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The magma plumbing systems of large silicic magmatic systems in Neogene NE Honshu, Japan

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Three prominent stages of the volcanic activity in late Cenozoic have been recognized in the NE Honshu arc. These are continental margin, back-arc basin and island-arc volcanism. Caldera-forming volcanism with more than 80 collapse calderas mainly occurred in the island-arc volcanic period (8-2 Ma). They were formed under a condition of neutral to weak compressional stress field, and are concentrated along the structural high of the uplifted region. The caldera-forming volcanism was followed with the Quaternary andesitic stratovolcanoes under highly compressional stress fields.

The late Cenozoic calderas are mainly classified into piston-cylinder type with subordinate funnel type. There are two clear peaks of caldera formation in the late Miocene to Pliocene with short dormancy in 5-4 Ma. The number and size of collapse calderas were down from late Miocene to Pliocene. The caldera-forming magma reservoirs are now mostly solidified, but they remain detectable as high temperature plutons at crustal depth. The reflection experiments (Sato et al., 2002) of the distribution area of the late Cenozoic calderas were confirm the existence of hot, solidified remnant of laccolithic magma reservoir with fluid-saturated top beneath the late Miocene caldera at depth of 3-5 km. The seismic tomography (Nakajima et al., 2005) also show that the existence of hot, solidified magma reservoirs beneath the each late Miocene and Pliocene calderas at depths of 3-7 km and 10-15 km, respectively. The compositions of pumice from each late Miocene and Pliocene calderas show different depth of equilibration. The estimated depth is well correspond with the tomographic images, and Pliocene calderas has much deeper magma. The site of caldera-forming reservoirs migrated to the back-arc side and depths of the magma reservoirs increased with time from late Miocene to Quaternary. And, its morphology changed from laccolith associated with piston-cylinder type caldera to vertically elongated stock associated with funnel type caldera.

Intra-crustal thermal structure of igneous arc is closely related with the evolution of arc magmatism including caldera formation. The geothermal gradient in the crust of the NE Honshu arc have fallen from late Miocene through the Pliocene to the Quaternary (Ban et al., 1992; Yamaji, 1994; Yoshida et al., 1995) in accord with the westward retreat of the volcanic front (Ohguchi et al., 1989). The depths of the crustal magma reservoirs increased as a results of this regional crustal cooling from the late Miocene to the Quaternary.