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Editorial

Environmental Geotechnics

Editorial

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Welcome to this issue of *Environmental Geotechnics*! I focus on emerging topics and challenges in environmental geotechnics, underscoring the vital role of geotechnical engineers in addressing increasingly complex environmental pressures through the development of innovative and sustainable solutions. The four papers presented in this issue exemplify this commitment to advancing the field. Each contributes a novel perspective on persistent and emerging challenges, with themes spanning from soil contamination to the utilisation of renewable energy.

Our journey begins with the critical issue of soil remediation. Wang *et al*. (2025) present an integrated approach for stabilising heavy metals – that is, cadmium and lead in soils, using soybean urease-induced carbonate precipitation in conjunction with various absorbent additives. Heavy metal contamination poses a significant threat to ecosystems and human health. The proposed approach can improve the sustainability as compared with the conventional bio-mediated method – that is, microorganism-induced carbonate precipitation, while enhancing the efficacy in heavy metal stabilisation through adding absorbent additives. The authors investigate the efficacy of porous silicon, coconut shell biochar, and sorbitol as enhancing agents. Their findings are particularly insightful, revealing that coconut shell biochar was most effective for immobilising cadmium, while sorbitol showed the greatest promise for lead. This research provides a valuable reference for the in situ stabilisation of heavy metal-contaminated sites, offering a promising sustainable soil stabilisation alternative.

The second paper addresses the fundamental challenge of predicting the thickness of water film on irregular granular soil particles, a key parameter influencing hydraulic conductivity, flow, and chemical transport. Existing models often rely on idealised geometries, failing to capture the complexity of natural granular materials. Guo (2025) proposes a new model based on Derjaguin–Landau–Verwey–Overbeek theory and the Kelvin equation, enabling the evaluation of the effects of solid surface curvature, relative humidity (RH), and temperature. The proposed model indicates that when RH > 95%, the film thickness increased rapidly with increasing RH, and when RH > 99%, surface curvature and temperature exhibited significant effects. This work enhances our fundamental understanding of water behaviour in the vadose zone and provides a more accurate tool for modelling flow and transport processes in unsaturated soils.

The third paper shifts our focus to sustainable infrastructure, investigating how varying groundwater levels impact the thermal performance of energy tunnels. As cities seek ways to decarbonise their heating and cooling systems, energy geosystems emerge as a promising solution. Magdy *et al*. (2025) employed numerical simulations to explore the profound impact of groundwater level and soil air entry suction on heat exchange rates in sand, silt, and clay. Their numerical analysis reveals that the presence of groundwater significantly improved thermal performance in sand, an effect that diminished as the water table dropped. Conversely, the influence was moderate in silt and negligible in clay. A key contribution of this work is the development of preliminary design charts for sand, enabling engineers to better estimate the thermal potential of energy tunnels under varying hydrogeological conditions.

Lastly, Jiang and Zhang (2025) conducted experimental and numerical investigations into the physical and mechanical properties of layered limestone under high-temperature heating rates. This topic is of great relevance to geothermal energy extraction and underground construction. Their experimental work demonstrates that as heating rates increased, the mechanical properties of the limestone progressively deteriorated, accompanied by a rise in pore and fissure formation. The authors propose an improved statistical damage model to describe the coupled damage from heating rate and mechanical load. This research underscores the importance of considering thermal gradients and transient effects when assessing the stability of rock masses in high-temperature environments.

These papers, published together, highlight the breadth and depth of research being conducted at the forefront of environmental geotechnics. They showcase the ingenuity of our colleagues in tackling complex problems using sophisticated analytical and numerical tools as well as rigorous experimental methods. I hope you find the articles in this issue as stimulating and insightful as I have.

As we welcome new voices into our field, I would like to offer a word of encouragement to young professionals. Becoming an excellent environmental geotechnologist requires more than technical expertise – it calls for curiosity, persistence, and a commitment to sustainability. I urge you to seek out interdisciplinary collaborations, embrace innovative tools such as artificial intelligence, data-driven modelling, and sensing technologies, and never lose sight of the societal impact of your work. The challenges before us – from mitigating soil contamination to adapting infrastructure to climate change – demand creative and bold solutions.

From my own experience, I can attest to the power of perseverance and innovation. In one recent project, my team conducted an experimental investigation and long-term monitoring of geocell-reinforced roads under freeze–thaw cycles, which demonstrated remarkable improvements in road performance and resilience. This work was recognised with the Alberta Minister's Award for Transportation Innovation, underscoring the value of research that directly benefits communities. In another project, we developed a novel lignin–magnesium oxide stabilisation method that integrates carbon dioxide (CO_2) mineralisation into loess improvement. This sustainable approach not only enhanced mechanical properties and durability but also reduced alkaline pollution and permanently sequestered carbon dioxide, showing how geotechnical innovation can contribute to climate solutions.

As young environmental geotechnologists, we must challenge ourselves, build strong networks, and remain engaged with the broader mission of protecting the environment through engineering. By staying curious, resilient, and committed to sustainability, you will not only advance your own careers but also help shape solutions to some of the most pressing challenges of our time. The future of environmental geotechnics depends on your energy, your creativity, and your passion – and I am confident that our field is in excellent hands.

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