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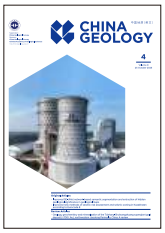

Short Communications (Research Advances)

Cassiterite U-Pb geochronology of the Sareshenke Tin deposit in the East Junggar: Implications for the two stages of tin mineralization

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1. Objective

The Eastern Junggar Kalamaili region in Xinjiang constitutes a significant tin metallogenic belt in northwest China (Fig. 1a). It hosts four independent tin deposits — Kamusite, Ganliangzi, Beilekuduke, and Sareshenke —from west to east, supplemented by two tin mineralized points, namely Hongtujingzi and Sujiquan (Figs. 1b). according to the ore type and the composition of gangue minerals, the tin deposits in the region are classified into two groups: Quartz vein type and greisen type, with the Sareshenke deposit ascribed to the former and the remainder to the latter. These deposits, recognized as primary tin sources linked to granite, predominantly occupy the contact zones of the granite with wall rocks, both internally and externally. This placement manifests a robust correlation between the tin mineralization with the intrusion of granitic magma. The granites associated with these mineralization, predominantly dated between 300 Ma to 330 Ma, are defined by different lithologies. These include granodiorite, biotite monzogranite, Sodderite granite, biotite alkali feldspar granite, and soda-ferriamphibole alkali feldspar granite, which reflect the signatures of polyphase magmatic events. Existing studies illuminate the mineralization episodes occurred in the Late age of Late Carboniferous (304−310 Ma), evidenced by the ^{40}Ar-^{39}Ar dating of muscovite from the greisen-type tin veins in the Beilekuduke area, as documented by Yang FQ et al. (2008). This mineralization epoch is further substantiated by the Re-Os dating result (307 Ma) of molybdenite from the Sareshenke quartz-type ore body (Tang HF et al., 2007). Lin JF et al. (2008) reported an alternative timing for tin mineralization based on a zircon age of 324 ± 3 Ma from the cassiterite-bearing quartz veins within the Sareshenke tin deposit. However, this zircon age has not been widely recognized as the age of tin mineralization. In this study, U-Pb isotopic dating was performed on cassiterite samples extracted from both the Sareshenke quartz vein-type and the Beilekuduke greisen-type tin ore bodies. These analyses facilitated the precise determination of the ages of mineralization and enabled the identification of distinct mineralization phases, which are crucial for elucidating the patterns of tin mineralization at regional scale.

2. Methods

The cassiterite samples studied were collected from the Sareshenke quartz vein-type ore body (samples SK7, SK9) and the Beilekuduke greisen-type ore body (sample BLKDK). Within the quartz vein-type ore body, cassiterite is densely scattered in a stellate, disseminated formation. Their mineral assemblage is composed of quartz and cassiterite, with cassiterite mineral crystals occurring as granular forms, ranging in size from 0.2 mm to 1.8 mm. Within the greisen-type body, cassiterite displays both automorphic and heteromorphic texture and possesses a sparse, disseminated structure. Within the greisen-type ore body, cassiterite displays both automorphic and heteromorphic texture and possesses a sparse, disseminated structure. The mineral assemblage within the ore body includes cassiterite, muscovite, and quartz, wherein cassiterite and muscovite exist in a state of equilibrium.

The selection, target making and cathodoluminescence (CL) photography of cassiterite were completed in the Hebei Regional Geological Survey Institute and the Key Laboratory for the Study of Focused Magmatism and Giant Ore Deposits MNR, Xi'an Center of Geological Survey, respectively. The LA-ICP-MS cassiterite U-Pb test was performed in the

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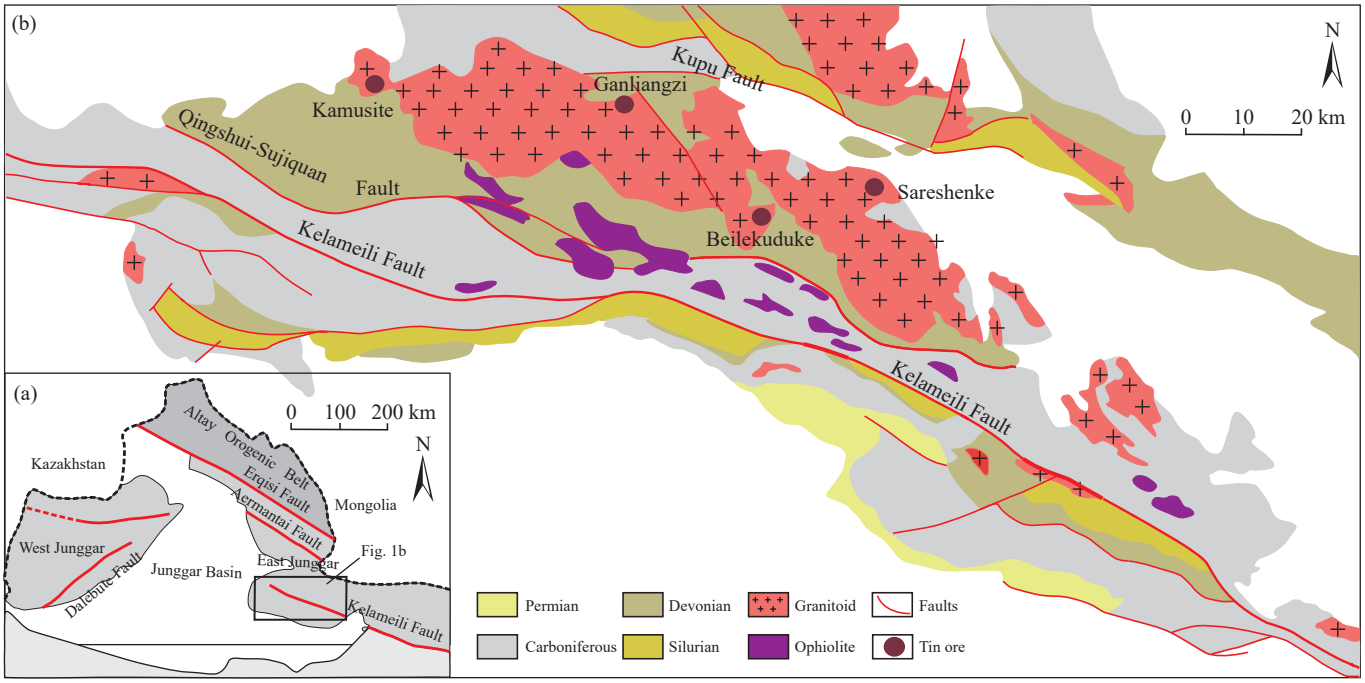

Fig. 1. Geological sketch map of the Kalamaili in the Eastern Junggar, Xinjiang.

Isotope Laboratory of Tianjin Geological Survey Center, and the age data were processed with Isoplot software. The instrument used was the NEPUNE multi-receiver inductively coupled plasma mass spectrometer produced by Thermo Fisher Company of the United States, and the laser ablation system adopted was the NEW WAVE 193 nm FX ArF excimer laser produced by ESI Company of the United States. The 193 nm FX laser was used to ablate cassiterite, and the laser-ablation substances were sent to the MC-ICP-MS with He as the carrier gas. The U-Pb determination was conducted by simultaneously receiving U-Pb isotopes with large differences in mass numbers through Zoom adjustment and dispersion expansion.

3. Results

The cassiterite samples exhibit uniform particle sizes, measuring approximately 400 μm in length and 300 μm in width, and are distinguished by their automorphic-heteromorphic texture. Under transmitted light, they appear dark brown and display no fractures on the surfaces. The U-Pb dating results are listed in Table 1, with the age curves shown in Figs. 2a, b, c.

In sample SK7, the ratio of $^{207}Pb/^{235}U$ varies between 0.4619 and 14.3656, whereas the ratio of $^{238}U/^{206}Pb$ ranges from 6.13 to 19.01. The lower intersection age estimated using the $^{207}Pb/^{235}U$-$^{206}Pb/^{238}U$ ratios is 321.8 ± 5.8 Ma (MSWD = 2.6, Fig. 2a). For sample SK9, the ratio of $^{207}Pb/^{235}U$ ranges from 0.4480 to 5.5140, and that of $^{206}Pb/^{238}U$ from 12.40 to 19.77. The lower intersection age is 321.4 ± 4.3 Ma (MSWD = 1.9, Fig. 2b). In sample BLKDK, the ratio of $^{207}Pb/^{235}U$ varies from 0.4318 to 3.8192, and the ratio of $^{238}U/^{206}Pb$ from 11.33 to 19.31. The lower intersection age is 320 ± 13 Ma (MSWD = 3.2, Fig. 2c).

4. Conclusion

This work firstly conduct an isotopic geochronology analysis of cassiterite in the tin ore belt of the Eastern Junggar region. The LA-ICP-MS cassiterite U-Pb ages obtained were 321.4 ± 4.3 Ma, 321.8 ± 5.8 Ma, and 320 ± 13 Ma, which corresponds to the formation age of the deposit. This reveals that in addition to the mineralization during the late stage of the Late Carboniferous, there was also mineralization in the early stage of the Late Carboniferous. Granular, clumpy, and disseminated cassiterite is found in quartz veins and alkaline granite in the field investigation, while the quartz veins are interspersed in the granite, which provides evidence for the above inference. This suggests that the Kalamaili area in the Eastern Junggar has two stages of tin mineralization that occurred concurrent with the granitic magmatism.

CRediT authorship contribution statement

Su-xia Peng and Kai Weng contributed equally to this research. Su-xia Peng and Kai Weng conceived of the presented idea, Bo Chen and Zhao-wei Zhang developed the theory. Su-xia Peng, Bo Chen, Xiao-qin Quan, Chao Sun participated in the field investigation, Su-xia Peng verified the analytical methods. 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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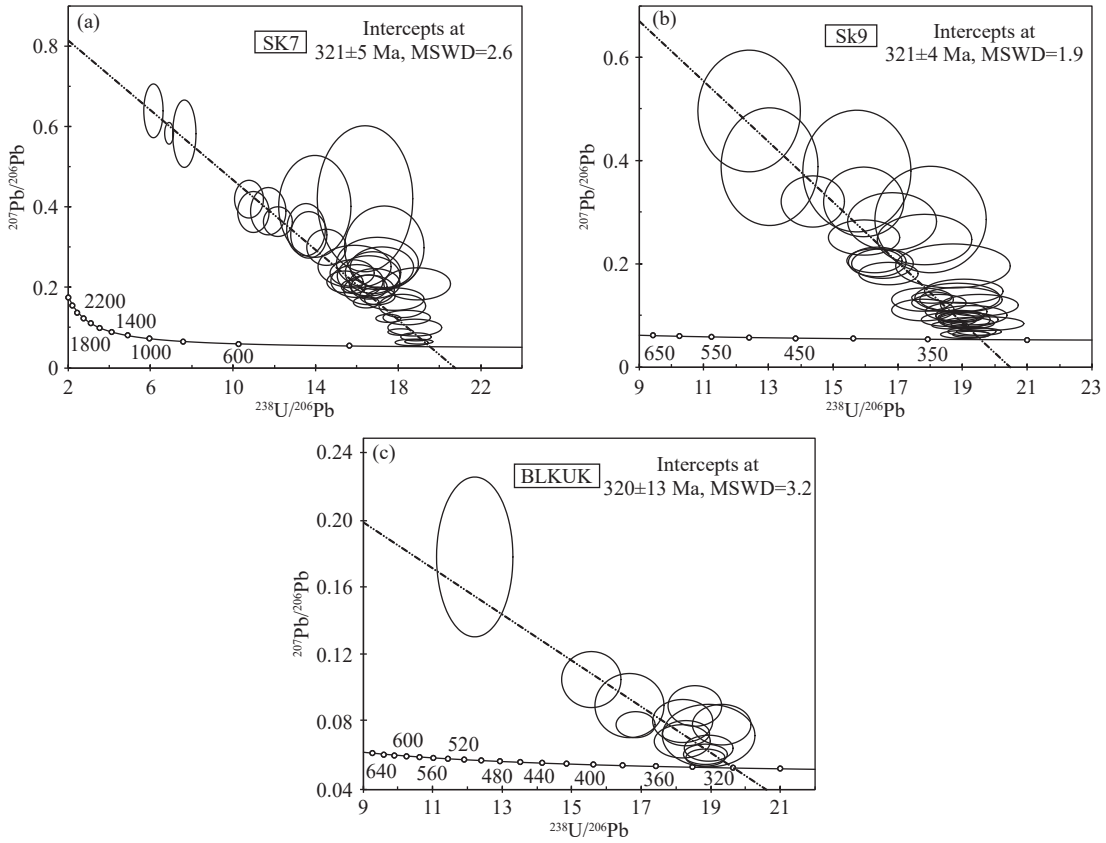

Fig. 2. Cassiterite U-Pb concordia diagrams from Sareshenke and Beilekuduke in the Eastern Junggar.

Supplementary dataset

Supplementary Table 1 LA-ICP-MS cassiterite U-Pb data at the Sareshenke area Sn deposit in the Eastern Junggar can be found in doi:10.31035/cg2024153

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