Can LA-ICP-MS ^{238}U-^{230}Th zircon dates constrain eruption ages?

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Determining eruption ages of large, silicic caldera-forming eruptions is important for understanding the frequency of large explosive eruptions and making tephrostratigraphic correlations. These age estimates are typically made using costly and time-consuming analytical techniques such as $^{40}Ar/^{39}Ar$, fission track, ID-TIMS U-Pb zircon, or SIMS U-Th zircon geochronology, when ^{14}C dating is not possible. We test a method to estimate eruption ages using ^{238}U-^{230}Th dates of young (<300 ka) zircons measured by LA-ICP-MS, which is a cost effecient, fast, and widely accessible analytical technique. For this, we attempt to reproduce independently determined eruption ages of rhyolitic tuffs from Sumatra, Indonesia. Using a laser-ablation single-collector ICP-MS (Thermo-Scientific Element 2) system, we measured U and Th isotopic compositions in zircon and matrix glass following the analytical and data reduction methods of Guillong et al. (2016; *GGR*). The isochron produced from the glass and zircon compositions were used to estimate the initial $^{230}Th/^{238}U$, which was used to calculate model crystallization dates of individual zircons.

The eruption age of the Ranau tuff was independently determined by ^{14}C dating of paleosols to be 33,830-33,450 cal years BP (Natawidjaja et al., 2017; *GeoLet*). The measured ^{238}U-^{230}Th zircon dates span 14 to 133 ka, resulting in a weighted mean age of 74.1 ± 3.0 ka (MSWD = 6.6, n = 144). However, applying the Bayesian age interpretation method of Keller et al. (2018; *GPL*) to our data, we estimate an eruption age of 32.9 +6.8/-7.9 ka.

Based on ^{14}C and glass fission track dates, the Maninjau tuff erupted at 52 ± 3 ka (Alloway et al. 2004; *EPSL*). The measured ^{238}U-^{230}Th zircon dates range from 47 to 78 ka with a weighted mean age of 61.5 ± 1.3 ka (MSWD = 10.5, n = 97). Applying the Bayesian approach to these dates produces an eruption age estimate of 48.8 +2.4/-2.8 ka.

Applying the Bayesian approach to our zircon dates results in accurate eruption age estimates although the weighted mean and youngest single zircon methods fail to do so. Futhermore, our results show that it is possible to determine eruption ages using LA-ICP-MS, which is a more accessible and faster, albeit less precise, analytical technique than those typcially used for dating Quaternary volcanic eruptions.