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A textbook example of lithological site effect in the Ecuadorian Pacific coast : the Cojimies-Chamanga case study

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Following the mainshock of the Pedernales earthquake (Mw 7.8) of April 16th, 2017, strong shaking have been recorded all along the Ecuadorian coast where many towns and villages are located. Macroseismic intensities were reported ranging from 6 "slightly damaging" to 9 and more ("destructive") in EMS scale. Other than the well reported differences in shaking levels due to source directivity effects to the north and to the south of the epicentral region, one of the most striking differences in damage levels have been reported at the Cojimies cape located 70 km to the east of the epicentral region. Two fishermen villages, Cojimies and Chamanga, are located less than 10 km away from each other on the sea side. Despite its closeness and similar building typology (basic, low-rise houses) quite different damage levels have been reported at these two sites: complete destruction at Chamanga, while slight damages at Cojimies.

To understand this phenomenon, the IG-EPN have carried out several geophysical campaigns (H/V microtremors points, active seismics MASW and ambient seismic noise arrays) in the weeks and months following the mainshock. After careful analysis of the signals (both earthquake and ambient noise data) a fine soil characterization of the Chamanga and Cojimies sites have been performed. Our results favor a extremely soft soil layer (mud and sands) underlying a relatively stiff bedrock composed of shales (Onzole formation) in Chamanga, while in Cojimies site no strong impedance contrast is found in the first tens to hundreds of meters depth. In addition, a relatively stiff soil layer is found very close to the near surface. Further in depth, saturated sands are identified which may have acted as an isolating layer for the incoming seismic waves during the Pedernales earthquake and its aftershocks, preventing the village to be impacted by the shaking. Therefore, we present here a typical example of what is known as lithological site effect, that is the difference in seismic waves amplification due to the mechanical characteristics of the superficial soil layers within relatively short distances.