Persistently Restless Volcanoes: Insights from Telica Volcano, Nicaragua

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Many of Earths volcanoes experience well - defined states of “quiescence” and “unrest,” with unrest occasionally culminating in eruption. Some volcanoes, however, experience an unusually protracted (i.e., decades - long) period of noneruptive unrest and are thus categorized as “persistently restless volcanoes” (PRVs). The processes that drive persistently restless volcanism are poorly understood, as our knowledge of PRVs is currently based on a small number of case studies. Here we examine multidisciplinary observations of the 1999 (Rodgers et al., 2013), 2011 (Geirsson et al., 2014), and 2015 (Roman et al., 2019) phreatic eruptions at Telica Volcano, Nicaragua, in the context of its long - term behavior (Rodgers et al. 2015). We suggest that the latter phases of the 2015 eruption were ultimately driven by destabilization of its shallow magma reservoir. Based on multiparameter observations at Telica over a 7 - year period, we propose that three distinct states of unrest occur at Telica over decadal timescales (Fig 1): a stable open state involving steady conduit convection and two distinct “unstable” states that may lead to eruptions. In the “weak sealing” state, phreatic explosions result from steady conduit convection underlying a weak seal. In the “destabilized” state, destabilization of the top of the convecting magma in the conduit leads to rapid accumulation of high pressures leading to strong/impulsive phreatomagmatic explosions. In contrast to “typical” precursory sequences, a decrease in low-frequency seismicity rates occasionally accompanied or followed by an increase in high-frequency seismicity rates (consistent with a transition from open - to closed - system behavior) appears to have been prognostic of phreatic eruption likelihood at Telica on both long (months) to short (minutes) timescales. Our observations and interpretations suggest that continuous seismic, ground - based deformation, gas emission, and thermal monitoring and interpretation of these data within a paradigm of sustained conduit convection modulated by episodes of sealing and destabilization of shallow magma reservoirs may allow robust forecasting of eruption potential, energy, and duration at Telica and similar PRVs worldwide.

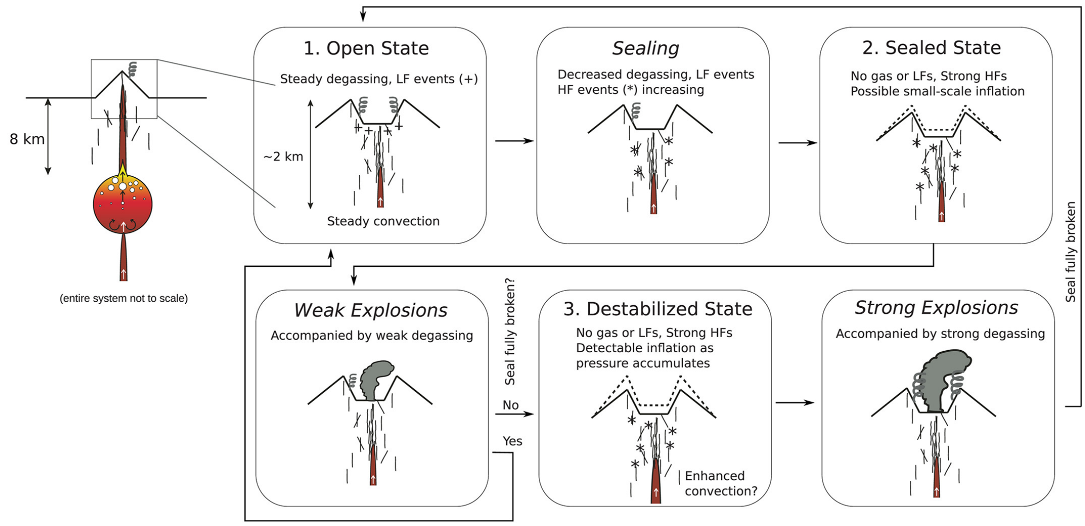

Fig. 1. Conceptual model of “stable” and “unstable” states and transitional behavior at Telica and similar persistently restless volcanoes over multidecadal timescales. Telica cycles from an open state through a sealed state leading to weak explosions. If the weak explosions are able to fully break the seal and relieve accumulated pressure, the stable open state is reattained. If the weak explosions are unable to fully relieve accumulated pressure, the shallow magmatic system is destabilized, leading to rapid accumulation of pressure that leads to strong explosions. The system then returns to a stable open state. HF = high frequency; LF = low frequency.

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