

Mining the Technosphere

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Over the last five decades, the global extraction of virgin materials has more than tripled, from 26.7 billion tonnes in 1970, to more than 106.1 billion tonnes in 2021. At the end-of-life, only 6.9% was redirected into a new life cycle by recycling. On top of that Europe also suffers from a lack of critical and non-critical raw materials (1, 2). Economy of the EU is already in a phase of transition from linear to circular, where the materials are maintained in the economy as long as possible, and waste generation is reduced.

Disposed waste, created as a result of human activities (called the technosphere), has been already recognized as deposits of secondary and critical raw materials (3). Mining the technosphere to valorise and exploit these resources is carried out by similar mining practices as in the processes of conventional mining the ore deposits in the lithosphere, including (i) exploration, (ii) exploitation, (iii) extraction, (iv) development of low-carbon construction products, (v) life-cycle and techno-economic analysis, and (vi) environmental risk analysis related to mitigation of potential negative impacts in all phases.

For the first time in Slovenia a comprehensive research on this topic is currently going on, based on field and laboratory activities, in the case of two landfills, i.e. the metallurgical landfill Vrhe (steel and foundry slags, foundry sand and metallurgical dusts) and the municipal landfill Gajke (residual plastic and organic/mineral part). The aim is to develop and validate feasible solutions for landfill mining practices and to prove that the mining processes can be performed safely and efficiently, with significantly lower environmental footprint compared to conventional lithosphere mining.

Such solutions are also intended to rehabilitate waste disposal sites and thus improve the state of the environment as well as provide a versatile source of materials for application in construction sector (aggregates for asphalt, concrete and materials for earthworks). The preliminary research results will be presented in the paper.

1. Circle Economy, **2025**: The Circularity Gap Report 2025, pp. 1-143, Amsterdam: Circle Economy.
2. Critical Raw Materials Resilience, **2020**: Charting a Path towards greater Security and Sustainability COM(2020), 474 final.
3. Johansson, N., Krook, J., Eklund, M., Berglund, B., An integrated review of concepts and initiatives for mining the technosphere: towards a new taxonomy, *J. Clean. Prod.*, **2013**, 55, 35-44.