TOWARDS AN ANALYTICAL PROOF OF ORIGIN FOR NATURAL GRAPHITE DEPOSITS

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Raw material supply chains are complex systems. They build on the presence of economically mineable mineral commodities that will undergo several steps until they are finally being used as consumer products. Trustworthiness into the transparency of a supply chain is of increasing importance, both to upstream and downstream companies. Any deviation from best-practice and quality standards in mining, processing and production is critically looked by consumers, especially nowadays. Therefore, certification and proof of origin concepts have emerged within the past years, aiming at providing transparency to supply chains (MELCHER et al., 2021).
30 raw materials have been classified as critical by the EU; some of which are particularly relevant for the Green Deal and the digital transformation, including graphite. The classification as a critical raw material is based on the assessment of whether longer interruptions or shortages in supply could have a negative impact on technological progress and economic growth.
In addition to the well-known use of (microcrystalline) graphite in pencils, another very important and currently highly sought-after application of large flake graphite in the electronic industry is in lithium ion batteries and fuel cells. The demand is constantly increasing.
POHL (2020) distinguishes four major deposit types, namely regional metamorphic graphite formed from coal or hydrocarbons; contact-metamorphic graphite formed from sedimentary rock; hydrothermal graphite as a product of magmatic, hydrothermal or volcanogenic processes; and supergene residual deposits. Large-flake graphite can be extracted at a minimum of 3–5 % graphite in rock, whereas fine-grained or microcrystalline graphite ore requires grades >45 %.
The increasing demand for this raw material and the limited market with a small number of players is also accompanied by concerns from industry and consumers about the origin of this raw material. Therefore, different graphite deposits distributed worldwide are included in the present study. The analysis of fingerprints for graphite is favourable in order to check and differentiate between different origins, in particular from African countries (Mozambique, Madagascar, and Zimbabwe), but also from Korea, China and others. Graphites offer several options for an analytical proof of origin, for example the determination of trace elements using ICP-MS and LA-ICP-MS, the $\delta^{13}C$ isotope ratio by MC-ICP-MS or gas mass spectrometry. Another useful parameter is the degree of graphitization, which is analysed by Raman spectroscopy. Also textural information, such as morphology and grain size, which is assessed by microscopy and scanning electron microscopy are useful parameters for the application of fingerprinting techniques.

MELCHER, F., DIETRICH, V., GÄBLER, H.-E. (2021): Minerals, 11, 461, 1-16.
POHL, W., (2020): Economic Geology: Principles and Practice, 2nd revised edition, Schweizerbart´sche Verlagsbuchhandlung, Stuttgart, Germany.