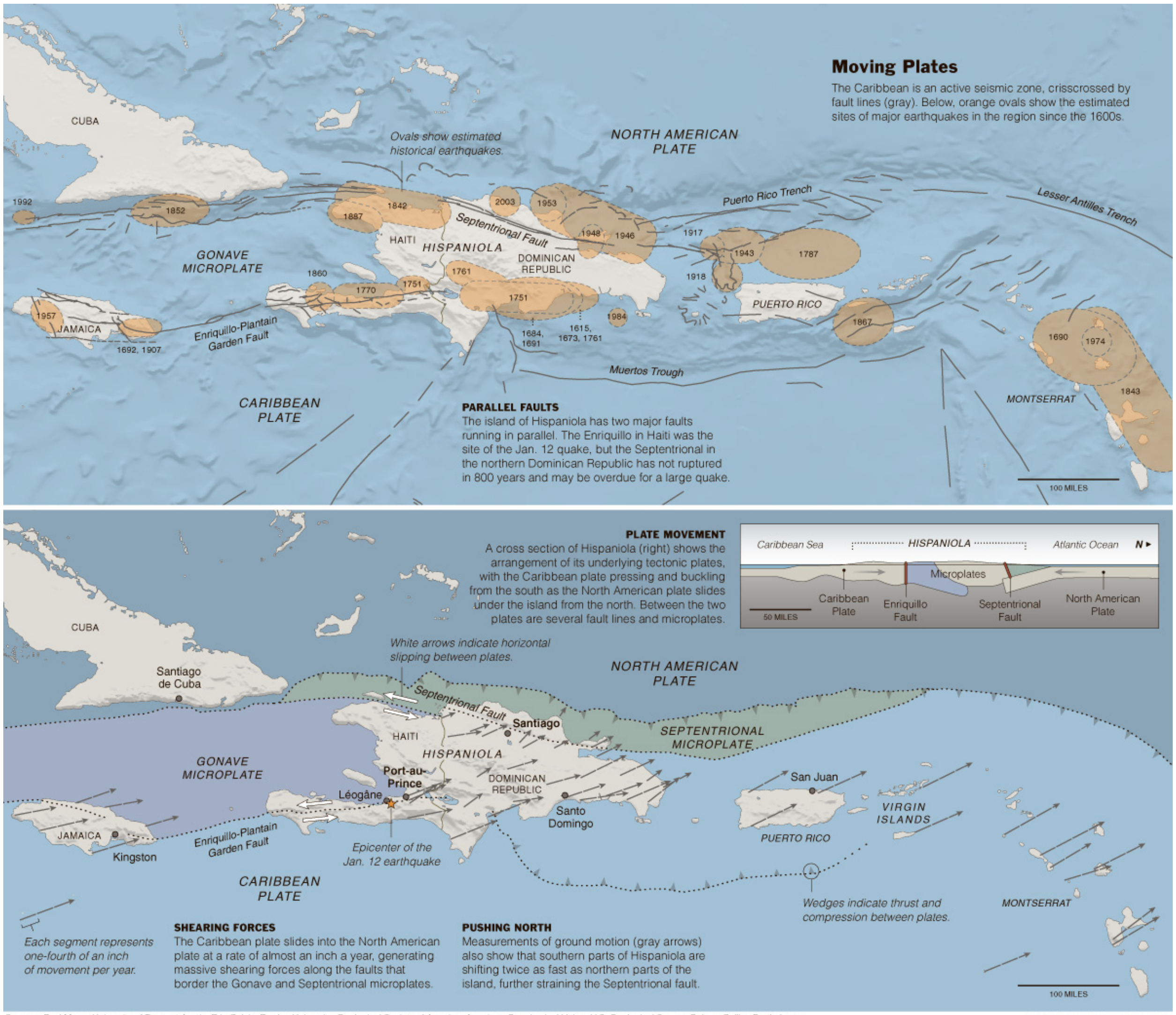
2.0 SEISMOLOGICAL ASPECTS

Haiti occupies the western third of the island of Hispanola, along the northern boundary of the Caribbean plate (Figure 2.1). The island occurs on a separate microplate bounded on the north by the Great Puerto Rican/North Hispanola subduction zone and transtensional strike-slip faults (Oriente-Septentrional fault) that define the boundary between the North American and Caribbean plates, and the Muertos trench subduction zone and strike-slip Enriquillo-Plaintain Garden fault zone (EPGFZ) that define the plate interface between the microplate and Caribbean plate (Figure 2.1).

The Mw = 7.0 Haiti earthquake occurred at 4:53 PM local time on January 12, 2010. The USGS reports that the earthquake epicenter was located at 18.457N, 72.533W, approximately 25 km west of the city of Port-au-Prince. The earthquake was initially presumed to have occurred on the Enriquillo-Plantain Garden Fault Zone (EPGFZ), a left-lateral, strike-slip fault that slips approximately 7 mm/yr (Figure 2.1). Although the EPGFZ is a strike-slip fault, the focal mechanism for this earthquake was identified as left-lateral/oblique. Additionally, as noted in Section 4.0 Surface Faulting and Coastal Uplift, the EPGFZ did not rupture at the surface and significant uplift occurred north of the EPGFZ, such that there is significant uncertainty regarding the causative fault for the earthquake. Large earthquakes have not occurred recently on the EPGFZ, but historical records indicate that Port-au-Prince was destroyed by earthquakes in both 1751 and 1770. These events are believed to have occurred on the EPGFZ (Figure 2.1).

Fault rupture inversions have been developed for this event by various researchers, including the USGS. One fault rupture inversion, generated by Anthony Sladen of Caltech (http://tectonics.caltech.edu/slip_history/2010_haiti/) using broadband teleseismic data, is shown in Figure 2.2. This inversion indicates that the fault rupture was concentrated along a 20 km segment west of the epicenter, with a maximum slip of about 4 m. Interestingly, a significant vertical component of slip is shown starting at about 10 km west of the hypocenter. This vertical component of slip is consistent with the identified focal mechanism and was corroborated by observations of coastal uplift in this area (see Section 4.0 Fault Rupture and Coastal Uplift). The derived Source Time Function (STF) for this event (Figure 2.2) indicates that the majority of the seismic moment was released in a relatively short time, approximately 6 seconds. A similar rupture pattern was reported by other slip inversions.



Sources: Paul Mann, University of Texas at Austin; Eric Calais, Purdue University; Geological Society of America; American Geophysical Union; U.S. Geological Survey; Gebco; Collins Bartholomew JONATHAN CORUM/THE NEW YORK TIMES

Figure 2.1 Historical earthquakes and fault zones in the region around the island of Hispaniola (New York Times, January 26, 2010)

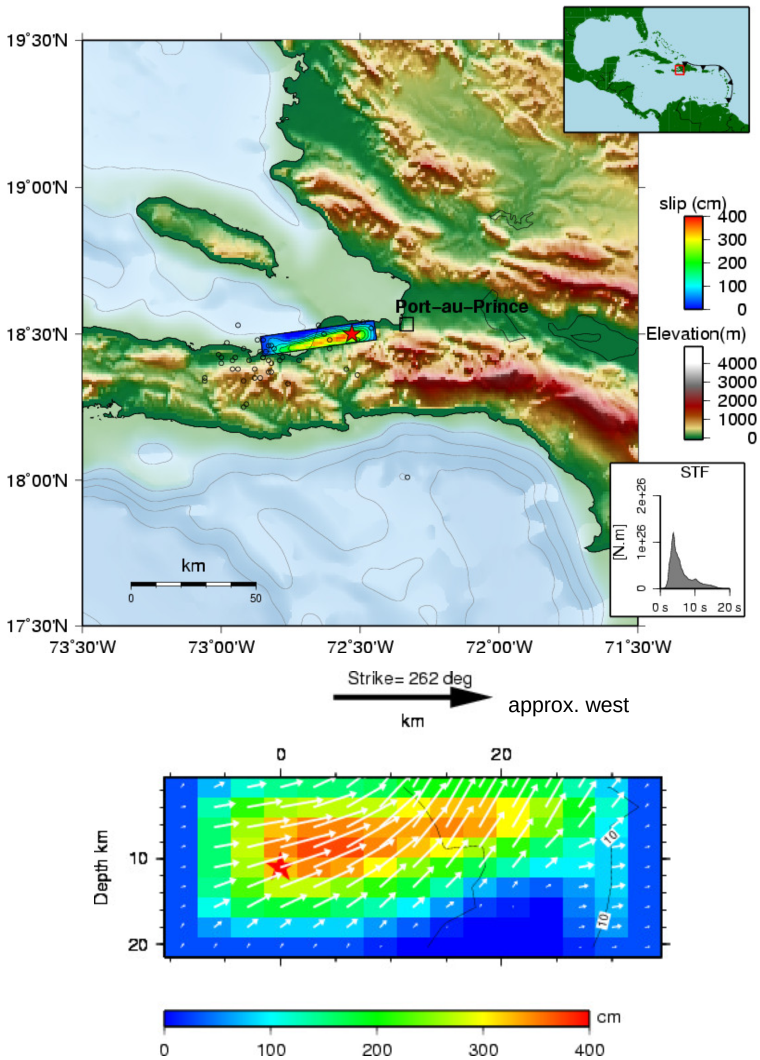


Figure 2.2 Slip distribution for the 2010 Haiti earthquake derived from teleseismic data (http://tectonics.caltech.edu/slip_history/2010_haiti/)

The preliminary locations for aftershocks located by the regional seismic data are shown in Figure 2.3, along with the slip inversion derived by Caltech. The aftershocks extend over a distance of about 50 to 60 km, predominantly westward from the epicenter, and generally scattered along the trace of the Enriquillo Plantain Garden fault. There is a distinct clustering of aftershocks about 30 km west of the epicenter (near Petit Goave), which corresponds with the end of the fault rupture inferred from the slip inversion as well as an extensional stepover in the fault. This extensional stepover (identified as the Miogoane Lakes Basin extensional etepover in Figure 3.2 of Section 3.0 Regional Geology) is a natural segmentation point for the fault, and together with the other data shown in Figure 2.3, appears to have arrested the westward progressing fault rupture. Therefore, it appears that the major portion of the mainshock rupture process was only about 30 km long. This is somewhat shorter than would be expected for M 7 earthquake as estimated from empirical relationships (e.g., Hanks and Bakun 2008, Wells and Coppersmith 1994) that predict a rupture length of about 50 km for a M 7 earthquake. However, comparisons of rupture lengths estimated from the earthquake rupture process versus the distribution of aftershocks are not generally reliable or definitive.

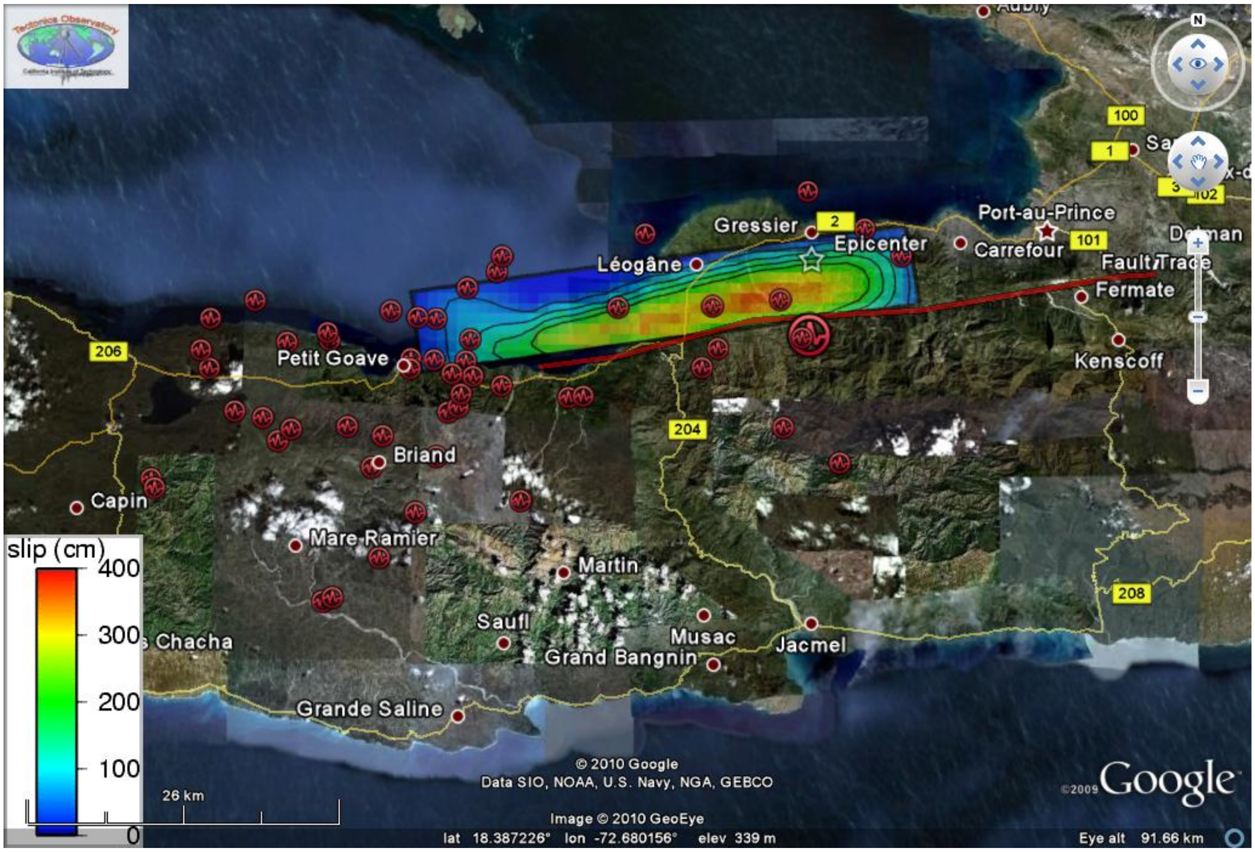


Figure 2.3 Aftershock distribution for the 2010 Haiti earthquake through 21 January 2010 (from USGS), along with slip inversion by Caltech

The USGS ShakeMap of Instrumental Intensity for the near-fault region is shown in Figure 2.4, and indicates violent to extreme shaking in the area around Port-au-Prince. Because there were no strong motion stations within 100 km of the fault rupture, the ShakeMap Instrumental Intensity information was derived solely from the magnitude of the earthquake, the location of the earthquake, empirical ground motion prediction models, and observed macroseismic intensities reported on the USGS Did You Feel It? website. Nonetheless, the ShakeMap zones of IX and X (shown in red) generally correspond with the hardest hit areas of the region. The USGS ShakeMaps for peak ground acceleration (PGA) and peak ground velocity (PGV) are shown in Figure 2.5, and were derived from the estimated Instrumental Intensities (i.e., Figure 2.3) and far field ground motions recorded in the Dominican Republic. These ShakeMaps estimate the largest PGA to be about 0.3 g and the largest PGV to be about 80 cm/s. These estimates should be considered very approximate because of the lack of strong motion recordings.

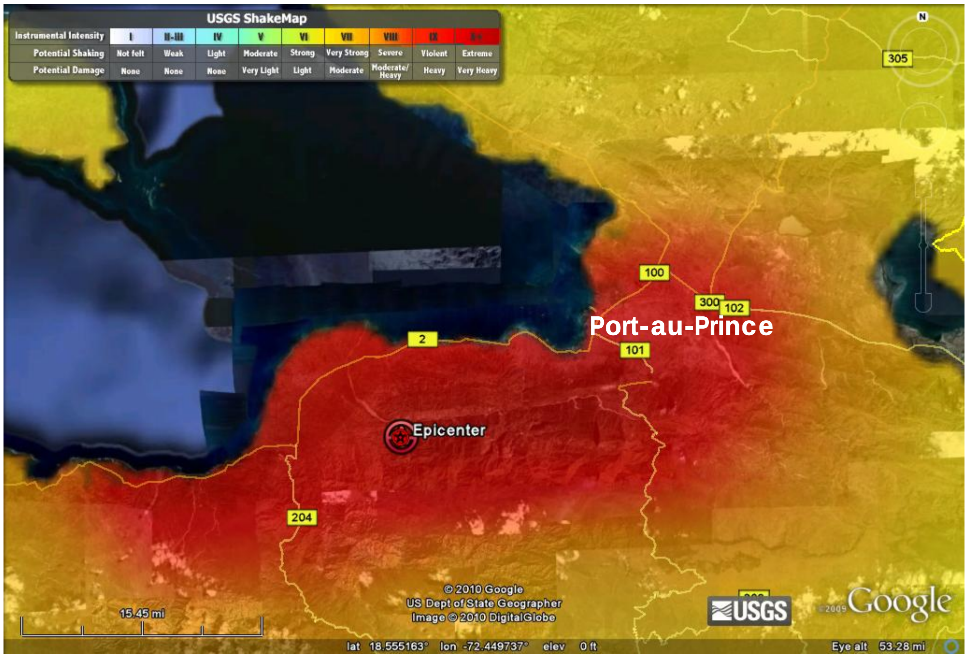


Figure 2.4 USGS ShakeMap of Instrumental Intensity for the near-fault region.

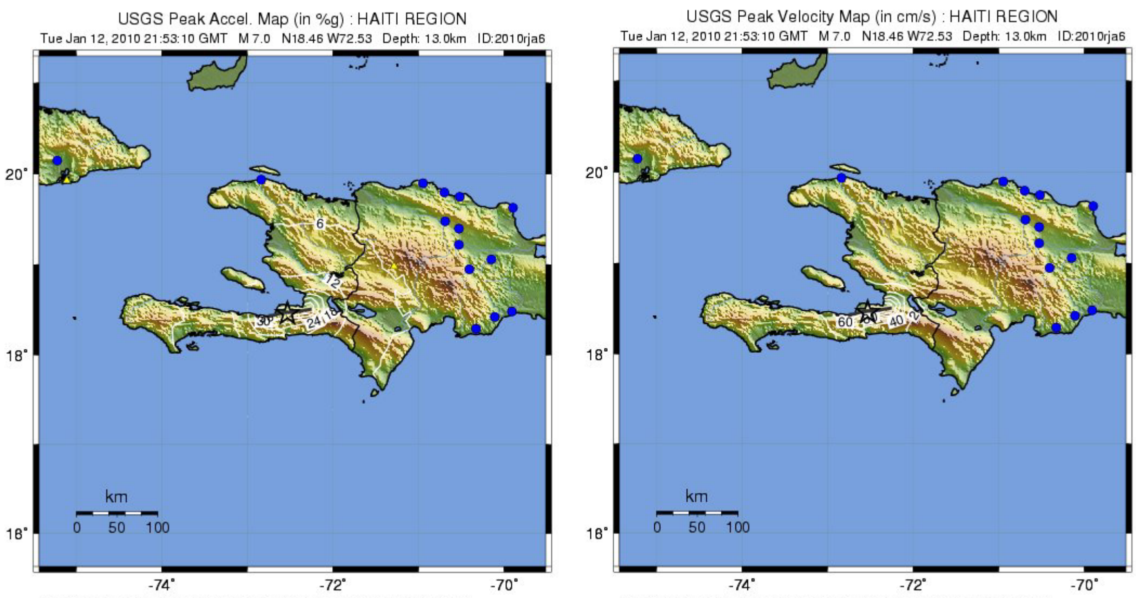


Figure 2.5 USGS ShakeMaps of PGA and PGV for the island of Hispaniola.

References

Hanks, T.C. and Bakun, W.H., 2008, M-logA Observations for Recent Large Earthquakes: Bull. Seism. Soc. Am. 98, 490 - 494.

Wells, D. L., and Coppersmith, K.J.,1994, New empirical relationships among magnitude, rupture length, rupture width, rupture area, and surface displacement: Bull. Seism. Soc. Am. 84, 974-1002.