

# FIELD ARCHAEOLOGY. EXCAVATIONS AND SURVEYS IN THE DIGITAL ERA: AN ASSESSMENT OF CUTTING EDGE TECHNIQUES FROM THE FIELD TO THE FINAL PUBLICATION, CONSERVATION AND VALORISATION

March 8-12 2022

François GILIGNY

Chair of Archaeological theories and methodology

UP1

## **Lecture**

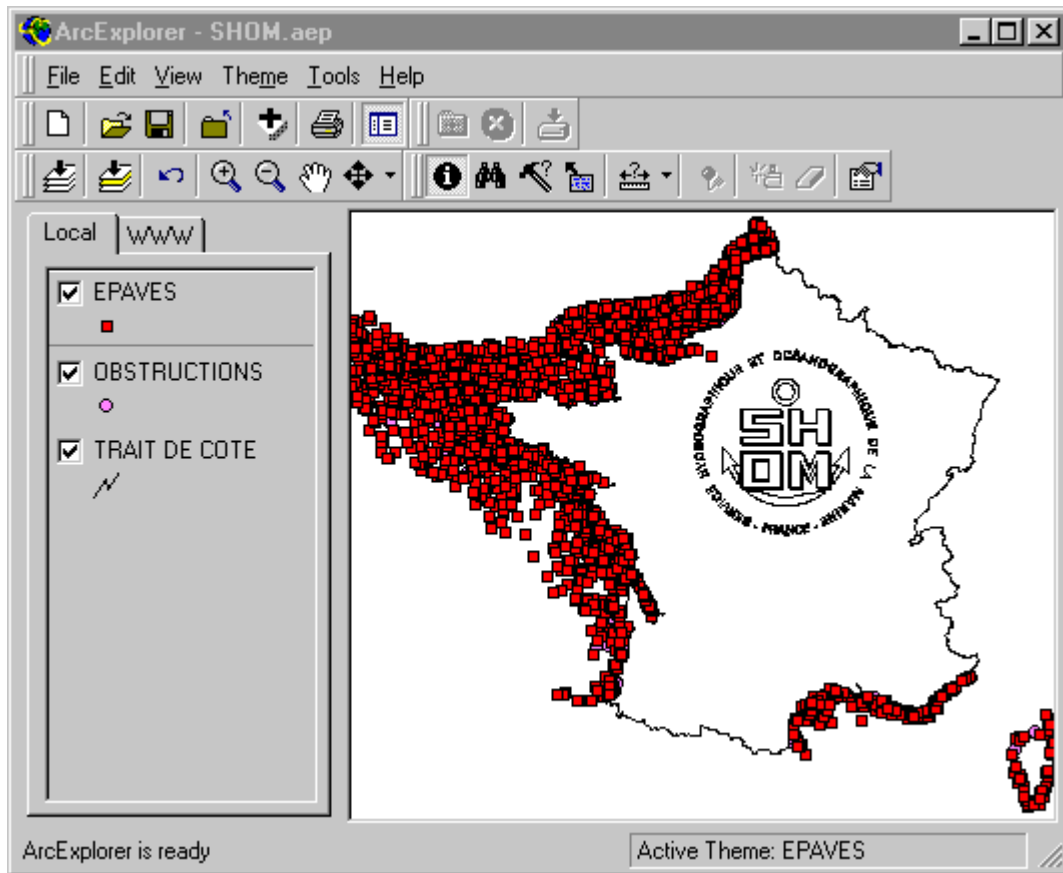
### **3.1. The excavation: type of excavation and flexible strategies in regard of the site/context**

# Environments

- Marine : wrecks (continental shelf, large depths)
- Marine coastlines:  
harbours, estuaries, coastal shellfish clusters  
island environments
- Continental Wetlands:
  - lakes, peatlands,
  - rivers, paleochlorines,
- Terrestrial:
  - open sites; extensive rural stripping
  - confined environments: caves, underground quarries, mining
  - urbanised areas: urban archaeology

# 1. Marine

- Sub-marine archaeology : seas & oceans are the most important archaeological reservation



**Wrecks inventoried on the  
continental shelf in  
metropolitan France  
(> 200 000)  
Doc DRASSM**

# Scuba

In 1942: invention of the scuba suit COUSTEAU-GAGNAN

Allows to explore the seabed of a few tens of meters of depth.

Consequences:

- Multiplication of dives, and thus discoveries;
- Radical change in research methods towards excavation rather than collection of remains or looting;

- 1948: First autonomous diving dive on the wreck of Mahdia
- 1957: first excavation with plan and position of the objects in Albenga, on the Ligurian coast. The site is at 1,5 km from the coast and - 42 m.
- 1960: first use of photogrammetry at Cape Gelydonya (southern Turkey) on a Bronze Age wreck, then at Yassi Ada (Halicarnasse) on a Byzantine wreck (7th AD).
- Underwater archaeology is developing rapidly with international congresses, the first of which is held in Cannes (1955), international conventions are voted by UNESCO to protect this heritage.



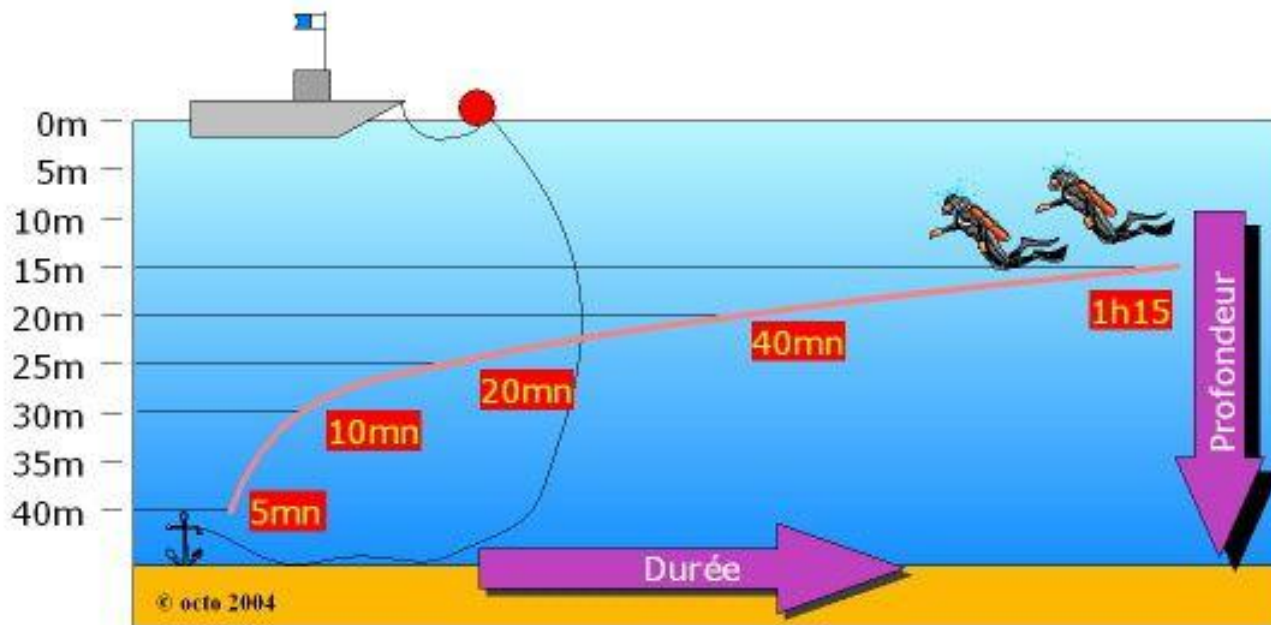
1942



1923

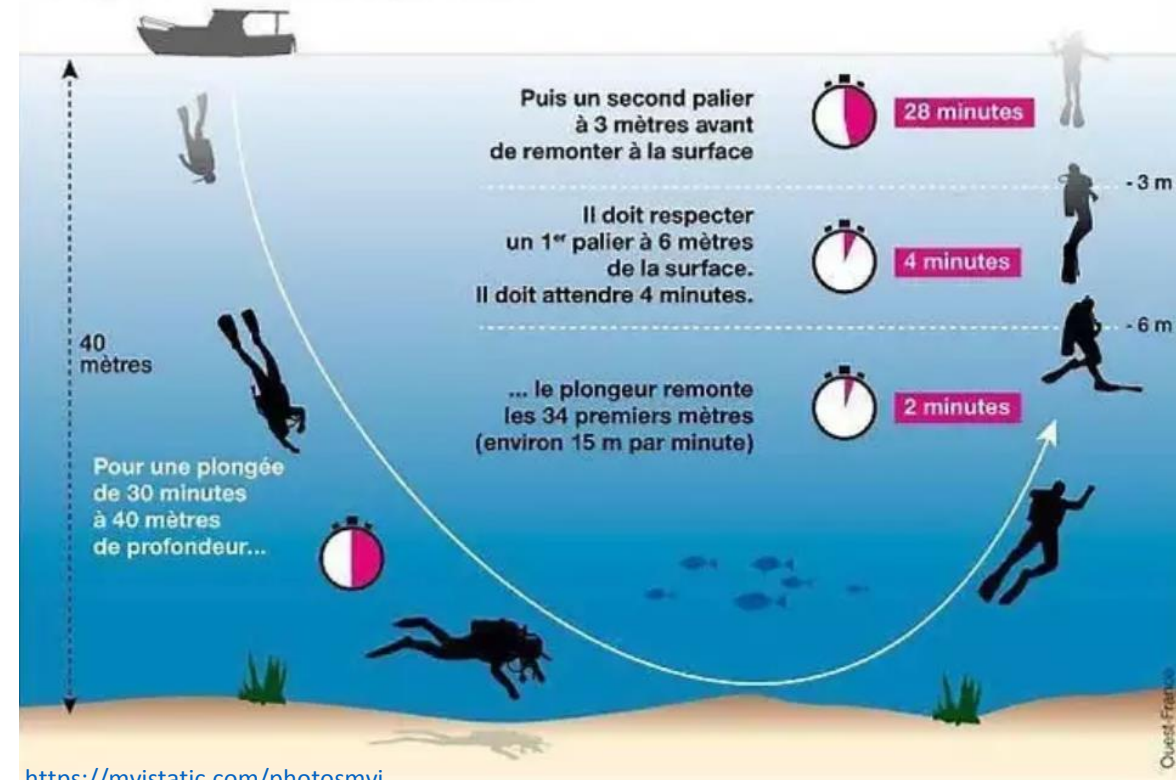
# Fouille en scaphandre

- Scuba diving requires diving skills and applying safety rules based on depth with decompression bearings.



temps de plongée sans paliers de décompression

## Les paliers de décompression



# Submarine research boat

André Malraux ship (DRASSM), 2012 >2050

- Main equipments:
  - High pressure air and nitrox (over-oxygenated air) inflating compressors
  - magnetometer
  - sonar
  - winch equipped with 800 m of sonar or magnetometer cable



- Longueur : 36,30 m.
- Largeur au maître-couple : 8,85 m.
- Tirant d'eau : 2,90 m.
- Vitesse : 13 Nœuds.
- Capacité portique arrière : 7 tonnes
- Capacité grue principale : 13T/mètre
- Centrale hydraulique
- Equipage : 7
- Equipements complets de plongée : 20
- Personnel scientifique : 30 en sortie + 9 en navigation

**2<sup>nd</sup> boat : Alfred Merlin 46 m**

# Sub-marine archaeology



- Prospecting: swineline, magnetic, electromagnetic, sonar, underwater drone
- Excavation: excavator or water lance, lift-up balloon,
- Surveys: photogrammetry, triangulation survey, bathymetric mapping





Autosub Long Range, drone with sonar

<http://noc.ac.uk/news/autosub-long-range-ready-cast>



Crabster, robot with sensors for deep water exploration

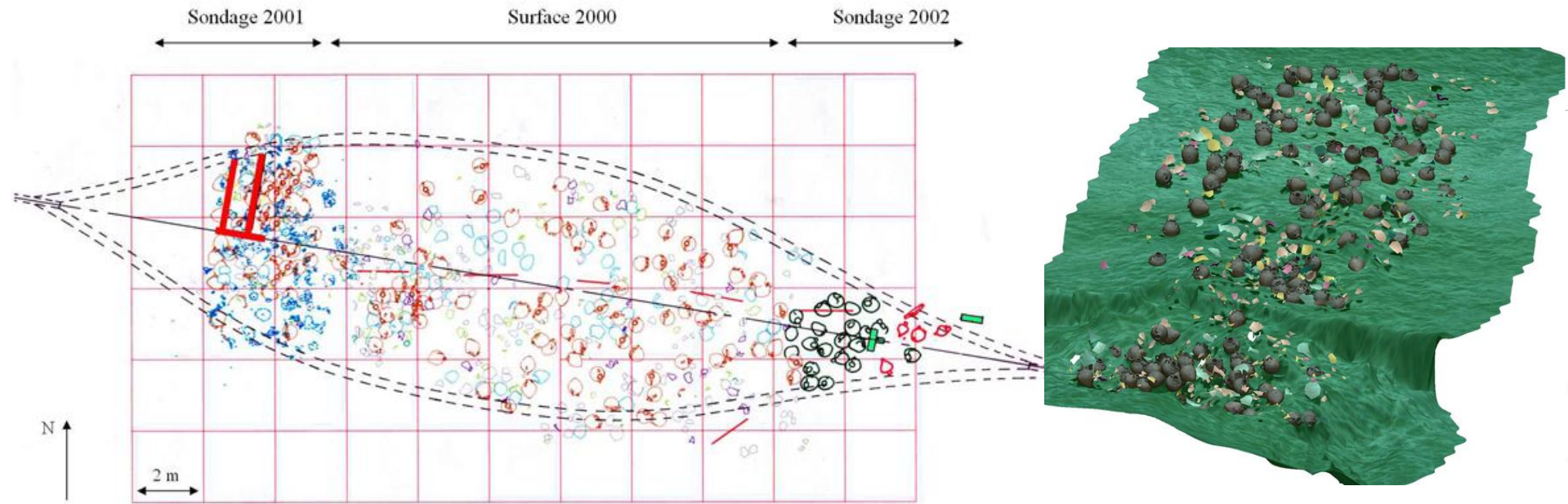


Mud vacuum cleaner

<http://www.gizmag.com/crabster-robot-kiost-korea/28165/>

# Shipwreck reconstitution

The loading modes of shipwreck cargoes are reconstructed using search data and amphorae analysis.



Etruscan wreck of the Great Ribaud: traces of wear on amphorae; experimental realization of the stacking of amphorae and reconstruction of the loading Musée d'Histoire de Marseille.

Source : <http://grandribaudf.gamsau.archi.fr/photogrammetrieSSM.html>



## Problems of preventive conservation for ship wrecks

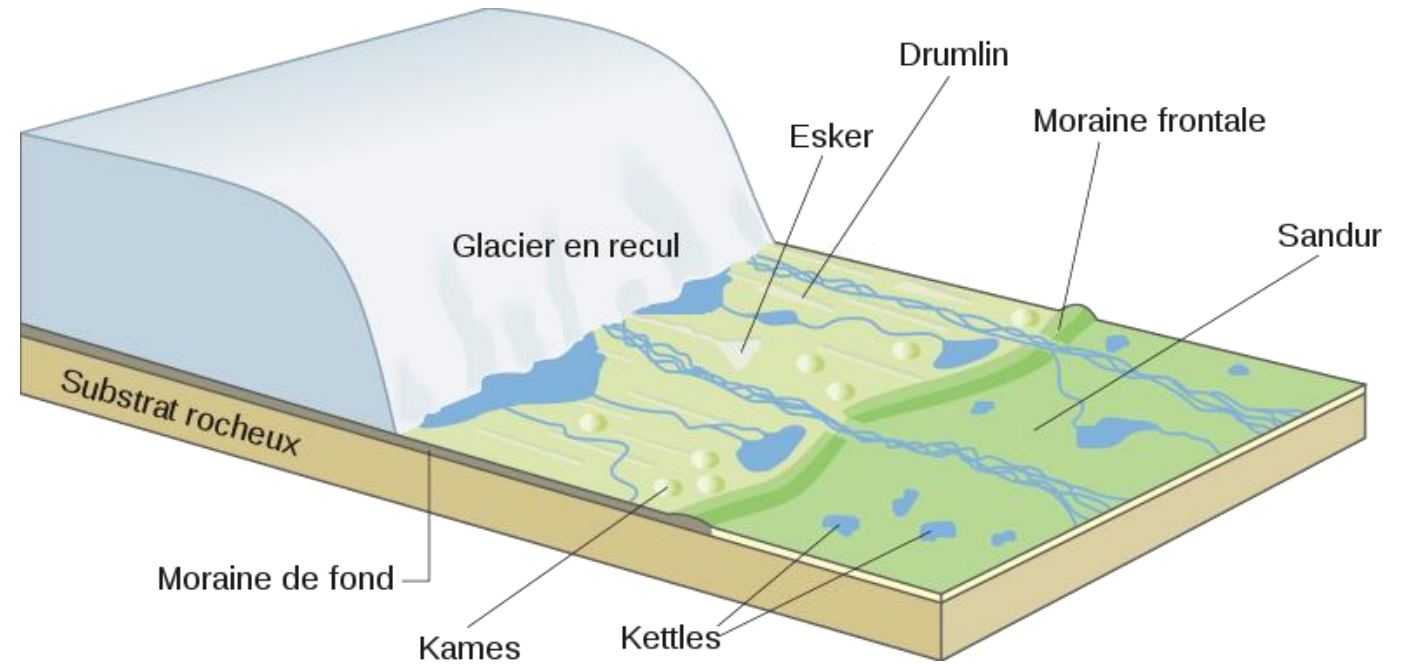
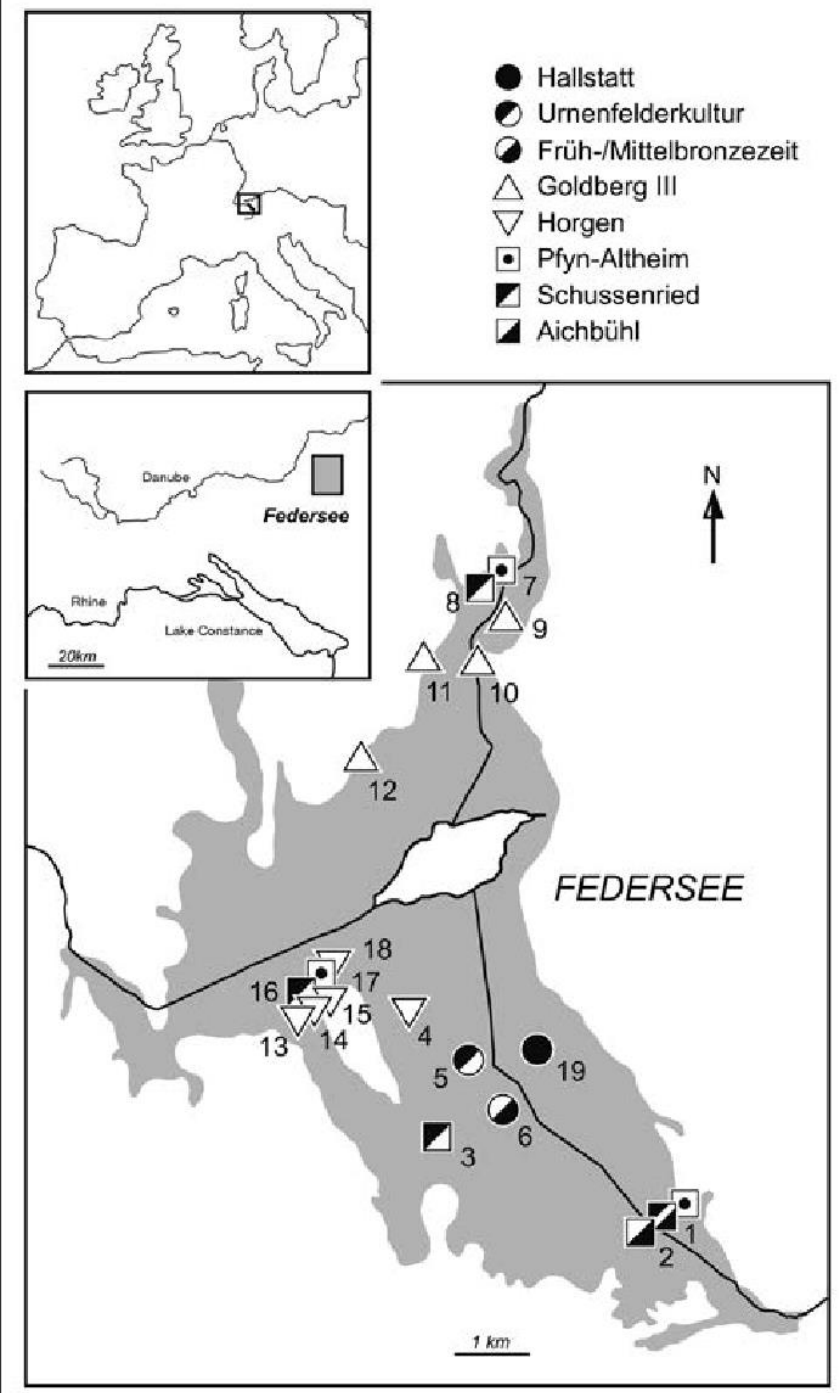


- Sunk in Stockholm in 1628 and refloated in 1961
- The wreckage of Vasa was sprayed with polyethylene glycol for 17 years and then dried for 9 years
- Exhibited in the museum built for this purpose since 1990, the most visited in Sweden (approx. 1M/year)

## **2. Lakes, rivers, bogs**

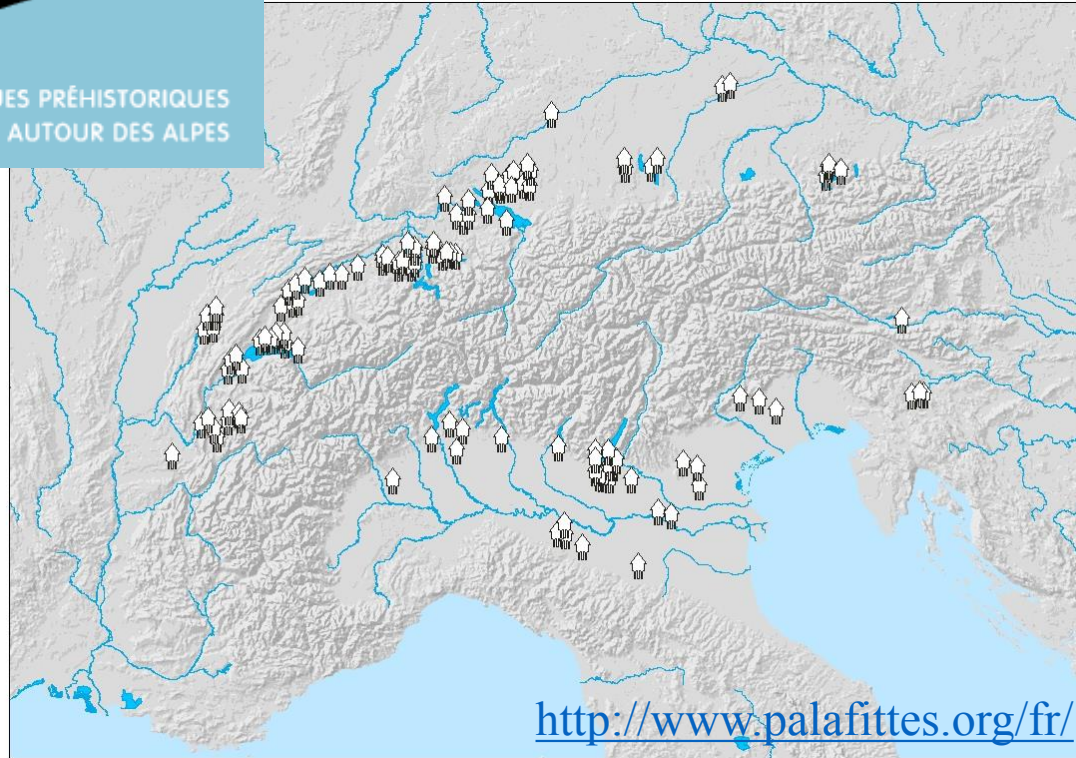
Human activities have destroyed and continue to destroy many wetlands with agriculture (forage crops, drying), urbanization and major works.

# Periglacial environments



Lake and peat bog from ice residue. Federsee, South Germany, a great concentration of archaeological sites

# Lakeshore



- Very large rescue excavations have taken place in Europe since the 1960s, as in the construction of the Swiss motorways. The density of sites can reach 1 site per km by the lake.
- Around the Alps, 111 sites in 6 countries labelled as UNESCO World Heritage in June 2011, dated mainly from the Neolithic to the Iron Age



Site de Concise sur plate-forme de craie lacustre, lac de Neufchâtel, Suisse

# Lakeshore dwellings « palafites »

The lakeshores have attracted sedentary occupations in the form of villages located in the floodplain – on stilts – or nearby from the Neolithic period to the Iron Age, and sometimes in the medieval period

<https://www.palafittes.org/home.html>



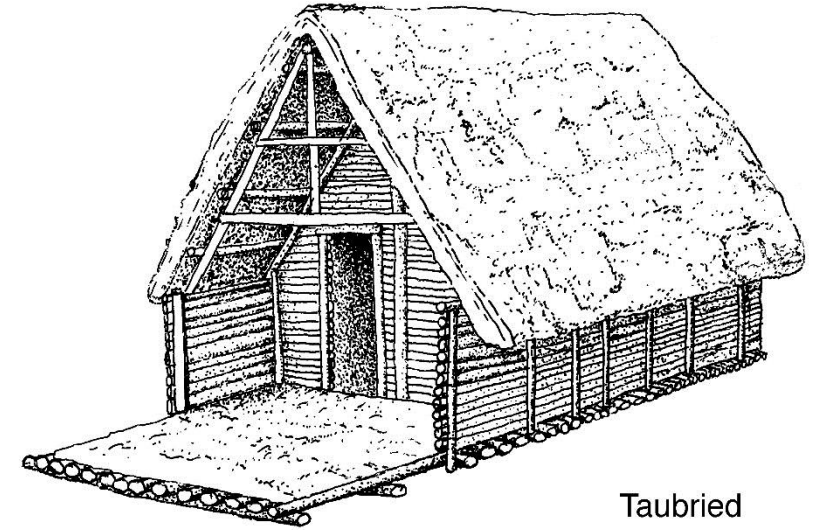
Cortaillod, village Bronze final (Neuchâtel, Suisse)



Pfahlbau Museum (Unteruhldingen, Allemagne)

# bogs

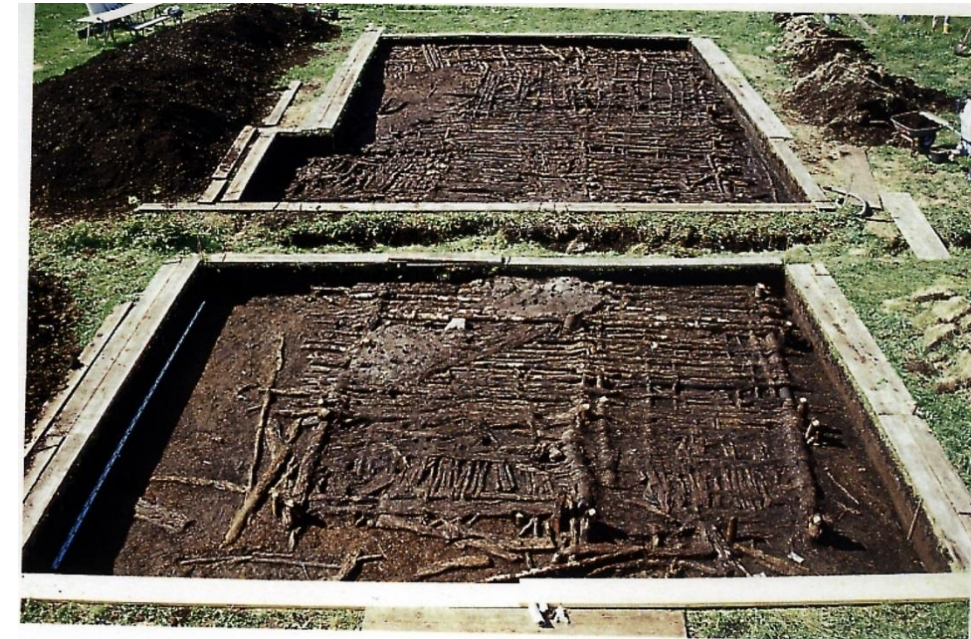
The floor levels of houses are conserved in the peatlands, unlike the edges of lakes where usually only stilts are conserved and some elements fall to the ground. These floors are sometimes rebuilt or superimposed to prevent soil moisture.



Taubried



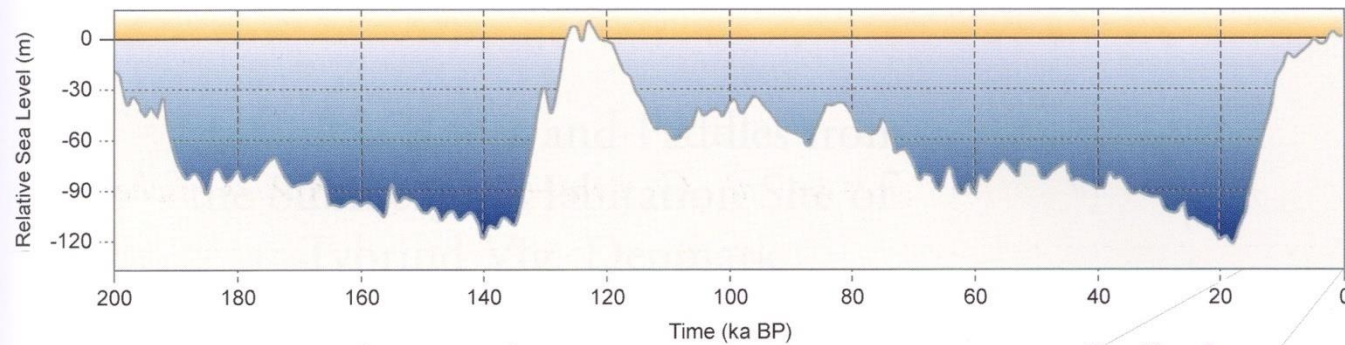
Detection of a site by the presence of wood trapped in peat by trenching(Federsee, Germany) *Clichés F. Giligny*



Stockwiesen (Germany)  
[Schlichterhle et Wahlster 1986](#)

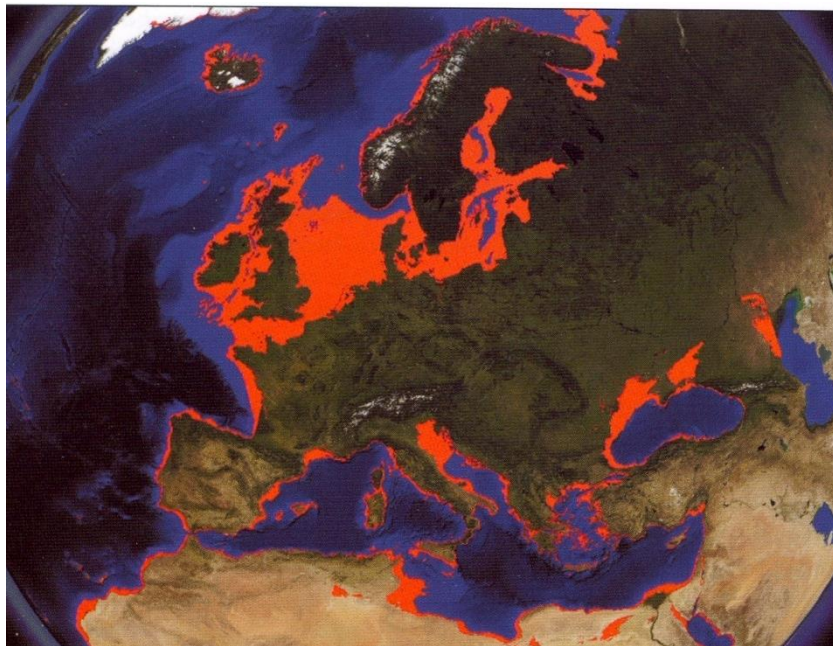


# Marine coastline

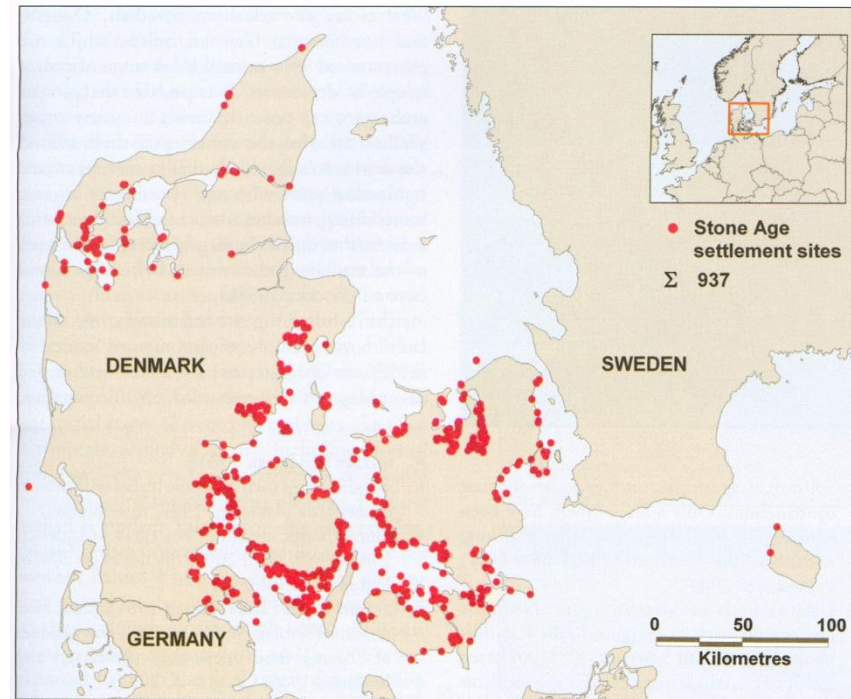


The end of the Ice Ages and the melting of the Polar Ice Cap (Ice Sheet) caused a rise in water levels and submerged prehistoric, Pleistocene and Holocene occupations, such as the famous Cosquer Cave.

Sea level change over the last 200 millennia  
(oxygen isotopes data Lister and Raymo 2005)

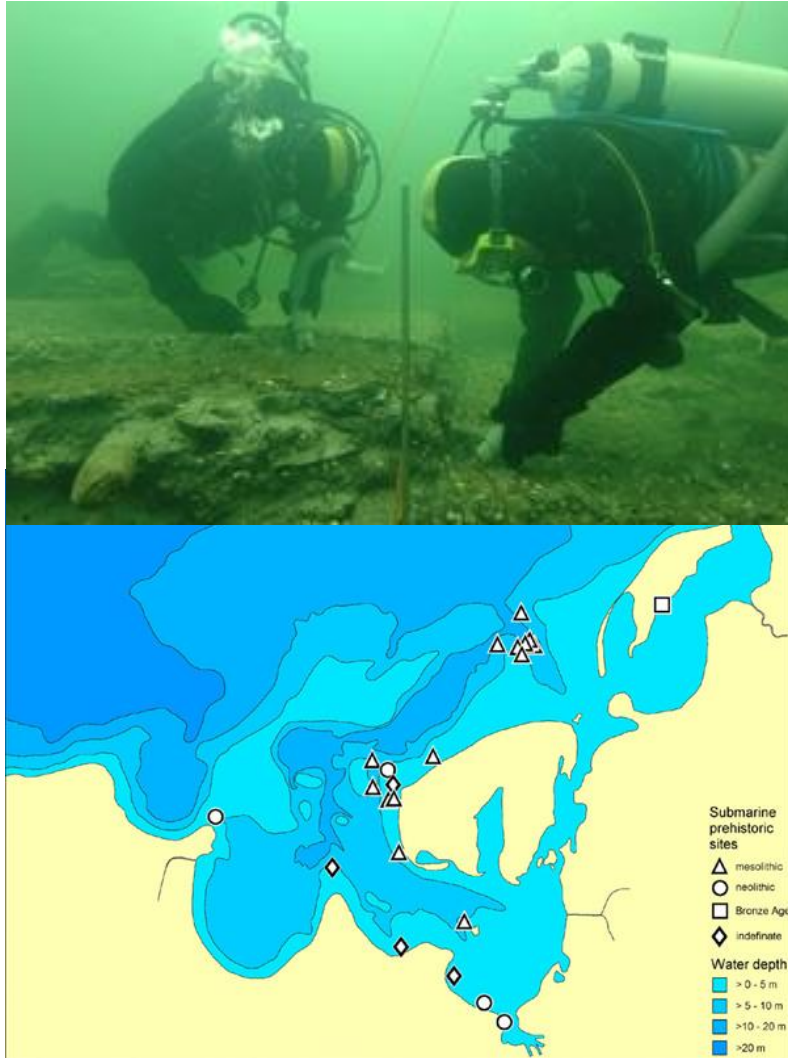


Coastal platform at the last glacial maximum

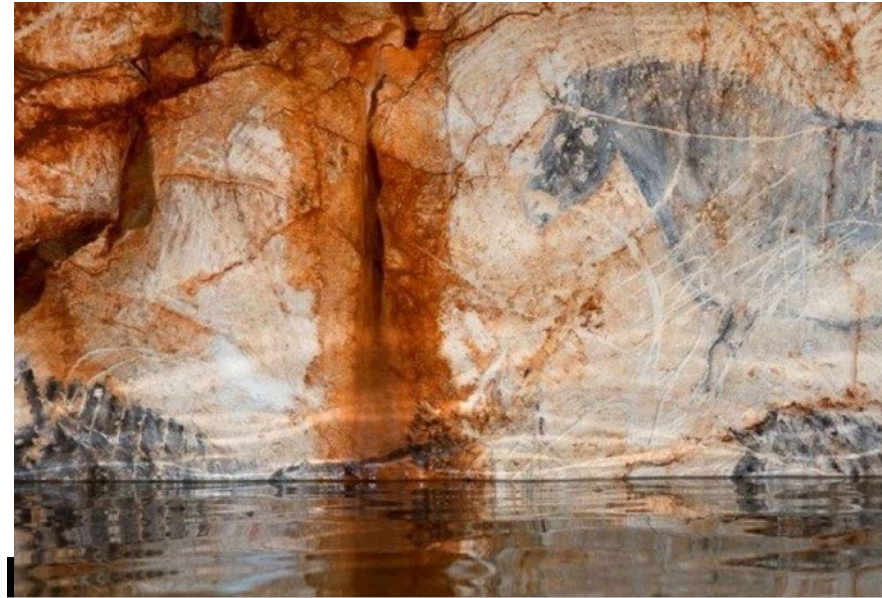


Submerged Neolithic sites in Denmark

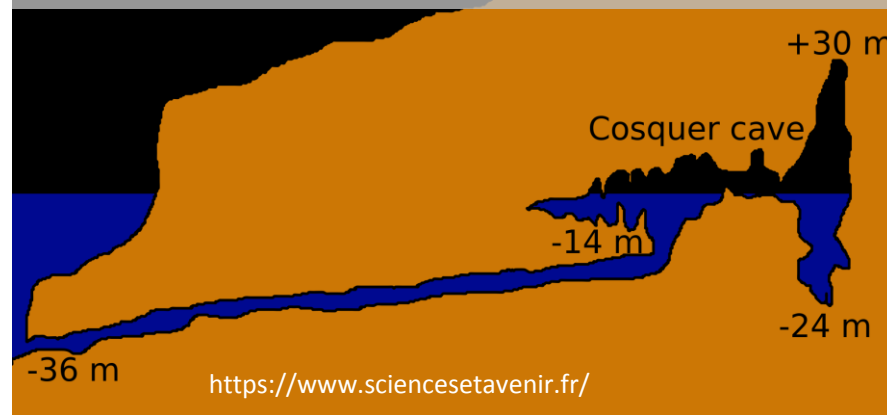
# Marine coastline



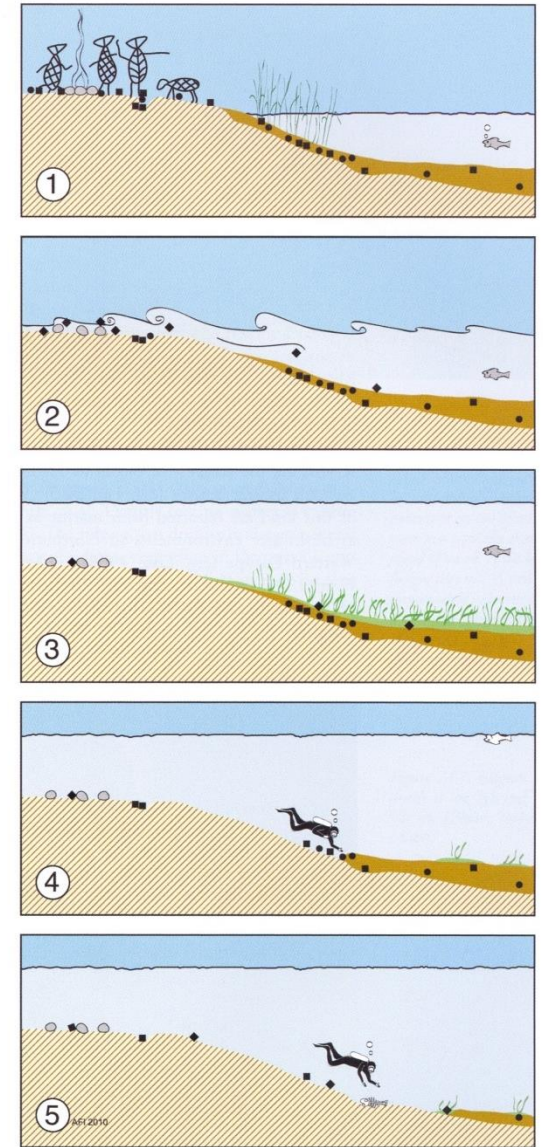
Sites on a coastal platform submerged by marine transgressions: Baltic Sea  
<http://www2008.io-warnemuende.de/projects/sincos/>



Cosquer cave Marseille (France)



Some palaeolithic cave sites are partially submerged, as the Cosquer Cave near Marseille France



Gradual destruction of sites according to their depth

# harbours

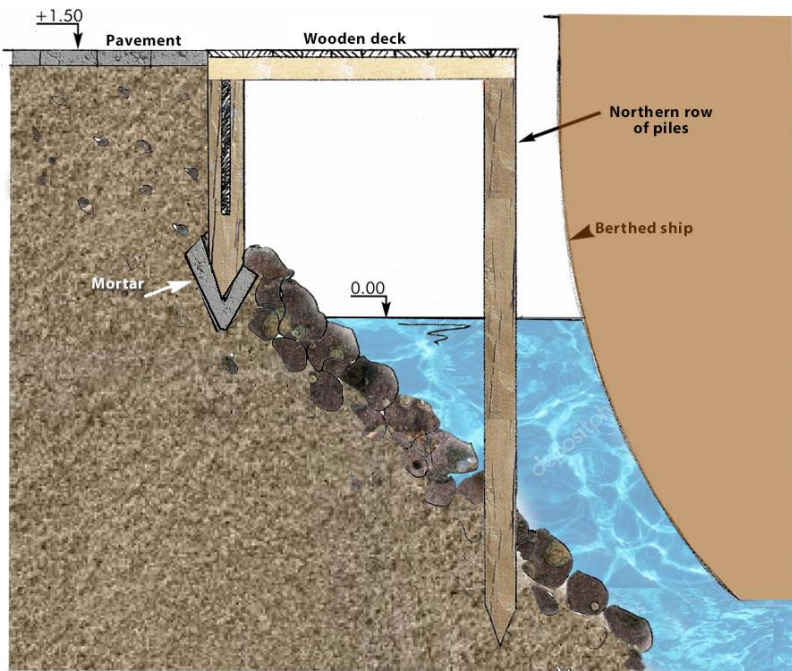
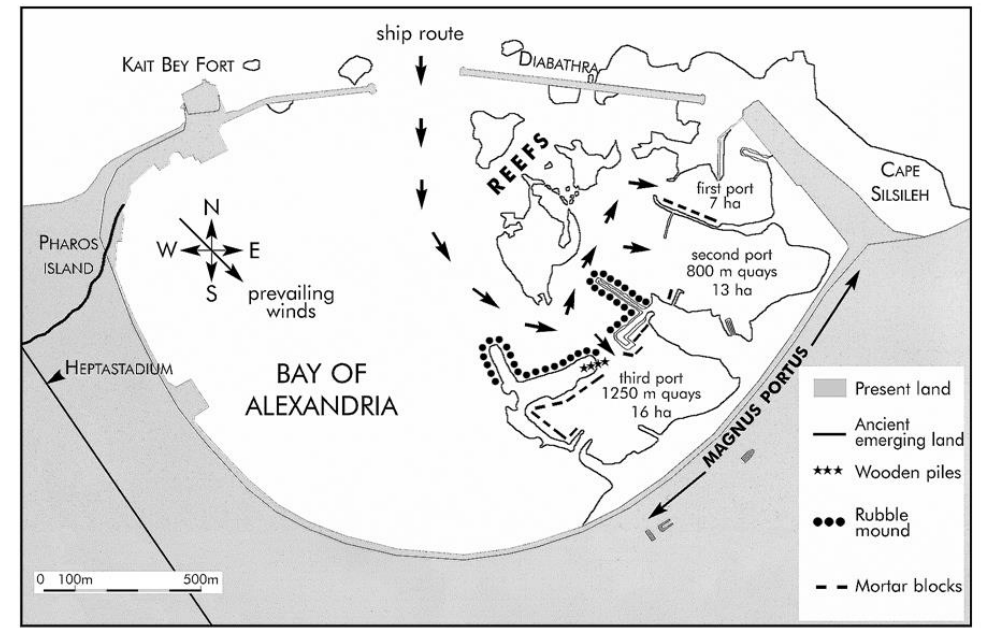
Harbour installations are regularly searched with all the infrastructure of landing, storage etc., whether by the sea, lake or river



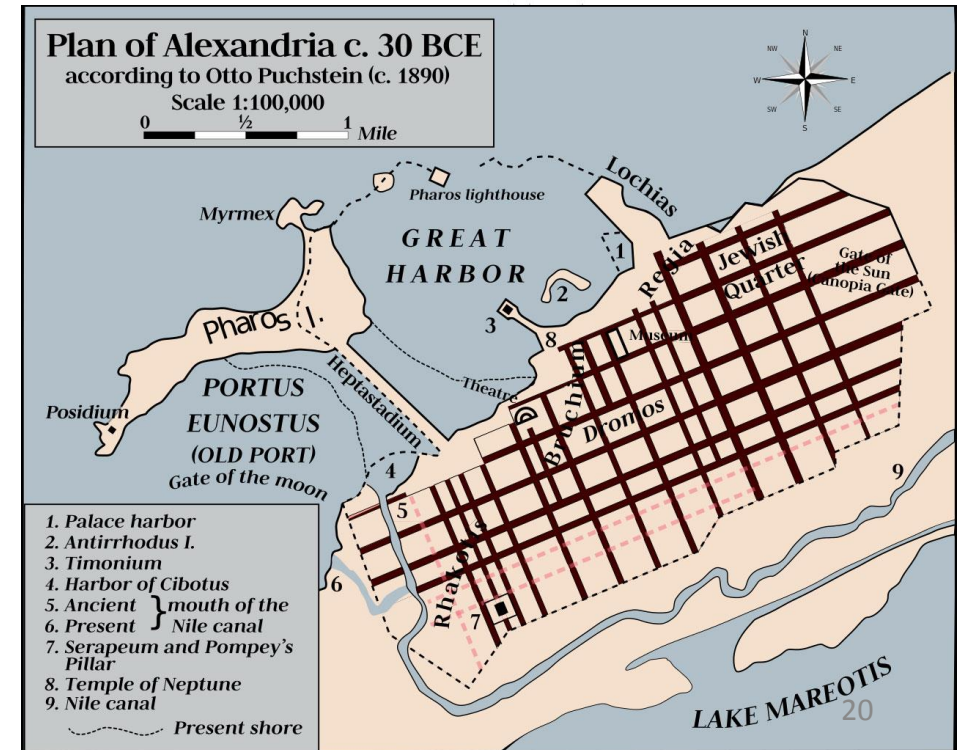
Wooden quay (mostly oak) Roman period, site du Grand Castélou à Narbonne. © C. Sanchez, CNRS



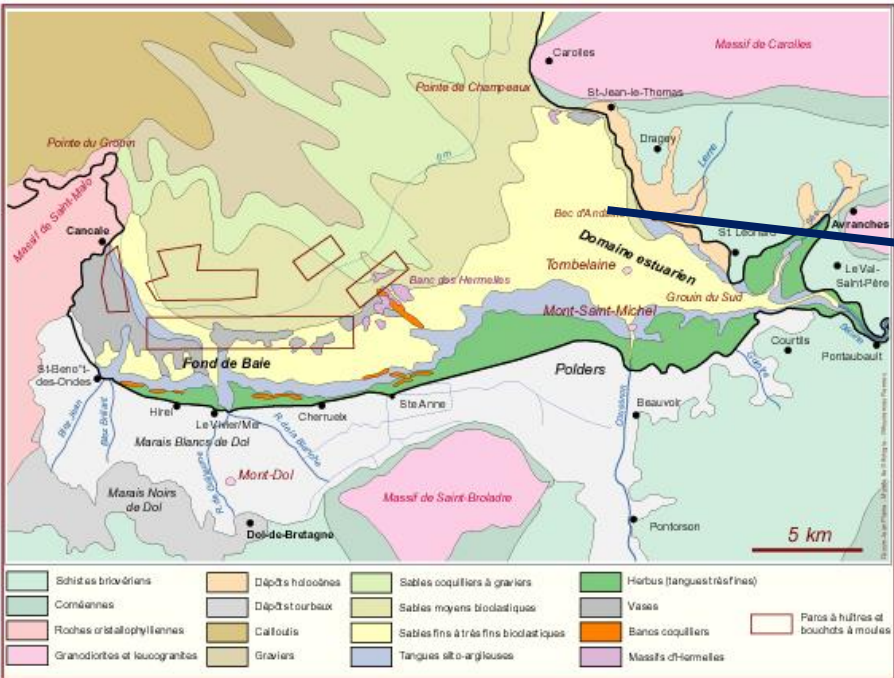
Reconstitution of Port-la-Nautique à Narbonne, Roman period. © Patrice Cervellin, GRAL/CNRS



Alexandria harbour is one of the best known and documented for eastern Mediterranean sea



# Estuaries/intertidal zone



Estuaries: Mont-St-Michel bay



Fish Dams are a traditional fishing system, made of stone or wood, rising or descending tides, or rivers



[http://www.saintjeanlethomas.com/Les-pecheries-prehistoriques-de-Saint-Jean-le-Thomas\\_a55.html](http://www.saintjeanlethomas.com/Les-pecheries-prehistoriques-de-Saint-Jean-le-Thomas_a55.html)

# Islands/shoreline



île de Molène ; habitat du Beg Ar Loued

<http://www.inrap.fr/archeologie-preventive/actualites/actualites-des-decouvertes/p-13810-Un-habitat-du-Bronze-ancien-sur-l-ile-de-Molene.htm>



île de Molène : Erosion à Toul An Truc

<http://www.panoramio.com/photo/86018119>

Shorelines and islands are threatened by climatic change and the elevation of the sea level. Urgent and rescue excavations have to be done and protection measures must be taken.

# Shell middens

Large dumps of shells – shell middens, have been left by late prehistoric people, especially on the North Sea, or the western US Pacific coast

- **Issues:**

- Geomorphological analysis of shorelines
- Paleo-environmental analysis of the aquatic environment and ecological conditions
- Reconstitution of food practices
- Cultural analysis

- **Methods:**

- Micro-topography,
- Stratigraphy
- Geophysics
- Absolute Datation
- isotopic analyses
- Malacology



**Ventura County, California,  
fouille du Moorpark College**

# Palaeochannels

Paleochannels have preserved architectural remains and organic material

- **Issues:**

- Geomorphological & hydrological analysis
- Palaeoenvironment
- Dating
- Operation and nature of occupations

- **Methods**

- Horizontal/vertical excavation
- Malacology, palynology, sedimentology, geomorphology
- Dendrochronology, radiocarbon
- Archaeozoology, chemical analysis and isotopes (food)
- Study of artefacts

- **Special means**

- Waterproof shielding and pumps







Bercy : pirogue en chêne dans un remplissage de chenal (sable travertineux)

Clichés : INRAP [http://www.images-archeologie.fr/Accueil/Recherche/p-13-lg0-notice-REPORTAGE-Sur-les-rives-de-la-Seine-le-site-neolithique-de-Paris-Bercy-.htm?&notice\\_id=1779](http://www.images-archeologie.fr/Accueil/Recherche/p-13-lg0-notice-REPORTAGE-Sur-les-rives-de-la-Seine-le-site-neolithique-de-Paris-Bercy-.htm?&notice_id=1779)



Site en paléoberge & chenal : Louviers (Eure) Néolithique (clichés F. Giligny 2005)

# Wells



Well at Niederröblingen, Germany (Landesmuseum für Vorgeschichte in Halle) (cliché: DPA)



Well at Altscherbitz, Germany (Cliché: LDA Sachsen).

Wells are known from the sedentarisation, as for the wells of the culture of the Rubané in Western Europe with wooden casing and system of blockbau (embedding)

# Sanctuaries



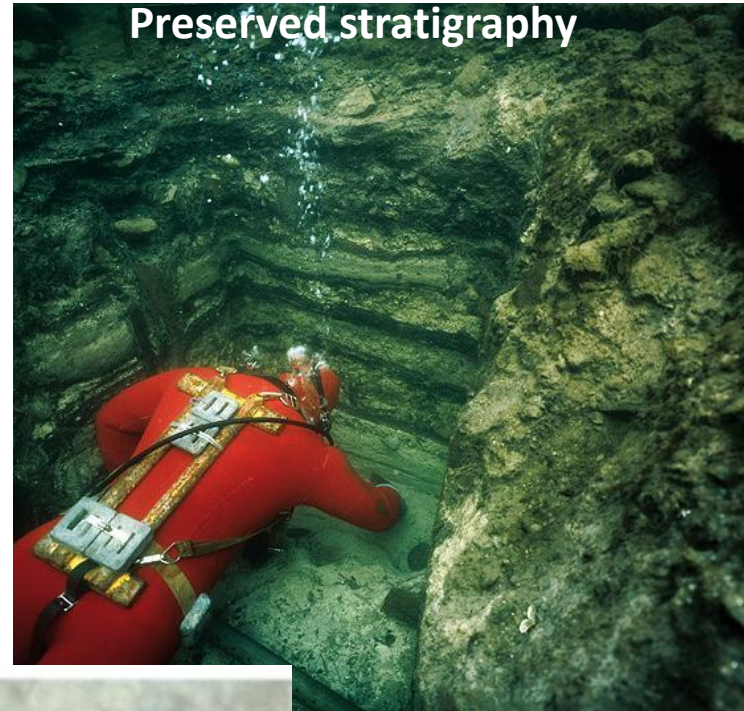
Sanctuary of the sources of the Seine linked to a cult healer and dedicated to the goddess Sequana (France)  
Ex voto and wooden statues  
Gaulish and Roman period,  
between 40 BC and 20 AD



Seahenge (Norfolk, England). Bronze age sanctuary (21<sup>e</sup> s. BC)  
55 oak trunks around an inverted stump

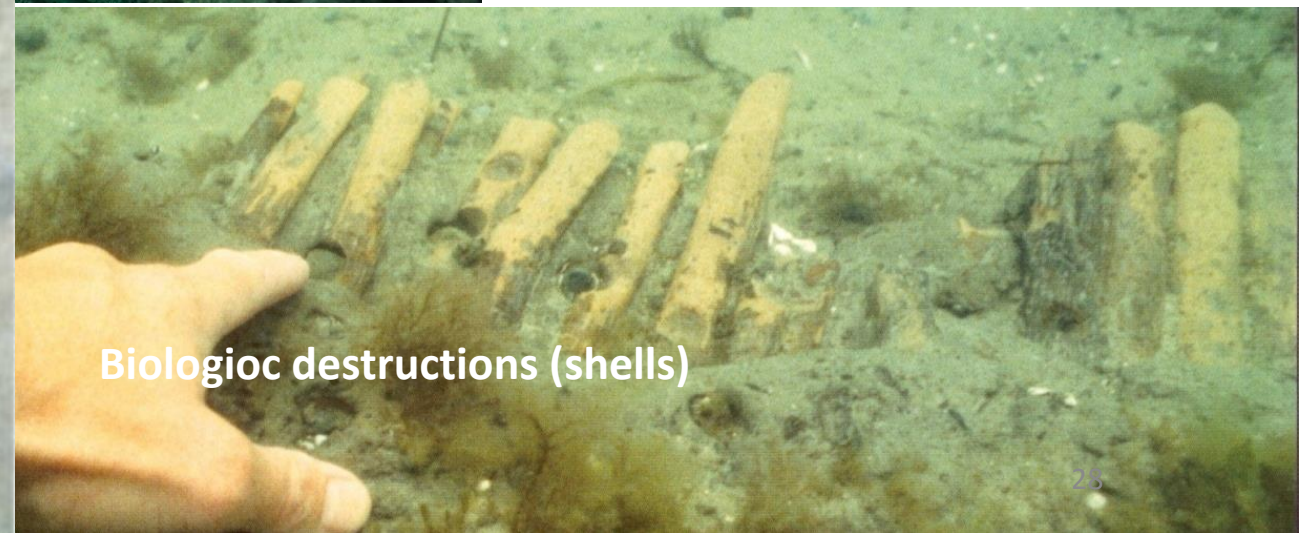


# Differential conservation



Underwater sites (lakeshore or under the sea) can present different states of conservation/preservation:

- Total erosion, only some finds have survived
- Partial preservation with biological threats (roots, animals, human public works)
- Well preserved and secured



# Excavation infrastructure



Near or under the water level, a Waterproof wooden casing must be constructed for excavation of the water with permanent industrial pumping system (more than 100 m<sup>3</sup>/hour) : Neolithic & Bronze age Rue Mozart, Parkhaus Opera, Zürich, Switzerland. Sometimes they excavate even at night.

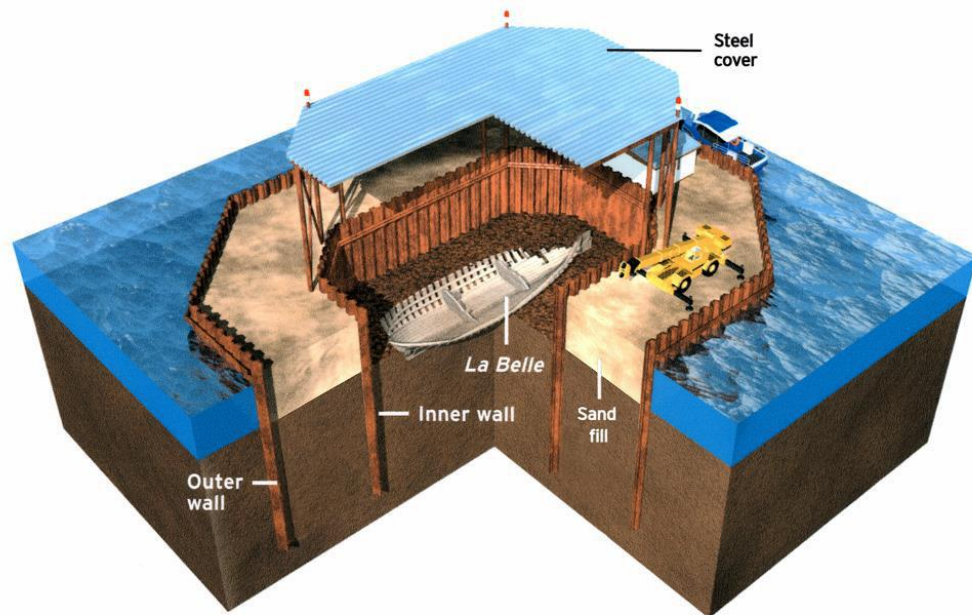
Source : Gross et al. 1987, Zürich « Mozartstrasse », <http://de.wikipedia.org/wiki/Feuchtbodensiedlung>



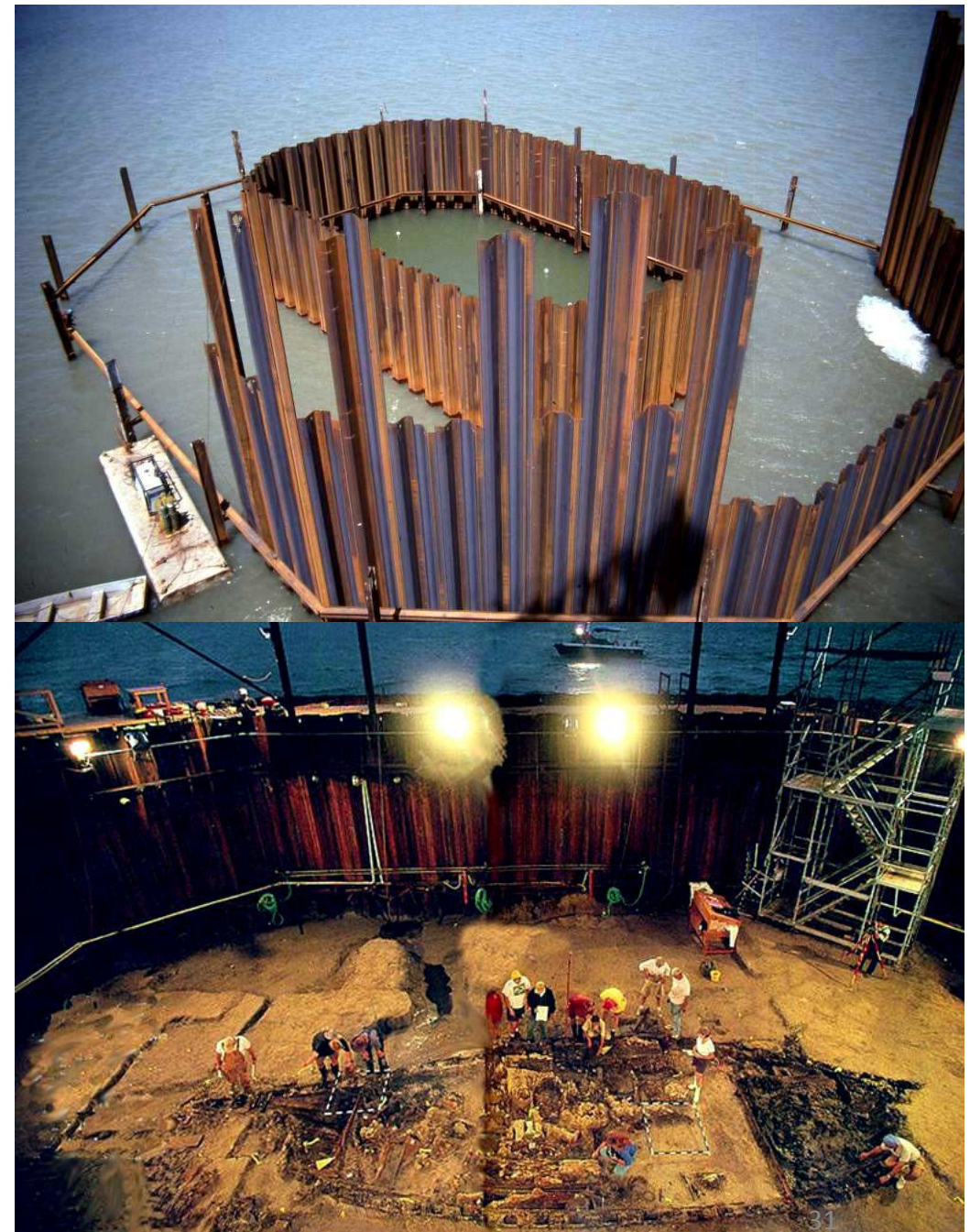
Wooden box with pumping system:  
Hornstaad (Allemagne)  
(LDA  
Baden\_Württemberg, fouille  
1988-89, clichés  
F. Giligny)

# Excavation on the sea

A surface of the continental shelf can be dried with a steel sheet piling system: Watertight box (used to build oil platforms). A dry search is more comfortable than a scuba dive.



Watertight Box:  
La Belle (Texas)



# **3. land environments**



# Countryside/rural open sites



UMR Trajectoires



INRAP

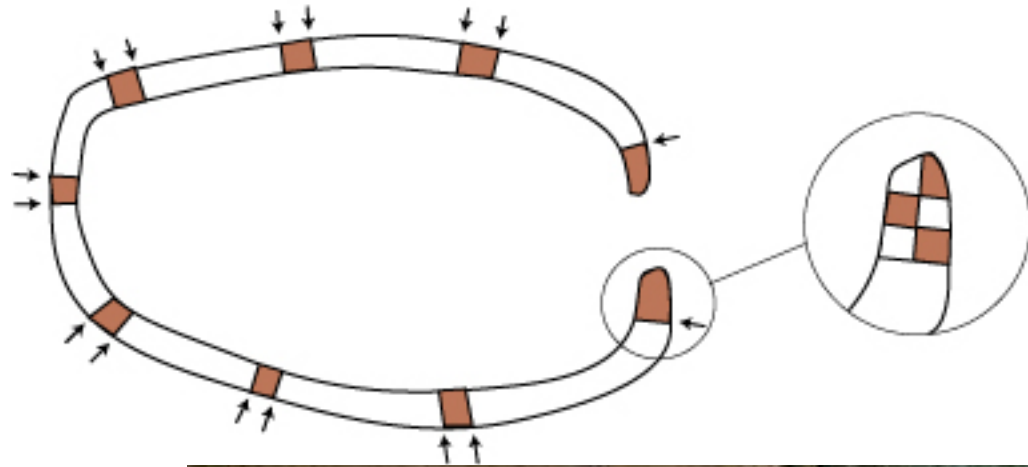


S. Oboukhoff, CNRS



S. Oboukhoff, CNRS

# Segmented enclosure excavation



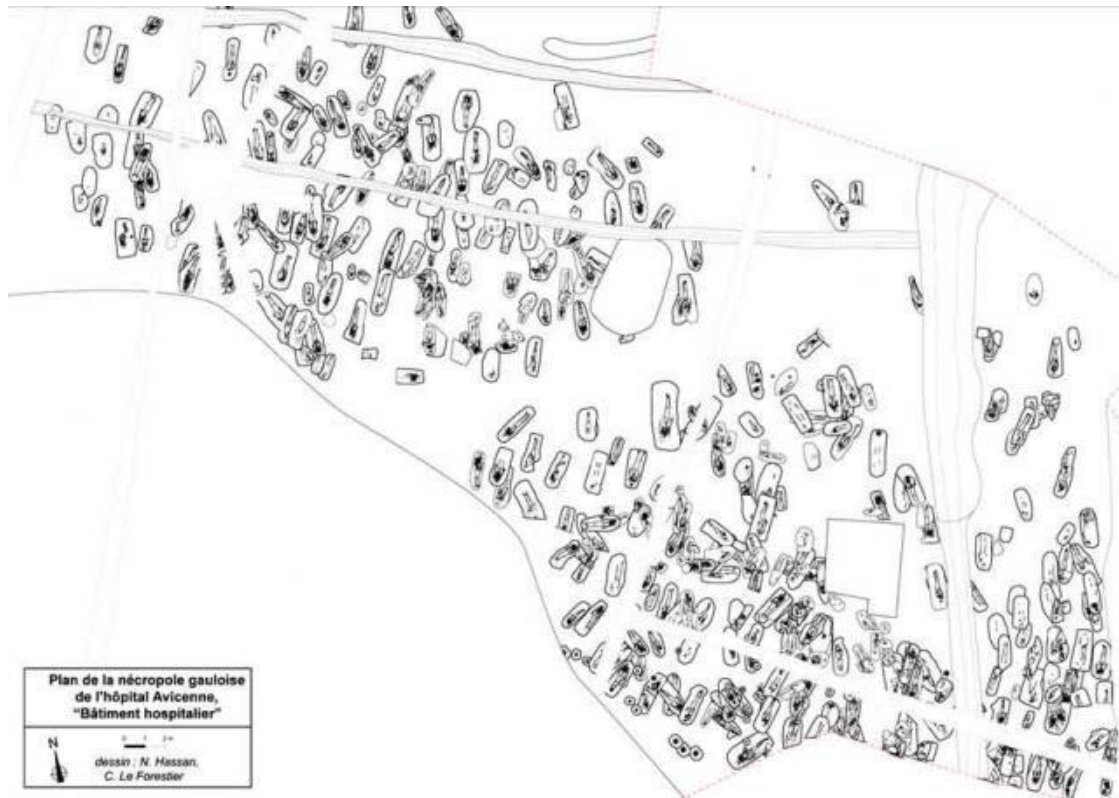
Sections of several metres wide ditches are sampled, manually excavated when the remains are abundant, or mechanically excavated when they are rare  
Extremities & interruptions can be excavated entirely or sampled at 50%



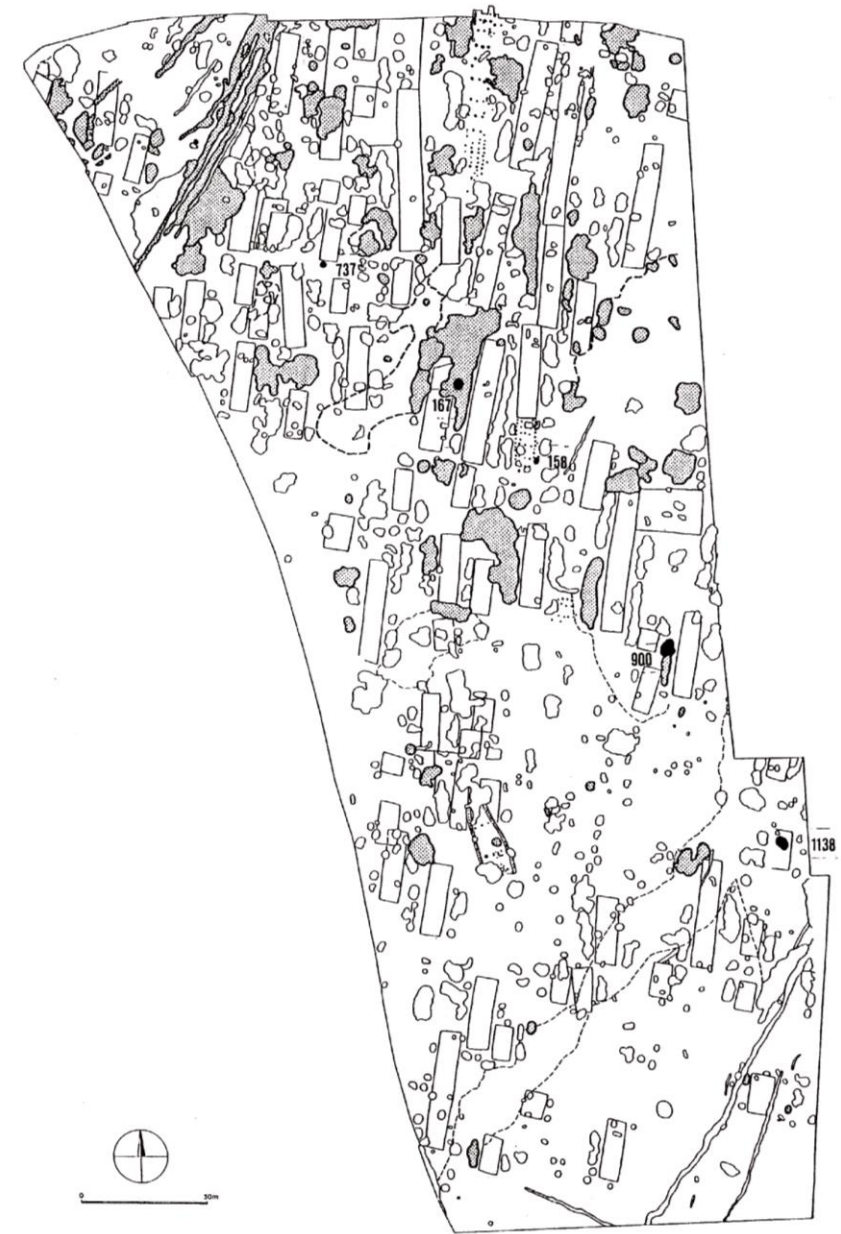
Enceinte de Bazoches-sur-Vesle (Aisne)  
fouille UMR Trajectoires  
<http://www.mae.u-paris10.fr/trajectoires/>

# A palimpsest of structures

Repeated occupations on the same site lead to a palimpsest of structures recreated in each other. A horizontal approach is required with observation of stratigraphic relationships between structures



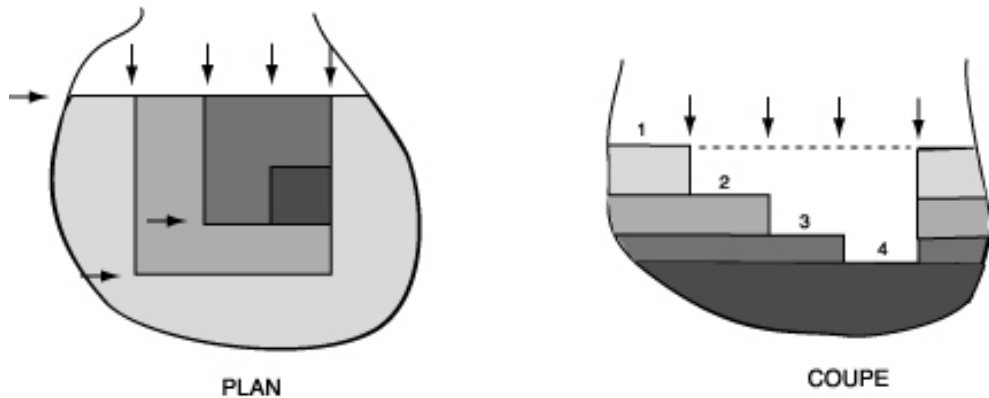
Avicenne Hospital, Bobigny, France, Gaulish cemetery



Neolithic settlement of Bylany, Bohemia (Czech Republic)

# **Confined environments: caves, underground quarries, mining**

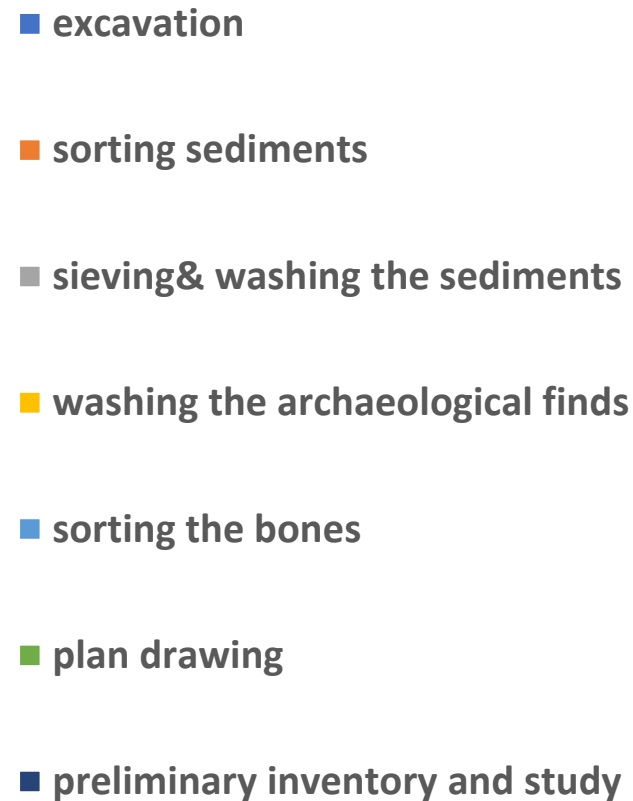
# Cave



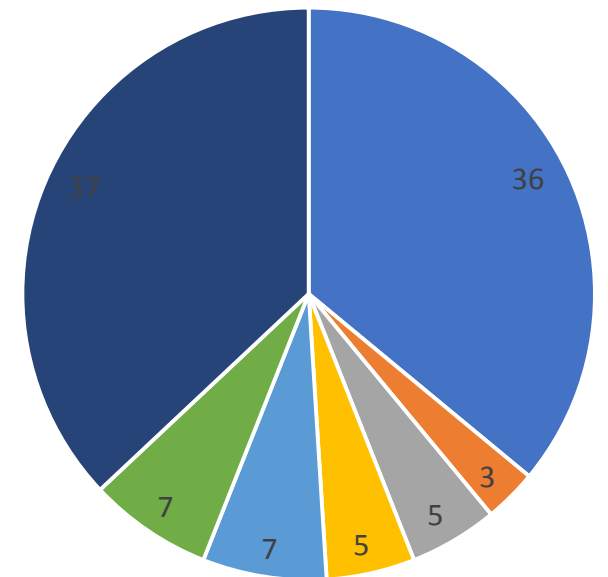
carroriage by cables attached to the ceiling  
Reduced observation surfaces

- **Process of excavation:**

1. Implementation of the horizontal reference plane (Z mark)
2. Placement of the Carroyage (lead wires suspended from the ceiling)
3. Stripping
4. Stratigraphic record
5. Registration of layers
6. Survey of objects (photographs, casts)
7. Samples for analysis
8. Sieving and washing
9. Sorting and grading of material

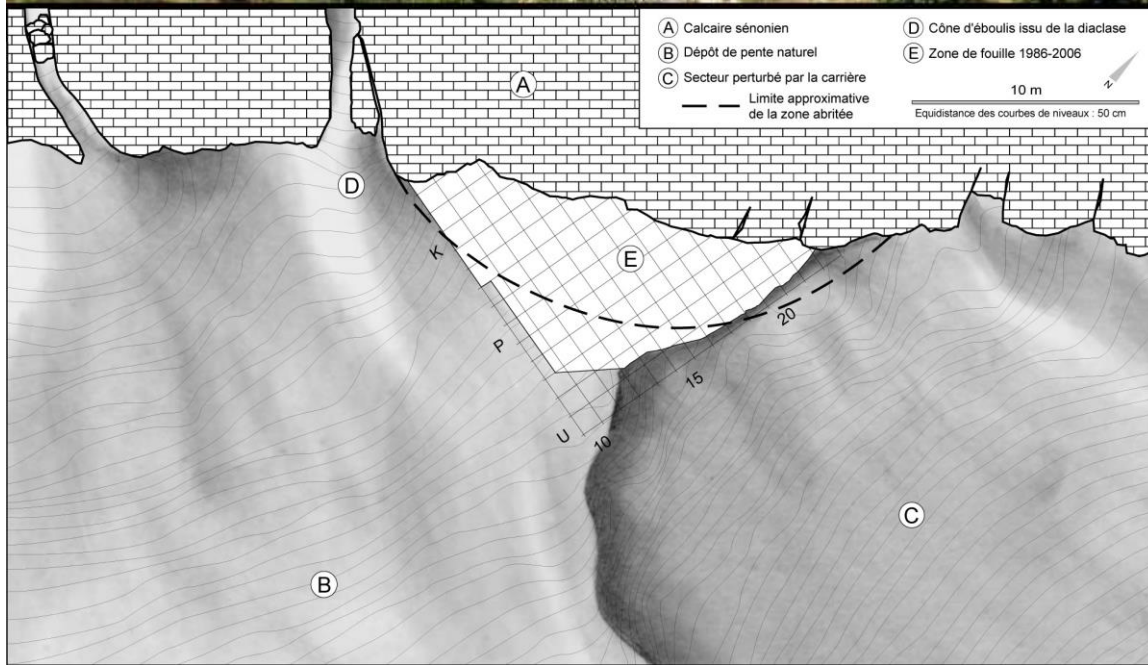
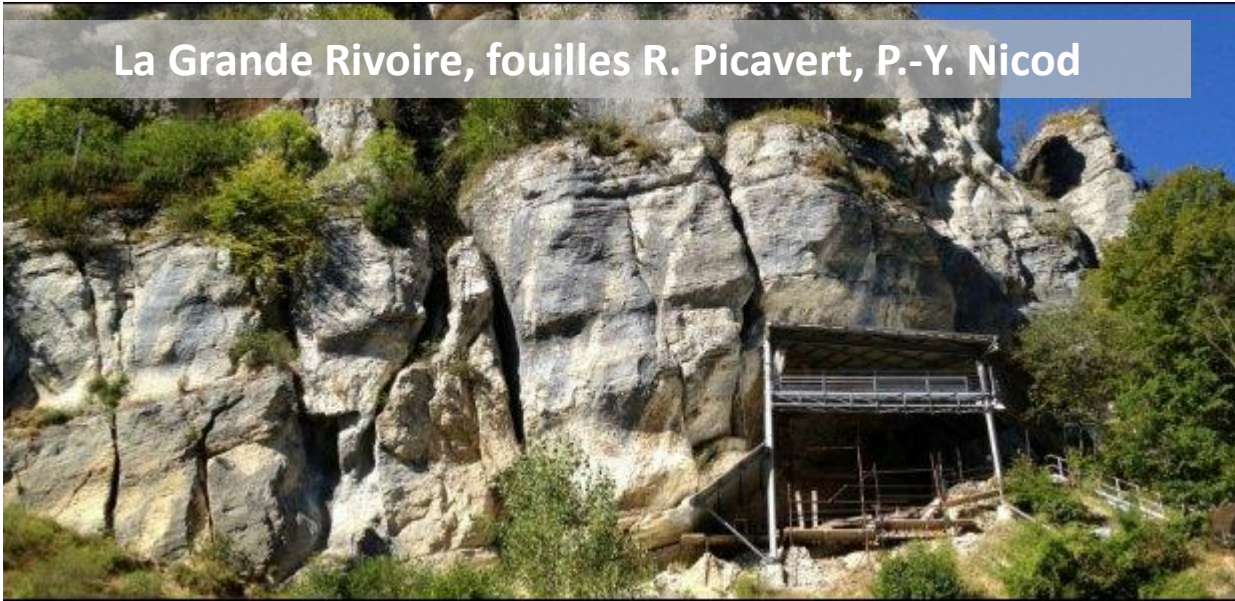


% de temps passé



# Rock shelter

La Grande Rivoire, fouilles R. Picavert, P.-Y. Nicod



## Constraints:

Access constraints

Topographic constraints (water, land disposal, slope and construction site installation, dry/water sieving)

Stability

Electricity access

Climate constraints: seasonal excavation

Replenishment of the excavation to prevent from natural damage and looting

## Methods:

Stratigraphic excavation

Manual excavation/fine

Grid/ 1 sq m carroyage

Sieving

Environemental sampling

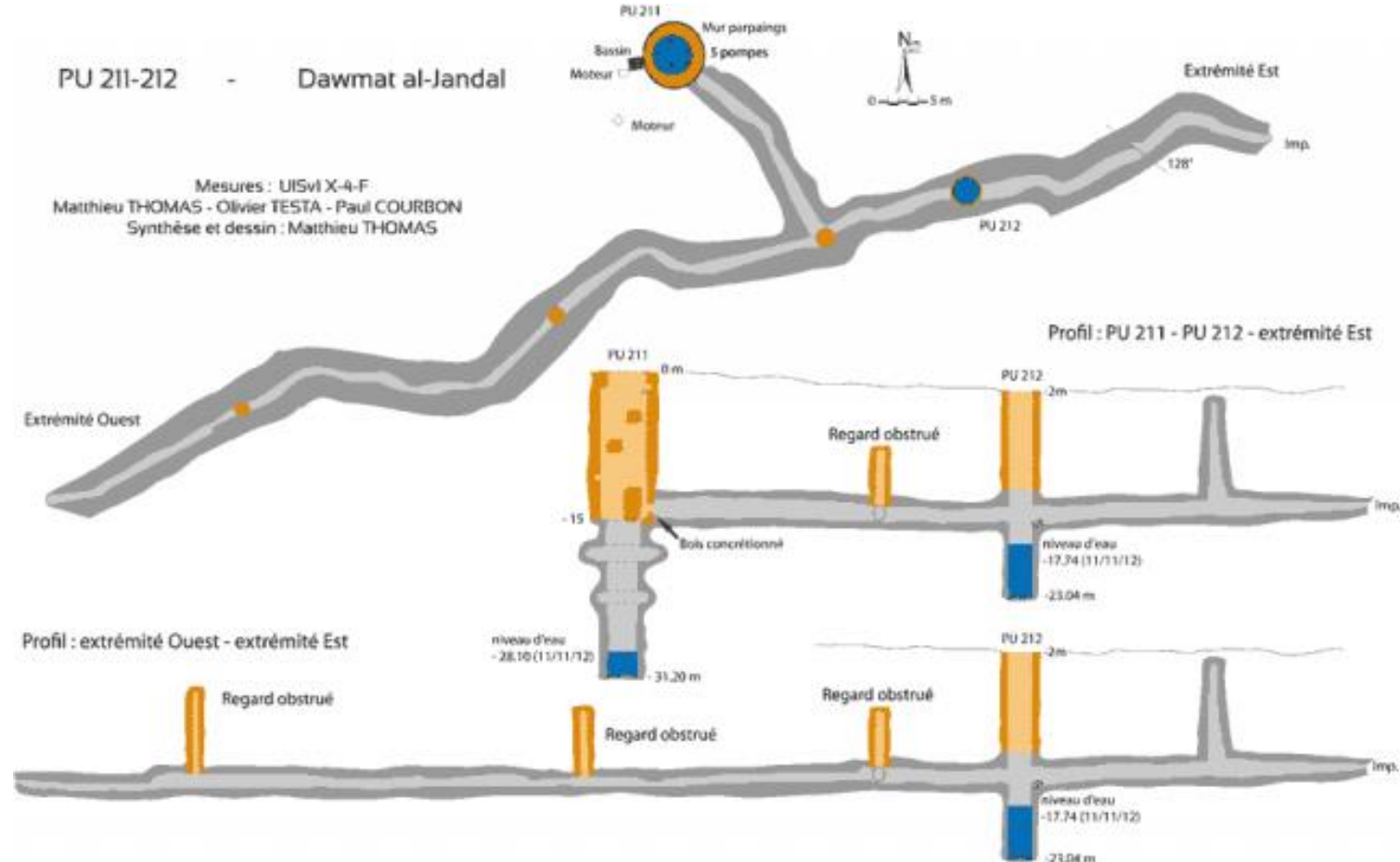




# Karst and well

Yves Billaud, Archéologie, spéléologie et plongée : gisements et vestiges en karst noyé. 2010 In Baritaud dir. Archéologie et spéléologie. Actes du colloque de Périgueux, 2006, p. 193-202 : 6 fig. (Spelunca Mémoires 34, 2009).

# Qanâts



Wells & qanâts Dûmat al-Jandal (Saoudi Arabia)

<http://www.olivier-testa.com/arabie-saoudite-les-puits-de-dumat-al-jandal.html>

# Acqueducs, underground



Munis de GPS, de télémètres à laser et d'un scanner 3D, des "spéléo-archéologues" plongent dans les aqueducs de Rome pour mettre à jour le plan de ces monuments d'une importance cruciale dans l'Antiquité.

[afp.com/Filippo Monteforte](http://afp.com/FilippoMonteforte)

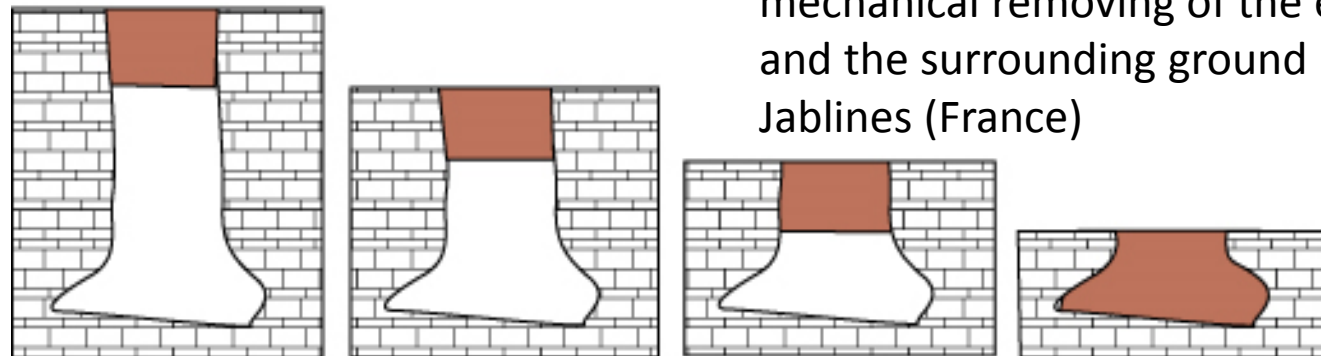
Jablones (Seine-et-Marne)  
Mine à silex



INRAP

# Flint Mines

- The archaeology of flint mining has been developed in Europe since the second half of the XIXe century
- Some of them are classified as UNESCO World Heritage sites : Spiennes (Blegium), Krzemionki (Poland).
- Most of them are from the Neolithic period.
- Their excavation needs huge means : mechanical excavations, shielding for the excavation underground
- Either the mines are excavated inside shafts and galleries, or the whole site can be excavated by vertical layers as an open pit mine



Excavation of the filling, followed by the mechanical removing of the excavated part and the surrounding ground used at Jablones (France)



Spiennes UNESCO World Heritage deeper shafts

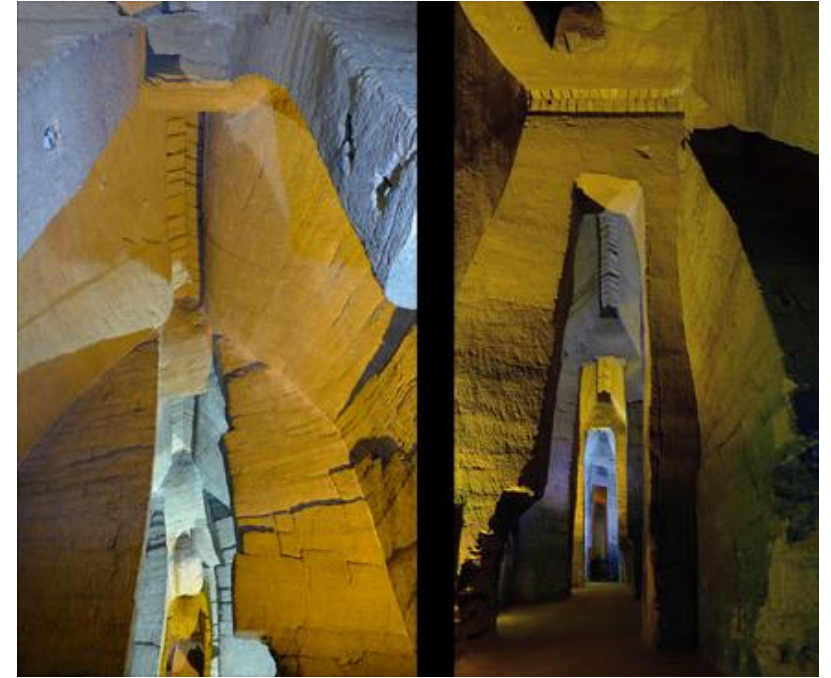
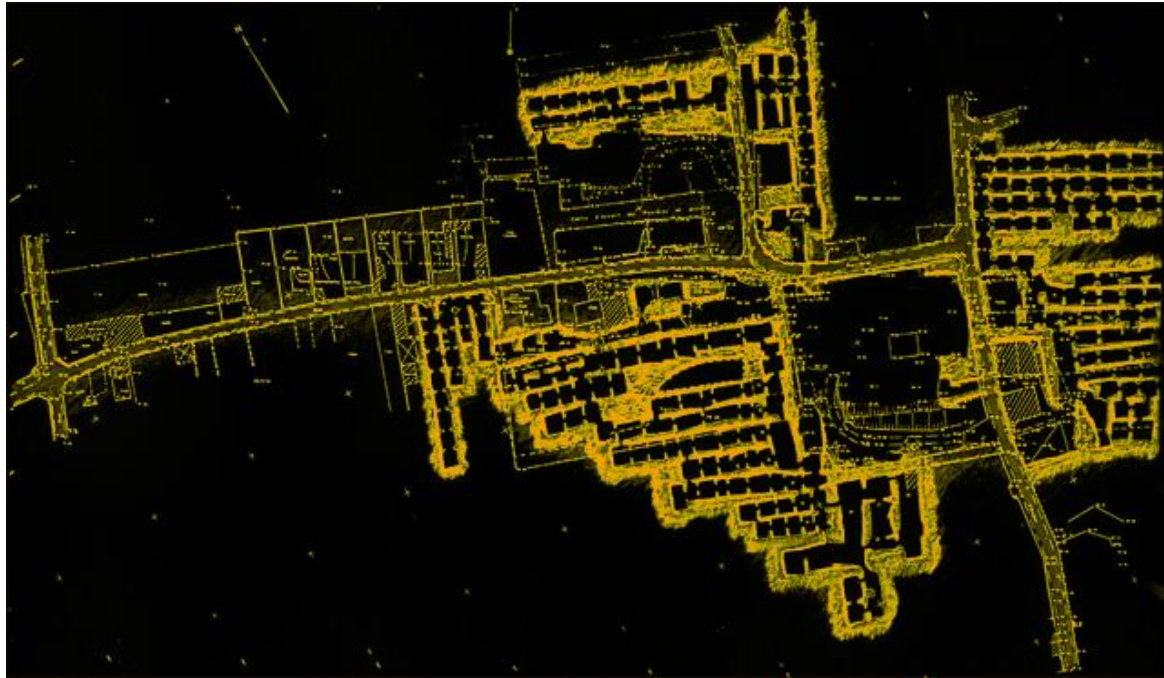
<http://minesdespiennes.org/>

At Spiennes, the deepest shaft reaches 16 m. Such depths pose problems of ventilation, lighting and management of cuttings and shoring of ceilings.



# Quarries

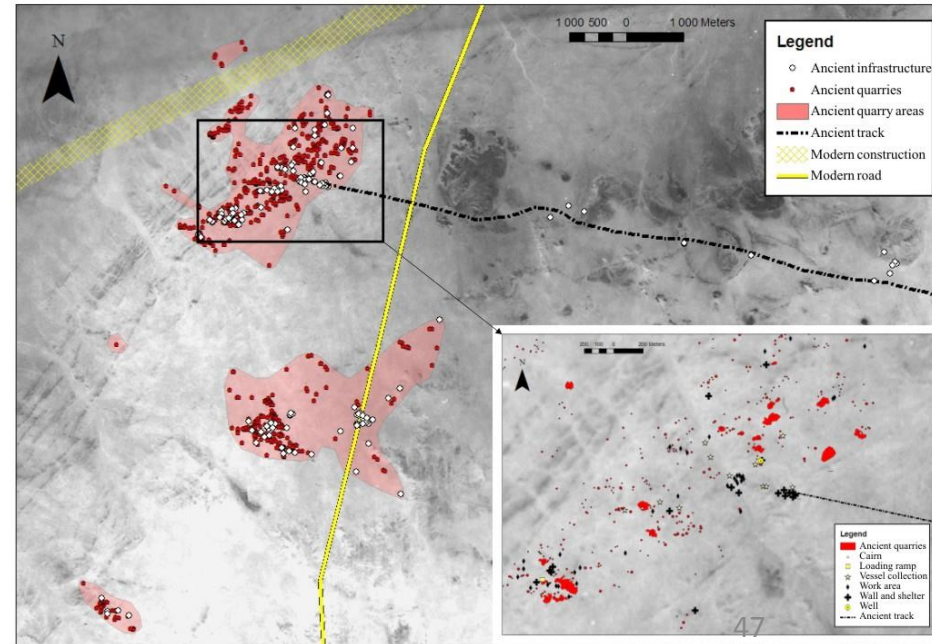
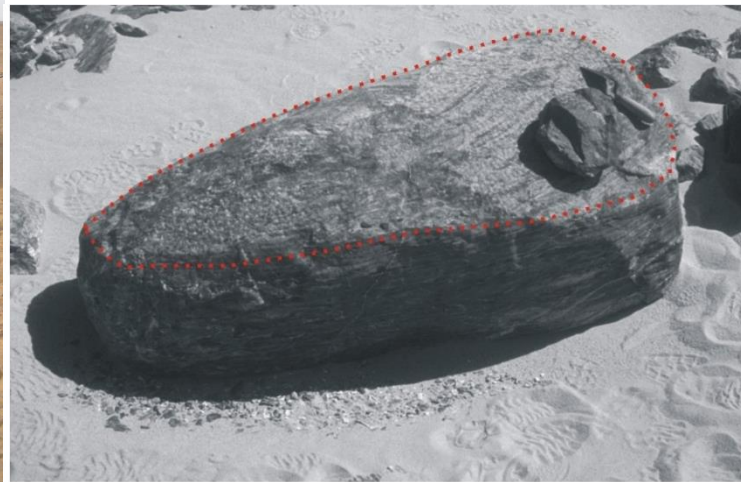
Doué-la-Fontaine (France), carrière de Falun 15<sup>e</sup>-19<sup>e</sup> s.



# Chepren gneiss quarry



- 3 rd and 4 th millennium BC  
From late Neolithic to Old Kingdom
- loose boulders of gneiss on the terrain surface, formed by in situ transformed into blocs with lots of waste
- Logistic features : roads, ramps for loading blocks, shelters & settlements, wells, cairns



# Quarries excavated as on open air mine



La Bazoge, Sarthe, France, Iron mine (Inrap)



# Study of extraction techniques



Vertical excavation by fire setting 8 m deep, la Pinée, L'Argentière-la-Bessée (France) © Inrap



Évolution of fleuret used in mines of Thillot from 1617 AD



Waste with charcoal issued from fire setting Saint-Roch, L'Argentière-la-Bessée). © Inrap

# Urban archaeology

*«The purpose of urban archaeology is the understanding of the processes of manufacturing and transformation of urban space by societies»*

Présentation du congrès CTHS de Tours, 2012



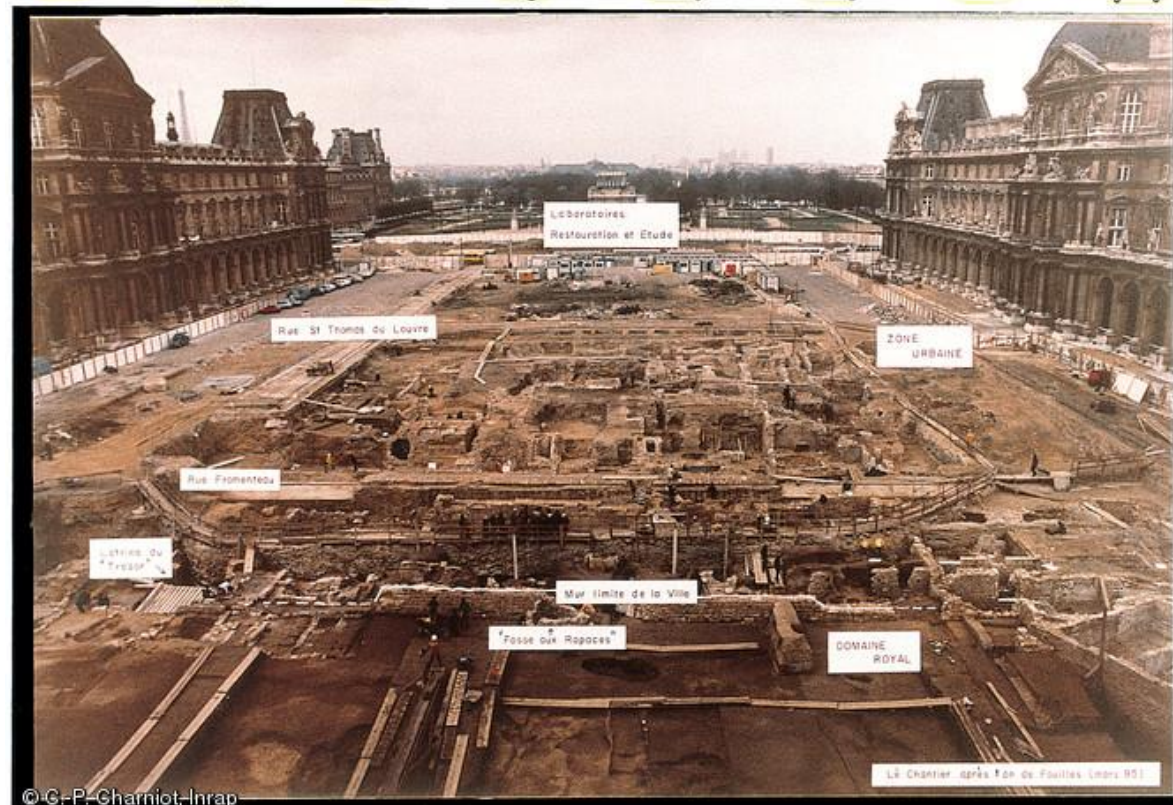
© Hervé Paitier, Inrap

- Double specificity: by the study of the urban fact, by the nature of sedimentary deposits and the importance of stratigraphies
- Essential character of historical, iconographic, textual, cartographic sources, etc.

Couvent des jacobins, Rennes, © fouille INRAP

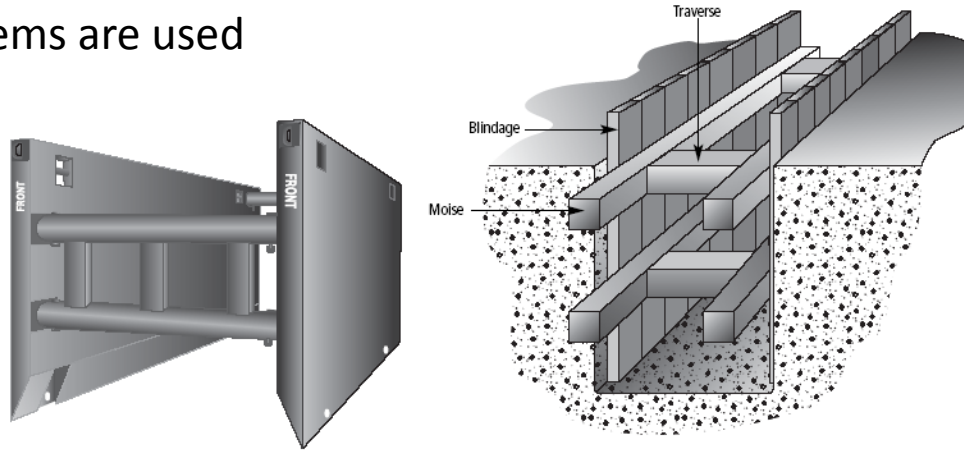
Restructuring of urban centres  
permits archaeologists to conduct large-scale rescue excavations

From the 1960' : Winchester, Martin Biddle, Tours 1973 Henri Galinié, 1974 Saint-Denis, fouille du Grand Louvre en 1983 etc.



# Protection systems for deep excavations

Types of armour/shielding used in trenches  
Public works systems are used



Étançonnement en aluminium

Étançonnement en bois



Urban site Paris



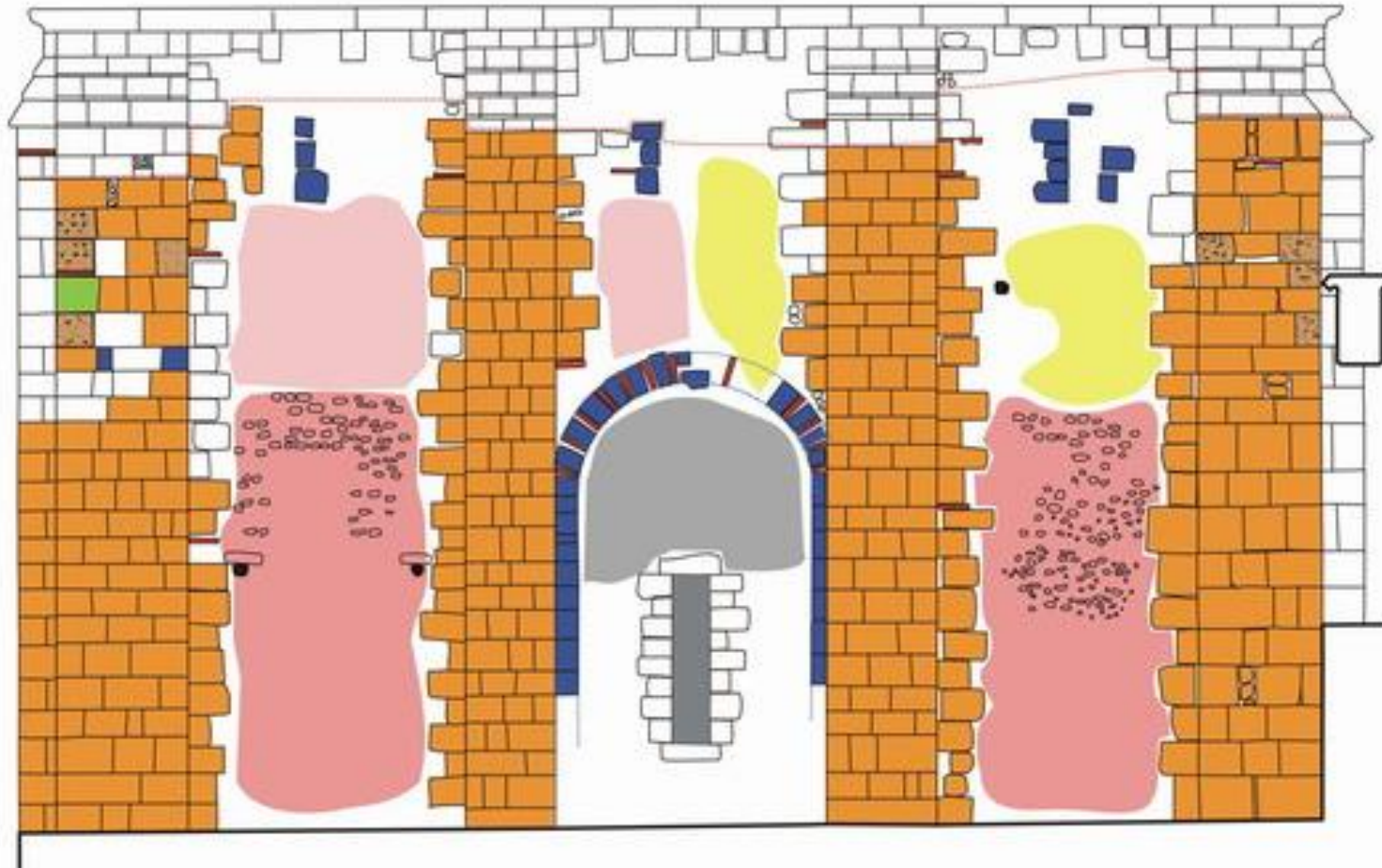
Wooden shielding system



Ceibal archaeological site in Guatemala

# Building/monumental archaeology

- Study of elevations with a stratigraphical system
- Uses the same methods as the excavation of sediments: build a relative chronology of events (decomposition in UC, construction units)
- Restore each state, often a re-use of the previous state Find the correspondence between the internal/external (US) states and repositories
- Importance of coatings and openings, not just the big work
- It is sometimes limited to a preliminary study of a layout, restoration or destruction in the frame of an Heritage project



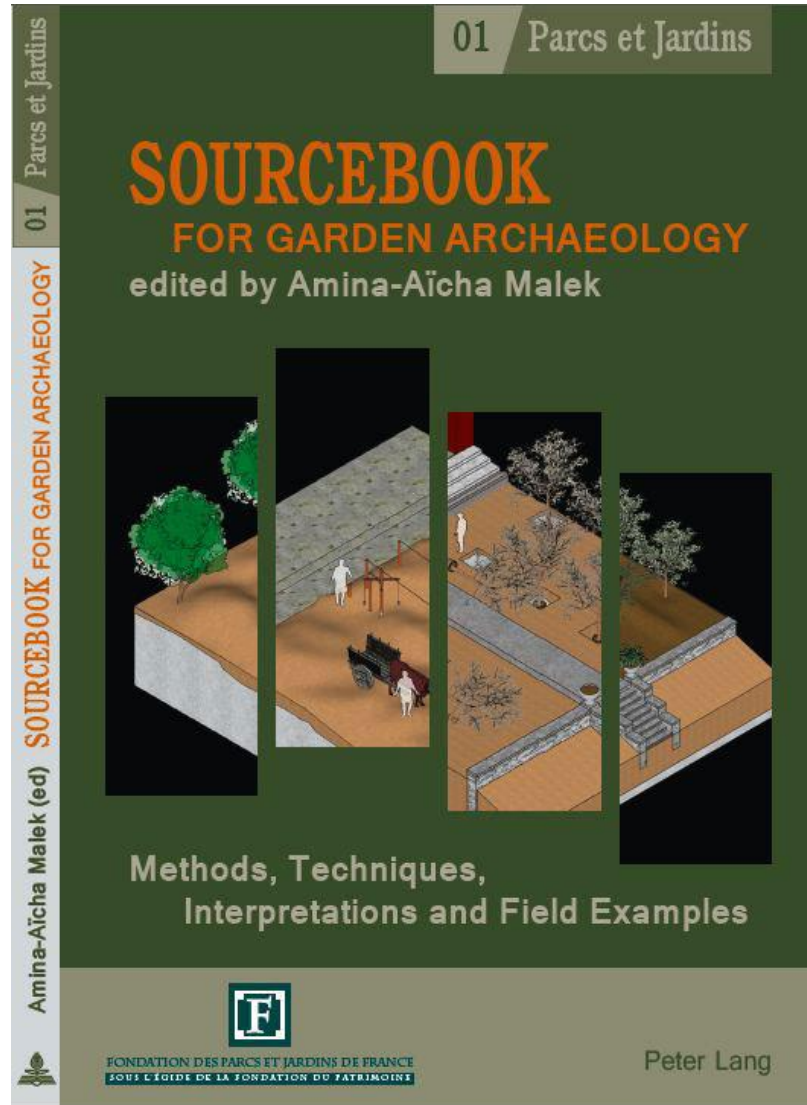
- |   |   |   |                                       |
|---|---|---|---------------------------------------|
|  | utilisation de berchères préalablement brûlés |    | mortier blanc XIII siècle             |
|  | berchères brûlés par incendie                 |    | mortier jaune compact                 |
|  | calcaires fins                                |    | mortier de gravillons + briques       |
|  | calcaires fins brûlés par incendie            |    | mortier de gravillons + briques brûlé |
|  | meulière                                      |    | mortier gris fin                      |
|  | briques                                       |    | silex                                 |
|  | poudingue                                     |    | moellons                              |
|  | pierre manquante                              |  | supposition des ouvertures            |
|   |   |  | limite de l'incendie                  |
|   |   |    | fissure                               |
|   |   |  | trou de boulin                        |

## Chartres Eglise St-Pierre Relevé DRAC

[http://www.culture.gouv.fr/public/mistra/memoire\\_fr?ACTION=CHERCHER&FIELD\\_1=REF&VALUE\\_1=MHR24\\_02285005](http://www.culture.gouv.fr/public/mistra/memoire_fr?ACTION=CHERCHER&FIELD_1=REF&VALUE_1=MHR24_02285005)



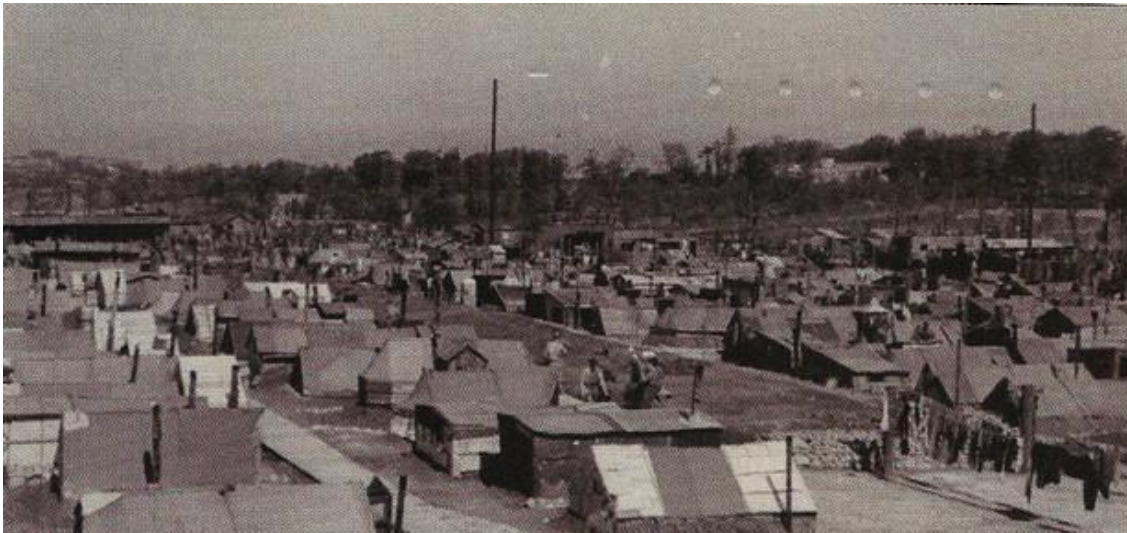
# Garden archaeology



# War archaeology



**Sobibor (Poland) 2<sup>nd</sup> WW  
extermination camp  
excavation**



**Fleury-sur-Orne (France) Prisoners camp 2<sup>nd</sup> WW**





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