EGU Education

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# Explore our planet with GeoMapApp

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*(EGU Educational Committee members)*

# WHAT IS GEOMAPAPP?

GeoMapApp is a free, Java-based geospatial application

It enables users to explore, visualize, and analyze a wide array of geoscience data sets in a geographical context.

digital elevations
earthquake data
geochemistry
plate motion information
research cruise tracks and profiles
sediment thickness grids
hydrothermal vent images
…

# WHO DEVELOPED GEOMAPAPP?

It has been developed by LAMONT-DOHERTY EARTH OBSERVATORY THE EARTH INSTITUTE AT COLUMBIA UNIVERSITY

It originally provided access
to the Global Multi-Resolution Topography compilation,
which features high-resolution bathymetry data
(about 100 m node spacing)
from multibeam surveys in ocean areas and topography datasets from
ASTER and the National Elevation Dataset for land.

Additional data has been integrated over time.

# WHO IS USING GEOMAPAPP?

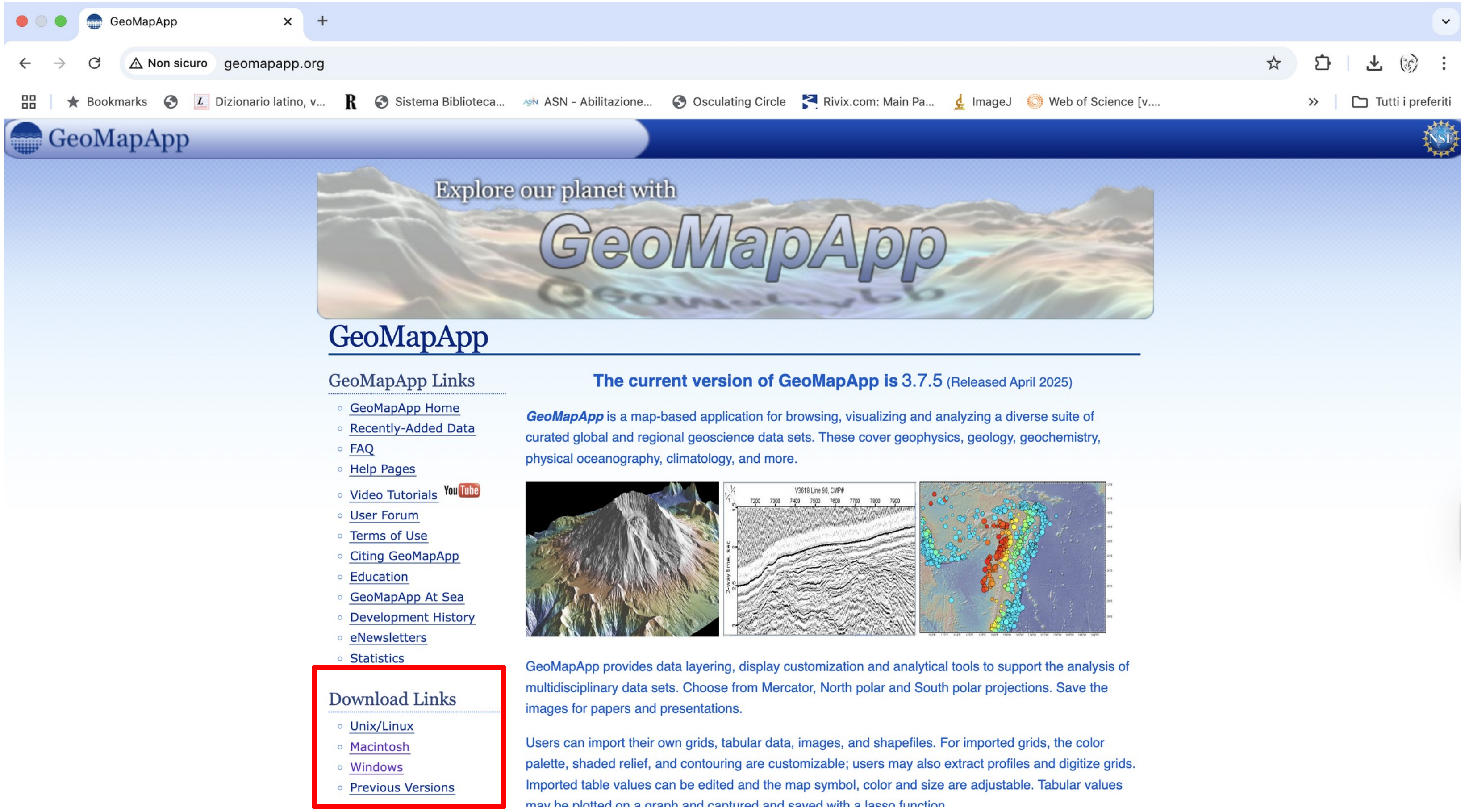
The application is widely used in
geoscience education and research,
allowing users to interact with complex geospatial data sets effectively.

Its lightweight design and comprehensive features make it an ideal platform for introducing students to different types of geoscience data.


# DOWNLOAD GEOMAPAPP

**www.geomapapp.org**

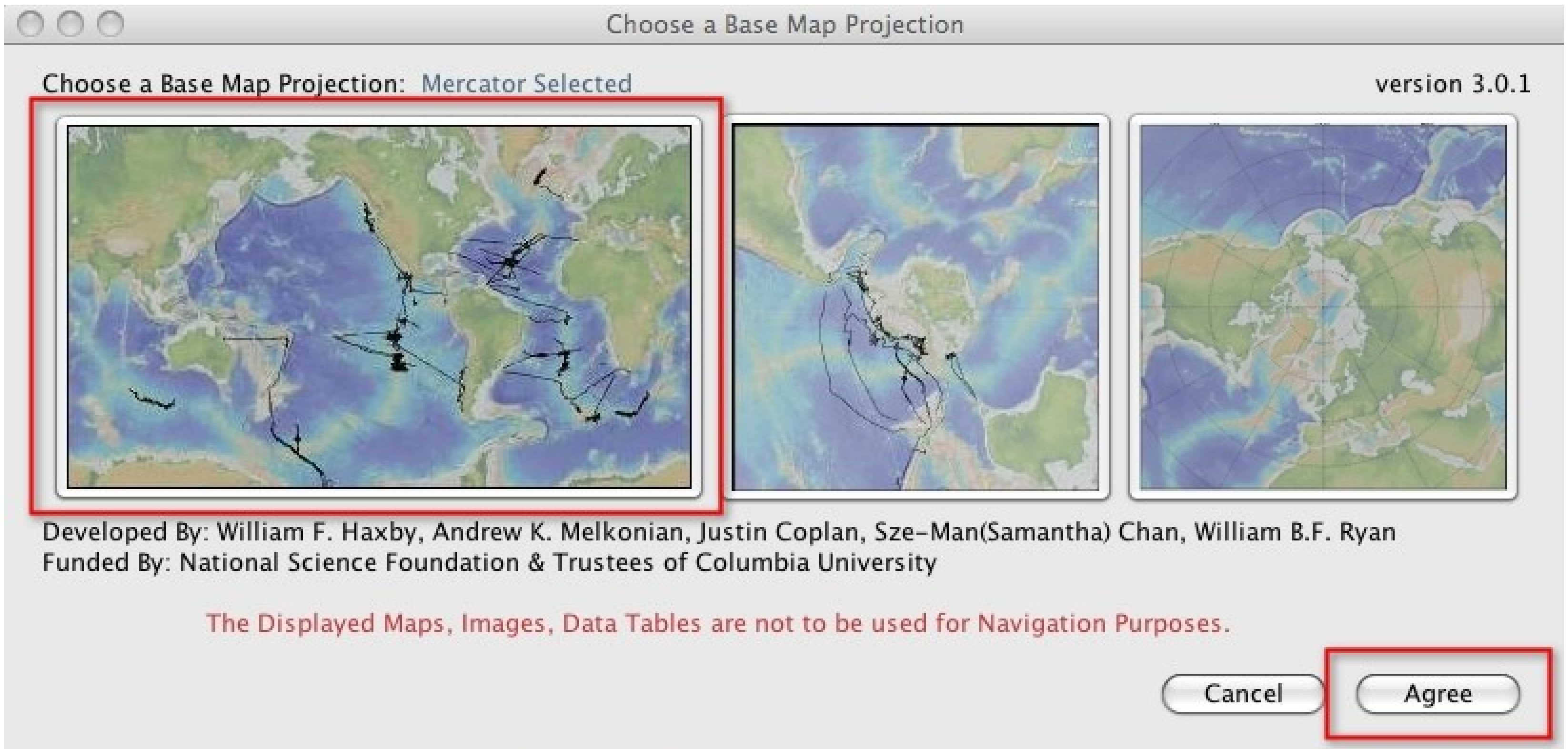
# DOWNLOAD THE LINK




From the Download Links panel on the left, click the link for your computer's operating system.
On the web page that comes up for your computer, scroll to the bottom of the page,
read the terms of distribution and click **AGREE** to download the GeoMapApp.

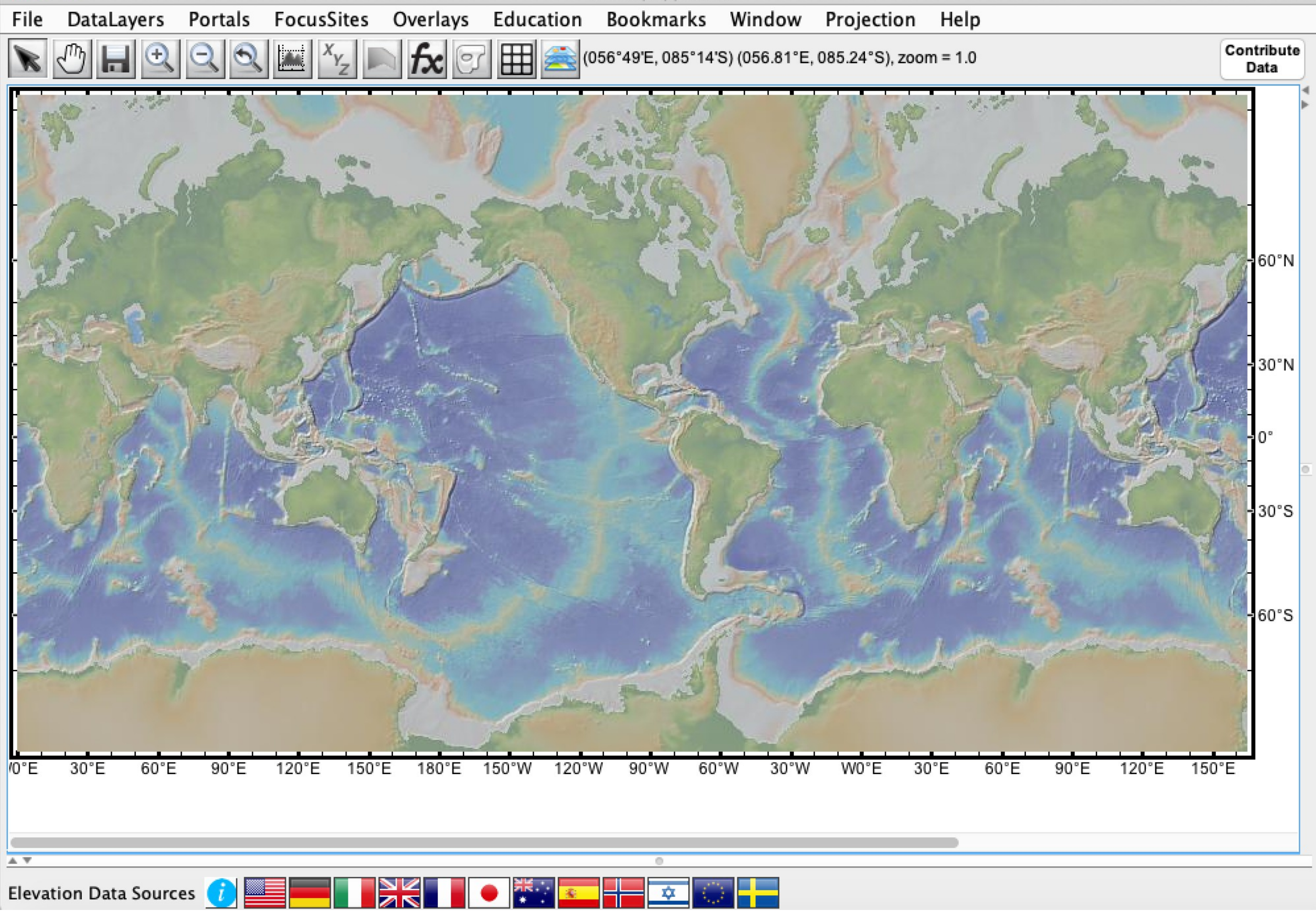
# START GEOMAPAPP

When the download is complete, locate the program file on your computer and double-click the **GeoMapApp** icon to start the program.




Click **Agree** to select the default Mercator Base Map (→linear scale is equal in all directions around any point, thus preserving the angles and the shapes of small objects).

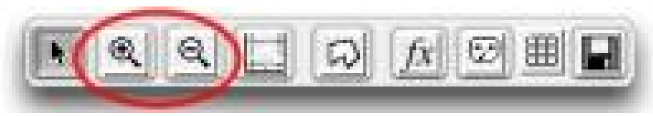

CONTINUOUS
IMPROVEMENT




once GeoMapApp is running, you'll see the map of Earth

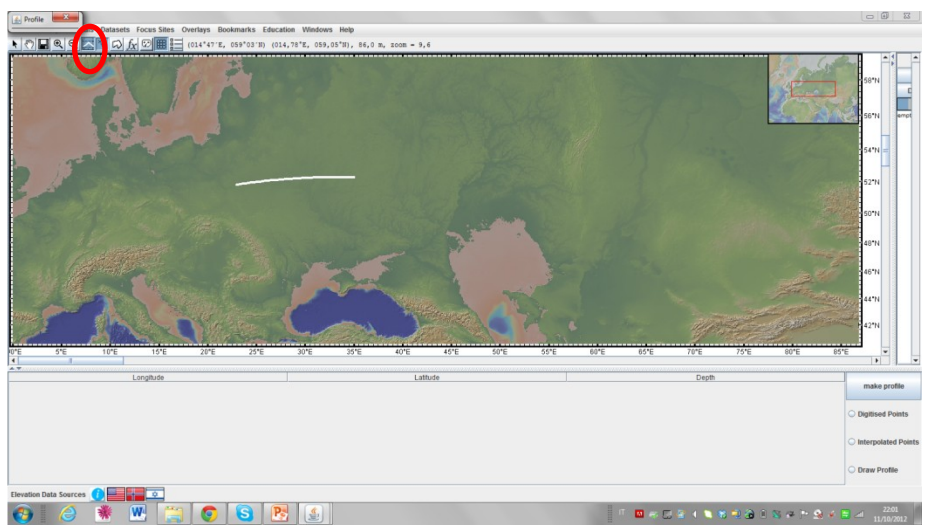
# EXPLORING THE STARTING MAP

# MAIN FEATURES OF GEOMAPAPP



ZOOM IN AND OUT

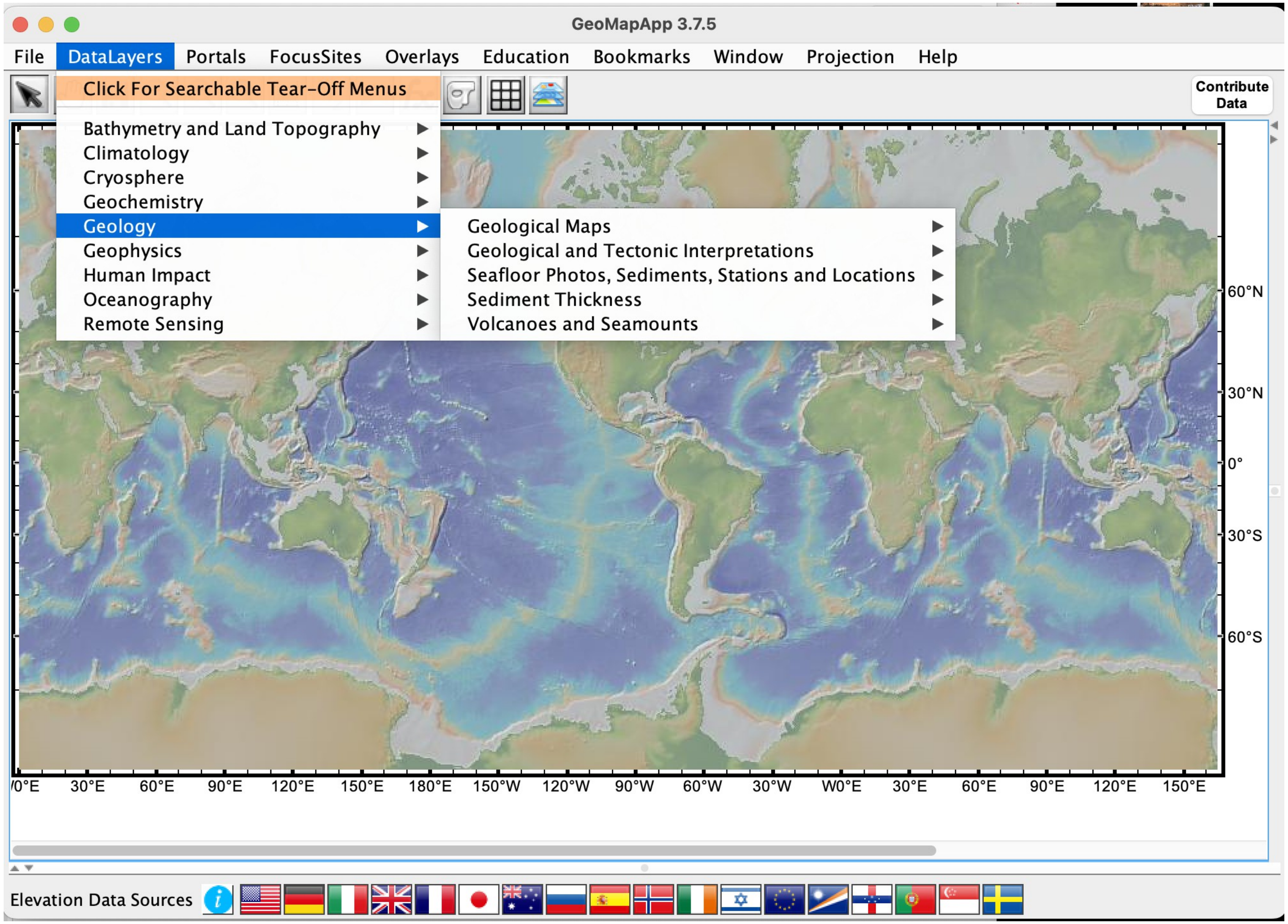

READ THE CURSOR LOCATION




DISTANCE/PROFILE TOOL

# MAIN FEATURES OF GEOMAPAPP

DataLayers menu

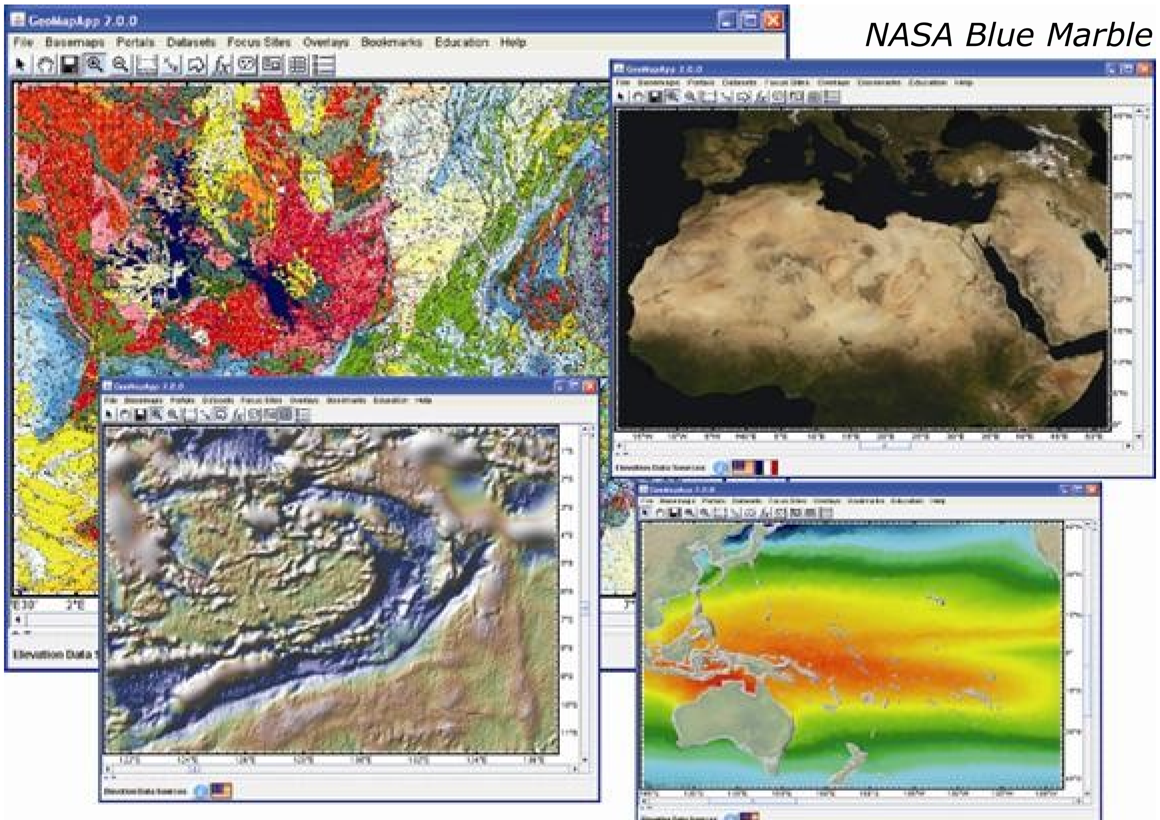


# MAIN FEATURES OF GEOMAPAPP

**DataLayers** menu

*Geologic map of France*

*NASA Blue Marble*

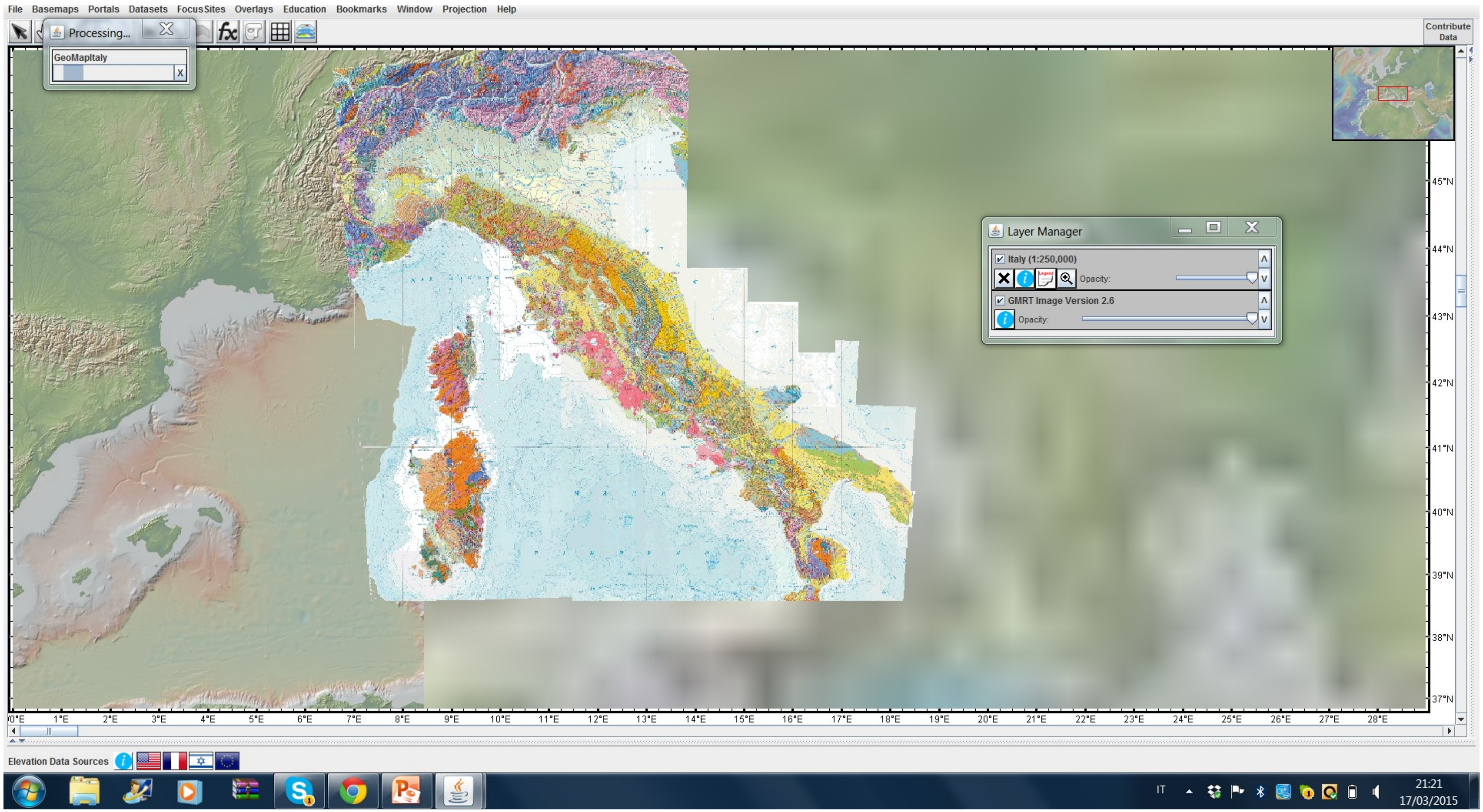



*Smith-Sandwell satellite altimetry-derived free air gravity anomaly*

*AVHRR average sea surface temperatures (1985-1997)*

# MAIN FEATURES OF GEOMAPAPP

DataLayers menu

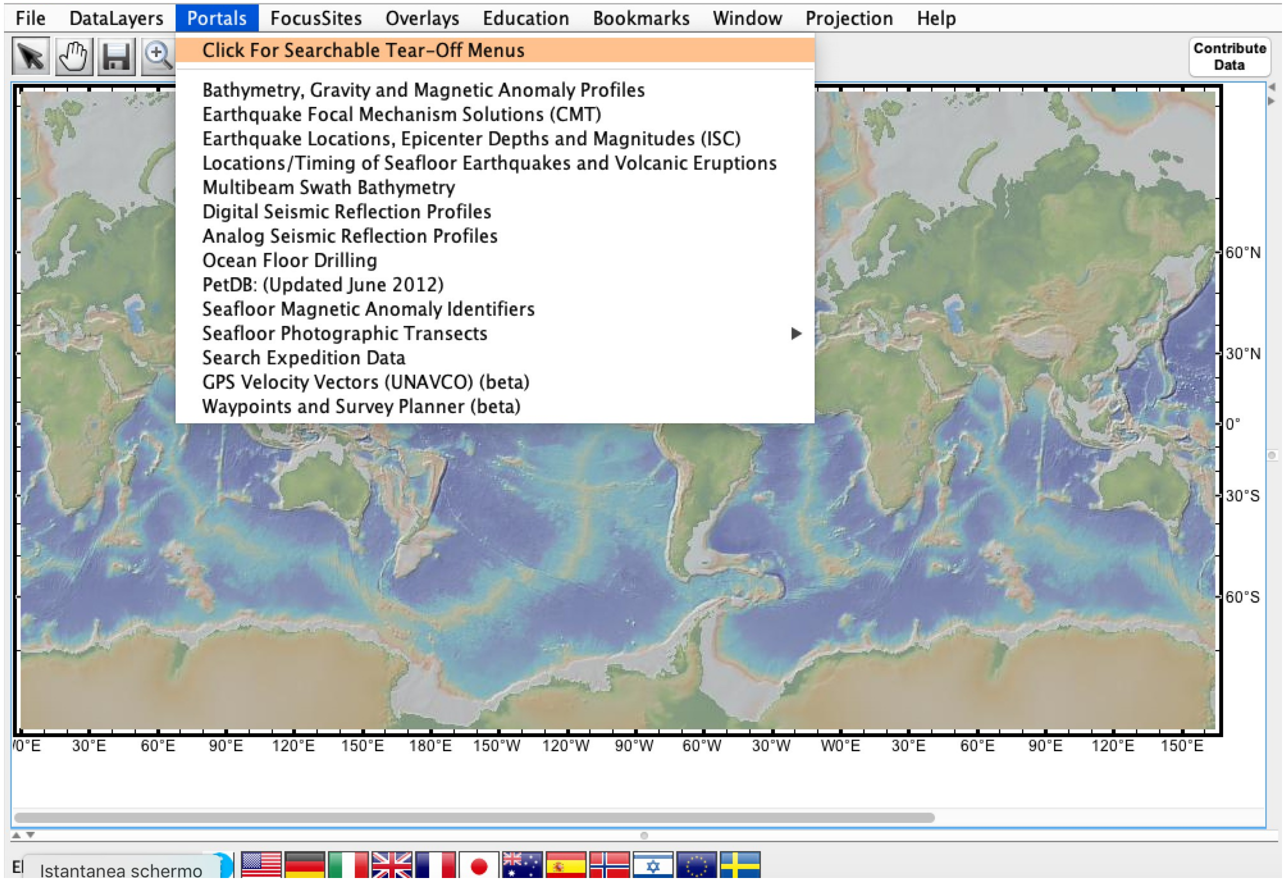



GEOLOGY OF ITALY 1:250:000

# MAIN FEATURES OF GEOMAPAPP

**Portals** menu offers customized data access and manipulation interfaces specific to each data type.

e.g. 1) the ocean floor drilling interface provides customized core profiling and searching,
e.g. 2) the photographic transects portal offers seafloor dive photos arranged along the dive track.



# MAIN FEATURES OF GEOMAPAPP

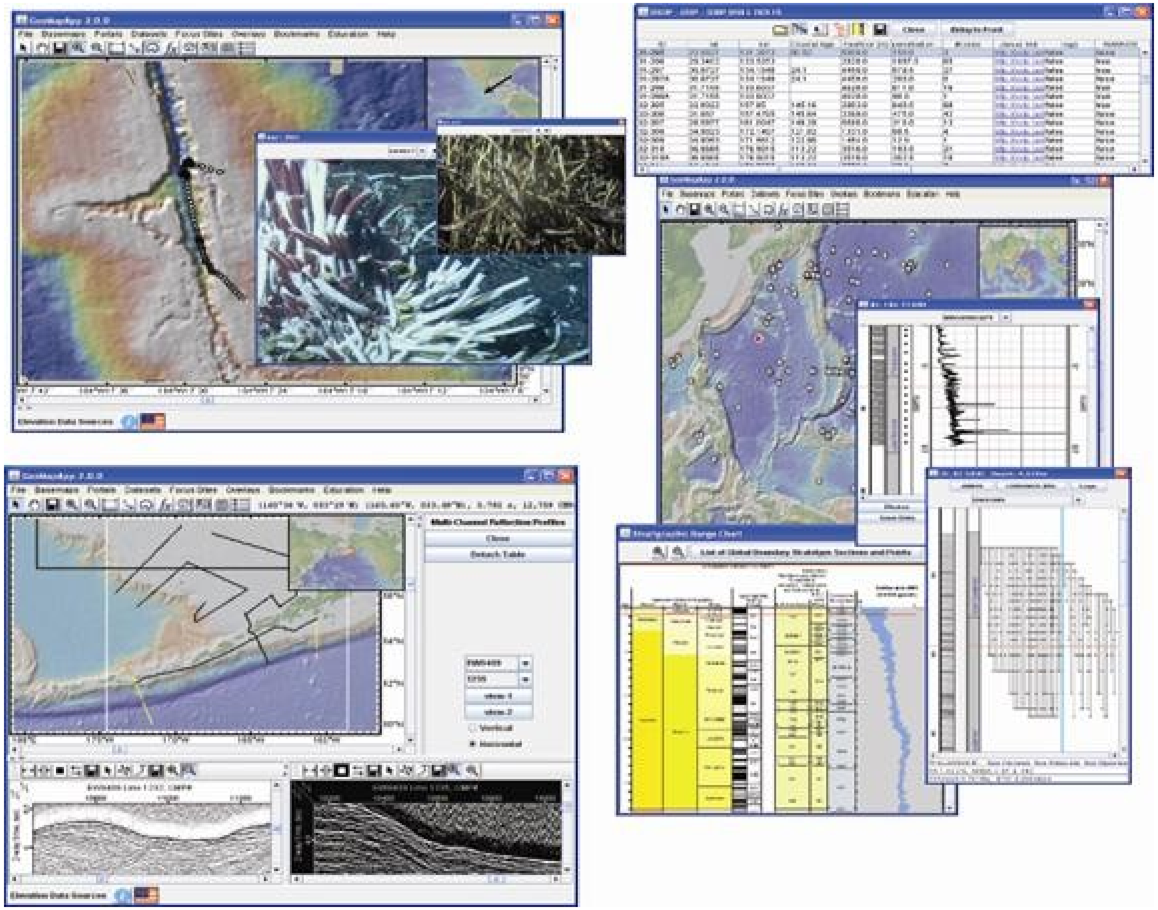
**Portals** menu

*(Clockwise from upper left)*

*Seafloor dive photos on high-resolution bathymetry for the EPR 9N Ridge 2000 study site.*

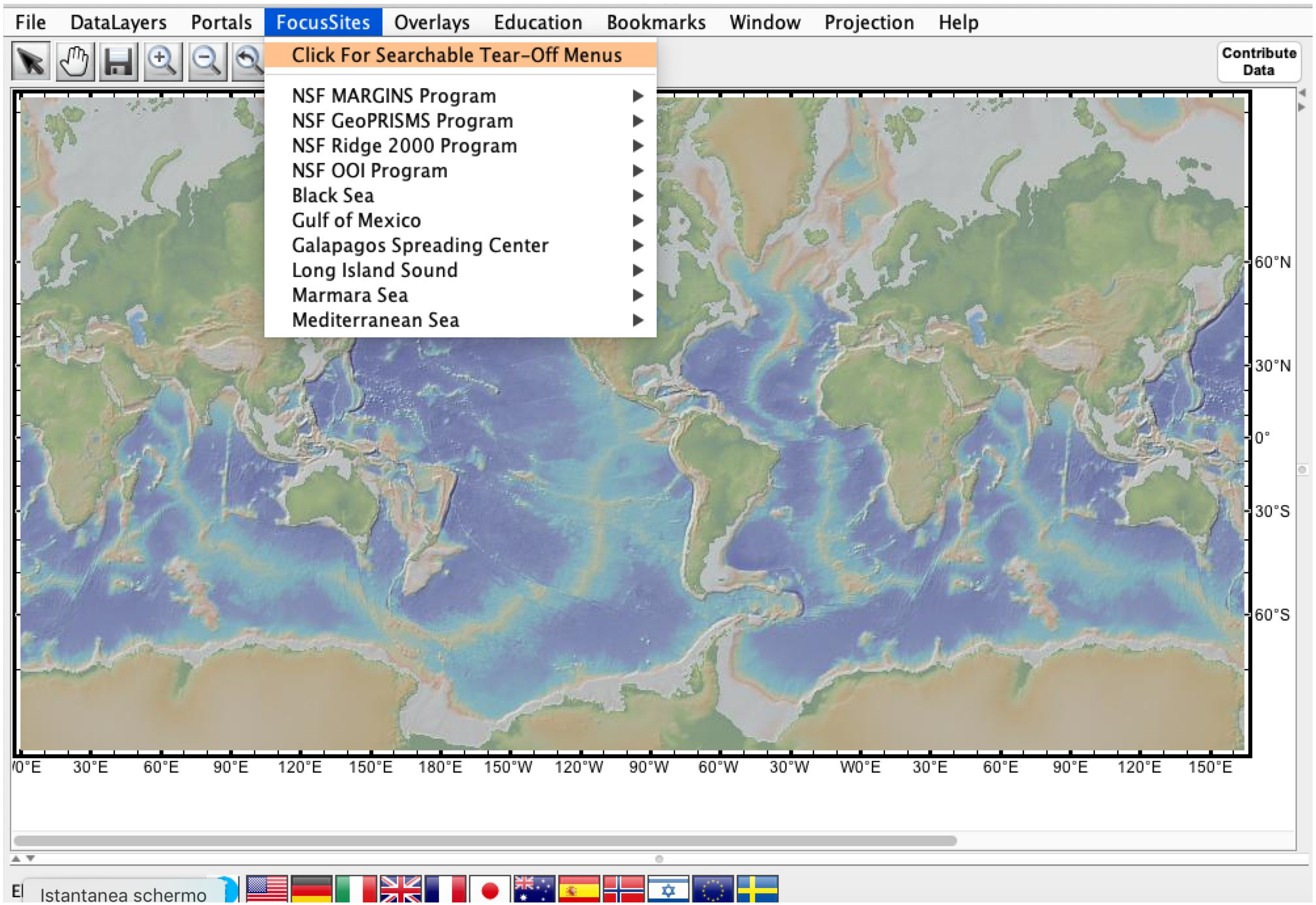
*the DSDP/ODP interface includes species range charts, down-hole physical measurements and stratigraphic information.*

*Multi-Channel Seismic reflection profiles over the Aleutian trench.*



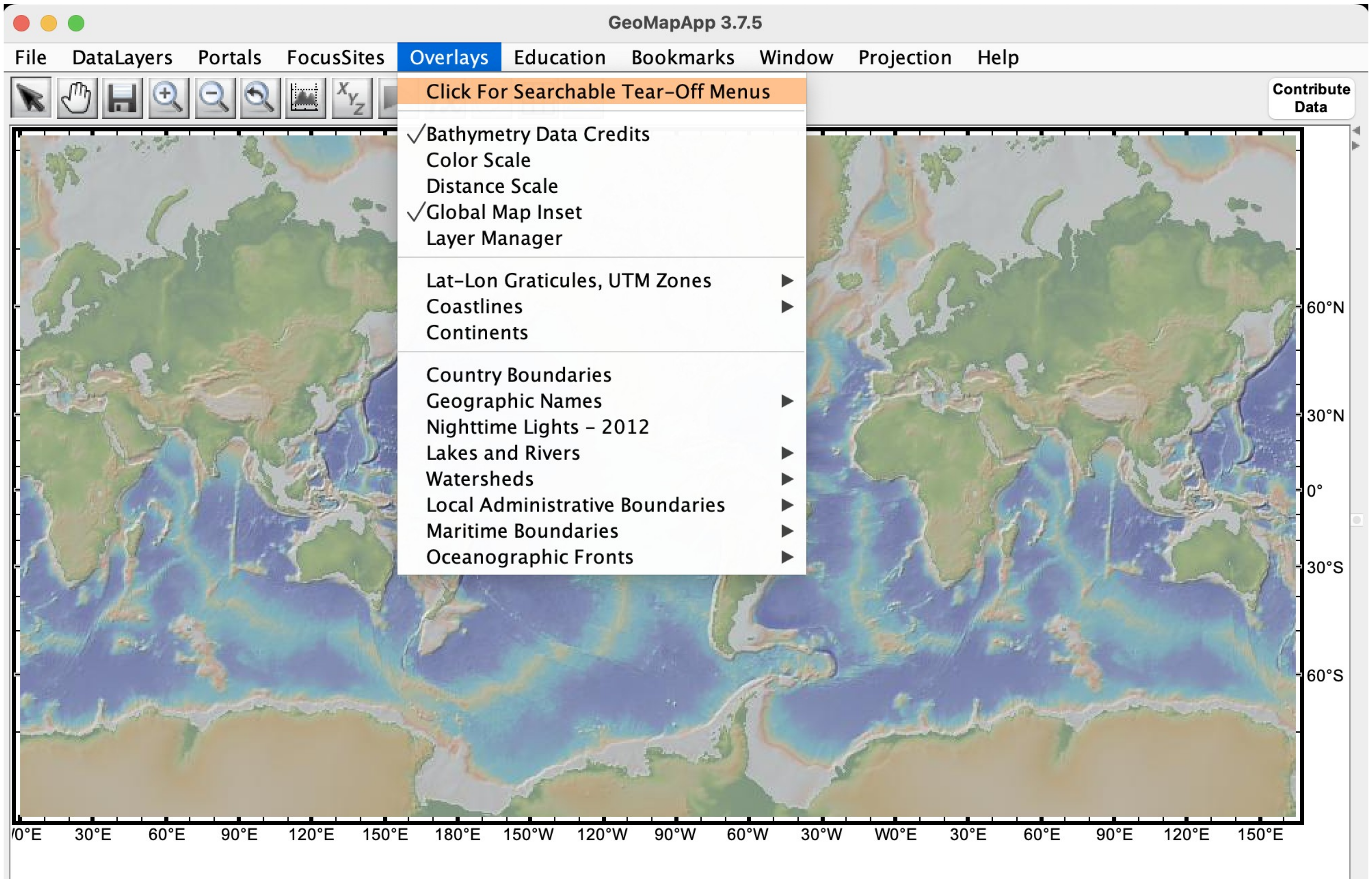
# MAIN FEATURES OF GEOMAPAPP

The **FocusSite** menu menu provides quick links to specific datasets (e.g. Ridge 2000 and MARGINS Focus Site data sets).

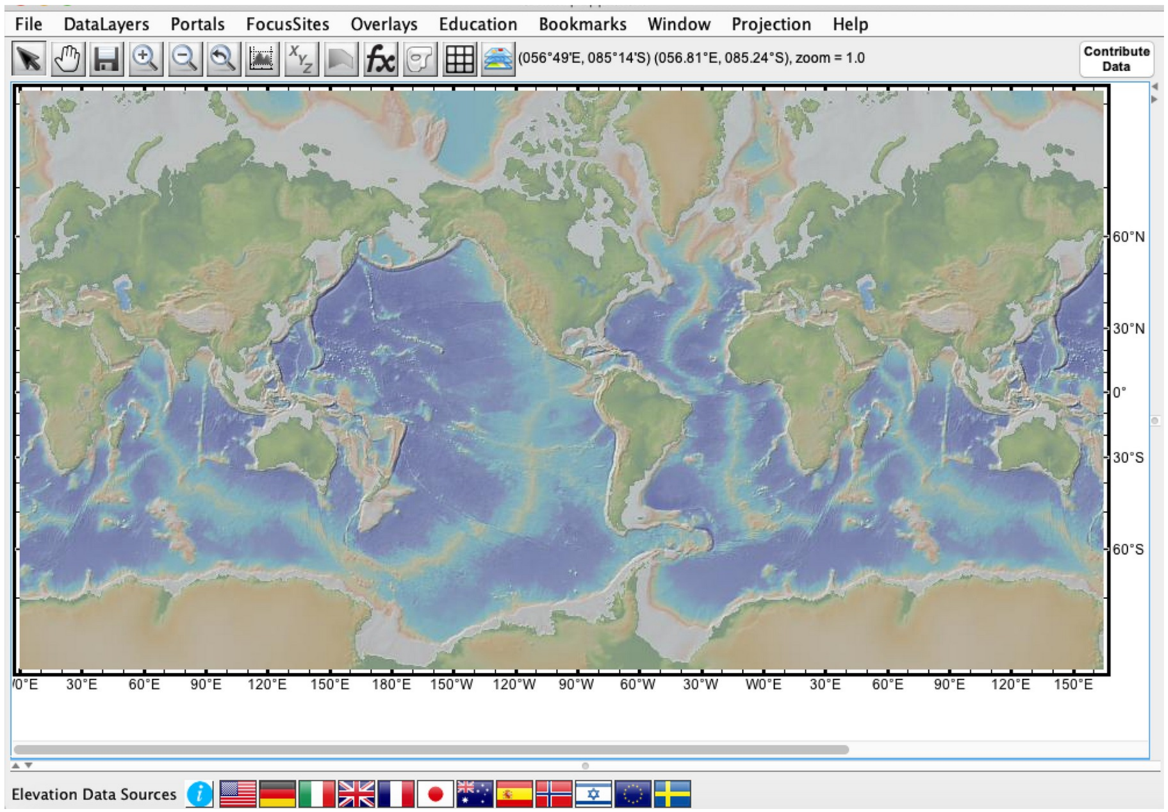


# MAIN FEATURES OF GEOMAPAPP

**Overlays** menu: various overlays an be selected and toggled on/off, including a distance scale, the inset map, coastlines, lakes and rivers and geographic/political names and boundaries.



# MAIN FEATURES OF GEOMAPAPP




The **Bookmarks** menu allows the current view to be saved, zooms out to global view, and zooms in to selected sites of interest.

**Projection** allows you to select both North and South projections.

**Education**-related links are given under the **Education** menu (you can contribute with you ideas)


GeoMapApp Learning Activities
Funded with NSF award 1035036
Andrew Goodwillie, Steve Kluge

**GeoMapApp Learning Activities**
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# Hawaiian Islands: Volcano Ages, Hotspots and Plate Motion
## Student Handout

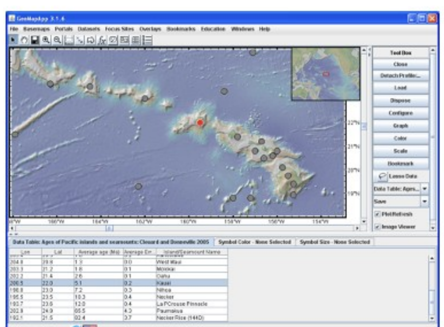
**Why?** The Pacific plate is the largest tectonic plate on the globe. One of its most striking features is the 6,000 km-long Hawaiian-Emperor Seamount chain. We use the ages of volcanic rocks to study the history of the chain, its formation above a hotspot, and motion of the Pacific plate over the last 70-80 Ma. Students are encouraged to think about the timing and nature of the distinctive bend in the chain.

**Structure of GeoMapApp Learning Activity:** As you work through the GeoMapApp Learning Activities you'll notice a box, □, at the start of many paragraphs and sentences. Check off the box once you've read and understood the content that follows it. Doing so will help you keep your place on the worksheet as your attention moves back and forth between your computer screen, your instructions, and your answer sheet. This ♦ symbol indicates that you must record an answer on your answer sheet. Action steps are numbered like this: 15. □ Questions are lettered and indicated by the ♦ symbol, like this: 15a. □♦.

**Learning Outcomes:** By the end of this activity, you should be able to:

- □ Analyze data related to the age of volcanic rocks
- □ Calculate the speed of plate motion using age and distance data
- □ Analyze and compare speeds at different times in Earth's history
- □ Speculate about the effects of tectonic activity on plate motions
- □ Assess evidence for the hotspot volcano formation model
- □ Load and explore data tables in GeoMapApp
- □ Use the distance profiler tool in GeoMapApp

1. □ Start GeoMapApp. With the zoom tool turned on, click two or three times on the north Pacific Ocean. Then, to refine the area being viewed, place the cursor roughly at 168°W, 25°N and draw the zoom box to 153°W, 18°N. This will zoom the image to the region of Hawaii.

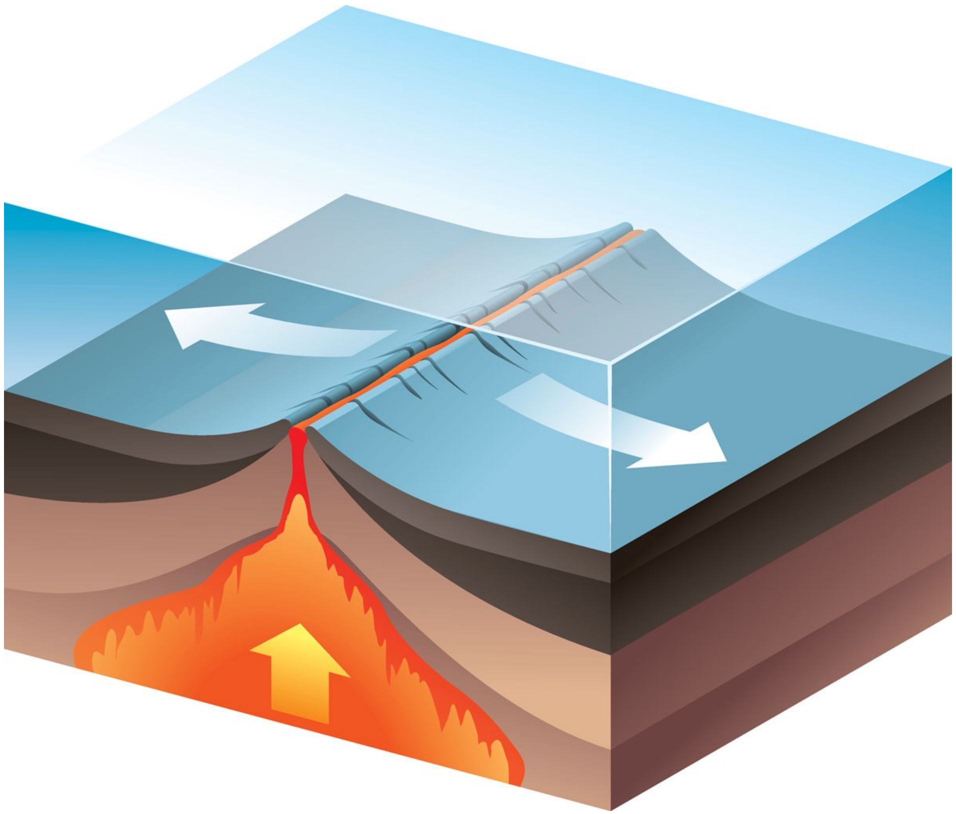


2. □ We are going to explore a data set that tells us the age of volcanic rocks collected from the Hawaiian islands and seamounts. The ages are determined using complex radiometric age-dating techniques. Click on the following menu options to load the data set: *Datasets -> Volcanoes and Seamounts -> Ages of Pacific islands and seamounts: Clouard and Bonneville 2005*. The map changes size and the data table is displayed below the map. Use the cursor to widen the middle (third) column which lists the *Average Age (Ma)* and the fifth column which lists

# EXERCISE #1

Calculate
the seafloor spreading

# WHAT IS THE SEAFLOOR SPREADING ?

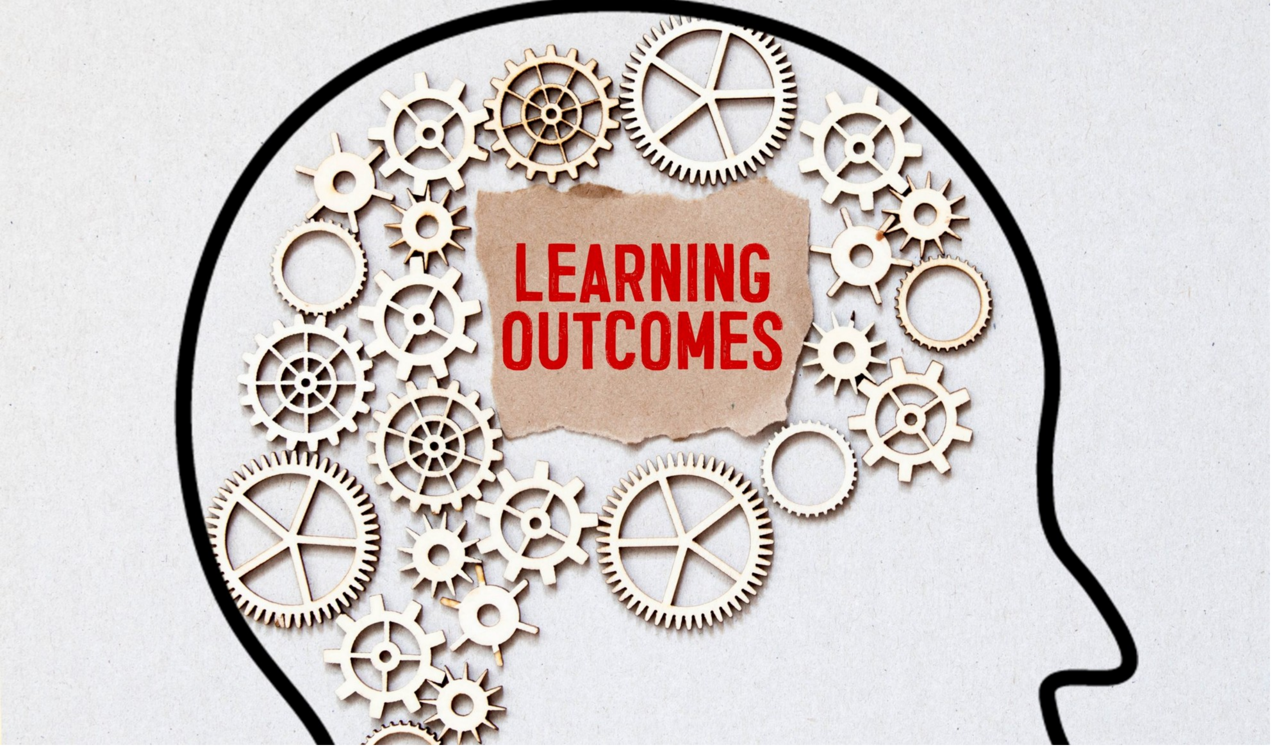


Seafloor spreading is a geologic process that occurs when tectonic plates move apart, creating new ocean floor. It's the primary mechanism that causes continental drift.

1. Magma rises up to fill the gap between the plates.

2. The magma solidifies into new oceanic crust.

3. The new crust moves away from the ridge, carrying older sediment and fossils with it.



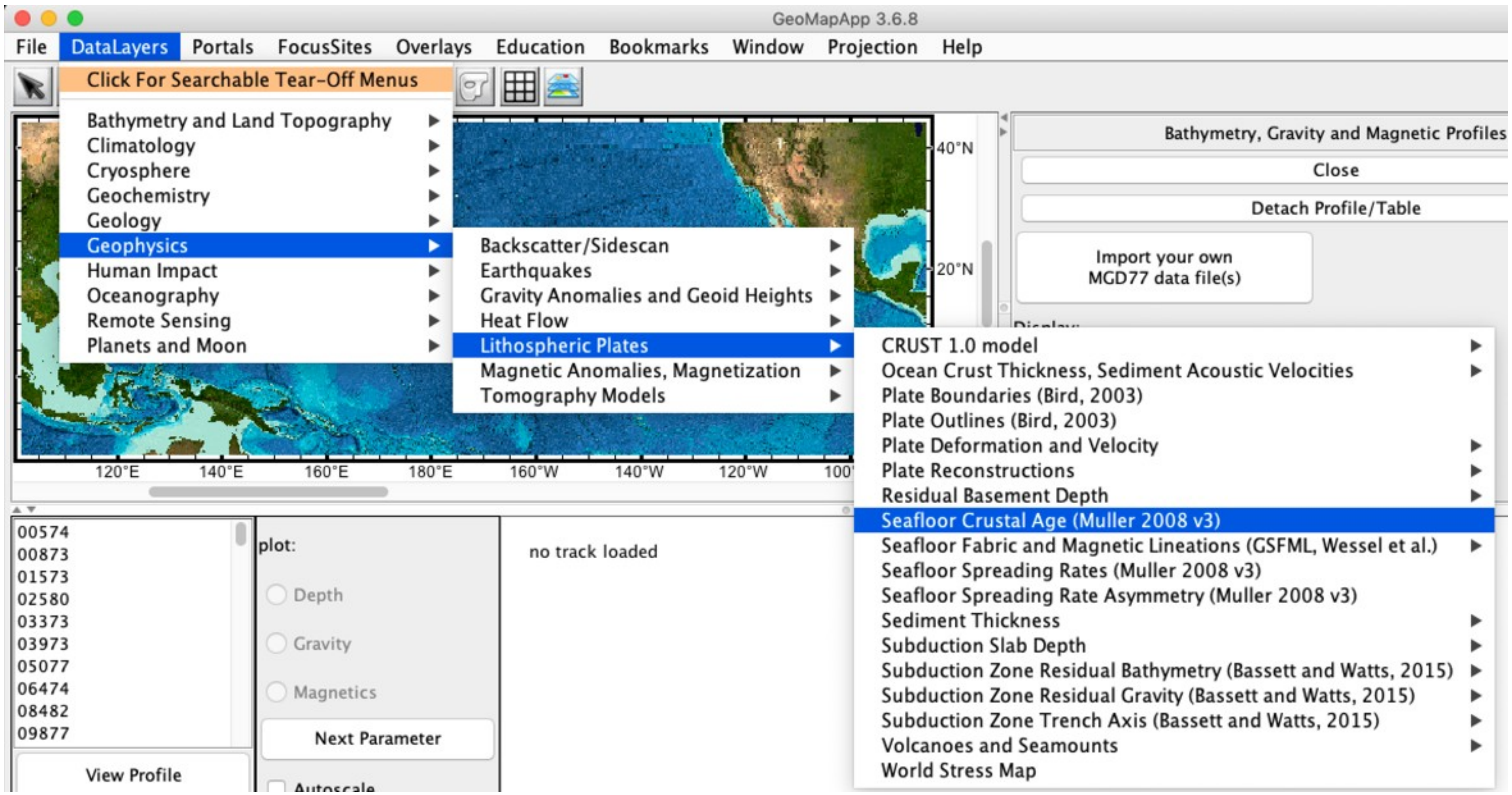

**TECHNICAL SKILLS**

- *Load and explore various grids in GeoMapApp*
- *Create seafloor age profiles in GeoMapApp*

**SCIENTIFIC KNOW-HOW**

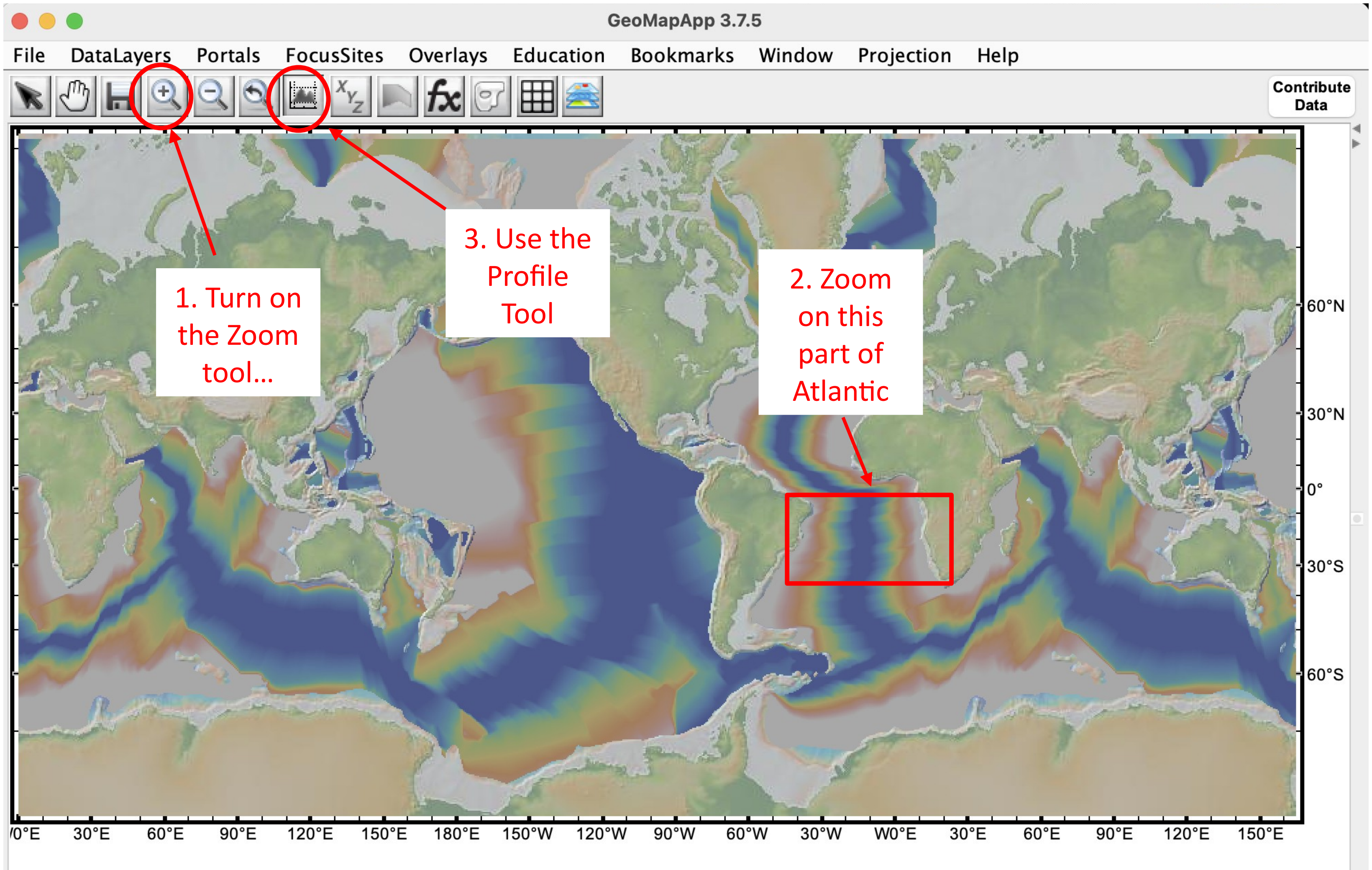
- Analyze data related to the age of seafloor crust
- Calculate seafloor spreading rates using profiles of seafloor age versus distance
- Analyze/compare spreading rates at various locations and at various times in Earth's history
- Speculate about the effects of tectonic activity on seafloor spreading rates

## STEP 1

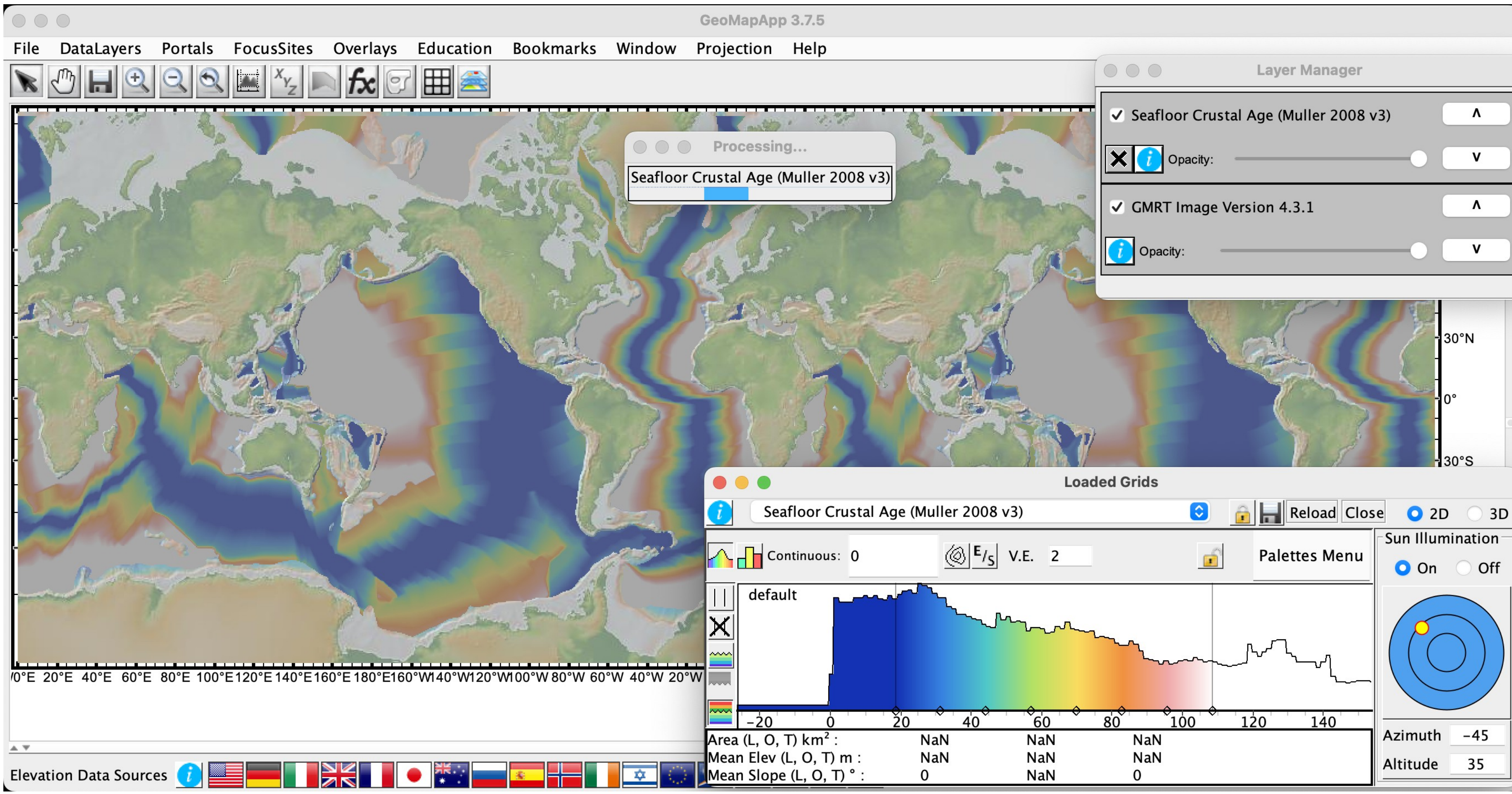



The *Seafoor Crustal Age* grid will load and a Contributed Grids window will appear.

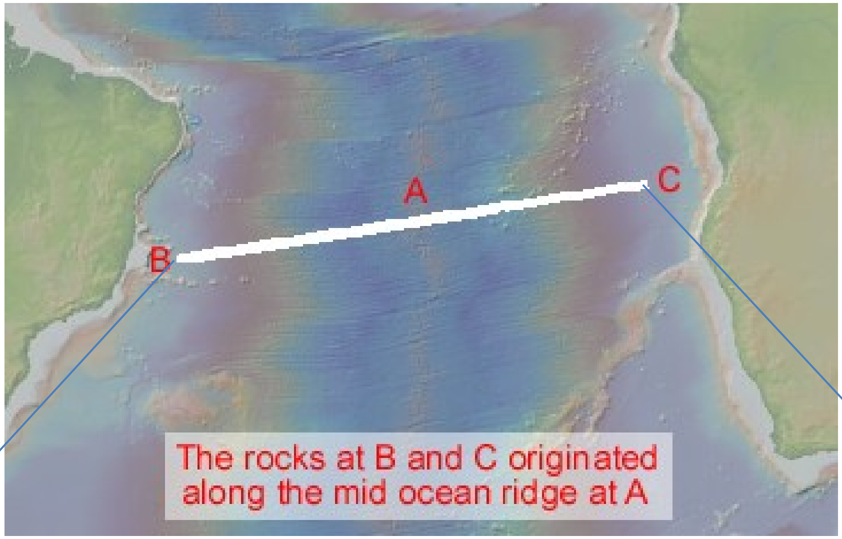
# STEP 2 SOUTH-ATLANTIC RIDGE



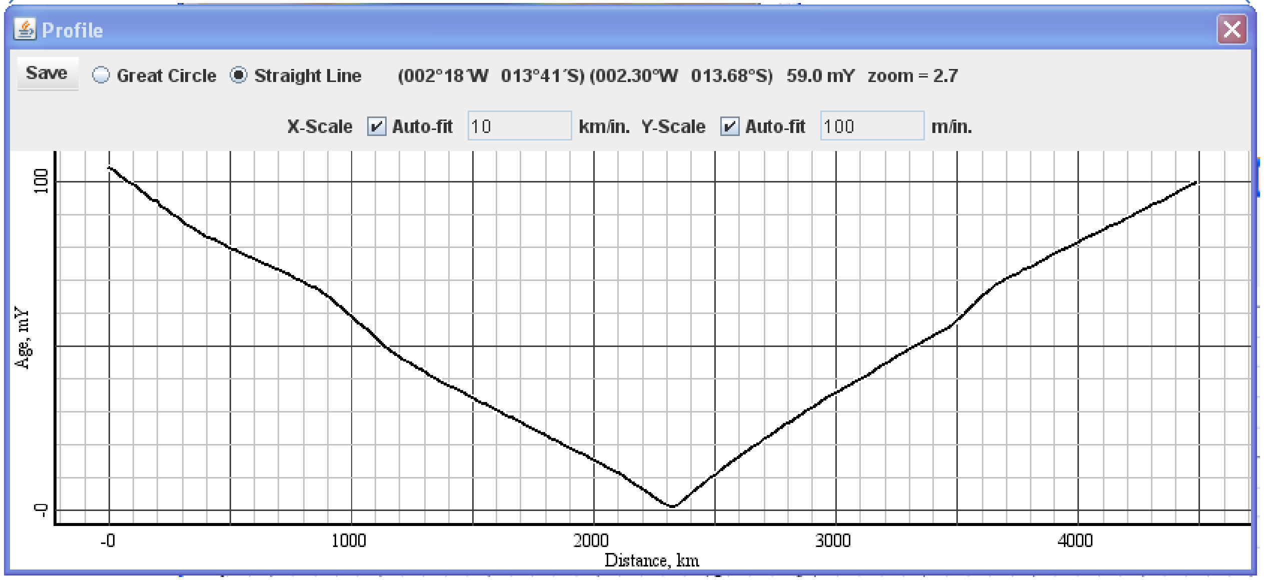
# SOUTH-ATLANTIC RIDGE



# SOUTH-ATLANTIC RIDGE




**37°W,22°S to 10°W,12°S**



# SOUTH-ATLANTIC RIDGE


Which variables are used to draw the profile chart, and on which axes are they plotted?

How many years are represented by each interval (step) on the y-axis?

What distance is represented by each interval (step) on the x-axis?

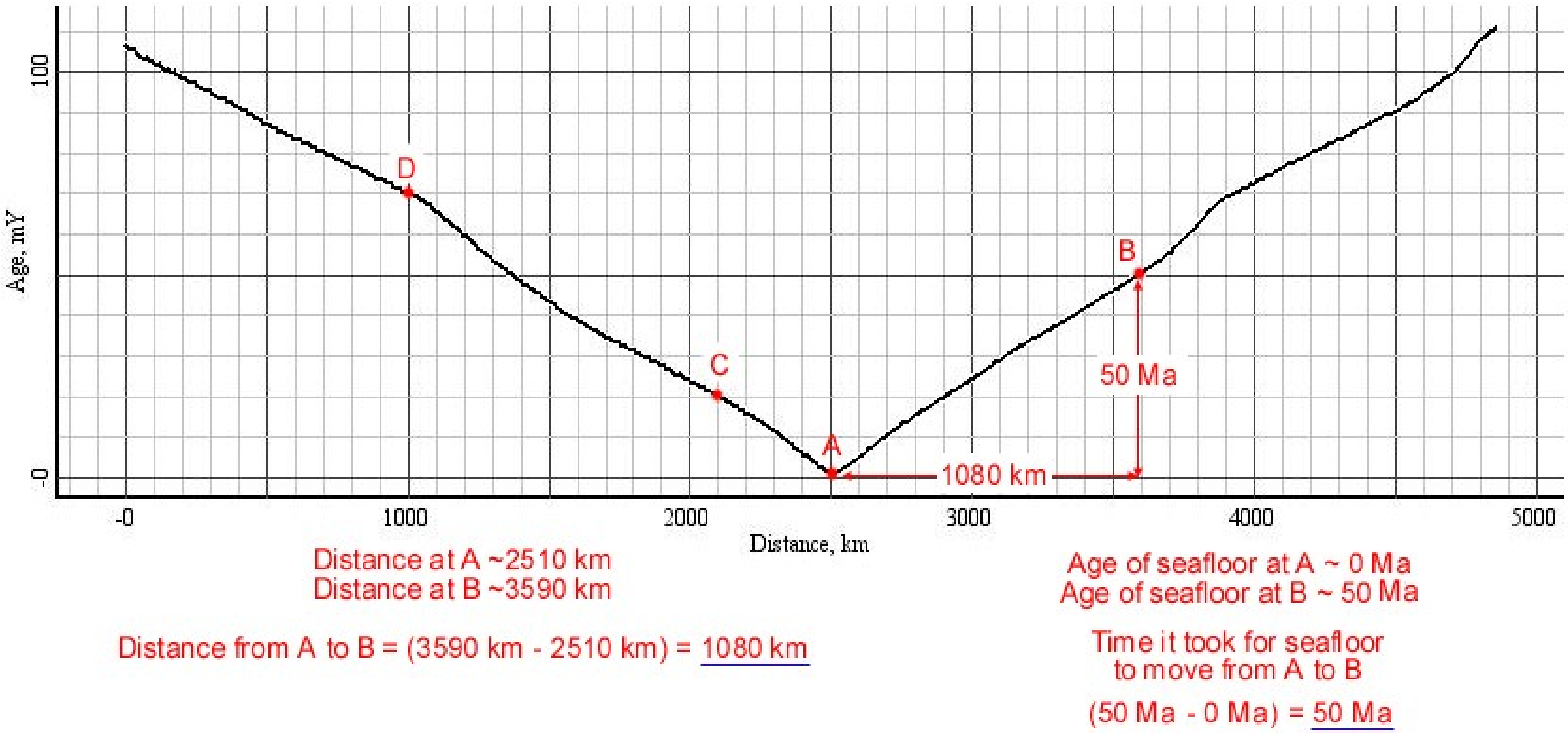
Where along the profile are the youngest rocks? Describe how the age of seafloor changes as you travel from the spreading center to the South American and African coastlines.

Is the age-distance profile roughly symmetrical on either side of the spreading zone?

# SOUTH-ATLANTIC RIDGE

Rate is described as a **change in distance over a period of time (→ velocity!)**.

The average rate of seafloor spreading during a particular period of time can be determined by analysis of the profile chart as shown in the following worked example.



# SOUTH-ATLANTIC RIDGE

**CHECK**

How much wider is the South Atlantic getting each year?

Explain how and why the appearance of this profile would change if the seafloor had been spreading at a much greater (faster) rate?

STEP 3

# SOUTH PACIFIC RIDGE

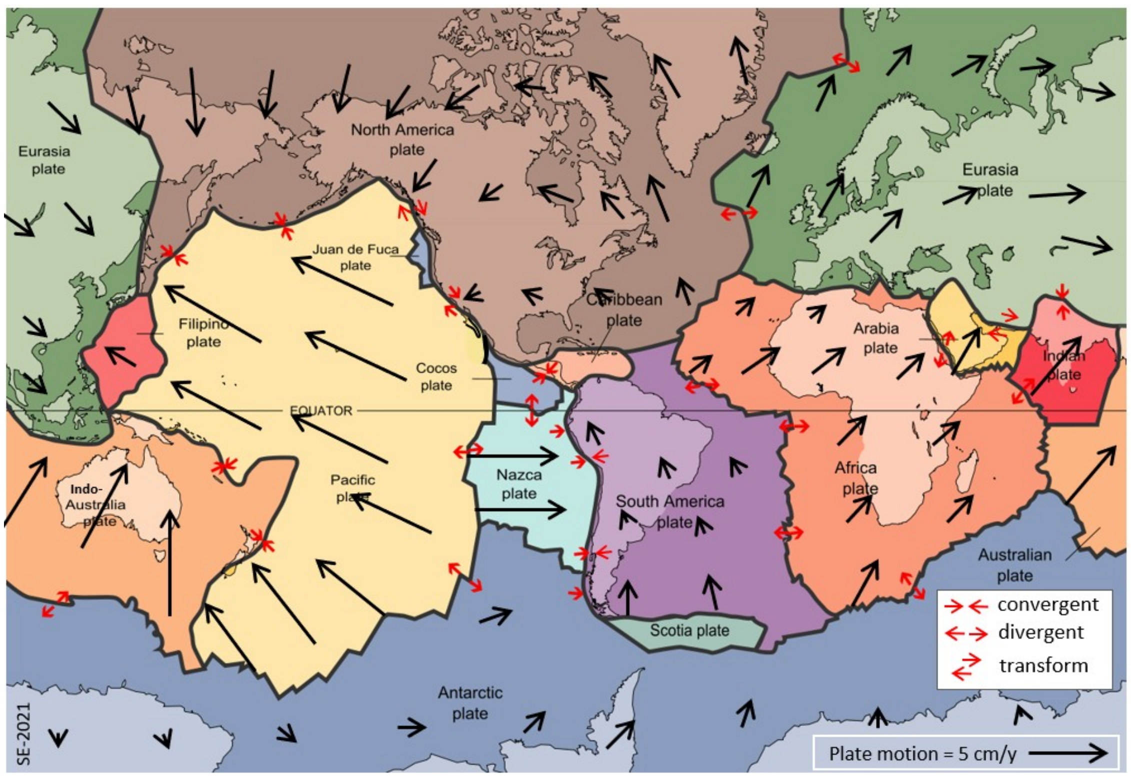
133°W,27°S to 90°W,32°S

| Location Description | Start Long, Lat | End Long, Lat | Spreading Rate Left (mm/yr) | Spreading Rate Right (mm/yr) | Combined Seafloor Spreading Rate (mm/yr) |
|---|---|---|---|---|---|
| South Atlantic | 37°W,22°S | 10°W,12°S | 22 | 21.6 | 43.6 |
| South Pacific | 133°W,27°S | 90°W,32°S | 60 | 112 | 172 |

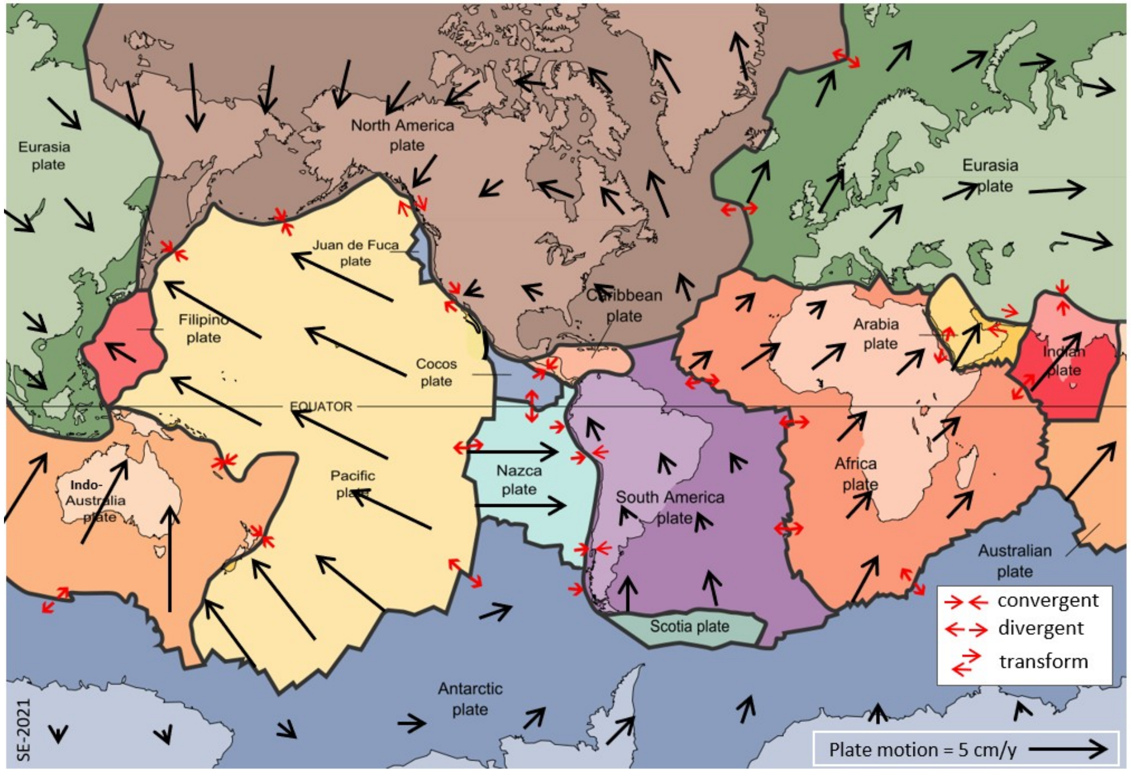
**POINT**

Describe the difference between the Atlantic and Pacific Oceans.

Explain a possible reasonably reason for this difference.



# POINT



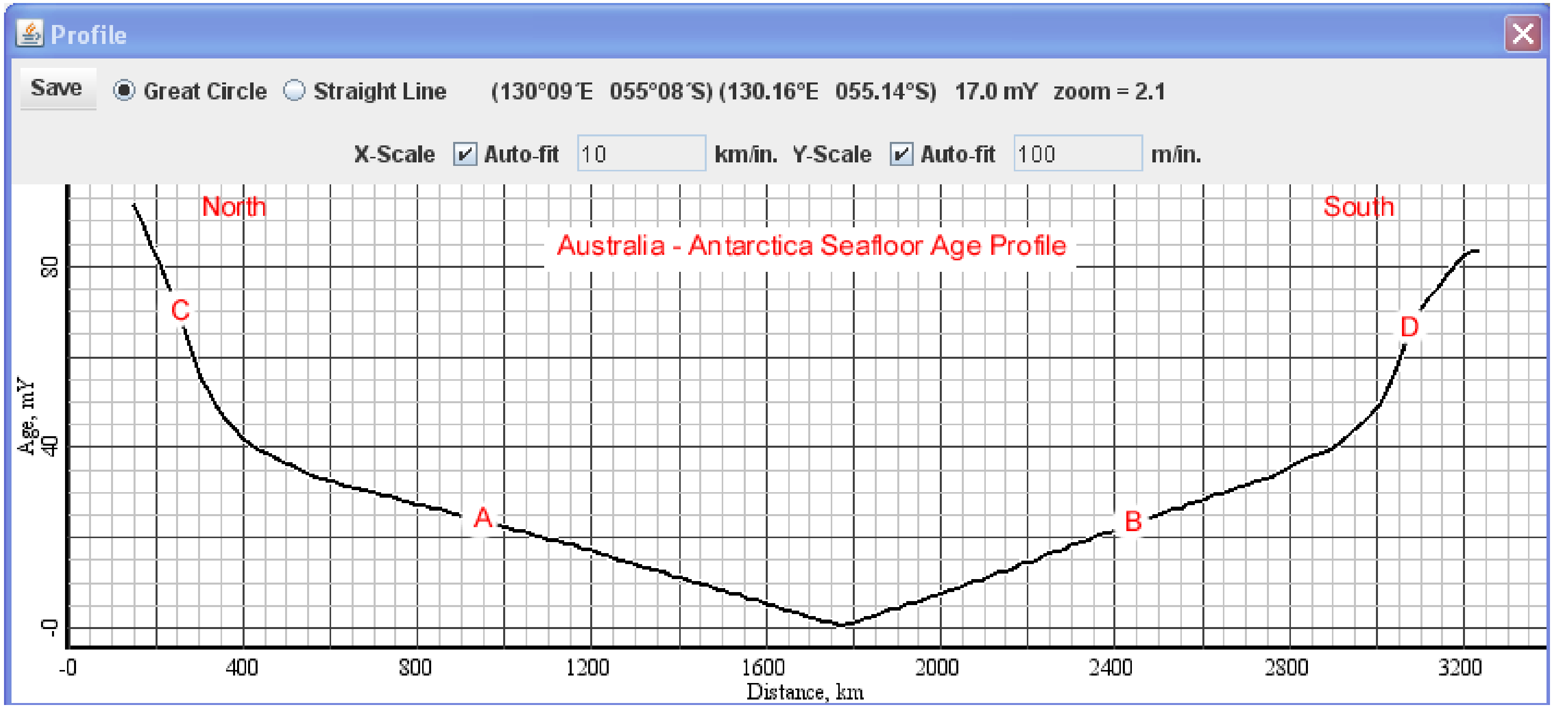

The **Atlantic** seafloor surrounding the Atlantic mid-oceanic ridge is attached to the continents at its margins → the Atlantic margins are passive margins.

The **Pacific** seafloor surrounding the East Pacific rise is attached to the subduction zones around the Pacific margin which adds slab pull to the ridge push at the spreading center. These combined forces increase the rate at which the Pacific lithosphere moves away from the spreading center

STEP 4

# INDIAN OCEAN RIDGE

**130°E , 33°S to 134°E, 63°S**




| Location Description | Start Long, Lat | End Long, Lat | Spreading Rate (Present – 40 mya) | | Spreading Rate (40 mya – 80 mya) | |
|---|---|---|---|---|---|---|
| | | | Left (north) (mm/yr) | Right (south) (mm/yr) | Left (north) (mm/yr) | Right (south) (mm/yr) |
| Australia - Antarctica | 130°E, 33°S | 134°E,63°S | 33.6 | 28.4 | 5.1 | 6.9 |
| | | | Combined Rate (mm/yr) | 62 | Combined Rate (mm/yr) | 12 |

# POINT

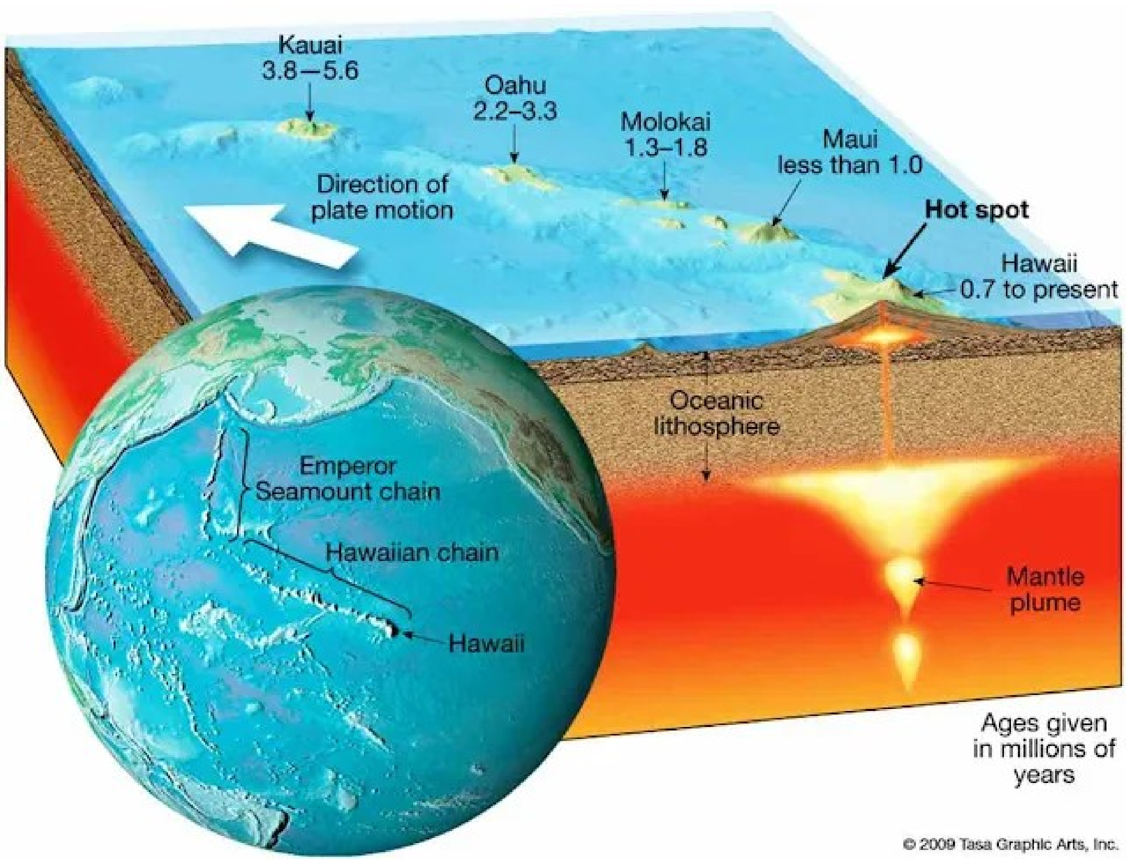
## describe the differences between the different analyzed spreading rates

- Are ridges symmetrical (as usually shown on textbooks)?
- Are all seafloor spreading rates around the Earth currently constant?
- Are spreading rate of a single ridge necessarily constant over time?

# EXERCISE #2

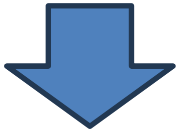
Volcano ages,
Hotspots
and
Plate Motion

# PLUMES AND PLATE MOTION

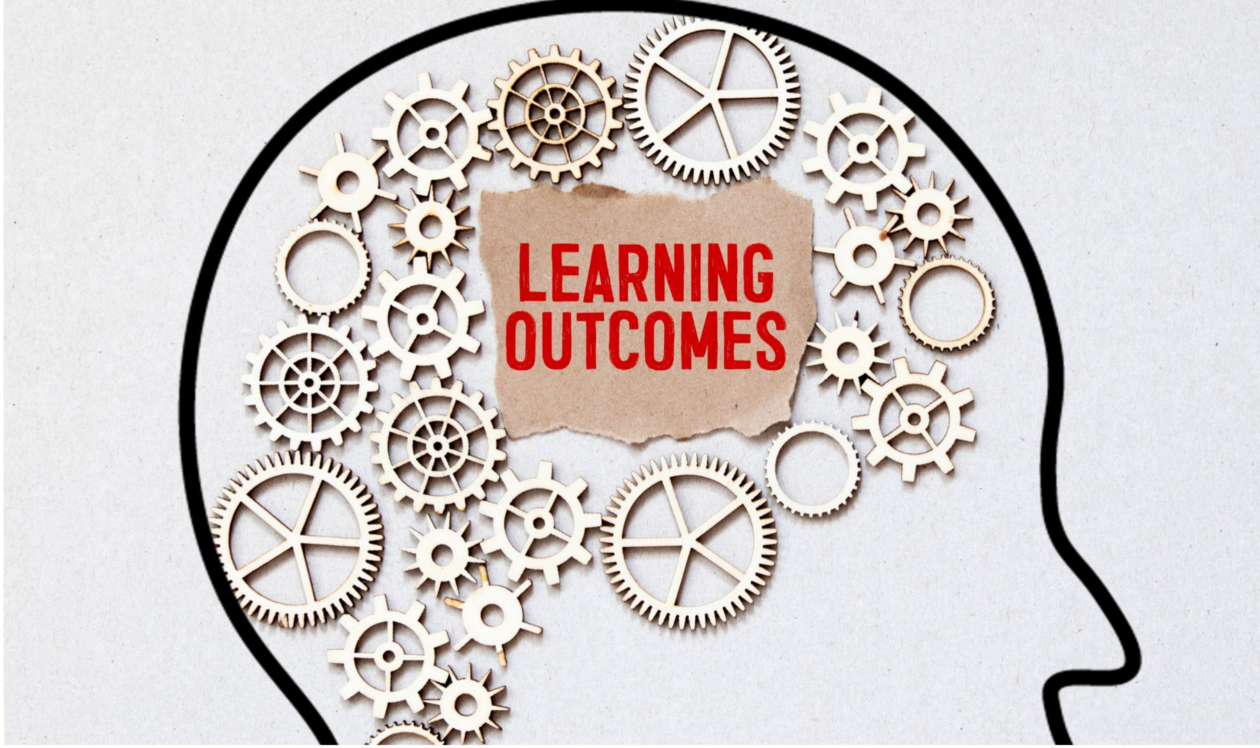



The Hawaiian-Emperor seamount Chain is a long chain of Pacific islands and extinct underwater volcanoes.

The accepted explanation of this structure implies the motion of the Pacific plate over a stationary plume.



**age and distance of volcanic data to calculate the rate of motion of the Pacific plate**




**TECHNICAL SKILLS**

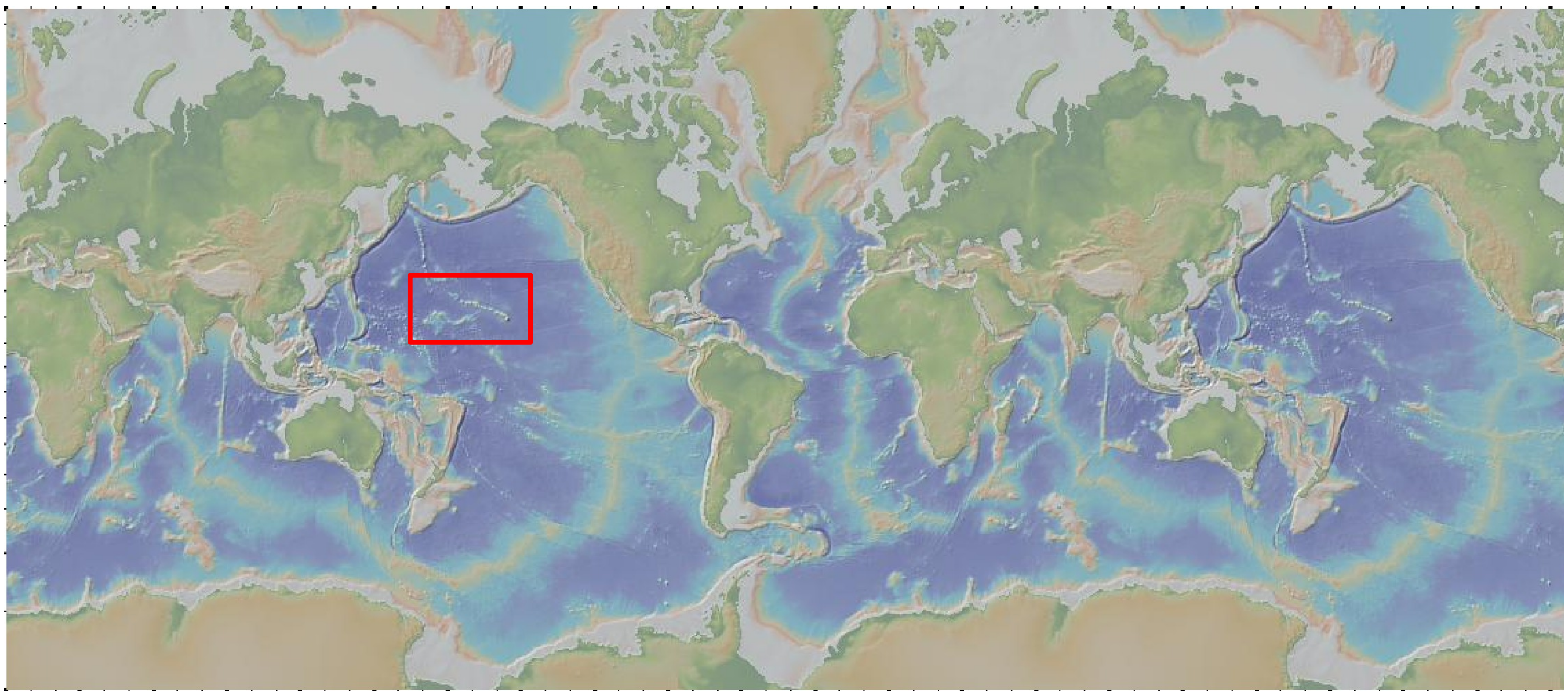
- *Load and explore data tables in GeoMapApp*
- *Use the distance profiler tool in GeoMapApp*

**SCIENTIFIC KNOW-HOW**

- Analyze data related to the age of volcanic rocks
- Calculate the speed of plate motion using age and distance data
- Analyze and compare speeds at different times in Earth’s history
- Speculate about the effects of tectonic activity on plate motions
- Assess evidence for the hotspot volcano formation model

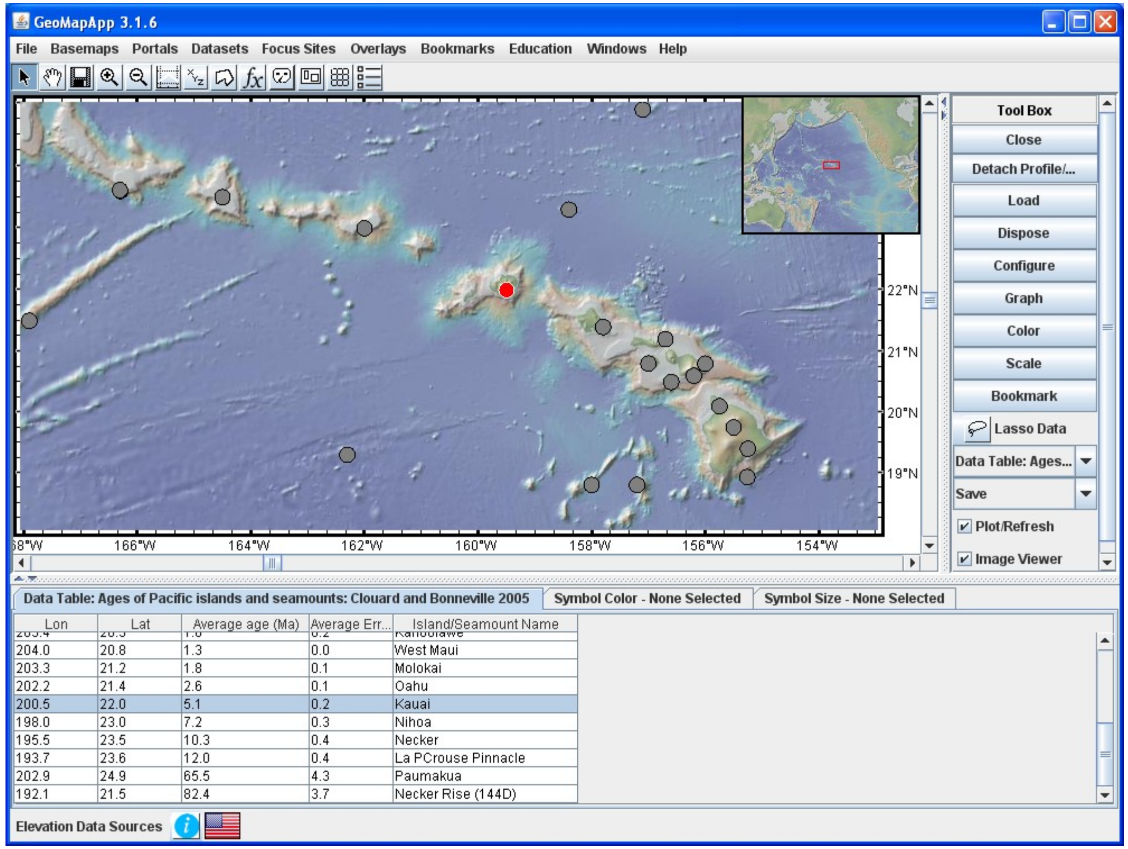
STEP 1

168°W, 25°N to 153°W, 18°N



## STEP 1

**168°W, 25°N to 153°W, 18°N**

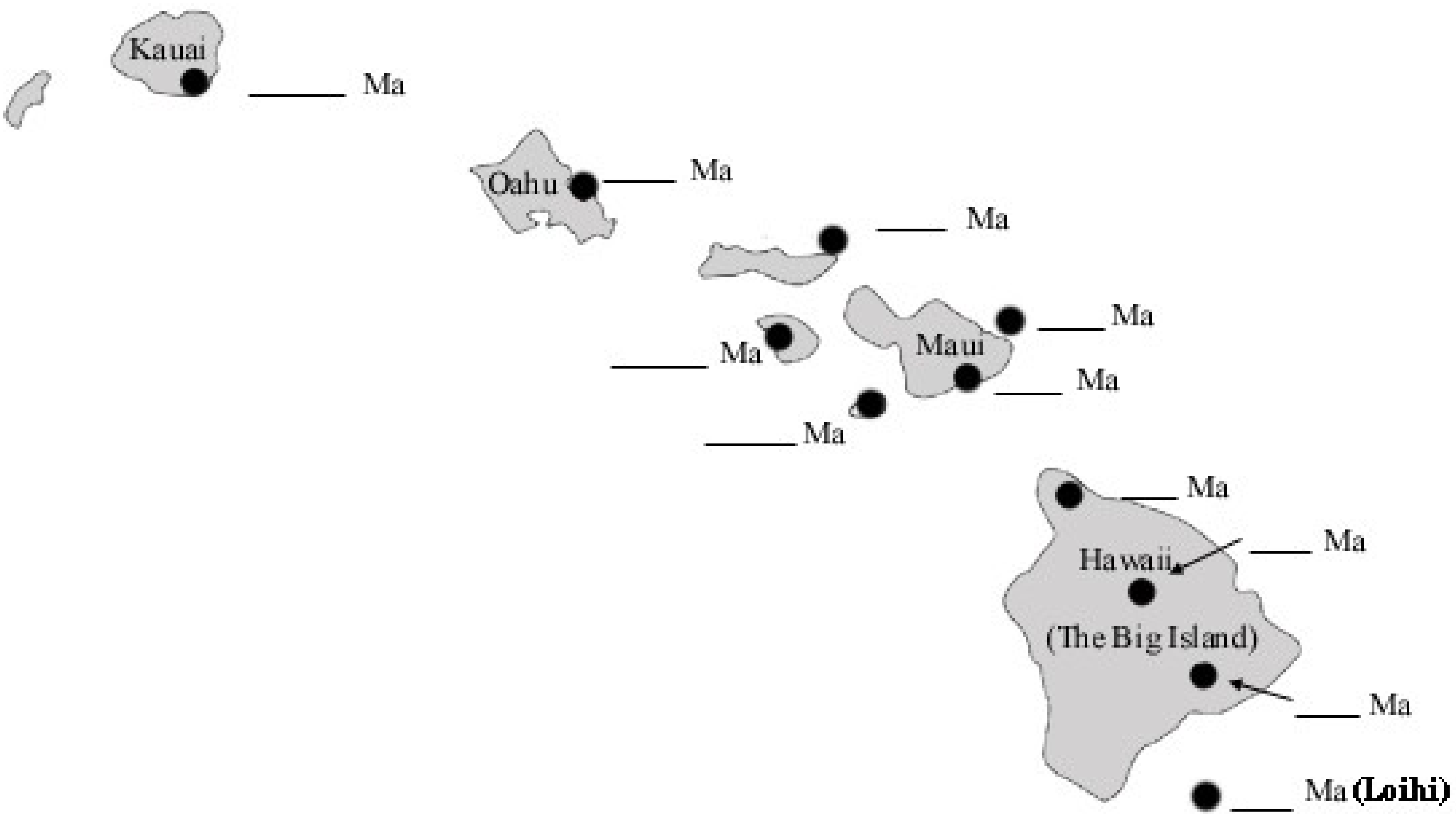



| Lon | Lat | Average age (Ma) | Average Err... | Island/Seamount Name |
|---|---|---|---|---|
| 204.0 | 20.8 | 1.3 | 0.0 | West Maui |
| 203.3 | 21.2 | 1.8 | 0.1 | Molokai |
| 202.2 | 21.4 | 2.6 | 0.1 | Oahu |
| 200.5 | 22.0 | 5.1 | 0.2 | Kauai |
| 198.0 | 23.0 | 7.2 | 0.3 | Nihoa |
| 195.5 | 23.5 | 10.3 | 0.4 | Necker |
| 193.7 | 23.6 | 12.0 | 0.4 | La PCrouse Pinnacle |
| 202.9 | 24.9 | 65.5 | 4.3 | Paumakua |
| 192.1 | 21.5 | 82.4 | 3.7 | Necker Rise (144D) |

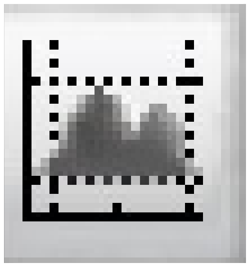
Click on *DataLayers -> Geology -> Volcanoes and Seamounts -> Ages of Pacific islands and seamounts: Clouard and Bonneville 2005* to load the data set of the age of volcanic rocks (determined radiometric age-dating techniques) collected from the Hawaiian islands and seamounts.

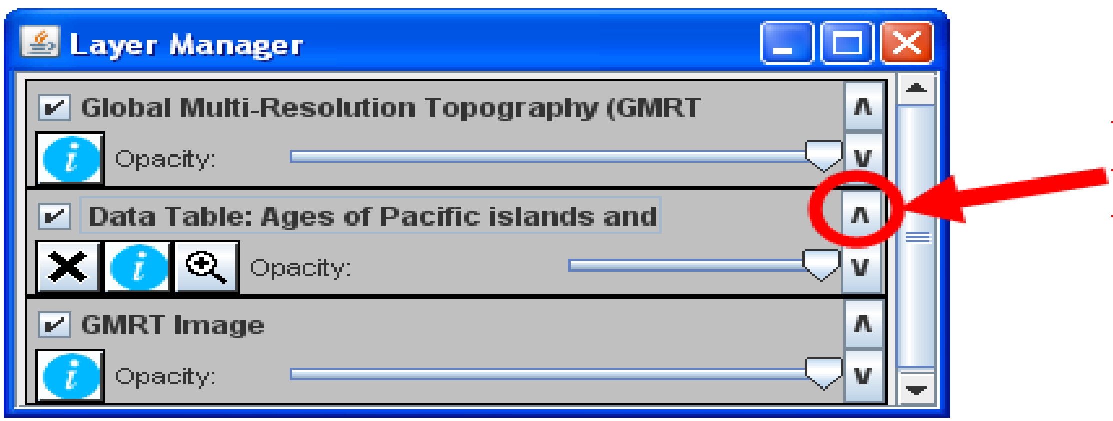
STEP 2

# DEFINE THE AGE OF HAWAIAN ISLANDS …



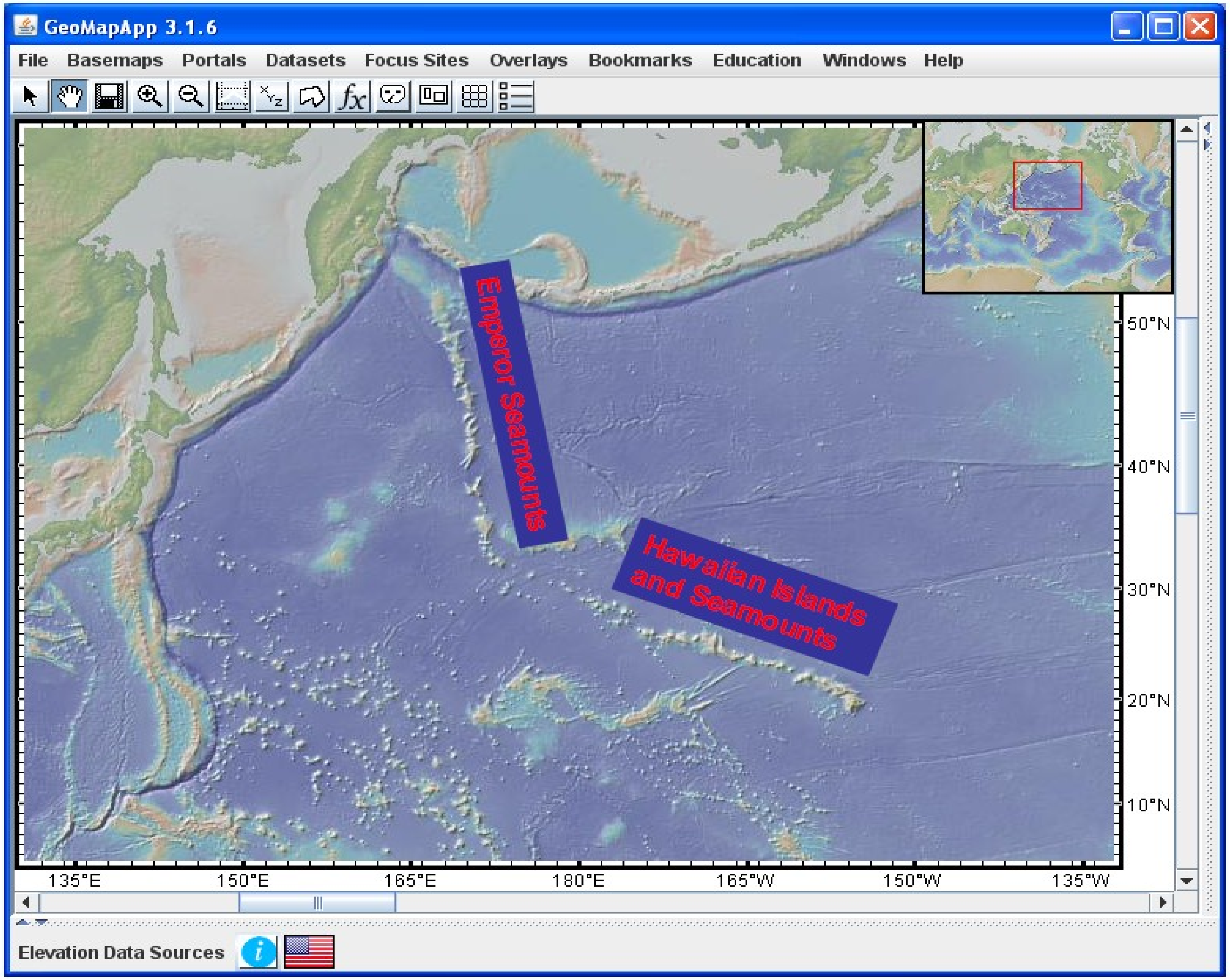
# … AND THEIR DISTANCE






Click this up arrow to make the age data set move to the top

# STEP 3 CALCULATE THE PACIFIC PLATE VELOCITY



# CALCULATE THE PACIFIC PLATE VELOCITY


- How long ago did the bend of Hawaiian-Emperor seamount chain occur?

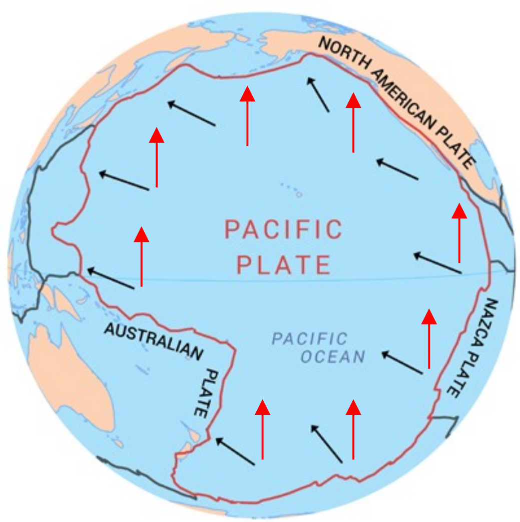
**Some time between 41.5 Ma and 47,.3 Ma.**

# POINT

describe the Pacific plate motion

# POINT

About 60 Ma, the Pacific plate was moving in a **northerly direction** ↑ relative to the hotspot. Currently the plate is moving in a **northwesterly direction** ↖ .



# POINT

What could be the cause of the major change in the organization of global plate motions around 45 to 55 Ma?

# POINT

The bend roughly correlates with the drastic change in the spreading rate observed between the Australian and Antarctic plates (--> recall the activity on seafloor spreading).

Possible explanations:

- the slightly earlier **collision of the Indian and Eurasian plates** that began forcing up the huge Himalayan mountain range and producing the extrusion of East and Southeast Asia;

- **temporary locking of the subduction process** in the NW Pacific;

- the **movement of the plume** within the mantle.


GeoMapApp