Toba super-eruptions through diverse magma storage revealed by zircon

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Earth is now in the middle of a flare-up of supervolcanic activities, which pose enormous threats to the environment and life-beings. Among the many factors leading to super-eruptions, thermal status and residence time of the magma reservoir are key findings over the past decades, yet remains highly controversial. Here we report, for the first time, a full dataset of zircon geochronology for six episodes of magmatic/volcanic activities in the Toba caldera, which is well-known for the 74-ka Youngest Toba Tuff (YTT) that accounted for the Earth's largest Quaternary volcanic eruption. Results show that the volcanic system started to form since as early as the Middle-Late Miocene. Two super-eruptions of the Oldest Toba Tuff (OTT) and the YTT share a prolonged residence time (up to ~450 k.y.) fueled by magma rejuvenation. However, they experienced different thermal histories in the magma reservoir that represent 'cold' and 'hot' magma storage, respectively. Therefore, the thermal status of silicic magma reservoirs cannot directly be correlated with the magnitude and time of eruptions, which challenges the geophysical argument that detection of a liquid magma reservoir in the upper crust indicates imminent eruptions.