

# Come Nascono gli Oceani

Enrico Bonatti



# H<sub>2</sub>O on EARTH

Ocean Volume → 1.370 million km<sup>3</sup>

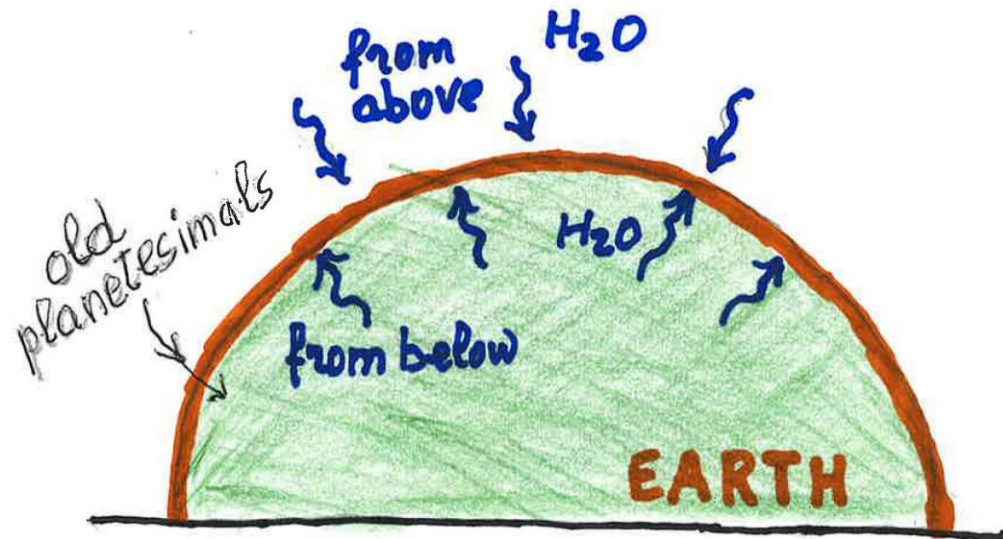
Why so much liquid H<sub>2</sub>O on our Planet?

Planetesimals → ~ 0.1% H<sub>2</sub>O

First atmosphere → H<sub>2</sub>O, CO<sub>2</sub>, CH<sub>4</sub>, NH<sub>3</sub>.

**ASTERIODS** (between Mars and Jupiter)

**COMETS** (contain ICE)

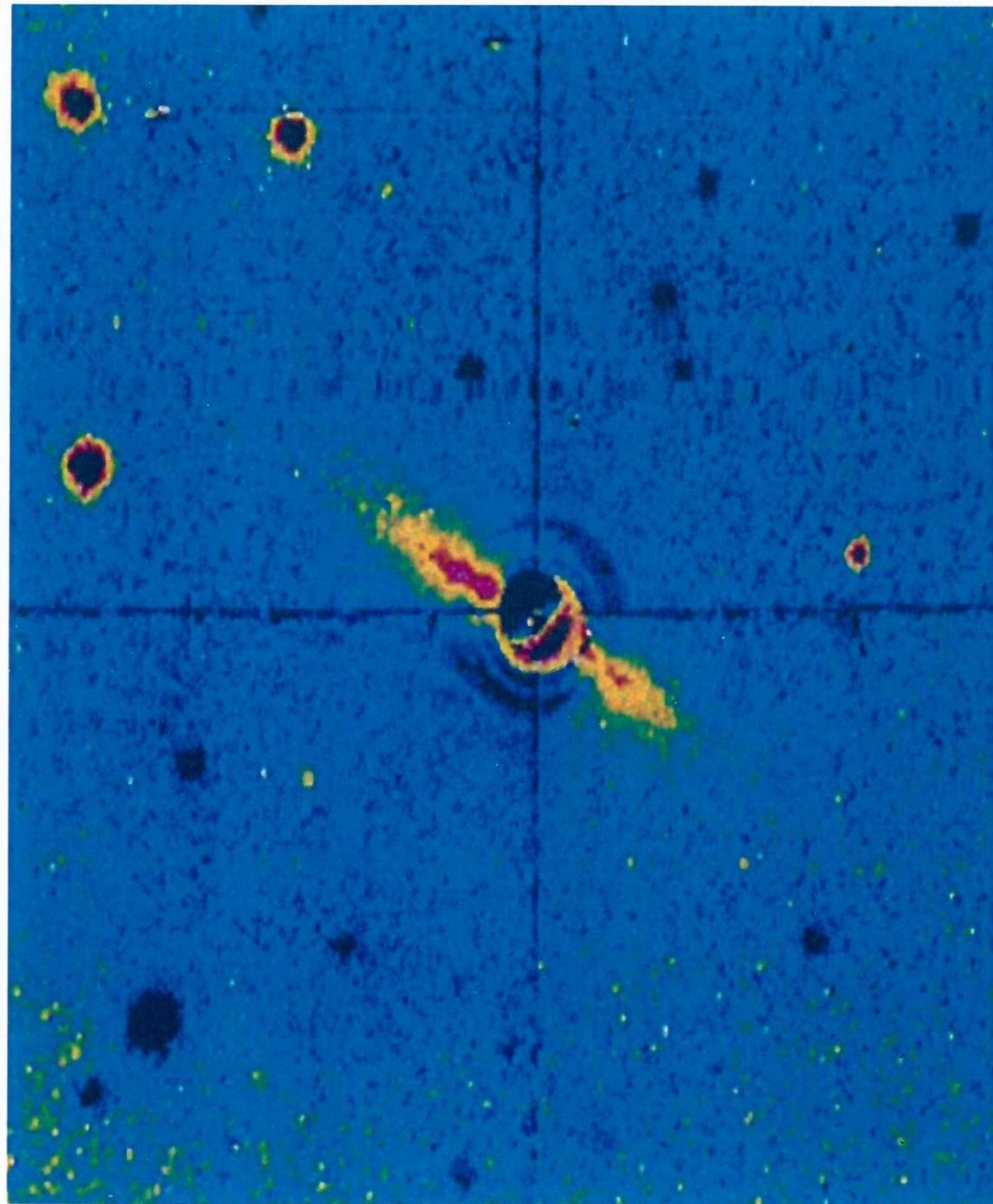






**A dusty beginning.** As comets streak by, a small, scarred planetesimal (foreground) forms from the dust encircling a young sun.







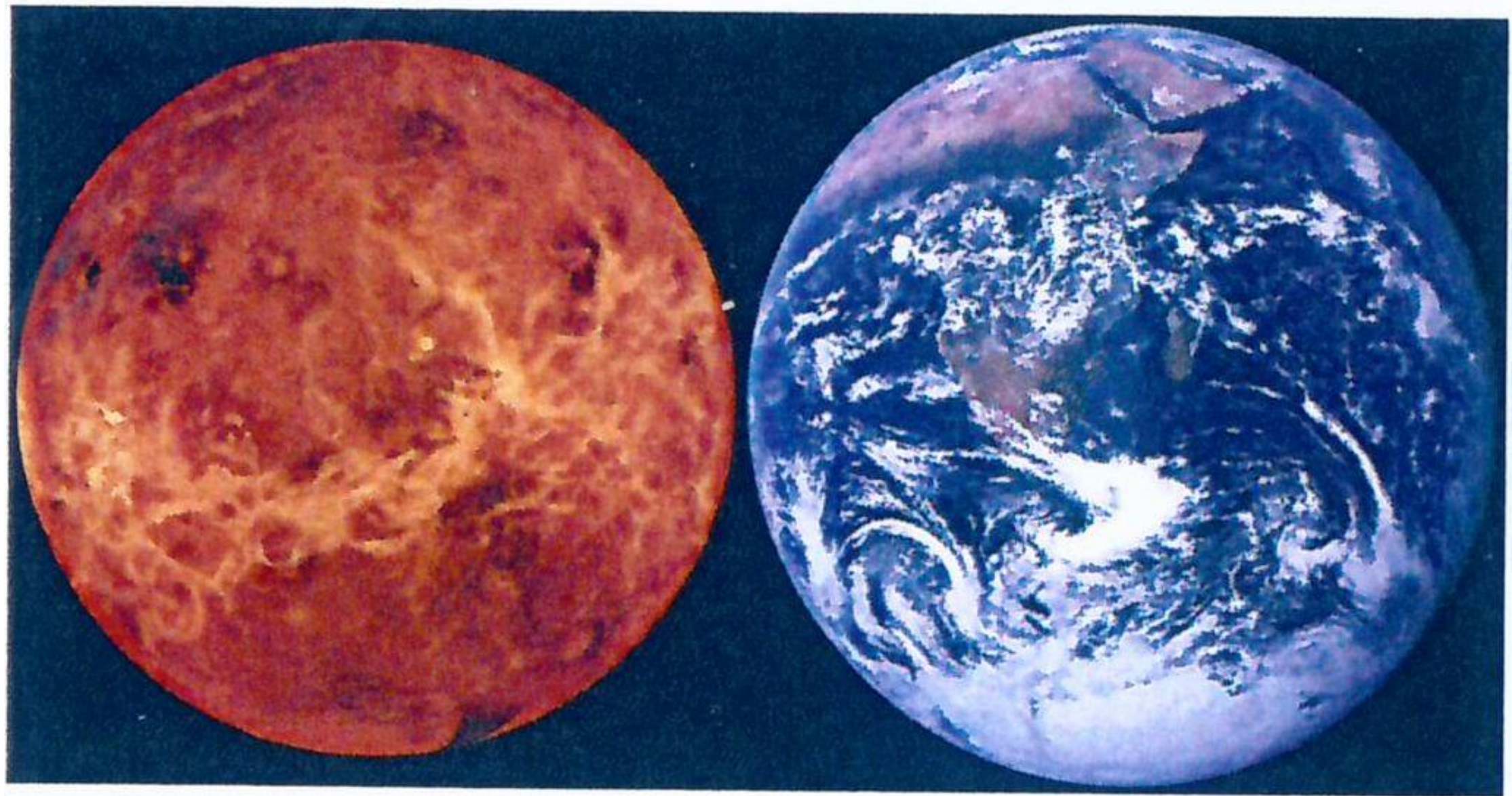
# CIRCUM-STELLAR HABITABLE ZONE



A diagram illustrating the circum-stellar habitable zone around a red star. The star is shown on the left as a large, textured red sphere. A blue band, representing the habitable zone, extends from the star towards the right. Within this zone, several celestial bodies are depicted: a small brown planet, a larger orange planet, and the Earth (blue and white). To the right of the habitable zone, a red planet, a gas giant with horizontal bands (Jupiter-like), and a ringed planet (Saturn-like) are shown. A yellow horizontal line with vertical end caps spans the width of the habitable zone, with the text '93,000,000 Mi.' written below it.

93,000,000 Mi.





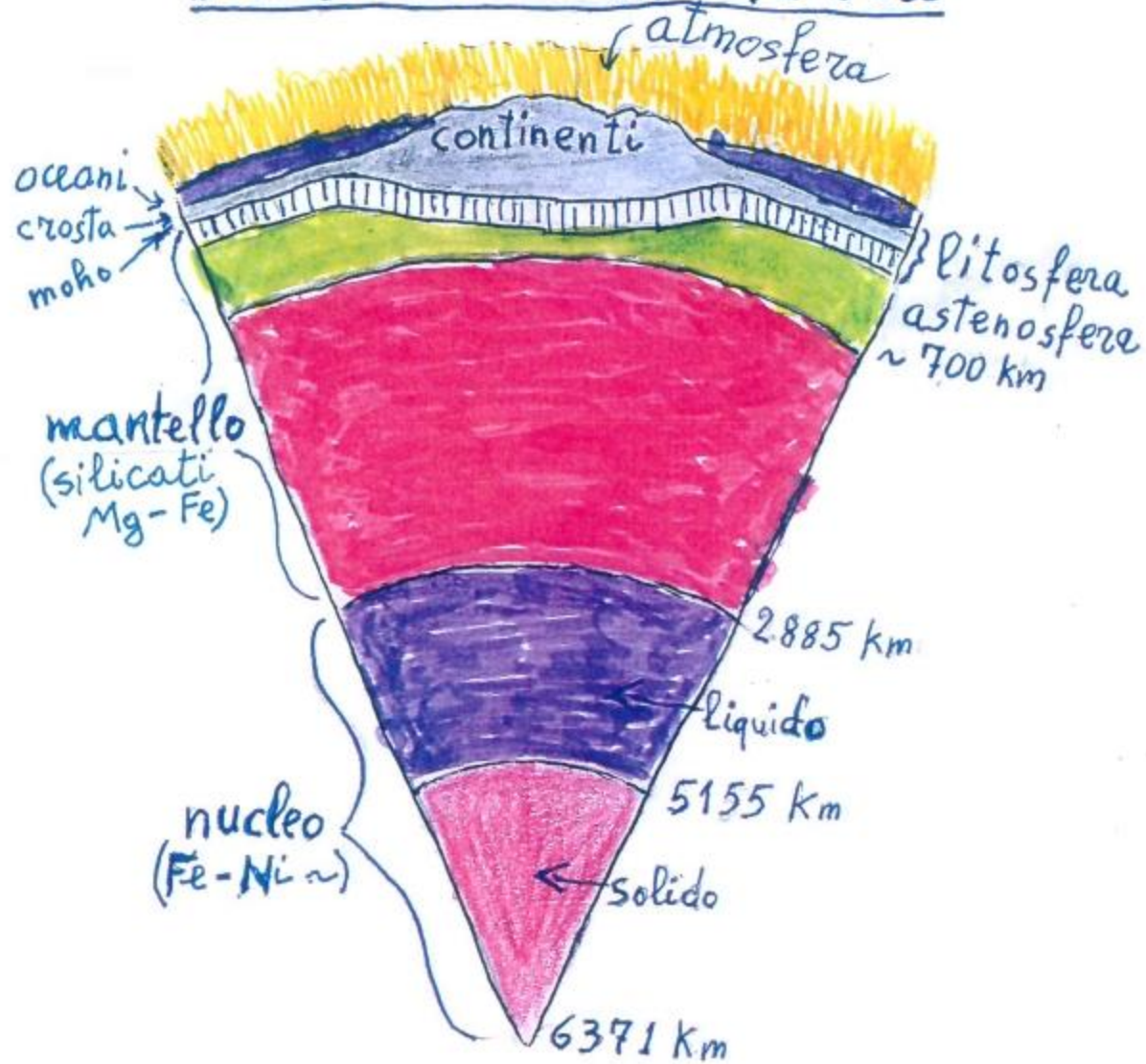


Encedalus





# Interno della Terra

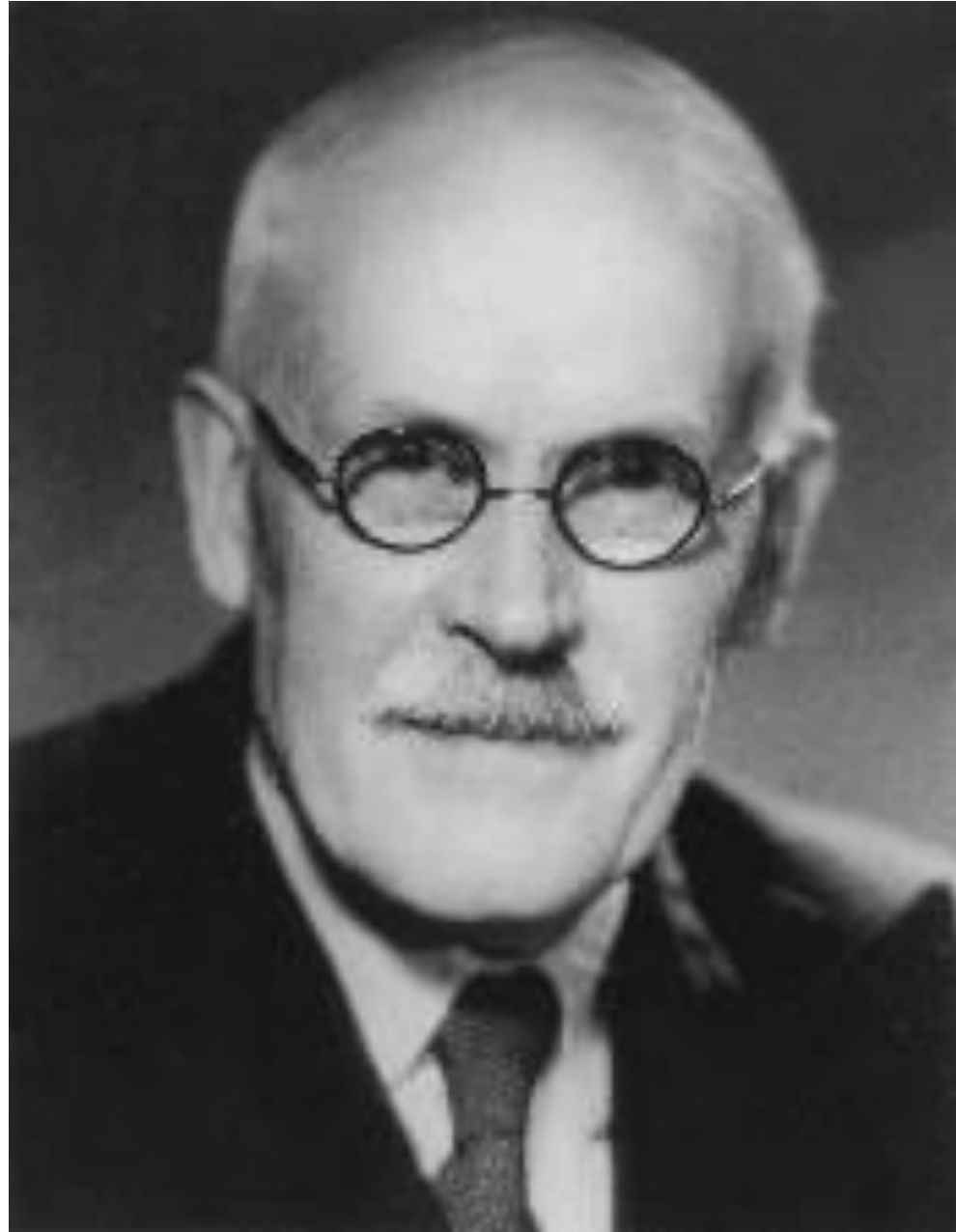








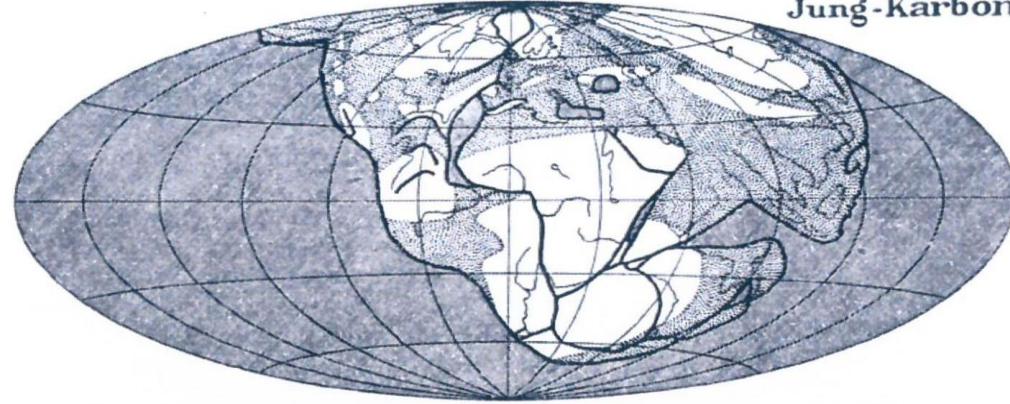
**Sir Harold Jeffreys**



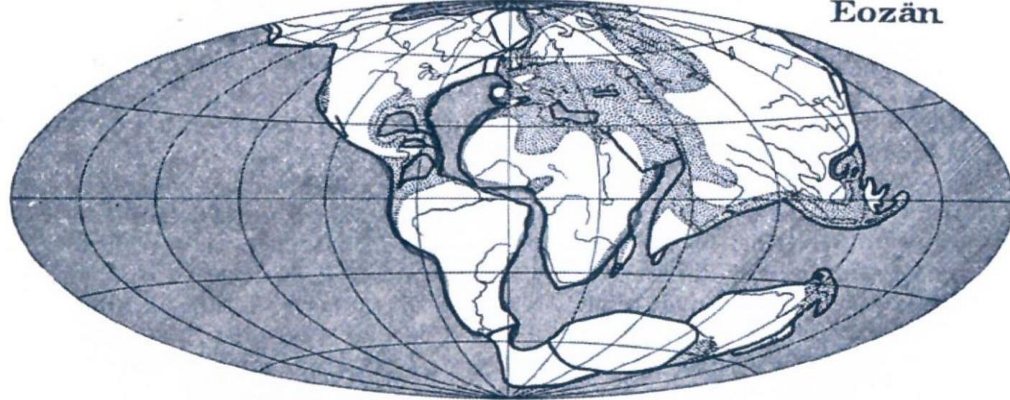




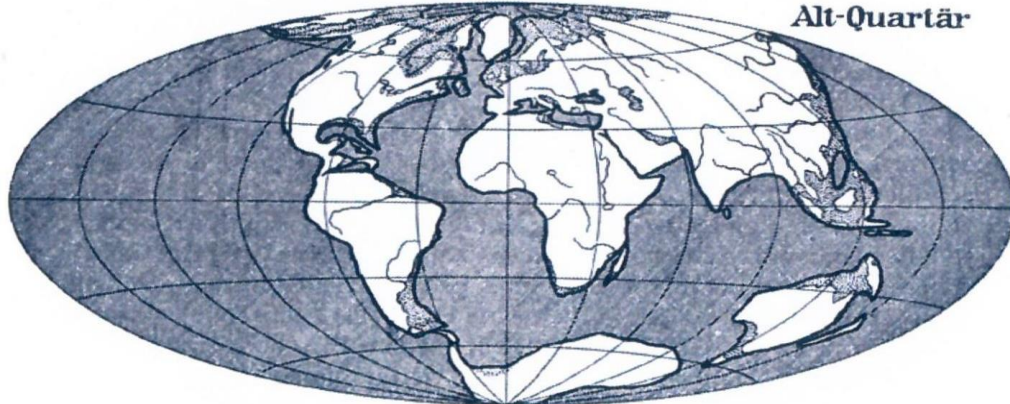
Jung-Karbon



Eozän



Alt-Quartär



Rekonstruktionen der Erdkarte nach der Verschiebungstheorie für drei Zeiten.

Schraffiert: Tiefsee; punktiert: Flachsee; heutige Konturen und Flüsse nur zum Erkennen. Gradnetz willkürlich (das heutige von Afrika).



Two types of  
SCIENTISTS {  
ORTHODOX  
MAVERICKS

Majority follow an orthodox Cartesian mode of logical deductive reasoning. They prefer limited, well defined problems with high probability of solution. They are systematic. →

H. JEFFREYS →

(1891-1989)

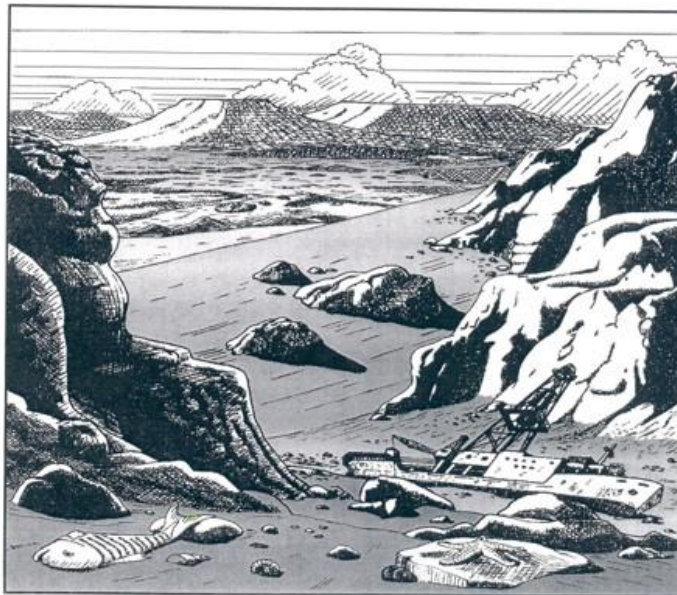
**ORTHODOX**

They work by a sort of global intuitive insight. They prefer broad, ill defined problems. They are synthesis-oriented. →

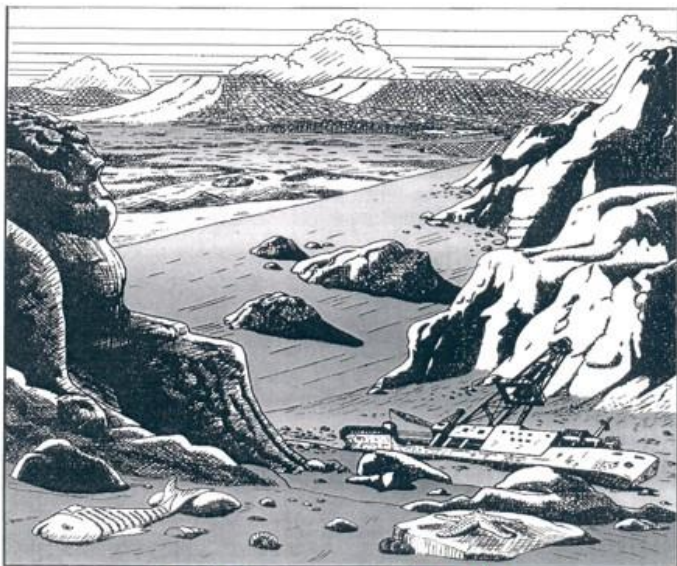
A. WEGENER →

(1880-1930)

**MAVERICKS**

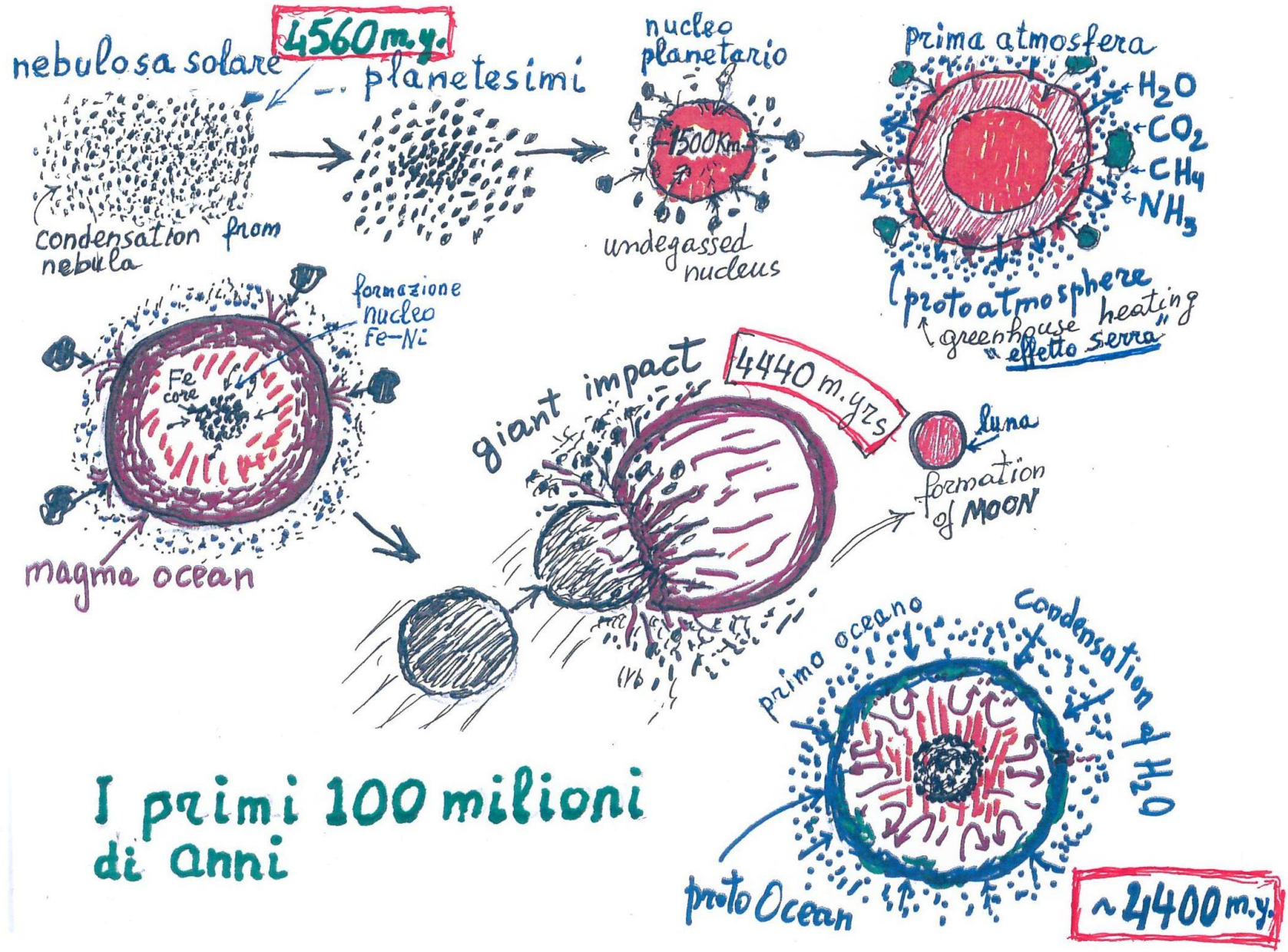


What marine geologists dream of ...

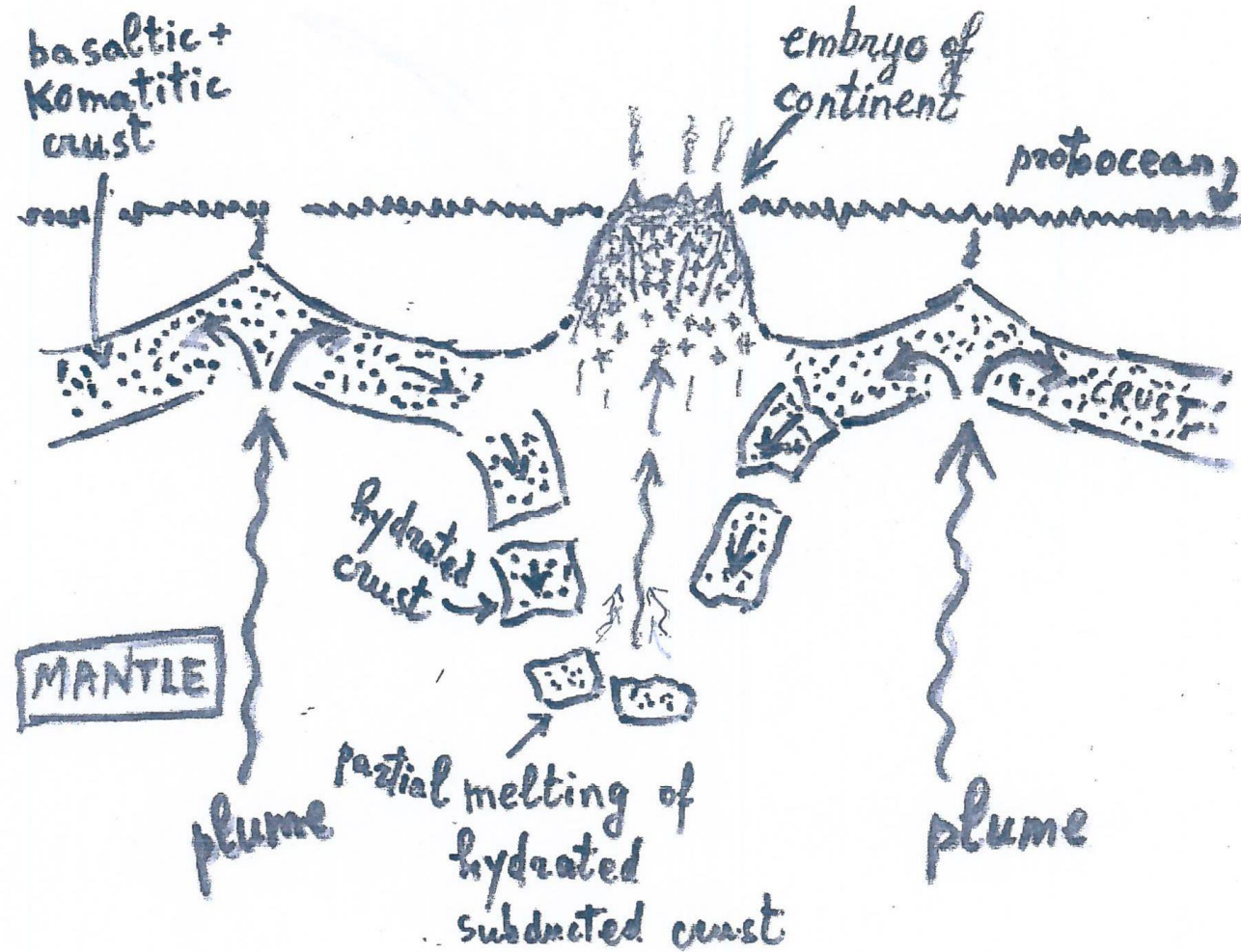


some do not  
What marine geologists dream of ... !





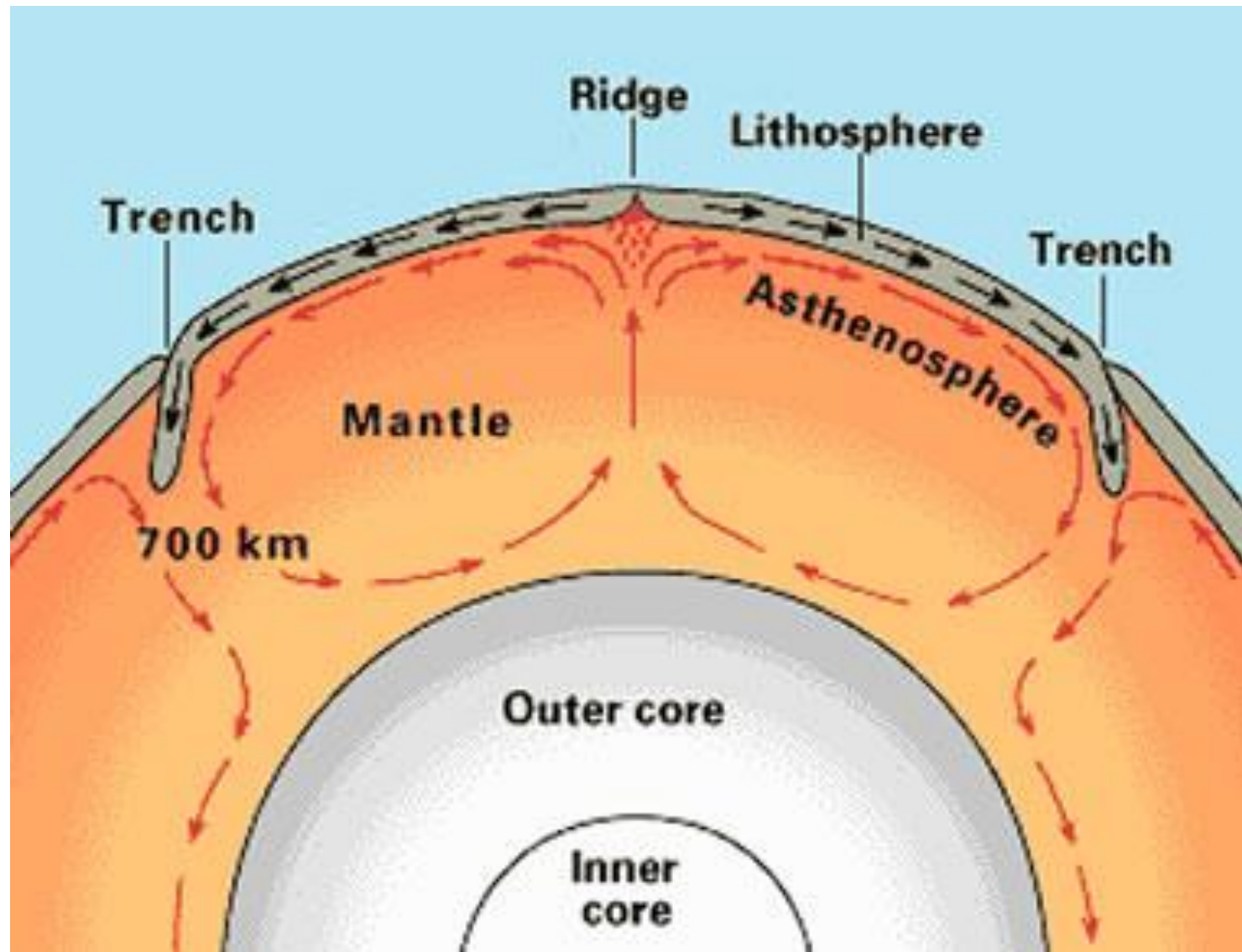
I primi 100 milioni di anni



NASCITA di un Embrione  
di CONTINENTE









## Gustave FLAUBERT (1889)

"Geology is too defective! We hardly know more than a few parts of Europe... As for the rest, including the sea bed, we shall never know about it"

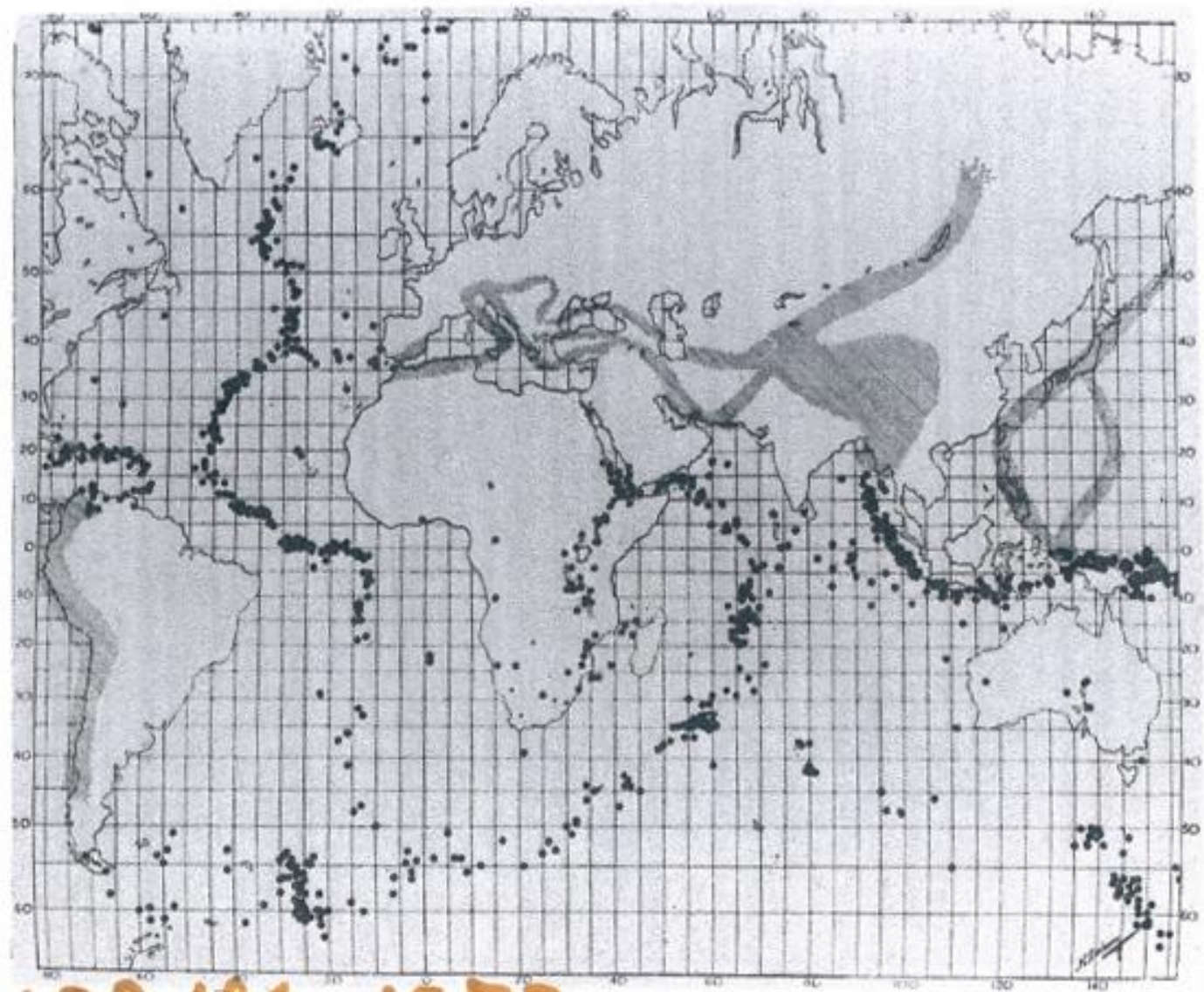
## Johann Gottfried HERDER (1769)

"..... the sea floor is the new land!  
Who can know it? Which Columbus  
or Galileo will be able to discover it?  
Which new underwater navigation,  
which new binoculars for this immensity  
must still be invented?....."







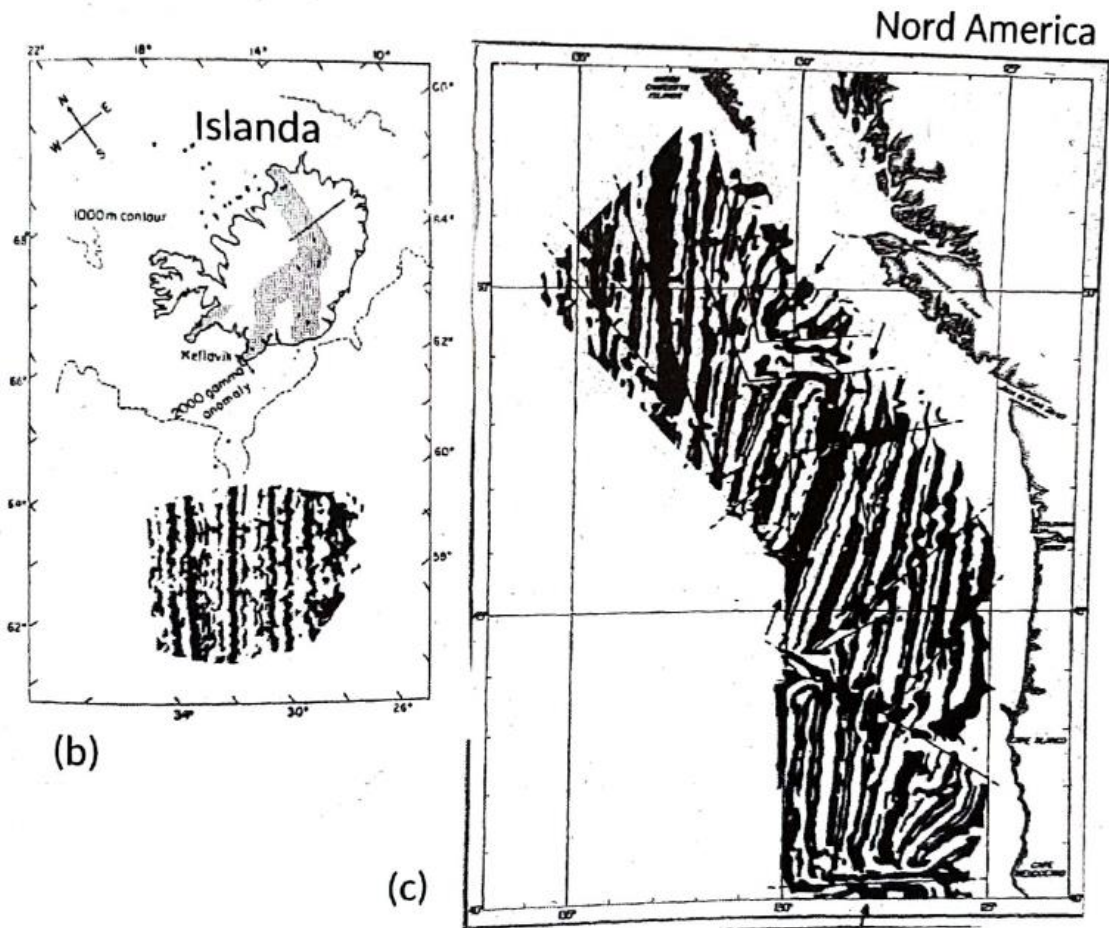
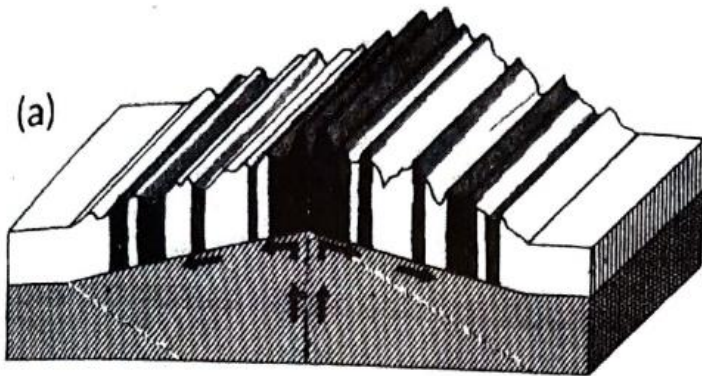


J.P. Rothe - 1953











# Age of Oceanic Lithosphere (m.y.)

## Data source:

Muller, R.D., M. Sdrolias, C. Gaina, and W.R. Roest 2008. Age, spreading rates and spreading symmetry of the world's ocean crust, *Geochem. Geophys. Geosyst.*, 9, Q04006, doi:10.1029/2007GC001743.

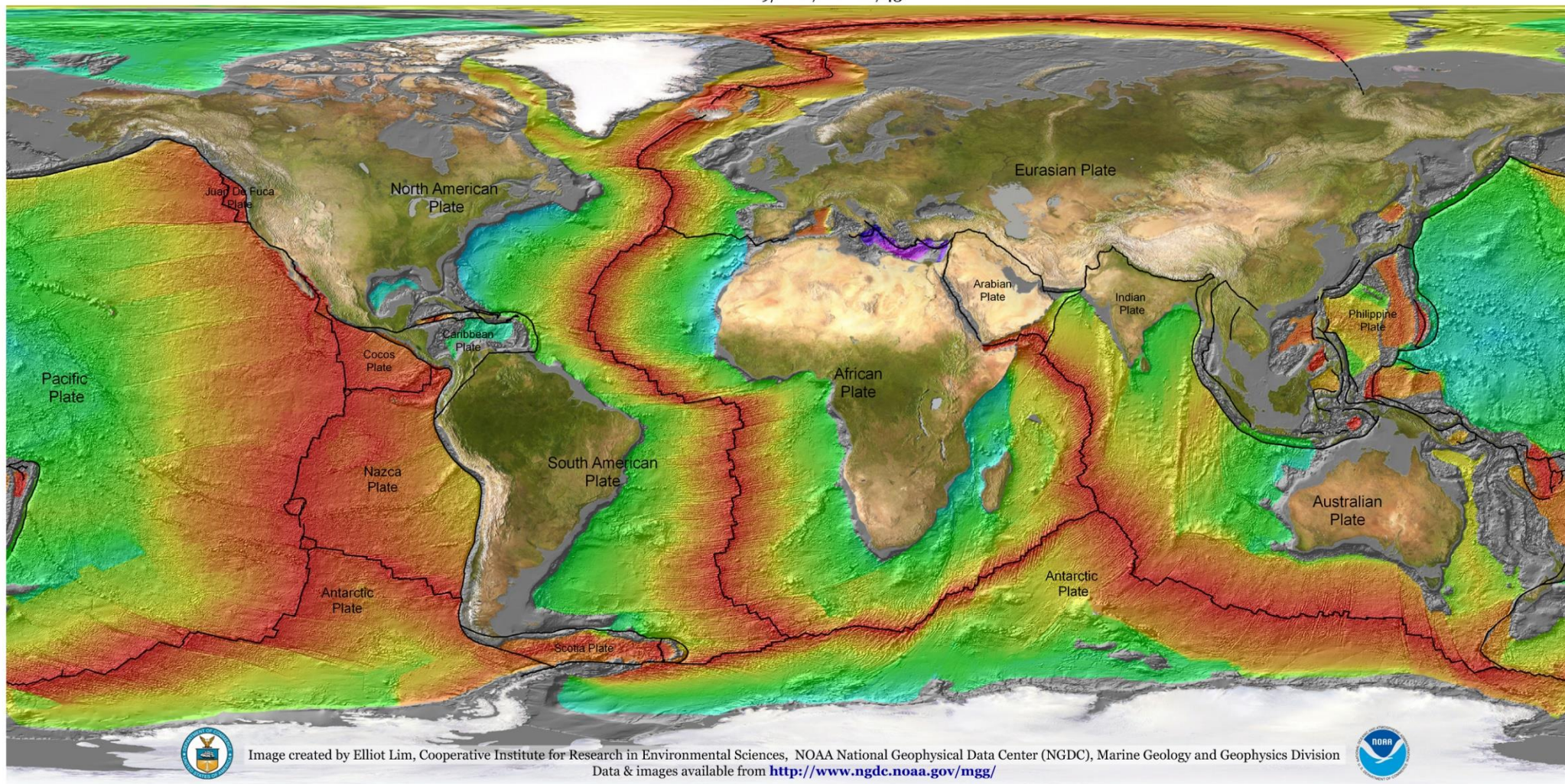
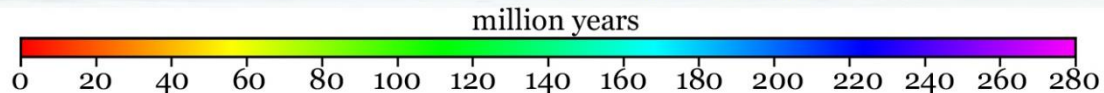
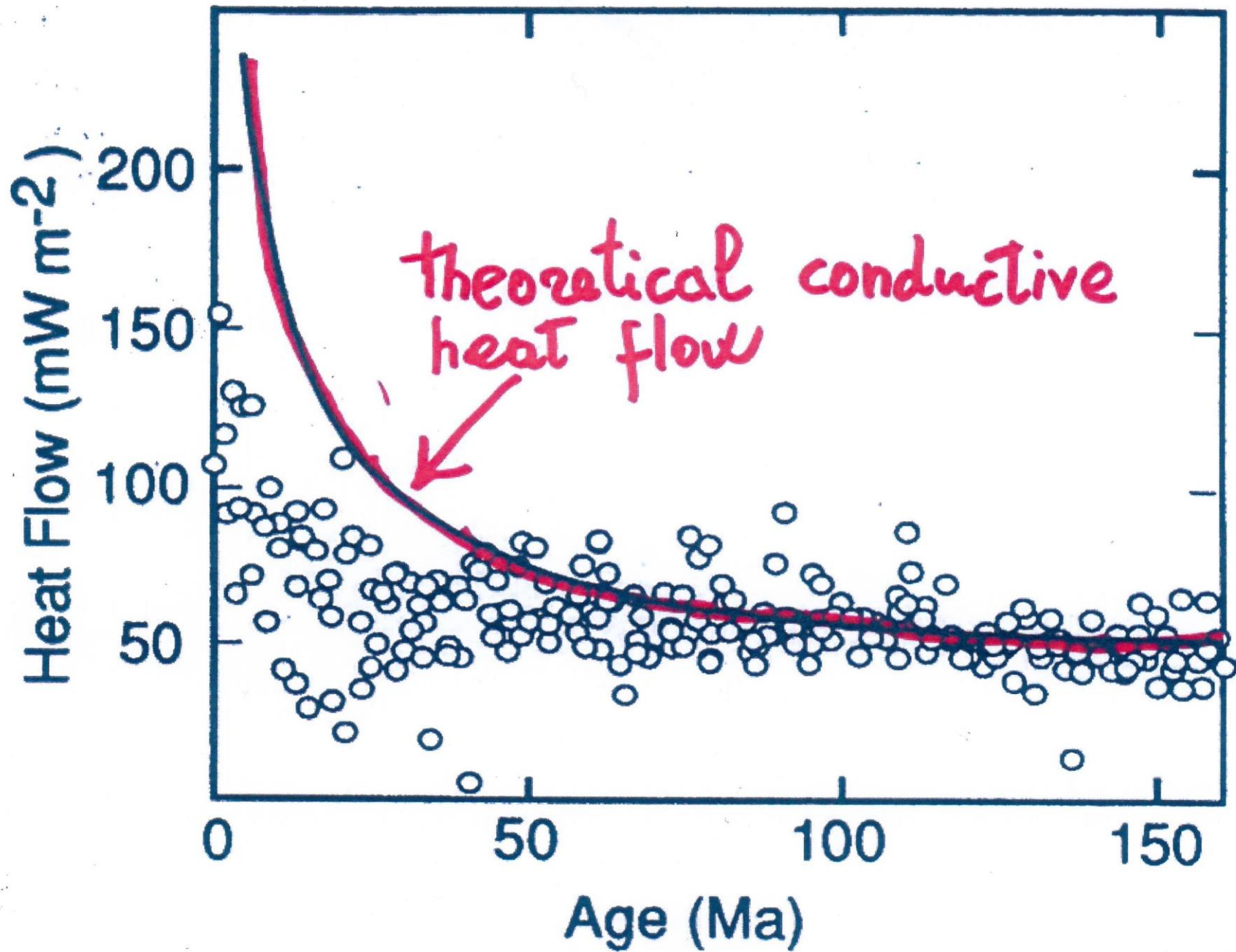


Image created by Elliot Lim, Cooperative Institute for Research in Environmental Sciences, NOAA National Geophysical Data Center (NGDC), Marine Geology and Geophysics Division  
Data & images available from <http://www.ngdc.noaa.gov/mgg/>







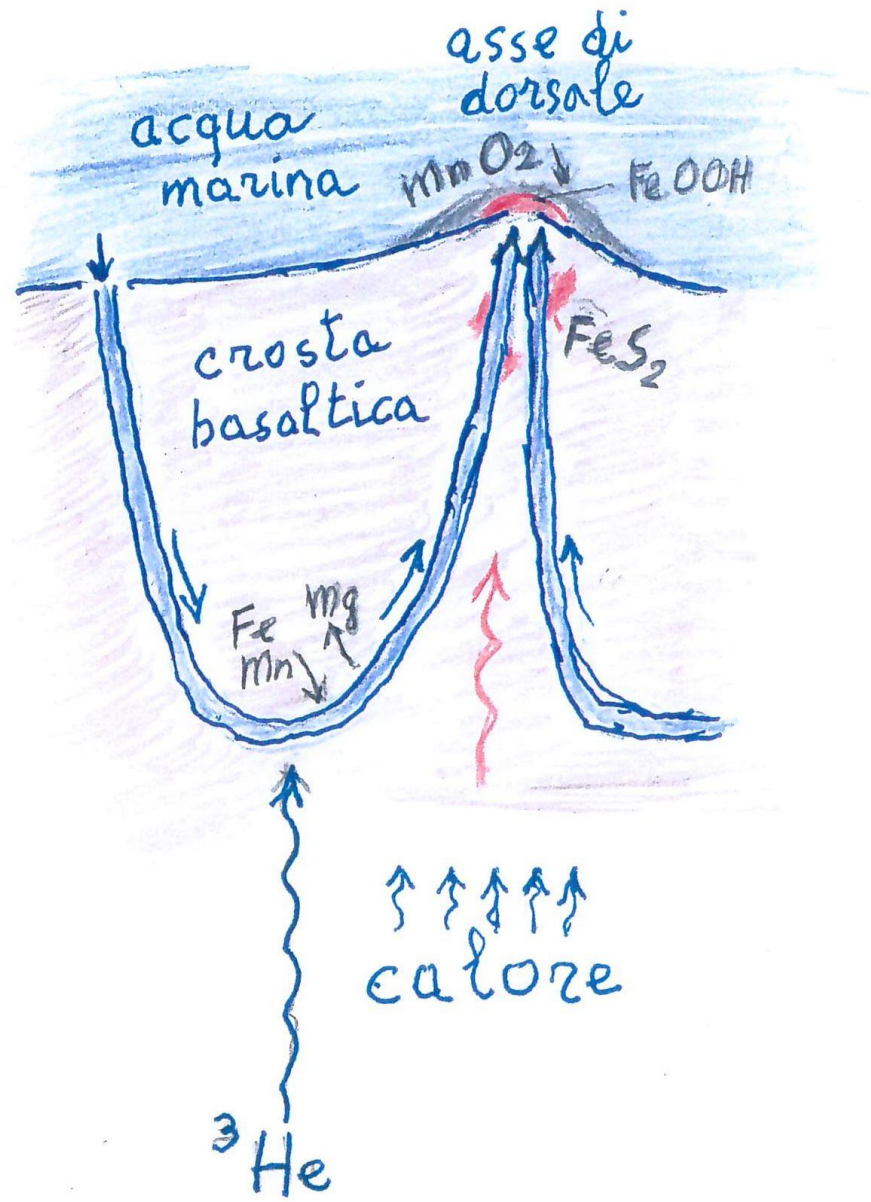




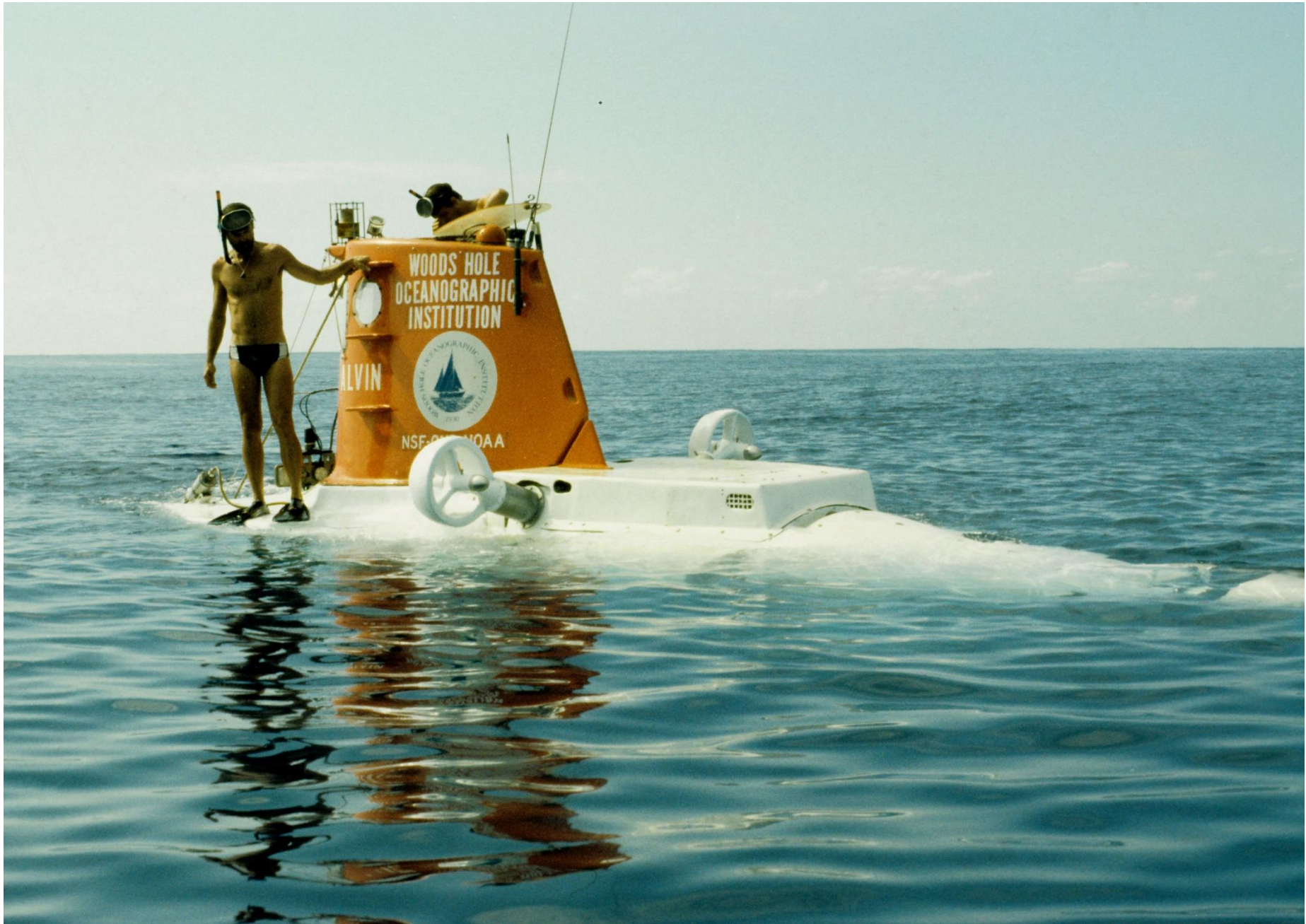


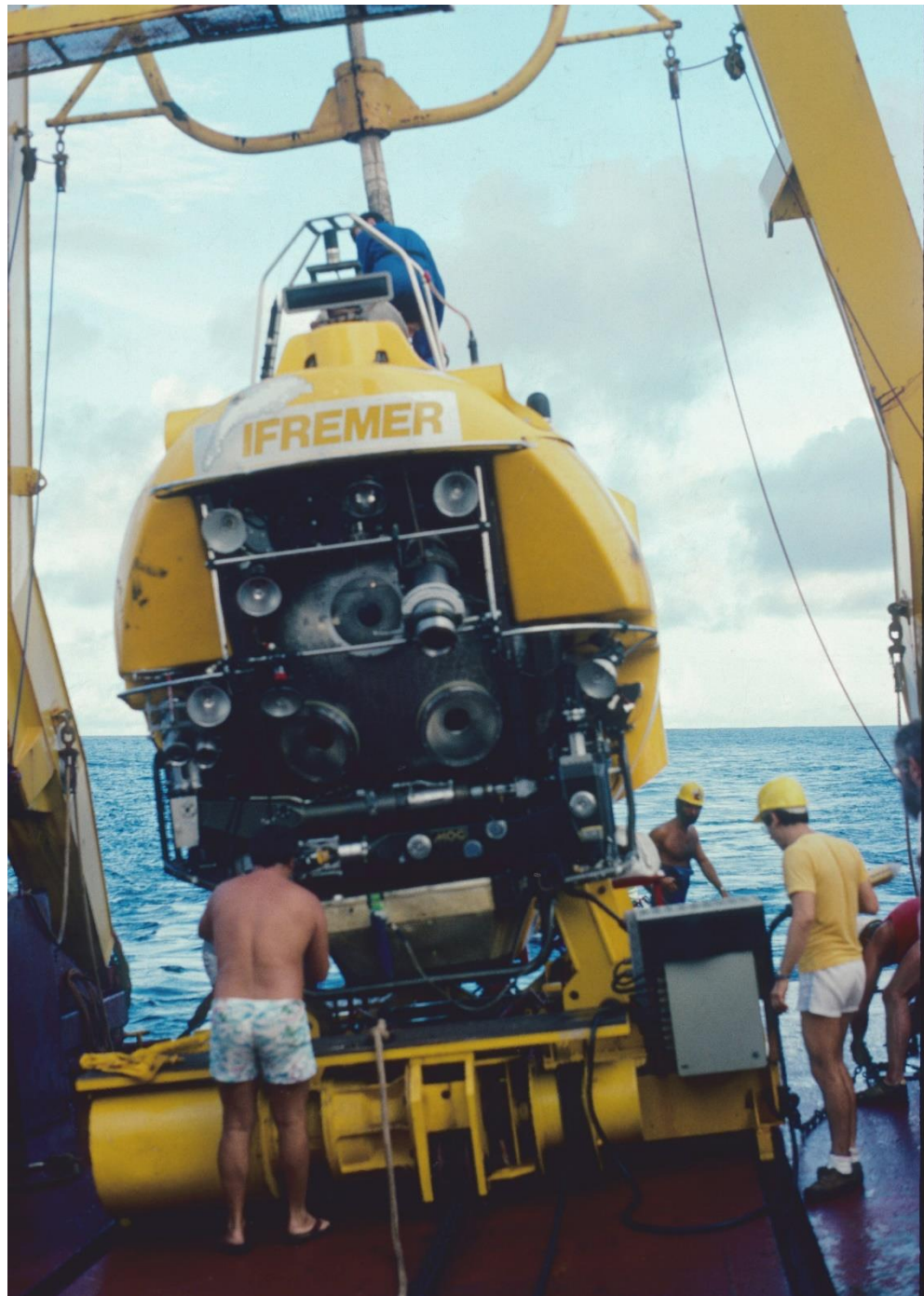














- Estrazione di CO<sub>2</sub> dall'atmosfera -

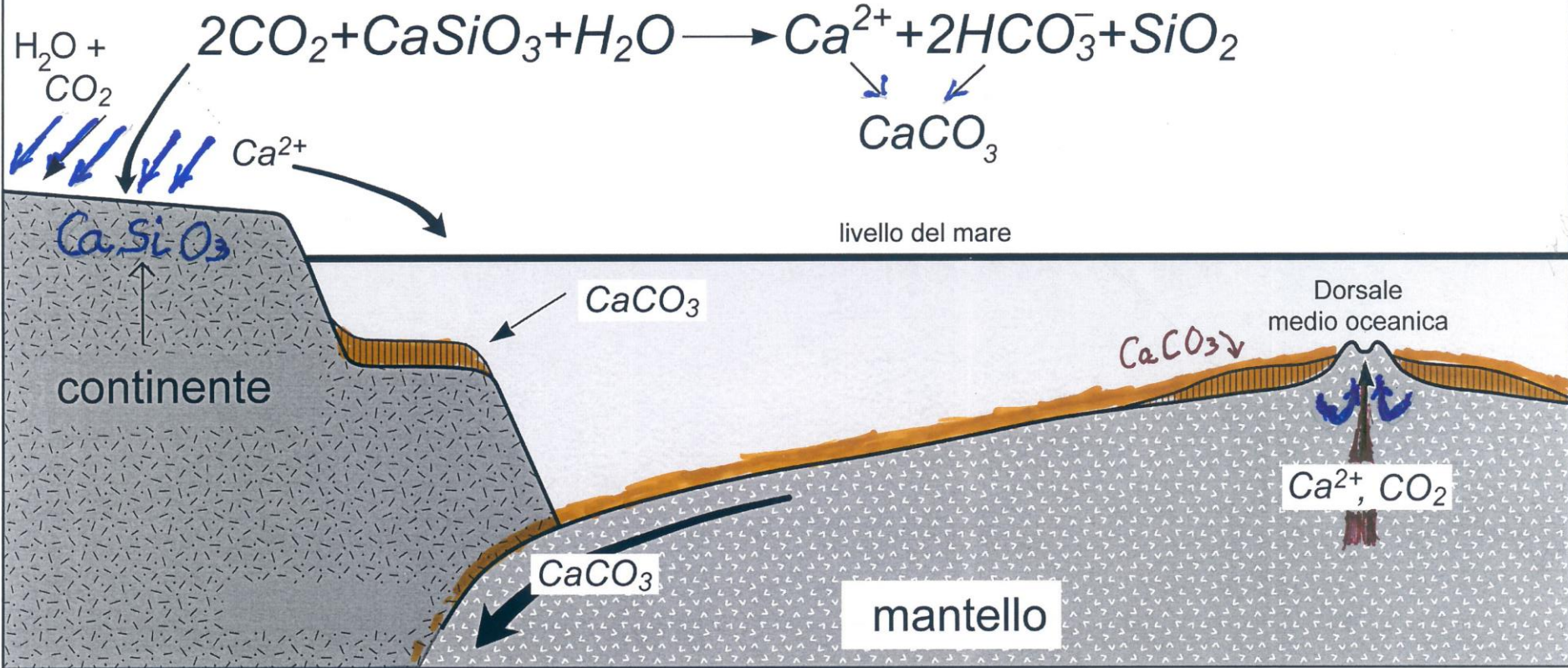
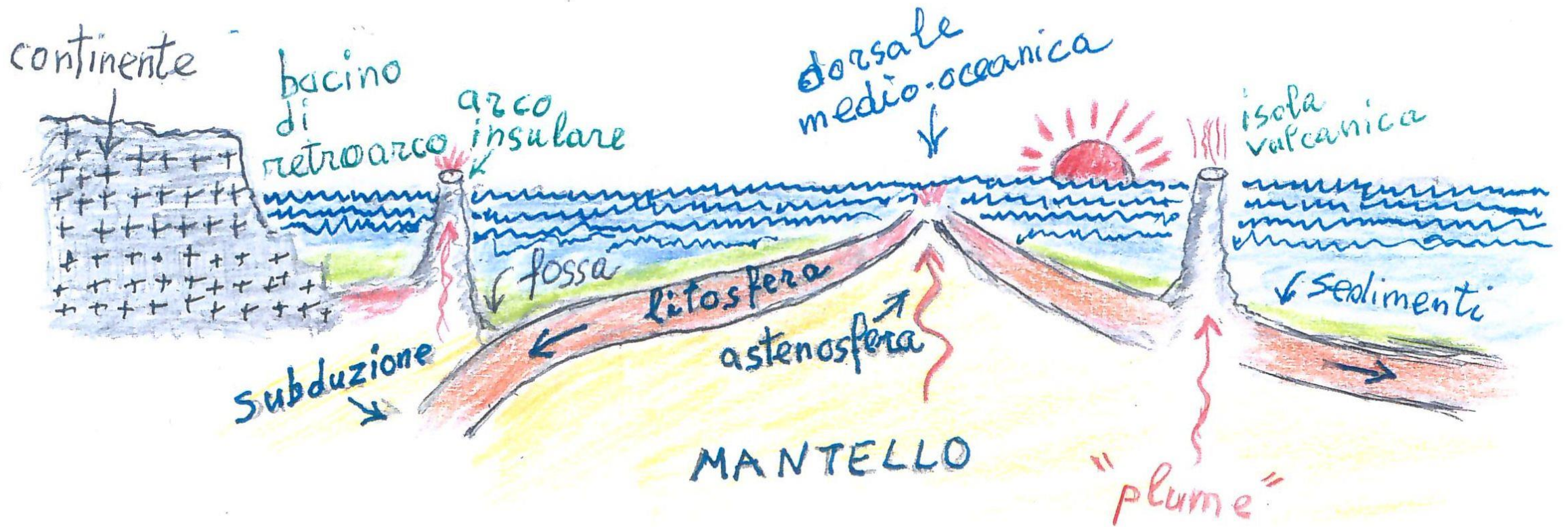
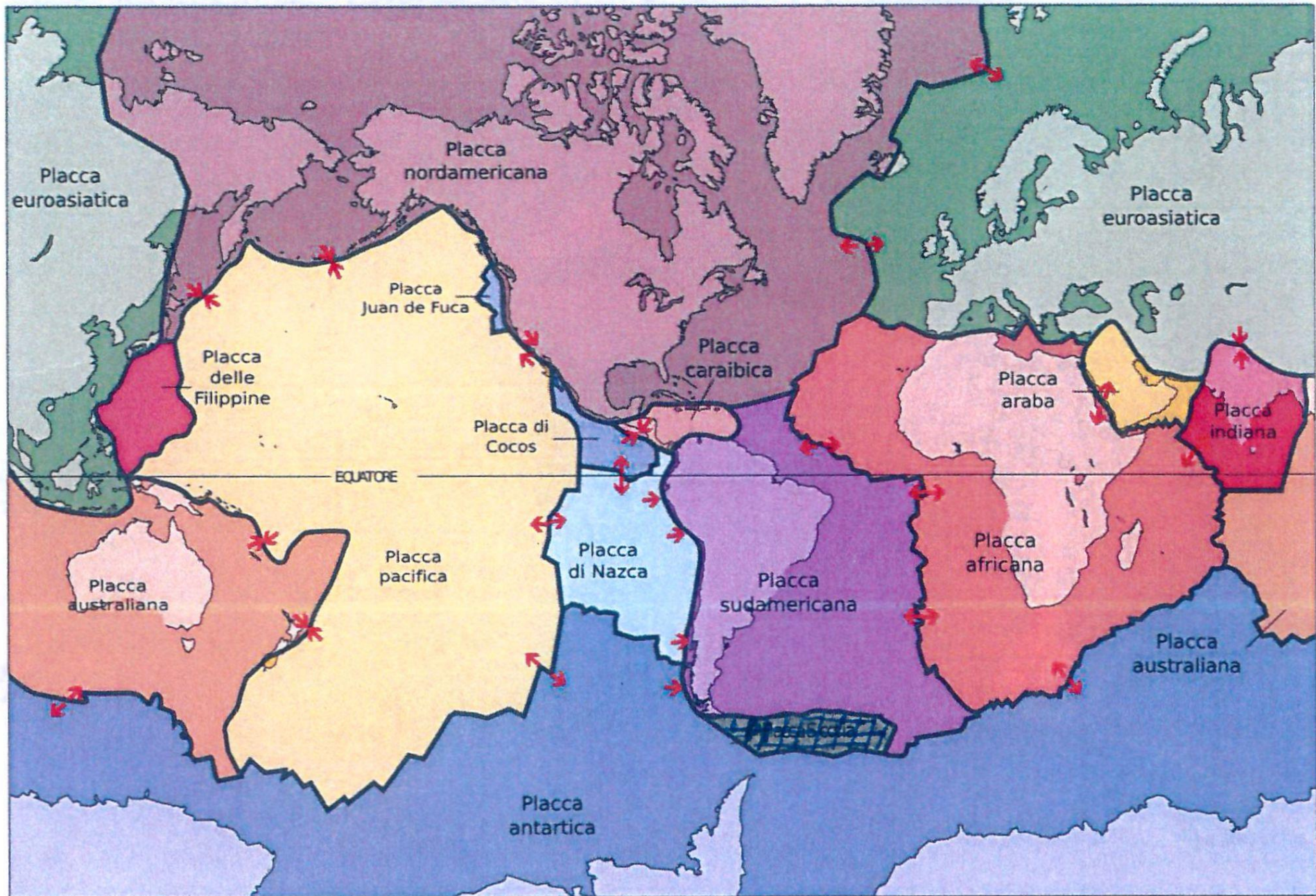


fig 19









# EAST PACIFIC RISE 1963



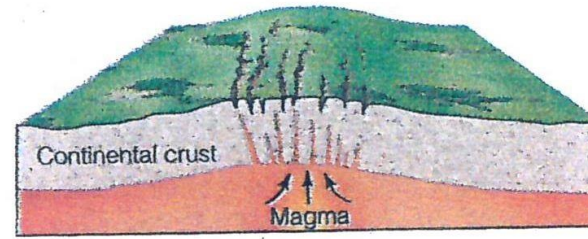
Expedition  
Amphitrite

R/V ARGO

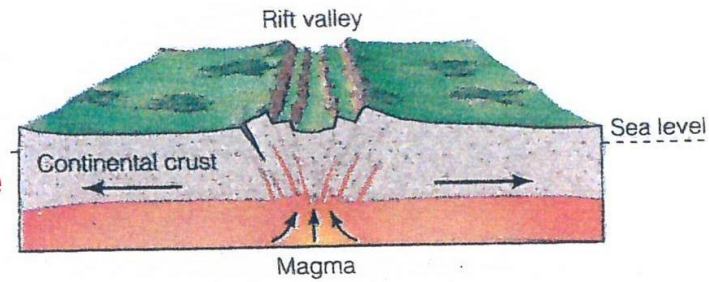




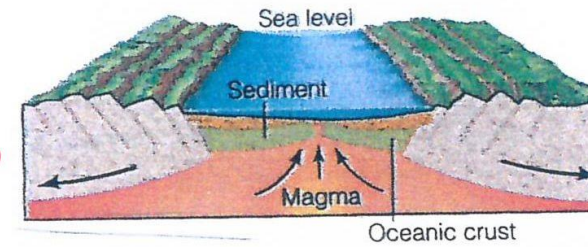
Fratturazione  
crosta  
Continentale



Rift Continentale  
(Est Africa)



Rift proto-oceanico  
(Mar Rosso)



Atlantico

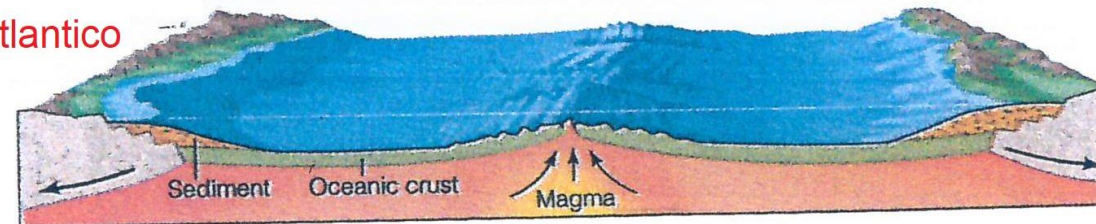


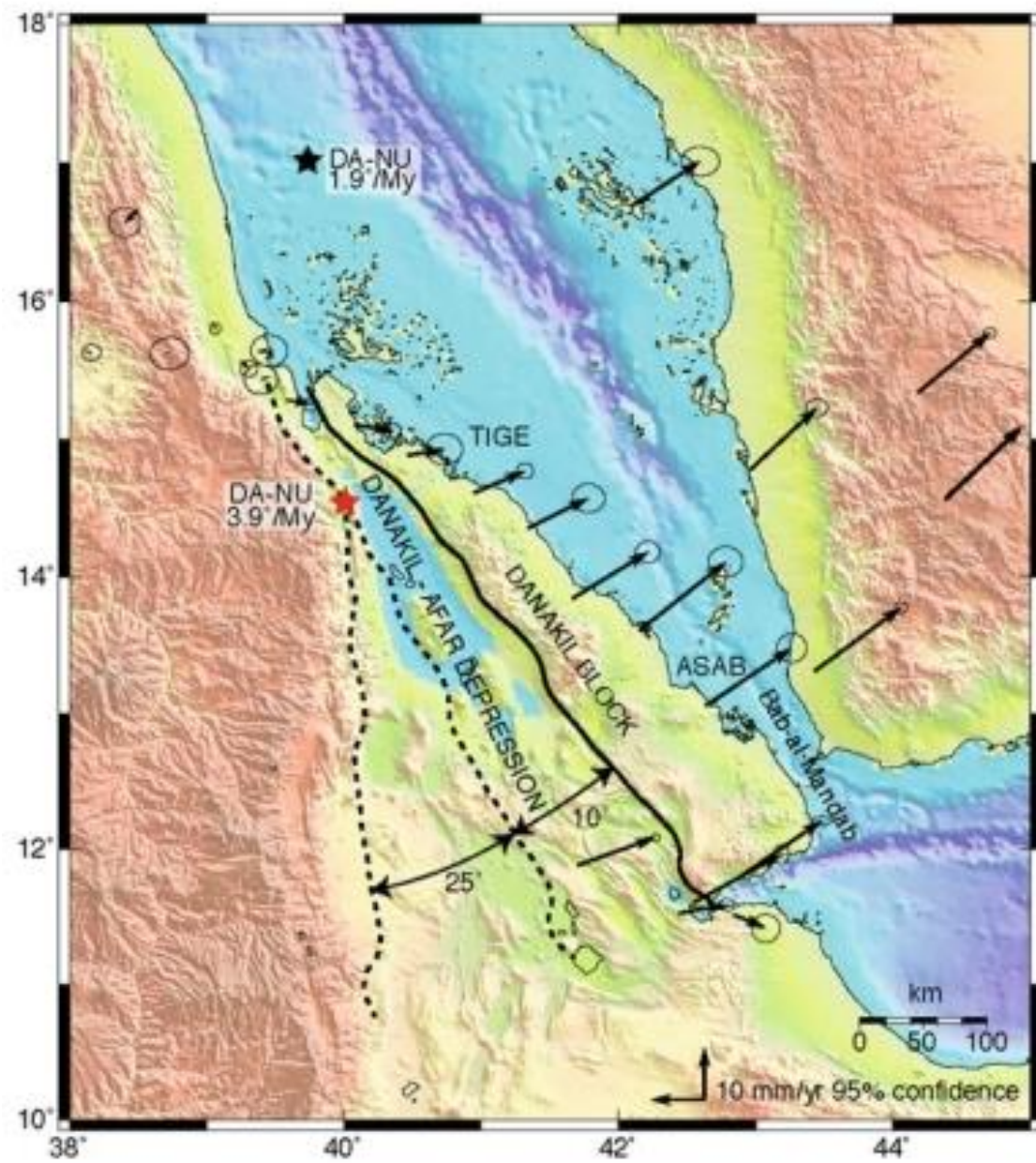




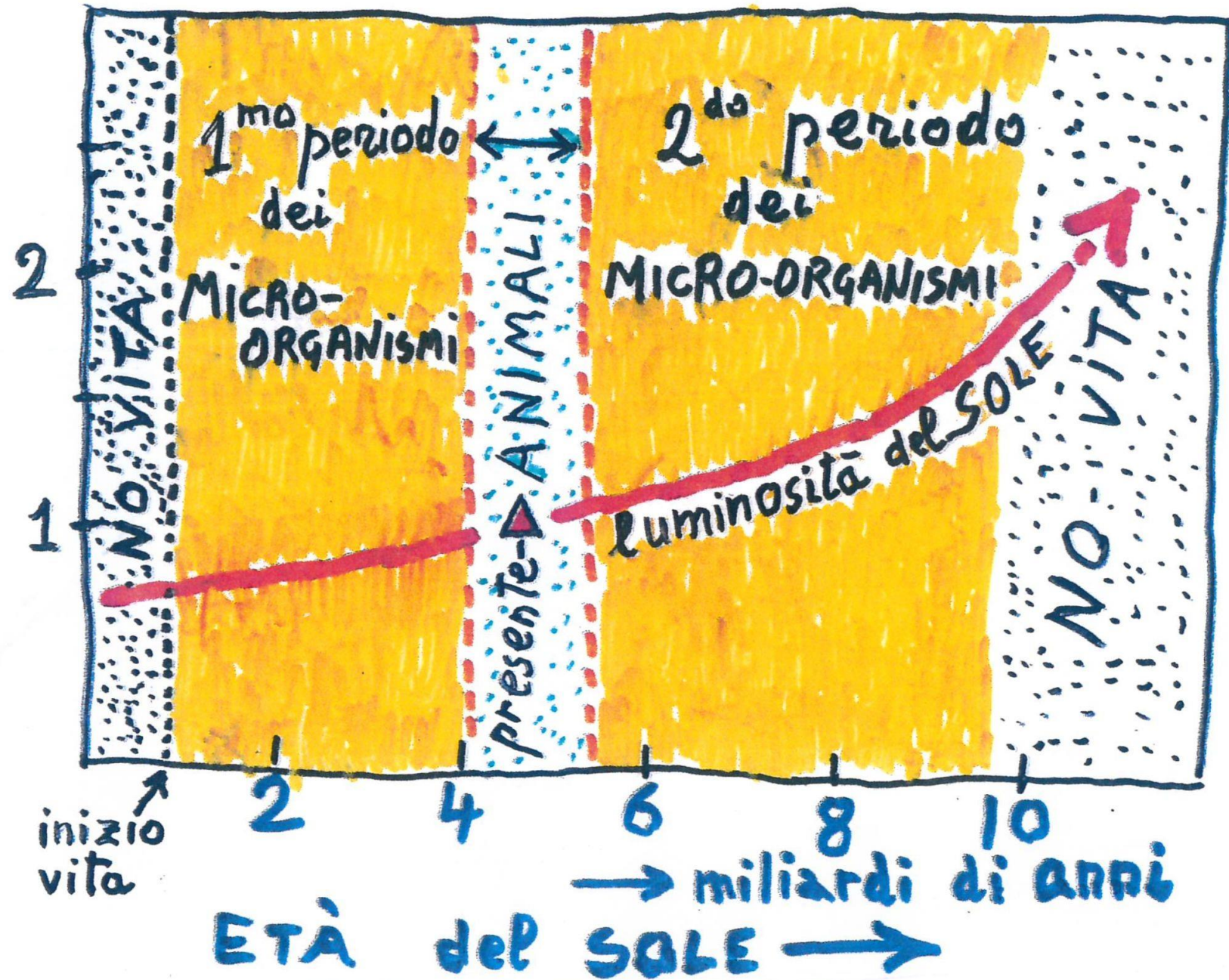
Image © 2005 MDA EarthSat

© 2005 Google











# CIRCUM-STELLAR HABITABLE ZONE

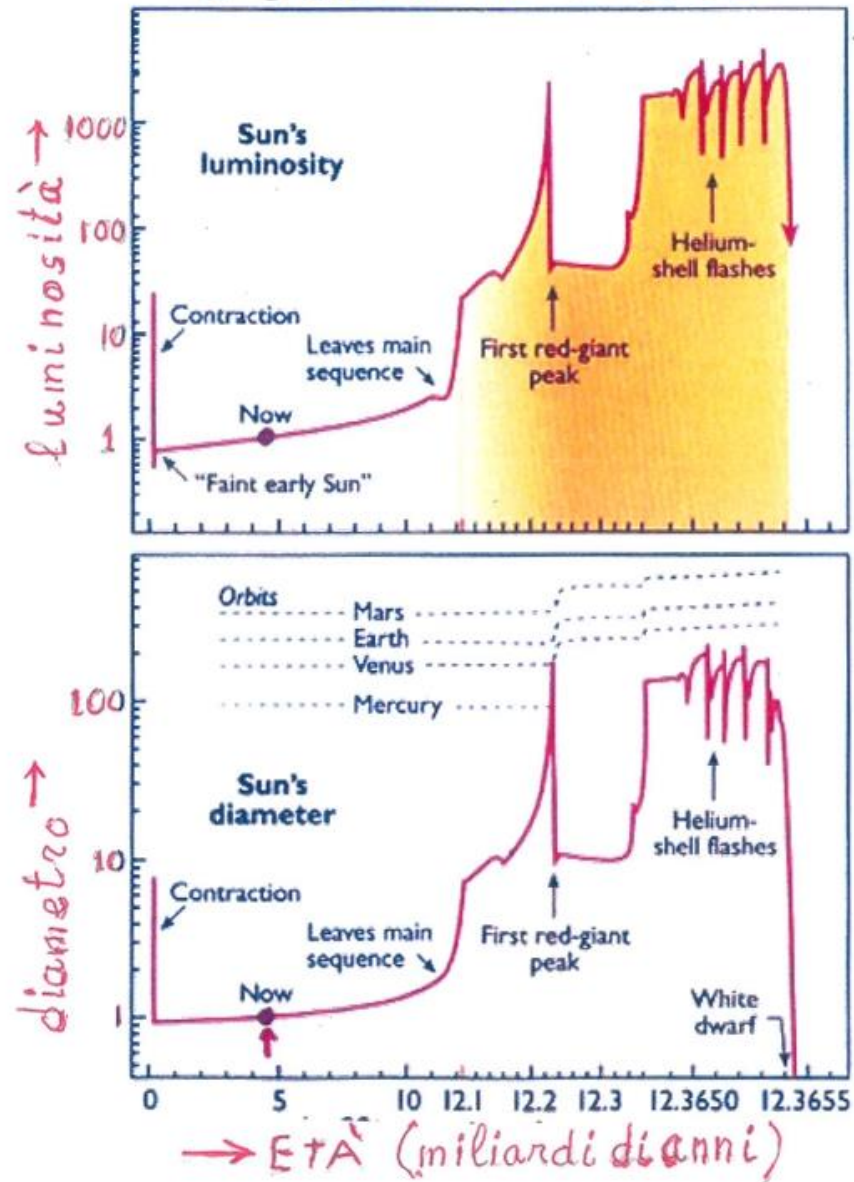


A diagram illustrating the circum-stellar habitable zone around a red star. The star is shown on the left as a large, textured red sphere. A blue band, representing the habitable zone, extends from the star towards the right. Within this zone, several celestial bodies are depicted: a small brown planet, a larger orange planet, and the Earth (blue and white). To the right of the habitable zone, a red planet, a gas giant with horizontal bands (Jupiter), and a ringed planet (Saturn) are shown. A yellow horizontal line with vertical end caps spans the width of the habitable zone, with the text '93,000,000 Mi.' written below it.

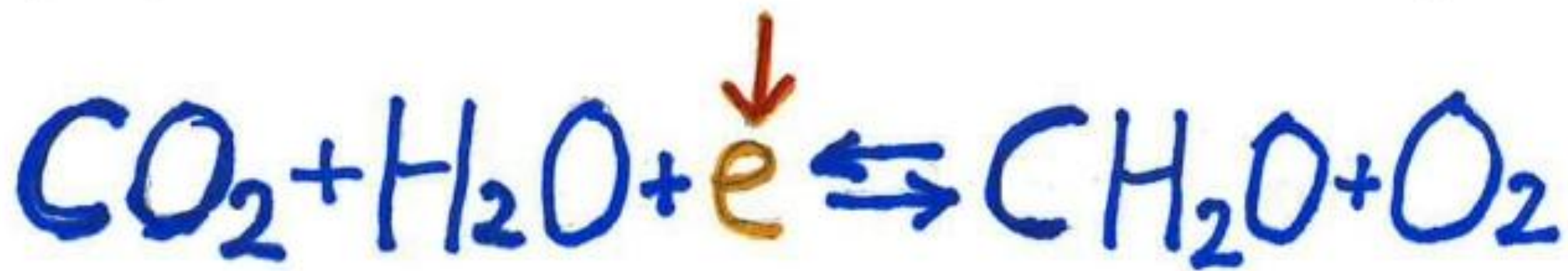
93,000,000 Mi.



# EVOLUZIONE del SOLE



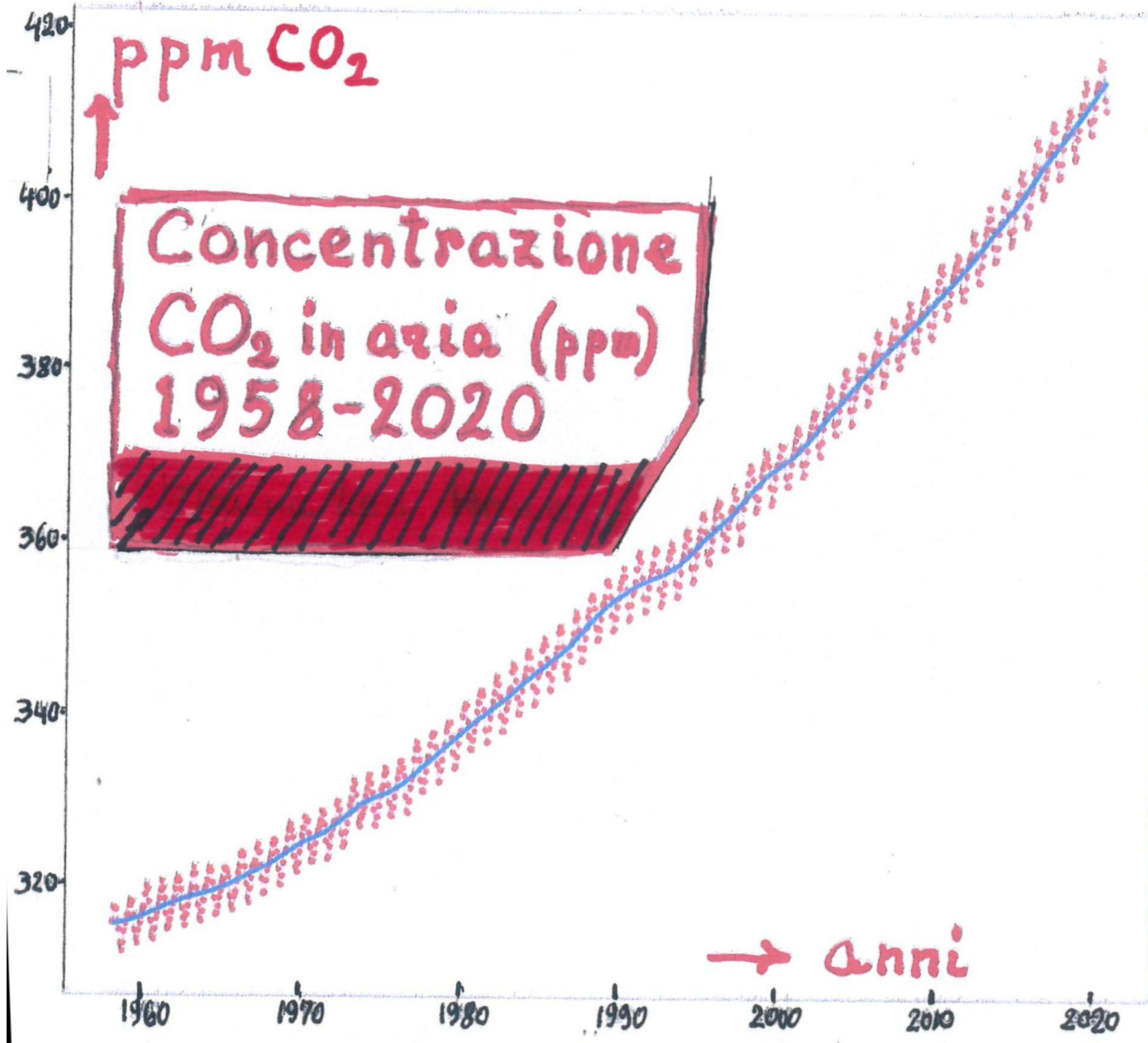
# photosynthesis

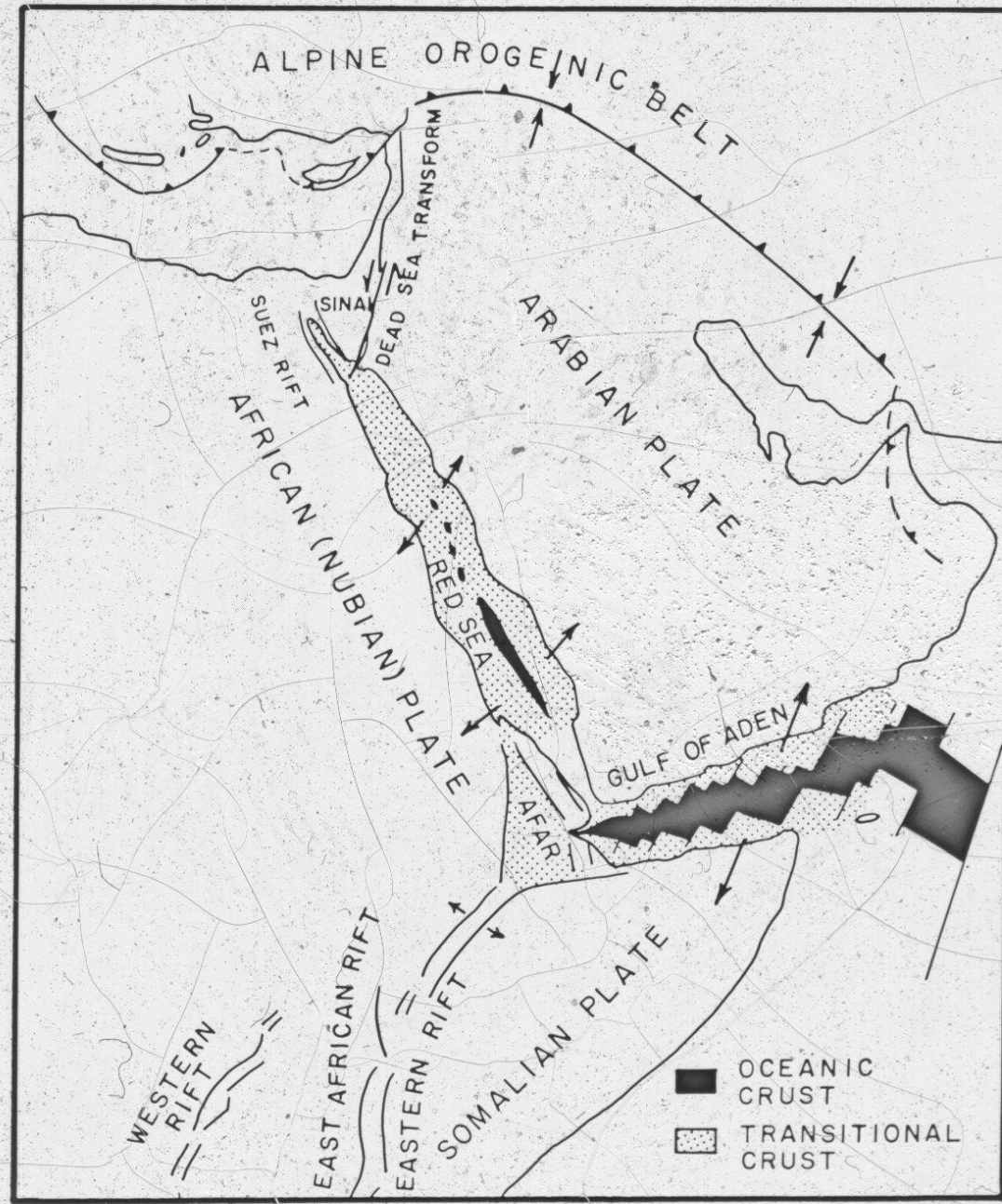


(cyanobacteria)

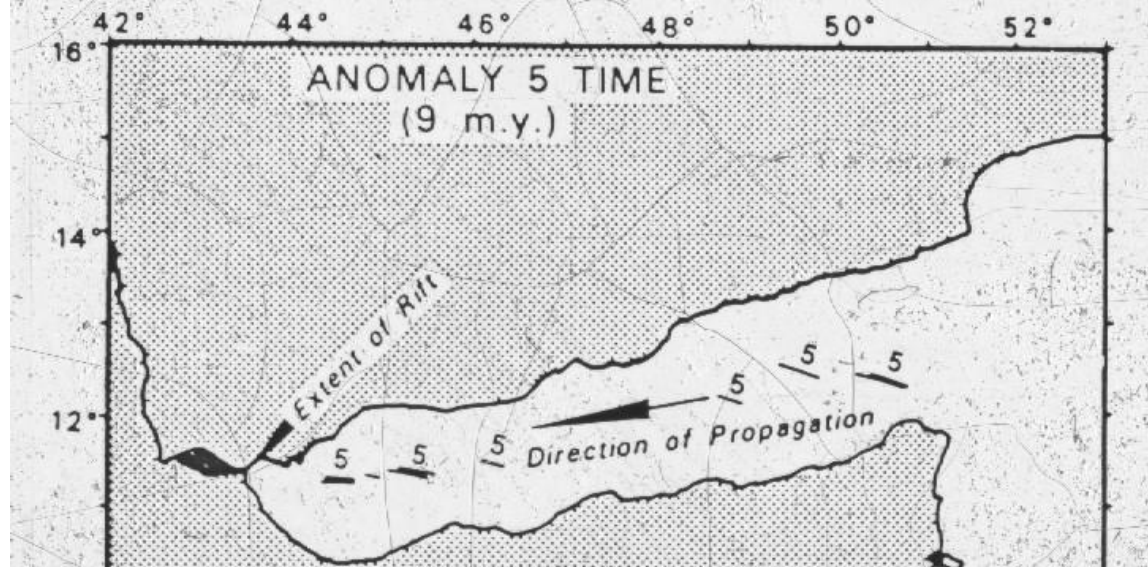
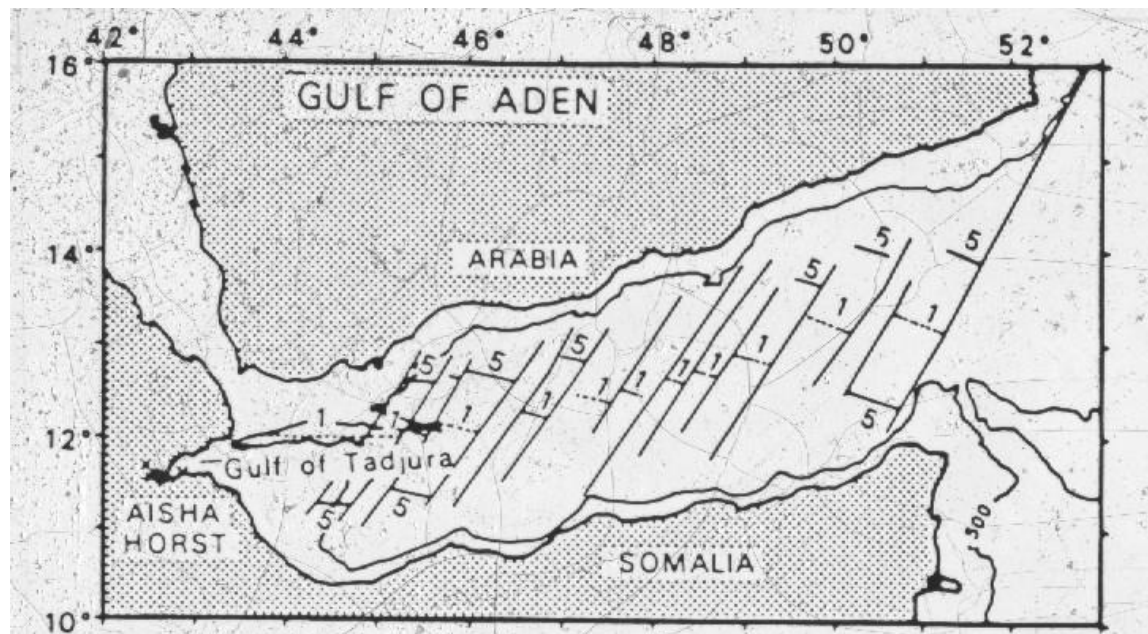


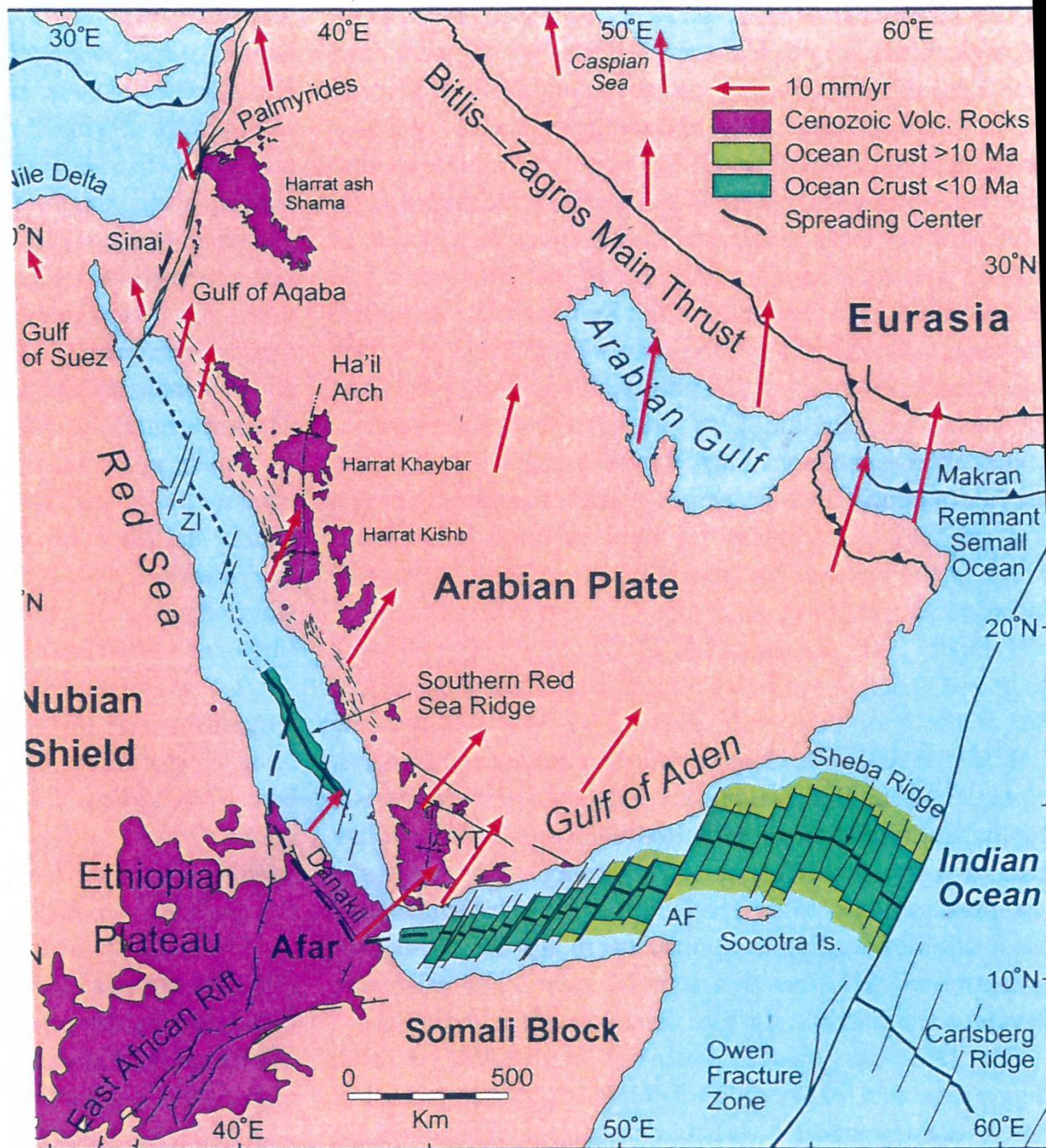
Mauna Loa 1958 - 2020



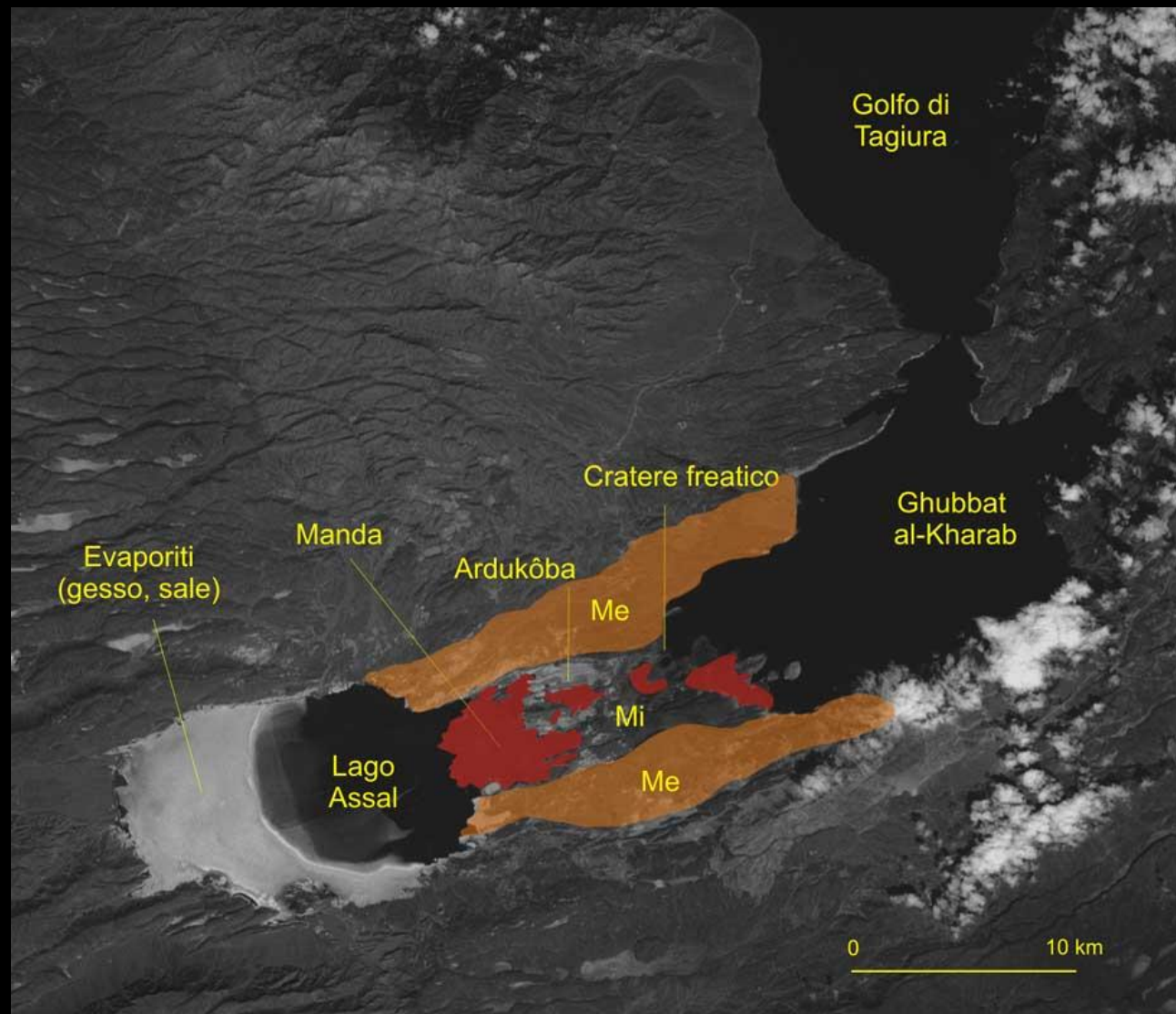






















# Rift Goubet-Asal





























































# Lake Afrera

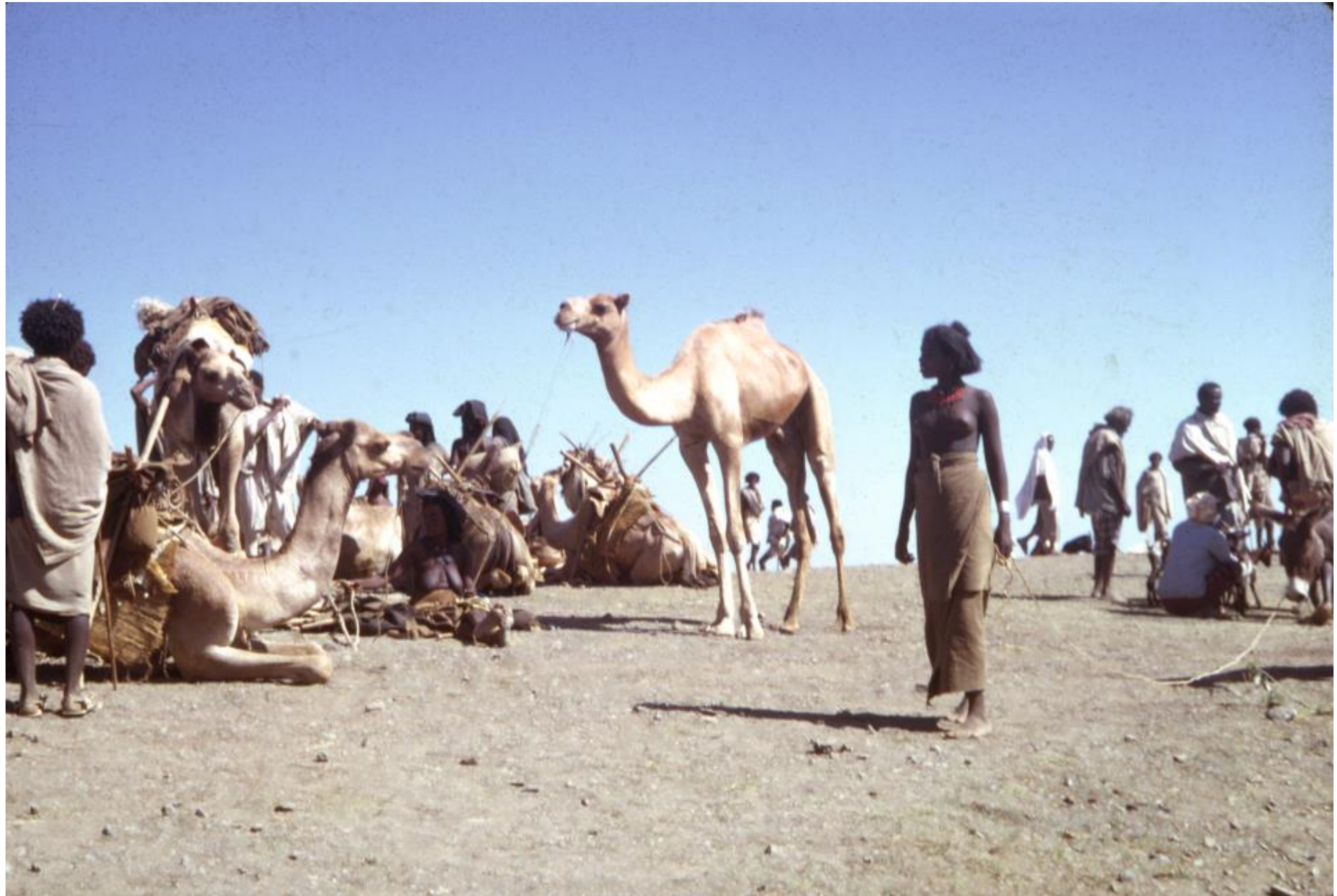


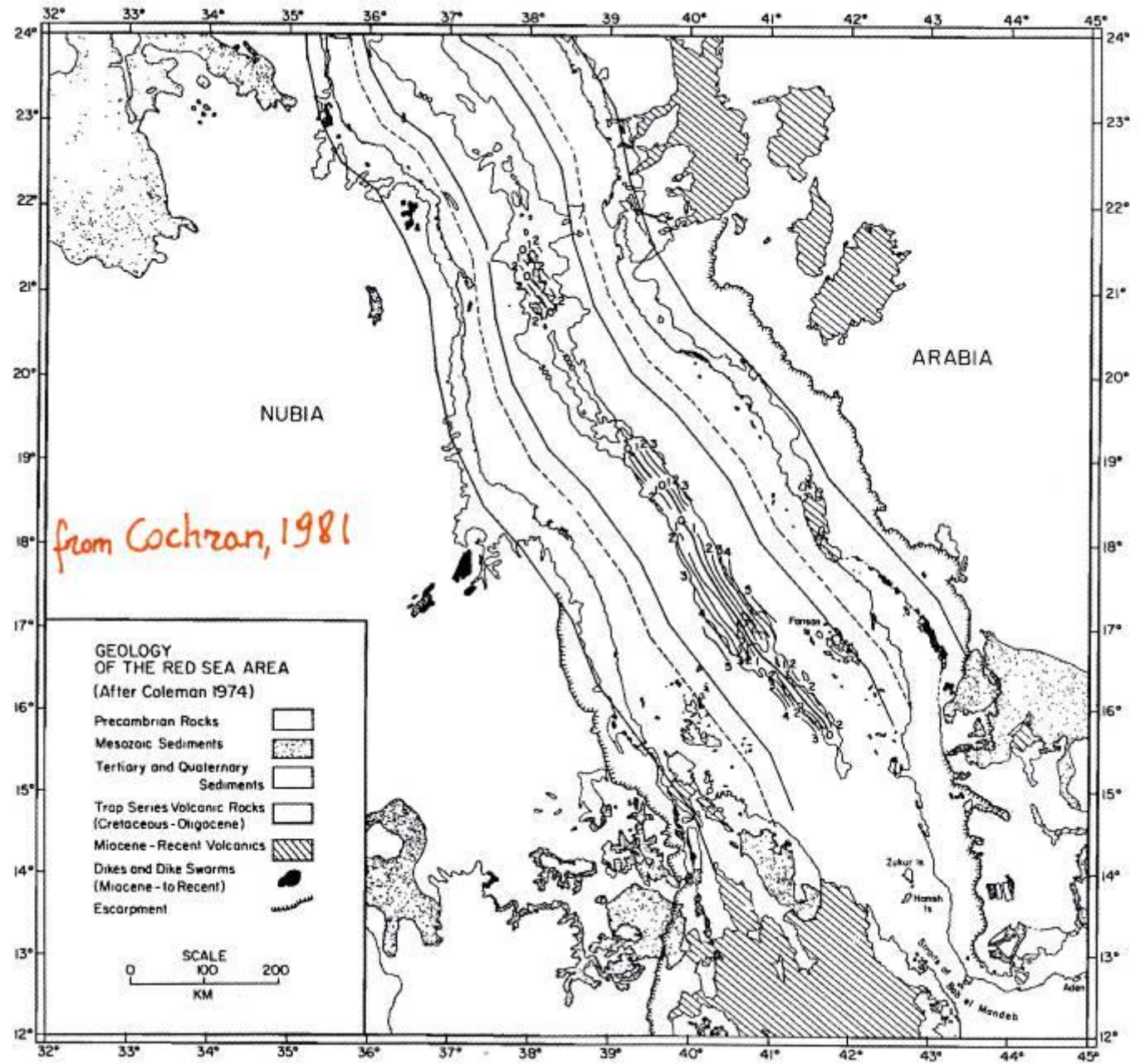






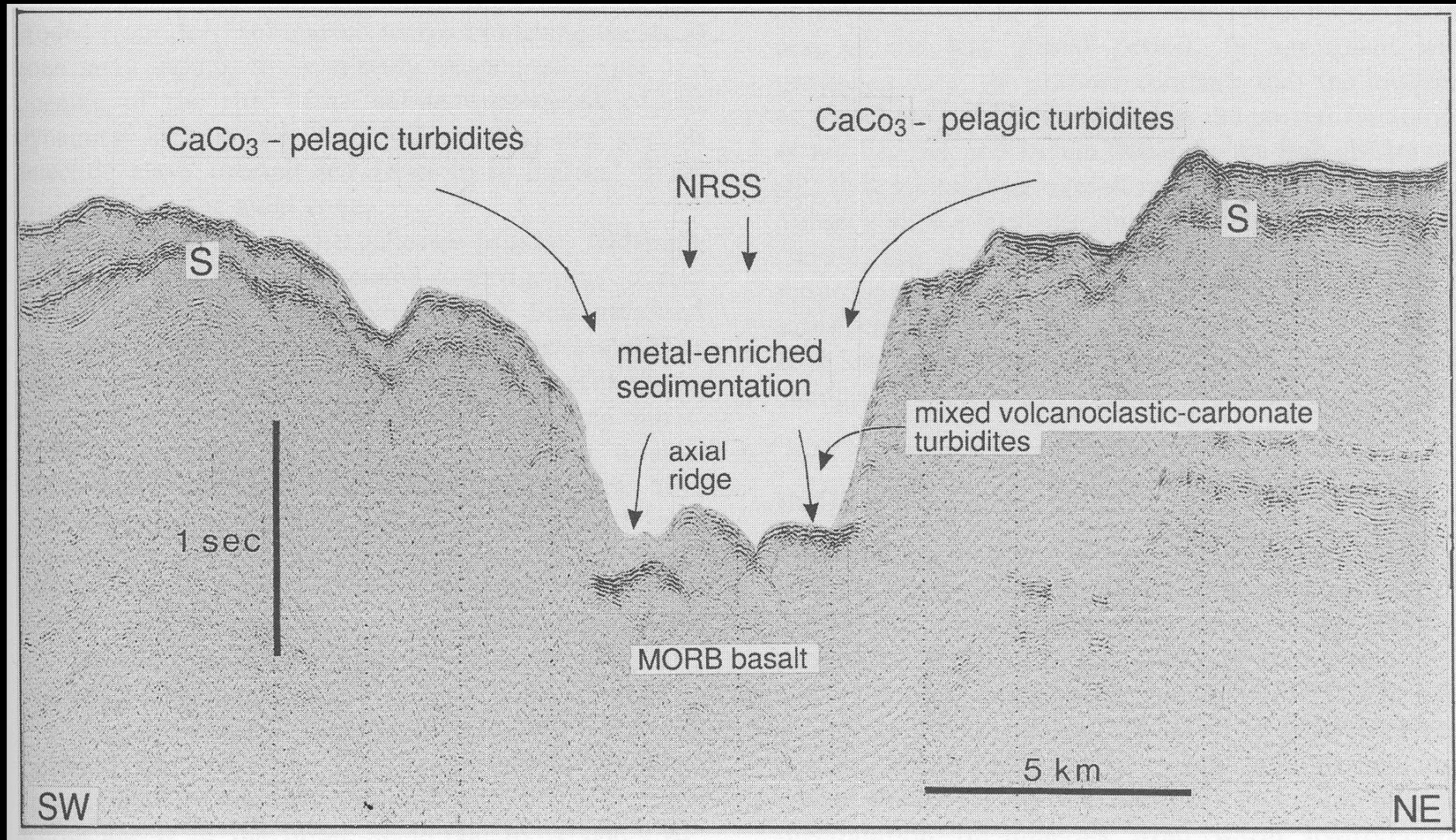




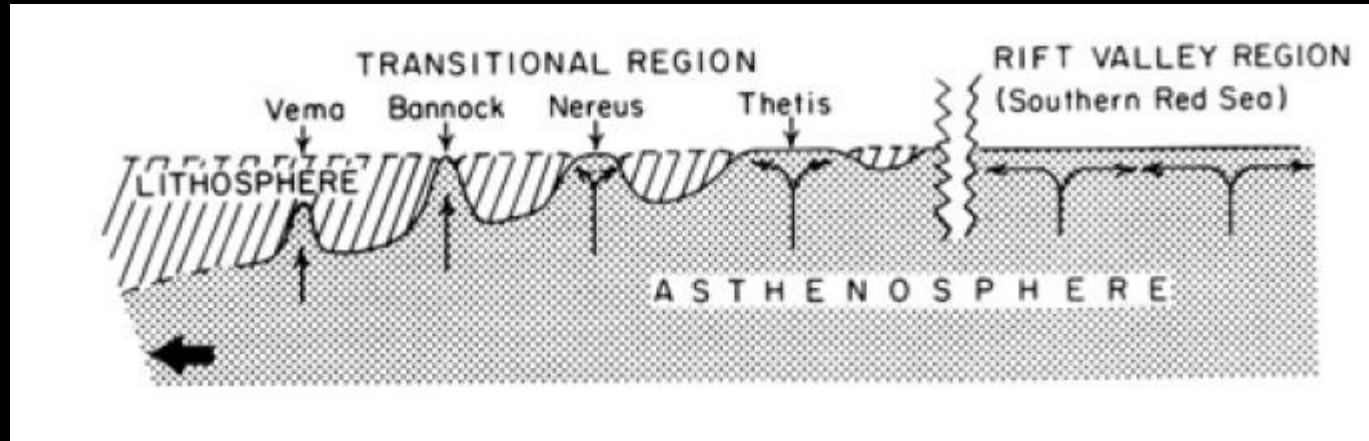
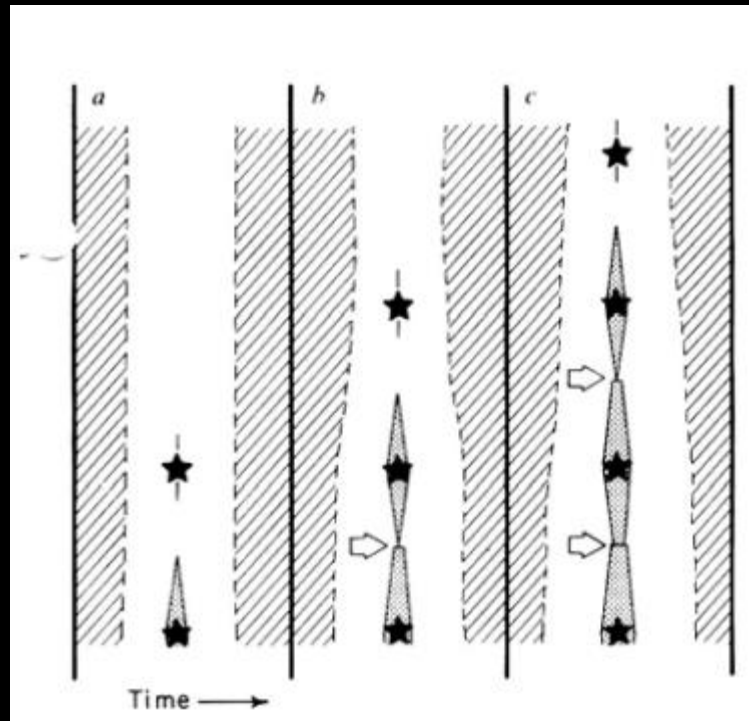




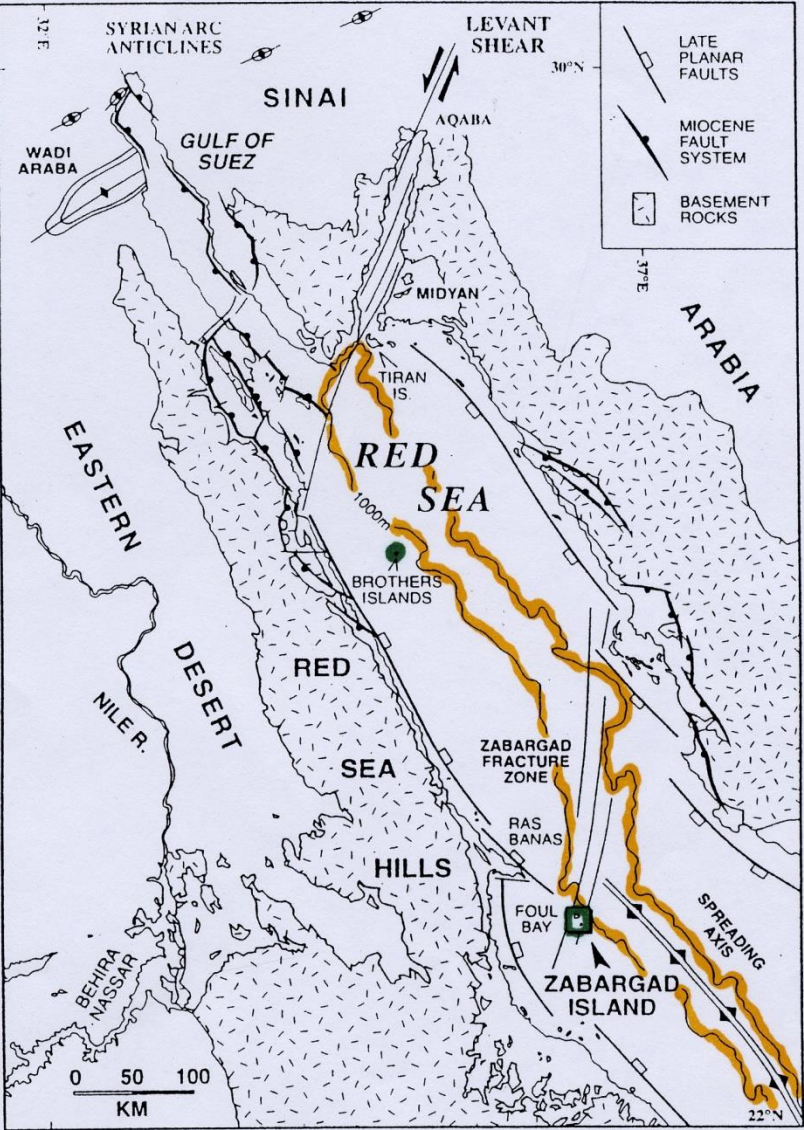
# Line MR83-07





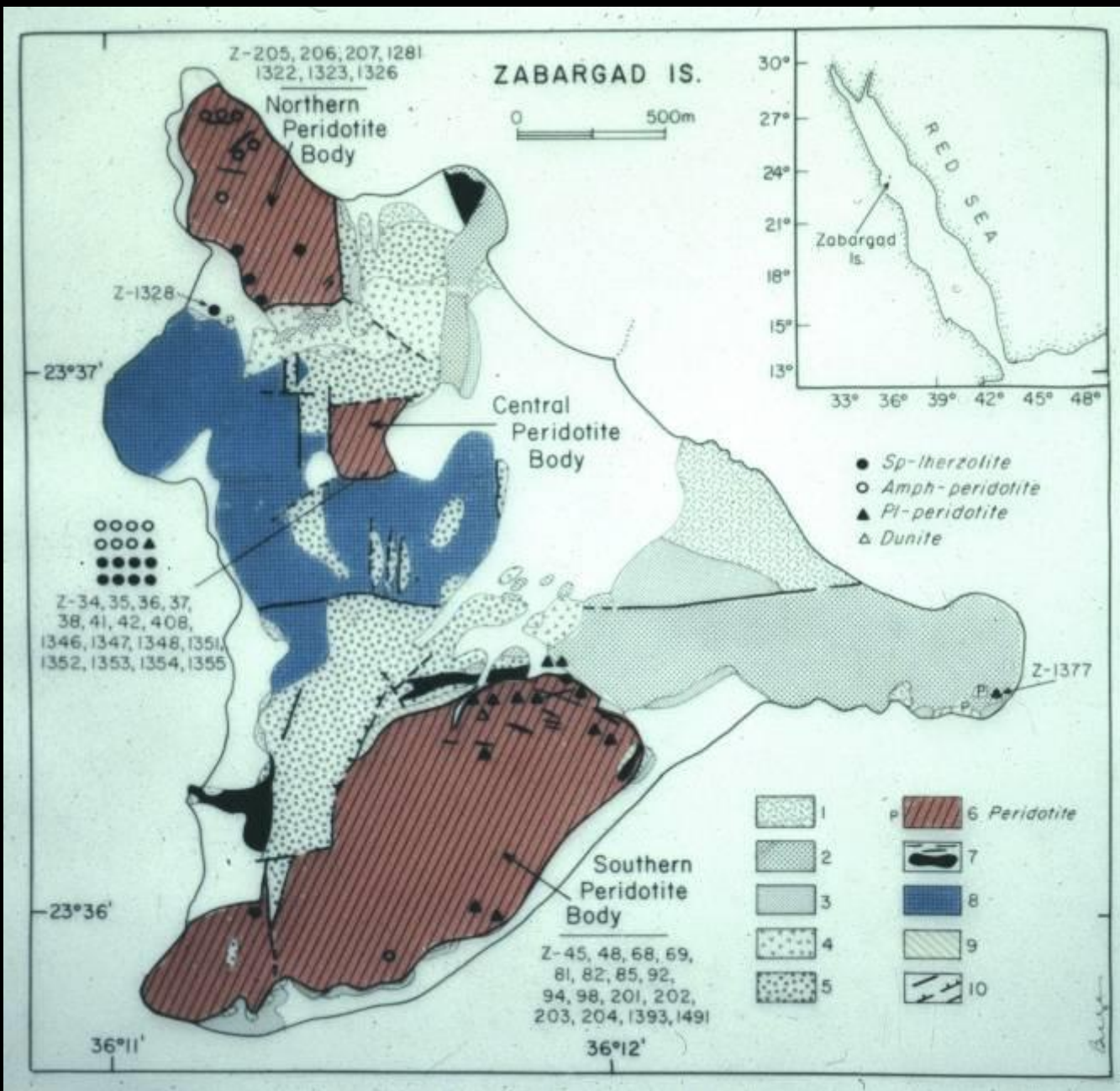


























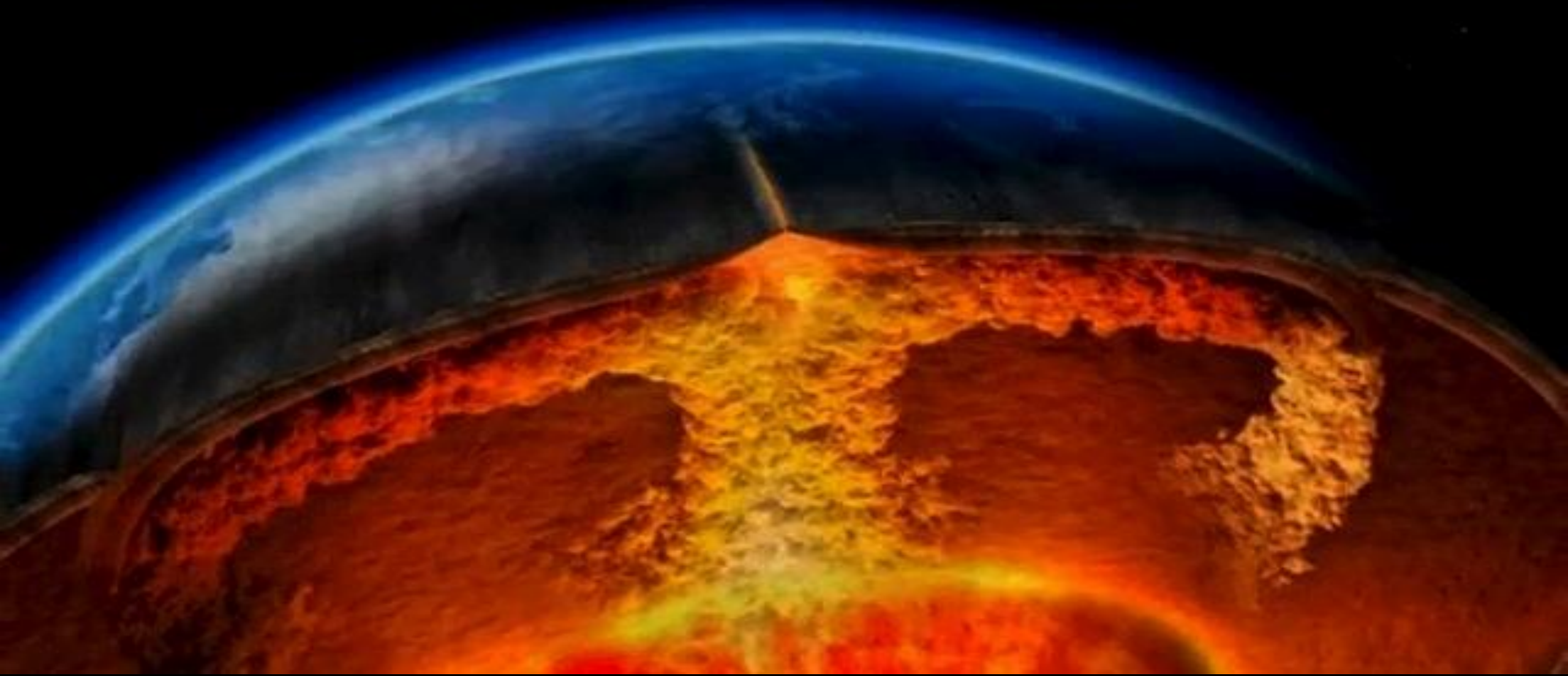






# Come Nascono gli Oceani

Enrico Bonatti



ALFRED WEGENER 1880 1930



GRÖNLAND  
FORSCHER

S4

REPUBLIK ÖSTERREICH

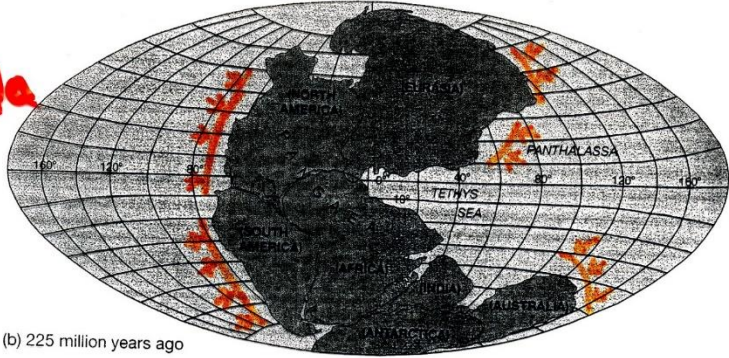
A. PILCH

1980

W. PFELER

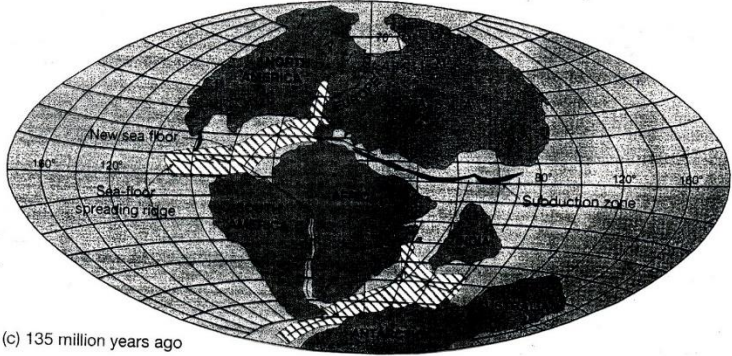


225Ma



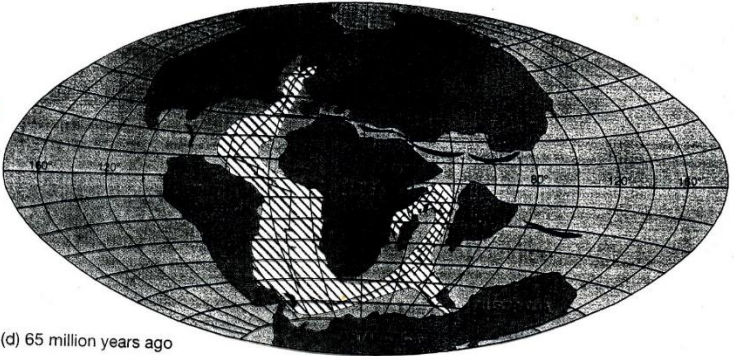
(b) 225 million years ago

135Ma



(c) 135 million years ago

65Ma



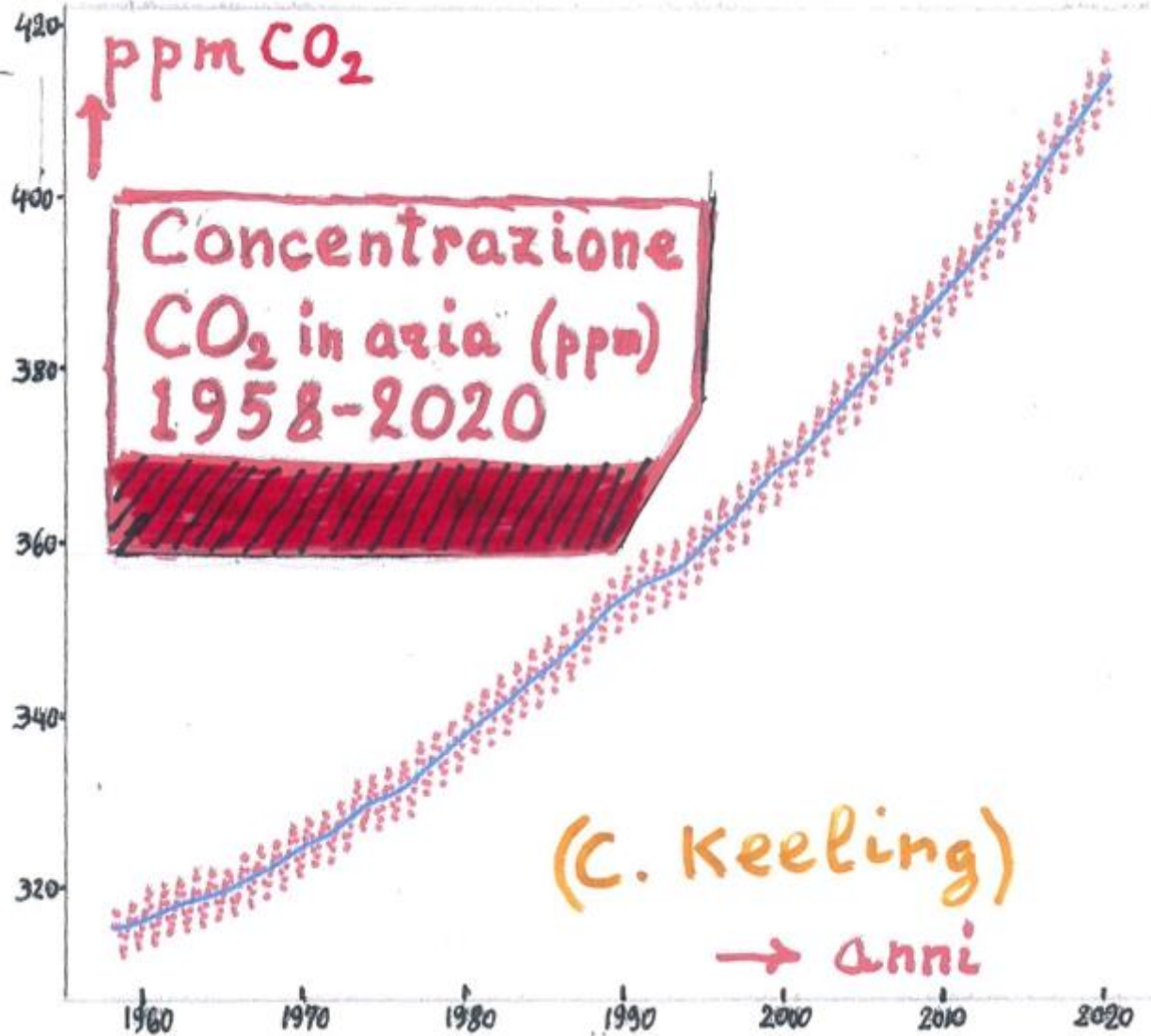
(d) 65 million years ago







Mauna Loa 1958 - 2020

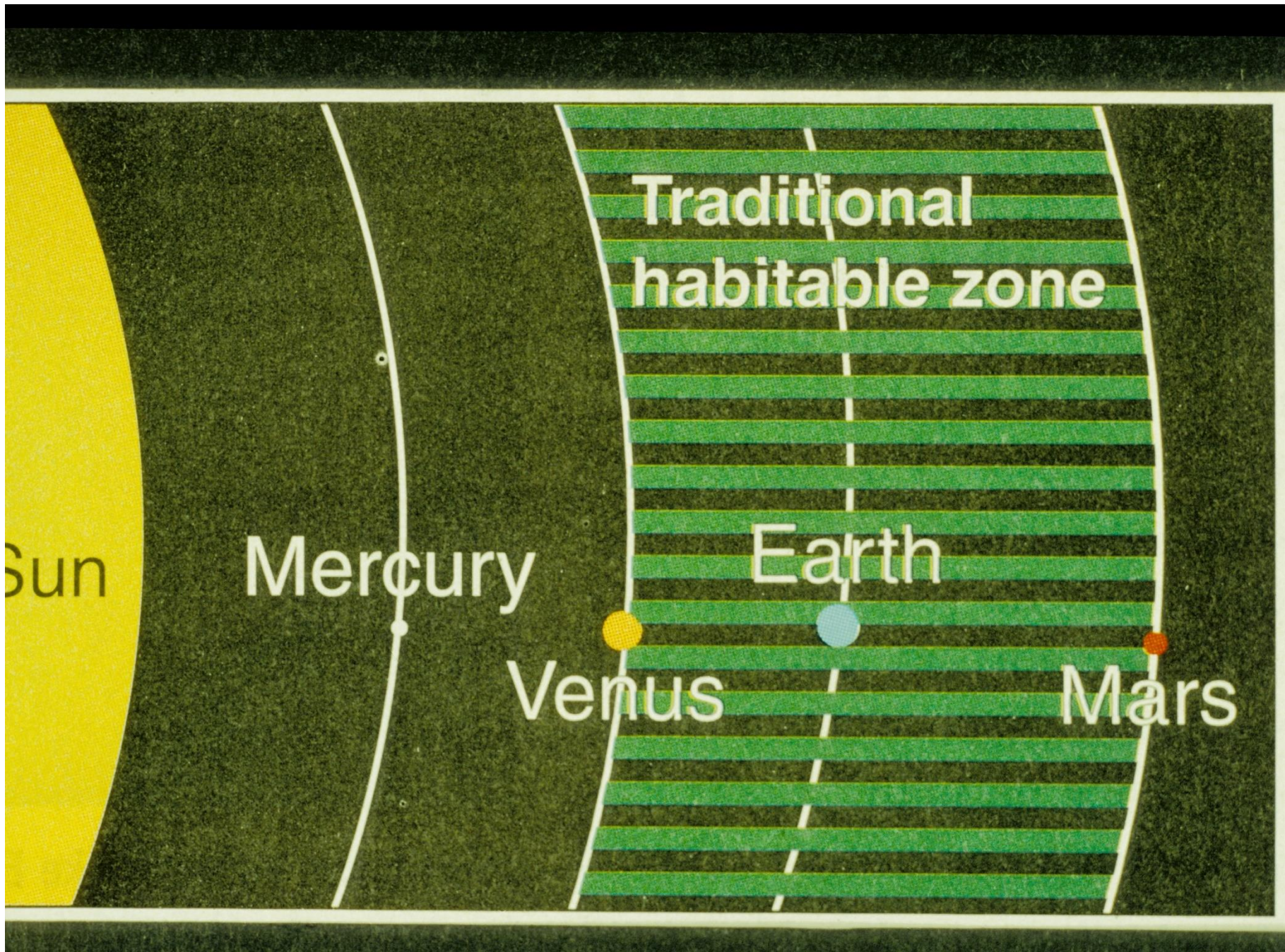




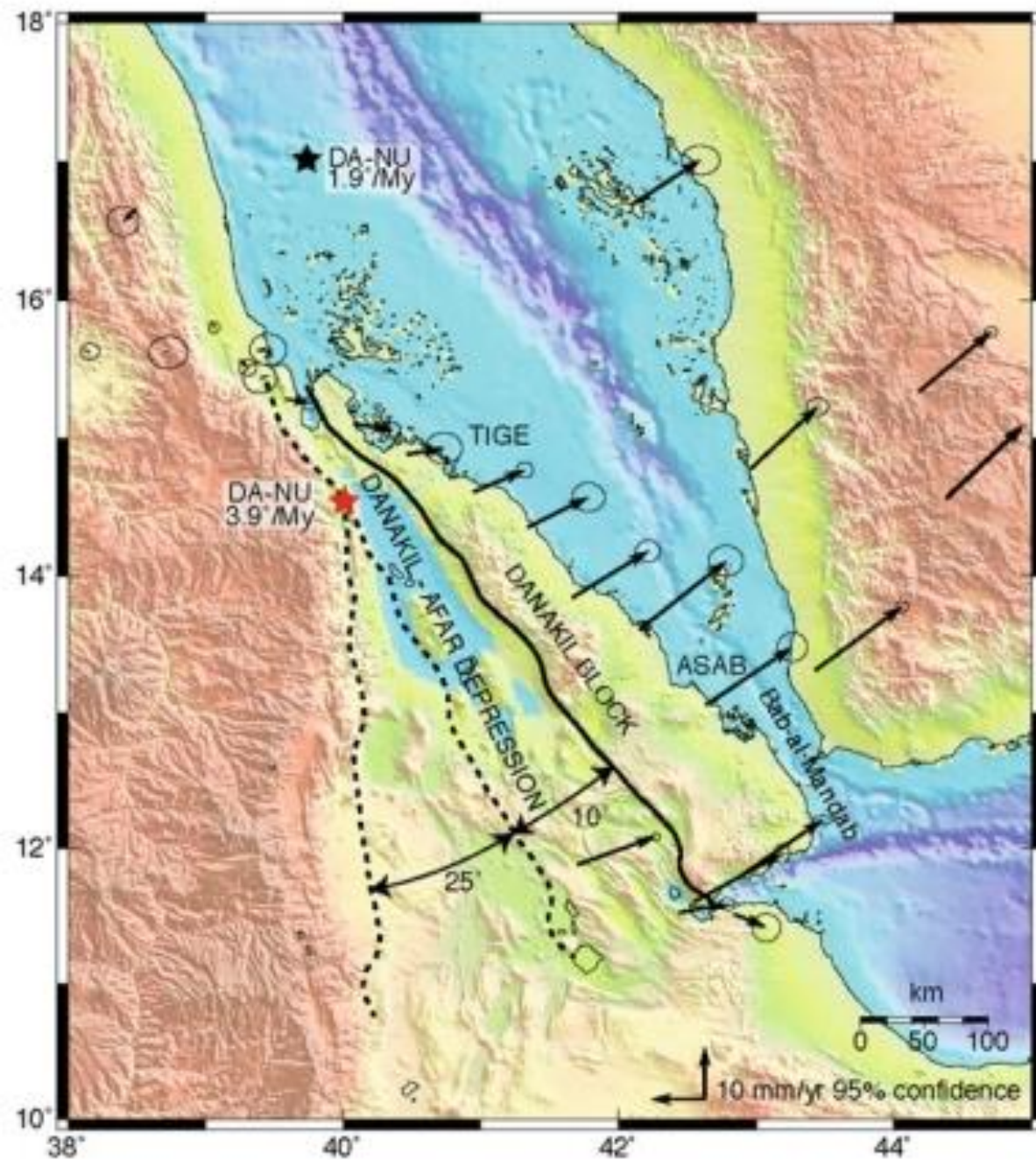




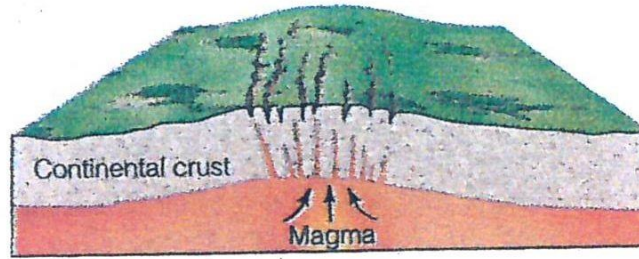




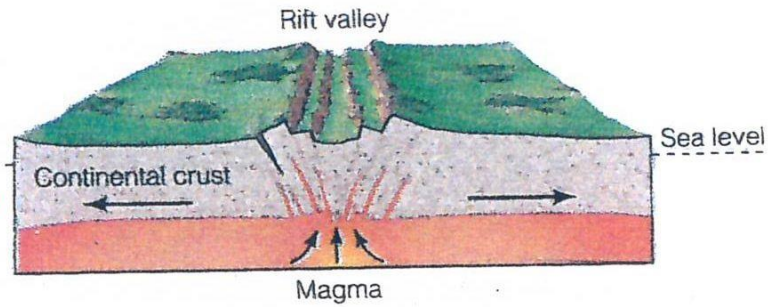




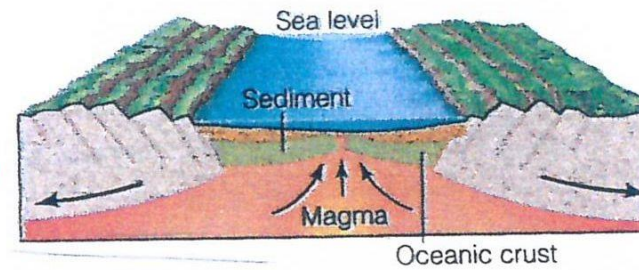
Fratturazione  
crosta  
Continentale



Rift Continentale  
(Est Africa)



Rift proto-oceanico  
(Mar Rosso)



Atlantico

