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Short Communications (Research Advances)

Cassiterite U-Pb dating of the Nasarawa lithium deposit, Central Nigeria

Gao-jie Liu[a, b], Xiang-ping Chen[a, b], Peng-fei Wang[a, b], Jian-qing Wang[a, b], Yu-yu Tang[a, b], Peng Hu[c], Liang Cao[c], Jun-sheng Jiang[c], Binta Fatima Etsu[d, e], Ji-kun Wang[a, b,*]

[a] *Tianjin North China Geological Exploration General Institute, Tianjin* 300170, *China*
[b] *Tianjin North China Geological Exploration General Institute Co., Ltd, Tianjin* 300170, *China*
[c] *Wuhan Center of China Geological Survey, Wuhan* 430205, *China*
[d] *School of Earth Sciences, China University of Geosciences (Wuhan), Wuhan* 430074, *China*
[e] *Regional Geology Department, Nigerian Geological Survey Agency, Abuja* 900108, *Nigeria*

1. Objective

Nigeria lies between the West African Craton and the Congo Craton, south of the Tuareg Shield (Ogunmola JK et al., 2015). The Nasarawa pegmatite field mainly comprises of the Precambrian Basement Complex (including Archean-Proterozoic migmatite, gneiss, schists and Pan-African "Older Granites"), Mesozoic alkaline ring complexes ("Younger Granites") and sedimentary basins (Yang QD et al., 2023; Fig. 1a). "Older Granites" are part of the Pan-African mobile belt; "Younger Granites" has significant peralkaline characteristics. "Younger Granites" has a wide distribution in the north-central region of Nigeria, including areas such as Kano, Jos-Bauchi, Mada, and Nasarawa, and the emplacement age gradually decreases from north to south from 213 Ma (Dutse complex) to 141 Ma (Afu complex) (Amuda AK et al., 2021). The sedimentary basin is mainly composed of Cretaceous–Neogene sediments. The Nasarawa area is located in the middle of the northeastward pegmatitic rare metal metallogenic belt, which is mainly composed of greenschist, granodioritic gneiss (orthogneiss) and Afu granite complex. Hundreds of granitic pegmatites are widely distributed in this area, more than ten pegmatitic type Li-Be-Nb-Ta deposits have been discovered, and the metallogenic conditions are superior. However, the age of rare-metal mineralization in Nasarawa is still unclear, and whether it is related to the Early Cretaceous Afu Complex is under controversial. Herein, LA-ICP-MS cassiterite U-Pb dating was conducted to determine the mineralization age of the rare metals.

2. Methods

Cassiterite single-mineral separation and target making were completed by Nanjing Daohu Technology Co., Ltd. After crushing, magnetic separation, and gravity separation, the samples were selected by hand under binoculars and then embedded in epoxy resin for polishing and photomicrography. The LA-ICP-MS system of the State Key Laboratory of Geological Processes and Mineral Resources of the China University of Geosciences (Wuhan) was used for *in situ* U-Pb dating of the cassiterite. The system was composed of a Thermal ICAP-QC-ICP-MS combined with an ArF excimer laser (RESOlution S–155, 193 nm). He and Ar-N_2 were used as the carrier and supplementary gases, respectively. Spot analysis mode is used for the cassiterite U-Pb dating. The laser beam spot was 50 μm, the scanning speed was 5 μm/s, the frequency was 8 Hz, and the energy standard was 3–4 J/cm^2. The external element and isotope calibration standard sample was NIST SRM 612, and the internal cassiterite standard sample was AY–4 (158.2 Ma). The obtained average $^{206}Pb/^{238}U$ ages in 16 analyses of AY–4 were 158.4 ± 0.8 Ma, which is consistent with the reference age of 158.2 ± 0.4 Ma. Concordia diagrams and weighted mean calculations were made using ISOPLOT, and lower intercept age of the Tera–Wasserburg diagram was treated as the formation age of cassiterite.

3. Results

A total of 16 reliable U-Pb dating analyses of cassiterite from the fresh rock at the bottom of the Nasarawa open pit are

First author: *E-mail address*: liu_gaojie@126.com (Gao-jie Liu).

* Corresponding author: *E-mail address*: nzjgzx@163.com (Ji-kun Wang).

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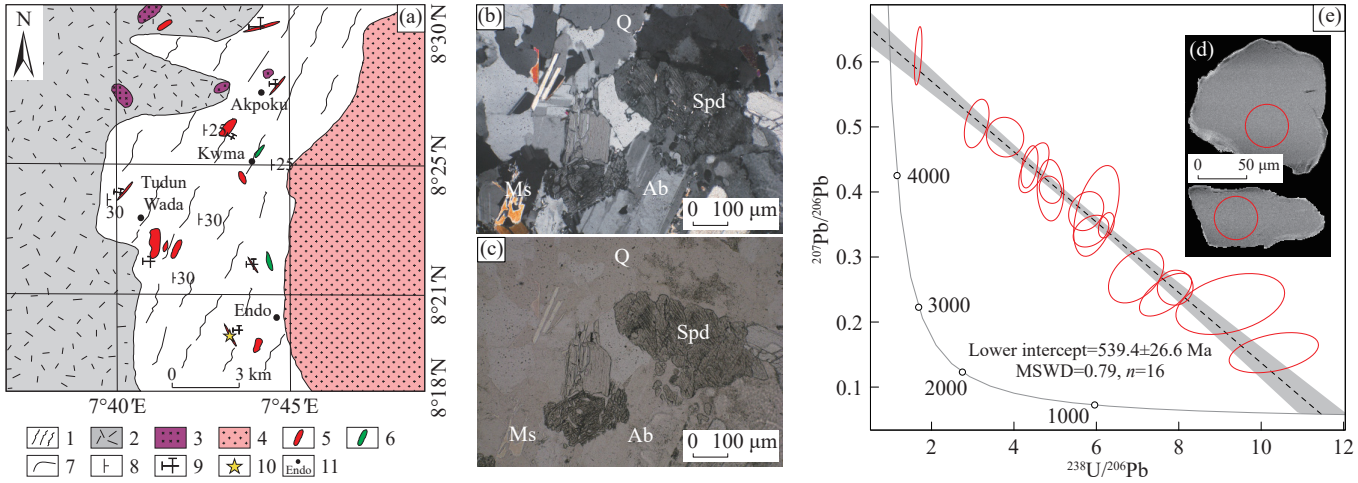


Fig. 1. a–Simplified geologic map of Nasarawa area; b–Perpendicular polarized light photomicrograph of pegmatite; c–plane polarized light photomicrograph of pegmatite; d–CL images of cassiterite; e–U-Pb concordia diagram for cassiterites from Nasarawa lithium deposit. 1–mica schist; 2–orthogneiss; 3–Pan-African granite; 4–Mesozoic granite complexes; 5–pegmatitic dyke; 6–basic dyke; 7–geological boundary; 8–foliation and occurrence; 9–rare-metal deposit; 10–sampling point; 11–village name. Spd–spodumene; Ab–albite; Q–quartz; Ms–muscovite.

presented in Table S1.

The spodumene-bearing pegmatite dyke intrudes into the mica-schist in a NW–SE direction (Fig. 1a). The boundary between the spodumene pegmatite dike and the surrounding rock is clear and distinct. There is a black turmaline belt several millimeters wide at the boundary, and the inner part is not obvious. Locally, pegmatite is distributed in strips. Pegmatite has coarse-grained, medium-fine-grained, massive and banded structure. Pegmatite is pegmatitic texture (Figs. 1b, c) and has a composition of albite (about 50%), quartz (about 25%), spodumene (about 20%), muscovite (about 5%), and minor green tourmaline (<1%). Spodumene is celandine green, columnar, and plate columnar, with a mineral particle size of 0.5–3 cm, partly varying from 5 cm to 10 c. The CL images show that cassiterite is mainly an automorphic-hypidiomorphic granular structure, with a particle size range of 100–300 μm (Fig. 1d); the internal structure is simple and the girdle is not developed. The U and Pb contents are between 0.5415 and 6.3910 and between 0.3602×10^{-6} and 7.9030×10^{-6}, respectively. The $^{207}Pb/^{235}U$ values are between 2.05 and 49.70, the $^{238}U/^{206}Pb$ values are between 1.68 and 10.31, and the $^{207}Pb/^{206}Pb$ values are between 0.15 and 0.61. Sixteen analyses yielded a Tera–Wasserburg lower intercept age of 539.4 ± 26.6 Ma (MSWD = 0.79, Fig. 1e).

4. Conclusions

The obtained cassiterite U-Pb age defines the Nasarawa rare-metal pegmatitic mineralization age of 539.4 ± 26.6 Ma (n=16, MSWD=0.79), indicating that it was formed in the late orogenic epoch after the peak of the Pan-African Orogeny.

CRediT authorship contribution statement

Gao-jie Liu, Xiang-ping Chen, Ji-kun Wang and Yu-yu Tang conceived the presented idea and prepared the manuscript and figures. Peng-fei Wang, Jian-qing Wang, Peng Hu, Liang Cao and Jun-sheng Jiang conducted the field work and collected the samples. All authors discussed 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 Table S1 to this article can be found online at doi: 10.31035/cg2024040.

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