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Editorial: Geohazard monitoring, modeling, and assessment in harsh environments

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Editorial on the Research Topic
Geohazard monitoring, modeling, and assessment in harsh environments

Introduction

Geohazards—including landslides, rockfalls, volcanic eruptions, and seismic events—pose serious and growing threats to infrastructure, ecosystems, and societies, especially in environments defined by harsh climate, complex terrain, or limited accessibility. Effective risk reduction requires not only technical innovation in monitoring and modeling, but also interdisciplinary approaches that integrate geotechnical, geological, and environmental perspectives. The seven contributions to this Research Topic, accordingly, advance our understanding and management of geohazards across three interrelated fronts: (1) enhancing stability of soils and rock masses, (2) advancing hazard detection and monitoring methods, and (3) developing predictive and mitigation strategies tailored for harsh environments.

Enhancing soil and rock stability

Soil and rock instability are fundamental challenges in geohazard-prone regions. Guo et al. investigate the reinforcing effect of geogrids on dry-shrinkage cracking of loess, demonstrating that geogrid inclusion significantly reduces crack propagation and improves soil stability—offering practical value for engineering in arid and semi-arid regions. Complementing this, Lu et al. conduct a detailed experimental study of acoustic emission signals in granite under biaxial compression. Their results yield new insights into the micro-mechanical processes preceding rock failure, supporting more robust assessment of rock stability in tectonically active and mountainous terrain. Yang et al. further address ground deformation by examining rebound behavior in pit bottoms after excavation, emphasizing the need for region-specific approaches when designing safe and resilient underground structures.

Advancing hazard detection and monitoring

Accurate detection and real-time monitoring of potential geohazards are critical for both early warning and understanding the mechanisms behind hazardous events. Wu et al. apply a combination of kinematic and numerical modeling techniques to assess the stability of a complex rock slope beneath a major overpass in Chongqing, China. Their multi-method approach provides a template for assessing infrastructure safety in urbanized, geologically complex settings. Meanwhile, Tak et al. employ GIS-based analysis to uncover the influence of altitude, slope, and waterway characteristics on slow-moving landslides in South Korea, providing valuable empirical data for the development of national-scale hazard information systems.

Developing predictive and mitigation strategies

Effective mitigation depends on both innovative materials and early warning systems. Zhu et al. propose improvements to enzyme-induced calcite precipitation (EICP) for soil stabilization, demonstrating that prehydrolysis and accelerated injection rates can markedly enhance the uniformity and total amount of calcite in treated soils. This technique holds promise for stabilizing loose, erosion-prone soils in harsh environments. Addressing compound geohazards, Ratnasari et al. develop an early warning system for tsunamis triggered by volcanic collapses, using numerical modeling and a precomputed database to support rapid, real-time forecasting for disaster-prone volcanic islands.

Conclusion

Collectively, the articles in this Research Topic highlight the benefits of interdisciplinary, multi-scale approaches to geohazard monitoring, modeling, and assessment. By bridging laboratory innovation, field monitoring, and predictive analytics, these studies help drive progress toward more resilient communities and infrastructure in the face of growing geohazard risks. We thank all contributing authors and reviewers for their dedication and insight, and we hope this Research Topic inspires further innovation and collaboration in the geoscience and engineering communities.

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