EGU21-2672, updated on 03 Jul 2022
https://doi.org/10.5194/egusphere-egu21-2672
EGU General Assembly 2021

Automatic swarm analyzer based on matched filtering algorithms: El Hierro 2011 and Torreperogil 2012-2013

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Dense seismic swarms usually show a high number of earthquakes per hour, the events may overlap and in most of the cases seismic records are characterized by a low signal-to-noise ratio. As a result, the manual characterization performed by seismic and volcanic observatories can become very complicated or impossible to perform. In order to solve this problem, we have developed a set of algorithms whose purpose is to detect the events, pick their phases and give a location (in an absolute and relative way) of the earthquakes associated with a known swarm.

These algorithms have been tested in two different tectonic environments: the volcano-tectonic pre-eruptive swarm of El Hierro, Spain (2011) and the tectonic seismic series of Torreperogil, Spain (2012-2013). Both crises mainly differ in the distances from the seismic stations to the hypocentres of the swarms: in the case of El Hierro, data corresponds to local epicentral distances (5-20Km) while the case of Torreperogil seismic series deals with regional distances (10-180km). Otherwise, both series present a similar evolution of the seismic network: as the number of earthquakes increased, more stations were deployed and the network became denser.

To analyze these series, we have used two sets of well relocated earthquakes of both swarms as masters, considering manually analyzed events by National Geographic Institute (IGN) with magnitude mbLg greater than 1.5. After the application of the new algorithms, we have increased the number of earthquakes of the IGN seismic catalog by a factor of 4.5 for Torreperogil and 2.9 for El Hierro. Similarly, the number of picked phases for these two series has been increased by a factor of 4.5 and 3.5, respectively.