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Seismic multiplets on São Miguel (Azores). Analysis of source, path and site effects

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An increasing number of seismic swarms has been registered in the last years in the central region of São Miguel Island, Azores, in an area between Fogo and Furnas Volcanoes, with a special concentration over an area surrounding Congro Lake.

On the behalf of the EU funded project, e-Ruption, in order to complement the SIVISA (Azores Seismic Survaillance System) permanent network, a field experiment was conducted from April 1^{st} to July 15^{th}, 2003, with the deployment of a sparse network of 14 stations equipped with short-period and broad-band instruments and three 12-channel seismic arrays, recording continuously.

The recorded seismicity during this period was characterized by tectonic and volcano-tectonic events. A seismic swarm recorded in a few hours of April 26^{th}, with more than three hundred events, was located near the Congro Lake, with a Md$<$3.

A recurrent feature from the seismicity observed in volcanic regions is the occurrence of seismic families, whose origin can be attributed to similar source mechanisms, acting in a reduced rock volume. Cross-correlation among waveforms allowed to identify six different groups of multiplets, with a correlation coefficient over 0.9, showing a high level of similarity throughout the different elements of the same seismic family.

The multiplets waveforms were stacked and the FFT algorithm applied, which allowed to determinate the dominant frequency for each family. The most common frequencies observed are around 7-9 Hz. Considering the results and the typical P-wave velocities, wavelengths on the order of 300 a 600 m were observed.

By assuming that significant (> 0.9) waveform correlation is achieved only for sources

separated by distances smaller than a quarter of the dominant wavelength, these data suggest that, for each family, the hypocenters span maximum distances on the order of 75-150 m.

Events from the same family were recorded at different stations with different frequency peaks, suggesting a strong influence of the propagation media in shaping the observed spectral features.

For most cases the noise dominant peaks were distinct from the signal dominant ones and, at the same station, for different families, they were generally dissimilar too. The site effect was negligible, however, examples of this were observed when comparing the noise spectra with the families signal sets. In those cases, the frequencies were filtered out with exception of those amplified by the local geology beneath the station.