Collapse mechanism of small calderas: a case study of the Ohachidaira caldera, Hokkaido, Japan

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In order to elucidate the collapse mechanism of small calderas, we have reconstructed the Ohachidaira caldera-forming eruption and revealed componentry of lithic fragments from the proximal products of the eruption to determine the conduit evolution. The proximal products consist of five units, from base to top: pumice and scoria fall (SK-A), climactic ignimbrite (SK-B), lithic breccia (SK-C), scoria fall (SK-D), and minor ignimbrite (SK-E). A thin fine-ash layer caps SK-C lithic breccia and is overlain by SK-D scoria fall, indicating a short hiatus in explosive activity after ejection of the lithic breccia. All units consist of dacitic pumices, andesitic scorias, and banded pumices as juvenile components. During the eruption, andesitic magma ascended alongside the conduit wall while dacitic magma ascended near the conduit center, since (1) plutonic lithic fragments are coated with scoria rather than pumice indicating that conduit and/or magma chamber walls composed of plutonic rocks attached to andesitic magma, and (2) the juvenile components in SK-A change laterally outward from scoria-rich to pumice-rich, suggesting that scoria clasts ascending alongside the conduit wall were thrown to lower heights and fell on closer to the vent while pumice clasts ascending near the conduit center reached greater heights and were transported farther. The plutonic lithic content is minor in SK-A (0%) and the lower part of SK-B (2%), and increases rapidly in the middle part of SK-B (50%) suggesting a collapse of the roof of the magma chamber. It then decreases gradually in the upper part of SK-B (26%) and decreases sharply in SK-C (2%), which probably means that the collapse propagated upwards. We postulate that SK-C lithic breccia marks conduit collapse that produced abundant lithic fragments, choked the conduit, and stopped the eruption. This hypothesis is further supported by the vertical variation of the volume ratio of pumice to scoria clasts in SK-C.

Keywords: small caldera, collapse mechanism, Ohachidaira, lithic componentry, plutonic rock

