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Glacial influence on caldera-forming eruptions

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Investigation of Ar-Ar, U-Pb, and ^{14}C ages of caldera-forming eruptions for the past million years in glaciated arc of Kamchatka has lead to observations that the majority of large-volume ignimbrites, which are associated with the morphologically-preserved calderas, correspond in time with "maximum glacial" conditions. The latter are defined as the highest $\delta^{18}O$ foraminifera values on the N Pacific SPECMAP stack. Additional evidence comes from clustering Kamchatka-derived marine ash layers with glacial moraines in DSDP cores. The strongest field evidence comes from glaciated multi-caldera volcanoes that hosted thick glacial ice caps. In this paper, we investigate how glacial load dynamics may alter eruption frequency in such glaciated multicaldera volcanoes. We present results of numerical simulations that include ice cap of different thickness (ranging from 0 to 1 km) on top of calderas of relevant sizes (5 to 40 km) with magma chambers at different depths. We also study the effects of an asymmetric ice distribution, a variable pre-caldera topography, glacial overpressure on volatiles solubility, and the subglacial intracaldera hydrothermal system on changing mechanical properties of roof rock. The results are: 1) Any ice cap retard ring-fall propagation and caldera formation; 2) Asymmetric distribution of ice plays no or minor role; 3) Glacial erosion of part of volcanic edifice or interglacial edifice failure may promote ring fracture; 4) hydrothermal system under an ice cap may have more acidic hydrothermal fluids leading to more effective hydrothermal rotting of the intracaldera roof rocks; 5) short period interstadial during maximal glaciation may play most important role in pressure fluctuations/volatite saturation condition; 6) Arching influence of the ice cap on roof rock may lead to ring fracture. Overall, the maximal glacial time represent the most dynamic time in a multi-caldera volcano life promoting physical and chemical feedbacks.