A new double-difference location method for LP event families: the ability to image structures within volcanoes.

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Long Period (LP) volcano seismic events have been observed at many volcanoes around the world. Swarms of LP events are often recorded prior to or during volcanic eruptions, and can be used to provide an insight into a volcano's internal dynamics. Within these swarms numerous recorded LP events can have almost identical waveforms, thus it can be assumed that these events have both similar source locations and source mechanisms; these events can be grouped together into families. An accurate source location is crucial in order to further understand the source processes involved in producing LP events, however locating these events can be difficult due to their emergent onset and poorly differentiated P- and S-waves. In this study we present a location method, an extension to the double-difference location technique, which can simultaneously determine the absolute location of a family of LP events and the relative source locations of each event within the family in order to image structures within the volcano. The location method has been tested on a synthetic dataset which was produced using 3D full-waveform simulations for a strongly heterogeneous, layered velocity model of a volcano, including topography, with a seismic network of 13 instruments realistically distributed around the edifice of the volcano. In order to create a family of LP events, the source locations of each synthetic event are slightly different, with the sources lying along a sloping, planar structure. When implementing the location technique we assume an unknown homogeneous velocity model, which we chose as the velocity structure is often poorly constrained due to the highly heterogeneous nature of volcanoes or even unknown. The location method was able to obtain an absolute location which was offset only by 40 m horizontally and 70 m vertically from the true source location, but what is most impressive is the ability of the method to accurately obtain the relative source locations and hence almost perfectly reconstruct the sloping, planar structure on which the LP events were originally located. The method will also be tested on real families of LP events recorded at volcanoes where other location techniques have been applied, in order to compare the methods and the corresponding results.