Collapse caldera and tectonic setting: Implications from middle Miocene ash-flow calderas at southwest Japan arc

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We reviewed and synthesized middle Miocene caldera volcanoes at the frontal margin of southwest Japan in order to reveal possible relationship between the caldera formation and the compressive tectonics. Cumulative frequency diagram for fault-slip can be used for determining the deformation style of caldera floor. The deformation style is defined as the ratio of caldera collapse energy to the total eruptive energy. The changing of style is to modify the ratio. Mechanical collapse energy for the piston model is reduced than the piecemeal deformation or the funnel explosion. This character is suitable to the larger caldera formation.

Long-term eruption rate of the Miocene calderas indicates larger rate for the compressive stress regime. The ellipticity, eruptive volume and roof aspect ratio of calderas in relation to distance from subduction trench was used to reveal an effect of strong compression. Both ellipticity and eruptive volume increase toward the trench area, and the upper limit of roof aspect ratio decreases toward there. These suggest that near the trench region, only the piston collapse caldera is capable to erupt against the strong compression.

Orientation of dyke swarm, caldera shape, and magma chamber were used to infer the orientation of paleostress at the time of caldera formation. The optimal paleostress orientation of horizontal compressive stress ($sigma_{Hmax}$) lies on NNE-SSW. The sinistral (left-wrenching) fault-slip of Median Tectonic Line (MTL) had occurred in the same period and is concordant to the NNE-SSW orientation of $sigma_{Hmax}$. The clockwise rotation of Japan-Sea Opening, however, occurred in the same period and it might have modified the original orientation into the NNE-SSW. In the southwest Japan, the migration of volcanic front took place backward after middle Miocene period. We concluded that the backward migration could be induced by the decrease of magma supply rate and increase of compressive stress at frontal margin after middle Miocene.