Seismic evidence for geologic influence on seismicity during the April 1, 2014 Pisagua, Chile Earthquake

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The 2014 Mw 8.2 Pisagua/Iquique earthquake sequence ruptured ~200 km of the "northern Chile seismic gap," a ~500 km section of the South American subduction zone where no great seismicity had occurred since two M>8 events last ruptured the region in 1868 and 1877. The boundary of the 2014 seismicity zone corresponds to geophysical observations including residual gravity anomalies and GPS-derived plate locking models. To investigate the geologic structure of the forearc and subducting plate in high-resolution, we acquired controlled-source seismic data with the R/V Marcus G. Langseth in the region of the 2014 event off the coast of northern Chile. Data acquisition for PICTURES (Pisagua/Iquique Crustal Tomography to Understand the Region of the Earthquake Source) included wide-angle and multi-channel seismic data along a ~350 km-long transect extending across the 2014 slip region southward into the remaining locked area, and a ~200 km 3D grid focused on the region of slip. It included a total of ~45000 airgun sources, 70 OBS, 50 land-based stations, and ~5000 km of seismic reflection data, and involved contributions from Oregon State Univ., GEOMAR, the Univ. de Chile, and the Univ. of Liverpool. Two- and three-dimensional seismic P-wave velocity models reveal along-strike variations in the velocity structure of the forearc that correspond to the spatial distribution of slip associated with the Pisagua earthquake sequence and high residual gravity anomalies that border the area of seismicity. The remaining unruptured section corresponds to a region of higher seismic velocities in the upper crust and high residual gravity, and poses a significant risk for future large earthquakes. Correlations between crustal structure and the 2014 seismic sequence indicate that the geologic structure of the upper plate influenced rupture propagation and the spatial distribution of fore- and aftershock events.