NEWSLETTER NO. 2 H2GEO

Information about new products of the H2GEO project

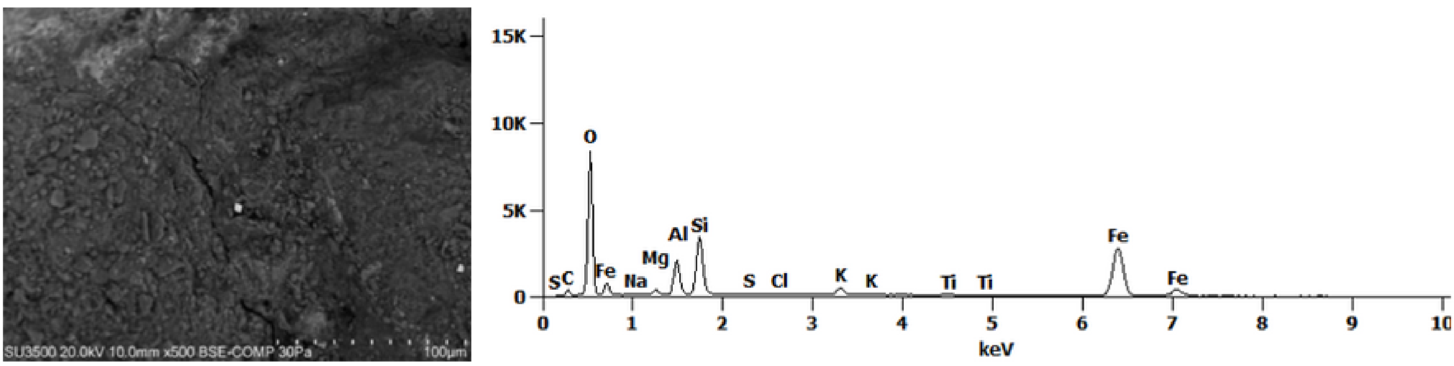
In March 2025, we published two Deliverables of the project: D3.2 and D3.3. The first was delivered by GIG, and the second by ITPE.

Deliverable D3.2 “Physicochemical analyses and mechanical property tests of the separation products”

As part of Task 3.2 (“Testing the physicochemical properties of mine waste”), key physicochemical and mechanical parameters of the coal-bearing and mineral fractions of selected mining waste from three heaps were determined, which can significantly affect the quality of the products obtained and the possibility of their use. The coal-bearing and mineral fractions were obtained through density-based separation of the waste samples on a laboratory jig stand. The results of the conducted work have been included in D3.2 "Physicochemical analyses and mechanical property tests of the separation products."

Technical and elemental analyses of mining waste samples were carried out, the ash composition was analyzed, and the characteristic melting points for ash were determined. Analysis of trace elements classified as "critical" to the global economy was carried out, which are considered crucial to the development of new technologies and whose deficiency could have a tragic impact on world economies. Density and sieve analysis of mine waste samples regarding the share of a combustible substance were performed. Microscopic evaluation using polarizing microscope of the landfill material was conducted to determine the deterioration of organic matter and to assist in the selection of materials.

a)



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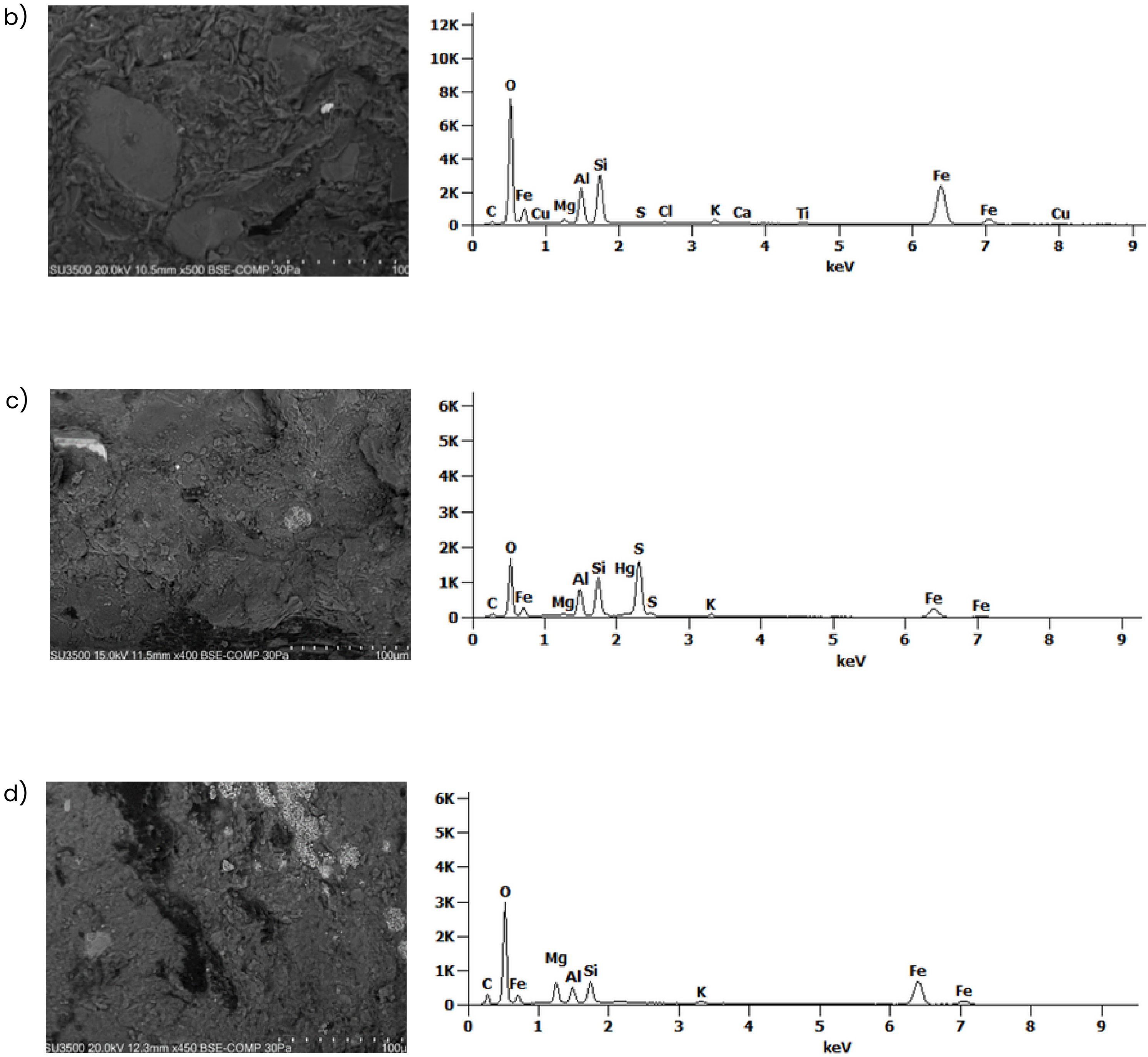

Fig. Morphology of the sample and chemical composition SEM EDS of the samples:
a) H1/m, b) H2/m, c) H/m, and d) K2/m

The samples were also analyzed using a scanning electron microscope (SEM-EDS) to determine the porosity and structure of the material. Mechanical properties (resistance to fragmentation, abrasion resistance, absorbability, frost resistance) were tested to determine the quality of the aggregate and its suitability for specific applications. The properties of mine deposits were also analyzed in terms of TGA technique.

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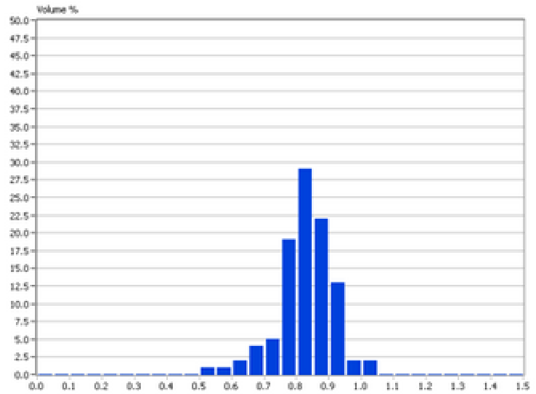
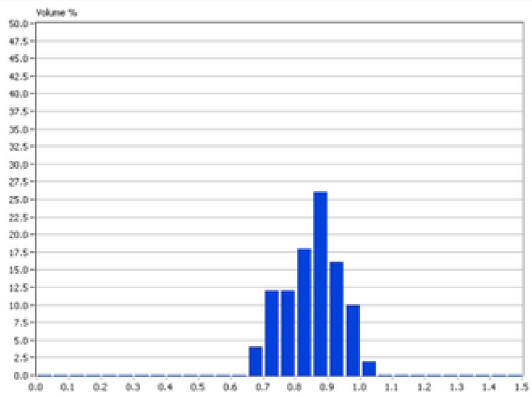
Sample	VR_0 [%]
Haldex 1	*0,83*



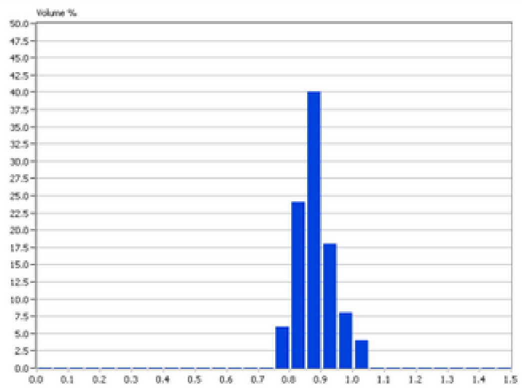
Based on the physico-chemical analyses carried out, a carbon-bearing fraction was selected for testing the gasification process. The material selected was from the Panwenicka heap - HALDEX. It was characterised by the highest calorific value (c.a. 26 MJ/kg), high content of carbon, hydrogen and volatile content. In the case of the mineral fraction, analyses showed that it is also suitable for the geopolymerisation process - it has the correct Na_2O/Al_2O_3 molar ratio.

The high levels of silicon and aluminium in all the mineral fraction samples tested indicate the potential for the waste to be used in the production of high value added geopolymeric materials. The characteristic ash fusion temperatures of the samples tested, both for the carbon-bearing product and mineral fractions, exceed 1200°C, which allows us to conclude that agglomeration and slagging problems will not occur when roasting these fractions in the fluidised bed reactor.

Sample	VR_0 [%]
Haldex 2	*0,85*



Sample	VR_0 [%]
Karvina 2	*0,88*



Microscopic morphological analysis of the enriched mining waste samples did not reveal any visible changes indicating that the organic matter contained in the waste had undergone any thermal or chemical transformations. The laboratory tests carried out also provide the input data for the development of a mine waste beneficiation system.

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Deliverable D3.3 “Analysis of possibilities of using selected fractions from mine wastes for recovery of rare trace elements and power production”

In March, another product of the H2GEO project was delivered: "Analysis of possibilities of using selected fractions from mine wastes for recovery of rare trace elements and power production”. Deliverable 3.3, prepared by ITPE, includes an assessment of the potential for utilizing selected fractions of mining waste for the recovery of rare trace elements and power production.

The study analyses the possibilities of recovering rare elements and other critical metals from mine waste dumps. Key elements identified include lithium (Li), nickel (Ni), gallium (Ga), scandium (Sc), and cobalt (Co), with lithium showing the highest concentrations. Given the growing global demand for these resources, their extraction from mining waste presents a promising opportunity. Magnetic separation has proven effective in increasing trace element concentration, enhancing recovery efficiency. The research also examines the industrial applications of recovered elements. While Zn, Cr, Ni, and Cu are widely used in metallurgy and electronics, toxic elements such as Pb, Cd, and As require careful monitoring.

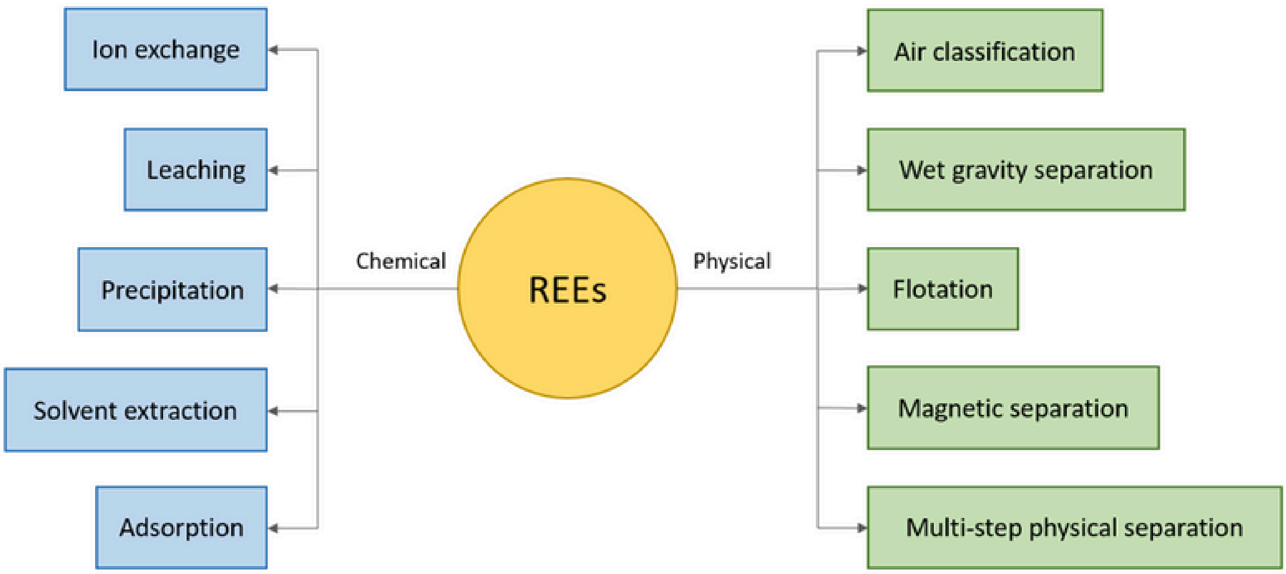

Fig. The purification of REEs is done through physical and chemical methods

REEs are crucial for high-tech industries, including electronics and nuclear energy. Both physical (e.g., flotation, magnetic separation) and chemical (e.g., leaching, solvent extraction) methods have been evaluated, with adsorption emerging as a promising technique due to its efficiency and simplicity.

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The mineral fraction of mine waste shows significant potential for construction, road infrastructure, and environmental applications. Its high SiO_2 (56.97–58.69%) and Al_2O_3 (22.12–25.20%) content makes it suitable for cement, concrete, geopolymers, ceramics, and insulation materials. The high melting point (>1200°C) prevents agglomeration issues in fluidized bed reactors, while the presence of Fe_2O_3 affects cement hydration and coloration. Low SO_3 content (0.15%) ensures durability in cement applications. The material's composition also supports its use in lightweight aggregates, refractory materials, and sorbents for wastewater treatment. In terms of energy applications, the coal bearing fraction of mine waste exhibits properties suitable for both direct combustion and gasification. Samples from the Panewnicka dump show a high calorific value (~26 MJ/kg), low moisture (~1.5%), and moderate ash content (~20%), making them compatible with various combustion technologies. However, sulfur (~0.7%) and ash fusion temperatures (1210–1360°C) must be managed to comply with environmental regulations. Gasification offers an alternative, producing syngas for energy and chemical industries, but requires advanced gas-cleaning technologies due to sulfur (~0.72–0.77%) and chlorine (~0.081%) content.

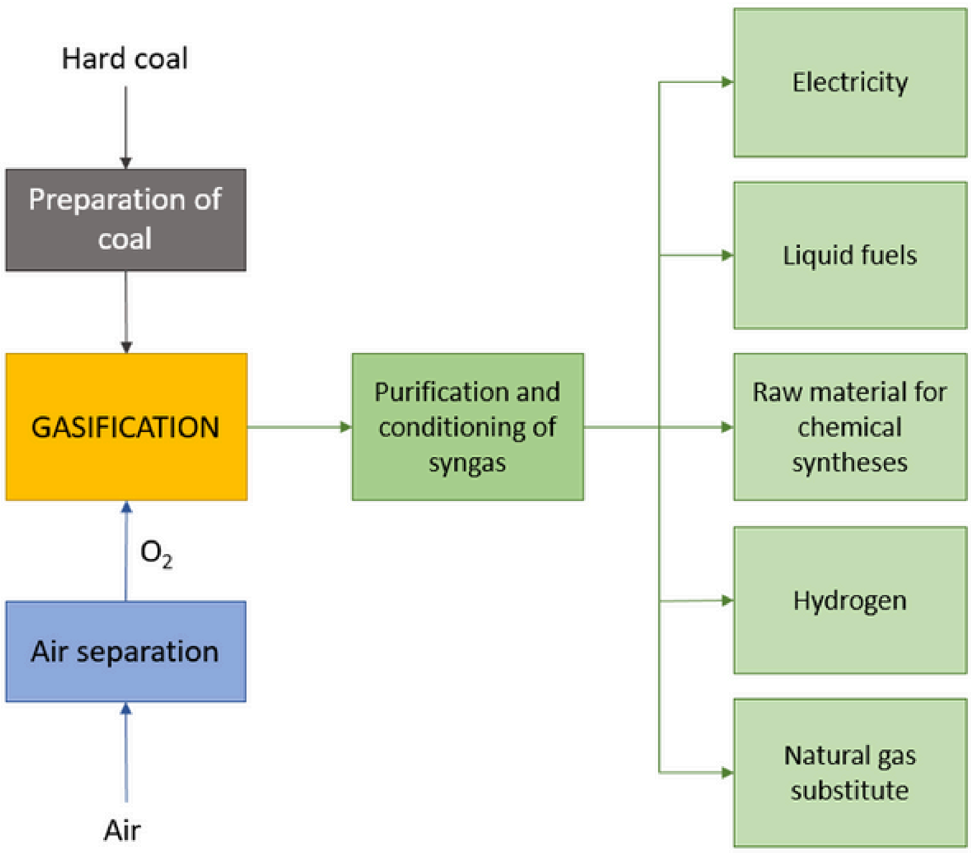

Fig. General coal gasification diagram

Overall, mine waste fractions can be utilized for raw material recovery, energy production, and construction applications. Future research should focus on optimizing separation and extraction methods to ensure economic feasibility and sustainable resource utilization.

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