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U-Pb Geochronology of LCT and NYF Pegmatite Occurrences of the Northern Appalachians

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Pegmatites host significant critical minerals resources worldwide. Lithium-cesium-tantalum pegmatites (LCTP) are the more abundant of the two highly evolved granitic pegmatite types, along with niobium-yttrium-fluorine pegmatite (NYFP)-type, and are enriched in rubidium, beryllium, boron, and tin. Hypotheses of pegmatite generation include derivation from extreme fractionation of parental granitic magmas, direct anatexis of enriched parent rocks, and formation below salars in orogenic belts.

Pegmatite mineral geochronology is the best way to determine their temporal relations. Zircon geochronology is problematic due to the presence of xenocrysts, inheritance, and Pb-loss/High-U. Cassiterite, the main ore mineral of tin, is common in LCTPs and some NYFPs and is a proven geochronometer. New LA-ICPMS U-Pb geochronology analyses of cassiterite from several LCTPs in western and central Maine are ~350-250 Ma. NYFPs from eastern New Hampshire are ~180 Ma—clearly related to the Mesozoic White Mountain magmatic series (WMMS). Altogether there were at least five episodes of evolved pegmatite genesis in the northern Appalachians.

Strikingly, most LCTP pulses occur at the terminus of magmatic events or during apparent regional magmatic lulls. This suggests that LCTP genesis in western Maine is not related to fractionation of coeval parental granitic bodies but, alternatively, is related to processes that followed major tectonomagmatic events like the Neoacadian and Alleghanian orogenies. That LCTPs follow tectonism is consistent with anatexis as a contributor to the genesis of LCTP. Relatively high-precision age constraints from cassiterite geochronology allows us to correlate paleogeographic positioning during formation. Western Maine at ~260 Ma was at an arid latitude making it feasible that fluids from salars could enrich the pegmatite source.

Cassiterite from select NYFPs in New Hampshire are coeval with emplacement of the WMMS and appears to be directly related to that event—NYFP formation is a fundamentally different process than the formation of LCTPs the region.