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Short Communications (Research Advances)

Cassiterite U-Pb dating of the Yelonggou pegmatite-type lithium deposit in western Sichuan and its metallogenic age constraints

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1. Objective

Pegmatite hosts important resource of rare metals, e.g., lithium (Li) and beryllium (Be). In recent years, increasingly more studies were dedicated to characterize and unravel the formation of pegmatite-type deposits, for which accurate dating of pegmatite formation and mineralization is essential.

The Songpan-Ganzi orogenic belt is a major rare metal metallogenic belt in China, hosting many important pegmatite-type Li deposits, including the Lijiagou, Dangba, Jiajika, Yelonggou, Cuola, and Declalongba. Radiometric age data (mica Ar-Ar and zircon/cassiterite U-Pb) from these Li deposits are sparse, ranging from 210 to 152 Ma. However, obtaining reliable zircon U-Pb dates can be a challenge due to the strong decidualization in pegmatites. As a result, the formation and mineralization ages of these rare metal pegmatites remain controversial, which hampers the development of pegmatite-type metallogenic model for the Songpan-Ganzi orogenic belt.

The Yelonggou Li deposit is located among the Yangtze, Qaidam-Kunlun, and Qiangtang terranes (Fig. 1a). It belongs to the Malkang-Jinchuan rare metal metallogenic subzone of the North Bayankala-Malkang metallogenic belt. The pegmatite-type Li ores are mainly hosted by the wallrock around the late Indosinian monzogranite, such as the Triassic Zagunao and Zuwo Formations, which comprise metasandstone, biotite-quartz schist, and diopside-quartz hornfels (Fig. 1b). The pegmatite dykes intruded mainly along the strata, forming stratabound or lenticular bodies (Fig. 1c). Previous works suggested that the mineralization was related to the Ke 'eryin monzogranite on the northern side of the deposit. In this study, the cassiterite at Yelonggou was U-Pb dated to constrain the timing of mineralization.

2. Methods

Based on systematic field investigation at the mining area, intact cassiterite crystals were picked from fresh ore samples, which were collected from the No. I orebody open-pit (Fig. 1b). The host rocks are grayish-white and grassy-green, coarse-medium-grained spodumene-albite pegmatite (Figs. 2a, b). Under the microscope, metasomatic texture was observed, with early spodumene replaced by albite, muscovite, and quartz (Figs. 2c, d). Major minerals include feldspar (albite and microcline), quartz, and spodumene, with minor lepidolite and muscovite, and accessory pyrite and cassiterite.

Cassiterite sample collection and preparation (incl. polishing and photography) were performed at the Langfang Hongxin Geological Exploration Technology Service Co. Ltd. The cassiterite U-Pb dating was carried out at the Tianjin Geological Survey Center of the China Geological Survey, with the data processing completed with the software ICPMS Data-Cal and Isoplot.

3. Results

Cassiterite grains (size: 50 to 150 μm) are euhedral to subhedral granular, with length-to-width ratio of 1∶2 to 1∶1 (Fig. 2e). The grains are brown to yellowish brown under transmitted light. They have high birefringence colors under crossed polars, with simple clear structure, uniform color, and a few cracks (Fig. 2f). These textural features suggest that our cassiterite samples are of magmatic origin.

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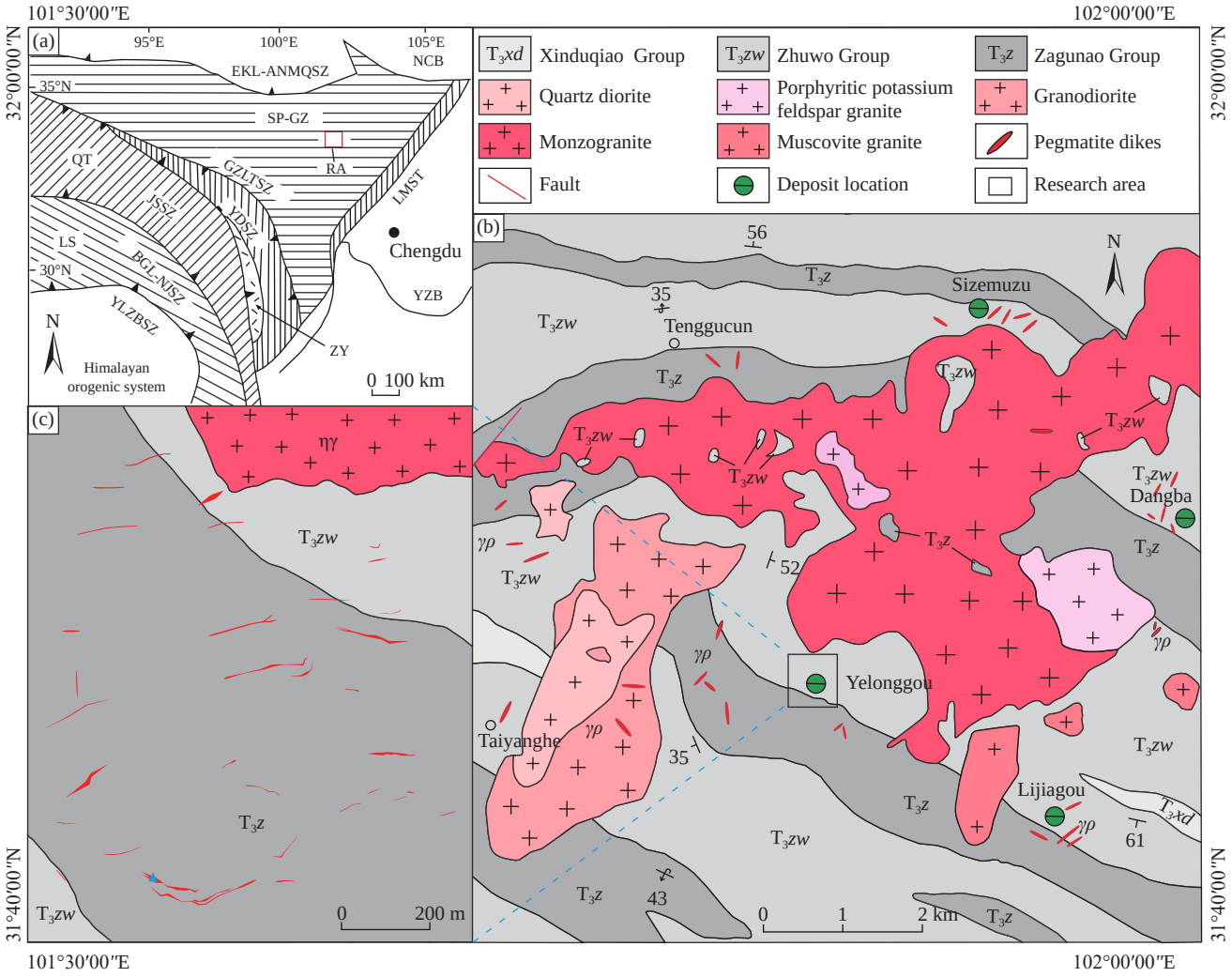

Fig. 1. (a)–Geotectonic map of the Yelonggou Li deposit; (b)–Geologic map of the Ke'eryin district; (c)–Geologic map of the Yelonggou mining area. Abbreviations: NCB–North China Block; NQLT–North Qilian Thrust; EKL-QDM-QL–East Kunlun-Qaidam-Qilian terrane; QT–Qiangtang terrane; LMST–Longmenshan thrust; YZB–Yangtze block; EKL-ANMQS–East Kunlun Anyemaqen suture zone; JSSZ–Jinshajiang-Ailaoshan suture zone; LS–Lhasa block; BGL-NJSZ–Bangong Lake-Nujiang suture zone; GZLTSZ–Ganzi-Litang suture zone; YDSZ–Yidun island arc suture zone; ZY–Zhongzan block.

The cassiterite U-Pb dating results are listed in Table 1. The samples $^{238}U/^{207}Pb$=3.860 to 457.433, $^{206}Pb/^{207}Pb$=1.207 to 15.768, $^{238}U/^{206}$ Pb=3.400 to 29.990, and $^{207}Pb/^{206}Pb$= 0.063 to 0.828. The samples yielded U-Pb concordia age of 202.6 ± 6.6 Ma (MSWD=6.6; Fig. 2g), suggesting late Indosinian mineralization for the Yelonggou Li deposit.

4. Conclusions

Pegmatite in the Yelonggou lithium deposit was cassiterite U-Pb dated to be 202.6 ± 6.6 Ma, broadly coeval to that of the Ke 'eryin intrusion, which suggests that the mineralization belongs to the late Indosinian orogenic event. Our results indicate that their mineralization is closely related, and thus attention should be paid to these pegmatites during field exploration campaigns.

CRediT Authorship contribution statement

Xiang-yuan Yue, Qian Zhang conceived the idea. Jun-jun Zhang, Wei Zhang, Jing Zhang, Zhi-quan Jia, Li-ping Luo participated in the field investigation. All the 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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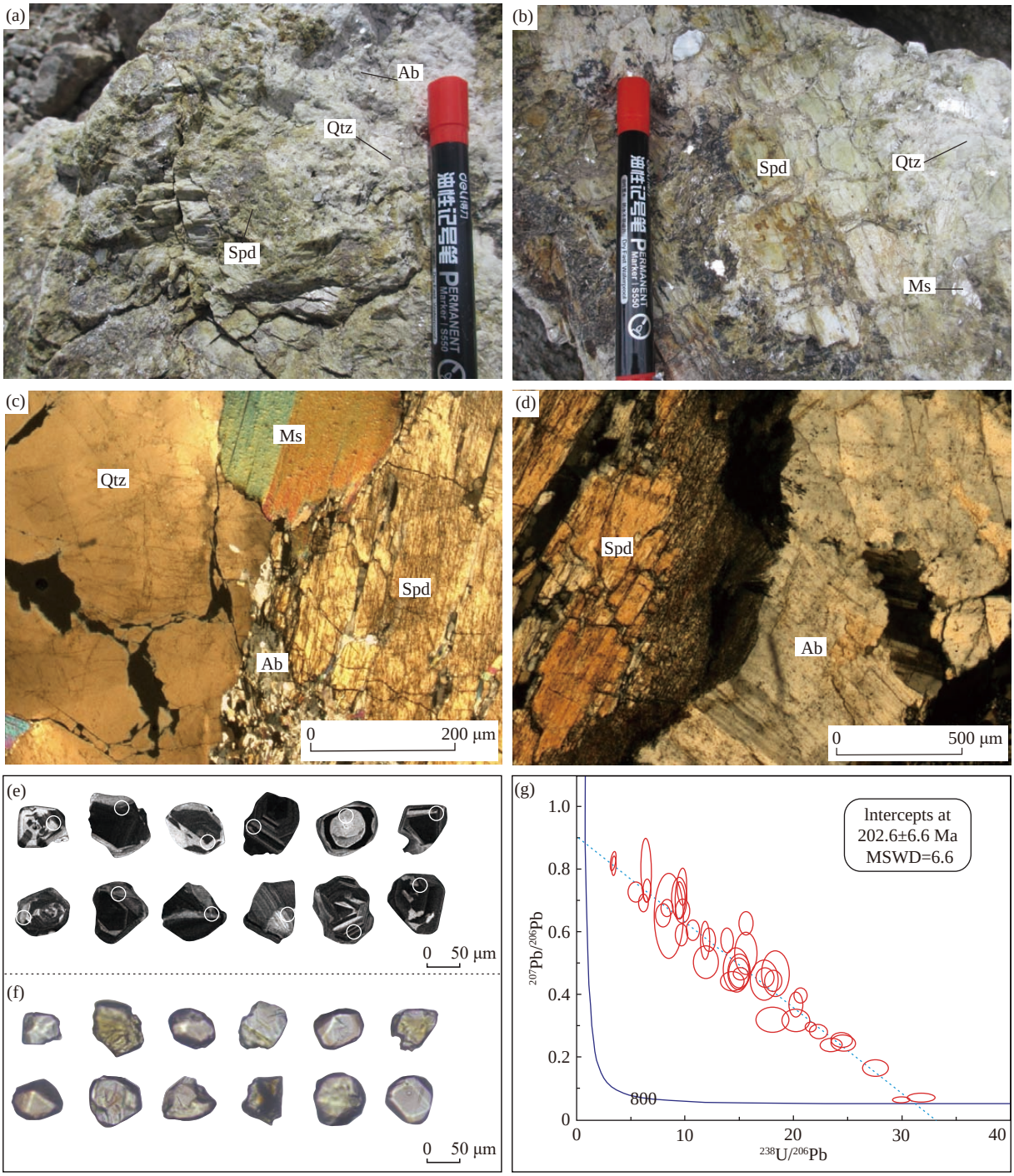

Fig. 2. (a–b) Hand-specimen photos and (c–d) photomicrographs (crossed-polar) of the pegmatite and spodumene ore; (e) Cathodoluminescence (CL) and (f) back-scattered electron (BSE) images of cassiterite; (g) Cassiterite U-Pb concordia plot for the Yelonggou Li ore-bearing pegmatite dyke. Abbreviations: Qtz–quartz; Ms–muscovite; Ab–albite; Spd–spodumene.

Table 1. LA-MC-ICP-MS cassiterite U-Pb isotopic data from the Yelonggou Li deposit.

Sample	$^{238}U/^{207}Pb$	2σ	$^{206}Pb/^{207}Pb$	2σ	$^{238}U/^{206}Pb$	2σ	$^{207}Pb/^{206}Pb$	2σ
YLG01.01	13.253	5.300	1.345	6.700	9.750	3.900	0.744	6.700
YLG01.02	31.714	7.600	1.884	10.500	15.630	5.300	0.531	10.500
YLG01.03	22.874	5.500	1.745	5.400	13.880	3.400	0.573	5.400
YLG01.04	42.171	9.400	2.240	11.700	17.360	6.000	0.447	11.700
YLG01.05	49.397	4.400	2.520	4.900	20.640	2.500	0.397	4.900
YLG01.06	23.775	4.600	1.593	4.800	15.600	3.300	0.628	4.800
YLG01.07	8.792	6.300	1.255	10.600	6.370	6.400	0.797	10.600
YLG01.08	45.226	8.000	2.144	12.800	18.320	5.600	0.466	12.800
YLG01.09	70.943	7.600	3.551	6.500	22.300	3.100	0.282	6.500
YLG01.10	457.433	8.400	15.768	10.200	29.990	2.400	0.063	10.200
YLG01.11	93.884	6.700	3.920	7.700	24.470	3.300	0.255	7.700
YLG01.12	11.326	6.800	1.479	3.300	8.300	5.500	0.676	3.300
YLG01.13	160.553	10.500	6.022	12.100	27.570	3.500	0.166	12.100
YLG01.14	100.576	6.900	4.102	8.900	24.580	3.700	0.244	8.900
YLG01.15	14.567	7.400	1.693	5.000	9.620	4.800	0.591	5.000
YLG01.16	8.026	7.000	1.444	3.500	6.140	6.000	0.693	3.500
YLG01.17	27.727	10.800	2.261	5.700	14.330	6.100	0.442	5.700
YLG01.18	13.818	6.600	1.413	7.800	9.460	5.600	0.708	7.800
YLG01.19	32.589	5.500	2.209	5.900	15.120	4.100	0.453	5.900
YLG01.20	8.273	5.800	1.368	4.200	6.500	4.400	0.731	4.200
YLG01.21	20.513	11.000	1.991	8.300	11.910	8.100	0.502	8.300
YLG01.22	28.321	9.700	2.133	8.600	14.930	5.200	0.469	8.600
YLG01.23	11.211	8.600	1.534	4.700	7.980	6.800	0.652	4.700
YLG01.24	41.815	13.500	3.131	10.300	18.110	6.800	0.319	10.300
YLG01.25	30.072	11.900	2.092	12.100	14.760	6.600	0.478	12.100
YLG01.26	3.919	5.700	1.234	3.300	3.400	5.400	0.810	3.300
YLG01.27	19.710	10.000	1.749	8.800	11.850	2.800	0.572	8.800
YLG01.28	92.686	7.500	4.173	7.400	23.500	3.400	0.240	7.400
YLG01.29	29.657	8.100	2.051	7.100	15.080	4.700	0.488	7.100
YLG01.30	12.318	15.000	1.536	17.100	8.470	13.100	0.651	17.100
YLG01.31	15.996	6.400	1.654	4.400	10.730	4.700	0.605	4.400
YLG01.32	56.085	10.500	3.139	9.300	20.220	5.100	0.319	9.300
YLG01.33	67.888	3.800	3.371	3.700	21.600	2.000	0.297	3.700
YLG01.34	36.718	5.500	2.198	5.800	17.410	3.800	0.455	5.800
YLG01.35	6.775	11.300	1.373	3.600	5.410	10.500	0.728	3.600
YLG01.36	52.208	8.400	2.720	8.800	20.260	2.600	0.368	8.800
YLG01.37	13.955	6.400	1.499	4.700	9.770	5.400	0.667	4.700
YLG01.38	3.860	4.500	1.207	3.100	3.430	3.800	0.828	3.100
YLG01.39	13.401	5.300	1.427	6.900	9.480	4.000	0.701	6.900
YLG01.40	40.089	5.400	2.257	6.200	18.110	3.400	0.443	6.200
YLG01.41	20.167	5.800	1.745	5.400	12.150	3.700	0.573	5.400
YLG01.42	446.422	11.300	13.869	14.800	31.790	3.300	0.072	14.800