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Temporal evolution of eruption dynamics controlled by composite plumbing systems

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Explosive eruptions are the final results of the interplay of magma dynamics taking place in the different subdomains of the volcanic system. Geophysical and petrological studies evidence common activation of multiple stacked magma bodies connected to each other, with eruption triggering often associated to arrival of deep magma into shallow reservoirs. Estimation of the source parameters (e.g., mass eruption rate) from volcanic plume observations are provided for well-characterized recent and historical eruptions and represent a relevant constrain to the temporal evolution of the underground system. Typically, an initial phase of large variation of the discharge rate with time is followed by an oscillating damped behavior. When the times scale of the processes acting in each subdomain are quite different (i.e. the time scale of magma chamber pressure variations is one order of magnitude higher than the travel time of magma in the conduit), a first order approximation allows to simulate the system evolution as a series of steady-state 1D solutions to the transport equations into the conduit, describing the magma reservoirs through lumped variables. Using this approach, we model the temporal evolution of the eruptive dynamics in a dual plumbing system represented by a deep, large reservoir connected to a shallow, smaller magma chamber discharging magma to the surface through a cylindrical conduit. The results provide the physical framework to explain the general observed trends.