The nested collapse structure found in the Oligocene Sakurae cauldron

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The Oligocene Sakurae Group, central Shimane Prefecture, Southwest Japan, composes a cauldron which mainly consists of acidic to intermediate volcaniclastic, and volcanic rocks intruded by some plutons. Our detailed mapping reverals a circular collapse structure about 4~5km in diameter at the center of this cauldron. This collapse structure is the secondary cauldron nested in the primary polygonal cauldron. The injection of basic magma into a pre-existing large silicic magma chamber triggered off the volcanic activity which began to form collapse basins. The FT age reports show that the nested cauldrons probably formed in ca. 40Ma within a short time interval, and igneous activity was almost continuous.

The Oligocene Sakurae Group, central Shimane Prefecture, Southwest Japan, mainly consists of acidic to intermediate volcaniclastic, and volcanic rocks intruded by some plutons. These igneous rocks compose a polygonal cauldron of 15*20kms (Matsuda and Oda, 1982 ; Nakamura, 1982 ; Yamauchi, 1985 ; Nakazawa and Komuro, 1996 ; Nyudo and Komuro, 1997 ; Komuro and Otsuka, 1999). Our detailed mapping reveals a circular collapse structure about 4~5km in diameter at the center of this cauldron. The northern to western rim of this structure is limited by an arcuate fault, but the southern rim is an asymmetric arcuate anticline. This collapse structure is the secondary cauldron nested in the primary polygonal cauldron.

Schematic cauldron-forming processes are as follows:

The injected basic magma layered, heated and expanded a pre-existing large silicic magma chamber (Sparks and Sigurdsson, 1977). This overheat expansion of the chamber caused a primary cauldron collapse at the surface. Volcanic eruption began when the collapse fractures reached this magma chamber from the surface. The early stage of the eruption is characterized by the bimodal volcanism with basalt lava and acidic pyroclastics, because the heavy basic substratum was sucked up by emission of upper silicic magma (Koyaguchi and Blake, 1989). The basalt lava flowed out at the rim of the primary polygonal cauldron. After the outflow of the basalt lava, andesite lavas sporadically flowed out during acidic pyroclastic eruption due to magma mixing. Water concentration in the residual liquid in proportion to cooling of the magma chamber caused catastrophic pumice eruption. The roof of the chamber collapsed by this eruption (the secondary cauldron). The piston-like subsided block of the secondary cauldron squeezed out magma through ring fractures. Because welded tuff accumulated in enormous thickness and the piston block lowered simultaneously with the pumice eruption, the upper part of welded tuff was not cut by the ring fault but bent as an arcuate anticline. The welded tuff contains the remarkable andesitic fragments along this anticline. This suggests that the substratum andesitic magma in the layered magma chamber was squeezed into the ring vent in connection with the secondary collapse. The rapid evacuation of volatiled magma increased the viscosity of residual silicic magma. The viscous silicic magma formed a large lava dome in the final volcanic stage. Granite intrudions in the primary cauldron area suggests the squeezing out of the upper silicic layer in the magma chamber, whereas porphyritic dikes around the secondary cauldron could represent the lower andesitic layer in the chamber because of the deep rooted secondary cauldron.

The reported FT ages are 40.6+-2.3Ma in the eastern part (in the secondary cauldron) and 40.7+-2.4Ma in the western part (in the primary cauldron) (Matsuura,1989). We have also obtained the FT ages of 37.3+-2.2Ma(crystal tuff), 42.0+-2.3Ma(andesite lava) and 36.8+-3.4Ma(crystal tuff) in the primary cauldron.

These FT age reports show that both the primary and secondary cauldrons were formed in ca. 40Ma. The nested cauldrons probably formed within a short time interval, and igneous activity was almost continuous.