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The seismic sequence of Arraiolos, Portugal, in January 2018

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On 15/Jan/2018, 11:51 UTC, an ML 4.9 earthquake struck Arraiolos, central Portugal. The earthquake was felt with a maximum intensity (MMI) of VI in Aldeia da Serra, generating widespread alarm in a region where few earthquakes have been felt in recent years. The mainshock was followed by several aftershocks, some of them felt by the population, such as the 1/Feb/2018, with ML 3.5.

Temporary seismic stations were quickly deployed after the mainshock (first station was installed 1h30 after the mainshock) , as a collaborative effort between ICT (Instituto de Ciências da Terra, Évora) and IDL (Instituto Dom Luiz). The full deployment encompassed 14 broadband stations (CMG 6TD, 30 s) and 21 short-period stations (CDJ, 2.0 Hz). The 35 stations, deployed around the epicentral area, together with the backbone permanent seismic network, allow a unique study of microseismic activity during this crisis.

At the same time, a macroseismic survey was carried out, resulting in the collection of a total of about 614 valid answers.

Earthquake detection was carried out manually by visual inspection of daily spectrograms recorded at an ensemble of stations. We identified a total of 318 events with enough phases to allow location and subsequent analysis. Among these, 294 had 6 or more phases and an azimuthal gap of less than 180 deg.

Preliminary locations were performed using a 1D model based on the 3D tomographic model of Veludo et al., 2017 (doi: 10.1016/j.tecto.2017.08.018), after adjusting the VP/VS ratio according to that determined from data. Disregarding the highest-magnitude aftershock, the seismic sequence follows a Gutenberg-Richter law with a b-value of 0.99, and a completeness magnitude of -0.3.

Aftershock locations suggest two main clusters, one of them encompassing about 2/3 of all detected events. Focal depths vary between 11 and 15 km, with most events concentrating at a depth of 12 km. Waveform similarity analysis allows the identification of two clusters of events with similar radiation patterns, which coincide with the two clusters of closely located earthquakes.

Curiously, although the mainshock had a strike-slip mechanism (computed both by first motion polarities and waveform moment tensor inversion, Mw 4.3) most aftershocks for which we could compute focal mechanisms (using first motion polarities) indicate reverse or mixed transpressional faulting. Modeling of changes in Coulomb static stress due the mainshock shows that most aftershocks occur in a region where stress is increased.

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