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Caracterization of fracture systems at Deception Island volcano, Antarctica, using precise array locations of earthquake multiplets recorded during the 1999 seismic series

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Volcano-tectonic earthquakes are common seismic events in active volcanic areas. The stress produced by volcanic processes is released through fracturing of the shallow crust. Very often, these earthquakes occur in multiplets with similar waveforms, what indicates common source characteristics. However, source mechanisms are not generally identifiable, due to poor coverage, low earthquake magnitudes, strong path and site effects, etc. In this work, we apply array techniques to determine the characteristics of the fractures produced during the 1999 seismic series at Deception Island volcano, Antarctica. We select a set of 16 earthquake multiplets, preliminary located in a small (4x4 km) region a few km NE of the array site. The variety of waveforms between the multiplets already anticipates a variety of source mechanisms. For each of these groups, we use the relative slowness estimate (RelSE) method to determine the apparent slownesses and propagation azimuths, relative to the selected master events. This information is used to calculate precise relative locations, that are generally distributed in well-defined planar geometries. Finally, we find the best-fitting planes, what correspond to fractures in the medium activated during the seismic episode. The results are generally well-constrained, and show a large variety of fracture plane orientations. The dip angles indicate that they are mostly subvertical planes, while the horizontal azimuths cover a wide range showing no preferred direction and including most of the space. It is interesting to point out that, in particular, the orientations of these fractures do not correspond to any of the preferred fault directions previously observed in the island. These directions are mostly E-W in the central part of the island were the seismicity has been located. However, this E-W trend is not found in our data. Perhaps the triggering volcanic event had not enough energy to activate those large faults, triggering instead a bunch of conjugate cracks with different orientations. We conclude that well-known and mapped cracks and faults may not be always responsible for the seismicity generated during seismo-volcanic episodes. In our interpretation, a small magmatic injection in a highly cracked medium such as Deception Island and the lubrication by hidrothermal fluids favoured the occurrence of the repetitive microfractures that are responsible for the 1999 seismic series.