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Innovation and Methodological Approaches to Deep Water Excavation; Warm Mineral Springs (8So19): A Case Study

With the focus of underwater archaeology beginning to shift towards the examination of submerged cultural resources in deeper waters on the Outer Continental Shelf and in lakes, springs, and sinkholes, it is essential that professional archaeologists begin to recognize the need for a continuing program of research and innovation in terms of diving technology (Cockrell 1973). Since the earliest stages of the research at Warm Mineral Springs in 1972, such a program has existed under the direction of Wilburn A. Cockrell. Cockrell was quick to realize that the archaeologically rich waters of Warm Mineral Springs presented a challenge in terms of developing new techniques to meet the ever increasing demands of his research design and the harsh diving environment. Beginning in 1972, Cockrell, assisted by his colleague, Larry Murphy, instituted a multi-disciplinary effort that has gained worldwide recognition as having remained on the cutting edge of innovation and adaptation.

Research efforts during Phase I (1972-1977) were directed by Cockrell and administered by the Florida Department of State's Division of Archives, History and Records Management. During six consecutive field seasons, he mobilized large crews and launched successful, large-scale archaeological field projects. The emphasis was then, and continues to be, three basic elements; preservation of the site and its archaeological materials; education of the public through information dissemination; and archaeological research. With those elements to guide them, Cockrell and his crews set out to explore and map the upper, shallow portion of the Springs and to excavate the remains of an intentional 10,300 year-old Native American burial on the 13 m ledge as well as the articulated remains of extinct Pleistocene megafauna (Cockrell & Murphy 1978). Although some exploratory dives were made to depths of up to 70 m, the principle research focus was the upper 19 m of the Springs.

In 1978, the Phase I portion of the research was phased out due to funding cuts and a lack of support in the Florida Department of State. A subsequent elimination of the Underwater Archaeological Research Section of the Division of Archives forced Cockrell to seek alternate funding sources. Phase II began in March 1984, and continues to date under the auspices of the Warm Mineral Springs Archaeological Research Project and is funded by the Florida State Legislature.

Initial underwater efforts during Phase II were directed towards cleaning accumulated sand from the 13 m ledge and re-establishing mapping points. Although hampered by limited funding, a small over-worked staff, and "hand-me-down" diving equipment, the projected goals for the 1984-1985 fiscal year were accomplished and staff members were able to begin working towards more ambitious goals for forthcoming field seasons, namely the establishment of deep excavation units in the debris cone at the bottom of the springs (Cockrell 1986).

Concurrent with the ever increasing demands of the Project's research design have come increasing demands upon new technology to insure diver safety in a harsh diving environment, notable for its extreme depth, partial overhead environment, and lack of ambient light. Therefore, research into increasingly more technologically advanced diving and data gathering techniques has been ongoing since the start of Phase II. The final stage of this research resembles the evolutionary process in that new equipment configurations and techniques are tested and evaluated on-site with safety and job-specific tasks in mind. Pieces of equipment or techniques which prove to be effective are retained and those that fail to produce positive results are discarded.

Initial excavations in Phase I were carried out utilizing what was then considered to be "state-of-the-art" sport diving equipment. Early recognition of the need for innovation and adaptation took the form of modifications to the individual gear of dive team members. Murphy, then functioning as Project Dive Officer, was an early proponent of techniques developed through the efforts of the membership of the National Association for Cave Diving. He recognized the value of their specialized diving equipment in terms of increased diver safety and the increased buoyancy control it afforded in the overhead diving environment. Keying on this, Murphy began by modifying his "horse-collar" Buoyancy Compensator to facilitate a more exaggerated "head down-feet up" swimming position which has proven to be extremely effective in working in close proximity to the fragile sediments found in Warm Mineral Springs. While a seemingly obvious and simple modification, Murphy's adoption of this technique marked the beginning of a relationship with the cave diving community which has continued to date. The close of Phase I in 1977, saw the application of other equipment attributable to the NACD, such as dual high pressure orifice tank valves and the use of redundant SCUBA regulators (Exley 1981).

Phase II saw the aforementioned extension of work areas into the depths between 36 m and 50 m. With diver safety in mind, the principle of redundancy of equipment was carried further to include redundant buoyancy control devices, redundant primary light sources, and alternate air supplies. Working at depth, well beyond the reach of ambient light from the surface and often with limited visibility due to suspended particulates in the water, the added safety factor provided to the diver by these redundancies cannot be underestimated. Short of a primary air supply failure, each diver is capable of self-rescue and the handling of most immediate equipment-related emergencies independently (Exley 1984).

During early efforts to establish an excavation unit in the 46 m area of the debris cone at the bottom of the Springs, it became obvious that staff divers were pushing open-circuit SCUBA to its maximum potential. Bottom times were limited by the amount of air that the divers could carry for use during the dive, as well as during the lengthy periods of decompression which resulted from working at depth.

Feeling somewhat like Mary Norton's "Borrower Family" in her book *The Borrowers*, staff members began to evaluate alternate life support equipment and technology. Where once the staff members borrowed heavily from the cave diving community, they now found that the most obvious progression technologically was to begin by looking at the time-tested equipment developed for the Commercial Diving Industry and the oil fields of the Gulf of Mexico and the North Sea.

Following a literature search by the staff, numerous inquiries were sent out to a wide spectrum of diving experts and consultants, seeking baseline data on what kind of equipment was available and who was available to provide the necessary training to bring the staff up to a safe, acceptable level of performance in its use.

Based upon research performed by the Project Manager, Barbara O'Horo, and the author, a firm commitment was made to purchase surface-air-supplied diving equipment. A compact, diving control console, manufactured by Diving Systems International was purchased following in-water testing and evaluation by staff members. This equipment, coupled with 300 foot hoses and two different configurations of diver headgear, allows the divers to have an unlimited air supply and direct contact with their surface support by means of hardline radio communications or line-pull signals (Larn and Whistler 1984). These advantages far outweighed the use and expense of closed-circuit rebreathers and other more exotic equipment. The surface-air-supplied equipment chosen represents the standard of the Commercial Diving Industry. This equipment has proven to be both durable and reliable. Training in its use was provided by outside consultants who came on-site and provided both classroom and in-water sessions.

Actual day to day diving procedures at Warm Mineral Springs were initially outlined by Murphy in 1978 (Murphy 1978). These procedures were applied with safety and success throughout the closing field seasons of Phase I. These same procedures were updated by this writer in January 1985 and adopted as the official diving policy of the Warm Mineral Springs Archaeological Research Project for Phase II. While these procedures satisfied the need for Project standards at that early stage, the increasing complexity of the applied diving technology involved created many unforeseen administrative concerns, problems, and resultant delays.

The question of the administrative and legal constraints involved in doing unprecedented deep research is one which must be confronted by any scientist considering the possibility of beginning the excavation of an archaeological site which exhibits a potential for a deeply submerged component. With the ever present threat of litigation as a result of accidental death or injury, coupled with the obviously increased risk of working at extreme depths, projects will undoubtedly be evaluated by sponsoring institutions and undergo scrutiny which will cause delays and involve administrative restructuring of project goals and procedures. Depending on the institution, projects may be restricted in scope to shallower depths or modified to conform to imposed standards created by sponsors or, as a last resort, to be cancelled.

For example, throughout the history of scientific diving and the research diving at Warm Mineral Springs, a heavy emphasis has been placed upon diver safety and accident prevention. Furthermore, close attention was paid to emergency evacuation procedures for treatment of hyperbaric incidents requiring recompression. With this fact in mind, funds were allocated during the 1985-1986 Fiscal Year for the purchase of an on-site, 54-inch, double lock recompression chamber and a low pressure compressor to operate it. The acquisition of this vitally important equipment has delayed by the Risk Management representatives of our administrating institution, while they evaluated the administrative and legal constraints of waivers, insurance coverage, and the potential for litigation in the event that misuse of the equipment results in the compounding of a hyperbaric injury. The aforementioned delay lasted approximately 26 months and was resolved only after three hyperbaric incidents occurred.

The beginning of the 1987-88 Fiscal Year saw the administrative sponsorship of the Warm Mineral Springs Archaeological Research Project change from Manatee Community College in Bradenton, Florida, to Florida State University in Tallahassee. This transfer placed the project under the auspices of the Florida State University Academic Diving Program. Placement into this program introduced a new administrative control which requires that all project staff divers must adhere to dive policies administered by an American Academy of Underwater Sciences-sanctioned Dive Control Board. This Board had never had review authority over an in-place, full-time diving project of the complexity exhibited by the Warm Mineral Springs Archaeological Research Project. The result of having to integrate into the Academic Diving Program, coupled with the Diving Control Board's lack of familiarity into the project's policies and procedures has created numerous administrative delays and resulted in the loss of five months of in-water time. Furthermore, the Academic Diving Program imposed a series of depth certification limitations upon project diving operations which have curtailed all deep excavations and completely changed the thrust of this year's research.

In addition, complications on the state level have severely restricted project spending, making it impossible to institute proposed deep diving operations, which require not only the purchase of equipment and supplies, but the salaries to hire a diving supervisor and two diving technicians. The Project Director, Wilburn A. Cockrell, anticipates a lessening of these administrative woes in the near future and an eventual return to the projected plan to utilize safer and more technologically advanced equipment (Cockrell, personal communication 1988).

It is proposed that project divers will begin to utilize alternate breathing mixtures for working in the lower reaches of Warm Mineral Springs, followed by decompression in the environmentally controlled atmosphere of a recompression chamber, located on the surface. Utilization of this technology will facilitate working at depth without the debilitating effects of nitrogen narcosis and allow unlimited access to the lower portion of the Springs in terms of depth and time.

The concept of applying alternate breathing mixtures is not a new one. It represents the future for all deep water archaeological projects. Research in to the use of a helium-oxygen mixture for diving began in 1919 with the work of Elihu Thomson and the United States Bureau of Mines and has become a standard for both military and civilian diving operations. Today research is continuing to explore the potentials of other mixed gases such as the oxygen enriched mixture, Nitrox, a nitrogen-oxygen-helium combination, Trimix, and, most recently, a hydrogen-oxygen mixture, Hydrox (Chandler 1987).

Concurrent with the advance in technology and theory, comes a need for sophisticated hardware. Robert Evans, formerly of the Florida Institute of Technology's Ocean Technology Program, was consulted in reference to adapting the standard surface-air-supply equipment which was on-site for use with mixed-gas valving assemblies, allowing its use with Heliox and Nitrox as alternate breathing gases. To accompany this hardware, Evans proposed a diving schedule which will alternate two deep diving days utilizing Heliox as a breathing medium with one day of shallow working dives on the 13 m ledge while utilizing a depth/site specific Nitrox mixture. This proposal should reduce physiological stress upon diving personnel.

Similarly, the utilization of a surface recompression chamber was proposed to reduce physiological strain by reducing the exposure of divers to their cold, wet diving environment during long periods of decompression. Decompression on the surface in an environmentally controlled recompression chamber using the U.S. Navy Surface Decompression Table Using Oxygen can actually increase in-water work time by increasing bottom time since the longer periods of decompression are less physically taxing (U.S. Navy 1975).

With an eye towards the existing administrative and logistical problems with making repeated deep dives to perform research tasks, efforts are underway to purchase a remotely operated vehicle (ROV). In recent years, the oil industry has begun to see the value of utilizing machines to do inspection tasks which do not require a diver's direct participation. In fact, industry sources indicate that the demand for ROVs is currently exceeding the rate of their production (Busby 1988).

As archaeologists, we could never condone nor relinquish the task of site excavation to a machine, but we can envision numerous tasks which could be performed by an ROV. These tasks include the deployment of television cameras for the inspection of deep excavation units by non-diving contributing scientists and the deployment and retrieval of remote sensing devices designed to do mapping, measure water temperature, ph, conductivity, or a host of other factors. This type of vehicle can perform these tasks expediently and limit the need for using divers in extreme exposure situations.

An eagerly awaited test and evaluation of a Sonic High-Accuracy Ranging and Positioning System (SHARPS) is anticipated during the current field season. The SHARPS is a sonic mapping system which allows the electronic plotting of X, Y, Z coordinates in respect to three pre-positioned transponders. Transmitted to the surface, these coordinates can be turned into maps with a 2 cm degree of accuracy. Applicable for deployment by ROV, the SHARPS appears to be particularly useful for mapping features and excavation units in the debris cone at Warm Mineral Springs where the extreme depth and fragile sediments make mapping a difficult task at best. For archaeologists in general, the SHARPS holds potential for examining sites in limited visibility areas such as rivers and blackwater drainages (Murphy 1987).

There appears to be no limit to the technology being developed to accomplish underwater tasks safely and efficiently. It is essential that the underwater archaeologist stay abreast of these developments and view them in terms of how they might be adapted and utilized to do job-specific archaeological tasks in a manner which insures the maximization of data recovery while minimizing the risk to diving personnel.

Archaeologists have long been heard to express the need for a scientist to be an archaeologist first and a diver second (Wilkes 1971). That may be true, but there is a new breed of archaeologist on the horizon who must bring to the profession a knowledge of computer aided design, SHARPS-type computer aided mapping and positioning systems, and other sophisticated skills heretofore unrecognized by archaeologists. He must also bring to the profession an appreciation for state-of-the-art diving technology. The future successful excavation of deep water archaeological sites will depend on the profession's willingness to be innovative and to use increasingly complex technology to meet the demands of an increasingly demanding field of scientific investigation.

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