

Le séisme de Haiti

de Mw 7.0 du 12 janvier 2010



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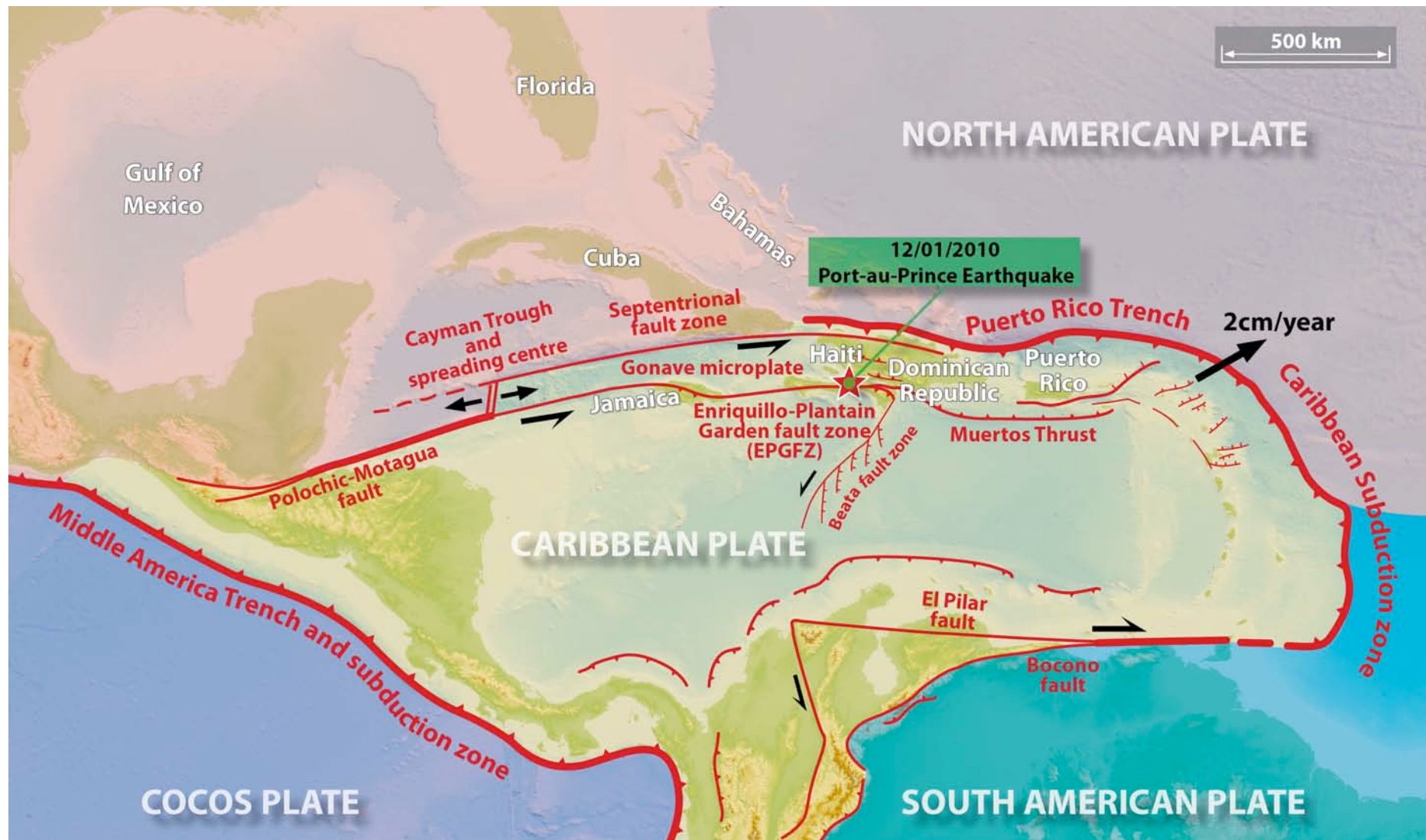
- Contexte tectonique
- Géodynamique actuelle
- Cinématique des Caraïbes
- La frontière de plaque nord
- Caractéristique du séisme du 12 janvier
- La faille d'Enriquillo et paléosismicité

Paul Mann

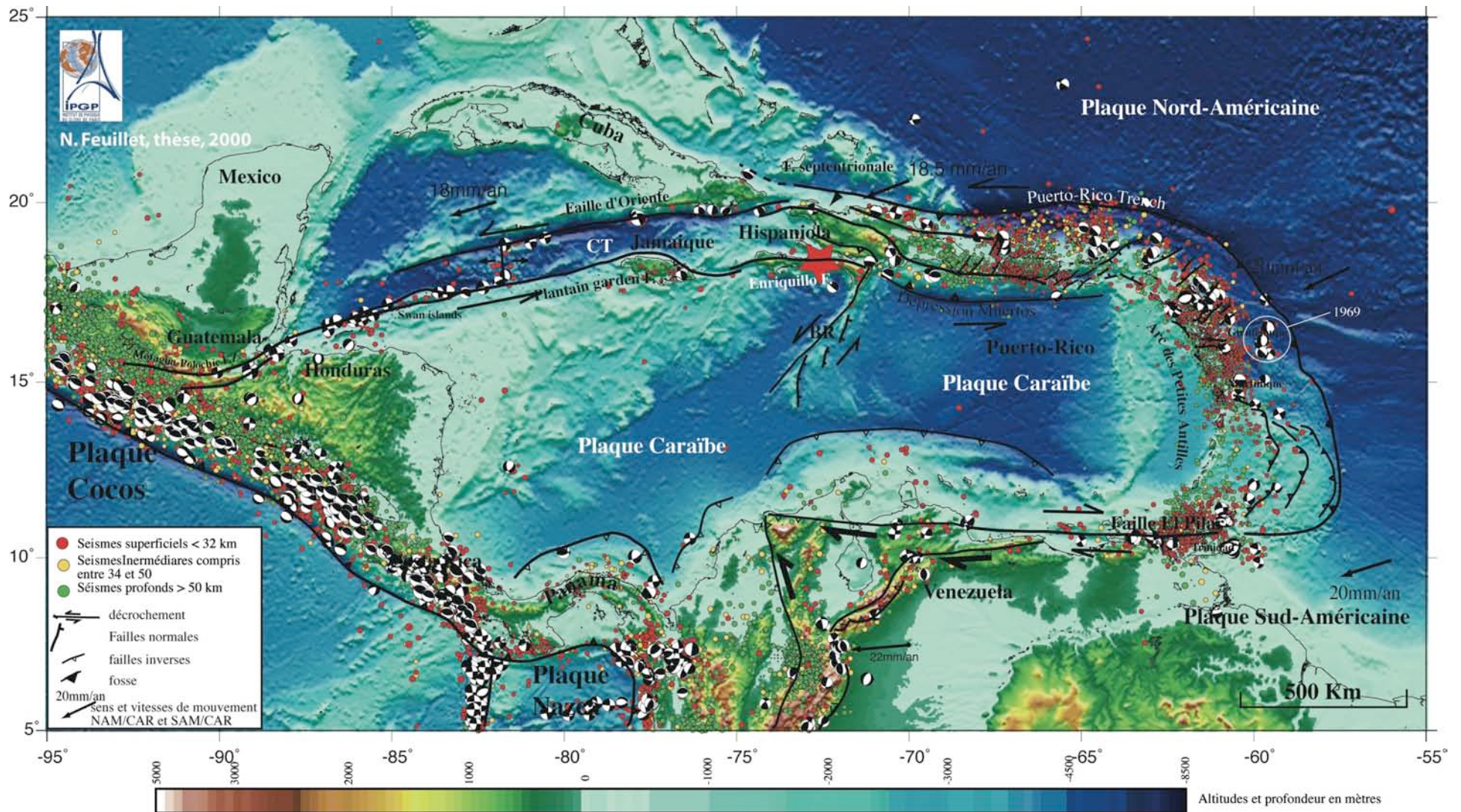
Jackson School of Geophysics, The University of Texas at Austin

Eric Calais

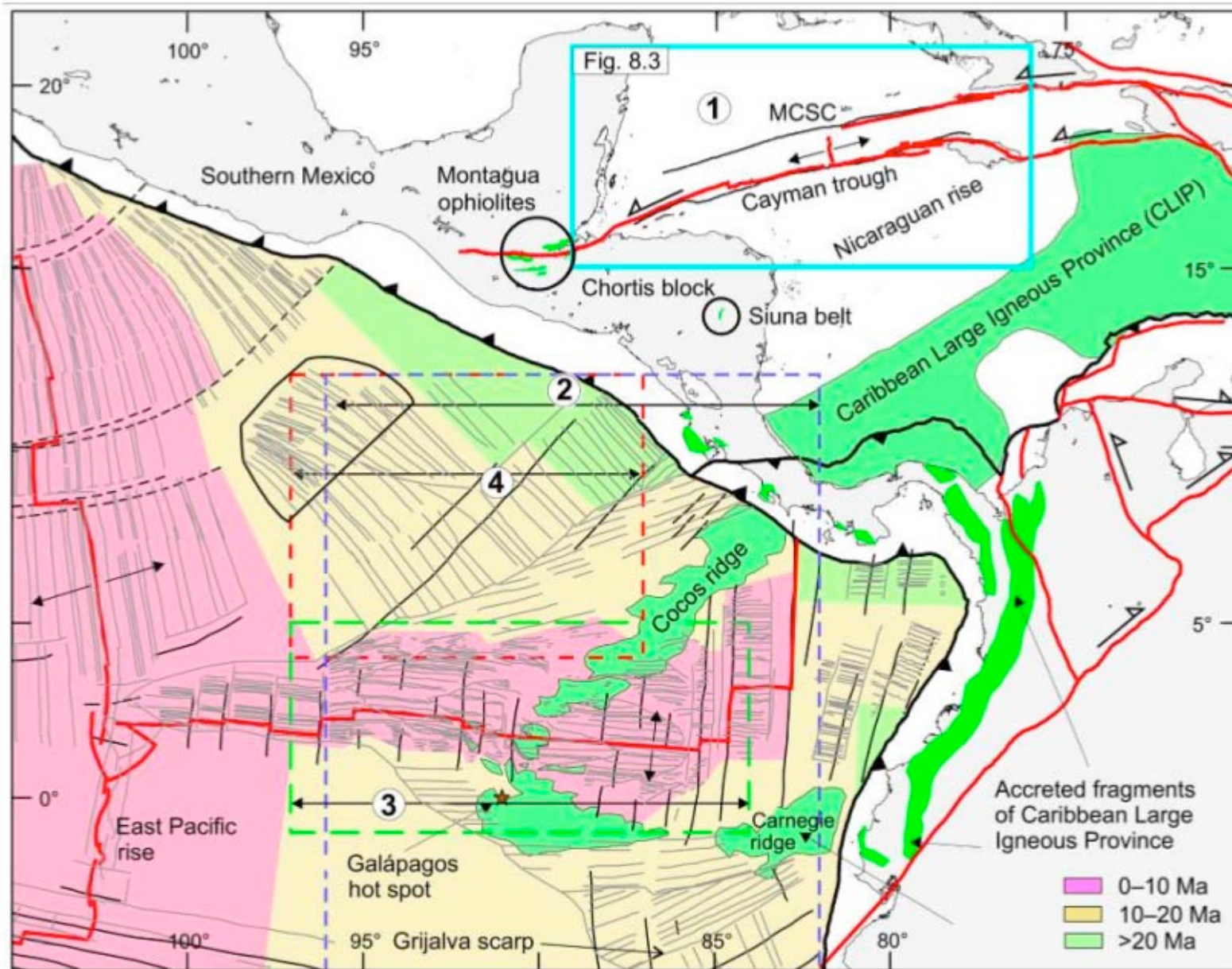
Earth Science Department, Purdue University, Indiana

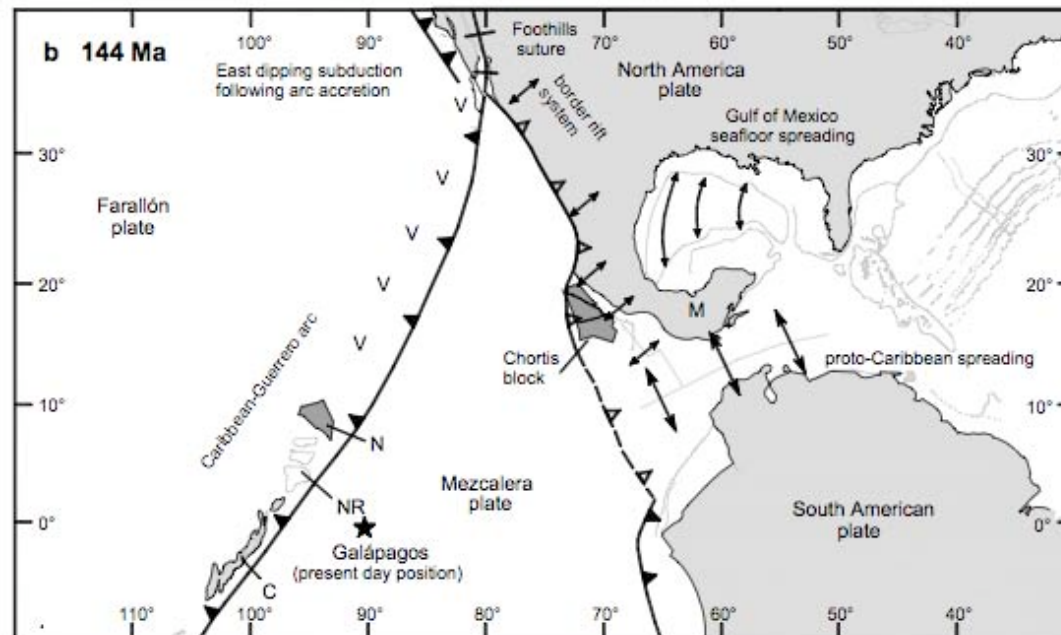
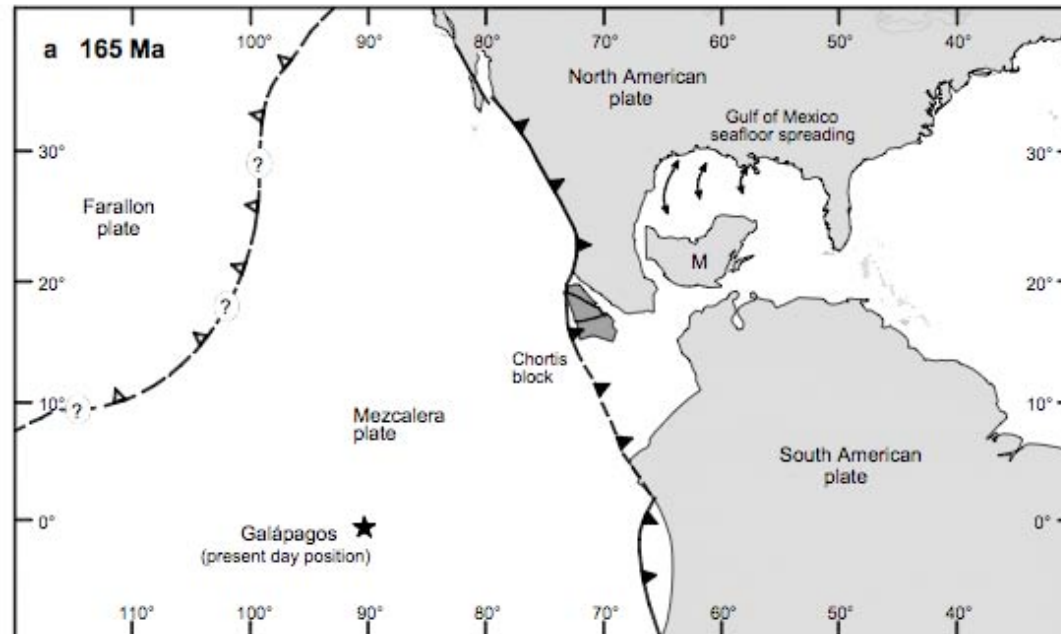


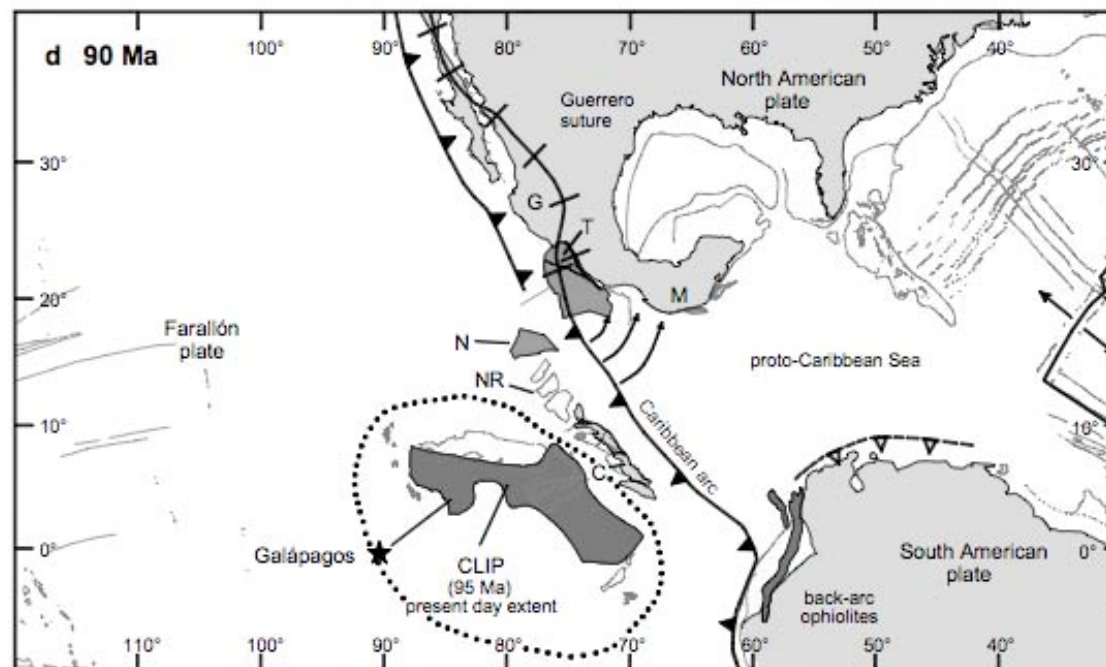
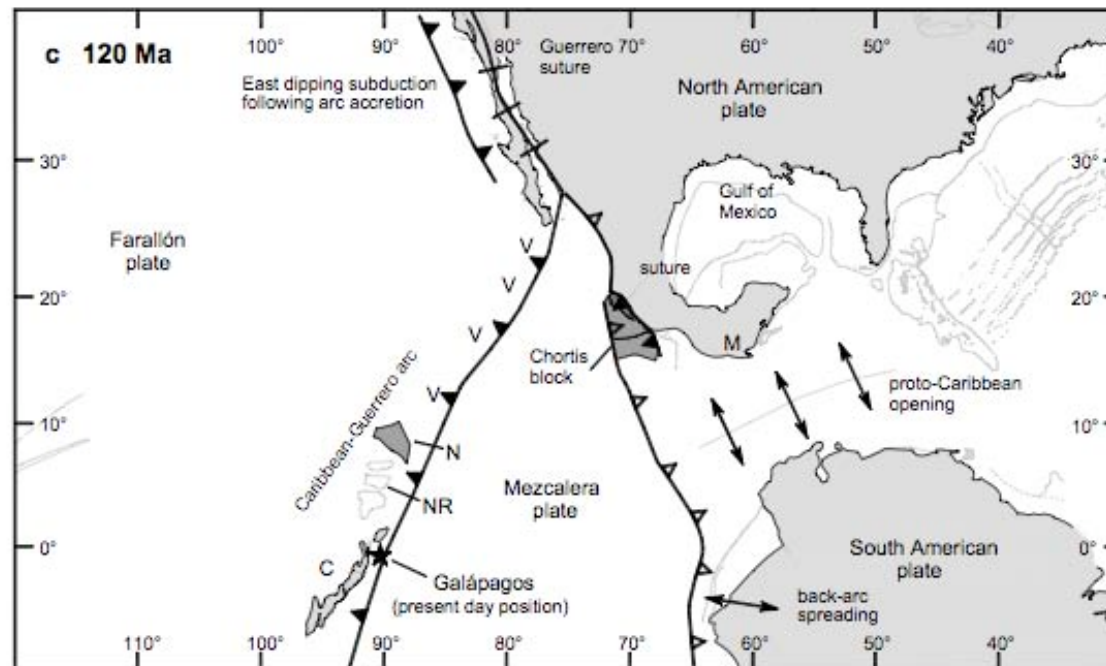
Tectonic map (P. Tapponnier, Earth Observatory Singapur)

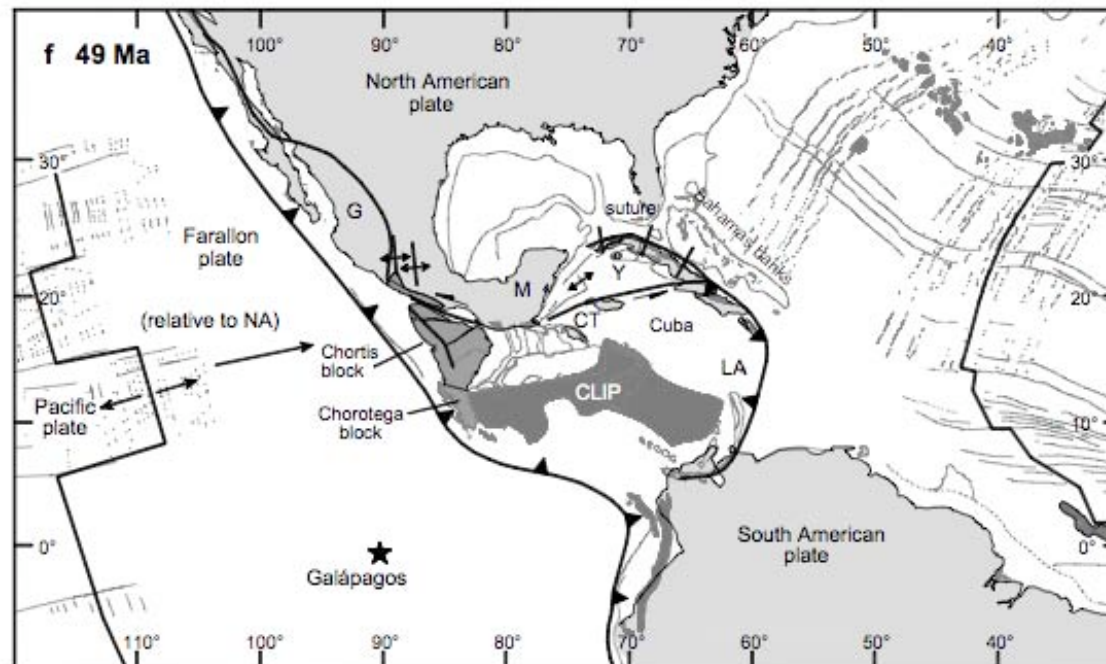
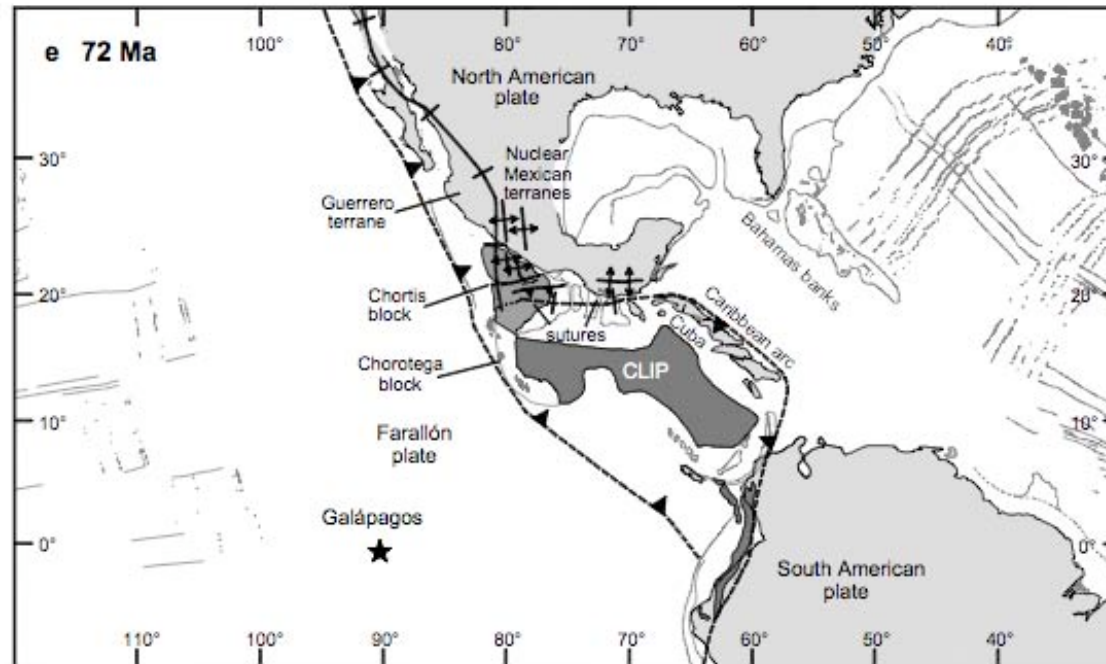


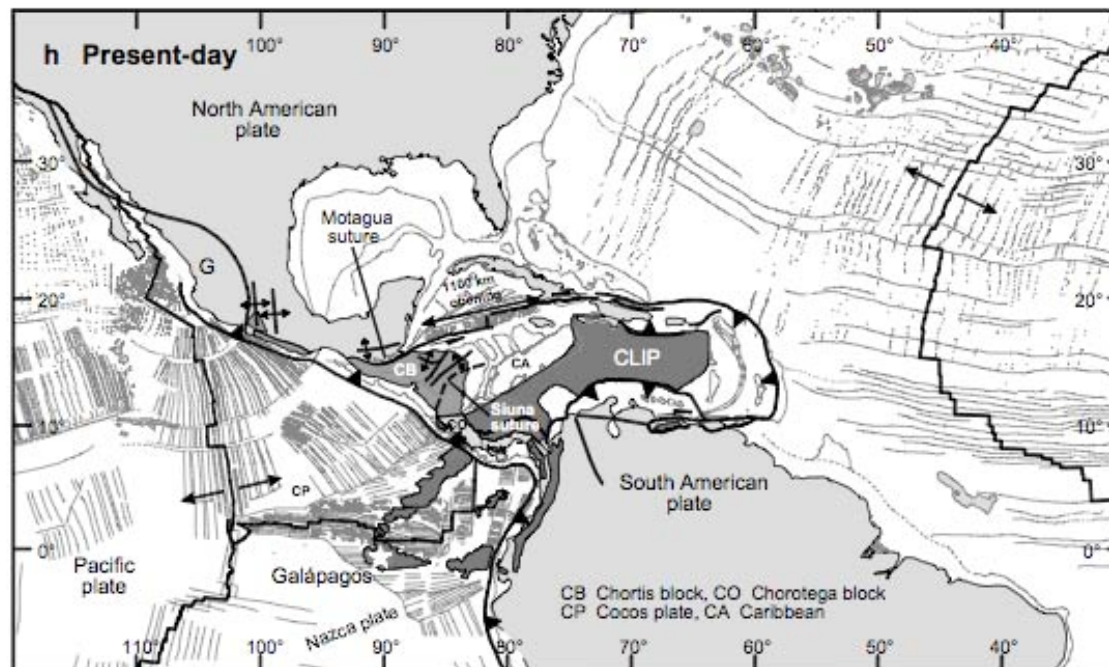
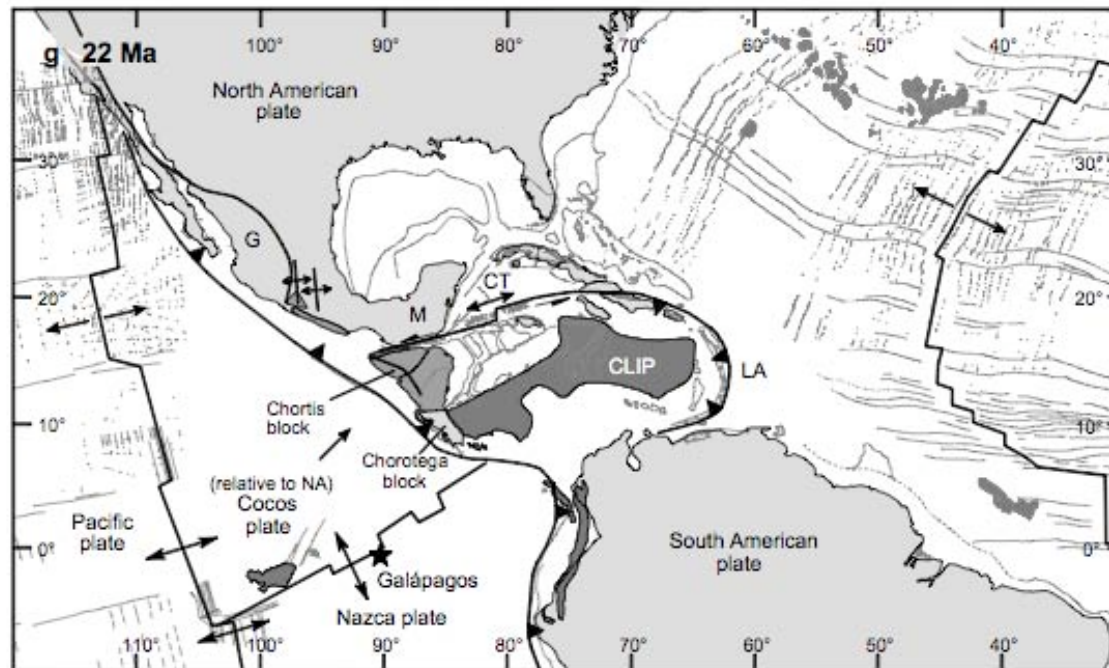
Sismo-tectonic map (N. Feuillet, 2000; IPGP)

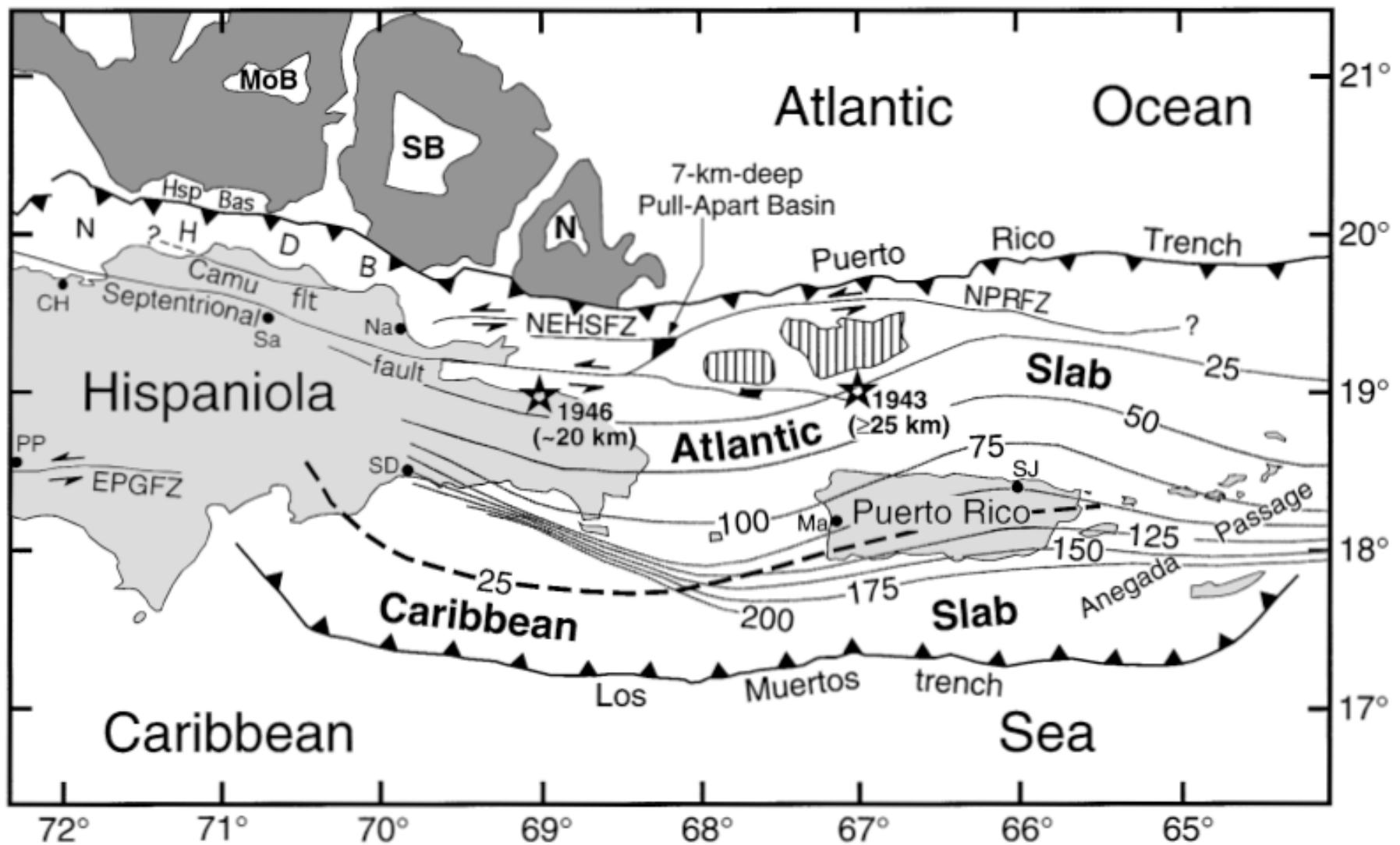




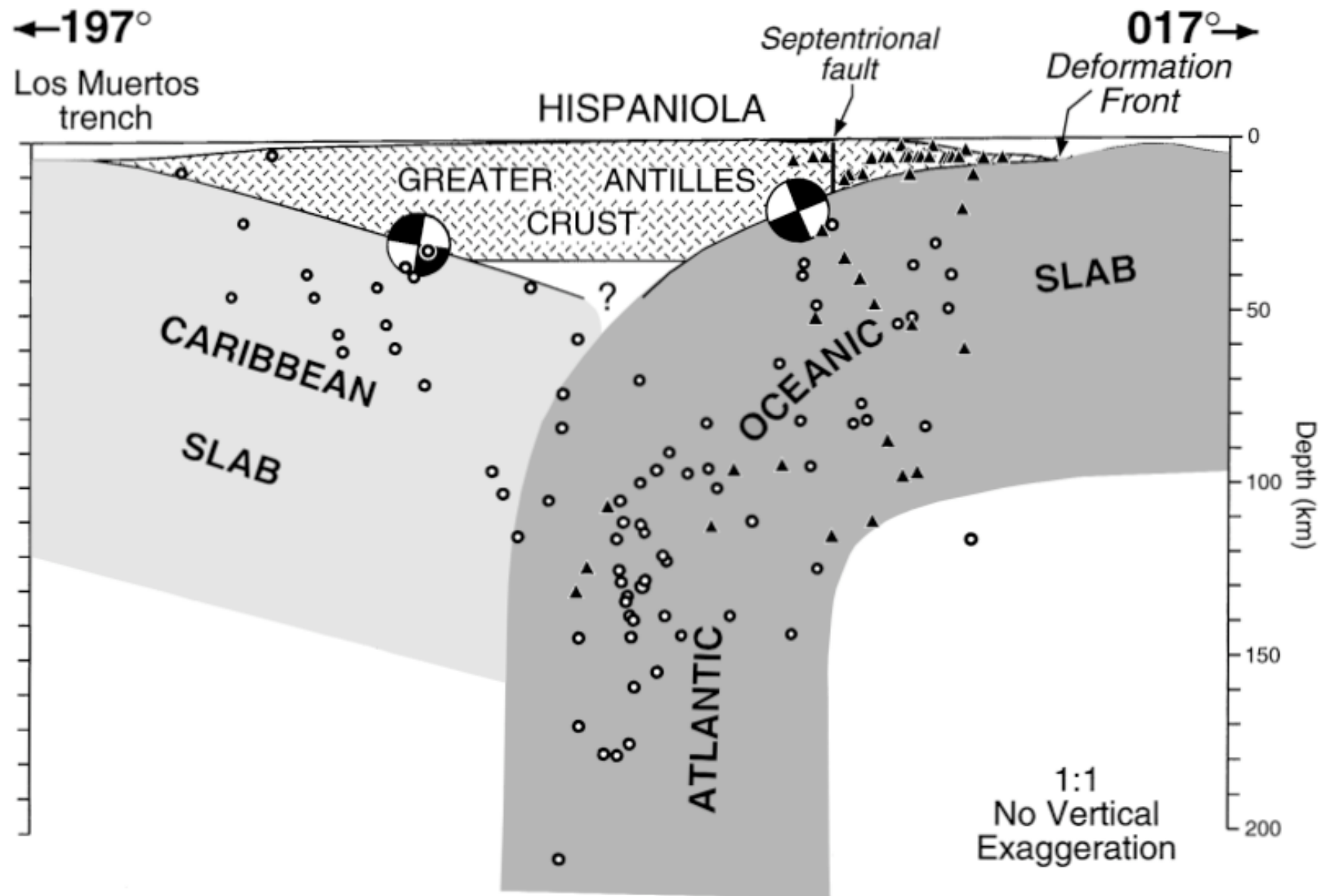






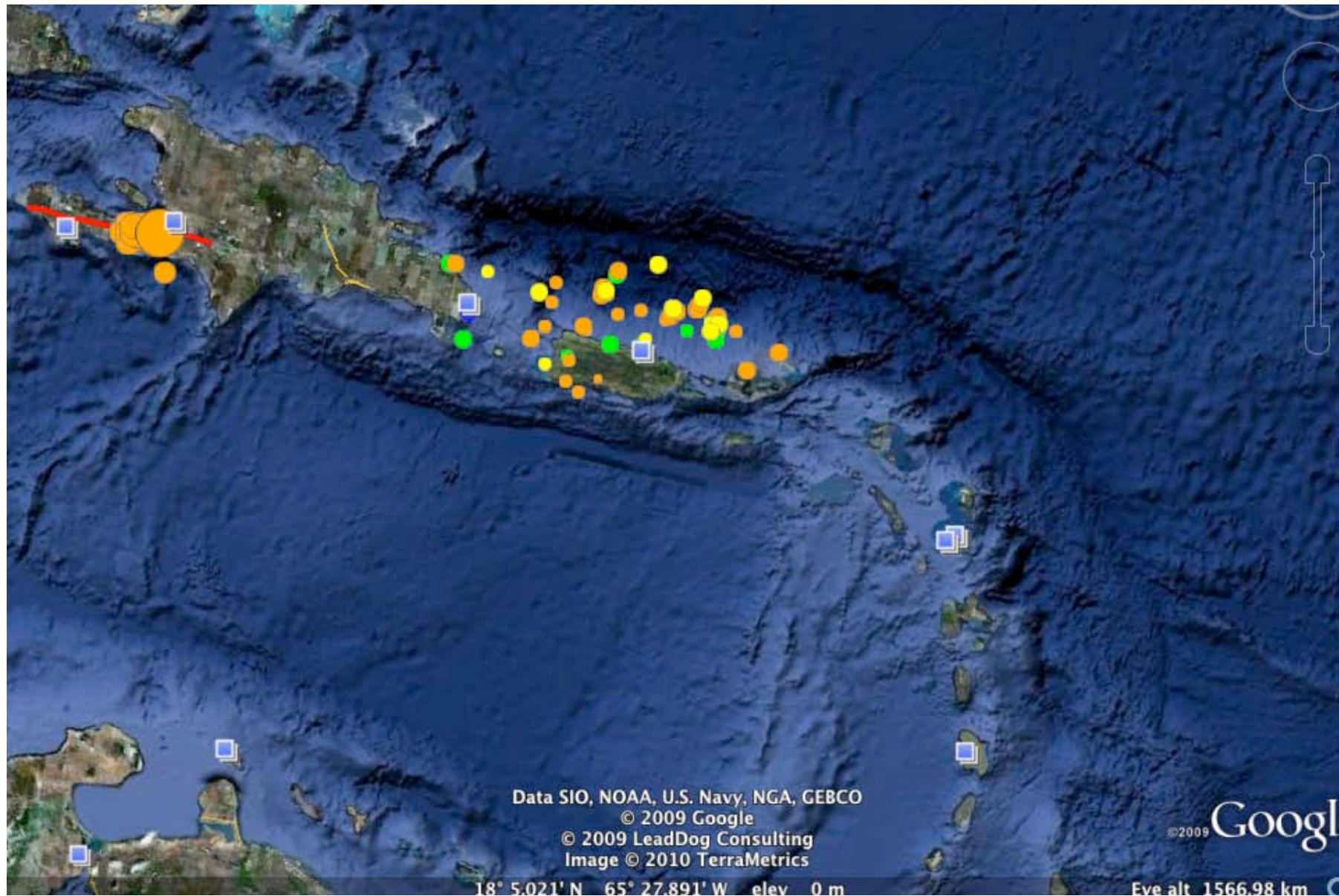


Slabs (Dolan and Wald, GSAsp, 1998)

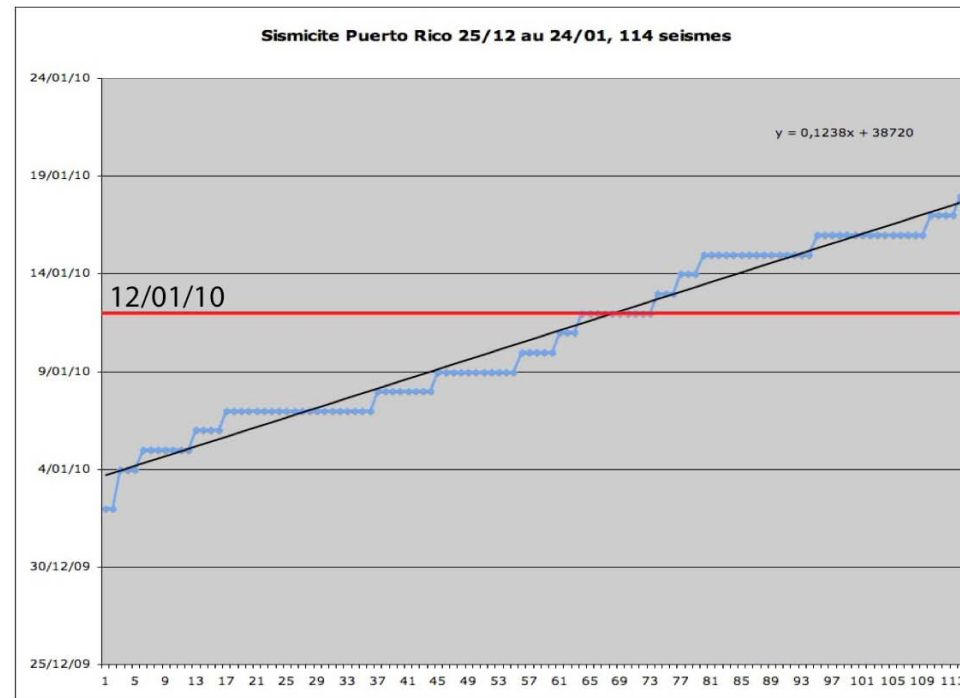
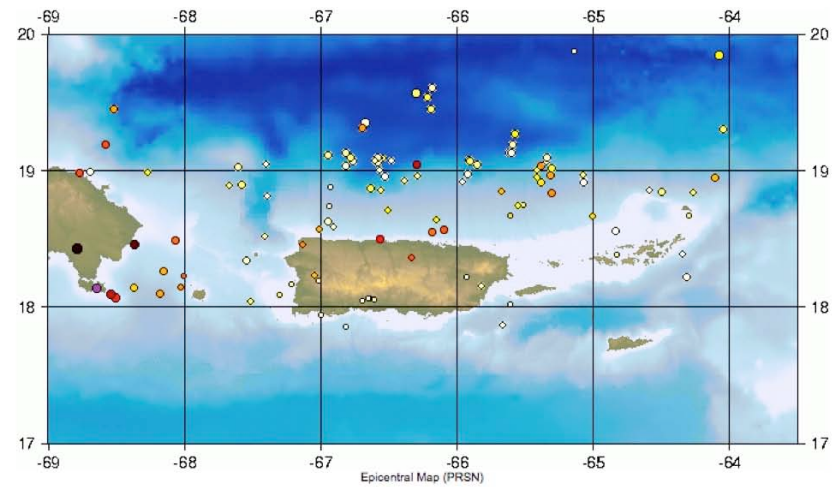


Slabs (Dolan and Wald, GSAsp, 1998)

Is anyone worrying about the swarm of M3's offshore Puerto Rico ?
(K. Sieh, EOS)

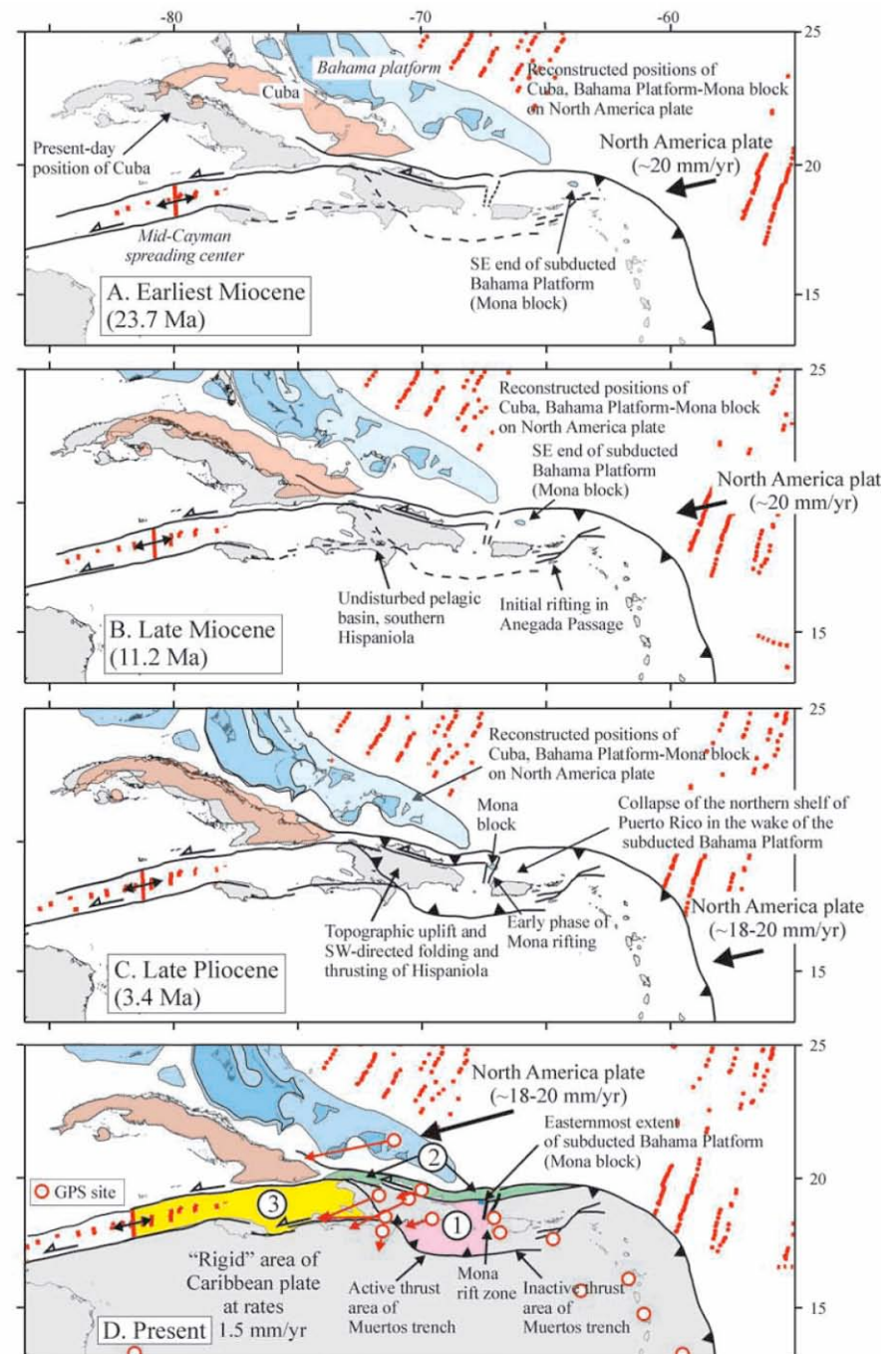


Data from Puerto Rico Seismic Network
114 events in one month

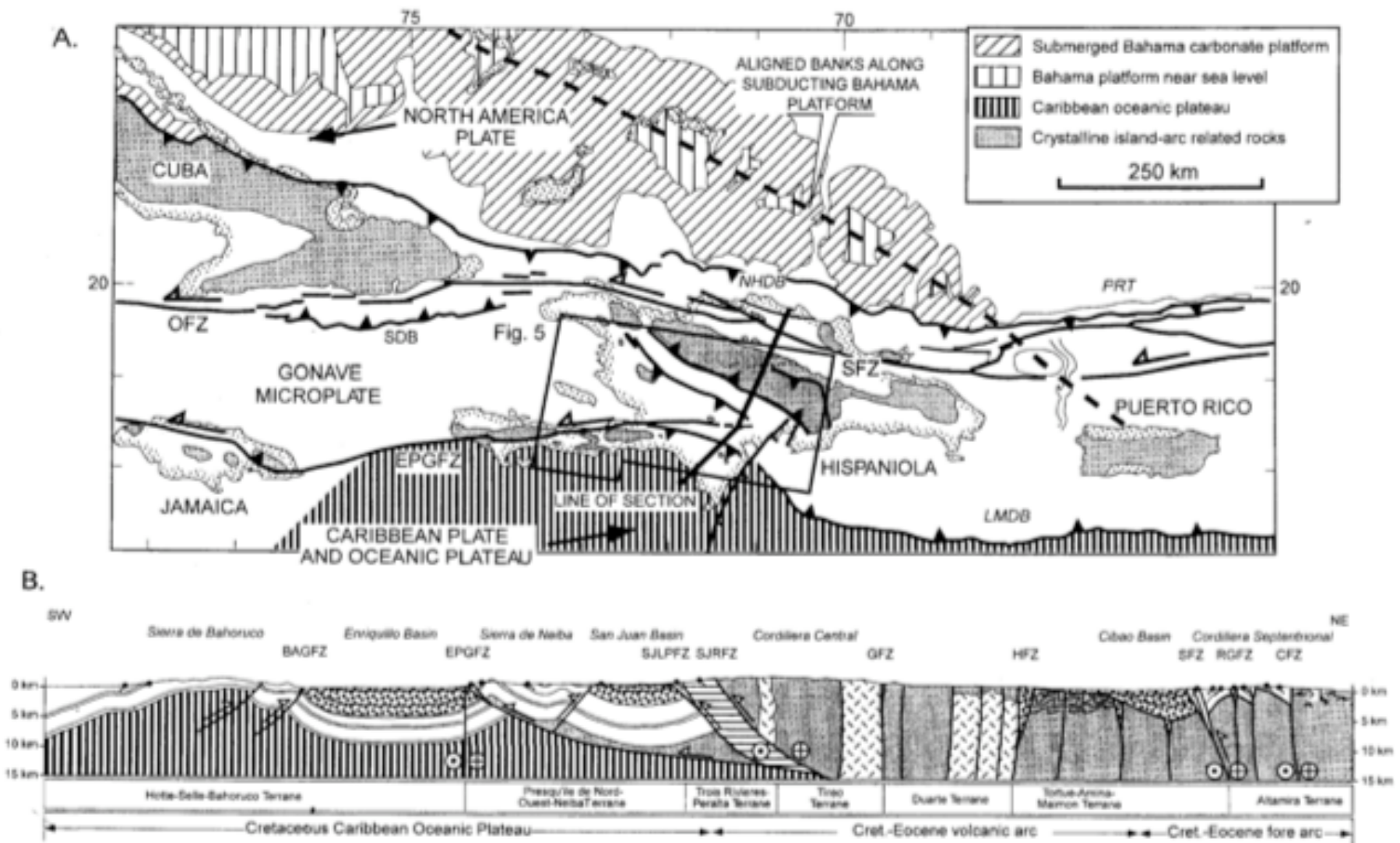


Tectonic origins of the EPGFZ and the Gonave microplate

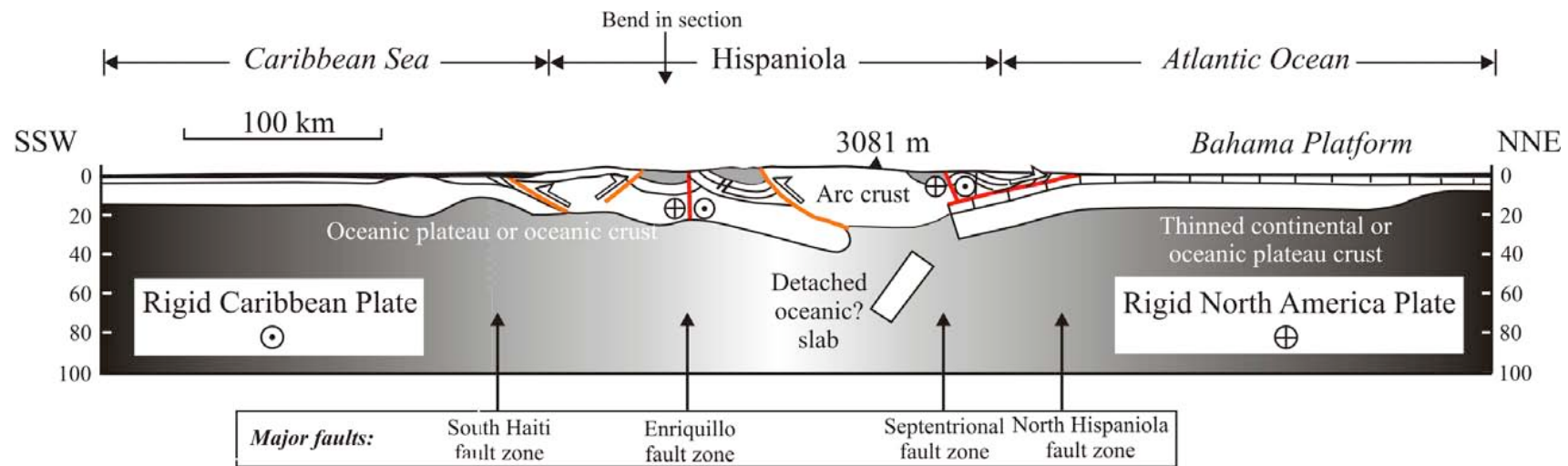
Mann et al., 2002

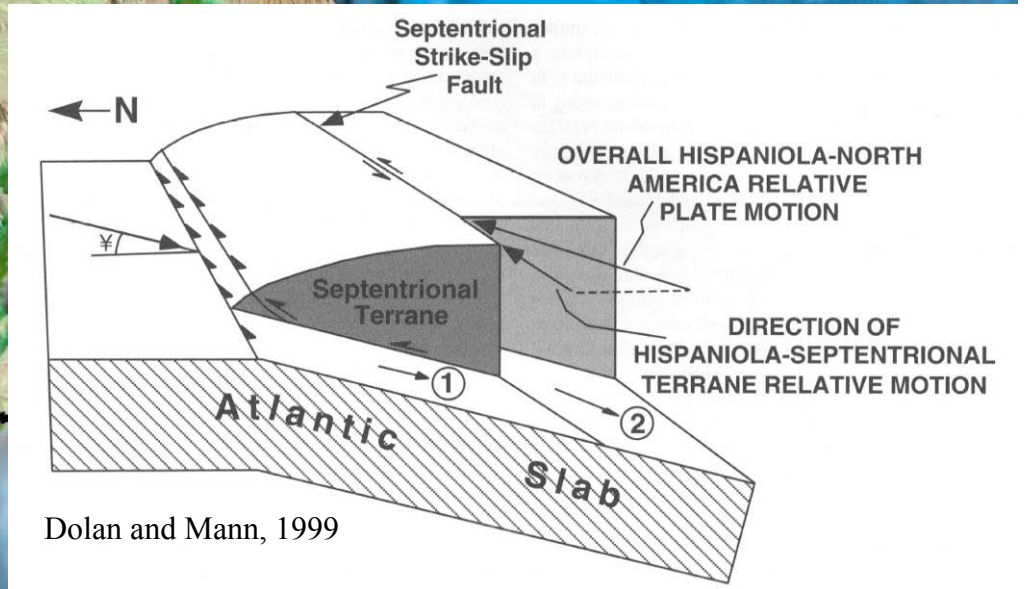
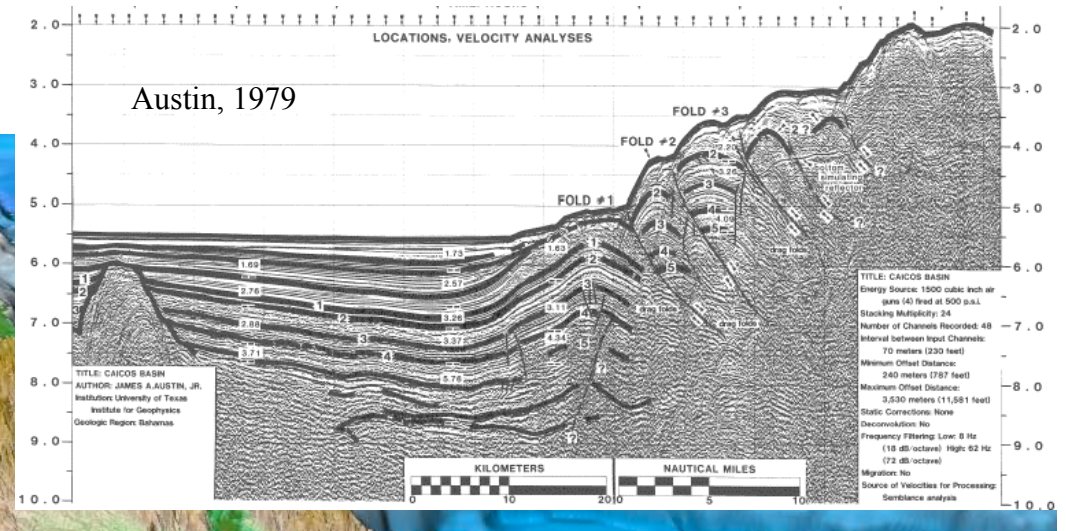
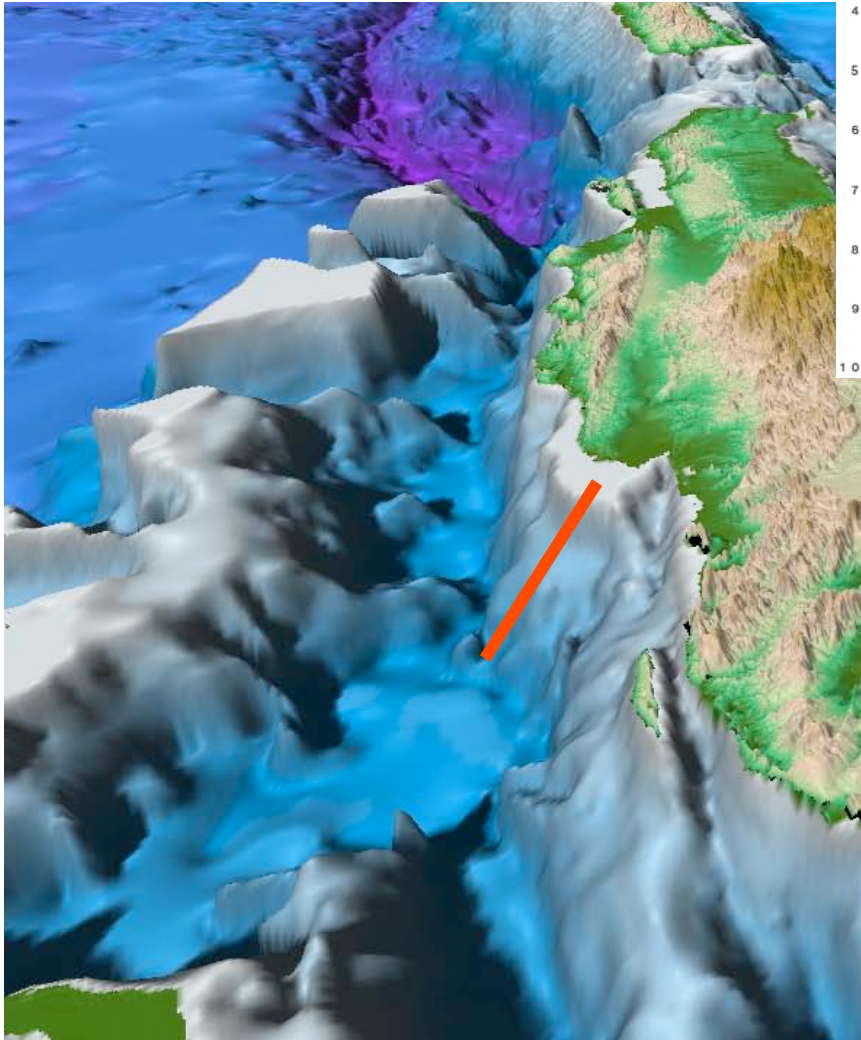






Mann et al. (1999)



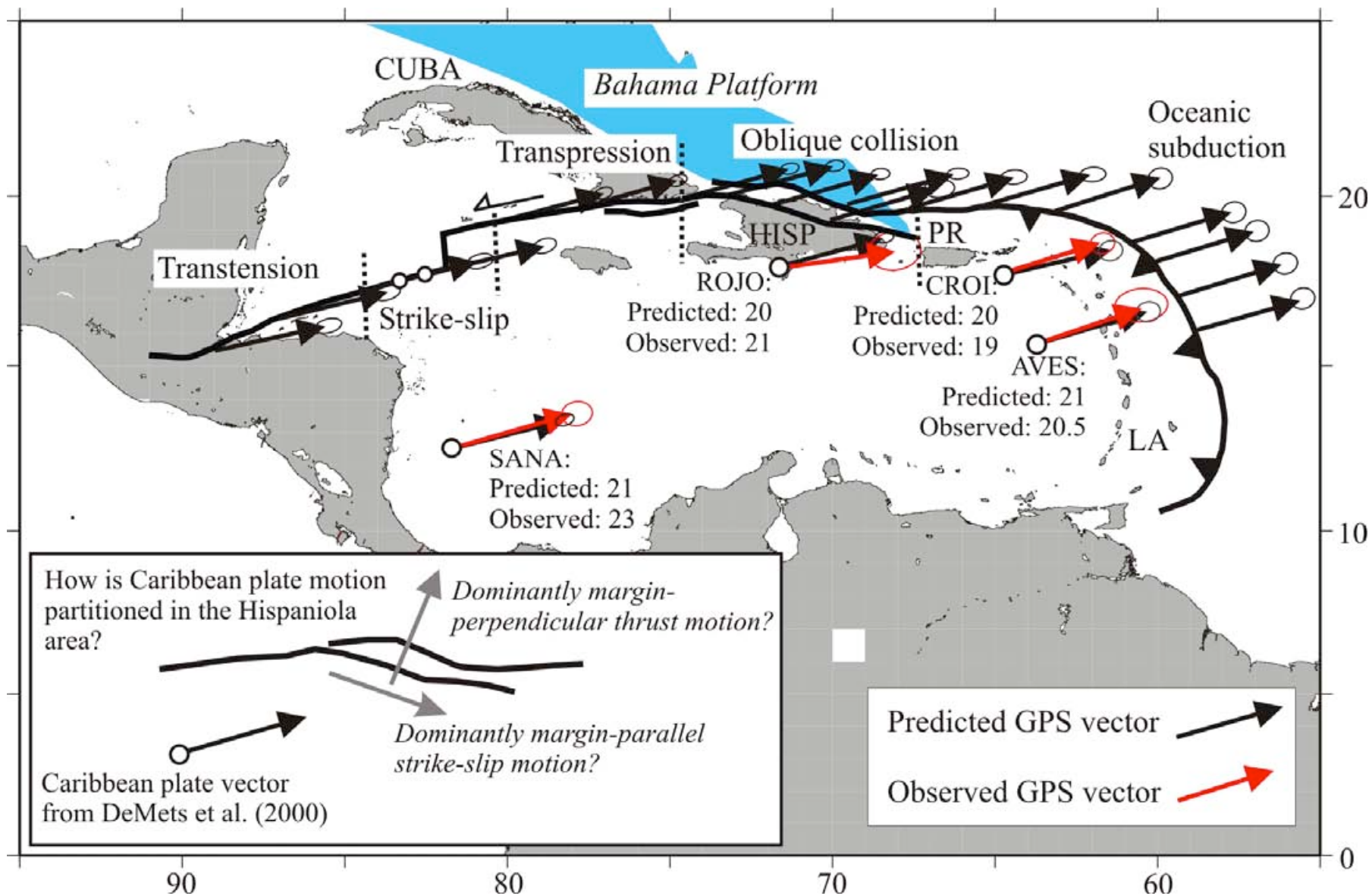


Dolan and Mann, 1999

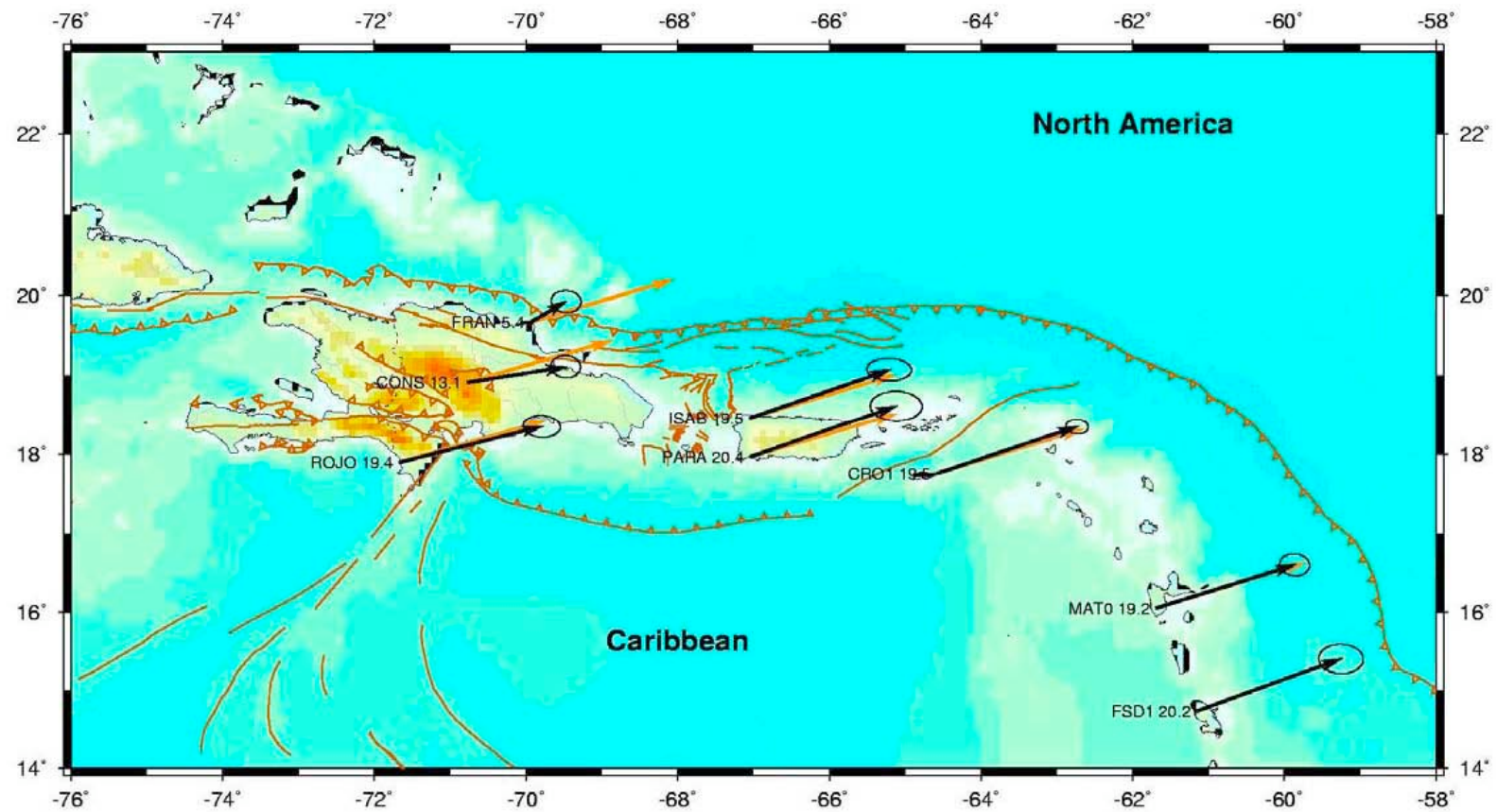


+0.3-0.4 mm/an

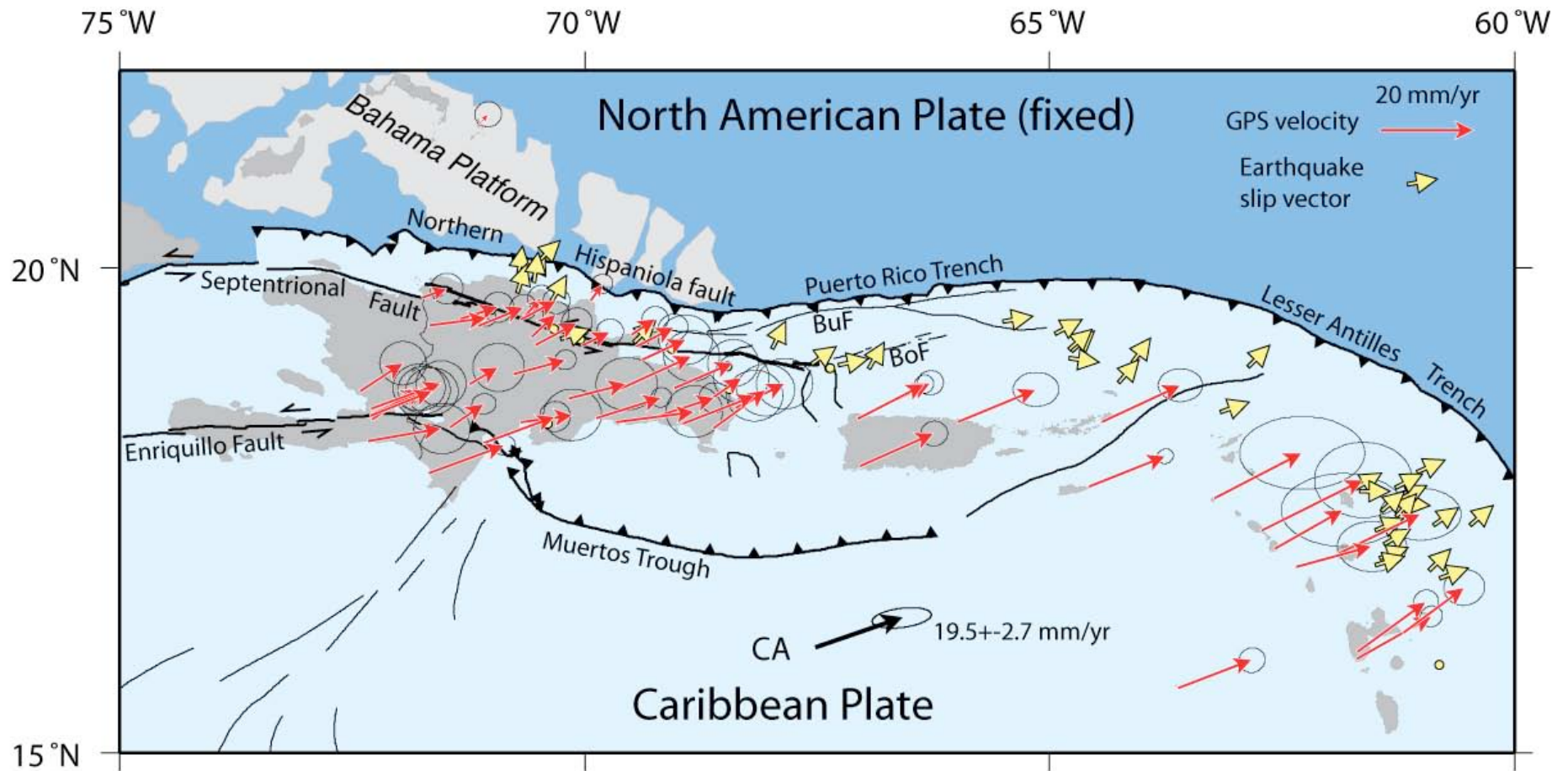
Cap St Nicolas, DEM SRTM



GPS (E. Calais)

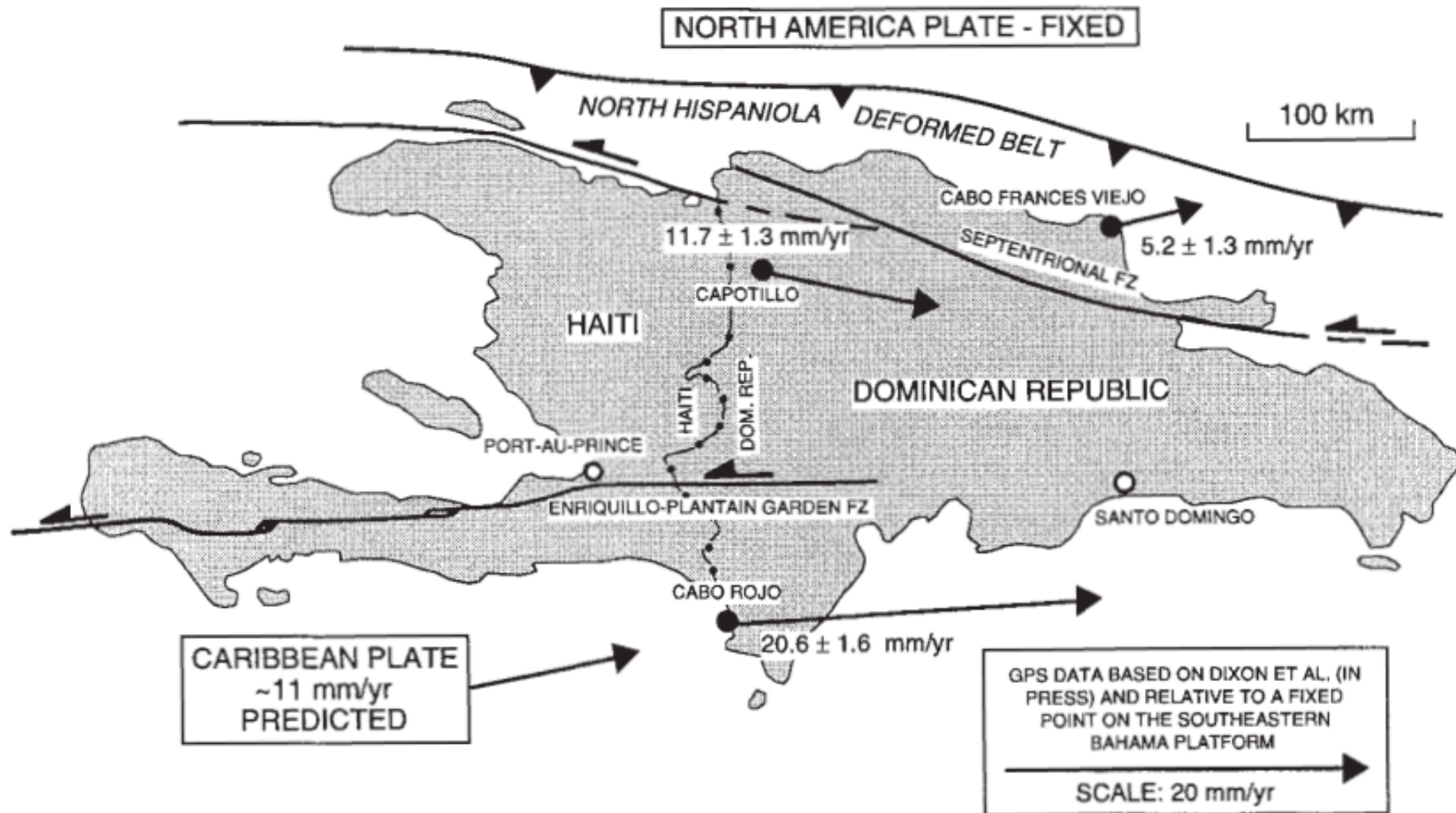


GPS (E. Calais)

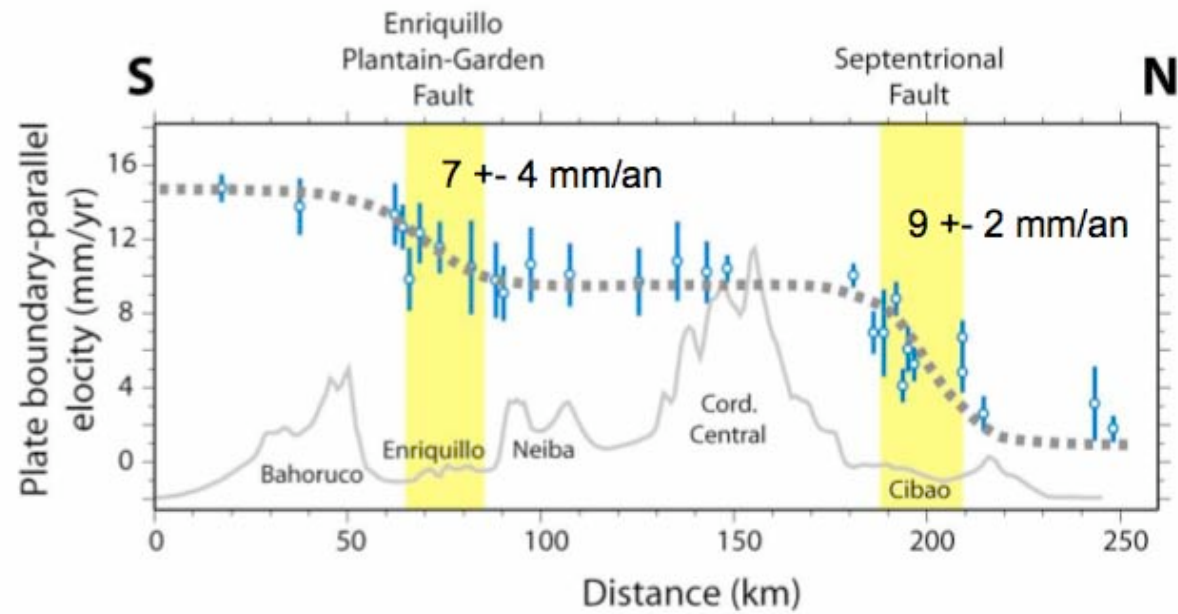
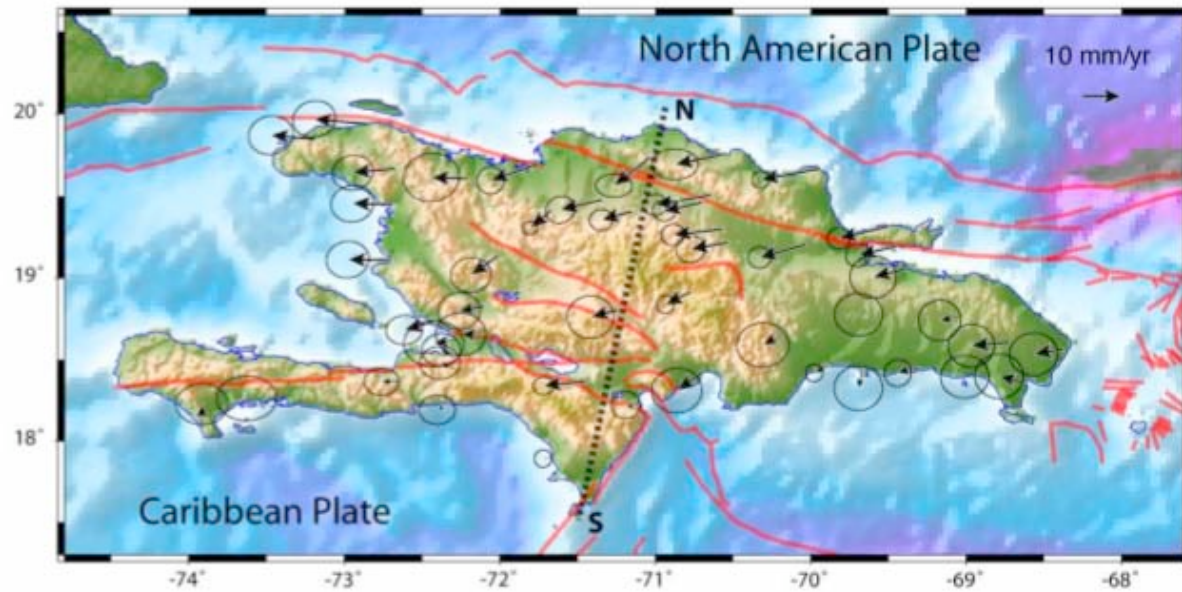


Manaker et al.

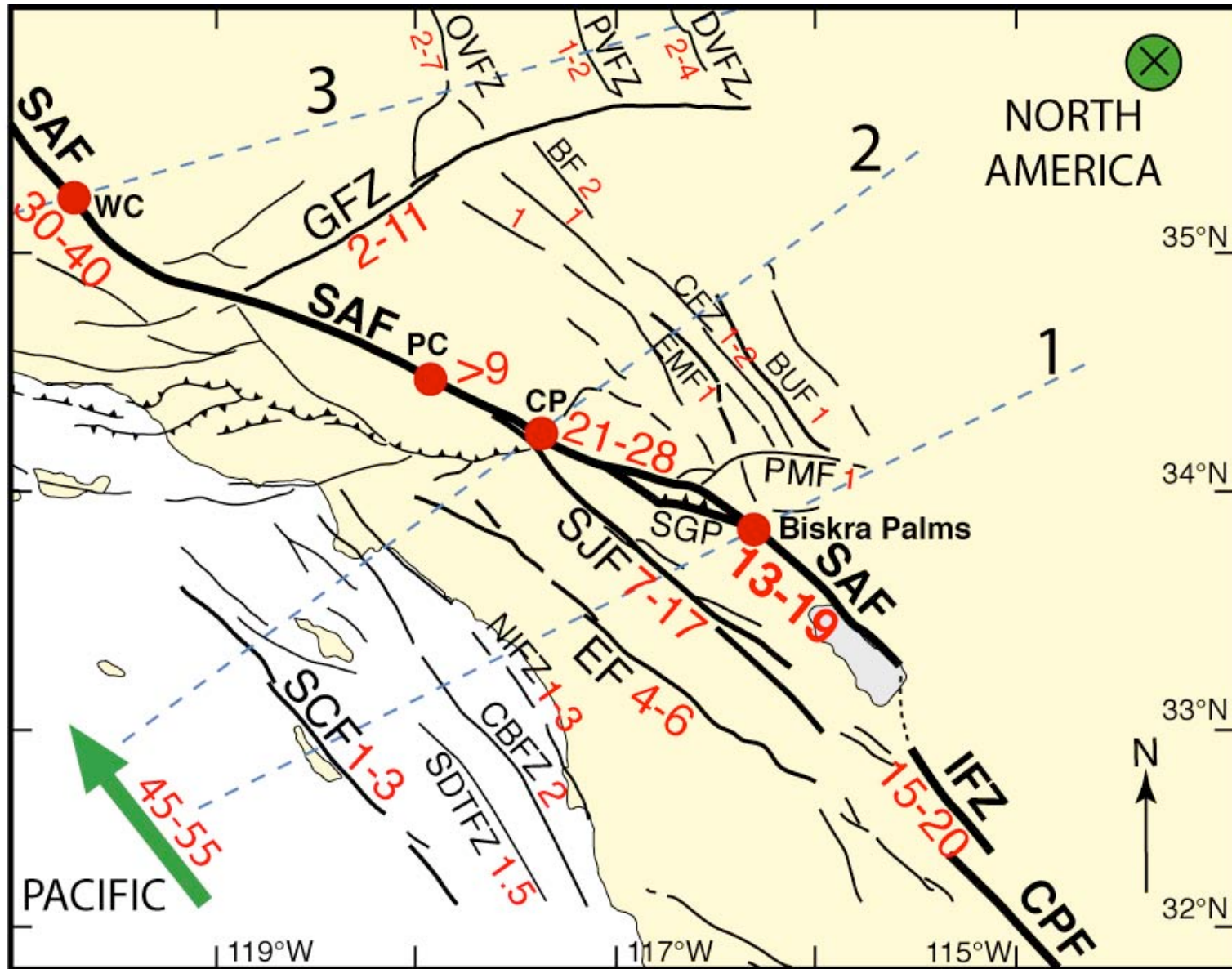
B. GPS-BASED PLATE MOTIONS IN HISPANIOLA

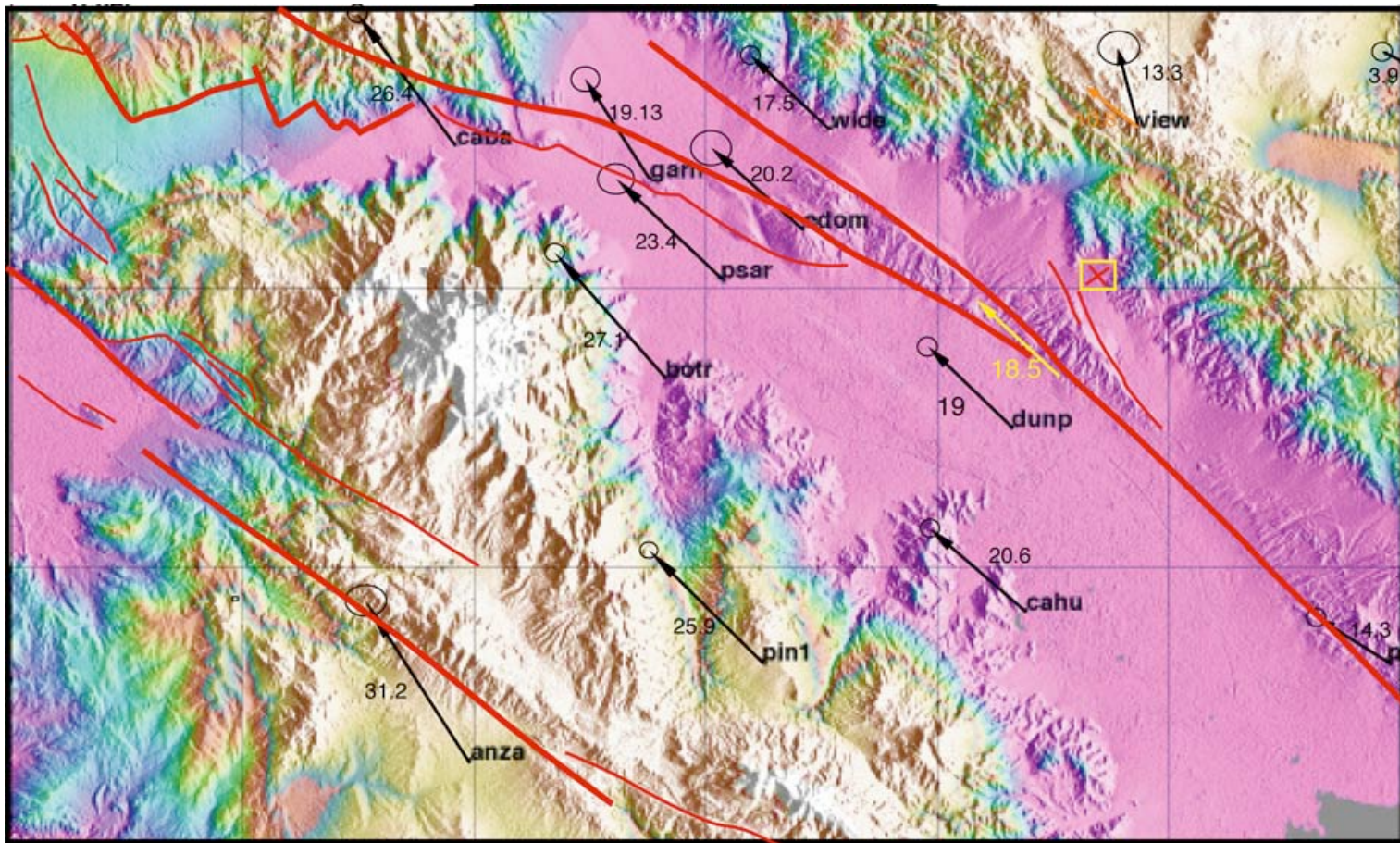


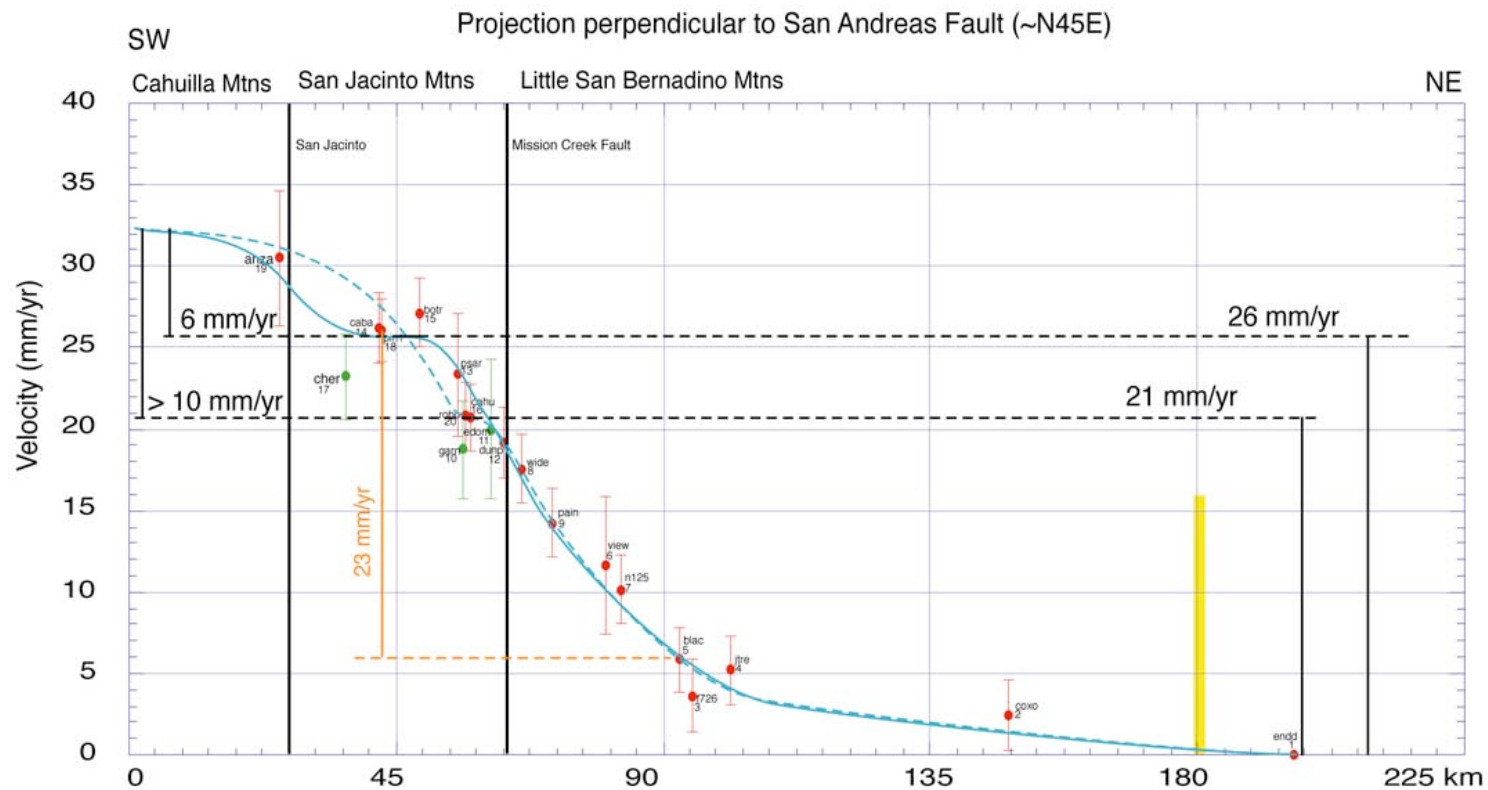
Mann et al. 1998.



Calais.







GPS data, Benett et al., JGR, 1996.

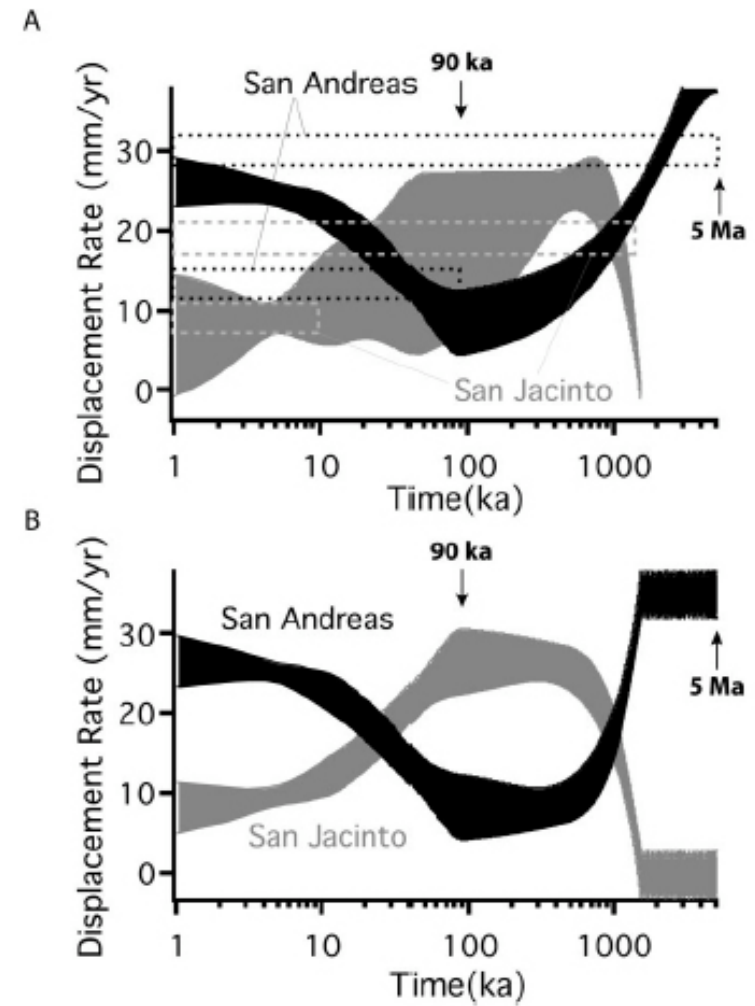
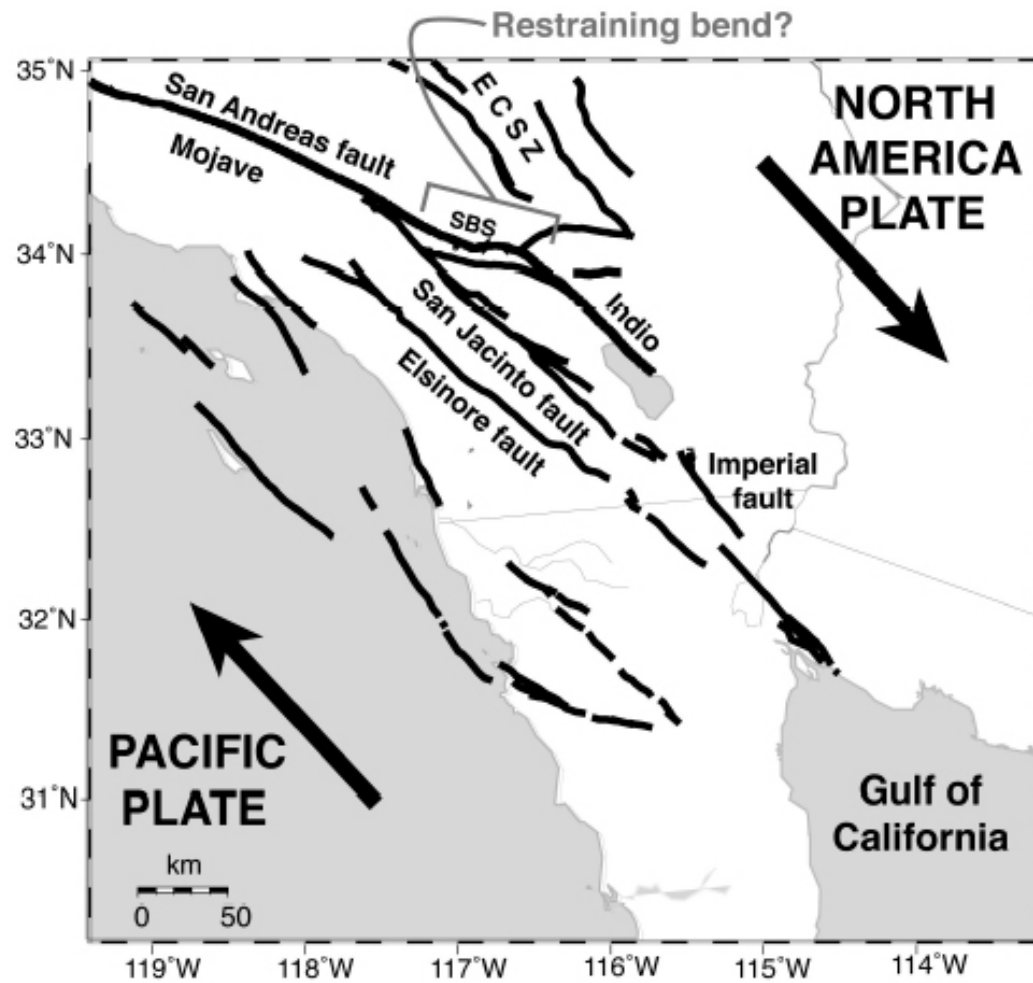
- unambiguously belonging to a block, north or south of the fault
- stations CHER, GARN and EDOM are between the southern Banning Fault (thrust) and northern Banning Fault (strike-slip)

^{10}Be rate : 15.9 ± 3.4 mm/yr at Indio

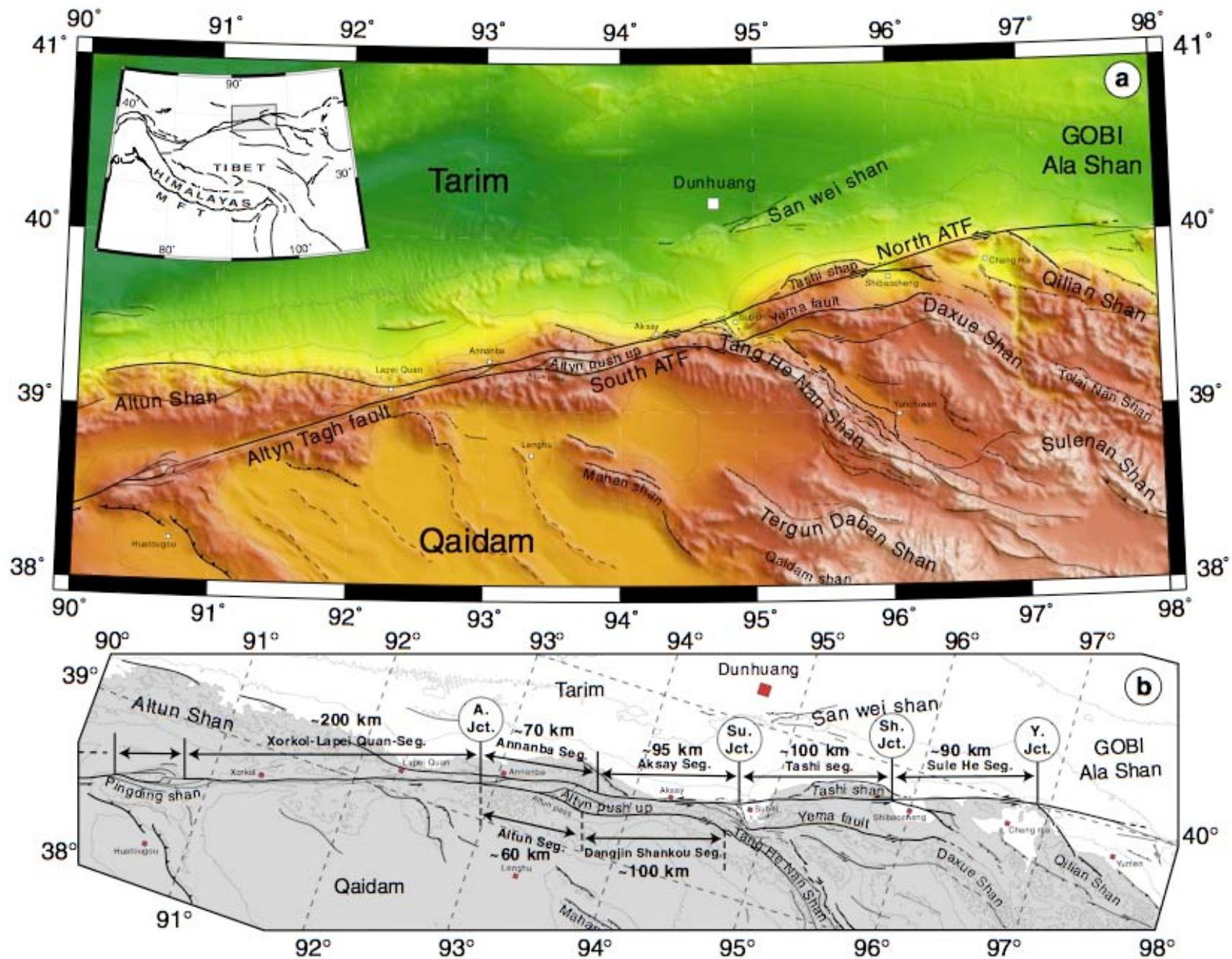
VLBI rate between BLAC and PIN, 23 ± 2 mm/yr, consistent with GPS (Feigl et al., 1993).

Possible fits to the data and corresponding rates:

- strain is uniform between San Jacinto and SAF
- - - strain is asymmetric between San Jacinto and SAF



Bennett et al., 2004
Chéry et al., 2008



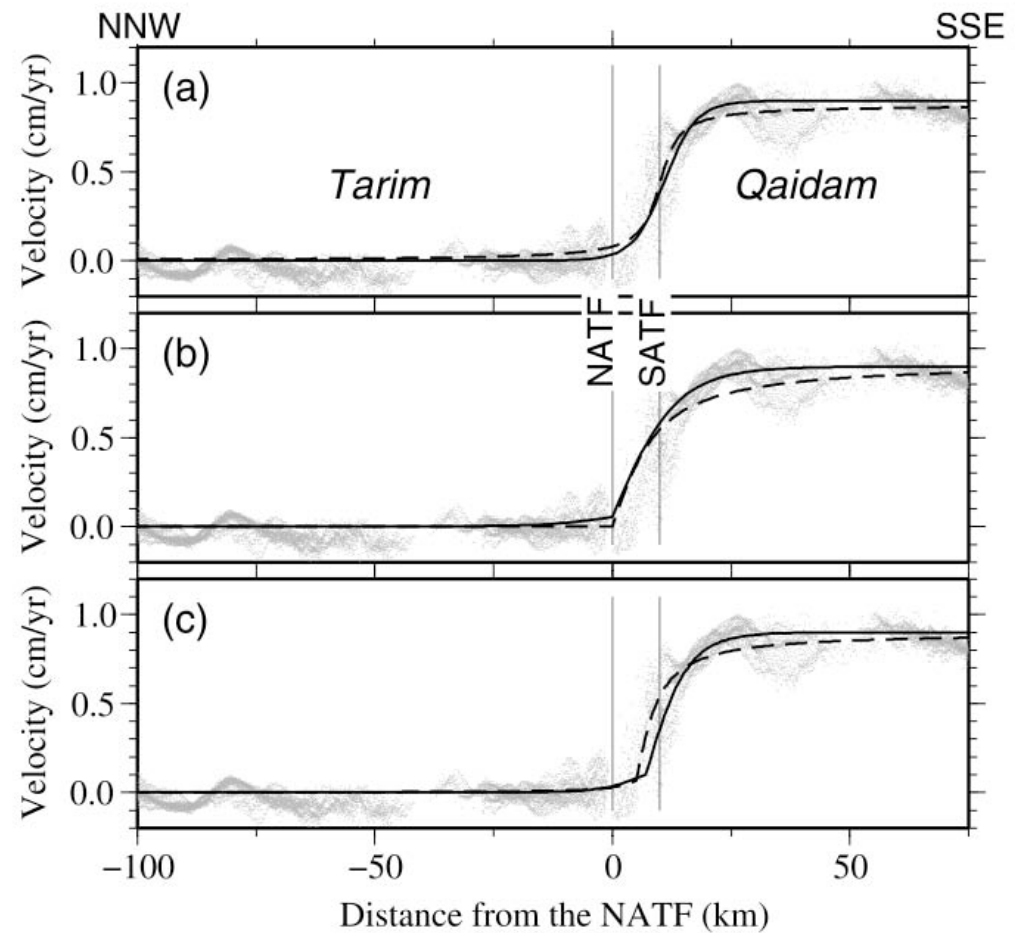
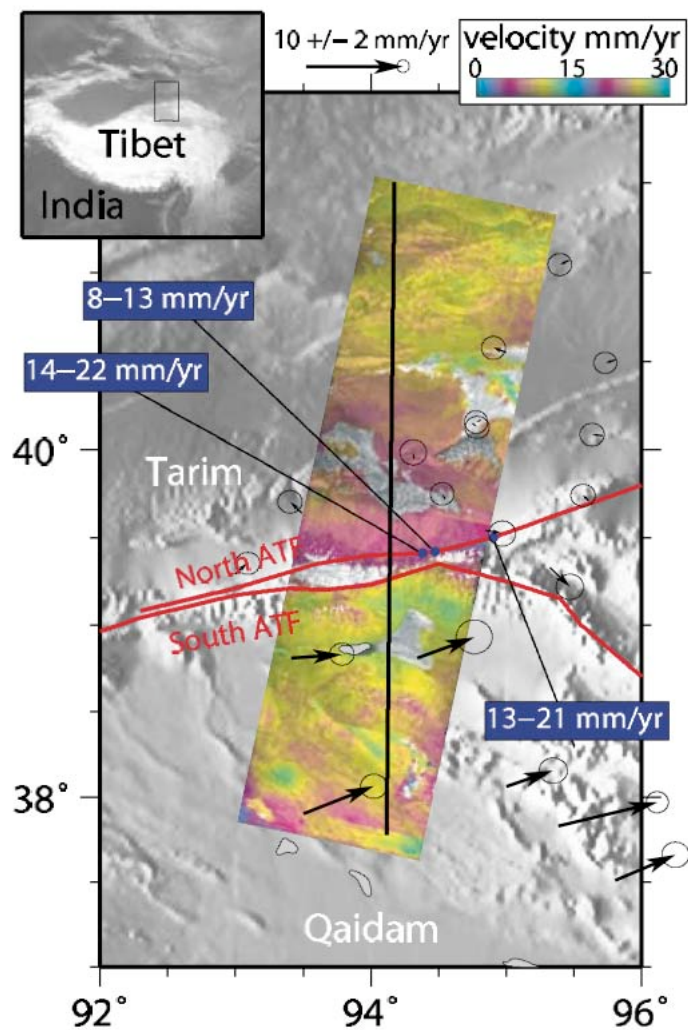
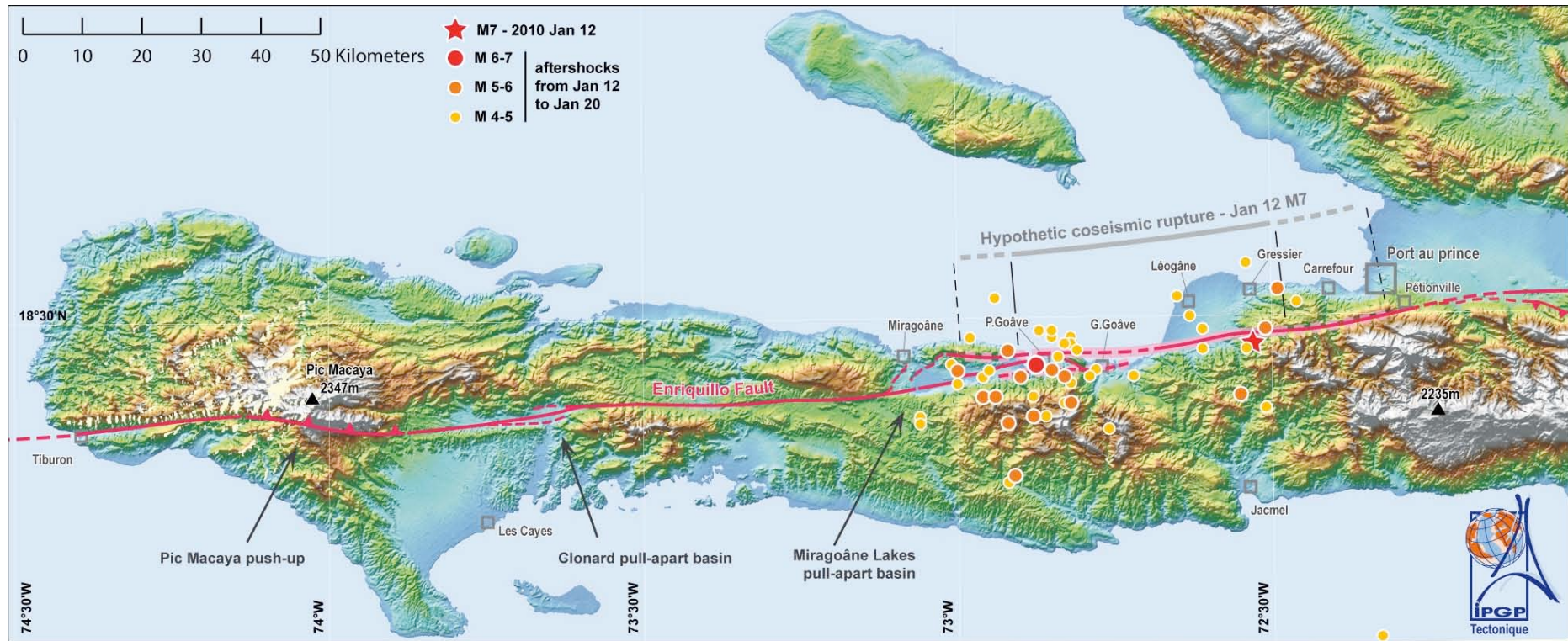


Figure 3. Interseismic velocity profile across the Altyn Tagh Fault system near Aksai. Grey dots are velocity data

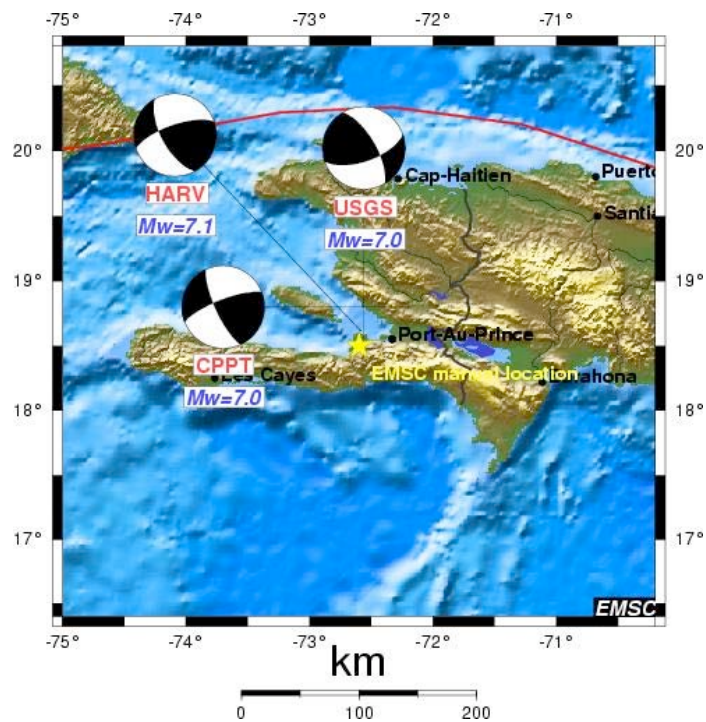


Faïlle d'Enriquillo (-Plantain-Garden ou EPGFZ)

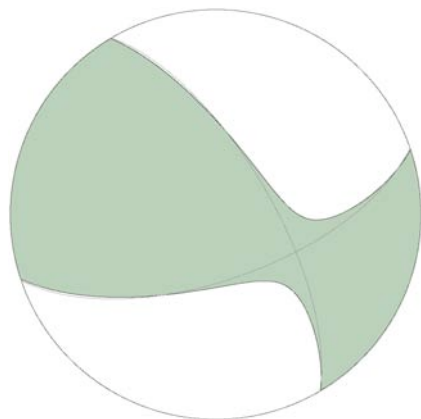
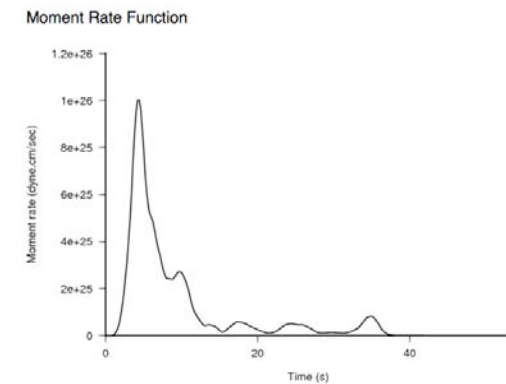
L: ~300 km

Segments : ~50-100 km

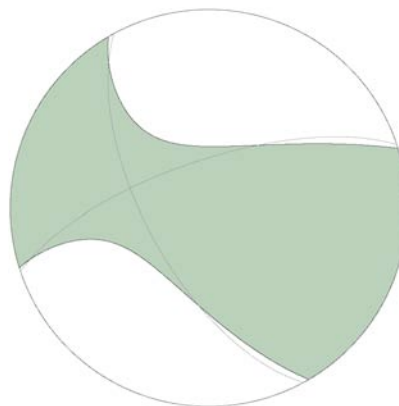
Relais push-up et pull-apart



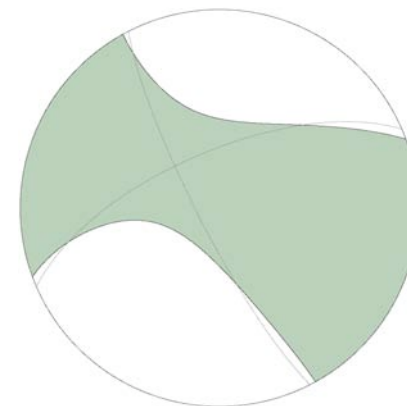
Date: 2010/ 1/12 Centroid Time: 21:53:24.5 GMT
 Lat= 18.82 Lon= -72.16 Depth= 10.0
 Moment Tensor: Expo=26 1.630 -3.710 2.080 0.420 1.930 2.500
 Mw = 7.07 ; Scalar Moment = 4.52×10^{26}
 Fault plane: strike=330 dip=68 slip=151
 Fault plane: **strike=71** dip=64 slip=25



USGS centroid

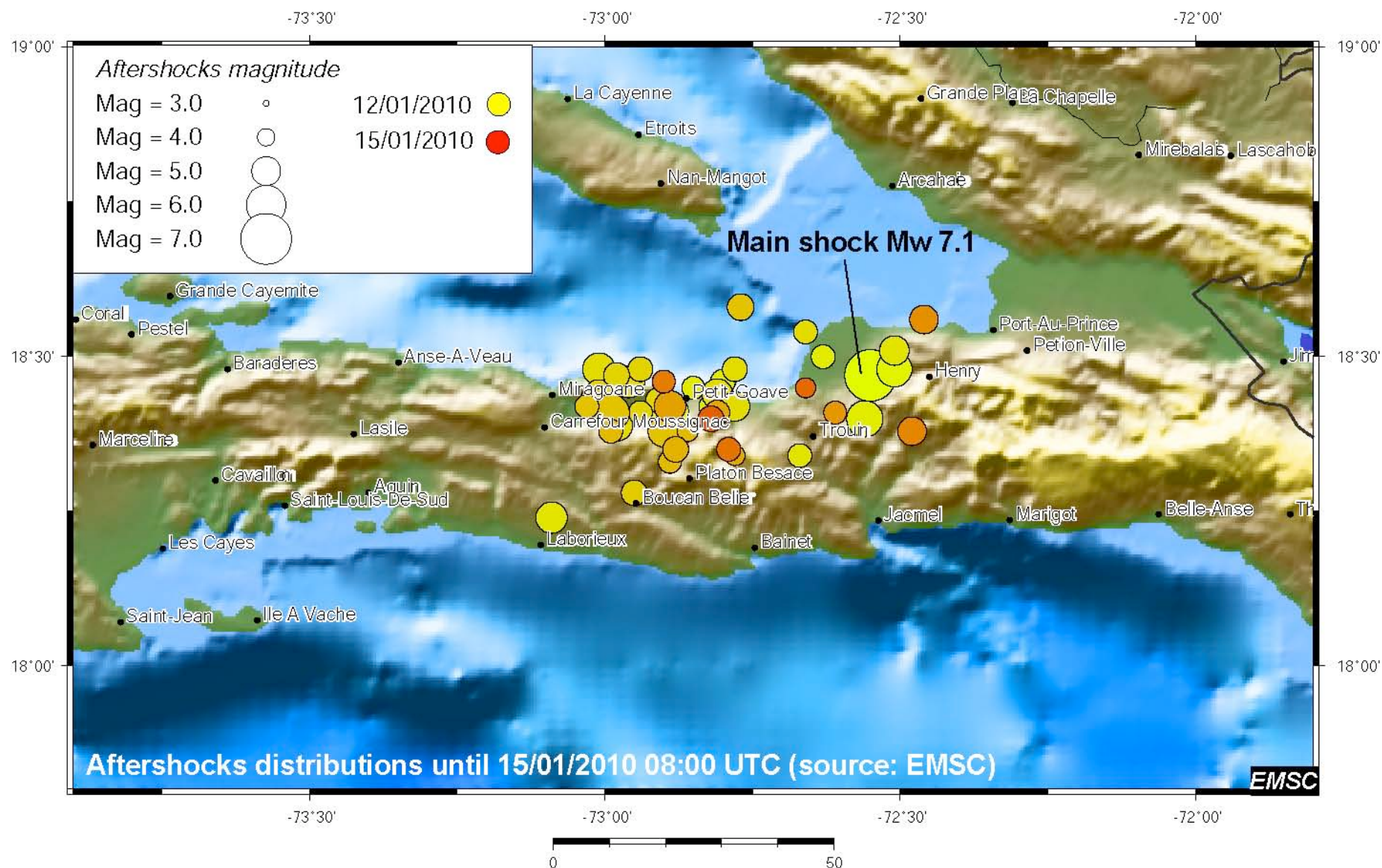


GCMT centroid



W-phase centroid

Aftershocks (CSEM, 18/01/2010)



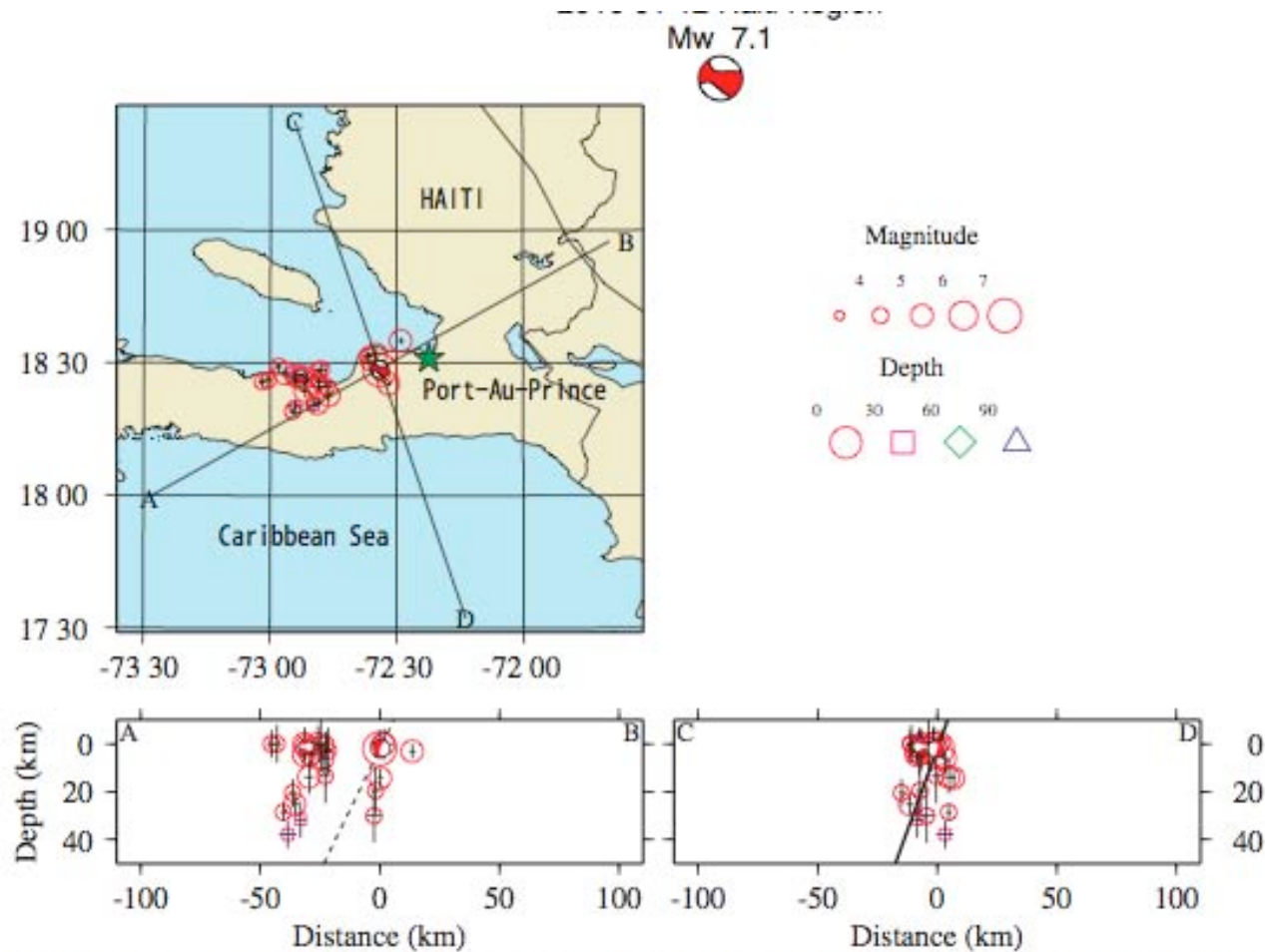
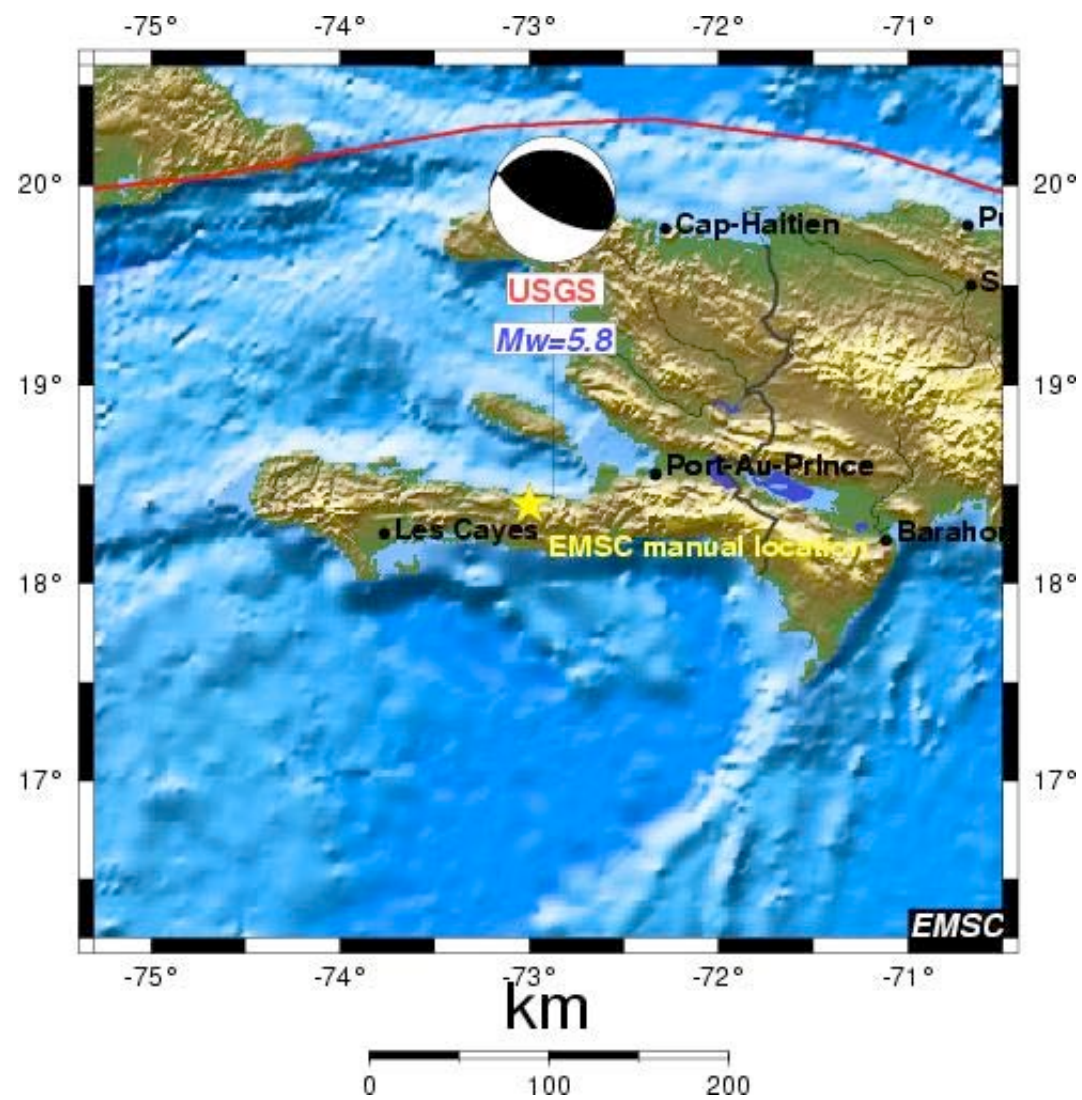


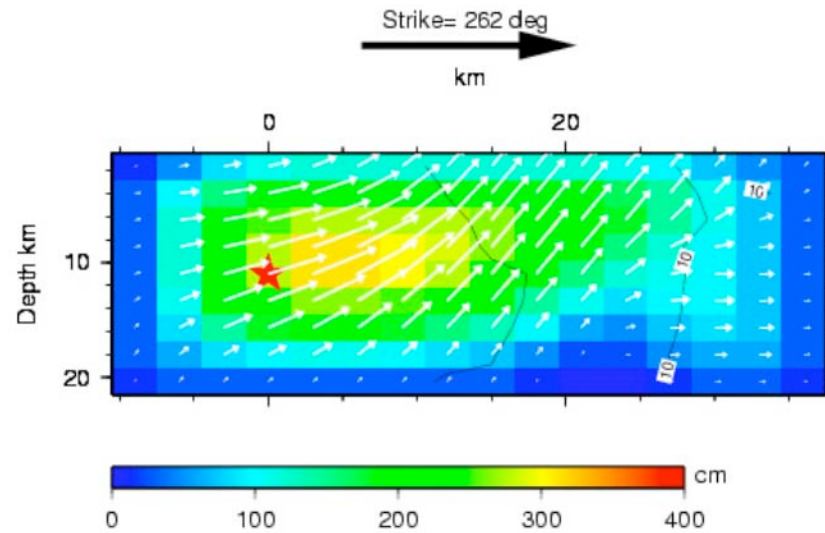
Fig. 1. Hypocenters relocated by the MJHD method. Global CMT solution is also shown. Epicentral distribution and two vertical cross sections along A-B and C-D lines, which are perpendicular to strikes of the two nodal planes, are shown. Two nodal planes are shown by lines in cross sections. The nodal plane corresponding to the fault plane is shown by a thick solid line in the C-D cross section.

MJHD relocation (Hurukawa, IISEE)



Aftershock 20/01/2010 (CSEM/USGS))

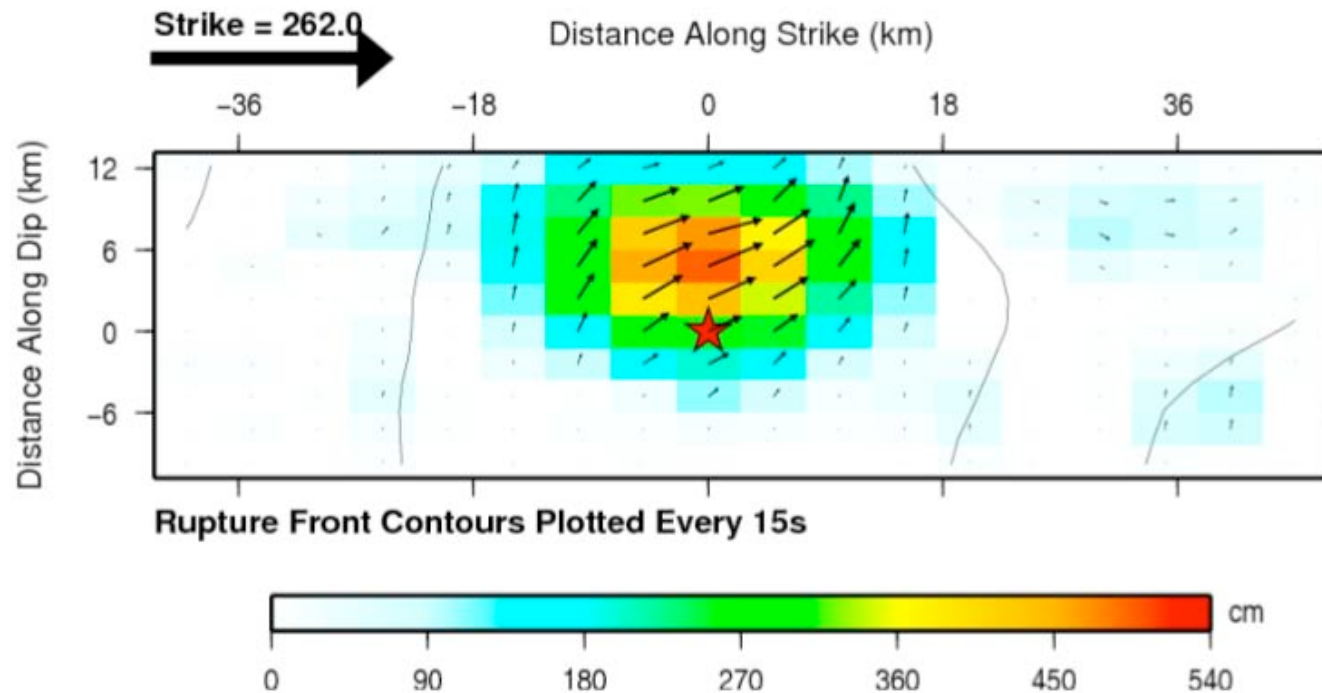
slip distribution



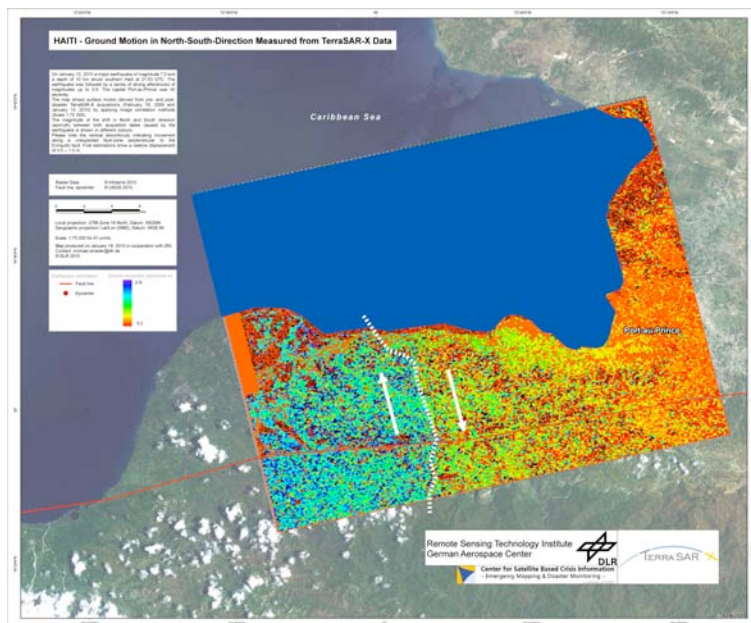
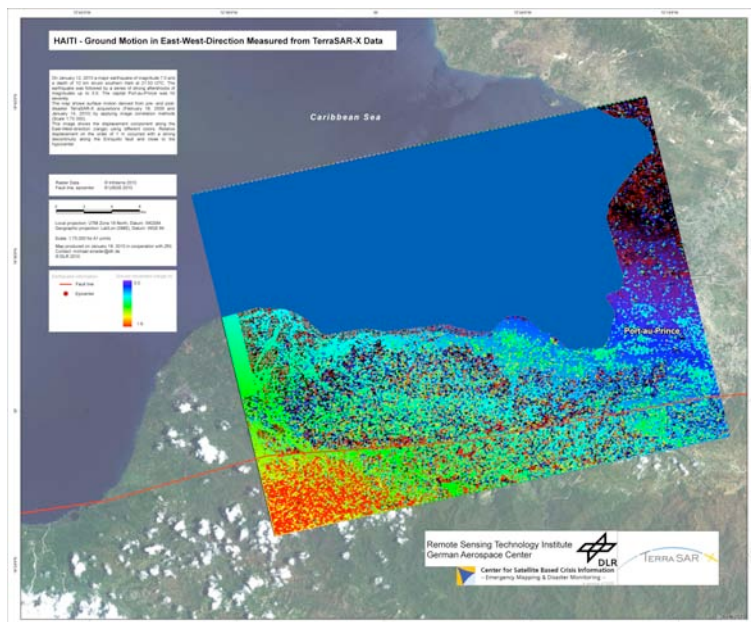
1 à 2 m en surface sur 20-30 km

Cross-section of slip distribution

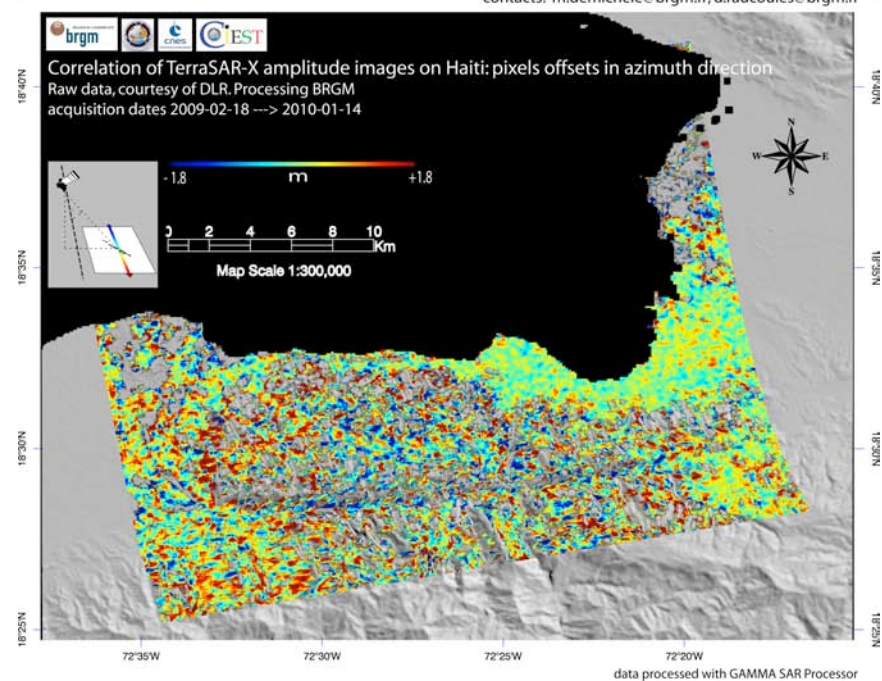
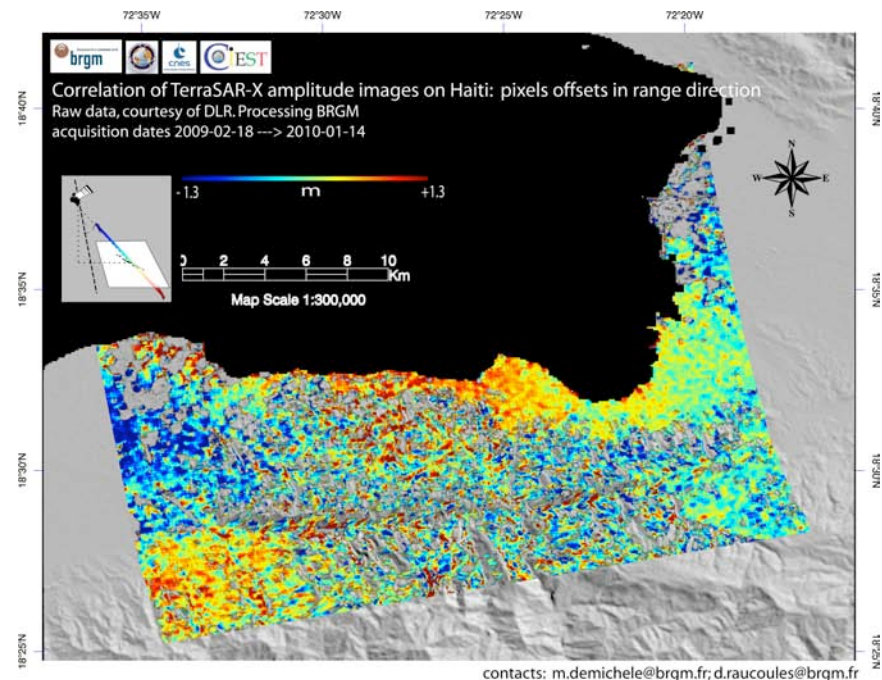
Sladen (Caltech)



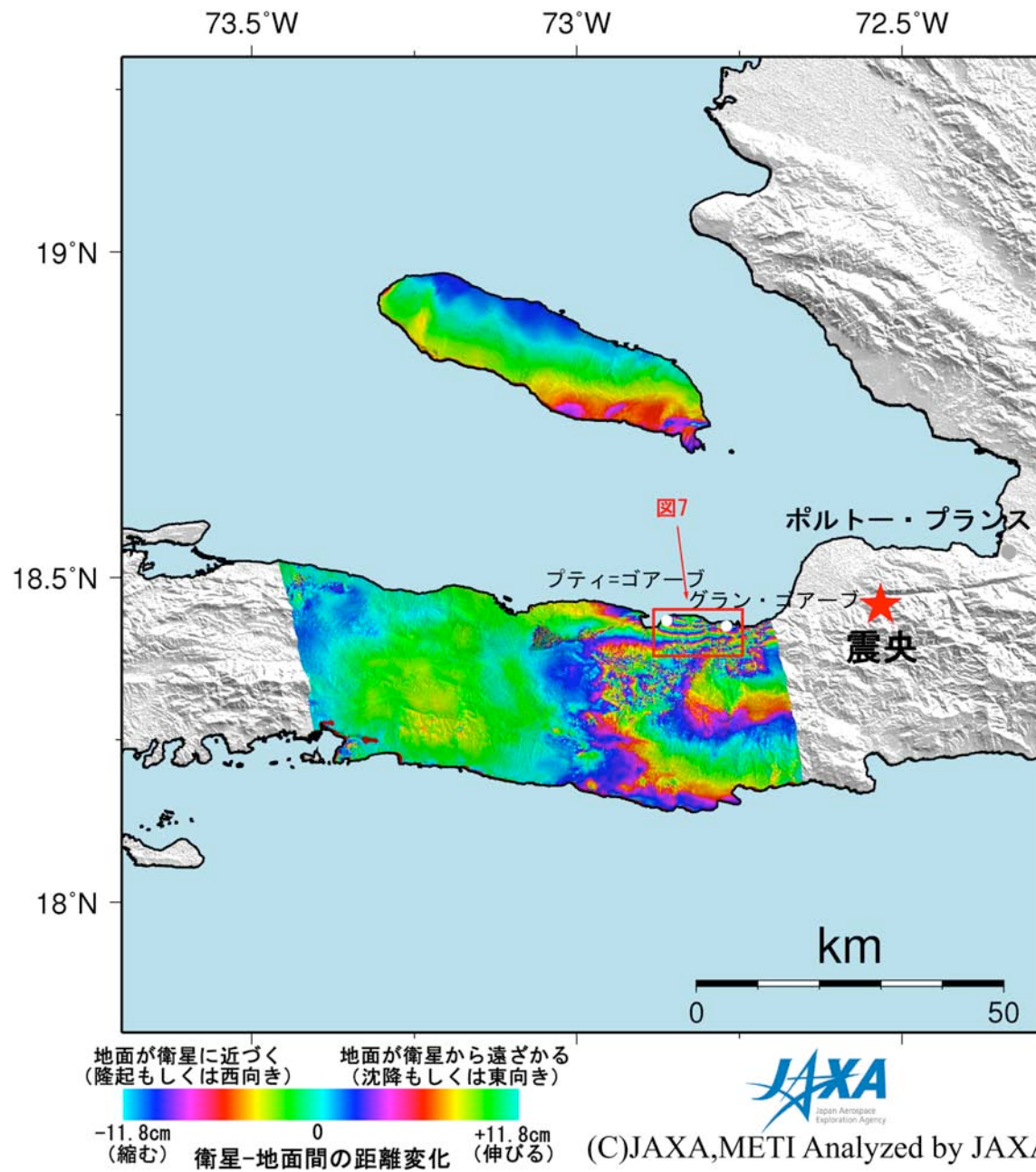
G. Hayes (USGS)



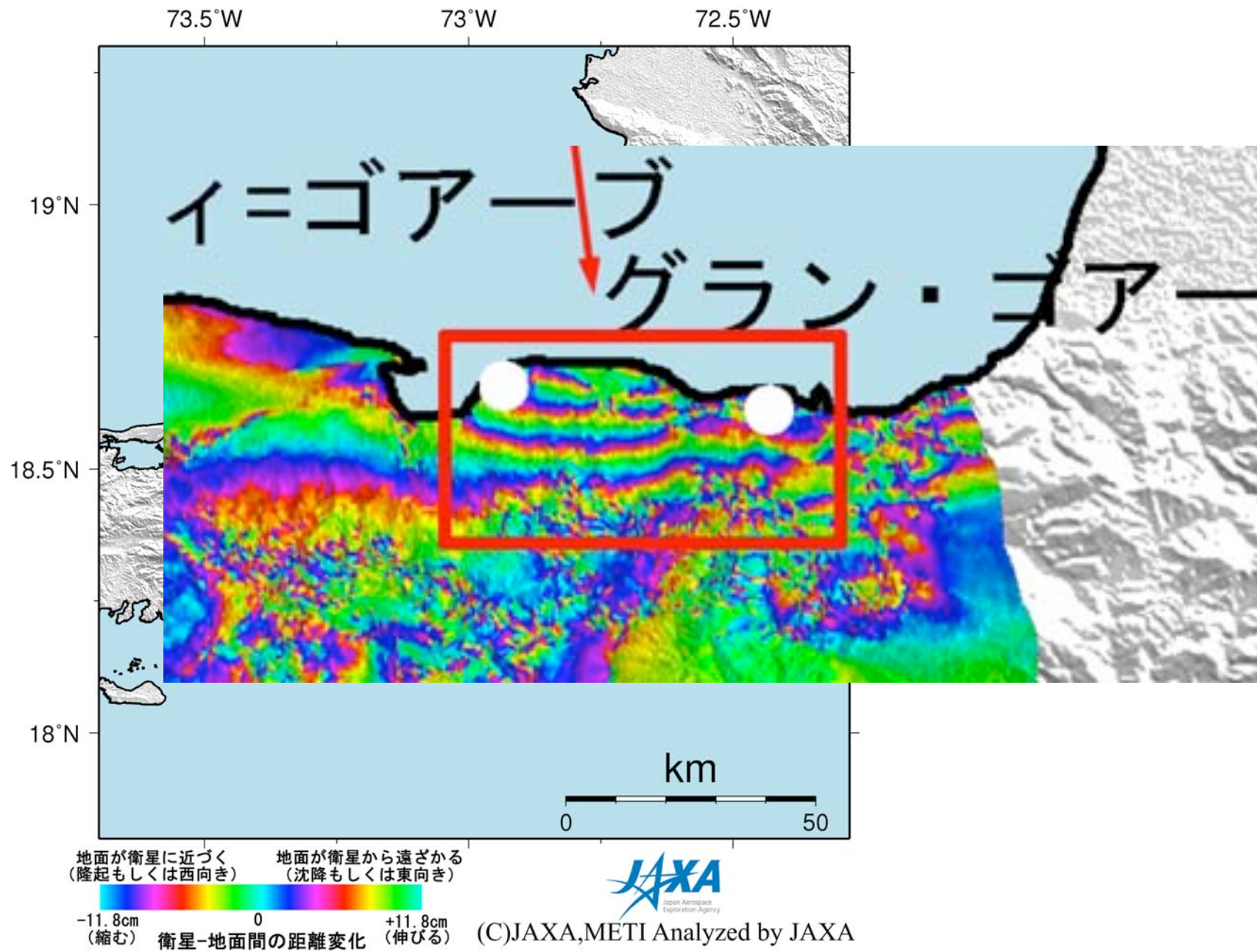
Amplitude image correlation 18/02/2009-14/01/2010 (DLR)



Amplitude image correlation 18/02/2009-14/01/2010 (DeMichele-BRGM)



Amplitude image correlation 18/02/2009-14/01/2010 (DLR)



Amplitude image correlation 18/02/2009-14/01/2010 (DLR)



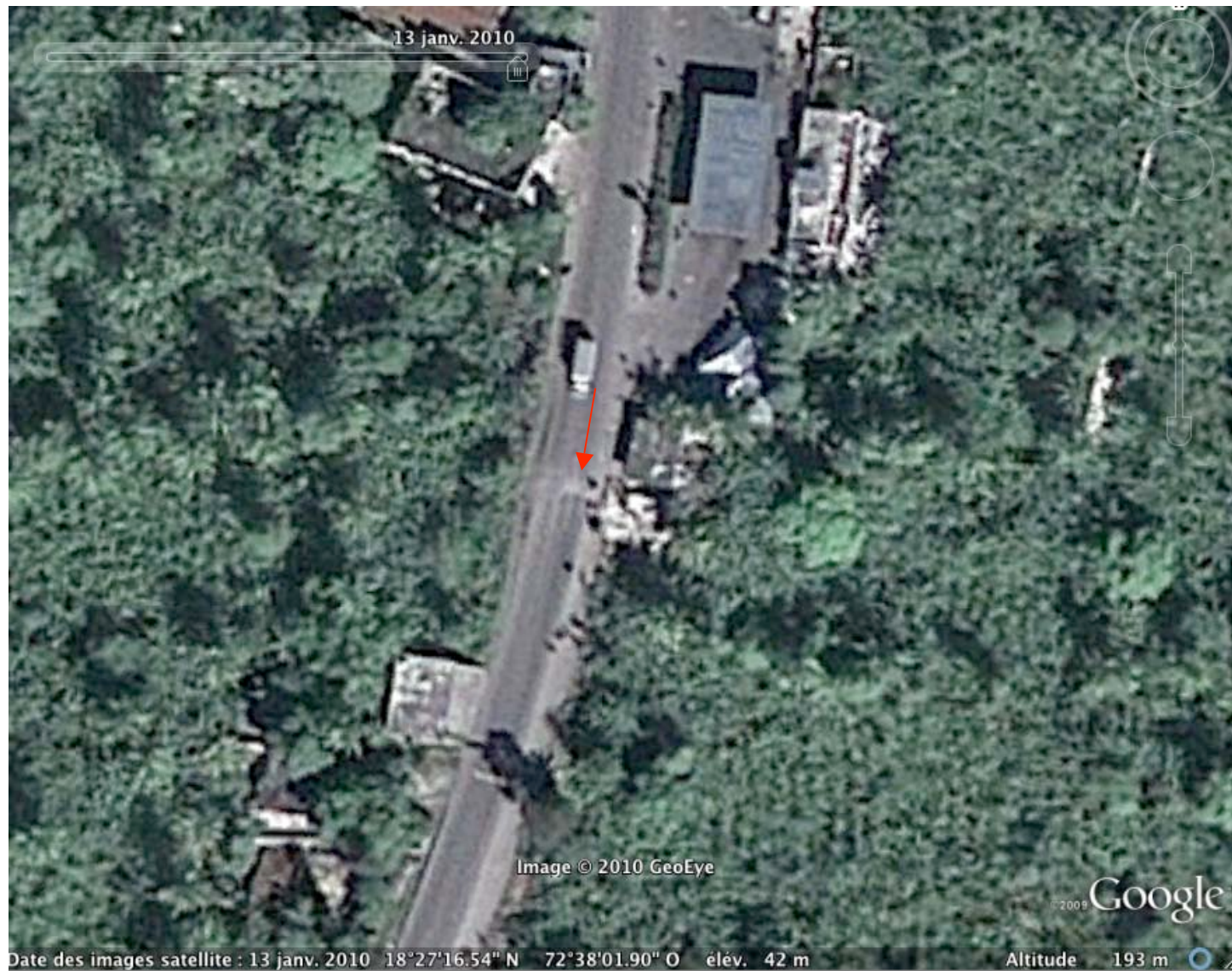


Image Geoeeye (résolution 60 cm) via Google Earth

Possible surface ruptures due to the Haiti earthquake visible on high resolution optical images Geoeye.



Offset road ?



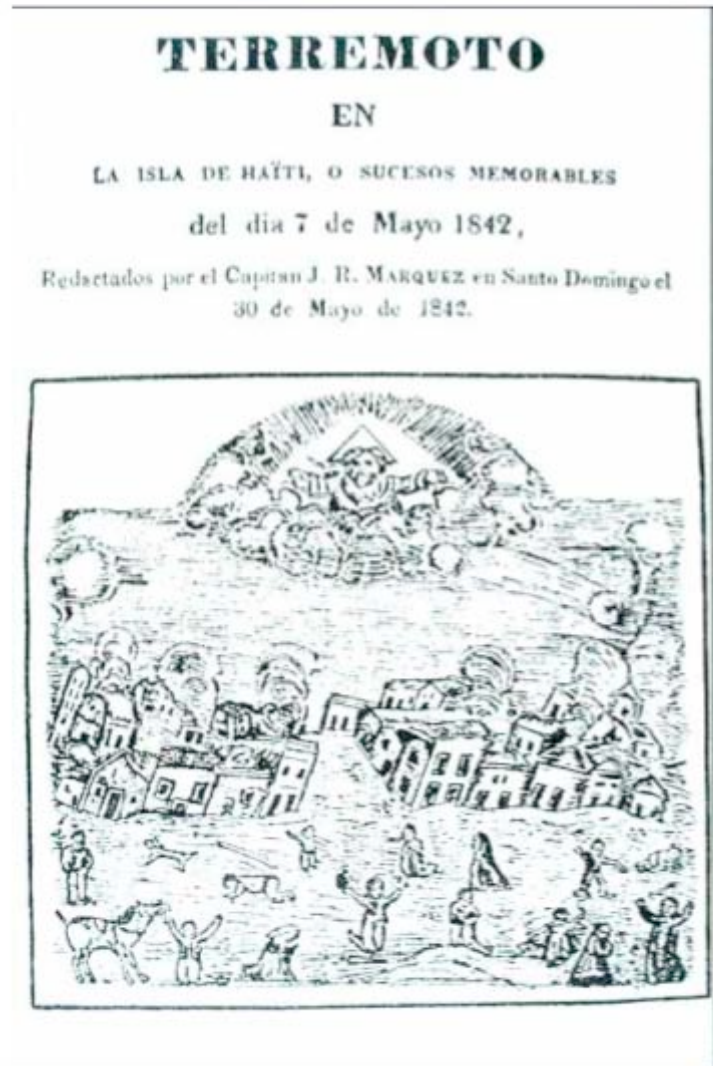
cracks en-echelons



18.454610N, -72.640491E

contact : klinger@ipgp.jussieu.fr

Le séisme du 7 mai 1842



- Séisme majeur du nord-ouest Hispaniola
- Nombreux témoignages de destructions:
 - *“On the arrival of the Tweed at Cape Hayti on Saturday morning, the 14 instant, that place was found to have been totally destroyed by an earthquake and the towns of Samana and Puerto Plata, on the East, Port Paix, Gonaives, Nicholas Mole, Port Au Prince and many others, have been equally sufferers.”*
 - *“En Port-de Pais el mar se retiro a gran distancia de la orilla y volviendo luego con terrible oleaje entro a la poblacion, sus aguas subieron a mas de 15 pie de altura y envolvieron en sombras de muerte a los que huyendo de la calda de los edificios se habian refugiado a la playa.”*
- Magnitude estimée: 8.0 (Mw)
- Affecte Haïti et la République Dominicaine

DESCRIPTION
TOPOGRAPHIQUE, PHYSIQUE,
CIVILE, POLITIQUE ET HISTORIQUE
 DE LA
PARTIE FRANÇAISE
 DE
L'ISLE SAINT-DOMINGUE

AVEC des Observations générales sur la Population, sur le Caractère & Mœurs de ses divers Habitans; sur son Climat, sa Culture, ses Productions son Administration, &c. &c.

Accompagnées des détails les plus propres à faire connaître l'état de cette Colonie à l'époque du 18 Octobre 1789;

Et d'une nouvelle Carte de la totalité de l'Isle.

Par M. L. E. MOREAU DE SAINT-MÉRY.

TOME SECOND.

COMPRENANT la Description des dix-sept Paroisses de la Partie de l'Ouest & de l'Isle la Grande & des quatorze Paroisses de la Partie du Sud & de l'Isle à Vache.

Les sources de la profusion ne font pas toutes tailler.

A PHILADELPHIE,

Et s'y trouve

Chez l'AUTEUR, au coin de Front & de Cullow-Hill Streets.

A PARIS, chez DUPONT, Libraire, rue de la Loi.

Et à HAMBURG, chez les principaux Libraires.

1798.

La terre fut tranquille ensuite jusqu'au 27 Décembre 1767, qu'elle trembla vivement à quatre heures & demie du matin, mais sans causer aucun dommage.

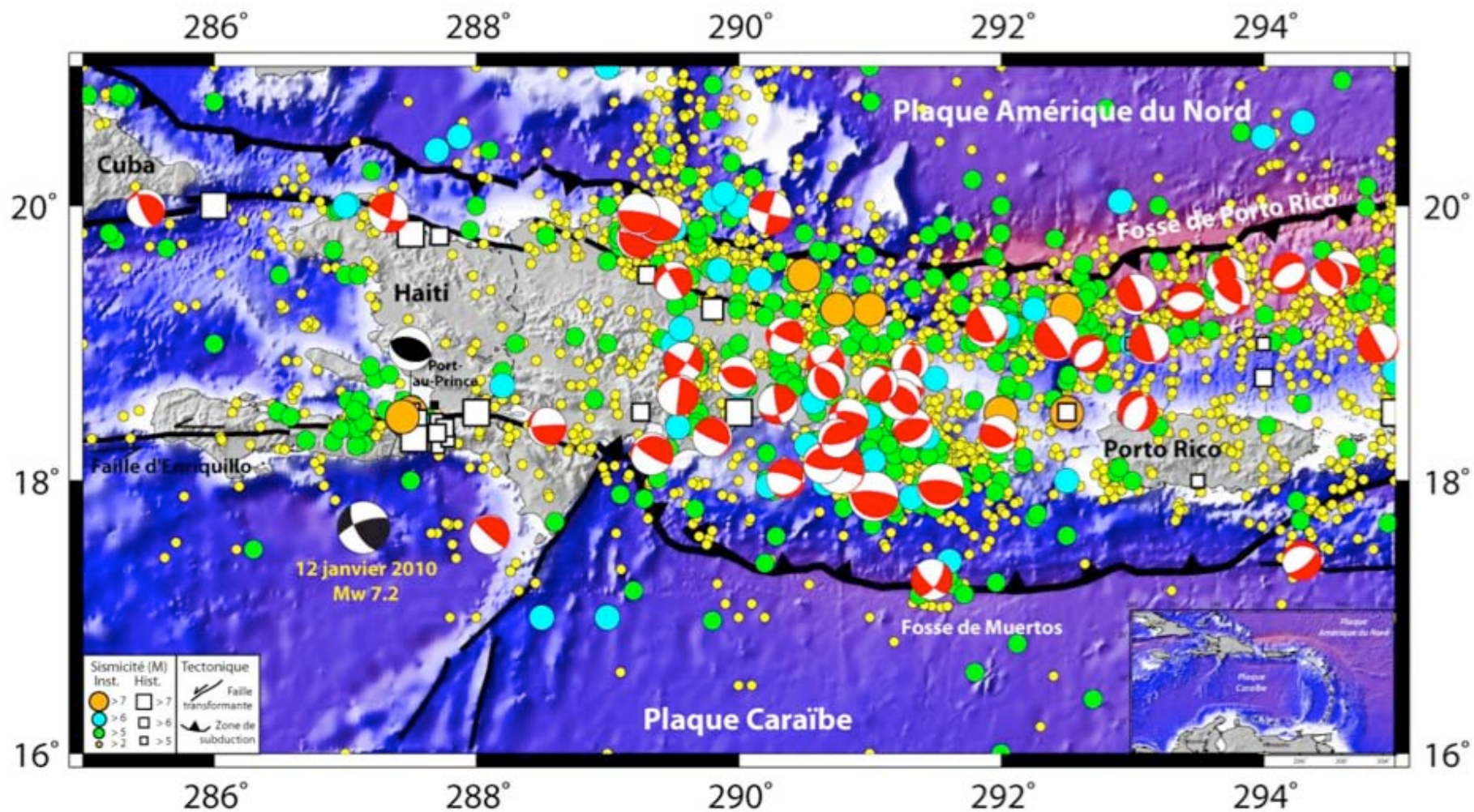
Le 10 Octobre 1768, il y eut trois secousses, & une le 14 Août 1769.

La terre trembla le 20 Janvier & le 12 Avril 1770.

Mais l'époque du plus grand désastre, fut le 3 Juin de la même année, jour de la Pentecôte. A sept heures & un quart du soir, l'Isle entière éprouva un tremblement de terre précédé d'un bruit sourd, semblable à un mugissement. Les deux premières secousses, ressenties au Port-au-Prince & qui se suivirent de très-près, durèrent, ensemble au moins 4 minutes, & pendant cette succession de mouvemens d'ondulation de l'Est à l'Ouest & de trépidation, la ville entière fut renversée; la poudrière seule résista & s'ouvrit seulement. Un horizon gras, une atmosphère brûlante, un air acca-

Le jour montra toute l'horreur de cette scène déchirante. Un sol entrouvert en mille endroits, des défenseurs de la patrie ensevelis sous les ruines des cazernes ou des hôpitaux, des prisonniers écrasés sous les débris de la geole, les montagnes voisines de la ville dégradées & affaissées; enfin, des monceaux de décombres couvrant toute l'étendue d'une ville, où il n'y avait plus d'autre abri que celui des arbres, qui indiquaient la direction des rues; tel était le tableau que contemplaient des infortunés, s'estimant trop heureux encore, lorsqu'ils n'avaient à déplorer que les pertes de la fortune, & qu'ils ne découvraient aucun objet cher à leur tendresse parmi deux cens cadavres.

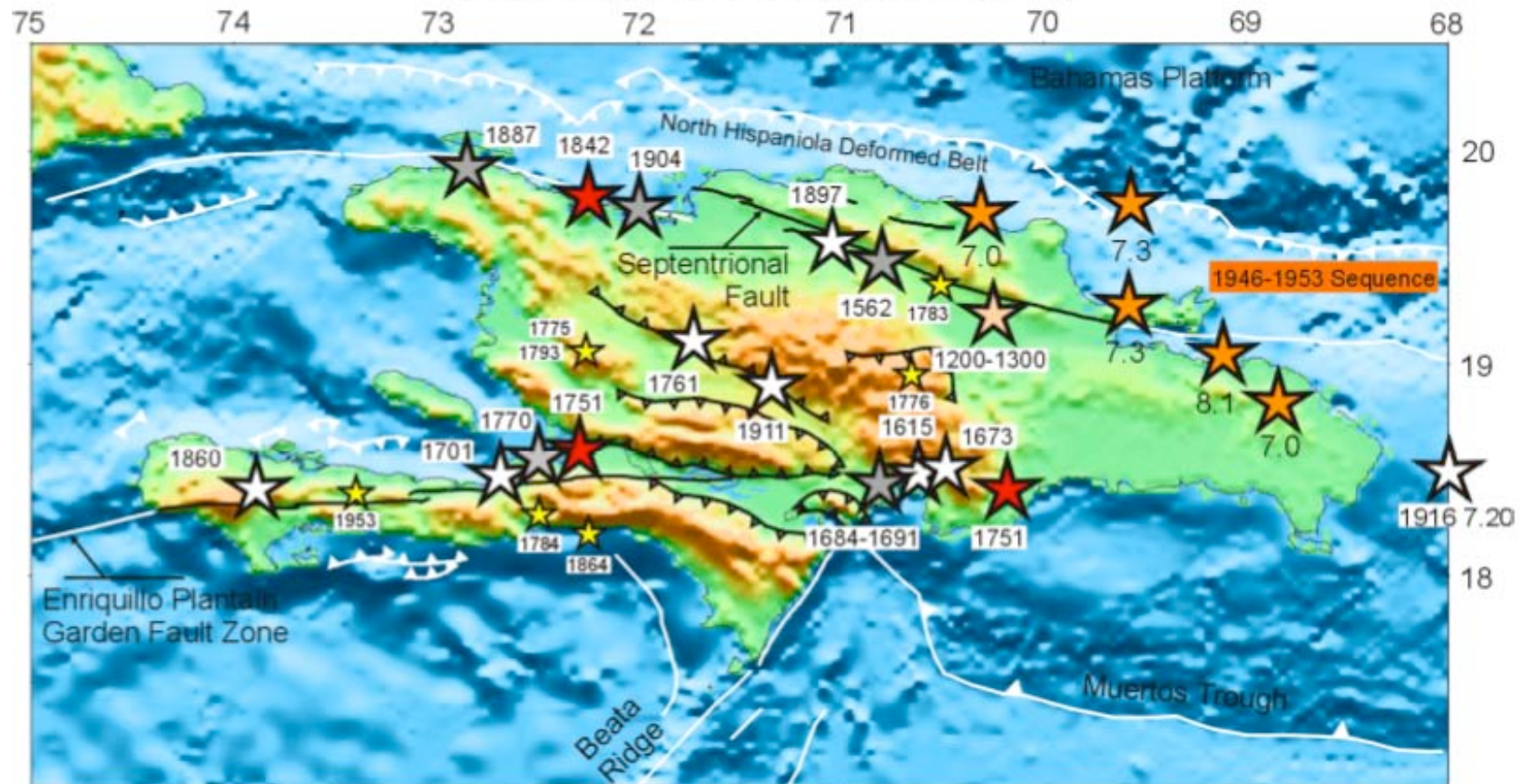
Le feu se manifesta dans plusieurs points par la chute des cuisines, &



Sismicité instrumentale et historique (Meghraoui, EOST)

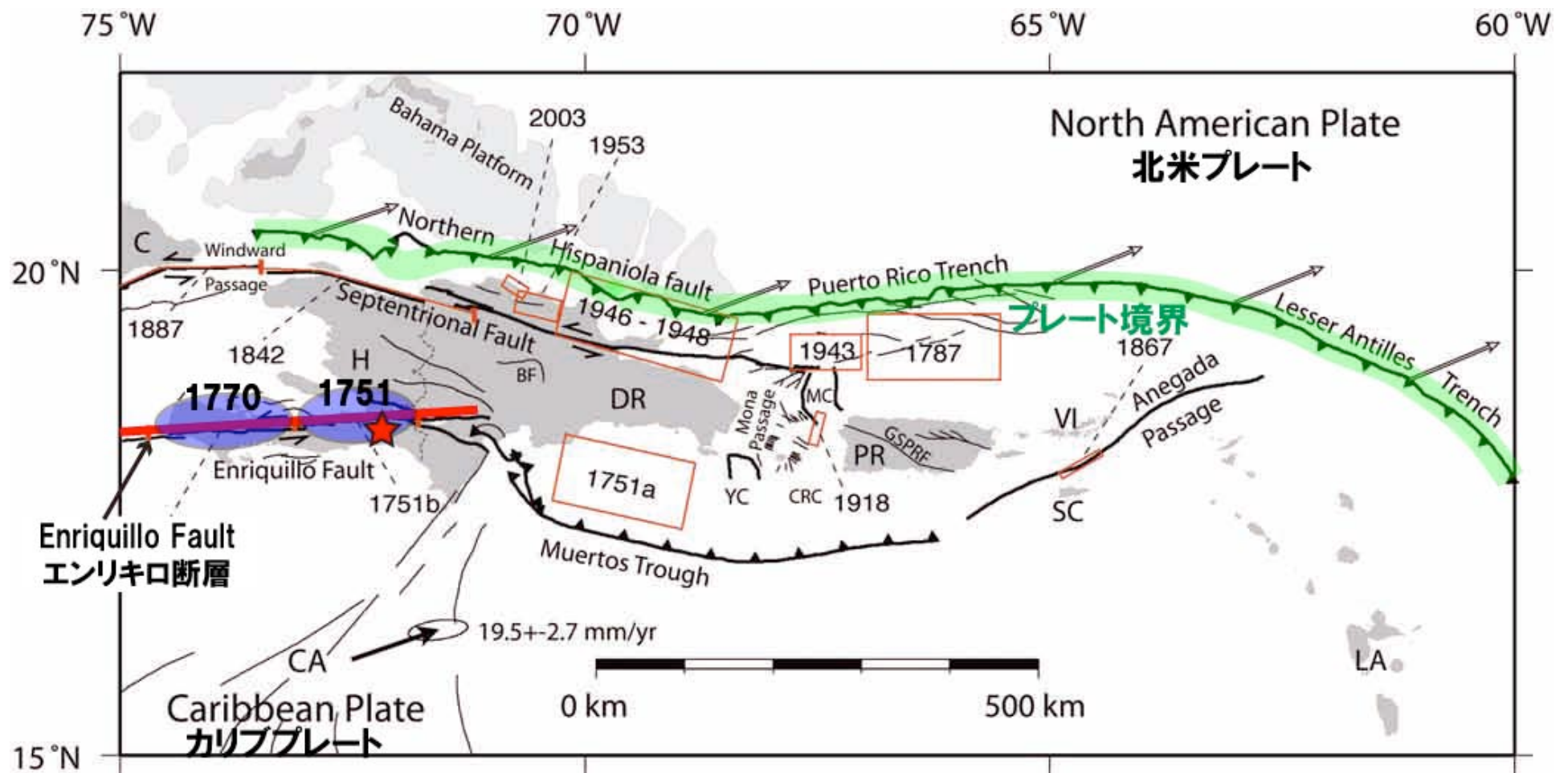
Historical seismicity in Hispaniola (before 1960)

(locations approximate except 46-53 sequence)



- ★ Major earthquakes
- ★ Other EQ
- ★ Paleo-earthquakes
- ★ Large EQ, city destroyed
- ★ 1946 sequence
- ★ Moderate EQ (NOAA DB)

Calais.



Manaker et al., GJI, 2008.

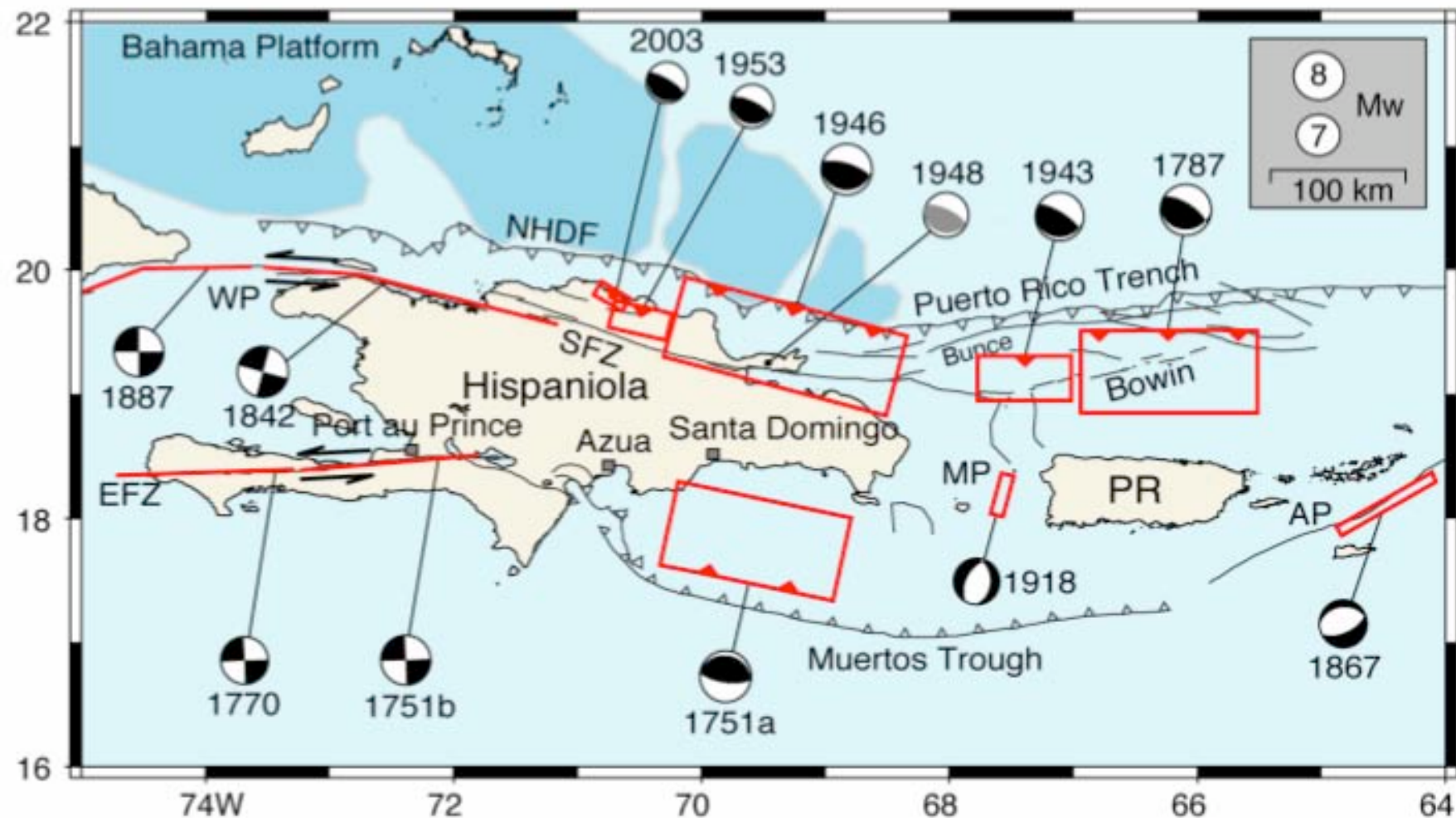
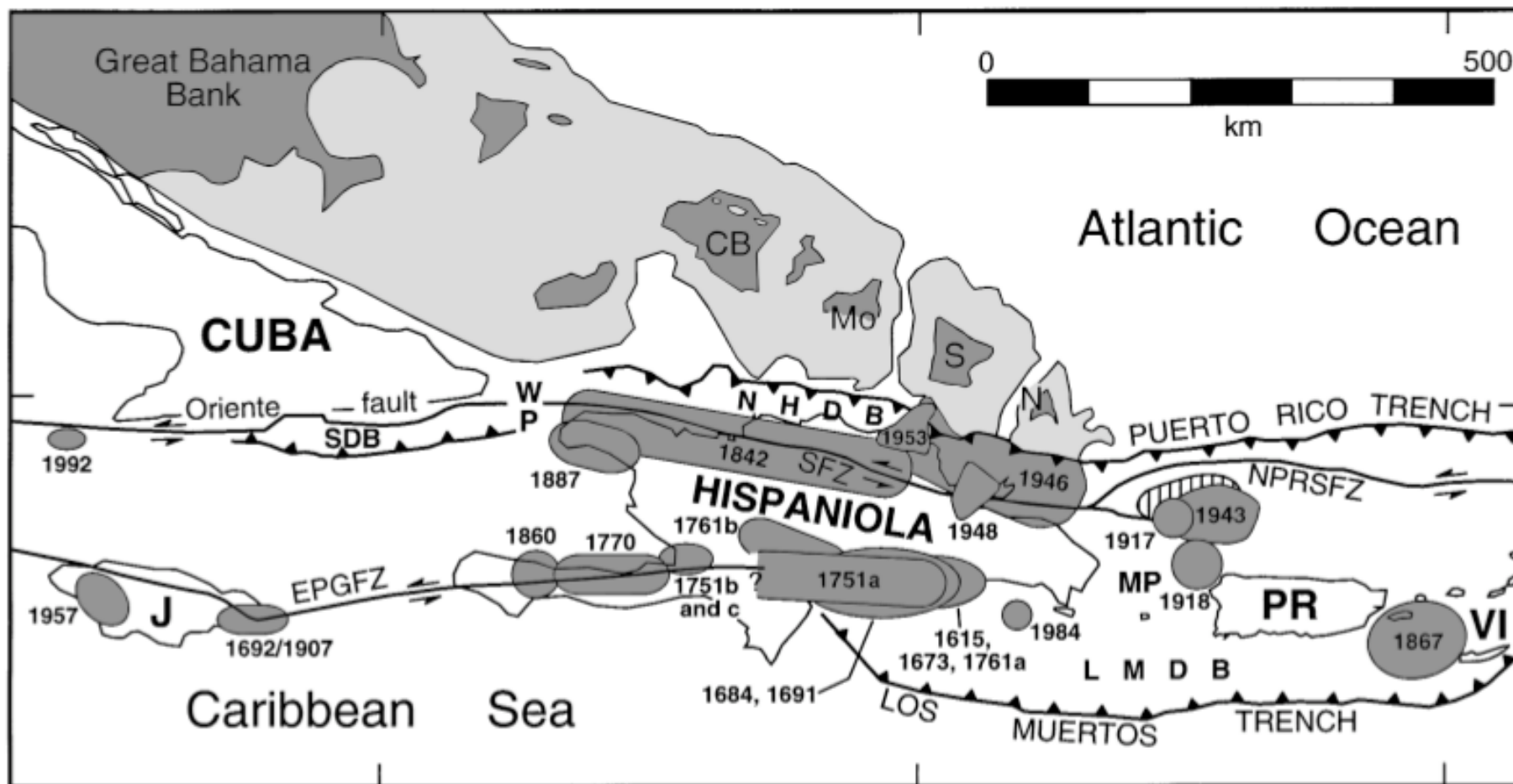
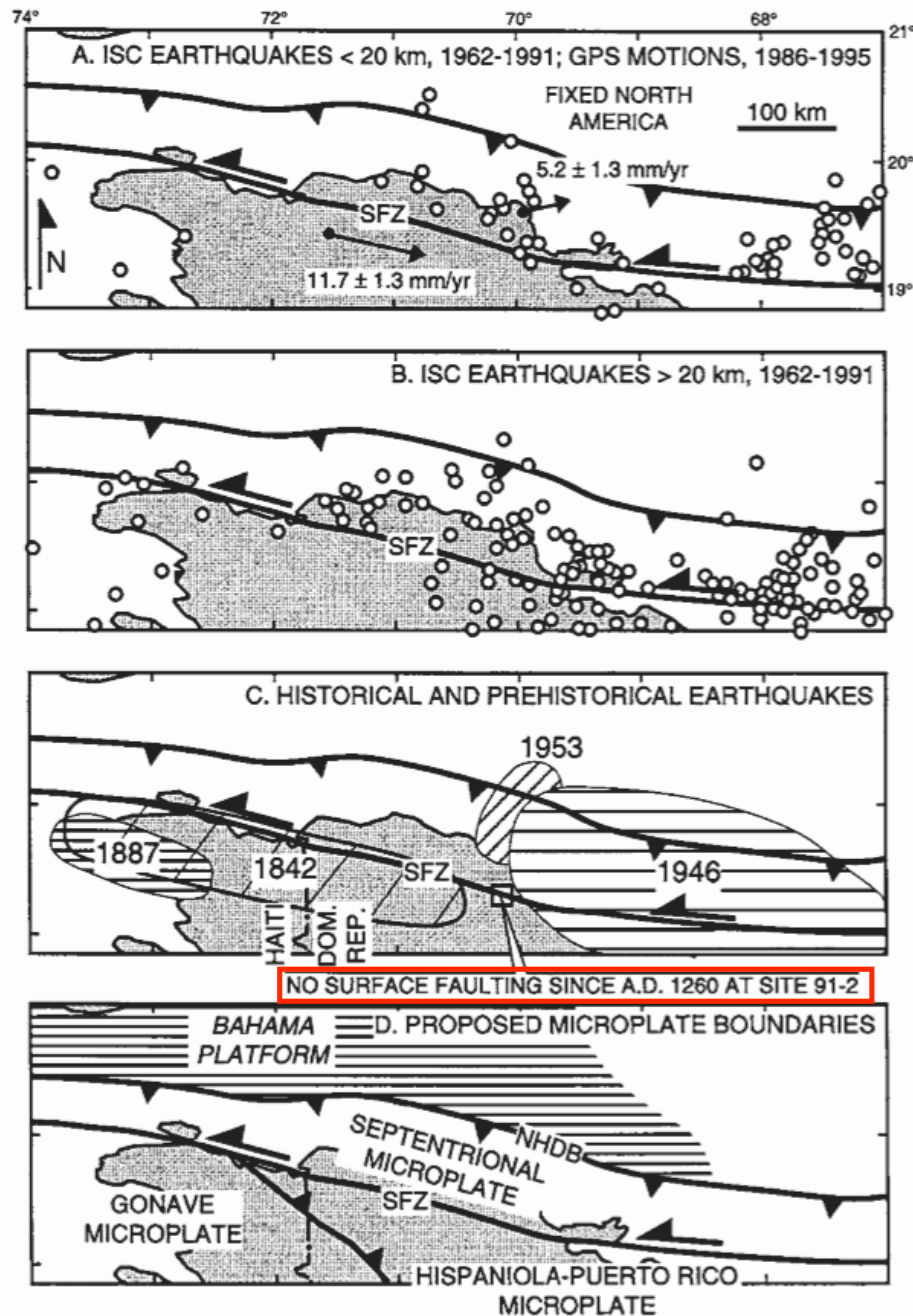


FIG. 1.1: Carte des séismes historiques et récents dans le nord-est Caraïbe. Les lignes rouges indiquent les zones de rupture sismiques estimées. Les symboles indiquent le type de mouvement sur les failles lors de ces séismes.



Paleoseismicity (Dolan and Wald, GSAsp, 1998)

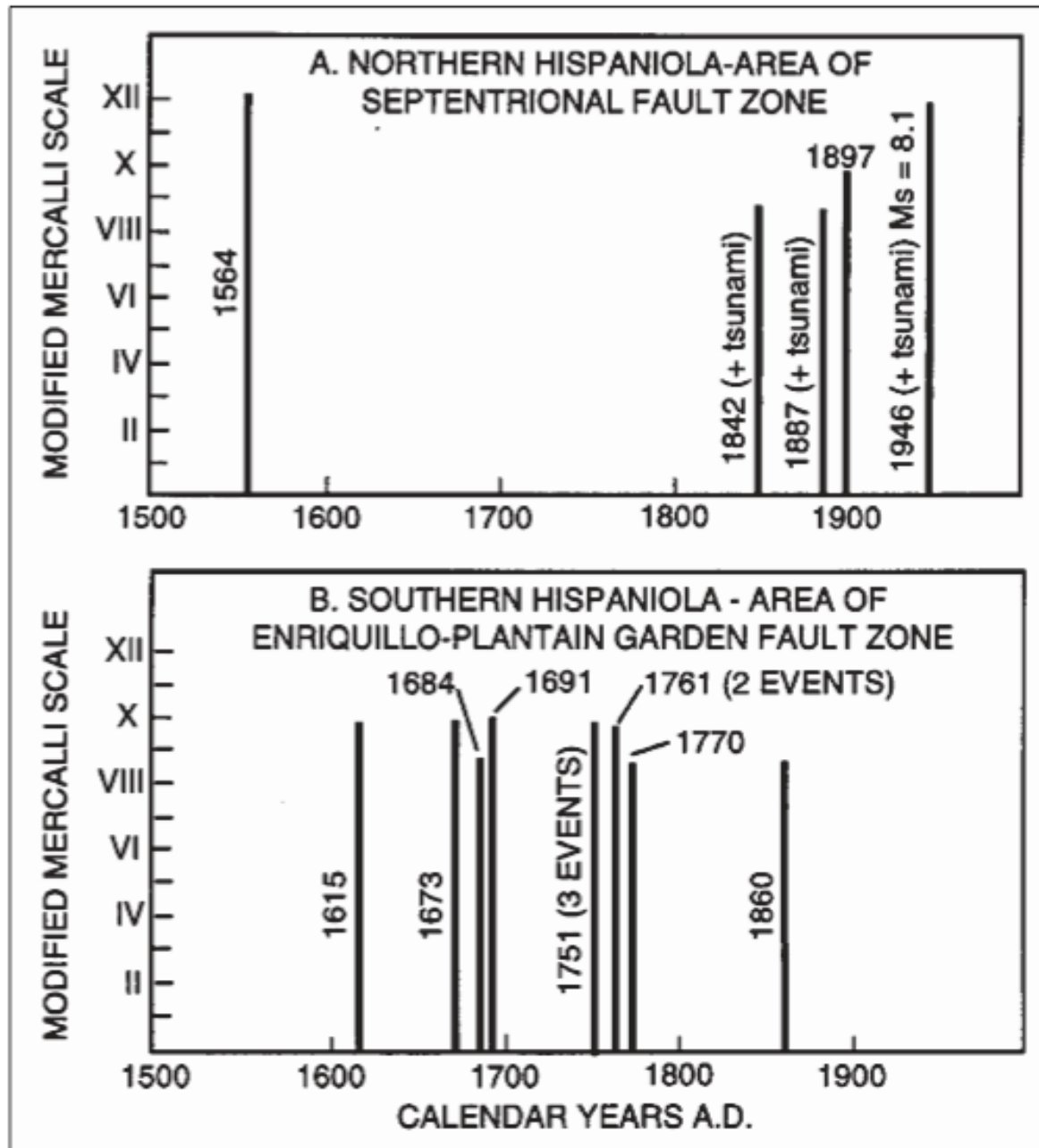


Geomorphic offsets and
trenching:

13 ± 4 mm/yr

23 ± 7 mm/yr

No events since 730 yrs...

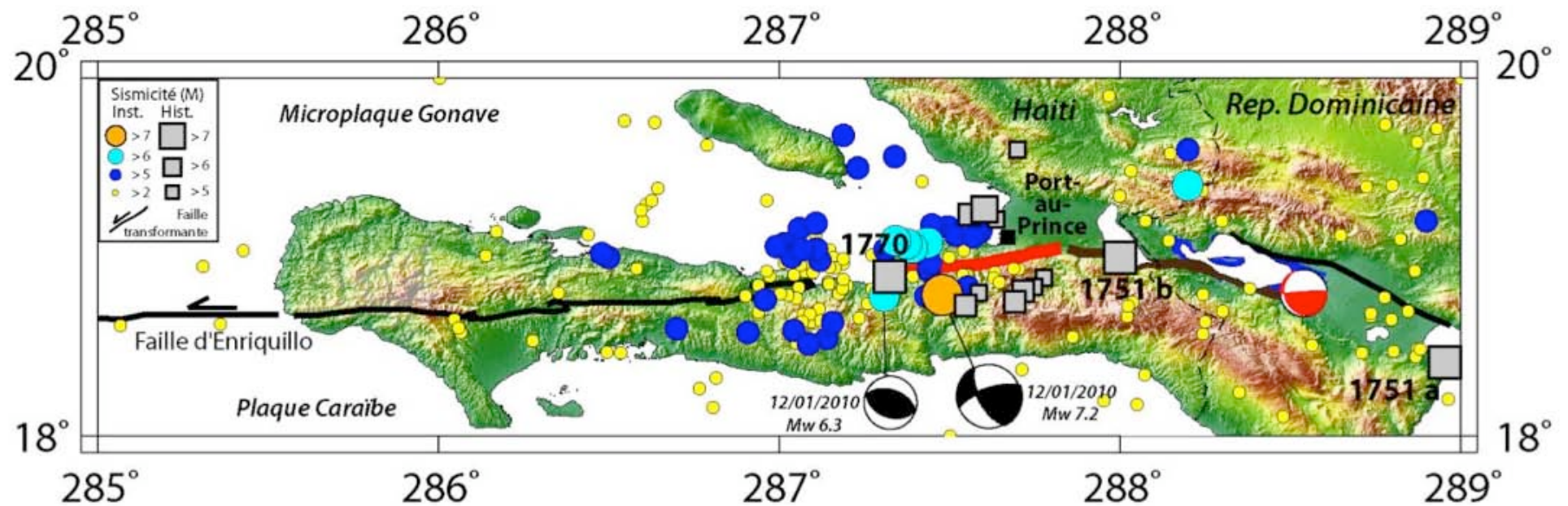


orphic offsets and
ing:

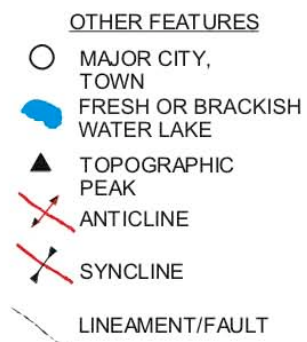
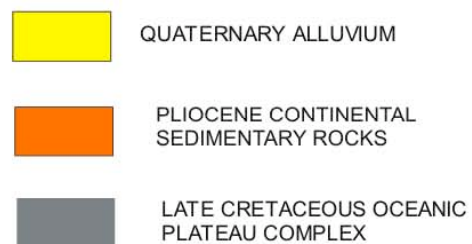
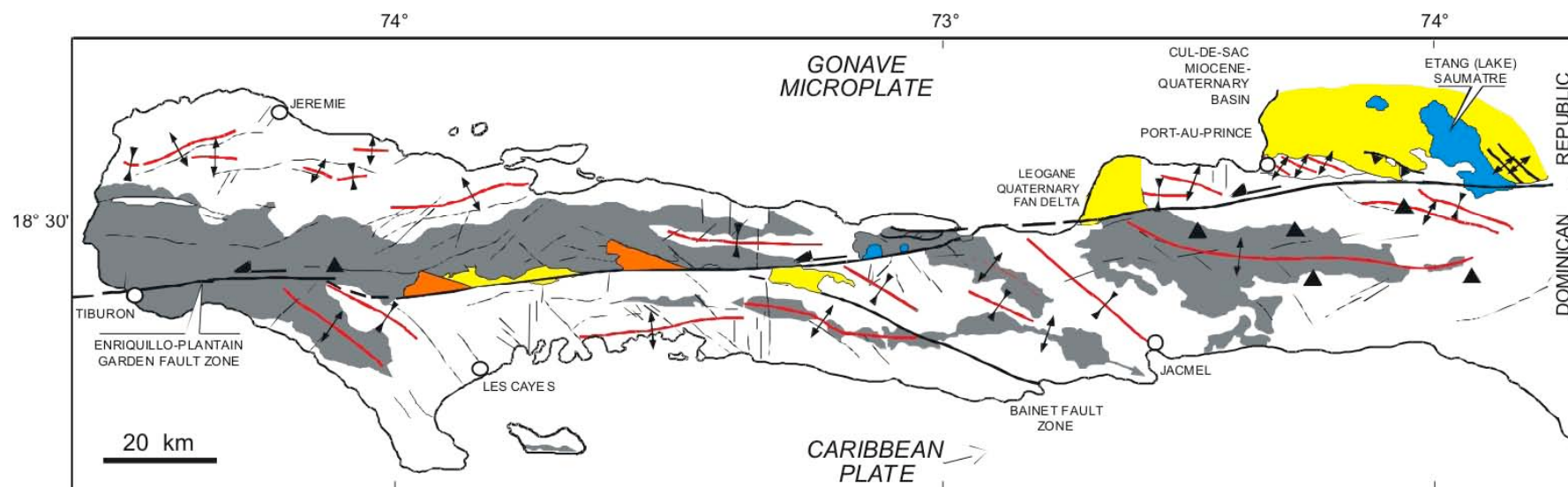
· mm/yr

· mm/yr

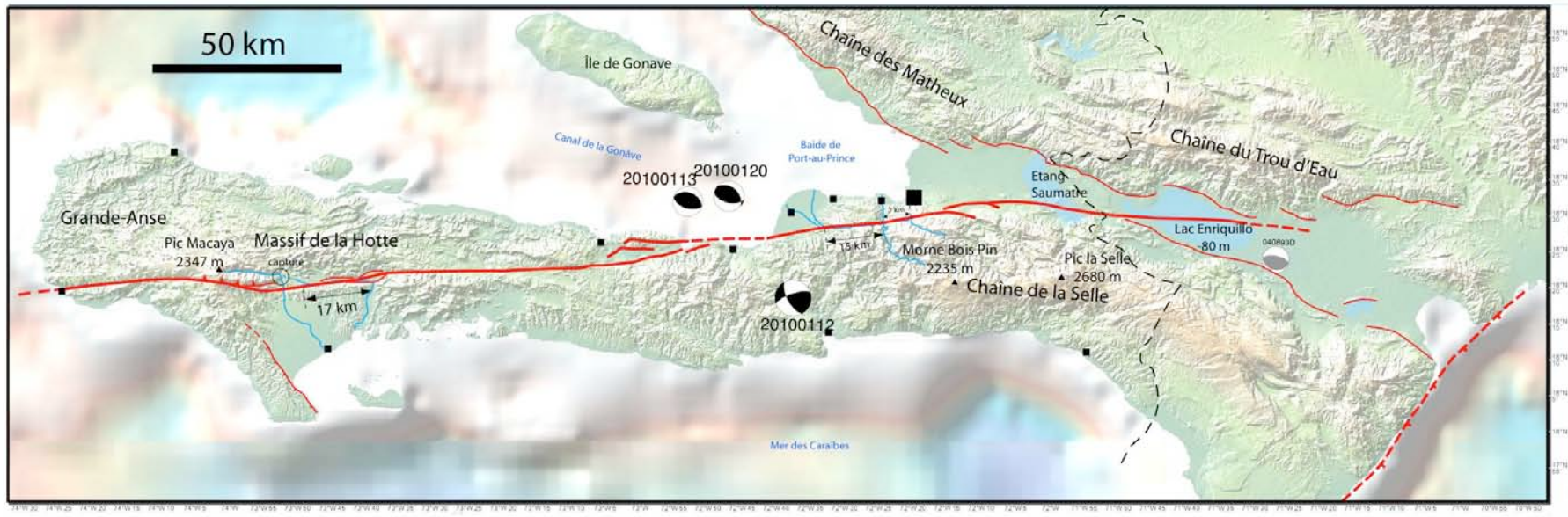
ents since 730 yrs...



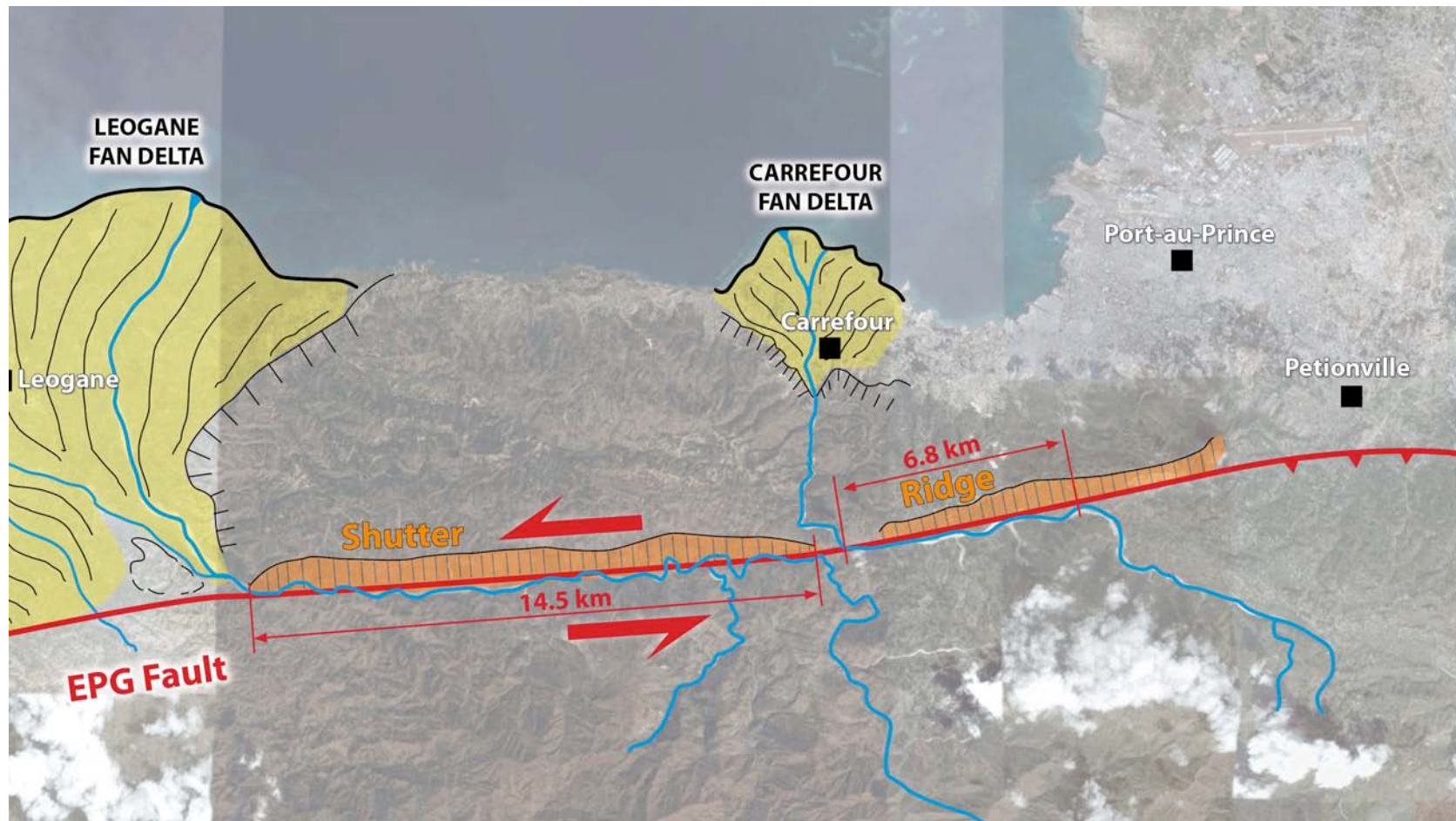
Faille d'Enriquillo, sismicité et paléosismicité (Meghroui, EOST)

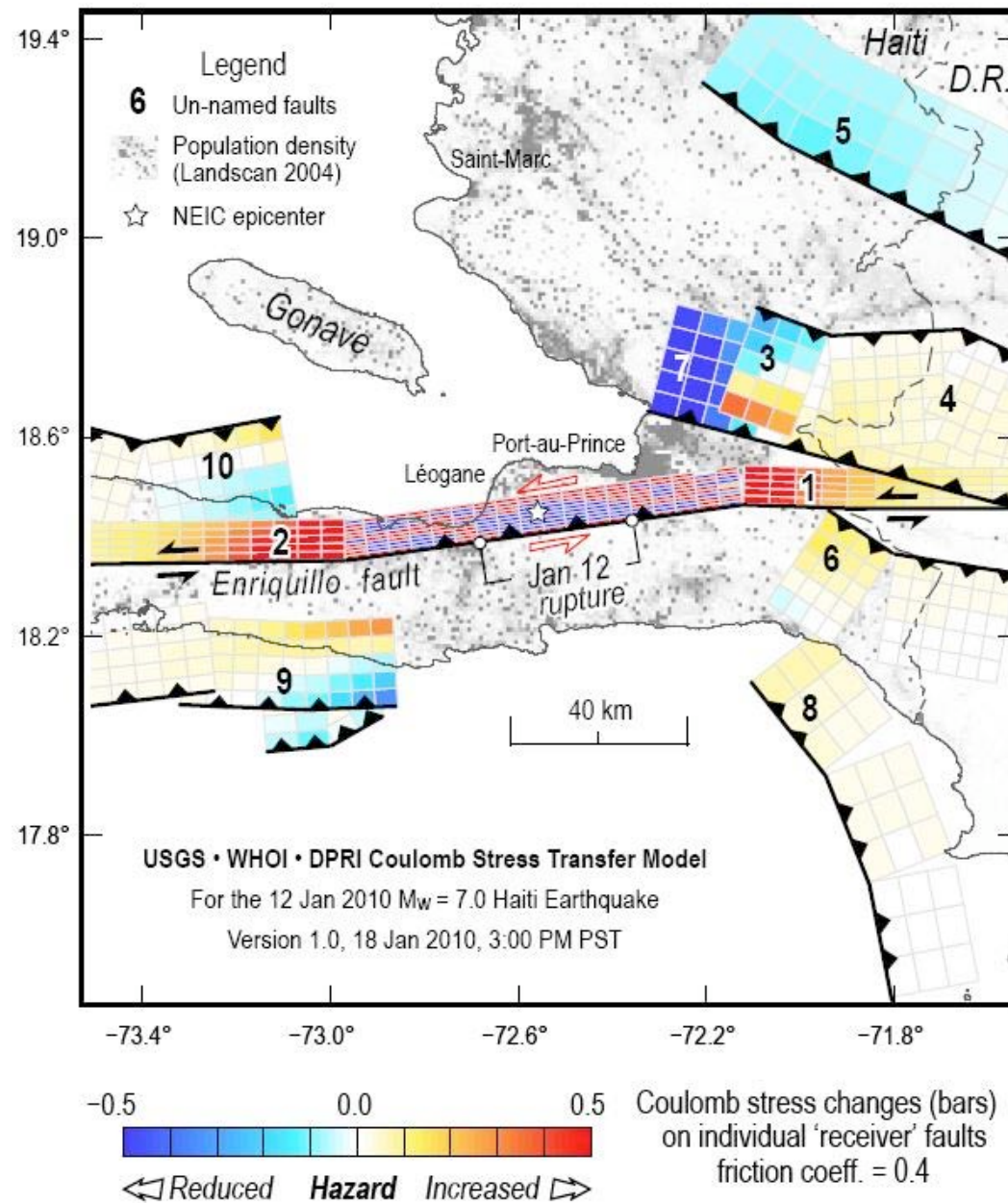


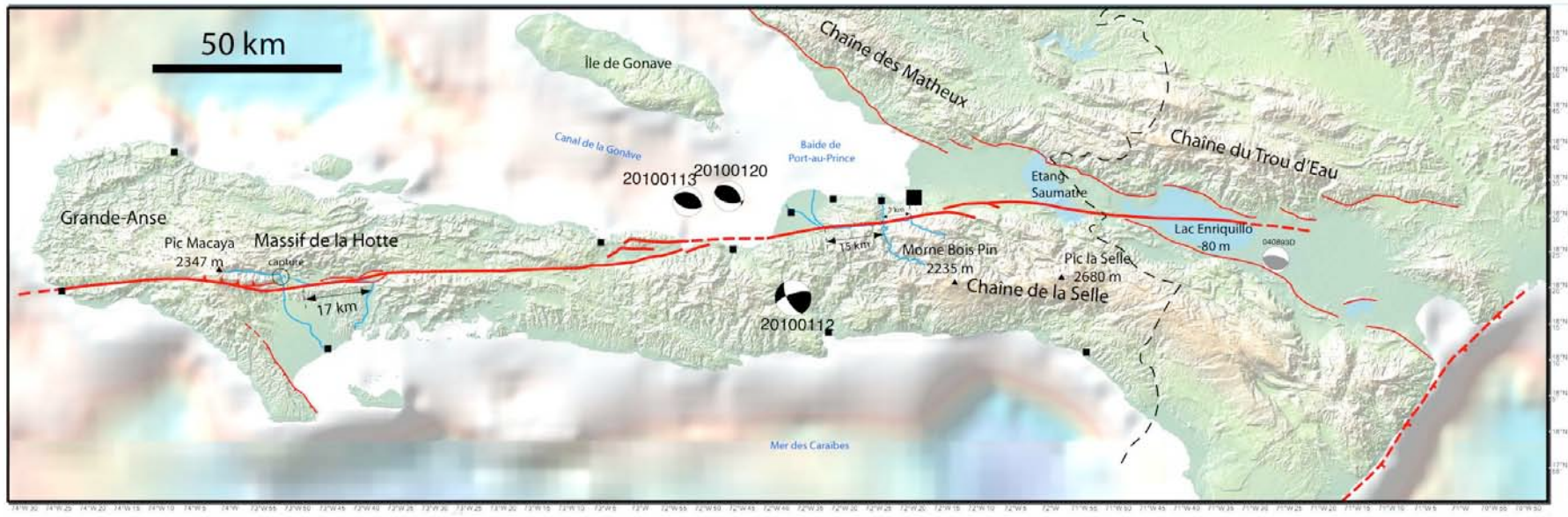
GPS (E. Calais)



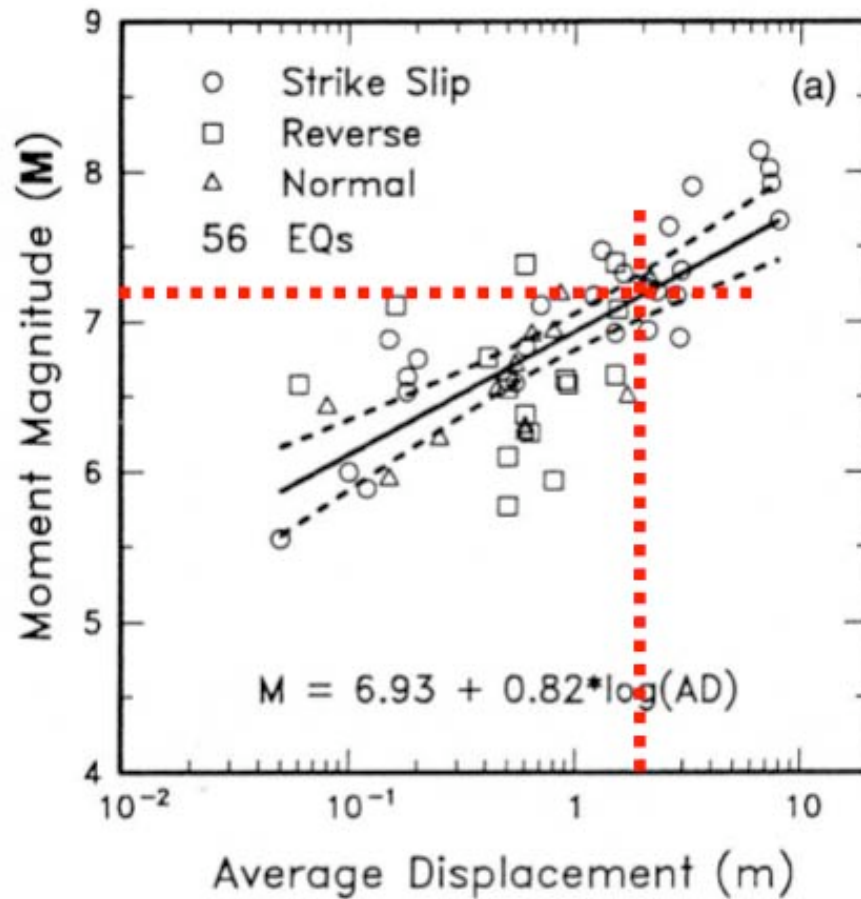
1:1000000.



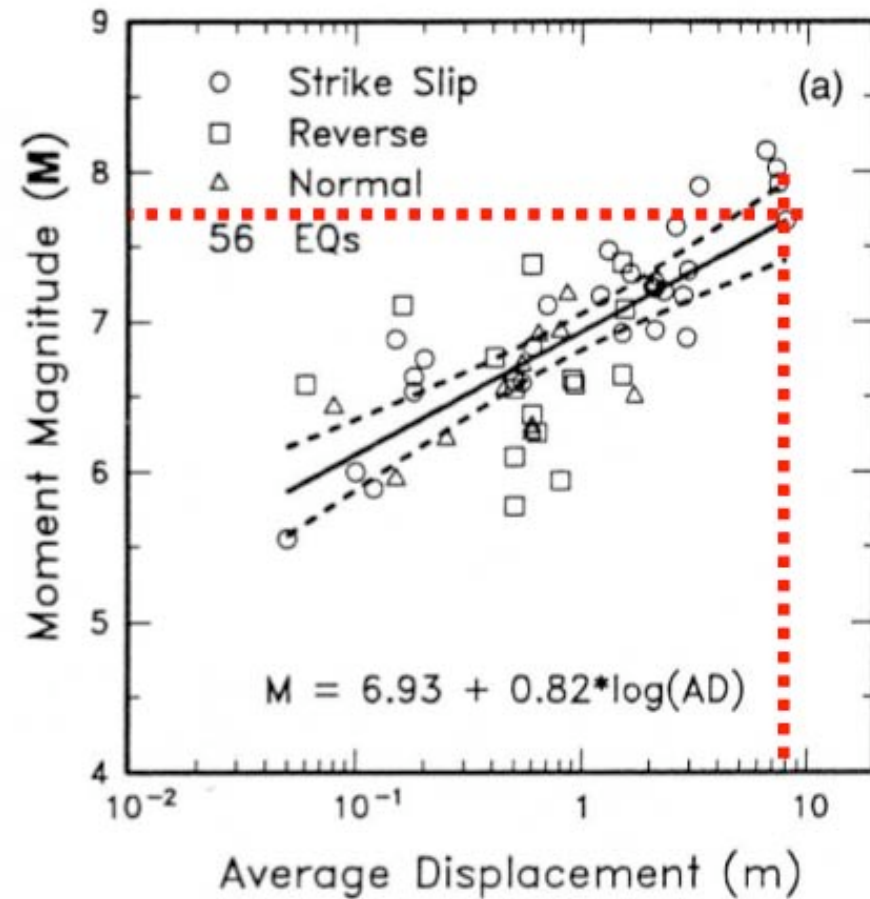




1:1000000.



- Faille de la Presqu'île du sud = 7 mm/an
- Dernier séisme majeur = 250 ans
- Déficit de glissement = $7 \times 250 = 1.7$ m
- Potentiel pour $M_w=7.2$



- Faille Septentrionale = 9 mm/an
- Dernier séisme majeur = 770-960 ans
- Déficit de glissement = 7-8 m
- Potentiel pour $M_w=7.7$

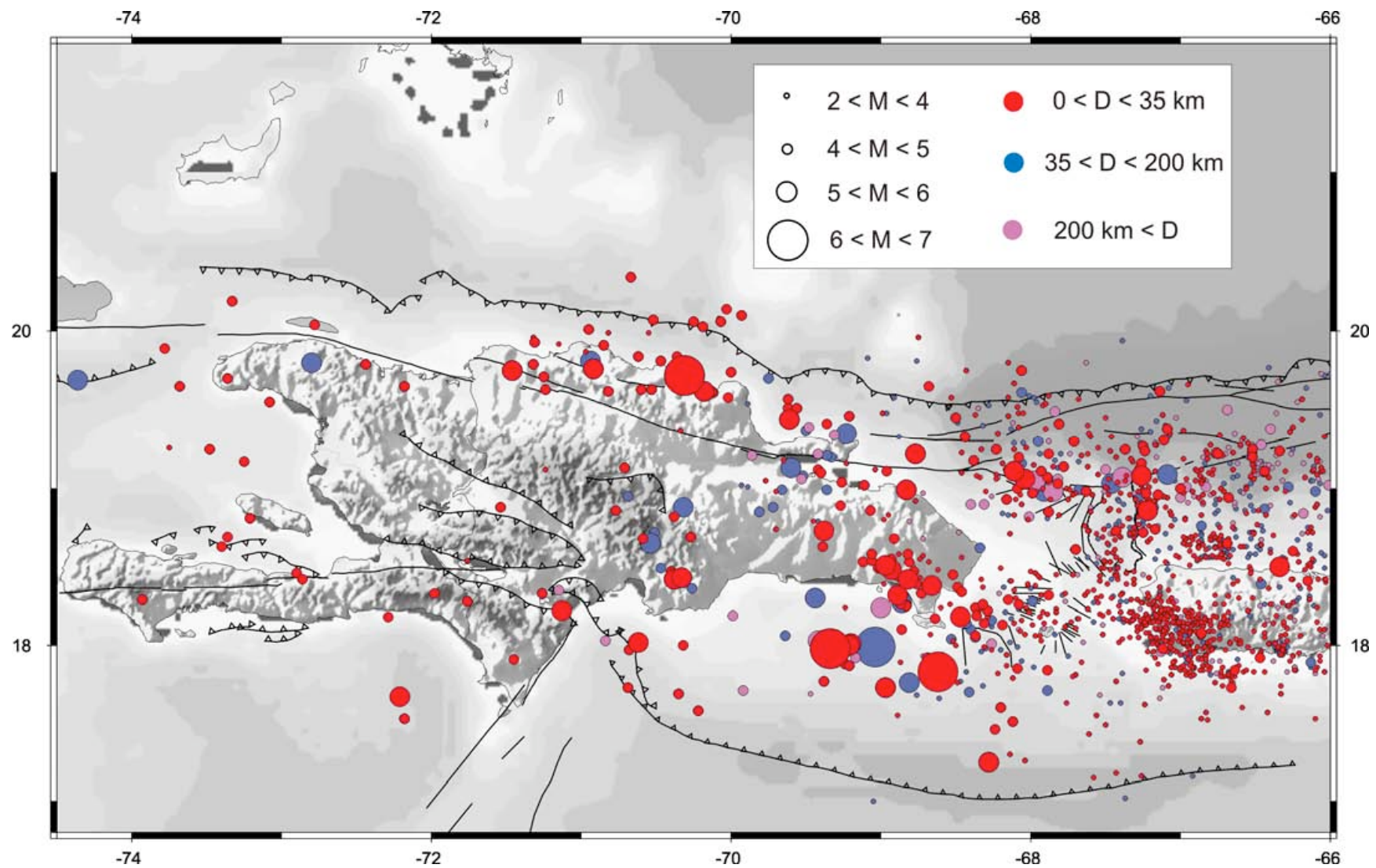




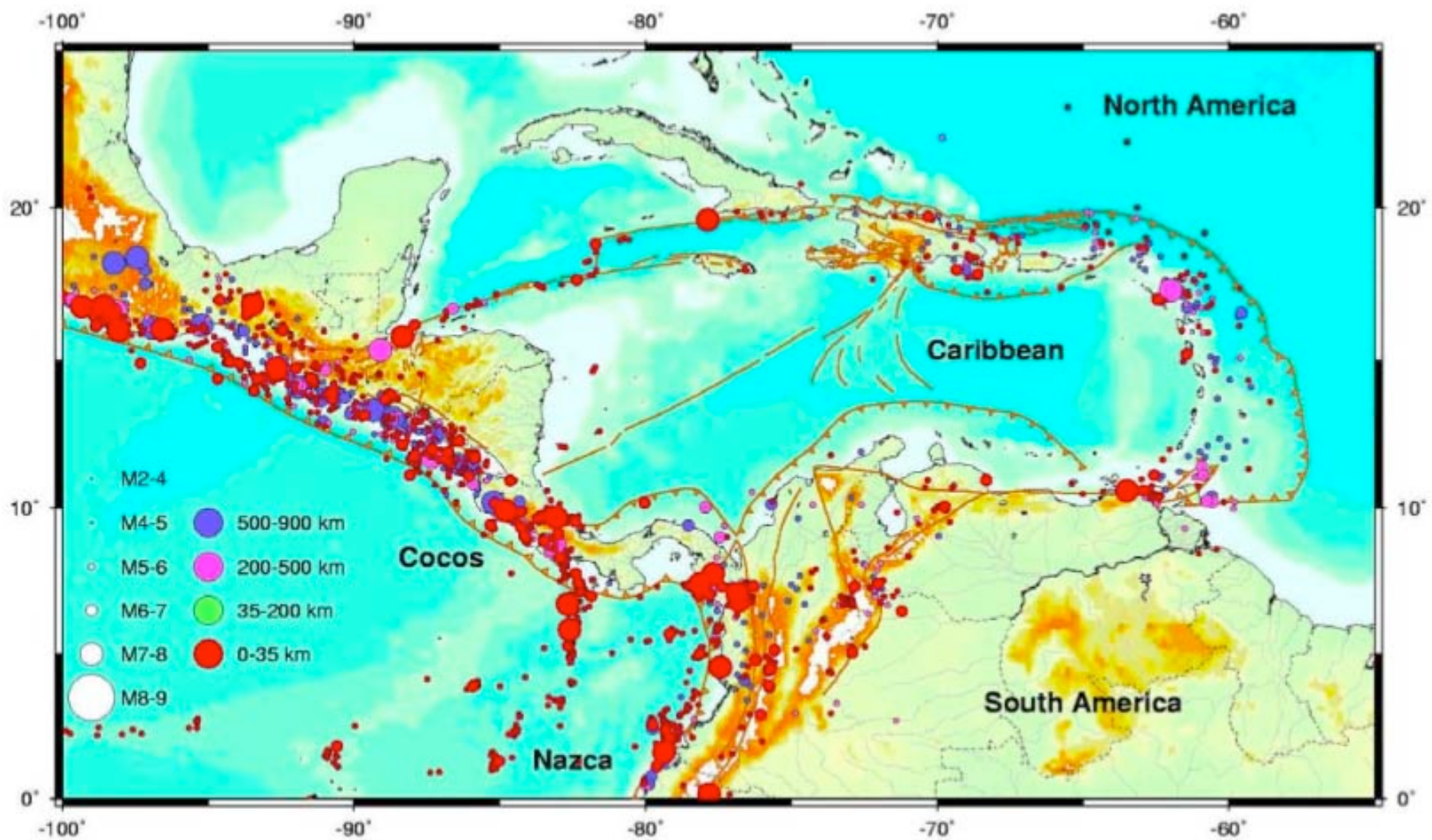




SRTM DEM (geoapp)



Sismicité 1977-2002 (E. Calais)



Sismicité caraïbes (E. Calais)

