Università di Trieste
Corso di Laurea in Geologia

Anno accademico 2020 - 2021

Geologia Marina

Parte I

Modulo 1.2 Oceani. Morfologia, struttura ed evoluzione

Docente
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The oceans

1. Oceans and seas of the world
2. Morphology of the ocean and sea floor
3. Structure of the ocean
4. Classification of the ocean and sea environments
5. Ancient oceans

1. Etymology

The term Ocean derives from Ὠκεανὸς (ΟΚΕΑΝΟΣ), greek river-god that was believed to surround the world, the external sea (not the Mediterranean).

But the rooth of word are from sanscrit ACAYANA, in the sense of «containing the waters».

Okeanos is one of the Titans,
son of Uran (sky) and Gea (earth),
husband of **Teti**,
and father of all the fluvial divinities.

The oceans and the seas are important because they :

The Blue Planet

- cover 71-72% of the Earth surface
- contain the 97% of the water of the Earth
- but less than 5-10% have been explored

The present Oceans of the world

International Hydrographic Organization

The International Hydrographic Organization is an intergovernmental organization that works to ensure all the world's seas, oceans and navigable waters are surveyed and charted.

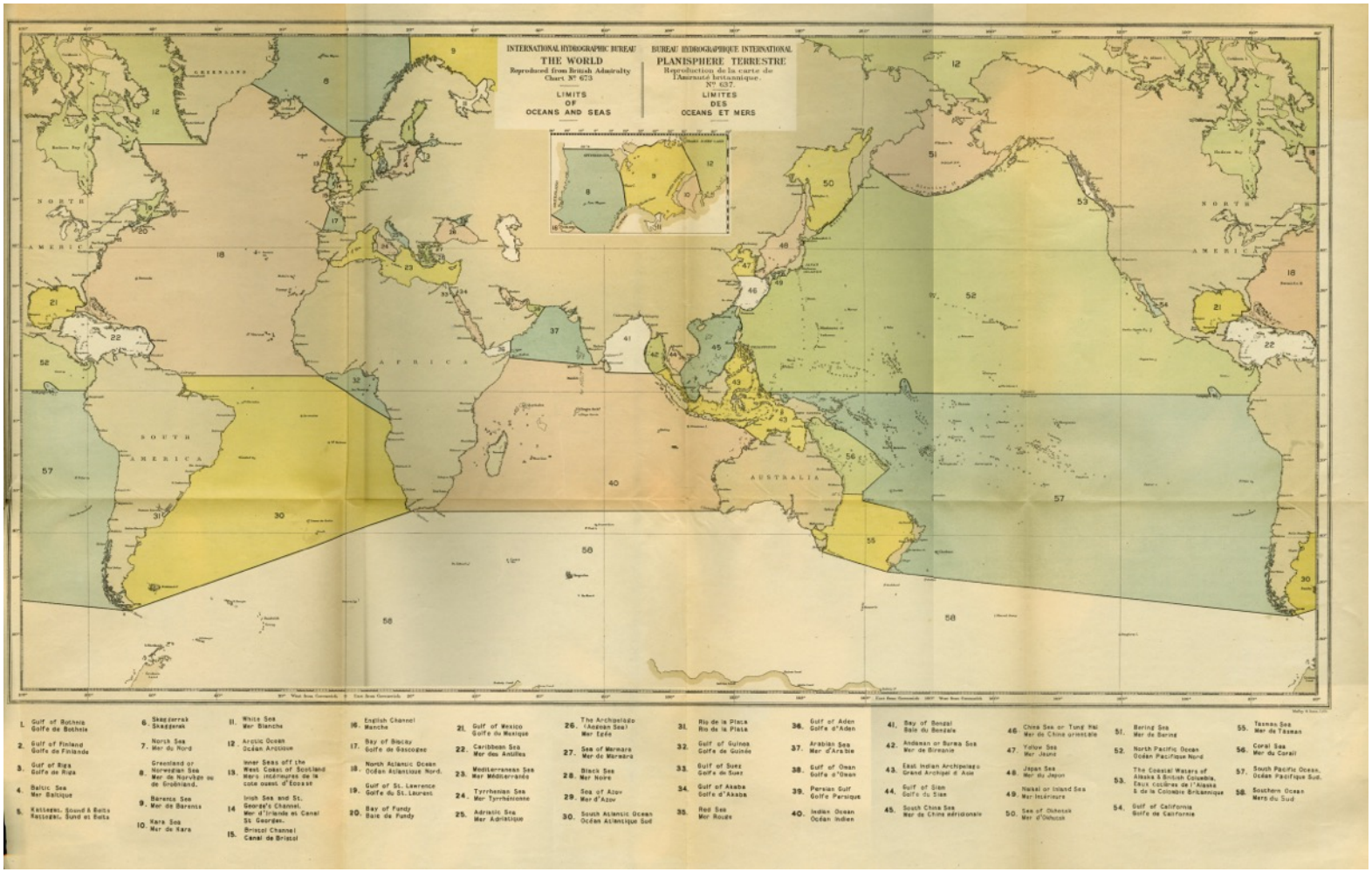
A principal Aim of the IHO is to ensure that all the world's seas, oceans and navigable waters are surveyed and charted.

The **Mission** of the IHO is to create a global environment in which States provide adequate and timely hydrographic data, products and services and ensure their widest possible use.

The **Vision** of the IHO is to be the authoritative worldwide hydrographic body which actively engages all coastal and interested States to advance maritime safety and efficiency and which supports the protection and sustainable use of the marine environment.

The limits of the oceans and seas

1st edition in 1928 by the IHO



The oceans of the world

The limit of the oceans formally defined by the IHO
(black line – excluding marginal waterbodies)

Pacific Ocean

Atlantic Ocean

Indian Ocean

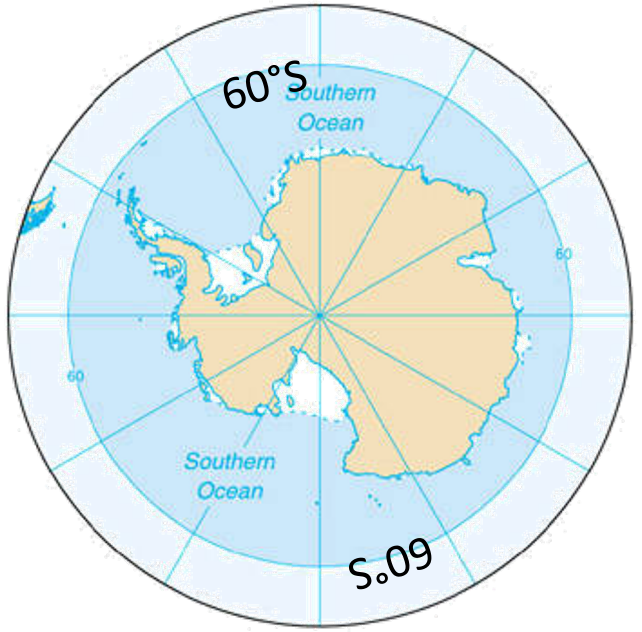
The oceans of the world

Artic Ocean

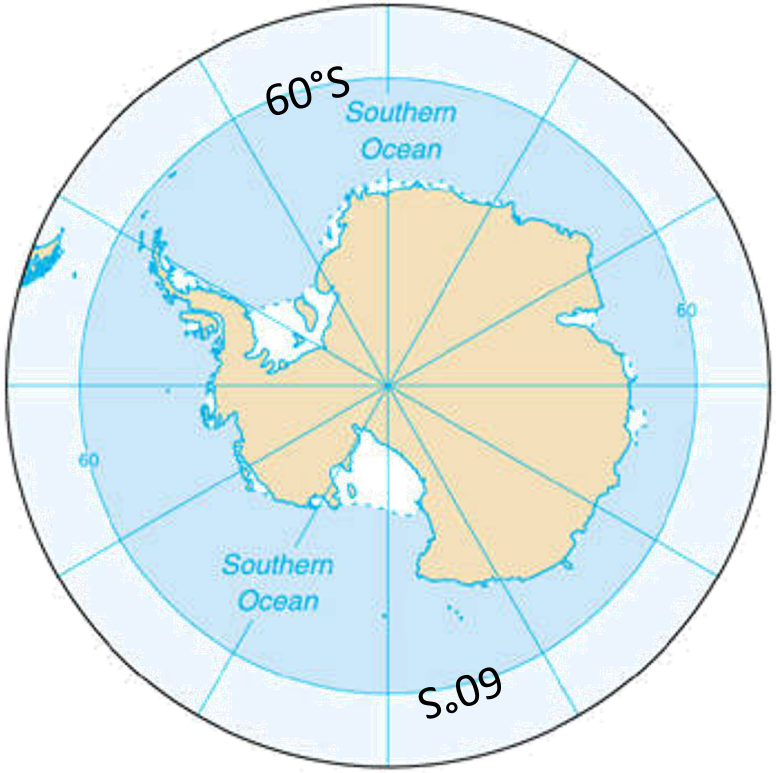
The limit of the oceans formally defined by the IHO (black line – excluding marginal waterbodies)

Southern Ocean

In 2000, the IHO published a draft definition of the Southern Ocean, surrounding Antarctica and extending to 60° S.
Up to now, the **Southern Ocean is not formally defined by the IHO**.



Southern Ocean



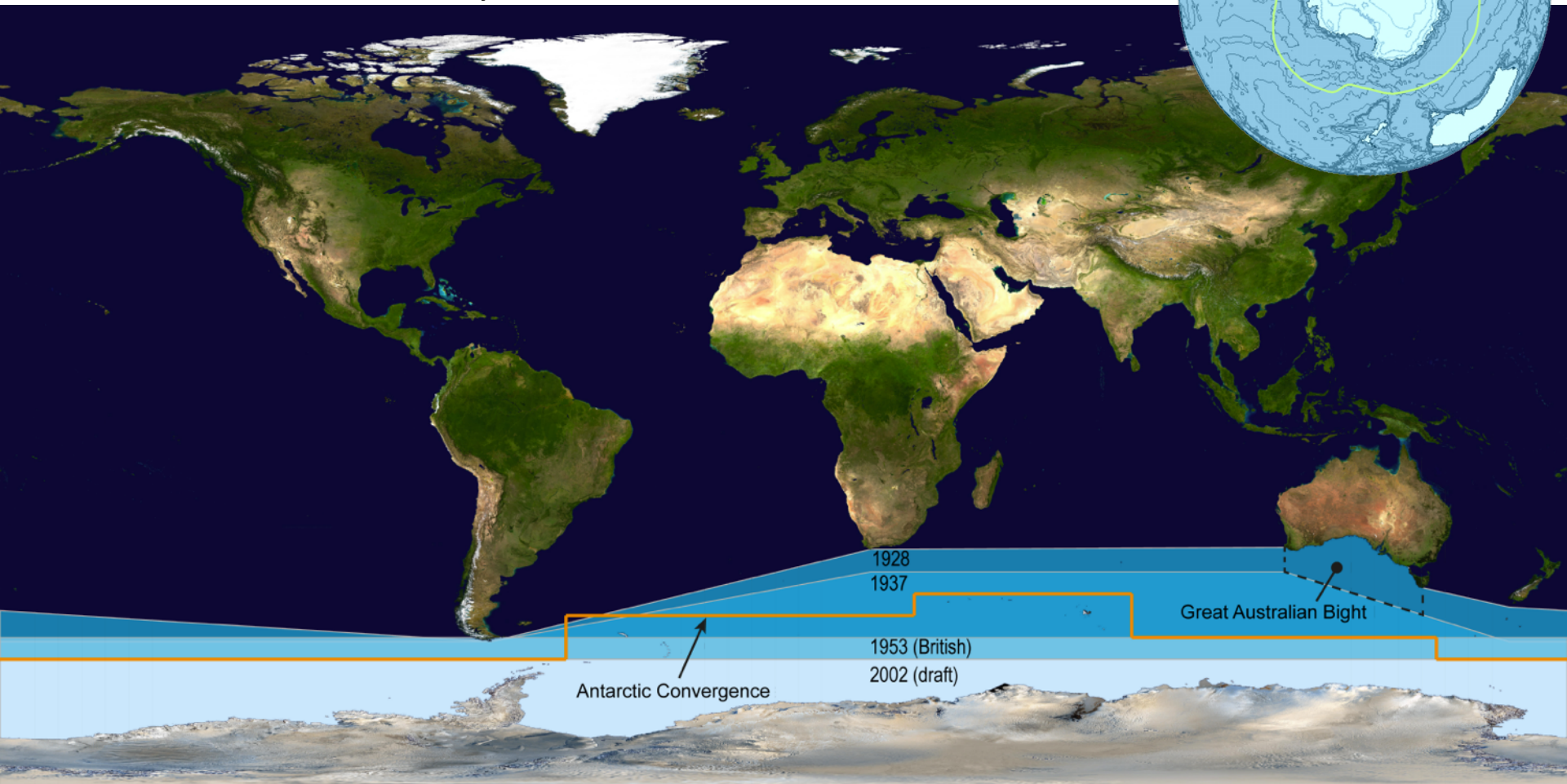
In 2000, the International Hydrographic Organization (IHO), published a draft definition of a new ocean:

the Southern Ocean

surrounding Antarctica and extending to 60° S. Up to now, the Southern Ocean is not formally defined by the IHO.

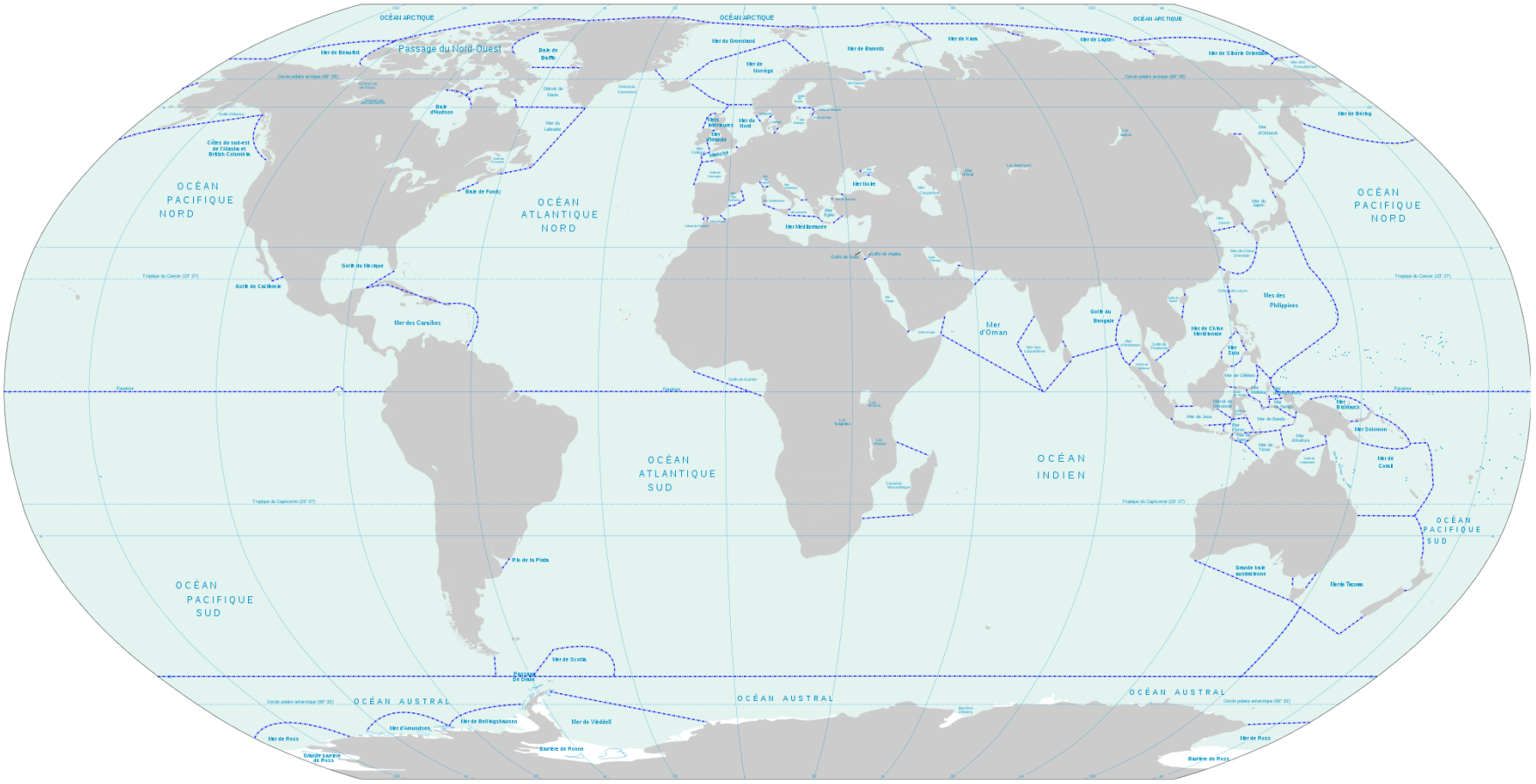
IH0's delineation of the Southern Ocean

Antarctic Convergence: a curve encircling Antarctica, varying in latitude seasonally, where cold, northward-flowing Antarctic waters meets the relatively warmer water of the subantarctic

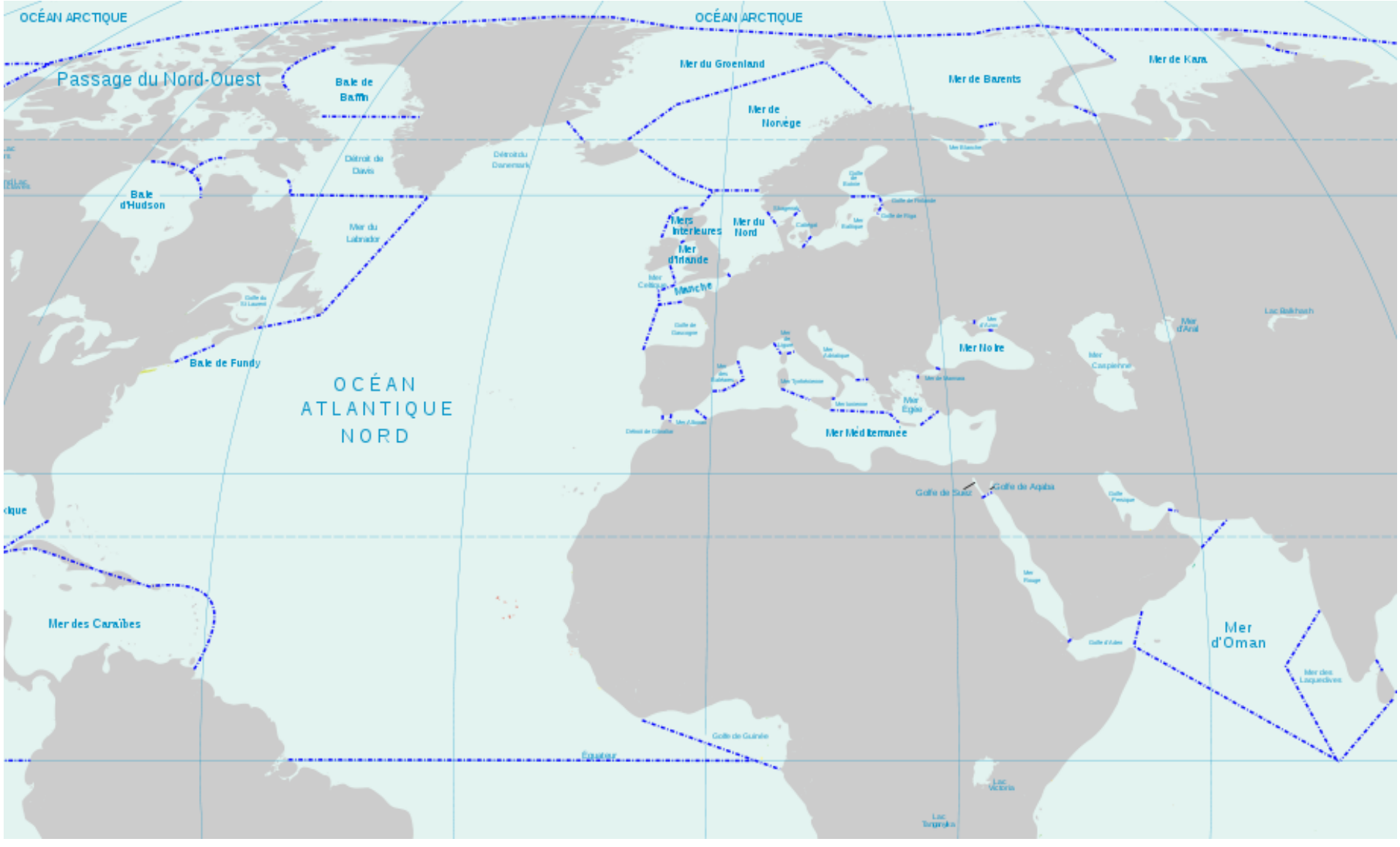


Ocean	Area	Average Depth (m)	Deepest depth (m)
Pacific Ocean	165,250,000 km^2	4,028 m	Mariana Trench 11,033 m
Atlantic Ocean	106,400,000 km^2	3,926 m	Puerto Rico Trench 8,604 m
Indian Ocean	73,560,000 km^2	3,963 m	Java Trench, 7,725 m
Southern Ocean	20,330,000 km^2	4,000 to 5,000 m	the southern end of the South Sandwich 7,236 m
Arctic Ocean	13,990,000 km^2	1,205 m	Eurasia Basin, 5,540 m

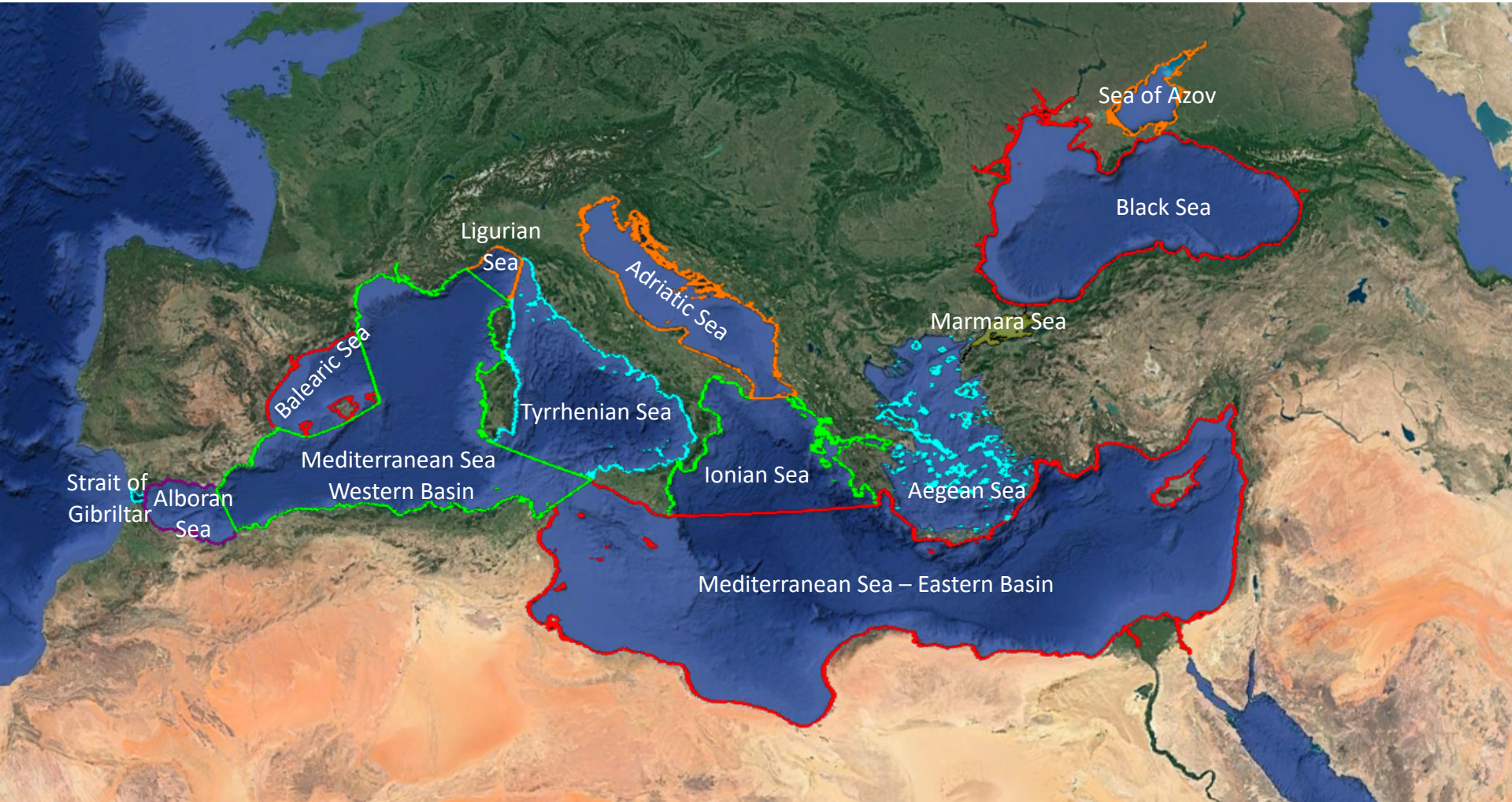
The limits of the oceans and seas
defined by the International Hydrographic Organization (IHO)



The seas of the world

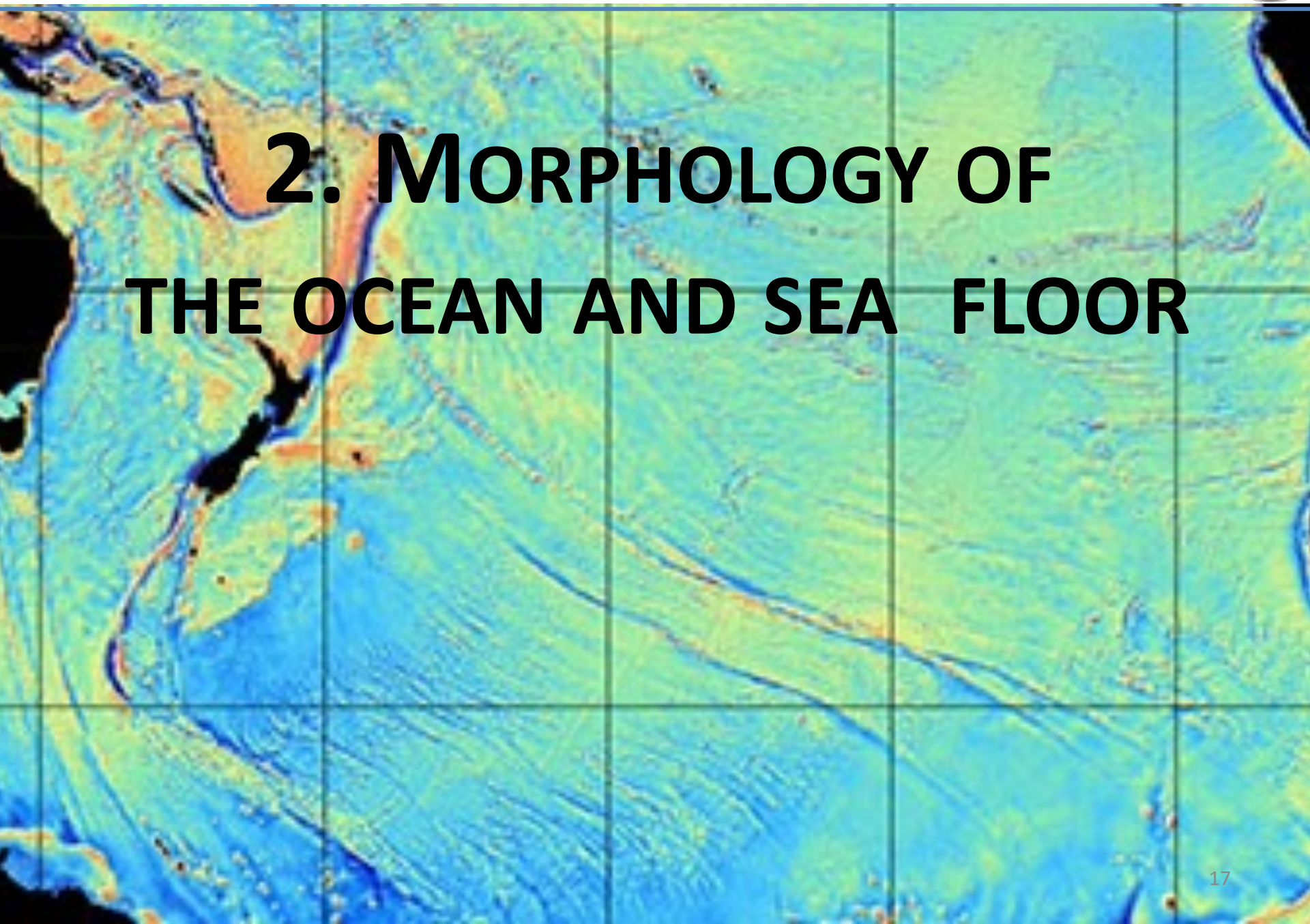


The seas of the Mediterranean formally defined by the IHO



The seas of the Mediterranean

from latin "Mediterraneus": medi > between terraneous > land



2. MORPHOLOGY OF THE OCEAN AND SEA FLOOR

OCEAN AND SEA FLOOR MORPHOLOGY

less than 5-10% of the ocean have been explored

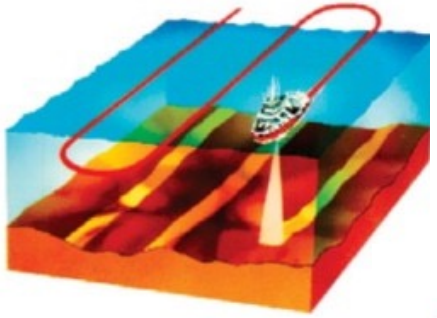
To investigate the oceans and seas we need appropriate instruments and techonologies:

5-10%

1) First instrument: the SONAR, constructed at the beginning of the 1900

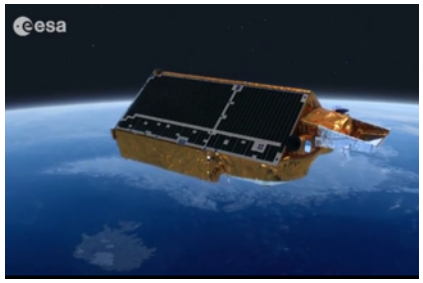
2) Multibeam technologies, developped in the last decades of the 1900

3) Satellite derived bathymetry and and sea floor morphology developped in the last decades of the 1900



(a) Single-Beam

(b) Multi-Beam

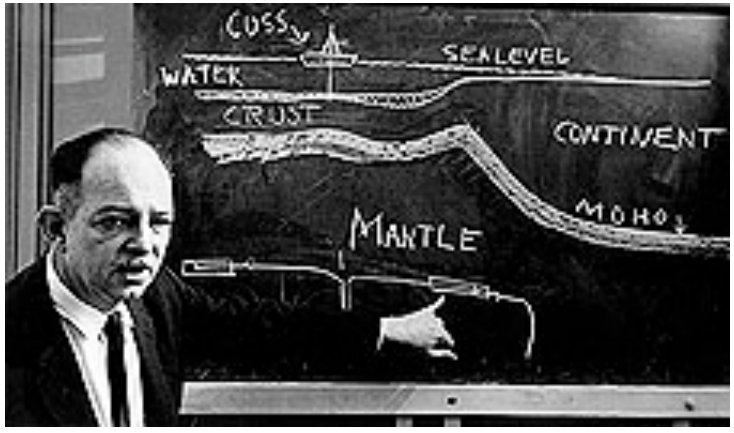


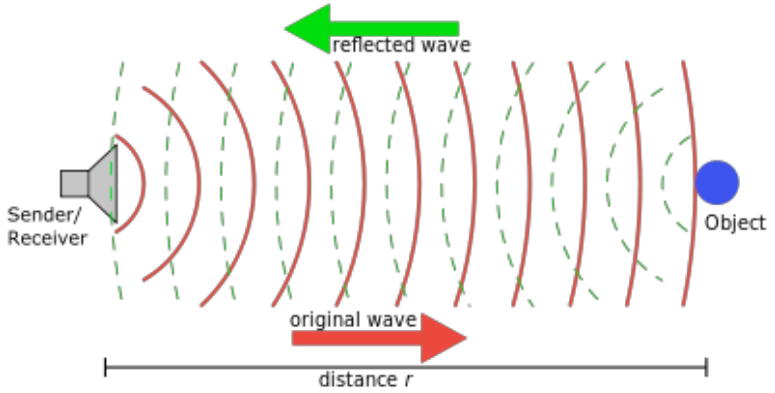
Harry Hess (1906 – 1969)

Professor of geology at Princeton University

During the Second World War, Hess was the captain of a ship equipped with a SONAR (SOund NAvigation and Ranging, invented in 1917 by Paul Langevin).

Hess discovered the Mid-oceanic ridges and the guyots, and in the ’62 he published the Sea floor Spreading theory, fundamental for the Plate Tectonic theory.



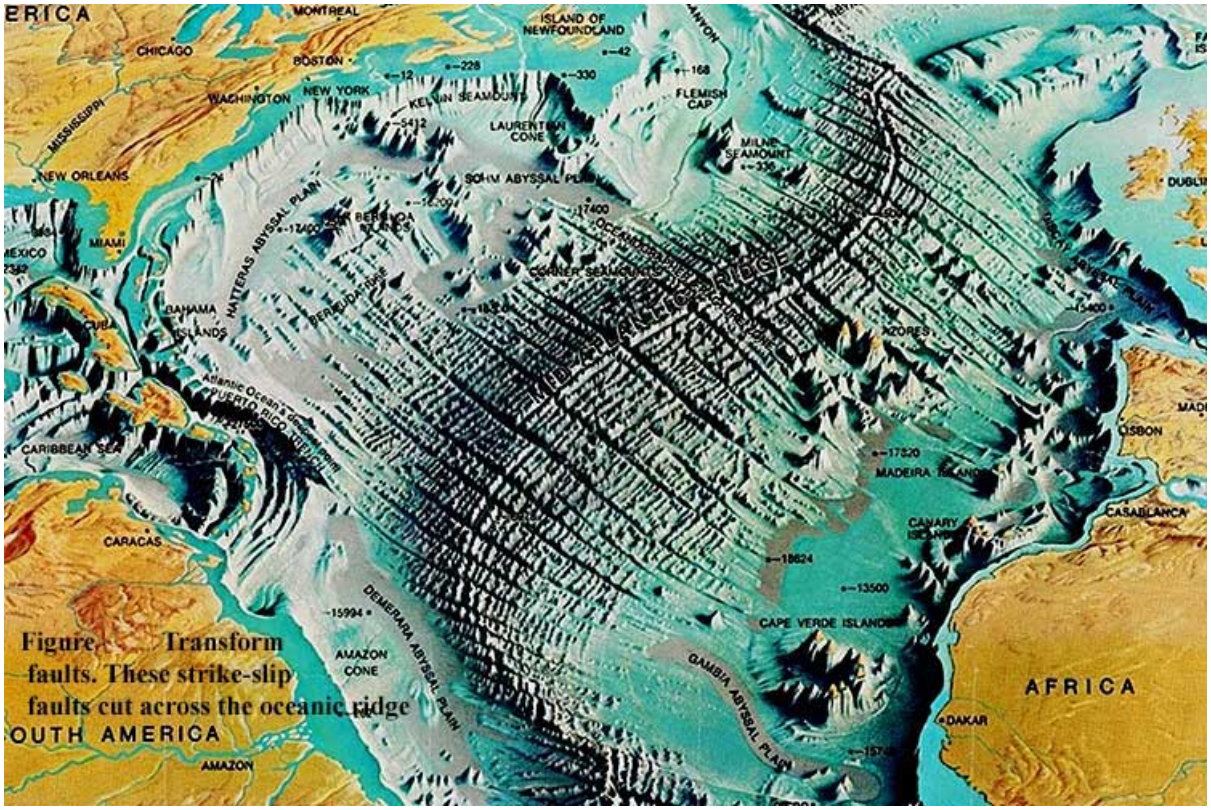


The SONAR principle

SEA FLOOR MORPHOLOGY 1977

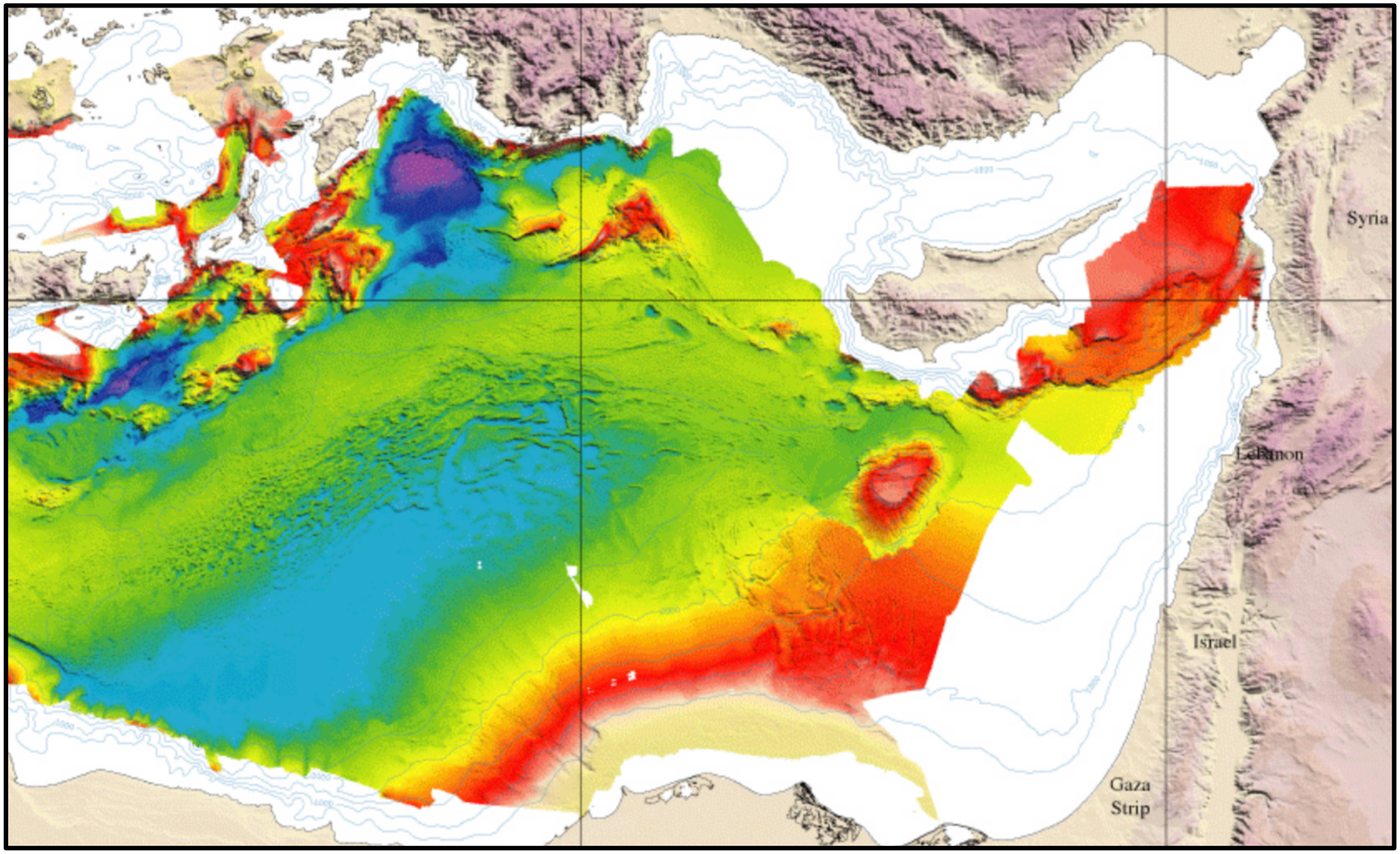
Marie Tharp and Bruce Heezen, oceanographers of the Columbia University's Lamont Geological Observatory. They discovered the 60.000 km of underwater ridges
The map was painted by Heinrich C. Berann.

Mid-Ocean Ridges

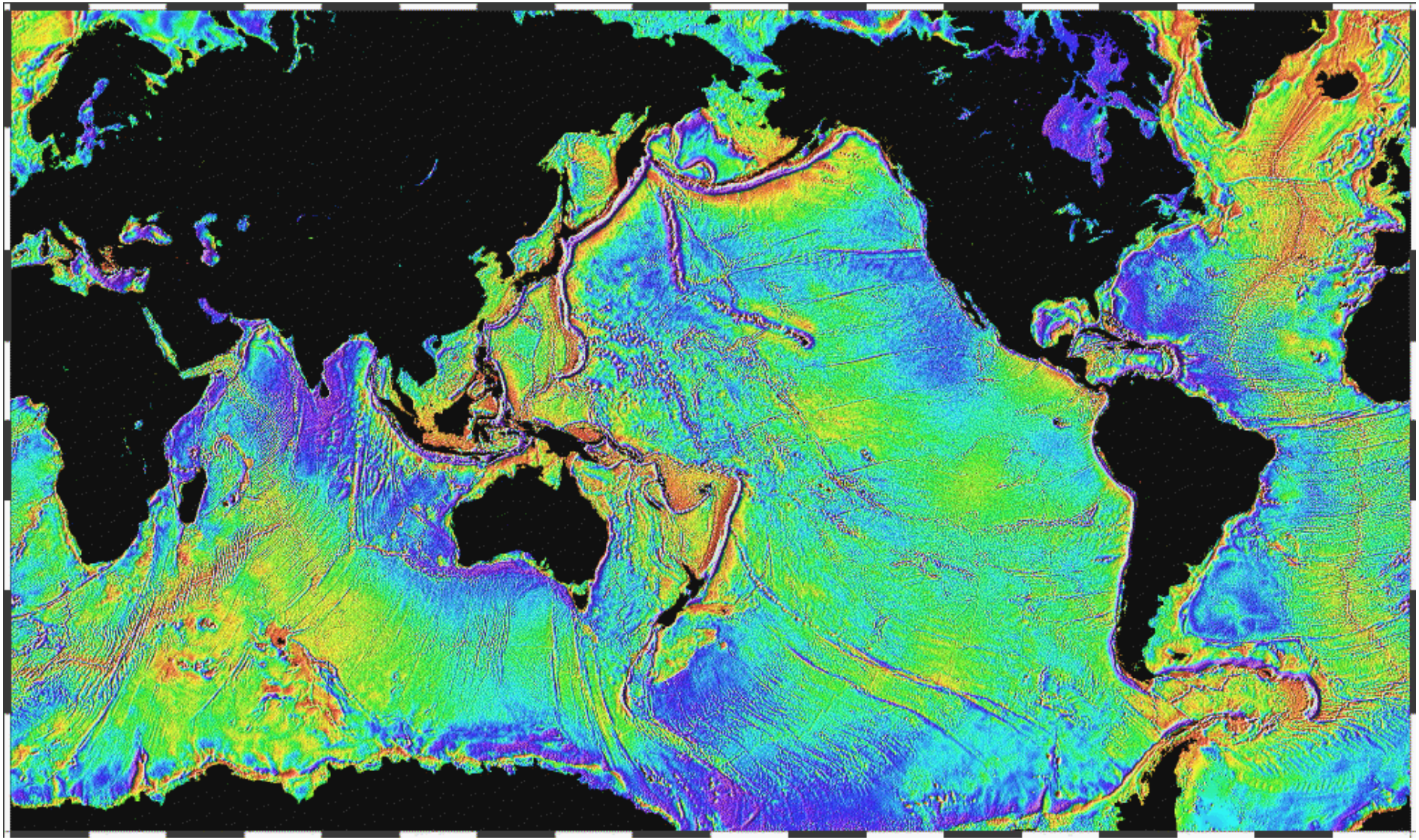


- The largest feature of the ocean floor.
- Linear belt of submarine mountains and active volcanoes about 60.000 km long.
- Plate boundaries: new magma forces its way up between two plates and pushes them apart.

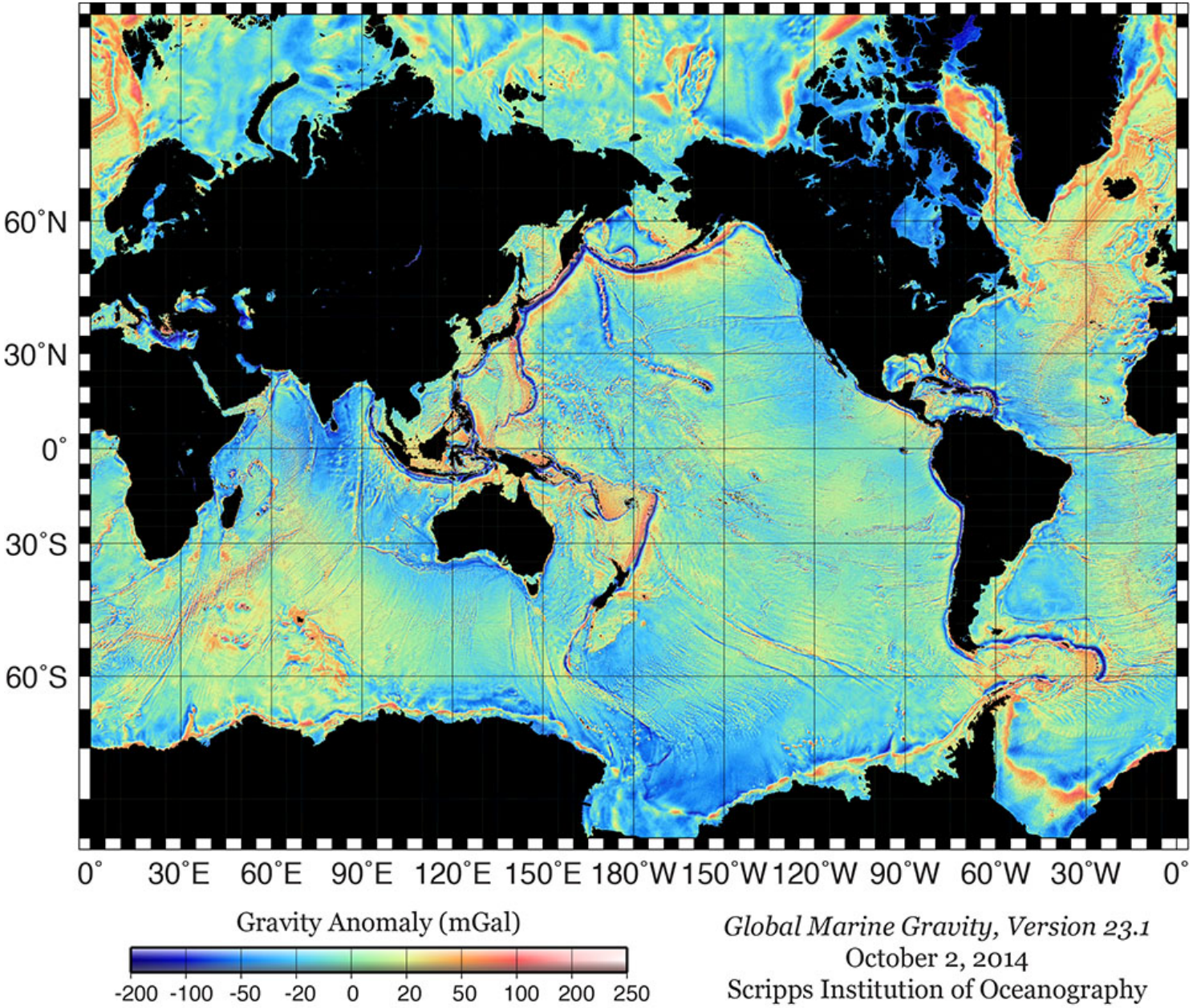
Sea floor mapping from multibeam data



Global gravity map of the oceans - from GEOSAT and ERS-1

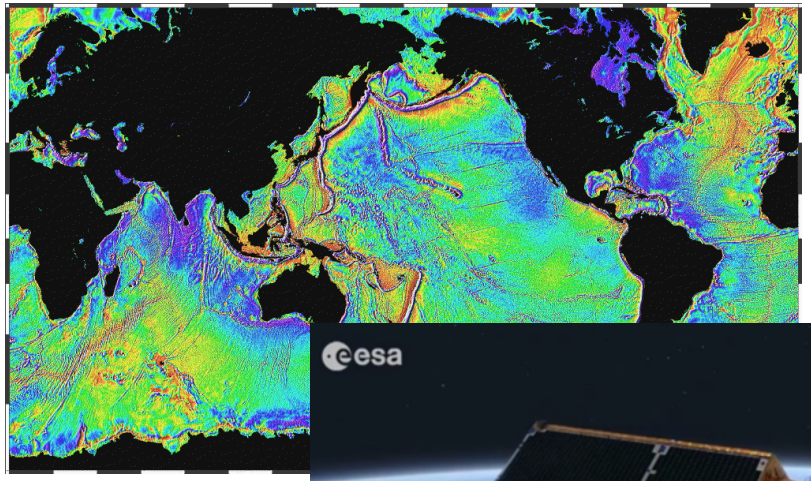


SMITH AND SANDWELL, 1996

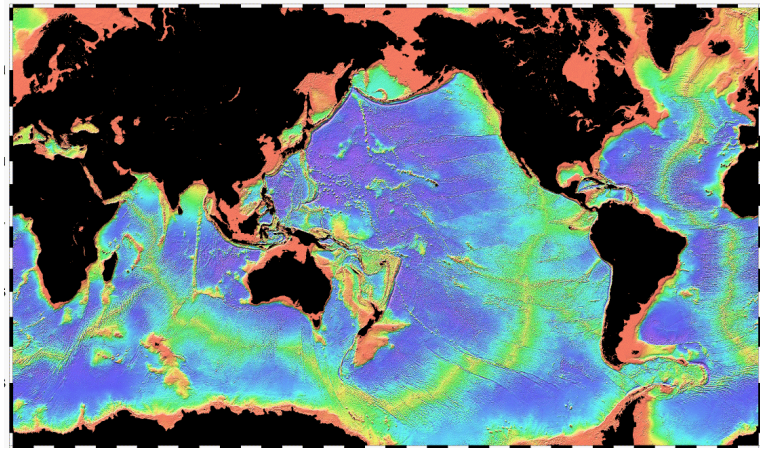


Sandwell et alii, Science 2014

Global gravity map of the oceans
from GEOSAT and ERS-1



Global sea floor topography
from gravity data and shipboard depth soundings



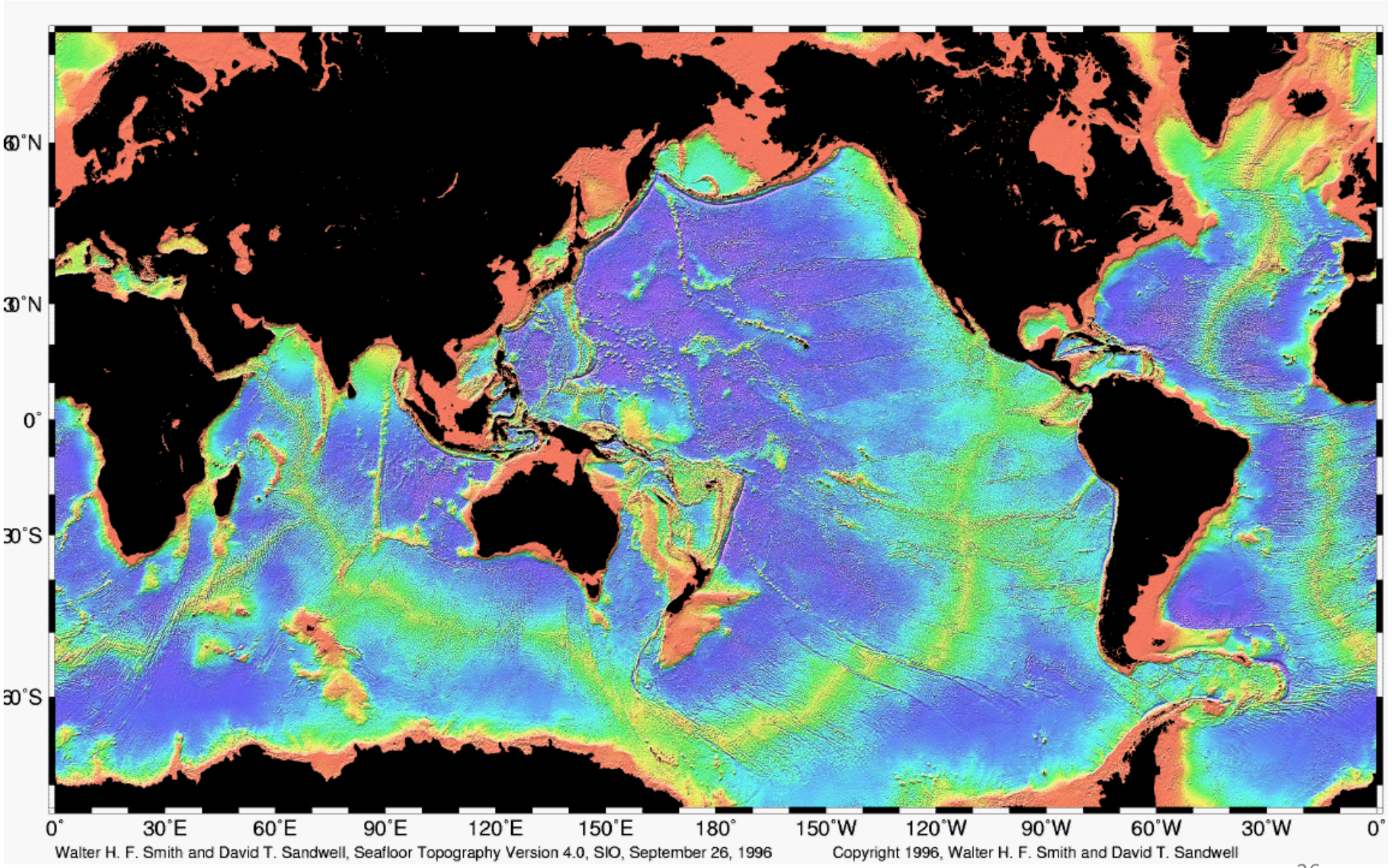
SMITH AND SANDWELL, 1996

Dixon *et al., JGR, (*1983) have summarized the basic theory for estimating sea floor topography from gravity anomalies.

Models of the isostatic compensation of sea floor topography furnish a spectral transfer function that predicts the gravity anomaly expected from sea floor topography.

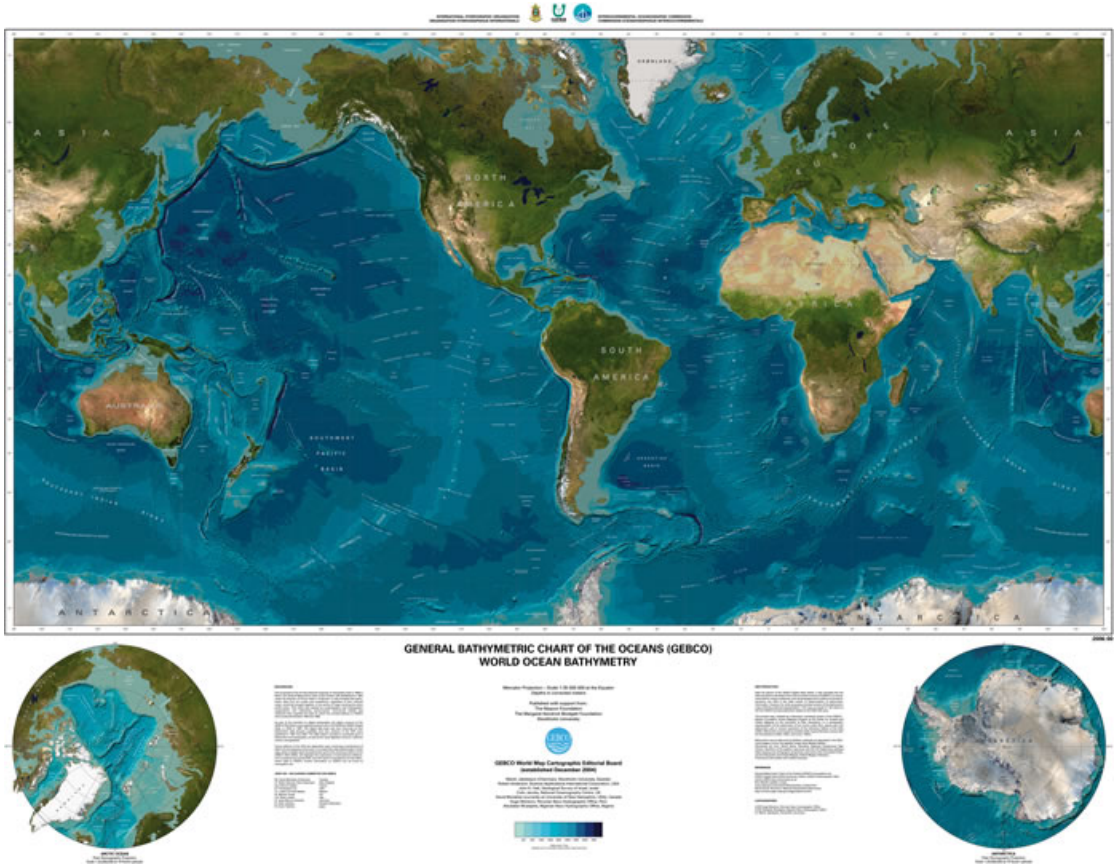
This transfer function depends on: mean depth, crustal density and thickness, and elastic lithosphere thickness.

Global sea floor topography from gravity data derived from satellite altimetry and shipboard depth soundings



SMITH AND SANDWELL, 1996

General Bathymetric Chart of the Oceans - GEBCO
http://www.gebco.net



Gridded bathymetry data

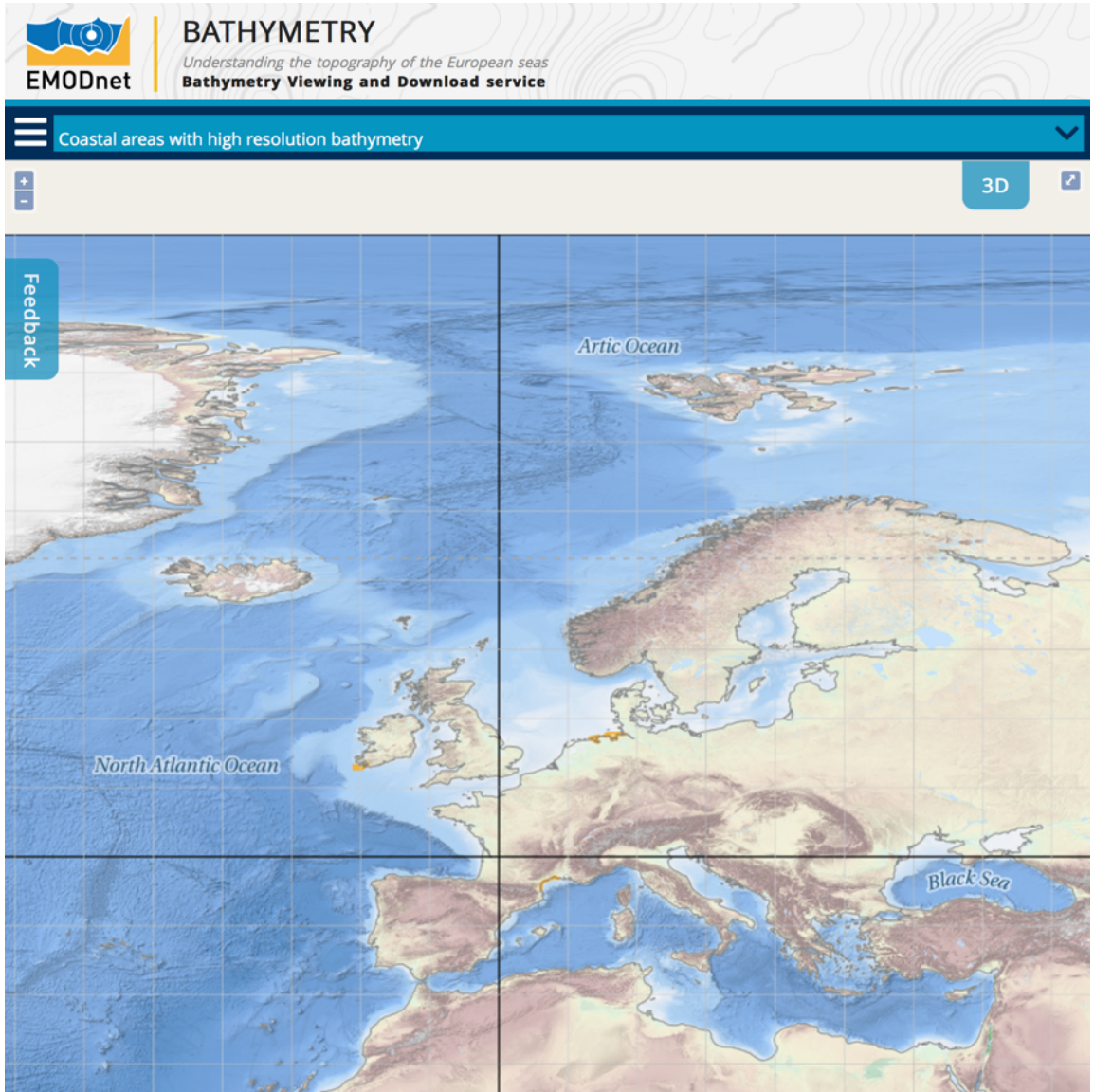
GEBCO's gridded bathymetric data sets are global terrain models for ocean and land and include the

- GEBCO_2014 Grid — a global 30 arc-second interval grid
- GEBCO One Minute Grid — a one arc-minute interval grid. Last updated in 2008. Please note that there are no plans for further development of this data set.

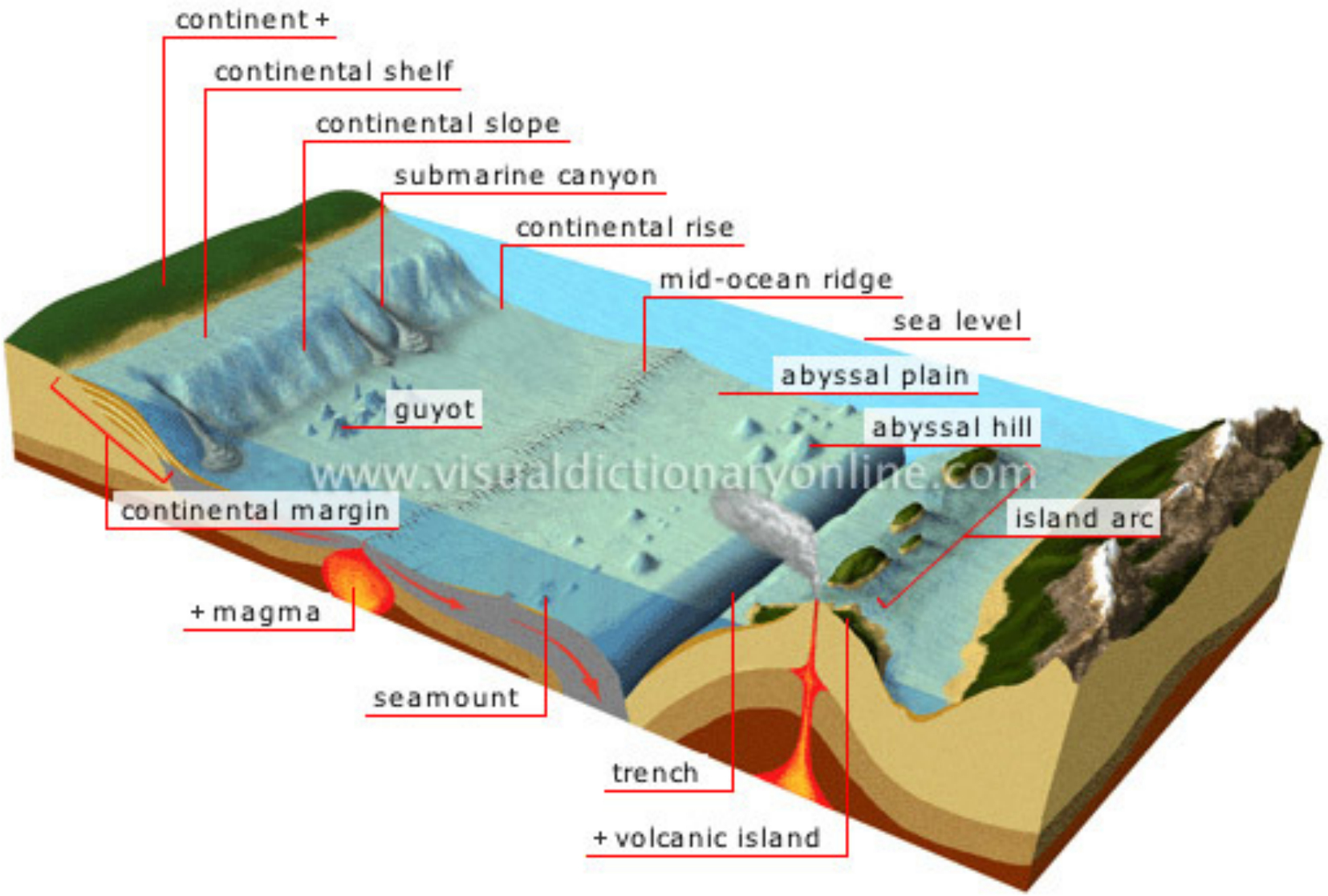
The GEBCO_2014 Grid is **available to download** for user-defined areas in netCDF, Esri ASCII raster or INT16 GeoTiff formats. The GEBCO One Minute Grid is available in netCDF only.

EMODnet

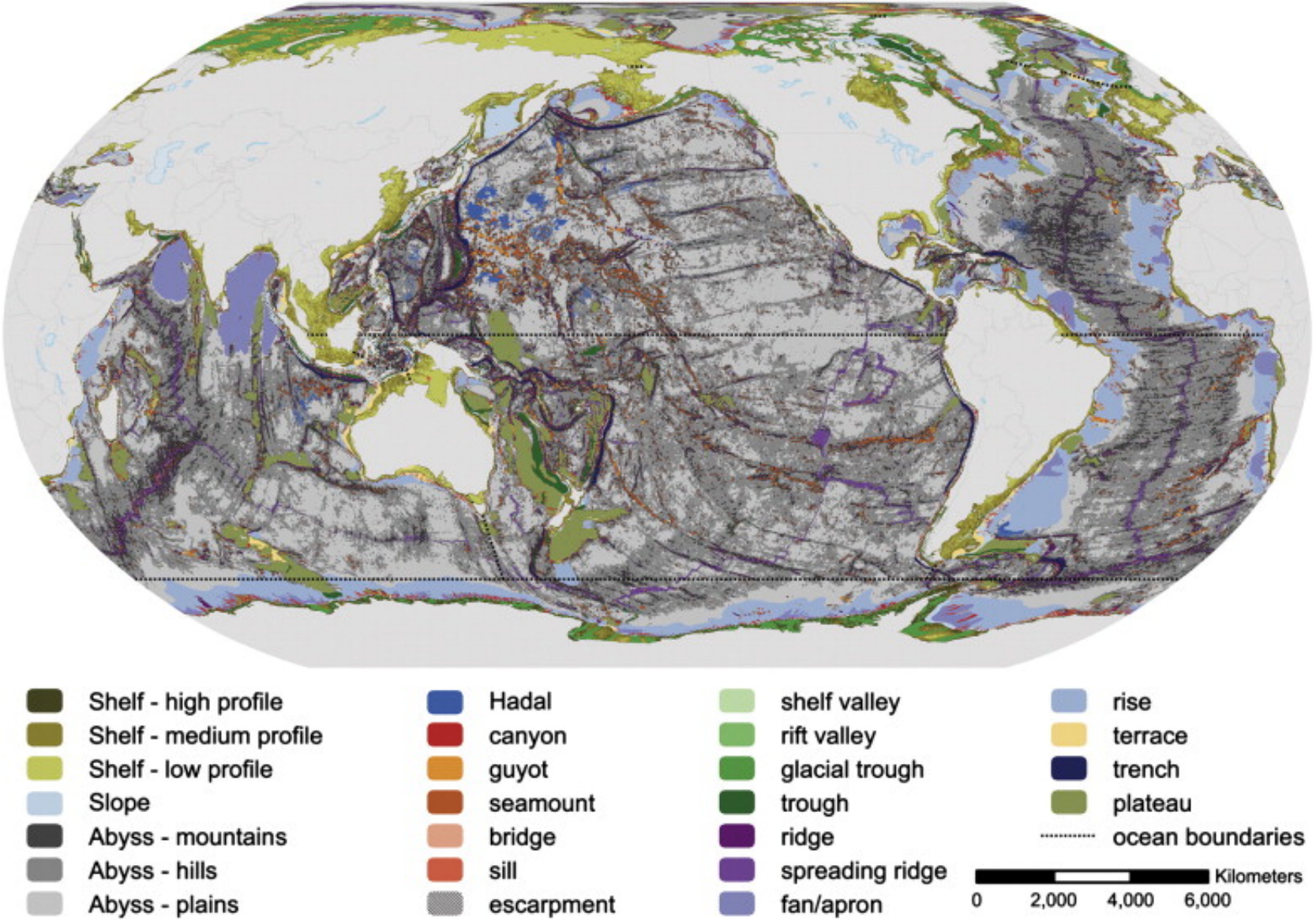
EMODNET
http://www.emodnet.eu



SEA FLOOR MORPHOLOGY



Geomorphic features map of the world's oceans.



Harris, Macmillan-Lawler, Rupp, Baker, 2014. **Geomorphology of the oceans.** Marine Geology, 352, 2014, 4–24. http://dx.doi.org/10.1016/j.margeo.2014.01.011

MARINE GEOSCIENCE DATA SYSTEM

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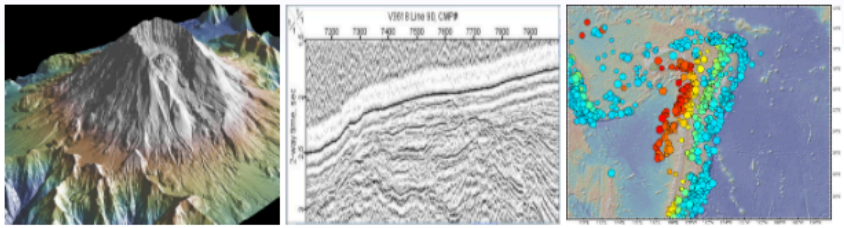
The current version of GeoMapApp is 3.6.10 (Released April, 2019.)

GeoMapApp is a map-based application for browsing, visualizing and analyzing a diverse suite of curated global and regional geoscience data sets. These cover geophysics, geology, geochemistry, physical oceanography, climatology, and more.



GeoMapApp provides data layering, display customization and analytical tools to support the analysis of multidisciplinary data sets. Choose from Mercator, North polar and South polar projections. Save the images for papers and presentations.

Users can import their own grids, tabular data, images, and shapefiles. For imported grids, the color palette, shaded relief, and contouring are customizable; users may also extract profiles and digitize grids. Imported table values can be edited and the map symbol, color and size are adjustable. Tabular values may be plotted on a graph and captured and saved with a lasso function.

Several custom portals provide visualization and basic analysis for data types that typically require specialist software. Examples include seismic reflection profiles and geodetic velocity vectors.

The GMRT base map provides multi-resolution global elevation data upon which other data sets can be layered.

GeoMapApp is developed and maintained as part of the Marine Geoscience Data System (MGDS) at Lamont-Doherty Earth Observatory of Columbia University.

http://www.geomapapp.org/

UiO : The Centre for Earth Evolution and Dynamics
The Faculty of Mathematics and Natural Sciences

https://www.mn.uio.no/ceed/english/

http://www.fabiocrameri.ch/colourmaps.php

Submarine Geomorphology
Editors: Micallef, Aaron, Krastel, Sebastian, Savini, Alessandra (Eds.)

Addresses the methodologies and key research topics in submarine geomorphology

Springer Geology