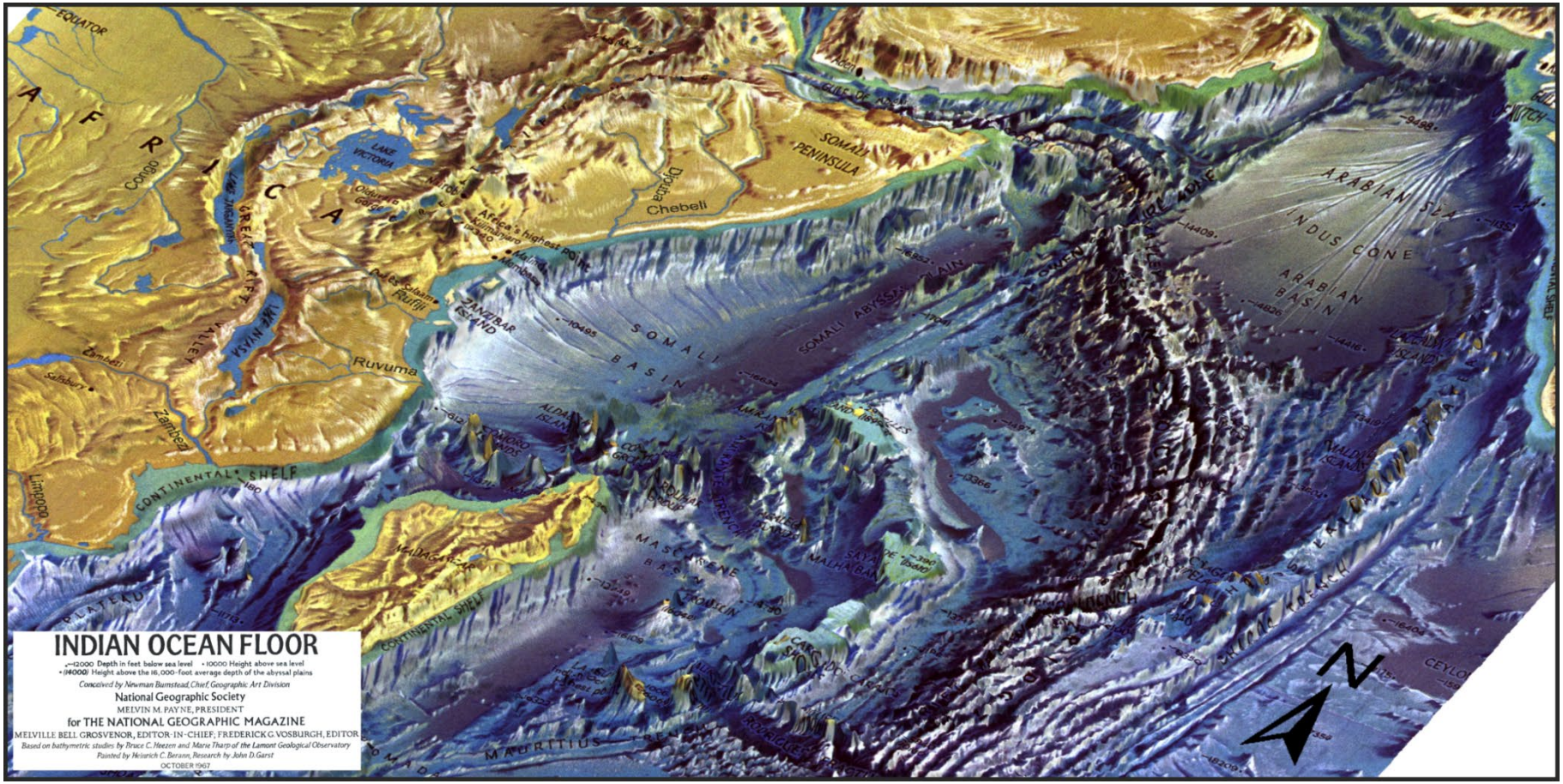
BATHYMETRIE DES FONDS OCEANIQUES

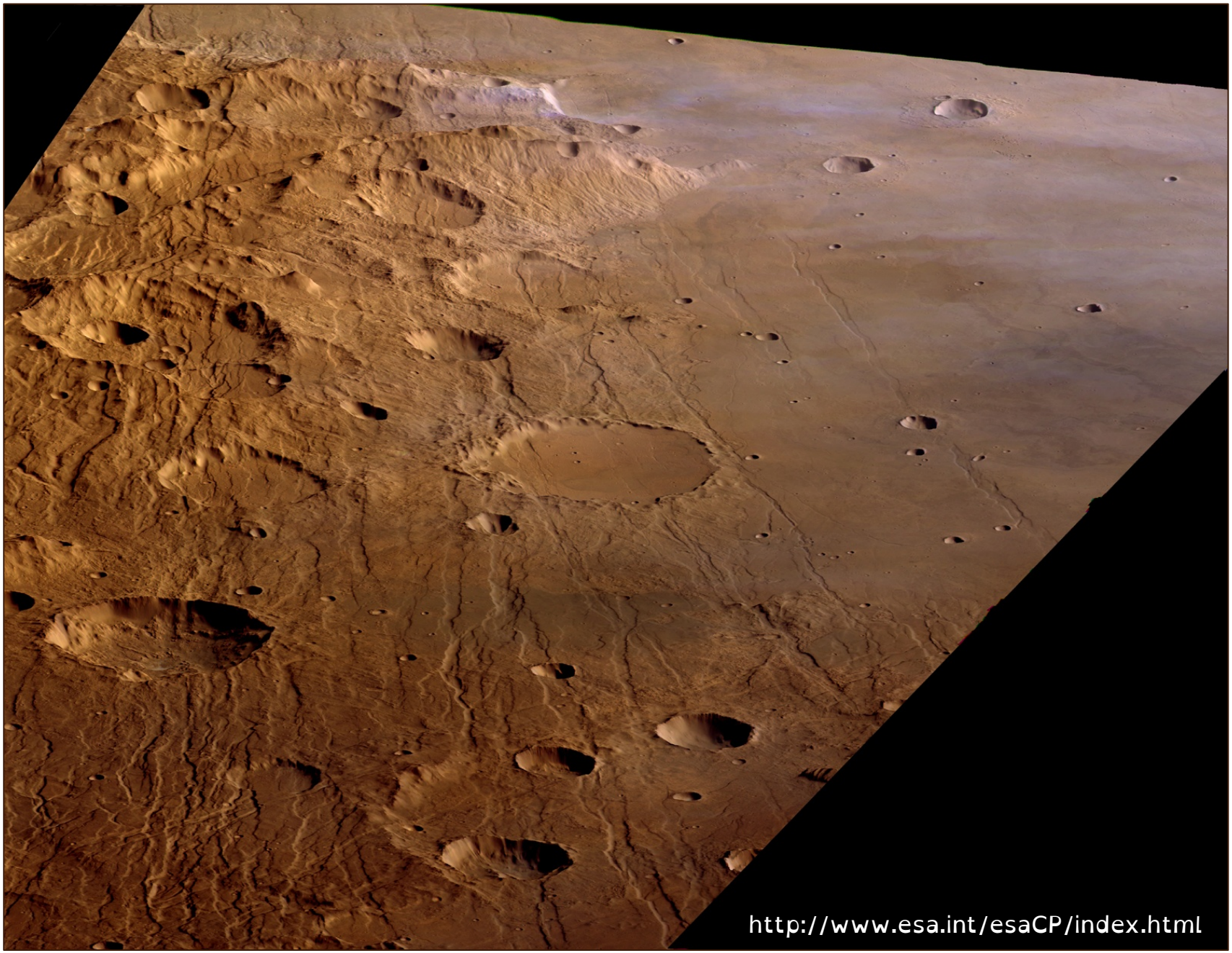


Sébastien Zaragosi

Université de Bordeaux

http://www.geocean.net

université de BORDEAUX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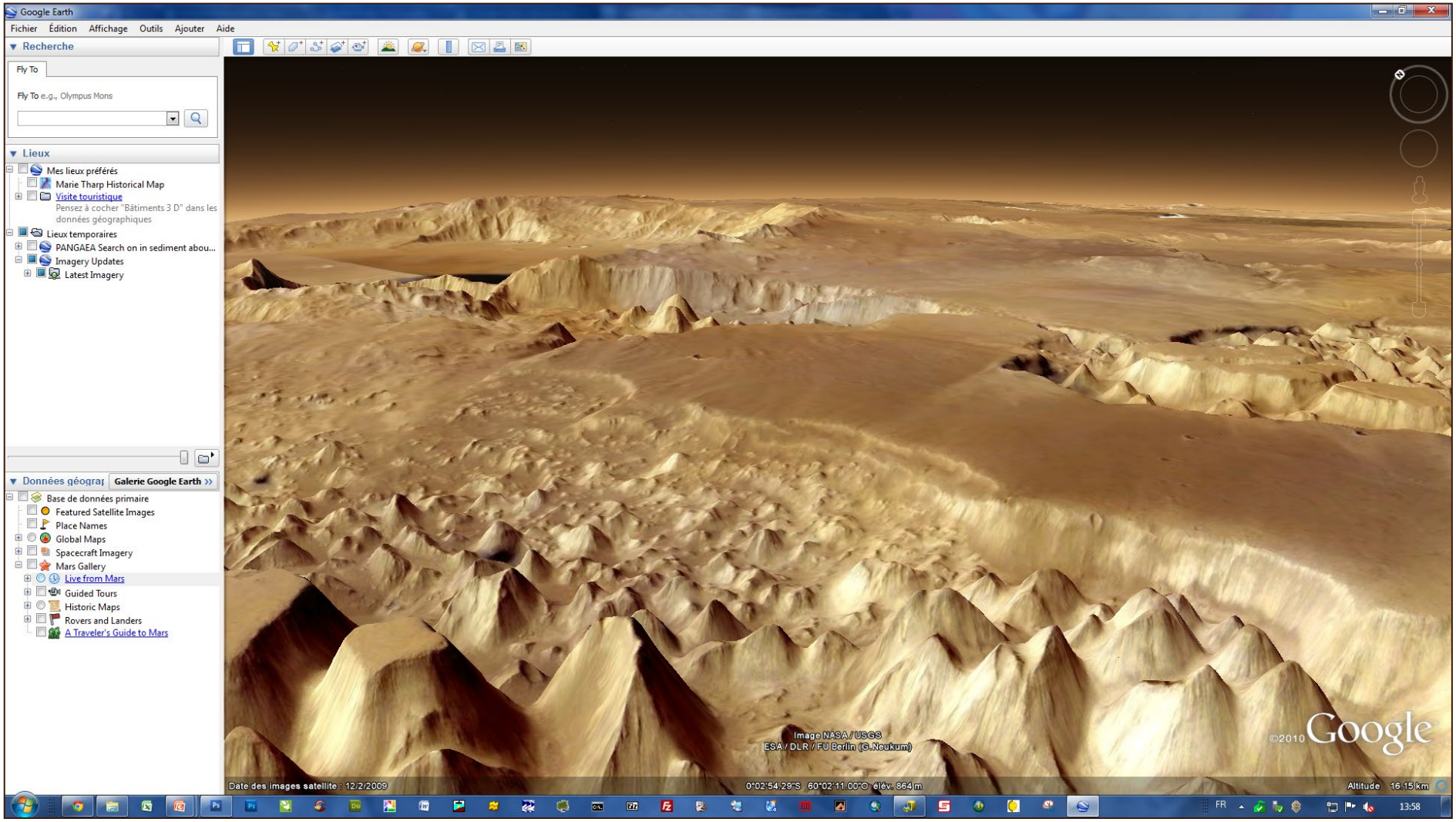
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Fly To
Fly To e.g., Olympus Mons
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Mes lieux préférés
Marie Tharp Historical Map
Visite touristique
Pensez à cocher "Bâtiments 3 D" dans les données géographiques
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A Traveler's Guide to Mars
Image NASA / USGS
ESA / DLR / FU Berlin (G.Neukum)
©2010 Google
Date des images satellite : 12/2/2009
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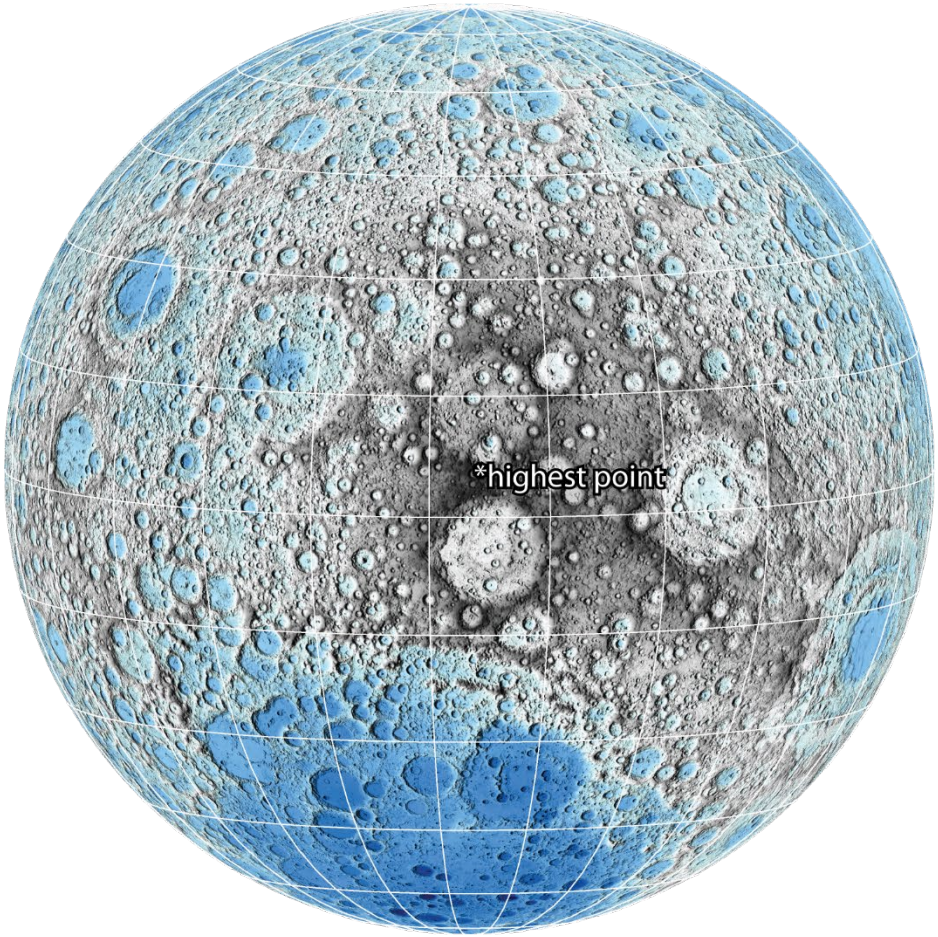
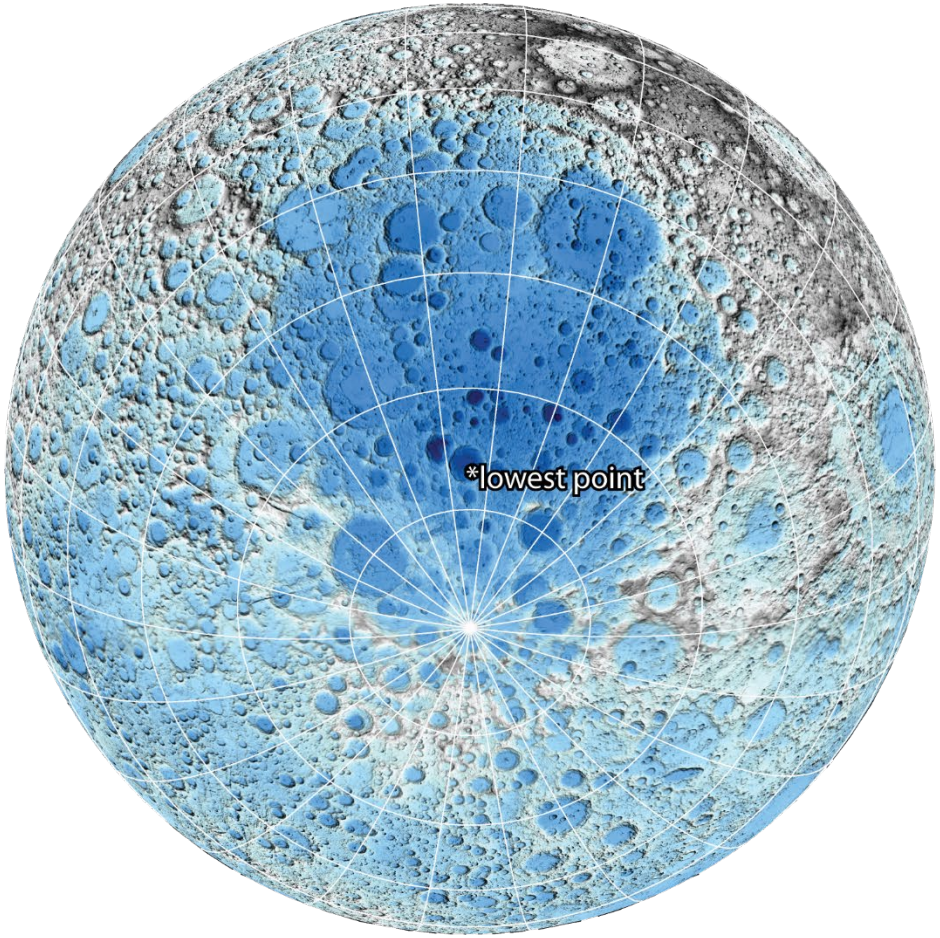
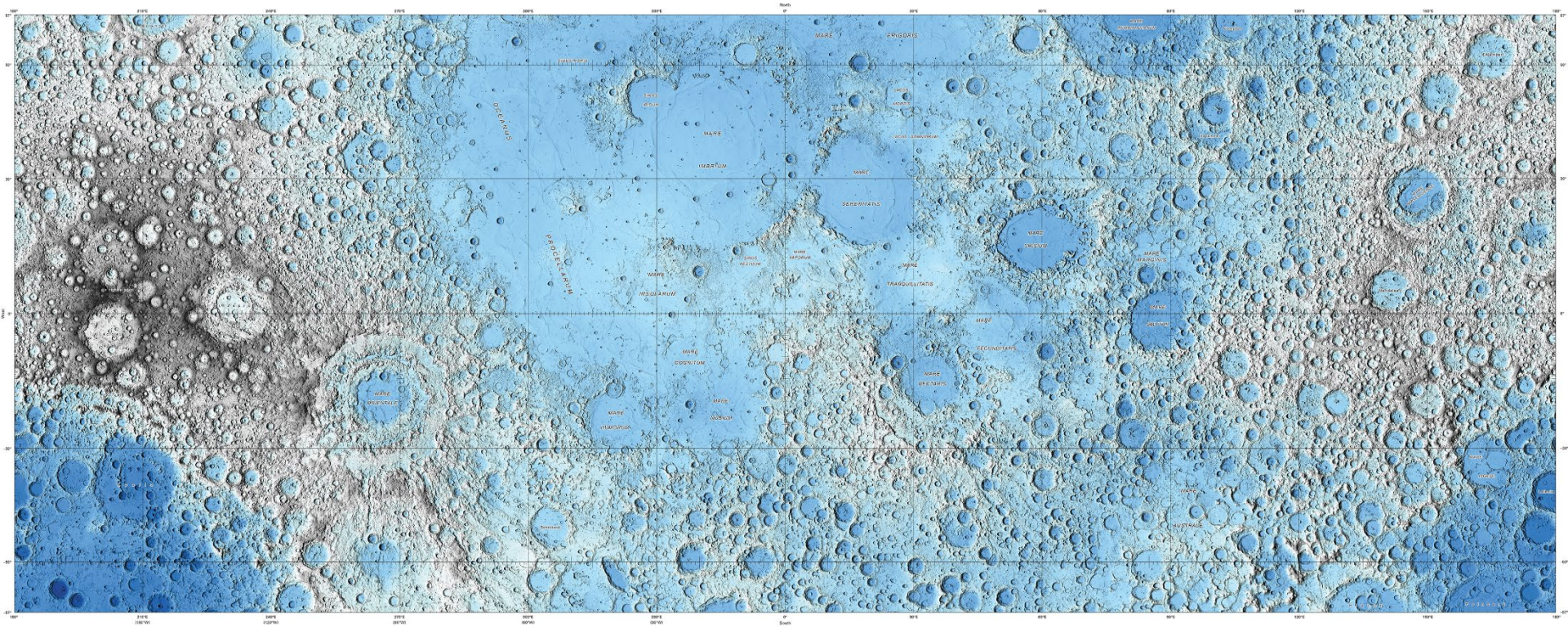




https://www.usgs.gov/news/visit-moon-without-leaving-your-desk



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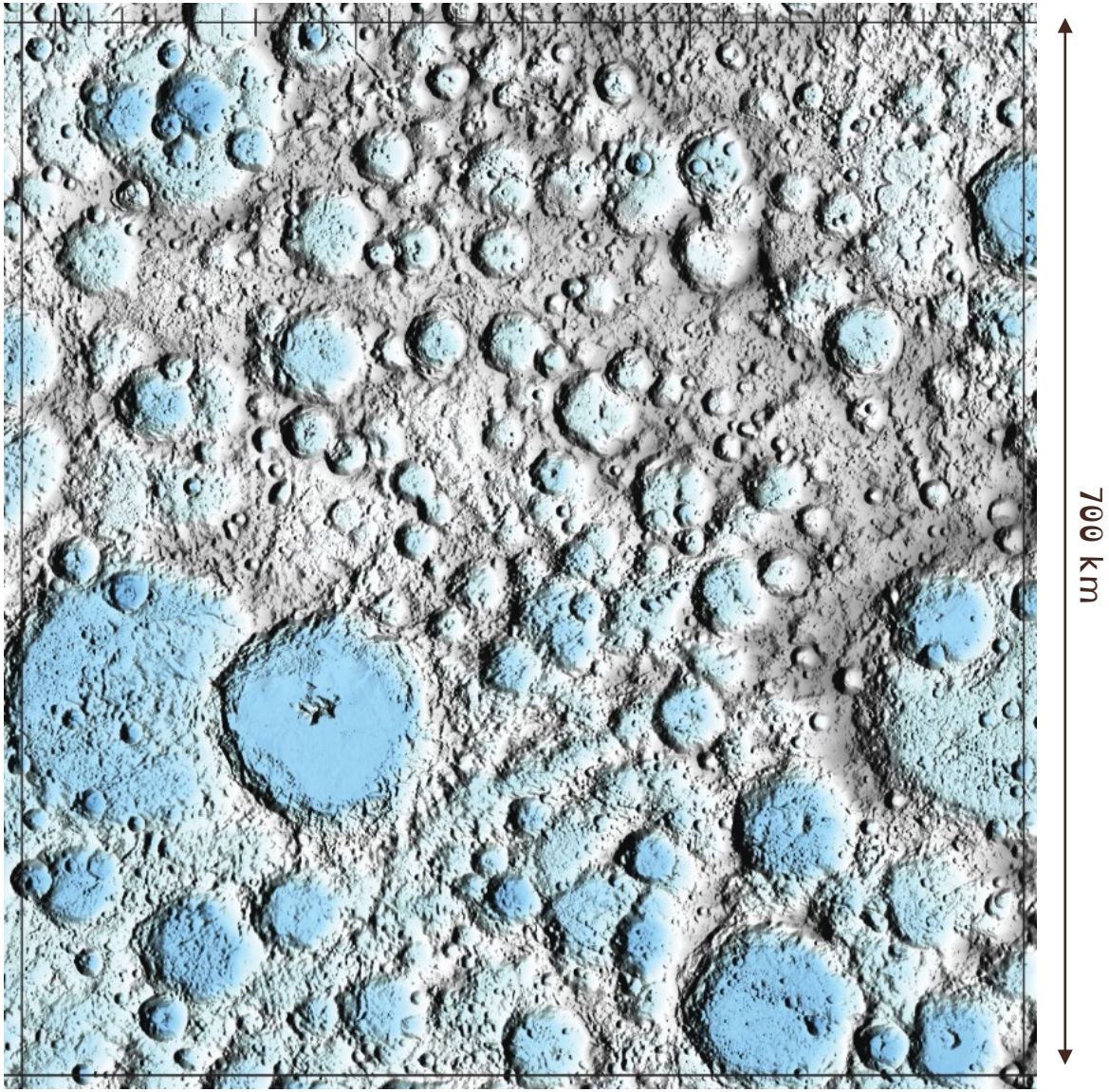

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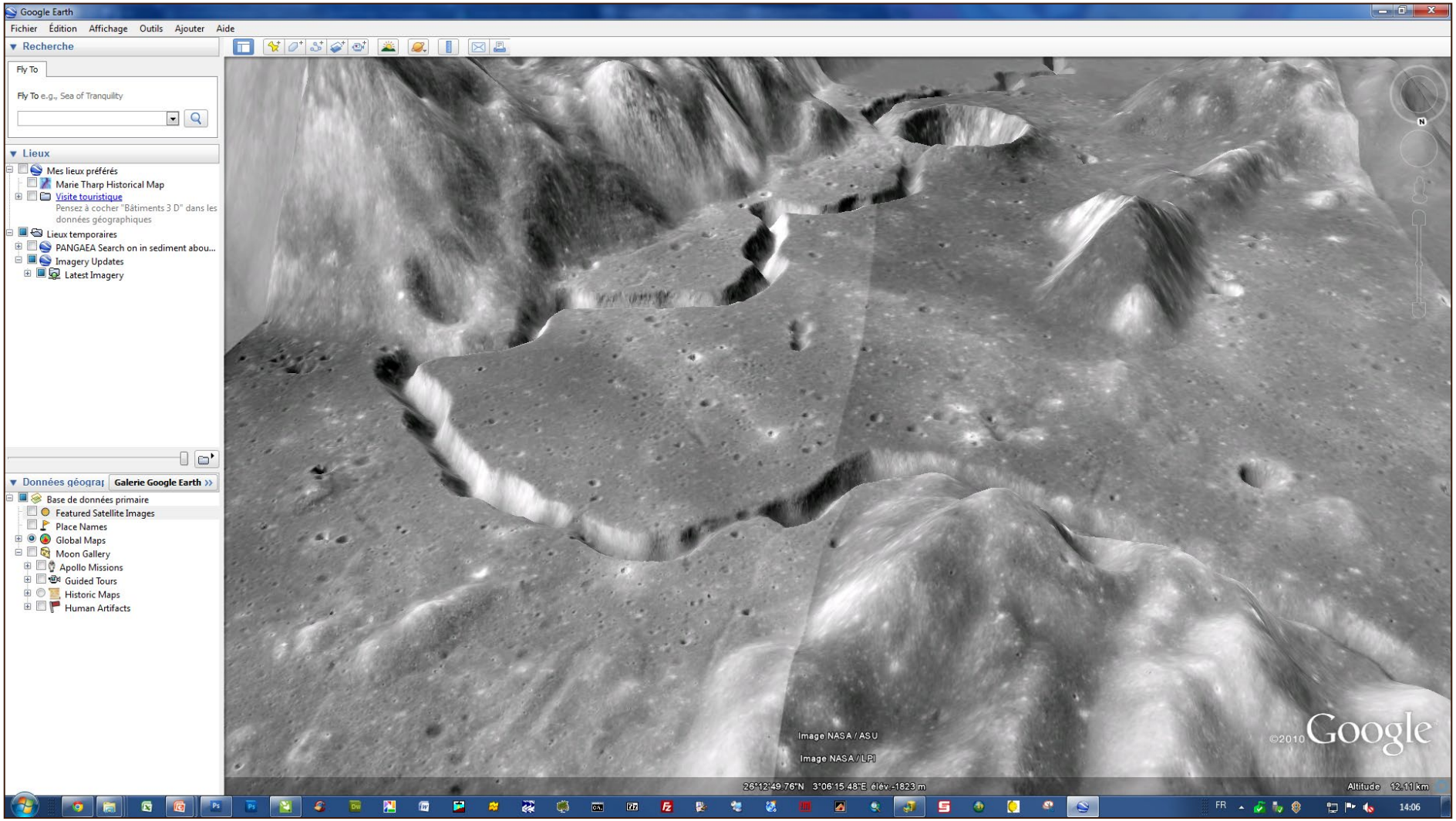
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Lieux
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Données géograp
Galerie Google Earth
Base de données primaire
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Human Artifacts
Image NASA / ASU
Image NASA / LPI
©2010 Google
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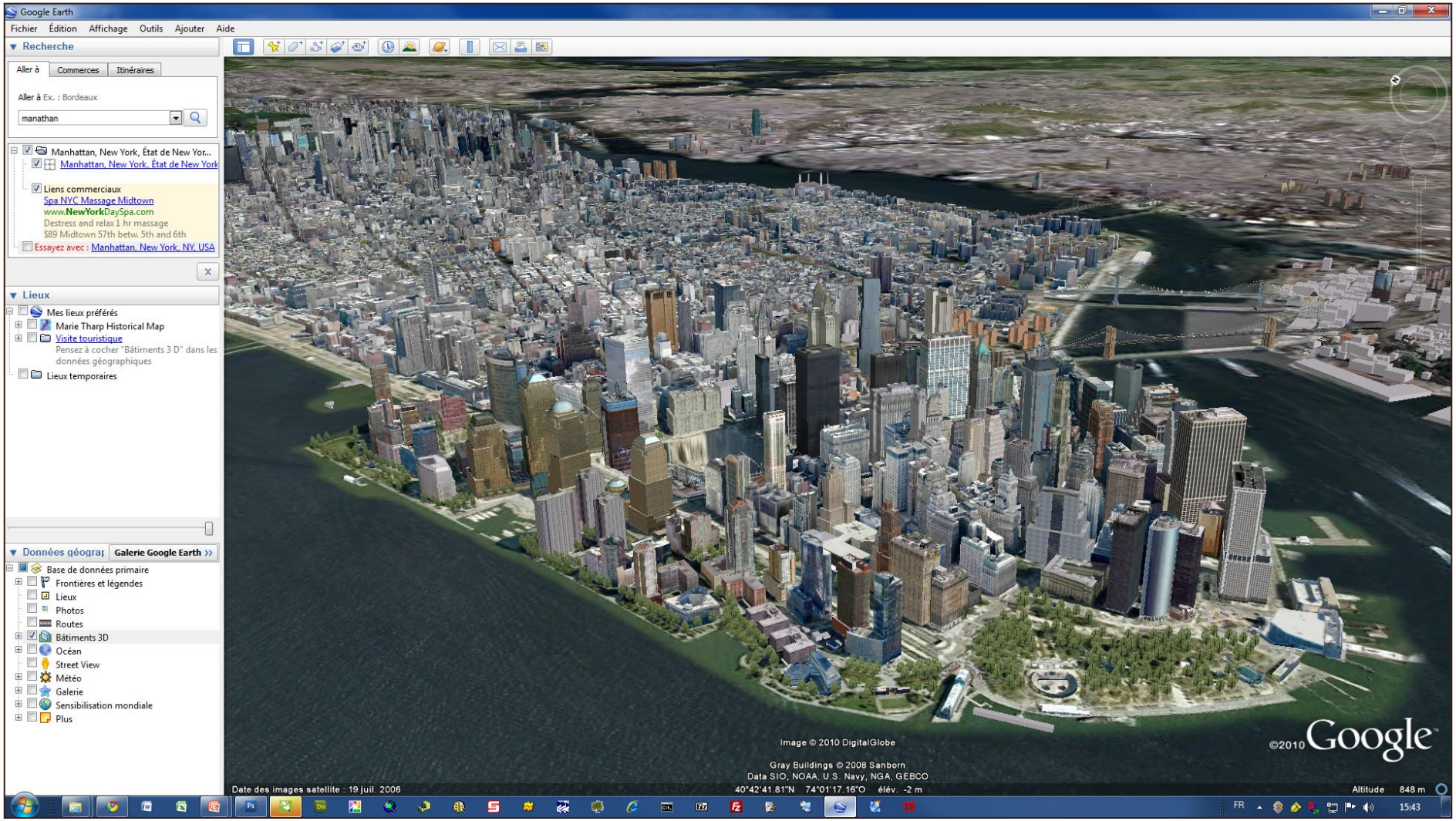
Altitude 12.11 km
FR
14:06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Manhattan, New York, État de New York
Liens commerciaux
Spa NYC Massage Midtown
www.NewYorkDaySpa.com
Destress and relax 1 hr massage
$89 Midtown 57th betw. 5th and 6th
Essayez avec : Manhattan, New York, NY, USA
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Lieux temporaires
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Base de données primaire
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Image © 2010 DigitalGlobe
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©2010 Google
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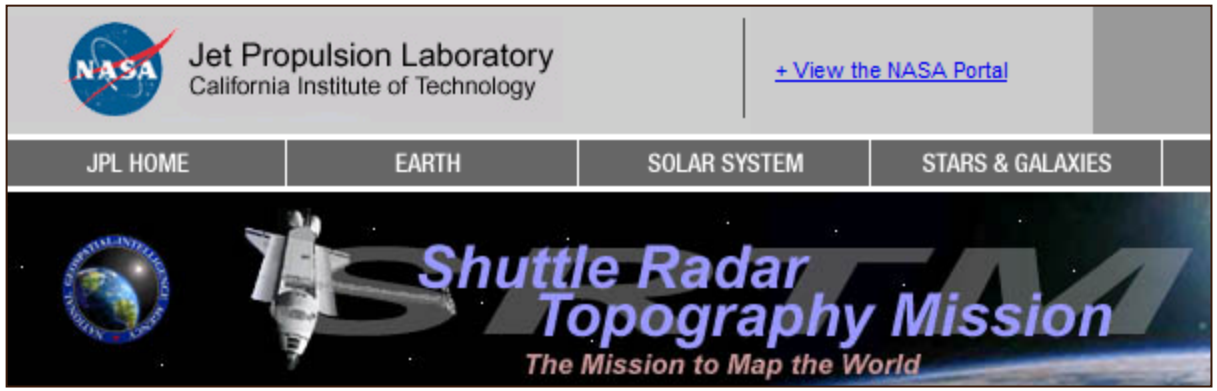

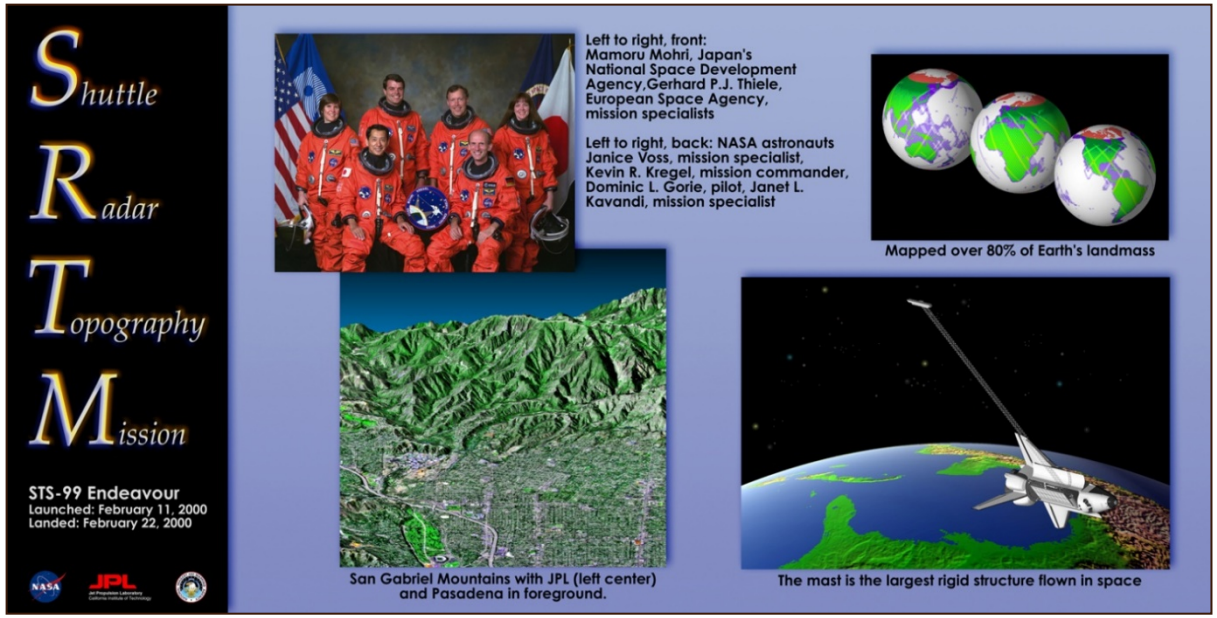

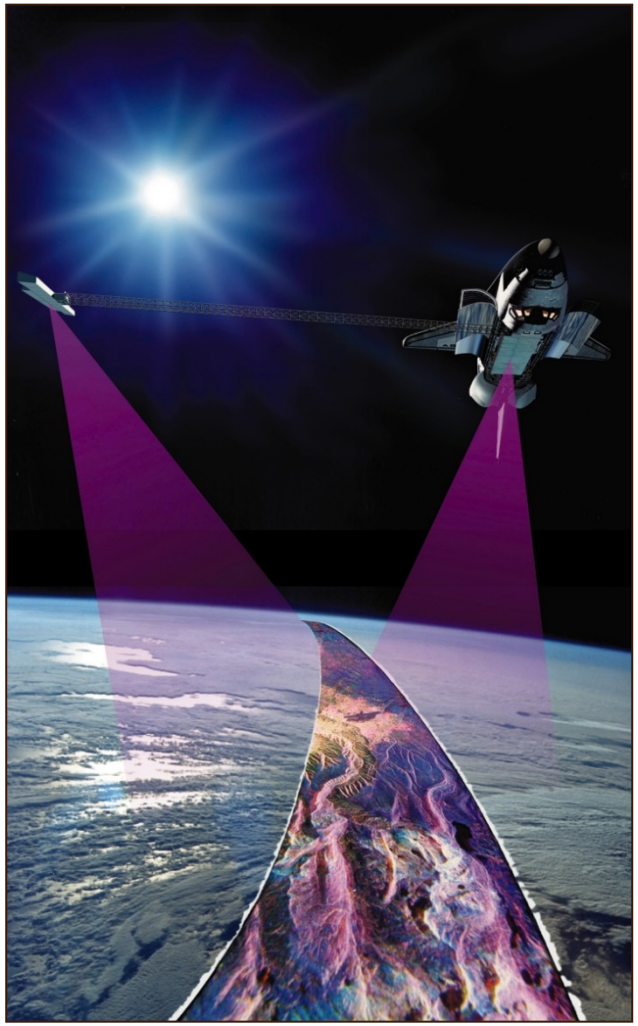

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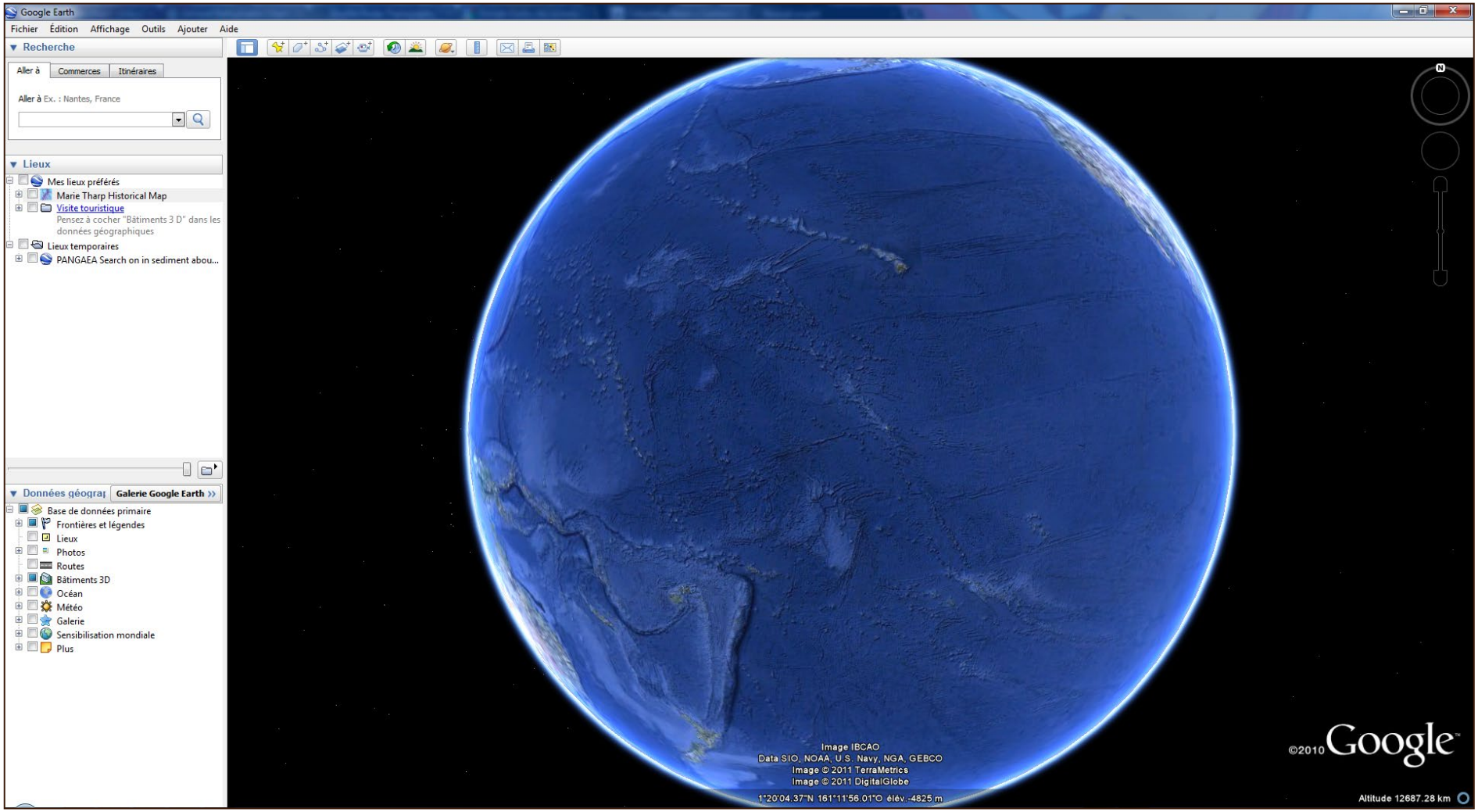
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Aller à
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Mes lieux préférés
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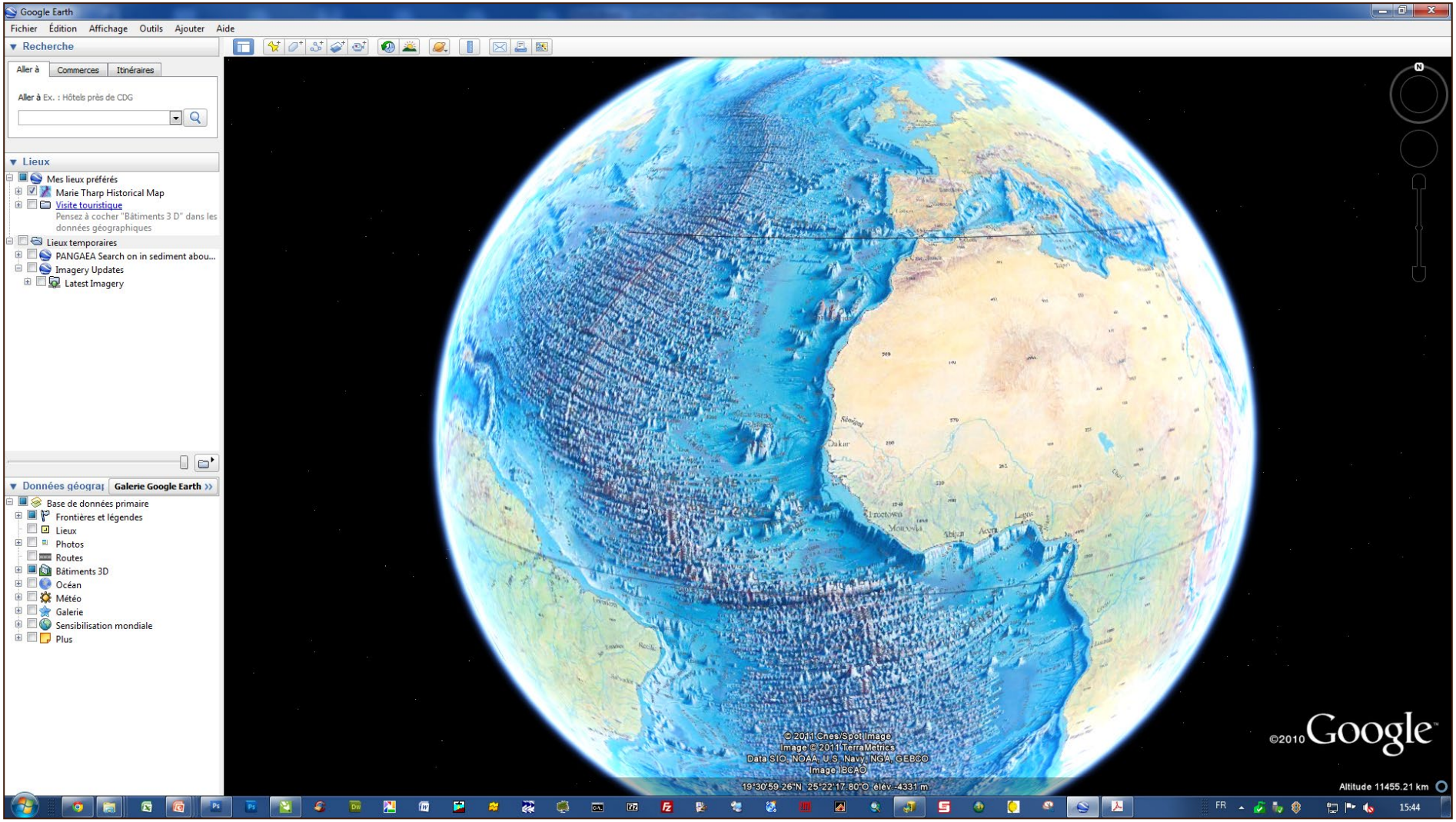
Océan
Météo
Galerie
Sensibilisation mondiale
Plus
Image IBCAO
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2011 TerraMetrics
Image © 2011 DigitalGlobe
1°20'04.37"N 161°11'56.01"O élév. -4825 m
©2010 Google
Altitude 12687.28 km

Marie Tharp et Bruce Heezen années 50 par Google Earth 21e siècle…



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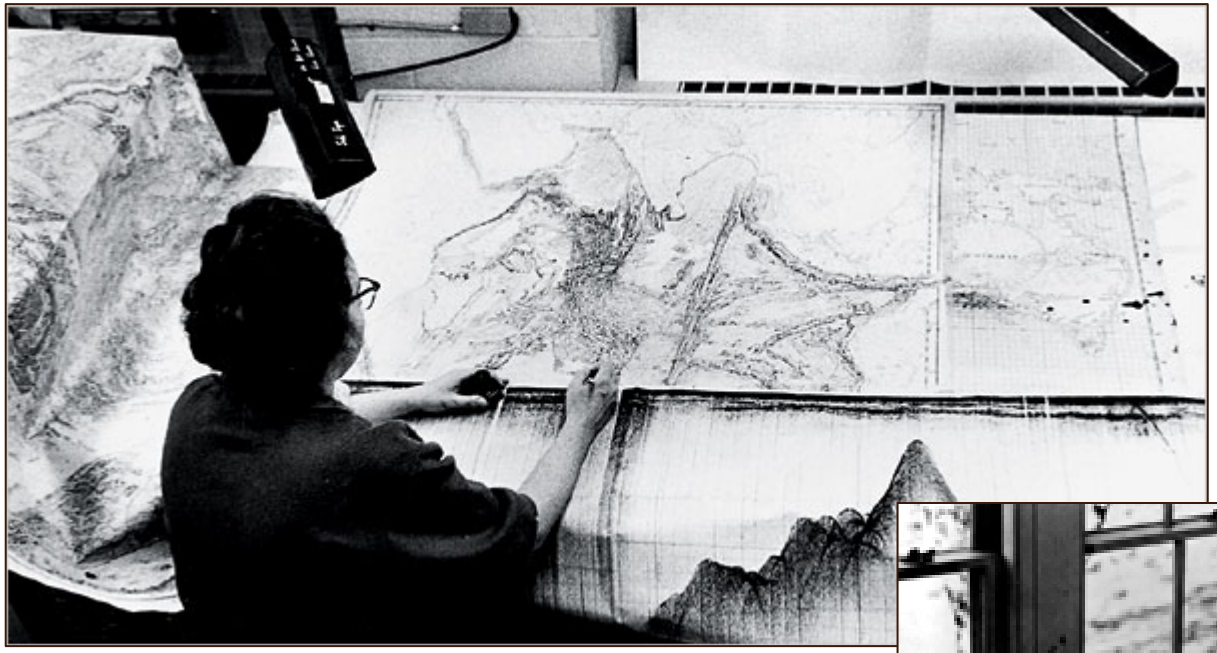

Marie Tharp (1920 – 2006)
Université de Columbia

WORLD OCEAN FLOOR
BY BRUCE C. HEEZEN AND MARIE THARP
Lamont Doherty Geological Observatory, Palisades, New York 10964
Based on Research and Exploration Initiated and Supported by the
UNITED STATES NAVY
OFFICE OF NAVAL RESEARCH
Mercator Projection
SUBMARINE DEPTHS IN CORRECTED METERS.
LAND ELEVATIONS IN METERS.
HORIZONTAL SCALE 1:15,236,500
FIRST EDITION, 1977 - THIRD PRINTING 1994
PUBLISHED BY THE UNITED STATES NAVY AS A MEMORIAL TO DR. BRUCE C. HEEZEN
IN RECOGNITION OF HIS CONTRIBUTIONS TO MAN'S KNOWLEDGE OF THE WORLD OCEAN FLOOR
URAL MOUNTAINS
CARPATHIAN MTNS
ALPS MOUNTAINS
CAUCASUS MTNS
TIEN SHAN
GREATER KHINGAN RANGE
HINDU KUSH
PYRENEES
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Dakar
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Monrovia
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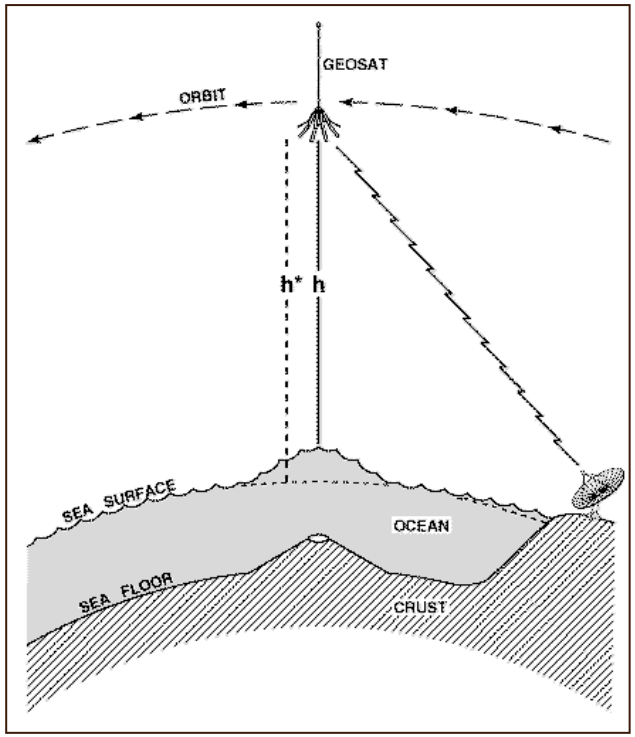
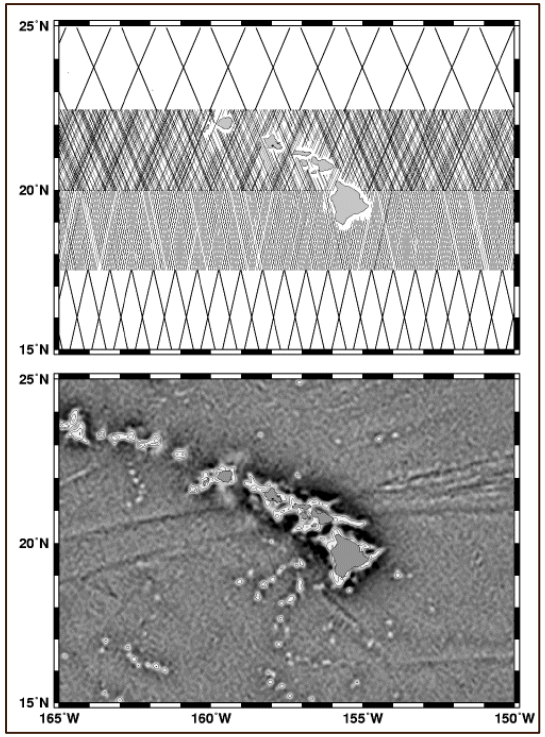
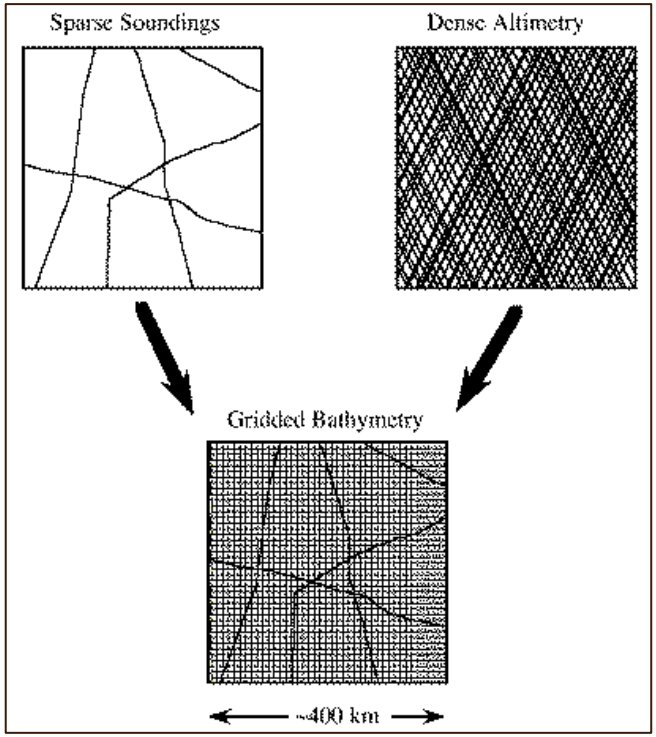


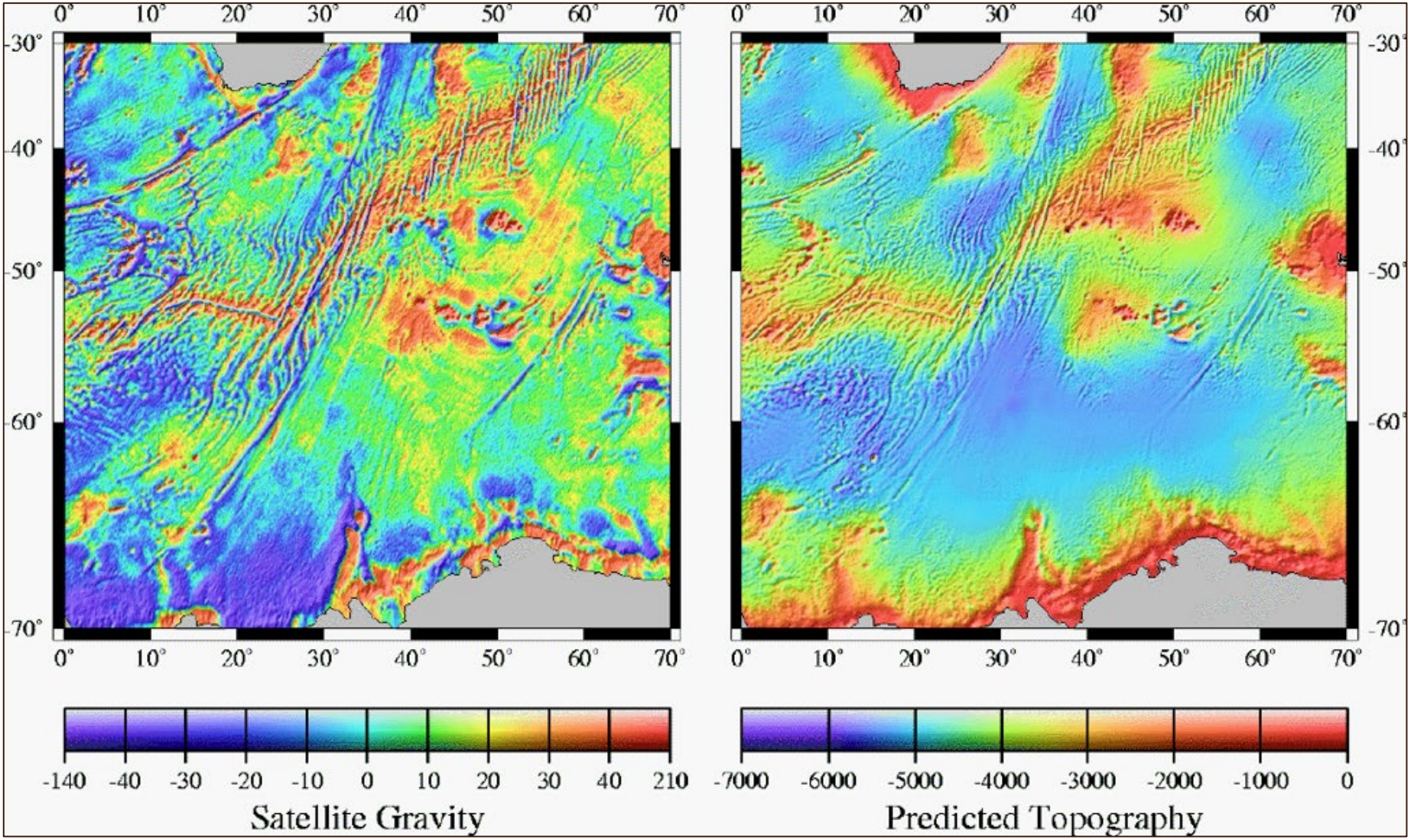




http://topex.ucsd.edu/marine_grav/explore_grav.html#sat_alt

Plusieurs passages d'un satellite altimétrique permettent de moyenner les mesures altimétriques -> surface moyenne de l'océan au repos

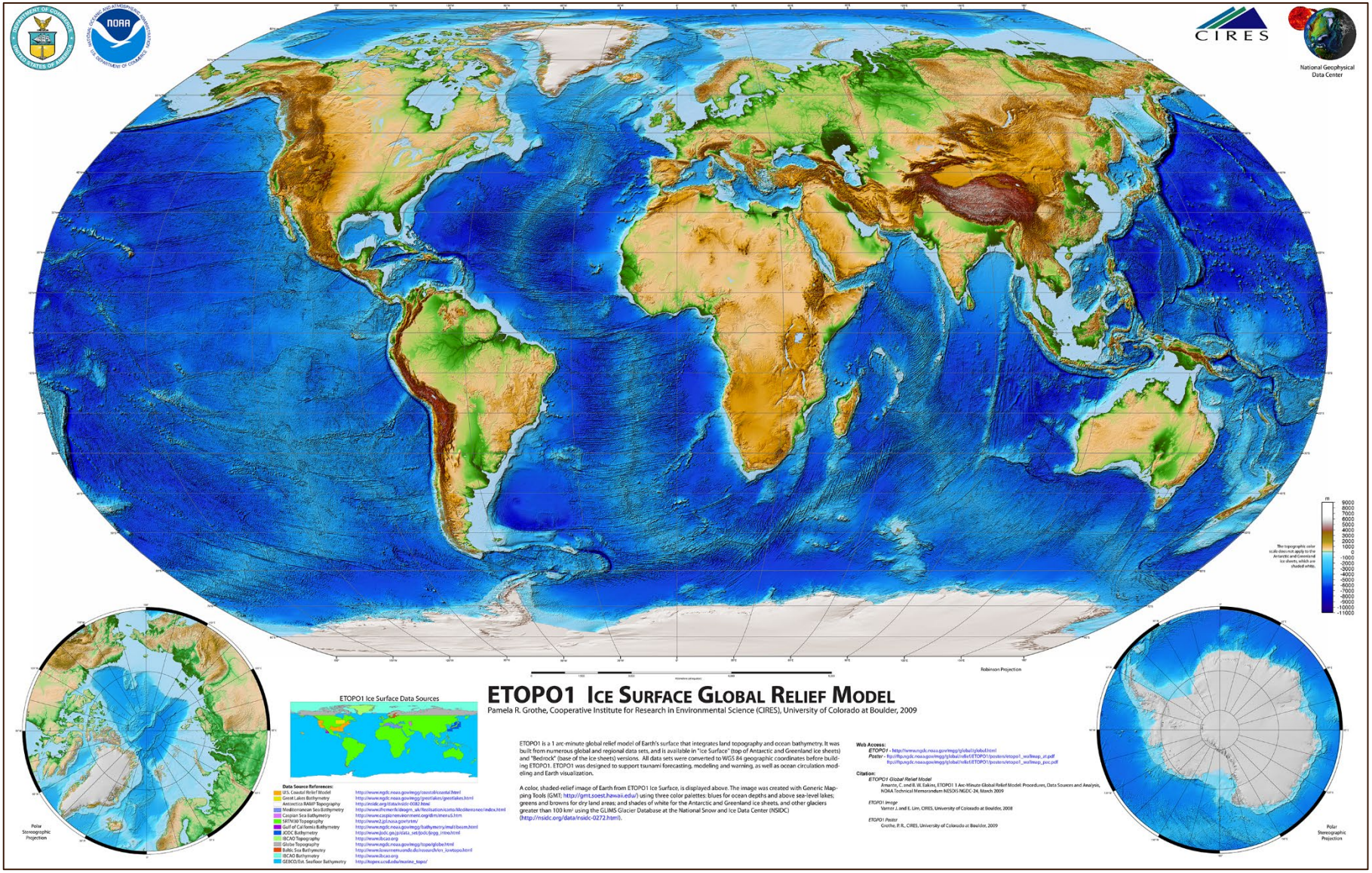
Mesures des variations de la gravité engendrées par des reliefs océaniques



http://topex.ucsd.edu

Les données gravimétriques servent prédire la topographie des zones vierges de sondages bathymétriques

ETOPO 1 : Précision 1 minute d'arc (111km/60 = ~ 1.85 km)



http://www.ngdc.noaa.gov/mgg/global/global.html

NOAA NATIONAL GEOPHYSICAL DATA CENTER
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Search NGDC

NOAA > NESDIS > NGDC > Marine Geology & Geophysics > Bathymetry & Relief

privacy policy

All Bathy/Relief | Coastal | DEM Portal | Fishing | Global | Lakes | Multibeam | NOS

Extract Custom Grid

Interactive Map Interface to Bathymetry Data

ETOPO1 Development Report (.PDF) (download data files at right)

NEW! Frequently Asked Questions

Ocean Volumes

NEW! Earth Hypsographic Curve

Data Sources

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Download KMZ Images File

Download "Posters"

Access Web Services

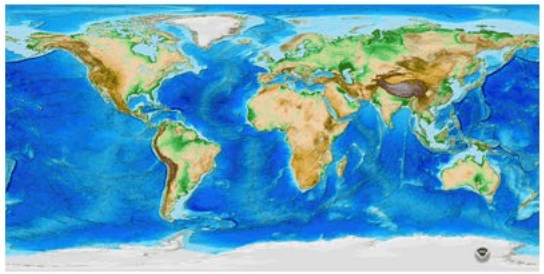
Global Grids at NGDC:

ETOPO2 Historic Global Relief
ETOPO5 Historic Global Relief
GLOBE Topography
Ocean Crustal Ages
Ocean Sediment Thickness

Project Contact:

Barry.Eakins@noaa.gov
phone: 303-497-6505

ETOPO1 Global Relief Model



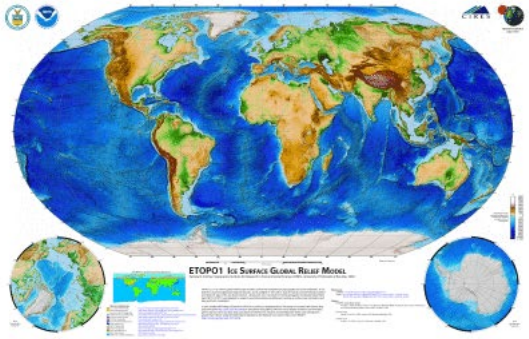
ETOPO1 is a 1 arc-minute global relief model of Earth's surface that integrates land topography and ocean bathymetry. It was built from numerous global and regional data sets, and is available in "Ice Surface" (top of Antarctic and Greenland ice sheets) and "Bedrock" (base of the ice sheets) versions. Historic ETOPO2v2 and ETOPO5 global relief grids are deprecated but still available.

NEW! NGDC has utilized the ETOPO1 Global Relief Model to calculate the volumes of the world's oceans and to derive a hypsographic curve of Earth's surface.

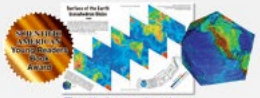
Color Image of Earth

A color shaded-relief image of Earth from ETOPO1 Ice Surface, created by NGDC, is displayed above. The image is downloadable as a georeferenced TIFF or KMZ file, and available for NOAA's Science On a Sphere®. It is also viewable in web browsers at ArcGIS.com. The image was created with Generic Mapping Tools (GMT) using three color palettes: blues for ocean depths and above sea-level lakes; greens and browns for dry land areas; and shades of white for the Antarctic and Greenland ice sheets, and other glaciers greater than 100 km^2 using the GLIMS Glacier Database at the National Snow and Ice Data Center (NSIDC). Image authors are J. Varner and E. Lim, CIRES, University of Colorado at Boulder.

NEW! Atlantic-centered and Pacific-centered wall posters of ETOPO1 are now available. Poster author is P. Grothe, University of Colorado at Boulder, now with Georgia Institute of Technology.



DEM Discovery Portal



Earth Icosahedron

More Images & Animations...

Related Projects:

Coastal Relief Models
Great Lakes

Related Data at NGDC:

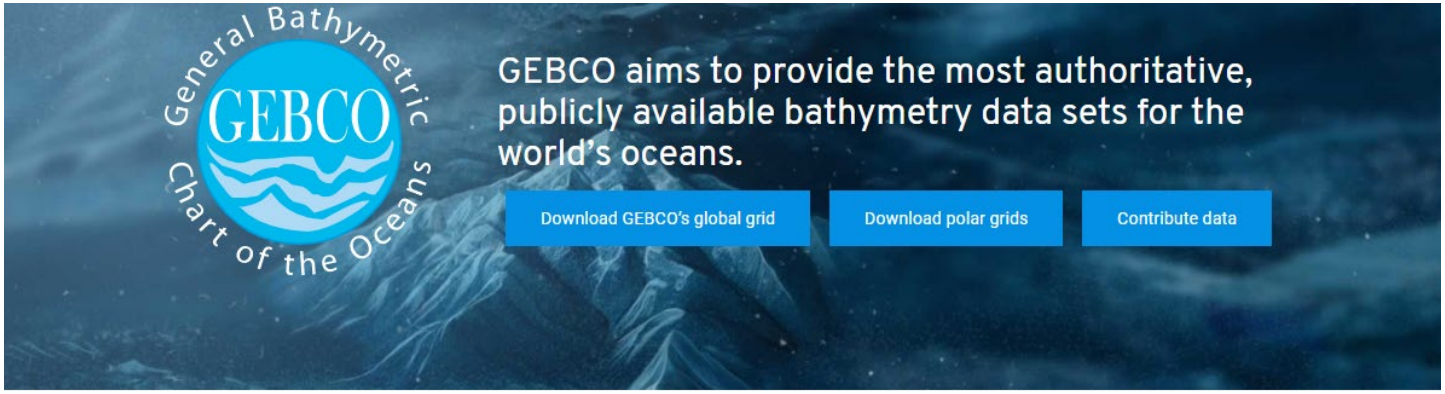
Bathymetry & Relief
Marine Geology & Geophysics

Related External Links:

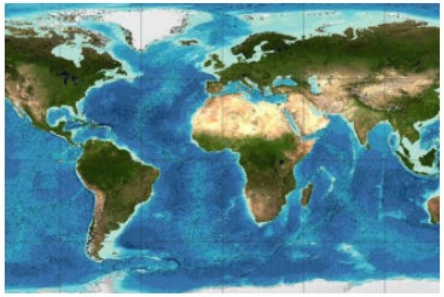
- ETOPO1 in NOAA's Science On a Sphere®
- Measured & Estimated Seafloor Topography from Satellite Altimetry
- GEBCO Global Bathymetric Grids
- MGDS Global Multi-Resolution Topography

http://www.ngdc.noaa.gov/mgg/global/global.html

Précision 15 secondes d'arc (111km/240 = 463m)



Gridded Bathymetry Data



GEBCO's gridded bathymetric data sets are global terrain models for ocean and land. The grids are available to download or access through Web Map Services.

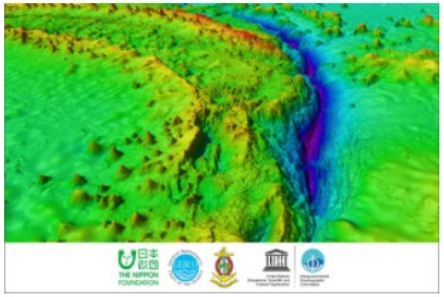
Read more

Data & Products

GEBCO produces and makes available a range of bathymetric data sets and products. This includes a global bathymetric grid; gazetteer of undersea feature names, a Web Map Service and printable maps of ocean bathymetry.

Read more

Seabed 2030

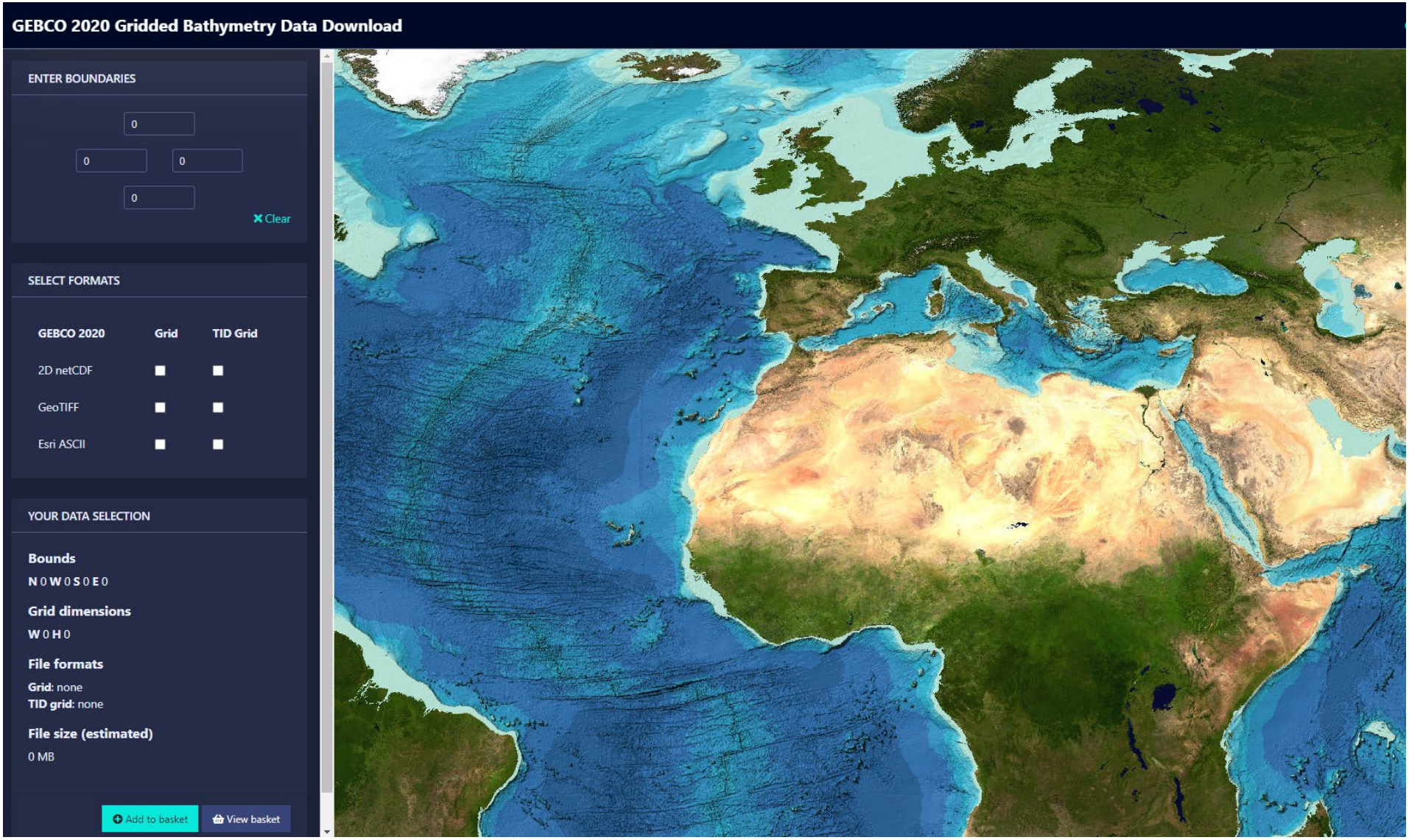


Seabed 2030 is a collaborative project between the Nippon Foundation and GEBCO. It aims to bring together all available bathymetric data to produce the definitive map of the world ocean floor by 2030 and make it available to all.

Read more

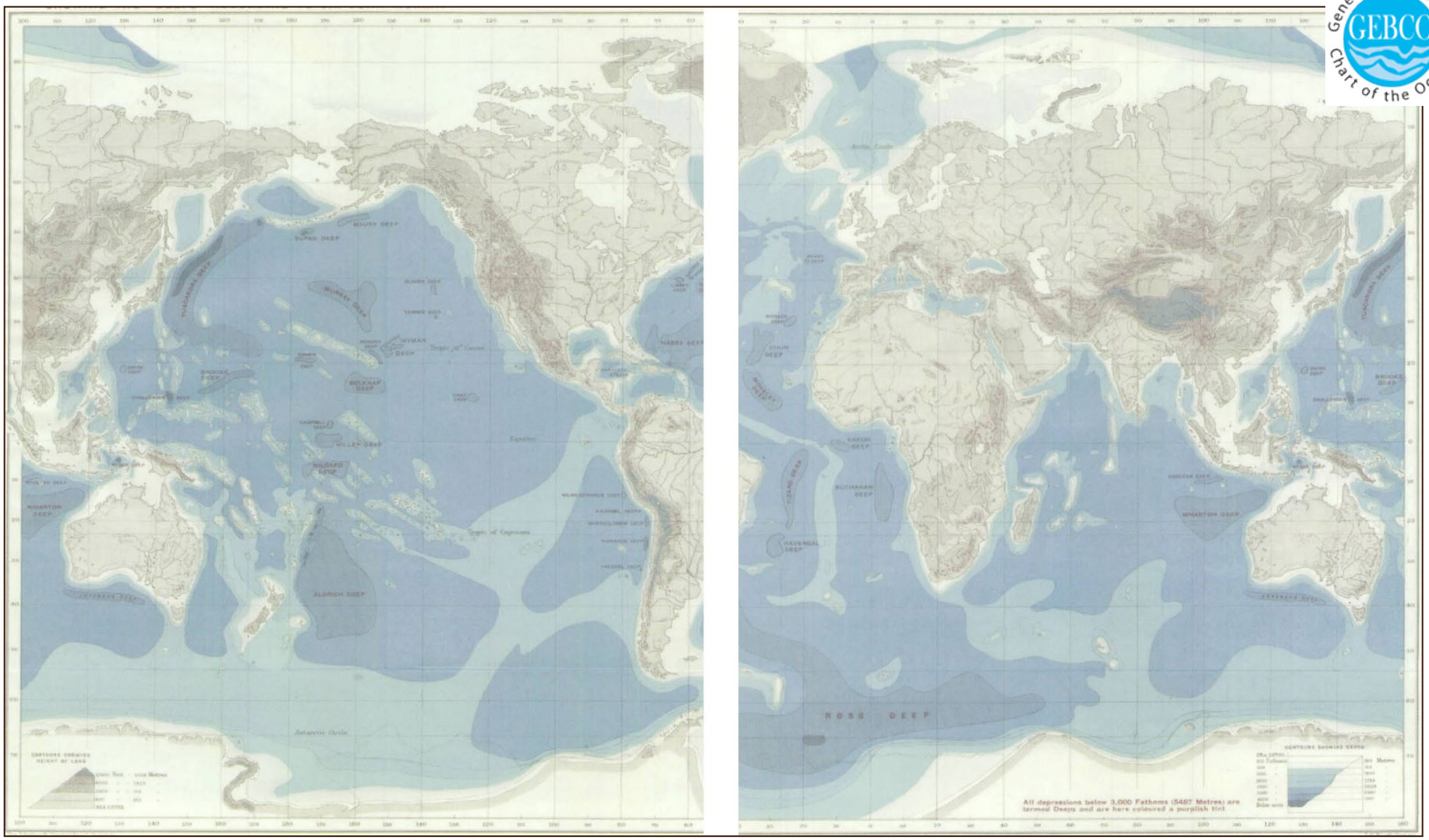
http://www.gebco.net/

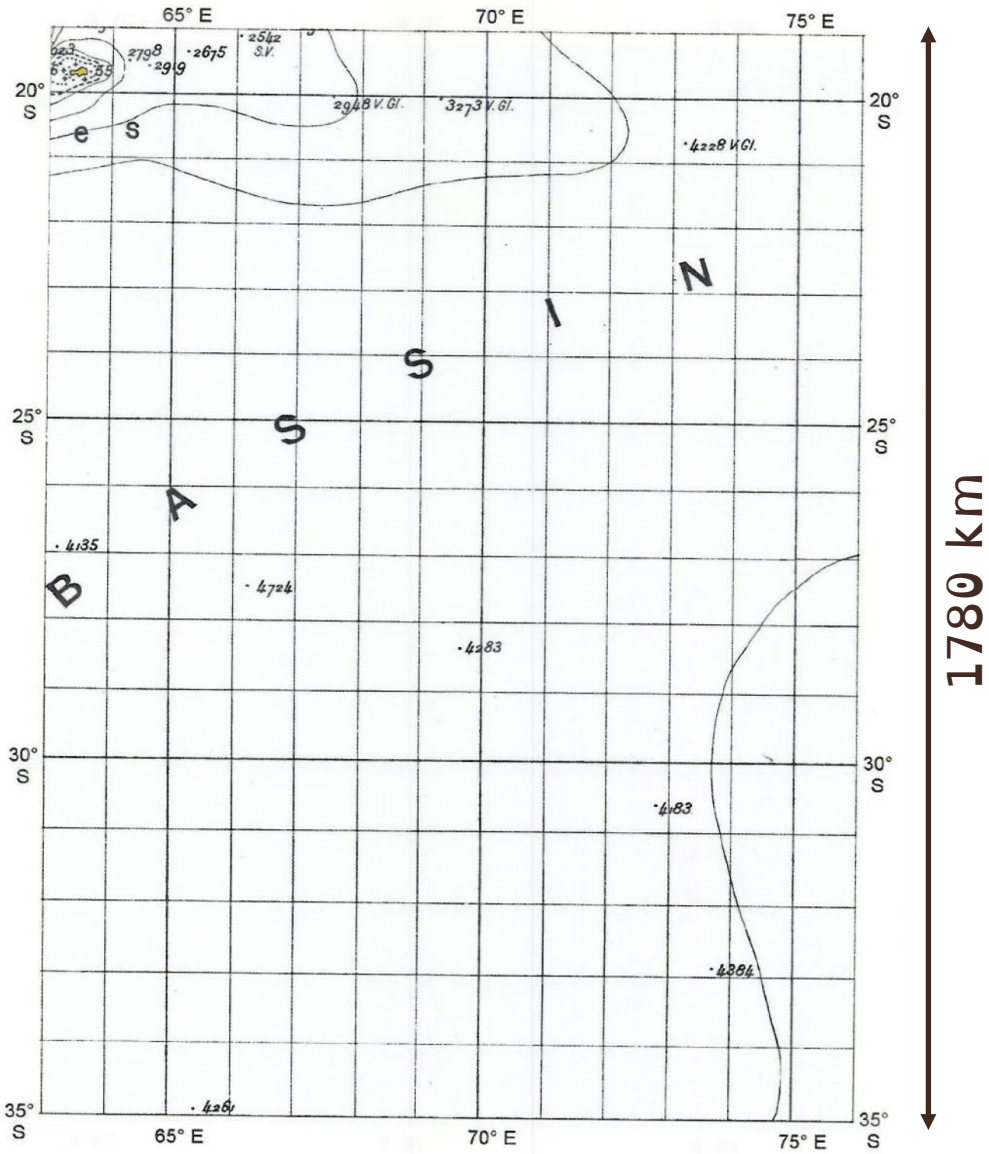
Bathymétrie par sondages



http://www.gebco.net/

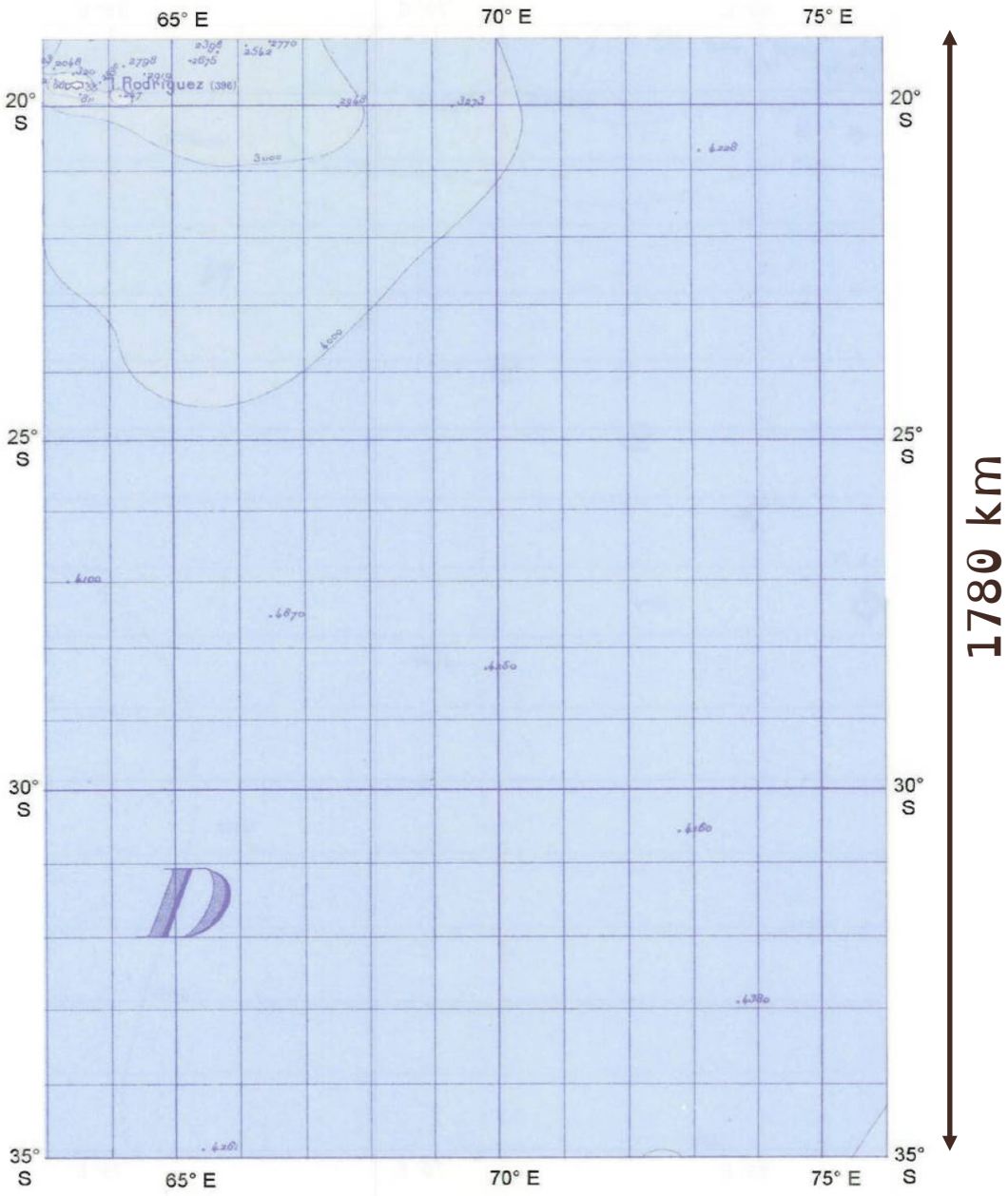
1e carte bathymétrique mondiale Sir John Murray 1899





1780 km

Dorsale Médio-Indienne
1903



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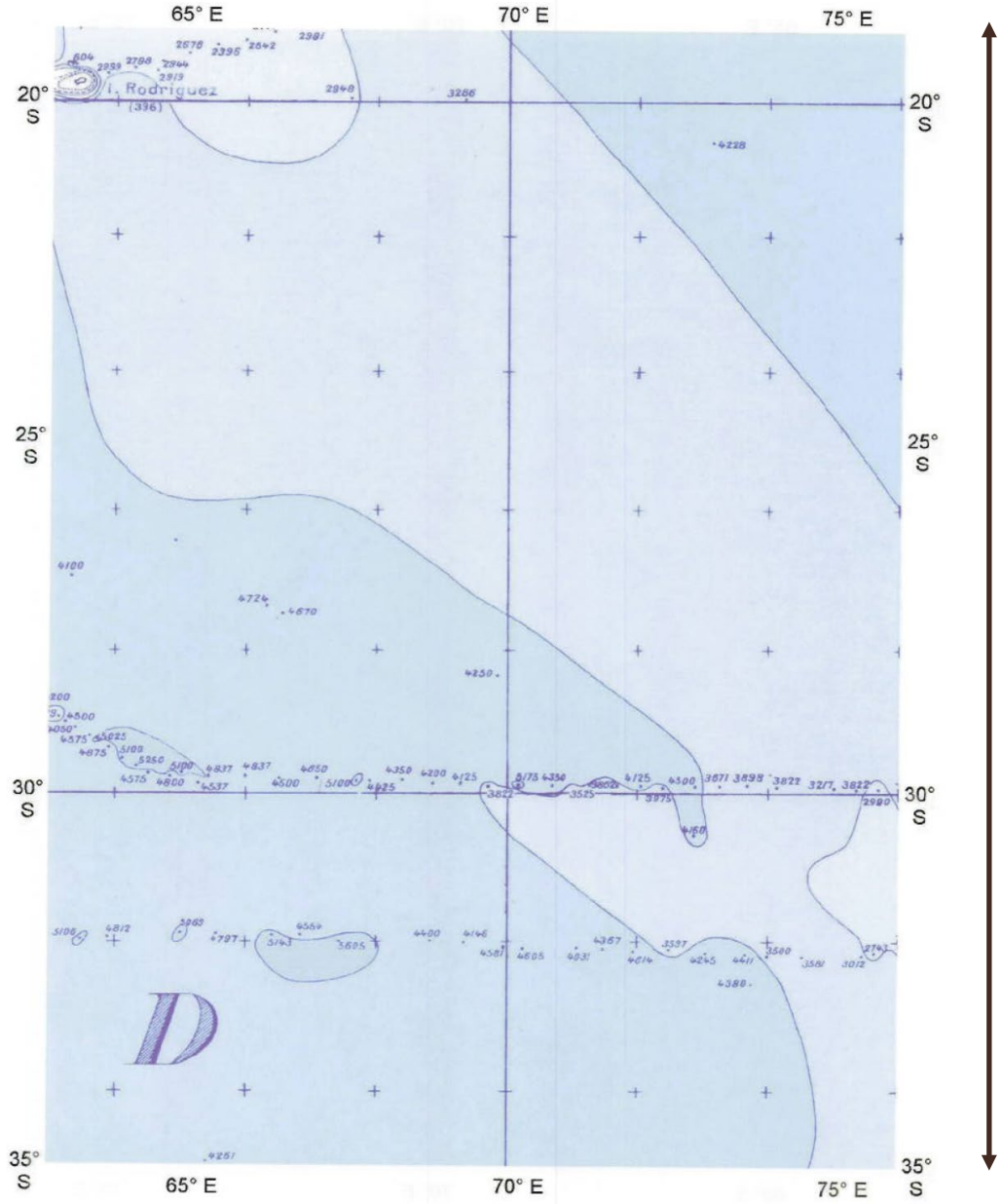
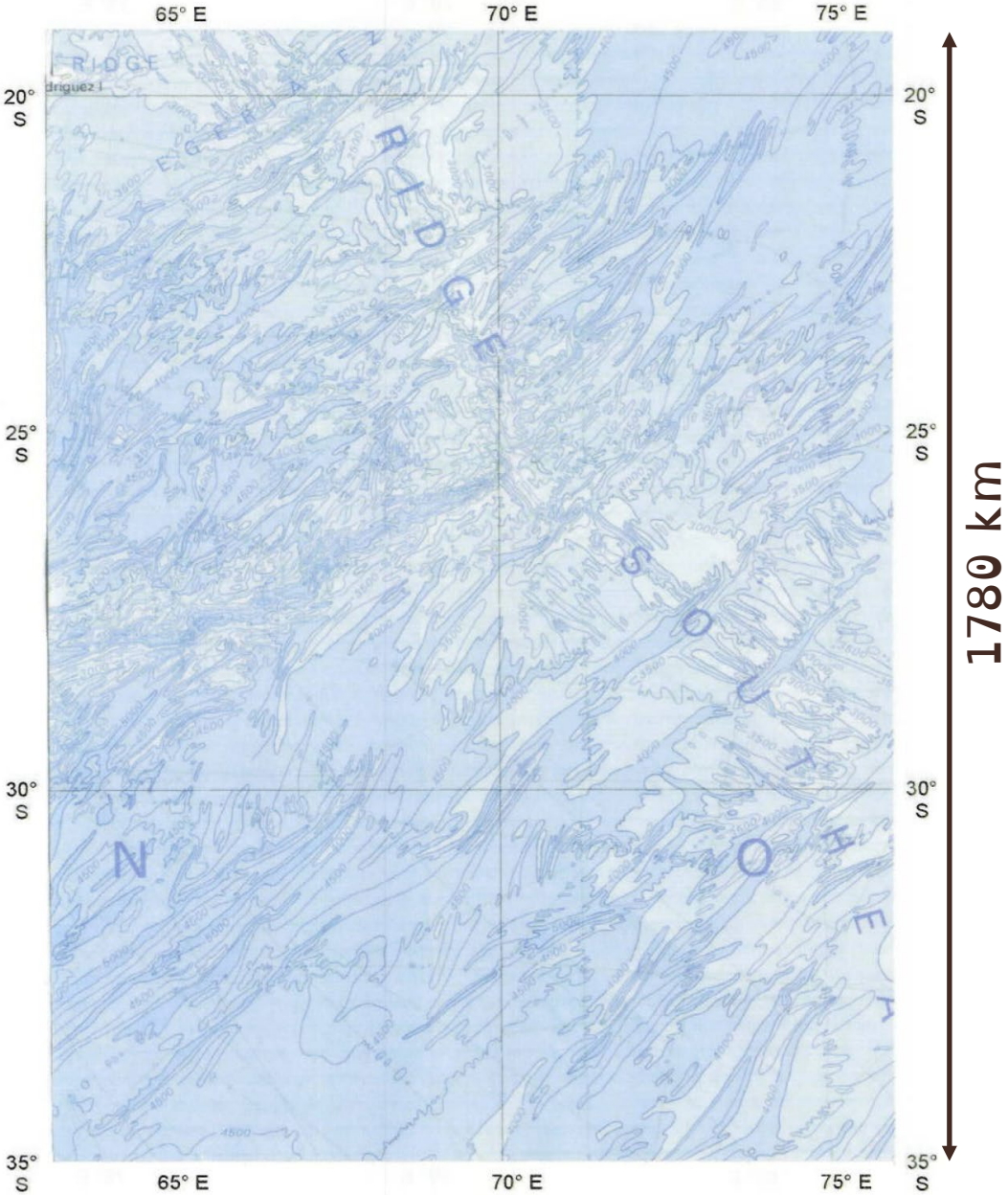


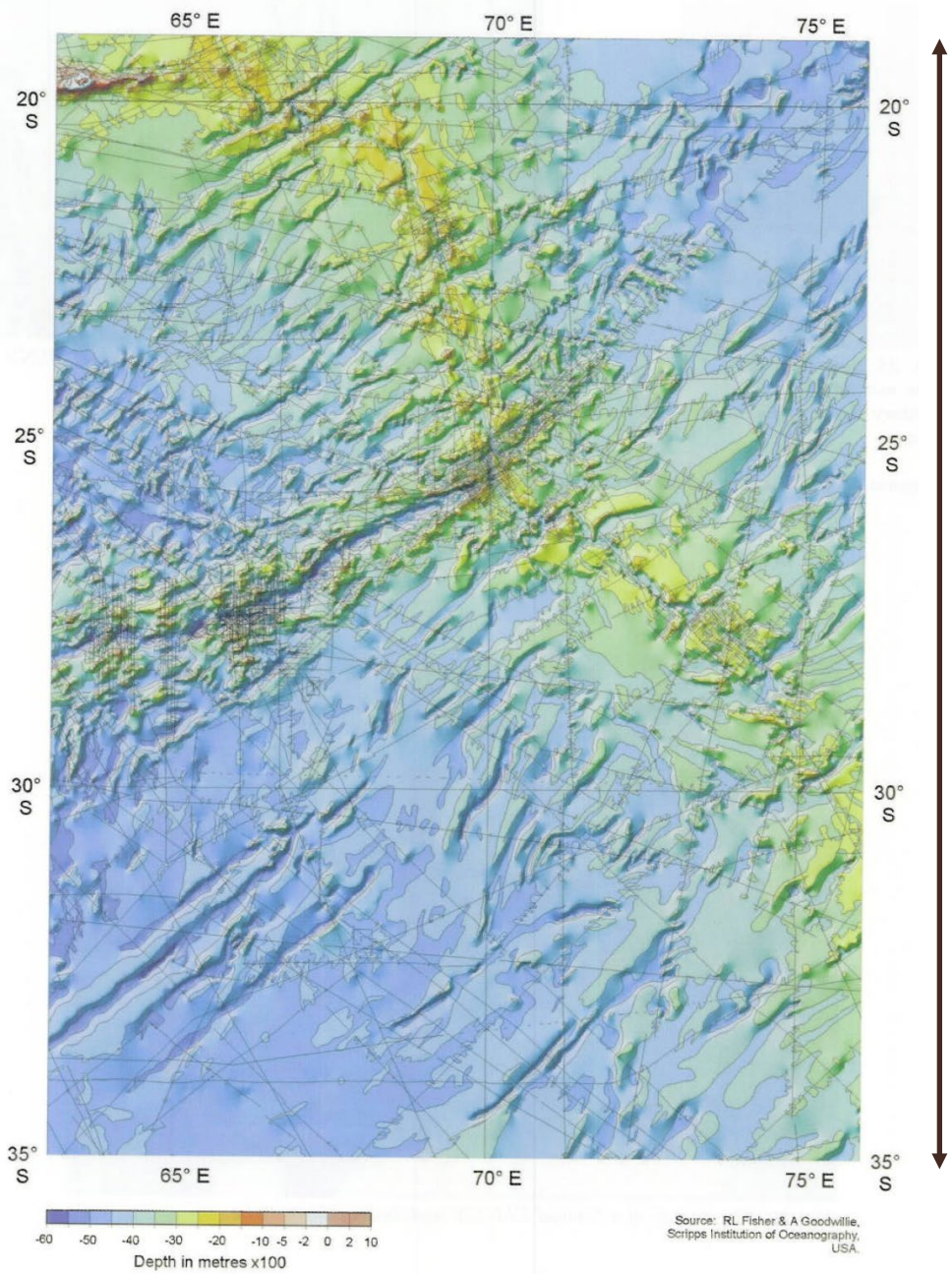
1780 km

Dorsale Médio-Indienne
1938



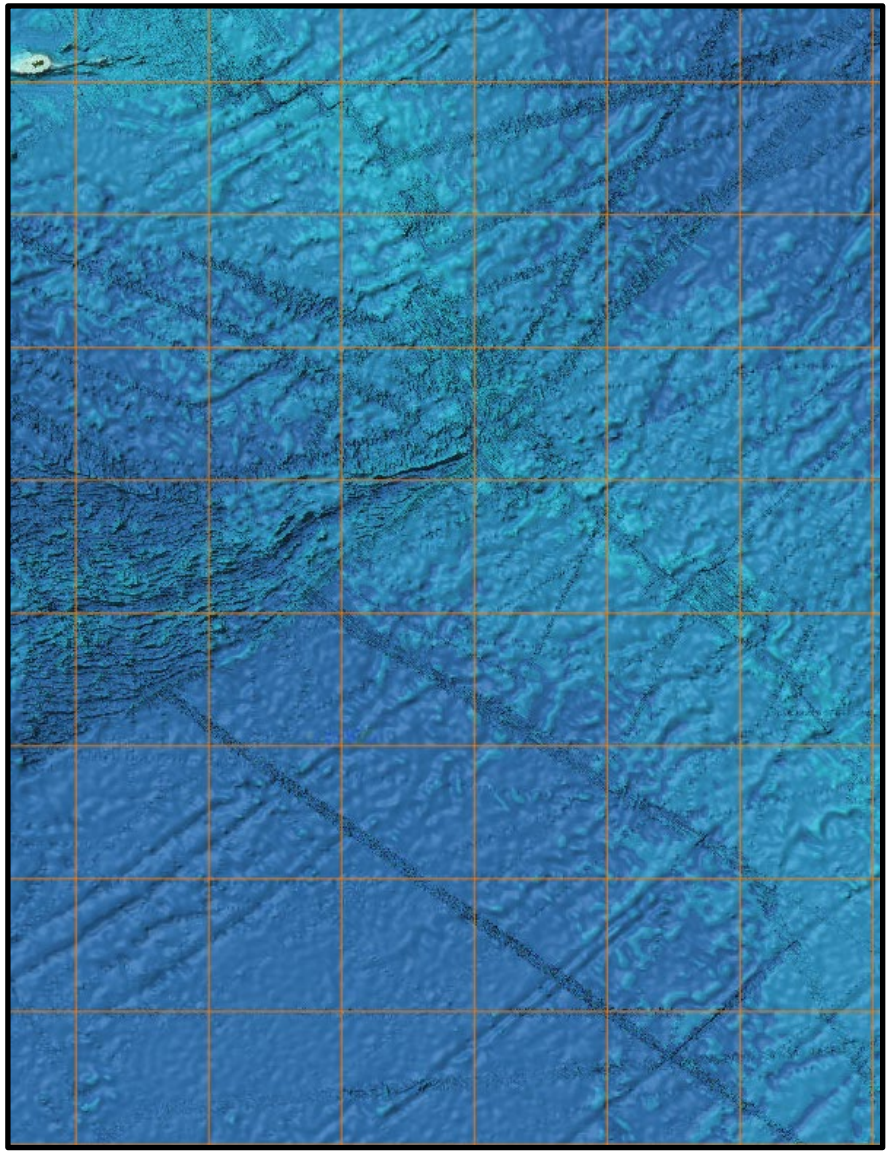
1780 km

Dorsale Médio-Indienne
1982



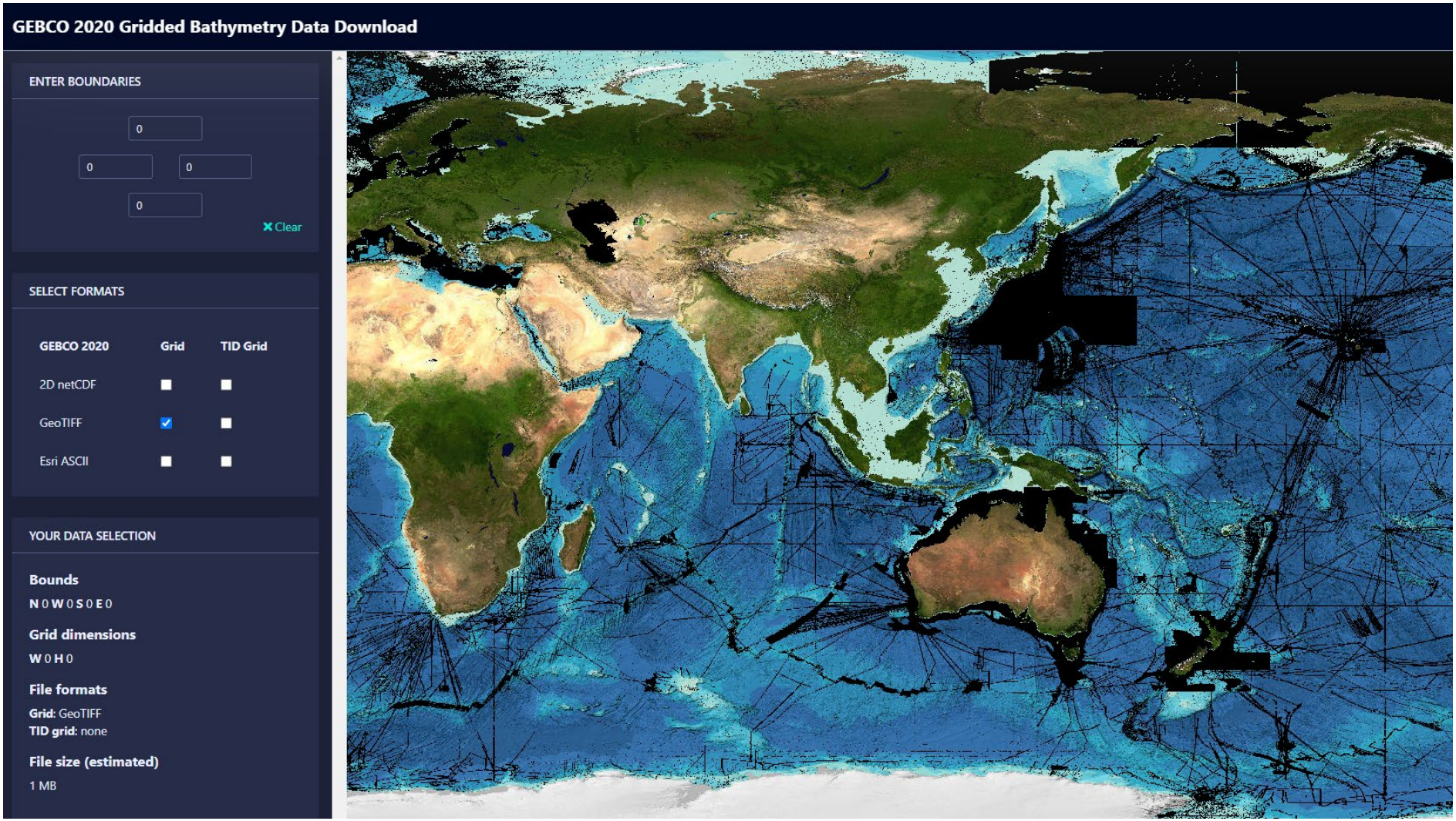
1780 km

Dorsale Médio-Indienne
2002

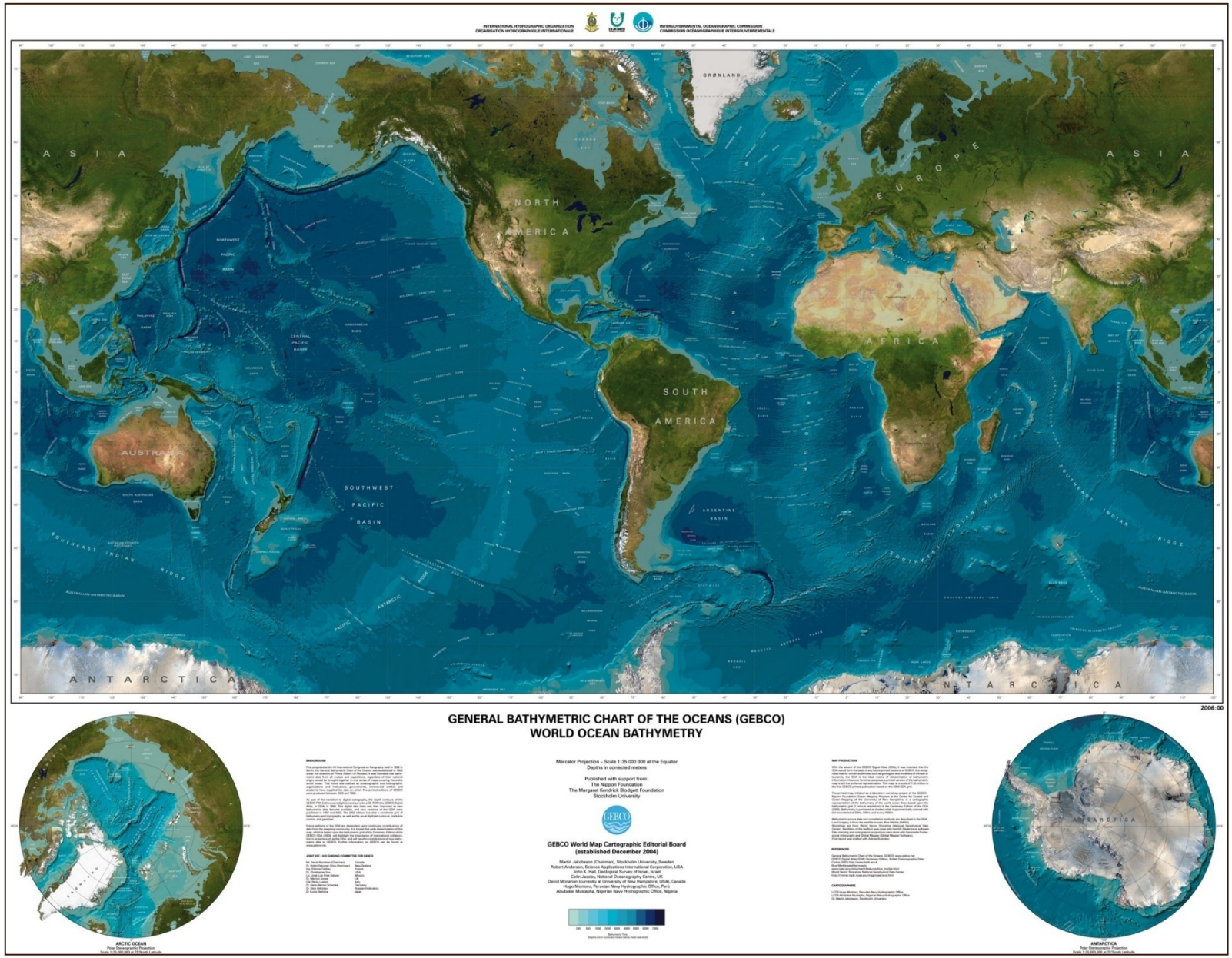


1780 km

Dorsale Médio-Indienne
2020


GEBCO 2020 Gridded Bathymetry Data Download
ENTER BOUNDARIES
0
0
0
0
Clear
SELECT FORMATS
GEBCO 2020
Grid
TID Grid
2D netCDF
GeoTIFF
Esri ASCII
YOUR DATA SELECTION
Bounds
N 0 W 0 S 0 E 0
Grid dimensions
W 0 H 0
File formats
Grid: GeoTIFF
TID grid: none
File size (estimated)
1 MB

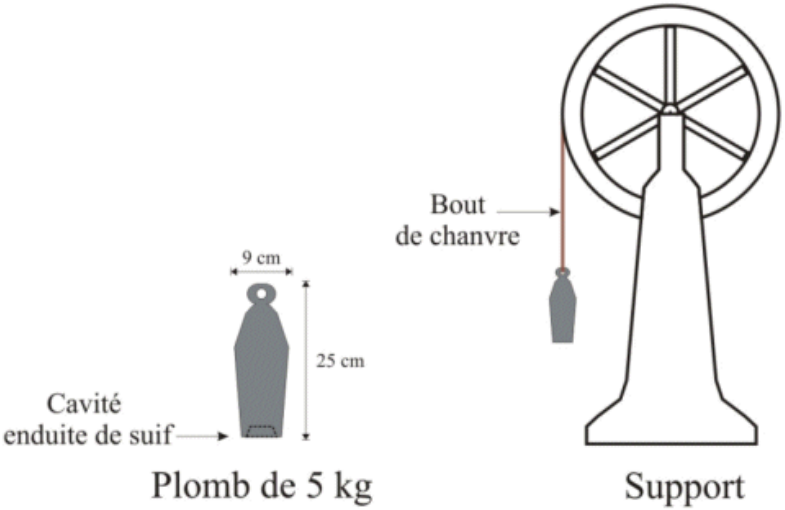
Bathymétrie par sondages

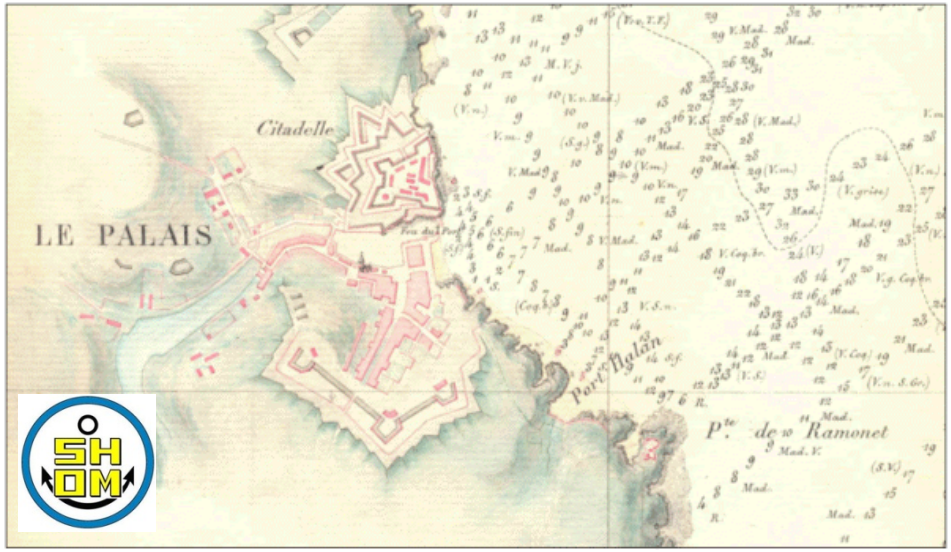


http://www.gebco.net/

Le fil à plomb

Sondages bathymétriques en Norvège (14e siècle)

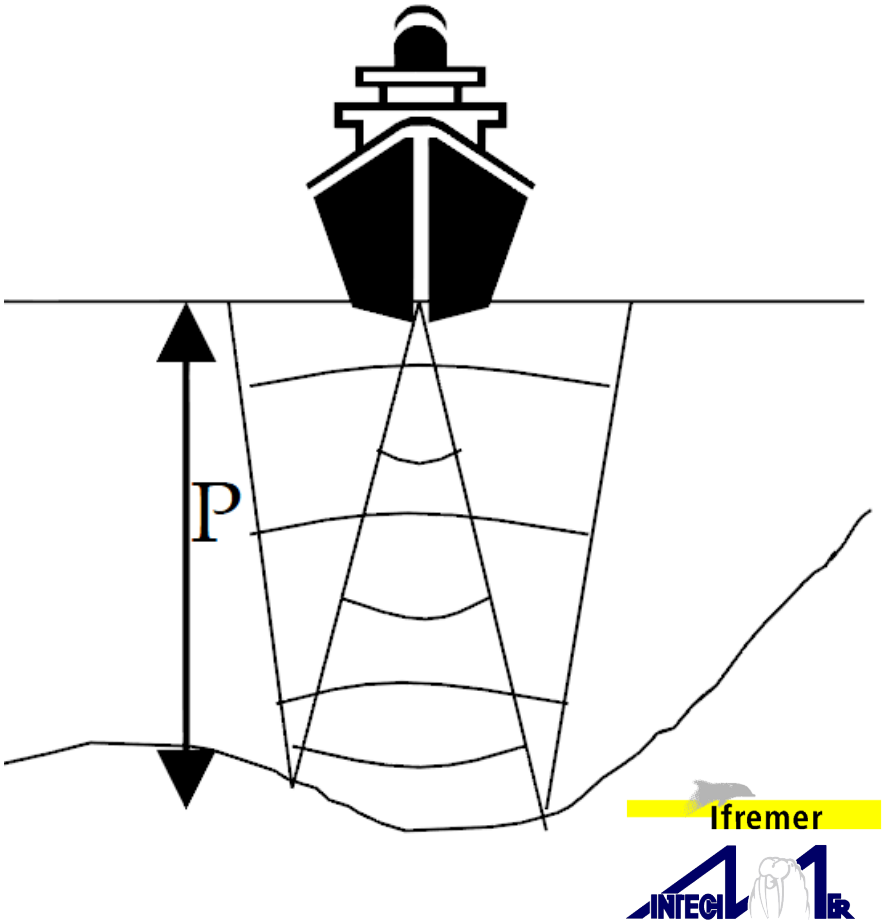




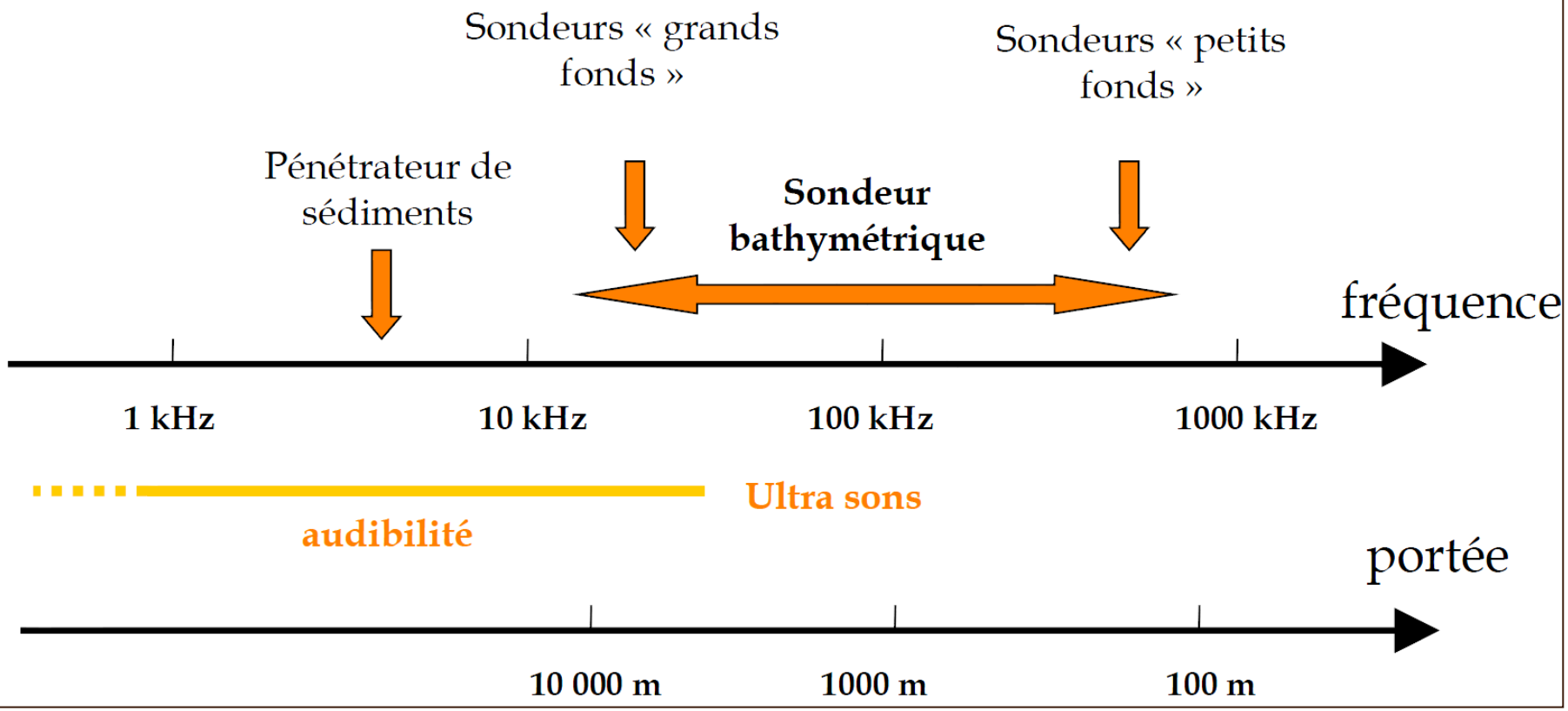
=> Utilisé jusqu'en 1940 !!!!

Le sondeur monofaisceau :

Profondeur = (Célérité x Δt) / 2

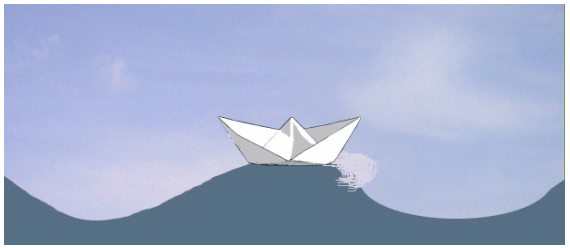


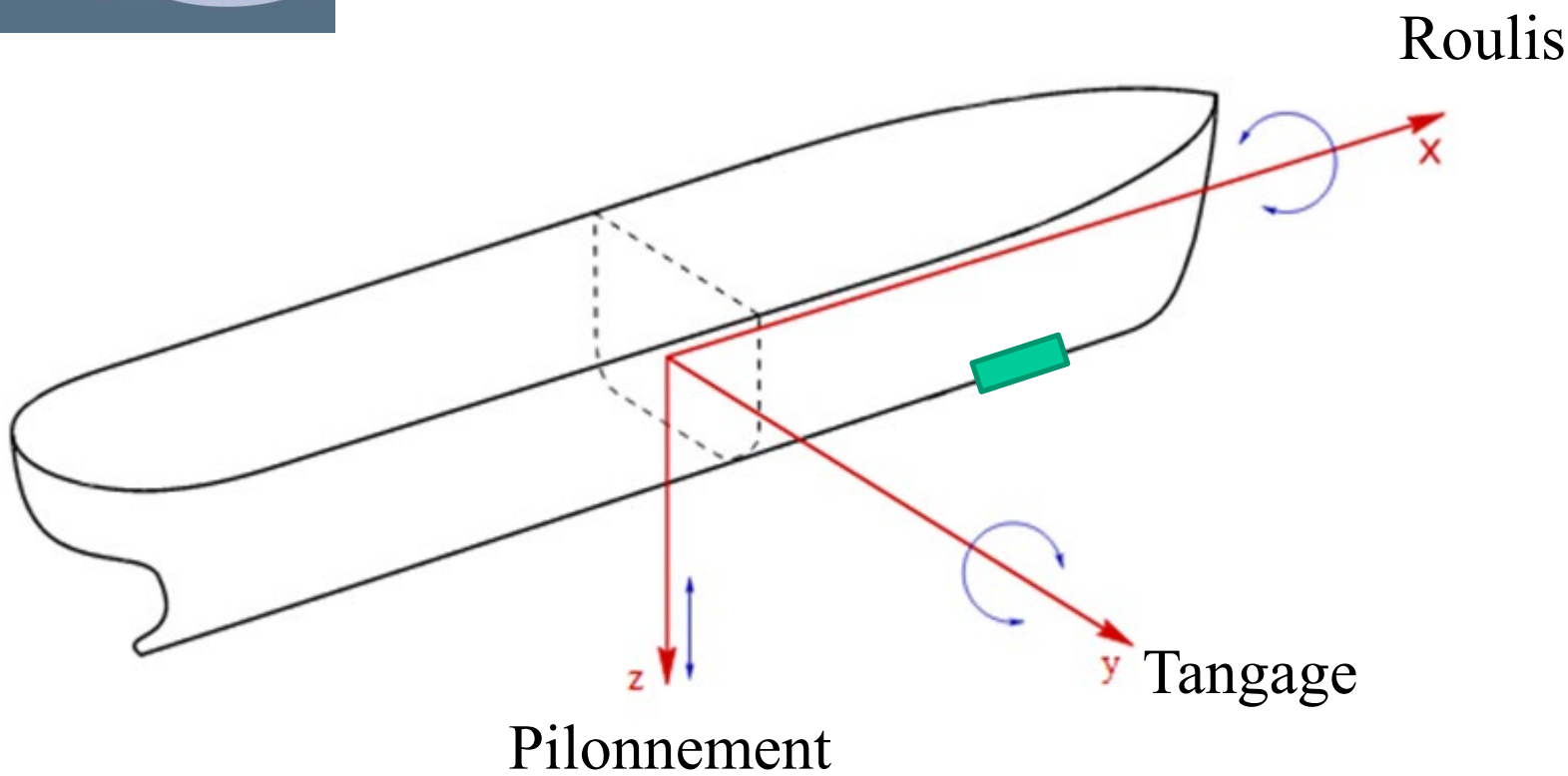
– **Quand la fréquence ↑ , le coefficient d'absorption ↑, la portée ↓**

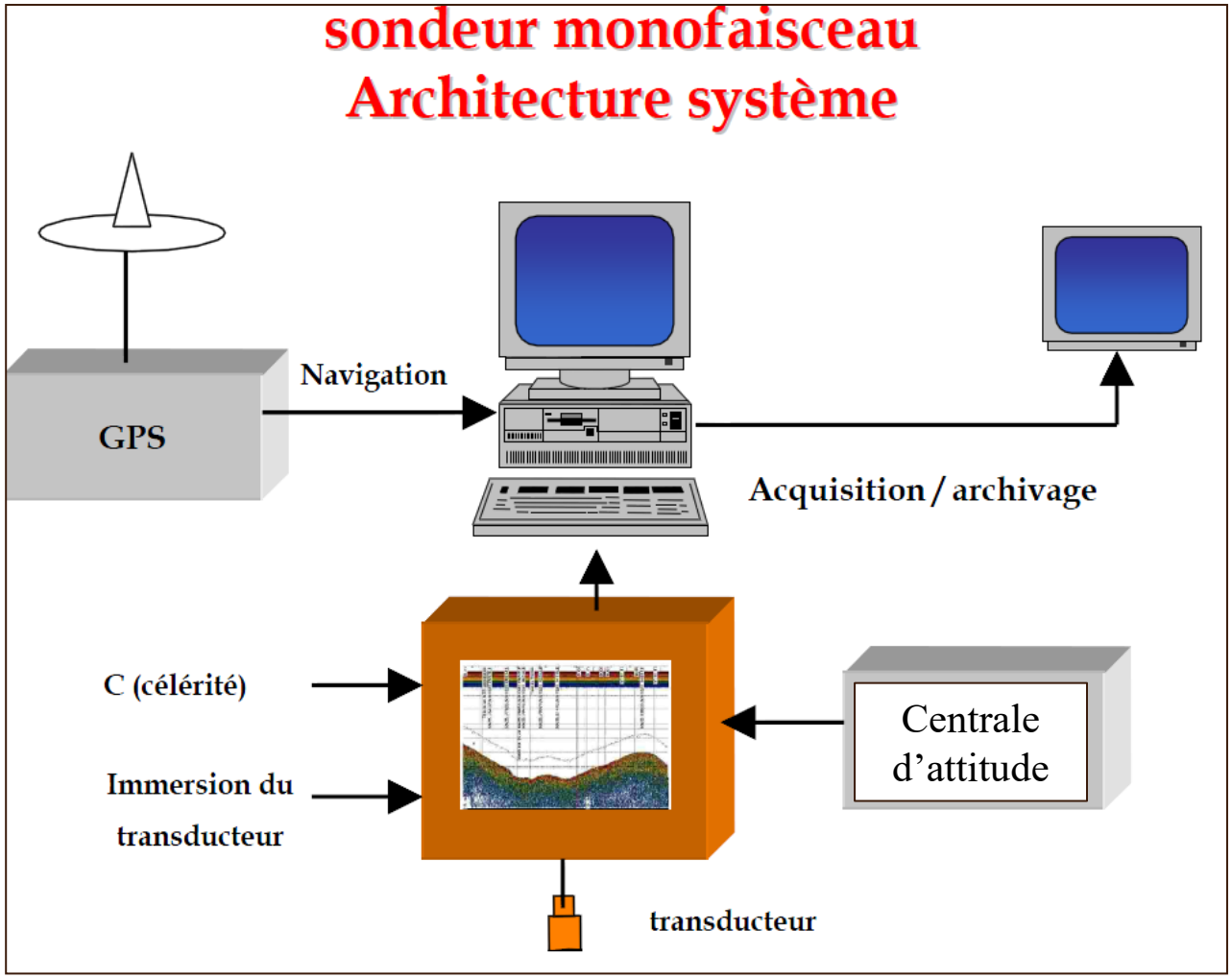


Sondeur monofaisceau fréquences couramment utilisées

- 12 kHz : océan
- 33 ou 38 kHz: grands fonds
- 200 kHz : plateau continental
- 400 kHz : très petits fonds

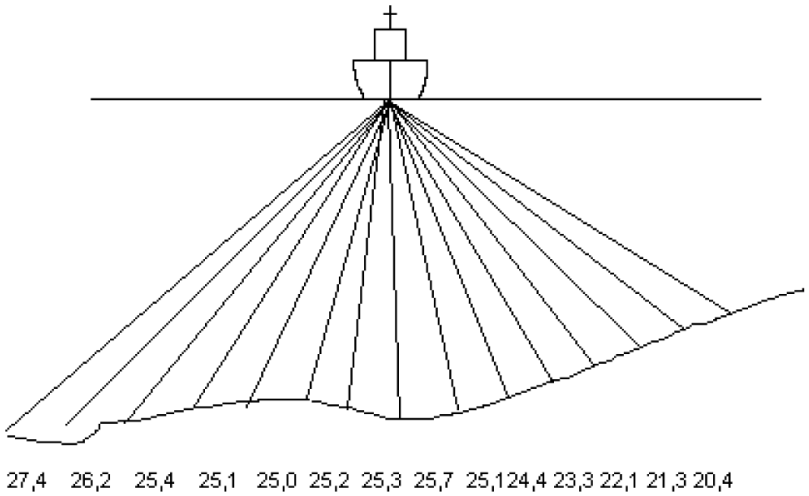



Roulis
x
z
y
Tangage
Pilonnement


sondeur monofaisceau
Architecture système
GPS
Navigation
Acquisition / archivage
C (célérité)
Immersion du transducteur
Centrale d'attitude
transducteur

Sondeurs multifaisceaux

Mesure de la profondeur dans n directions (n faisceaux acoustiques).
Ces faisceaux forment une fauchée perpendiculaire à l'axe du navire.
On explore ainsi le fond sur une large bande :**levé surfacique - insonification totale**

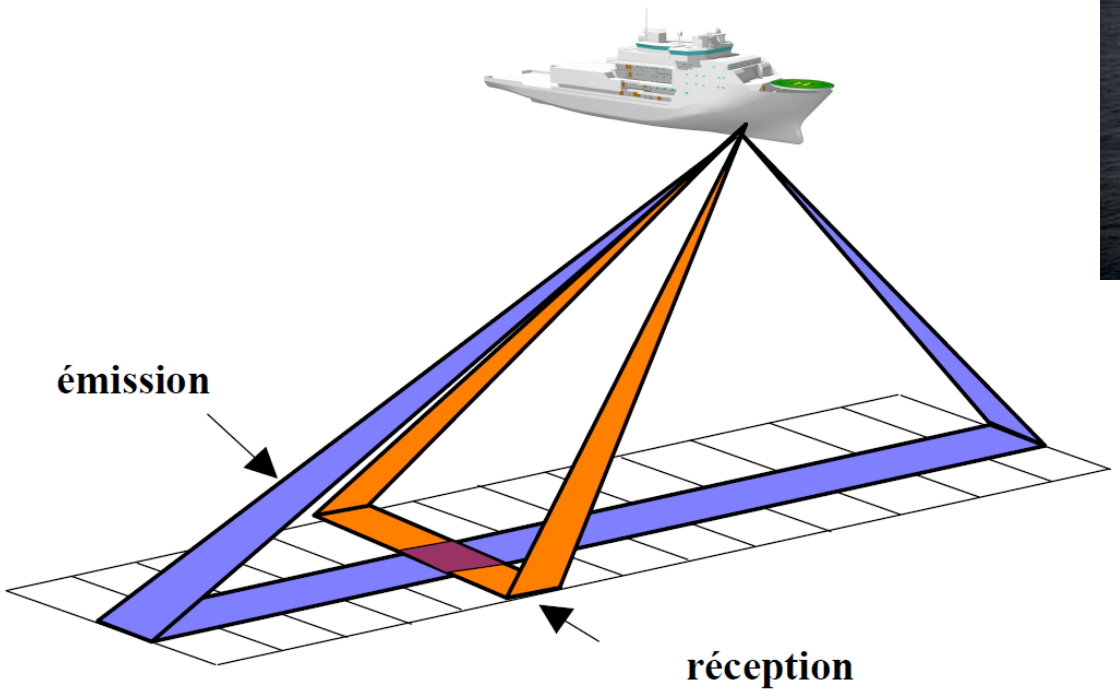


Avantages du sondeur multifaisceau :

- exploration (“ insonification ”) d’un large couloir (“ fauchée ”), le long de la route du navire,
- grande résolution (d’autant plus grande que ses faisceaux sont étroits).

Ifremer

Principe des faisceaux croisés



- **Emission d'une impulsion sonore au travers d'un faisceau d'émission** (longitudinalement # 1° - transversalement # 150°)
- **Réception du signal réfléchi par le fond selon N faisceaux de réception** (transversalement # 1°)
- Pour chaque faisceau de réception, la zone du fond explorée est l'intersection entre les faisceaux d'émission et de réception.

Ifremer

Systèmes multifaisceaux – antennes carénages

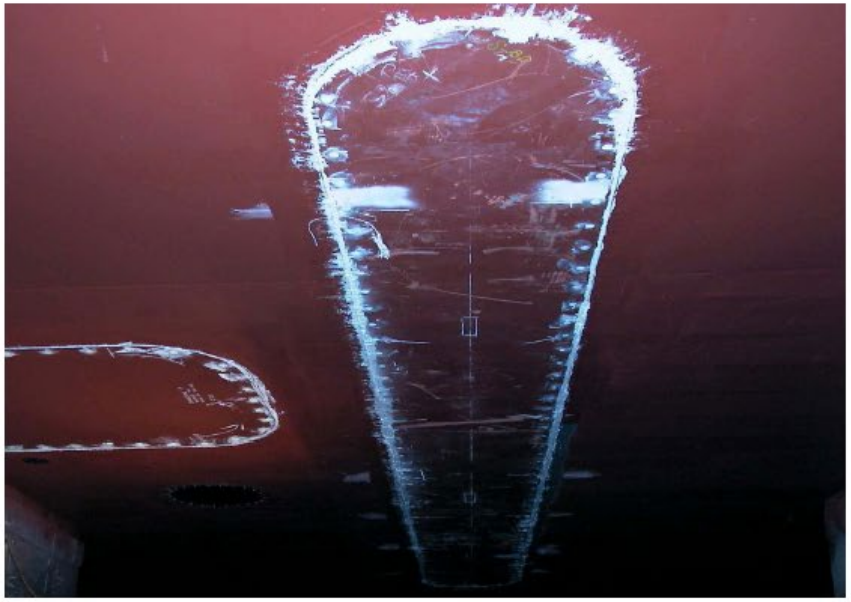
Le Suroît - EM302 - 30 kHZ

Tx = 3 m / Rx = 1,5 m

BH2 - EM1002 - 95 kHZ Tx/RX : Ø = 0,6 m

Ifremer

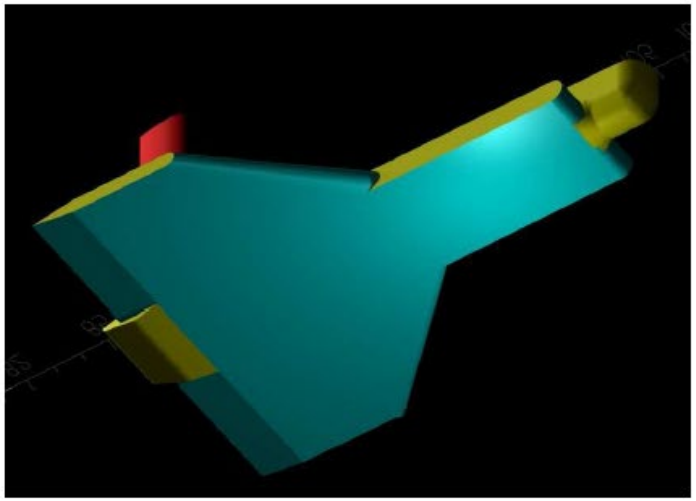
Systèmes multifaisceaux – antennes montage flush

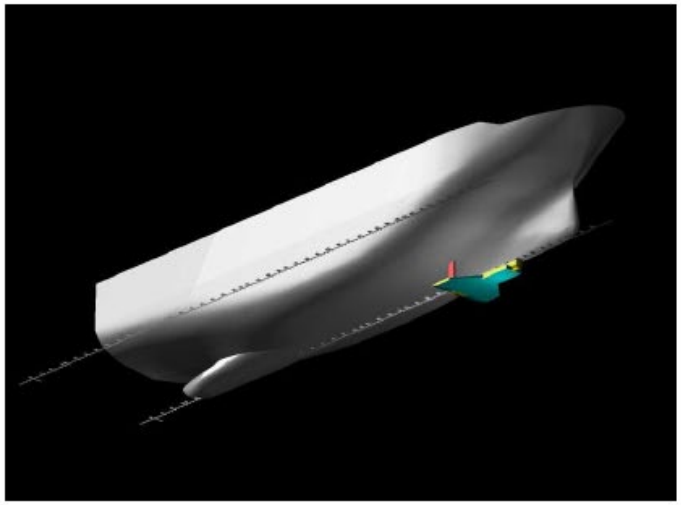


EM120 - 12 kHz

Tx = 8 m / Rx = 8 m

Systèmes multifaisceaux - gondole





Beautemps Beaupré - EM120 - 12 kHZ

Tx = 8 m / Rx = 8 m

L'ensemble des bases acoustiques est regroupé dans une « gondole »

EA 600 200 kHz

Pourquoi pas?

Seabat 7150 – 12 / 24 kHz

Seabat 7150

Tx 12 kHz

EA 600 12 kHz

EA 600 38 kHz

Sondeur navigation

8,5 m

Seabat 7150

Tx 24 kHz

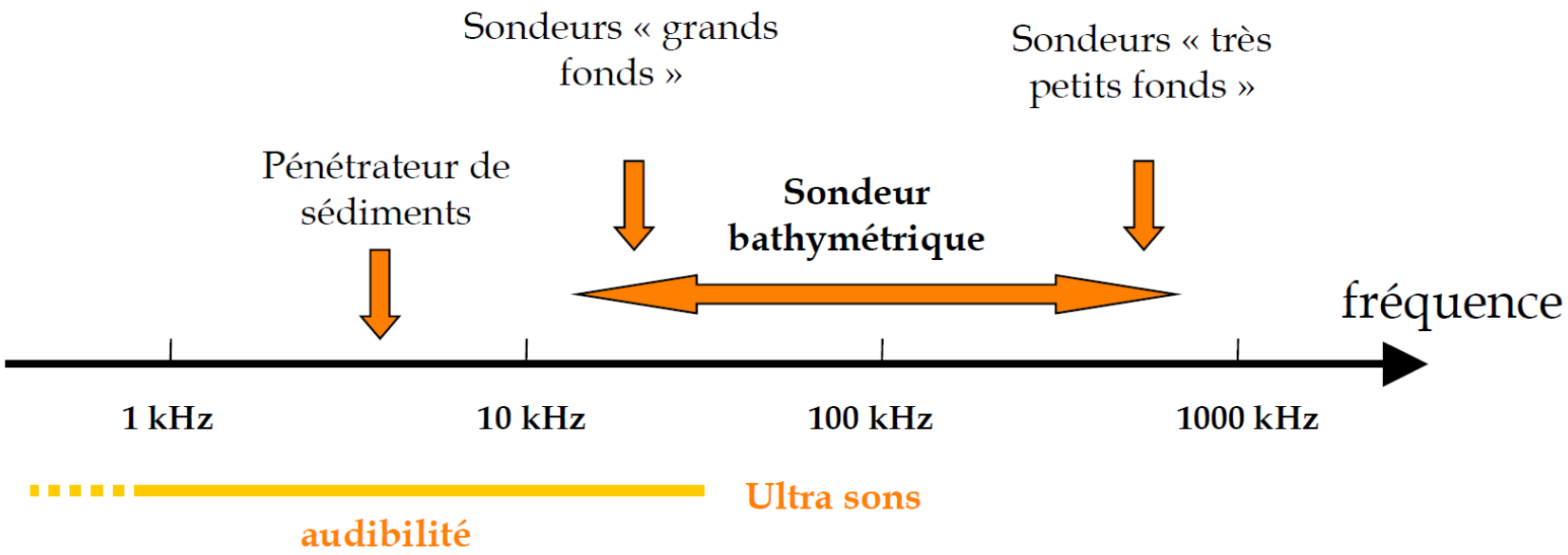
Pénétrateur de Sédiments

Seabat 7150 Rx

12,3 m

Fréquence

- Quand la fréquence ↑ , le coefficient d'absorption ↑, la portée ↓



sondeurs	Plage de profondeur	Fréquence	Types de levé
Grands fonds	100 à 12 000 m	10 – 15 kHz	Talus, dorsale et plaines abyssales
Moyens fonds	30 à 3000 m	30 – 50 kHz	Plateau, talus
Petits fonds	5 à 500 m	80 – 120 kHz	Plateau continental
Très petits fonds	0 à 100 m	200 à 400 kHz	Zones littorales

Nombre de faisceaux

De 100 à 1000, suivant les équipements

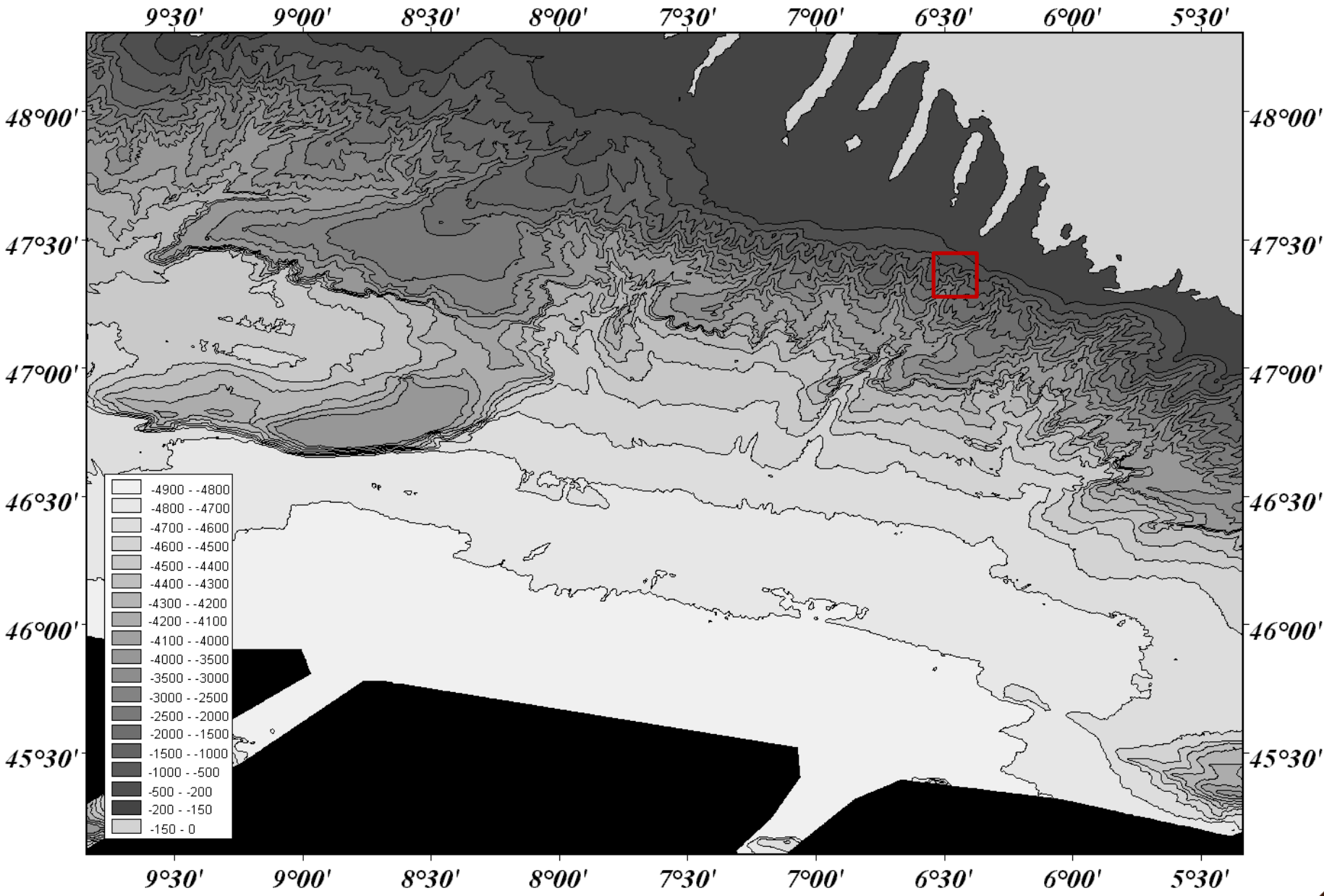
ex : *Seabeam (Jean Charcot - 1977) : 16*

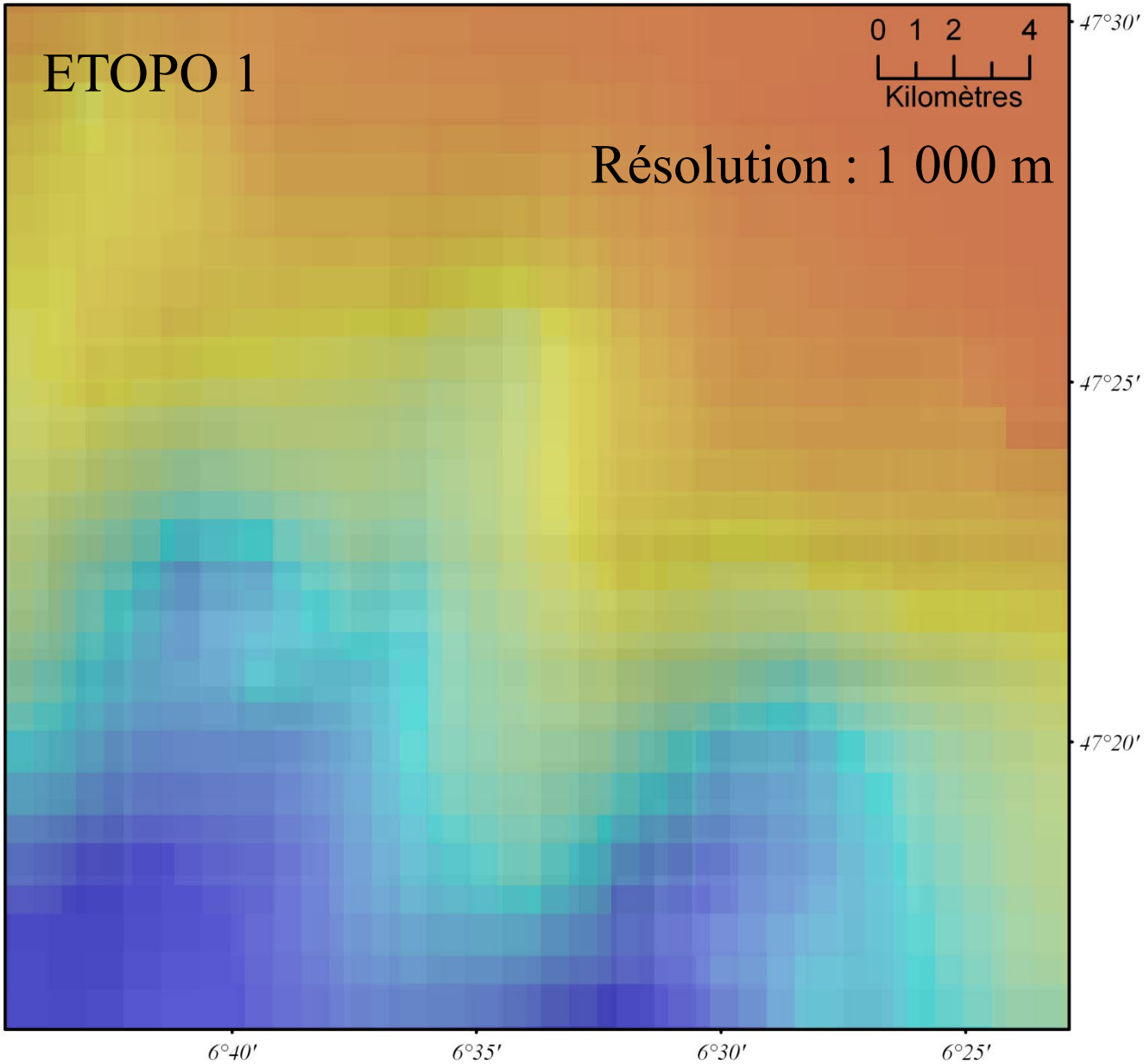
EM1000 (Thalia - 1993) : 60

EM120 (Beautemps Beaupré - 2002) : 191

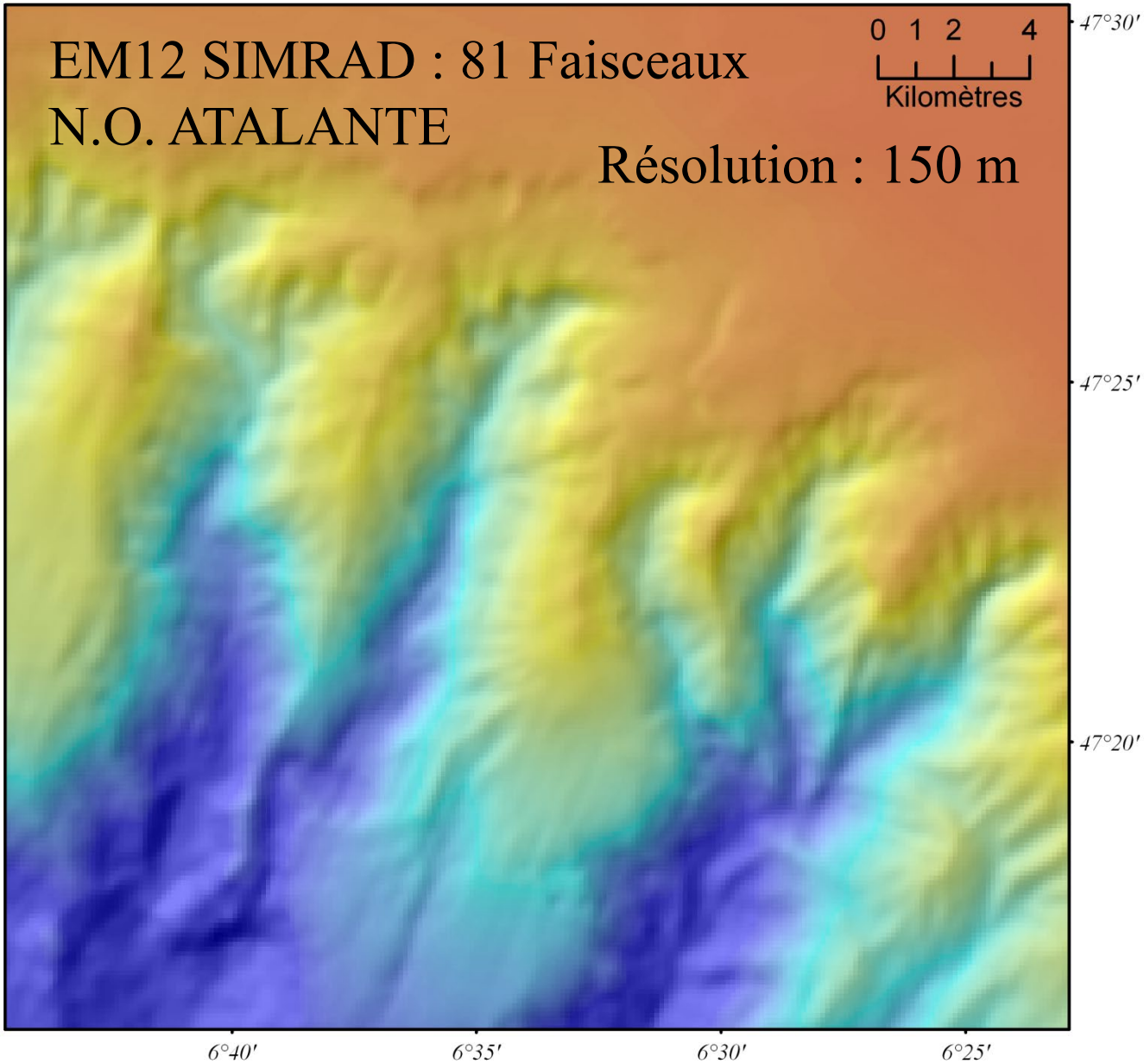
Seabat 7150 (Pourquoi pas? – 2007) : 880

Ifremer


9°30'
9°00'
8°30'
8°00'
7°30'
7°00'
6°30'
6°00'
5°30'
48°00'
47°30'
47°00'
46°30'
46°00'
45°30'
-4900 - -4800
-4800 - -4700
-4700 - -4600
-4600 - -4500
-4500 - -4400
-4400 - -4300
-4300 - -4200
-4200 - -4100
-4100 - -4000
-4000 - -3500
-3500 - -3000
-3000 - -2500
-2500 - -2000
-2000 - -1500
-1500 - -1000
-1000 - -500
-500 - -200
-200 - -150
-150 - 0

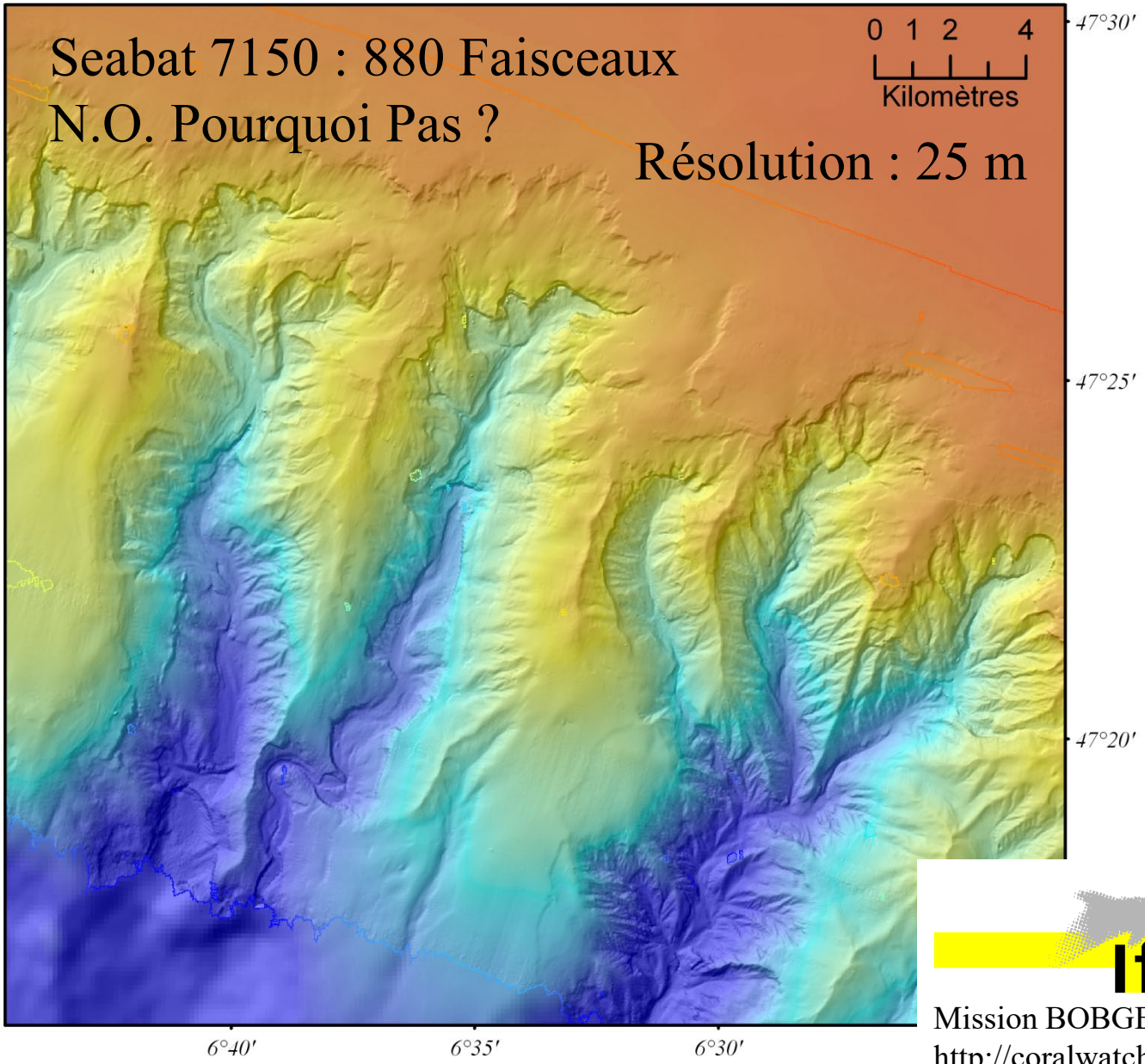

ETOPO 1
Résolution : 1 000 m
0 1 2 4
Kilomètres
47°30'
47°25'
47°20'
6°40'
6°35'
6°30'
6°25'

1997



Ifremer

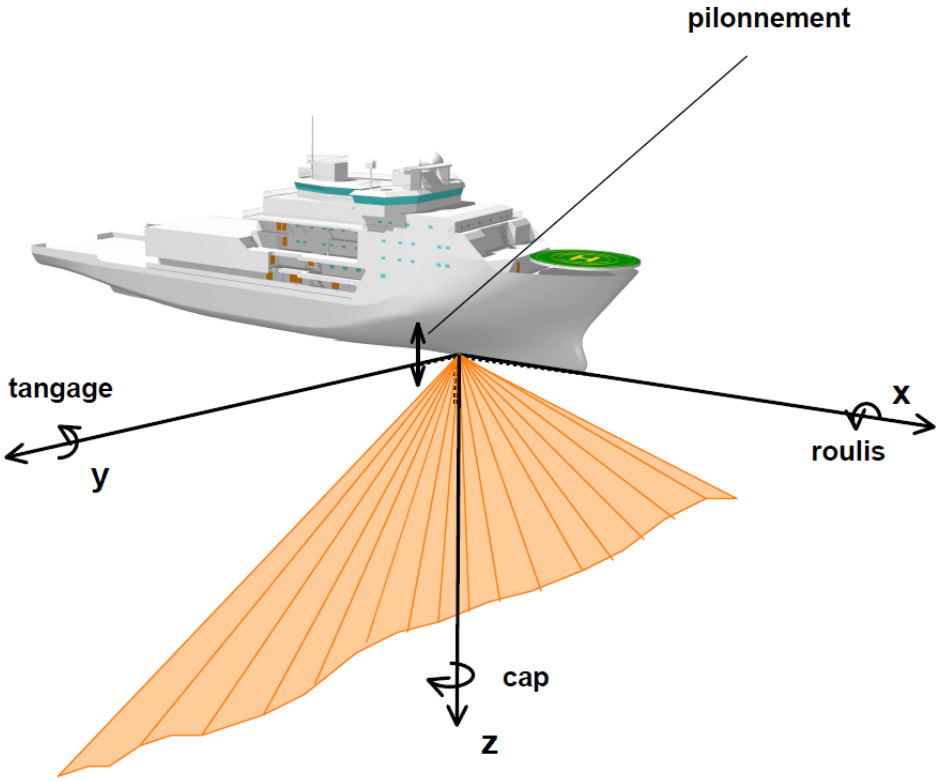
2009



Ifremer

Mission BOBGEO
http://coralwatcher.wordpress.com/

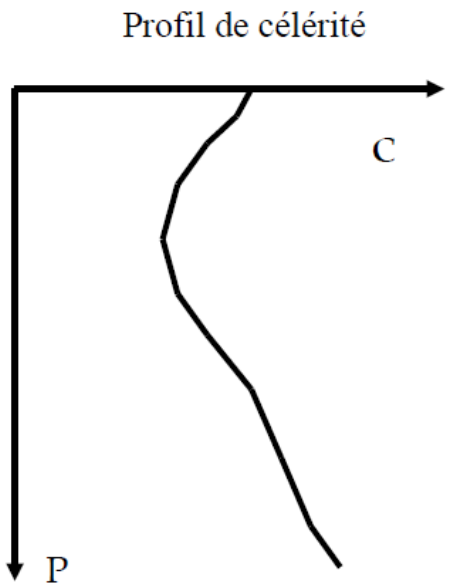
Corrections d'attitude



➡ Correction par la centrale d'attitude

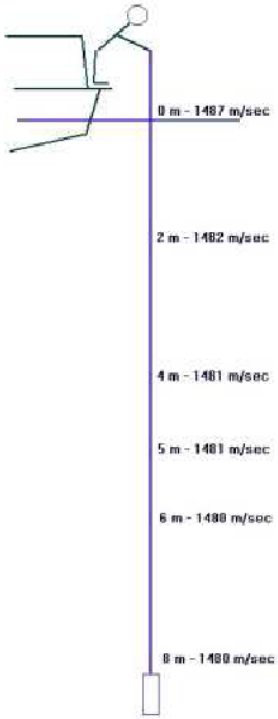
Correction de réfraction

Les variations de célérité provoquent une courbure des rayons sonores. Il est nécessaire, pour établir le trajet de l'onde sonore, pour une incidence et une durée de trajet donnée, de connaître la célérité du son dans l'eau (profil de célérité).



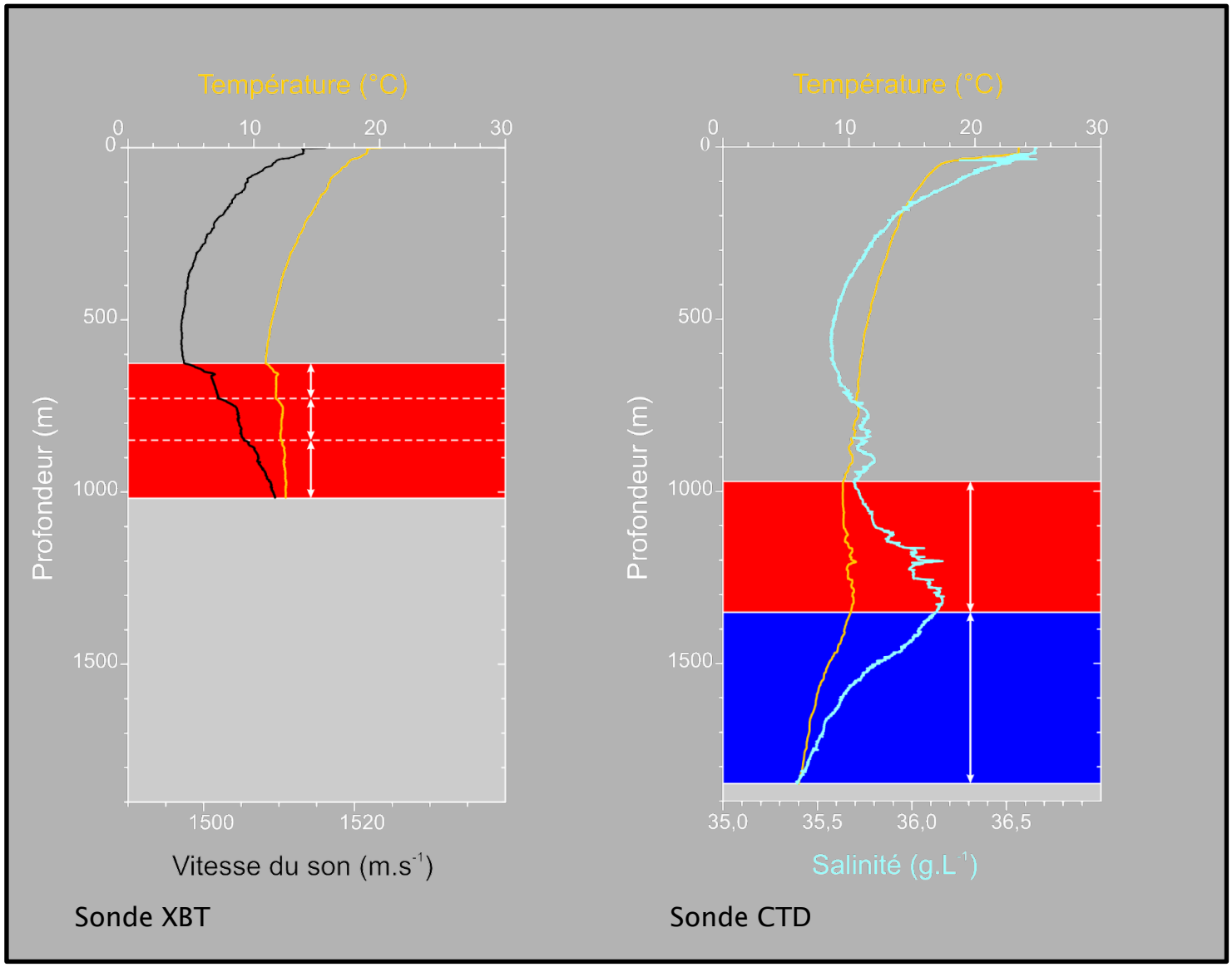
Mesure du profil de célérité cadence

- **Levé « petits fonds »**
  - début / fin de séance



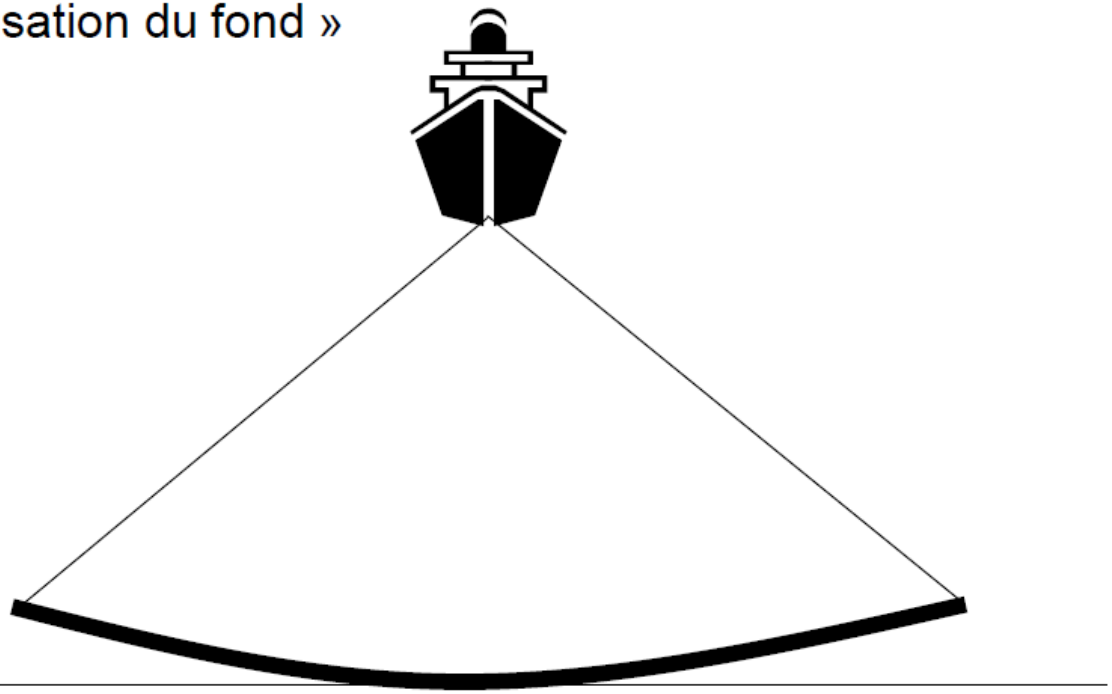
- **Levé « grands fonds »**
  - # 4 / 6 heures

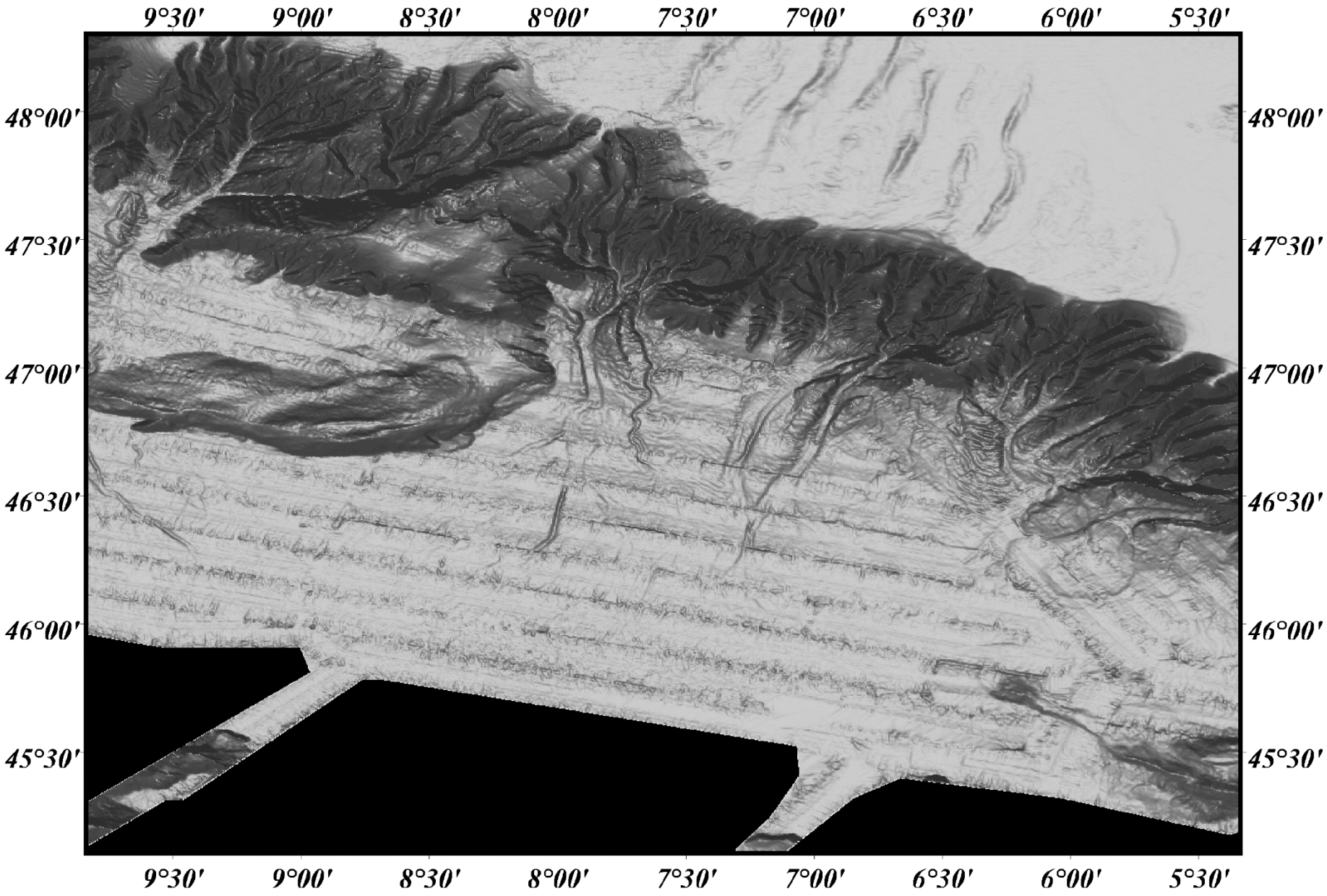
Ifremer


Température (°C)
0
10
20
30
0
500
1000
1500
Profondeur (m)
1500
1520
Vitesse du son (m.s-1)
Sonde XBT
Température (°C)
0
10
20
30
0
500
1000
1500
Profondeur (m)
35,0
35,5
36,0
36,5
Salinité (g.L-1)
Sonde CTD

Artefact induit par une mauvaise correction de célérité

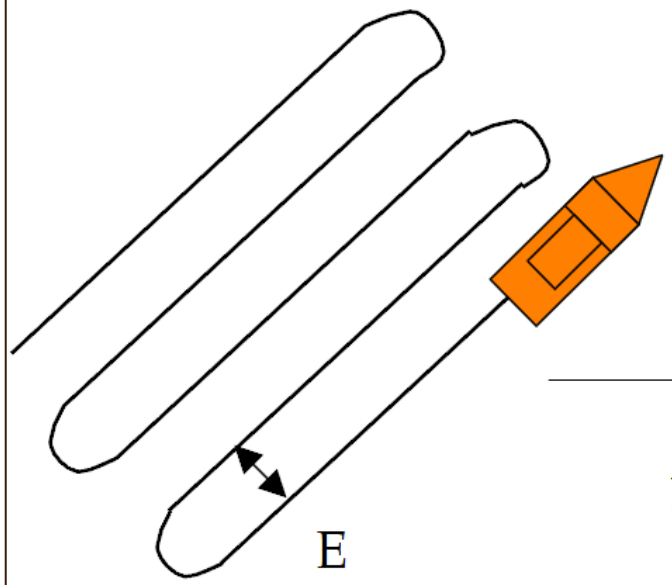
→ « circularisation du fond »



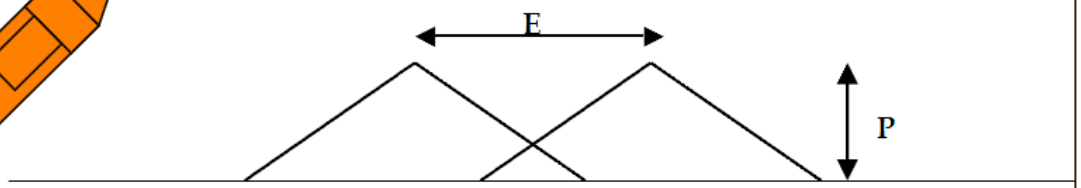

9°30'
9°00'
8°30'
8°00'
7°30'
7°00'
6°30'
6°00'
5°30'
48°00'
47°30'
47°00'
46°30'
46°00'
45°30'

Le levé « régulier »

Suivi de routes (« profils ») régulièrement espacées



E = f (profondeur)



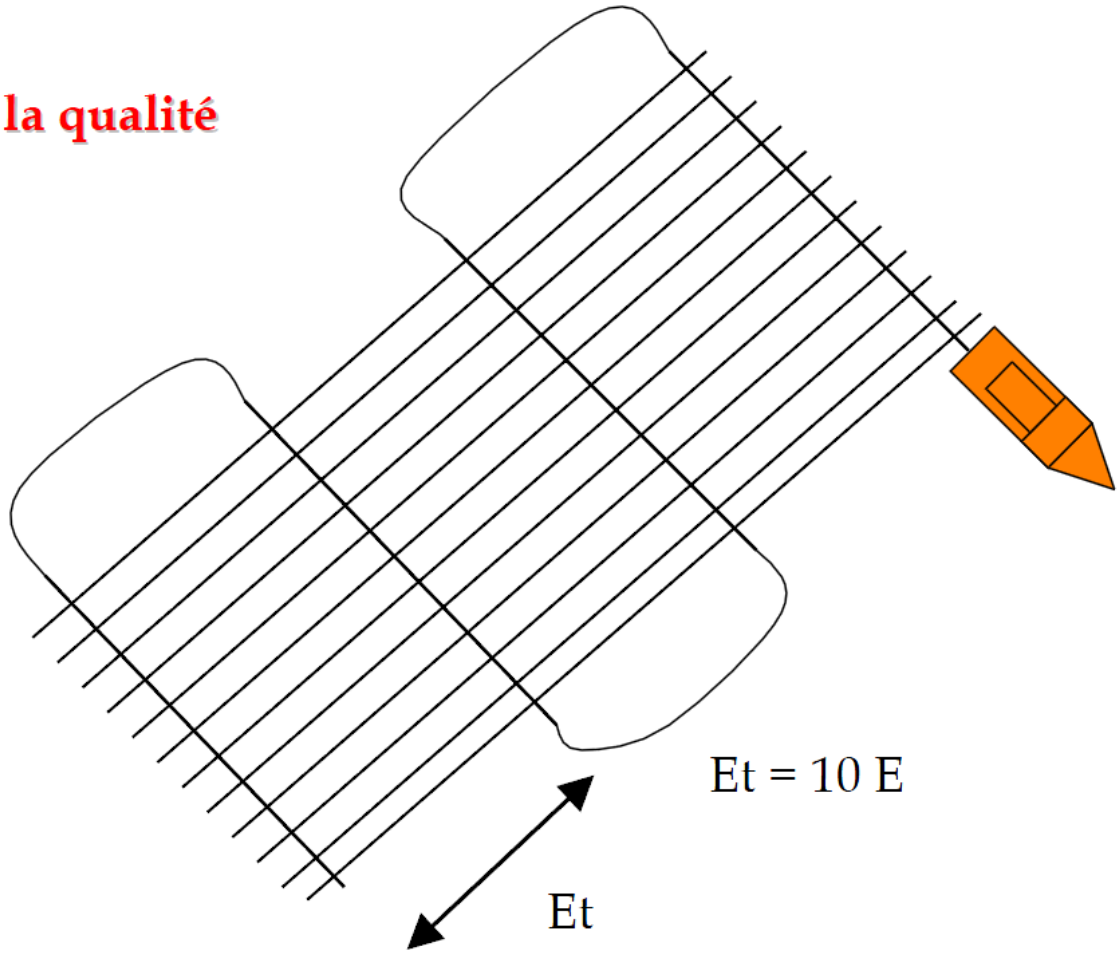
$E = 0{,}8 * F = 0{,}8 \times 2 * P \tan(\theta_M)$

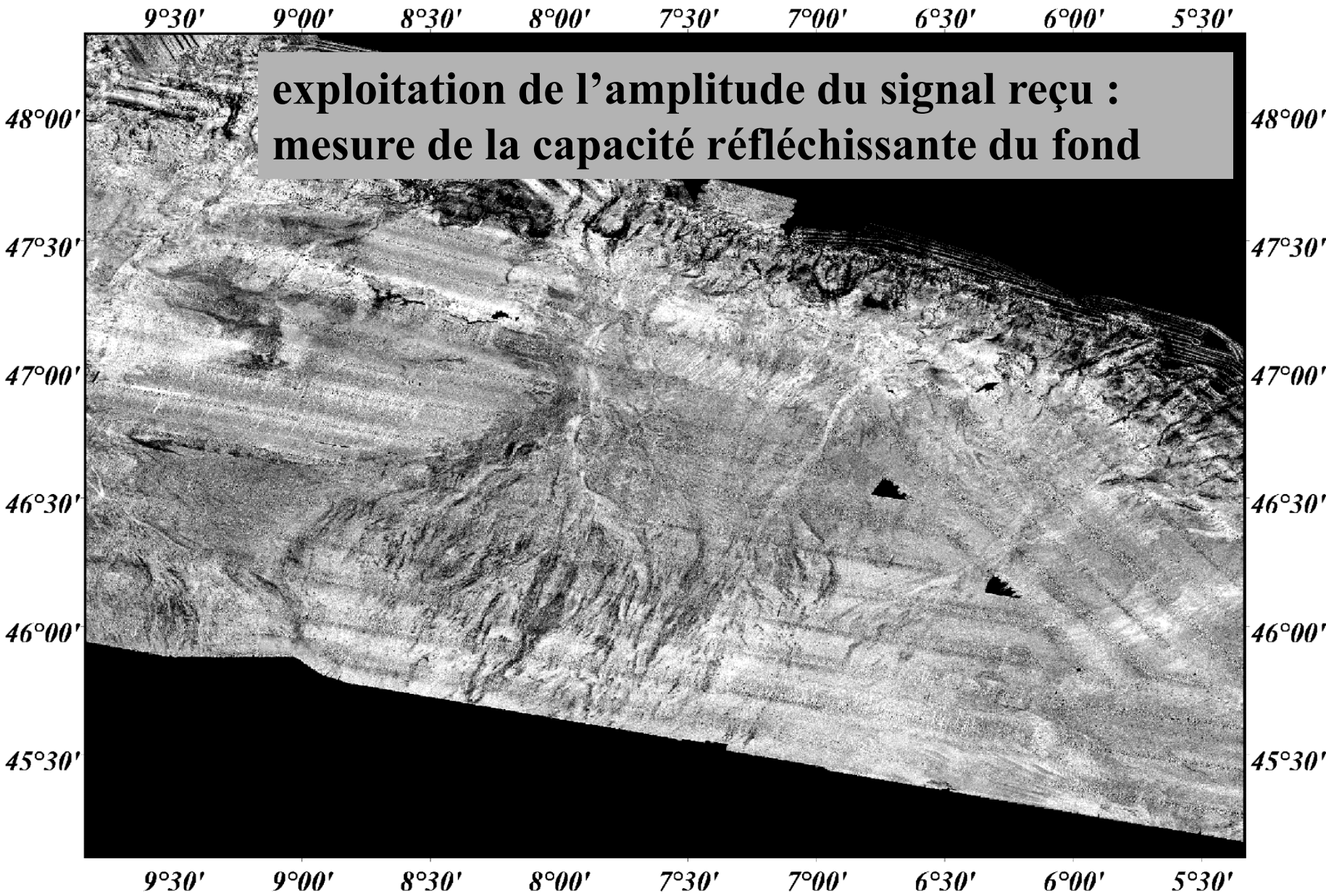
ex = $P = 1000$ m / $2\theta_M = 140°$ -> E # 4000 m

$P = 5$ m / $2\,\theta_M = 140°$ -> E # 20 m

Profils traversiers

Contrôle de la qualité

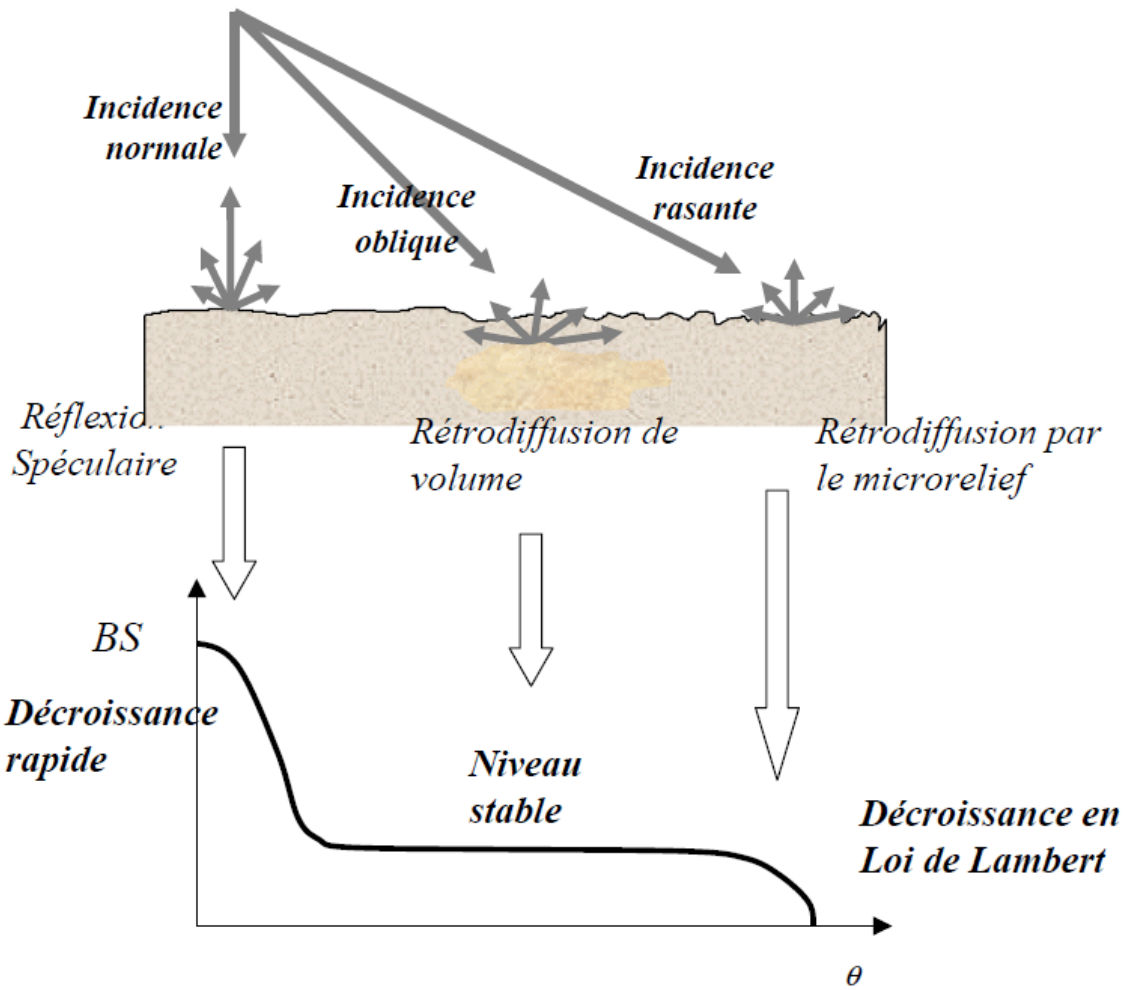




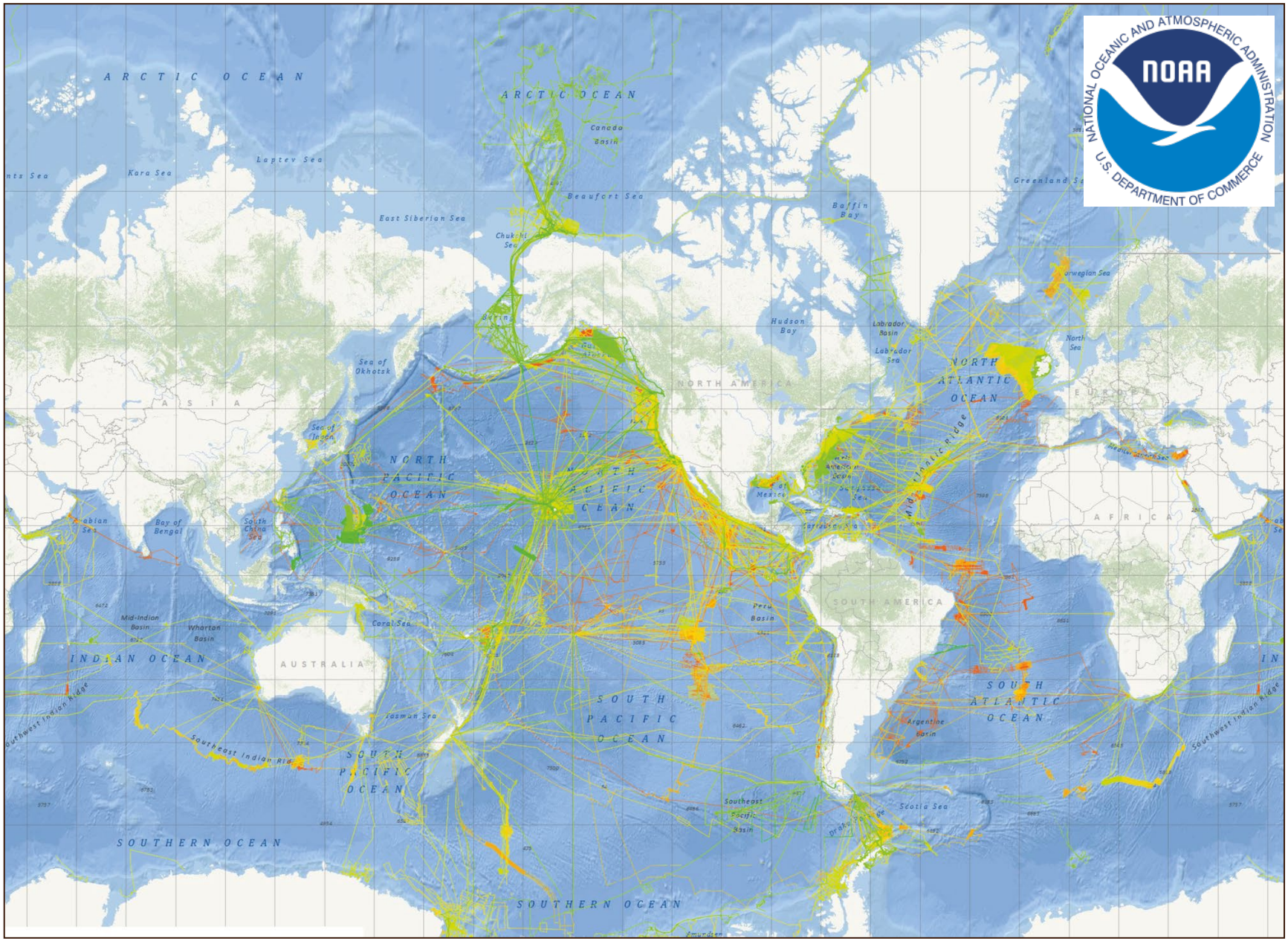
exploitation de l'amplitude du signal reçu : mesure de la capacité réfléchissante du fond

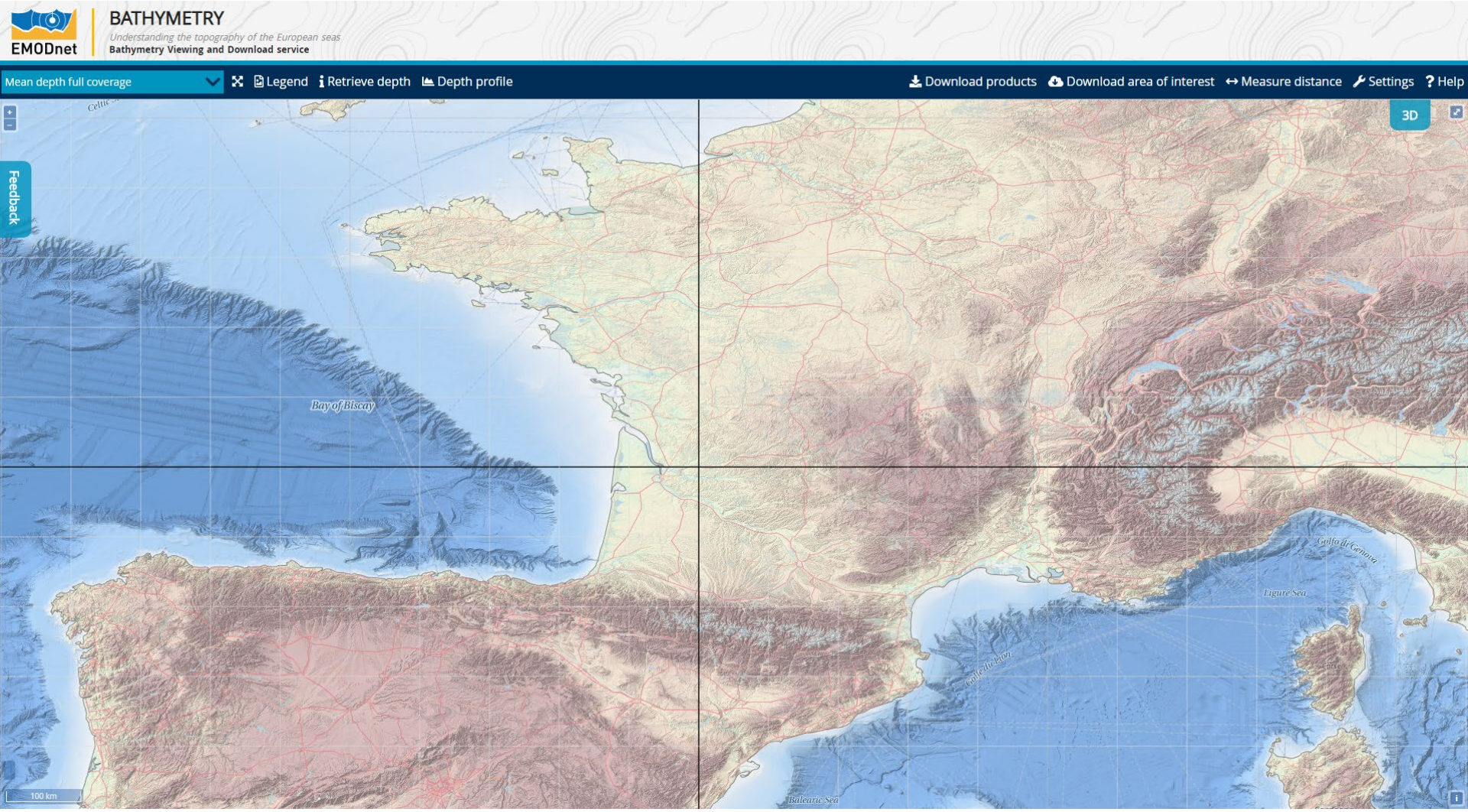
Réflectivité angulaire du fond BS (dB/m²)

BS = f(fréquence, incidence, type de fond)



Ifremer


ARCTIC OCEAN
Kara Sea
Laptev Sea
East Siberian Sea
Chukchi Sea
Beaufort Sea
Canada Basin
Baffin Bay
Hudson Bay
Labrador Basin
Labrador Sea
Greenland Sea
Norwegian Sea
North Sea
Sea of Okhotsk
Sea of Japan
ASIA
NORTH AMERICA
EUROPE
NORTH PACIFIC OCEAN
NORTH ATLANTIC OCEAN
Gulf of Mexico
Caribbean Sea
Mediterranean Sea
AFRICA
Arabian Sea
Bay of Bengal
South China Sea
Mid-Indian Basin
Wharton Basin
INDIAN OCEAN
AUSTRALIA
Coral Sea
Tasman Sea
Southwest Indian Ridge
Southeast Indian Ridge
SOUTH PACIFIC OCEAN
Peru Basin
SOUTH AMERICA
SOUTH ATLANTIC OCEAN
Argentine Basin
Scotia Sea
Southeast Pacific Basin
SOUTHERN OCEAN
Amundsen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BATHYMETRY
Understanding the topography of the European seas
Bathymetry Viewing and Download service
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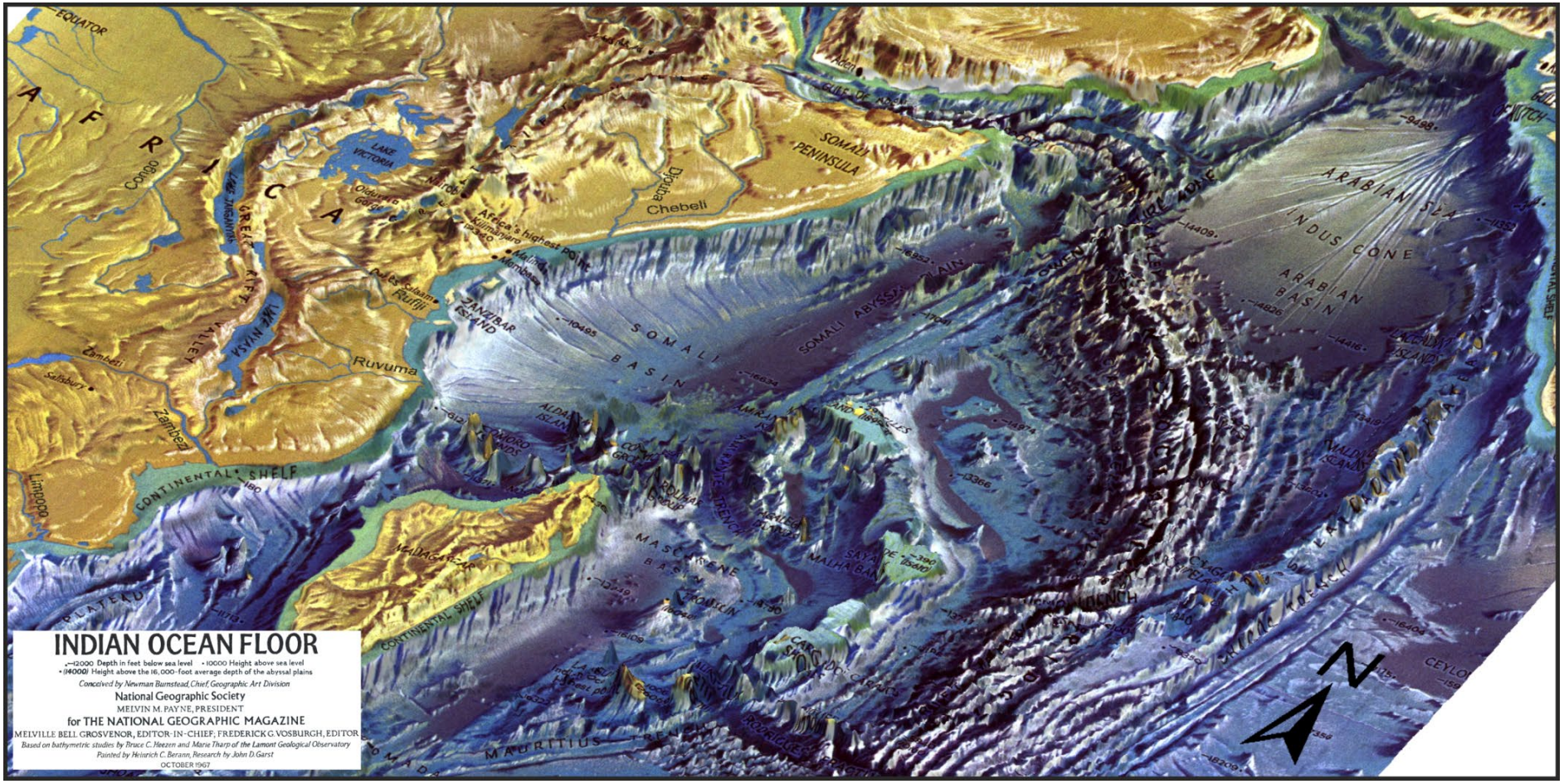
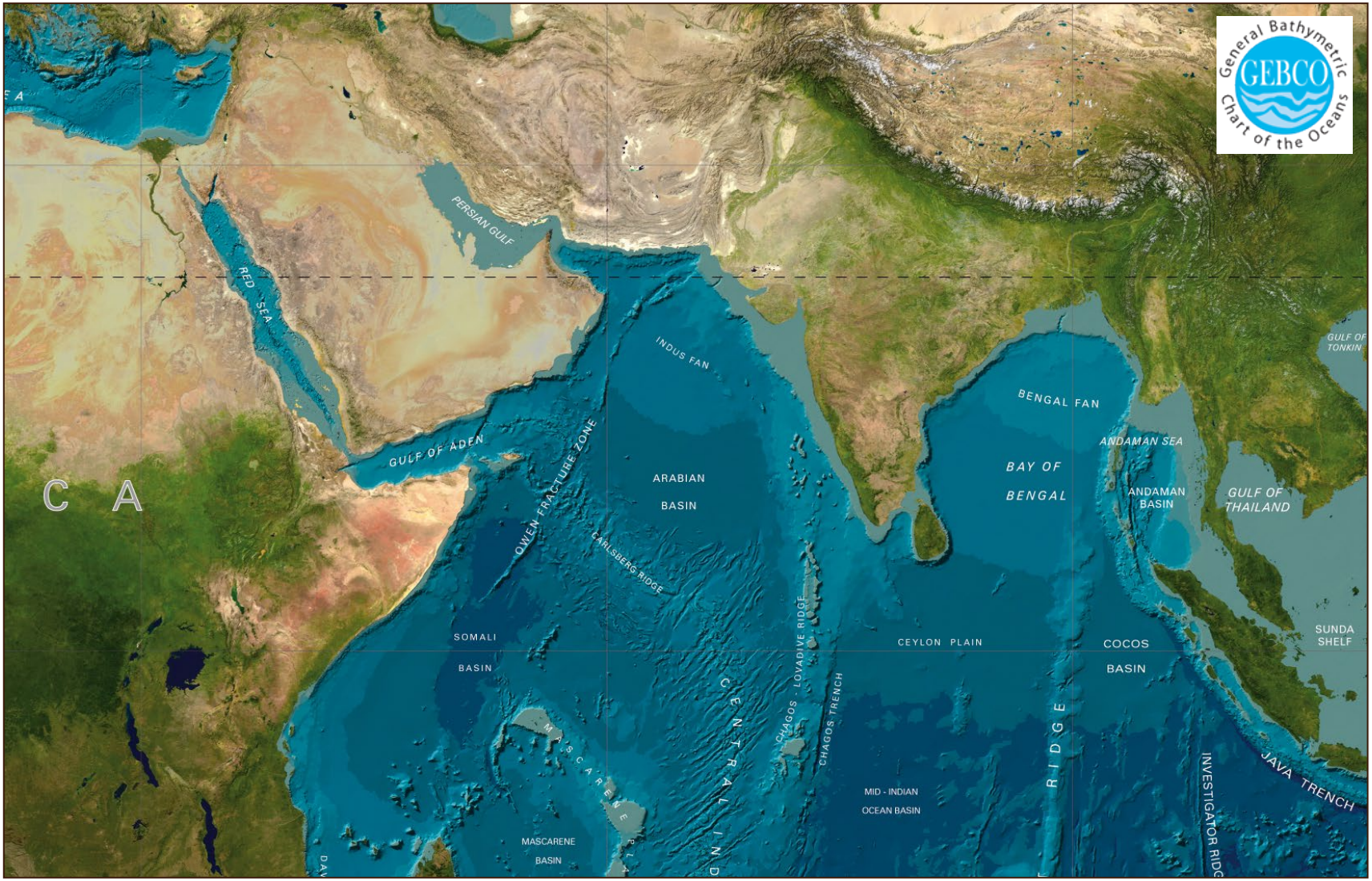
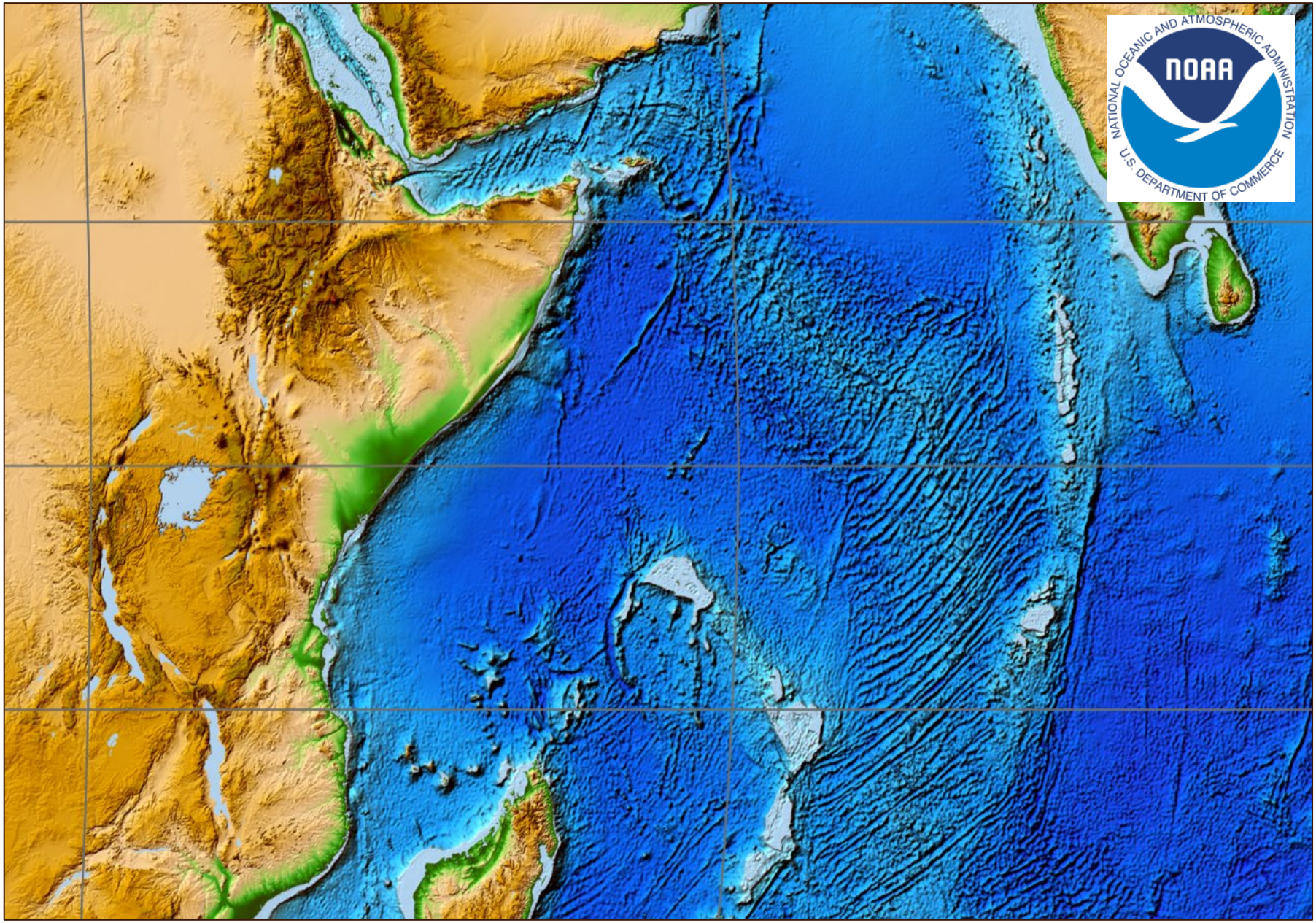
Legend
Retrieve depth
Depth profile
Download products
Download area of interest
Measure distance
Settings
Help
3D
Feedback
Bay of Biscay
Gulf of Genova
Ligure Sea
Balearic Sea
100 km

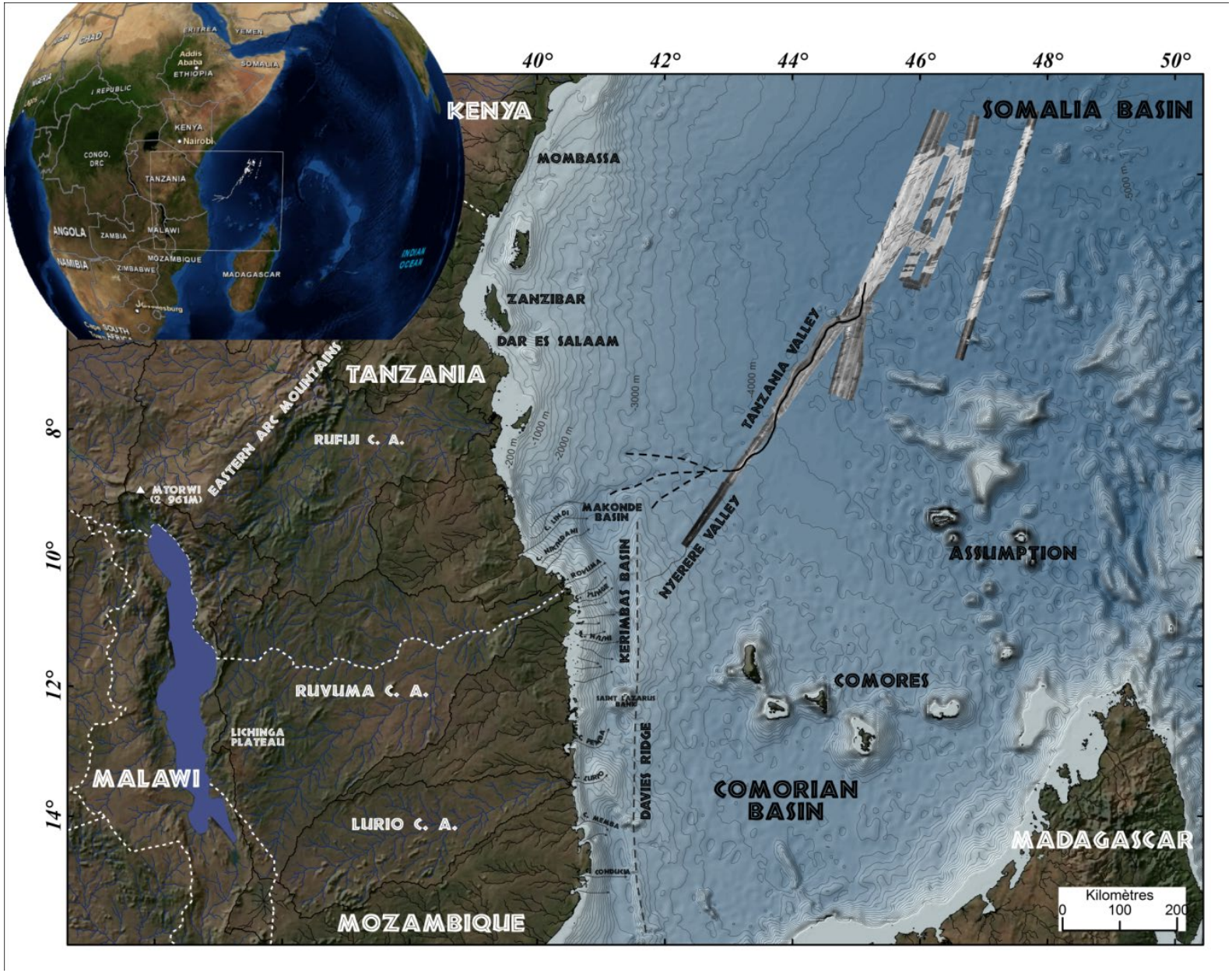

INDIAN OCEAN FLOOR
Conceived by Newman Burnstead, Chief, Geographic Art Division
National Geographic Society
MELVIN M. PAYNE, PRESIDENT
for THE NATIONAL GEOGRAPHIC MAGAZINE
MELVILLE BELL GROSVENOR, EDITOR-IN-CHIEF; FREDERICK G. VOSBURGH, EDITOR
Based on bathymetric studies by Bruce C. Heezen and Marie Tharp of the Lamont Geological Observatory
Painted by Heinrich C. Berann, Research by John D. Garst
OCTOBER 1967
EQUATOR
AFRICA
Congo
LAKE VICTORIA
LAKE TANGANYIKA
GREAT RIFT VALLEY
LAKE NYASA
Zambezi
Ruvuma
Limpopo
Chebeli
SOMALI PENINSULA
Aden
Africa's highest point
Mombasa
ZANZIBAR ISLAND
SOMALI BASIN
SOMALI ABYSSAL PLAIN
ARABIAN SEA
INDUS CONE
ARABIAN BASIN
CONTINENTAL SHELF
MADAGASCAR
MASCARENE BASIN
MAURITIUS
CEYLON
N

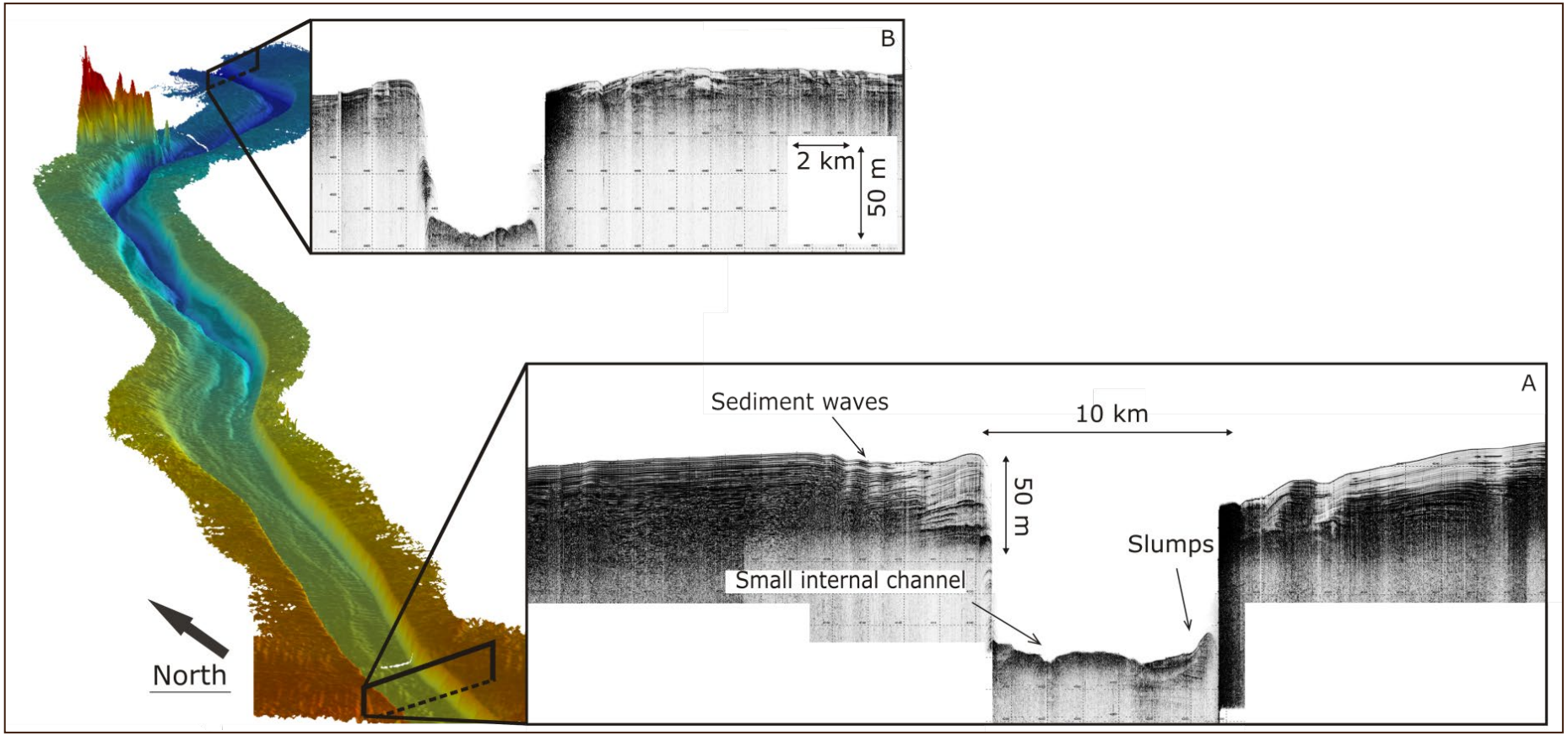
Cas d'étude : le bassin de Somalie

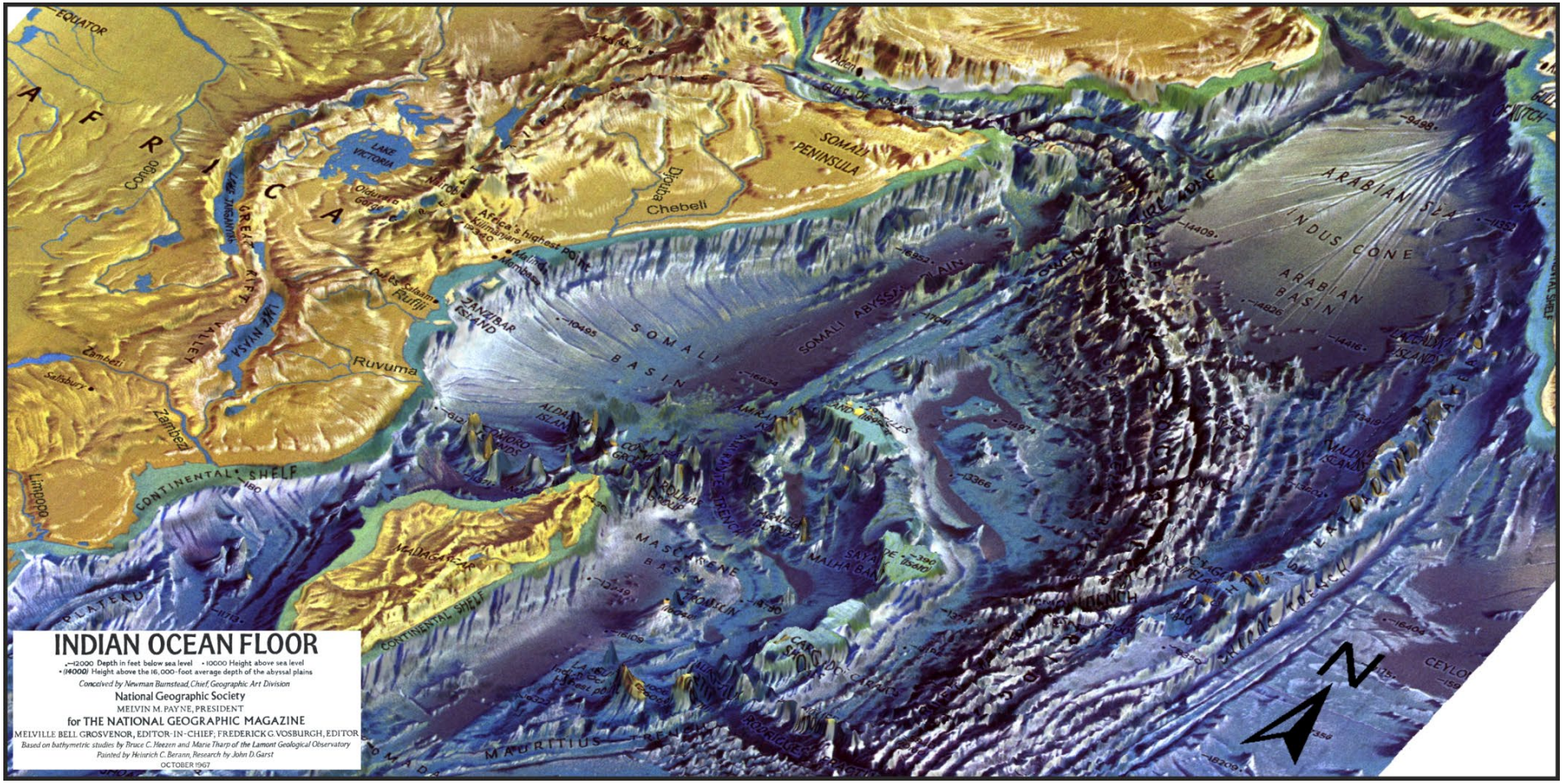


Cas d'étude : le bassin de Somalie




40°
42°
44°
46°
48°
50°
8°
10°
12°
14°
KENYA
MOMBASSA
ZANZIBAR
DAR ES SALAAM
TANZANIA
SOMALIA BASIN
TANZANIA VALLEY
NYERERE VALLEY
EASTERN ARC MOUNTAINS
RUFIJI C. A.
MTORWI (2 961M)
MAKONDE BASIN
KERIMBAS BASIN
DAVIES RIDGE
ASSUMPTION
COMORES
COMORIAN BASIN
MADAGASCAR
RUVUMA C. A.
LICHINGA PLATEAU
MALAWI
LURIO C. A.
MOZAMBIQUE
Kilomètres
0
100
200


B
2 km
50 m
A
Sediment waves
10 km
50 m
Slumps
Small internal channel
North


INDIAN OCEAN FLOOR
–2000 Depth in feet below sea level • 10000 Height above sea level
(14000) Height above the 16,000-foot average depth of the abyssal plains
Conceived by Newman Burnstead, Chief, Geographic Art Division
National Geographic Society
MELVIN M. PAYNE, PRESIDENT
for THE NATIONAL GEOGRAPHIC MAGAZINE
MELVILLE BELL GROSVENOR, EDITOR-IN-CHIEF; FREDERICK G. VOSBURGH, EDITOR
Based on bathymetric studies by Bruce C. Heezen and Marie Tharp of the Lamont Geological Observatory
Painted by Heinrich C. Berann, Research by John D. Garst
OCTOBER 1967
AFRICA
Congo
LAKE VICTORIA
LAKE TANGANYIKA
GREAT RIFT VALLEY
LAKE NYASA
Zambezi
Limpopo
Ruvuma
Rufiji
Pangani
Kilimanjaro
Mombasa
Malindi
Chebeli
Juba
SOMALI PENINSULA
Aden
GULF OF ADEN
ZANZIBAR ISLAND
SOMALI BASIN
SOMALI ABYSSAL PLAIN
ARABIAN SEA
INDUS CONE
ARABIAN BASIN
LACCADIVE ISLANDS
CONTINENTAL SHELF
MADAGASCAR
MASCARENE BASIN
MAURITIUS
CEYLON
N

GOOGLE a découvert l'Atlantide !!!

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Google — google earth atlantide

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L'**Atlantide** découverte via **Google Earth** ? - YouTube
www.youtube.com/watch?v=oPeqPEDhY5A
21 févr. 2009 - 1 mn - Ajouté par xxxAlethxxx
Serait-ce l'un des vestiges de l'**Atlantide** ? Avec **Google Earth** 31°21'45.10" N ; 24 °24'00.51" O.

Dailymotion - L'**Atlantide** retrouvée grâce à **Google Earth** - une vidéo ...
www.dailymotion.com/.../x8qgd7_l-**atlantide**-retrouvee-grace-a...
21 mars 2009 - 1 mn
Via **Google Earth**, à près de 1400 km à l'Ouest du Détroit de Gibraltar - 31°21' 45.10" N ; 24°24'00.51" O - se dessine au fond ...

Autres vidéos pour **google earth atlantide** »

L'**Atlantide** dans **Google Earth** ? Google dément... - Actualité ...
actu.abondance.com/2009/.../**atlantide**-dans-**google-earth-google**.ht...
25 févr. 2009 – Paru sur Abondance le mercredi 25 février 2009, Auteur : Olivier Andrieu. Retrouvez ici toute l'actualité des moteurs de recherche majeurs et ...

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24 févr. 2009 – Après les canaux de Mars, les sillons de l'océan... **Google Earth**, comme chacun peut le constater, montre quelque part au large des îles ...

Images correspondant à **google earth atlantide** - Signaler des images inappropriées

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Découverte de l'**Atlantide** sur **Google Earth** | Korben
korben.info/decouverte-de-**atlantide**-sur-**google-earth**.html
20 févr. 2009 – L'**Atlantide** (ou **Atlantis** en anglais), mythe ou réalité ? Cette civilation prospère aurait disparue sous les flots en 9700 avant JC, soit il y a 12000.

Atlantis trouvée sur **Google Earth** | Gizmodo
www.gizmodo.fr/2009/02/22/**atlantis**-trouvee-sur-**google-earth**.html
22 févr. 2009 – Cette image montrerait les ruines de la cité perdue **Atlantis**, trouvées sur **Google Earth**. Évaluons les preuves à charge et à décharge et voyons ...

GOOGLE a découvert l'Atlantide !!!

GOOGLE a découvert l'Atlantide !!!

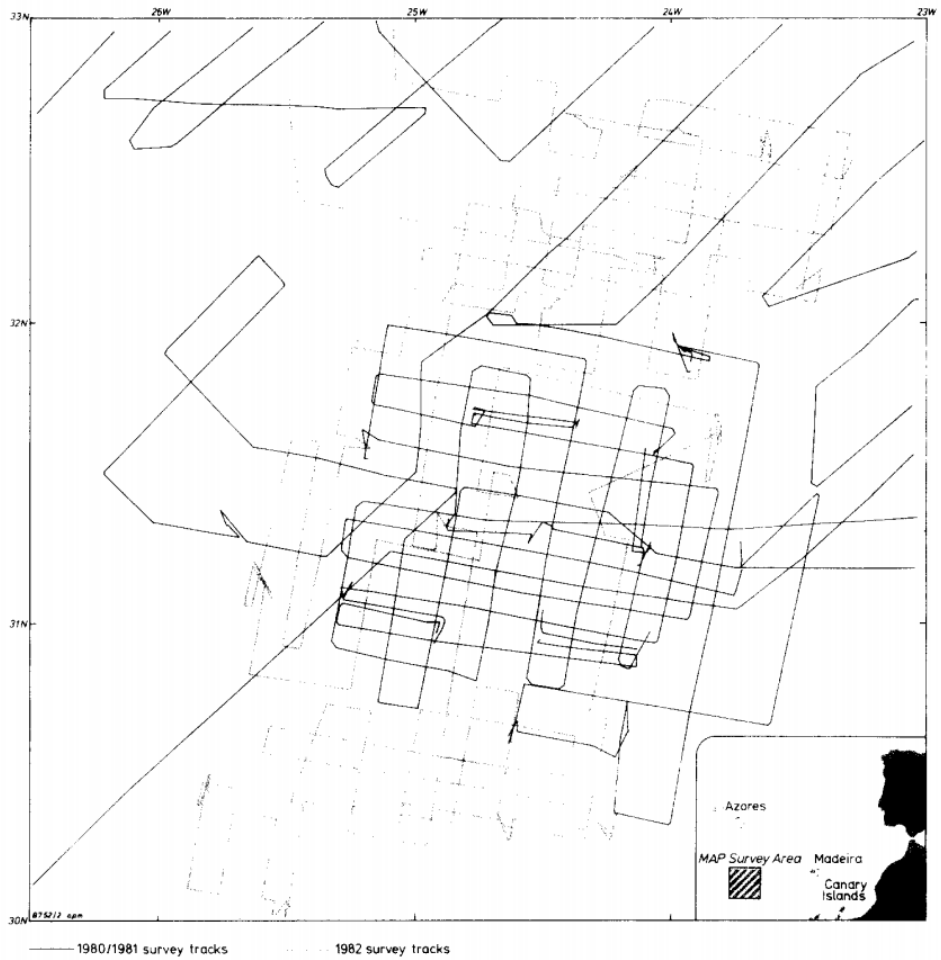

Fig. 1. Recent track lines in the Madeira Abyssal Plain area. The inset shows the location of the area.

Marine Geology, 56 (1984) 299—308
Elsevier Science Publishers B.V., Amsterdam — Printed in The Netherlands

Letter Section

FAULTING IN MADEIRA ABYSSAL PLAIN SEDIMENTS

E.J.Th. DUIN, C.S. MESDAG and P.T.J. KOK

Geological Survey of The Netherlands, P.O. Box 157, 2000 AD Haarlem (The Netherlands)

(Received March 10, 1983; revised and accepted October 4, 1983)

ABSTRACT

Duin, E.J.Th., Mesdag, C.S. and Kok, P.T.J., 1984. Faulting in Madeira Abyssal Plain sediments. Mar. Geol., 56: 299—308.

Interpretation of high-resolution seismic data revealed the occurrence of faults in the sediments of two North Atlantic abyssal plain environments, the Madeira Abyssal Plain (MAP) and the Nares Abyssal Plain (NAP). Most of the data are from the MAP, where faulting appears to be confined to particular locations. From our data individual faults cannot be traced from one seismic section to another. A positive correlation exists between the concentration of faults and the maximum sediment thickness.

Although the mechanism that caused the faulting is still not understood, the faults apparently are related to processes which have been active for a long period of time.

INTRODUCTION

Since 1980 the Geological Survey of The Netherlands (RGD) has been active in applied ocean floor studies. In this context two major cruises (1980 and 1982) were made to the Madeira Abyssal Plain (MAP), situated in the eastern North Atlantic between 30—33°N and 23—26°30′W (Fig. 1). On behalf of RGD the Marine Geophysics Department (VML) of the Utrecht State University carried out a short survey in 1982 in the Nares Abyssal Plain (NAP), situated in the western North Atlantic between 22—24°N and 62—64°W.

Both in the MAP and in the NAP seismic recordings have been made using a 3.5 kHz echosounder and an 80 in.^{3} (1.3 dm^3) watergun as sound sources. From the 3.5 kHz recordings (maximum penetration down to approximately 120 ms) as well as from the watergun recordings (penetration often to the acoustic basement) it appears that well-defined reflectors, which can easily be traced over large distances, display abrupt discontinuities. This is an unexpected feature of these abyssal plain environments with a uniform sedimentation pattern.

Because the majority of the seismic data come from the MAP we have restricted ourselves in the following to that area. The MAP survey area

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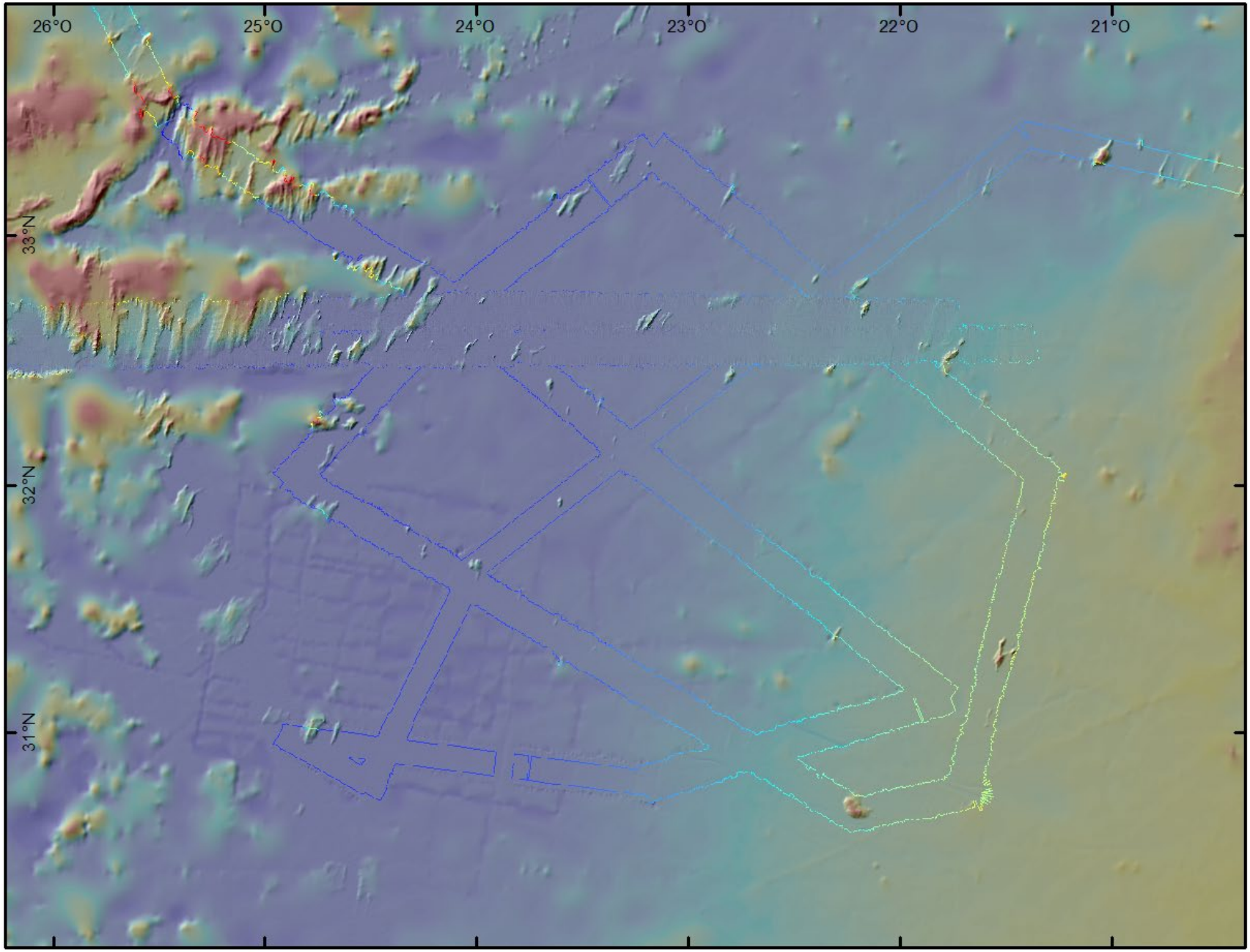
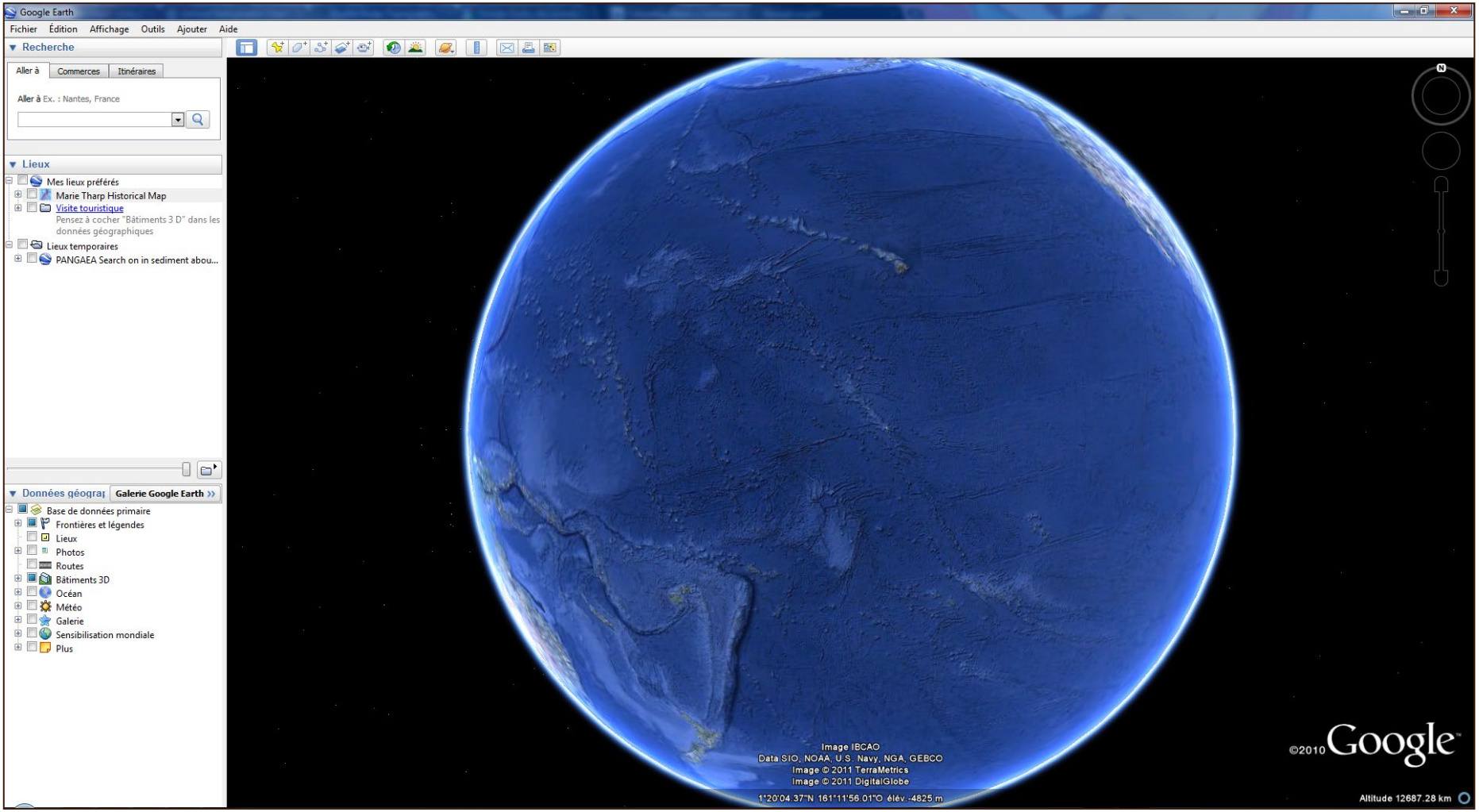


Au travail …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Altitude 12687.28 km