UNDERWATER ARCHAEOLOGY:
ITS PROBLEMS AND TECHNIQUES

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During the past two hundred years, archaeology has developed into a science that incorporates certain techniques in its operations. These techniques have, however, been developed for land-based archaeologists. They are adequate for land work, but when man moves into the underwater world, adaptations to these techniques must be employed. It is a study of the problems encountered by underwater archaeologists and the techniques which have been, and will be applied in the future, for solving these problems to which I devote this paper.

With the invention of SCUBA (self-contained underwater breathing apparatus) in the early 1940's, man was able to gain complete freedom for working underwater. Before that time, underwater archaeology had, in almost all cases, been nothing more than a salvage operation. Men using devices to smare artifacts that lay on the bottom or sponge divers, dressed in bulky diving suits, collecting artifacts do not constitute an archaeological operation. It was only after achieving freedom of movement underwater that man was able to conduct archaeological studies of sites that had previously been inaccessible to him.

The invention of SCUBA solved the problem of how man could successfully work underwater but dangers soon became apparent that restricted a diver somewhat in his activities there. These were the bends, nitrogen narcosis, and embolism. Although these pro-
blems have not entirely been solved, enough information has become available so as to prevent them from arising.

It has been found that the bends occur after a diver has remained too long at a given depth. While diving, a diver's blood absorbs nitrogen while his body is under pressure. If he returns to the surface before his body can use up the nitrogen in the blood, it will come out of solution as bubbles. It is these bubbles being trapped in certain areas of the body that cause lack of circulation, paralysis, shock, and severe pain for which the bends are noted.

Various navies of the world have conducted studies of the bends and have published diving tables which show a diver the length of time he can remain at any given depth before returning to the surface without having to make stops to allow the body to rid itself of the nitrogen. If a diver should exceed the specified time for a particular depth, the tables also include the decompression stops which must be made on ascending to insure that there is no occurrence of the bends.

Nitrogen narcosis usually occurs at depths exceeding 100 feet. The problem is that as a diver descends deeper more nitrogen is being breathed. This has a dulling effect on the brain, causes loss of judgement, and a person generally shows the symptoms of one who has been drinking alcohol. The narcotic effect will disappear as the diver starts making his ascent.

Embolism is one of the most easily avoided problems of SCUBA
diving, but it is the most dangerous one if it does occur. If a diver makes an ascent without exhaling continually, the air will expand with the decrease in pressure and could rupture his lungs or force bubbles directly into the bloodstream. These bubbles, carried by the blood, can do extensive damage to vital areas such as the brain or heart should they be trapped there cutting off circulation. This problem can be avoided by normal breathing at all times during a dive.

After achieving freedom of movement underwater, archeologists could concentrate on developing techniques for conducting work there. This meant modification of existing land techniques and invention of ones applicable to various underwater situations. There is such diversity of conditions that operation techniques can differ from site to site. Currents, depth, temperature, visibility, bottom terrain and composition, accessibility to the site must be taken into consideration. These variables have a direct bearing on the tools and styles of operations which are used on any particular underwater excavation.

There are four major areas for which an archeologist must develop techniques differing from those employed on land for similar operations:

1) Search and survey
2) Mapping and recording
3) Excavation
4) Preservation
Underwater search and survey operations can often rely on information obtained from local residents of an area such as fishermen, sponge divers, sponge druggers, or other people familiar with the area involved. In some cases, historical or literary documents may be referred to in order to locate the general area of a site.

If the exact location of a site is not known, some method of searching the bottom must be employed. Some of the methods previously used include divers swimming freely, a manned submersible vehicle, cameras and magnetometers towed over the bottom by a surface vessel, aerial photographs in shallow water, and sonar.

The mapping and recording of underwater sites can be extremely difficult. Poor visibility often hinders, if not restricts, the use of conventional mapping techniques. The depth and size of the site must also be taken into account when considering the method of mapping to be used. On other than relatively small sites, archaeologists encounter the problem of being unable to "see" the site until it has been placed on a general plan of the area. At present, assembly of photographic mosaics of a large area have not been too successful, but I feel this procedure will be improved in the future.

Obtaining horizontal measurements can be accomplished quite cheaply and in an uncomplicated manner by triangulation. This is
a time consuming process and uneconomical at depths where diving
time is limited. Another method has been used by Kendall Peterson
of the Smithsonian Institution. A wheel marked off in degrees is
mounted on a shaft which is driven vertically into the site. By
the use of a water tape attached to the top of the shaft, the dis-
tance and direction to any point may be determined in relation to
a fixed point.

Elevation measurements must be taken in order to study the
positioning of objects in the site. One method has been the tak-
ing of stereo-photographs of the site. The use of a micrometer
and simple formula are then employed to determine the elevation
of the objects. The pictures can be taken by a camera mounted on
a tower constructed over the site or by a manned submersible as
it moves over the site. A differential depth gauge has been in-
vented by Robert Love for determining elevations. With this in-
strument, divers can take elevation readings of a point in relation
to a reference chamber attached to the gauge.

Sonic devices have proven useful for locating walls and other
objects which are buried in the bottom. These objects have a gree-
ter density than the surrounding material and will reflect the
impulses in a different manner. In shallow water, surface markers
can be attached to the objects and mapping can be conducted on the
surface.
Of the tools used for land excavations, practically none of them are used in underwater work. They have been replaced by the air lift, an underwater vacuum cleaner. The air lift is constructed of a pipe which has air pumped in near the bottom opening. As the air enters the pipe, it rises to the surface creating a suction at the bottom opening. Depending on the surface conditions, the material picked up can be deposited on a surface vessel or into a wire basket attached to the lift below the surface. This allows the material to be screened before being disposed of. For raising large or fragile objects to the surface, a lift bag can be used. This is just an air bag which can be inflated on the bottom and will allow air to escape as it expands on rising.

Other items which have been used with some success have been core samplers and metal detectors. These enable an archaeologist to determine if anything lies buried on the bottom.

The steps in an underwater excavation must be recorded. Photography is the most important tool in that it is fast and usually quite effective. Drawings are good but they are usually too time consuming unless done in fairly shallow water.

All objects brought to the surface from an excavation must be carefully treated in order to preserve them. Wood must be kept wet until it can be treated with a preservative or it will shrink and warp beyond recognition. Some metallic objects may have disintegrated but their impressions have been left in the sand and shell concretions which surrounded them. These concretions can
be cut in half and casts can be made of the object.

The future of underwater archeology holds unlimited possibilities. The major reference has been G.F. Bass' *Archeology Underwater*, 1966. He mentions in closing some of the ideas for the future. These include undersea habitats, greater use of submersibles, saturation and mixed-gas diving, and better methods of preservation. Both government and privately backed projects since 1966 have only reinforced these ideas. Projects with divers living and working at depths to 500 feet for days and weeks at a time have been successful. There have been problems to arise which deal mainly with the breathing mixture being used and the decompression tables which must be employed upon surfacing.

In making deep dives, a great deal of time is spent decompressing. It has been found that extended dives require little more decompression than shorter ones. I feel the future will find archeologists living on the ocean floor for long periods of time in an undersea habitat located on the site. If necessary, they could be monitored by personnel in a surface vessel to insure safety and a thorough excavation of the site.

Underwater archeology is only now getting started but I feel it will greatly increase man's knowledge of the past in the years ahead.
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