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Spodumene $^{40}Ar/^{39}Ar$ geochronology for a cleaner future

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To meet the increasing demand for lithium-ion battery manufacturing resulting from renewable energy sources battery based storage systems, the importance of improved efficiencies in exploration, mineral beneficiation and processing techniques, for elements such as lithium, is paramount.

The $^{40}Ar/^{39}Ar$ technique on pyroxene minerals has been shown to be viable for obtaining geologically meaningful crystallization ages for mafic igneous samples [1]. The Li-pyroxene spodumene, $LiAlSi_2O_6$, is considered to be the most important ore of lithium. Preliminary $^{40}Ar/^{39}Ar$ geochronology data for spodumene from the Mount Cattlin mine in Western Australia did not yield a plateau age but suggest an approximate age around 1.17 Ga. More importantly, the results display a high radiogenic argon component, which indicates a strong potential for high quality $^{40}Ar/^{39}Ar$ geochronology results.

A suite of spodumene samples from the main Li pegmatite deposits in Western Australia is being analysed to verify the ability to date spodumene mineralization directly. Spodumene from these deposits has undergone detailed physico-chemical characterization including: (Q)XRD, SEM-based mineral mapping, EPMA, LA-ICP-MS, thermal analysis, Raman spectroscopy and LIBS. This extremely well characterized sample set will enable geochronological data to be related directly to the petrography disclosing exactly what the isotopic dates represent in a geological context (i.e. primary or alteration age of pyroxene or a different K-rich phase, such as orthoclase, mica, fluid or melt inclusions). Regardless, on a micro-scale the obtained dates will constrain the Li mineralizing system by establishing either the crystallization age of spodumene or the age of alteration and fluid flow through the system.

Critical to this research is that industries such as electric car manufacturers are looking to impose strict compliance conditions on the entire lithium battery production and supply chain. Therefore, we aim to determine if $^{40}Ar/^{39}Ar$ analysis of spodumene, prior to the processing phase, has potential to fingerprint ore samples to certify that they represent ethically sourced battery material from Australia.