Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.30492

# Eruption History and Magma Chamber Dynamics of the Tatun Volcano Group, Taiwan: Insights from Mineral Chemistry and Advanced Geochronological Methods.

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Growing evidence for an active magmatic system in the Tatun Volcano Group (TVG), northern Taiwan, has intensified efforts to understand its eruption history. Determining both the timing of past eruptions and pre-eruptive conditions is crucial for assessing volcanic hazards, particularly given TVG's proximity to the Taipei metropolis, home to over 7 million people. However, previous studies have reported conflicting age results, highlighting the need for reliable dating methods to establish a robust geochronology. This study focuses on the Shamao lava dome, considered the youngest eruptive product in TVG, using a combination of zircon U-Th disequilibrium and (U-Th)/He dating (zircon double-dating) alongside high-precision $^{40}Ar/^{39}Ar$ groundmass dating. These geochronological methods are further supported by petrographic and mineral chemistry analyses, which provide insights into magmatic processes and storage conditions. New $^{40}Ar/^{39}Ar$ groundmass dating (15.0 ± 6.3 ka) aligns with zircon (U-Th)/He dating (16.3 ± 4.9 ka) and radiocarbon ages (23–13 ka), contradicting earlier interpretations of Holocene (1.3 ka) volcanism. Zircon U-Th disequilibrium data constrain the maximum eruption age to 16.3 ± 1.2 ka and reveal a prolonged magmatic history (~200 ka) with episodic recharge events, indicated by age clusters at ~23, 60, and 117 ka, as well as older grains in secular equilibrium (>300 ka). Petrographic and geochemical analyses of Shamao lava flow samples reveal disequilibrium textures in plagioclase phenocrysts, variable pyroxene compositions, and opacitic-rimmed hornblende, suggesting magma mixing or decompression. Amphibole-based geothermobarometric calculations indicate crystallization depths of 4–6 km (100–220 MPa), temperatures of 790–870°C, magmatic water content of 4–6 wt%, and oxidizing conditions (NNO+1.2 to NNO+2.2). These findings suggest that Shamao's lava flows originated from a shallow, water-rich, oxidized magma chamber during the late Pleistocene. Although further data are required to refine eruption recurrence models, these findings serve as a crucial basis for enhancing hazard assessments and risk evaluations in northern Taiwan.