Version of Record: https://www.sciencedirect.com/science/article/pii/S0967064517301005
Manuscript_2c345c543b2a9dc46ae0ea1f1a337dbf

Deep-Water Archaeological Discoveries on Eratosthenes Seamount

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Abstract

A team of earth scientists conducted a series of exploratory transects across the summit of Eratosthenes Seamount in 2010 and 2012 to better understand the geologic structure of this unique flat-topped feature in the East Mediterranean Sea. and optical imaging systems. The researchers could instantaneously communicate with archaeologists on shore by utilizing a high bandwidth satellite system on the E/V *Nautilus*. This system allowed researchers and archaeologists to better take advantage of this series of discoveries. The data collected during these field seasons, presented and discussed in this article, contributes to existing literature on the maritime traffic patterns of the ancient Eastern Mediterranean, and of open-sea travel over the underwater plateau from 800 BC—800 AD.

1. Introduction

The purpose of this paper is to demonstrate how telepresence technology was used by oceanographers in the field to assess and analyze three shipwrecks and numerous artifacts discovered during exploratory expeditions of the submerged plateau known as Eratosthenes Seamount (Figs 1, 2, 5) The goals for this expedition were expanded from the original focus on biologic and geologic research to explore the environment of the Eratosthenes Seamount as an ideal location for deep-sea archaeology. Not only does the summit provide the perfect physical setting, but the seamount is positioned in a central location for maritime traffic between the Aegean, Crete, the Levant, Cyprus, and Egypt. The limitations of underwater archaeological techniques (Muckelroy, 1978) have heretofore restricted investigations to coastal regions and shallow waters, preventing scholars from gaining insight into the movements of ancient seafarers as trade routes move away from shore. Technological innovation has made it possible for social scientists to study previously unexamined sections of ocean and sea.

From August 22 - 28, 2010 the research team aboard the E/V *Nautilus* conducted a survey of Eratosthenes Seamount discovering 70 isolated amphorae and returned in 2012 for a more systematic survey of the underwater plateau. Between August 14 - 25, 2012 the research team found another 149 isolated amphorae in addition to three shipwrecks, one of which was modeled via photomosaic. Approximately 18% of the seamount was explored between the two seasons. The potential for evidence of distant-offshore maritime traffic in the Mediterranean is more apparent when the collected data is extrapolated. It is the hope of the research team that archeologists will take advantage of the data collected in this preliminary exploratory survey to conduct a more exhaustive investigation of the seamount after accessing the data presented in this paper.

2. Area of Study: Eratosthenes Seamount

The Eratosthenes Seamount is an underwater plateau 120 km in length and 80 km in width situated between the northern and central segments of the Eastern Mediterranean (Schattner, 2010; Fig 1). The seamount rises from the surrounding seafloor at a depth of 2,700 meters to its summit at an average depth of 690 meters. Its flat top was formed in the Miocene epoch (23-5.3 million years ago) when its upper limestone cap lay above sea level (Robertson, 1998) much like the Bahamian Archipelago today. The seamount is located 93 km south of the island of Cyprus, 260 km west of Beirut, and 260 km from the entrance to the eastern Nile River.

It became clear during the Exploration Vessel (E/V) *Nautilus* survey in 2010 that the Eratosthenes Seamount offered ideal conditions for the preservation of cultural resources. Deep sea trawling damage to artifacts is less apparent on the underwater plateau because the average elevation is too deep for most fishing trawlers. Furthermore, the plateau has a low sedimentation rate averaging 2 cm/1000 years (Flecker and Grove, 1994), compared to 83 cm/1000 years in the nearby Herodotus Abyssal Plain (Reeder et al., 1998). The primary sources of sediment in the Herodotus Abyssal Plain are turbidites from the Nile Cone, the Libyan-Egyptian shelf and debris flows from the Mediterranean Ridge. Sunken artifacts and ships resting on the seamount summit are in a high enough position to avoid being quickly covered by bottom-traveling sediment flows. Artifacts and ships also benefit from the karst topography which reduces buildup of sediments by acting as a natural sieve. The depth of the seamount additionally affects the way sunlight interacts with the environment. Sunlight from the surface cannot reach the seamount making it difficult for organic life to grow on sunken artifacts. The Eratosthenes Seamount is an ideal environment for the preservation of artifacts because they require less effort to identify and are better preserved than those exposed to higher sedimentation rates and sunlight.

3. Methodology

Aboard E/V *Nautilus* are several deep-sea vehicle systems (Phillips et. al., 2011) including: *Echo* and *Diana,* a dual frequency towed side-scan sonars which have 100 and 400 kHz transducers and 300 and 600 kHz transducers, respectively, *Argus,* a deep-towed camera sled and *Hercules,* a remotely operated vehicle (ROV). Important to the research in this paper, the exploration vessel has been fitted with a high bandwidth satellite link allowing real time connection between the research team aboard, with scientists and engineers on shore (Kulin, et. al., 2011; Coleman and Ballard, 2011; Austin et. al., 2011). This satellite uplink system allows the team on board to consult remotely with experts around the world via video interface.

A survey of the Eratosthenes Seamount was plotted using a map generated by the Medimap Group (Loubrieu et al. 2005). *Argus* was initially used to survey the top of the Seamount to detect individual artifacts or isolated shipwrecks using dual frequency towed side-scan sonars (Mesotech 1071 profiling sonar, and the EdgeTech 4200 MP CHIRP side-scan sonar) operating at 100 and 400 kHz.

Argus was used next in tandem with the *Hercules* ROV to locate targets detected by *Argus* and obtain high-resolution images, measure their dimensions using a laser-measuring sensor, and capture a photo-mosaic of one of the three shipwrecks encountered. *Argus*, connected to *Nautilus* via ship-board winch, absorbed fluctuations caused by changes in above-water conditions and the position of the ship, allowing *Hercules* (connected to *Argus* via loose fiber optic cable) to maneuver with greater accuracy. The photo-mosaic was constructed by maneuvering *Hercules* over the site in a 10 x 30 m "checkerboard" grid imaging the wreck using the 1,375 kHz BlueView Technologies multibeam, color and black-and-white 12-bit 1,360 × 1,024 Prosilica stereo cameras, along with a 100 mW 532 nm green laser sheet and a dedicated black and white camera (Roman et al. 2012; Figs 6a, 6b).

The telepresence capabilities of the E/V *Nautilus* played an integral role in the research team's ability to properly identify the artifacts observed over the course of the 2010 and 2012 field seasons. Through consultation with both Dr. Lawrence Stager of Harvard University and Andrei Opait of the Institute of Archaeology, Iaşi, researchers in the field were able to accurately classify and analyze the amphora they encountered across the seamount.

4. Results

During the 2010 expedition 70 individual artifacts (Table 1) were found across the Eratosthenes Seamount, as well as two shipwrecks from the 19th century (Wachsmann, et al., 2011). A preliminary analysis was completed on 31 of the 70 individual artifacts revealed ages ranging from the 7th century BCE to the beginning of the Byzantine period; roughly 6th to 7th centuries CE (Wachsmann, et al. 2011). The remaining 39 vessels found during the 2010 field season have not yet been identified. These vessels were either too fragmented, covered with extensive silt or the image quality was too low to analyze. The team did not have archaeological permits to handle or raise any of the found artifacts and did not try to move otherwise identifiable pieces from the seafloor to get higher quality pictures.

High definition video and still images of isolated artifacts were captured by the *Hercules* ROV during the 2012 return of the E/V *Nautilus* to the Eratosthenes. The research team aboard *Nautilus* found 149 new isolated artifacts using a grid-pattern method to survey the face of the seamount (Table 2). Out of the 149 vessels found, 69 were positively identified and catalogued. These vessels ranged from amphorae to cooking and eating vessels, which dated from the early 6th century BCE, with continuous representation, up to the 7th century CE. Approximately half of the remaining 80 vessels found in 2012 have been deemed unidentifiable for of the same reasons noted for the 2010 unidentifiable finds.

During the 2012 expedition one shipwreck, the Eratosthenes C wreck, was surveyed and imaged. A high definition photo-mosaic was created of the wreck site using the acoustic and optical imaging systems of *Hercules* (Fig 3). The photomosaic of the wreck allowed a detailed analysis of the site while leaving it undisturbed. The main cargo appears to have been wine carried in amphorae along with large pithoi (Fig 4, Bottom Right). Nearly 100 complete amphorae are visible and another 10–15 are broken. The amphorae from wreck C are primarily from the SE Aegean area: Rhodes and its Peraea, Knidos, Samos (mushroom rim types), and Chios. The next most represented group is north Aegean amphorae: Mende, Peparethos, Pella, Thasos, and perhaps other small northern centers (Akanthos, Samothrace). Isolated amphorae originating from Corinth/Corfu, Sinope, and a Phoenician center can be added to the above groups. At least 14–15 amphorae belong to unknown types. Drinking vessels and the kitchen ware make up the secondary cargo: large and medium krateres, krateriskoi, kantharoi represented by numerous large-neck jugs of five to six liter capacity, several small, narrow-necked jugs, and numerous kitchen wares that primarily consisted of pots and casseroles. A single lamp was visible, although there were possibly more that went undetected, covered by sand or were stored inside the larger vessels for protection. Based on all of this exposed cargo, the shipwreck has been given a preliminary dating of late 4th century BCE, possibly around 330 BCE. In addition, the ship's length (~26 m) is congruent with that of biremes used across the Mediterranean during this period. (Encyclopædia Britannica,Inc 2012, Naval Ship) The wreck's amphorae are concentrated in high density at the fore and aft of the vessel, and separated by a long depression in the sediment potentially caused by initial weight of the now deteriorated hull. The low-density of artifacts at the vessel's center may be due either to the presence of foodstuffs and other goods that would deteriorate over time, or the presence of rowing benches.

5. Discussion

The National Oceanic and Atmospheric Administration's Office of Ocean Exploration and Research (NOAA OER) sponsored these expeditions with the stipulation that all data collected on an expedition it sponsors is "open-sourced" and available to any scholar seeking access to this database. What follows is a preliminary description of the archaeological data available to interested scholars wanting such access. Data from the E/V *Nautilus*' 2010 and 2012 field seasons can be requested through the Ocean Exploration Trust website: "OET Home Page. Data Request Form. http://www.oceanexplorationtrust.org/data-request" (April. 2017)

The 2010 and 2012 field season surveys of Eratosthenes Seamount yielded a large number of isolated artifacts. Both the volume of artifacts and their location far from sight of land provide evidence in support of deep-sea trade routes. The 219 ceramic vessels, 100 positively identified, vary widely in date and origin. The Levantine area of production dominates the assemblage (see Table 1 & 2), yet numerous ceramic vessels from the Aegean, Egypt, and western Asia Minor were also present. This collection of ceramics provides evidence for continuous maritime traffic from 800 BCE—800 CE, and may be used as a reference when determining the frequency of maritime travel across other offshore survey areas. Each isolated artifact is evidence of the passage of a vessel, which must have sailed over that spot and discarded the amphora, bowl or wine jug. While a single artifact may not necessarily indicate the origin port of a vessel, tracing its origin gives us a better understanding of the intricate web of cultural exchange that tied together the varied corners of the Mediterranean world for centuries.

Literary evidence and previous archaeological discoveries suggests that people in the Levant actively traded goods and wares with those in the Aegean as early as the Late Bronze Age (Wachsmann, 2008). Similarly, it is known that there was commerce between Egypt and Cyprus (Wachsmann, 1986). Wachsmann scrupulously investigates a recorded maritime journey from Egypt to Syria via Cyprus. The text he examines explains that Rib-Addi is forced to send his envoy on this roundabout route under the duress of war; however, normally the route from Egypt to Syria would be a straight sail (Wachsmann, 2008, p. 295-296). Still other archaeological finds provide evidence for cultural diffusion between the Near East and North Africa (Casson, 1991; Aubet, 2001), as the Phoenicians are suspected to be the early settlers in what eventually became Carthage (Aubet, p. 208).

It is evident that these trade routes existed and approximately when they occurred, but the precise routes have been elusive. With advances in modern technology (Ballard, 2008), we are now able to explore previously unreachable areas that may contribute information toward our understanding of ancient open-sea voyaging. It is even possible that the isolated artifacts found on this underwater plateau could help define some specific maritime routes to and from known ancient ports.

The Eratosthenes C wreck (Fig 3), for example, was carrying primarily Aegean wares, but held a small number of Levantine kitchen wares. This combination of cargo and personal belongings suggests the merchant ship may have been importing foreign goods from the Aegean into the Near East when it sank. Understanding this we are able to hypothesize the potential trade relations between cities and states at the time of the ship's sinking.

In figure 5 the distribution of known individual artifacts is plotted over the bathymetry of Eratosthenes Seamount. Several patterns appear through this analysis, the most prominent of are the two E-W and two N-S trails. Without a full survey of the underwater plateau, it is not possible to equate these trails with individual 'routes' or if these patterns are merely a consequence of the track lines of the survey. Interestingly, prior to 100 BCE wares from Greece and the Near East are common, and after 400 CE the pottery is of different types but of a similar origin. The concentration of Rhodian amphorae (denoted by green) in the southwest corner of the seamount may be the result of a single event. Their grouping suggests the possibility of a shipwreck; however, a search around this concentration found no evidence of a wreck. Just as with the archaeological remains at the Skerki Bank, it is hoped that the isolated artifacts and shipwreck site found on the Eratosthenes plateau can contribute to understanding specific maritime routes far offshore, and that this material can be used for comparison to similar future discoveries.

Acknowledgements

The authors wish to thank Dr. Robert Ballard, Dr. Lawrence Stager, Dr. Daniel Master, Dr. Michael Brennan, Dr. Chris Roman, Dr. Daniel Davis, and Dr. Shelly Wachsmann for their insight and support during the research and writing process. We thank the Ocean Exploration Trust, Bechtel, the Graduate School of Oceanography, University of Rhode Island, the Richard Lounsbery Foundation, the National Geographic Society, Ocean Exploration Trust Directors, Sponsors, and Contributors, the Office of Education, the National Oceanic and Atmospheric Administration, the Office of Naval Research, the Office of Ocean Exploration and Research, National Oceanic and Atmospheric Administration, and the Sea Research Foundation for making this research possible. In addition, we recognize the aid given by the reviewers of this manuscript; their comments were crucial to the editing and formatting of the final manuscript.

Table 1 - Dates for Amphora Catalogued During 2010 Expedition

Source #	Origin	Classification	Period	Quantity	Image
1	Levant	Phoenician	750–700 BCE	1	Appendix I, Figure 1
2	Levant	Late Roman	6th—4th centuries BCE	1	
2	Levant		4th century BCE	1	
2	Levant		4th century BCE	1	
3	Levant	Early Roman	1st—3rd centuries CE	1	Appendix I, Figure 2
4	Knidos	Greek	2nd century BCE	1	Appendix I, Figure 3
5	Crete	Mid Roman	1st BCE—1st centuries CE	1	
6	Crete	Mid Roman	1st—2nd centuries CE	1	
7	Aegean		1st—2nd centuries CE	1	
8	Crete		2nd century CE	1	Appendix I, Figure 4
9	Cyprus or Cilia	Late Roman	6th—7th centuries CE	7	Appendix I, Figure 5
10	Egypt	Late Roman	5th century CE	1	Appendix I, Figure 6
11	Egypt	Late Roman	6th century CE	6	
12	Egypt	Late Roman	7th century CE	1	Appendix I, Figure 7
13	Egypt	Late Roman	6th century CE	1	Appendix I, Figure 8
14	Egypt	Late Roman	7th century CE	1	Appendix I, Figure 9
15	Egypt		3rd—4th centuries CE	1	Appendix I, Figure 10
16	Palestine		2nd—3rd centuries CE	1	Appendix I, Figure 11
17	Egypt		1st—3rd centuries CE	1	
18	Carthage	Mid Roman	2nd century CE	1	

Table 2 - Dates for Amphora Catalogued During 2012 Expedition (1 of 2)

Source #	Origin	Classification	Period	Quantity	Image
19	Levant	Canaanite	15th century BCE	1	Appendix I, Figure 12
20	Levant	Phoenician	6th—5th century BCE	1	Appendix I, Figure 13
21	Gaza		2nd—4th centuries	1	Appendix I, Figure 14
22	Rhodes		1st century BCE to the 1st century CE	10	Appendix I, Figures 15–21
23	Kos		3rd to 1st centuries BCE	2	Appendix I, Figure 23
24	Chios		6th century BCE	1	Appendix I, Figure 22
23	Kos		2nd century BCE	2	
25	Pompeii	Mid Roman	1st—2nd centuries CE	1	Appendix I, Figure 24
26	SE Agean		4th century BCE	1	Appendix I, Figure 25
27	Rhodes		4th century BCE	1	Appendix I, Figure 26
28	Rhodes		first half of the 1st century CE	1	
29	Thrace		3rd century BCE	1	
30	Thrace		5th—6th centuries CE	1	Appendix I, Figure 27
31	Crete		2nd century CE	1	
32	Knidos		3rd century CE	1	
33	Tyrrhenian and Adriatic Italy	Greco-Italic	3rd century BCE	1	Appendix I, Figure 28
34	Pontis	Herakleian	2nd century CE	1	Appendix I, Figure 29
35	Pontis	Colchian	5th—6th centuries CE	2	Appendix I, Figure 30
36	South Pontis	Herakleian	4th century CE	1	
37	Egypt		1st – 3rd centuries CE	3	Appendix I, Figure 31

Table 2 - Dates for Amphora Catalogued During 2012 Expedition (2 of 2)

Source #	Origin	Culture	Period	Quantity	Image
38	Tripoli		3rd century CE	2	Appendix I, Figure 32a – 32b
39	Cyprus or Cilia	LRA 1	6th – 7th centuries CE	12	Appendix I, Figure 33, 34 examples
40	Cyprus or Cilia	LRA 1	4th – 6th centuries CE	4	Appendix I, Figure 33, 34 examples
41	Egypt	LRA 4	6th century CE	5	Appendix I, Figure 35
42	Egypt	LRA 4	7th century CE	2	Appendix I, Figure 36
43	Egypt	LRA 5	6th century CE	4	Appendix I, Figure 37
44	Egypt	LRA 5	7th and 8th centuries CE	5	Appendix I, Figure 37
45		Byzantine	12th – 13th CE	1	Appendix I, Figure 38

Figure 1 – Bathymetric Survey of the Eratosthenes Seamount

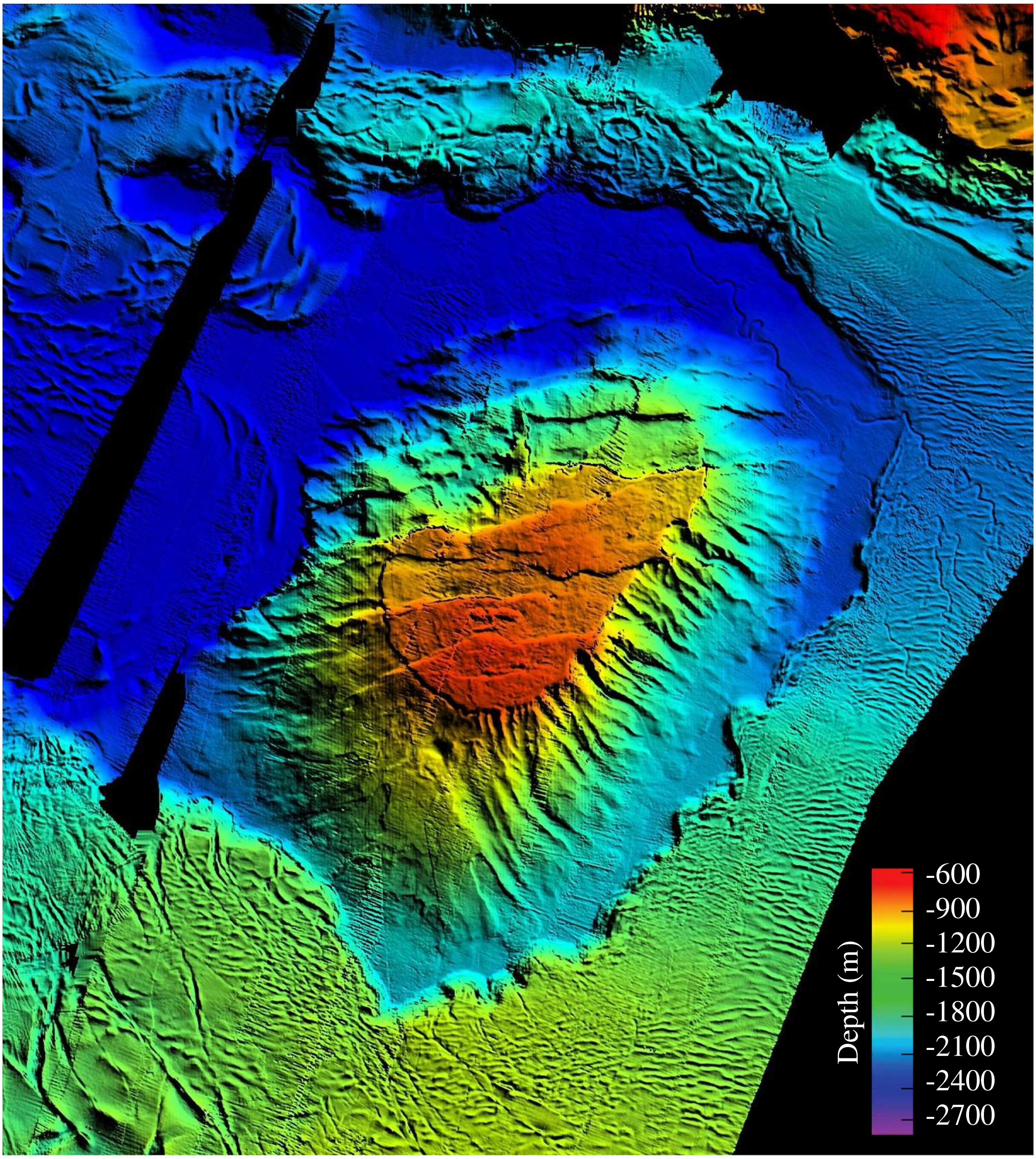
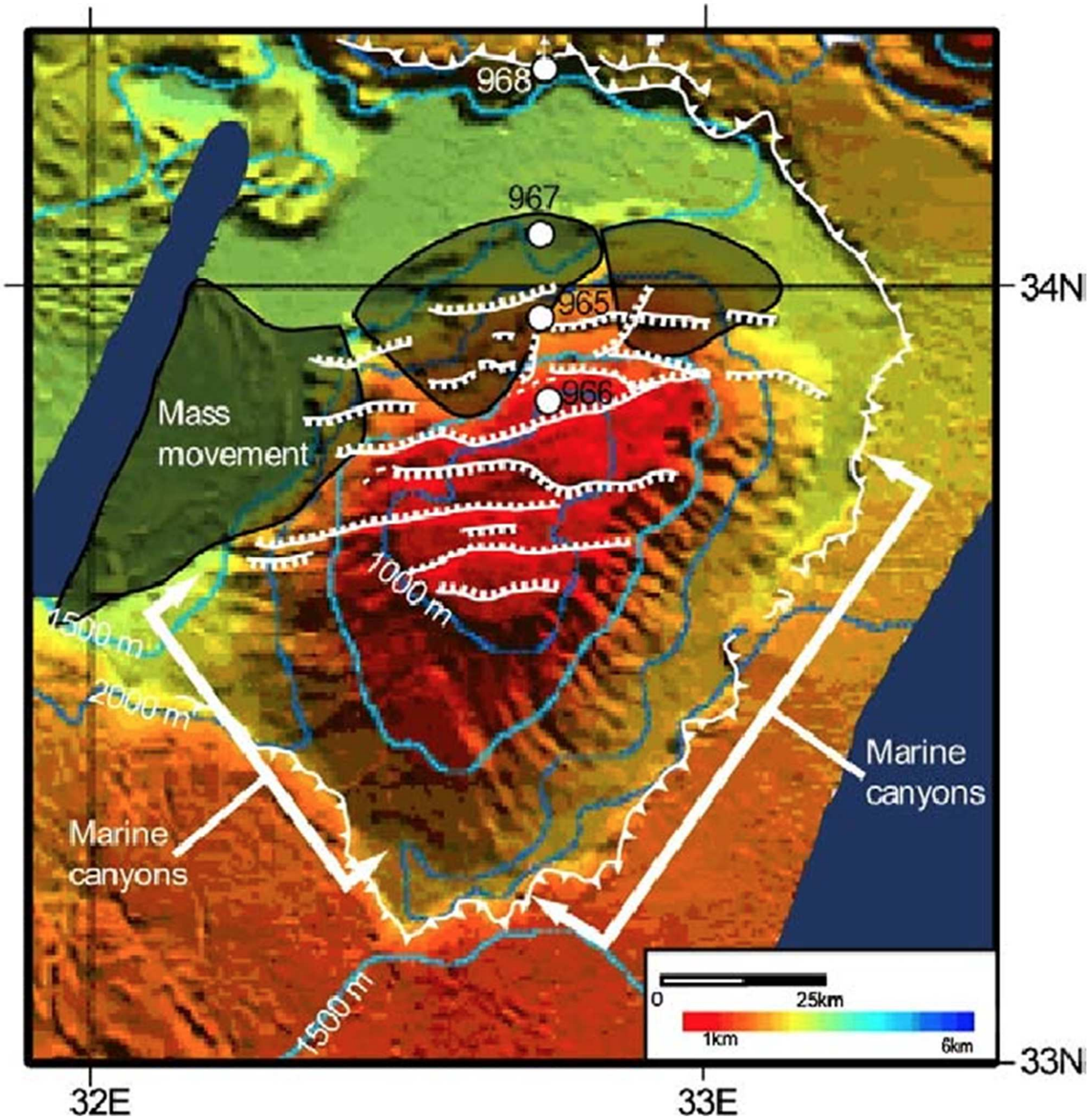
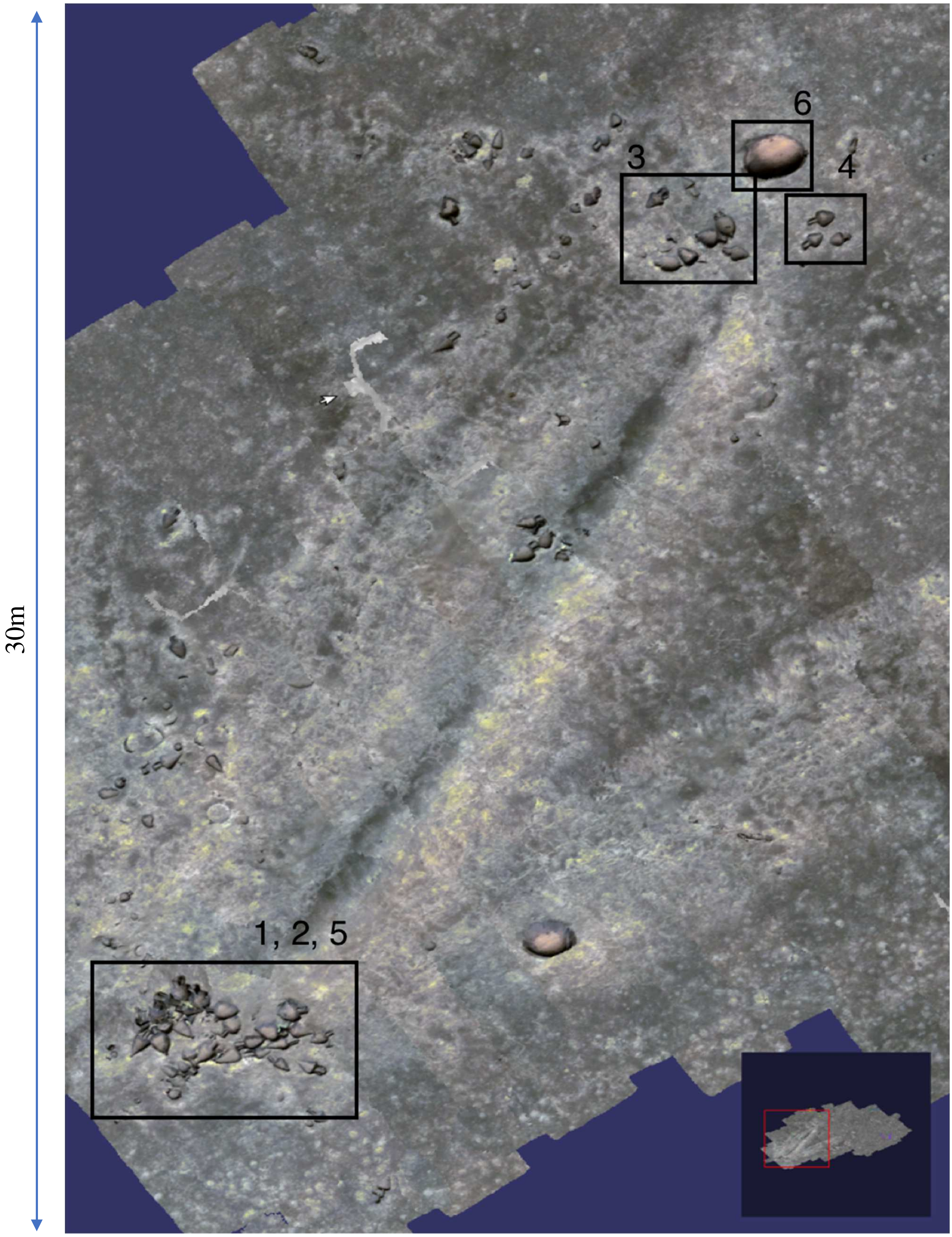


Figure 2 – Bathymetric Analysis of the Eratosthenes Seamount (Schattner, U., 2010)



Originally adapted from the work of the Medimap Group (Loubrieu et al. 2005) with additional geomorphological analysis (Mascle et al., 2000).

Figure 3 - Photo-Mosaic Image of the Eratosthenes C Wreck

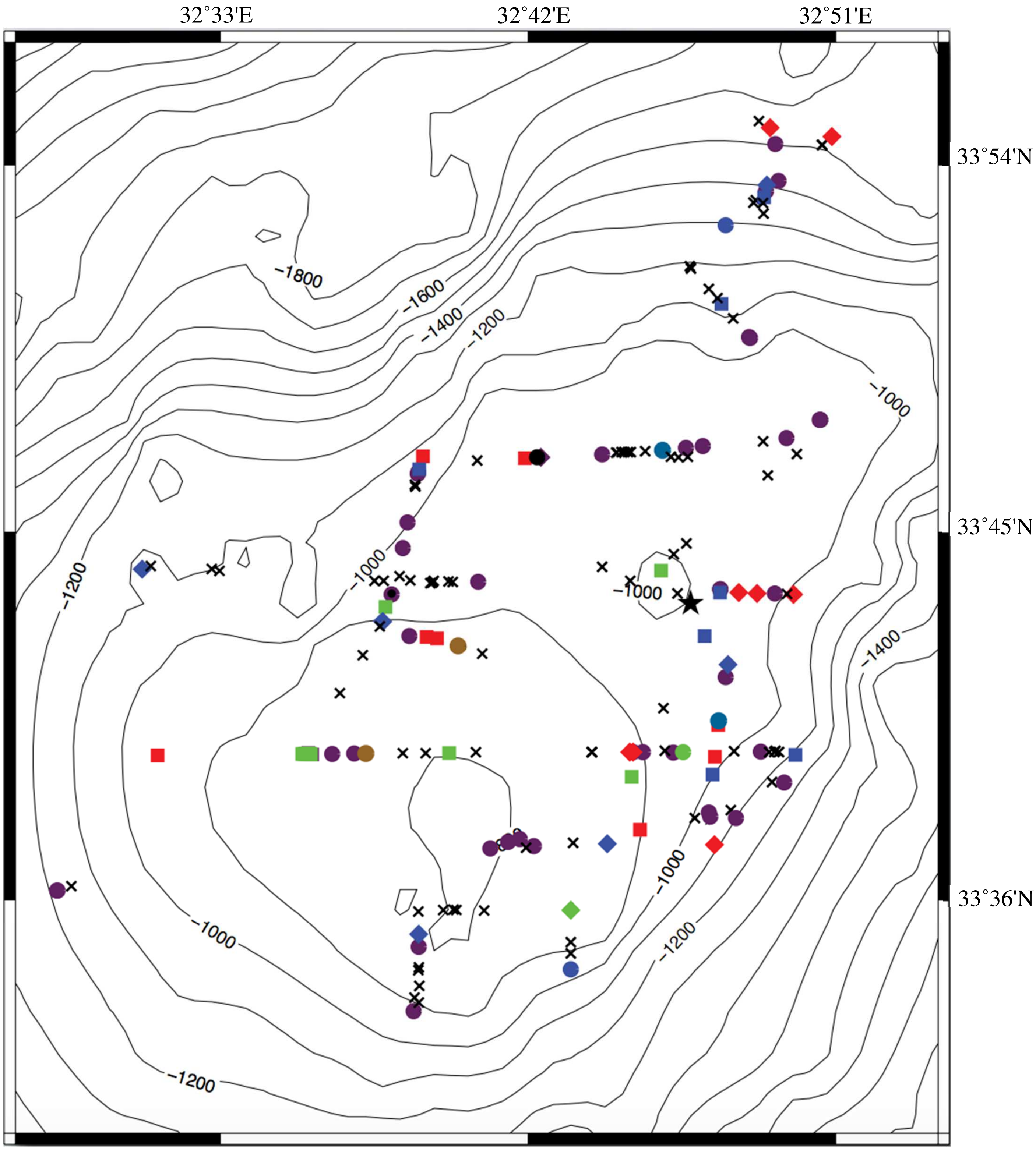


Positions of artifacts shown in Figure 4 are designated by number.

Figure 4 - Images of the Eratosthenes C Wreck Cargo

Positions of the artifacts above are shown in Figure 3.

Figure 5 - Bathymetric Map of Isolated Artifacts Distribution

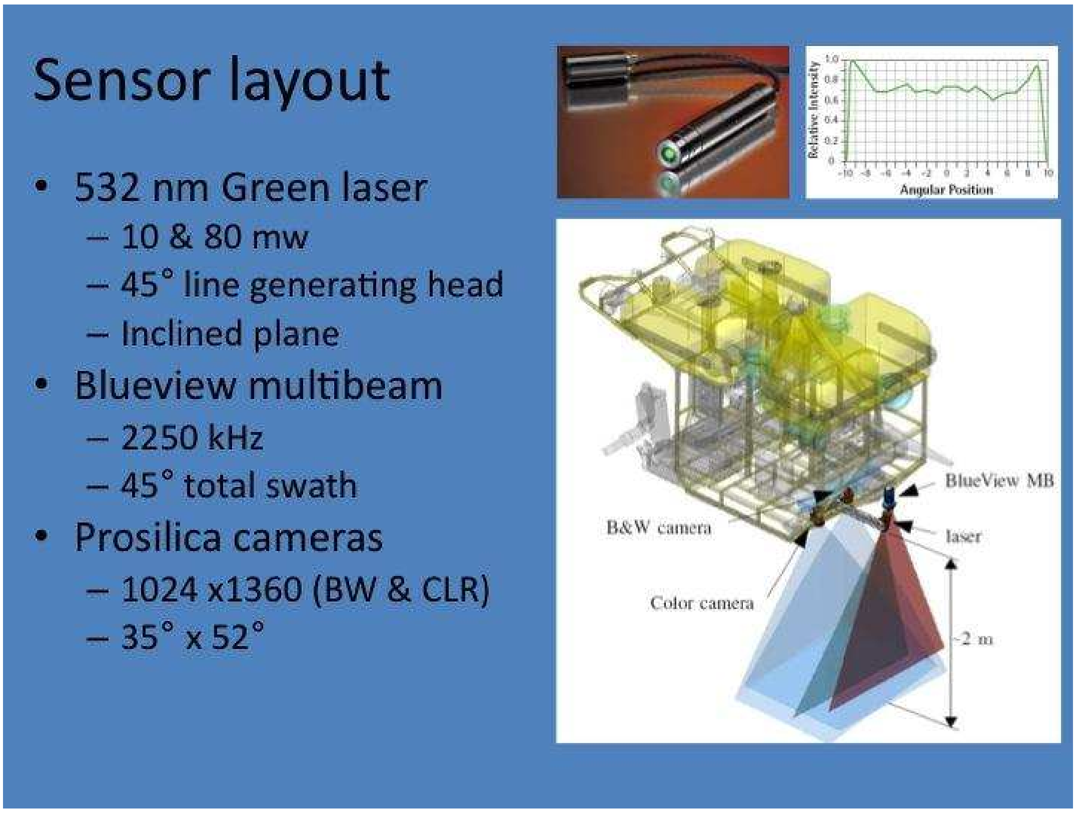


Key:

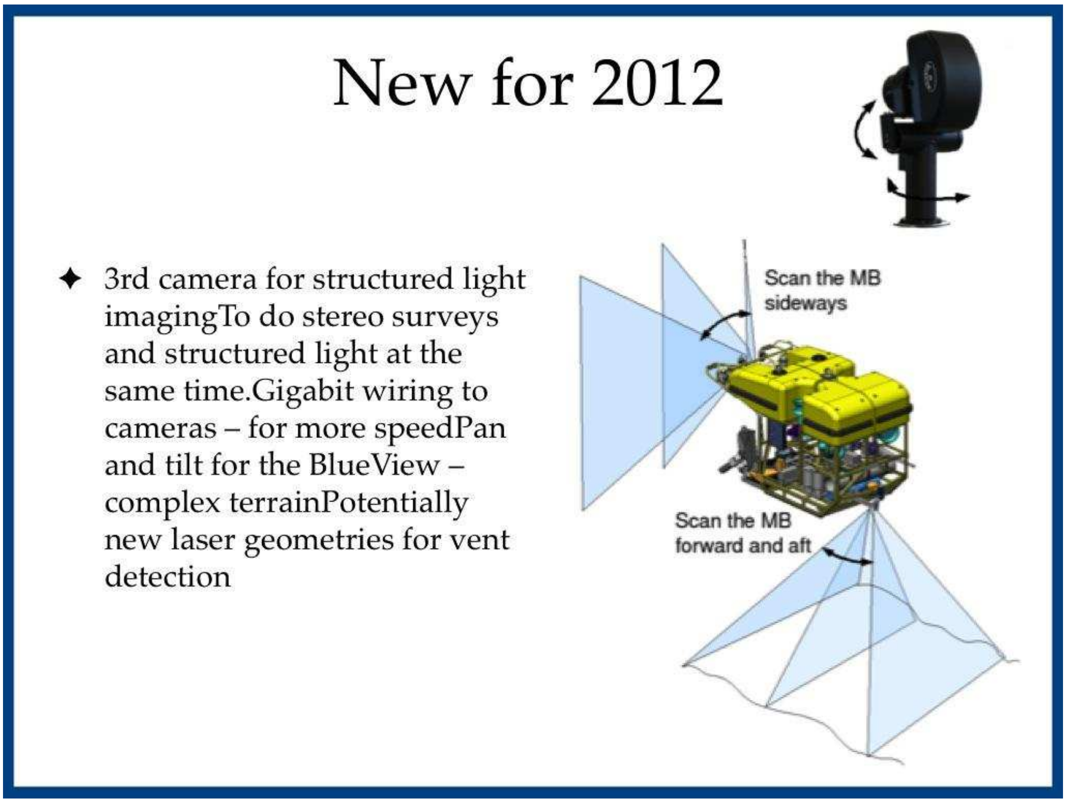
Shapes represent amphorae from different regions: *circles* = Roman, *squares* = Hellenic, *diamonds* = Near Eastern.

Colors represent time periods: *orange circles* = Pre-1000 BCE, *red* = 800–100 BCE, *green* = 100 BCE to 100 CE, *blue* = 100–400 CE, *purple* = 400–800 CE, *black circles* = Byzantine, *teal circles* = post-1000 CE. The *black star* indicates the approximate location of the Eratosthenes C wreck, and black x's represent unidentified amphorae.

Figures 6a – *Hercules* ROV Photo Imaging Sensor Layout



Figures 6b – 2012 Additions to *Hercules* ROV Photo Imaging Capabilities



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[13] Egloff 1977, type 186, pl.60.4; Pieri 2005, 119;21, fig.76.type 3; Zemer 1978, 66, pl.20.54

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Appendix I

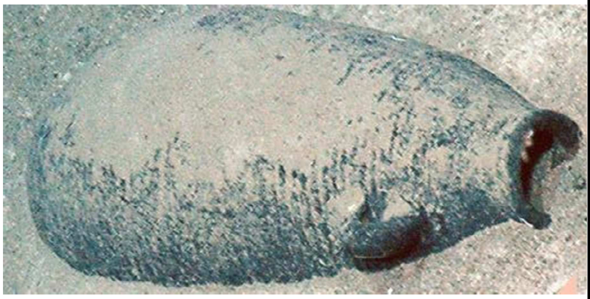
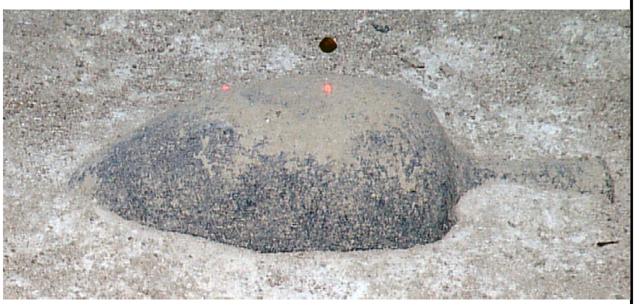
	Figure 1 – Phoenician
	Figure 2 – Levantine
	Figure 3 – Knidian
	Figure 4 – Cretan

	Figure 5 – LRA 1

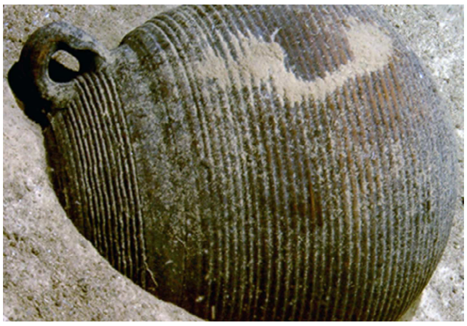
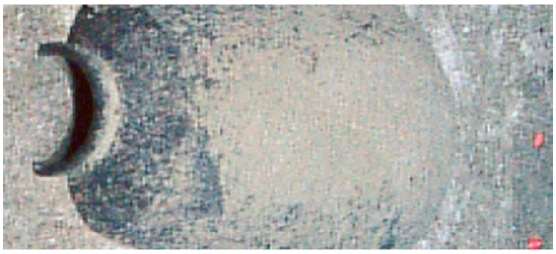
	Figure 6 – LRA 4
	Figure 7 – LRA 4
	Figure 8 – LRA 5
	Figure 9 – LRA 5

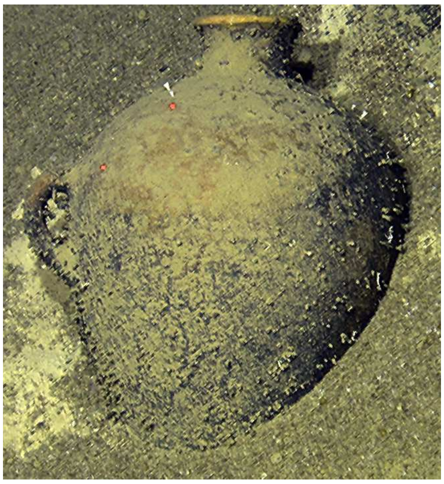
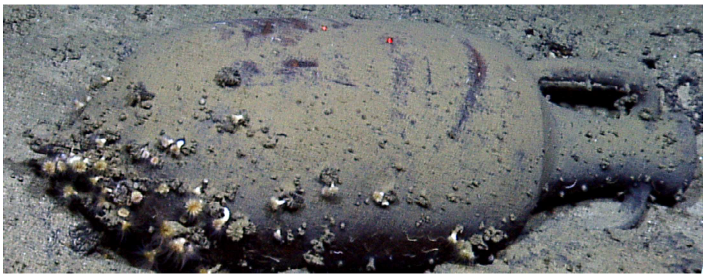
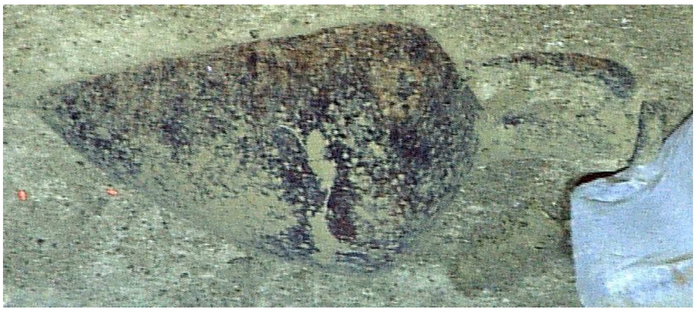
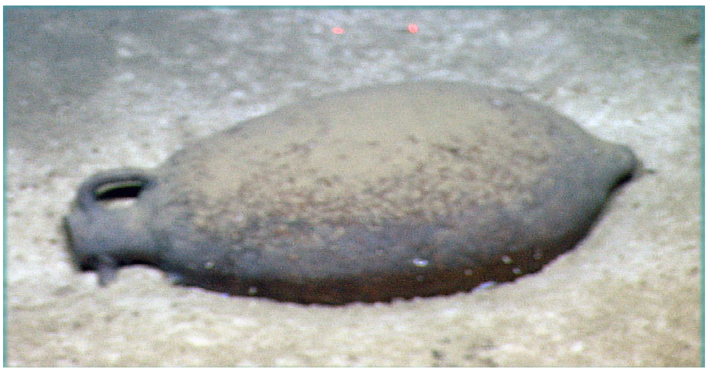
	Figure 10a – Egyptian
	Figure 10b – Egyptian
	Figure 11 – Palestinian
	Figure 12 – Possible Canaanite Jar

	Figure 13 – Phoenician13
	Figure 14 – Gazan
	Figure 15 – Rhodian
	Figure 16 – Rhodian
	Figure 17 – Rhodian

	Figure 18 – Rhodian
	Figure 19 – Rhodian
	Figure 20 – Rhodian
	Figure 21 – Rhodian
	Figure 22 Possibly Chian

	Figure 23 – Koan
	Figure 24 – Pompeian
	Figure 25 – Aegean
	Figure 26 – Rhodian
	Figure 27 – Thracian

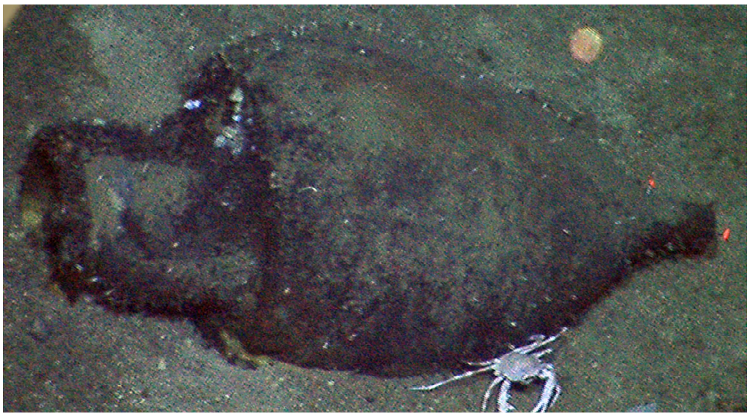
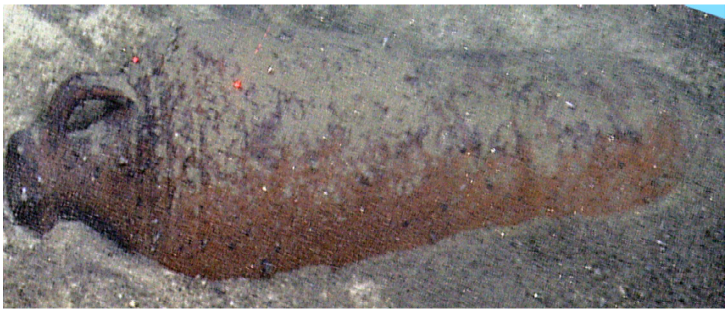
	Figure 28 - Greco-Italic
	Figure 29 - Herakleian
	Figure 30 - Colchian
	Figure 31 - Egyptian
	Figure 32a - Tripolitan

	Figure 32b - Tripolitan
	Figure 33 - LRA 1
	Figure 34 - LRA 1
	Figure 35 - LRA 4
	Figure 36 - LRA 4

	Figure 37 - LRA 5
	Figure 38 - Byzantine
	Figure 39 - Byzantine