Can passive degassing induce volcanic crisis?

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Openly-degassing volcanoes (e.g. Asama, Japan; Mayon, Philippines; Etna, Italy) usually erupt every few months or years. During quiescence, they passively emit several thousands of tonnes of gas per day (mainly water vapour). Such gas mass withdrawal leads to a volume change of melt because the volatiles were previously dissolved in it. On the other hand, there are evidences showing that openly-degassing volcanoes have well developed conduits with the head of the magma column close to the summit. Thus, a volume decrease of magma could decrease the mean liquid level in the conduit and may, in turn, decrease significantly the pressure at depth. This reasoning suggests that passive degassing may play an important role in the pressure evolution of magma plumbing systems. However, the problem is much more complex when we consider a response of the host-rock to pressure changes and hydraulic connection between deeper sources and shallow reservoirs. In such a case, there is a feedback between degassing-induced underpressure, closure of the conduit and reservoir, and magma replenishment. We have modelled these processes and we have found that underpressures up to some tens of MPa may easily occur during the observed repose timescales. Continuous magma intrusions through permanent hydraulic connections are induced by passive degassing without the need of a pressurized magma source. Intermittent replenishment can also be explained via passive degassing and successive openings and closures of the feeding dykes. These pressure decreases may also cause physical destabilizations of the chamber wall-rock and massive bubble nucleation and growth in the reservoir. The imbalance created by the large amount of gas released during repose may incite the frequent volcanic unrest and eruptions of openly-degassing volcanoes. This "top-down" process contrasts with the commonly proposed "bottom-up" processes of magma intrusions in shallow reservoirs driven by unspecified mechanisms occurring at depth. Coupling of top-down models with real time monitoring of total gas fluxes may open new doors for anticipating volcanic crisis.