

Resources for circular economy - understanding vanadium enrichment and carriers in metalliferous black shales

Summary

The PhD project will be carried out under a research grant from the Estonian national research program for the valorization of resources, starting in 2020. Vanadium is regarded as a critical battery metal for a low-carbon circular economy. Polymetallic black shales are a potential low-grade high-tonnage future source for vanadium but remain largely unexploited today due to the geochemical complexity of fine-grained organic-rich deposits. The complexity lies in the heterogeneous and disseminated nature of mineralization in such ores and in the shortcomings related to an understanding of metal trapping pathways and interactions between different organic and inorganic compounds. The proposed PhD project will focus on gaining more thorough insights into vanadium distribution across Cambrian to Lower Ordovician metalliferous black shales from the Baltic Paleobasin. The project's goal is to characterize the forms and ways of vanadium enrichment, trapping, and retention by mineral and/or organic matter. The research outcomes of the project will form the basis for further geochemical modeling of the considered system, help to advance resource models of polymetallic black shales, and tailor more efficient recovery technologies for such resources. The project will be based on combined geochemical and mineralogical research, as well as leaching and demineralization experiments, and involves both fieldwork and laboratory studies in Estonia as well as abroad.

Research field:	Physical Sciences
Supervisor:	Rutt Hints
Availability:	This position is available.
Offered by:	School of Science Department of Geology
Application deadline:	Applications are accepted between November 16, 2020 00:00 and December 16, 2020 23:59 (Europe/Zurich)

Description

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Polymetallic black shales are complex resources, which could show enrichment in the number of heavy and rare metals, including vanadium. In black shales, enriched metals dominantly occur via disseminated sulfidic minerals or via different organic-metal complexes. In the case of vanadium, the development of metal porphyrins and isomorphic substitution of vanadium to the crystal structure of clay minerals have been suggested as the main pathways for metal trapping. However, until now, technological limitations and inadequate breaching between the studies focused on inorganic and organic compounds have hindered the development of a more sound understanding of vanadium behavior through syngenetic enrichment in oxygen-deprived paleomuds to diagenetic maturation processes of organic-rich deposits.

The objective of the PhD project is to investigate vanadium distribution in thermally immature black shales of the Baltic Paleobasin in order to understand factors and pathways, which controlled the development of vanadium enrichment and preservation. The secondary objective is to gain deeper insights into vanadium carriers in the considered black shales, including the possible influence of diagenetic changes and the formation of authigenic phases to vanadium retention.

The project involves collaboration with the Laboratory of Inorganic Materials (TalTech), the Estonian Geological Survey, and the Department of Geology, University of Tartu.

Responsibilities and tasks

The position is for a fixed-term period of 4 years, studying with full-load.

The specific task will include:

- Collecting samples and conducting in-situ measurements with μ XRF from drill cores and outcrops
- Performing SEM observations and microanalyses with SEM-EDS, conducting ICP-MS analyses
- Participating in the design and conducting laboratory experiments on black shale leaching and demineralization
- Comparing and integrating collected and multidisciplinary data from other sources (XRF, XRD, organic geochemistry, stable isotope geochemistry), performing statistical analysis of the datasets

- Reconstructing vanadium enrichment pathways and interpreting vanadium carriers in black shales

General responsibilities

- Managing and carrying out the research project
- Attending PhD courses
- Writing 3 scientific articles and the PhD thesis
- Disseminating the research results of the project
- Participating in teaching and undergraduate supervision

The laboratory analyses and experiments will be conducted mostly at TalTech Department of Geology. The PhD student will visit an external research institution for a few months (GFZ German Research Centre for Geosciences or another partner institution).

The doctoral student will get doctoral allowance paid by the government and regular scholarship fixed by TalTech. Extra funding might be provided for the PhD student based on the progress of study and research.

Qualifications

A MSc Degree in Earth Sciences or related discipline (e.g., mineral processing, environmental engineering, chemical engineering, or material science)

Specific requirements for candidate:

- Highly motivated in pursuing applied research in geochemistry and economic geology
- Basic knowledge in the areas of geochemistry and mineralogy and interest in analytical techniques (ICP-MS, SEM-EDS)
- Relevant experience in laboratory experimental or analytical studies in geochemistry or in associated disciplinary fields
- Readiness to work on multidisciplinary research problems, good communication skills, using personal initiative for problem-solving



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