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Lithium in volcano-sedimentary deposits: Contents and characterization by the Tessier method of sequential extraction

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Global lithium demand is projected to increase twofold by 2040, driven primarily by the rise of electric vehicles and other renewable energy technologies. Existing hard rock and brine sources are unlikely to meet all this demand, making the development of alternative sources such as lithium-rich volcano-sedimentary deposits necessary. Determining whether a site is appropriate for development depends on the financial and environmental costs of extraction, which requires a detailed understanding of the mineralogical and geochemical characteristics of the host deposit. This study compares lithium concentrations and modes of occurrence in 11 samples of volcano-sedimentary deposits from four sites in the western United States. Three sites are classified as tectonic lithium basins, and one is characterized as a caldera-hosted basin. Mineralogical analyses were conducted using scanning electron microscopy (SEM) and powder X-ray diffraction (XRD), and total lithium content was determined by $HNO_3/H_2O_2/HF$ digestion and Li concentration measurement by ICP-MS. Lithium leachability was assessed using the Tessier sequential extraction method. Smectite crystallite size was estimated from XRD patterns using the Scherrer equation. We found that total lithium concentrations ranged from 400 to 2,600 mg/kg, with the residual (non-leachable) fraction comprising 42% to 97% of the total. While no correlation was found between total lithium content and the proportion in the residual fraction, both total lithium and residual lithium concentrations were positively correlated with smectite crystallite size, with the largest crystallites containing, and retaining, the most lithium. Our results show that a better understanding of the sample mineralogy, crystallite size, and leaching characteristics could improve the feasibility assessment of a potential volcano-sedimentary deposit and lead to cleaner, lower-cost extraction methods.