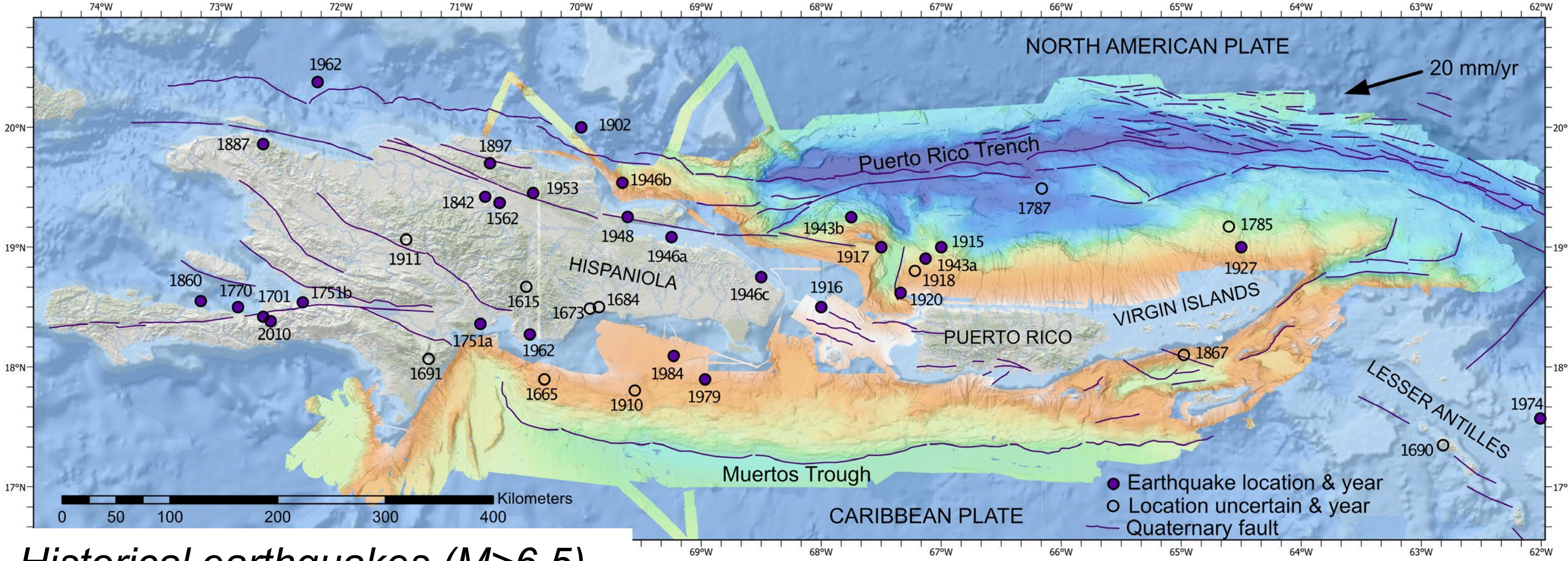
Recent and future studies of the Northern Caribbean subduction zone



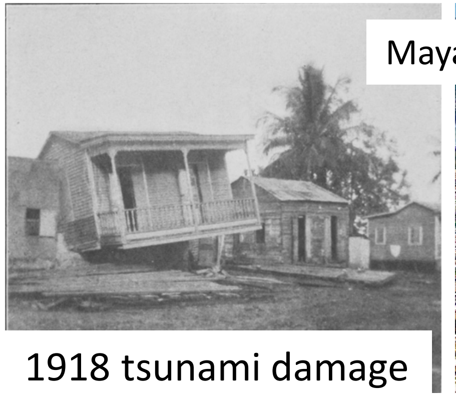
Historical earthquakes (M>6.5)

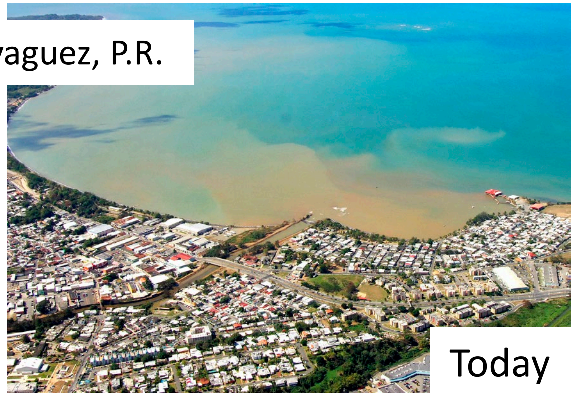
The region is densely populated and has a history of destructive tsunamis and earthquakes

U.S. Navy ship Monogahela thrown on a reef in U.S. Virgin Islands by the 1867 tsunami

Aguadilla, P.R.

Mayaguez, P.R.





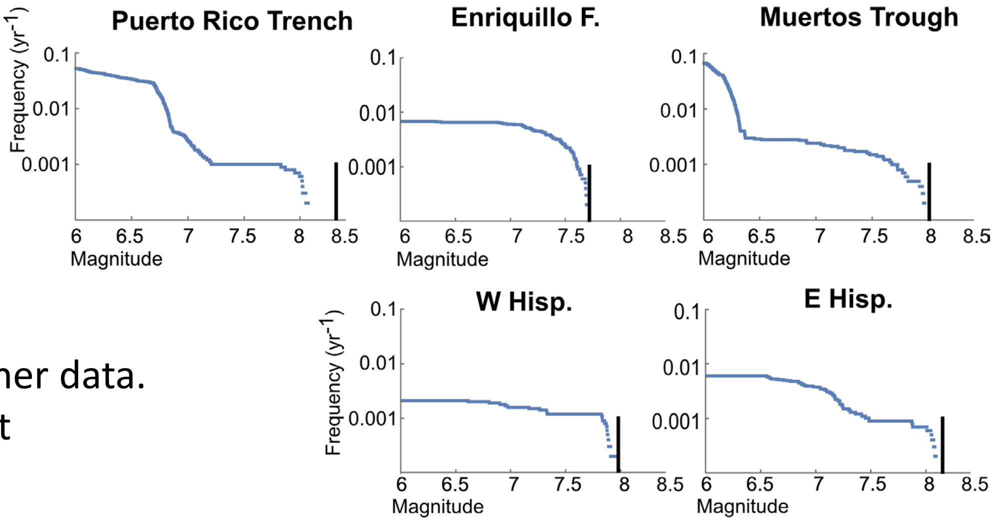
Earthquake magnitude-frequency distributions in the Northern Caribbean plate boundary using combinatorial optimization

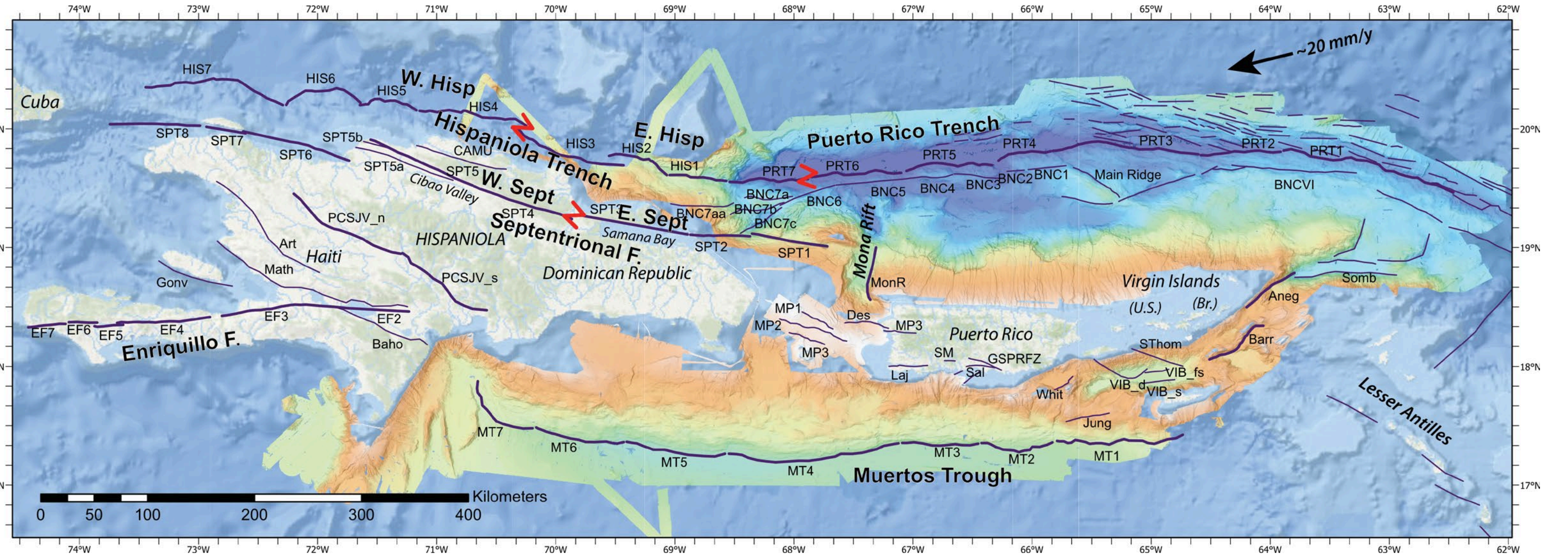
(based on the integer-programming method of Geist & Parsons, 2018)

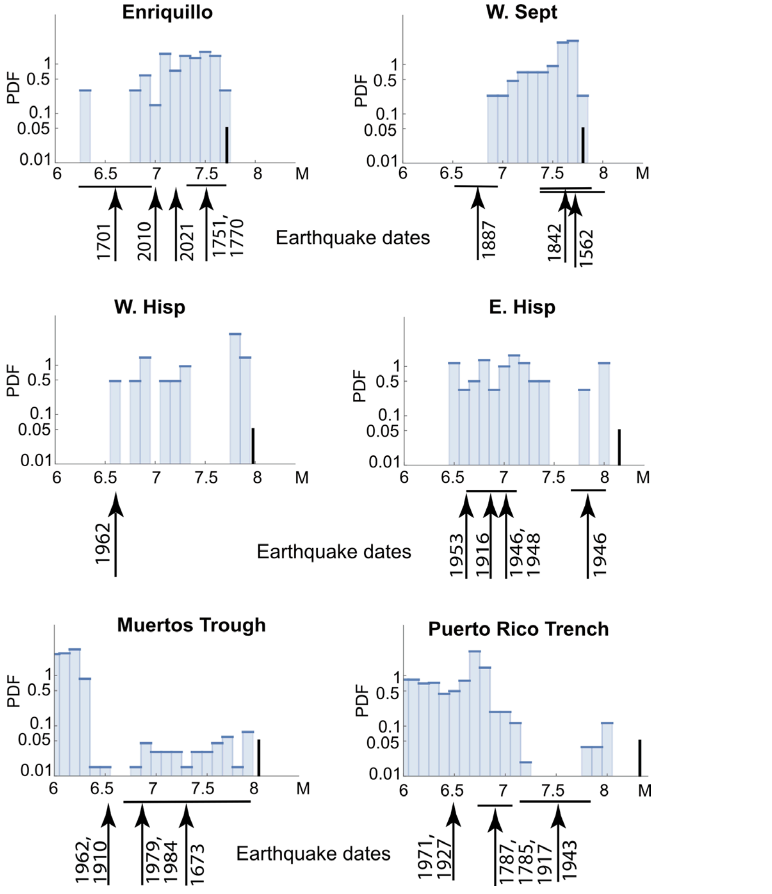
<u>Goal:</u> Find the optimal spatial distribution of a random sample of earthquakes from a regional earthquake moment-frequency distribution (MFD) that minimizes the misfit in target slip rates for all faults.

<u>Input:</u> (1) Constructed regional MFD. (2) Slip rates on major faults and from GPS and other data.

<u>Sources of uncertainty:</u> (1) Seismic coupling along the plate boundary fault. (2) Different segmentation scenarios for major faults in the region.

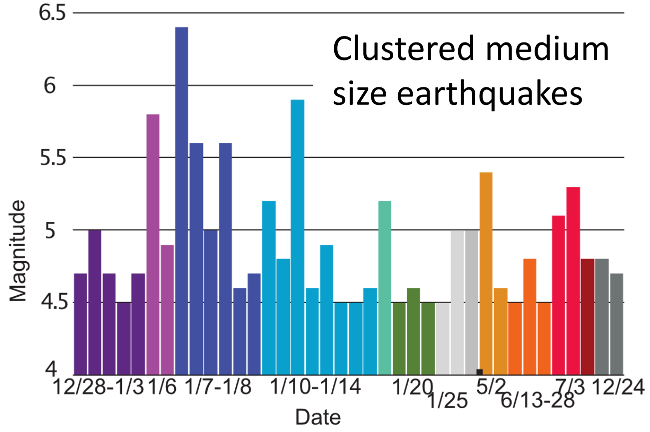


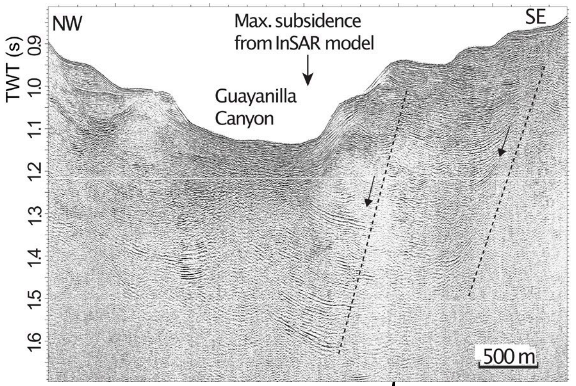


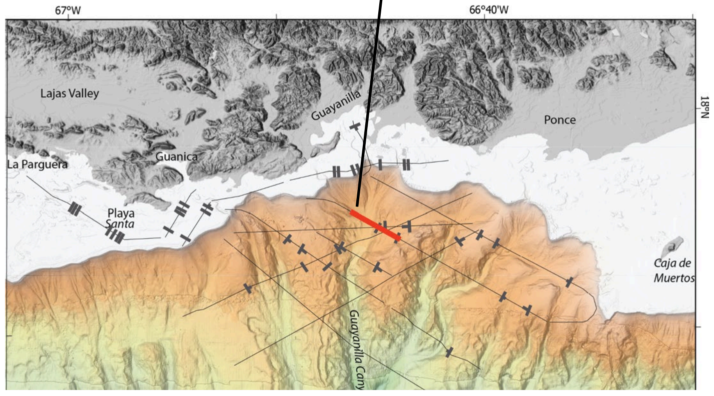


Model results: (1) Optimal seismic slip rate on the Puerto Rico Trench (PRT) is 2 mm/yr.
(2) Rupture is segmented on the E. and W. Hispaniola Trench and on E. and W. Septentrional fault.
(3) Maximum magnitude for the PRT from the forecasted distribution is less than the physical maximum magnitude calculated from its areas (i.e., M≤8.1, not M≤9).
(4) Reducing slip rate on the PRT fault has significant effects on earthquakes placed on not only the PRT itself, but also on the Hispaniola Trench and the Septentrional and Enriquillo faults.

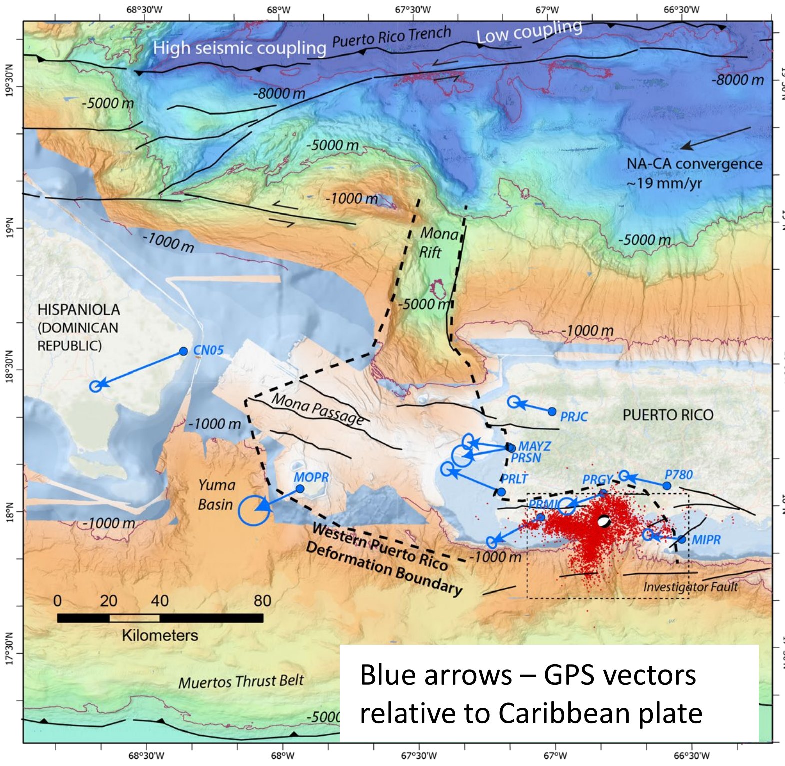
Mature diffuse deformation revealed by the 2020 southern Puerto Rico seismic sequence



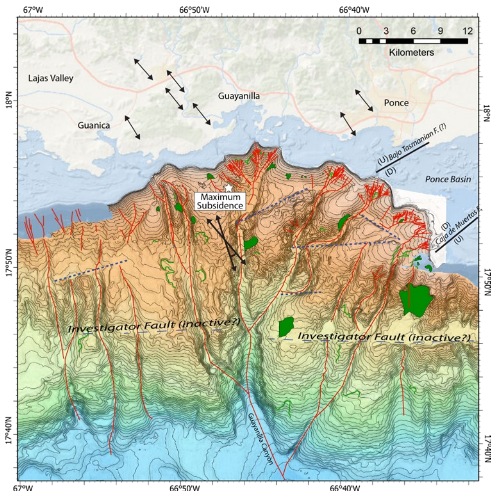




Multiple faults (black) at different orientations

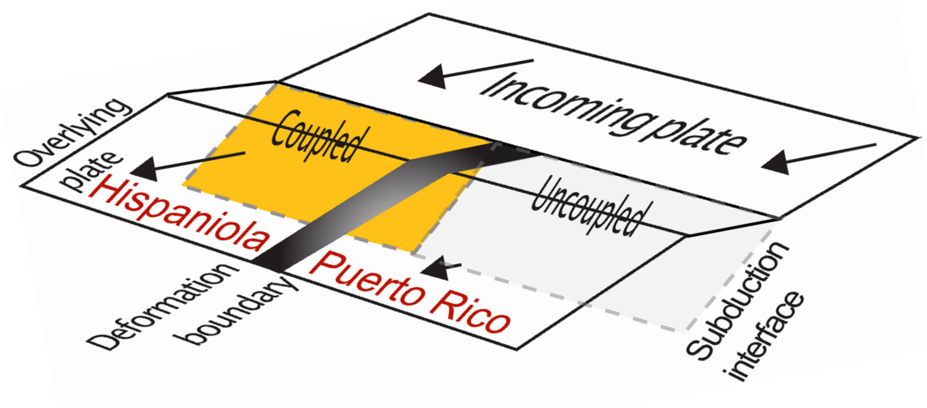


Blue arrows – GPS vectors relative to Caribbean plate

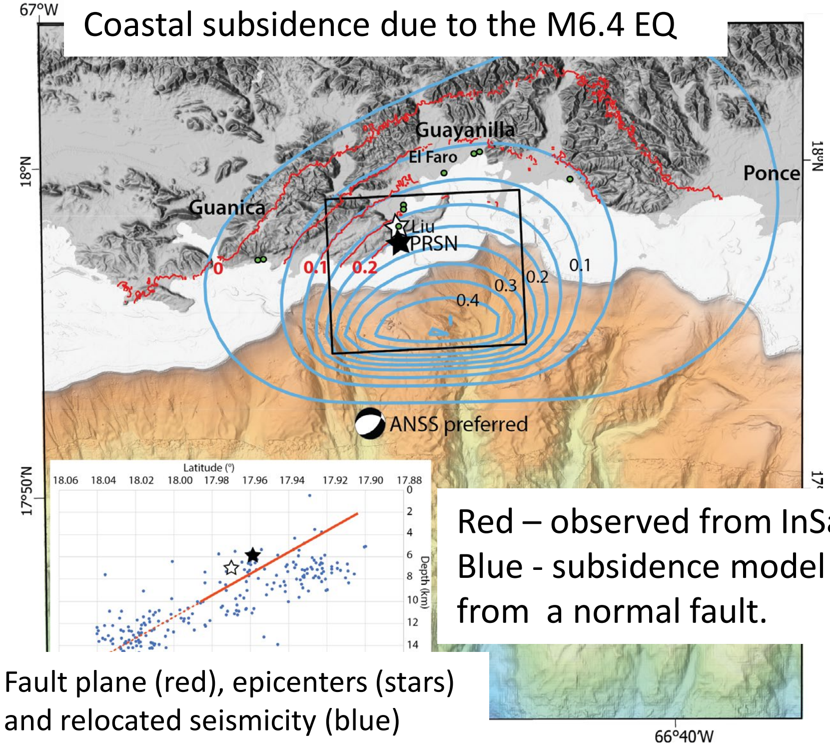


<u>Mature deformation:</u>
- Earthquakes' t-Axis orientation is similar to ~3 Ma extension markers on land.
- Local shelf-edge indentation.
- Right-angle canyons.

The diffuse tectonic block boundary may be caused by differential seismic coupling of the subducting plate (Hispaniola: coupled; Puerto Rico: uncoupled)



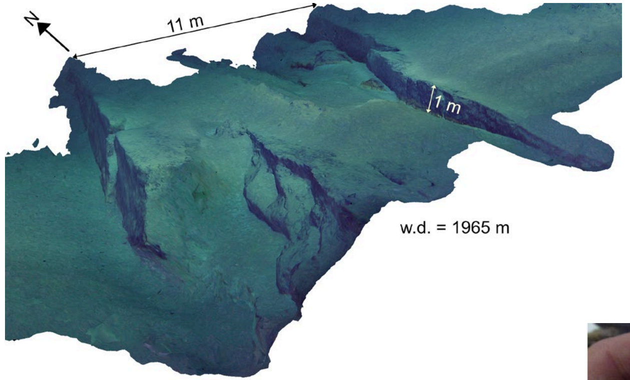
Coastal subsidence due to the M6.4 EQ



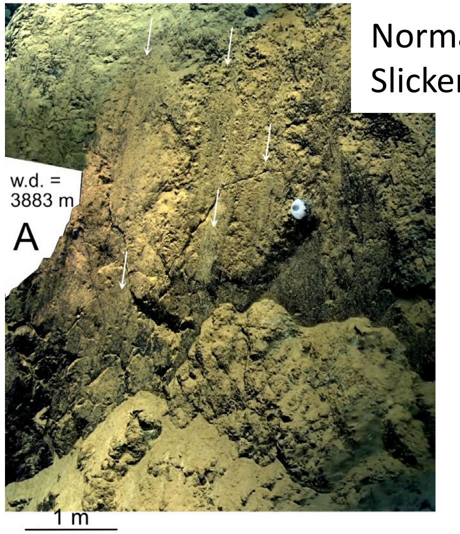
Red – observed from InSar
Blue - subsidence model from a normal fault.

Fault plane (red), epicenters (stars) and relocated seismicity (blue)

Seafloor observations eliminate landslide as the source of the 1918 Puerto Rico tsunami. Two-segment normal fault is suggested as an alternative source

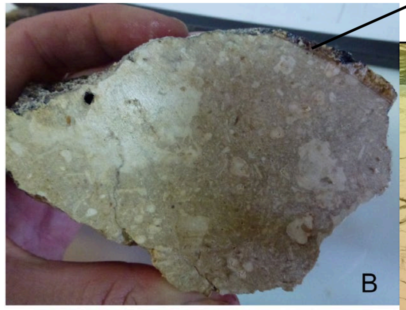


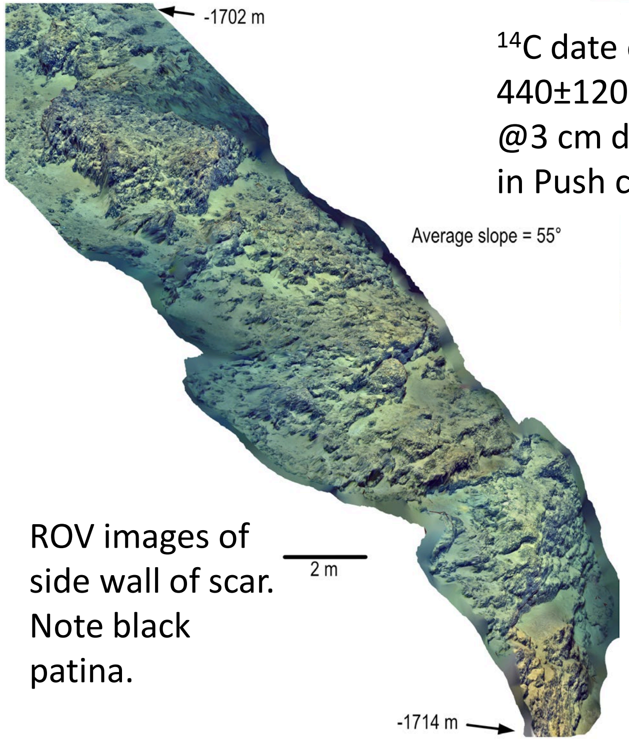
ROV images of scar floor.
Note heavy sedimentation.



Normal fault
Slickensides?

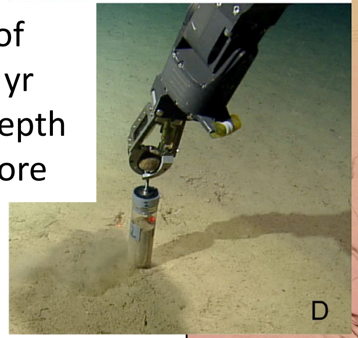
Rate of black patina growth: 1-5 mm/m.yr.

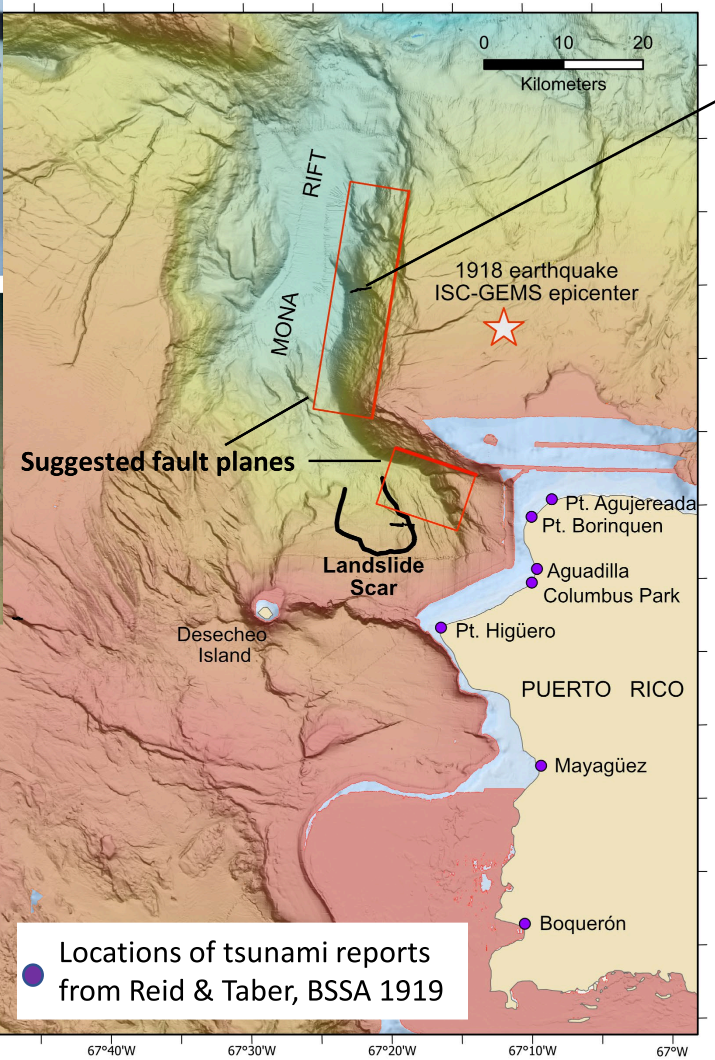




ROV images of side wall of scar. Note black patina.

^{14}C date of 440±120 yr @3 cm depth in Push core





Locations of tsunami reports from Reid & Taber, BSSA 1919

Observed tsunami amplitudes (red dashed), arrival times and polarities (red arrows) and modeled marigrams