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Traceability of lithium raw material - A new application for trace element chemistry in lithium minerals?

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The traceability of critical raw materials along supply chains can only be achieved using mineralogical-geochemical data in order to determine the source of raw materials between producers, suppliers and consumers. In the upstream part of the lithium supply chain between the mine and lithium converters, mineral raw materials that contain economically relevant, lithium-rich minerals such as spodumene, petalite or lepidolite are particularly important.

The occurrences and deposits of these minerals are globally widespread and are linked to pegmatites or granite-associated greisen, with a mineral processing plant commonly close to the mine. In contrast, mineral concentrates are shipped over long distances for the conversion into lithium monohydroxide or lithium carbonate. As the Environmental-Social-Governance criteria, sustainability concerns and the diversification of supply chains gain in importance, fingerprinting will be required as proof of origin for lithium. To achieve this, the development and curation of a geochemical database is essential. In this study, a selection of global pegmatites and spodumene mineral concentrates from various origins and suppliers were analysed to provide proof of origin for lithium minerals.

We analysed whole rocks and mineral concentrates for trace elements and individual minerals for major and trace elements using solution ICP-MS, electron microprobe and laser ablation ICP-MS methods. The results show that spodumene, petalite and various lithium micas have systematically different contents of trace elements. Distinctions between different pegmatite provinces were successfully made using trace element data (e.g. bivariate trends of Ga and Fe in spodumene) but also based on the mineralogy of the concentrates. The occurrence, the type, the composition and the amount of accessory minerals, in particular feldspar and garnet, can provide differentiation possibilities.

Lithium isotopes also show potential to be used for proof of origin [1]. In our dataset, we found differences of up to 12 ‰ between spodumene concentrates of different origins. The combination of lithium contents and isotopic compositions provide additional constraints regarding the origin of spodumene concentrates.

[1] Desaulty, Climent, Lefebvre, Cristiano-Tassi, Peralta, Perret, Urban & Guerrot (2022) Nature communications 13 (1), 4172