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Ascending seismic sources associated with an explosion and tremor and their implications for volcanic conduit dynamics

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Application of seismic techniques to an explosion event at Tungurahua volcano, Ecuador, provided clear images to elucidate its source process. We used waveform inversion and a source location method to analyze the event observed by five broadband seismic stations on the volcano. The source location method assumes isotropic radiation of S waves, which has been shown to be valid in a high frequency band because of the path effect caused by the scattering of seismic waves. The source location method using seismic amplitudes in a frequency band of 5-10 Hz indicates that the event was triggered at a depth of 6 km below the summit, and the source ascended toward the summit at a speed of about 1600 m/s. Waveform inversion of low-frequency signals in a period band of 2-10 s at the event onset points to an isotropic mechanism with initial deflation and subsequent inflation at a similar depth of 6 km. This source-time history can be explained by a sudden pressure drop and subsequent bubble growth in magma. Similar ascending sources were estimated during tremor associated with sustained eruptions. The ascending sources suggest that a pressure wave generated by the growth of bubbles travelled up the magma conduit, which triggered fragmentation of magma at shallow depths. Our study suggests that a pressure disturbance in magma at depth and its upward propagation are fundamental processes to trigger eruptions.