Precursors to explosive eruptions at the persistently restless Telica Volcano, Nicaragua.

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Persistently restless volcanoes (PRVs) are characterised by consistently high levels of geophysical activity, such as a high or variable seismicity rate, strong degassing and sporadic explosions. PRVs do not exhibit typical distinct 'background' and 'unrest' states, but do experience non-eruptive and eruptive episodes. Traditional methods of forecasting volcanic activity based on seismicity patterns are not applicable to PRVs and the physical processes behind the transition between non-eruptive and eruptive episodes are not well understood. Telica Volcano, Nicaragua, is a PRV that has experienced numerous VEI 1-2 eruptions over the last century, as well as historic VEI 4 eruptions. We present geophysical data from the two most recent VEI 2 eruptions, in 1999 and in 2011. The 1999 eruptive episode started in May 1999 and consisted of ash emissions and discrete explosive activity, including explosions in August and October 1999 and the most energetic explosions in December 1999. We observe a sudden short-lived swarm of high-frequency (HF) (> 5 Hz) seismic events in September 1999, between the August and October 1999 explosions, coincident with the onset of many (22) short-lived long-period (LP) (< 5 Hz) seismic event multiplets. This is followed by a reduction in the seismic event rate between the October 1999 explosions and the large December 1999 explosions. In May 2011 an eruptive episode occurred at Telica with a five-week-long series of explosions. Nine months before the eruption we observe a swarm of HF events followed one month later by a significant drop in both LP and HF events. The event rate continued to decline until it reached a minimum six weeks before the eruption. Seismic event locations between September 2010 and May 2011 suggest that all events are shallow (< 2 km) and clustered beneath the active vent. Continuous GPS observations of the 2011 eruption of Telica show no deformation that can be related to volcanic activity and precludes a large influx of magma. Both the 1999 and 2011 eruptions show similar characteristics of a HF swarm followed by decreased seismicity before the most energetic explosive episodes. We suggest that these patterns of seismicity relate to the sealing of the magmatic/hydrothermal system. This transition from open-system degassing to a closed system may have lead to pressurisation of the system, resulting in explosions.