figure 9.7). By operating the airlift inside the drum, the interior base can be excavated away and, as this happens, the caisson drops lower and lower. The caisson keeps the sand from falling into the hole, thus enabling an easy excavation down to approximately 1 m. Using this system, it is also

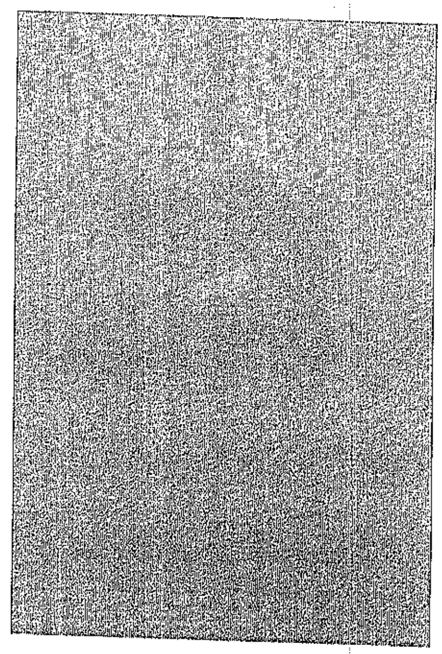


Figure 9.7 Caisson excavation using a 200-L fuel drum open at both ends, Takashima, Japan.

possible to make careful records of the different layers excavated and record their depth by measuring how far the drum has penetrated into the seabed.

III. STRATIGRAPHY

It is not usually possible to excavate vertical cross sections under water, except when working in thick mud; therefore, stratigraphy can be difficult to record under water. In sand, silt, or gravel areas it is impossible to excavate in vertical sections, so excavation strategy will need to be carefully thought out if stratigraphy is to be recorded. The merits of working over a large area and excavating systematically downward have to be considered in relation to the difficulty of doing this evenly over the whole area. The problem with working in small grid squares (about 2 m^2), as discussed previously, is that the excavation ends up with a conical hole or pit, simply because the sand or silt will not hold any appreciable wall. Working along a front enables systematic recording and some degree of stratigraphy can be observed, although inevitably the working face will have slippage. The methods used will depend on the circumstances and the correct choice will only come with experience. Alternatively, careful excavation of layers is a possibility. With the judicious use of excavation tools, the excavator can remove layers over quite large areas, so for a start, the sterile overburden can be removed in one stage.

In many cases there is no stratigraphy, but rather a sterile overburden, followed by an archaeological layer, followed by a sterile layer. This is not always the case, and excavators must be cautious not to miss the subtle changes. Particularly, inside ship structures, it is possible to observe different stratigraphical layers trapped in compartments or on decks representing different phases of the wreck disintegration process. Additionally, when changes are observed, these are often difficult to record because of problems in establishing vertical datum points. This can be an extremely difficult problem and bubble tubes or depth-measuring devices will have to be used to make these measurements. These problems are discussed in Chapter 4.

It is additionally worth noting that under water, archaeological chronology can have a different significance than that for an archaeological site on land. In the excavation of a shipwreck, stratigraphy usually relates to a single event in time. Consequently, the stratigraphy may have little or no temporal significance, but it may have a particular spatial significance. Thus a shipwreck lying upright on the seabed will disintegrate in time. Any thing lying on top of another is determined by a spatial relationship rather than a temporal one. If the ship settled upright on the bottom, material would generally collapse downward and outward. If a ship sank heeled over on its

port side, the guns (for example) on the starboard side would lie on top of the port guns after the wreck collapsed. By interpreting the events subsequent to the wreck, the excavator can thus determine more information about the ship. The unusual circumstance of a wreck, with the immediacy of the event, makes the spatial aspect of the site of much greater significance than the temporal aspect. This does not mean that one should ignore stratigraphy. The point is simply that the vertical component may be of no more significance than the horizontal component. As noted above, localized stratigraphy inside the structure of a shipwreck can have great significance.

Stratigraphy has played an essential part in the excavation of a number of shipwreck sites. In the IJsselmeer polder, sites can be dated using stratigraphical evidence. Because the vessels sank at a particular point in time archaeologists can identify the stratigraphy of the IJsselmeer and thus date the event (Reinders, 1982; Reinders *et al.*, 1978, 1984). Similar approaches have been made on the *Mary Rose* (Marsden, 2003) and the HMS *Pandora* (Gesner, 2000). Likewise, inundated land sites have an essential stratigraphical component. In the past, stratigraphy on underwater archaeological sites has often been ignored or not properly examined. It is essential in planning modern underwater archaeological excavation that the question of stratigraphy is taken into consideration. It is advisable to thoroughly understand the implications of stratigraphy on a wreck site as it will have quite a different significance to that of a land archaeological site.

Many other new and interesting underwater excavation techniques have been pioneered in the last few years. Some of these have been standard on land excavations for many years, but as the practice of maritime archaeology improves, so the technology moves with the times. On the *Amsterdam* project (Gawronski, 1986, 1987) the excavation work has developed into a multifaceted scientific study taking into account a wide variety of excavation strategies. Likewise, the examination of the mud in a late Saxon logboat found at Clapton shows the extent of the information that can be recovered using suitable excavation strategies (Marsden, 1989).

IV. COMMUNICATION

Communication between staff during an archaeological excavation is vital. Without good communication, excavations can become inefficient and artifacts and data can be lost. First, the excavation director must keep everyone informed of what is happening. This should be done on a day-to-day basis, either at a morning or evening meeting. It is the director's responsibility to ensure that the overall excavation strategy is being maintained and advise everyone when there is need for a change or where the excavation is working particularly well. This rapport with staff members is essential.

How this is handled will depend on the individual, but it is important for the excavation that everyone has a clear idea of what they are doing and why. (see Chapter 2, Section V).

How to maintain continuity on a site is one excavation problem that is often difficult to resolve. If there are a number of different people excavating the same area then achieving continuity can be an exacting task, particularly if it is necessary to spend time on a decompression stop. There are several possibilities and these will depend on the type of site. In shallow water (<10m), excavation can continue for considerable periods of time without interruption with cold or fatigue the limiting factors. Given that time will not be a limitation, excavators can always work in their own particular area, or a number of people can be assigned to a particular area. Continuity can be maintained by ensuring that at the changeover the next team is aware of what has happened in that area. On deeper sites, there will probably be a period on a decompression stop. During this time, there will be the impending problem of deciding whether to send the next team in straightaway or whether to wait so that they can be briefed. Because of the time constraints on deep-water sites, it will usually be necessary to send the next team in. Therefore, it is worth considering organizing the excavation so that successive teams work in alternate areas. Thus team A works in area 1; while they are decompressing on the stop, team B goes in and works area 2. When team A comes out of the water, they brief team C, which goes in and works in area 1 when team B is on the stop. Some variation of this type of system can be devised for any site, and it does ensure the continual awareness of what is happening in an area. Alternatively, diver-to-surface communication can be used (see next section).

A very useful method of communication was pioneered by Bass on a series of excavations in Turkey (Bass and Katzev, 1968). It consists of an underwater booth made out of a dome of clear Perspex or Plexiglas is anchored to the seabed and filled with air (Figure 9.8). This served as a refuge in case of emergency and as a place where the person working under water could communicate with a partner. In addition, a telephone was installed in the booth enabling the diver to communicate with the surface and obtain advice and exchange information.

Self-contained diver communications systems present a real advantage. Whereas once the encumbrance of a communication cable between the diver and the surface made the system unattractive, there are now a number of interesting alternatives. First, however, it will be essential to adopt a full face mask (or a "voice box") to enable clear voice recognition. Full face masks range from the simple to the complex (simple like the Aga and Scubapro to the complex Ultralight) and today these systems are more common in the field of underwater archaeology because of occupational

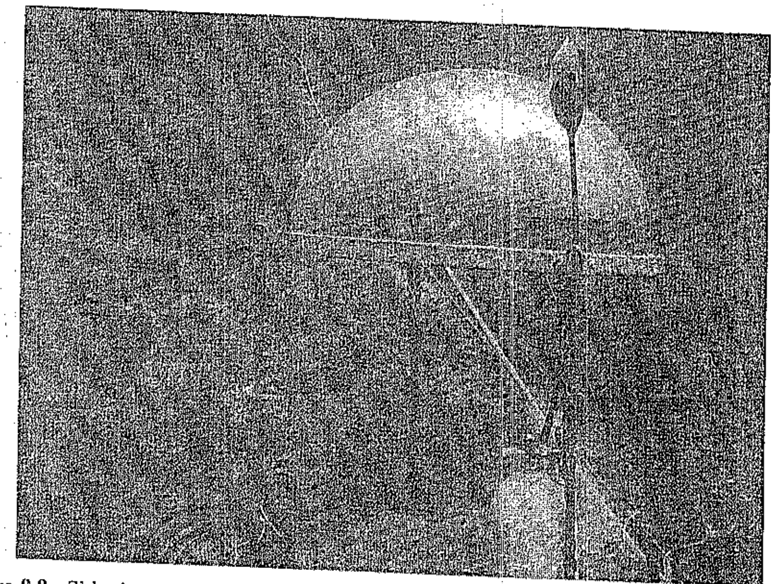


Figure 9.8 Telephone booth on the Tektash Brunu site, Turkey, at a depth of 40m. (Courtesy of Jeremy Green, Department of Maritime Archaeology, Western Australian Maritime Museum and the Institute of Nautical Archaeology, Bodrum, Turkey.)

health and safety considerations. If the full face mask is used with scuba then through-water communications are possible (Buddy Phone, for example). This system works remarkably well, but allows only "simplex" voice transmission (i.e., either the diver is talking or topside is talking). If the system is surface supplied air (SSBA), then communications can be hard-wired in the umbilical and both the diver and the operator can talk at the same time. Being able to communicate with a partner or with the surface is a huge advantage, not only for improving the efficiency of the operation but also for training and safety. With this sort of arrangement it is possible to avoid some of the logistical problems that would occur when operating successive diving teams as previously described. The main disadvantage of the system is that it is generally expensive.

V. MACHINERY

A. WORK PLATFORMS

All sorts of different working platforms can be used, depending on the nature of the work and on factors such as on the type of site, budget, size of staff, etc. (Figure 9.9). In planning an excavation and the size and type of platform required, it will be necessary to take into consideration the number of staff members that have to be on the platform at any one time, what facilities are available for relaxation after the diving operation, catering facilities, distance from base camp, etc. The prime consideration will be to provide a safe, stable work platform where machinery and staff can be comfortably accommodated. Thus operations can range from a simple raft made up of old 200-L fuel drums to a fully equipped rig tender vessel with costs ranging accordingly.

B. Airlift

The airlift is one of the most widely used tools for removing spoil from a wreck site. It operates best in water deeper than about 5 m, but can be used in shallower water. The principle of operation is that air, under pressure, is introduced into the bottom of a tube. As the air rises up the tube, it expands and this expansion causes a suction at the lower end of the tube. The air is usually provided by a low-pressure air compressor. The greater the volume of air and the greater the vertical rise from one end of the pipe to the other, the greater the suction. A variety of compressors can be used to power the airlift, and the choice of size depends on the number of airlifts needed, the depth of water (shallow water requiring a greater volume), and the size of the surface support vessel. The efficiency of an airlift can be improved by various means. First, if the air entering at the bottom of the airlift tube is a constant stream of large bubbles, these bubbles will expand as they rise, and one single bubble may end up filling the cross-sectional area of the tube. At this point, the efficiency will drop drastically because the debris, instead of being carried up the tube in an emulsion, tends to fall through the bubbles of air. To avoid this, the air should be emulsified at the point of introduction. This can be done by drilling a series of small holes in a band around the entry point of the air and enclosing this in an external box The air enters the box and then passes, in a fine stream, through the holes into the airlift tube. Alternatively, the air supply tube can be sealed, and a series of small holes drilled into the lower end of the tube. The tube is then introduced into the airlift through a small hole in the wall of the airlift tube thus providing emulsified air for the airlift. However, in this situation there is a danger of the air supply tube causing an obstruction and blocking the airlift. An alternative is to introduce the air supply tube into the working end of the airlift, and if the airlift should become blocked the supply tube can be pulled out, thus unblocking the airlift. Additionally, using this technique, the airlift can be turned on and off (to turn off simply extract the air supply pipe) and the power may be controlled by adjusting the distance of the supply pipe up the airlift tube (the further up the less the suction).

Because the airlift pipe is buoyant when in operation, the lower end will have to be anchored to the seabed or weighted. It is possible when running small airlifts at low power to counterweight the pipe so that it is neutrally buoyant, thus making the whole thing totally mobile. In most cases, some form of anchoring arrangement will be necessary, usually a static weight. This can be attached near the working end or, better still, up the tube, just below the center of gravity. This then provides a lot of maneuverability at the working end as the airlift can be worked quite easily in an arc. Even greater maneuverability can be achieved with large airlifts by attaching a long, flexible tube to the suction end. The rising airlift pipe is firmly anchored just above the seabed, and the air is introduced at the base of this tube. The flexible tube is attached to this working end, so that it can move around the site without the need to move the anchor point (Figure 9.10). One serious disadvantage with this system is that the shut-off valve is not adjacent to the operator; in this situation, the air control system can be diverted via the operating end or the supply tube can be inserted at the working end as described previously. It is obviously extremely dangerous to operate a powerful airlift without the possibility of the operator being able to shut it down in an emergency.

It should be kept in mind that the air compressor, except when operating in deep water, will be operating in the free-flow condition against a very small back-pressure. This is not the normal working mode for some compressors, and it is worth checking with the manufacturer if this is possible. The compressor specifications will usually indicate an output volume against pressure. Running in free-flow results in a low pressure, which may affect the output and thus the efficiency. In shallow water, this may be a serious problem, because the output pressure will be related to the depth of the water. It may be necessary to put a restriction in the outlet to increase output and reduce overheating. Clearly, the compressor must be able to produce a pressure greater than the water pressure at the depth of operation.

When working an airlift in spoil or overburden, it is often necessary to work quickly or with reasonable suction. In such cases, if the spoil contains material of comparable size to the diameter of the airlift tube, it is likely that these objects can block the airlift. Therefore, certain precautions should be taken and some form of restriction at the mouth of the airlift should be introduced to limit the size of the spoil entering the tube to about 75% of the diameter of the tube. Otherwise the large objects will have a tendency to jam in the tube and cause a blockage. Unblocking can be a time-

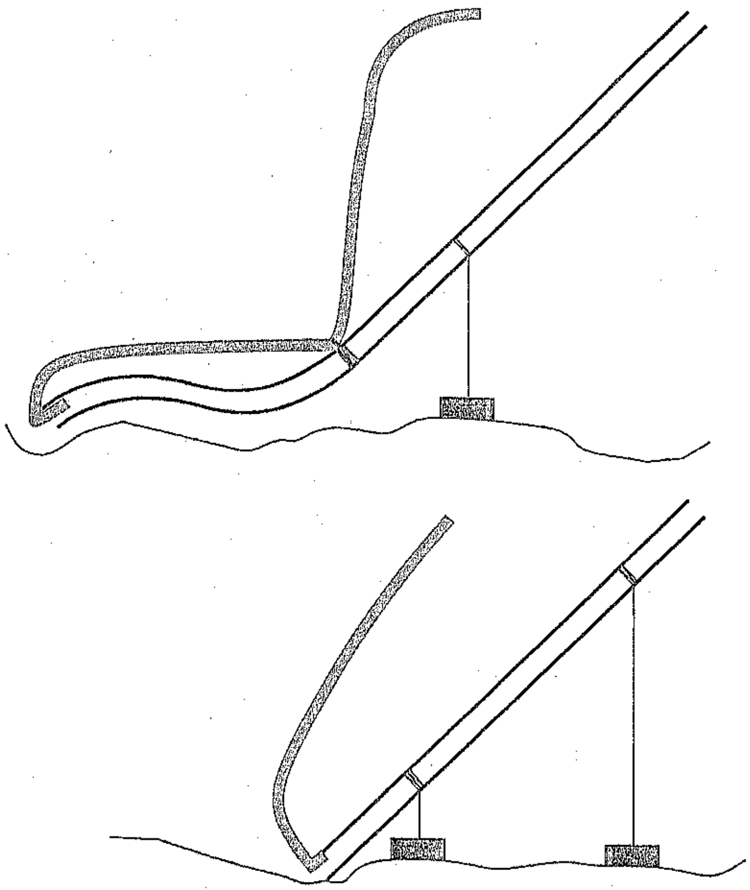


Figure 9.10 Two types of airlift design, one with a flexible hose and rigid riser and the other rigid.

consuming and frustrating operation. A removable pin fitted across the mouth of the airlift is a simple solution and there are complicated stone ejectors which can be constructed to remove an oversized object jamming the opening.

The only way to work an airlift in areas where there is archaeological material is to hand-feed the airlift with the intake about 100 mm above the seabed. In this situation, the excavator puts selected heavy material into the airlift, but hand-fans the archaeological layer. The hand-fanning removes the light sediments from the seabed which are then sucked up the airlift, leaving the water clear and enabling the excavator to reveal light, delicate

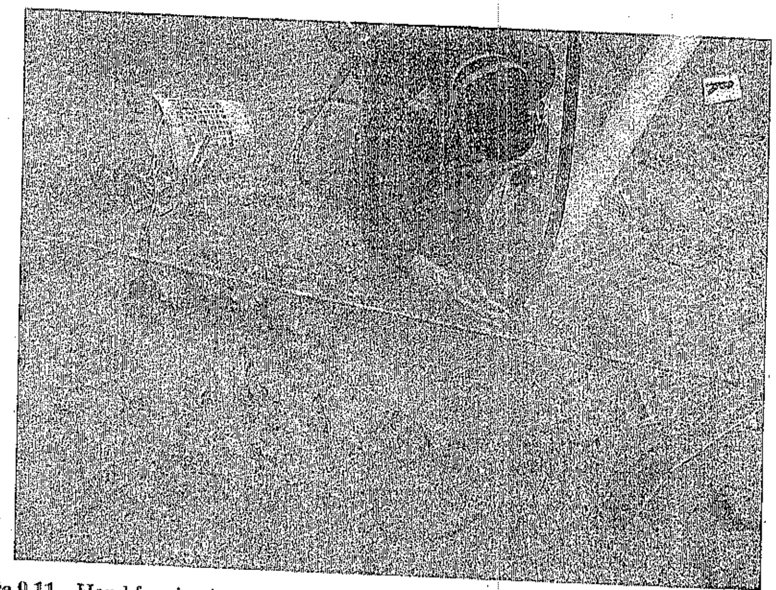


Figure 9.11 Hand fanning into an airlift on Tektash site, Turkey. (Courtesy of Jeremy Green, Department of Maritime Archaeology, Western Australian Museum and the Institute of Nautical Archaeology, Bodrum, Turkey.)

objects (Figure 9.11). This system is quite impractical when removing large quantities of overburden. In this situation, the airlift is placed just above the overburden so that it is sucked up the tube, rather like a vacuum cleaner. Great care must be taken, but if the tube is kept above the spoil, it can be removed quickly and easily should artifacts appear. The airlift should only be operated this way when the visibility is good and with two skilled operators working side by side, one operating the suction tube, the other watching the spoil. Excavation is something of an art, and operators tend to get a feel for a particular site. It is often possible to detect differences in the composition of the material being excavated, which in turn indicate that artifacts may be anticipated or that the region is sterile. Common sense dictates the method; if you know from survey that there is 1 m of sterile sand over the archaeological layer there is no point in taking a long time to excavate it. A simple test is to check the spoil mound; if there are more than one or two artifacts there at the end of the day then one's methods need to be revised.

In very shallow water there may be problems with discharging the spoil far enough off the site because the shallow depth restricts the distance that the airlift pipe can be set. In this case it may be possible to run additional lengths of pipe and float them on the surface a sufficient distance from the

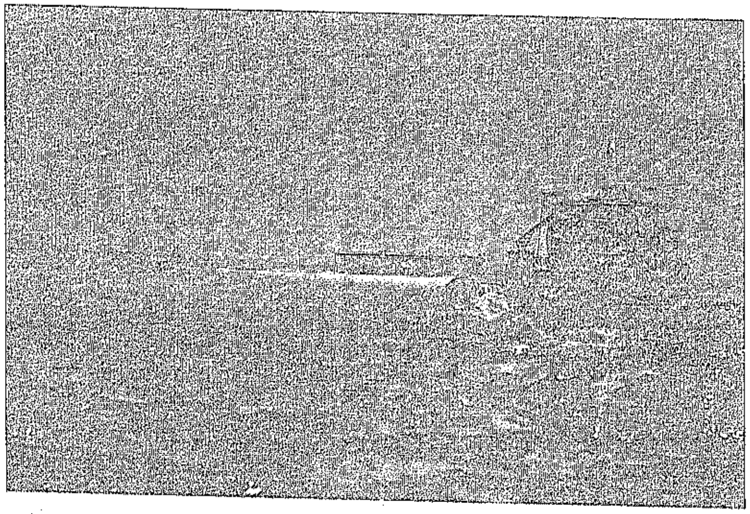


Figure 9.12 Airlift in operation on a shallow water site with the pipe running on the surface discharging spoil off the site. (Courtesy of Patrick Baker, Department of Maritime Archaeology, Western Australian Maritime Museum.)

site. This enables the spoil to be deposited outside the site (Figure 9.12). In deeper water, where the airlift pipe can be made quite long, the orientation of the airlift and the location of the discharge is important. No one wants a situation where the discharge spoil simply rains back down over the site, redistributing it uniformly over the site to be subsequently re-excavated. The solution is to ensure that the discharge is far enough off the site that it is clear of archaeological parts. If there is a current, this will have to be taken into account, as the current should carry the finer sediments away from the site. There will generally be a collection of the heavier material directly below the discharge and then finer and finer material off down current. In some cases the current can change direction, due to tides or other influences, and the excavator needs to be aware that the location and direction of discharge may need to be changed when the current changes.

C. Water Dredge

The water dredge consists of a long tube with a bend at one end forming an obtuse angle. High-pressure water (usually from a fire pump) is injected into the tube at the bend and directed so that the flow is axial with the long pipe. The flow of water along this pipe causes an induced suction at the working end (Figure 9.13). It is possible to attach a flexible tube to the

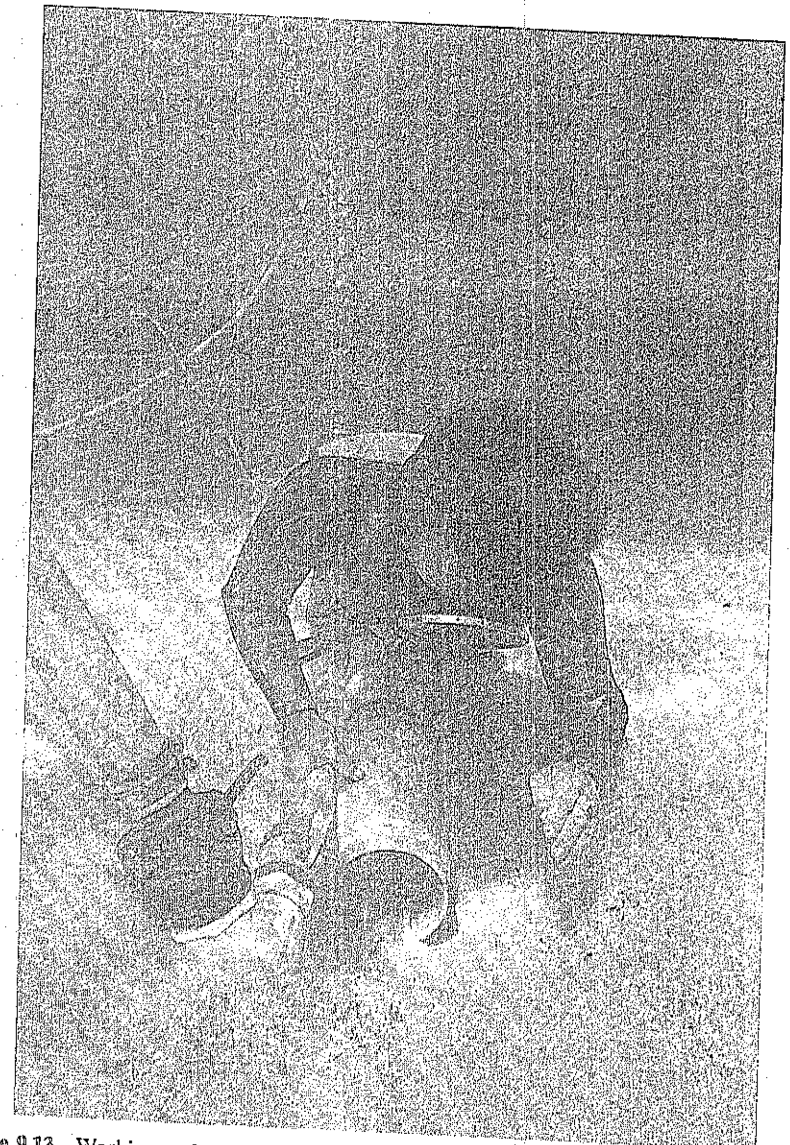


Figure 9.13 Working end of a water dredge showing where high-pressure water is injected into the dredge head. (Courtesy of Patrick Baker, Department of Maritime Archaeology, Western Australian Maritime Museum.)

suction end to increase mobility of the dredge. The advantage of the dredge is that it can work efficiently in very shallow water as well as in deeper water. The water pump is also generally lighter than the equivalent air compressor, so that excavation can be carried out from a more mobile work platform like a small boat. The dredge does not need to be securely fastened to the seabed, although there is a force caused by the water discharge at the end which tends to drive the dredge forward.

There are a number of disadvantages with the dredge. It does not work well when inclined upward, causing problems when it is necessary to excavate in a hole. This can be resolved by keeping the main dredge section horizontal and running a flexible tube down into the hole (Figure 9.14). If there is a current the water dredge needs to be set up so that it discharges down current taking into account current changes. Additionally, the efficiency of the dredge diminishes with increasing length of discharge tube. Thus, there is a limit to the distance that spoil can be discharged off the site. It is usually not possible to discharge more than about 5–10 m with a medium-sized fire pump. This can cause problems when excavating a large site, but with careful planning spoil can be deposited off the site. This contrasts sharply with the airlift which discharges its spoil high up above the site, usually some distance horizontally off the site, and utilizes the current to carry debris even further off. One final problem is that it is difficult, at the end of operations, to coil up the fire hose used to supply the water to the dredge. It is worth

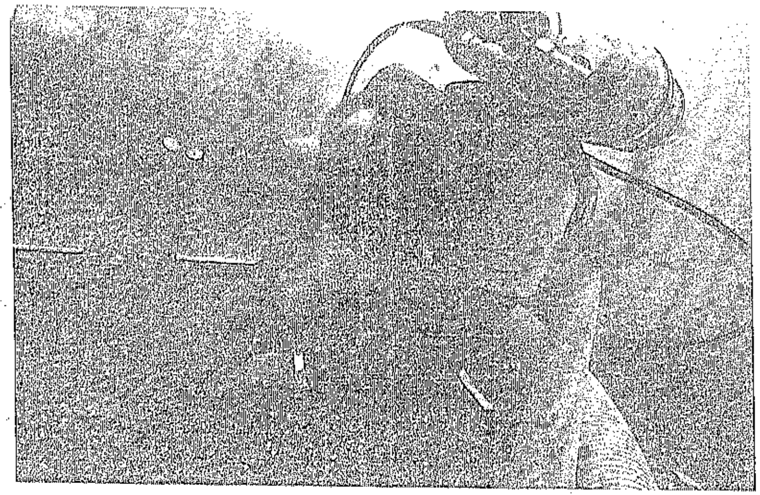


Figure 9.14 Dredge with flexible tubing which connects with dredge head (out of frame in foreground). Discharge extends behind diver. (Courtesy of Brian Richards, Department of Maritime Archaeology, Western Australian Maritime Museum.)

making a fitting that can be attached to the boat-end of the pipe so that air can be introduced into the hose to facilitate recovery, which otherwise requires a great deal of effort to load inboard when filled with water (see Negrel, 1976).

D. Water Jet

This is of limited archaeological use under water because it is difficult to control. When operated where there is any silt or light sediments, it rapidly reduces the visibility to zero. The jet requires a reverse thrust to balance the backward force of the jet. Without this back-thrust jet, the diver will be projected across the site in a random, uncontrolled, and quite spectacular manner, which is quite useless apart from entertainment.

E. Water or Air Probe

Difficulty is often experienced when trying to probe the sediments on a site. The relatively weightless diver will find it almost impossible to drive a rod into the ground by hand, particularly to any significant depth. One simple solution is to use a long, thin, hollow metal tube about 10 mm in diameter and pump air or preferably water into it. The air or water helps to clear obstructions from the path of the tube and keeps the sediments from sticking to it. Probing is, therefore, relatively easy and the nature of deposits such as pottery, wood, or metal can be determined with experience by the sound of the contact (see Chapter 5). The pressure needs to be carefully controlled, particularly in the water probe to ensure it does not become unmanageable.

F. Prop-Wash

Prop-wash systems were developed in the United States and have been used extensively by treasure hunters to remove large sand overburdens. These systems were called various names: mail box, blaster, prop-wash, etc., but essentially they diverted the water thrust from the vessel's propeller downward by means of a tube with a right-angle bend. The resultant down thrust could be used to dig extensive holes in sand overburden. An excellent illustration of how not to use a prop-wash is shown in the search for the *Atocha* where the seabed looks more like the result of an aerial bombing raid than some carefully controlled search for a site. The more

Figure 9.15 Small prop-wash mounted on outboard motor to clear overburden. (Courtesy of Catherina Ingleman-Sundberg, Department of Maritime Archaeology, Western Australian Maritime Museum.)

powerful the thrust, the greater depth at which it can work effectively and the bigger the hole that can be dug. Used carefully, the prop-wash can be a reasonably useful tool, but used carelessly, it can cause untold damage. It is best used where large quantities of sterile overburden need to be removed, otherwise it is not a good excavation tool because it cannot be properly controlled. Small prop-wash systems mounted on outboard motors have been used for shallow-water work, but the systems are not particularly efficient (Figure 9.15).

VI. RECORDING

On an archaeological site one of the most important issues is recording information and then bringing this information to the surface and it is often surprising at what little thought goes into this process. Quite often notes are scribbled onto tiny slates that are used over and over again. These notes, on arrival at the surface, are transcribed into filed notebooks and the data then removed prior to the next dive. If a transcription error has occurred there is no opportunity to check it against the original data. A better solution is to have large slates (A3 is ideal) with removable sheets of Mylar or some other waterproof writing film. This then provides a large working surface to record information and make sketches, and at the end of the dive the sheet can be removed, washed in fresh water, and immediately filed.

In addition, underwater communications can be extremely useful where data or information needs to be recorded. It can be particularly useful where one is conducting a measurement survey as the underwater operator does not have to stop to write things down, but can simply call out the reading and to be confirmed topside. Again, one is looking to reduce transcription errors in recording, and any system that helps to improve this situation is worth using.

A. Writing Slates

A simple clipboard or writing slate is ideal for recording. It is strongly recommended that proper writing slates be constructed made of rugged plastic sheet onto which a plastic frame can be clamped. Sheets of pre-cut drawing film can then be clamped between the board and the frame and removed when necessary. The sheets can be pre-punched with ring binder holes so they can be immediately filed for safe-keeping. A pencil, compass, ruler, and depth gauge can be attached to the slate and the back of the slate can be used for temporary notes; with a carrying handle the whole set makes an extremely useful piece of equipment. It is worth making a holder to put the pencil in when it is not in use. Half pencils are more economical, as whole ones usually break or get lost. Make sure there is a suitable diving knife for sharpening. An excellent alternative to a writing pencil is the Poppet Pencil. It consists of a series of short pencil leads mounted in small plastic holders, one on top of each other, in a tube. When the lead is worn away, the lead and holder is removed, inserted in the end of the pencil, and the next new lead is pushed into place.

Surprisingly, alcohol-based, fiber-tipped pens work under water, e.g., the Magic Marker or Shachihata types. They can be used to mark plastic tags for labeling objects for photography or recovery. Used on the surface, they serve as excellent markers for all sorts of work, particularly on plastic.

B. Carrying

A simple, large, net catch-bag is one option for carrying tools and equipment and for returning robust artifacts to the surface. Make sure that there are no holes in the netting and that the mouth of the bag can be clipped shut. When recovering fragile material, it is best to utilize a rigid plastic box like an old ice cream container or storage jar. These can be filled with sand to assist in supporting extremely fragile materials such as rope or leather. A spatula or kitchen fish slicer can be used to support this material as it is

E. Explosives

Explosives have been used with great success to break up concretion. Contrary to what one would imagine, this is an extremely effective technique if used carefully. It clearly has the potential for a disaster if uncontrolled, but this is true for many excavation techniques. A number of different types of underwater explosives are available, the most common are Cordtex, a fast, explosive detonating wire; plaster gel, a slow, gelignite-type explosive; plastic explosive (PE), a fast, easy to handle explosive; and Nitropril, a slow, home-brewed explosive that is difficult to manage. The reference to fast and slow relates to the speed at which the explosive wave travels. Thus, in summary, PE produces a sharp crack and is used extensively in cutting, whereas plaster gel produces a muffled boom and is used for breaking things. Experiments indicate that slow explosive is the best choice when dealing with concretion.

With a flat, pancake-like concretion, the best position for the explosive is in the center. Small charges of 10–50 g should be taped onto a thick rubber mat which acts as a protection for the potential damage the explosive would cause to the surface of the concretion and anything just underneath the surface. The objective of the explosion is to flex the concretion and crack it so that the concretion can be dismantled. The explosive is initiated by a Cordtex train which, in turn, is initiated by a detonator. Electrical detonation is the most convenient method of initiation (Figure 9.21).

The effect of the explosive is, in some cases, quite unusual. The shock wave seems to travel through the hard concretion cracking it, while the soft cast iron material is left undamaged. It may be that the interface between the hard and soft material creates some form of mirroring or shielding effect. The concretion can then be easily dismantled and the artifacts recovered. This process has been described as "getting cherries out of a cherry cake" (Green, 1975; Martin and Long, 1975).

F. Lifting

In most situations where material has to be recovered from a site unless the material weighs less than a few kilograms material will have to be raised using some form of assistance. For light loads, a simple line to the surface with a catch bag may be adequate (Figure 9.22). Alternatively small lifting bags can be used. Heavy objects like cannons, anchors, masonry blocks, etc., can be raised in several ways. Where a working platform is directly over the site, it is best to raise the object using a winch or endless chain hoist, and

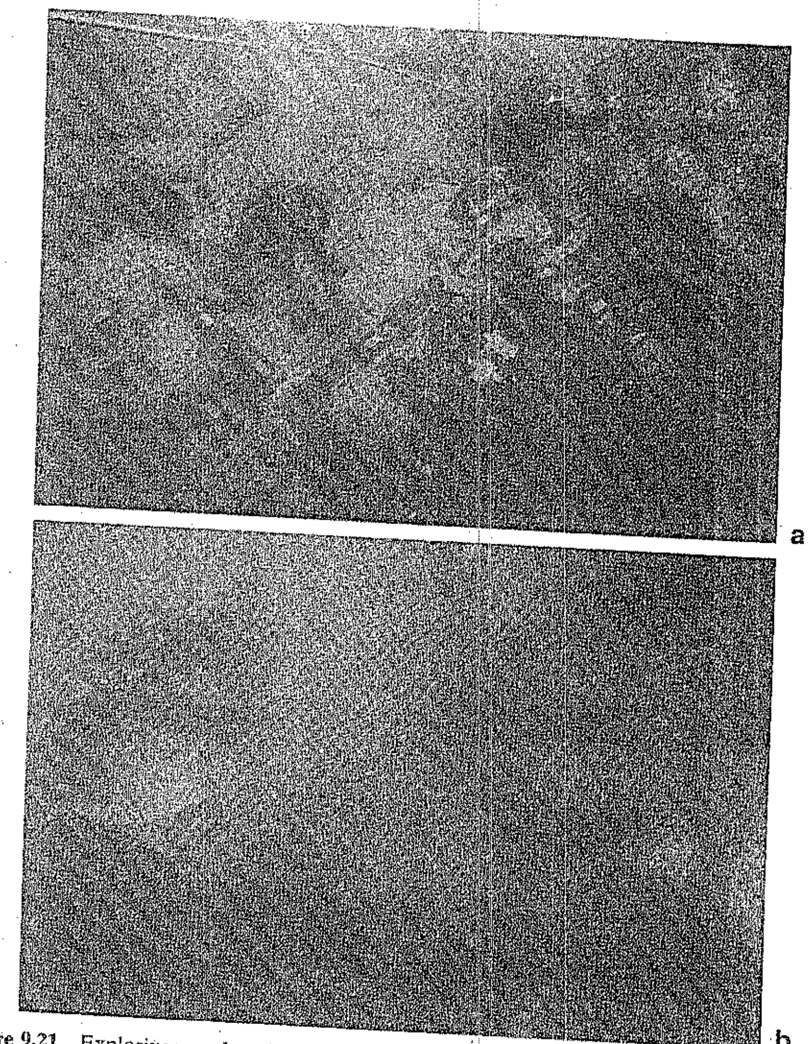
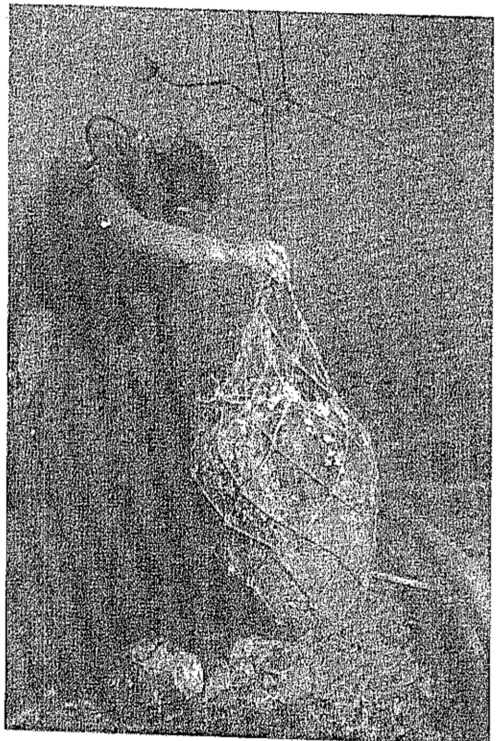


Figure 9.21 Explosives used on *Batavia* wreck site, Western Australia. (a) Placing charge on iron cannon ball concretion, the two white squares have small quantities of gelignite taped to a thick rubber mat, and (b) shows the charge exploding. (Courtesy of Patrick Baker, Department of Maritime Archaeology, Western Australian Maritime Museum.)

then, if need be, load directly onto a transport vessel (Figure 9.23). Where it is necessary to bring material onto the lifting platform, some form of inboard swing is required. This can range from a simple swivel davit to an A-frame, and ultimately to a hydraulically operated, articulated arm.



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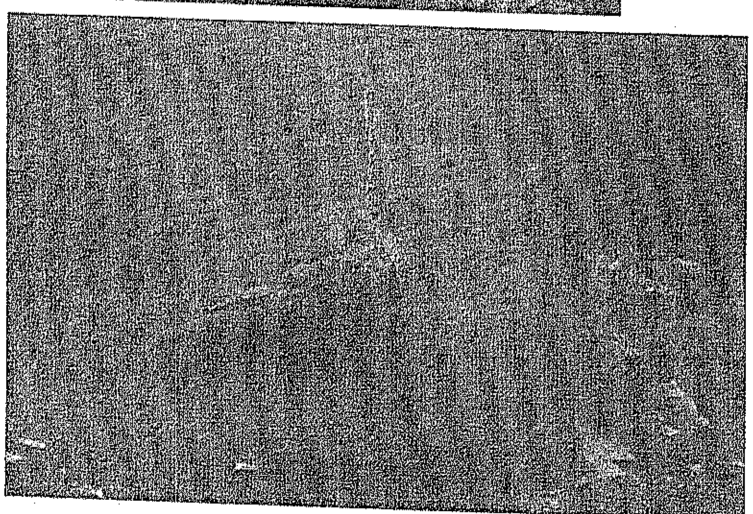

b

Figure 9.22 (a) Lifting using a mesh bag, Ko Si Chang, Thailand, and (b) raising a large iron cannon with rope-lifting strops, *Batavia* wreck site, Western Australia. (Figure 9.22a is courtesy of Brian Richards and Figure 9.22b is courtesy of Patrick Baker, both of the Department of Maritime Archaeology, Western Australian Maritime Museum.)

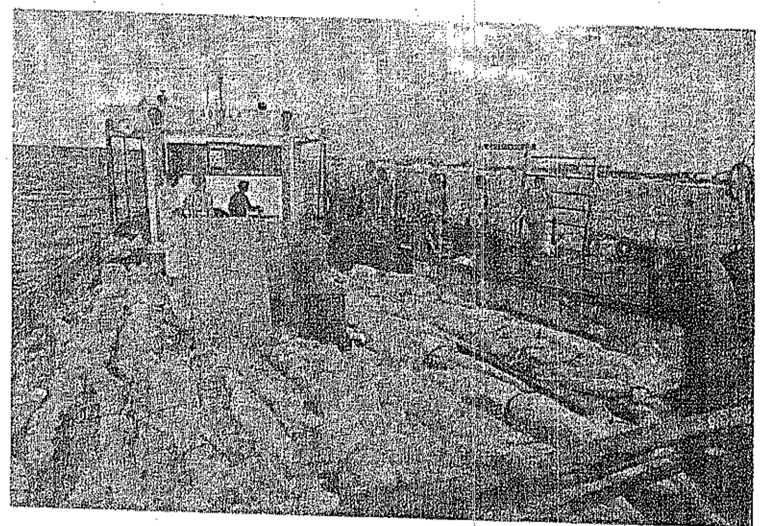

Figure 9.23 Transportation of *Batavia* timbers from the Abrolhos Islands by sea to Fremantle. (Courtesy of Patrick Baker, Department of Maritime Archaeology, Western Australian Maritime Museum.)

Before undertaking any heavy lifting, the vessel should be surveyed by a qualified marine surveyor to determine the stability parameters for safe working of heavy lifts. When using wire and shackles for lifting, it is essential to provide a method of ditching the lift in an emergency. It is almost impossible to undo a shackle while it is under tension. A simple solution is to include a rope loop between the object and the shackle. This can be made up of several loops of light rope so that it is easy to cut through one strand and free the object in an emergency.

If resources are limited, some quite simple and ingenious systems of lifts can be devised. One particular system utilizes an inflatable boat with a strong board mounted amidships across the pontoons. A simple, hand-operated trailer winch is attached to the center of the board; the wire is run over a roller at the end of one side of the board, down to a snatch block, and then back up and attached to the other side of the board. This forms a pulley system with a mechanical advantage and, as the weight is well below the center of gravity of the craft, gives a stable situation. Using such a system, an object can be raised under the boat and the boat brought into shallow water under power.

Similarly, a vertical hollow tube can be welded inside the hull of the boat, amidships, near the keel. The hull is cut away from around the inside of the tube and, provided the tube rises above the water line, the boat will not sink. A tripod is mounted over the tube, from which an endless chain is supported; the lifting chain passes through the tube and out below the boat. Although the attachment point is high, any tilt on the vessel will be righted by the effect of the chain acting at the entrance to the tube at the bottom of the hull. Hence, it would be impossible to capsize the boat (although it may be possible to sink it).

There are a number of commercially available lifting or air bags. These range in lifts from a few hundred kilograms up to several tonnes (Figure 24). Air is introduced into the bottom of the bag and it inflates until the whole bag is full and maximum lift is achieved. Where possible, it is better to have a number of small bags than one big one. This is because as a bag rises, the air in it expands. Thus, if a big bag is only partially full on liftoff,

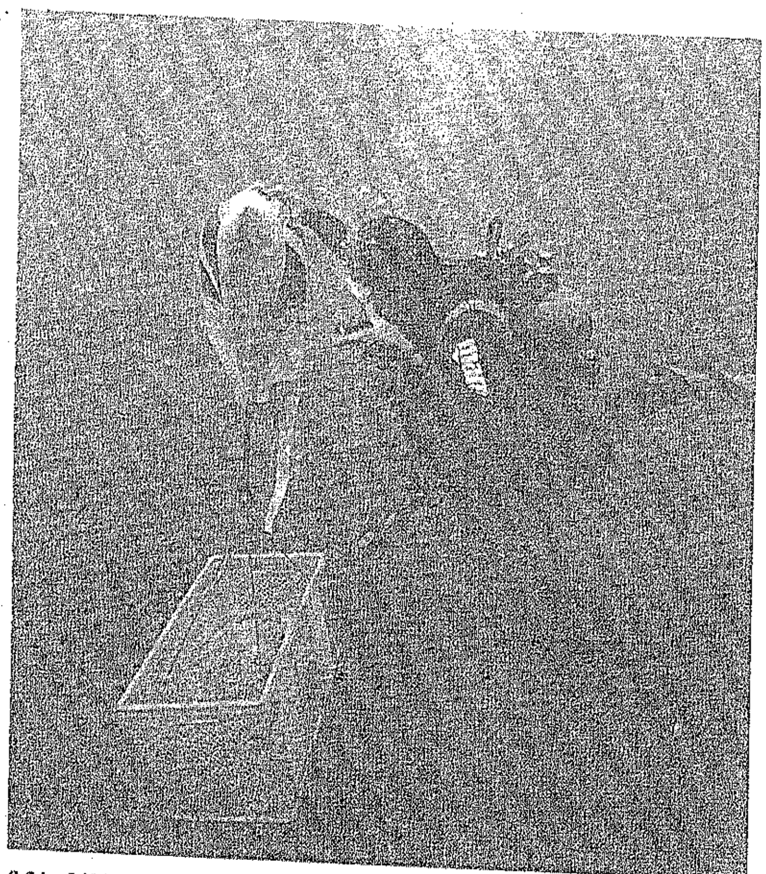

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Figure 9.24 Lifting bags of various sizes and in various situations. (a) On the Tektash Brunu site.

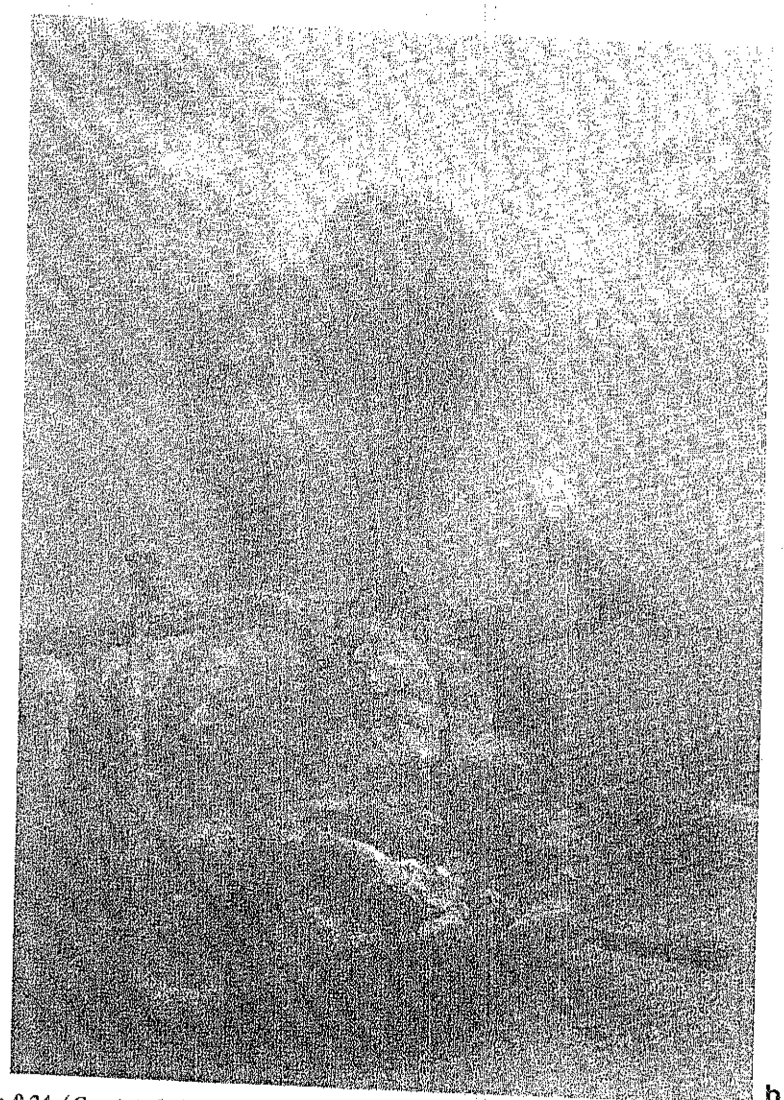

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Figure 9.24 (*Continied*) (b) On the Xantho site. (Figure 9.24a is courtesy of Jeremy Green, Department of Maritime Archaeology, Western Australian Maritime Museum and the Institute of Nautical Archaeology, Bodrum, Turkey; Figure 9.24b courtesy of Patrick Baker, Department of Maritime Archaeology, Western Australian Maritime Museum.)

as it rises the air inside it expands and the force of the lift increases resulting in an uncontrolled and extremely fast ascent. On arrival at the surface, the bag may exit from the water and lose a large proportion of its buoyancy, resulting in an equally fast and dramatic return to the seabed. If a number of small lifting bags are used, then on liftoff, the buoyancy of all the full bags will remain the same, and an increase in buoyancy will only occur in the one partially full, small bag. Alternatively, 200-L steel fuel drums can be utilized. The bottom of one end is cut out and chains attached in a bridle. This is a cheap method but should be used only in calm conditions and with great caution as divers can be easily injured working on them.

Most lifting bags have a vent control so that the diver at the mouth of the bag can let air out of the top of the bag and thus control the lift. With experience, a single diver can easily control the lift of quite large objects using vent control. As the lift rises the air expands in the bag and the operator lets enough air out to control the rate of ascent.

When carrying out deep-water lifts or working in murky conditions, it is important to keep a line from the surface attached to the object (not the bags). If the object breaks free from the lifting bags, or the lift fails and gets lost, this line can facilitate relocation. In most cases, during such lifts, the bags and the objects may be out of sight of both the diving team and the surface support crew. The diving team should never follow the rapid ascent of a lift to the surface and should always take every safety precaution during heavy lifts.

When towing an object supported by air bags, a buoy line should be attached to the object and streamed behind; should the object break free and sink, it can be quickly relocated. It is also essential, when towing something that could potentially sink the towing vessel, to ensure that the length of tow exceeds the maximum depth of water or that an axe or sharp knife is available to sever the towline.

Chapter 10

Recording

I. INTRODUCTION

Recording information and data either during a survey or an excavation is surprisingly difficult to do in a systematic manner and often information is lost. In this section, artifact recording, both on site and after recovery, and the subsequent management of the artifact and its record are discussed. The artifact record enables the excavator to identify an object and locate its position of discovery on the site and to obtain quickly and efficiently all up-to-date catalog and record details. This can then be used by the archaeologist in the process of the research related to each object. Thus, when it is time for the archaeological analysis, the data are available in a systematic form.

The record is also important for the efficient management of a collection. From the time an object is recovered, throughout field storage, transportation to the central repository, preconservation storage, during the conservation process, into long-term storage, and then possibly onto display in a museum, there is a need to know where the object is and what is happening to it.

II. RECORDING DURING EXCAVATION

On a site where only a small quantity of material is being collected by the excavators during the working day, it is usually possible to carry away from the site the unregistered material, together with the written records,