

# EXPLORATION INFORMATION SYSTEM: COMBINING MINERAL SYSTEMS MODELLING WITH MINERAL PROSPECTIVITY MODELLING

by

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The project “Exploration Information System” (EIS) is a European Union (EU)-funded research and innovation initiative aiming to combine mineral systems modelling with mineral prospectivity analysis methods aimed at finding new sources for critical domestic primary raw materials within the EU. With the emerging exploration data, the need for efficient data analysis has become essential. The data are expensive and there is a need to get the most out of them. Recent advances in the use of artificial intelligence, including various machine learning algorithms within GIS platforms, have made it possible to combine geological knowledge and exploration data in complex mathematical models that can be used to make predictions about the existence of new mineral occurrences.

## INTRODUCTION

The European project “Exploration Information System” (EIS) is operated by a consortium consisting of 17 partners from leading research institutes (4), academia (5), service providers (4) and the mining industry (4). The consortium member organizations come from six European Union (EU) member states (Finland, France, Germany, Spain, the Czech Republic and Sweden) and South Africa. One associate member of the consortium comes from Brazil. The project has received funding from the Horizon Europe research and innovation funding programme of the EU under Grant Agreement no. 101057357. The main objective of the EIS project is to develop innovative exploration concepts and data analysis tools to enhance the probability of finding new sources of critical raw materials for the EU's economy.

The rapid deployment of clean energy technologies as part of the energy transition implies a significant increase in demand for minerals. Global demand by the automotive industry for raw materials is likely to continue and is predicted to grow 5 to 10 times the current demand, due to increasing request from the EV sector (IEA 2021). This is a great motivation for developing new methods to find new sources of critical domestic primary raw materials within the EU.

## TARGET AREAS

This consortium represents the main metal producing regions of Europe, including the Fennoscandian Shield and the Iberian and Central European Belts (Fig. 1).

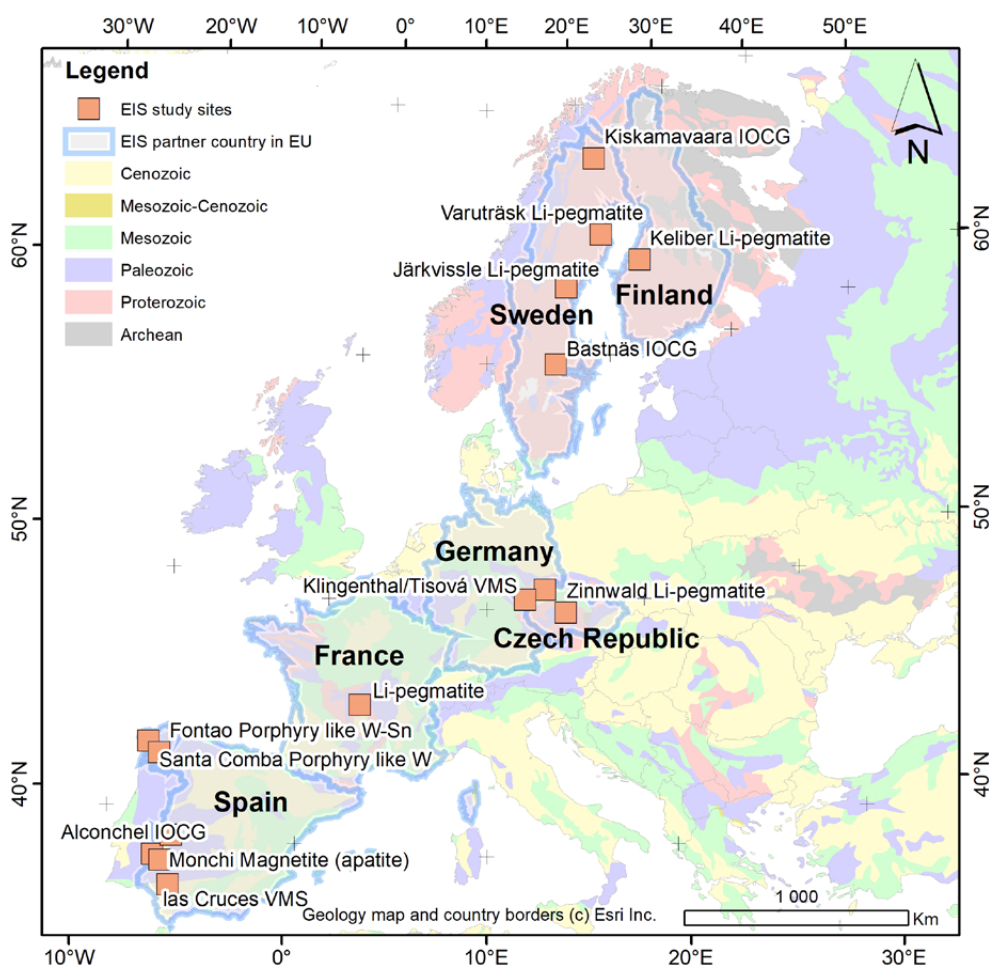


Fig. 1. EIS project study sites. Project partner countries within the EU are Finland, Sweden, Germany, the Czech Republic, France and Spain. Outside the EU, the project has two partner countries, South Africa and Brazil (associate partner).

The economically most important metallogenic belts of the EU show diverse geological contexts with evident potential for various mineral resources. The mineral deposits in the belts are the most feasible sources of critical, high-tech, and other economically important metals in the EU. In the EIS project, we are promoting the utilization of a hybrid approach using mineral systems modelling as a basis for mineral prospectivity modelling (Fig. 2).

## MINERAL SYSTEMS

A critical part of EIS is a library of geological fingerprints of diverse types of mineral systems. These fingerprints are used for choosing the most relevant mappable geoscientific features which are essential for successful prospectivity analysis. In this project, we are using selected mineral deposits as study sites or test sites, and we have three different mineral systems as a case study in the project:

1. Cobalt minerals in VMS systems.
2. Lithium–tin–tantalum–tungsten minerals in granite/pegmatite-related systems.
3. Rare earths–cobalt minerals in IOCG systems.

The study and test sites are situated within the partner countries shown in Figure 1. Furthermore, the project has reference sites in South Africa and Brazil. These reference sites are Li-bearing pegmatites situated in the 450-km-long Orange River Pegmatite Belt in South Africa and the world class Carajás IOCG province in Brazil.

This project will increase access to critical raw materials in Europe by providing new information on critical mineral systems and new efficient data-analyst tools leading to an extension of the knowledge of existing deposits in Europe. The development of the new digital exploration tools will lead to faster new discoveries of mineral deposits (Li, W, Ta, Co and REE) within the EU.

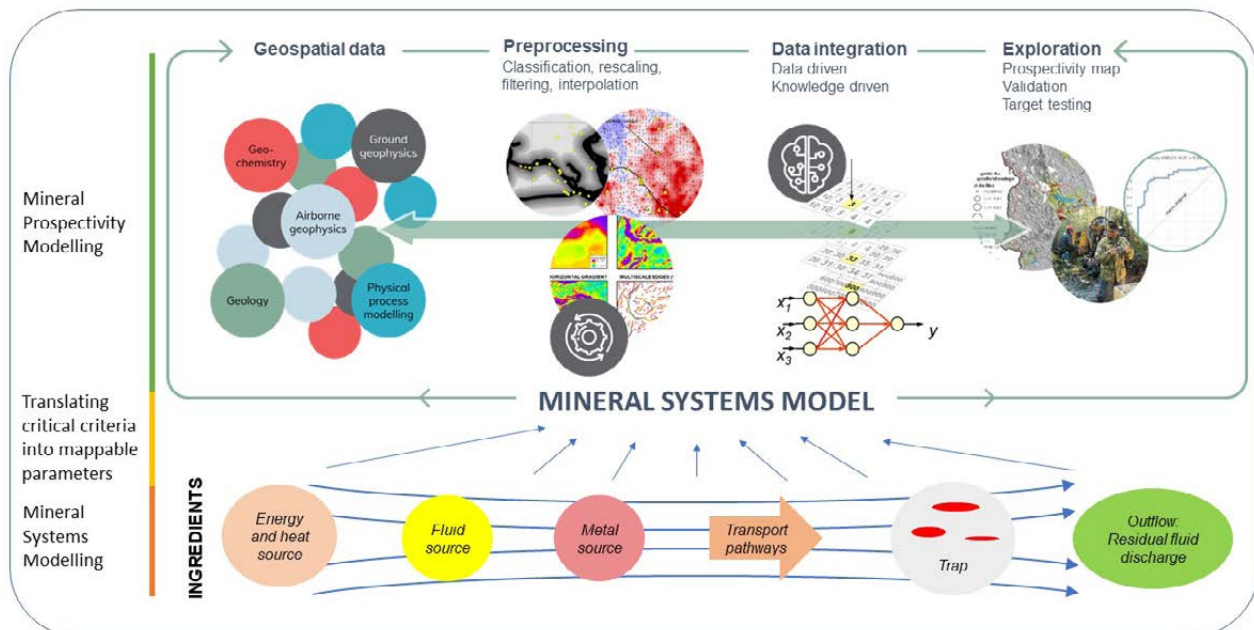


Fig. 2. Exploration Information System (EIS) combines mineral systems models (Knox-Robinson & Wyborn 1997) and mineral prospectivity modelling (Bonham-Carter 1994).

## EIS METHODOLOGY

The ideal exploration information system consists of components for different steps of prospectivity analysis (Fig. 2). In the data pre-processing step, data are transformed to represent proxies for critical parameters of the mineral systems. Pre-processed data are then used as input to predictive modelling or other data analysis methods. In the final step of prospectivity analysis, model validation is performed to test how well the modelling and prospectivity mapping have performed. The EIS project will develop new data analysis methods by applying artificial intelligence, machine learning and deep learning in mineral prospectivity mapping together with new geo-models and mineral systems modelling (Yousefi et al. 2019, 2021). The methods developed will reduce the current high exploration costs and improve the accuracy of targeting in early phase exploration. This will make mineral exploration responsible in terms of energy efficiency and minimizing the footprint of mineral exploration in nature, as the aim is to make the most of the already existing exploration data. The project will apply UNFC code to harmonize the diverse population of mineral deposits and occurrences that will be used as training sites and validation data sets in prospectivity mapping for critical raw materials within the EU. In addition, tools will be tested for critical secondary raw materials prospectivity. The project will also raise the awareness of the general public about the importance of critical raw materials to the EU's economy and welfare.

After the completion of this project, the EIS will be a collection of software tools for semi-automated exploration targeting. Building all these components as modules in an open-source community-based platform will allow for contributions from numerous developers globally, outside the project consortium, boosting the development and maintenance of the product.

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