

Distribution, Mineralogy, and Formation Conditions of Lithium-Rich Clays in the Salar de Pastos Grandes, Argentina

Owen McCaffrey¹, Kristina Butler¹, Tom Benson^{2,3}, Dan Ibarra⁴, Gordon Williams⁵, David Boutt⁶, Frost Gwyn-Hutchinson¹, LeeAnn Munk^{7,8}

¹Department of Sustainable Earth Systems Sciences, The University of Texas at Dallas, Dallas, United States,

²Lithium Argentina AG, Zug, Switzerland, ³Lamont-Doherty Earth Observatory, Columbia University, Palisades, United States, ⁴Department of Earth, Environmental, and Planetary Sciences, Brown University, Providence, United States, ⁵Division of Earth and Climate Sciences, Nicholas School of the Environment, Duke University, Durham, United States, ⁶Department of Earth, Geographic, and Climate Sciences, University of Massachusetts-Amherst, Amherst, United States, ⁷Geophysical Institute, University of Alaska Fairbanks, Fairbanks, United States, ⁸Department of Geosciences, University of Alaska Fairbanks, Fairbanks, United States

Clay minerals are increasingly recognized as important components of closed-basin brine systems and volcano-sedimentary lithium (Li) deposits. Although the Lithium Triangle region of the Central Andes contains approximately half of global Li reserves and several economic borate deposits, its Li-rich siliciclastic component remains poorly constrained. To address this gap, this study characterizes the distribution, mineralogy, and formation conditions of Li-rich clays in Neogene basin-fill sediments in the Salar de Pastos Grandes, Argentina. This basin hosts Li and B rich paleolake sediments that are stratigraphically associated with an economic-grade Li brine and borate deposit.

We analyzed the ore succession of altered tuffs, claystones, and associated evaporitic facies using bulk and clay-fraction X-ray diffraction, SEM-EDS, bulk geochemistry, and stable isotope analysis of clay separates. Lithium concentrations range from 73.8 to 1,650 ppm, with the highest values concentrated in central lacustrine claystone intervals. Two Li-rich clay assemblages defined by distinct formation pathways are identified, with Li hosted in montmorillonite in altered tuff beds and in hectorite within claystone layers. Calculated clay formation temperatures indicate low-temperature lacustrine to early diagenetic formation conditions and a lack of direct hydrothermal interaction.

This study includes detailed characterization of the most Li-rich clays documented in the Lithium Triangle to date. Several characteristics distinguish the Pastos Grandes system from many Li-clay systems globally, including the presence of Li-montmorillonite, low-temperature formation and absence of illite Li hosts. Building on these results, we present an updated model for Li-clay formation progression in volcanic closed-basin lake settings. This work provides a foundation for evaluating brine-clay interaction and refining Li cycling models across the Lithium Triangle and Li deposits globally.