

Temporal evolution of a magmatic dike system inferred from the complex frequencies of very-long-period seismic signals

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I present a detailed description of temporal variations in the complex frequencies of very-long-period (VLP) events observed in association with an earthquake swarm that occurred beneath Hachijo Island, Japan. The individual VLP signals show simple decaying harmonic oscillations with periods near 10 s and last for about 300 s. The VLP activity began on 20 August 2002 and continued until 2 April 2003. Spectral analysis of the VLP waveforms identifies two spectral peaks, of which the complex frequencies show systematic temporal variations at the beginning of the VLP activity. The Q values of both the peaks show increasing trends from roughly 15 to 35 in the period between 22 and 26 August. The frequency of one peak shows a decreasing trend from 0.1 to 0.09 Hz, while the frequency of the other peak shows an increasing trend from 0.128 to 0.136 Hz in this period. After these systematic variations, the frequencies and Q values of the two peaks remain roughly constant. Waveform simulations based on a fluid-filled crack model indicate that the observed systematic temporal variations can be reasonably explained by gradual expansion of a crack containing a basalt-gas mixture. The roughly constant frequencies and Q values of the two peaks after these systematic variations suggest that the magmatic dike persistently existed beneath Hachijo Island for more than six months. Mass and heat advection is required to sustain the dike system, implying magmatic flow and convection in the dike and magma chamber beneath this island.