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Editorial Commentary

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Introduction

This issue of the African Journal of Geophysics and Earth Sciences (AJGES) consolidates emerging advances in geophysical and Earth system sciences, reflecting Africa's growing contribution to global, innovative, and application-driven environmental research.

I am delighted to present this latest issue of AJGES, which continues to provide a platform for high-quality interdisciplinary research in geophysics, hydrometeorology, environmental science, and Earth system science, focusing on Africa and other diverse regions.

The contributions in this issue reflect the increasing sophistication of geophysical and Earth observation methods, as well as the growing integration of machine learning, remote sensing, and classical field-based approaches in addressing resource exploration, environmental hazards, and climate variability (Reichstein et al., 2019). Collectively, they demonstrate the critical role of Earth system science in supporting sustainable development, risk reduction, and evidence-based resource management (United Nations, 2015).

1. Context and Relevance

Across Africa, Earth system processes are increasingly influenced by the interaction between natural variability and anthropogenic pressures. These include rapid land-use change, growing exposure to hydrometeorological extremes, increasing demand for mineral and groundwater resources, and heightened vulnerability to geohazards such as floods, droughts, and seismic activity (IPCC, 2023). Concurrently, advances in geophysical instrumentation and computational methods are transforming our ability to image the subsurface, monitor environmental change, and improve predictive capacity (Reynolds, 2011).

In this context, integrated geophysical research is essential for both scientific understanding and practical applications in mineral exploration, groundwater management, hazard mapping, and climate adaptation. The papers in this issue collectively illustrate how diverse geophysical techniques, including airborne gamma-ray spectroscopy, gravity surveys, aeromagnetic analysis, hydrometeorological modelling, and machine-learning-based forecasting, can be applied to pressing environmental and societal challenges.

2. Overview of Contributions

The first article, "Helicopter Gamma-Ray Survey for Mineral Prospecting and Environmental Assessment in Tafoughalt, Qalaat Mgouna, Eastern Anti-Atlas, Morocco," presents an innovative application of airborne gamma-ray spectrometry to map hydrothermal alteration zones and assess natural radiological risk. The study identifies potassium enrichment patterns and delineates an approximately 11-km hydrothermal alteration zone associated with structural controls on mineralisation. Importantly, the analysis reveals elevated radiological dose rates ranging from 0.37 to 1.49 mSv, exceeding recommended safety limits and highlighting the environmental implications of mineralised zones. The work demonstrates the dual utility of gamma-ray data in both mineral exploration and environmental health assessment.

The second contribution, "Improved Geological Structural Mapping and Depth to Basement Measurements of the Kata Basin, South-Eastern Ghana," applies aeromagnetic data and advanced processing techniques, including CET grid analysis and 3D Euler deconvolution, to characterise subsurface structures. The study reveals significant spatial variability in basement depth, with shallower regions in the northern and central basin (<1500 m) and deeper structures exceeding 2.6 km in the southern parts. These findings provide important constraints for structural interpretation and have direct implications for local hydrocarbon exploration and basin evolution studies.

The third contribution, "Integration of ASTER Multispectral Data and Spectral Angle Mapper Classification for the Mapping of New Hydrothermal Alteration Zones" employs ASTER multispectral imagery and Spectral Angle Mapper (SAM) classification to identify and map hydrothermal alteration zones associated with mineralization. The study delineates major alteration facies, including propylitic, argillic, phyllic, and ferruginous zones, and reveals a well-defined hydrothermal zoning pattern across the Tiouit gold district. The spatial distribution of these alterations shows a strong correlation with regional structural features, highlighting the influence of tectonic controls on hydrothermal fluid circulation. These findings demonstrate the value of multispectral remote sensing for mineral exploration and the identification of prospective targets in arid environments.

The fourth article, "Hydrometeorological Hazard Analysis and Mapping for Zimbabwe Using Historical Data and Multiple Geophysical Layers," integrates meteorological records, remote sensing data, and geospatial modelling to develop hazard profiles for floods and droughts. Using the Standardised Precipitation Index alongside terrain and land-use variables, the study identifies pronounced hazard hotspots in the northwestern and southeastern regions of Zimbabwe. The results indicate that moderate events recur every 1–3 years and extreme events every 5–10 years, highlighting the urgent need for better early warning systems and disaster preparedness strategies.

The fifth contribution, "Evaluating the Skill of ML Post-Processed Short-Range Rainfall Forecasts Against the WRF Model Over Ethiopia," compares traditional numerical weather prediction with a conditional Generative Adversarial Network (cGAN) approach. The study demonstrates that the ML-based model significantly reduces bias and RMSE relative to WRF, particularly in capturing regional rainfall variability during the March–May season. While WRF still performs better for certain event types, the findings highlight the value of hybrid and ensemble-based forecasting systems for improving precipitation prediction in complex terrains such as Ethiopia.

3. **Synthesis**

Together, these studies reflect the growing convergence of classical geophysical methods and modern computational approaches in Earth system science. From subsurface imaging and mineral exploration to hazard mapping and machine learning-based climate prediction, the contributions illustrate how methodological innovation is expanding the frontiers of geoscience research in Africa and beyond.

A common theme across the papers is the importance of spatial variability and structural complexity, whether in geological formations, hydrometeorological extremes, or atmospheric processes. The studies also emphasise necessity of integrated, multi-method approaches to improve accuracy, interpretability, and policy relevance

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4. Acknowledgements

I extend my sincere appreciation to all authors for their valuable contributions to this issue and to the reviewers for their rigorous and constructive assessments, which have significantly strengthened the scientific quality of the published work. I also acknowledge the dedication of the editorial and production teams for their continued support in advancing the AJGES mission.

Finally, I remain grateful to the broader geoscience community whose work keeps motivating interdisciplinary research and innovation. We encourage ongoing engagement from researchers, practitioners, and policymakers as we collectively advance Earth system science for sustainable development and resilience building across Africa and globally. Collectively, these contributions reinforce AJGES as an emerging platform for high–impact, interdisciplinary geoscience research that bridges methodological innovation with pressing environmental and societal challenges across Africa and beyond.

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