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Foreshocks and aftershocks locations of the 2014 Pisagua, N. Chile earthquake: history of a megathrust earthquake nucleation

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The April 2014 Mw 8.1 Pisagua earthquake occurred in the Northern Chile seismic gap: a region of the South American subduction zone lying between Arica city and the Mejillones Peninsula. It is believed that this part of the subduction zone has not experienced a large earthquake since 1877.

Thanks to the identification of this seismic gap, the north of Chile was well instrumented before the Pisagua earthquake, including the Integrated Plate boundary Observatory Chile (IPOC) network and the Chilean local network installed by the Centro Sismologico Nacional (CSN). These instruments were able to record the full foreshock and aftershock sequences, allowing a unique opportunity to study the nucleation process of large megathrust earthquakes.

To improve azimuthal coverage of the Pisagua seismic sequence, after the earthquake, in collaboration with the Instituto Geofisico del Peru (IGP) we installed a temporary seismic network in south of Peru. The network comprised 12 short-period stations located in the coastal area between Moquegua and Tacna and they were operative from 1st May 2014. We also installed three stations on the slopes of the Ticsiani volcano to monitor any possible change in volcanic activity following the Pisagua earthquake.

In this work we analysed the continuous seismic data recorded by CSN and IPOC networks from 1 March to 30 June to obtain the catalogue of the sequence, including foreshocks and aftershocks. Using an automatic algorithm based in STA/LTA we obtained the picks for P and S waves. Association in time and space defined the events and computed an initial location using Hypo71 and the 1D local velocity model. More than 11,000 events were identified with this method for the whole period, but we selected the best resolved events that include more than 7 observed arrivals with at least 2 S picks of them, to relocate these events using NonLinLoc software. For the main events of the sequence we carefully estimate event locations and we obtained their regional the Moment Tensor solutions by 1-D full waveform inversion of the broadband data using ISOLA software.

In this work we analysed the evolution of the seismicity during the whole sequence and the spatial relation with coupling observed by previous geodetics studies.