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To erupt or not to erupt: modeling the transition between non-explosive degassing and normal activity at Stromboli

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Stromboli exhibits a wide range of degassing regimes from passive degassing to explosive dynamics. The dynamics of the conduit system are thought to be driven primarily by gas as evidenced by the relative masses of erupted gas and pyroclastic rocks. The idea that degassing drives eruptive activity at Stromboli raises the question why different eruptive regimes exist and which factors determine the transition between these regimes.
The goal of this study is to develop a conceptual model for the transition between non-explosive degassing and the famously episodic normal activity at Stromboli. It was motivated by (1) several petrological studies that demonstrated the presence of highly crystalline magma in the upper part of the Stromblian conduit system and (2) infrasonic recordings from the 2002-2003 effusive eruption. This eruption offers a unique opportunity for deciphering the transition between eruptive regimes, because normal activity ceased temporarily during the effusive phase of the eruption and because its reestablishment starting in May 2003 was recorded in detail by a local infrasonic array.
Based on this newly available observational evidence, we suggest a new model for normal Strombolian activity in which the presence of a layer of highly crystalline magma in the upper conduit plays a crucial role, because it slows the ascent of the gas: Instead of rising through a viscous fluid with low crystallinity content, the gas bubbles are forced to percolate through a dense network of crystals upon reaching the upper conduit and slow down. As a consequence, a gas layer gradually builds up below the highly-crystalline magma and exerts an increasing force on the crystalline layer. Eventually, the force will be sufficient to fracture the crystalline layer and the over-pressured gas layer escapes through the crack.
We argue that this new model is appealing for three main reasons: (1) It offers a natural explanation for the famous episodicity of normal activity, (2) it connects different eruptive regimes to dynamical processes in the volcanic conduit, and (3) it is consistent with the new observational evidence provided, amongst others, by the 2002-2003 effusive eruption at Stromboli.