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Pre-eruptive architecture and reactivation timescales prior to the 1956 climactic eruption of Bezymianny volcano (Kamchatka, Russia)

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Laterally-directed blasts are explosive events following a major sector collapse of a volcano, with the potential of devastating areas of several hundreds of km^2, due to powerful dilute and turbulent pyroclastic density currents. We are so far still incapable of predicting the date, style, and damage extent of these violent eruptions. Understanding the processes controlling these devastating eruptions is necessary to progress towards a better evaluation of the risk assessment, which is particularly important in densely populated areas. Although located in a remote area with limited risks of casualties, Bezymianny volcano awoke in 1956 after 1000 years of dormancy. The eruption started with a catastrophic flank collapse that depressurized the magma stored in a cryptodome, generating a laterally-directed blast followed by a Plinian eruptive column of tens of km high. Combining petrological constraints (from amphibole reaction rims, phenocryst-hosted glass inclusions, and matrices) to existent phase-equilibrium data, we firstly refined the plumbing system below Bezymianny, by proposing a multi-stage magma system, consisting of a deep reservoir (~200-400 MPa and ~850-950 °C, in which amphibole is stable), a shallower reservoir (~50-100 MPa and ~850-950 °C, in which quartz is stable), and a cryptodome (< 25 MPa and > 950 °C, in which there is no quartz but cristobalite). Secondly, by combining the orthopyroxene and magnetite petrological chronometers from the clasts of the paroxysmal phase of the eruption, we showed that magma rejuvenation in the deep reservoir occurred in the last 2-3 years before the eruption, followed by magma ascent in both, the shallow reservoir and the cryptodome over the last six months. Two months before the eruption, the cryptodome magma experienced a heating event that was recorded by the whole mineral assemblage (orthopyroxene, plagioclase, amphibole and magnetite). Such a timing sequence during the last few months prior to eruption compares to previously observed for the 1980 flank collapse and laterally-directed blast of Mount St Helens (WA, USA), which are valuable piece of information for future reactivations of andesitic volcanoes showing similar eruptive dynamics.