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Evolution of magma plumbing system beneath Tambora volcano, Indonesia: A process to a large eruption

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Eruptive history before the great 1815 eruption of Tambora volcano in the east Sunda arc, Indonesia, was studied with mapping and K-Ar and 14C datings. A new mechanical model is proposed that the balance of stress beneath a stratocone complex control magma accumlation, based on the eruptive history and the structure along the caldera wall. The evolution of the magma plumbing system to a large eruption is reconstructed, adding data of bulk rock chemical compositions to the model.

Eruptive history before the great 1815 eruption of Tambora volcano in the east Sunda arc, Indonesia, was studied with mapping and K-Ar and 14C datings. Tambora volcano (1000 km3) grew on the southwestern flank of Kawinda Toi volcano (300 km3; ~400 ka) including Minta Nae pyroclastic flow deposit. Tambora volcano before the 1815 eruption is composed of Old Stratocone (OS) (590km3; 200-100 ka), Young Stratocone (YS) (100 ka-1815). The eruptive history of YS is divided into YSI(290 km3; 100-50 ka),YS II(80 km3; 50-20 ka),YSIII(42 km3; 20-10 ka), and YSIV (~a few km3; younger than 10 ka) stages. Only Doro Api Toi (0.002 km3) was recognized as post caldera cone. A new mechanical model is proposed that the balance of stress beneath a stratocone complex control magma accumlation, based on the eruptive history and the structure along the caldera wall. The evolution of the magma plumbing system to a large eruption is reconstructed, adding data of bulk rock chemical compositions to the model. During the period of OS-YSII (200-20 ka), a stratocone complex of shoshonitic basalt with flank fissure eruptions grew at the average long-term eruption rate of 2.5-5 km3/ ky. The accumulated stress caused by dike intrusions was relaxed repeatedly, for example, by a shift of central vent from OS to YSI, faulting and fracturing of the volcanic edifice, and sector collapses during YSII. As magma flux concentrated on a thermally stable magma plumbing system, erupted magma became more fractionated, and homogeneous, which is supported by variations of chemical compositions in SiO2-oxide and SiO2-trace elemnts diagrams. During YSIII (20-10 ka), the stress relaxation process had not worked well. The restriction of fissure eruption sites to the eastern flank indicates the partly suppression of magma ascent from a magma chamber. Magma accumulation in a magma chamber resulted in an decrease in eruption rate. Degassing including strombolian and ash eruptions through a main conduit started to produce plagiocalse-phyric basalt magma, while fractional crystallization in a magma chamber multiplied andesite magma. During YSIV(younger than 10 ka), the magma plumbing system separated into a main conduit connecting to the central vent, a small, isolated pocket, and a main magma chamber. The restriction of eruption sites to the central vent accelerated magma accumulation in the main chamber. Strombolian and ash eruptions of basalt to basaltic andesite occurred intermittently at the low eruption rate from the central vent, while only three eruptions occurred on the flank of the volcano. With an increase in buoyancy of andesite magma, the main magma chamber became unstable. A small plinian eruption of andesite occurred from a small magma pocket at 1 ka. Intermittent ash eruptions followed this eruption for the last 1000 years. In 1815 andesite magma in the magma chamber reached the climactic eruption.