The 2007 Pisco earthquake (Mw 8.0), a key event to understand the seismotectonic evolution of subduction zones


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ABSTRACT

On August 15, 2007, an earthquake of Mw 8.0 struck the region of Pisco in Central Peru, and caused more than 1500 deaths. The event generated a very large tsunami, with significant damage along the coast and further inland, and widespread damage to possessions. We use InSAR and teleseismic data to characterize the rupture process of the event. The configuration of the rupture as well as the quality of the data used for the inversion allow to obtain robust and simple solution, where velocity is confirmed consistently by a large number of independent data sets.

Data from the joint inversion of Teleseismic + InSAR - The sharp bend of the coastline indicates that this is not a coincidence. Uplift pattern anti-correlated with topography - Topography correlates deformation of the inter-seismic period.

THE PISCO EQ. OCCURRED IN A SEISMIC GAP

The right figure shows 45 days of aftershock activity recorded by a local network of 12 stations (triangles). The gray triangles correspond to areas with a low density of aftershocks (computed using a gaussian kernel estimator), and emphasize the anti-correlation with areas of high coseismic slip. Post-seismic slip inverted from a temporary but continuous network of GPS stations. The analysis is performed using the PCA method. The pink contours correspond to the areas of high coseismic slip, while the green contours show the areas of high aftershock density.

INTERPRETATION

What can we learn from this model?

Co-seismic slip is usually distributed parallel to a linear coastline. The sharp S bend of the Pisco coastline allows to shed light on the relation between earthquake and topography. The Pisco earthquake was probably the first event for which we are able to get a reliable source model as well as a very complete aftershock catalog and GPS measurements of the post-seismic slip. This unique combination of data allows to better understand the transition from coseismic to inter-seismic.

COSEISMIC SLIPS ARE DISTRIBUTED PARALLEL TO THE COASTLINE

The seismological community widely agrees on the coseismic slip being distributed parallel to the coastline. This is not the case for the post-seismic displacements.

SOURCE ANALYSIS

For an accurate and robust image of the rupture

The InSAR and teleseismic data indicate that the average rupture between the two asperities was very slow (1 km/s). However, we cannot distinguish whether the rupture was very slow and constant, or if it propagated at a standard speed and stopped on its way to the second asperity.

The tsunami generated by the 2007 Pisco earthquake was one of the largest events to be recorded by deep-ocean pressure sensors. Those records are not affected by non-linear coastal amplifications.

INVERSION OF THE TSUNAMI DATA

Inversion becomes unstable with a higher number of subfaults, even with smoothing and moment damping.