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Causes of distal volcano-tectonic (dVT) seismicity inferred from hydrothermal modeling

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Abstract Distal volcano-tectonic (dVT) seismicity typically precedes eruption at long-dormant volcanoes by days to years. Precursory dVT seismicity may reflect magma-induced fluid-pressure pulses that intersect critically stressed faults. We explored this hypothesis using an open-source magmatic-hydrothermal code that simulates multiphase fluid and heat transport over the temperature range 0 to 1200°C. We calculated fluid-pressure changes caused by a small (0.04 km³) intrusion and explored the effects of flow geometry (channelized vs. radial flow), magma devolatilization rates (0-15 kg/s), and intrusion depths (5 and 7.5 km, above and below the brittle-ductile transition). Magma and host-rock permeabilities were key controlling parameters and we tested a wide range of permeability (k) and permeability anisotropies (k_h/k_v), including k constant, $k(z)$, $k(T)$, and $k(z, T, P)$ distributions, examining a total of ~1600 realizations to explore the relevant parameter space. Propagation of potentially causal pressure changes ($\Delta P \geq 0.1$ bars) to the mean dVT location (6 km lateral distance, 6 km depth) was favored by channelized fluid flow, high devolatilization rates, and permeabilities similar to those found in geothermal reservoirs ($k \sim 10^{-16}$ to 10^{-13} m²). For channelized flow, magma-induced thermal pressurization alone can generate cases of $\Delta P \geq 0.1$ bars for all permeabilities in the range 10^{-16} to 10^{-13} m², whereas in radial flow regimes thermal pressurization causes $\Delta P < 0.1$

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