

Cenozoic magmatic stages in Sumatra and the incipient of Toba: Zircon ages and Hf isotope evidence

YU-MING LAI^{1*}, PING-PING LIU², AZMAN A. GHANI³,
HAO-YANG LEE⁴, SHAN LI⁵, SAYED MURTADHA⁶,
LONG XIANG QUEK¹, MUHAMMAD HATTA ROSELEE³
AND SUN-LIN CHUNG^{4,7}

¹Department of Earth Sciences, National Taiwan Normal University, Taiwan (longxiang.quek@gmail.com, correspondence: ymlai@ntnu.edu.tw)

²School of Earth and Space Sciences, Peking University, China (ppliu@pku.edu.cn)

³Department of Geology, University of Malaya, Malaysia (azmangeo@um.edu.my, hattarosley@yahoo.com)

⁴Institute of Earth Sciences, Academia Sinica, Taiwan (haoyanglee@earth.sinica.edu.tw)

⁵Institute of Geology, Chinese Academy of Geological Sciences, China (shanli@cags.ac.cn)

⁶Department of Geology, Syiah Kuala University, Banda Aceh, Indonesia (ali_madzhir@yahoo.com)

⁷Department of Geosciences, National Taiwan University, Taiwan (sunlin@ntu.edu.tw)

The Cenozoic magmatism in Sumatra island was formed by the Indo-Australian Plate subducted beneath the Eurasian Plate. Here we present zircon U-Pb ages and Hf isotopes of 38 volcanic rocks and 18 plutonic rocks from Sumatra. Magmatic zircons show four stages in Cenozoic including (1) Paleocene to Early Eocene (~66-48 Ma), (2) Middle Eocene to Miocene (~48-23 Ma), (3) Miocene to Pliocene (~23-2.6 Ma), and (4) Quaternary to Recent (~2.6-0 Ma). Four major flare-up events during 55-50 Ma, 25-20 Ma, 15-10 Ma, and 5-0 Ma can be observed with an obviously magmatic gap between 48-23 Ma. Comparing with ages and Hf isotopes, magmatism display different characteristics in the western Sumatra, Toba-related areas, central Sumatra, and eastern Sumatra. It is notable that only in the western Sumatra, magmatism suspended between 15-10 Ma and showed a temporal and spatial migration from southern to northern during that time. Except Toba-related samples show negative $\epsilon_{\text{Hf}}(t)$ values, Hf isotopes in other areas show typical Sunda Arc ratios ($\epsilon_{\text{Hf}}(t) = +7$ to $+19$). The negative $\epsilon_{\text{Hf}}(t)$ values can be found not only in the recent eruption of Toba, but also traceable to several events in 5 Ma, 10 Ma, and ~50 Ma nearby Toba area. We suggest there might be some materials with enriched Hf isotopes beneath the Toba area since at least ~50 Ma, and contributed to each stage of magmatism. These results provide a new idea of the incipient of recent Toba.