Sustainable Earth Resources Communications

Editorial

Advancing integrated and intelligent solutions for resource-energy-environment systems

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Received: July 14, 2025
Revised: August 20, 2025
Accepted: August 23, 2025
Published: August 24, 2025

Cited as:
Ma, D., Wu, J., Cai, X. Advancing integrated and intelligent solutions for resource-energy-environment systems. Sustainable Earth Resources Communications, 2025, 1(1): 1-3.
https://doi.org/10.46690/serc.2025.01.01

Abstract: Global energy transition and urbanization are driving unprecedented demand for mineral resources in terms of both scale and speed. However, conventional resource extraction models and linear economic paradigms remain major contributors to global greenhouse gas emissions, biodiversity loss, and environmental degradation. Addressing this contradiction requires a fundamental shift toward a new paradigm for Earth resource development centered on systemic, circular, and intelligent principles. In this context, *Sustainable Earth Resources Communications* is established to address a critical scientific gap: the absence of a platform dedicated to the integrated study of the resource-energy-environment nexus. By transcending traditional disciplinary boundaries, the journal aims to foster and advance innovations across the full range of earth resources. With a focus on three interconnected pillars: green mineral extraction, circular utilization of mine solid waste, and repurposing of mine geothermal resources, it seeks to advance the integration of Earth sciences, engineering, and sustainable development goals while providing scientific support for a global low-carbon future.

Keywords: Resource mining; mine waste recycling; geothermal energy development; sustainable engineering

1. Intelligent mineral resource development and lifecycle management

The strategic importance of mineral resources is undeniable, particularly for critical metals underpinning low-carbon technologies, whose demand is projected to grow exponentially over the next two decades (Ali et al., 2017). This journal advocates moving beyond end-of-pipe solutions by promoting green mining principles integrated throughout project lifecycles. This requires adopting digital twin technology from the exploration phase to create virtual mine models for dynamic simulation and optimization of mining processes, geohazards, and environmental impacts. During extraction, non-conventional techniques such as in-situ leaching and bioleaching significantly reduce surface disturbance, energy consumption, and tailings generation, representing key technological advancements. Furthermore, intelligent decision-support systems leveraging big data and artificial intelligence enable precise resource targeting, optimized mining plans, and security alerts, fundamentally enhancing resource recovery rates and operational efficiency. This journal will focus on cross-disciplinary applications of these frontier technologies to advance mining toward precision, transparency, and environmental sustainability.

2. Mine solid waste: From linear disposal to circular value chain reconstruction

Mine solid waste epitomizes the linear metabolism of resources, yet holds significant potential for a circular economy (Wu et al., 2025). Recognizing tailings and waste rock as "anthropogenic mineral deposits" or "urban mines" represents a paradigm shift toward sustainable resource management. A core mission of this journal is to advance the innovation and industrialization of high-value, functional applications for mine solid waste, including but not limited to:

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- Component cascade recovery: Advanced separation and extraction technologies to reclaim valuable elements, rare earths, and critical metals from tailings.
- Functional material conversion: Transforming solid waste into high-value products such as fine powders, ceramic raw materials, soil amendments, or environmental remediation agents.
- Engineering applications and carbon sequestration: Large-scale utilization of solid waste for goaf backfilling, road construction, and exploring its potential for mineral carbonation to sequester CO_2.

Germany's successful transformation of abandoned coal mines into pumped-storage hydropower stations compellingly demonstrates the strategic value of mine underground spaces. This journal welcomes research on the physicochemical properties of solid waste, resource recovery pathways, secondary environmental impact assessments, and related policy and economic incentives.

3. Mine geothermal energy: activating a clean energy engine for mining area transition

The underground networks and water systems formed after mine closure are not "waste sites," but natural infrastructure for developing low-to-medium temperature geothermal resources (Diego et al., 2018). Repurposing mine geothermal energy represents an innovative pathway toward energy self-sufficiency, industrial transformation, and socio-economic revitalization in mining regions. This journal will systematically report cutting-edge advancements in this field, with a key focus on:

- Mine water heat pump systems for district heating/cooling, significantly reducing carbon emissions;
- Compressed air or pumped hydro storage utilizing abandoned mines, coupled with renewables to enhance grid stability;
- Exploration of enhanced geothermal systems (EGS) technology in deep hot rock formations.

Economic viability is absolutely crucial for scaling these technologies. As demonstrated by the EU's GeoSmart project, which reduced geothermal drilling costs by 30% through data sharing, open scientific collaboration is essential. This journal aims to serve as a central hub for such knowledge exchange, driving innovation across the entire spectrum—from geothermal resource assessment and heat exchange optimization to commercializable business models.

4. Creating synergistic innovation ecosystems

The vision of *Sustainable Earth Resources Communications* is to serve as an interdisciplinary knowledge integration platform connecting geology, mining engineering, materials science, environmental science, chemical engineering, information technology, and social sciences. We firmly believe that addressing complex challenges in Earth resource sustainability requires cross-disciplinary collaboration and innovative thinking.

To this end, we have established an international editorial board comprising leading global experts, ensuring academic rigor and practical relevance. We particularly welcome research applying systematic methodologies such as life cycle assessment (LCA) and material flow analysis (MFA) to evaluate the environmental impacts of resource development, waste utilization, and geothermal projects. Studies exploring business models, policy frameworks, and community engagement are also strongly encouraged.

The sustainable management of Earth's resources represents a monumental undertaking in systems engineering that demands fundamental rethinking of traditional approaches. This paradigm shift requires us to reconceptualize mining operations as integrated "Resource-Energy-Environment" complexes where these three dimensions interact synergistically rather than being managed in isolation. Such transformation necessitates interdisciplinary collaboration across geology, engineering, environmental science, and social sciences to develop holistic solutions.

Sustainable Earth Resources Communications positions itself at the forefront of this transition by serving as both a chronicler of progress and an active catalyst for innovation. The journal will provide a platform for disseminating breakthrough research that bridges theoretical advances with practical applications. We are committed to facilitating the translation of knowledge into technologies that can be deployed globally, particularly focusing on circular economy models, digital transformation in mining, and clean energy integration.

Through international collaboration, we aim to foster dialogues that address the complex interplay between resource extraction, energy transition, and environmental stewardship. The journal will highlight case studies demonstrating successful integration of sustainable practices across the mining lifecycle—from exploration and extraction to closure and repurposing.

By advancing the scientific foundation for sustainable resource management, we contribute to the broader global agenda of achieving the UN sustainable development goals. Our ultimate vision is to help build a future where resource development not only meets human needs but also enhances environmental resilience and promotes social equity. We invite researchers, practitioners, and policymakers worldwide to join us in this critical endeavor to create a more resource-efficient, environmentally responsible, and socially inclusive world.

Funding

This research received no external funding.

Conflicts of Interest

The authors declare no conflict of interest.

Use of AI and AI-assisted Technologies

No AI tools were utilized for this paper

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