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Three-component seismic array location of LP and explosions

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Seismo-volcano source localization is essential to improve our understanding of eruptive dynamics and of magmatic systems. The lack of clear seismic wave phases prohibits the use of classical location methods. Seismic antennas composed of one-component (1C) seismometers provide a good estimate of the direction of arrival of the wavefield. The depth estimation, on the other hand, is difficult to determine. As in classical seismology, the use of three component (3C) seismometers is now common in volcano studies. In order to determine the source location parameters (back-azimuth and depth), we extend the one component seismic array approach to 3C seismic array. This work discusses a high-resolution location method using a 3C array survey by using multiple signal characterization (MUSIC) algorithm with data from two seismic antennas installed on an andesitic volcano in Peru (Ubinas volcano). One of the main scientific questions related to the eruptive process of Ubinas volcano is the relationship between the magmatic explosions and LP swarms. After introducing the 3C array theory, we evaluate the robustness of the location method on a full wavefield 3D synthetic dataset generated using a digital elevation model of Ubinas volcano and a heterogeneous velocity model obtained from a tomography study. Results show that the back-azimuth determined using the 3C array has a smaller error than a 1C array. Only the 3C method allows the recovery of the source depths. Finally, we applied the 3C approach to a seismic event recorded in 2009. Crossing the estimated back-azimuth and incidence angles, we find a source located 1000 +/-250m below the bottom of the active crater. Therefore, extending 1C arrays to 3C arrays in volcano monitoring allows a more accurate determination of the source epicenter and now an estimate for the depth.