Rapid crystal growth causing trace element and Li-isotope enrichments in quartz crystals from the Stewart pegmatite

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Pegmatites contain valuable ore resources. Determining the chemistry and kinetics involved in pegmatite formation is important for understanding the element enrichment process. This work uses trace elements and Li isotope ratios from quartz crystals to comprehend equilibrium and kinetic crystal growth effects. The quartzes come from the Stewart pegmatite, a gem and Li-bearing pegmatite, located in the Pala mining district, California, USA. We studied 3 quartz crystals from miarolitic cavities housed in the pegmatite. The cavities source from a core zone and extend upwards into the lower part of the hanging wall of the pegmatite. The core zone contains spodumene, as well as albite and other Li-bearing minerals. Using trace element profiles, we ascertain three growth zones in the crystals—a slow growing core (1-10 cm/day) and rapid growing middle zone and rim (1-10 m/day). Assuming a sudden increase in growth rate across a growth zone, we calculate the expected trace element distributions and compare them to measurements. Core Li isotope ratios (δ^7Li_{LSVEC} = 20-25‰) are consistent with the quartz growing from a water-rich fluid that was initially in equilibrium with spodumene (15-20‰). Towards the rims of the crystals, the ratios are heavier at 25-35‰ with one crystal reaching >50‰. These values are high compared to granitic systems. In conjunction with the trace elements, kinetic growth modelling shows these outer ratios to be consistent with rapid crystal growth (1-10 m/day).