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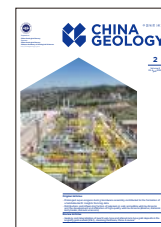
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Short Communications (Research Advances)

Zircon and cassiterite U-Pb age constraining Eocene mineralization of the Mawchi Sn-W deposit, Kayah State, Eastern Myanmar

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1. Objective

The Southeast Asian W-Sn belt, stretching over 2800 km from Yunnan Province in China through Myanmar, Thailand, Peninsular Malaysia, and into Indonesia (Figs. 1a, b), is recognized as the world's most significant tin resource base. The W-Sn mineralization in this region is closely associated with Mesozoic-Cenozoic granites. Within this belt, Myanmar, as a central segment, hosts approximately 400 Sn-W deposits, prospects, and occurrences, making it a major global tin producer. It contributes 6.2% of the world's tin reserves and 18.6% of its tin production. Among these deposits, the Mawchi Sn-W deposit in Myanmar stands out as a world-class deposit, with estimated ore reserves of 31×10^6 t. This deposit has been a focal point for geological studies, with extensive research conducted on its geology, geochemistry, zircon geochronology of the ore-related granites, and molybdenite Re-Os geochronology. In recent years, there has been a notable scarcity of new data on the mineralization age of the Mawchi deposit, particularly the absence of in situ cassiterite U-Pb ages, which are crucial for directly determining the mineralization age of Sn deposits. In this study, the authors present the U-Pb dating results of both zircon and cassiterite from the Mawchi Sn-W deposit (N18°49.322', E97°49.322', 1044 m), providing critical constraints on the mineralization age and offering valuable insights into the genetic relationship between Tethyan tectonic evolution and tin mineralization.

2. Geological setting

Myanmar is tectonically divided into seven tectonic units

from north to south: The Indo-Myanmar Ranges, the Myanmar Central Basin, the Jade Mine Belt, the Tagaung-Myitkyina Belt, the Mogok Metamorphic Belt, the Shan Plateau Sequence, and the Slate Belt (Fig. 1a). The Mawchi deposit is located in the western part of the Shan Plateau, within the central region of the Western Granite Province (WGP) of Southeast Asia. The primary lithological units exposed in the Mawchi deposit consist of metamorphic rocks of the Mogok Metamorphic Belt, low-grade metasediments of the Mawchi Group, and the Plateau Limestone, which unconformably overlies the Mawchi Group (Fig. 1c). The deposit is characterized by NNW-SSE-striking faults that align with the regional structural trend of the Mawchi Group. Mineralization is predominantly manifested as cassiterite-wolframite-quartz veins, hosted within both granitic and metasedimentary rocks. These veins are typically confined to a N-S trending fracture system.

3. Methods

Zircon U-Pb dating samples were collected from tourmaline granite in the Mawchi deposit (Figs. 1d, f). The dating analyses were performed using laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS) at Wuhan Sample Solution Analytical Technology Co., Ltd, China. The analyses utilized a GeoLas HD laser ablation system coupled with an Agilent 7900 ICP-MS instrument. The laser was operated at a frequency of 5 Hz, with a wavelength of 193 nm and a spot size of 32 μ m.

For cassiterite U-Pb dating, samples were collected from a cassiterite-quartz vein within the tourmaline granite (Fig. 1e). The LA-ICP-MS analysis was also conducted at Wuhan Sample Solution Analytical Technology Co., Ltd., China, using a laser beam spot size of 44 μ m and a frequency of 3 Hz. Cassiterite AY-4 is unknown. $^{206}\text{Pb}/^{238}\text{U}$ age of AY-4 is 157.3 ± 3.2 Ma in this research, which is accordant with the age of 158.0 ± 2.5 Ma.

Zircon 91500 and NIST610 were used as external standards for correcting isotope and trace element

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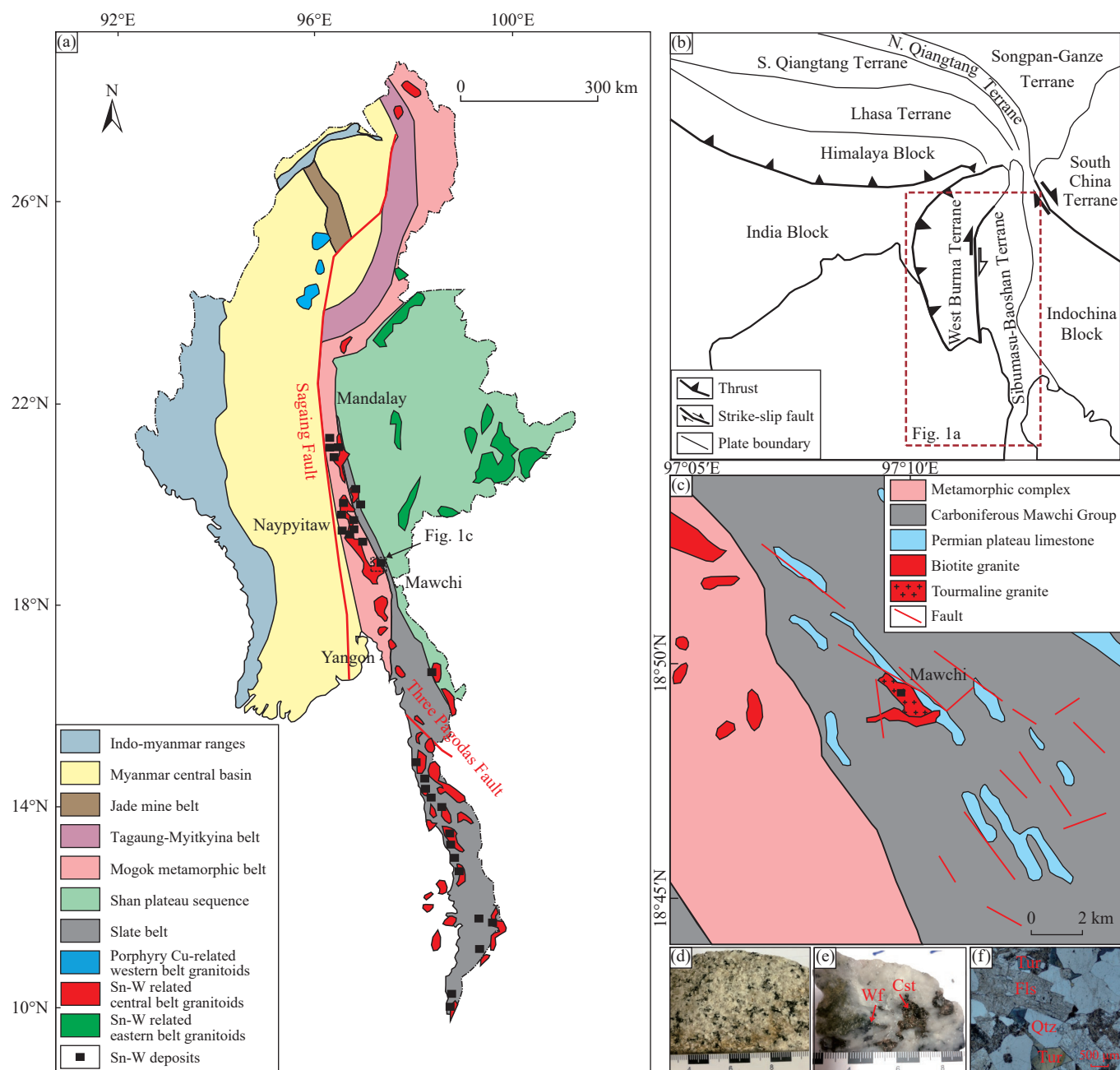


Fig. 1. a—A schematic map showing the tectonic framework, distribution of magmatic rocks and main tin deposits in Myanmar and its adjacent area); b—distribution of principal continental terranes, sutures of Southeast Asia; c—geological map of the Mawchi deposit; d, e—representative images of the tourmaline granite and ore sample in Mawchi deposit; f—plane polarized images of the tourmaline granite. Cst—cassiterite; Fls—feldspar; Tur—tourmaline; Qz—quartz; Wf—wolframite.

fractionation. The analytical data were processed offline using ICPMS DataCal software.

4. Results

Nineteen zircon grains from the tourmaline granite were analyzed (Fig. 2a), and the results of U-Pb dating are presented in Supplementary Table S1. Most zircon crystals are colorless, euhedral to subhedral, and display distinct oscillatory growth zones. The U and Th contents of these zircons vary widely, ranging from 665×10^{-6} to 6395×10^{-6} and from 346×10^{-6} to 1287×10^{-6} , respectively. The Th/U ratios, which range from 0.14 to 0.94, indicate a magmatic origin. The $^{206}\text{Pb}/^{238}\text{U}$ ages of the 10 analyzed points are relatively concentrated, with

concordance values between 90% and 97%. These results exhibit a strong linear correlation, yielding a crystallization age of 43.67 ± 0.60 Ma ($n=10$, MSWD=2.0) (Fig. 2a), representing the emplacement age of the tourmaline granite.

The U-Pb dating results of 24 cassiterite grains are provided in Supplementary Table S2. These samples exhibit relatively high common Pb content, which introduces some experimental deviation (Fig. 2b). Despite this, the results generally define an approximate linear correlation, aligning along a straight line in the concordia diagram. The measured points share a consistent U-Pb isotopic age, yielding a mineralization age of 38.2 ± 5.8 Ma ($n=24$, MSWD=0.57) (Fig. 2b). This age indicates that the Mawchi deposit formed during the middle Eocene epoch.

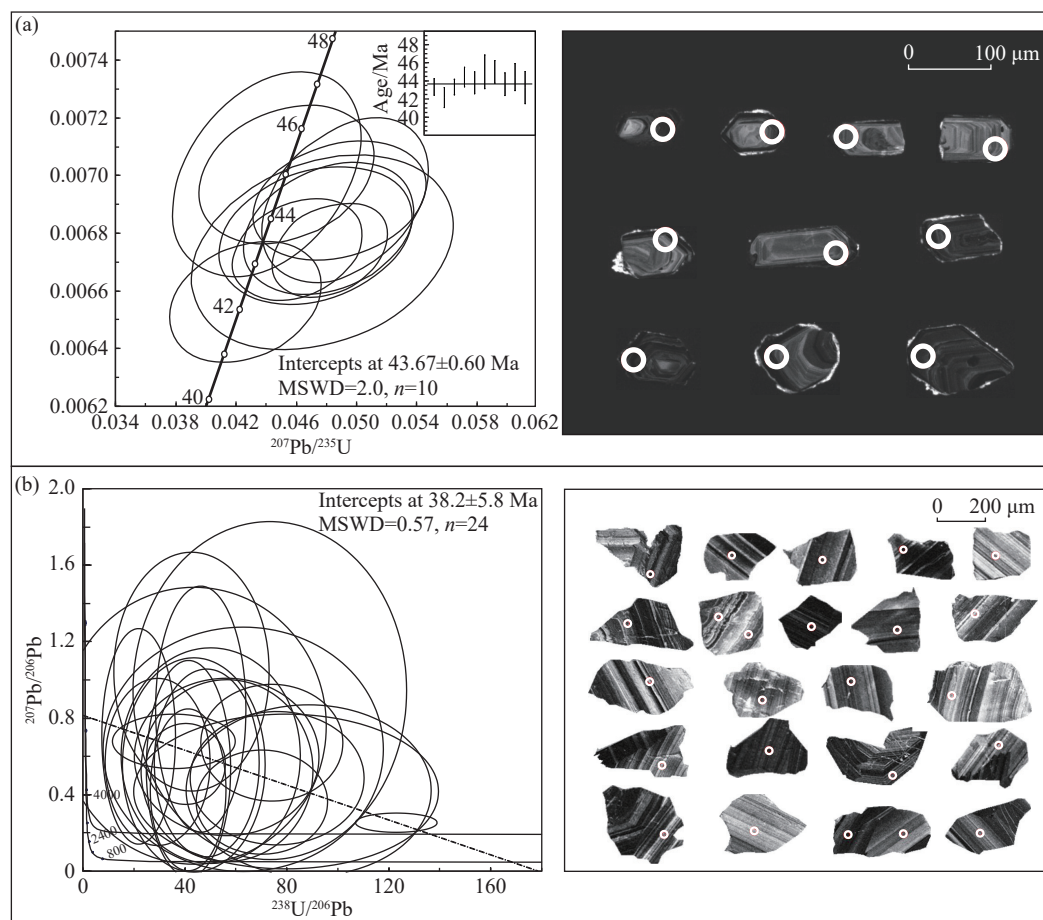


Fig. 2. a–Zircon U–Pb concordia diagram of the Mawchi deposit and cathodoluminescence images of zircon grains used for U–Pb dating; b–U–Pb concordia diagram of cassiterites from the Mawchi deposit and cathodoluminescence images of cassiterite grains used for U–Pb dating.

5. Conclusion

The zircon U–Pb age of the tourmaline granite in the Mawchi Sn–W deposit is 43.67 ± 0.60 Ma, indicating that the granite formed during the Eocene. This age is younger than those reported for other tin granites in the W–Sn Belt. Similarly, LA–ICP–MS zircon U–Pb ages of approximately 53 Ma have been documented for the Lailishan tin granites in Yunnan Province, which are interpreted as the likely northern extension of the W–Sn Belt.

The *in-situ* cassiterite U–Pb age of 38.2 ± 5.8 Ma ($n=24$, MSWD=0.57) is consistent with the zircon U–Pb age of the tourmaline granite within the margin of error, despite the high common Pb content in the samples, which introduces some experimental deviation.

Previous regional studies have shown that the emplacement of granites at 43.67 ± 0.60 Ma in the Mawchi deposit occurred in a post-collisional setting following the India–Asia collision. The timing of mineralization in the Mawchi Sn–W deposit is essentially coeval with magmatic crystallization and fluid exsolution, suggesting a close temporal and genetic relationship between granite emplacement and mineralization.

CRediT authorship contribution statement

Hui-min Liang, Yong-fei Yang, and Shu-sheng Liu

conceived the presented idea and prepared the manuscript. Bin Zhang, Lin-nan Guo, Yao-yao Duan, and De-kun Zhao performed the experimental analyses and created the figures. Hui-min Liang, Yong-fei Yang, and Bin Zhang conducted the fieldwork and collected the samples. All authors participated in discussing the results and contributed to the final manuscript.

Declaration of competing interest

The authors declare no conflicts of interest.

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Supplementary dataset

Supplementary data (Supplementary Tables S1, S2) to this article can be found online at doi: [10.31035/cg2024104](https://doi.org/10.31035/cg2024104).