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Multiple tin mineralization events in Africa: Constraints by in-situ LA–ICPMS cassiterite U–Pb ages

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Cassiterite (SnO_2) is a common ore mineral in rare metal granites/pegmatites and tin deposits, and is also an associated mineral in some tungsten and VMS deposits. It belongs to the rutile group ($M^{4+}O_2$), which in principle should have high U and low common Pb contents in its crystal structure. Cassiterite U–Pb ages can be determined by TIMS, LA–ICPMS, LA–MC–PCMS and SIMS, and directly date tin mineralization event. The African continent is richly endowed with episodic tin mineralization events from Archean to Mesozoic. Several tin provinces can be identified including Bushveld Sn, Central African Sn, Eastern Desert Ta–Sn, Damaran Sn and Jos Plateau Sn provinces. Tin deposits from these provinces are associated with highly fractionated granites/pegmatites. Zircon grains in these fertile granites/pegmatites commonly have high Th and U contents. The Th and U decay easily lead to the damage of zircon lattice. Most previous published radioactive ages are obtained by Rb–Sr or K–Ar methods, both of which are indirect dating methods. The Rb–Sr and K–Ar isotopic systems have low closure temperature and are easily to be disturbed by late-stage tectono-hydrothermal events. In this contribution, we conducted in-situ U–Pb dating on seven cassiterite samples to precisely constrain the tin mineralization events in three Pre–Ordovician tin provinces including Bushveld tin province (South Africa), Central African Ta–Sn province (Rwanda, DR Congo, Burundi), Damaran tin province (Namibia).

The cassiterite grains collected from tin exogreisen in Leeuwpoort deposit, Bushveld tin province, South Africa yield a lower intercept U–Pb age of 2081 ± 23 Ma in the Concordia plot (n = 40, MSWD = 1.6). This age is slightly older than the zircon U–Pb age (2054 to 2055 Ma) of the felsic rocks in the top of Bushveld complex but consistent with the TIMS U–Pb age of cassiterite (2099 ± 3.1 Ma) from the Zaaiplaats deposit obtained by Gulson and Jones [1], which represent the timing of Paleoproterozoic Bushveld tin mineralization event. The cassiterites from Central African tin province are sampled from the Gatumba Ta–Sn pegmatite and Rutongo quartz vein deposits in Rwanda, Mulehe quartz vein deposit in Burundi, and Kalimbi quartz vein deposit in DR Congo. Dating on the Gatumba cassiterites give a lower concordant intercept U–Pb age of 998 ± 10 Ma (n = 36, MSWD = 0.9). Hydrothermal cassiterites from Rutongo and Mulehe deposits have variable common Pb contents and yield two lower intercept U–Pb ages of 957 ± 21 Ma (n = 49, MSWD = 1.4) and 1049 ± 61 Ma (n = 33, MSWD = 4.4) in the Tera–Wasserberg plot, respectively. The above three ages are consistent with the zircon U–Pb age of the parental G4 granite (986 ± 10 Ma) within error. The Kalimbi cassiterites have relatively young U–Pb age of 558 ± 8 Ma (n = 25, MSWD = 1.5). The above dating results indicate that the peak Ta-Sn mineralization event occurred at 960–1050 Ma overprinted by Neoproterozoic Pan-African Orogeny. The Cape Cross–Uis pegmatite belt is the most important belt in the Damaran tin province, Namibia, SW Africa. The Uis pegmatite is unzoned and hosts cassiterite, columbite–tantalite, ixiolite, rapiolite and wodginite. Dating on two cassiterite samples give Tera–Wasserberg lower intercept ages of 503.8 ± 5.9 Ma (n = 27, MSWD

= 0.7) and 513.0 ± 6.9 Ma (n = 38, MSWD = 0.7), respectively. Both dates are older than the previous Rb–Sr isochron age (486 Ma) [2] but agree well with the coltan TIMS U–Pb age of 505.6 ± 2.6 Ma [3]. The coltan and cassiterite U–Pb dates represent the crystallization age of the Uis pegmatite which was induced by the Cambrian post-tectonic magmatic event in Damaran Orogen.

References:

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