

Techniques d'exploration sous-marine : Histoire et innovations

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Enseignant-chercheur à l'ENSTA-Bretagne / Lab-STICC (Brest)
Festival Baie des Sciences, Saint-Brieuc, 12/10/2019











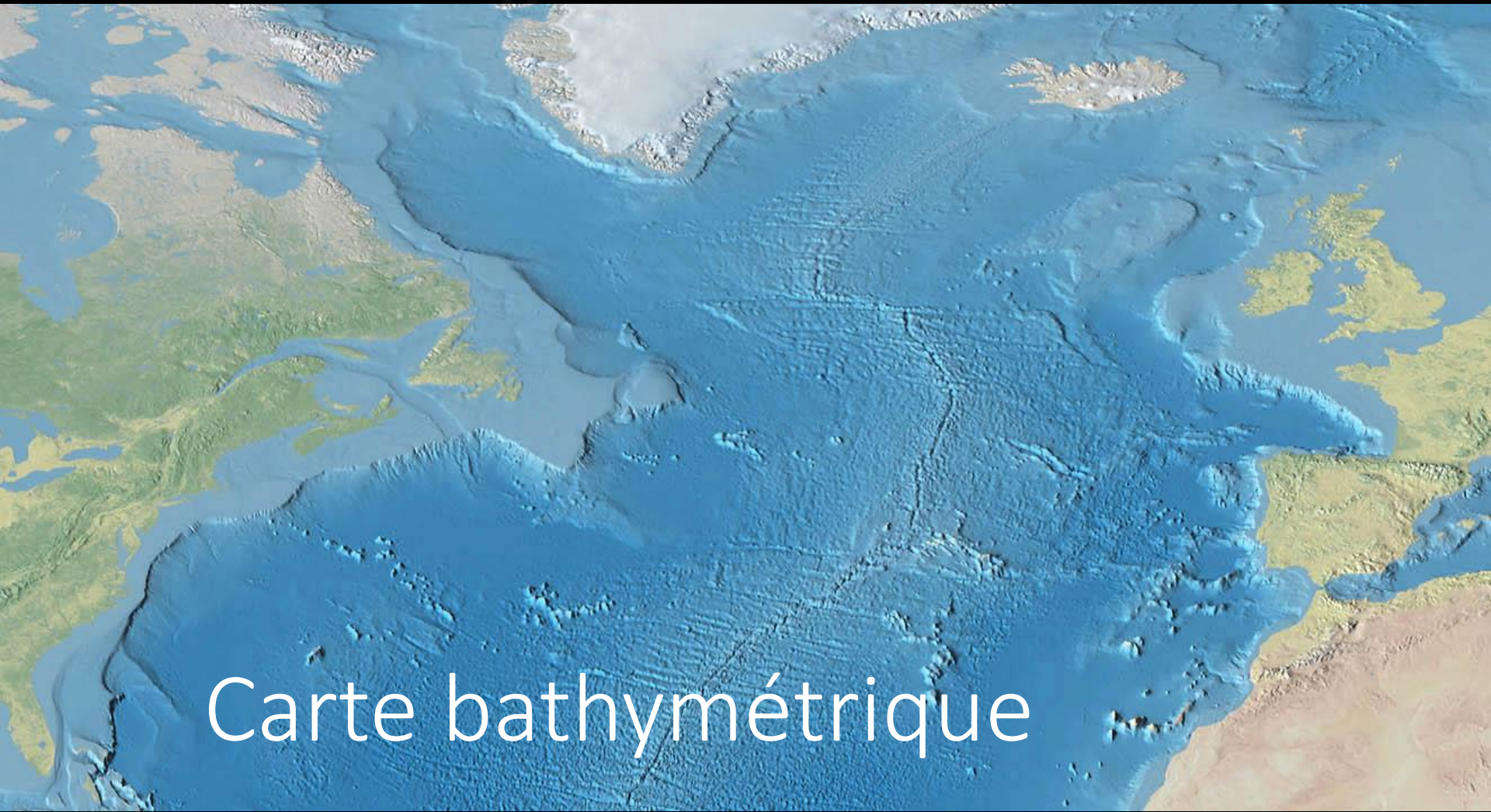
Surface terrestre
couverte par les océans :

71%

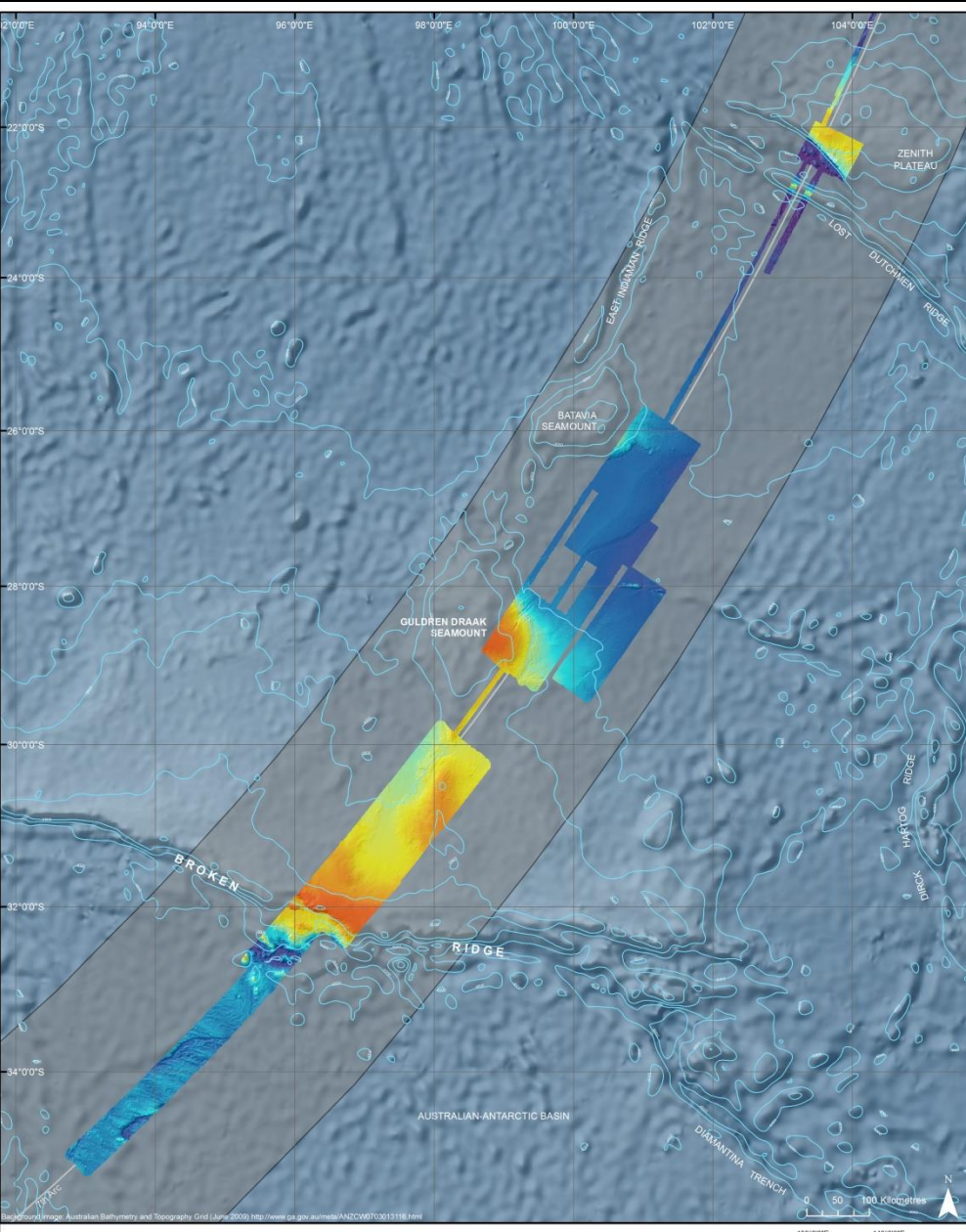
Étendues explorées :

5% ? 15% ? 25 % ?

HMS Challenger



Carte bathymétrique



Australian Government
Australian Transport Safety Bureau
Geoscience Australia

Search for Malaysia Airlines Flight MH370
 Progressive Map
 Bathymetric Survey Data Capture

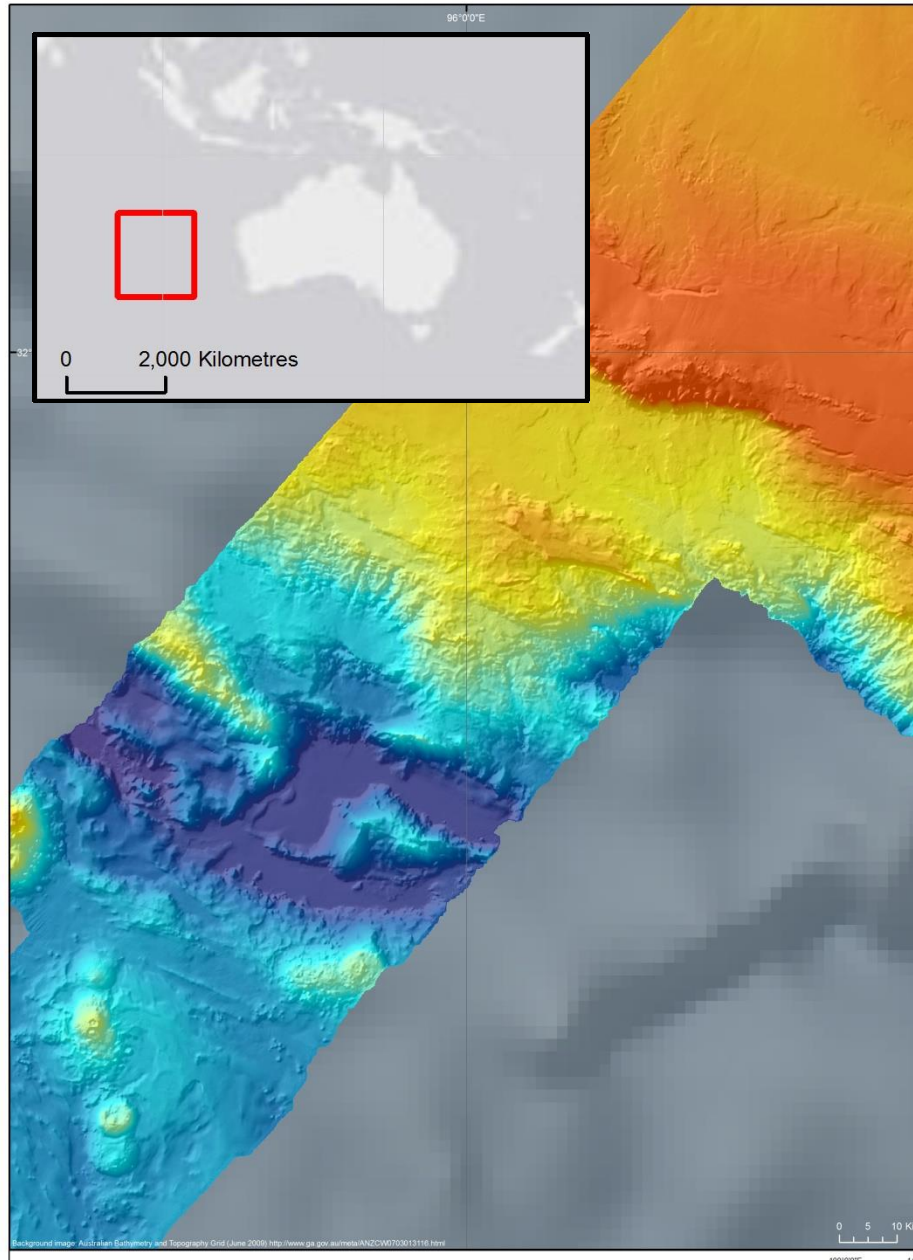
Search Areas
 Wide search area

Bathymetry Survey Data
 Capture Elevation ramp:
 -1325 m
 -4500 m
 -6250 m

Background Bathymetry
 Elevation ramp:
 0 m
 -4000 m
 -7285 m approx.

Scale: 0, 50, 100 Kilometres

Map Number: 2016/111



Australian Government
Australian Transport Safety Bureau
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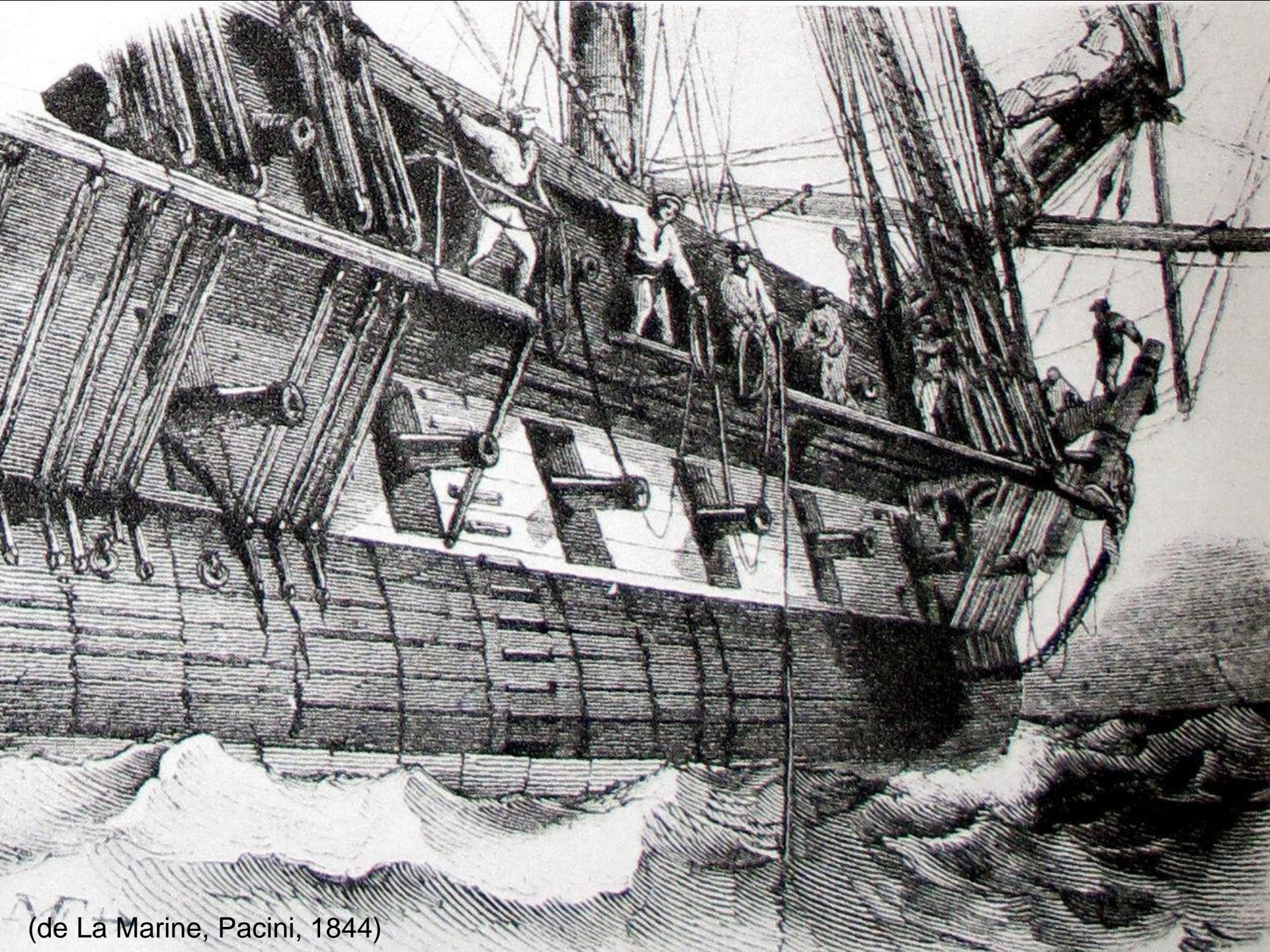
Scale: 0, 5, 10 Kilometres

HMS Challenger

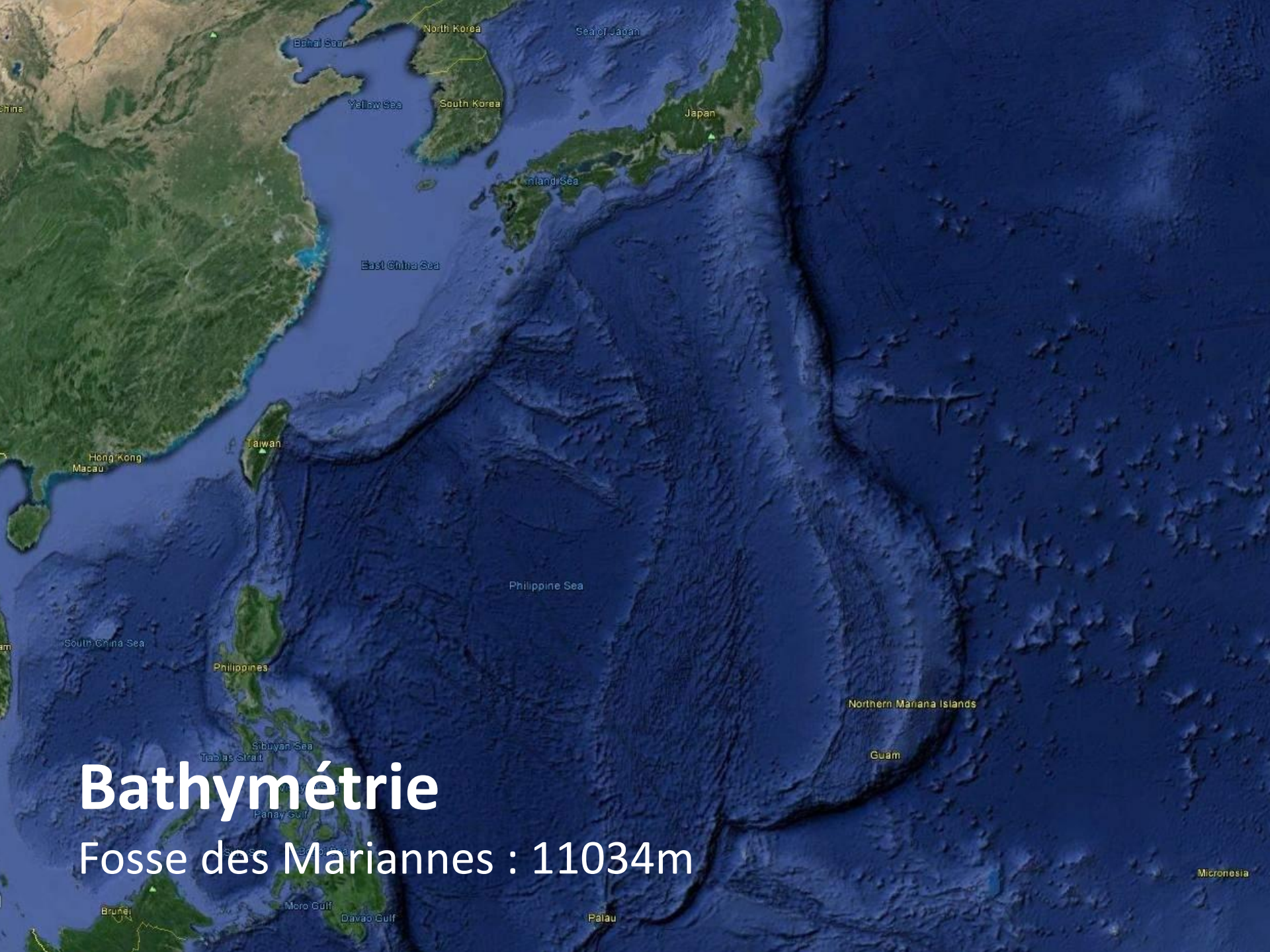
Campagne océanographique de 1872-1876



(peinture de William Frederick Mitchell)



(de La Marine, Pacini, 1844)



Bathymétrie

Fosse des Mariannes : 11034m

Le Trieste

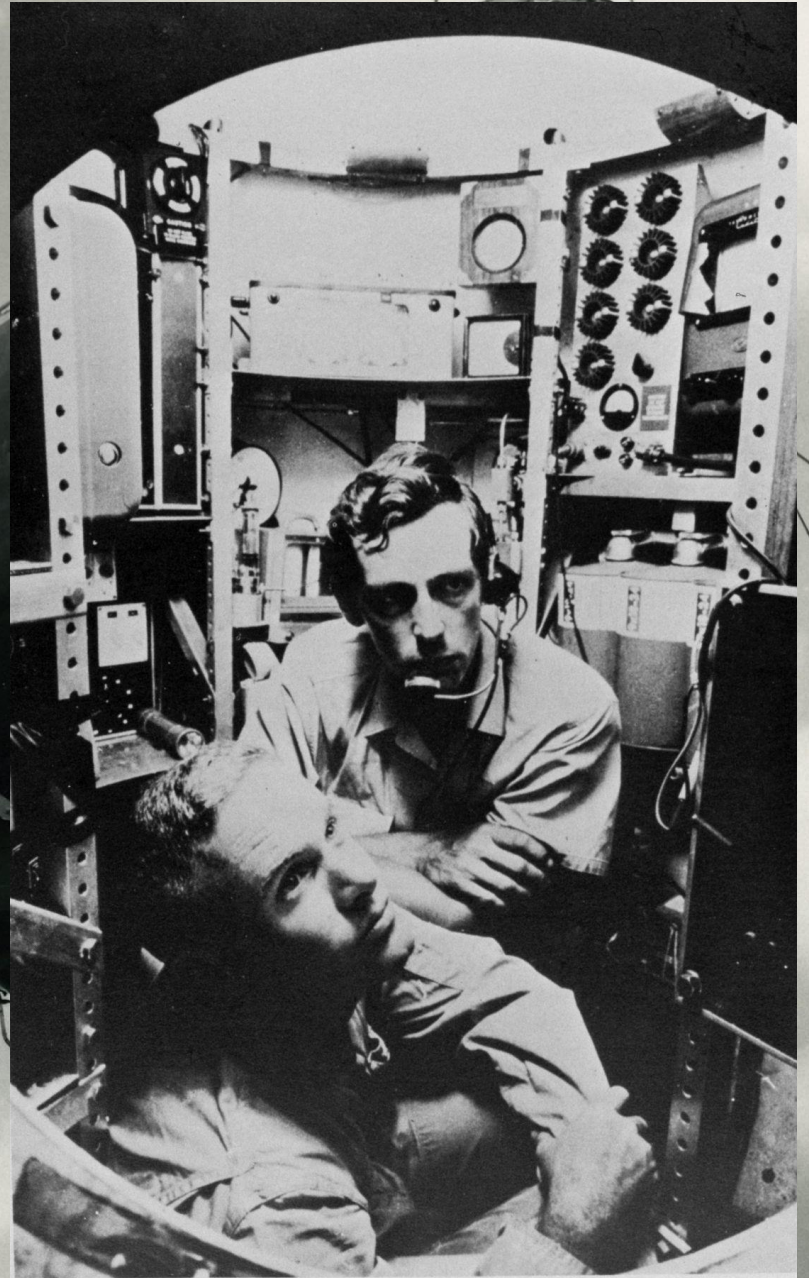
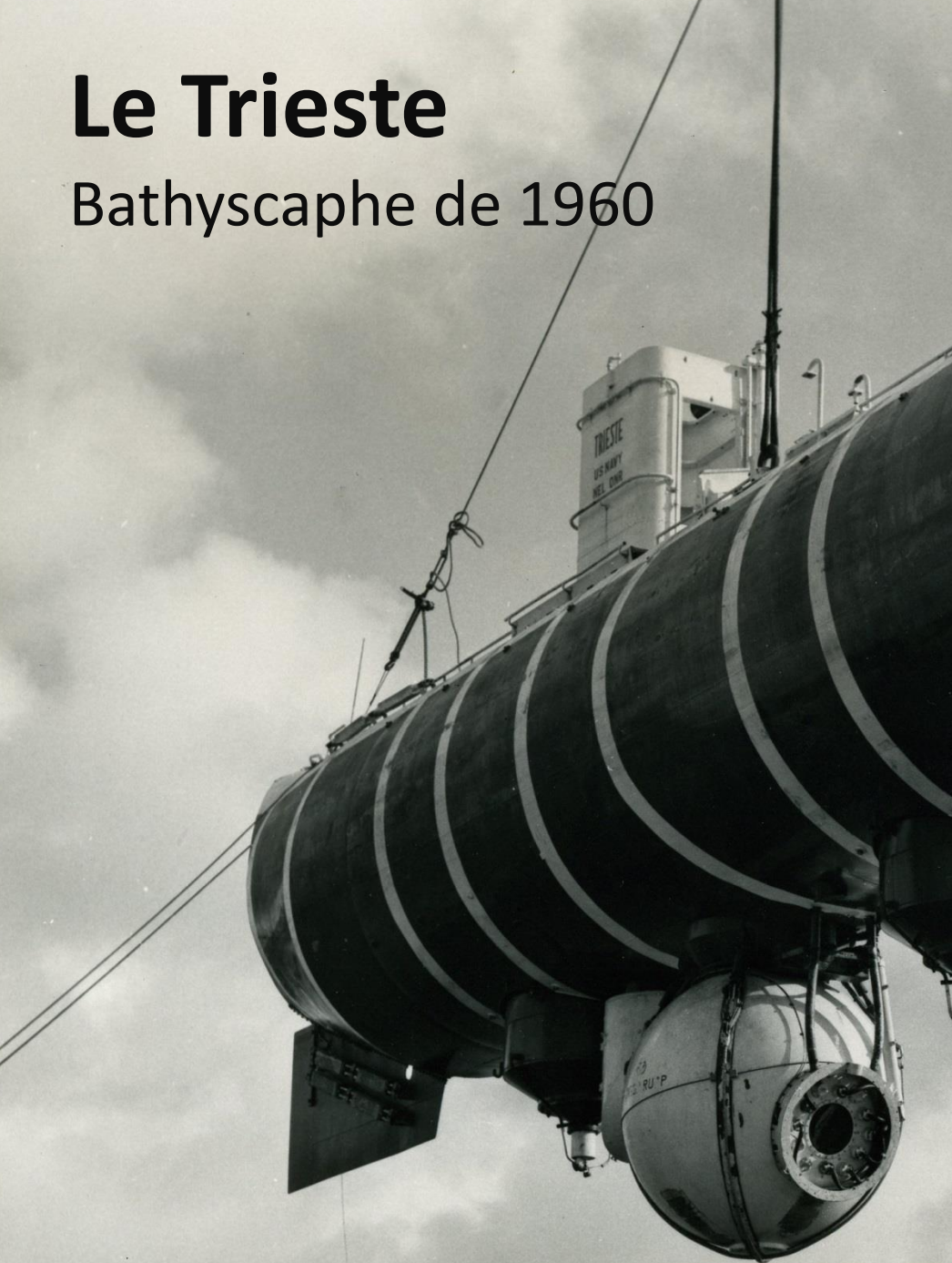
Bathyscaphe de 1960



(photo de Steve Nicklas)

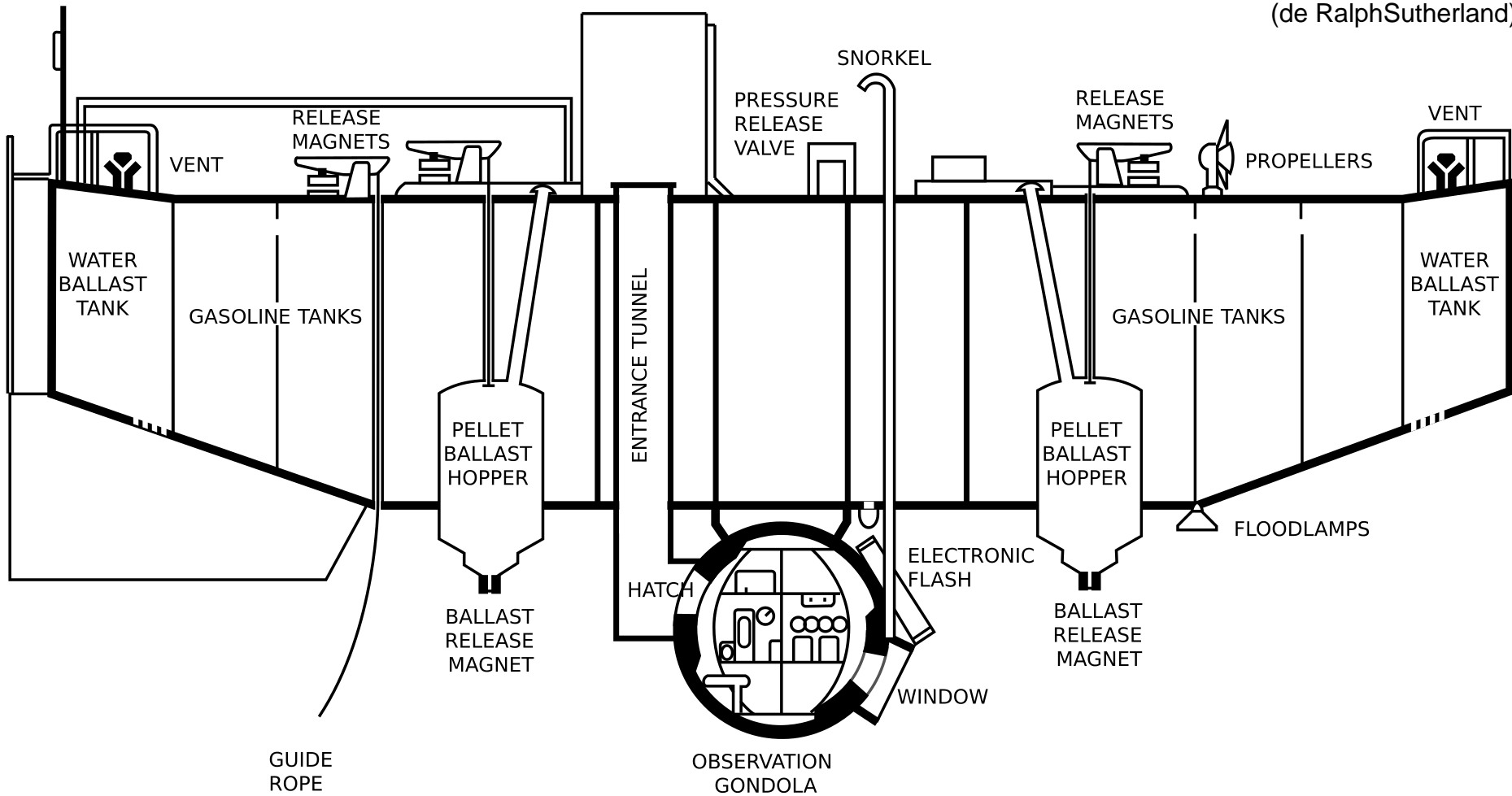
Le Trieste

Bathyscaphe de 1960



(photo de Steve Nicklas)

(de Ralph Sutherland)



GENERAL ARRANGEMENT DRAWING OF TRIESTE, CA. 1959





Exploration habitée

Le Nautilus de l'Ifremer : max 6000m



Ifremer

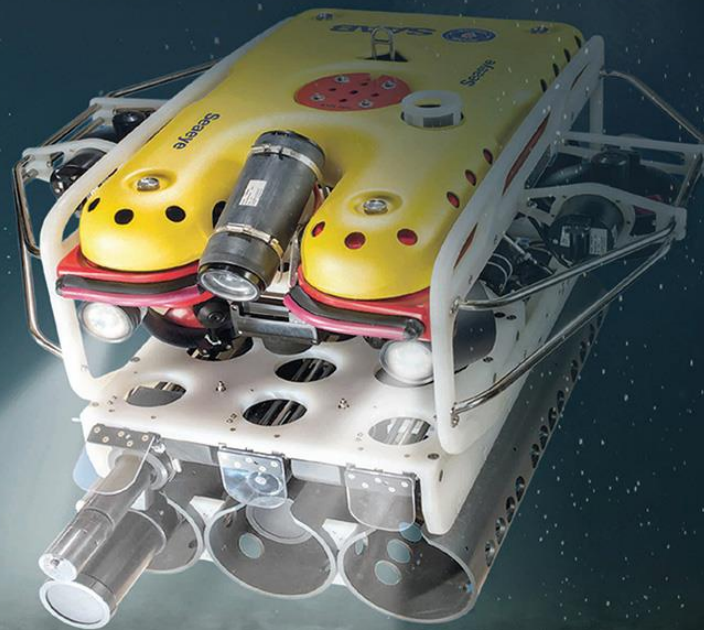
MOC

An underwater photograph showing sunlight filtering through the water surface, creating a shimmering effect. The water is a deep blue color, and the light rays are visible as bright, glowing patterns. The overall scene is serene and mysterious.

Explorer les fonds :
Quelles motivations ?

La guerre des mines

Recherche et destruction



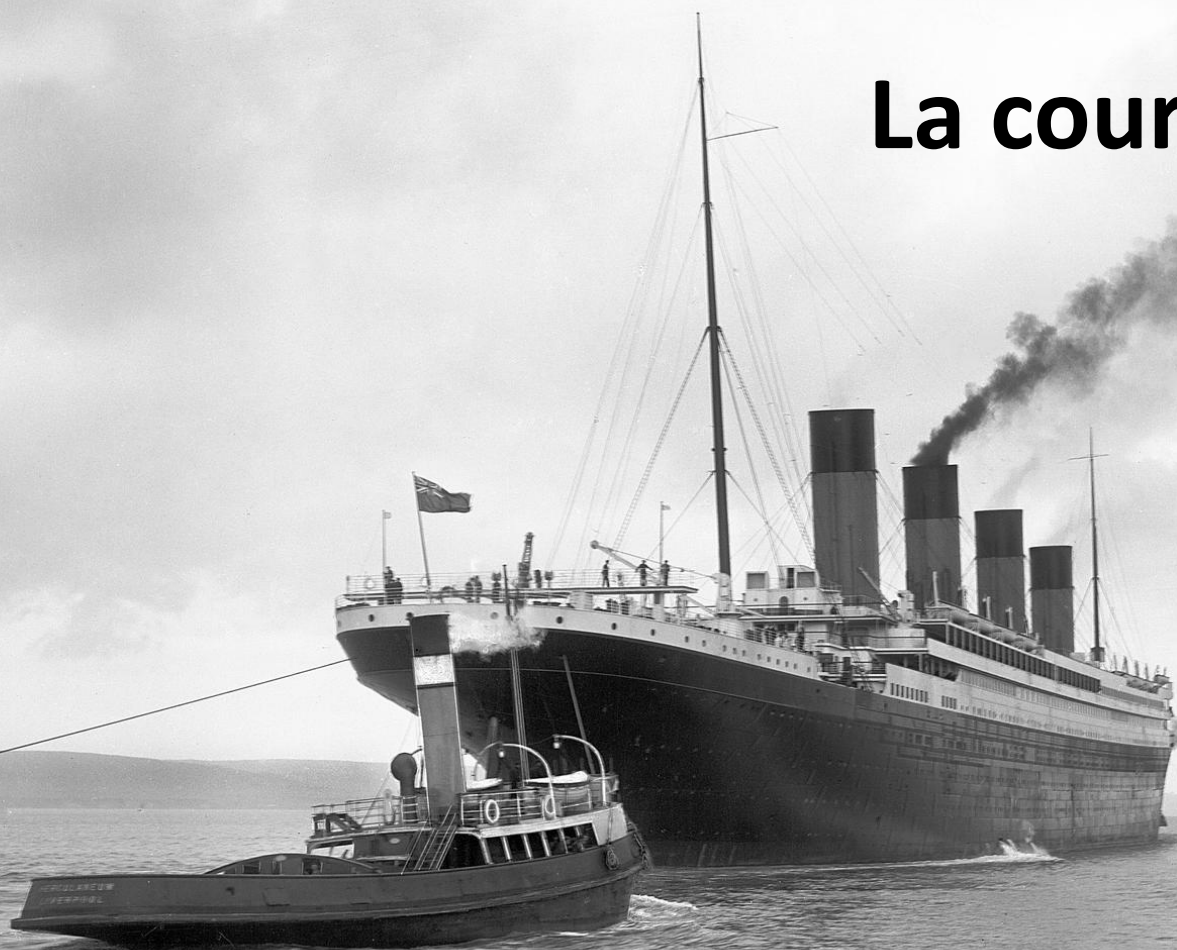


L'industrie sous-marine

Champ d'exploitation pétrolier (TOTAL)

La course aux épaves

RMS Titanic



La course aux épaves

La proue du Titanic par 3821m de fond



La course aux épaves

La poupe du Titanic à 600m de là



An underwater photograph of the Titanic wreckage, showing the ship's hull and debris on the ocean floor. The scene is dimly lit with a blue-green tint. The ship's structure is heavily damaged and partially buried in the seabed. The text "La course aux épaves" is overlaid in white on the right side of the image.

La course aux épaves

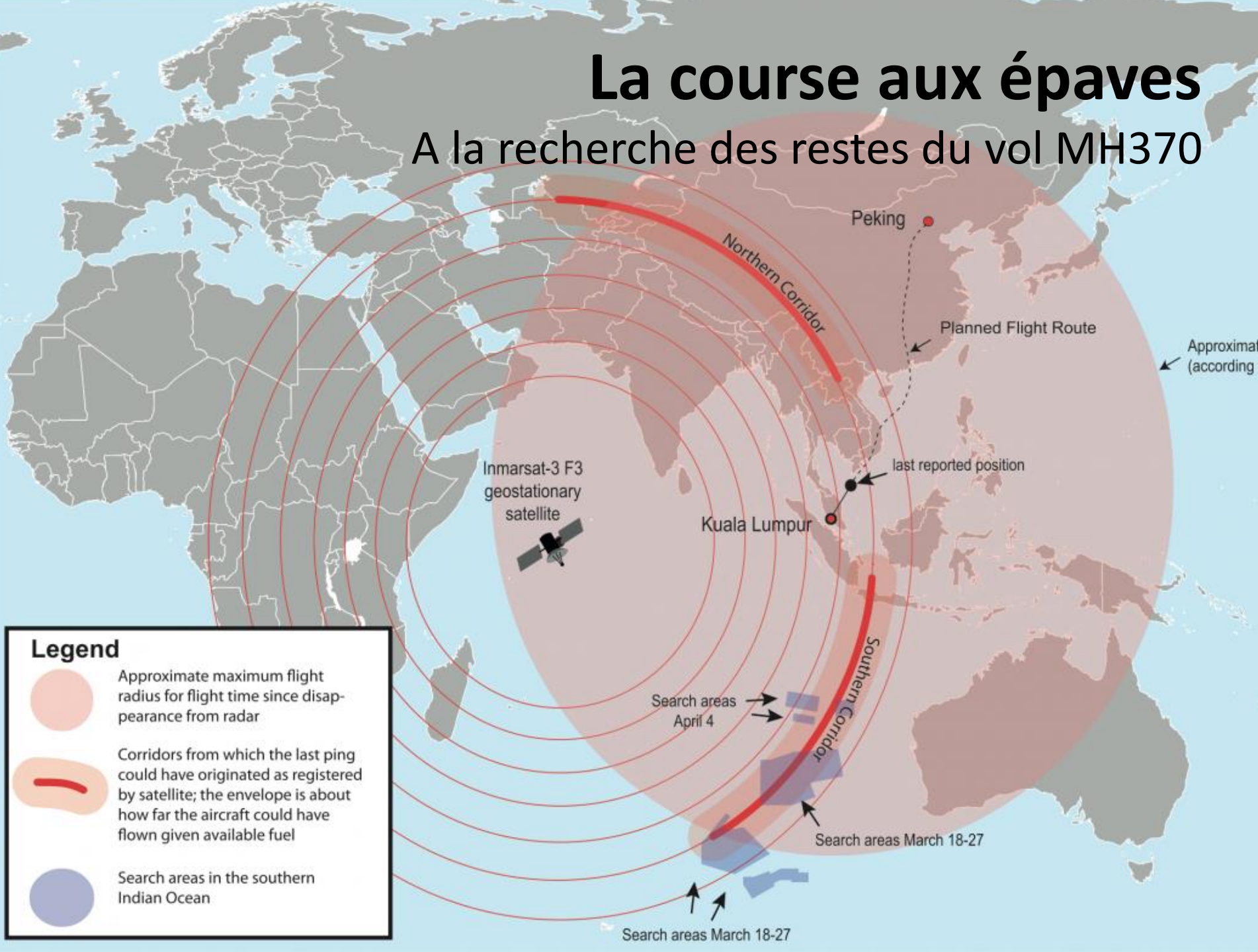
Le Britannic






Le Vasa
Stockholm

La course aux épaves

A la recherche des restes du vol MH370



Legend

-  Approximate maximum flight radius for flight time since disappearance from radar
-  Corridors from which the last ping could have originated as registered by satellite; the envelope is about how far the aircraft could have flown given available fuel
-  Search areas in the southern Indian Ocean

Search areas March 18-27

Search areas March 18-27

Search areas
April 4

Approximate
(according to...)

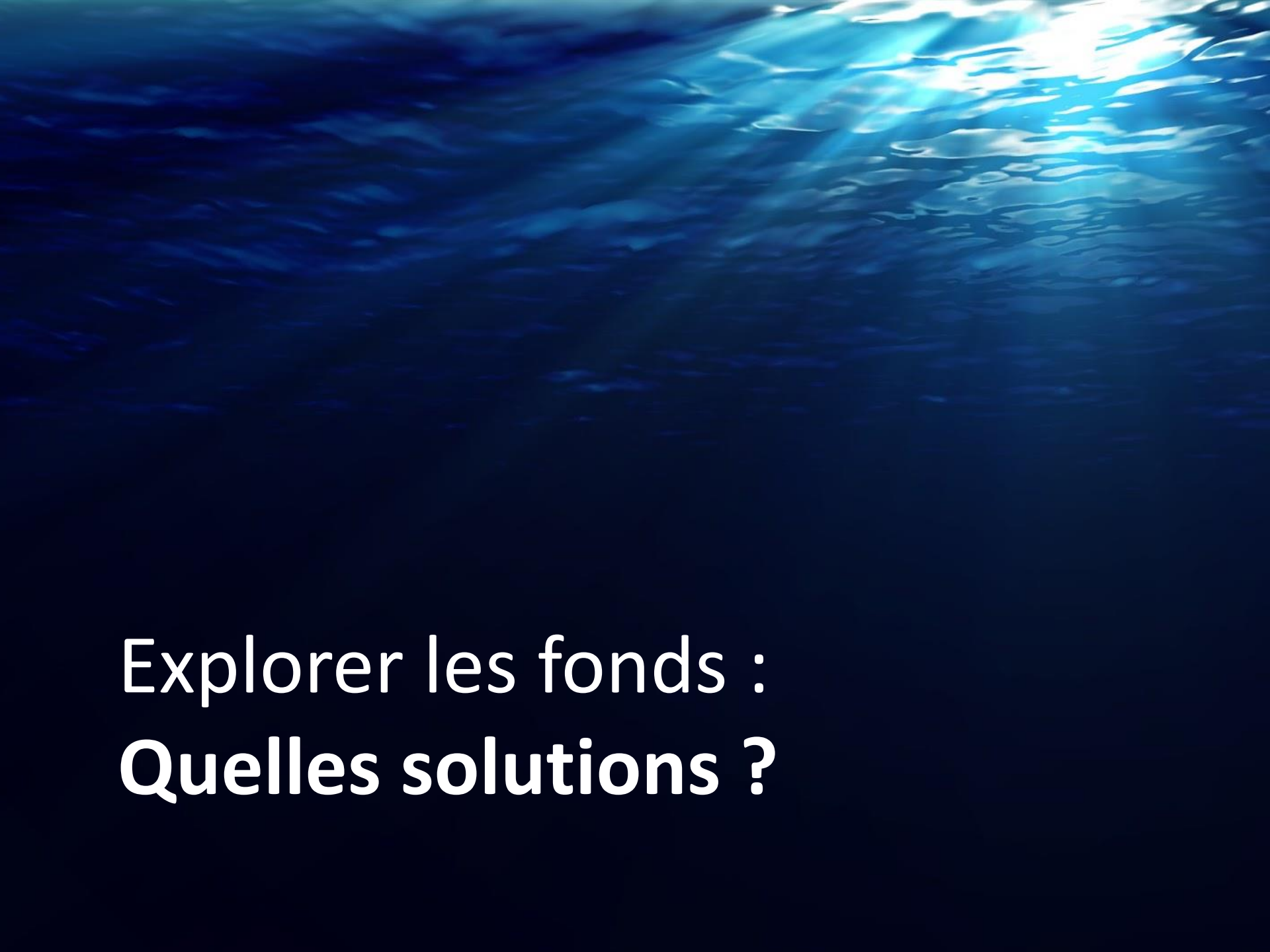
last reported position

Planned Flight Route

Peking

Kuala Lumpur

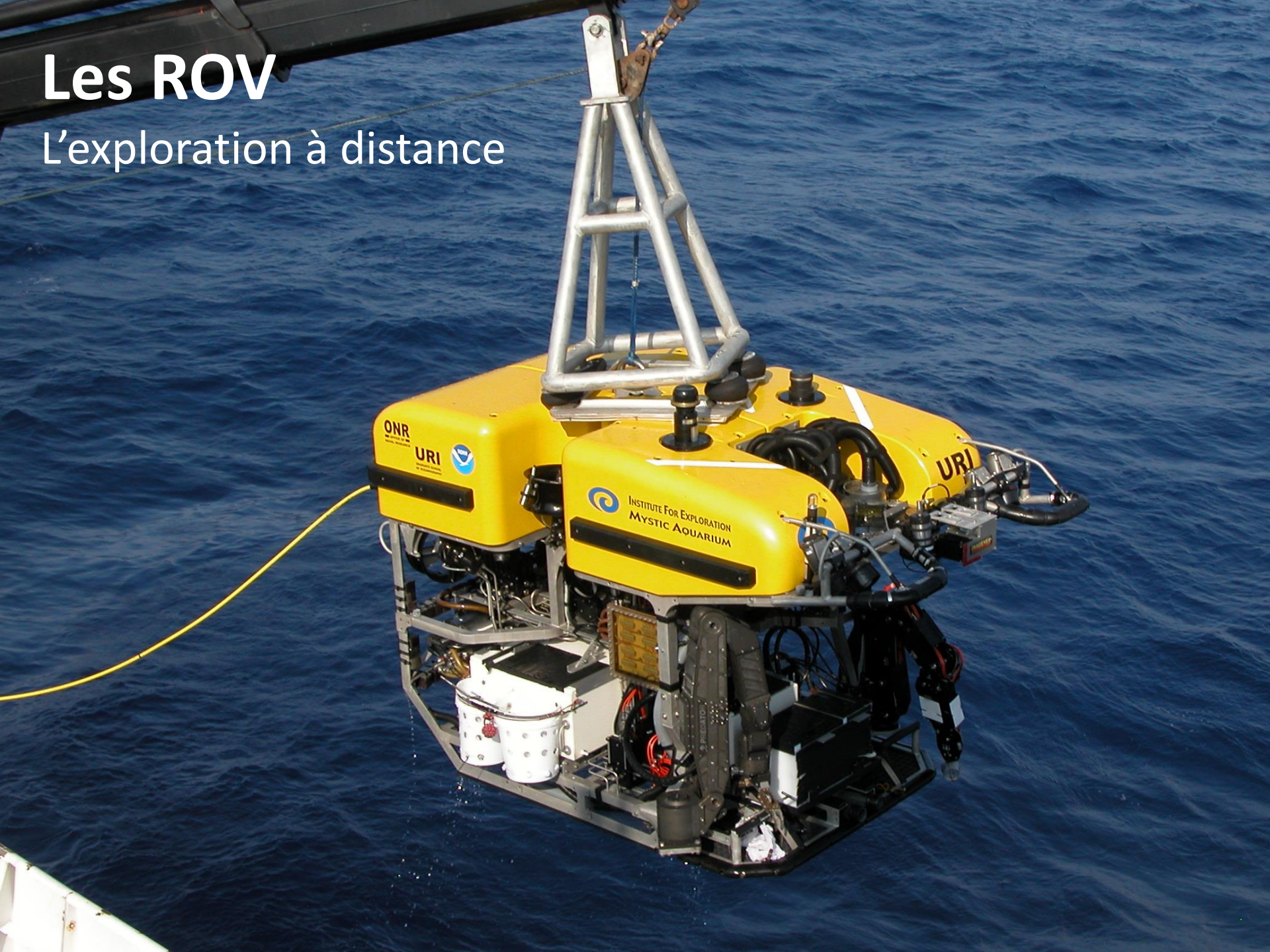
Inmarsat-3 F3
geostationary
satellite

An underwater photograph showing sunlight filtering through the water surface, creating a shimmering effect. The water is a deep blue color, and the light rays are visible as bright streaks. The overall scene is serene and suggests a deep-sea environment.

Explorer les fonds :
Quelles solutions ?

Les ROV

L'exploration à distance





La solution de l'autonomie

Le robot autonome Bluefin 21



Véhicules habités

Exemple : le Nautil de l'Ifremer



Véhicules téléguidés : ROV

Remotely Operated Vehicle



Véhicules autonomes: AUV

Autonomous Underwater Vehicle



Les gliders

Véritables planeurs sous-marins

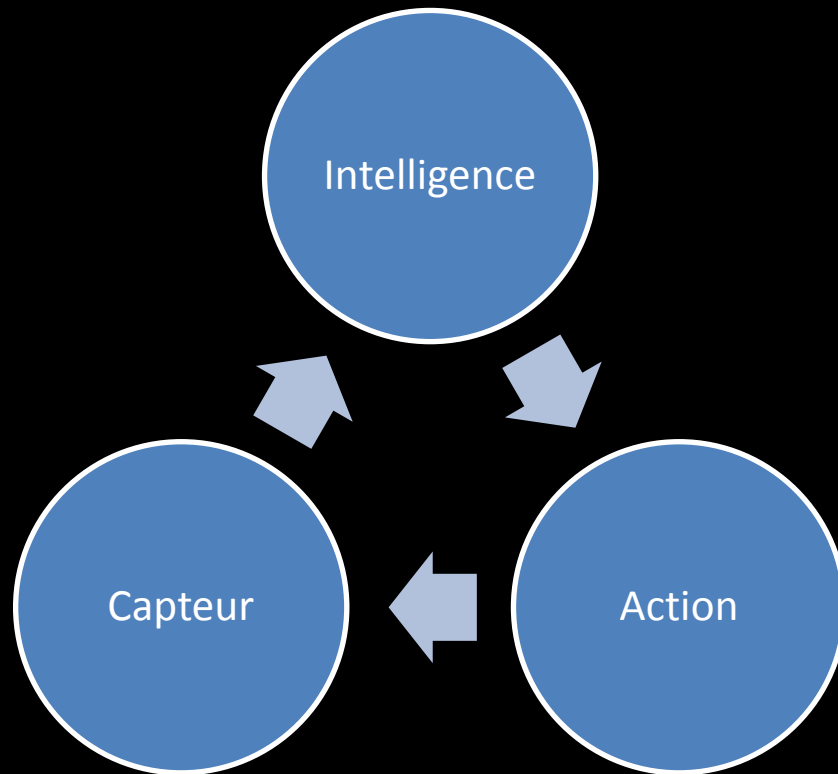


Les robots semi-autonomes

Le HROV Ariane de l'Ifremer

Véhicules autonomes : AUV

Autonomous Underwater Vehicle



L'AUV Daurade

DGA TN / Shom



Vidéo

L'AUV Daurade

DGA TN / Shom



An underwater photograph showing sunlight filtering through the water surface, creating a shimmering effect. The water is a deep blue color, and the light rays are visible as bright, glowing patterns. The overall scene is serene and captures the beauty of the underwater world.

Les challenges de l'acoustique sous-marine

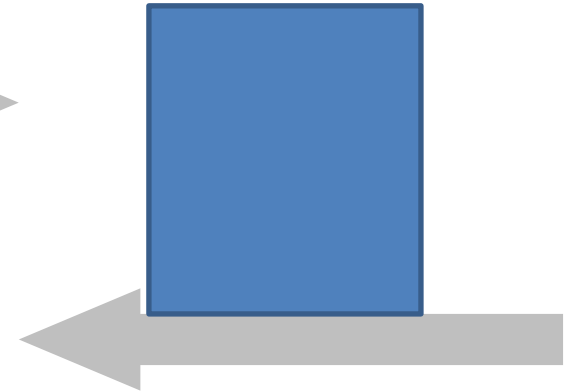
Principe



Modem
acoustique
(émetteur)



Signal acoustique



Obstacle

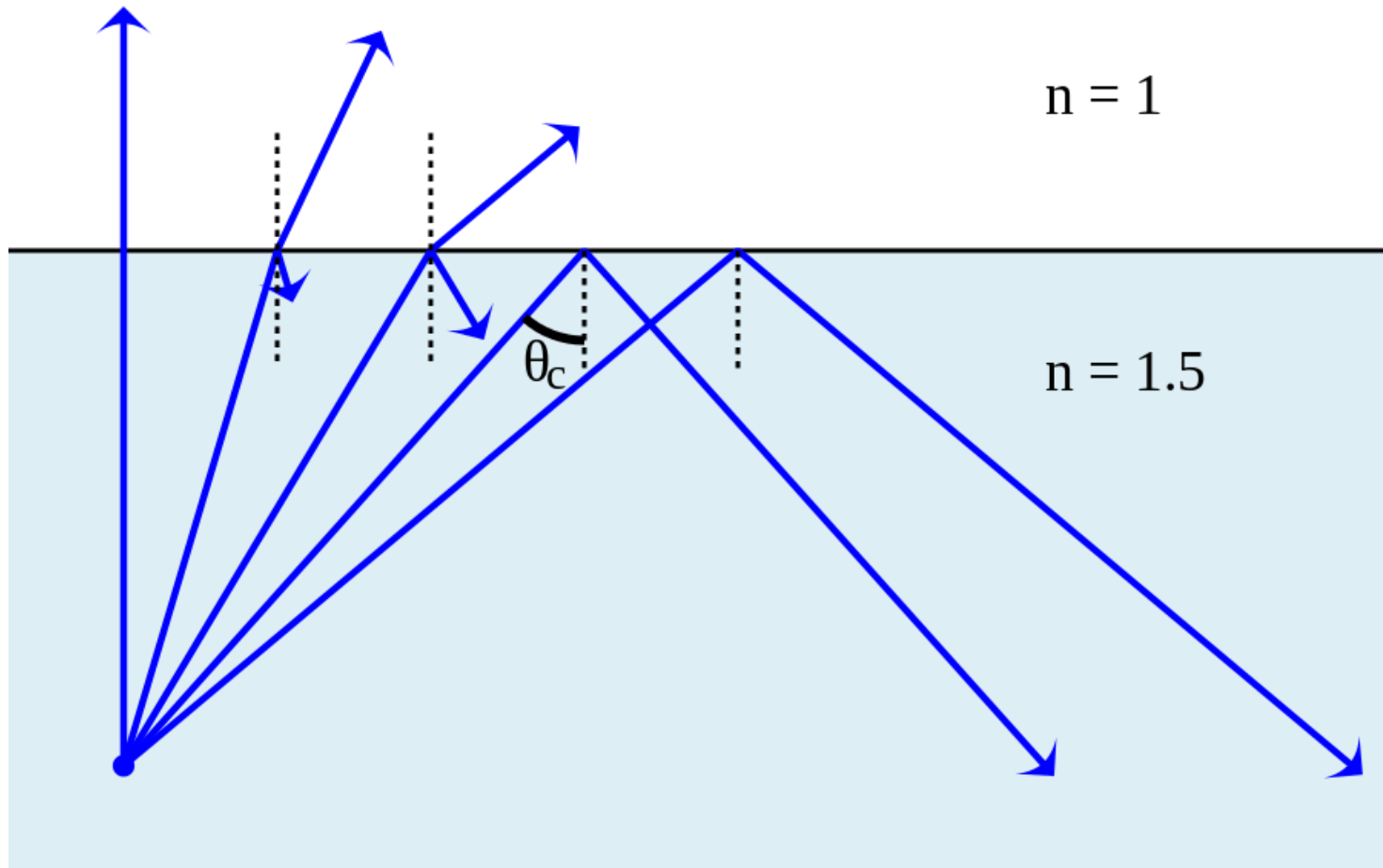
$$d = c \cdot t$$

c : célérité du son

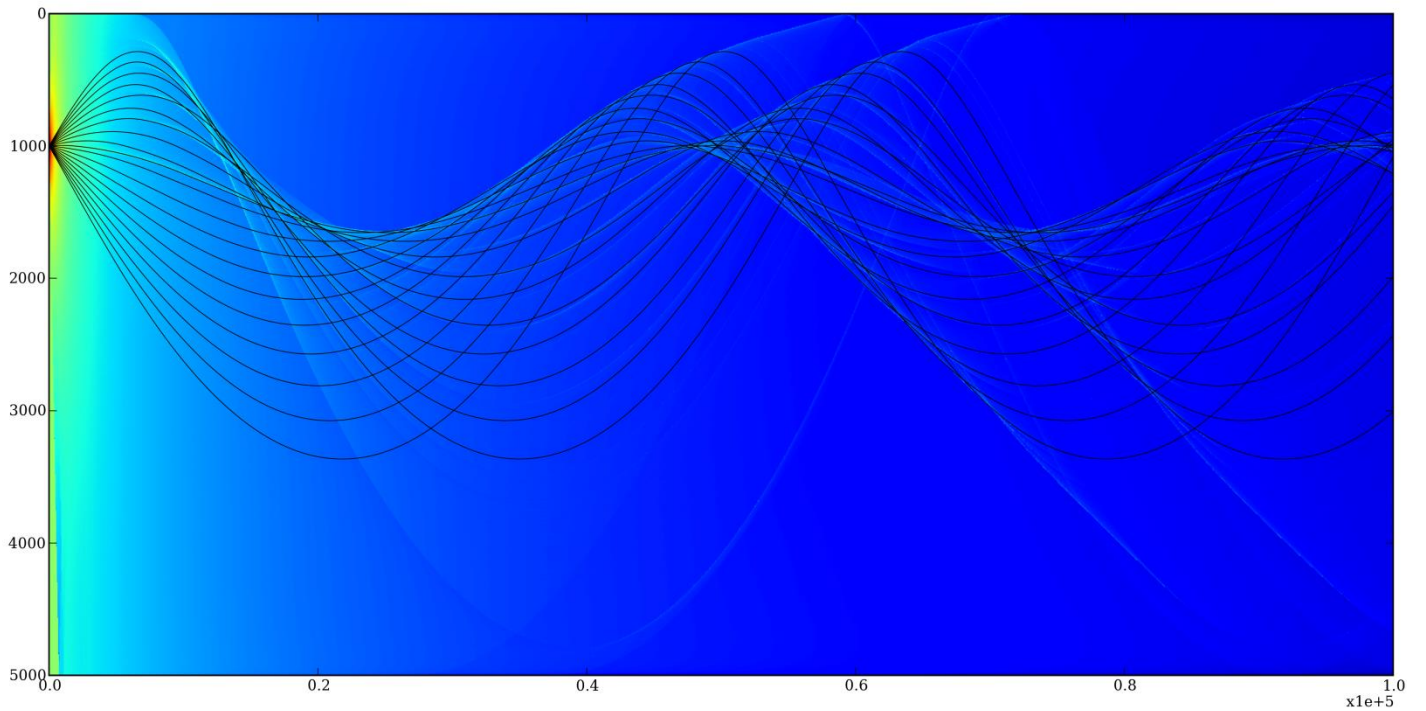
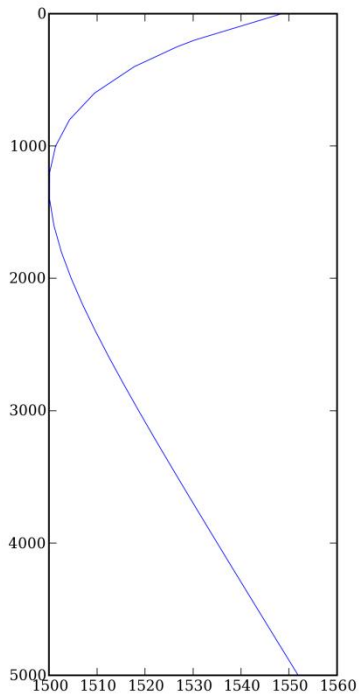
t : durée de propagation

d : distance parcourue

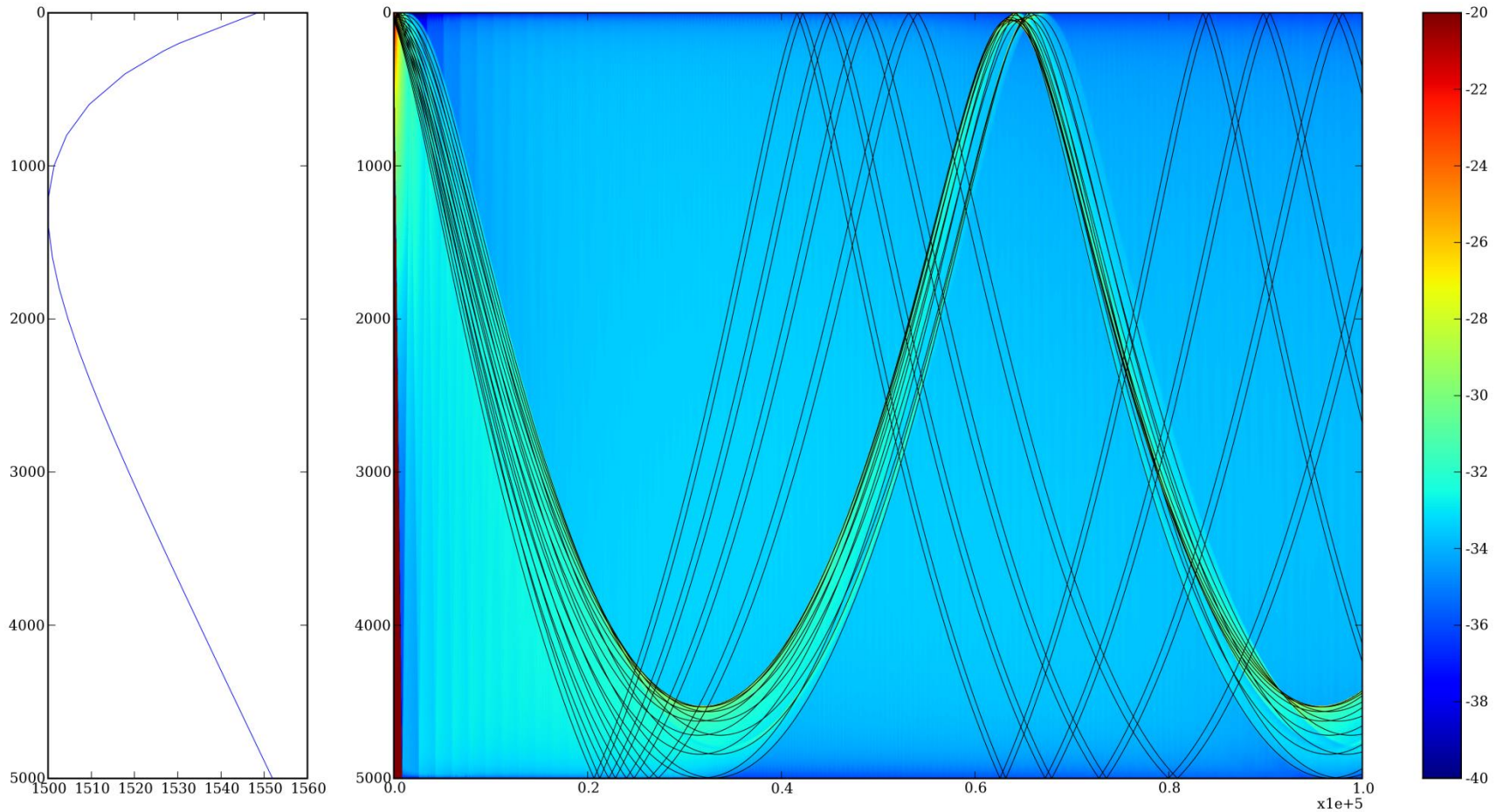
Les lois de Snell-Descartes



Le canal SOFAR

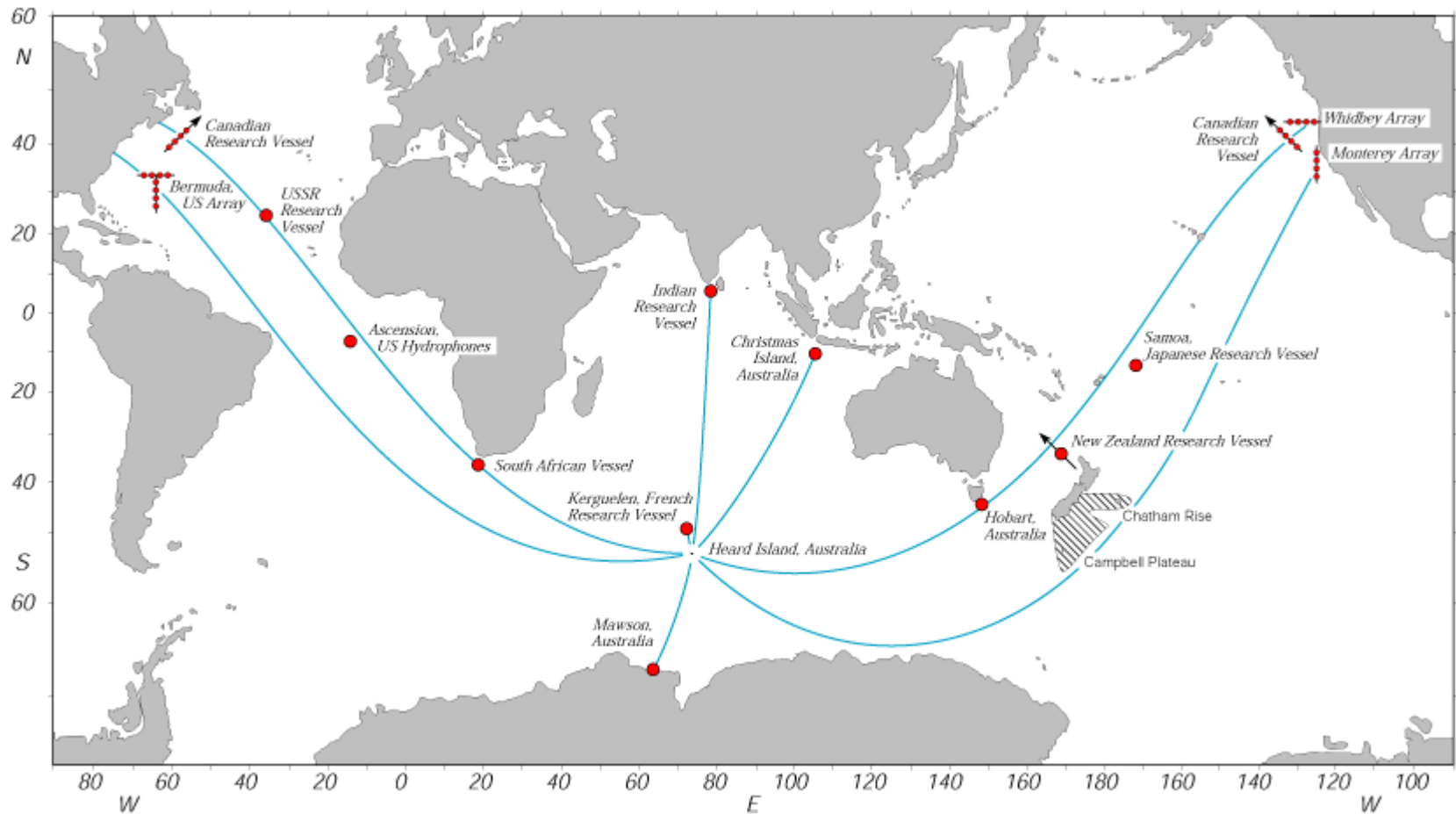


Les zones aveugles



La portée

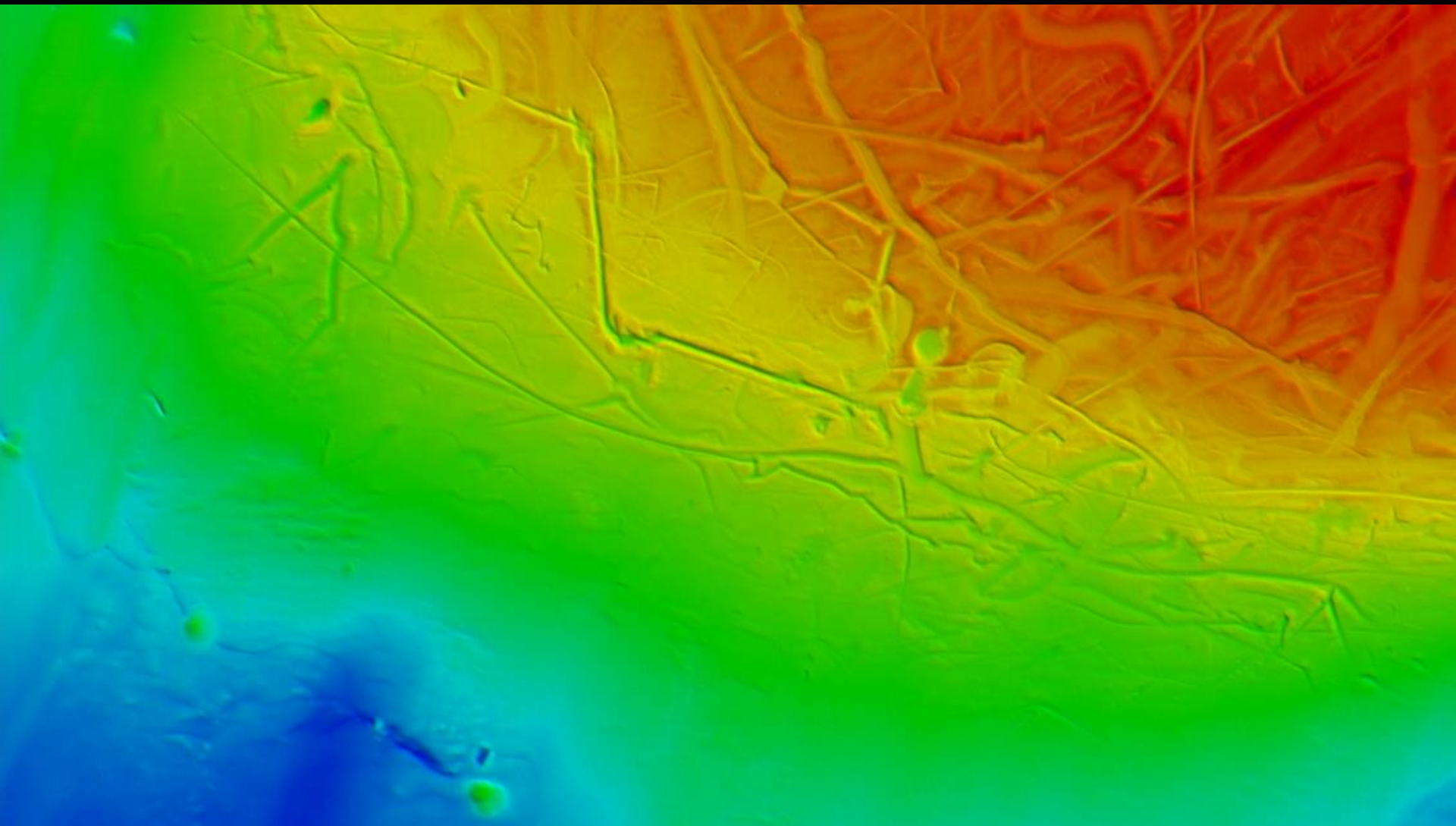
Heard Island test, 1991 – 57Hz



An underwater photograph showing sunlight filtering through the water surface, creating a shimmering effect. The water is a deep blue color, and the light rays are visible as bright, wavy patterns near the surface.

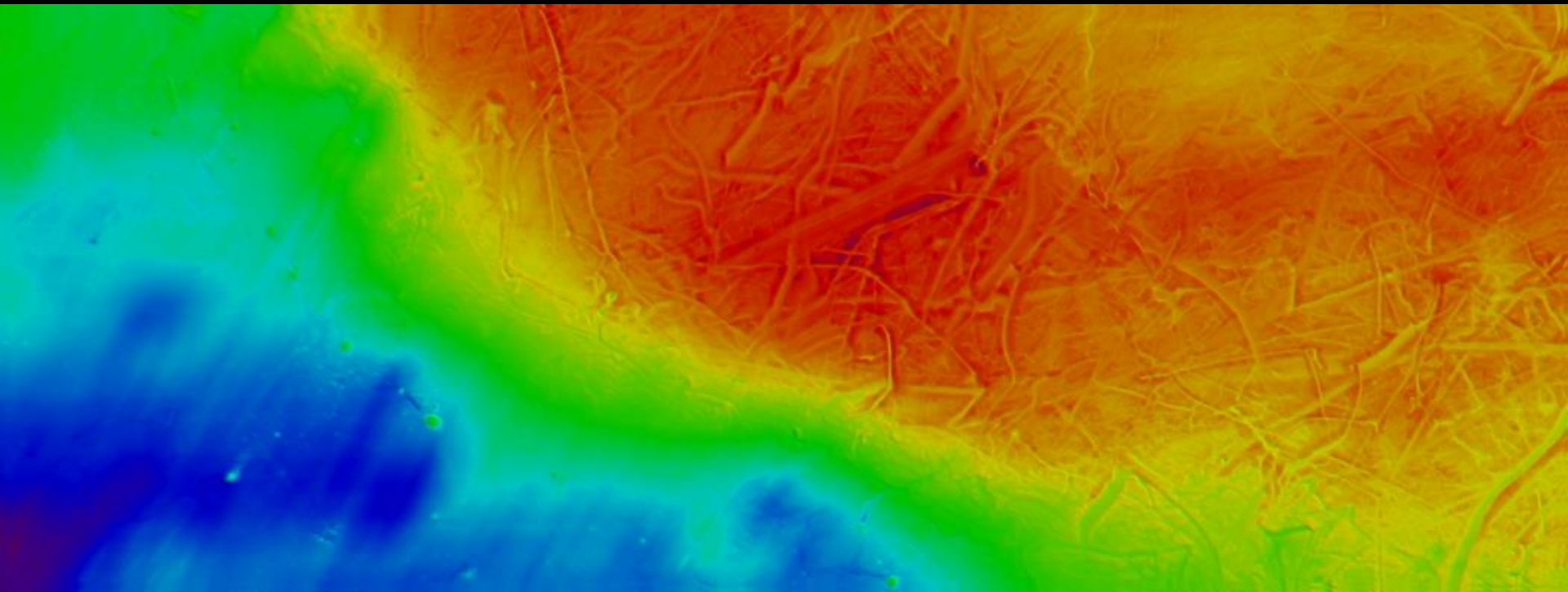
Perceptions par sonars





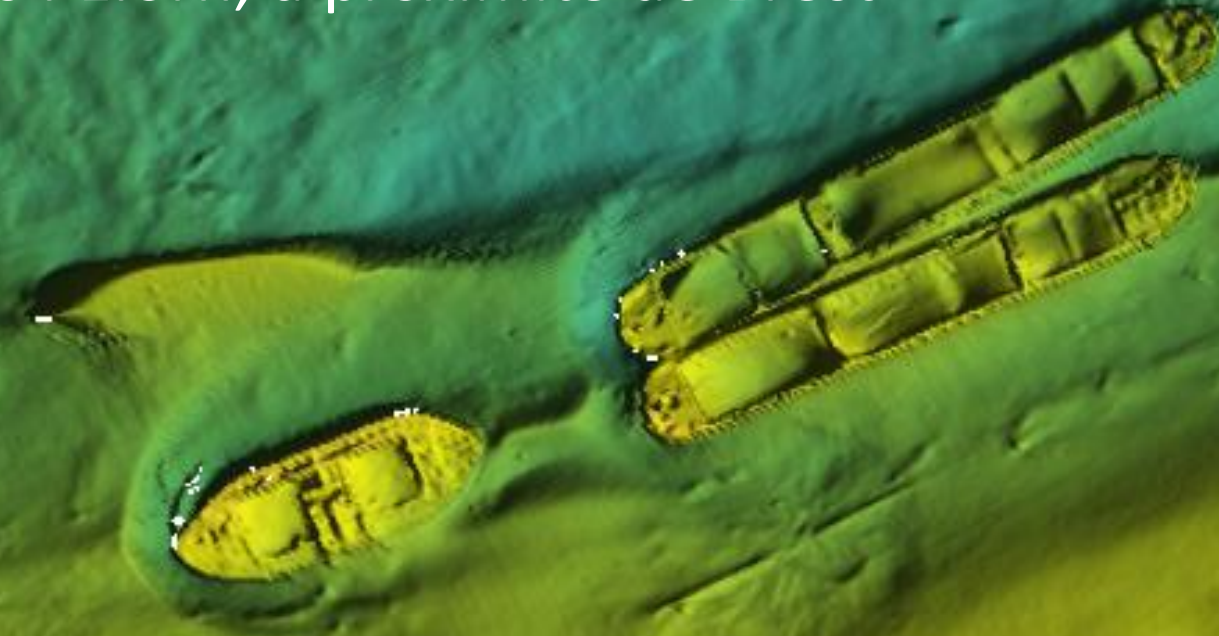
Dérives d'icebergs

En mer de Barents



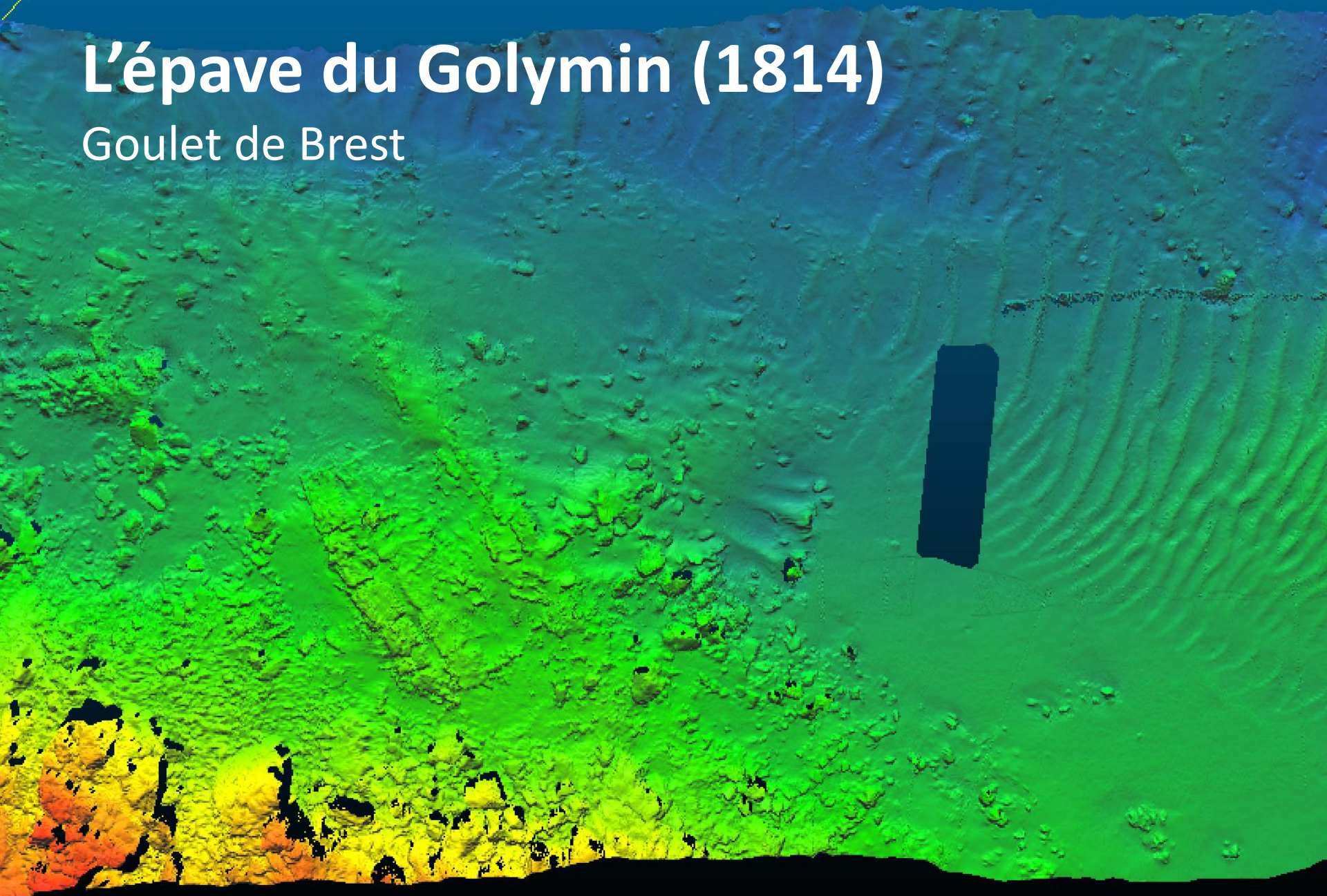
Découverte de barges

Dans l'Elorn, à proximité de Brest



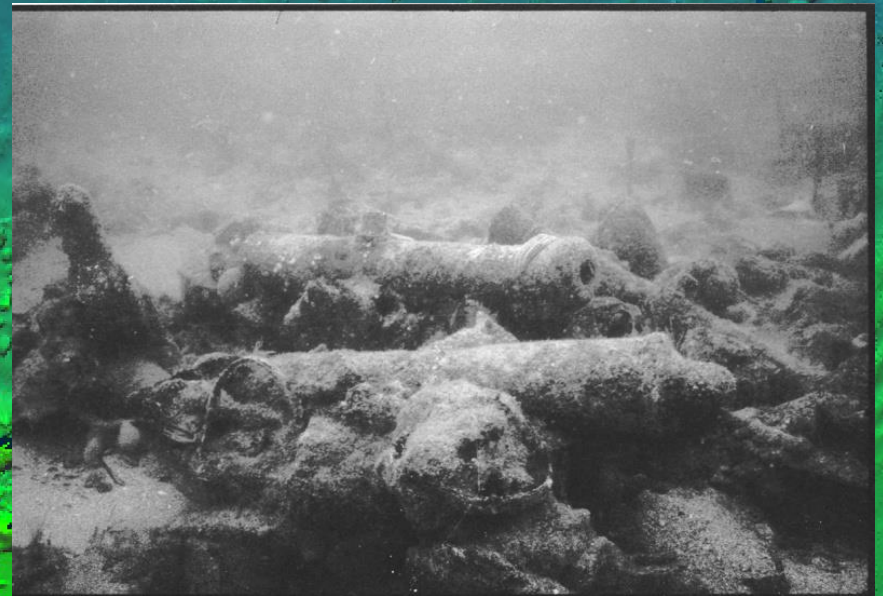
L'épave du Golymmin (1814)

Goulet de Brest



L'épave du Golymmin (1814)

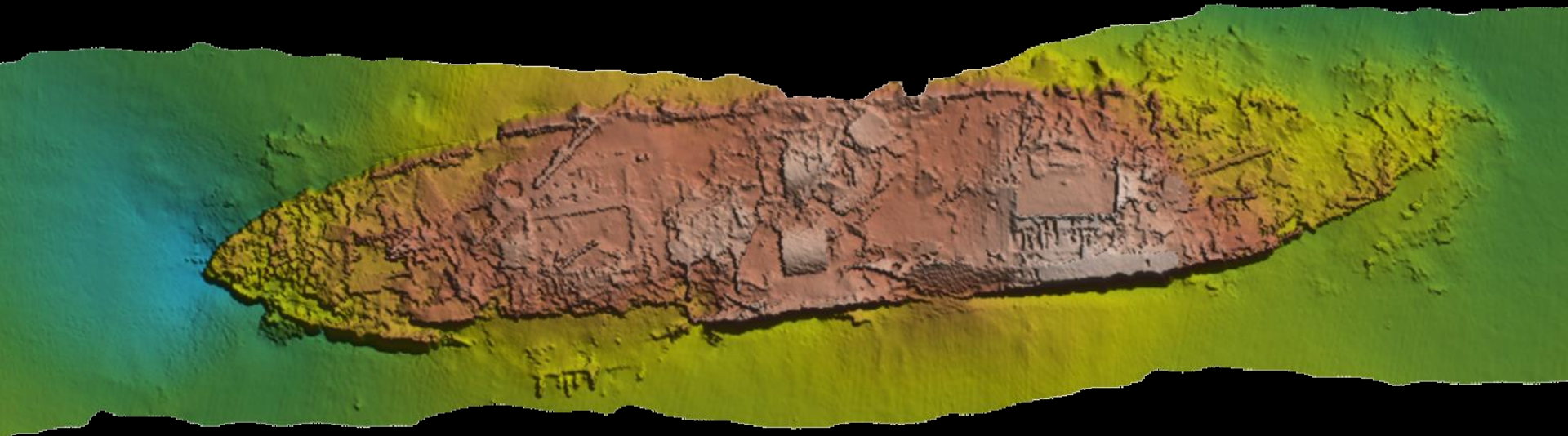
Goulet de Brest



Christian Hamard/Fonds DRASSM

L'épave du Gobetas

Pointe des Espagnols, Brest





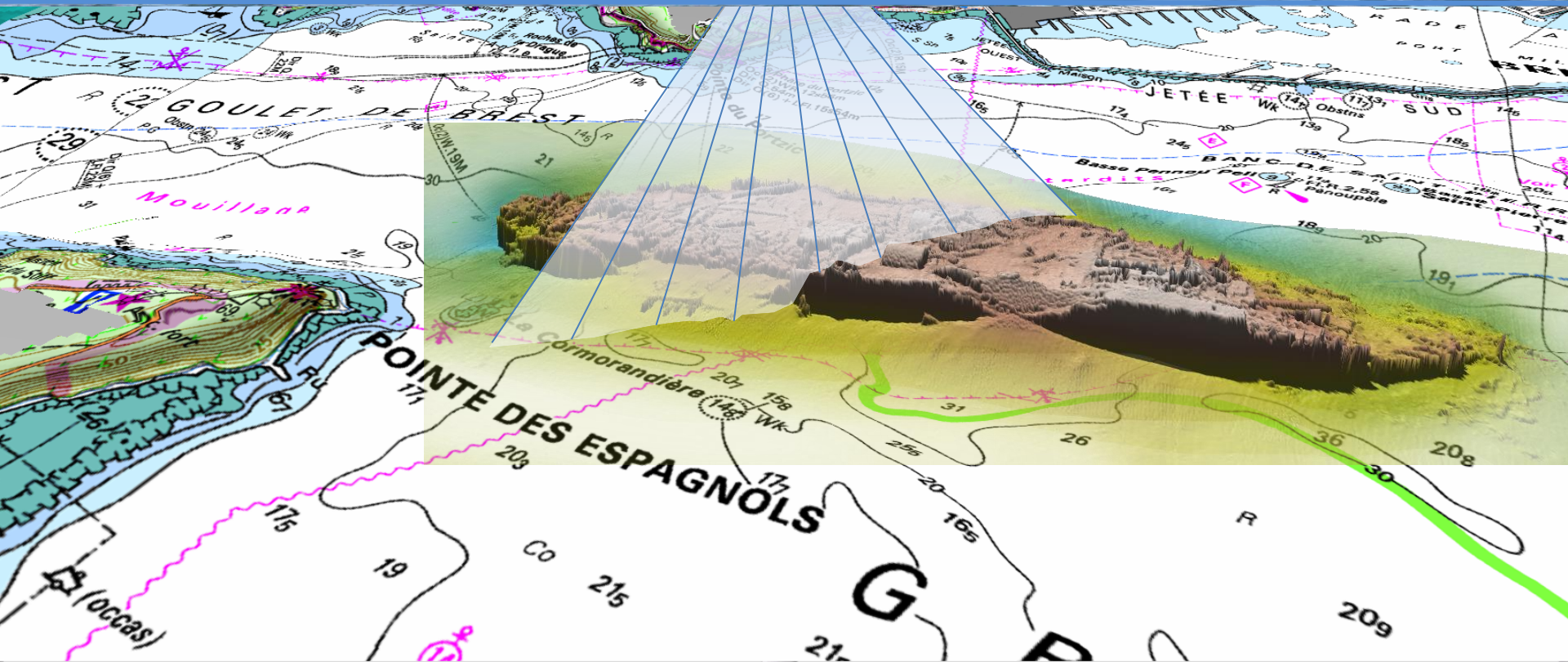
Gobitas, 2011

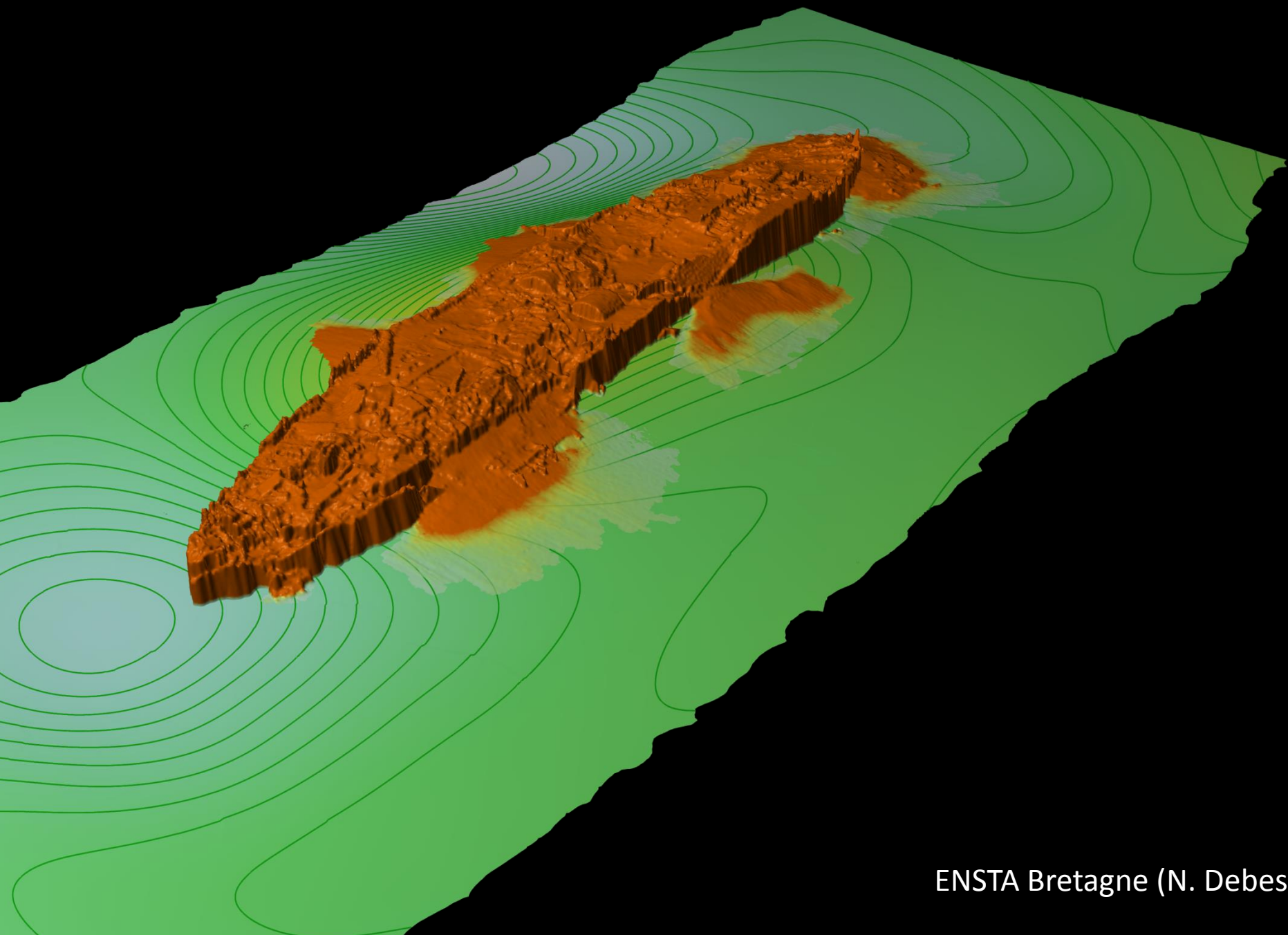
A. Carnot



© A.Carnot







Février 2003

SIMRAD EM3000 (300kHz)

128 faisceaux - 1.5° x 1.5°

Juin 2009

SIMRAD EM3002 (300kHz)

254 faisceaux - 1.5° x 1.5°

Juin 2009

R2Sonic2024 (400kHz)

256 faisceaux - 0.5° x 1°

Mai 2019

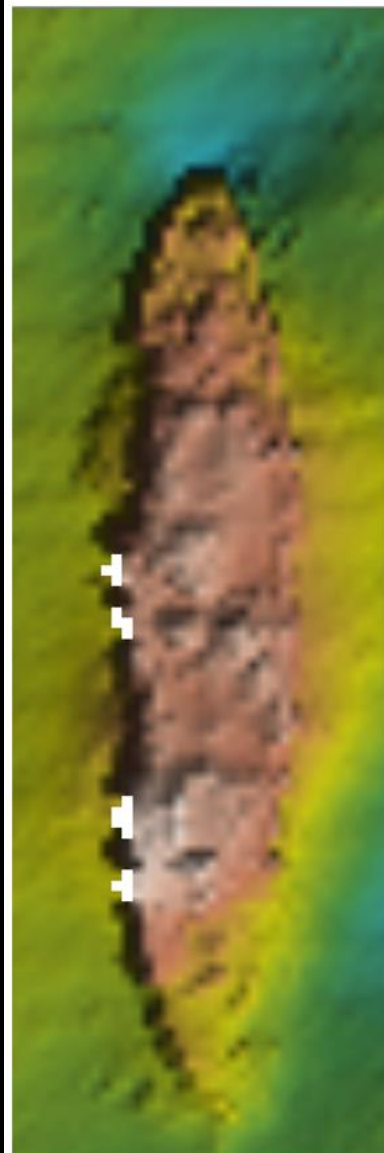
SIMRAD EM2040C (400kHz)

400 faisceaux - 1° x 1°

Juin 2014

R2Sonic2022(700kHz)

256 faisceaux - 0.6° x 0.6°



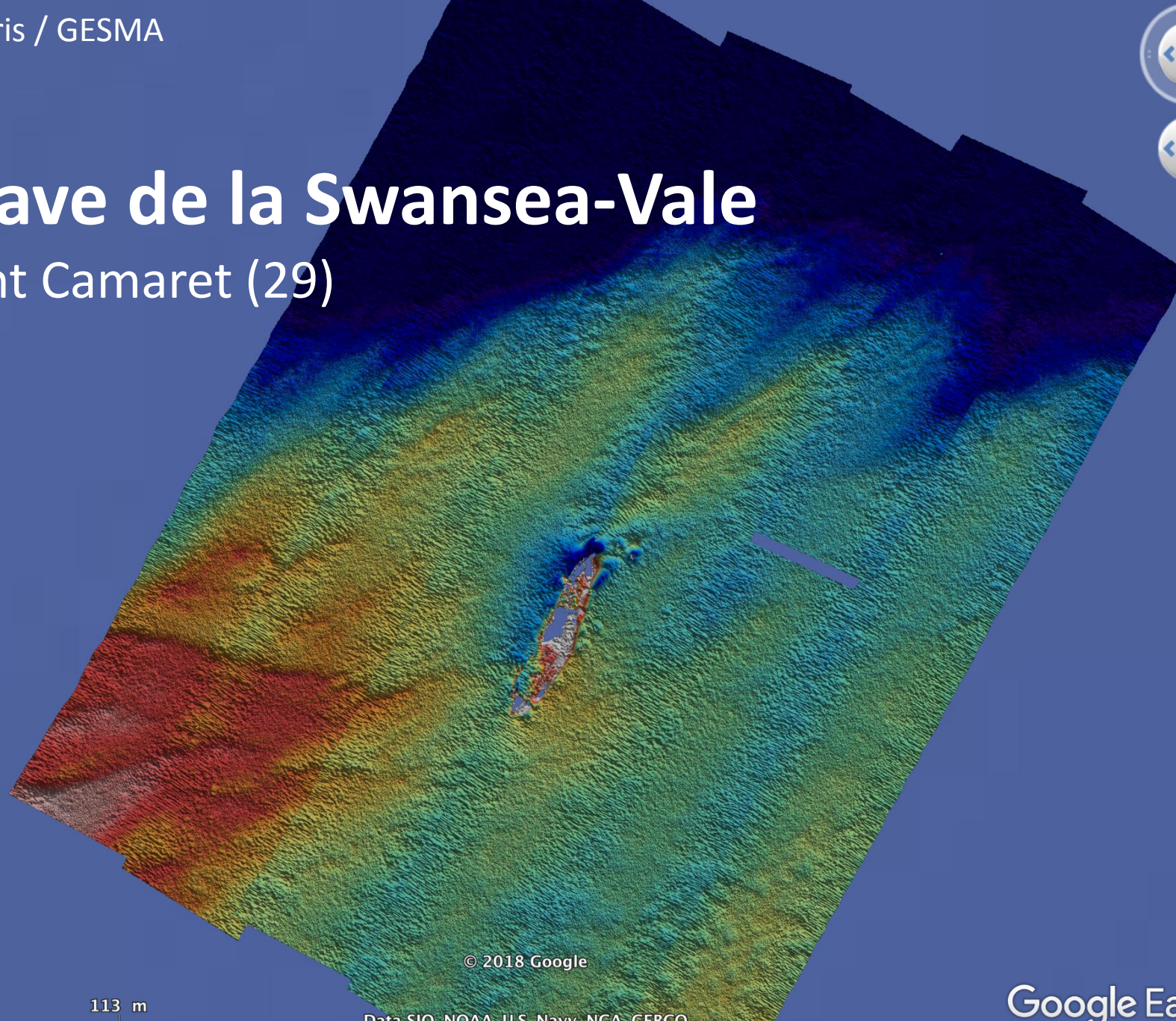
(Shom)

Profondeur (m)



L'épave de la Swansea-Vale

Devant Camaret (29)



© 2018 Google

Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Google Earth



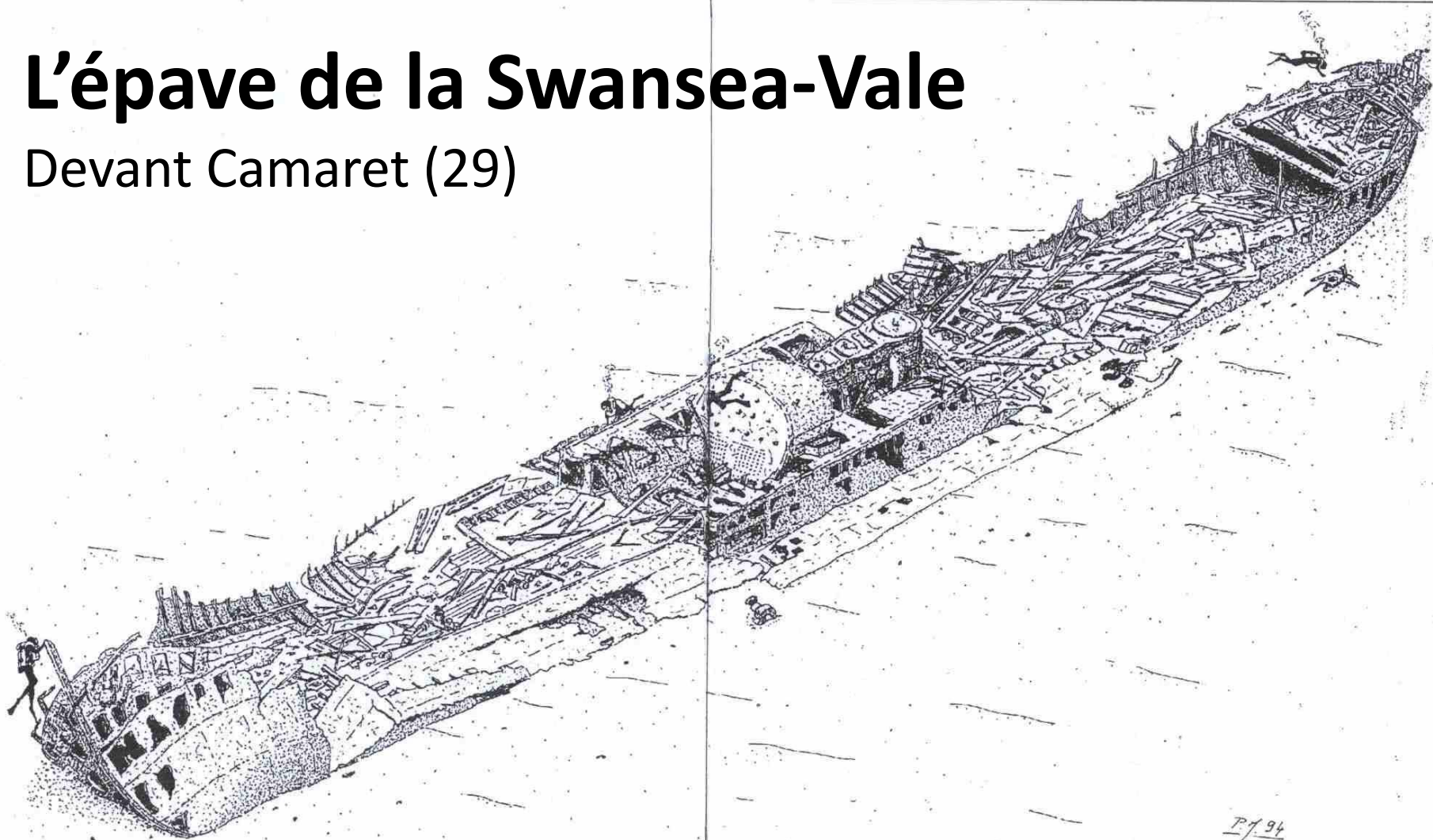
2002

48°18'11.76"N 4°38'37.73"O élév. 0 m altitude 490 m



L'épave de la Swansea-Vale

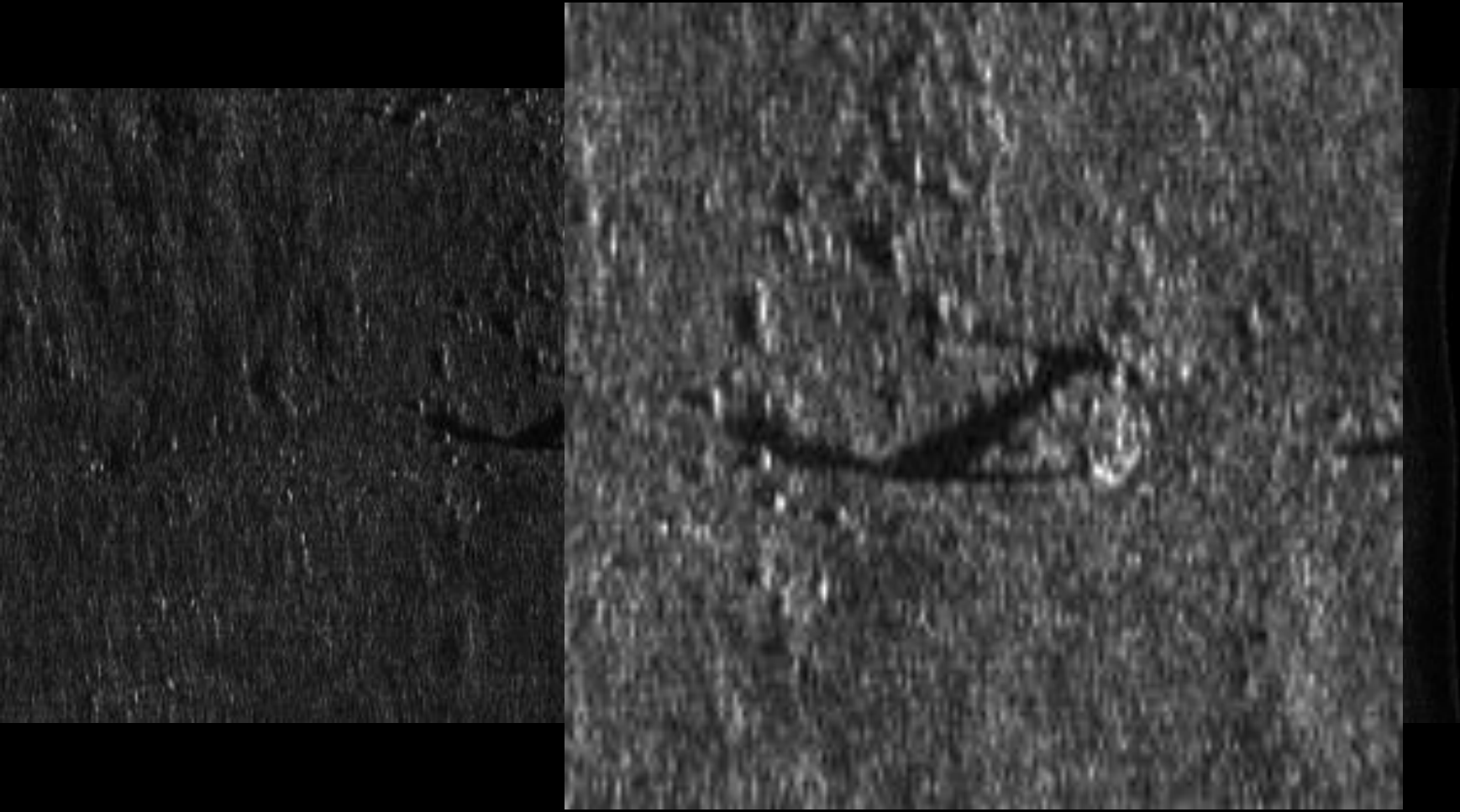
Devant Camaret (29)



Les parois de ses cales écroulées, l'épave du Swansea-Vale, repose par 32 m de fond devant Camaret.
Dessin P. Marec - 1994.

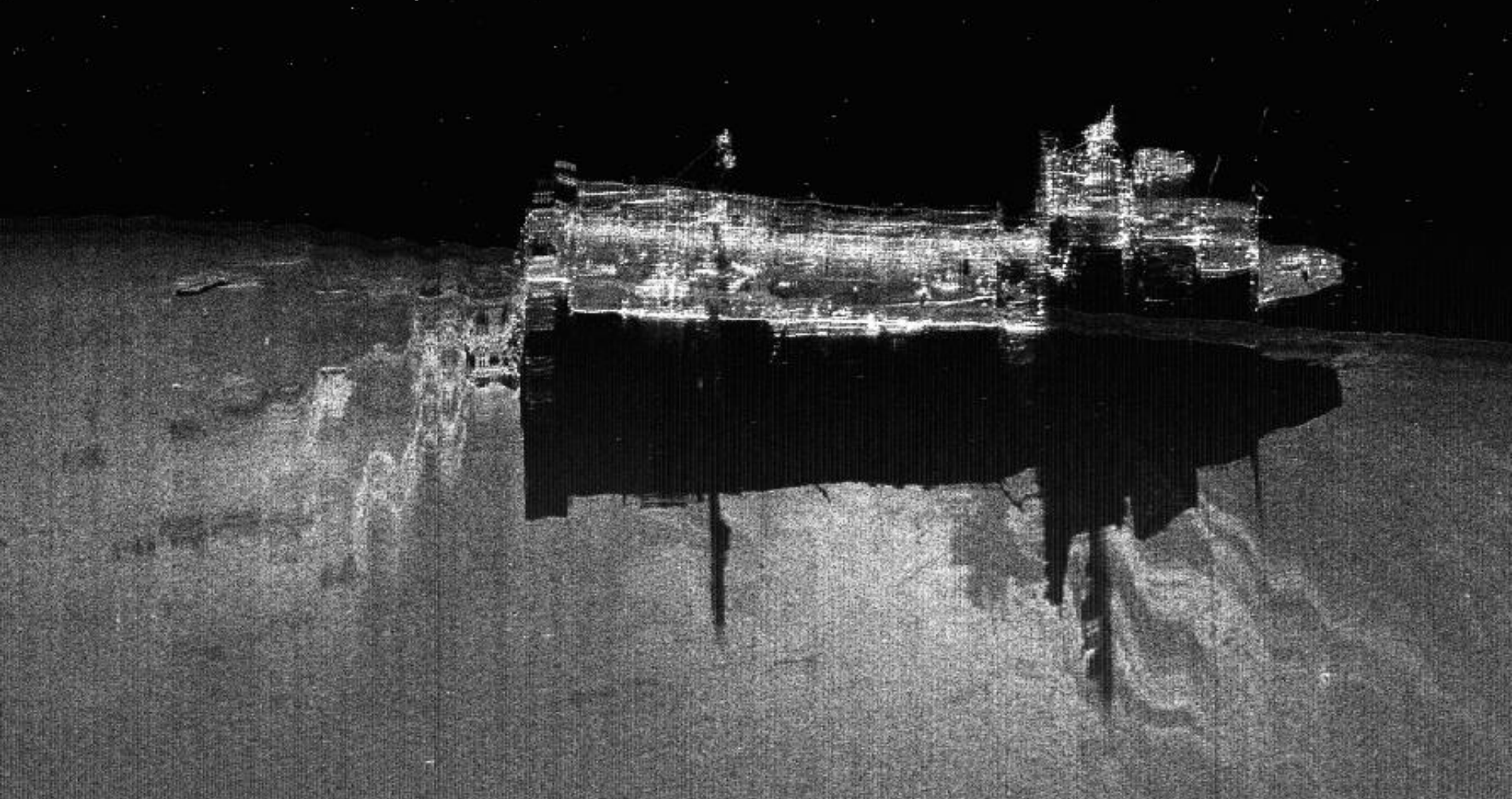
Image au sonar latéral





L'épave de l'Erika

Dans l'Elorn, à proximité de Brest

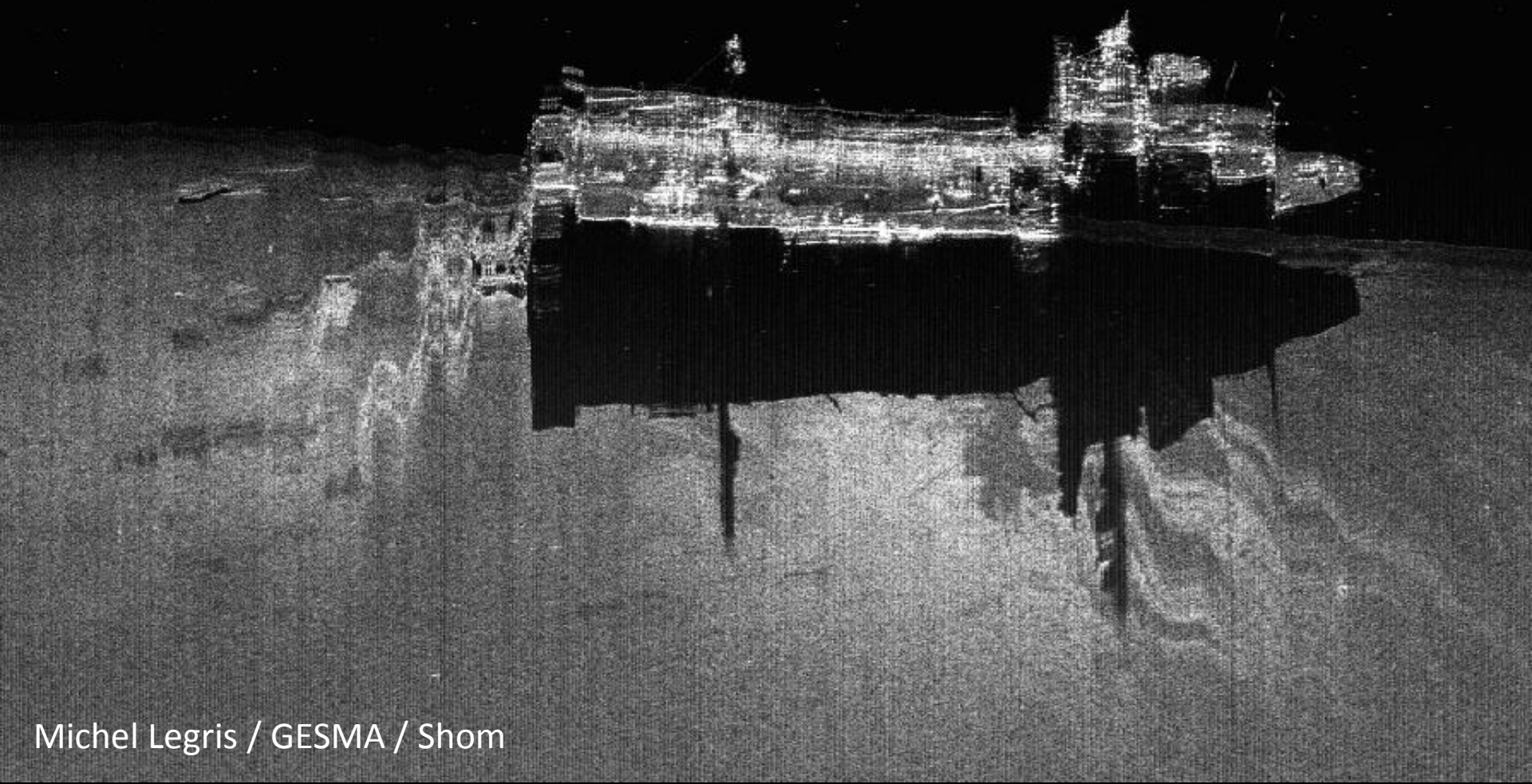




Sonar latéral avec déflecteur

(Michel Legris, Shom)

Trajectoire du sonar

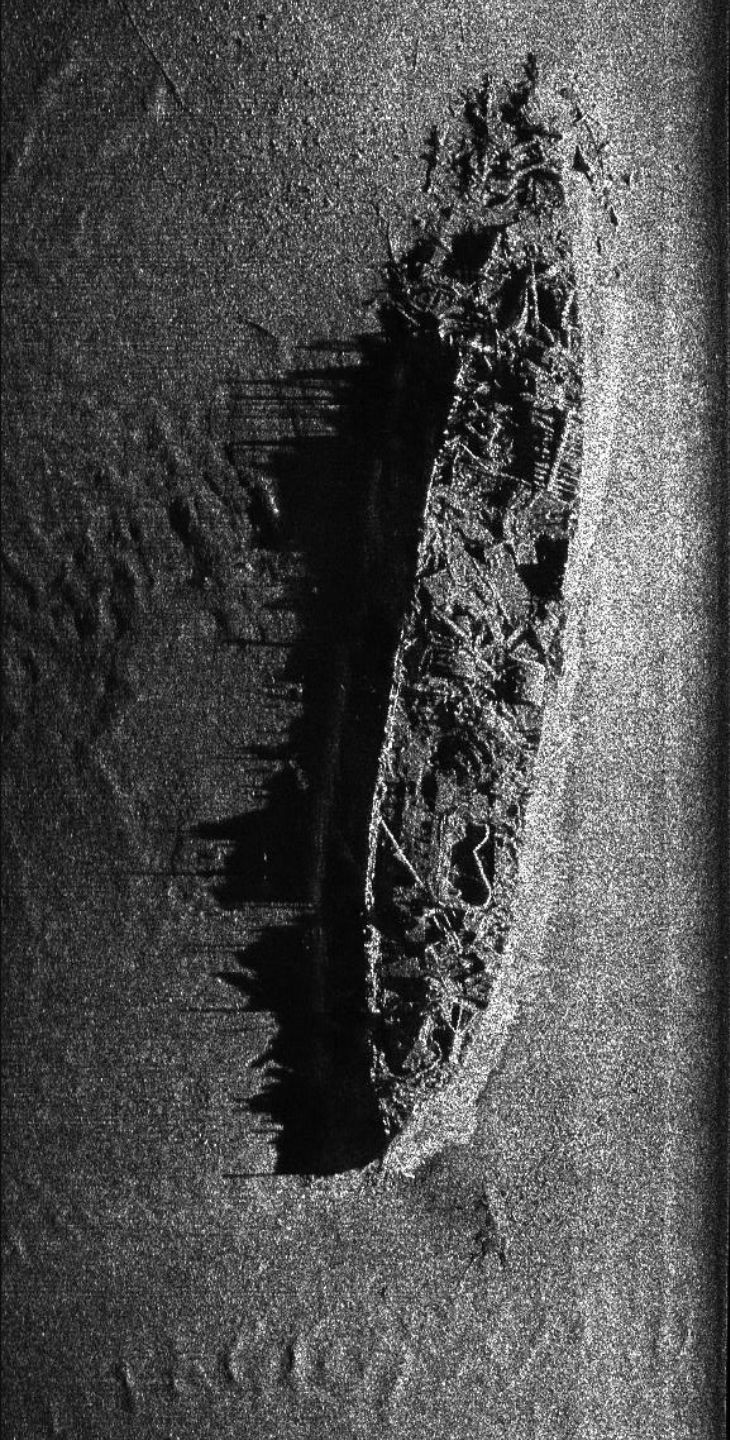


Vidéo



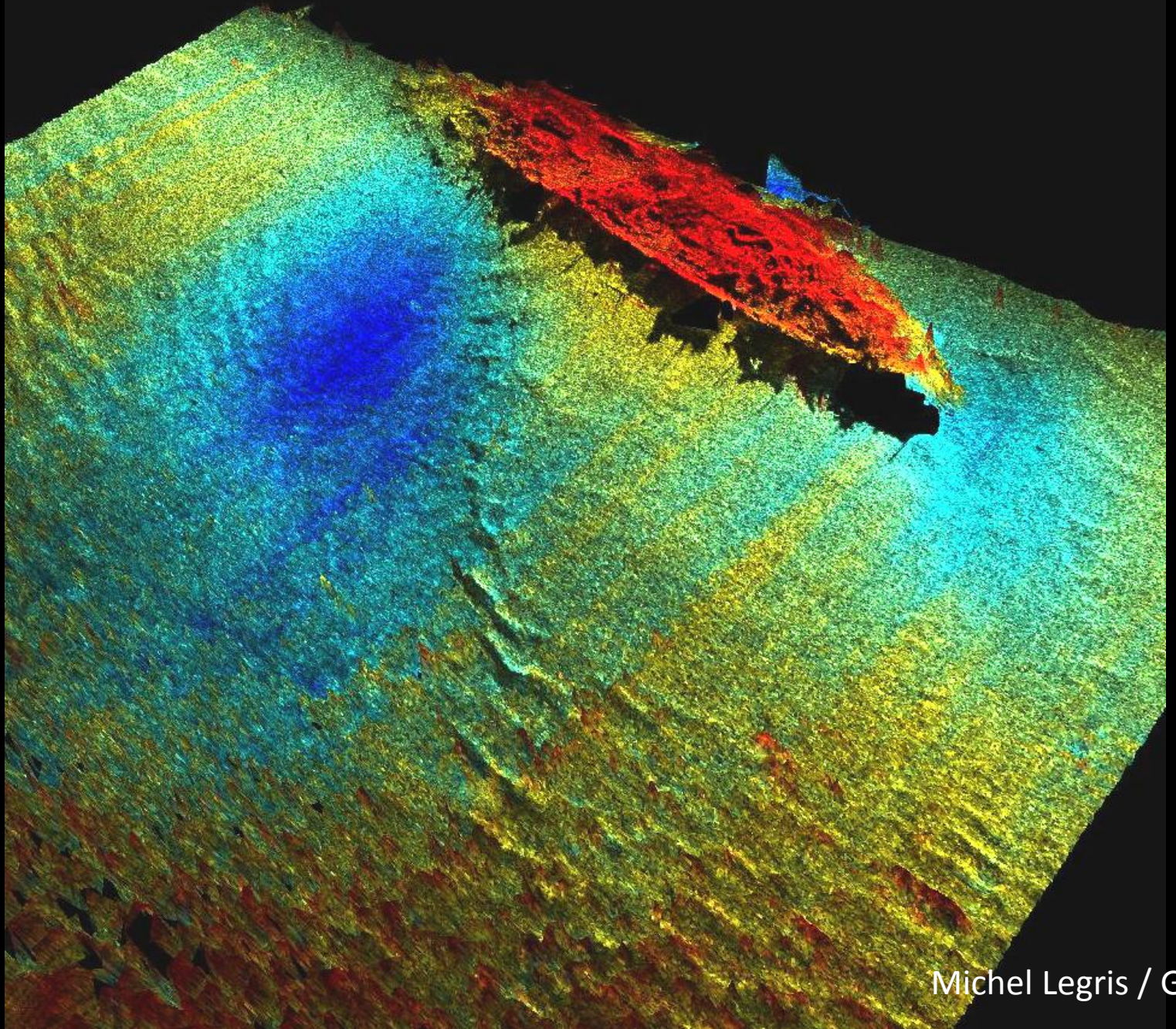
L'épave de la Meuse

Baie de Douarnenez



Trajectoire du sonar





Michel Legris / GESMA

An aerial, black and white photograph of a shipwreck in the Baltic Sea. The ship's hull is visible, tilted and partially submerged. The surrounding water is dark, and the seabed is visible in some areas. The image has a grainy, historical quality.

Epave en Baltique

1942, au large de la Suède



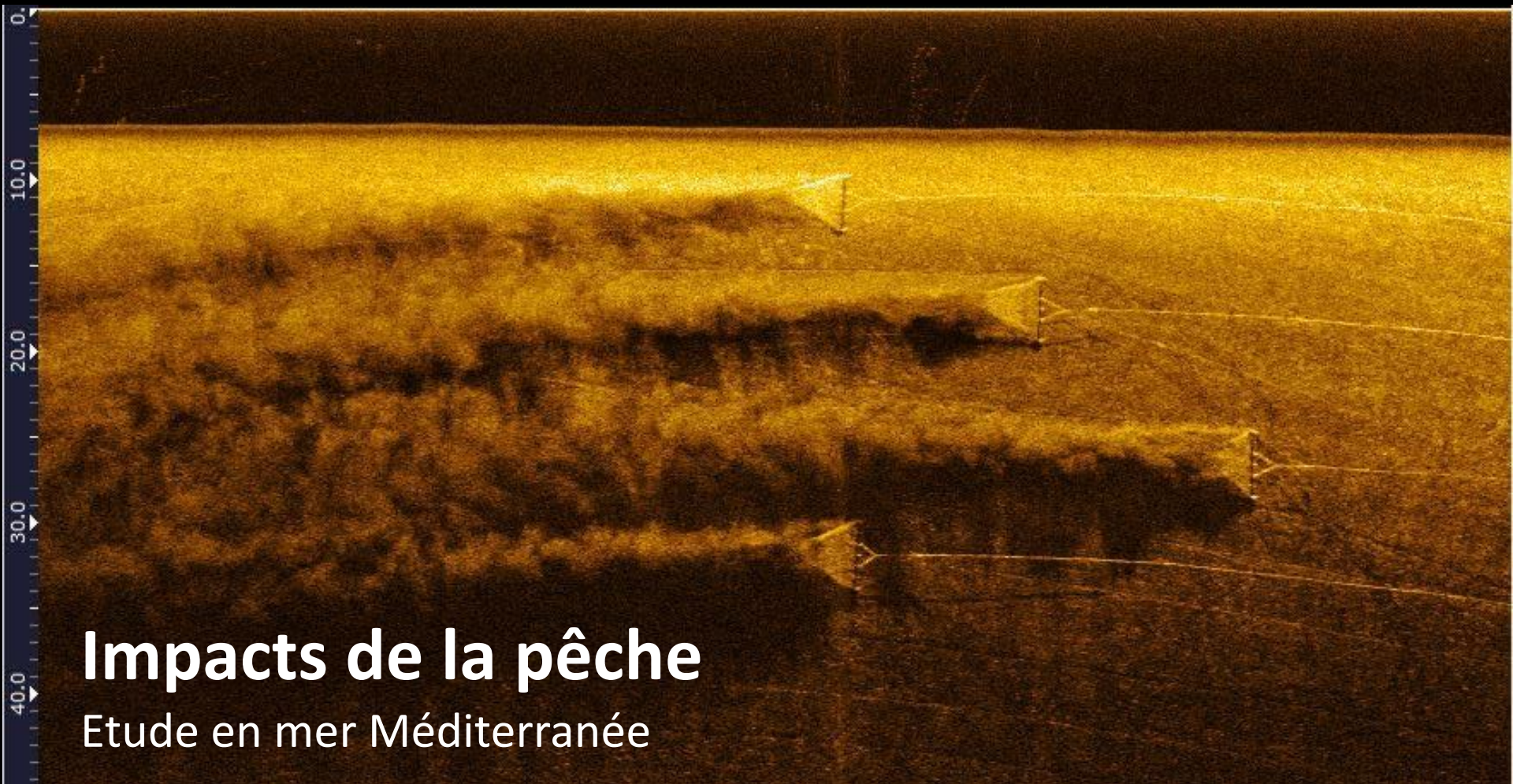
Impacts de la pêche

Etude en mer Méditerranée

Impact and performance of Mediterranean fishing gear by side-scan sonar technology

Alessandro Lucchetti, Antonello Sala

Canadian Journal of Fisheries and Aquatic Sciences 69(11):1806-1816 · November 2012




Impacts de la pêche

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Impact and performance of Mediterranean fishing gear by side-scan sonar technology

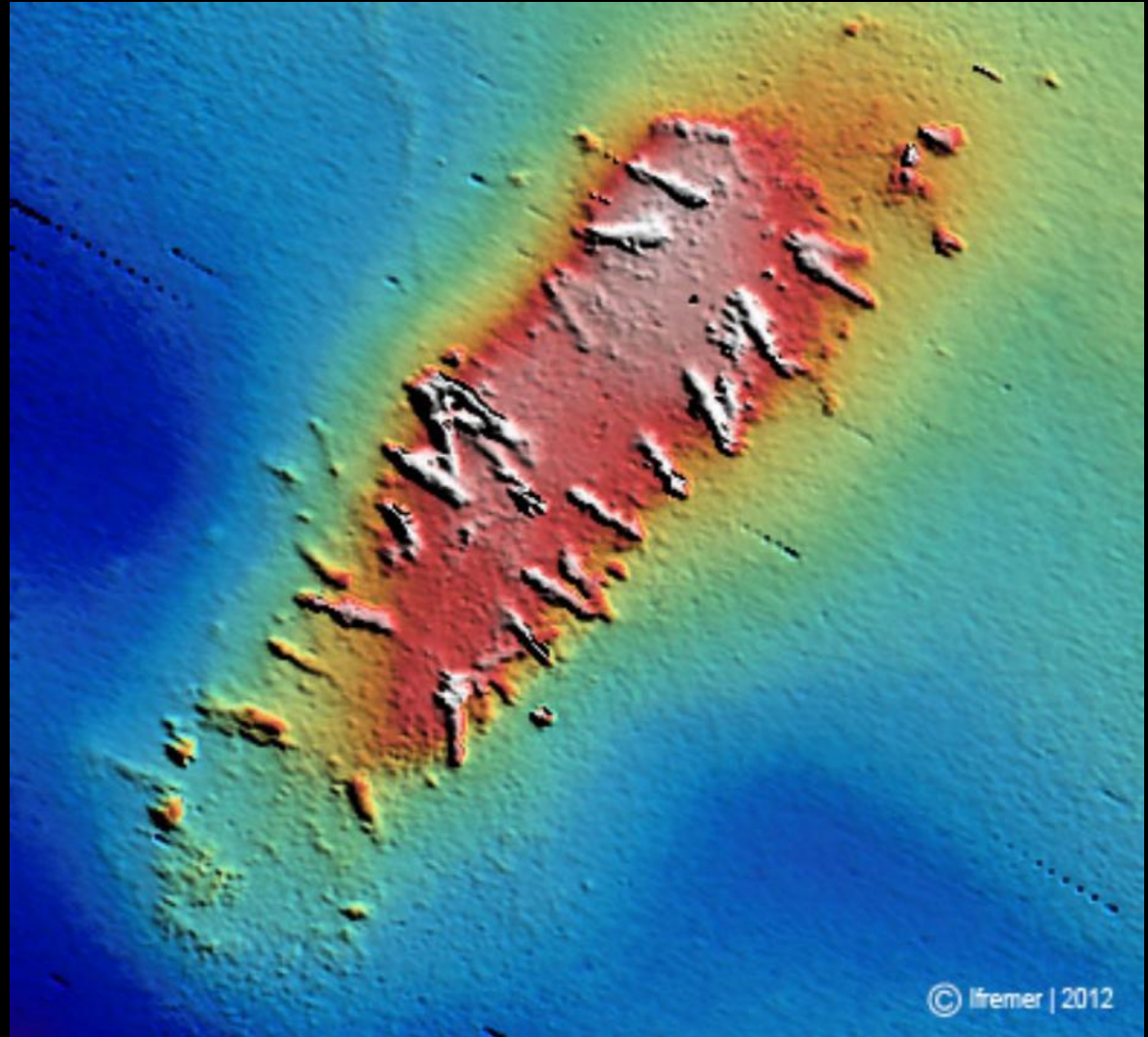
Alessandro Lucchetti, Antonello Sala

Canadian Journal of Fisheries and Aquatic Sciences 69(11):1806-1816 · November 2012

An underwater photograph showing sunlight filtering through the water surface, creating a shimmering effect. The water is a deep blue color, and the light rays are visible as bright, wavy patterns near the top of the frame.

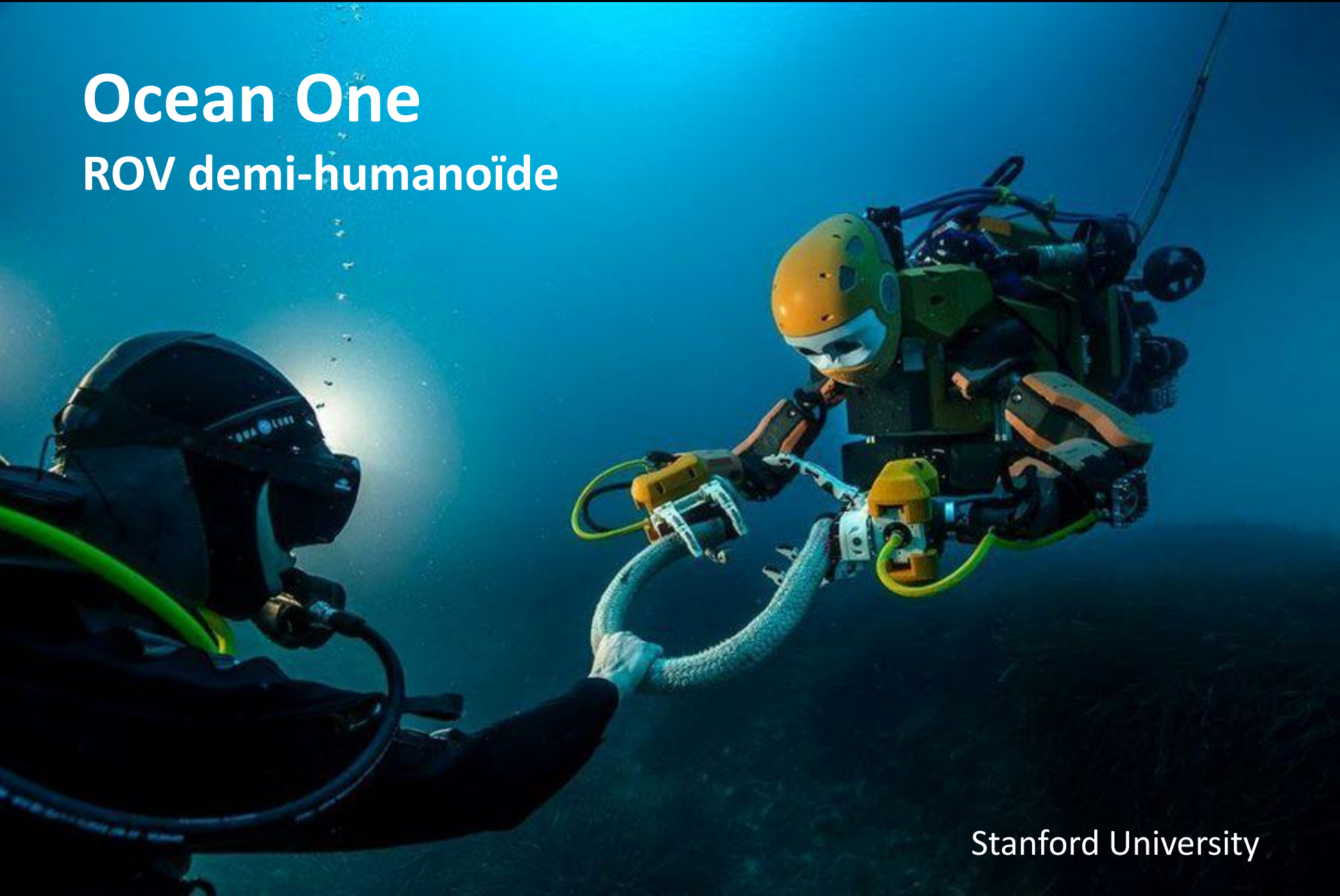
Innovations et futur de l'archéologie sous-marine

Plonger sur la Lune (1664)



Ocean One

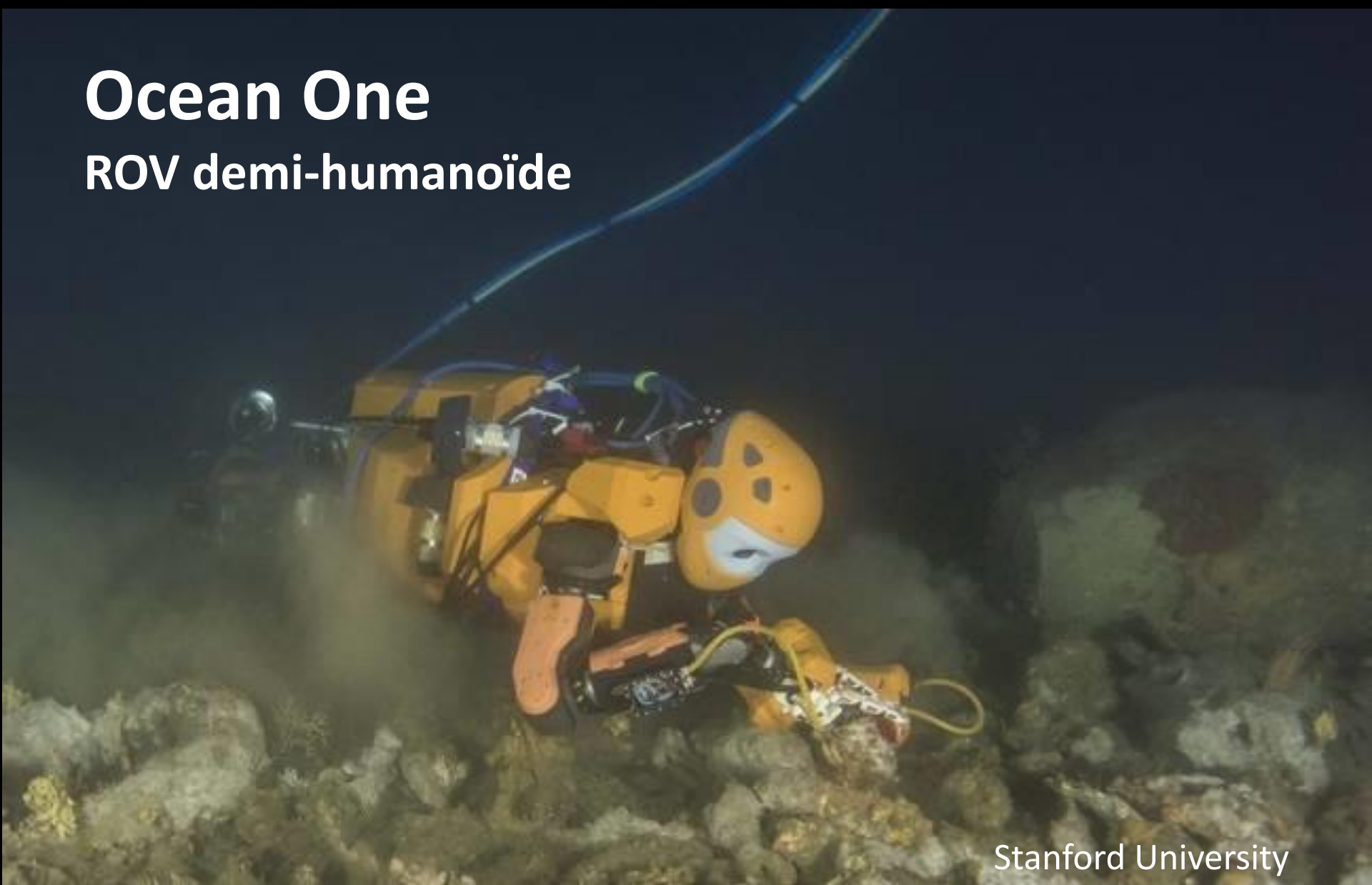
ROV demi-humanoïde



Stanford University

Ocean One

ROV demi-humanoïde

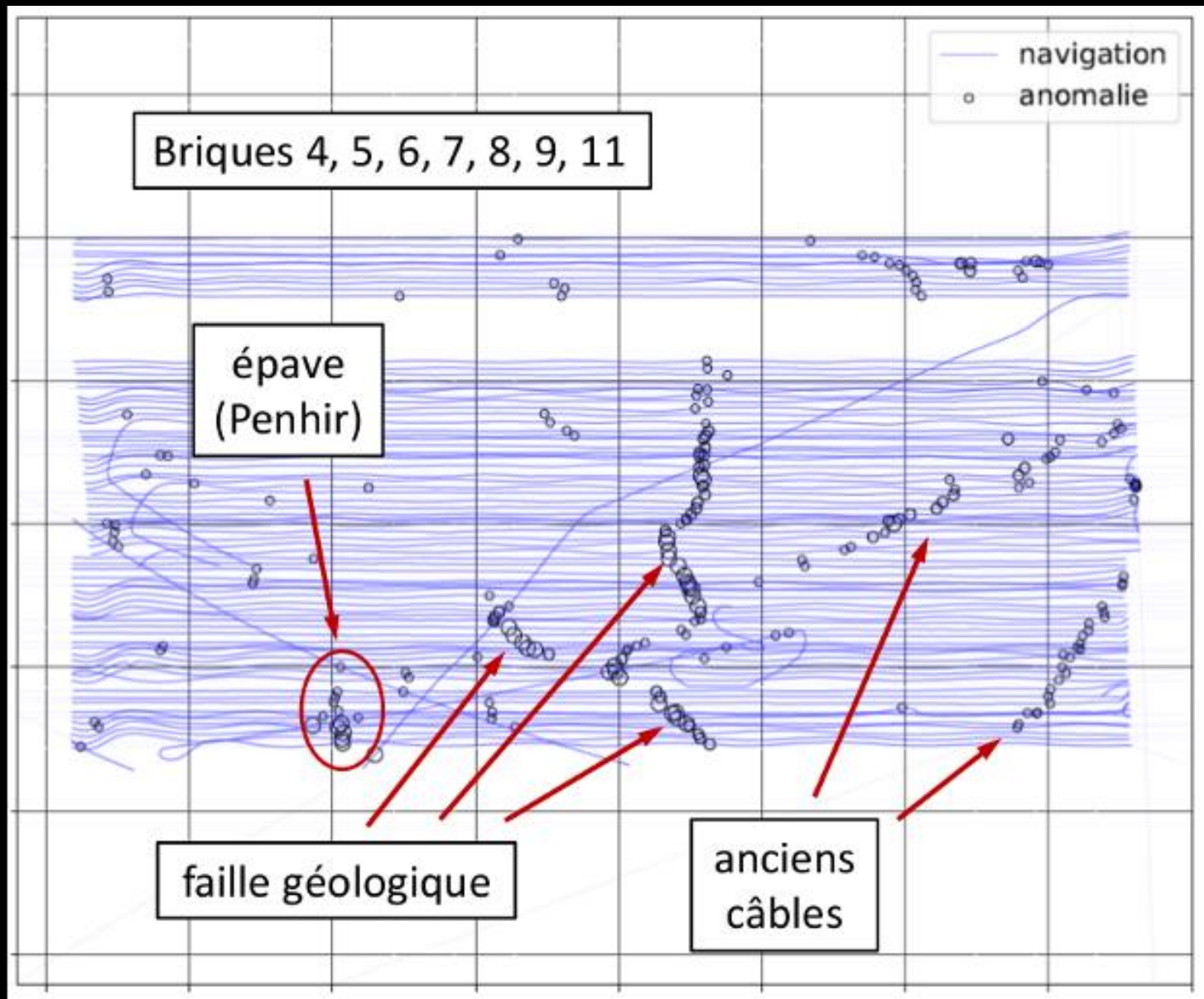


Stanford University

La Cordelière

Naufrage en 1512, au large de Brest





Des drones marins autonomes



Carte bathymétrique

Roscanvel

