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Volcanic plumbing system control on the dynamics and magnitude of explosive eruptions

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Explosive eruptions are the final result of complex dynamics occurring within the volcanic plumbing system and involving domains such as one or more magma chambers, their connecting dykes, and the conduit or dyke connecting magma with the surface. We present here a 1D quasi-steady numerical modeling approach that allows the interplay between magmatic reservoirs located at different depths to be taken into account in the analysis of the eruption dynamics. We simulate a set up, common to a large number of real eruption cases, where a shallow, relatively small magma chamber hosting partially degassed, chemically more evolved magma is connected through a dyke to a deeper, much larger, gas-rich, less differentiated magmatic body. The numerical results describe two separate regimes controlled by either the shallow or the deep magma reservoir. While the shallow-controlled regime shows a general increase of eruption magnitude with increasing volume of magma stored at shallow depth, the deep-controlled regime, that we associate to the potential occurrence of a large caldera collapse, lacks such a relationship, resulting in eruption magnitudes that are substantially independent from the volume of the shallow magma reservoir. The efficiency of the deep interconnections between magmatic reservoirs, exemplified in our simulations by the width of the interconnecting dyke, is found to be a major factor controlling the shift from one regime to the other.