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Traceability of natural graphite based on mineral impurities

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Graphite is a fundamental raw material in energy storage and is officially classified both as a critical and strategic raw material (CRM and SRM). In the European Union, ambitious goals have been set (i.e. Critical Raw Materials Act) with respect to the responsible sourcing of CRMs. Among others, at least 10% of each of these materials should stem from the EU by 2030. This can only be achieved, if the deposits can be reliably distinguished. However, there is currently no method available to differentiate between graphite sources.

In this study, we investigated 35 traded graphite concentrates from the most important graphite producers worldwide and developed a protocol for distinguishing them.

1. First, the particle size distribution of the graphite concentrates was determined by the laser diffraction method in a water–isopropanol mixture (Malvern Mastersizer 3000™).
2. Mineral impurities and graphite-silicate intergrowths were extracted by density separation via sodium polytungstate solution (=2.46 g/cm^3) and embedded into epoxy to facilitate further measurements.
3. A SEM-EDX-based particle analysis system (Carl Zeiss SmartPI™) was used for mapping, general phase recognition and morphological characterization of the mineral impurities.
4. The phase determination was carried out based on the SEM-EDX maps, where each phase was cross-checked via Raman spectroscopy.
5. A database of the impurities was established for automatic phase identification, which is used to identify several hundred of mineral grains per concentrate.

Impurities identified by the above-described protocol show distinct differences between individual graphite deposits. The relative abundance of minerals reflects the natural signature of the host rocks and also the processing habits (e.g. sieving, grinding and chemical treatment) applied at each mine/processing plant. The combination of these features contributes to a definite fingerprint of each deposit, thereby providing a promising approach for graphite traceability.

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