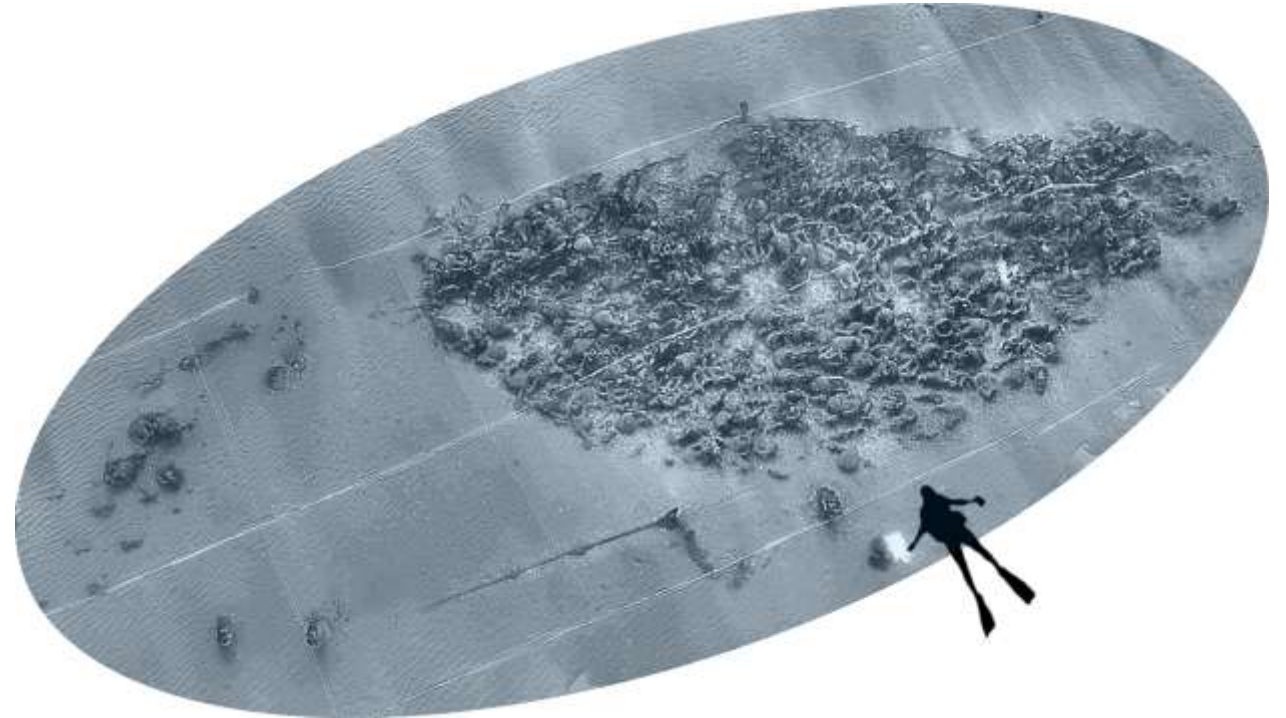


Ship Construction Techniques in Antiquity around the World and Modern Documentation Methods in Underwater Archaeology



INP Séances scientifiques
Speaker: Max Fiederling M.A.

Ancient Ship Building and construction techniques around the world



Terms and categories:

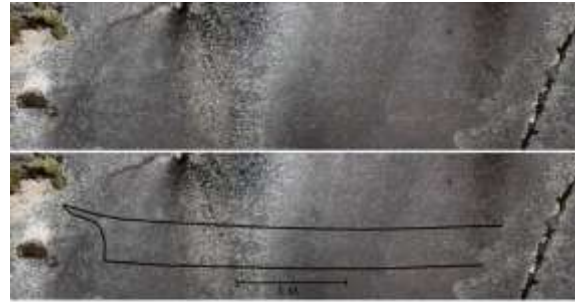
hide, log, sewn, lashed-plank, clinker (and reverse-clinker), Mortise and tenon / shell-first and frame-first.

Frame-first technique dominates the modern ship construction industry, the ancient ship builders relied primarily on the other techniques to build their watercrafts.

Regardless of differences in the construction, the vessels of the ancient world were also seaworthy crafts, capable of allowing people to engage in large-scale maritime trade as well as in inland trade on rivers and lakes.



Petroglyph near Caspian Sea
Azerbaijan (~ 10,000 BCE)



Stone carving - Norway / 9000 BCE?



Pesse Dugout Canoe
~ 8,000 BCE
Found in Holland

During the Paleolithic people probably began to build watercrafts for the first time, with which the high seas can be sailed.

They were probably already plank boats or larger skin boats.

Cyprus, Crete, Sardinia, Ireland, Canary Islands => first traces of settlements originating from the mainland.

The targeted deep-sea fishing also begins a little outside of visual contact with the coast.

Framed Boats

Skin boats



Skin boats dominated seafaring in places that were scarce on wood, including the arctic and subarctic. They were made by stretching skin or leather over frames of wood or bone. These include [kayaks](#) and [umiaks](#), [coracles](#) and [currachs](#)



Coracle / India 2019.



Ancient Assyrian bas relief (700-629 BC) of the river Tigris showing the shipping of building materials in a coracle, on the right, to the city of Nineveh (Mosul, Iraq).

Bark Canoes



Birchbark Canoe

Large birchbark canoes, like the one pictured above (1926) were used by northern Indigenous groups to reach interior waterways in search of caribou.

Canoes were also used by indigenous groups elsewhere around the globe.



Tasmanian Bark canoe



Bark canoe made in a traditional style from a sheet of bark folded and tied at both ends with plant-fibre string.

The bow (the front) is folded tightly to a point; the stern (the rear) has looser folds.

(1938 by Albert Woodlands, an Aboriginal man / northern coast of New South Wales)

Early wooden boats

Rafts

Made where wood was available but not large enough for dugouts.

Earliest Egyptian boats => rafts made of papyrus; wooden boats did not replace them until the [Gerzean/Nagada II](#) Period (3400-3100 BC). These rafts are also depicted in early petroglyphs.

The earliest discovered remains of reed boat are 7000 years old, found in [Kuwait](#).

A famous example is the [ark of bulrushes](#) in which baby [Moses](#) was set afloat. These vessels were also constructed from early times in [Peru](#) and [Bolivia](#), and boats with remarkably similar design have been found in [Easter Island](#). Reed boats are still used in Peru, Bolivia, [Ethiopia](#), and until recently in [Corfu](#).

Norwegian ethnographer/adventurer [Thor Heyerdahl](#) => better understanding of the construction/capabilities of reed boats.

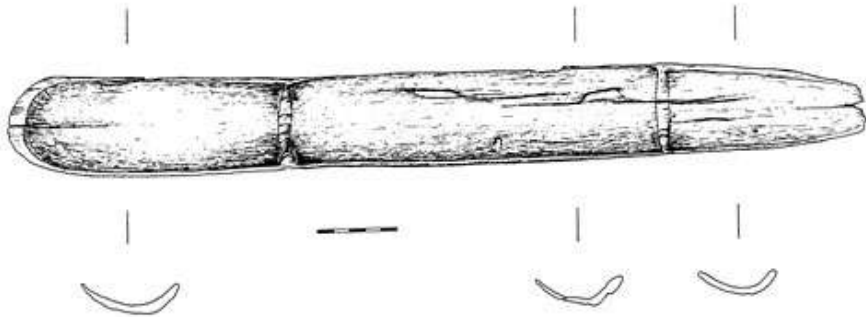


Fabrication of papyrus boats in ancient Egypt. Wall fragment from the Sun Temple of Nyuserre Ini at Abu Gurob, Egypt c. 2430 BC.

Dugout boats / Logboats



Logboat of Wasserburg / Lake Bodensee / Germany 2015-2018 / Late Bronze Age. Dating 1124 +/- 10 BC



Latène / 485-45 BC Kempfenhausen, Lake Starnberg/Germany



Lake Starnberg, fishing by Logboat / 20th c.

Dugout boats/Logboats were made wherever trees grew large enough (including Holocene Europe, the West Coast of America, and Polynesia).

Dugouts are defined as being carved/burnt out of a single piece of wood. They could be elaborately decorated and quite seaworthy.

Shell-first

The shell-first technique involves constructing the "shell" of the boat first, then laying in the framework.

Sewn and lashed-plank

Boat with its planks sewn, stitched, tied, or bound together with tendons or flexible wood, such as roots and willow branches.

Construction techniques used in many parts of the world also prior to the development of metal fasteners and continued to be used long after that time for small boats to reduce construction costs where metal fasteners were too expensive.

Archaeological remains of 64 sewn boats have been excavated in the Mediterranean region / Dating from the Bronze Age to the Medieval periods.



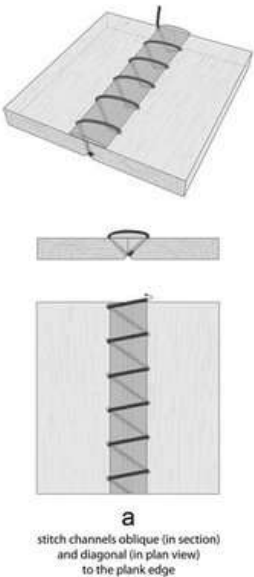
Earliest known example of a sewn boat => 40+ m. long
"Solar" funerary boat / Gizeh pyramid / from 2600 BC.



Roman wreck / Poreč 1 c. A.D.



Halsnøy boat / Norway (4th Century AD)



Shell-first...





Oseberg ship / Norway (793–1066 AD)



Carvel
Kraweel



Clinker
Klinker



Reverse-clinker (Bengal)

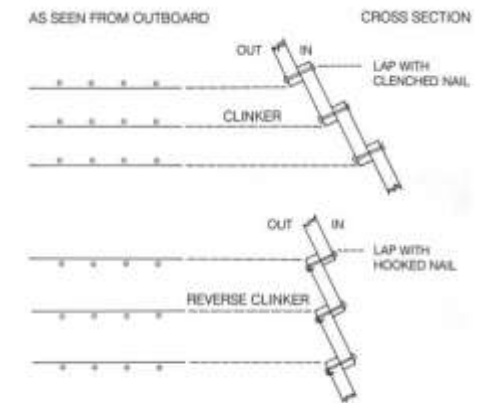
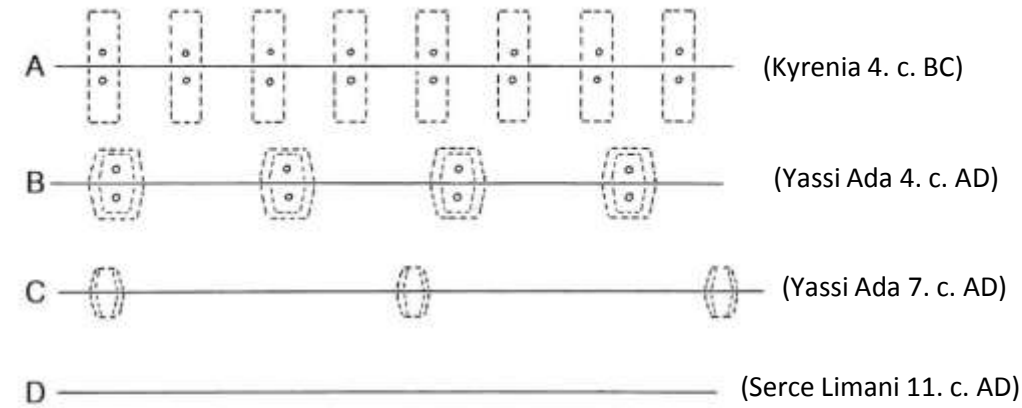
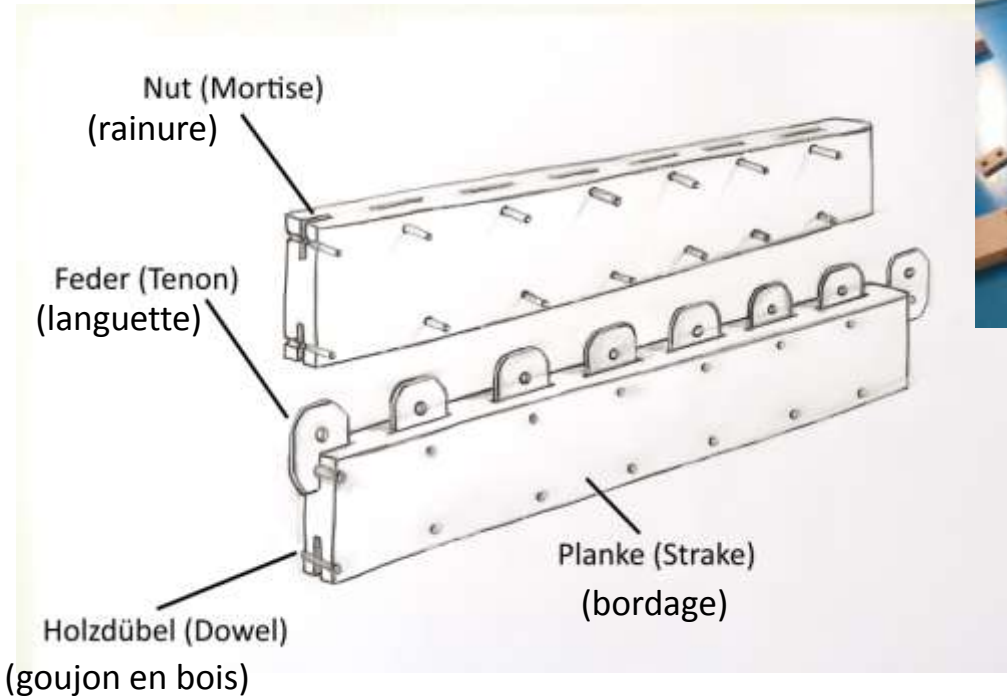


Figure 2.3 Diagram showing two methods of fastening planking: European clinker (upper); reverse-clinker (lower). Not to scale. Drawing: Institute of Archaeology, Oxford.

Clinker

The [clinker](#) and reverse-clinker construction techniques involve fastening together an overlapping layer of planks with straight nails or hooked nails.

Clinker tradition developed in Northern Europe, while the reverse-clinker technique (very rarely found worldwide) is prevalent among certain South Asian communities.



Mortise-and-tenon joint

Used in early Neolithic wooden lining of water wells and has also been found in ancient furniture from sites in the Middle East, Europe and Asia.

As Phoenician joints (*coagmenta punicana*), the construction technique with pegged mortises and tenons was used heavily in shipbuilding during antiquity and spread westward from the Levantine littoral.

It relies extensively on structural support provided by peg-[mortise-and-tenon](#) joinery through the shell of the boat.



Wood-lined well with mortise and tenon
Joints (Altscherbitz / Germany 5000 BC)



Egyptian stool with tenons
(1991 –1450 BC)

Frame-first

Laying down the framework before attaching the planks to the boat.

Normally done by erecting a "master frame" in the center of the keel and deriving the shapes of the other frames using a curved piece of wood stretched between the frame and the end posts, or through a geometric curve.

The [Yassi Ada](#) wreck dating to the 7th century AD was long cited as the earliest evidence for frame-first construction technique, but two wrecks from Dor (Tanura) Lagoon in Israel dated to around 500 AD were also built frame first.

This technique was rarer in the rest of the world until the coming of the modern era.

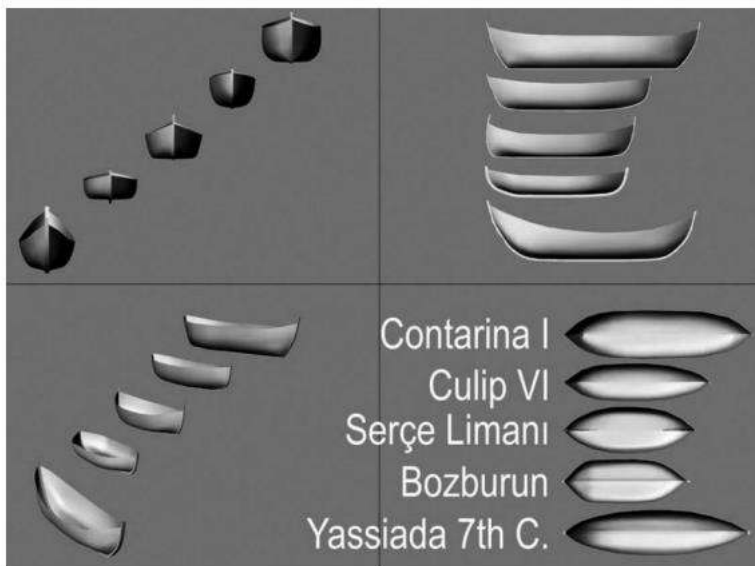


Figure 2.17. Development of hull shapes in the Middle Ages. Yassi Ada: 7th century AD. Bozburun: AD 874. Serçe Limanı: c. AD 1025. Culip VI: c. 1300. Contarina I: c. AD 1450. (© 2008 F. Castro, N. Fonseca, T. Vacas and F. Ciciliot, 'A quantitative look at Mediterranean lateen- and square-rigged ships (Part 1)', *International Journal of Nautical Archaeology* 37 (2): 358, fig. 6a. John Wiley & Sons Ltd.)



Frame-first construction



Yassi Ada wreck (7. c. AD) / museum Bodrum

Mixed techniques

Romano Celtic and other mixed ship building techniques

Celtic / spatial distribution => regions formerly occupied by Celtic-speaking people
Roman => temporal distribution 1-4 c. AD.

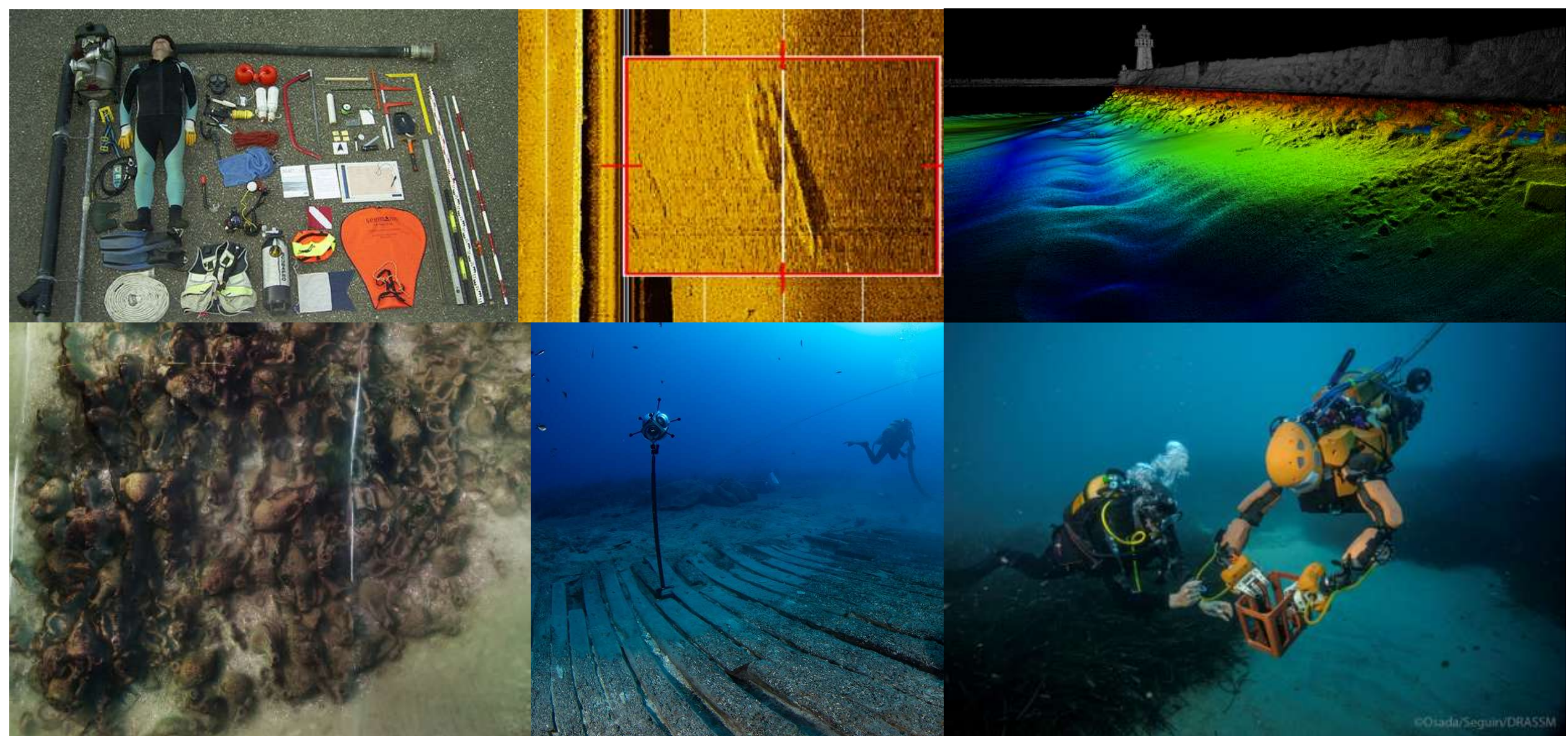


Blackfriars 1 (150 AD).



Fiumicino 1 (4./5. c. AD).

„Modern“ Documentation Methods in Underwater Archaeology



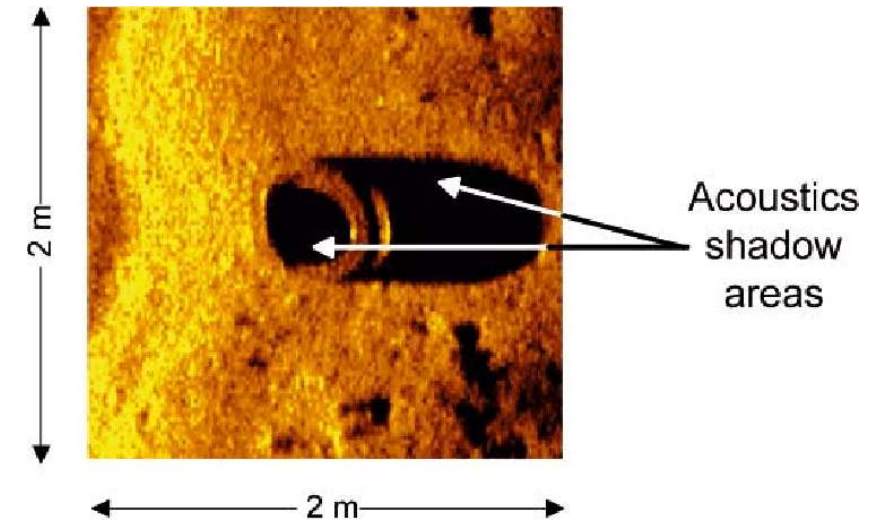
Geophysical Prospection

Side-Scan Sonar

Method

Lateral emission of acoustic waves on the lake or river bed and registration of the echoes

=> Acoustic image of the sea floor due to the different signal strengths, objects and structures are distinguished by their acoustic shadows.

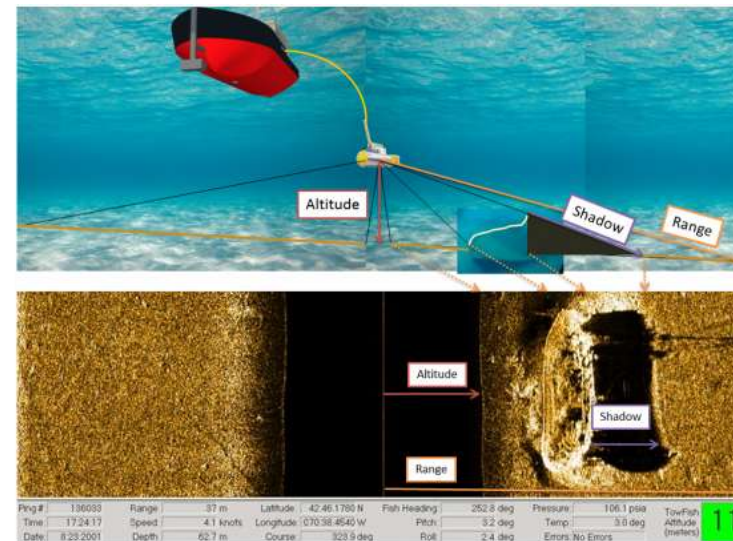


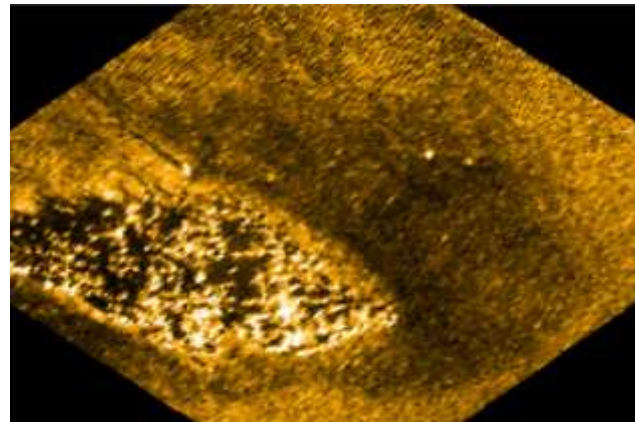
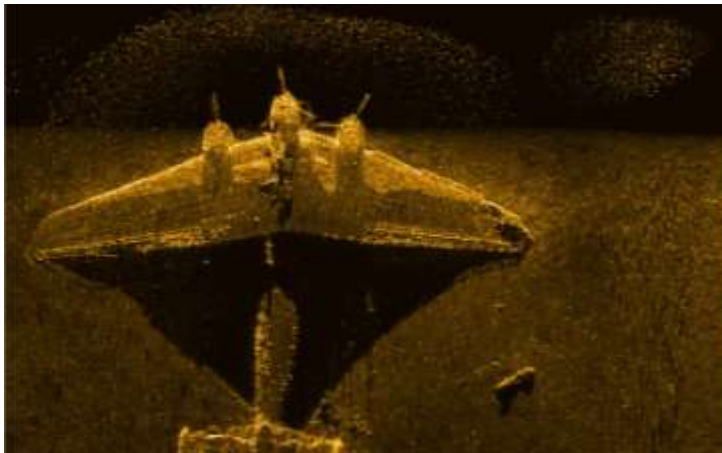
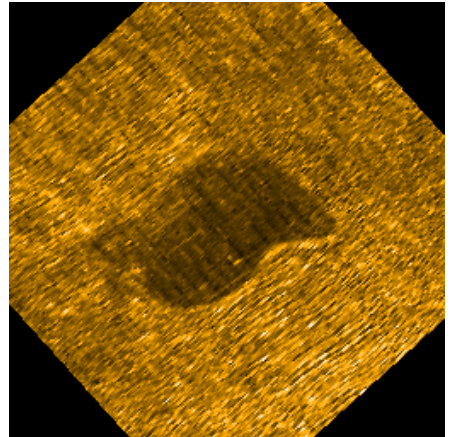
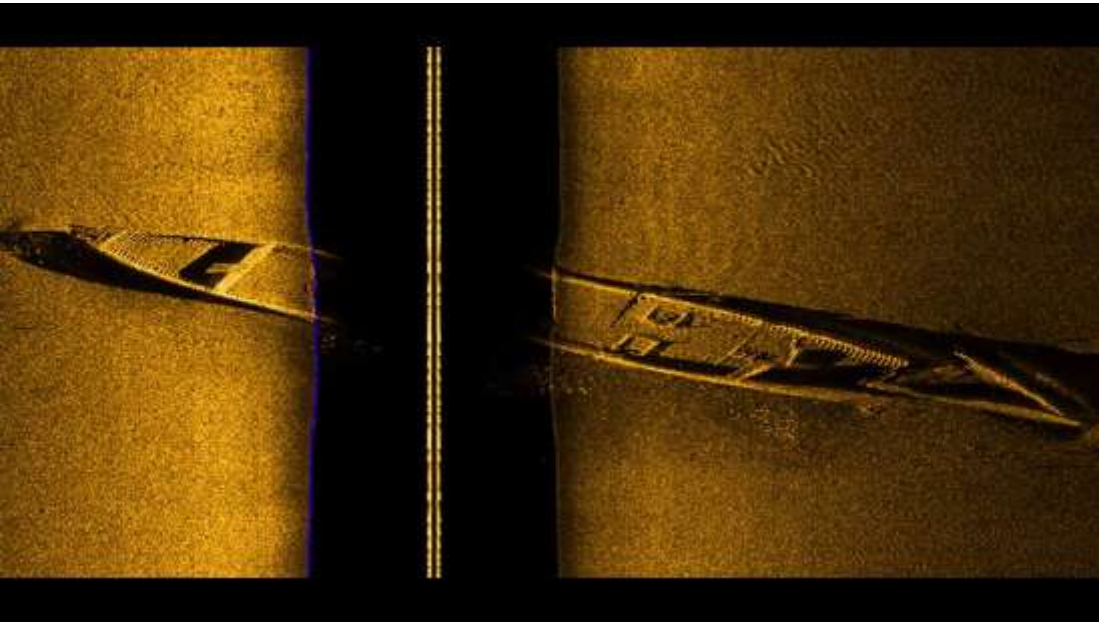
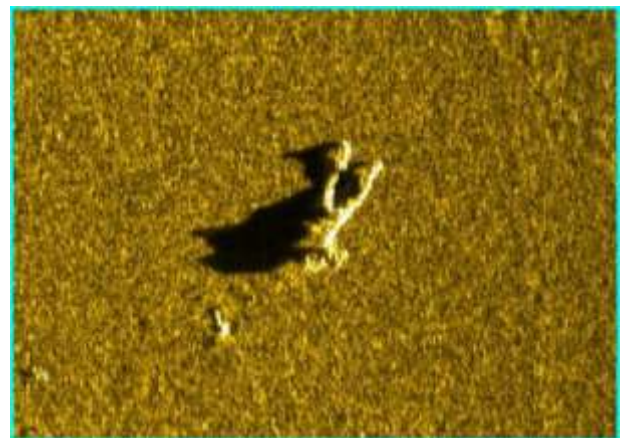
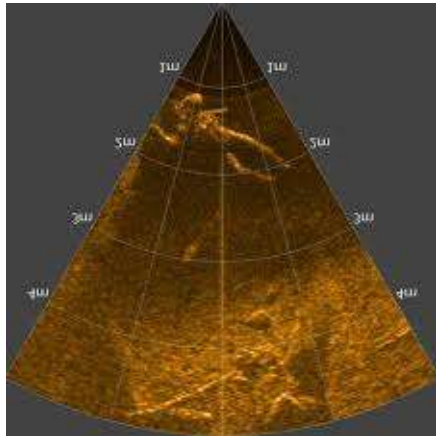
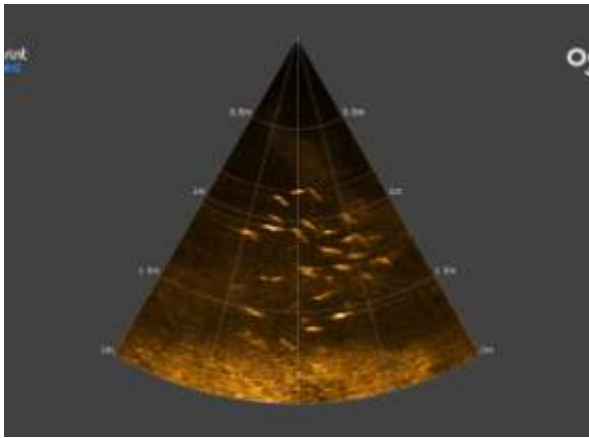
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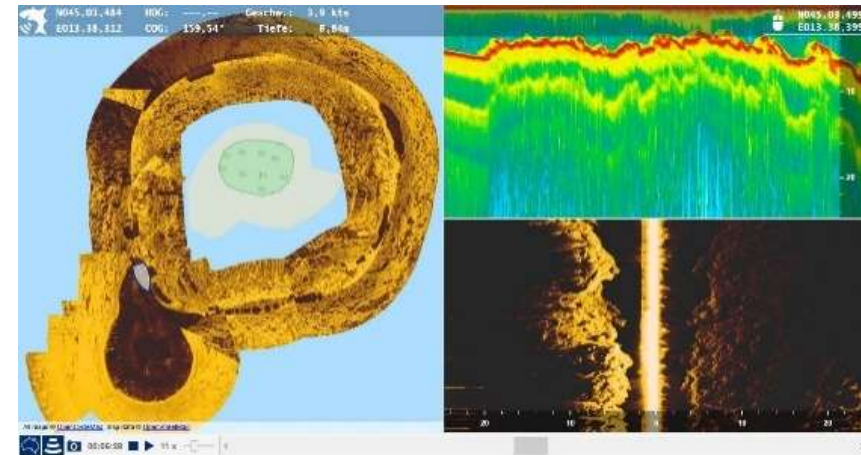
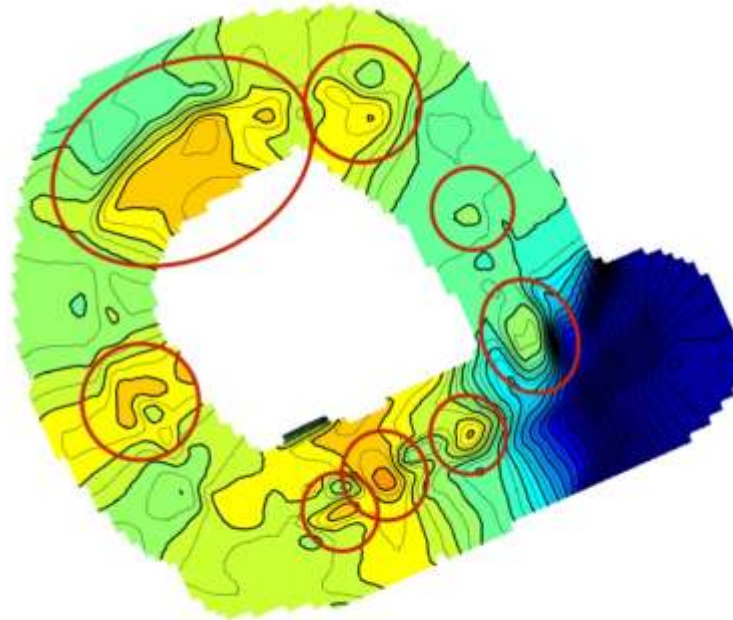
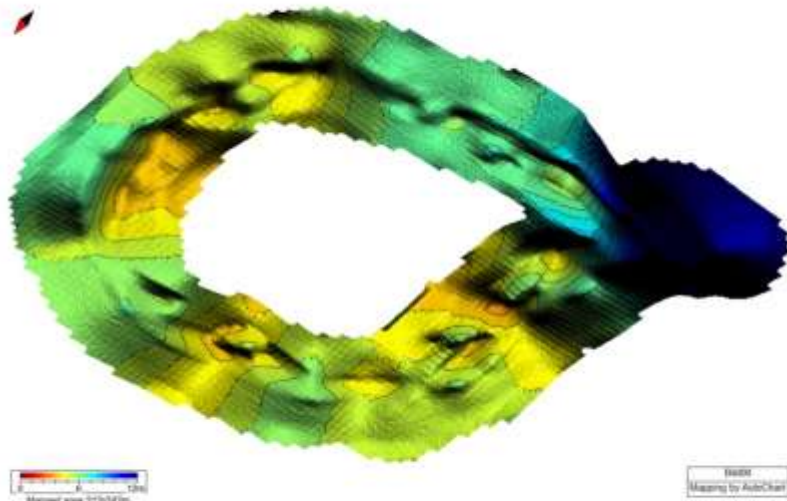
Optimal conditions = calm water surface and low speed c. 5-6 knots (c. 8km per hour) / ships can cause disturbing noise with their engines (note the direction of rotation of the rotor in the survey and time schedule).

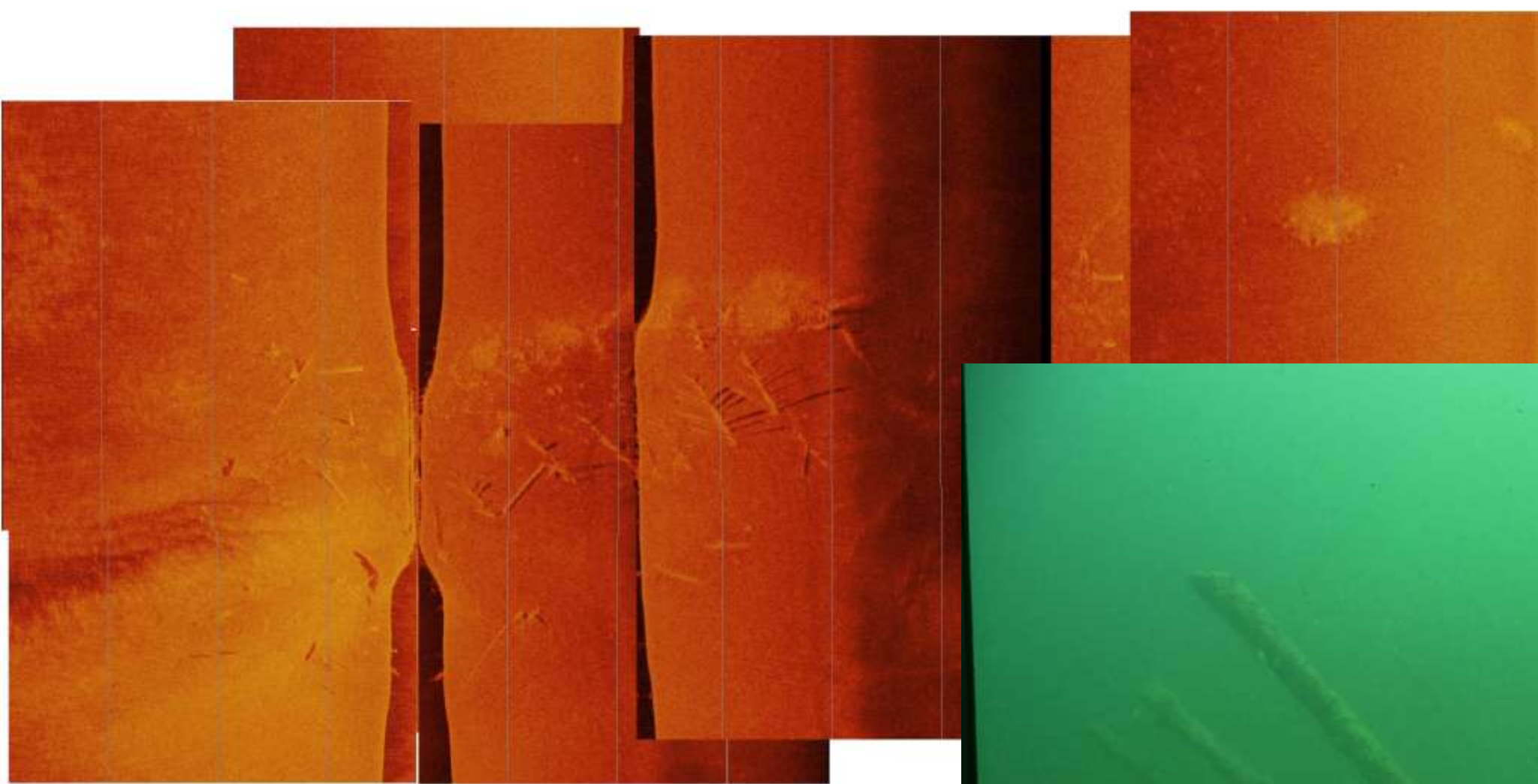
Application

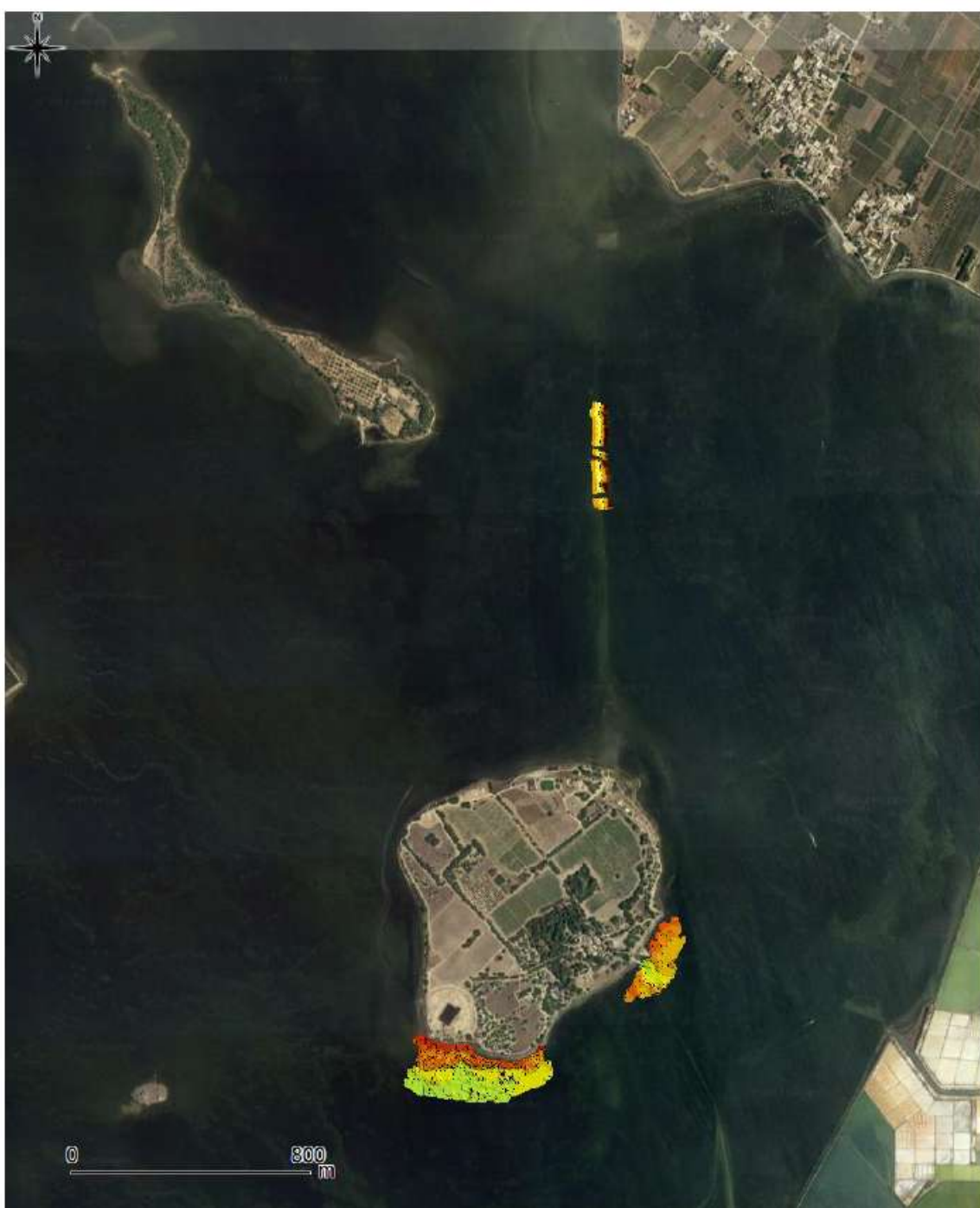
Search for wrecks, lighter points and collections of lost objects, architectural structures (port facilities, etc.)
documentation of submerged settlements.



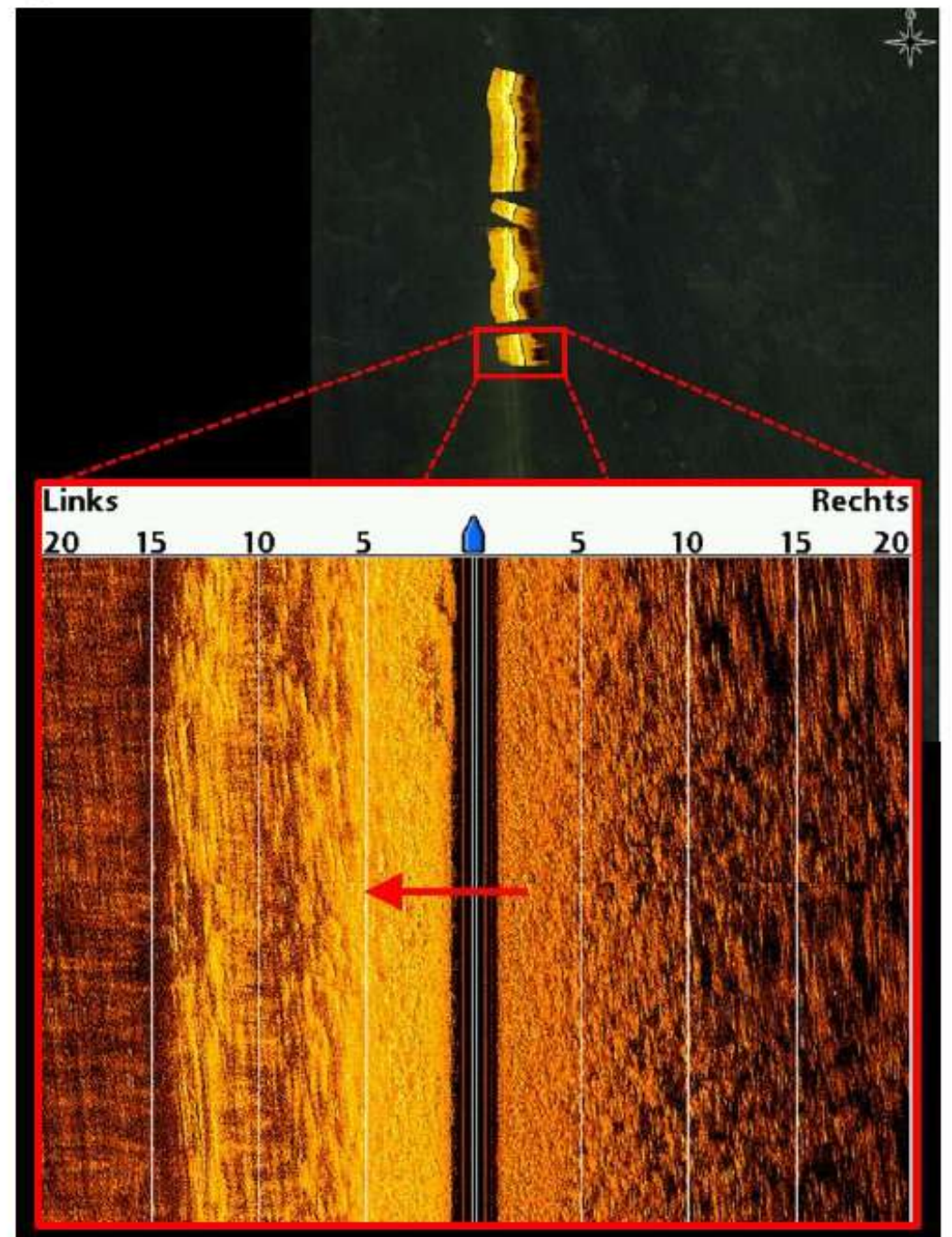








Mr. Medering



“Sedimentsonar” (sub-bottom profiler) and "Fan echo sounder" Multibeam Echosounder

Method

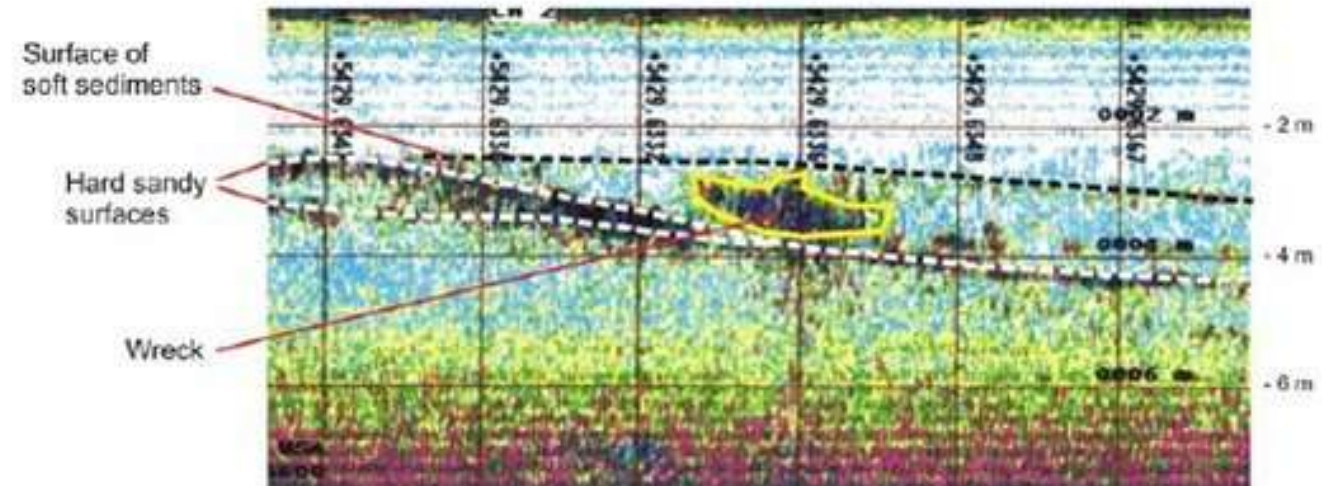
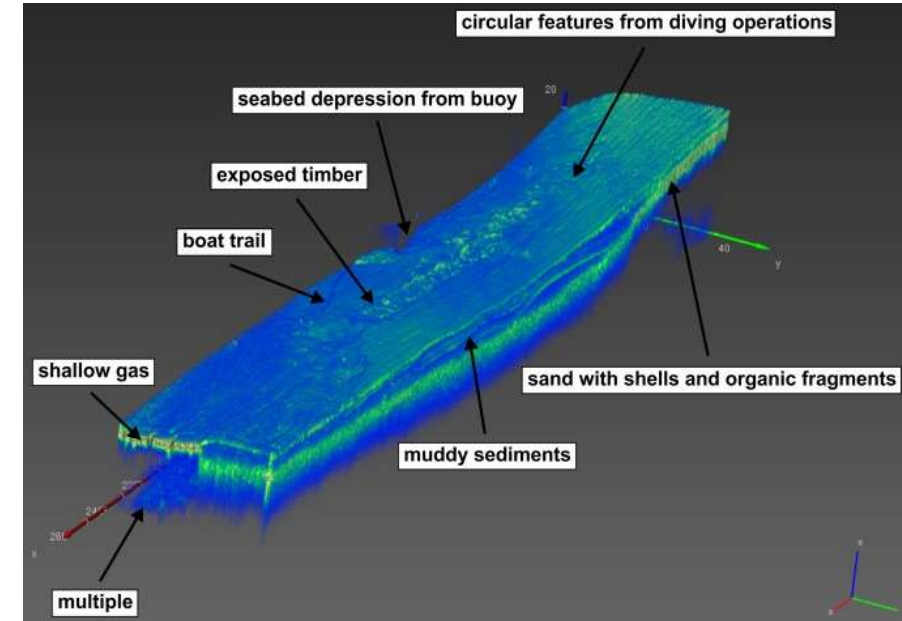
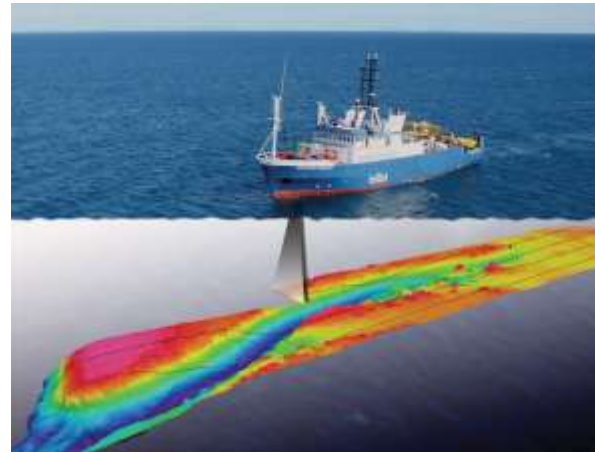
Same technical basics, but work with different frequencies and measurement geometries; The type of data analysis also differs in some cases considerably from the methods used for side-view sonars.

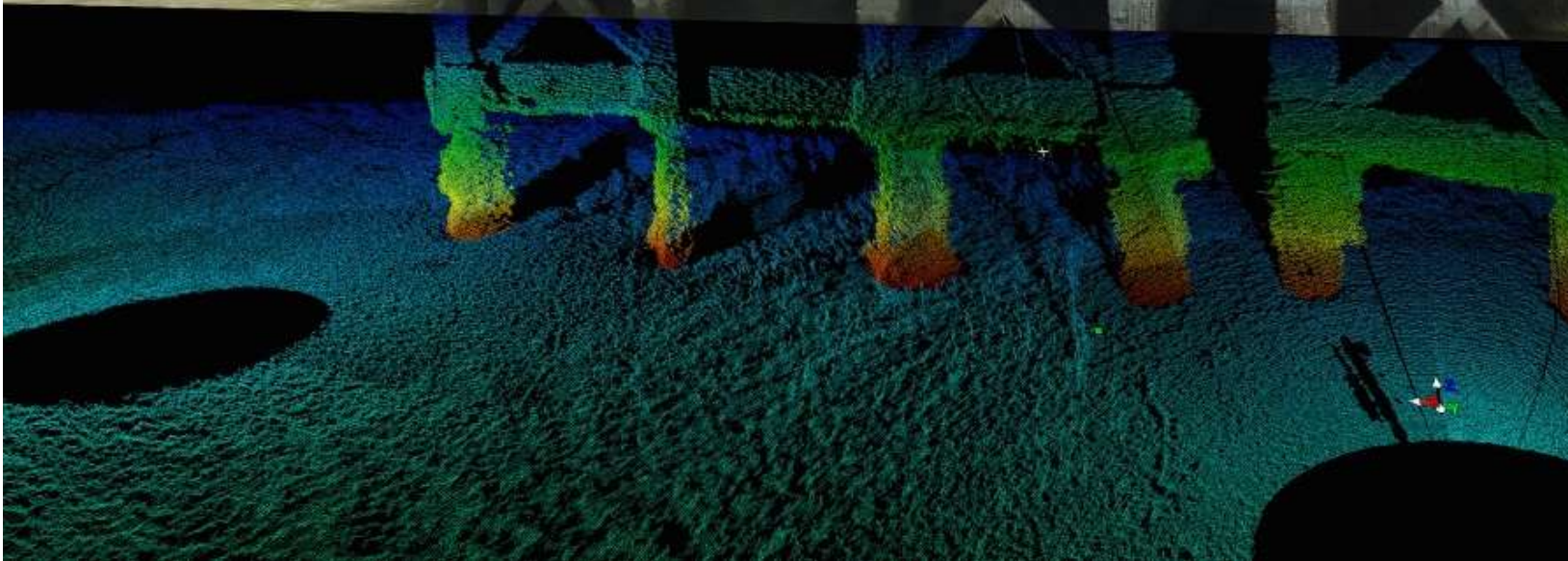
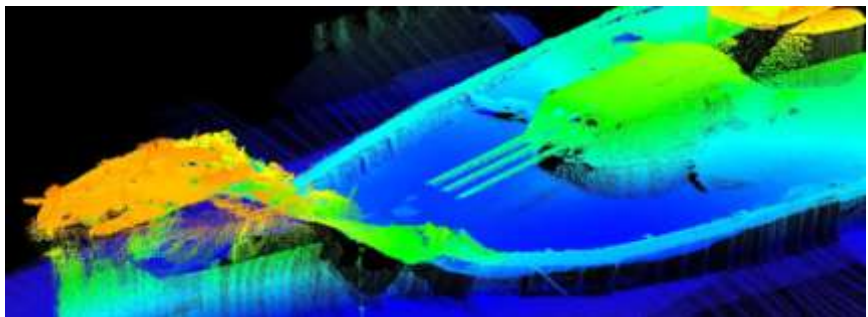
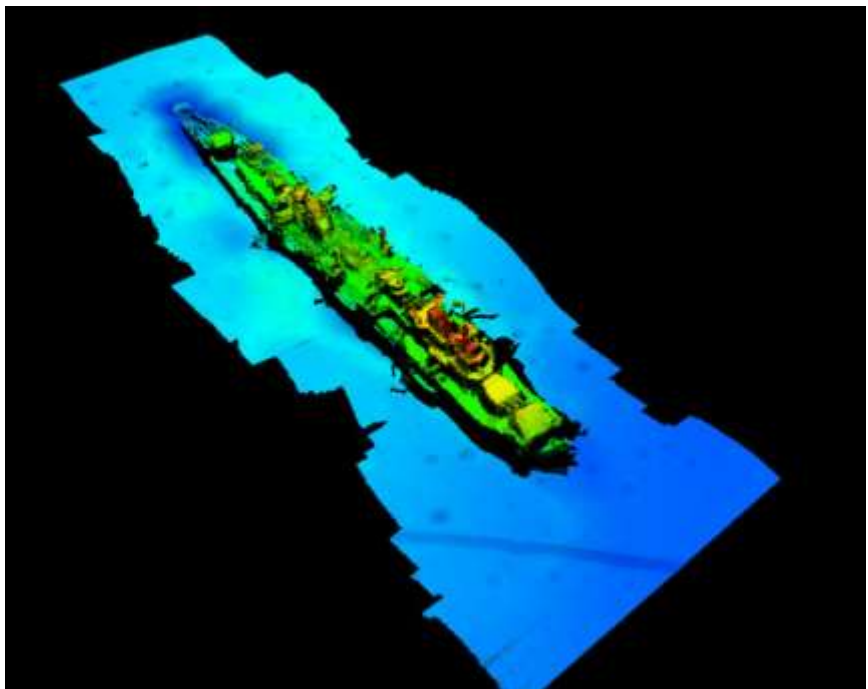
Characteristics

Optimal conditions for high-resolution measurements with very calm water surface, other ships can cause annoying noise with their engines

Application

For example in the search for wrecks or in the documentation of remains of submerged or silted settlements near the present shoreline





The use of ROVs / Remote Operating Vehicles

Method

Self-sufficient diving device (control via watchman or control center on board a ship) which can operate at great depths.

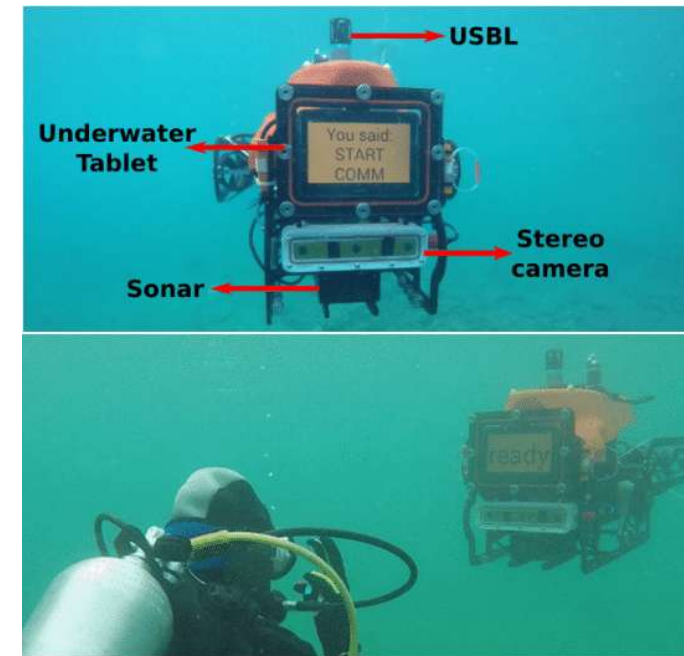
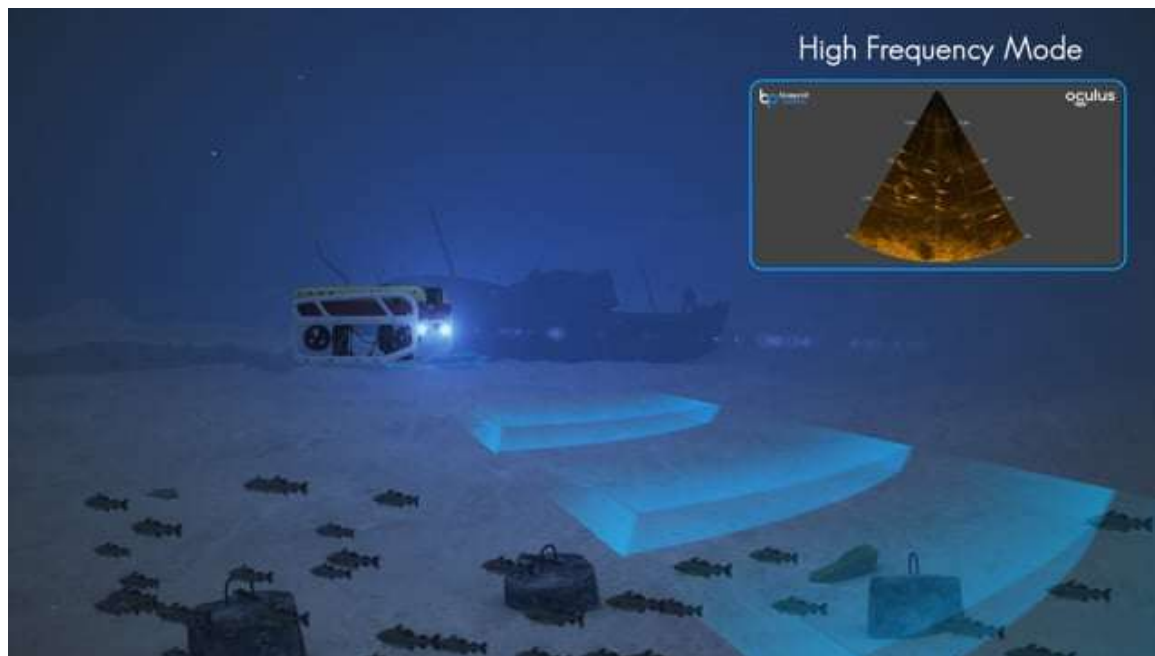
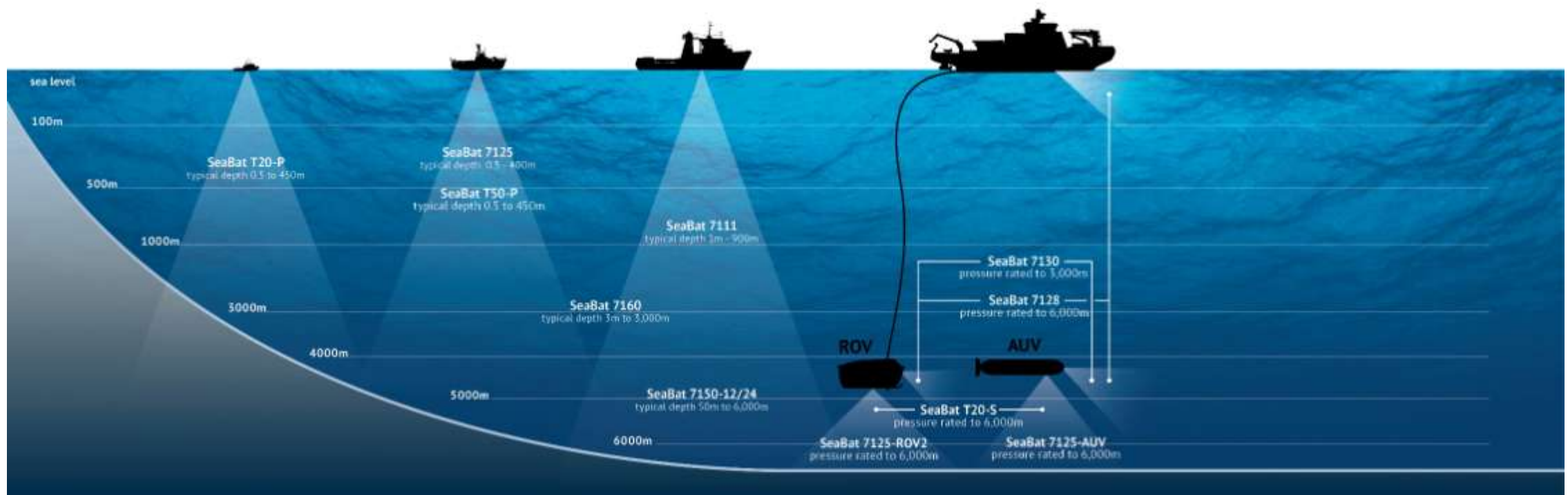
Characteristics

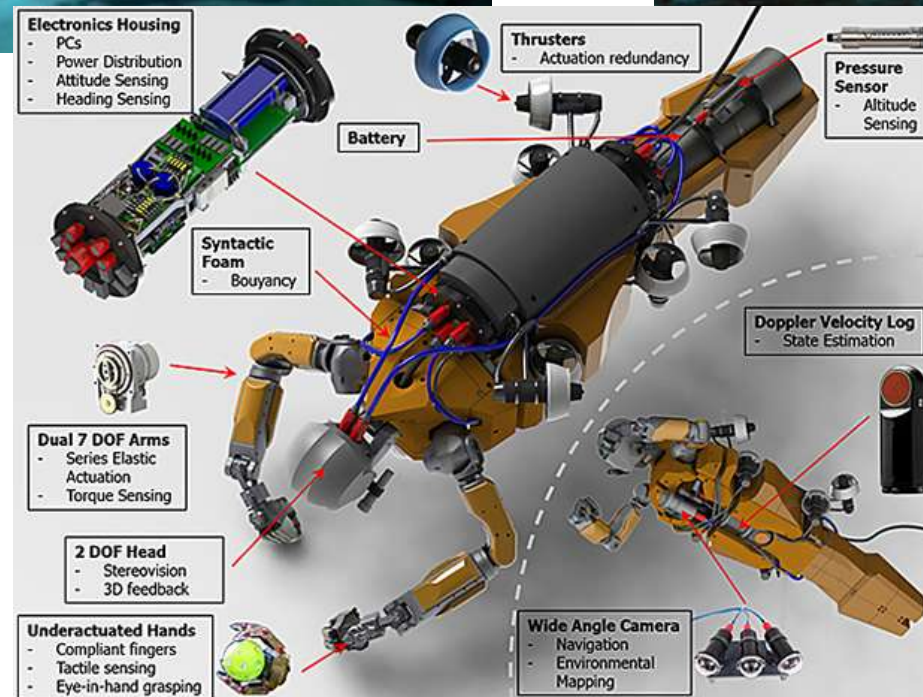
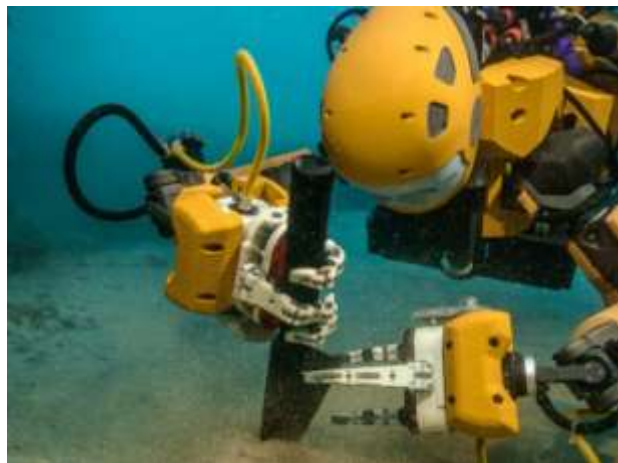
Remotely operated vehicles (ROVs), robotics equipped with powerful LED lights, powerful cameras and gripper arms, with which samples can be taken even at great depths. (E.g. low budget Deep Trekker connection cable to the device extends 300 meters).

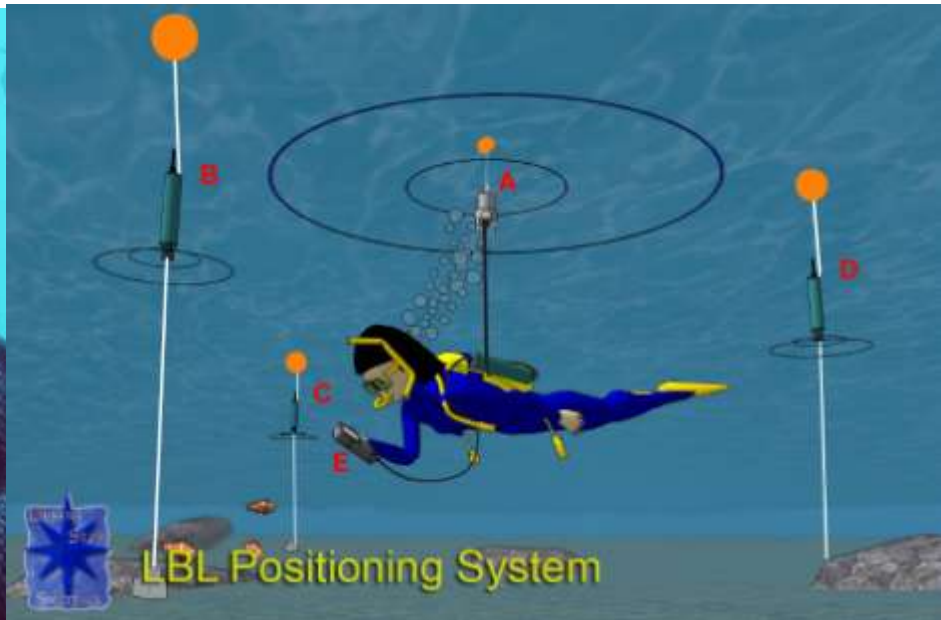
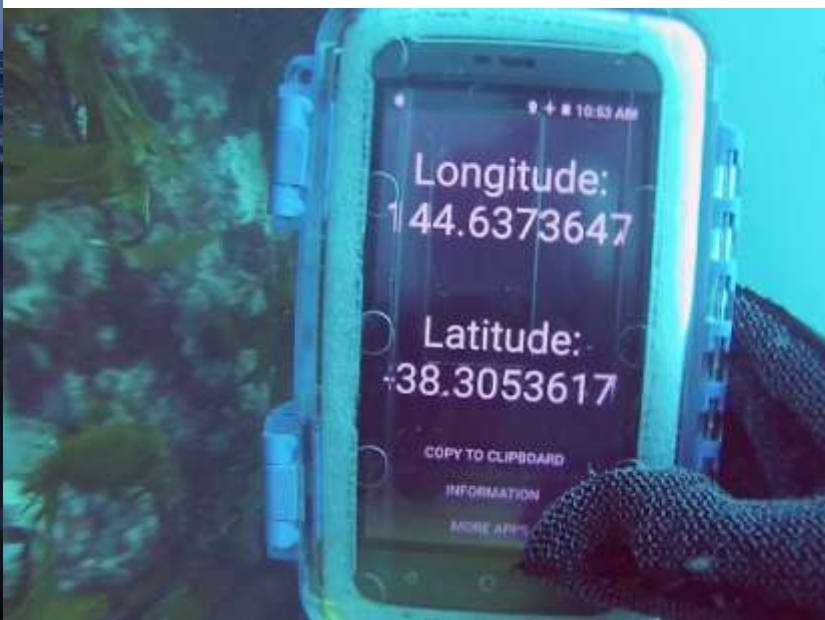
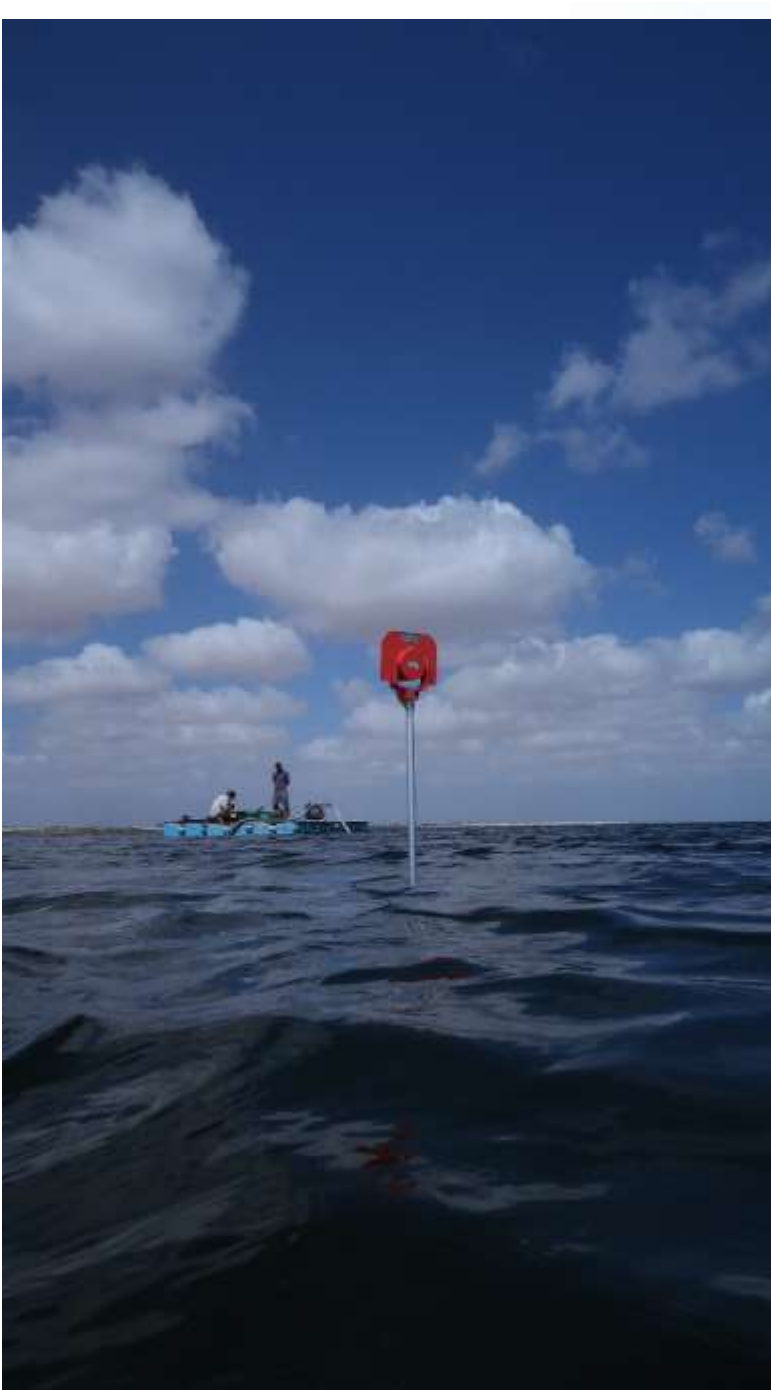
Application

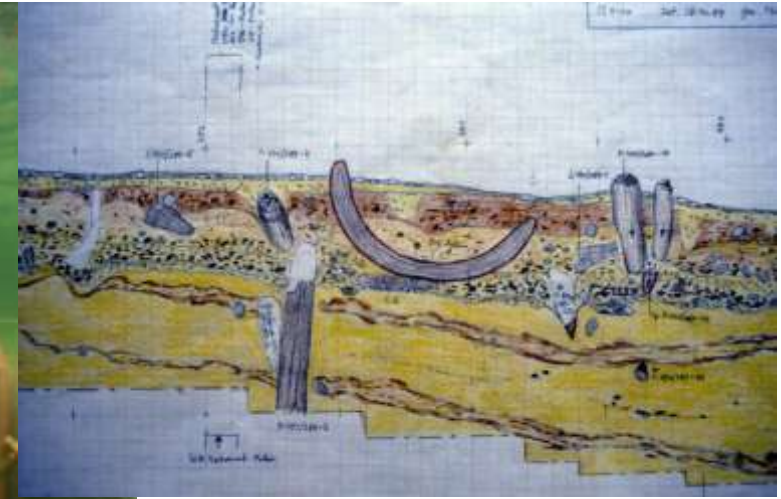
E.g. for visual check of previously registered anomalies by Sonar prospection / for the subsequent sampling - even for partial excavations



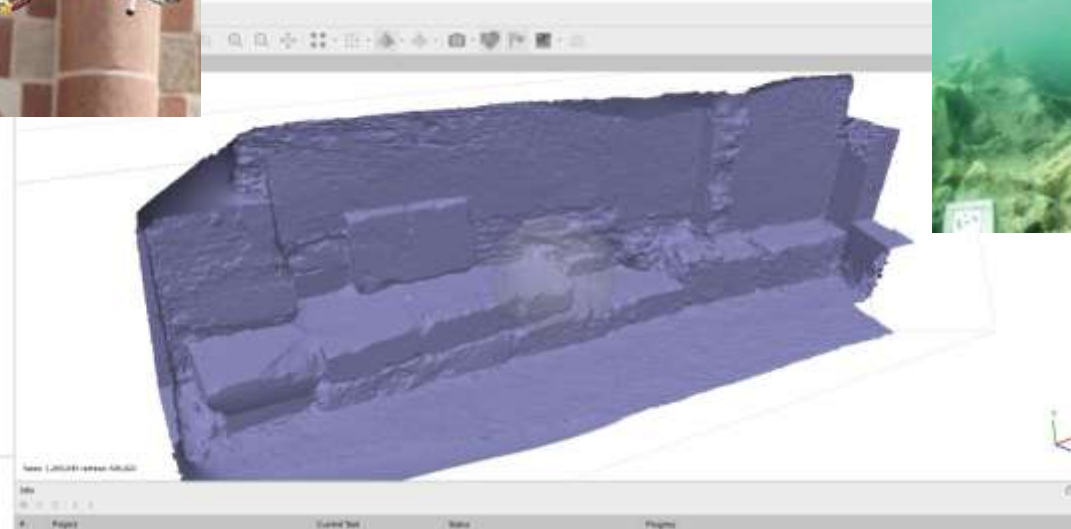
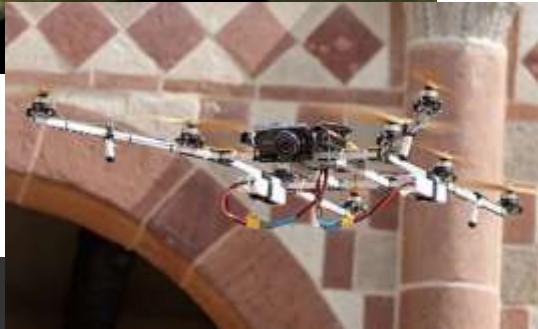
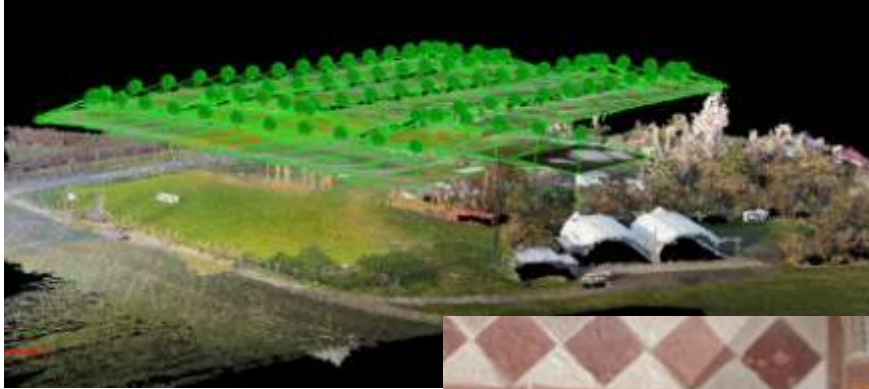


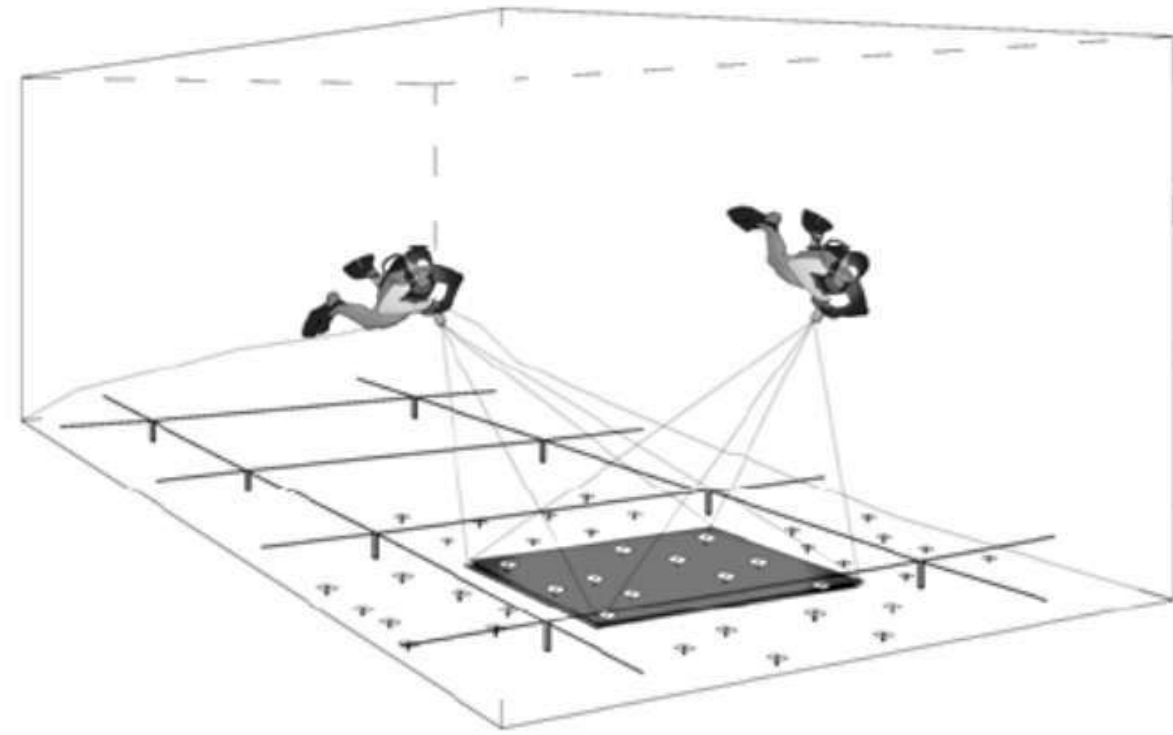
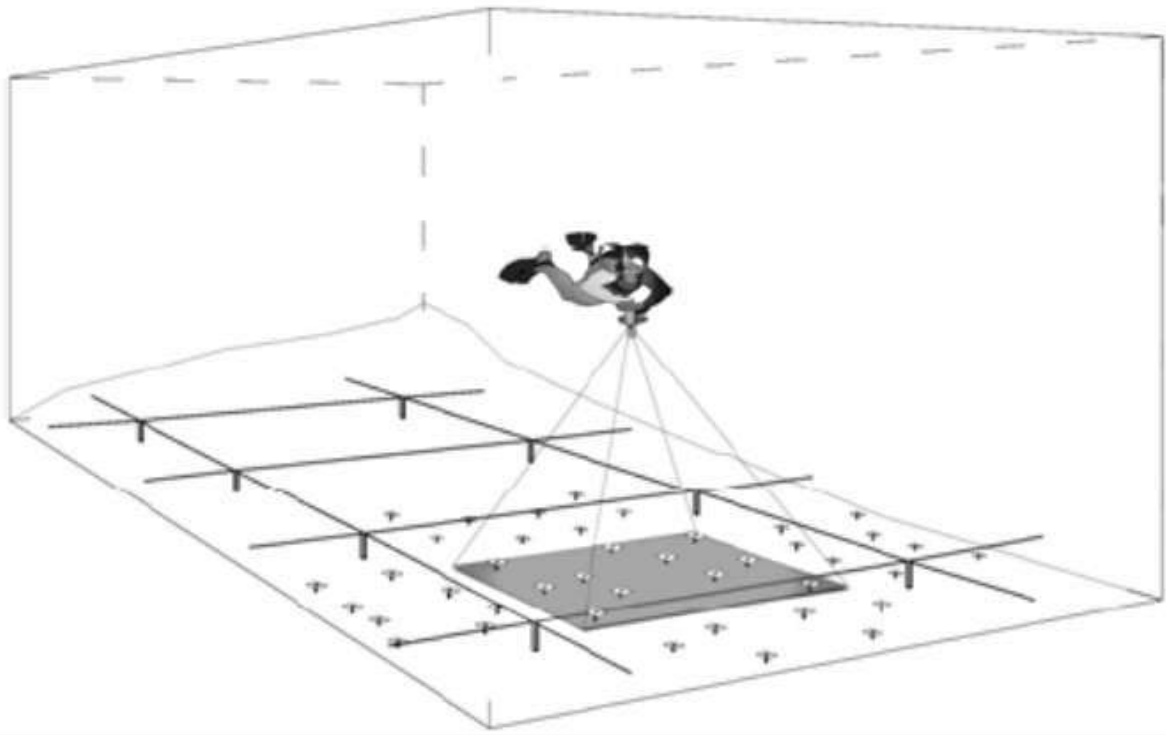


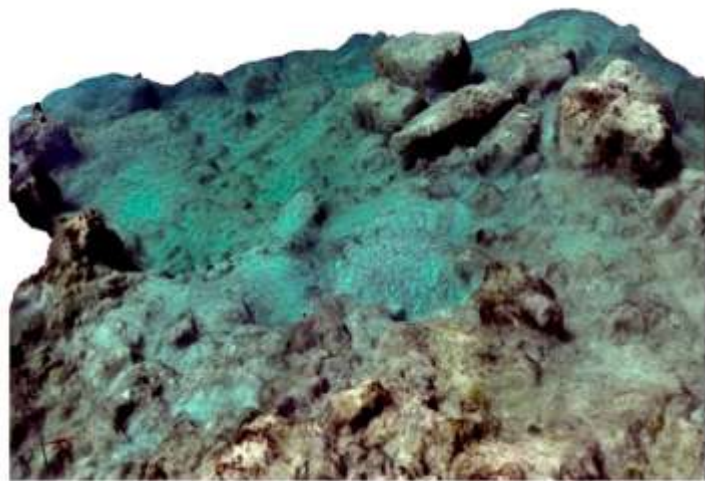




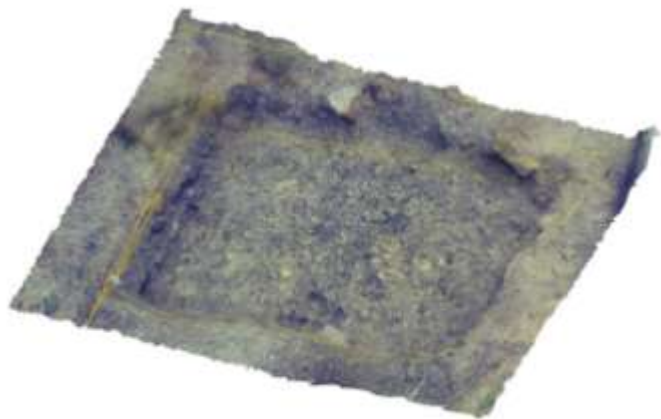
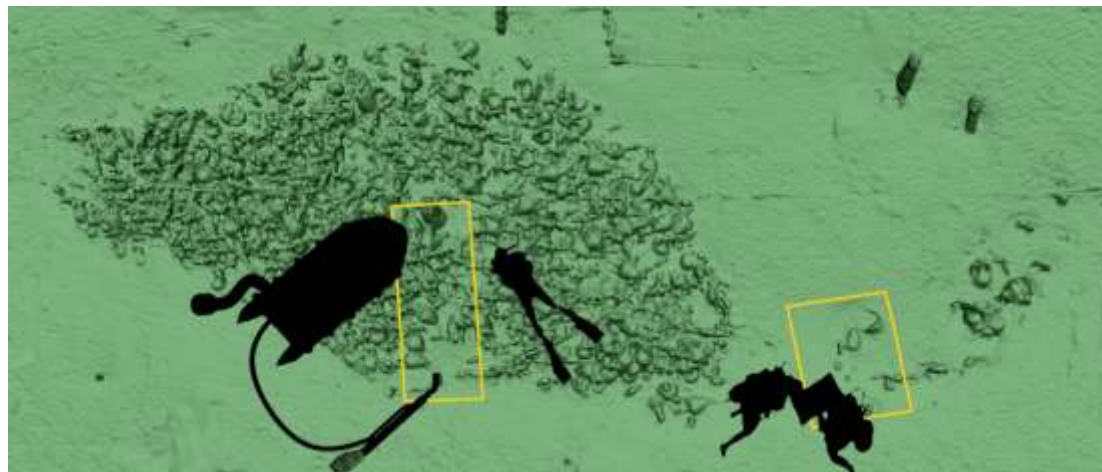
Photogrammetry: Aerial photogrammetry, terrestrial or short-range photogrammetry



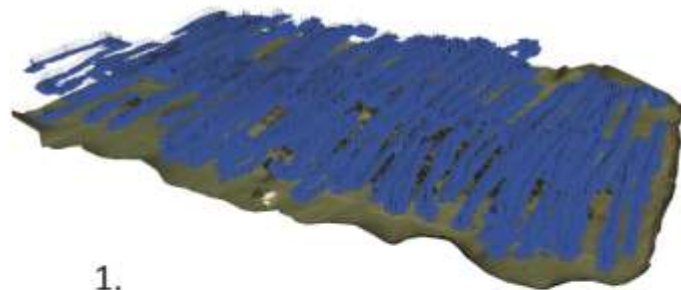
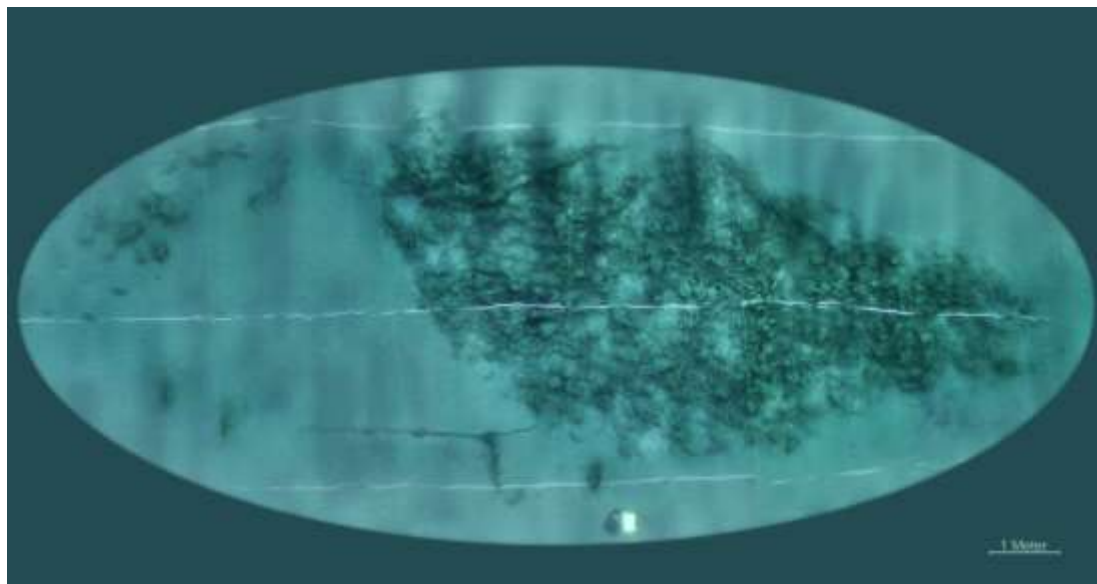




Generated with Agisoft Photoscan



Close-range photogrammetry under water



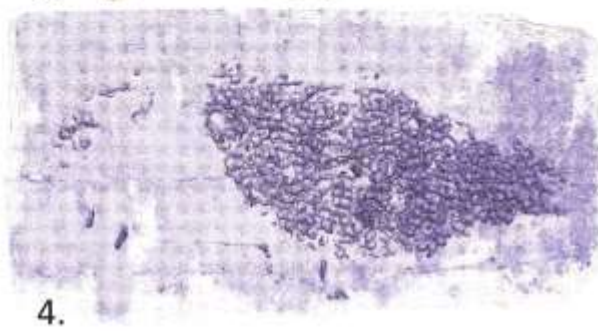
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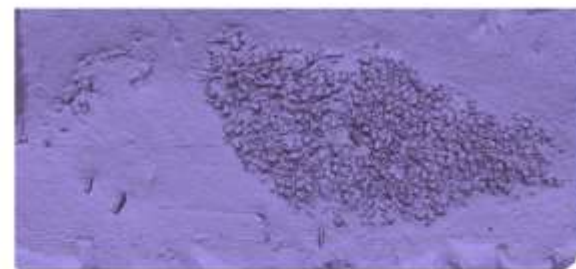
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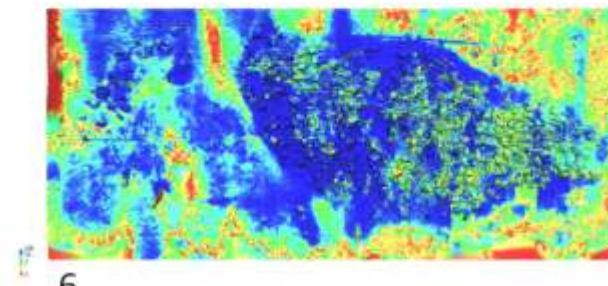
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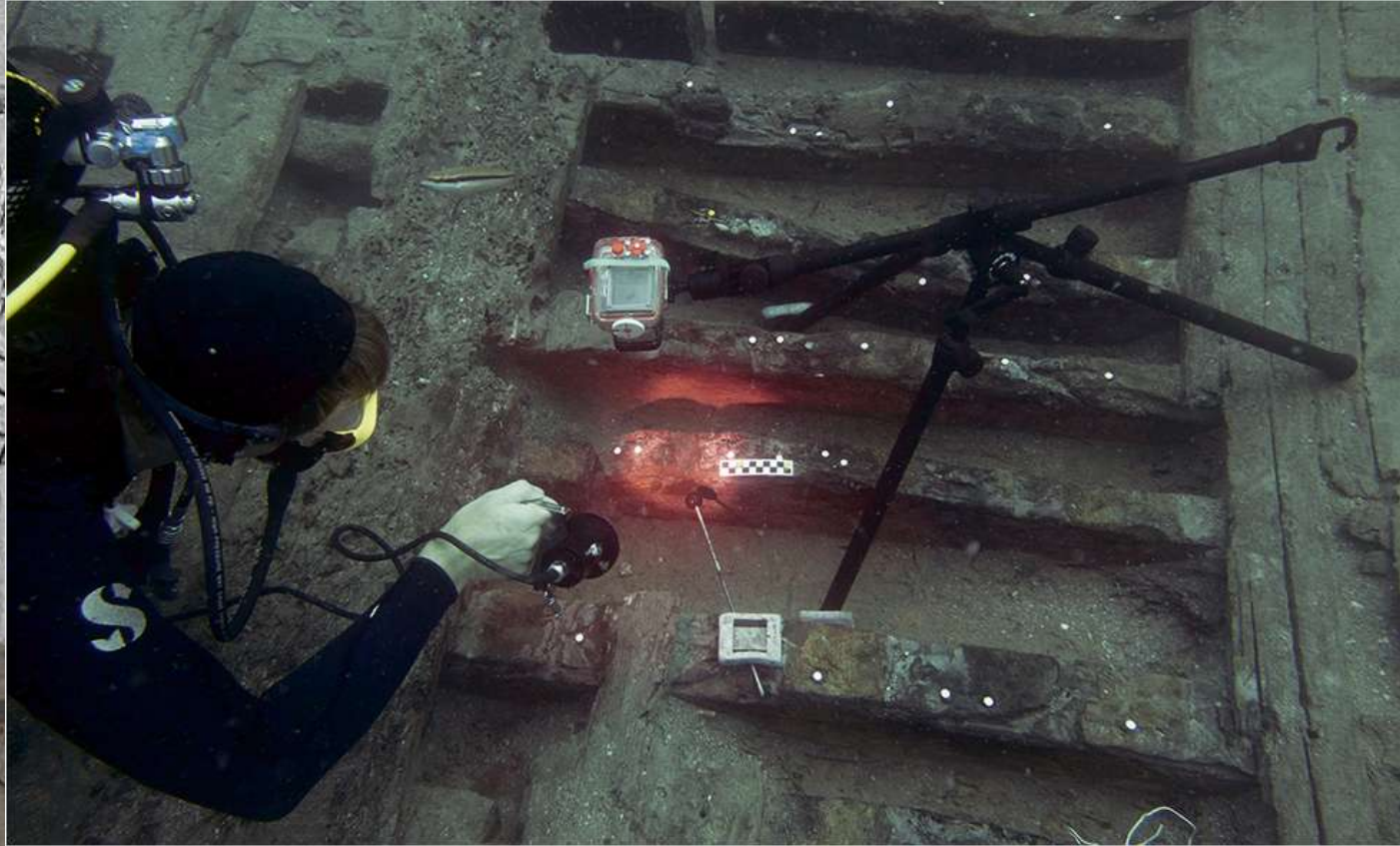


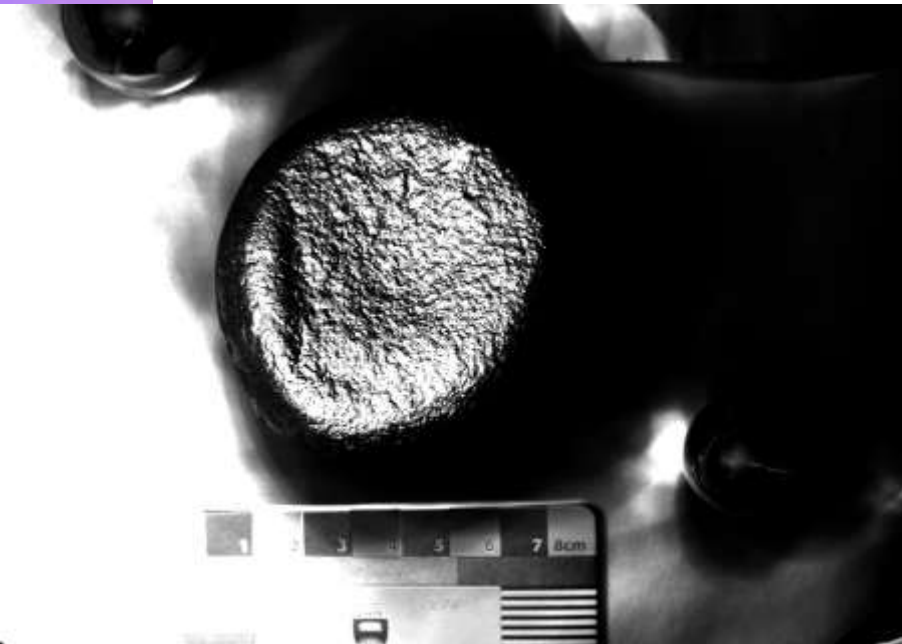
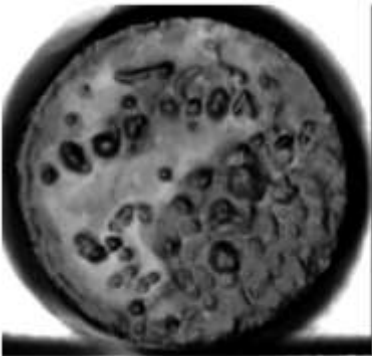
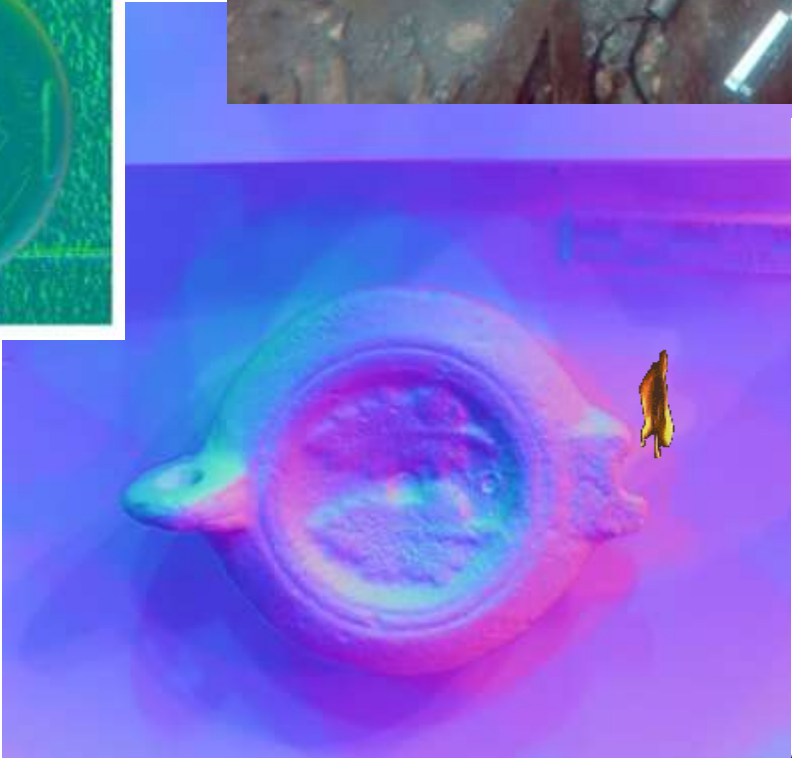
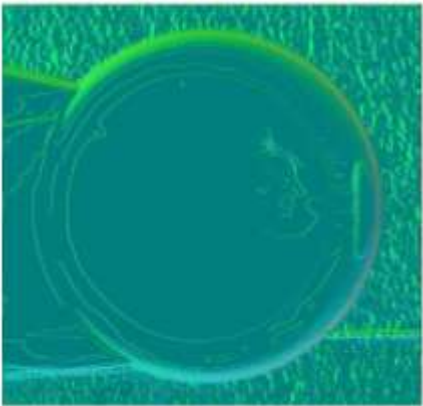
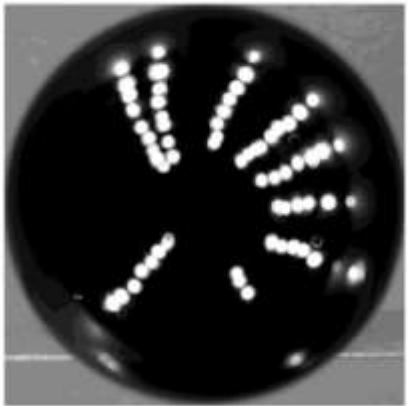
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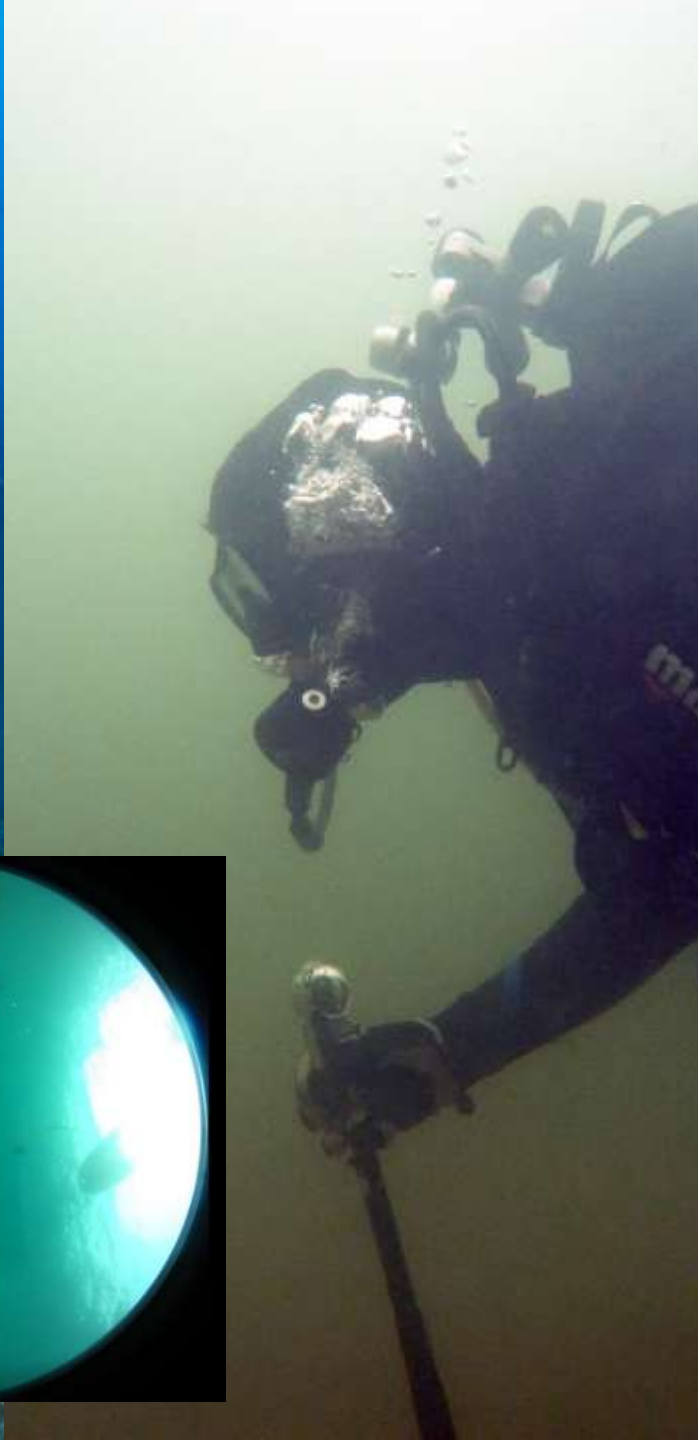
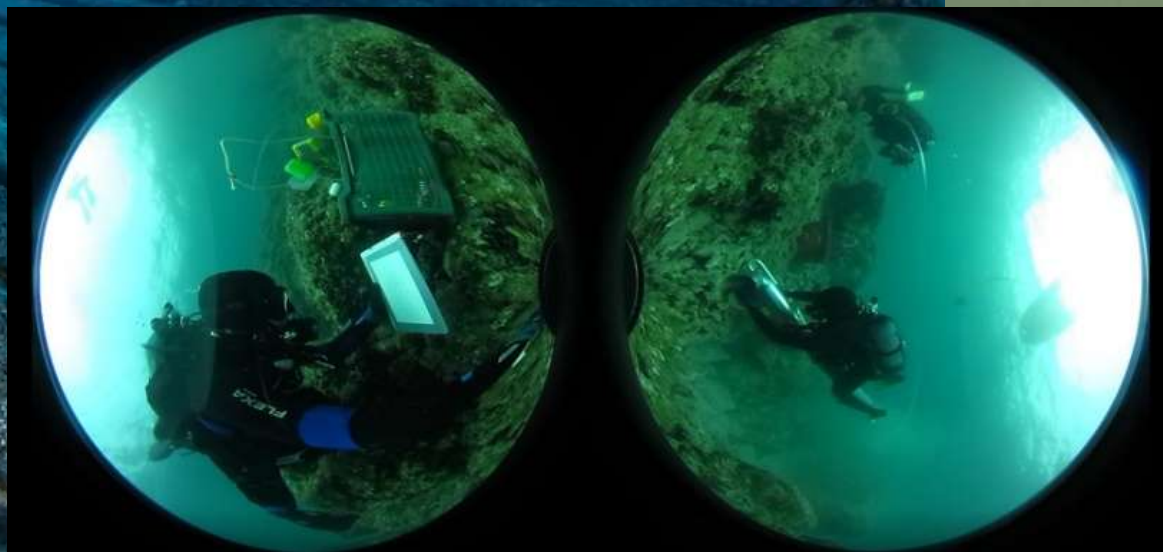
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RTI and URTI (Reflectance Transformation Imaging)









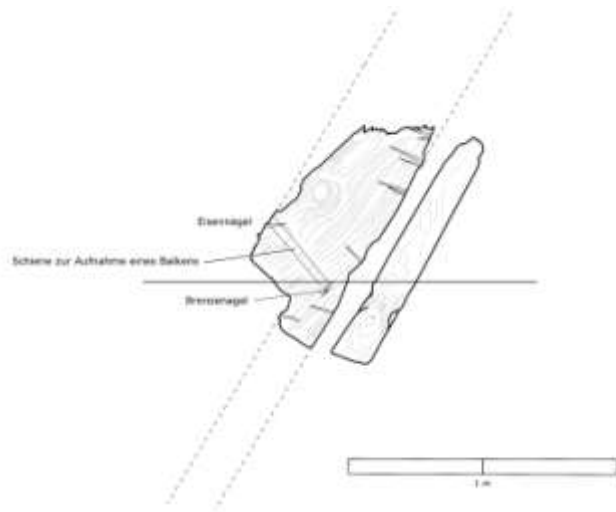






Figure 2.10. Mosaic from the *statio* of the traders of Sullectum (Salakta, Tunisia) in the Piazzale delle Corporazioni at Ostia, showing a three-masted and a two-masted ship. (From Pomey 1997: 85.)

Table 2.1: Ports with long moles on the Tunisian coast.^a

Site	Length (m)	Width (m)	Platform at end
Leptiminus	560	15	rectangular
Sullectum	350		
Thapsus	1000	100 in places	
Acholla	460+ (perhaps originally at least 500)	33	rectangular 100 x 70 m
Gigthis	140	17	semicircular

^a Data from Constans 1916: 70; Yorke et al. 1966 Report: 7, 11–12, 14–16 (privately circulated, now available at: http://www.societies.cam.ac.uk/cueeg/Archives/Sabratha_1966.pdf last accessed 1 June 2011); Slim et al. 2004: 105–6, 138, 152, 154.

Sullectum (Salakta), excavations and investigations were carried out in the area of the ancient city in the past. First comprehensive works on salinisation basins and ceramic production in the area were published and also first approaches to investigate the harbour area were made.

A c. 350 m long ancient breakwater was roughly documented.

Sources e.g. Prokop., Wars 3.16-17 regarding the support of the place of Belisarius against Gelimer and the Vandals 533 AD.

Our Cooperation Project aims for a holistic approach of new research and investigations at the site, combining classical and modern Survey and documentation techniques in Underwater Archeology

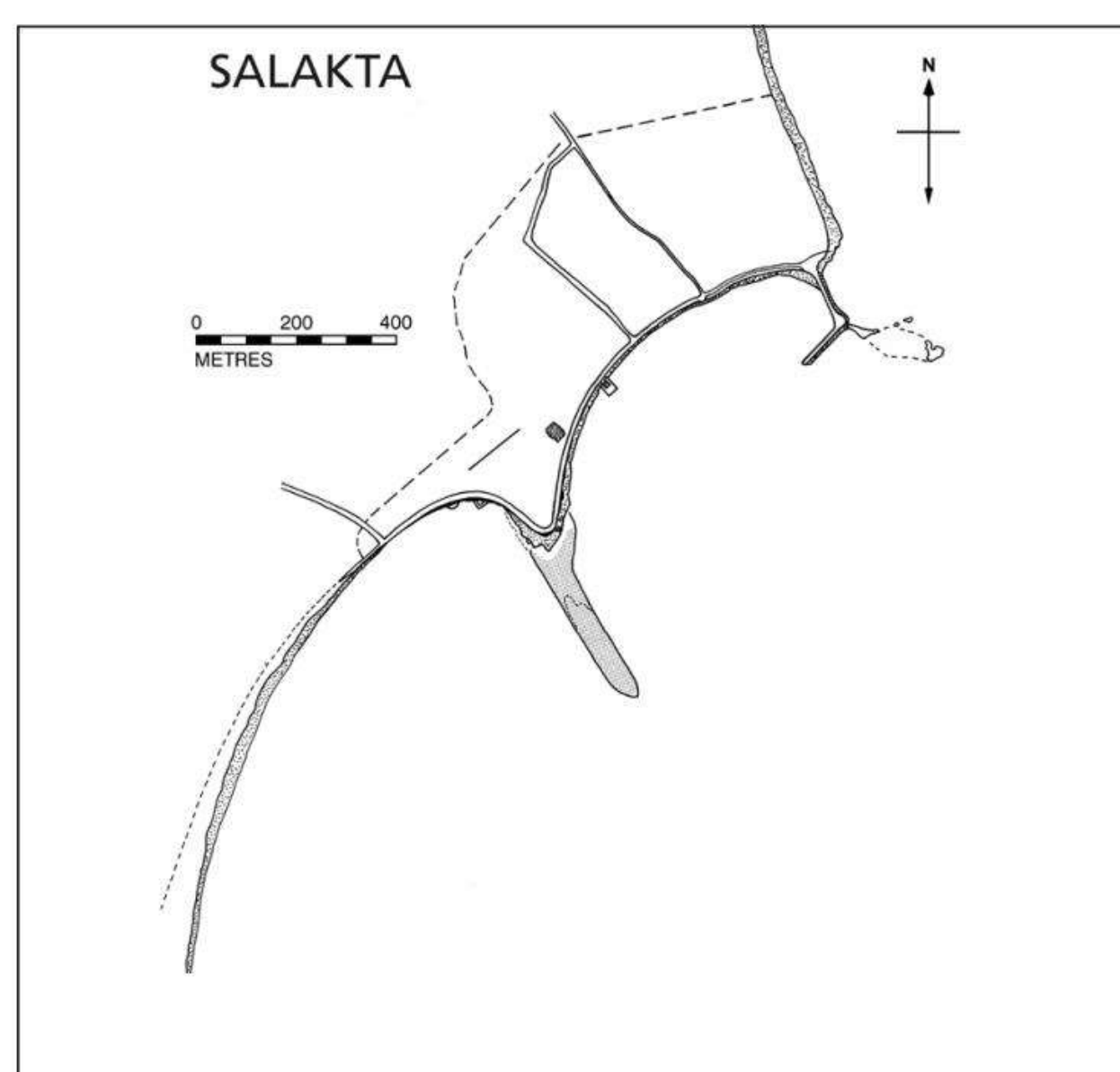
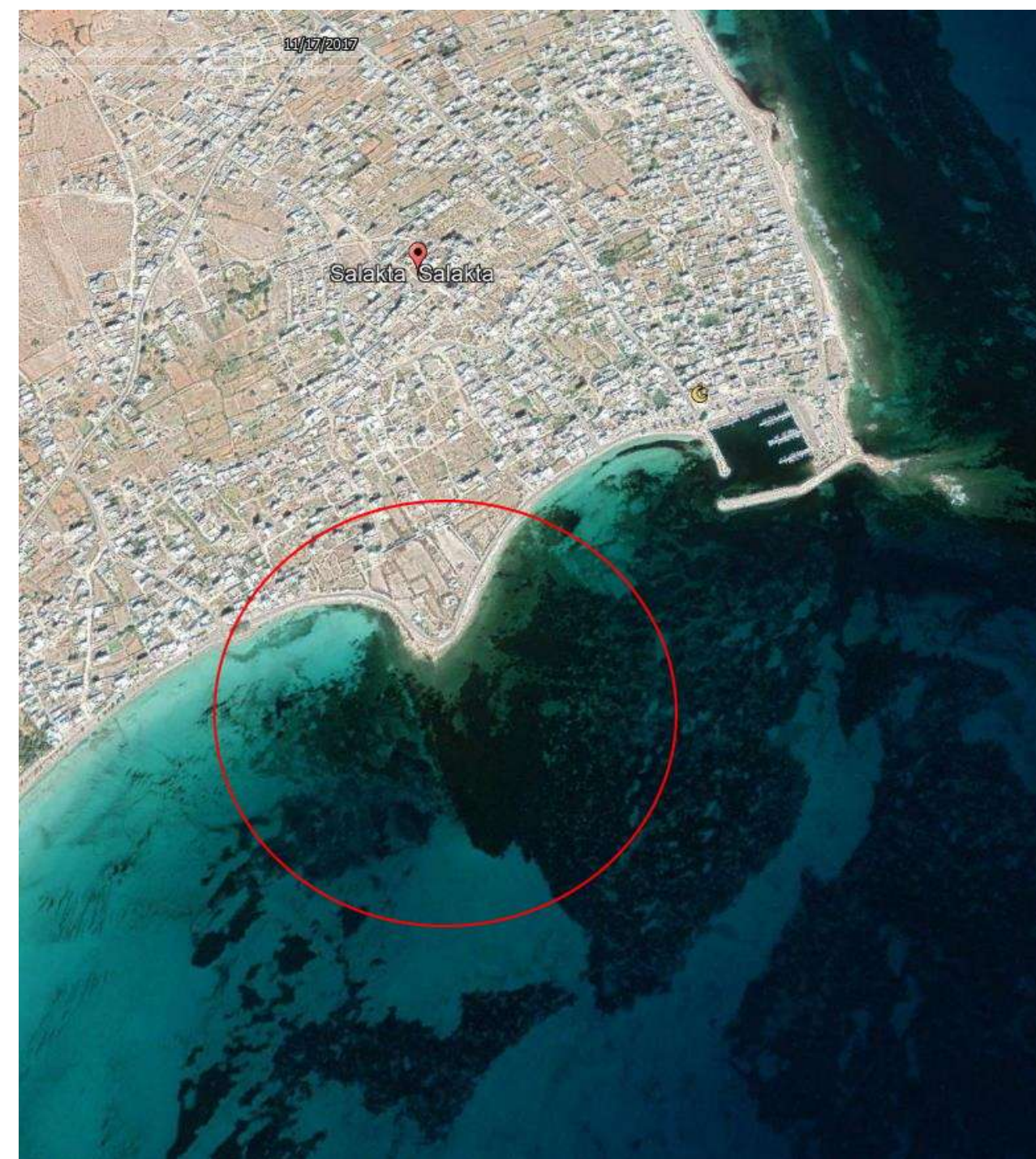
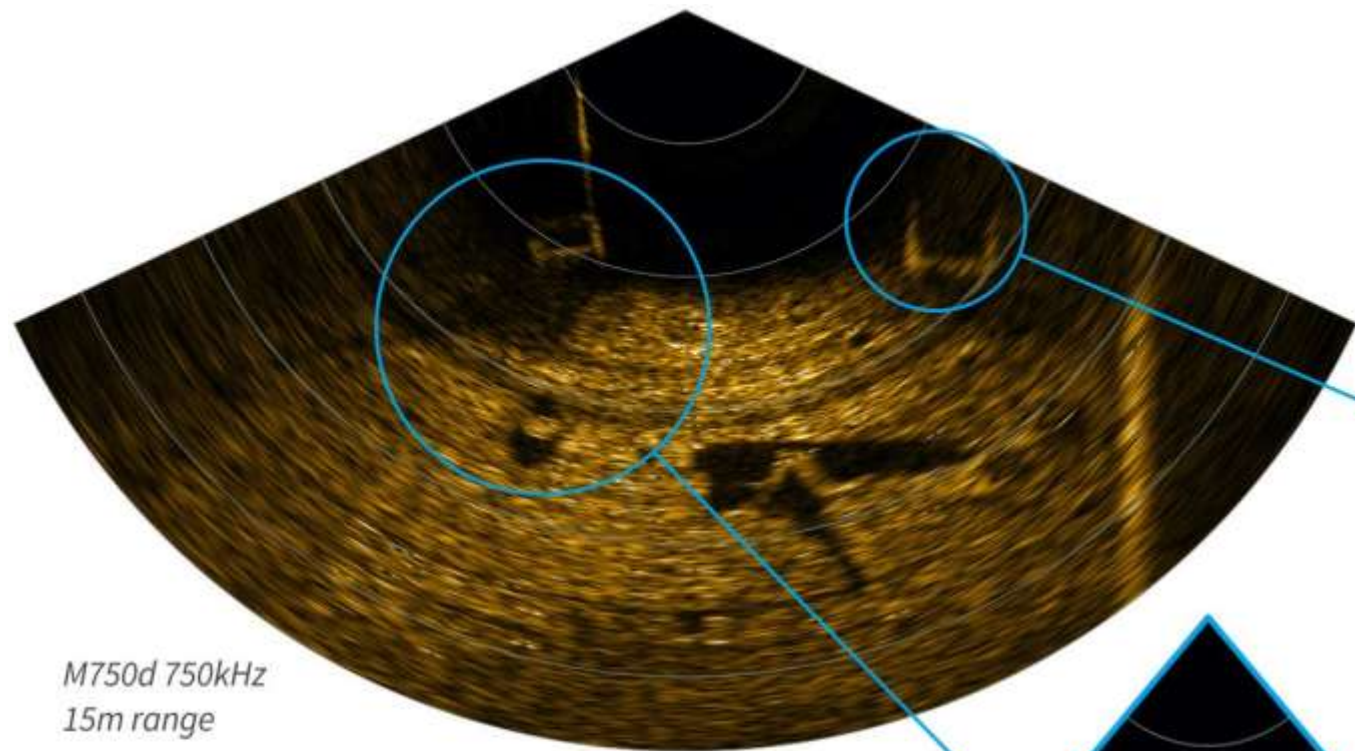


Figure 2.24. Plan of the Roman mole at Sullethum (Salakta, Tunisia). (© Yorke *et al.*, Cambridge Expedition to Sabratha 1966, previously unpublished.)

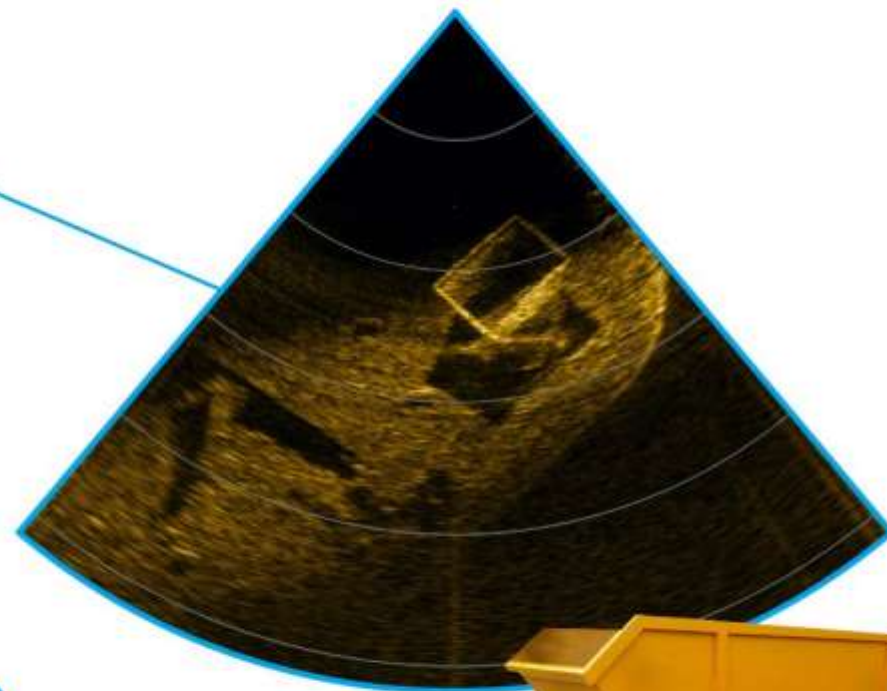


Merci pour votre attention!





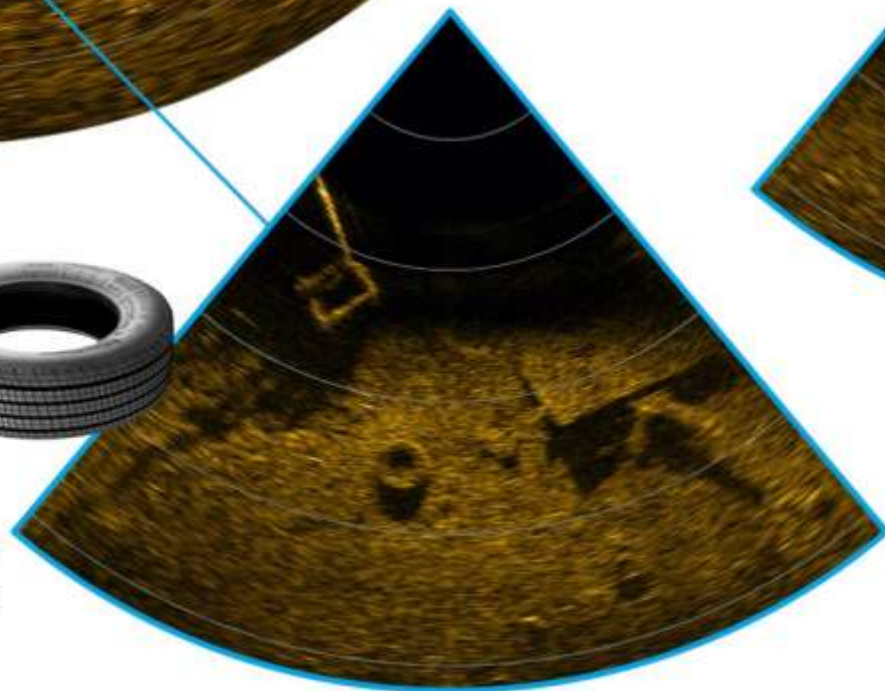
M750d 750kHz
15m range

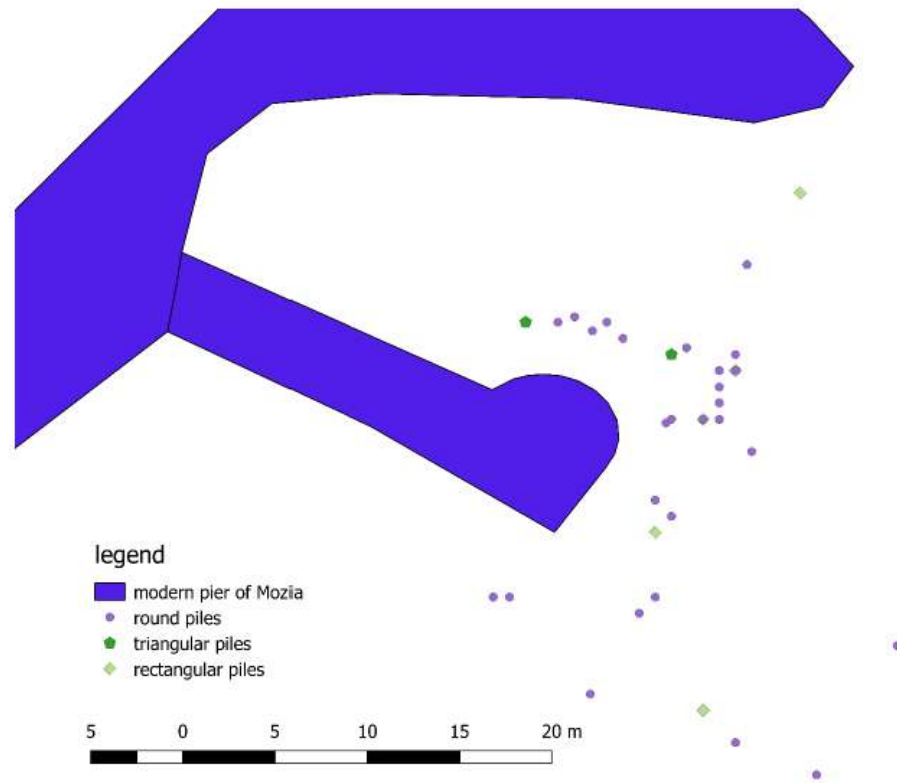


M750d 1.2MHz
Skip/Dumpster



M750d 1.2MHz
Car Tyre & IBC







2016



2017



2018

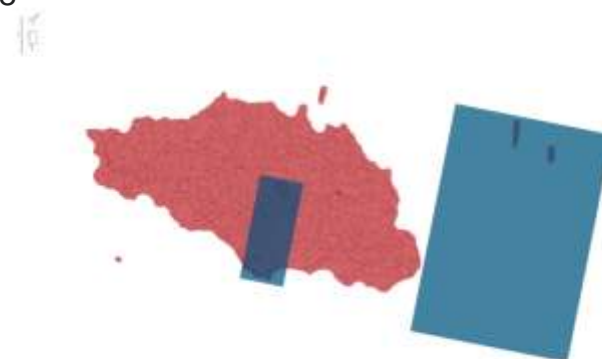
Sediment increase during 2016-2018



Sediment marks



Looting



Geotextile coverage

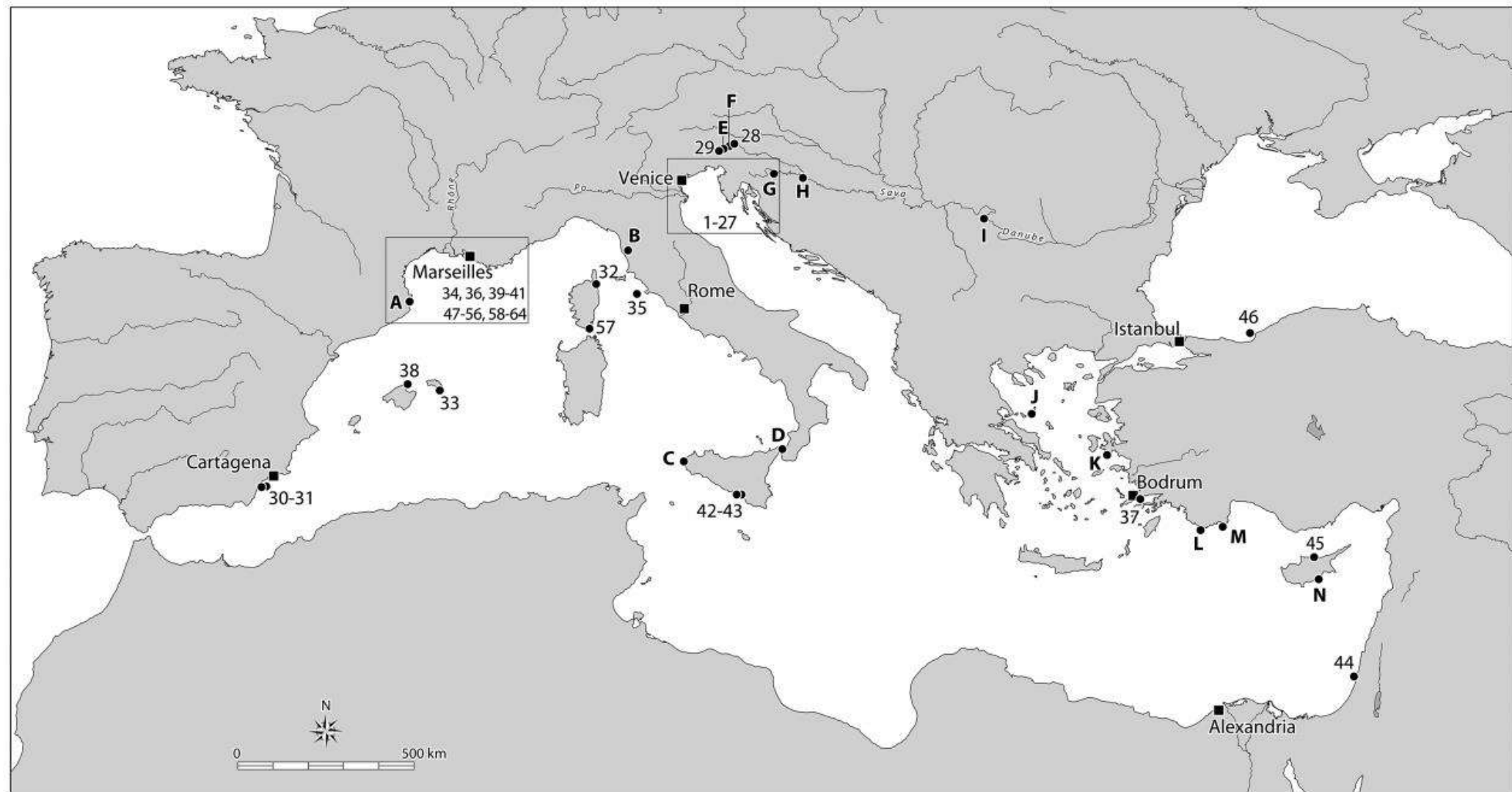


Figure 1. The ancient Mediterranean shipwrecks cited in the article. Sewn boats: 1) Zambratija; 2) Pula 1; 3) Pula 2; 4) Zaton 1; 5) Zaton 2; 6) Zaton 3; 7) Caska 1; 8) Caska 3; 9) Caska 4; 10) Barena del Vigno; 11) Cavanella d'Adige; 12) Comacchio; 13) Stella 1; 14) Lido di Venezia 1; 15) Lido di Venezia 2; 16) Lido di Venezia 3; 17) S. Francesco del Deserto; 18) Marcon; 19) Meolo 1; 20) Corte Cavanella 1; 21) Corte Cavanella 2; 22) Padua; 23) Aquileia 1; 24) Aquileia 2; 25) Santa Maria in Padovetere; 26) Cervia; 27) Pomposa; 28) Lipe; 29) Vrhnika 2; 30) Mazarrón 1; 31) Mazarrón 2; 32) Golo; 33) Binisafüller; 34) Bon-Porté; 35) Giglio; 36) Jules Verne 9; 37) Pabuç Burnu; 38) Cala Sant Vicenç; 39) Jules-Verne 7; 40) Villeneuve-Bargemon 1/César 1; 41) Grand-Ribaud F; 42) Gela 1; 43) Gela 2; 44) Ma'agan Mikhael; 45) Kyrenia; 46) Ereğli E; 47) Cap Béar 3; 48) La Tour-Fondue; 49) Cavalière; 50) La Roche-Fouras; 51) Mèdes 6; 52) Dramont C; 53) Palamos; 54) Plane 1; 55) Barthélemy B; 56) Jeaume-Garde B; 57) Perduto 1; 58) Cap del Vol; 59) Saintes-Maries 2; 60) Saintes-Maries 24; 61) Baie de l'Amitié; 62) Cala Cativa 1; 63) Port-Vendres 3; 64) Port La Nautique. Other shipwrecks: A) Los Ullastres; B) Pisa C; C) Marsala; D) Porticello; E) Vrhnika 1; F) Sinja Gorica; G) Kamensko; H) Sisak; I) Kušjak; J) Alonessos; K) Tetktaş Burnu; L) Uluburun; M) Cape Gelidonya; N) Mazotos (drawing V. Dumas, G. Boetto, P. Pomey, AMU, CNRS, CCJ).

