minerals

Editorial

Editorial for the Special Issue "Sustainable Mining as the Key for the Ecological Transition: Current Trends and Future Perspectives"

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A crucial aspect in the pursuit of sustainable development is the necessary shift toward an "ecological transition", a transformation in societal paradigms to align human activities with the global ecosystem. This change stems from the urgent need to tackle challenges such as climate change and growing social disparities.

A key component of the ecological transition involves moving away from fossil-fuel-dominated energy production to renewable and less environmentally harmful sources like solar, wind, and geothermal energy. However, this shift to alternative energy sources increases the demand for minerals, surpassing historical needs associated with fossil fuel energy generation. This includes essential materials such as iron, aluminum, and copper, which are necessary for any kind of engine (from wind turbines to electric motors), as well as scarce metals like lithium, cobalt, and rare earth elements (REE) used in technological devices, batteries, solar panels, magnets, etc.

Paradoxically, the ecological transition intensifies our reliance on mining, which is historically linked to environmental and societal issues. Addressing these challenges falls under the concept of "Sustainable Mining," requiring diverse expertise in geology and eco-friendly extraction, and an understanding of the long-term environmental impacts. It also involves waste recycling, improved reclamation planning, and strategies to minimize permanent effects on the mining areas and their surroundings.

In this Special Issue, we present a collection of papers addressing various facets of sustainable mining, spanning from the characterization of new resources to the assessment of the environmental impact of dismissed mines, as well as the development of new solutions aimed at the reuse of wastes, to offer an updated snapshot of the current state of the art and upcoming challenges.

The introductory paper by Richard Herrington provides a comprehensive overview of the impending needs and challenges for a low-carbon future. While recycling remains a priority, new mined resources will be indispensable until at least 2050 due to the escalating demand for metals in emerging technologies. This may involve re-evaluating old deposits, repurposing abandoned mining wastes, and exploring unconventional new deposits, all while adhering to environmental and social governance standards.

The work by Sedda et al. epitomizes the theme of this Special Issue by investigating a segment of the Montevecchio vein system located in Sardinia, Italy. This former mine district is recognized for its substantial production, exceeding 2 million metric tons of lead (Pb) and zinc (Zn) metals. The research integrates conventional resource characterization with an assessment of the environmental consequences and the prospective retrieval of crucial materials, including REE, from tailings, wastes, and biomineralization.

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Grieco et al. describe the formation of ophiolite-hosted magnesite deposits in Evia Island, Greece, where the magnesite ores are in close spatial association with chromite and olivine. As both magnesium (Mg) and chromium (Cr) are critical metals, the authors suggest their potential for an efficient combined exploitation.

Fornasaro et al. and Onnis et al. investigate the long-term environmental impacts of past mining activities. Fornasaro et al. show how tree rings in chestnut grown in the former mercury (Hg) district of Monte Amiata, Italy, clearly document the evolution of atmospheric Hg concentrations during Hg production, and after the cessation thereof in the district. A notable aspect behind this study is that Hg was, in the past century, a true "critical metal" due to its many applications. Onnis et al. investigate how fluvial geomorphology and soil geochemistry drive zinc and lead dispersion along a mine-impacted stream in Wales, UK. This study pinpoints the fluvial geomorphological zones (erosional, transport, and depositional areas) where metals were released and trapped across different streamflow conditions and identifies the phases with which the metals are associated.

Further papers explore the efficient handling of waste produced by mining and related industrial activities. Muedi et al. and Mogashane et al. present innovative methods for utilizing acid mine drainage (AMD) as a resource, while Fugazzotto et al. illustrate the transformation of waste material from the ceramic industry into precursors for building blocks/binders through an alkaline activation process.

In the context of ecological transition, coal and fossil fuels will gradually be phased out. However, they will remain in use for some time. The paper by Alexandrova et al. presents an optimized magnetic separation process for iron recovery from coal ash and slag. Lastly, Arunachellan et al. detail how used tires, a bulky waste, can be recycled into carbon-based nanostructures, with various applications including the remediation of copper-contaminated water, a common environmental issue associated with copper mining and processing.

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List of Contributions:

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