Puerto Rico Seismic Network and GPS Applications

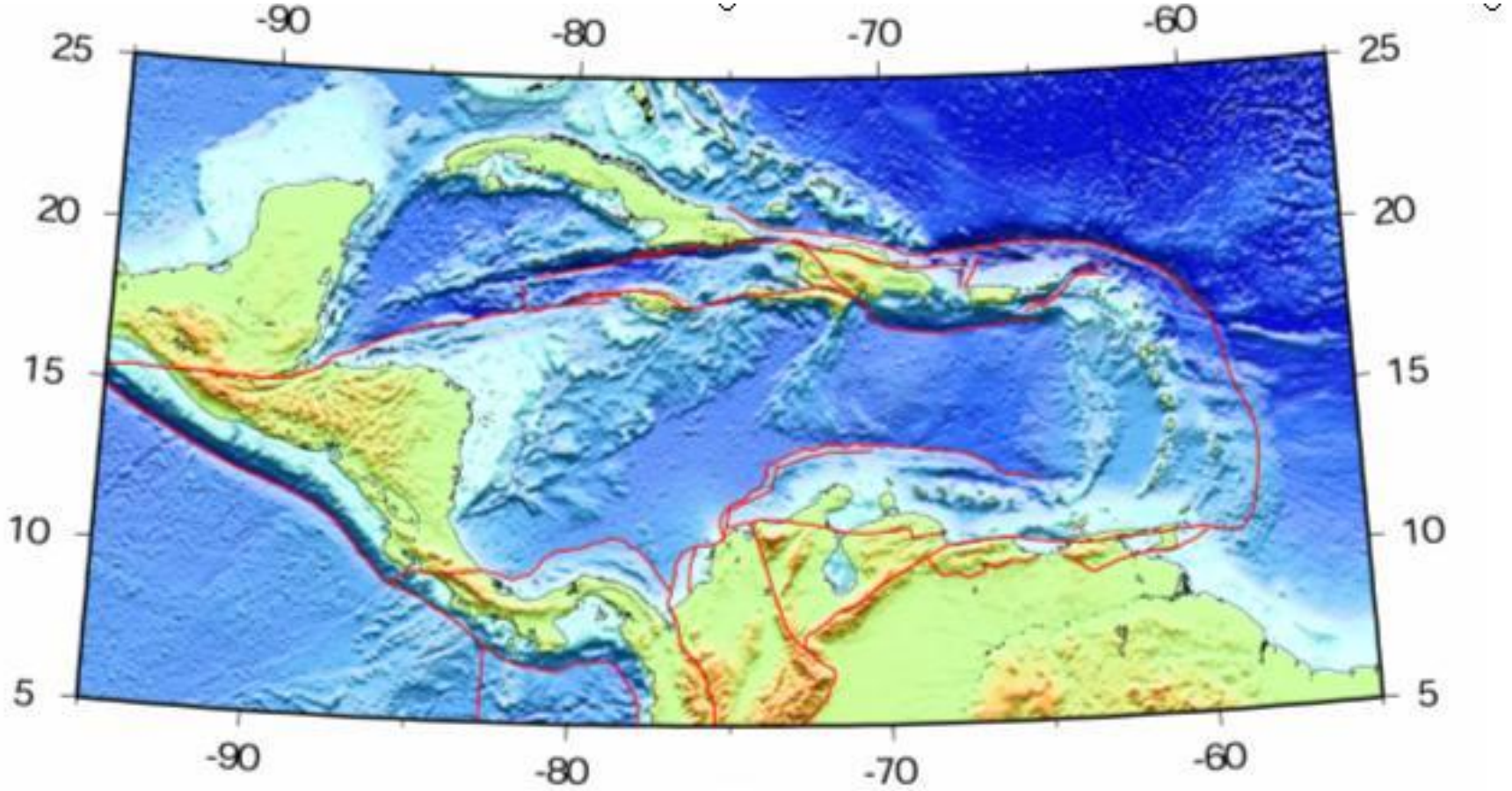
Civil GPS Service Interface Committee
States and Local Government Subcommittee
Regional Meeting
Puerto Rico

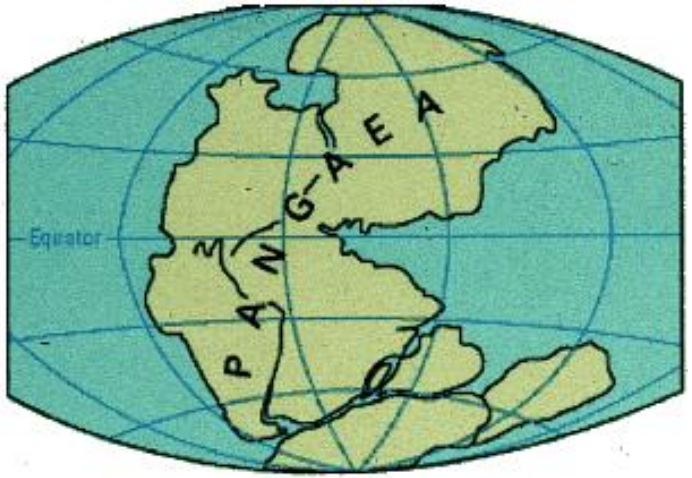
May 23-24, 2006

Christa von Hillebrandt-Andrade

Red Sísmica de Puerto Rico,
Universidad de Puerto Rico,
Mayagüez, PR

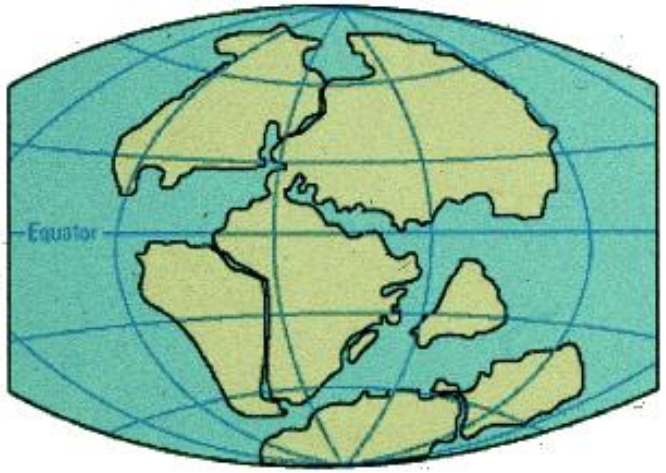
Tectonic Features Caribbean Region





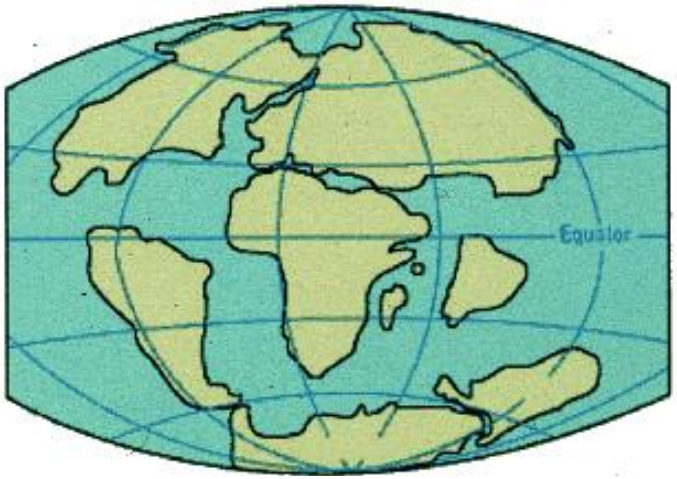
Permian

225 Mio year BP



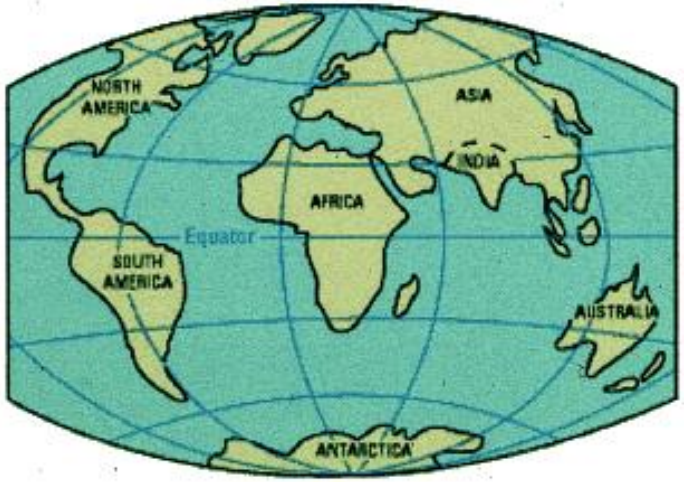
Jurassic

135 Mio years BP



Cretaceous

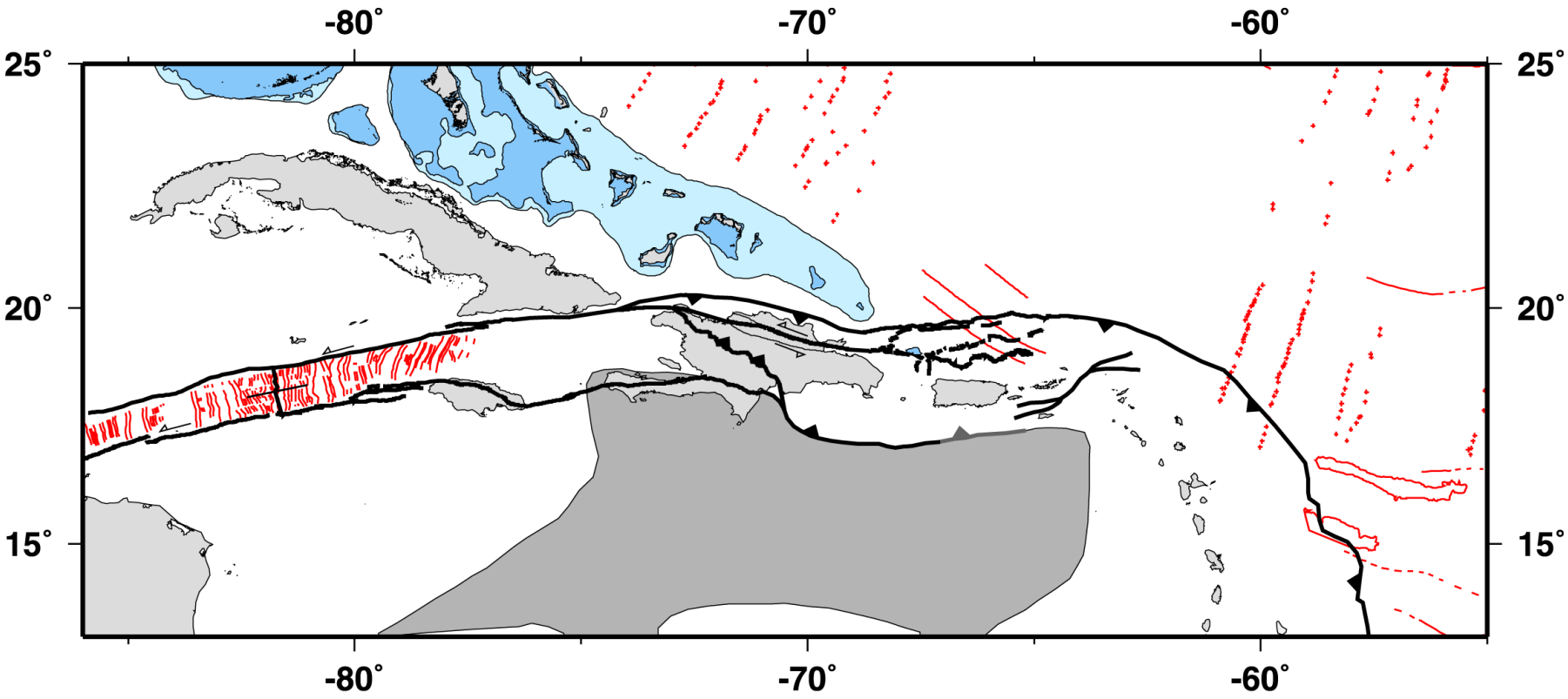
65 Mio years BP



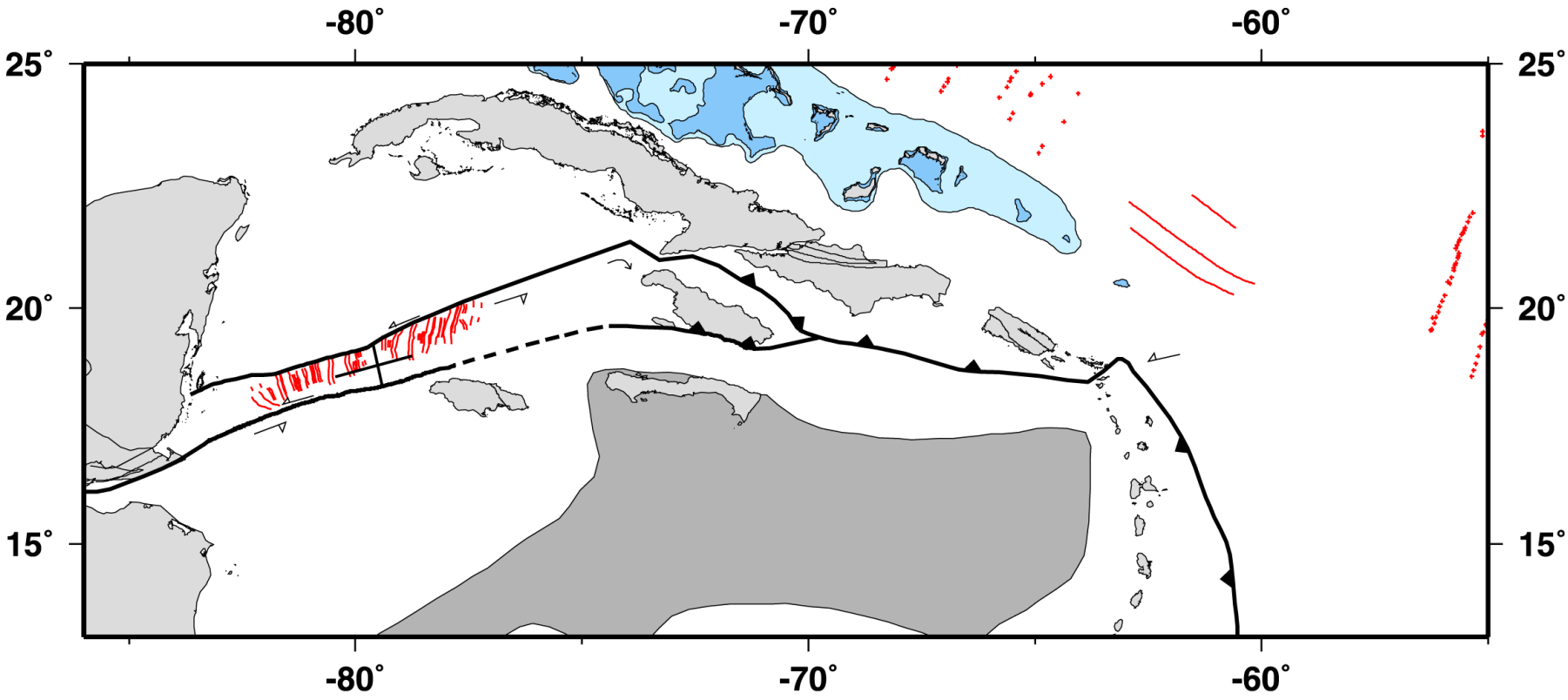
present

GFZ POTSDAM

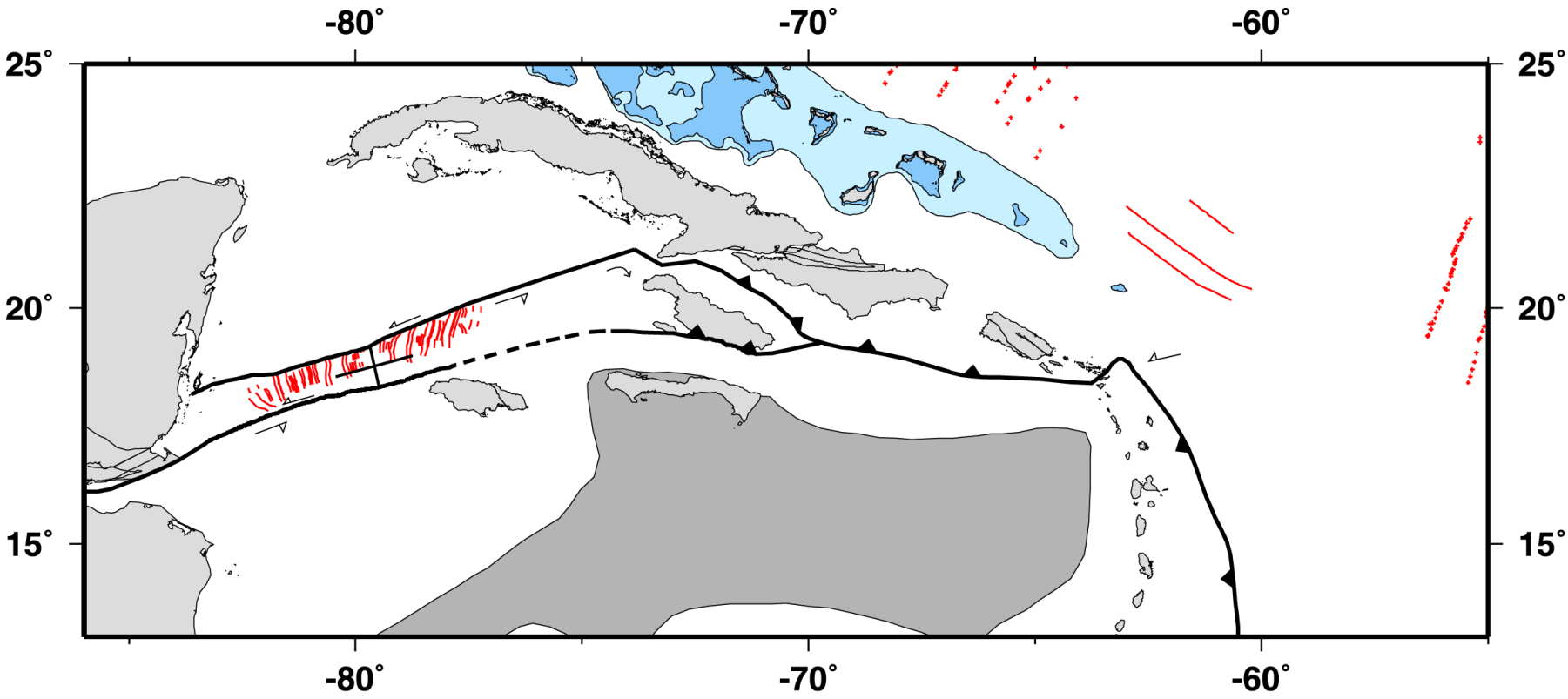
Continental drift according to Alfred Wegener (1912)



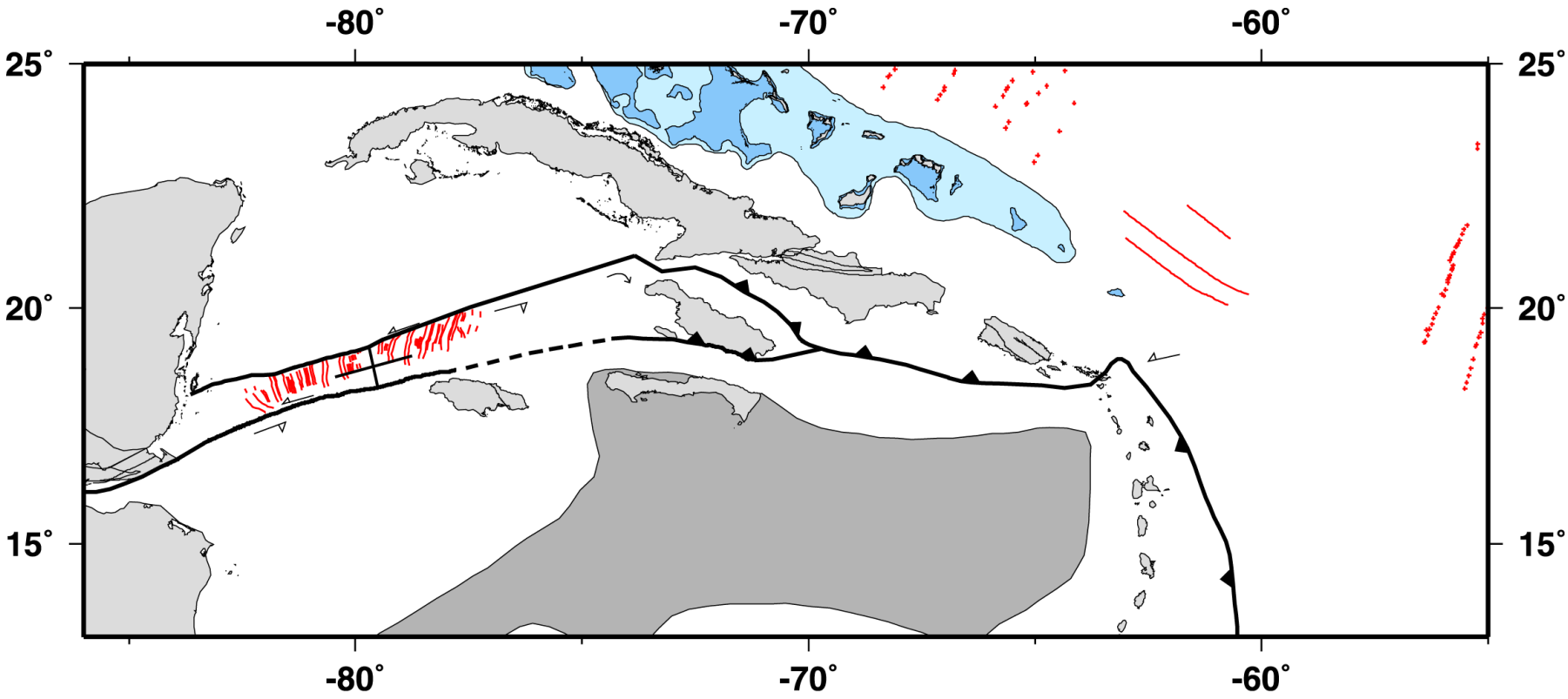
Present Day
00.0 Ma



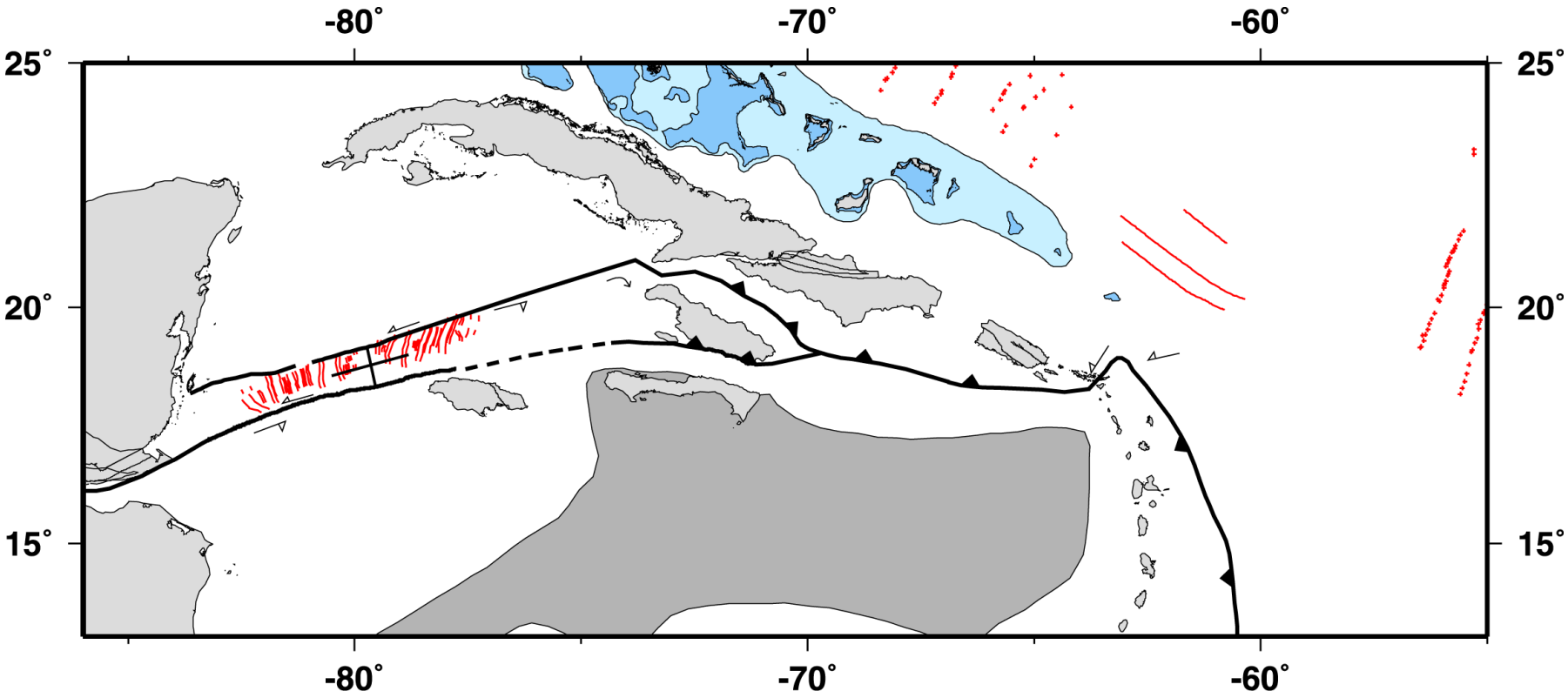
Late Oligocene
24.0 Ma



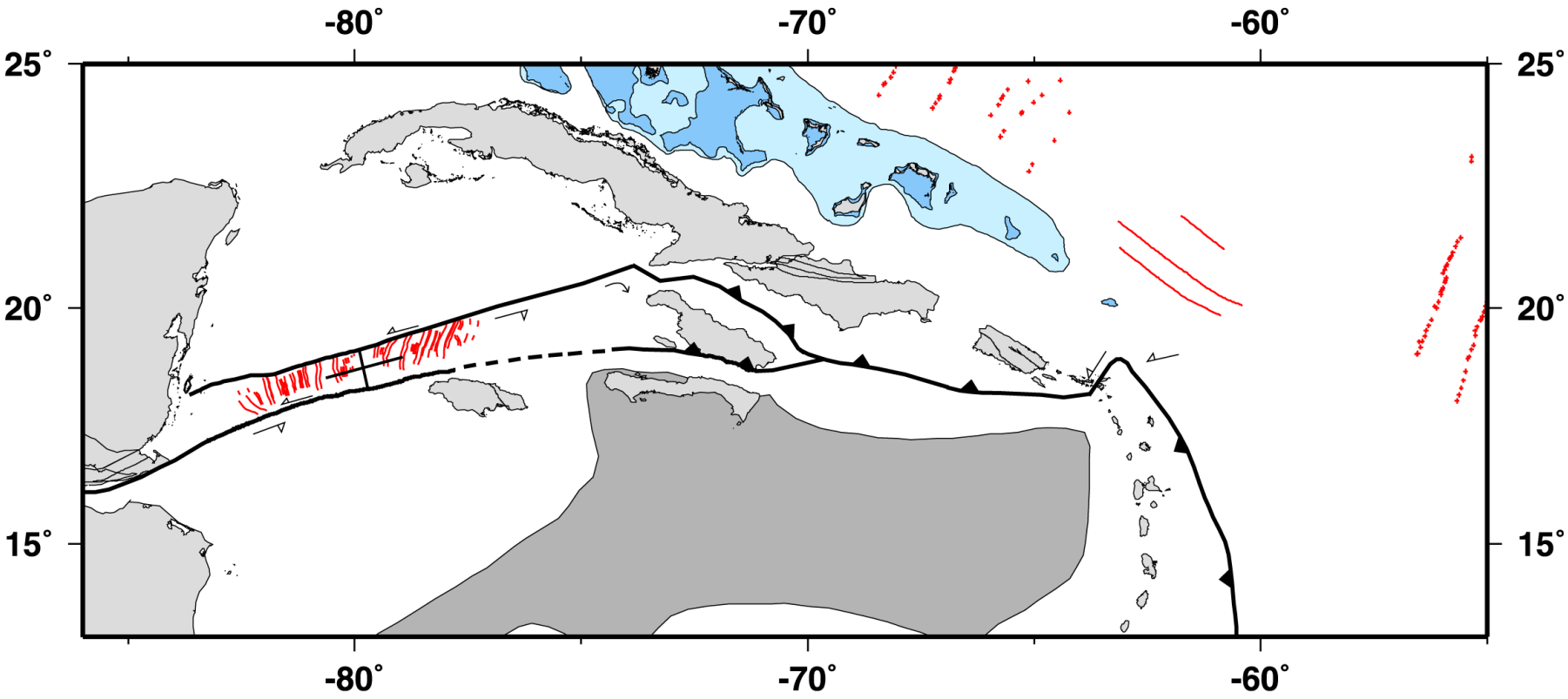
Early Miocene
23.5 Ma



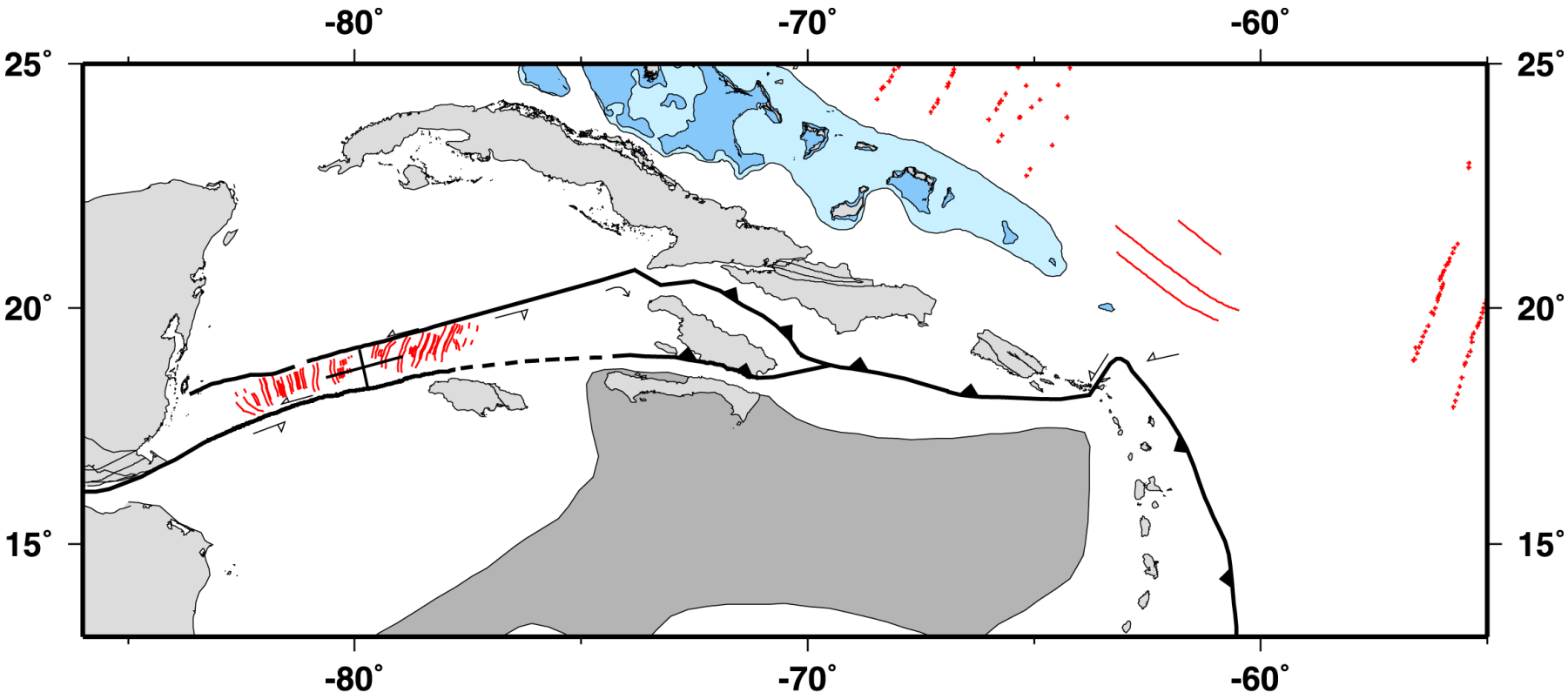
Early Miocene
23.0 Ma



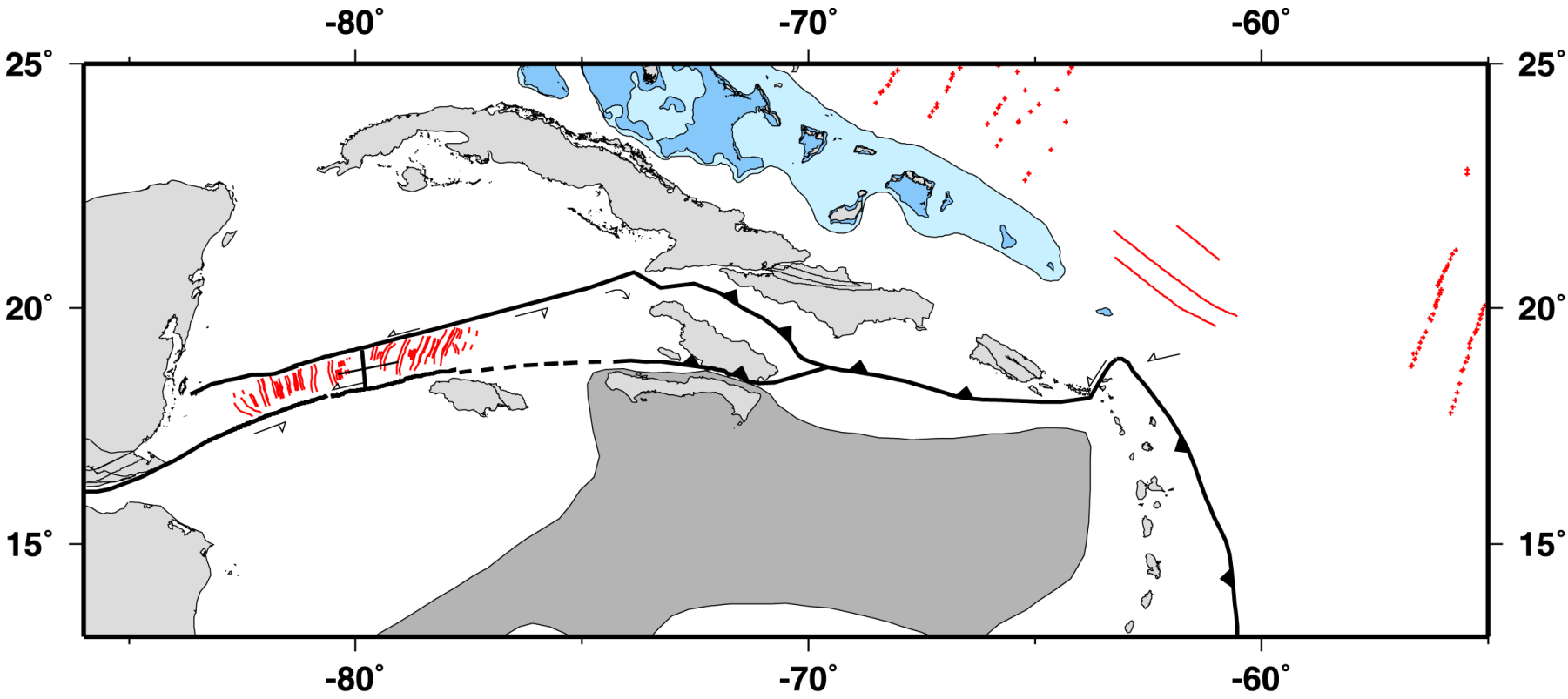
Early Miocene
22.5 Ma



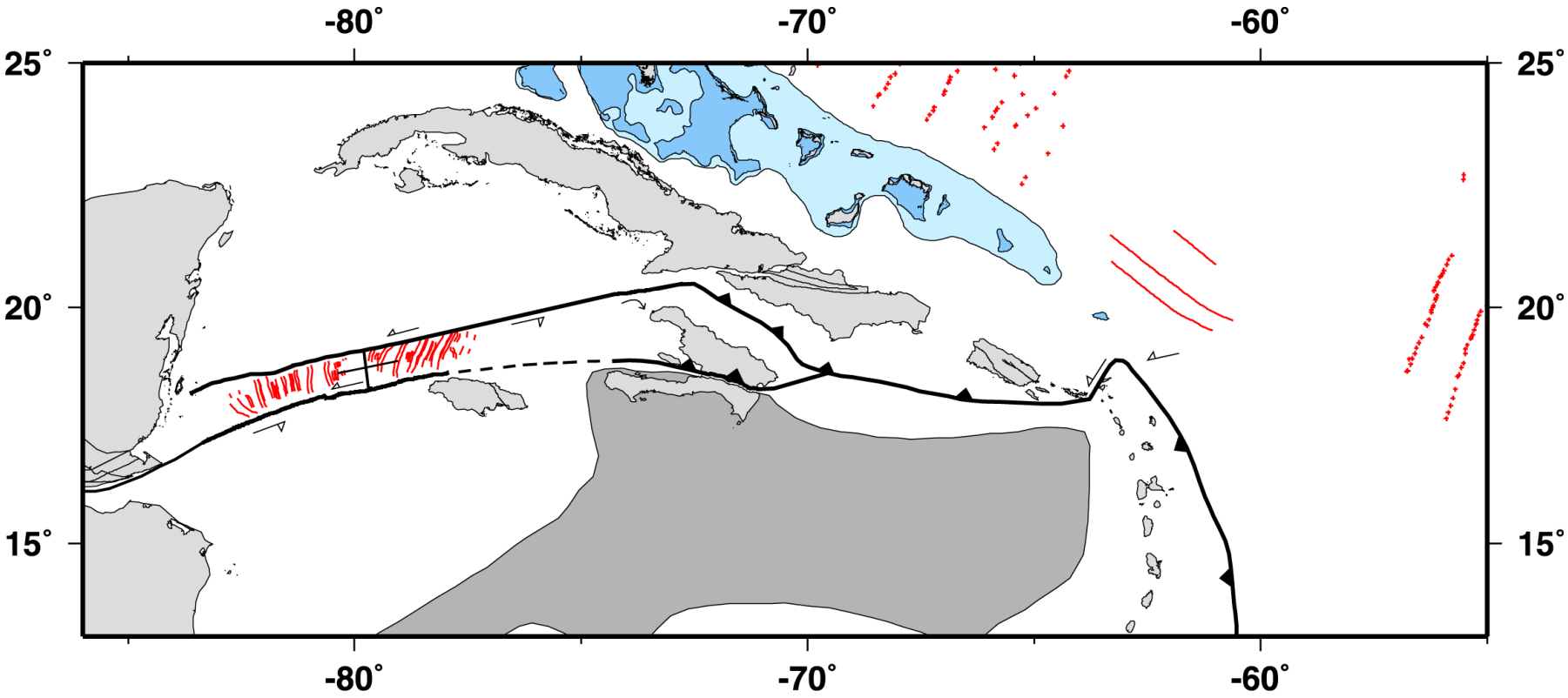
Early Miocene
22.0 Ma



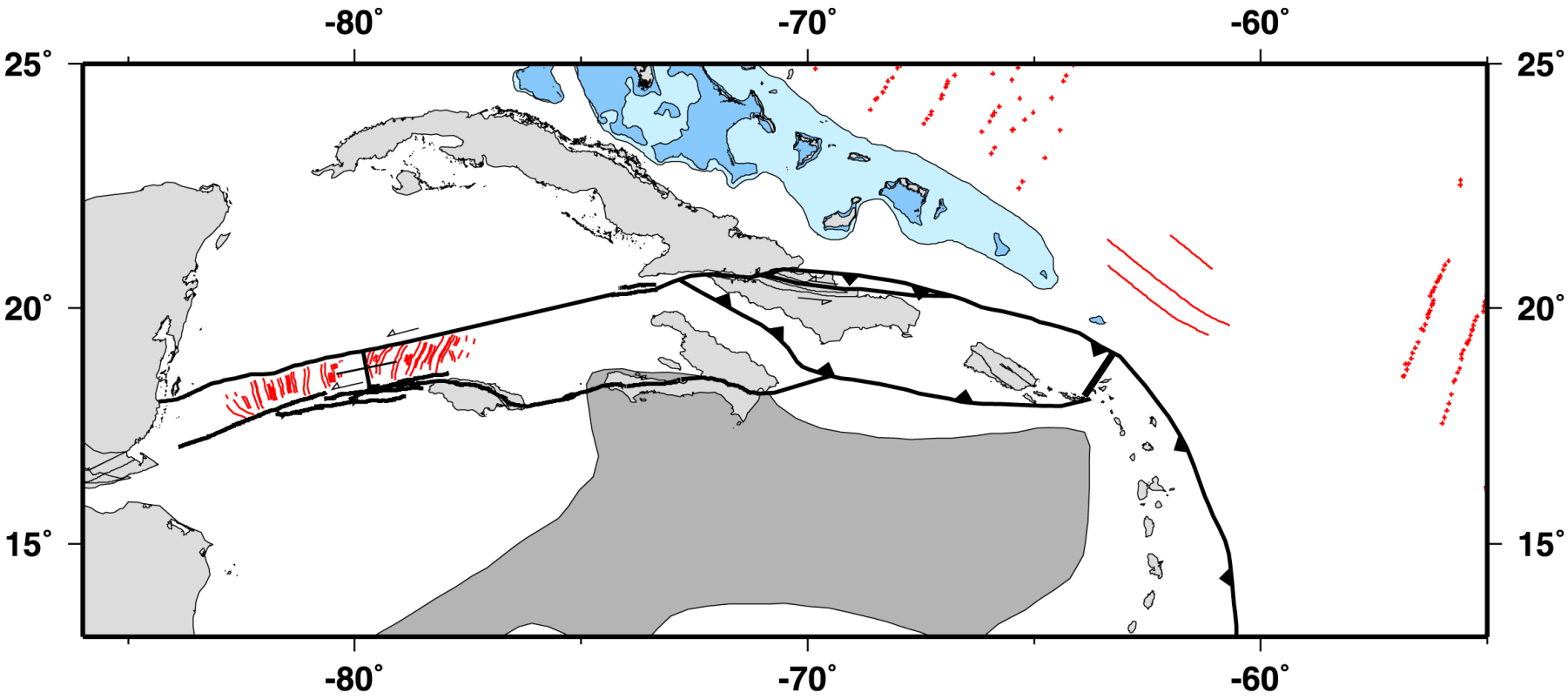
Early Miocene
21.5 Ma



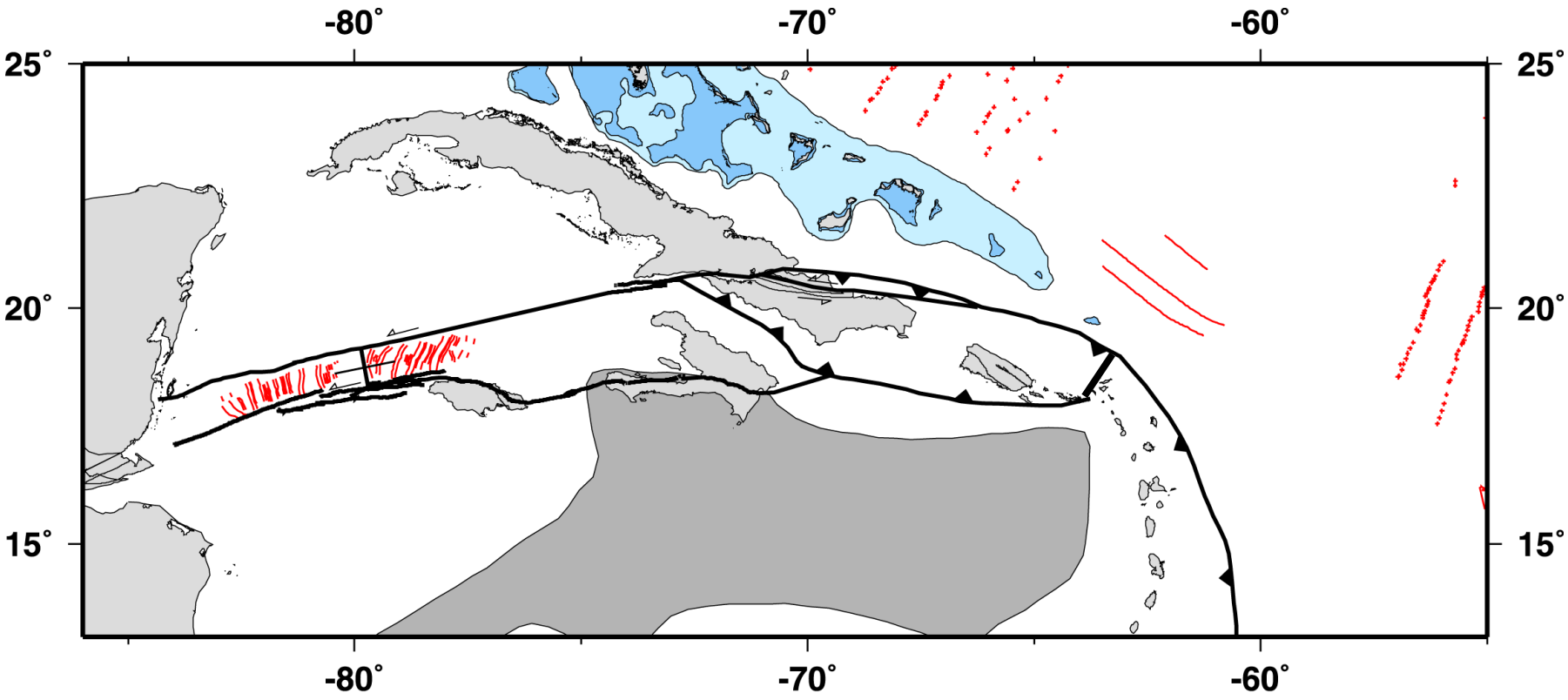
Early Miocene
21.0 Ma



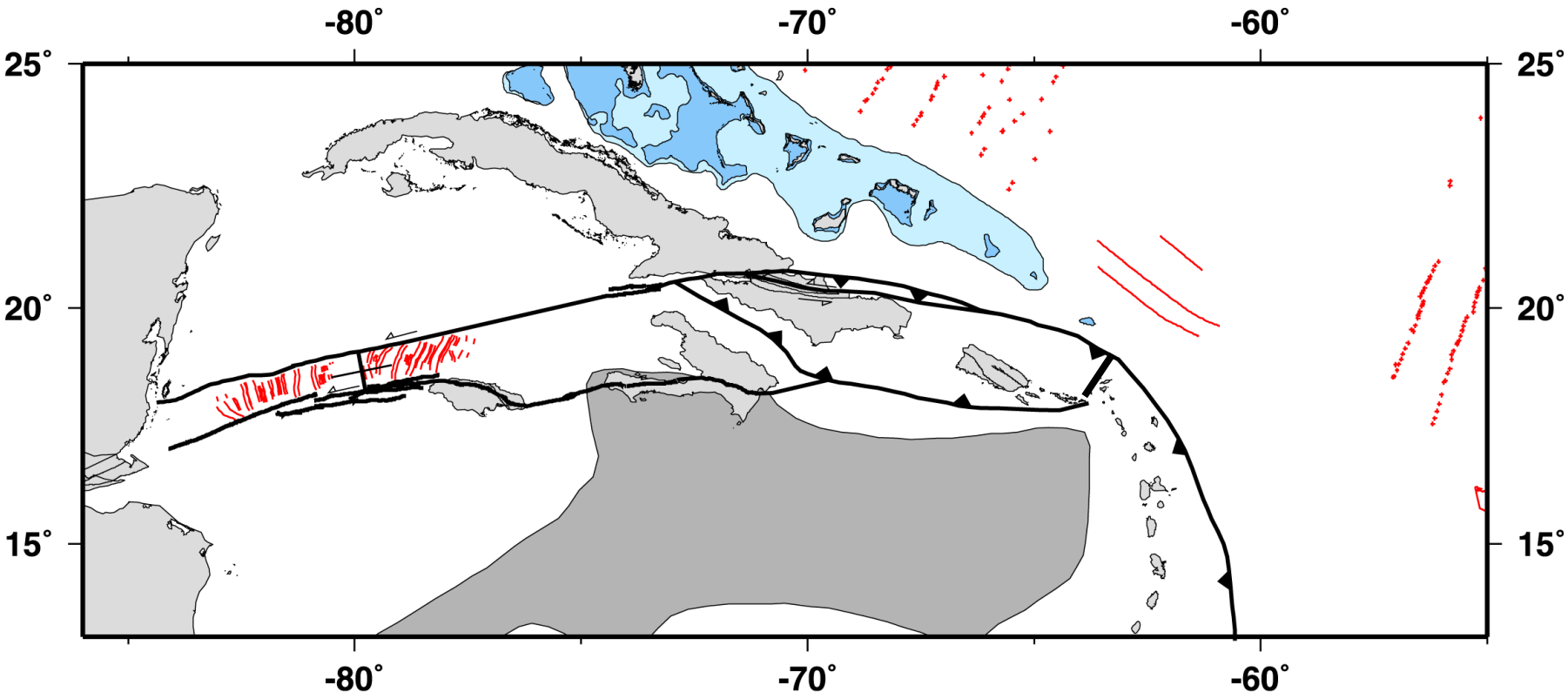
Early Miocene
20.5 Ma



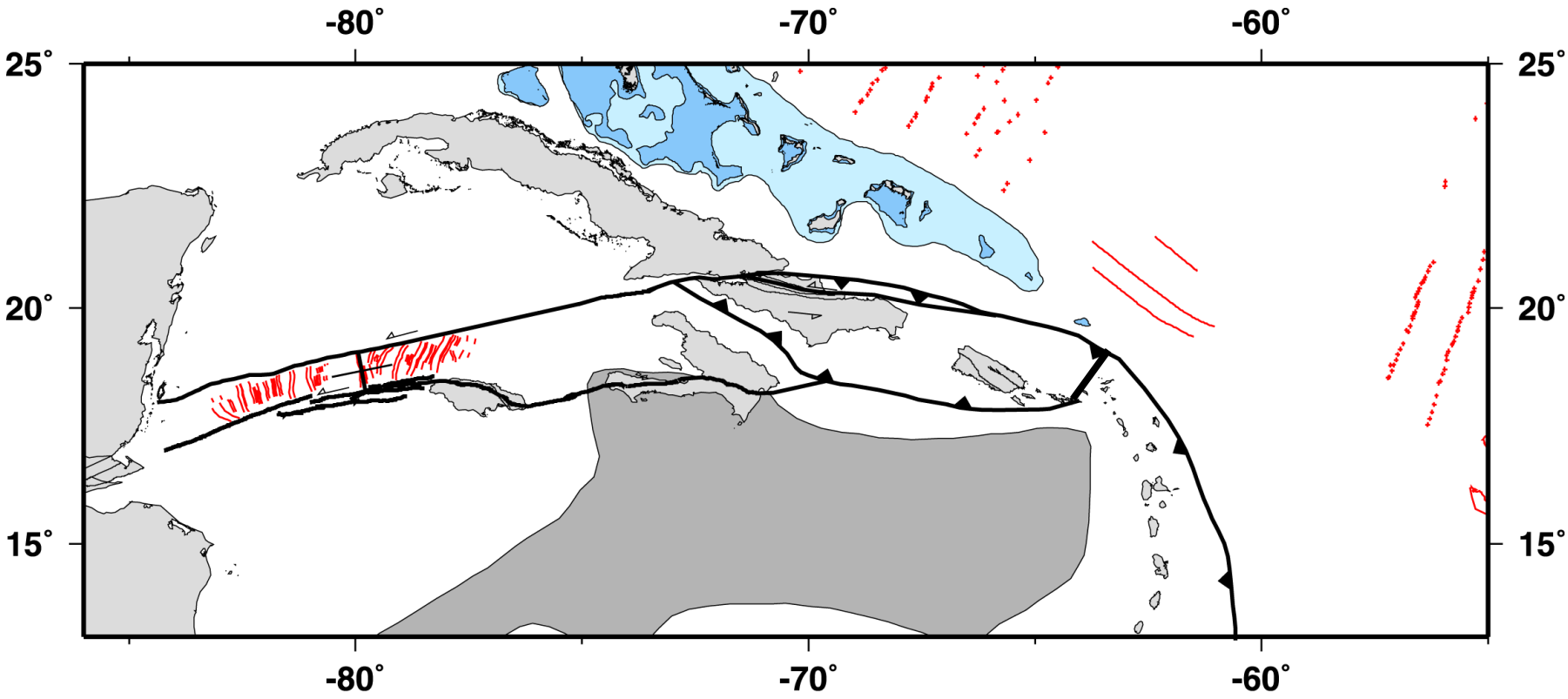
Early Miocene
20.0 Ma



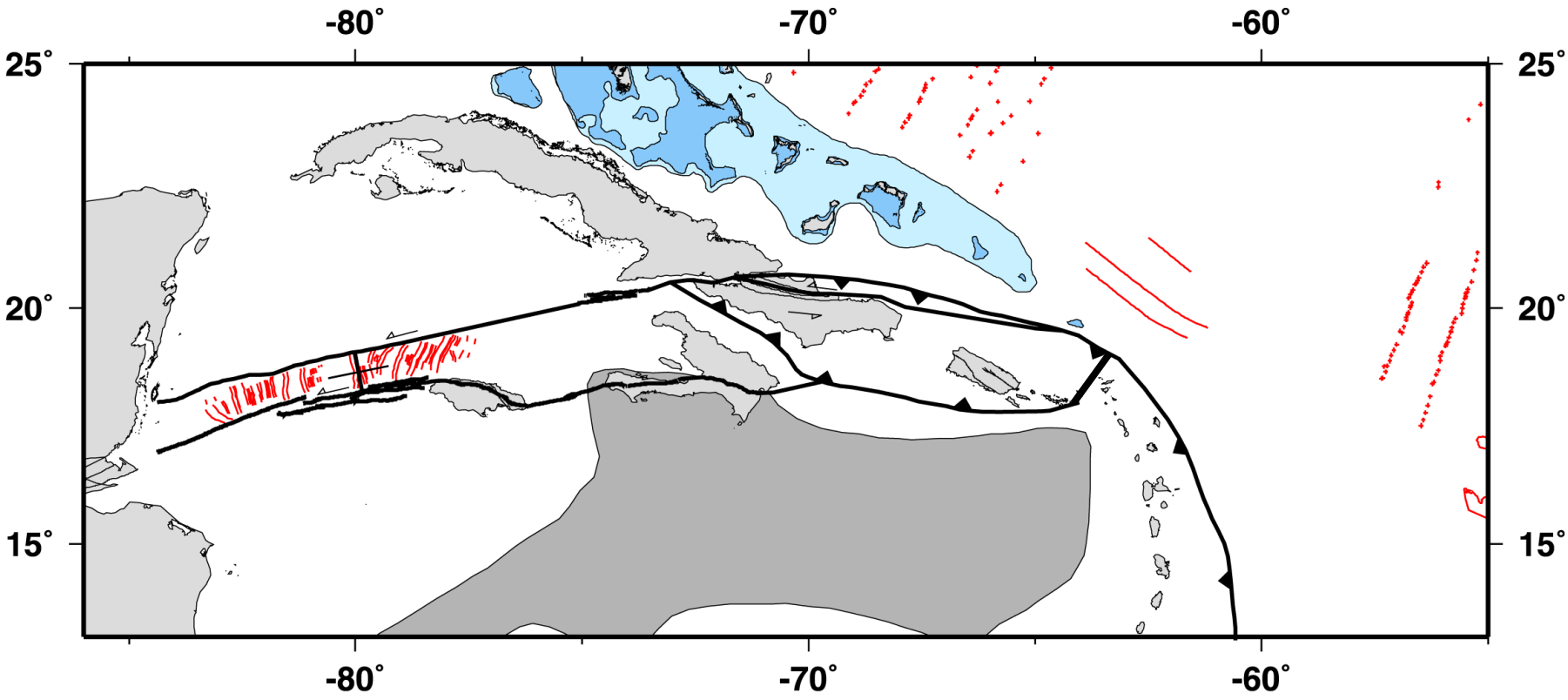
Early Miocene
19.5 Ma



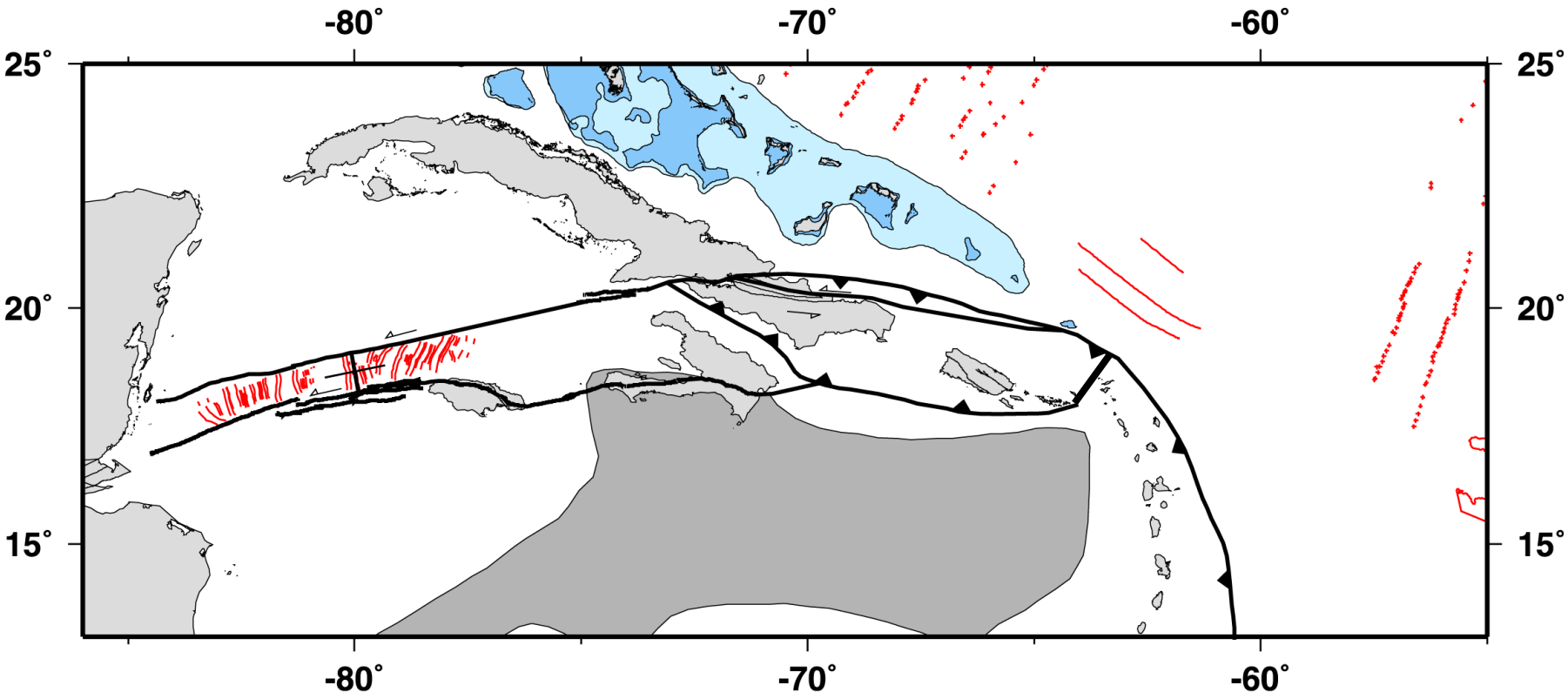
Early Miocene
19.0 Ma



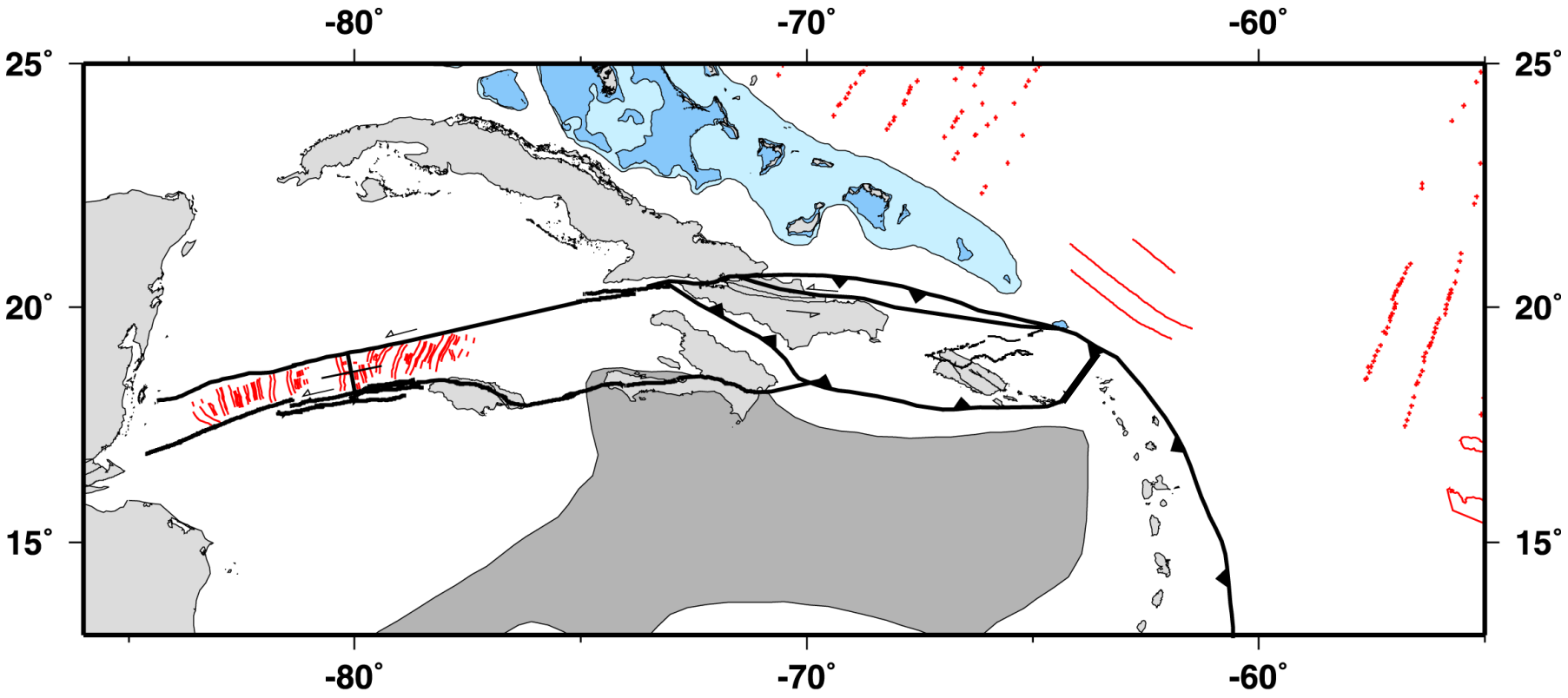
Early Miocene
18.5 Ma



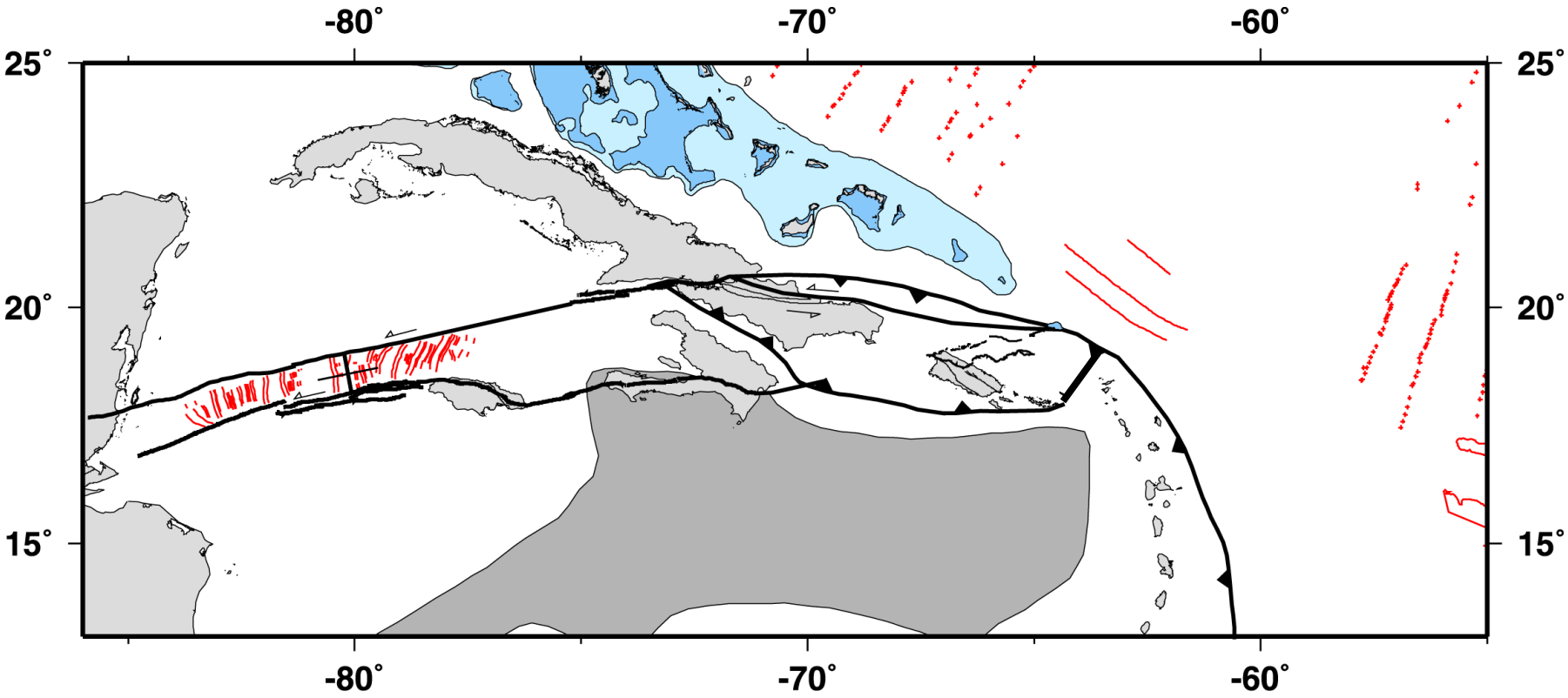
Early Miocene
18.0 Ma



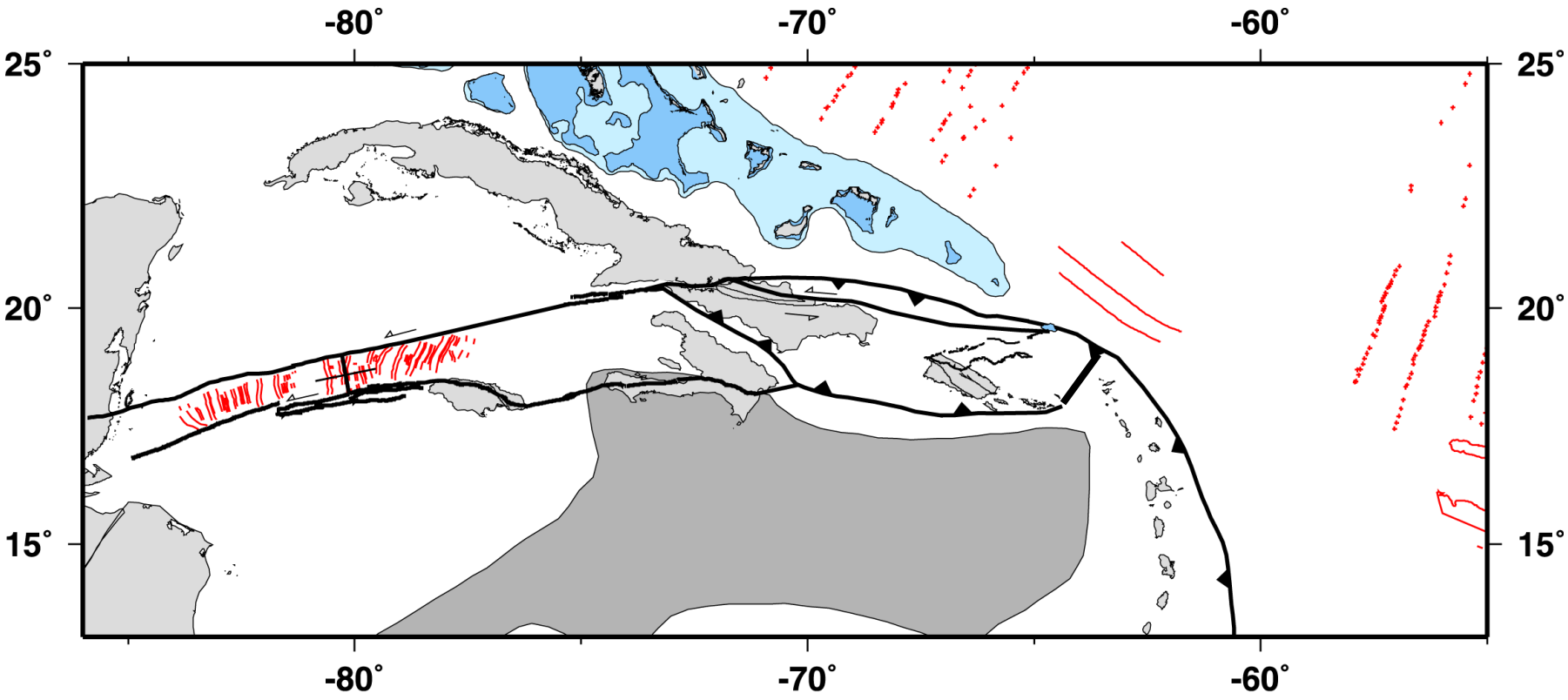
Early Miocene
17.5 Ma



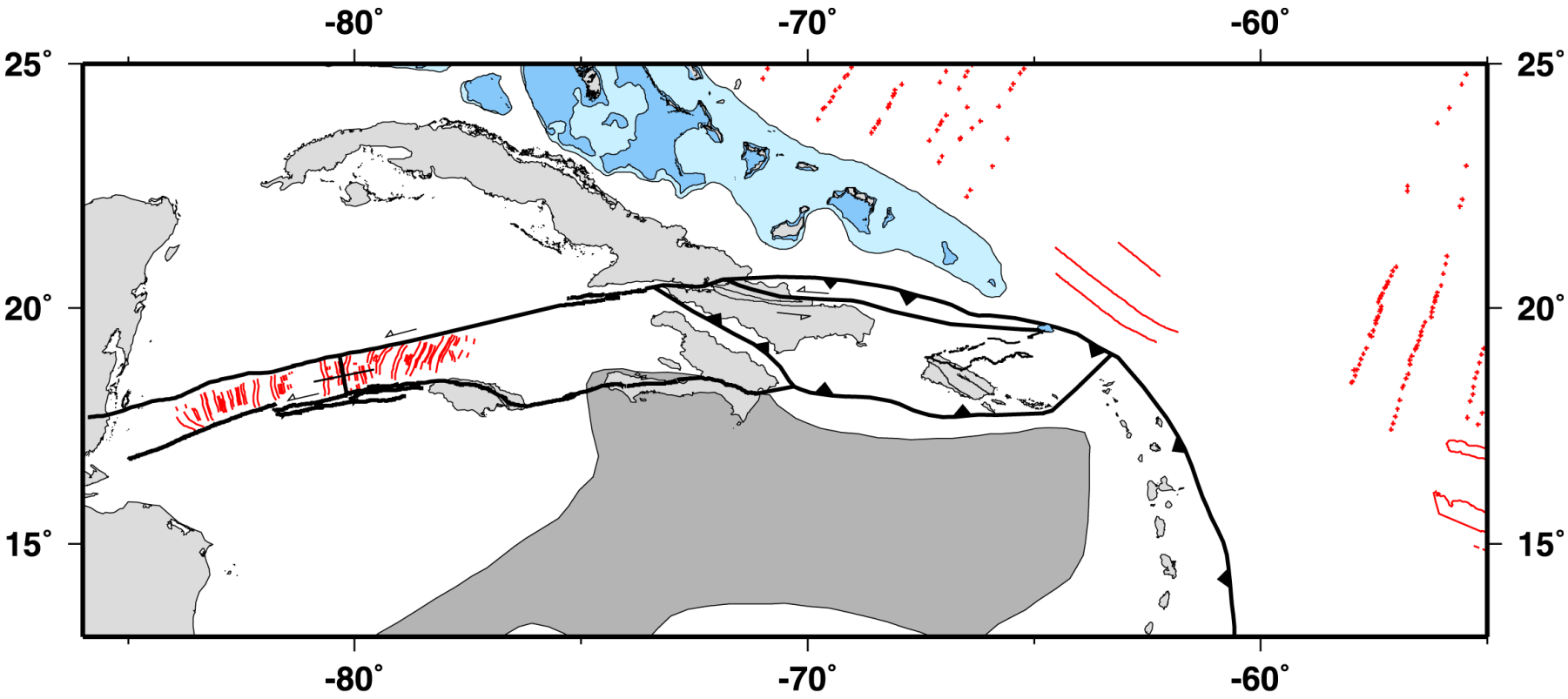
Early Miocene
17.0 Ma



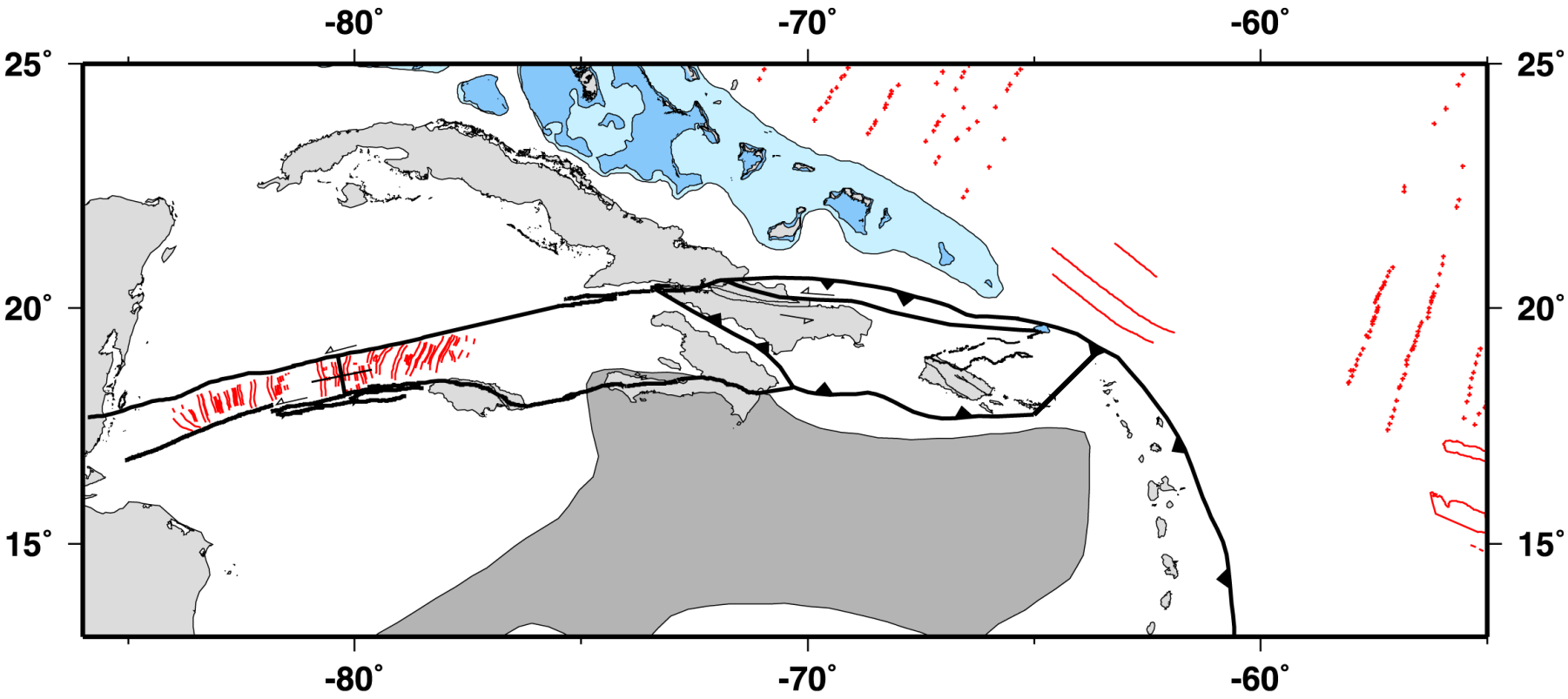
Early Miocene
16.5 Ma



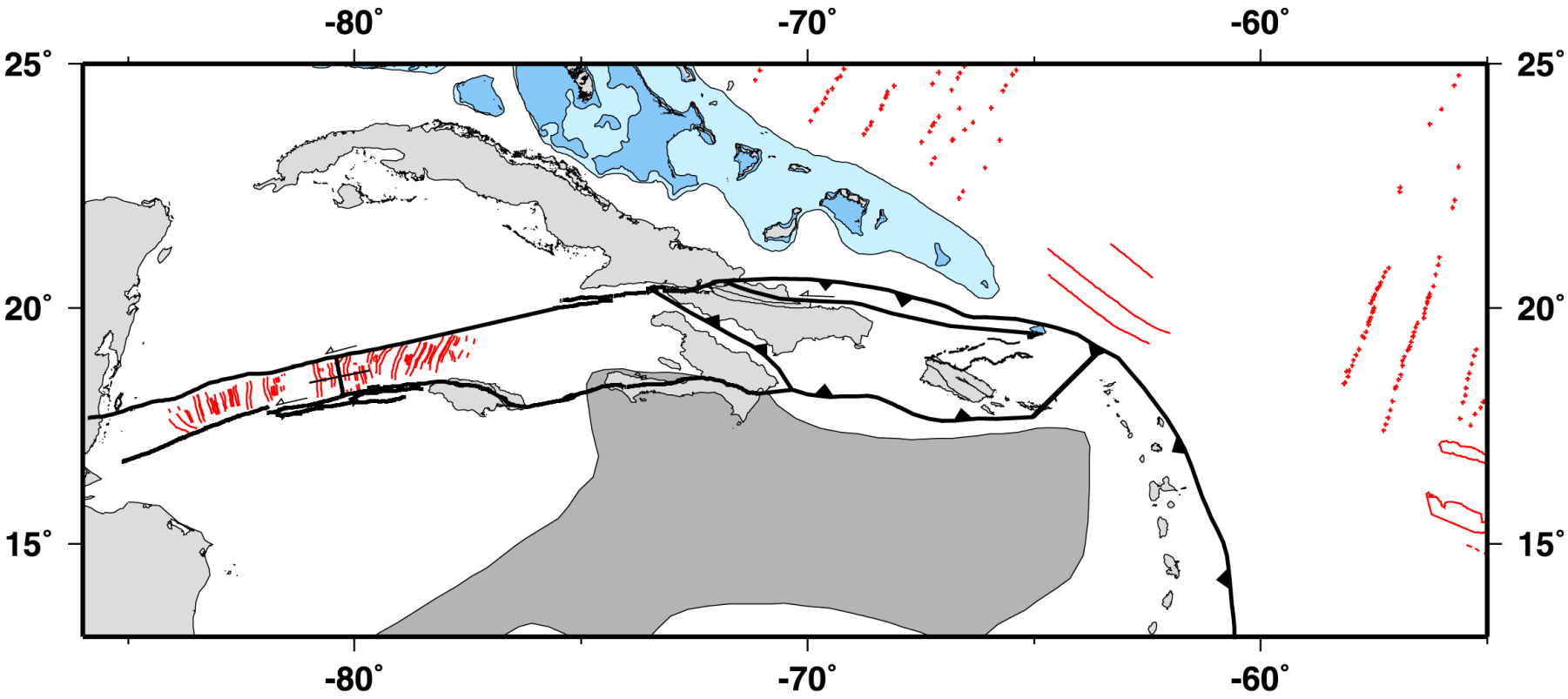
Middle Miocene
16.0 Ma



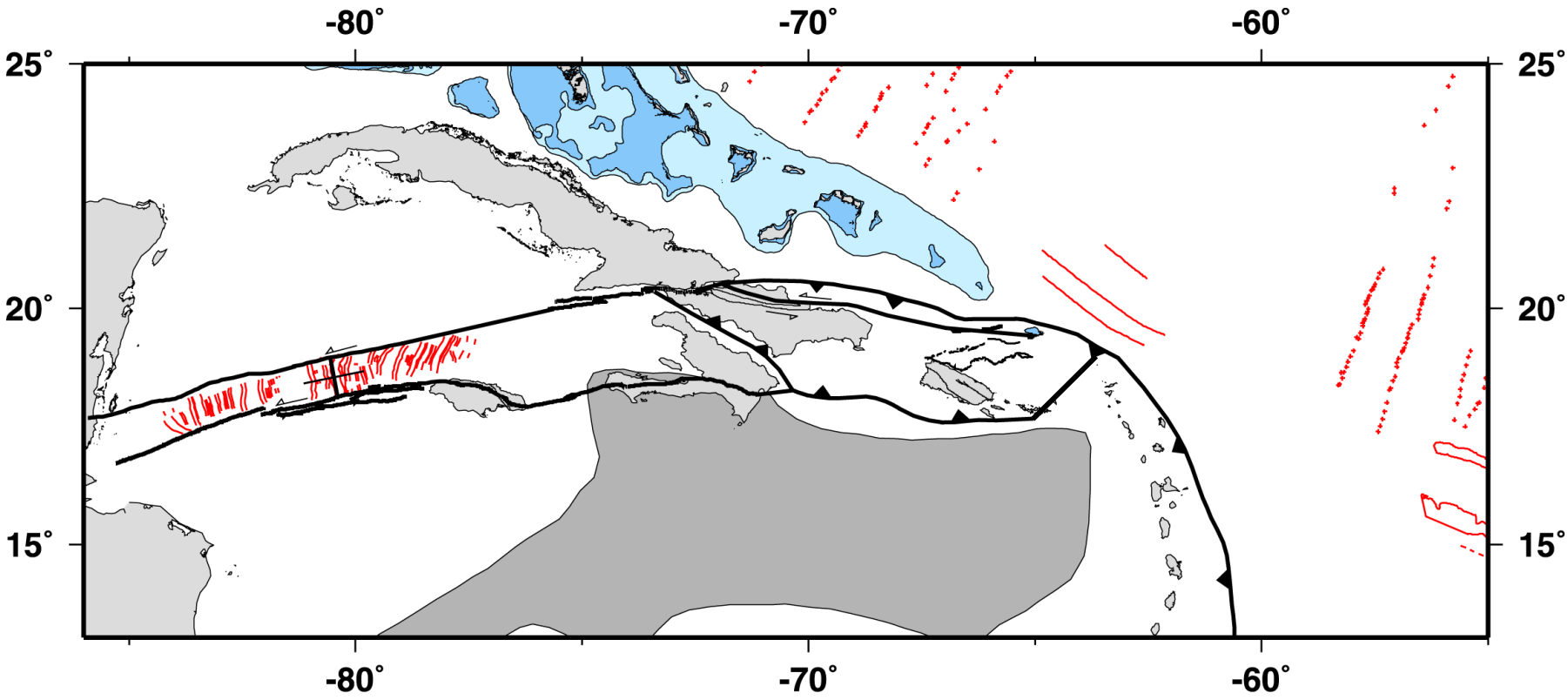
Middle Miocene
15.5 Ma



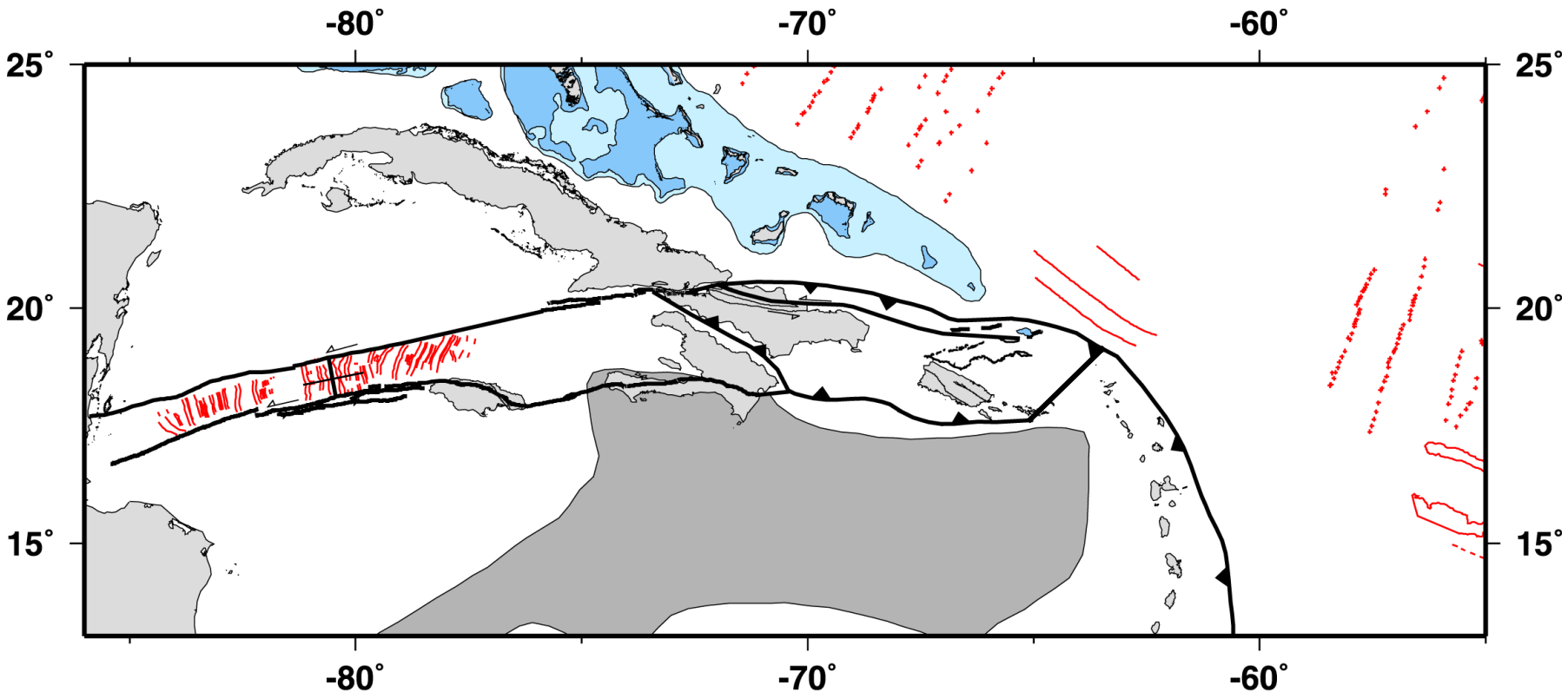
Middle Miocene
15.0 Ma



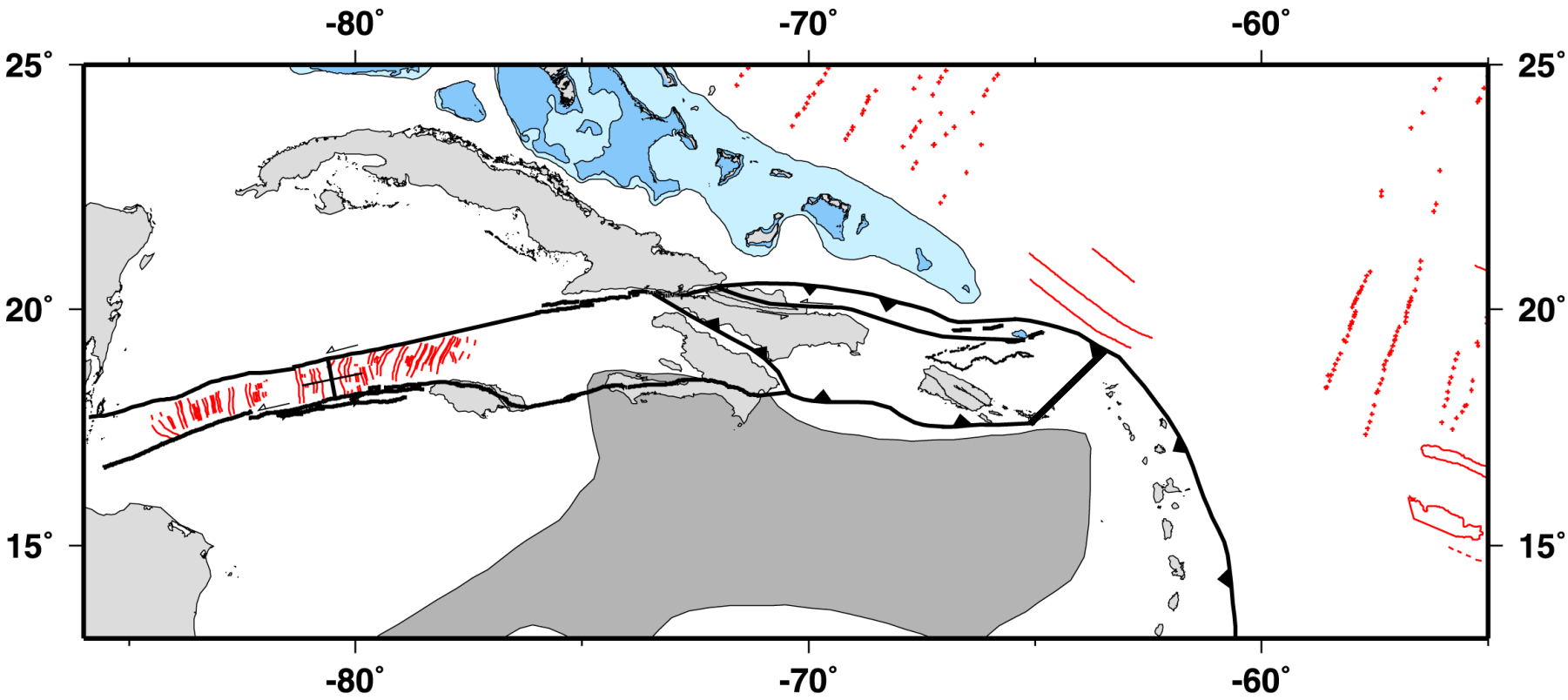
Middle Miocene
14.5 Ma



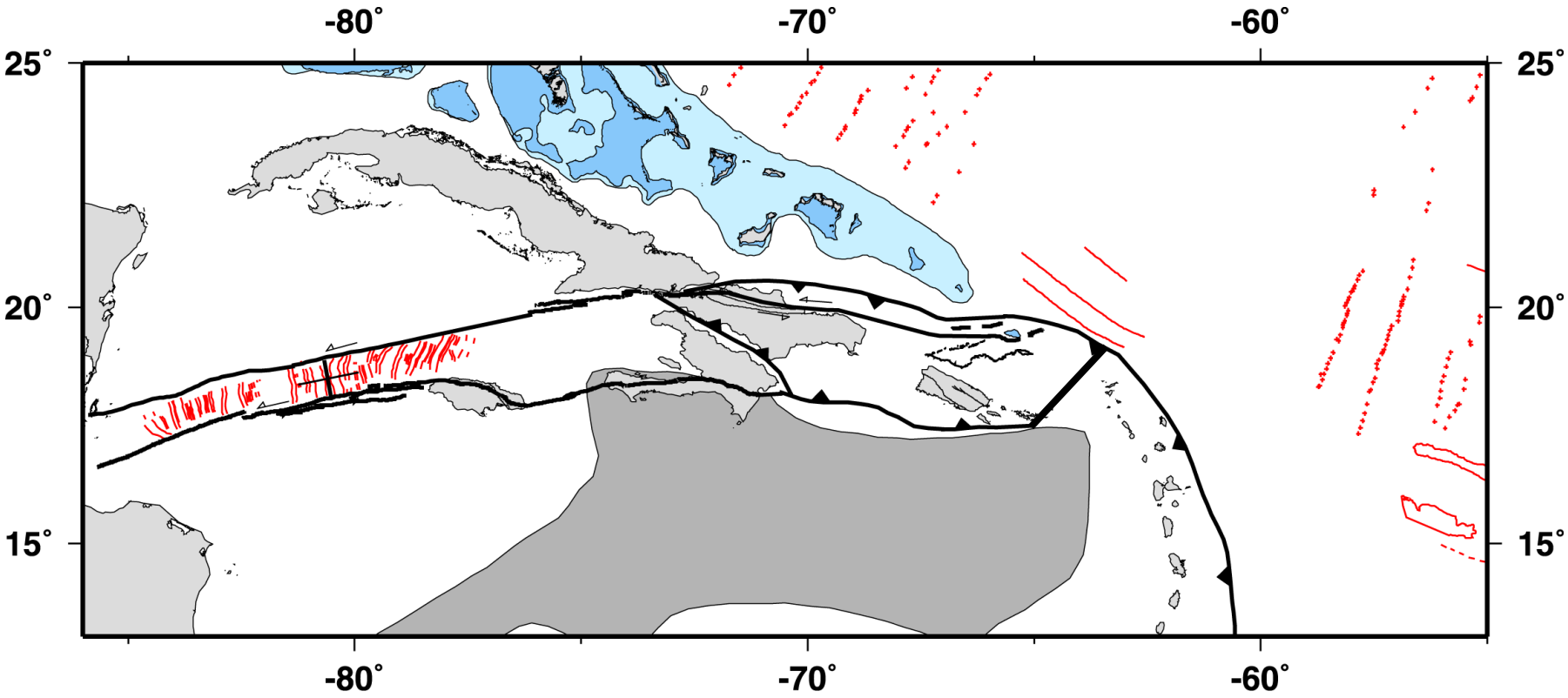
Middle Miocene
14.0 Ma



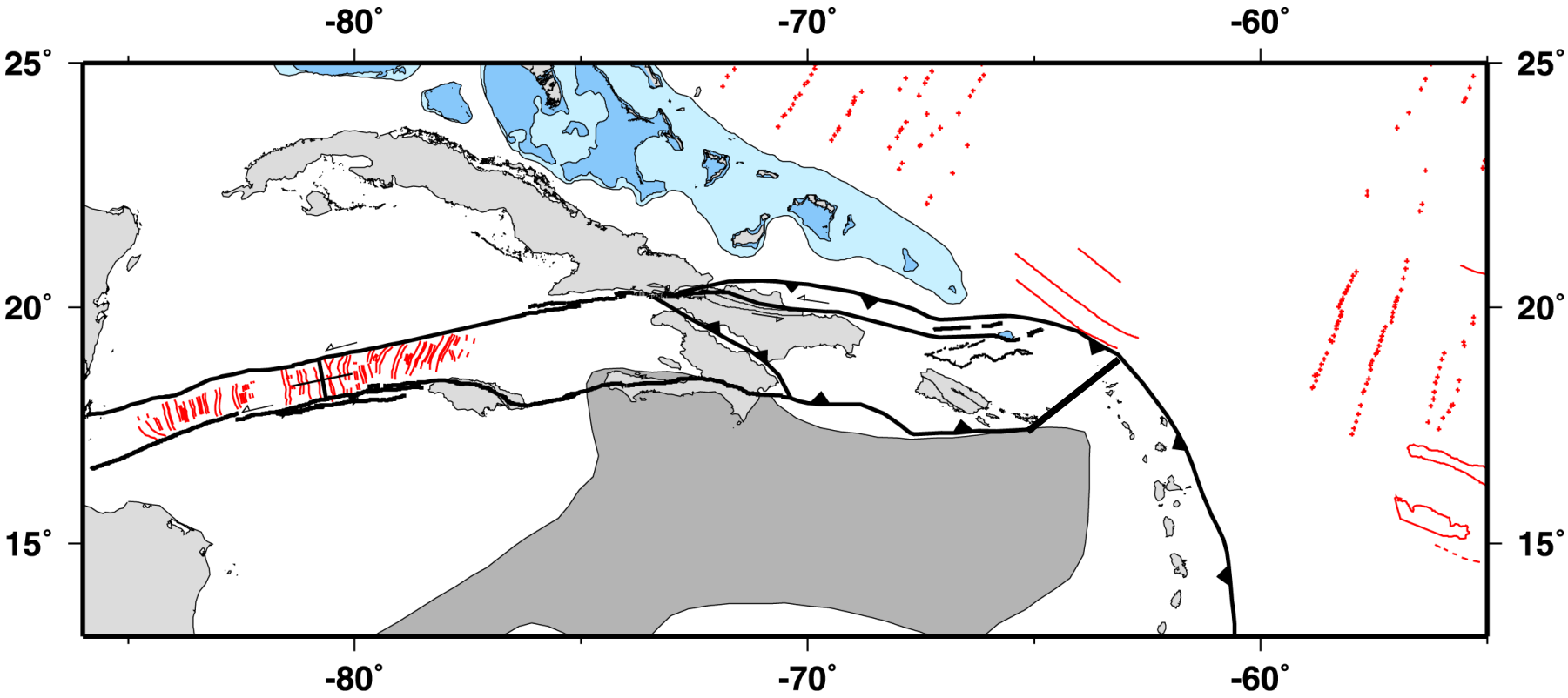
Middle Miocene
13.5 Ma



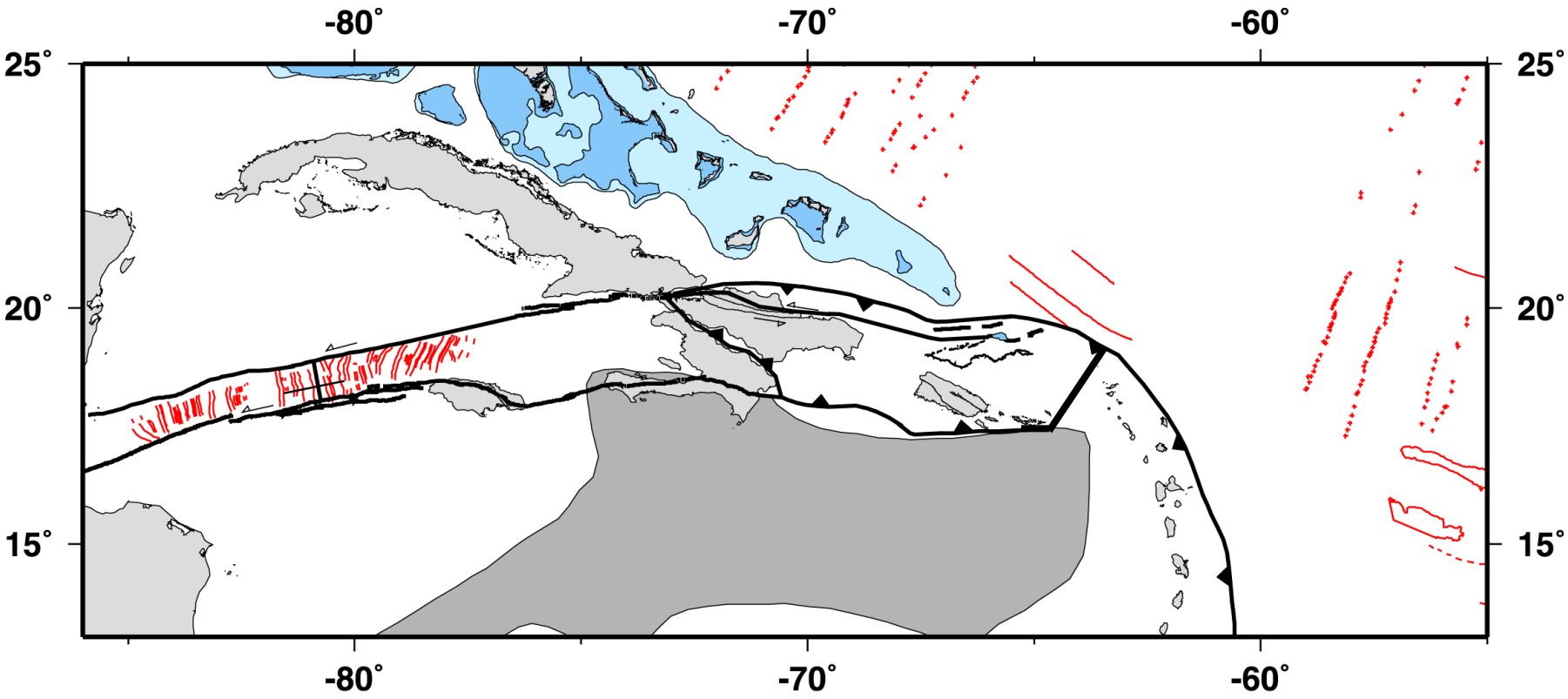
Middle Miocene
13.0 Ma



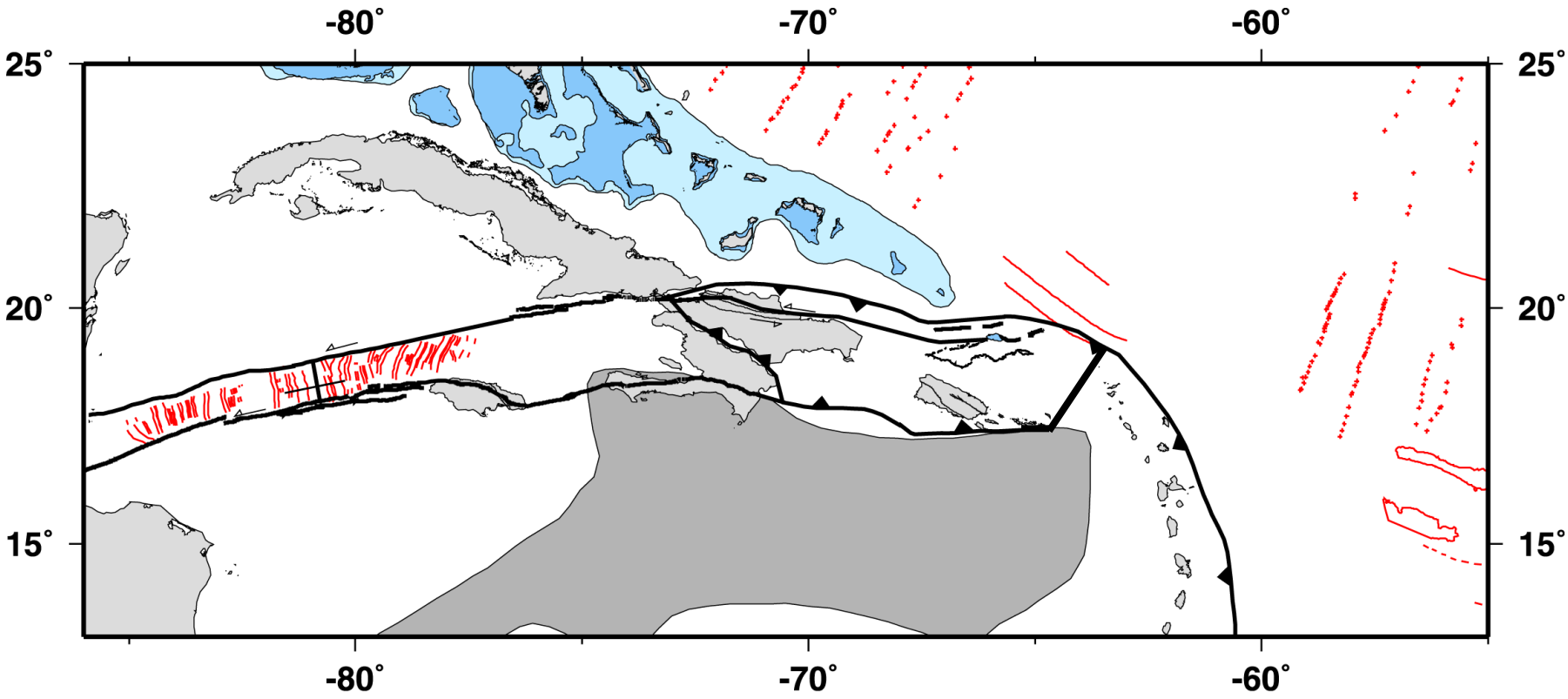
Middle Miocene
12.5 Ma



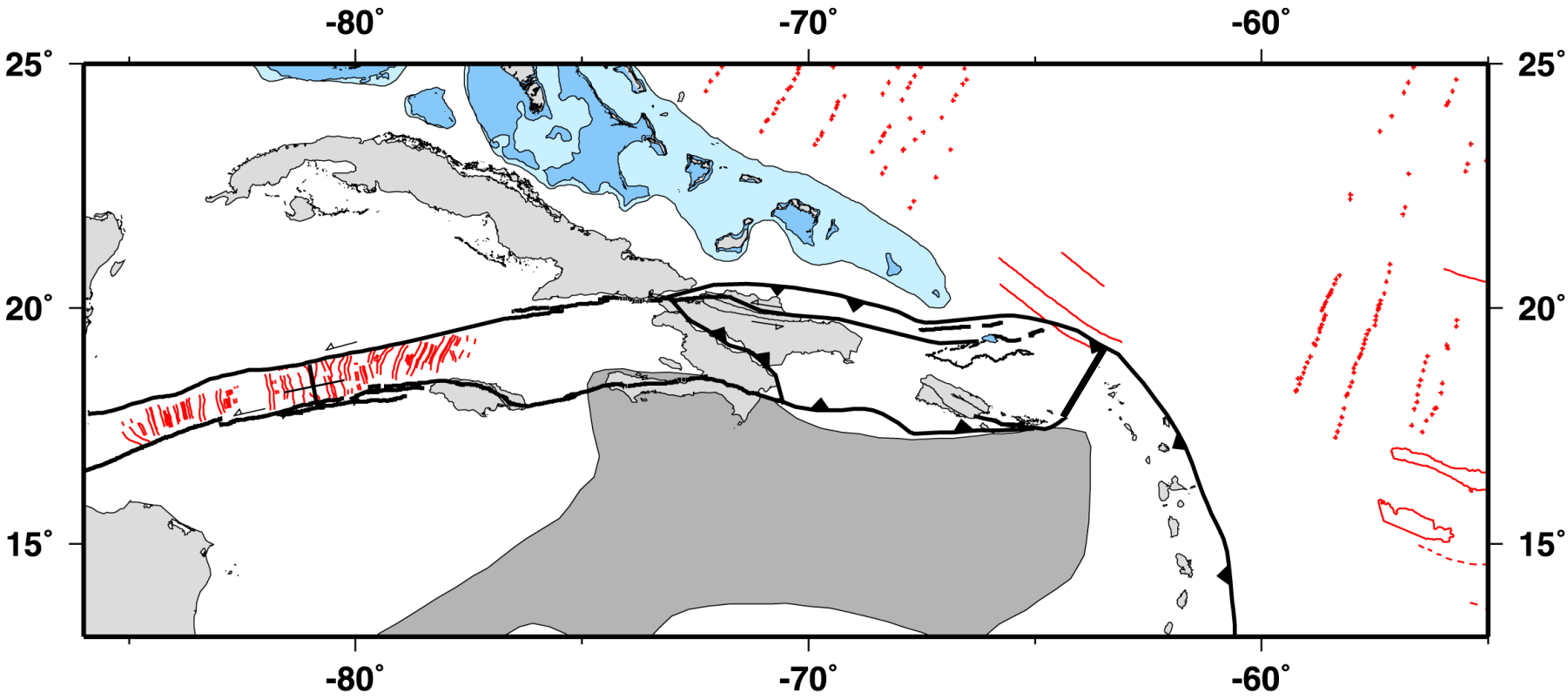
Middle Miocene
12.0 Ma



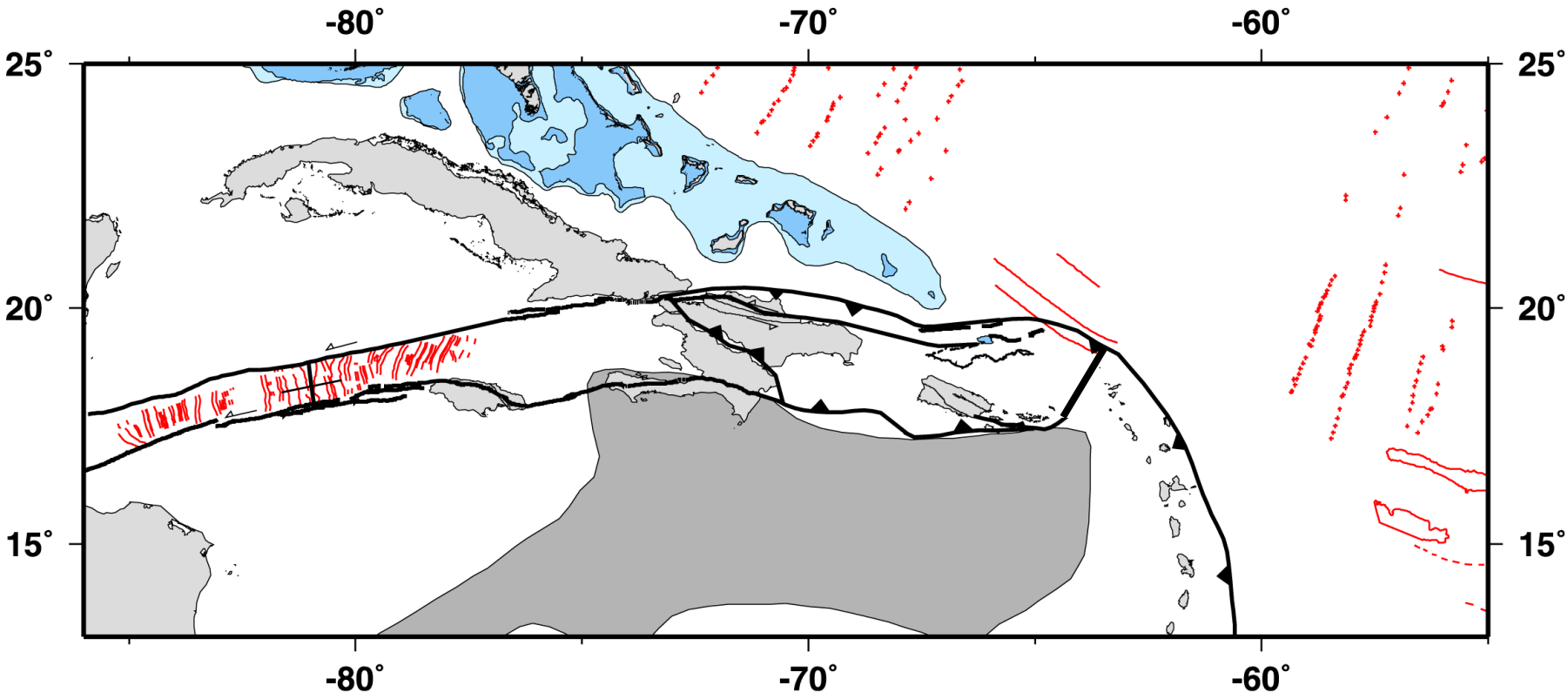
Middle Miocene
11.5 Ma



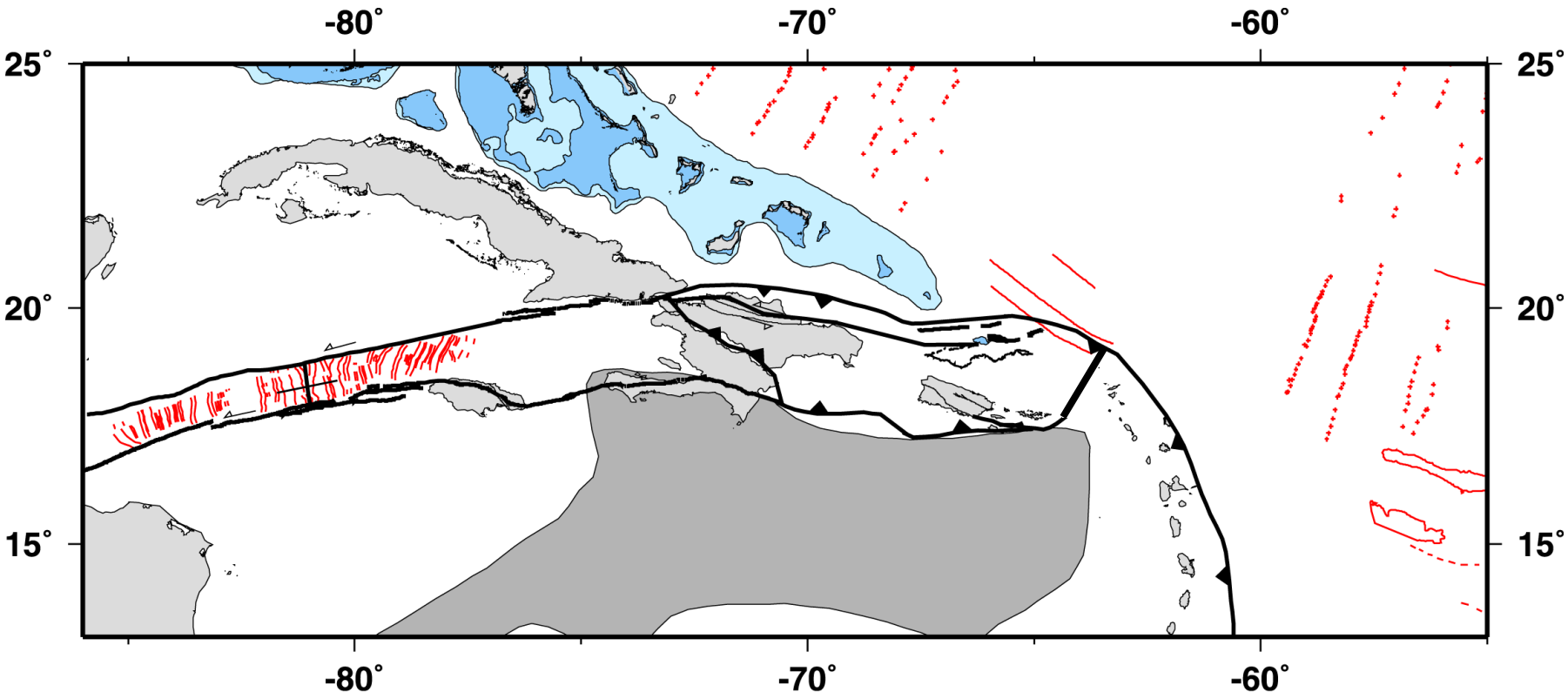
Late Miocene
11.0 Ma



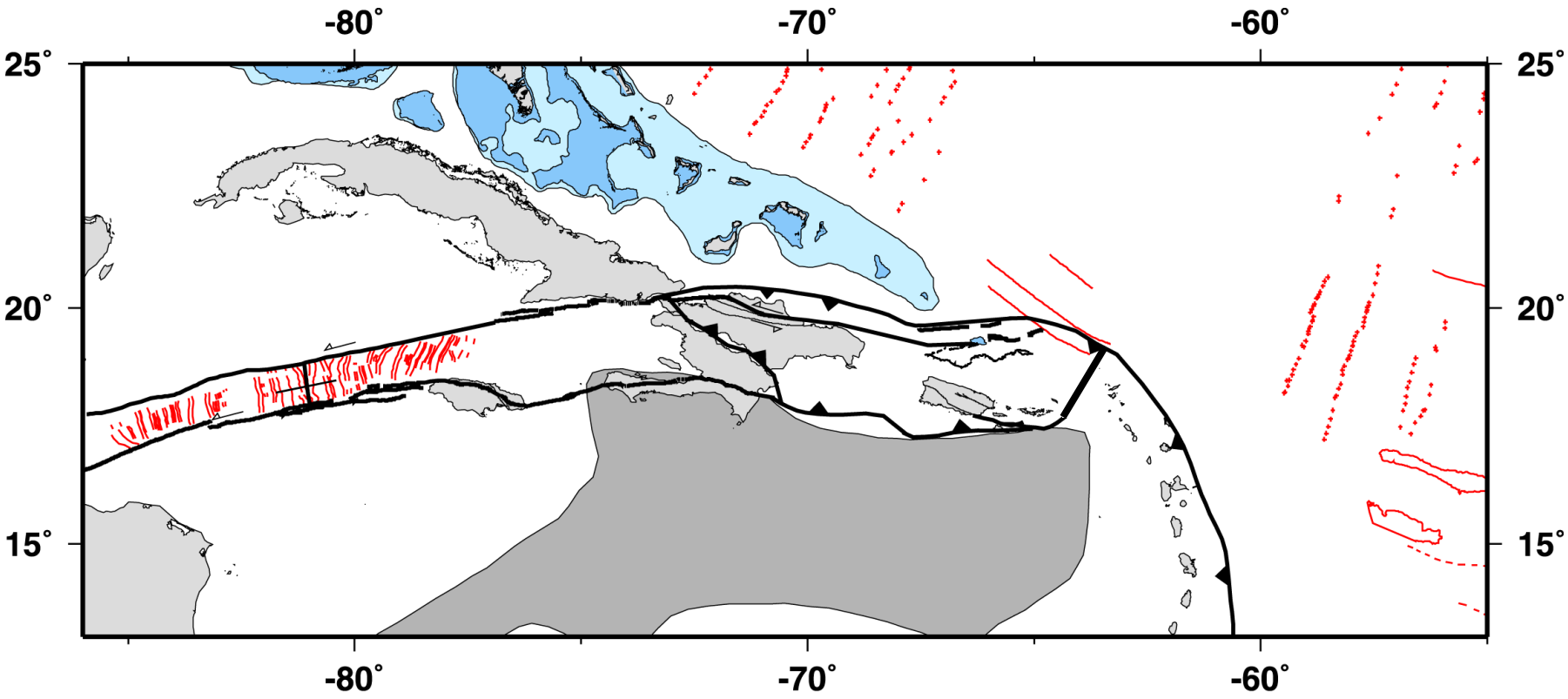
Late Miocene
10.5 Ma



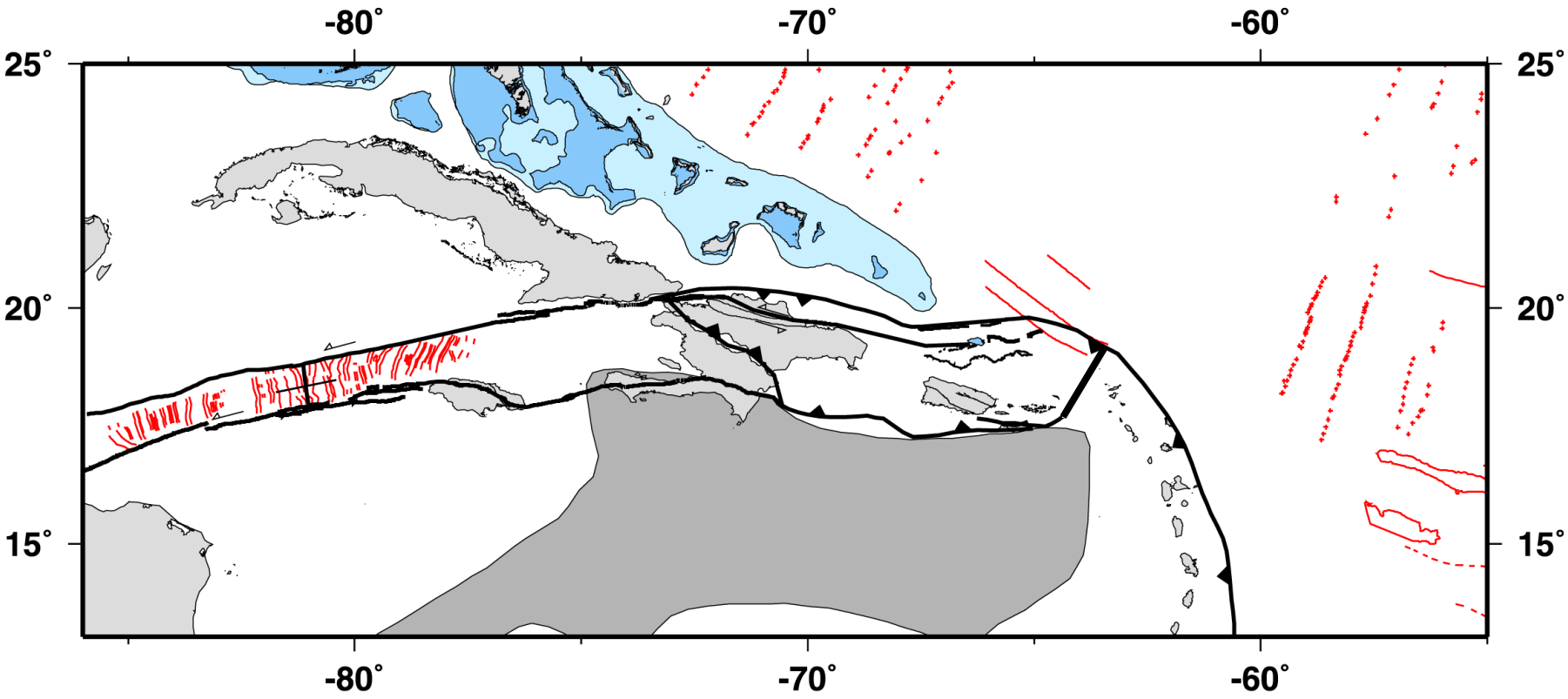
Late Miocene
10.0 Ma



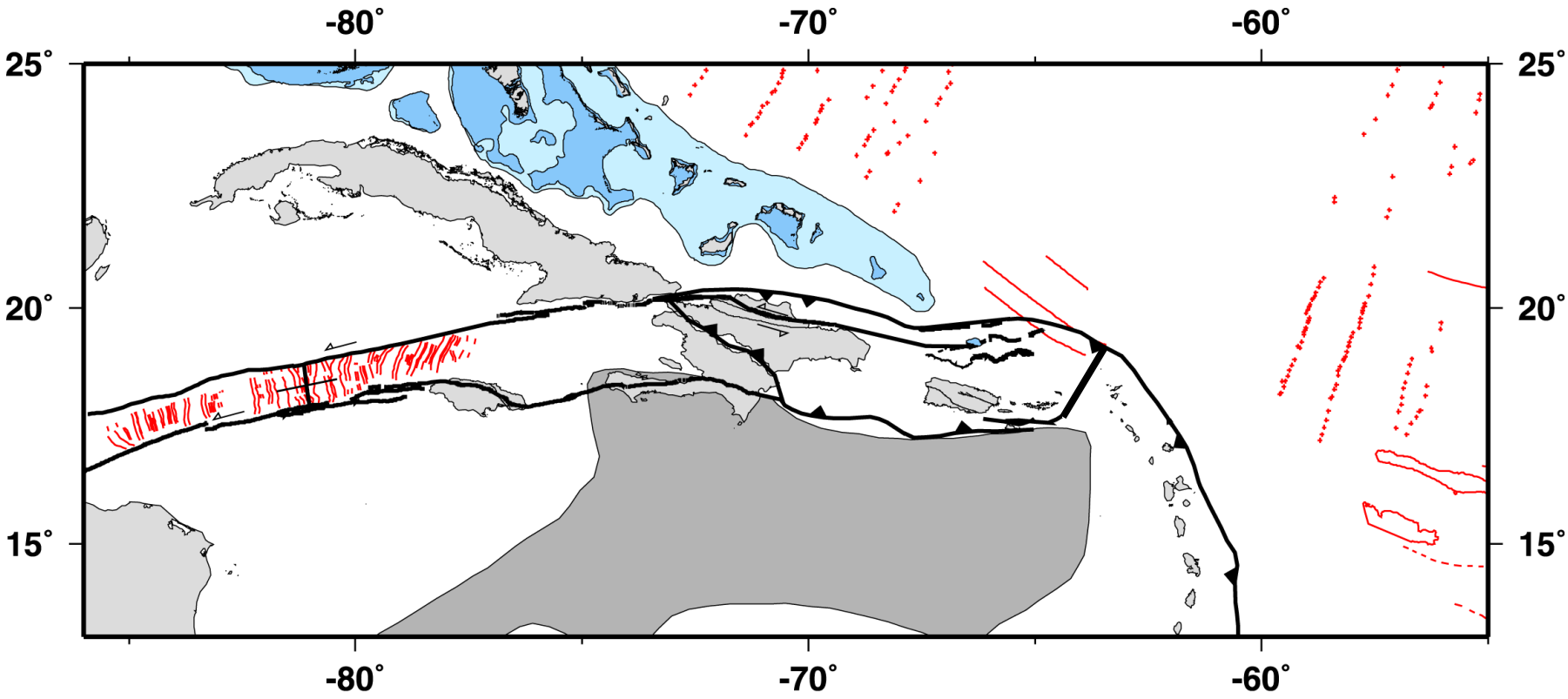
Late Miocene
09.5 Ma



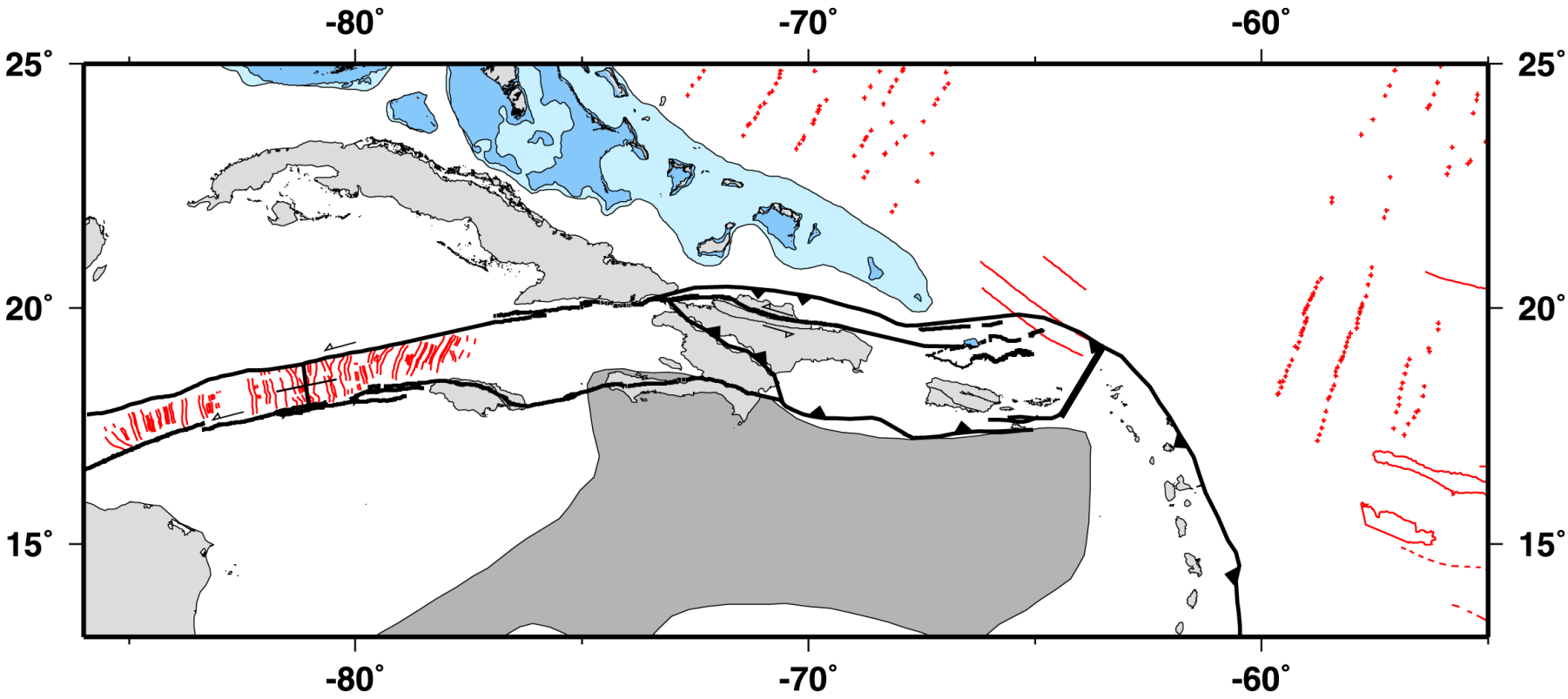
Late Miocene
09.0 Ma



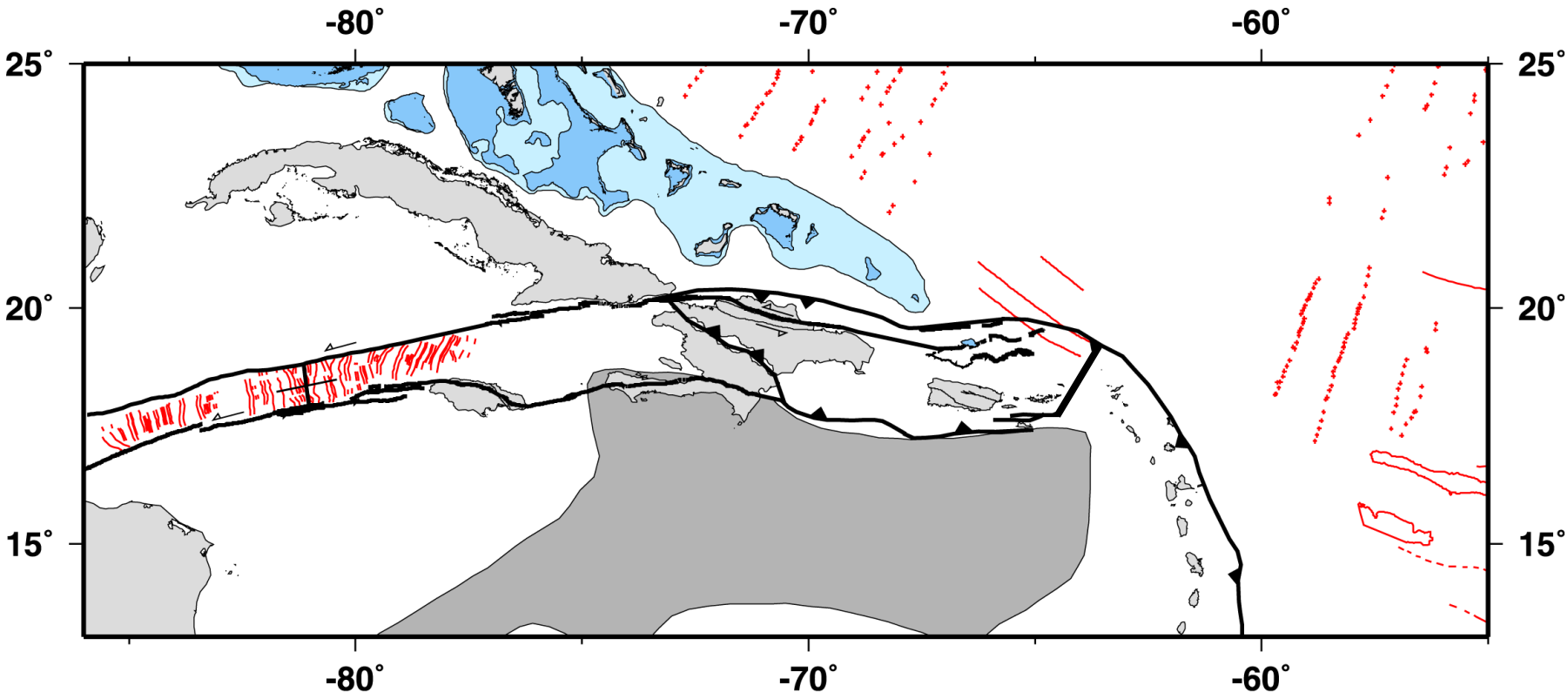
Late Miocene
08.5 Ma



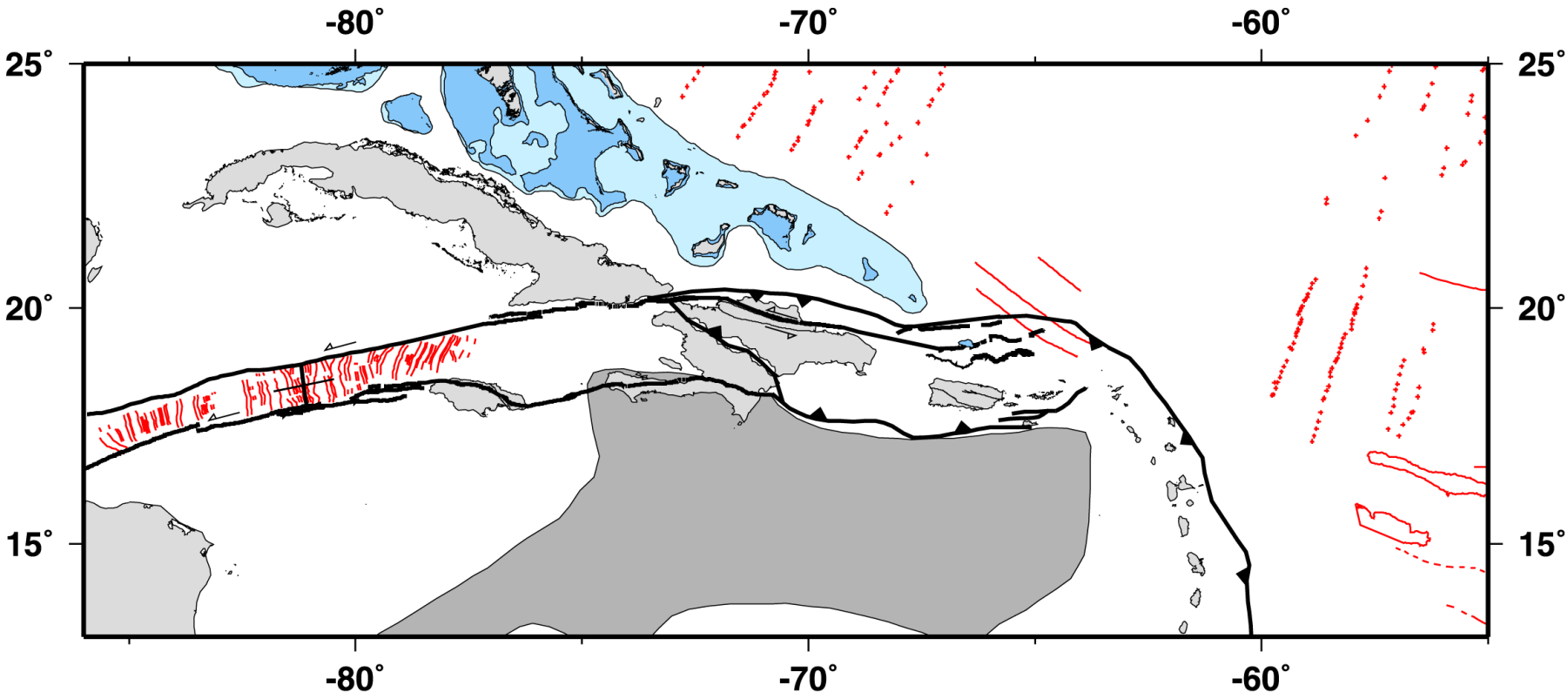
Late Miocene
08.0 Ma



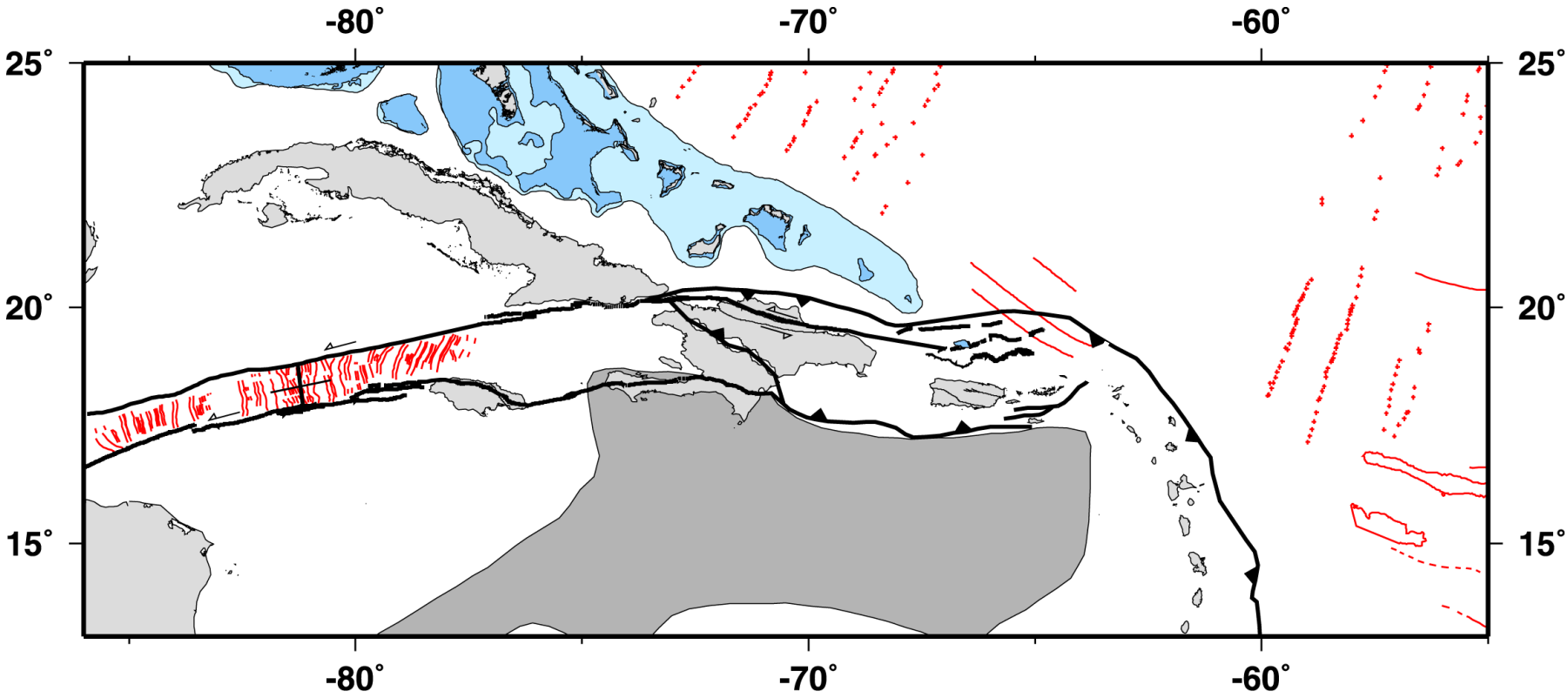
Late Miocene
07.5 Ma



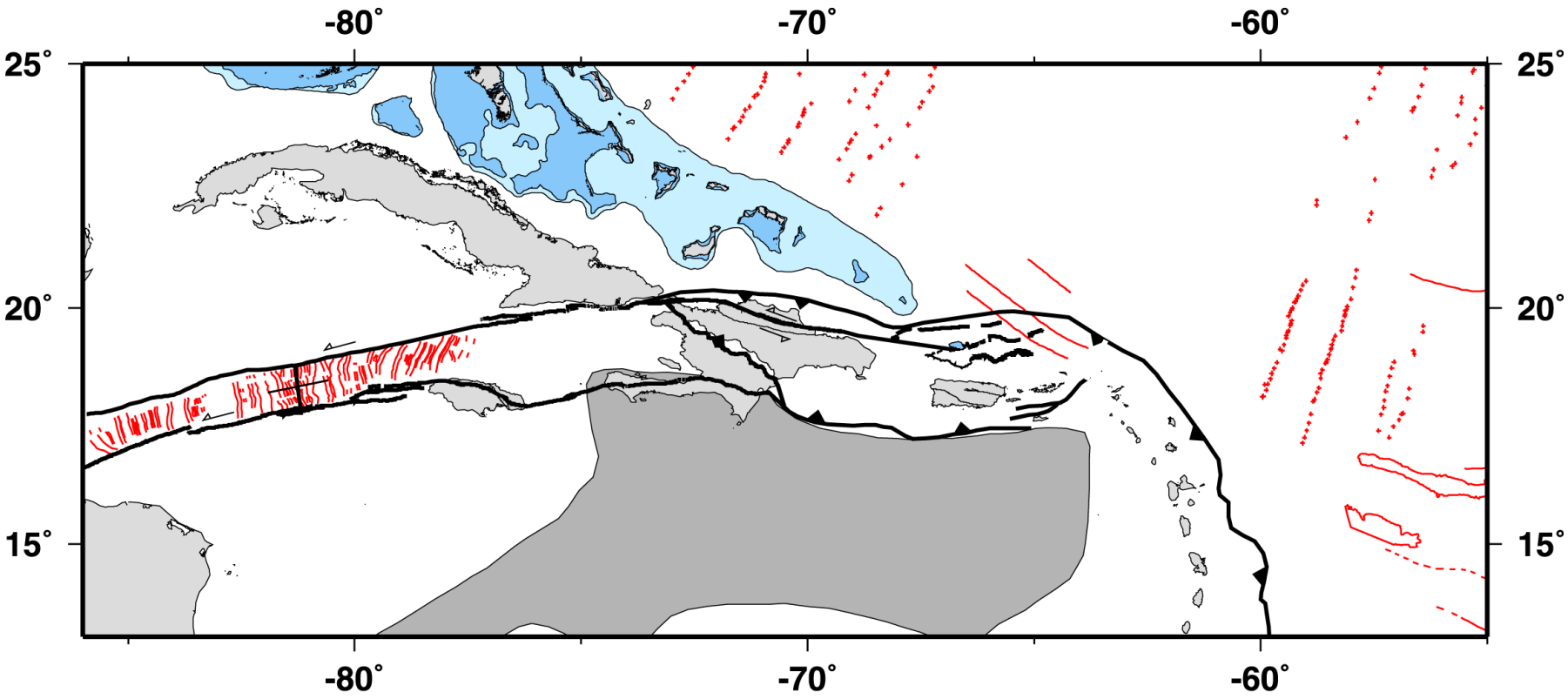
Late Miocene
07.0 Ma



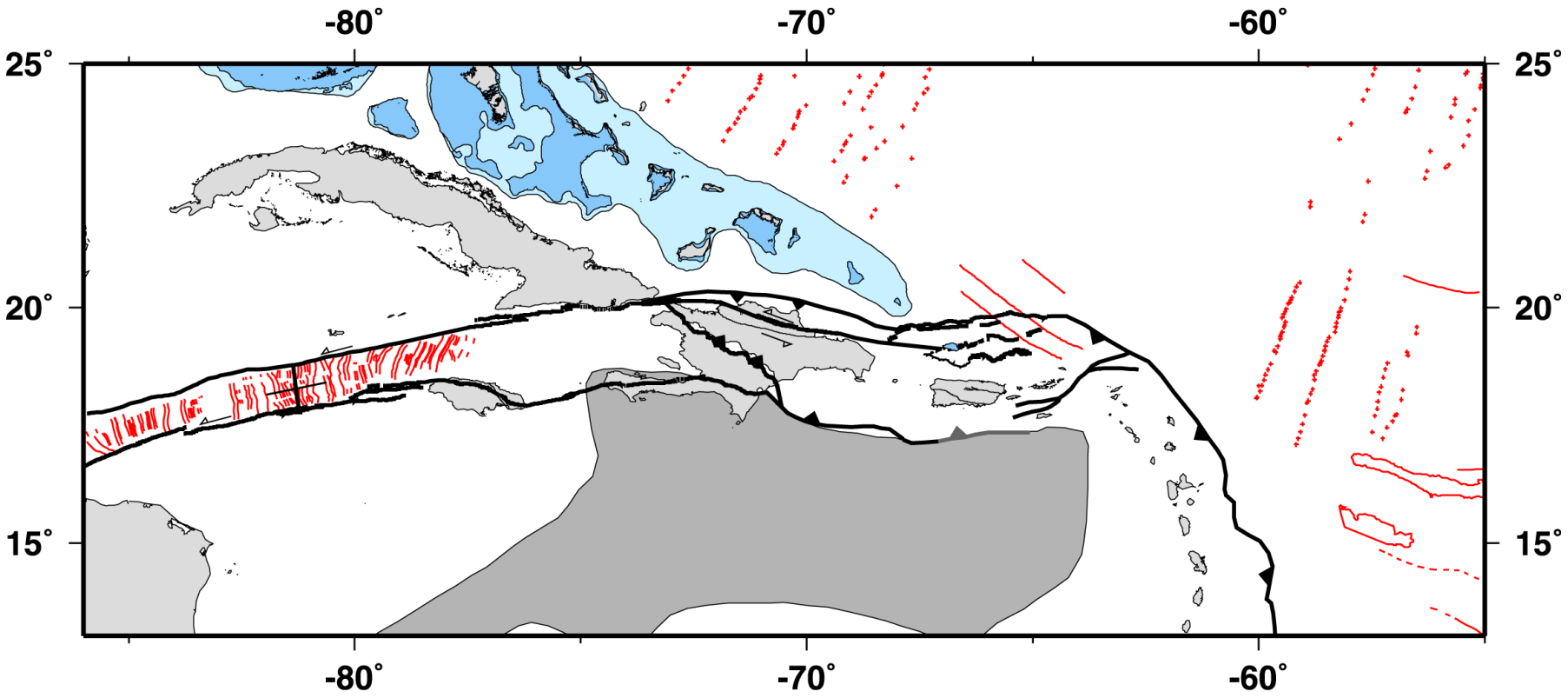
Late Miocene
06.5 Ma



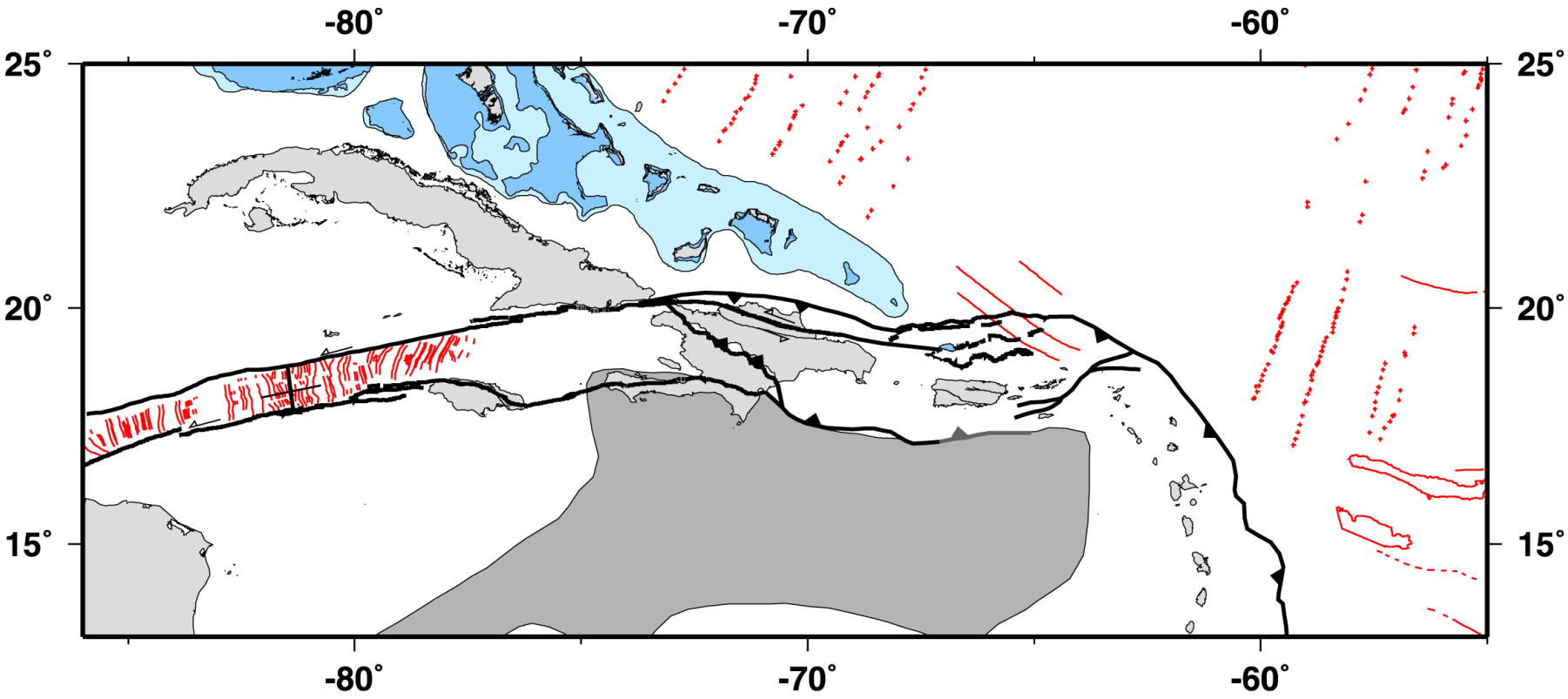
Late Miocene
06.0 Ma



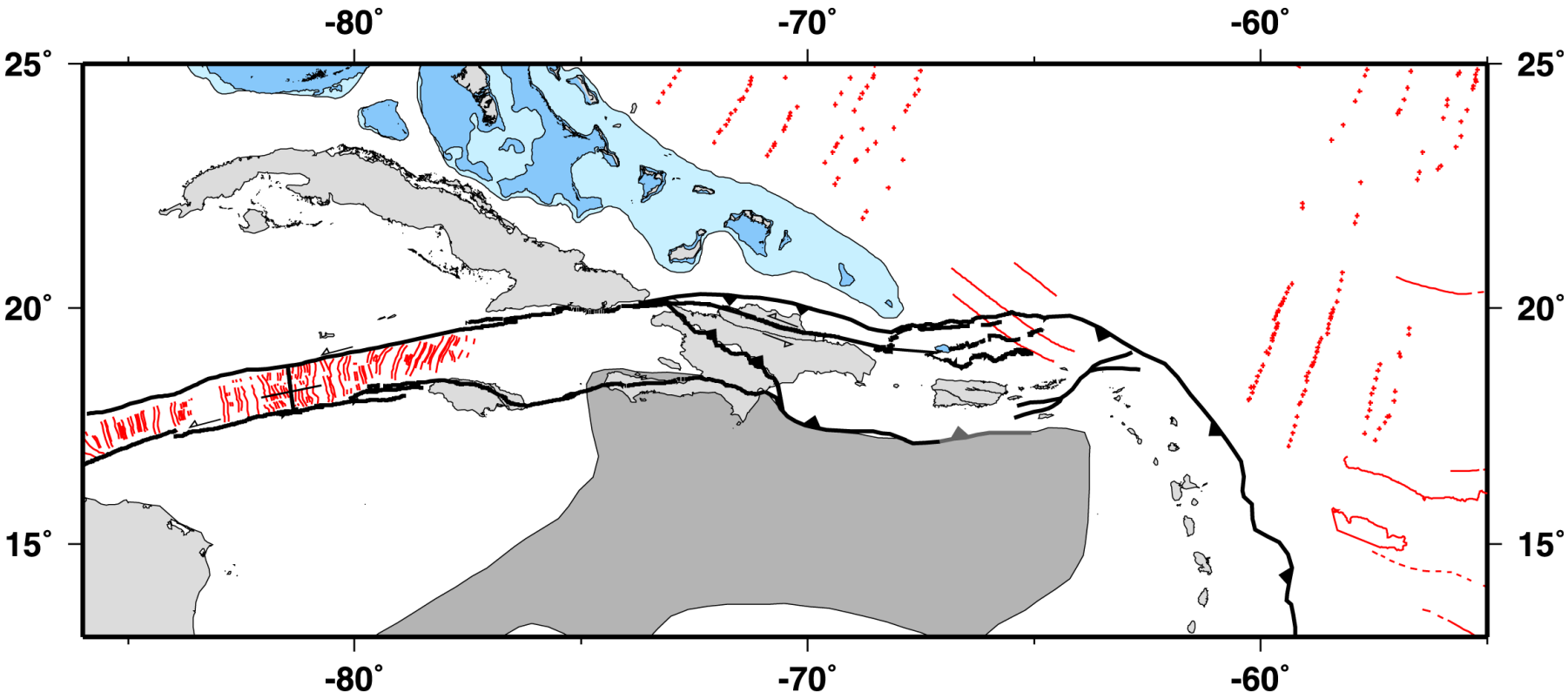
Late Miocene
05.5 Ma



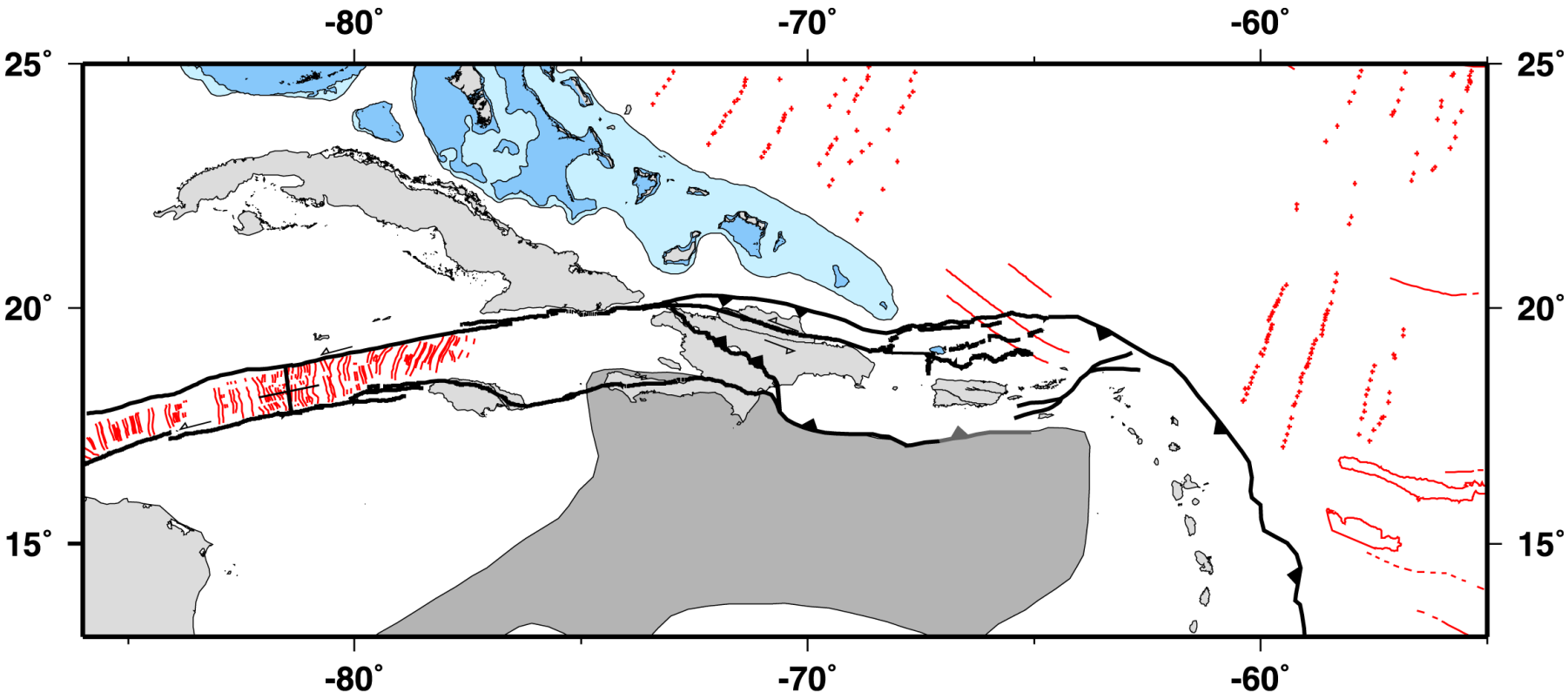
Early Pliocene
05.0 Ma



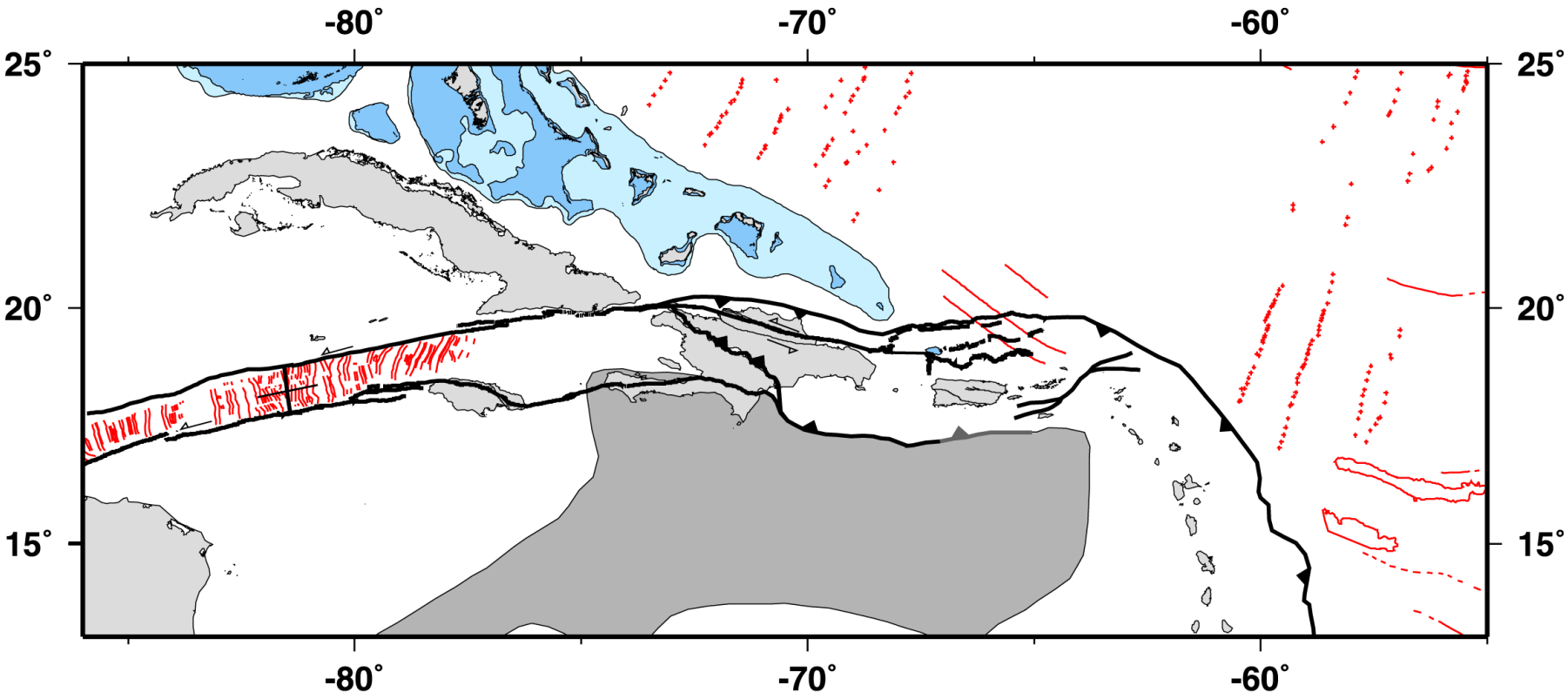
Early Pliocene
04.5 Ma



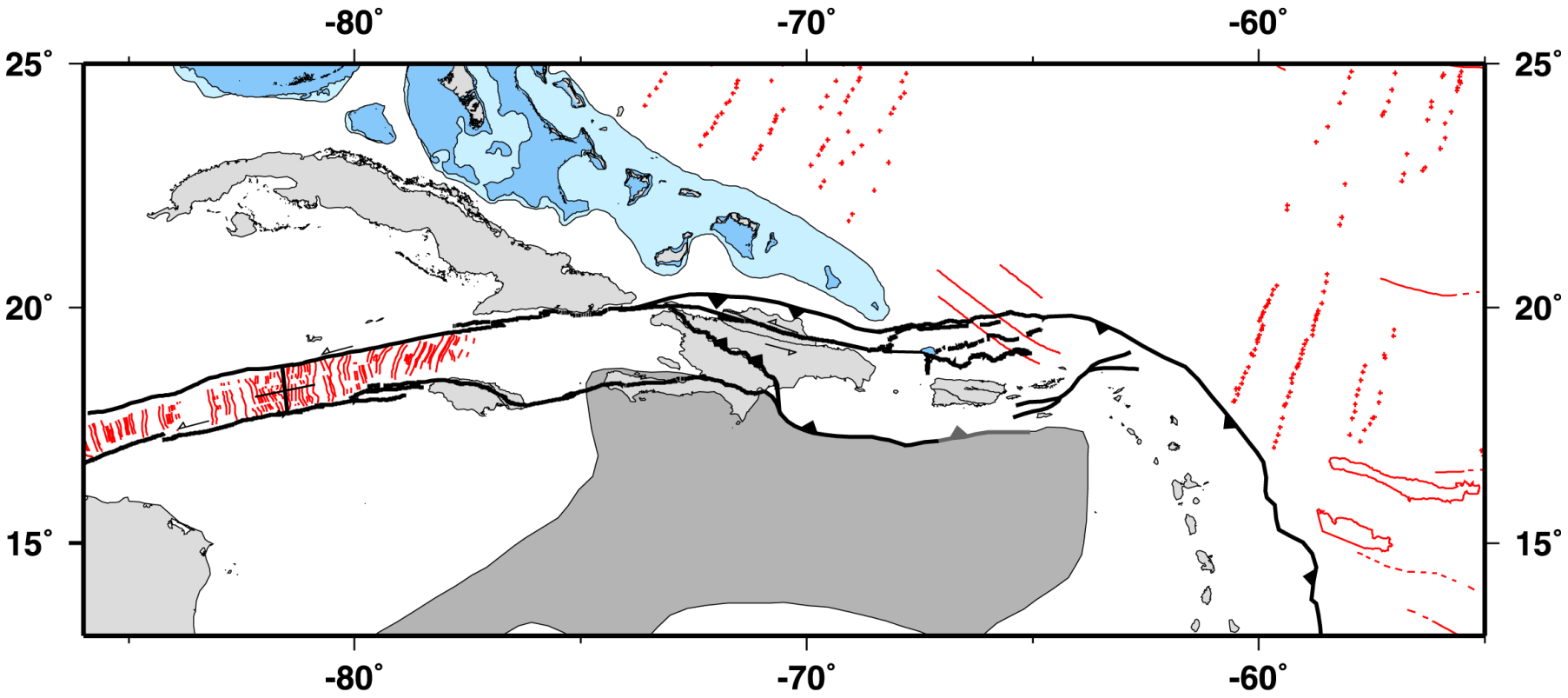
Early Pliocene
04.0 Ma



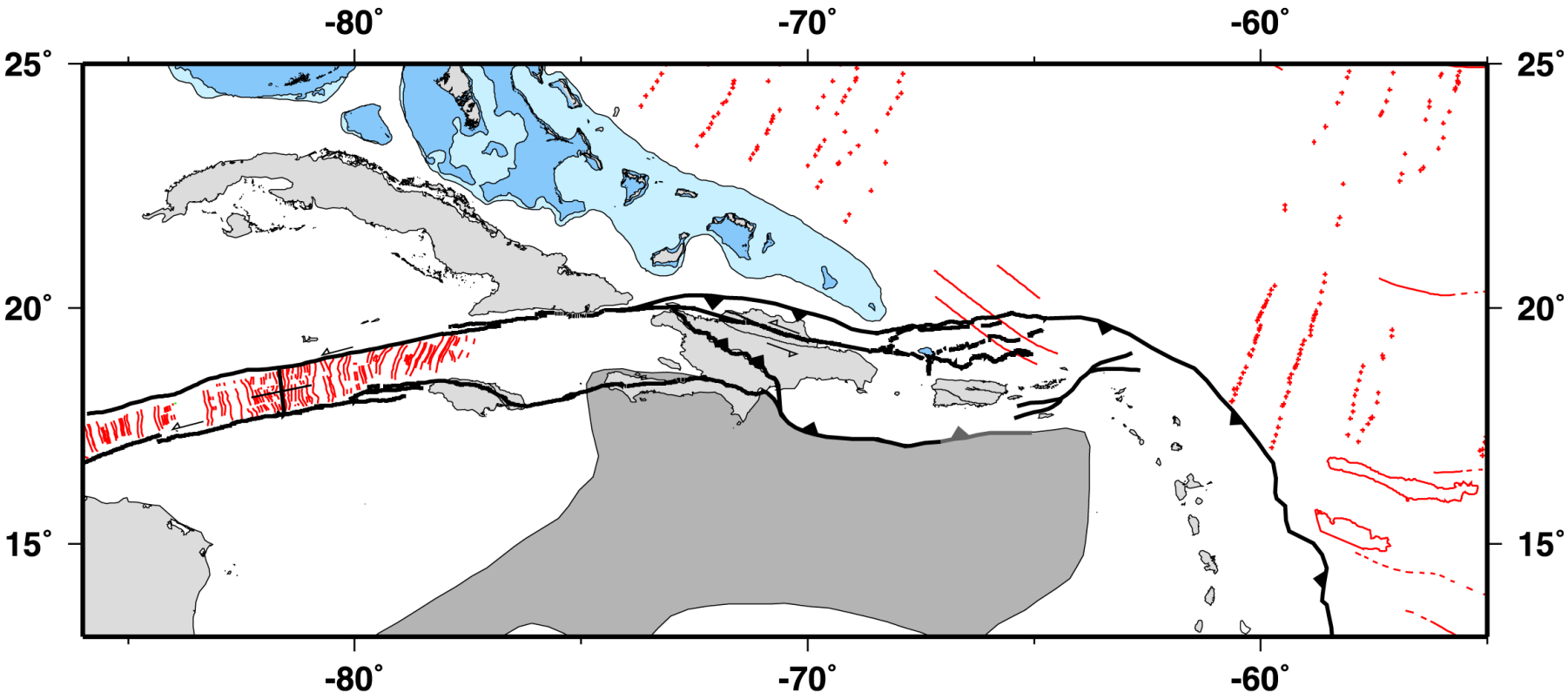
Late Pliocene
03.5 Ma



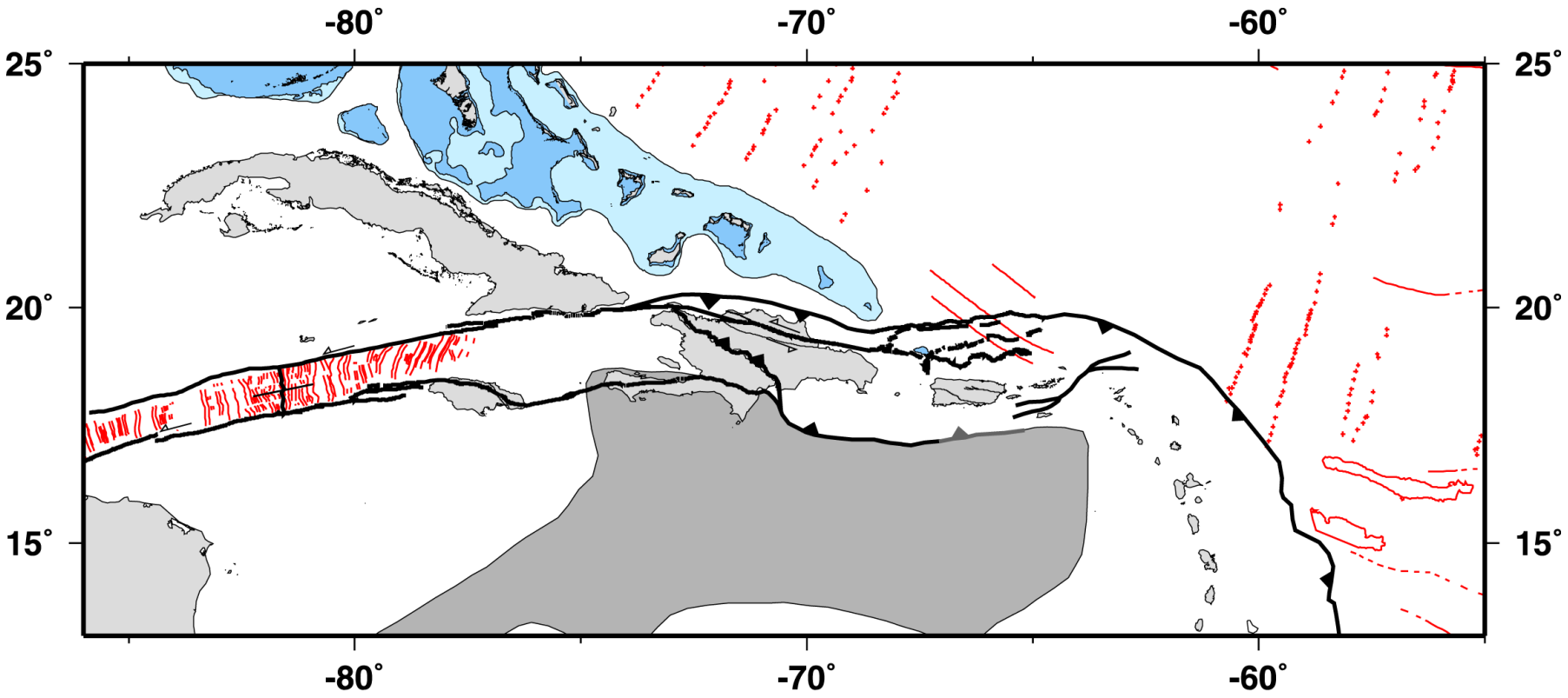
Late Pliocene
03.0 Ma



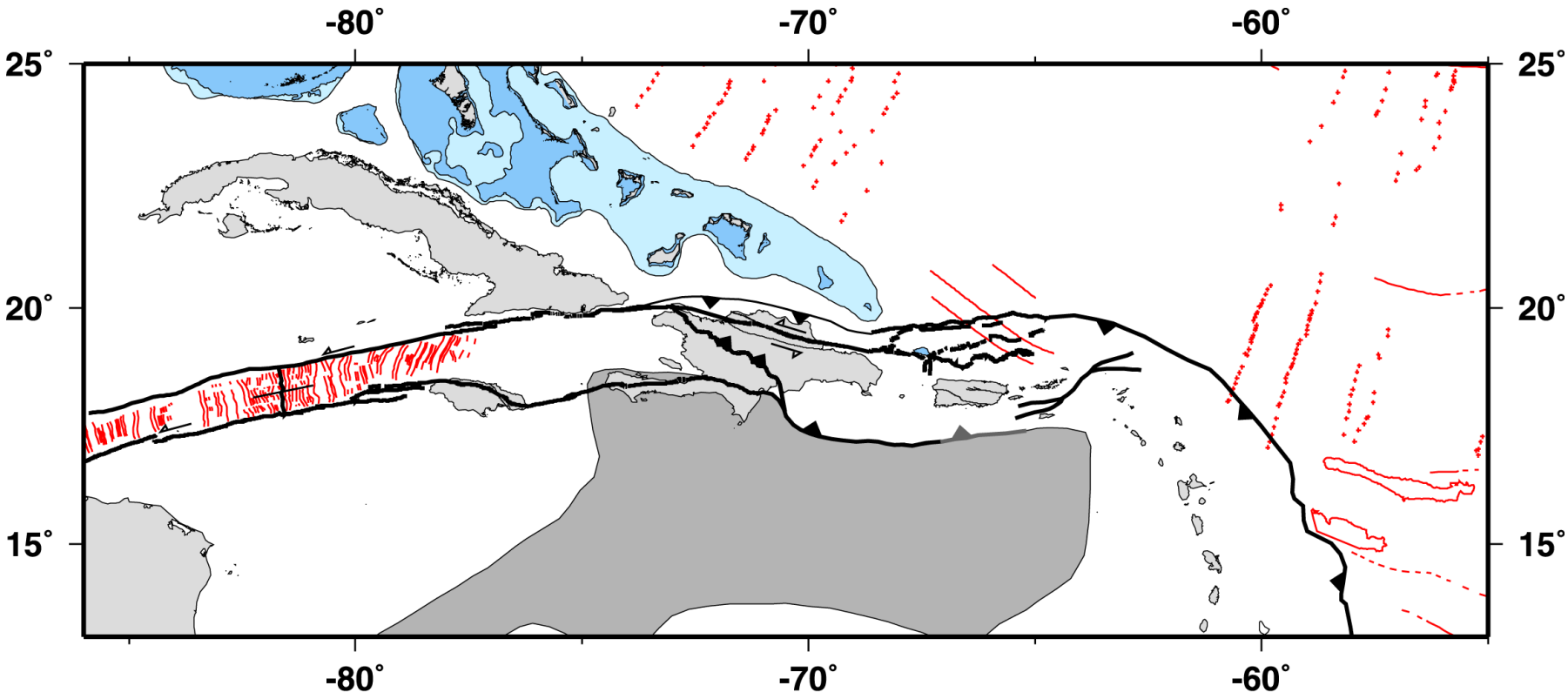
Late Pliocene
02.5 Ma



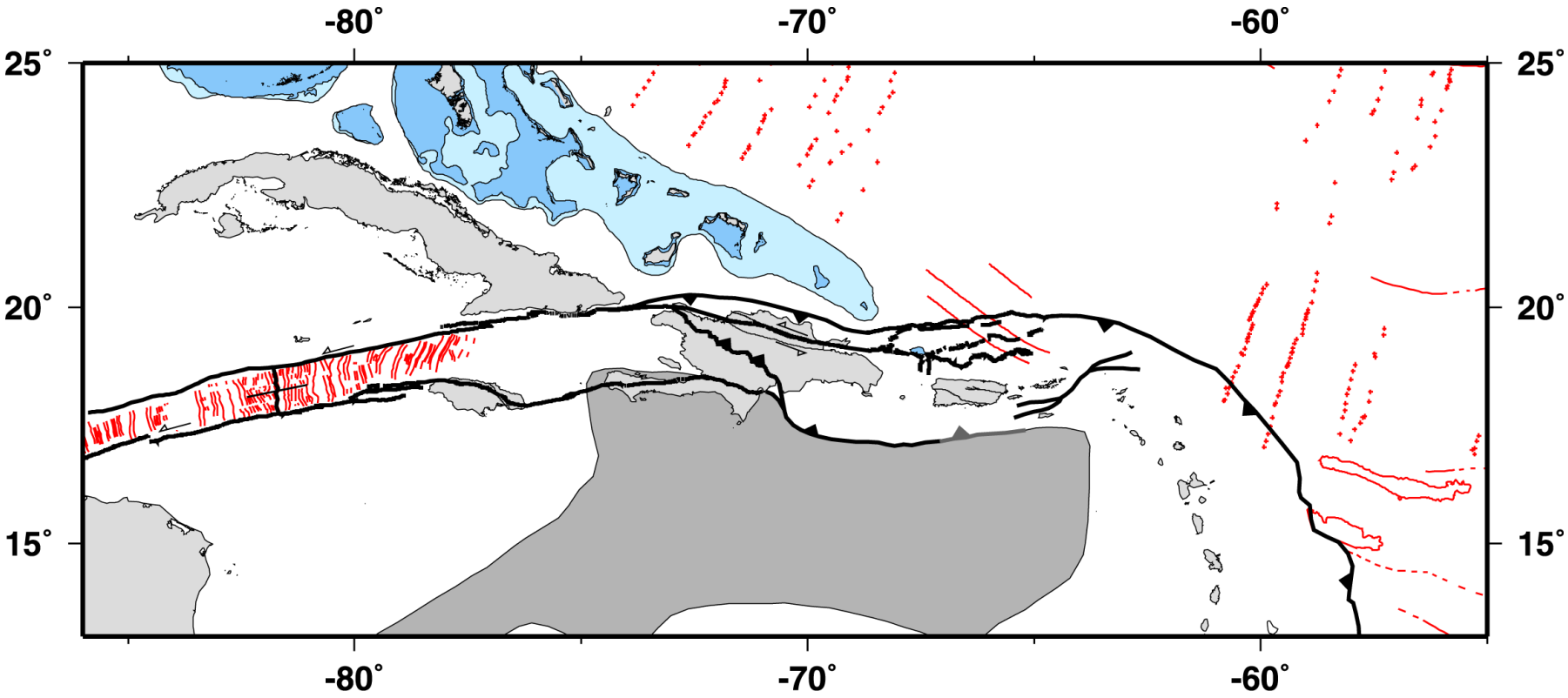
Late Pliocene
02.0 Ma



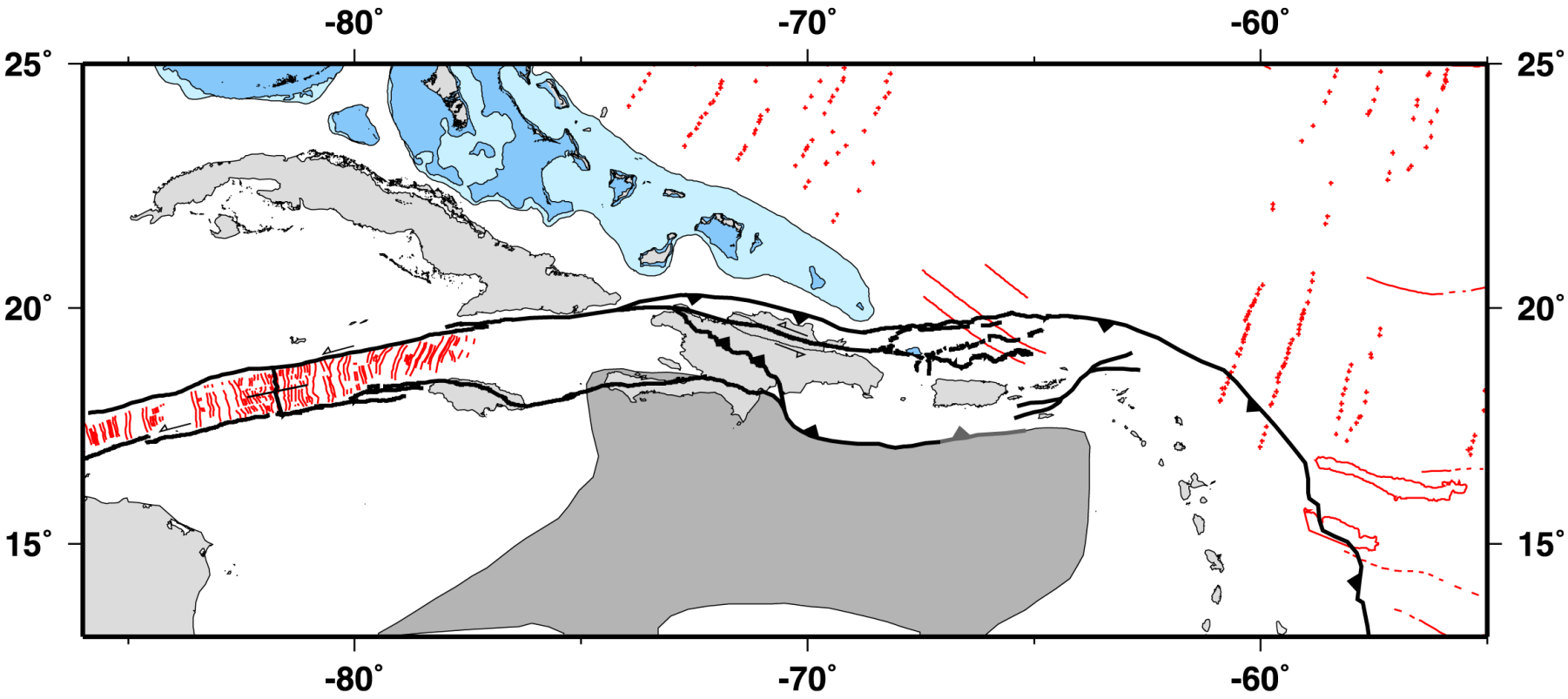
Pleistocene
01.5 Ma



Pleistocene
01.0 Ma

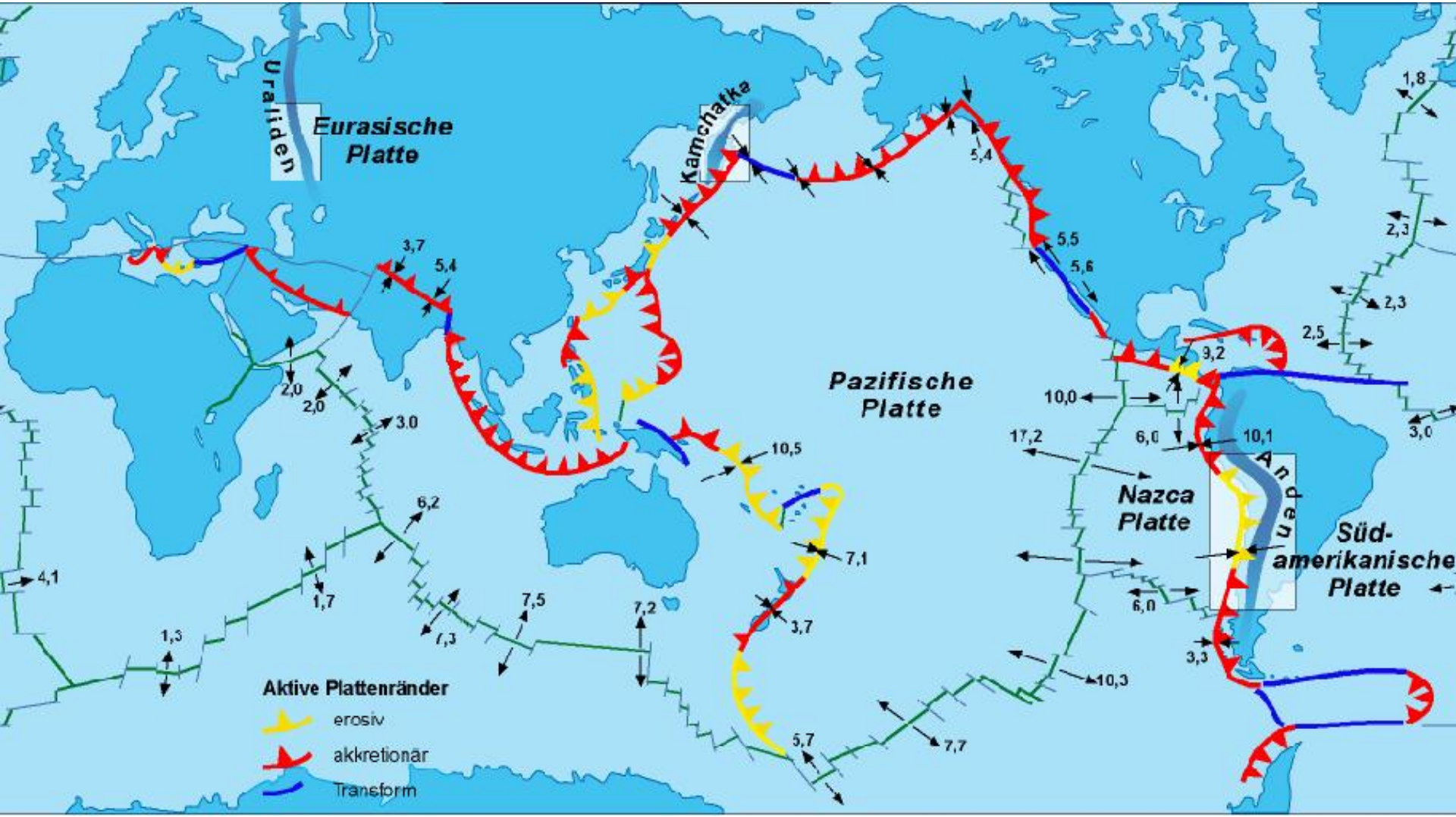


Pleistocene
00.5 Ma

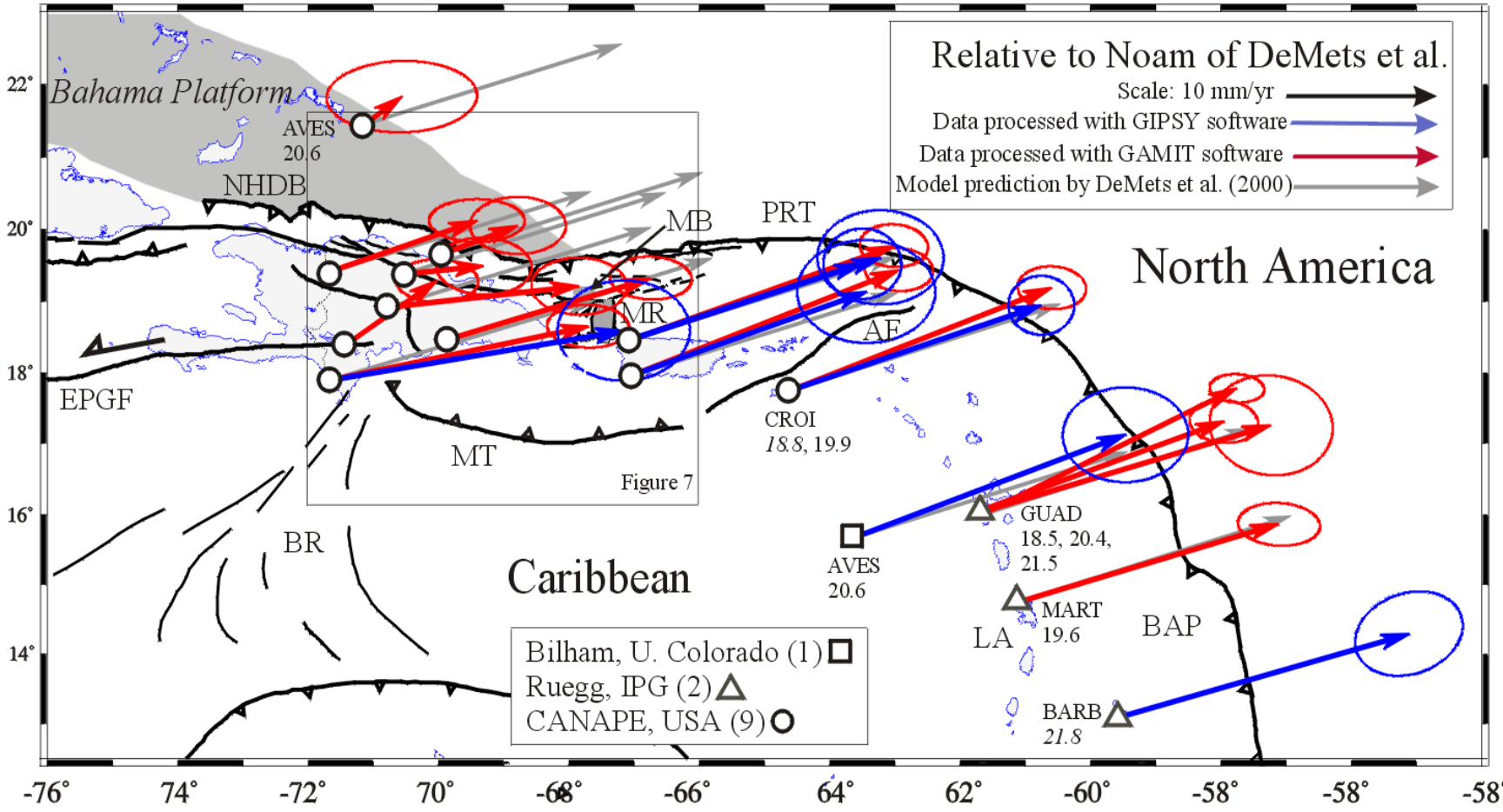


Present Day
00.0 Ma

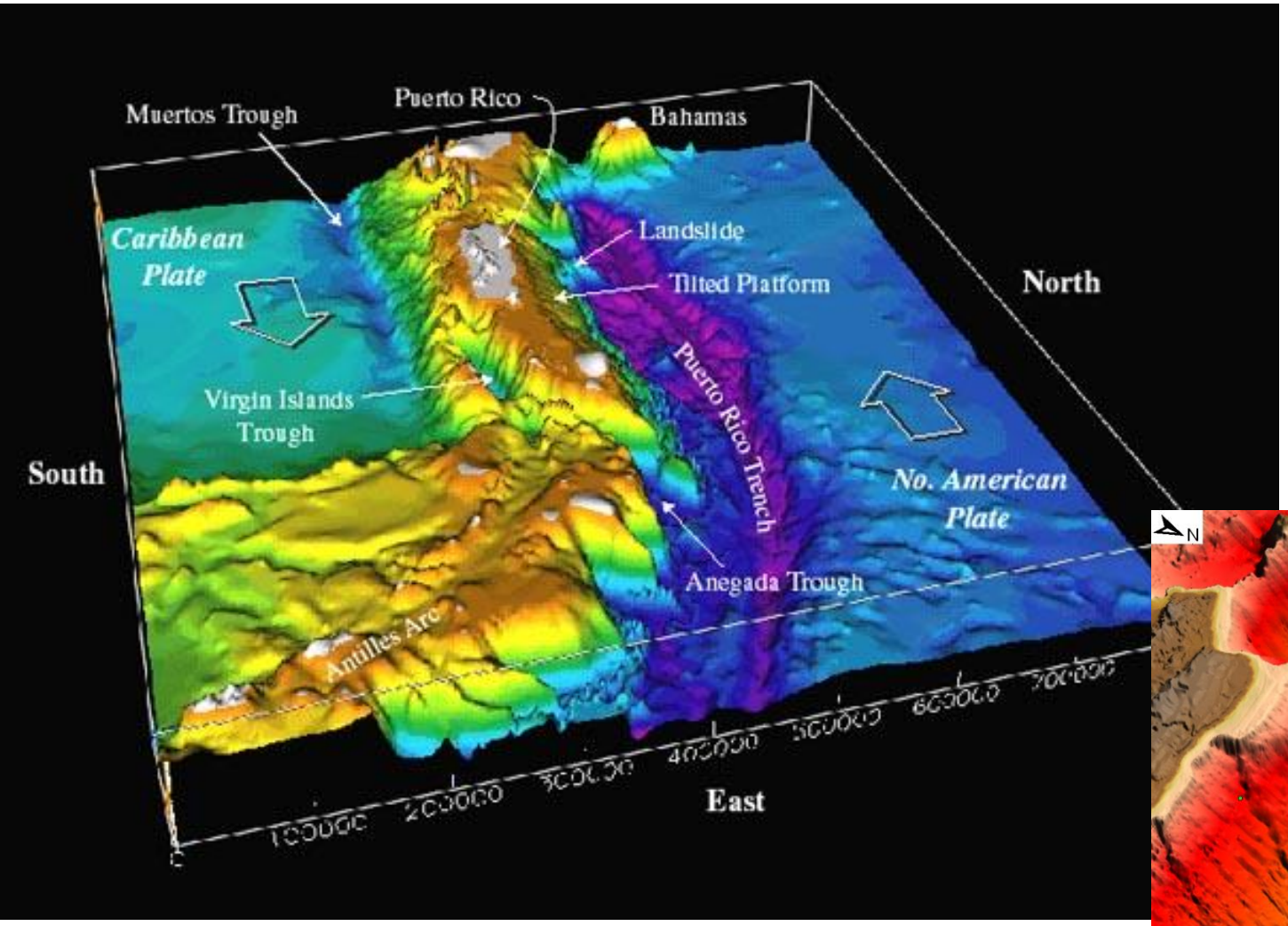
Plate motions

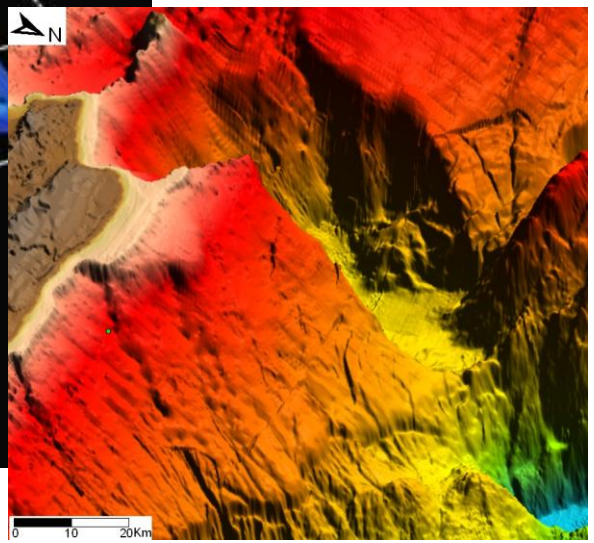


GFZ
POTSDAM

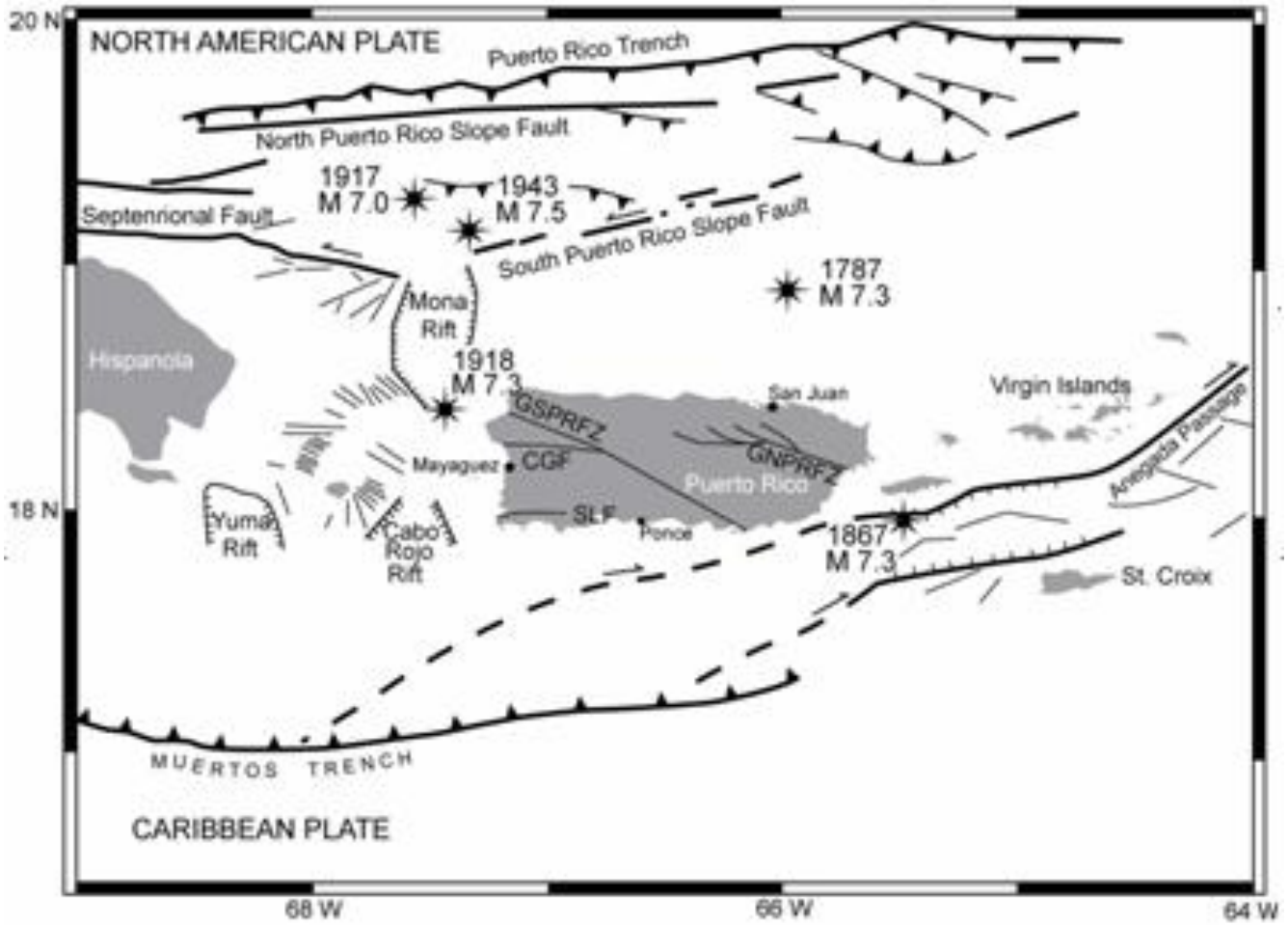

Relative to Noam of DeMets et al.
Scale: 10 mm/yr
Data processed with GIPSY software
Data processed with GAMIT software
Model prediction by DeMets et al. (2000)
Bahama Platform
North America
Caribbean
AVES
20.6
NHDB
MB
PRT
MR
AF
EPGF
CROI
18.8, 19.9
MT
Figure 7
BR
GUAD
18.5, 20.4,
21.5
AVES
20.6
MART
19.6
LA
BAP
BARB
21.8
Bilham, U. Colorado (1)
Ruegg, IPG (2)
CANAPE, USA (9)
22°
20°
18°
16°
14°
-76°
74°
-72°
70°
-68°
-66°
64°
62°
-60°
-58°
-58°
-58°

Tectonic Features from ten Brink, 2005

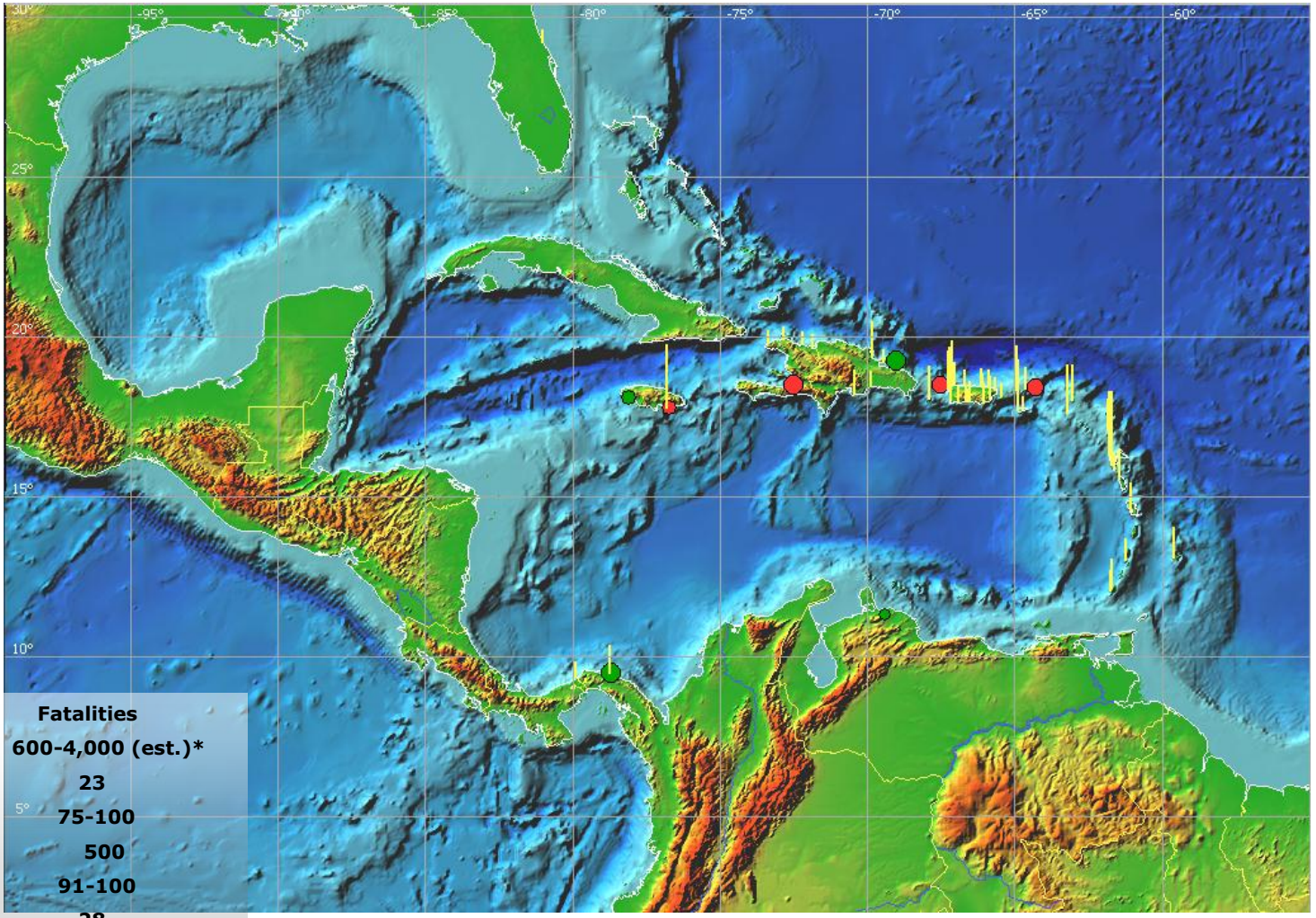




Major Faults and Earthquakes PR Region



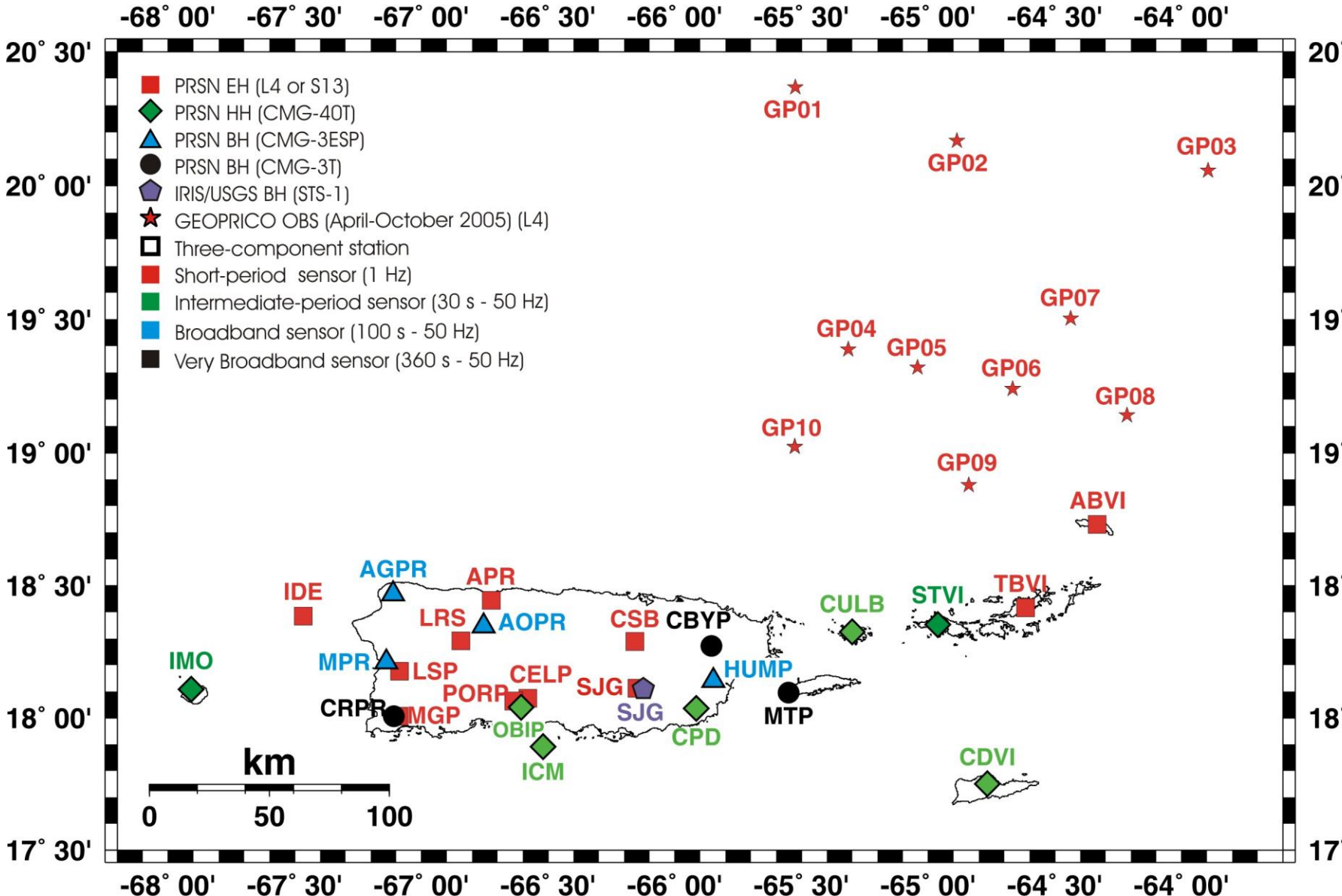
Tsunami History



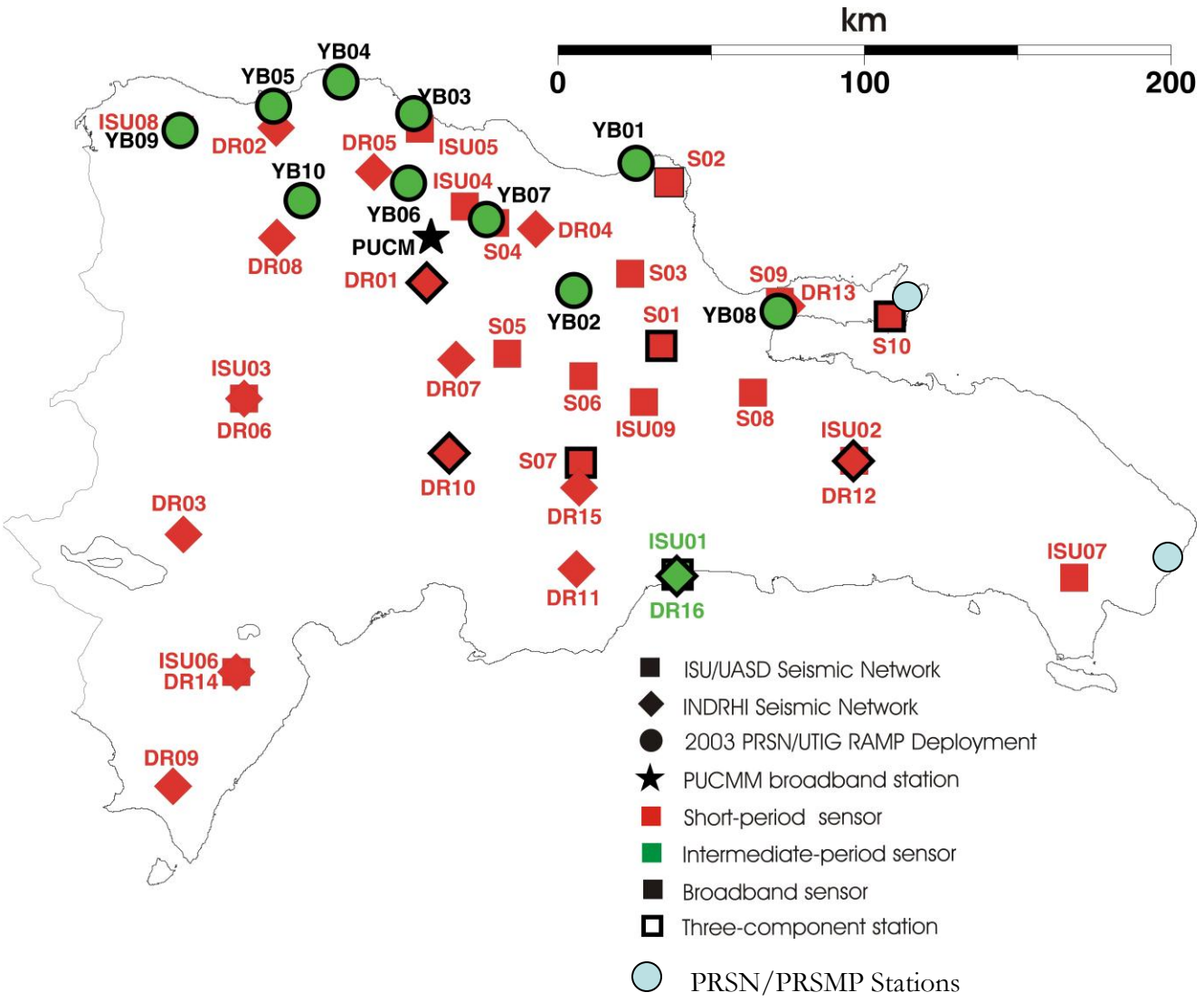
Date	Place	Fatalities
1853	Venezuela	600-4,000 (est.)*
1867	Virgin Islands	23
1882	Panama	75-100
1907	Jamaica	500
1918	Puerto Rico	91-100
1929	Canada	28
1946	Dominican Republic	1,790; 75
1991	Costa Rica	2
		2,584 TOTAL

*not included

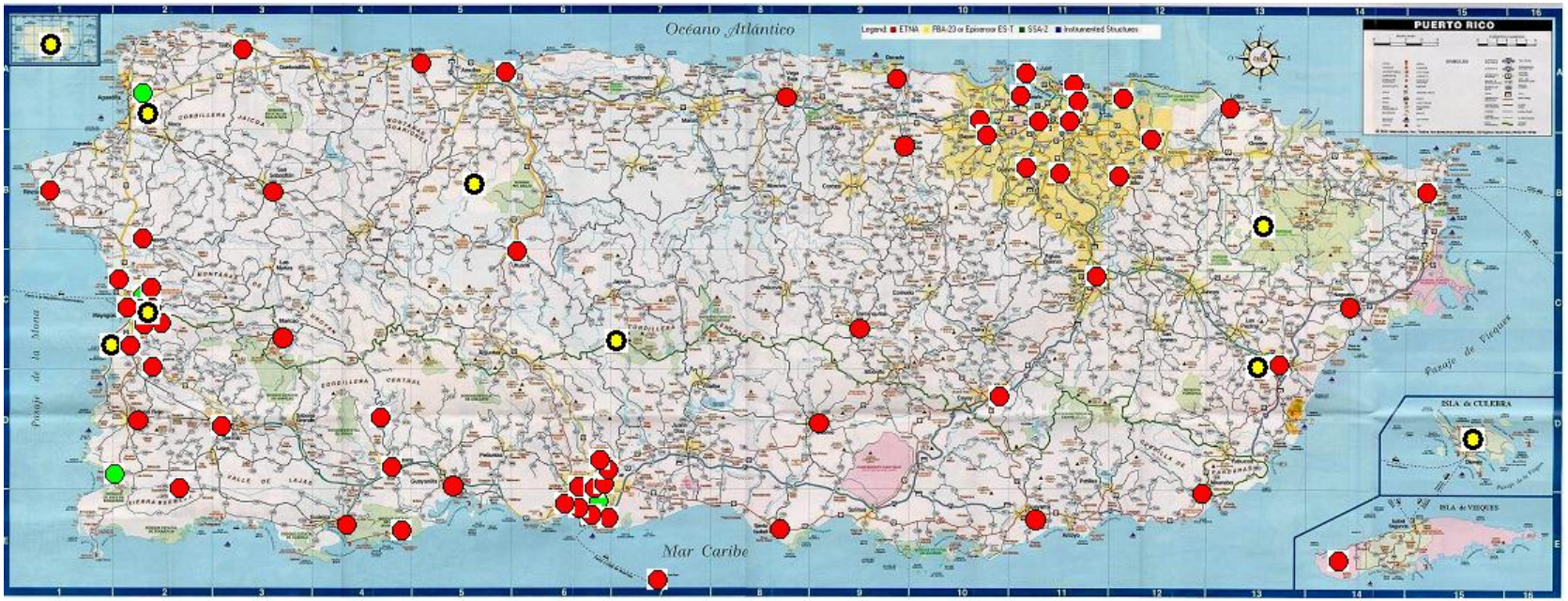
Estaciones Sísmicas RSPR - 2005



Seismic Monitoring in the DR

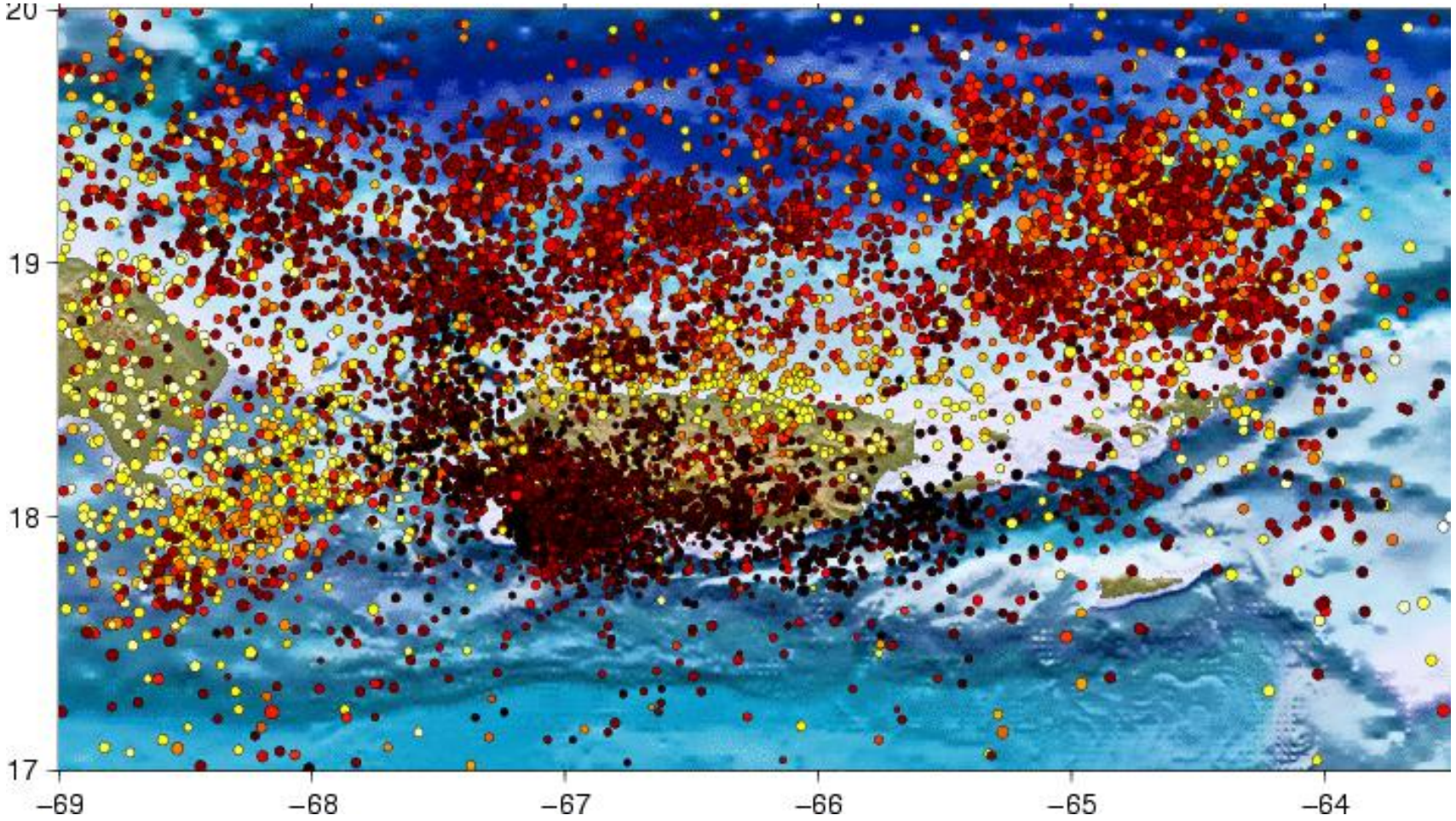


Strong Motion Monitoring
Puerto Rico Strong Motion Program
Dept. Civil Engineering, UPRM



Sismicidad en Puerto Rico

1995-2005



USGS Seismic Hazard Map 2003

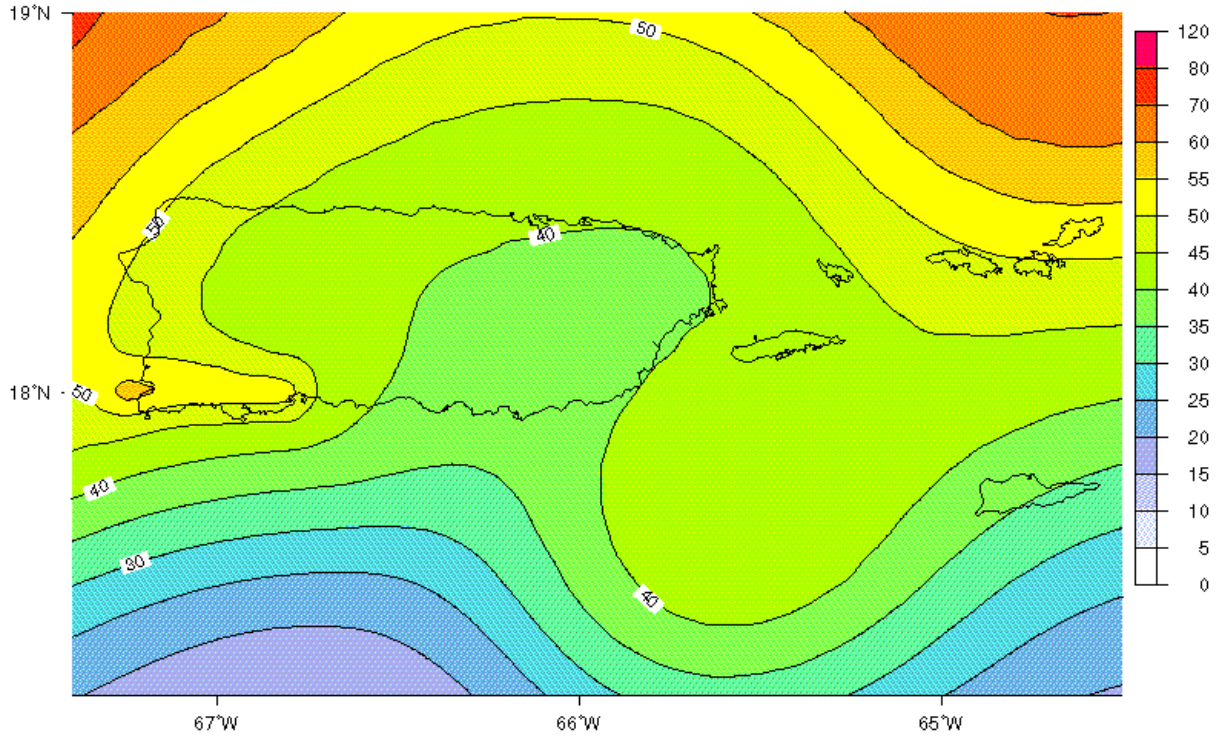
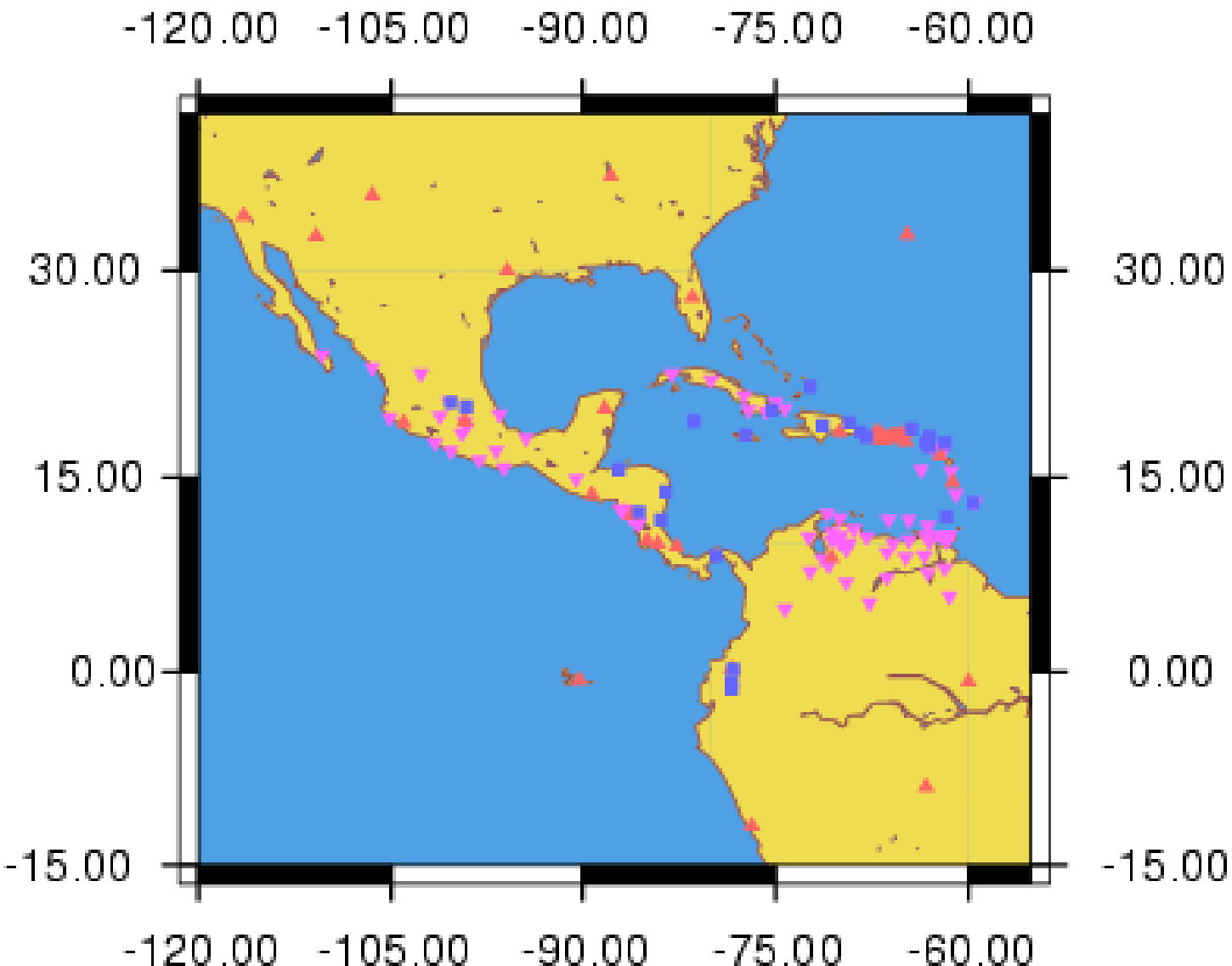
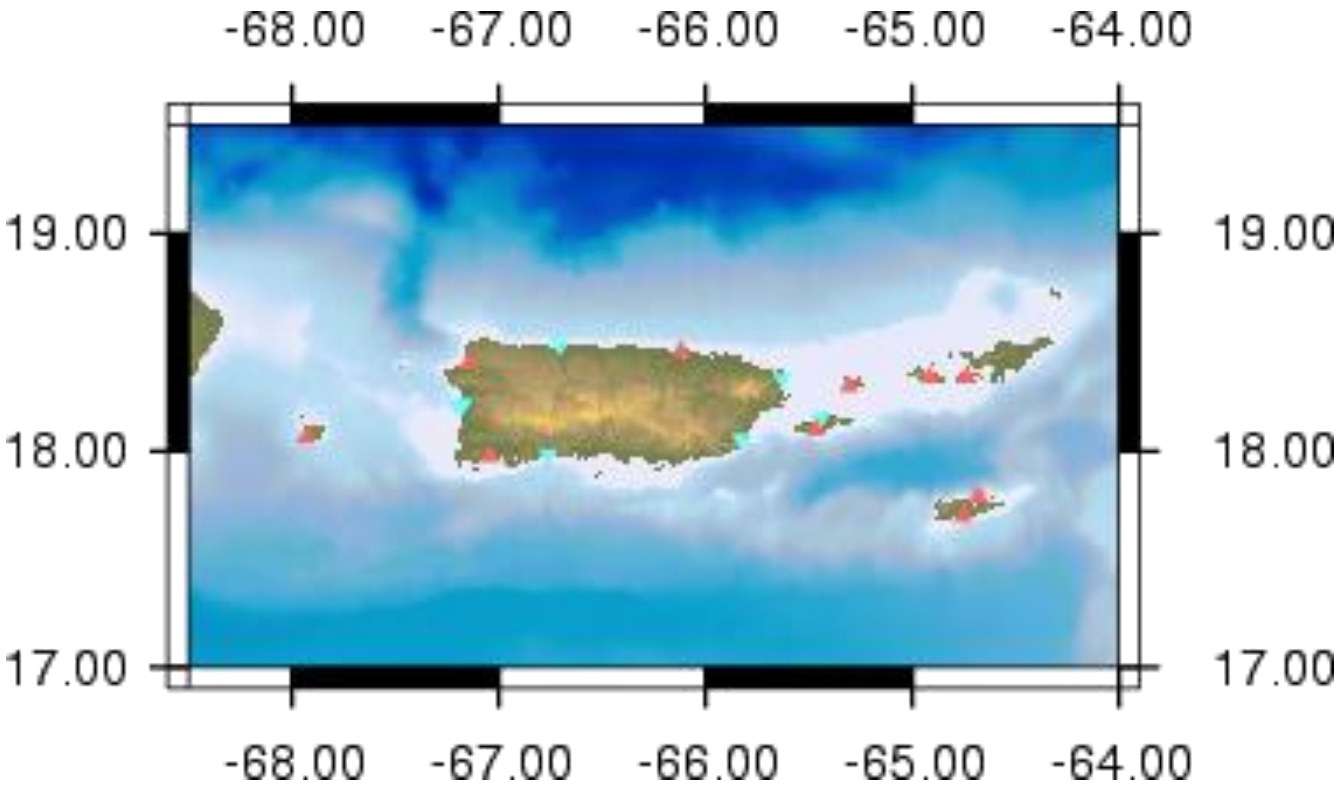


Fig.4: PGA (%g) with 2% probability of exceedance in 50 years from all modeled sources.

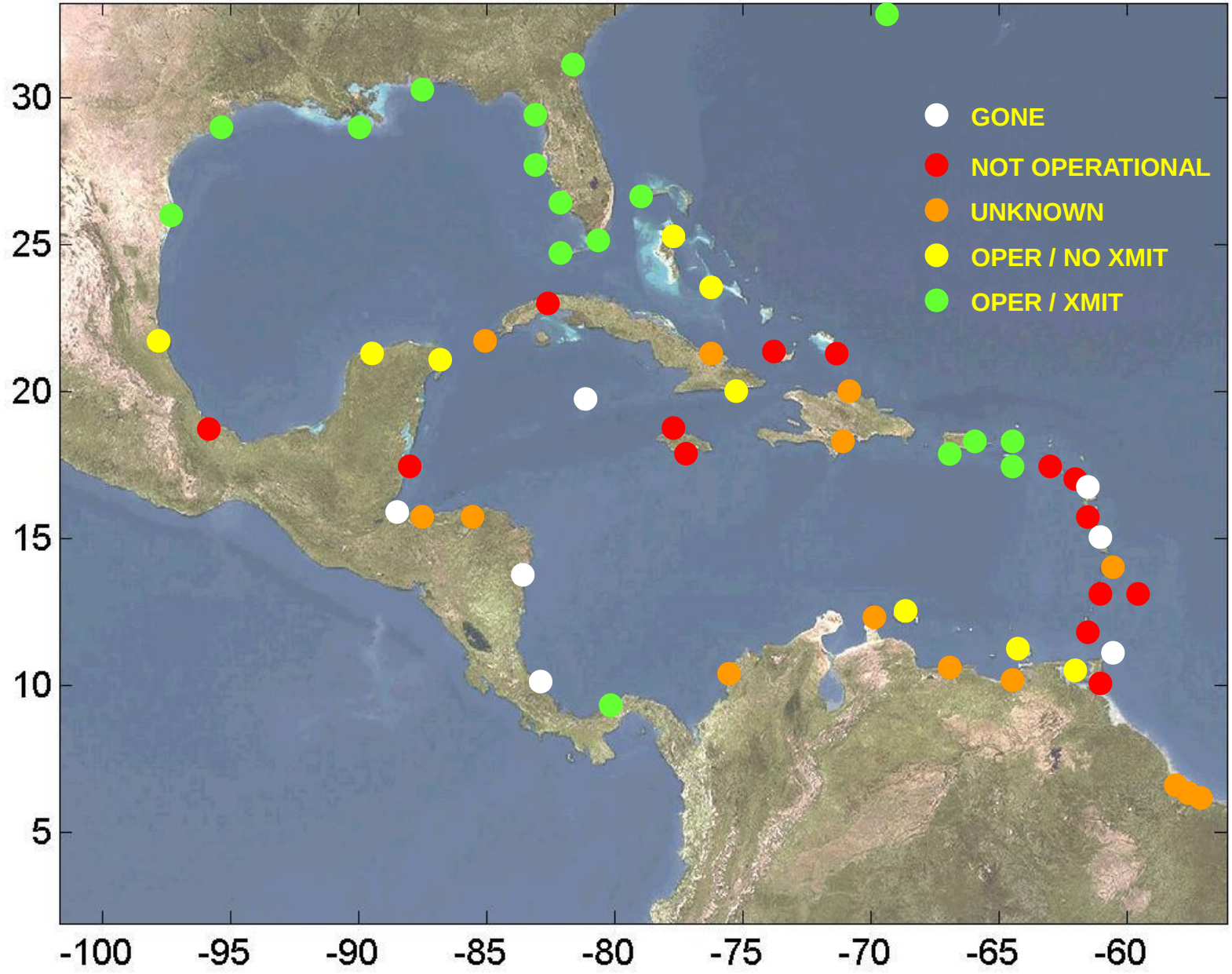
Estaciones Sismicas de Banda Ancha en el Gran Caribe



PR/VI Tsunami Ready Tide Gauges

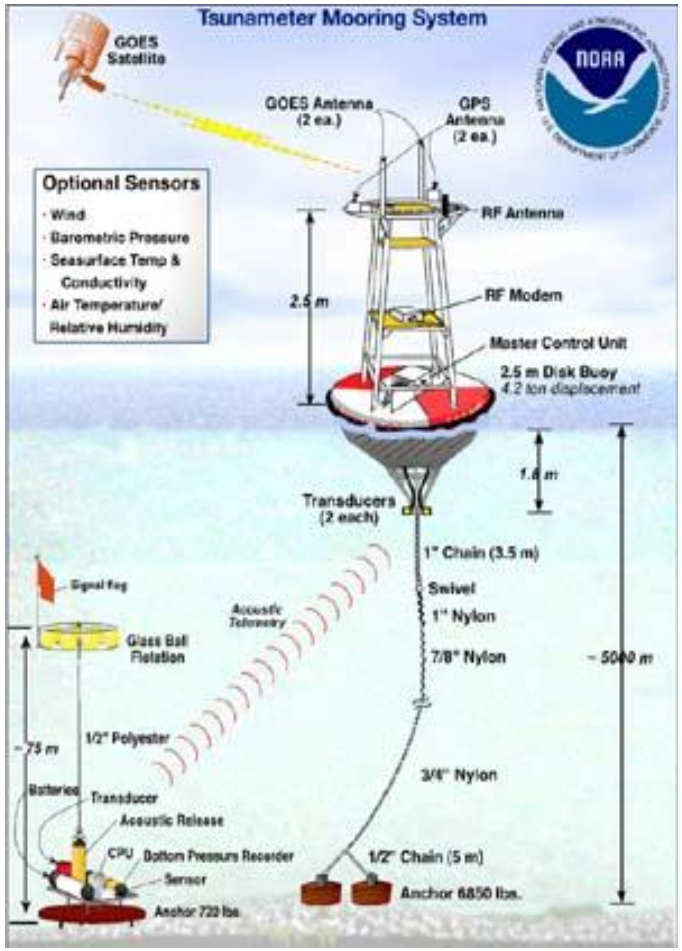


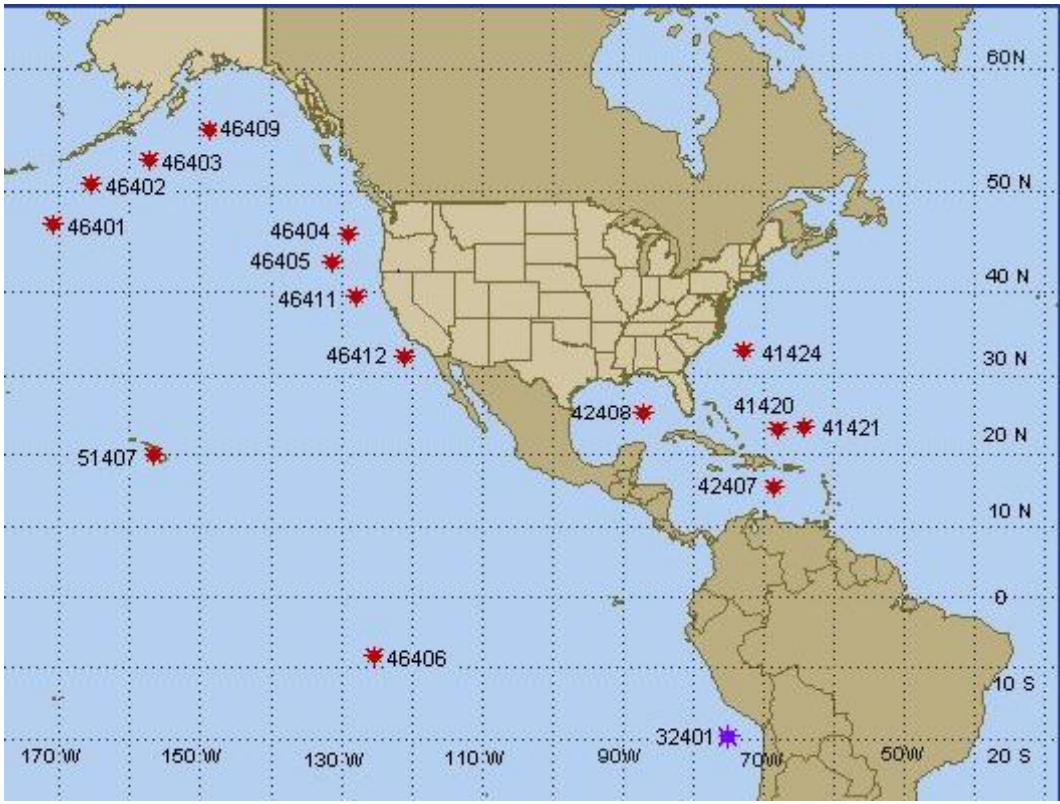
Intra-Americas Sea Water-Level Network



Status reported GLOSS IX 02/05

DART Buoys


Tsunameter Mooring System
GOES Satellite
GOES Antenna (2 ea.)
GPS Antenna (2 ea.)
NOAA
Optional Sensors
· Wind
· Barometric Pressure
· Seasurface Temp & Conductivity
· Air Temperature/ Relative Humidity
RF Antenna
2.5 m
RF Modem
Master Control Unit
2.5 m Disk Buoy
4.2 ton displacement
1.6 m
Transducers (2 each)
1" Chain (3.5 m)
Swivel
1" Nylon
7/8" Nylon
~ 5000 m
Signal Flag
Acoustic Telemetry
Glass Ball Flotation
~ 75 m
1/2" Polyester
Batteries
Transducer
Acoustic Release
CPU
Bottom Pressure Recorder
Sensor
Anchor 720 lbs
3/4" Nylon
1/2" Chain (5 m)
Anchor 6850 lbs.

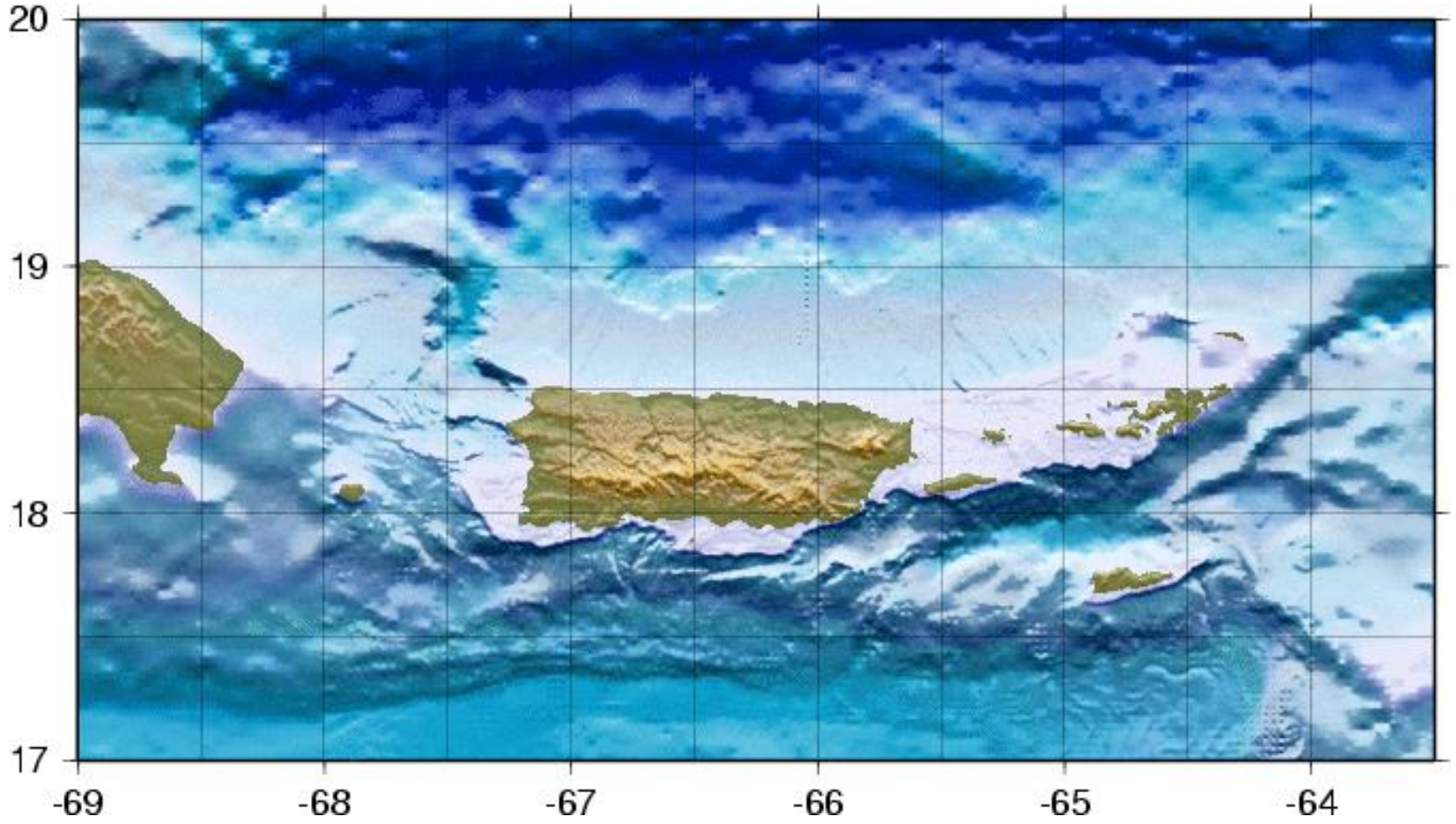

46409
46403
46402
46401
46404
46405
46411
46412
41424
42408
41420
41421
51407
42407
46406
32401
60N
50 N
40 N
30 N
20 N
10 N
0
10 S
20 S
170 W
150 W
130 W
110 W
90W
70W
50W

Puerto Rico Seismic Network

USGS

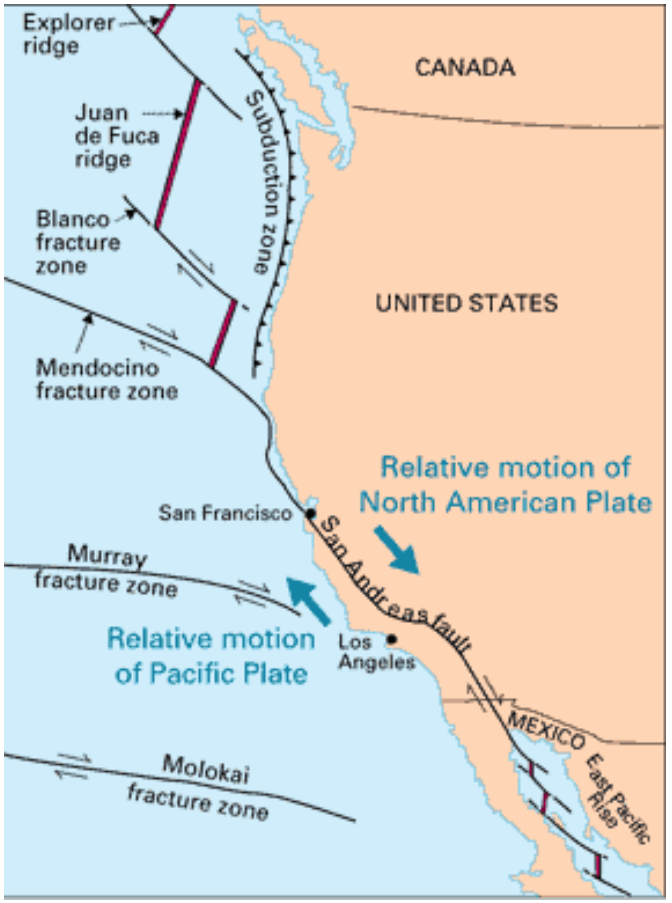
PTWC

GPS Stations Available to PRSN in Real Time



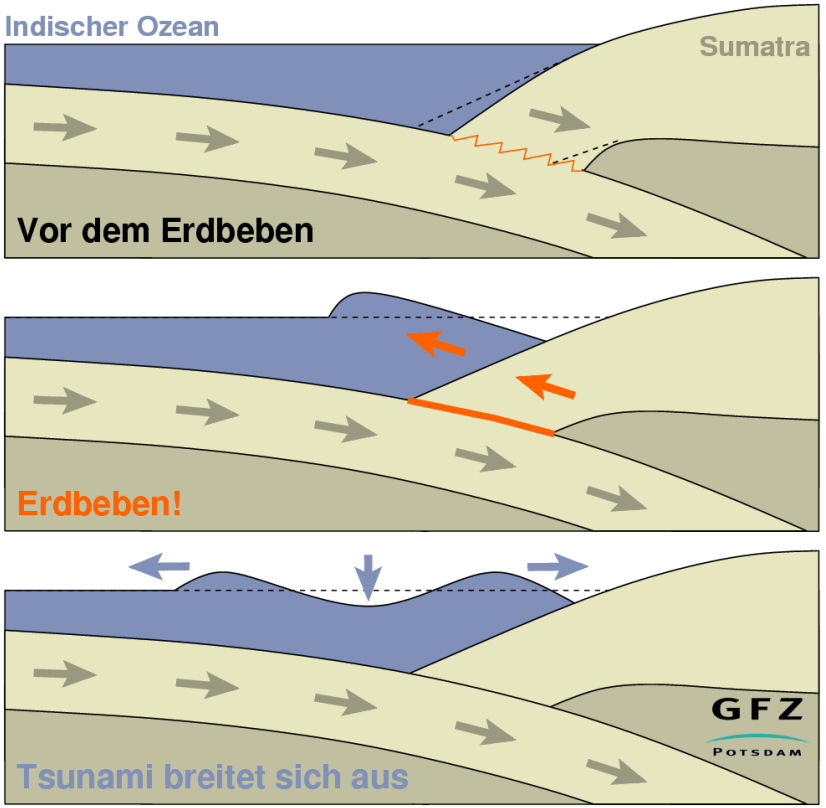
GPS Applications at PRSN

- Further constrain seismic sources in the Northeastern Caribbean
- Identification of aseismic fault movements
- Constrain the source model of large earthquakes, magnitude and fault rupture
- “Calibration” of tide gauges
- Surveying of seismic stations



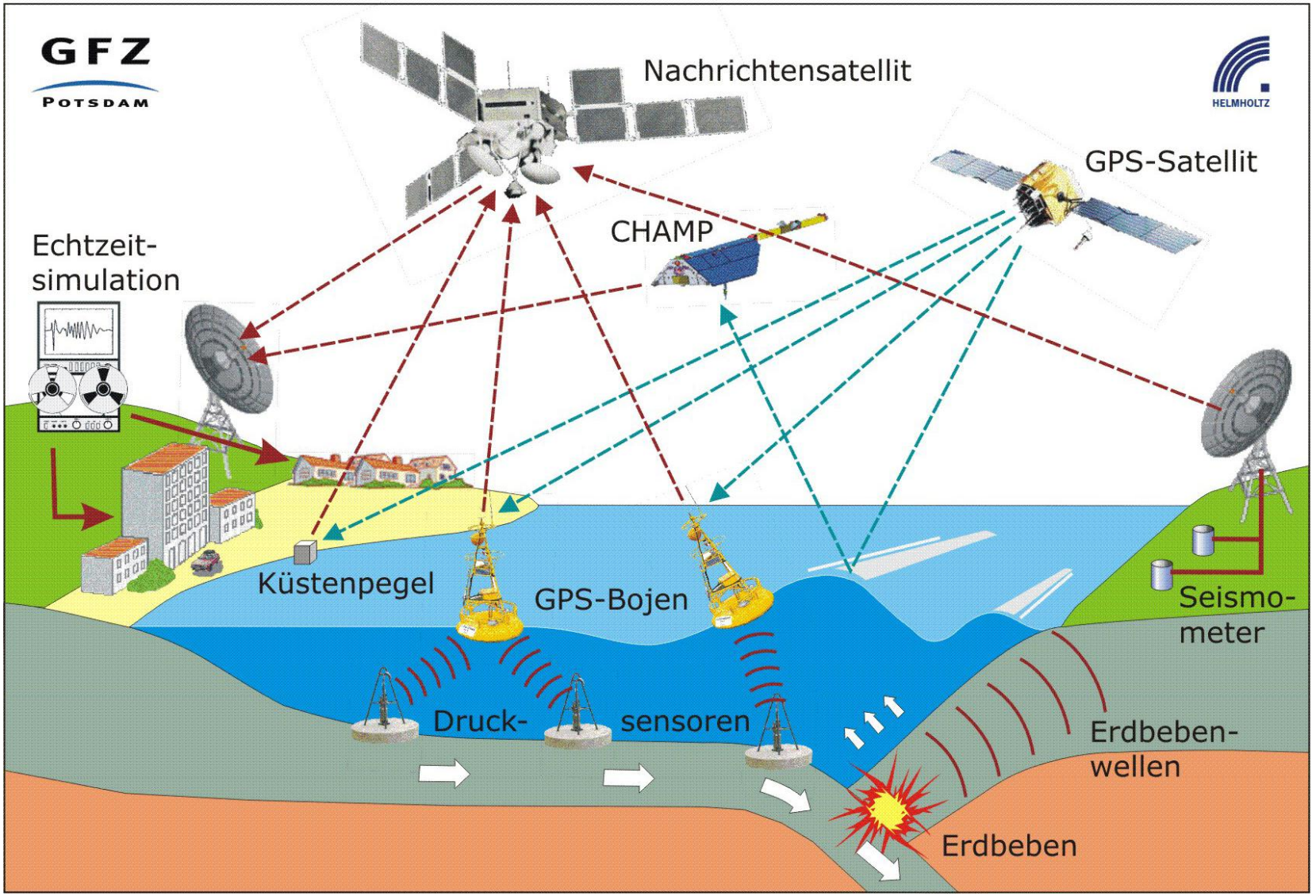
Requirements of Data

- 1 Hz data
- High precision to detect the small displacements
- Real time access and monitoring of the data



Dec. 26, 2004. About 15 m Displacement in the direction of plate motion and 2-3 m upward

Scheme of an earthquake/tsunami early warning system



PRSN Resources

- Continuous monitoring
- Scientific and technical instrumentation personnel
- Field stations/infrastructure
- Process of hiring seismologist who has reseached applications of 1 Hz GPS data
- Participation in Caribbean wide initiatives