The entire magmatic history of the Toba Caldera Complex, northern Sumatra, inferred from zircon U-Pb geochronology and elemental analyses

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The entire magmatic history of the Toba Caldera Complex (TCC), which involves the climactic Youngest Toba Tuff (YTT) super-eruption at ~74,000 years ago with erupted volume of >2,800 km^3, was investigated using zircons from the 0.8 Ma >1,000 km^3 Oldest Toba Tuff, a post-caldera lava dome and detrital zircons from Toba lake sediments deposited after the YTT activity. Here I reconfirmed by LA-ICP-MS U-Pb dating that magmatic activity of TCC started at ~1.3 Ma and newly found that zircon-forming magmatic activity of TCC flared up at ~0.3 Ma and significantly declined at ~0.2 Ma, well before the ~0.07 Ma YTT eruption. Therefore, the climatic YTT eruption was not triggered by intensive/rapid magma supply at the time of eruption. The trigger should have been a small magmatic input or some other mechanisms (such as mechanical roof failure and roof subsidence into the magma reservoir). Most TCC zircons have Ti content of 2–5 ppm, which is the same with the Bishop Tuff zircons, whose magmatic temperatures were estimated to have been <720˚C. Since some TCC zircons have >5 ppm Ti, TCC magma has been mostly <720 ˚C with occasional temperatures higher than 720 ˚C, assuming that TiO_2 activity in zircon and melt is similar in both magmatic systems. Hence, the TCC magma was stored incrementally over 1 million years as cold storage and it vented >1,000 km^3 tephras paroxysmally at ~0.8 Ma and ~0.07 Ma. The remarkable accordance of zircon U-Pb age distribution between YTT and a post YTT lava dome indicates that post-caldera magmatic activity/resurgence occurred using essentially the same magma with YTT. Finally, the significant decline of magmatic inputs since ~0.2 Ma may indicate that magmatic build up has been weak since then and therefore another super-eruption is unlikely for at least hundreds of thousands years to come in the TCC.