Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.38235

Hydrothermal calcite constrains timing and temperature of Li-clay mineralization at Thacker Pass

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The Thacker Pass volcano-sedimentary deposit within the McDermitt Caldera, Southeast Oregon and Northwest Nevada, is one of the world's largest Lithium (Li) deposits. While Li-smectite clays can be found in the lacustrine sediments throughout the caldera, a ~ 40m thick lens of Li-illite is responsible for making Thacker Pass so uniquely endowed in Li. The origins of the Li-illite have been debated because illitization can occur over a range of temperatures and conditions. We analyzed diagenetic minerals, calcite and fluorite, within the Thacker Pass deposit to understand how the process of Li enrichment developed. Authigenic calcite grew displacively within the clay sediments and formed at elevated temperatures >100°C based on carbonate clumped isotopes. The authigenic calcites are sector zoned, with appreciable concentrations of rare earth elements (REEs) and thorium (Th) partitioned in the same crystal face. Such high concentrations of these traditionally immobile elements could be facilitated by significant fluorine (F) concentrations within the precipitating fluid. F has also been shown to play a key role in the alteration of smectite to Li-illite. Oxygen isotopes of the illite and calcites also suggest they are derived from the same fluid at elevated temperatures. U-Pb dating of these calcites yielded an age of 16.23 ± 0.17 Ma, during resurgent doming of the caldera's magma chamber. Therefore, the hydrothermal system which precipitated these authigenic calcites was the same fluid which altered the smectite clays to Li enriched illites during magmatic resurgence making Thacker Pass the most endowed volcano-sedimentary Li deposit in the world.