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The eruption history of Tondano Caldera, North Sulawesi, Indonesia

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Some of the most basic data required to understand the dynamics of any large silicic caldera system are the number and timing of its eruptions. We delineate the history of such voluminous silicic eruptions from Tondano Caldera, North Sulawesi, Indonesia using field geology, $^{40}\text{Ar}/^{39}\text{Ar}$ geochronology, geochemistry, and tephrostratigraphy. In addition, we attempt to correlate proximal deposits at Tondano with ash layers in cores from the recent International Continental Scientific Drilling Program on Lake Towuti. Tondano Caldera is a 20x15-km silicic caldera occupied by several active geothermal areas and a plethora of post-caldera vents, some of which erupted as recently as 2015. Additionally, Sopotan volcano, which erupted in 2016, is adjacent to the caldera's south margin. Eruptions from the caldera have emplaced voluminous silicic ignimbrite and tephra-fall deposits that blanket over 2000 km² of the northern tip of Sulawesi. Voluminous portions of the deposits are also likely present in adjacent parts of the Molucca and Celebes Seas. Prior whole-rock $^{40}\text{Ar}/^{39}\text{Ar}$ dating, which is subject to excess argon contamination, suggests that Tondano formed progressively during two caldera-collapse eruptions at 2 Ma and 1.3 Ma and experienced a third voluminous eruption at 0.1 Ma which did not expand the caldera. Our preliminary $^{40}\text{Ar}/^{39}\text{Ar}$ ages on plagioclase, however, suggest that Tondano caldera is much younger than previously known and perhaps formed within the last 250 ky. Field and geochemical evidence further suggests that the caldera experienced at least four eruptions that emplaced voluminous ignimbrite deposits up to 50 km from the caldera margin and tephra-fall deposits up to 580 km away. Geochemically fingerprinting each individual eruption and correlating them to ash layers in the Lake Towuti cores provides age constraint for the cores and has the capacity to elucidate and clarify stratigraphic relationships between Tondano's deposits that are not exposed in the field.