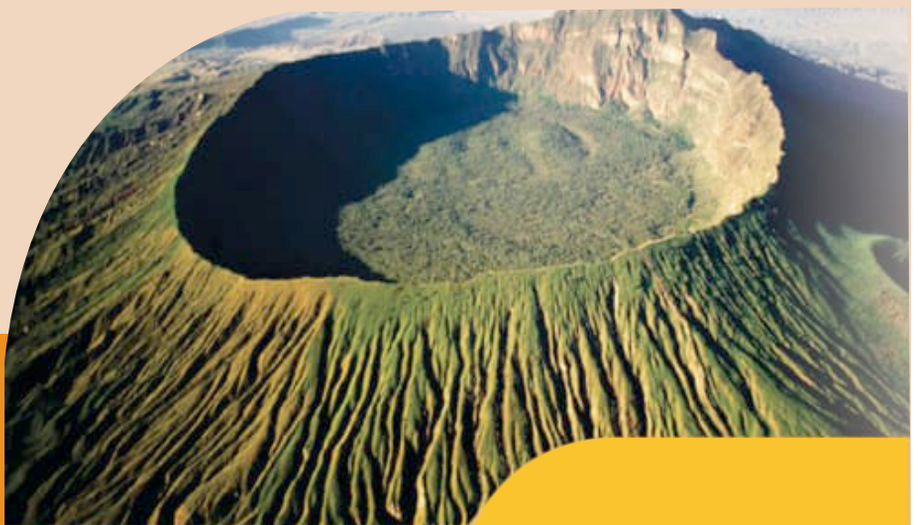
30th COLLOQUIUM OF AFRICAN GEOLOGY

BOOK OF ABSTRACTS

"Unveiling Africa's Geological Resources: Forging a Path for Sustainable Development"



September 23rd – 27th 2025
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EDITORS:

Lydia A. Olaka, Christine A. Omuombo, Winnie Bett, Lorna Njanja Chege, Brilliant Mwendwa, Karen Nguna Masila and Ann Gatigwa

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"Unveiling Africa's Geological Resources: Forging a path for sustainable development"

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ACKNOWLEDGEMENTS

On behalf of the Organizing Committee of the 30th Colloquium of African Geology (CAG30), we wish to extend our deepest appreciation to all those whose contributions have made this event a success. The successful planning and execution of this important gathering would not have been possible without the generous support, unwavering commitment, and collaborative spirit of numerous individuals and organizations.

We are especially grateful to our esteemed sponsors for their invaluable financial and logistical support, which has been instrumental in enabling the realization of this colloquium. Their partnership reflects a shared commitment to advancing geoscientific research, education, and sustainable development across the African continent.

We also wish to recognize the critical contributions of institutions, professional bodies, and geological associations, both within Kenya and internationally, for their endorsement, participation, and resource mobilization. Their involvement has enriched the scientific and professional value of the conference.

Our sincere thanks go to the members of the Local Organizing Committee, the Scientific Committees, and all subcommittees who have dedicated significant time and energy to the meticulous planning, coordination, and execution of this event. Their professionalism, attention to detail, and passion for the geosciences are deeply appreciated.

We acknowledge with gratitude the enthusiastic response from the scientific community, particularly those who submitted abstracts for both oral and poster presentations. The diversity and quality of the submissions are a testament to the dynamic and evolving nature of geoscientific research across Africa and beyond.

In particular, we extend our profound thanks to the panel of reviewers, whose expertise, diligence, and critical evaluation have ensured that the abstracts and scientific content presented at CAG30 meet the highest standards of academic and professional excellence. Their role has been central in maintaining the integrity and quality of the conference proceedings.

To all our partners, participants, speakers, facilitators, exhibitors, and volunteers, we thank you for your presence, your contributions, and your continued engagement with the advancement of geological sciences on the continent. Your support and collaboration are what truly define the spirit and success of CAG30.

With heartfelt appreciation, we thank each and every one of you.

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MESSAGE FROM THE PRESIDENT OF THE GEOLOGICAL SOCIETY OF AFRICA

The Colloquium of African Geology (CAG) is a major biennial event, held under the auspices of the Geological Society of Africa, where earth scientists from around the globe have the opportunity to present their research on topics of African geology to an international forum of their peers. The Colloquium also serves as a catalyst for collaboration between academia, industry, and society through project development and networking.

At the 29th Colloquium of African Geology (CAG29), hosted by Namibia, it was announced that the next Colloquium (CAG30) will be hosted by Kenya during the final week of September 2025. This landmark edition will celebrate the 60th anniversary of the CAG and mark its 30th occurrence. The inaugural CAG, held in Leeds, United Kingdom, played a pivotal role in advancing the scientific concept of the "Pan-African Orogeny." Since then, the Colloquium has grown in stature and is now widely regarded as the "Olympics of African Geology."

The theme of CAG30 is "Unveiling Africa's Geological Resources: Forging a Path for Sustainable Development". The event will bring together participants from academia, scientific research, mining, exploration, and the geothermal sectors. Representatives from government, civil society, and the media are also expected to attend.

Career scientists from African countries and other developing regions are especially encouraged to participate and showcase their work to a diverse and international audience. Kenya, the host country, boasts an interesting, heterogeneous geology covering some 2.6 billion years of earth history, with a wide variety of mineral deposits and mineralization

styles, that have contributed – and still contribute – immensely to the country's economy. In addition, Kenya's impressive geomorphic landscapes have great potential for geo-tourism, while the host city, Nairobi, is a culturally diverse center of learning.

The scientific sessions and field excursions scheduled for CAG30 aim to provide deeper insights into the complex geological history of the African continent. I therefore enjoin all geoscientists globally to start making plans to attend what will be an interesting and geologically fulfilling event, which will be held in Nairobi, Kenya from 23rd to 27th September 2025.

Prof. Olugbenga Okunlola
PRESIDENT GEOLOGICAL SOCIETY OF AFRICA

MESSAGE FROM THE CHAIRPERSON OF THE LOCAL ORGANIZING COMMITTEE

It is with great pleasure that I extend a cordial invitation to the 30th Colloquium of African Geology (CAG30), which will be held in the vibrant and welcoming city of Nairobi, Kenya, from the 23rd to the 27th September, 2025. The theme of this year's colloquium, "Unveiling Africa's Geological Resources: Forging a Path for Sustainable Development," reflects our shared aspiration to advance knowledge of the continent's geological richness while promoting its responsible and sustainable utilization for the benefit of current and future generations.

The colloquium is being organized by the Local Organizing Committee in collaboration with the National and International Scientific Committees, and with the generous support of various sponsors. The event will offer a comprehensive and intellectually stimulating programme designed to foster scientific exchange, professional development, and collaboration. Kenya, often regarded as the cradle of mankind and renowned for its natural beauty and cultural heritage, also possesses extraordinary geological diversity. Positioned along the Equator, the country features a geological history that spans from the Archean to the Quaternary periods. It is a global leader in geothermal energy development and home to the remarkable Rift Valley system and its associated inland lakes.

CAG30 will include keynote addresses, scientific presentations, poster sessions, thematic workshops, training opportunities, field excursions, and exhibitions. Among the critical subjects to be explored are the integration of artificial intelligence in geoscientific research, the geopolitical implications of strategic mineral resources, and the sustainable management of groundwater systems. These topics will be addressed within a framework that encourages dialogue, innovation, and interdisciplinary collaboration.

The colloquium will convene a diverse community of participants, including scholars, researchers, policymakers, professionals from the extractive and energy sectors, representatives of civil society, media practitioners, and students from Kenya, across Africa, and the international community. All participants, whether from government institutions, academic establishments, professional associations, or private enterprises, are most sincerely welcome.

We look forward to your presence at CAG30 and to engaging in meaningful discussions that will shape the future of geology on the African continent. Karibu Kenya!

Geol. Joseph Ng'ang'a Kuria,
PRESIDENT, GEOLOGICAL SOCIETY OF KENYA

INTRODUCTION

The 30th Colloquium of African Geology (CAG30) is proudly spearheaded by the Geological Society of Kenya, under the auspices of the Geological Society of Africa, in collaboration with key players in mining, groundwater, engineering, oil and gas, academia, and research. First held in 1964 at the University of Leeds, the Colloquium has become a premier biennial platform for geoscientists across Africa and beyond. With this milestone edition, Kenya becomes the twelfth African country to host the event. CAG30 will take place from 23 to 27 September 2025 at the iconic Safari Park Hotel in Nairobi, a world-class venue known for its African elegance and conference excellence. Over 1,000 delegates are expected to attend, representing science, industry, government, and academia, all engaging under the theme "Unveiling Africa's Geological Resources: Forging a Path for Sustainable Development."

This special edition marks the 60th anniversary of the Colloquium and the 51st anniversary of the Geological Society of Kenya, a leader in advancing geoscientific knowledge and professionalism since 1974. CAG30 will feature expert presentations, exhibitions, networking forums, and discussions on groundwater sustainability, geoscience education, artificial intelligence, geoheritage, engineering geology, and investment opportunities. Delegates will also enjoy pre and post conference field excursions to Kenya's breathtaking geological sites shaped over 2.6 billion years. Set in a vibrant and diverse city, CAG30 offers a unique opportunity to connect, learn, and contribute to Africa's sustainable development through geoscience.

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SUB-THEMES, SESSIONS AND THEIR RESPECTIVE CODES

Table 1: Sub-themes, sessions, and their codes

THEMES CAG30	SESSIONS
T1. Trends in Development of Minerals in Africa	**T1- S1** Strategic Mineral Resources in Africa
	T1- S2 Geopolitics of Critical Minerals: Africa's Role in Global Supply
	T1- S3 Artisanal and Small- Scale Mining in Africa
	T1- S4 Policy and Governance in Mineral Resource Development
	T1- S5 Environment and Social Governance
	T1- S6 Circular Economy and SDGs
T2. Petroleum, Coal and Energy Resources Amidst Climate Change.	**T2- S1** Petroleum Resources in Africa
	T2- S2 Role of Fossil Fuels in Africa's Energy Transition to Carbon Neutral Economies
	T2- S3 Nuclear Energy As A Low- Carbon Power Source
	T2- S4 Carbon Capture, Utilization, and Storage (CCUS): A Path to Decarbonization
T3. Geothermal Development Maximizing Geothermal Energy As a Key Green Energy Resource in Africa.	**T3- S1** Geothermal Exploration and Development
	T3- S2 Role of The Mineral industry in the Green Hydrogen Energy Economy
	T3- S3 Indirect Utilization of Geothermal Energy
T4. Geoscience Education. The Role of Geoscience Education in Promoting Development and Sustainability.	**T4- S1** Exploring Geoscience Education Across Africa
	T4- S2 Geoscience Education and Outreach for All

T5.	**Sustainable Development of Groundwater Resources in Africa: Challenges and Mitigation Measures for A Better Tomorrow**	T5- S1 Hydrogeology and Water Sustainability Under a Changing Climate
		T5- S2 Groundwater Quality
		T5- S3 Groundwater Exploration
		T5- S4 Groundwater Systems, Modelling and Surface Water Interactions
		T5- S5 Hazards Related to Groundwater
		T5- S6 Managed Aquifer Recharge
T6.	**Geo Heritage, Geodiversity and Geotourism**	**T6- S1** UNESCO Global Geoparks
		T6- S2 Geo Heritage and Geodiversity Conservation and Management
		T6- S3 Paleoclimate and Paleoenvironment Reconstruction
T7.	**Mineral Resource Exploration: Tools and Techniques**	**T7- S1** Innovation and Integrated Approaches in Geophysics
		T7- S2 Advances in Geochemical Exploration Techniques, Data Interpretation and Integration
		T7- S3 Geotechnical Techniques in Mining
		T7- S4 Mineral Resource Assessment
		T7- S5 Seabed Mining
T8.	**AI and Machine Learning in Geosciences in Africa.**	T8- S1 Data - Driven Discovery in Geoscience
		T8- S2 General Topics
T9.	**Pan African Orogeny, Plate Tectonics and Earth Processes**	T9- S1 Pan African Orogeny
		T9- S2 Tectonics and Earth Surface Processes in Shaping Africa's Landscape and Climate
		T9- S3 The Impact of Plate Tectonics on Africa's Natural Resources
		T9- S4 General Hazards

T10.	**Ore Deposit Geology of Africa (Mineral Resources and Ore Forming Processes)**	**T10- S1** Metallogeny and Ore Deposits in Africa
		T10- S2 Gold and Allied Metals
		T10- S3 Geological Characterization and Ore Genesis of Critical Metals
		T10- S4 New Analytical Techniques and Equipment Applied to Ore Deposits
		T10- 05 African Pegmatites
T11:	**Engineering Geology and Geo Techniques and Geohazards**	T11- S1 Cross Disciplinary Geo-Techniques for Infrastructure Resilience
		T11- S2 Natural Geohazards
		T11- S3 Human Induced Hazards
		T11- S4 Engineering Geophysics
T13	**Cross Cutting Themes**	**T13- S1** GIS and Remote Sensing Applications
		T13- S2 Digital Innovations in Geo Techniques
		T13- S3 Geological Surveys Collaborations
		T13- S4 Gender in Geosciences

T1- S1 Strategic Mineral Resources in Africa

Abstract ID: T1_001

Integration of Seismic and Petrophysical Data for Effective Hydrocarbon Exploration and Field Development in Otio Oil Field, Niger Delta

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Abstract

The study integrates 3D seismic data and well logs to delineate subsurface structures and assess the hydrocarbon potential of the field. Five key horizons were evaluated using petrophysical analysis, revealing porosity values ranging from 18% to 27%, water saturation levels between 20% and 31%, and Net-To-Gross ratios of 59% to 96%. Time-depth structure maps were generated for each horizon, allowing for the identification of two prospects, namely the North-Eastern and South-Eastern prospects. The North-Eastern prospect was ranked higher due to its larger estimated hydrocarbon volume, with Sand E2 identified as the most promising reservoir based on volumetric analysis. This study underscores the importance of integrating seismic and petrophysical data for effective exploration and field development, providing a basis for future drilling decisions in the Otio Field. The research method started with the subsurface evaluation of the "Otio Field" integrating well log data from the field and seismic data spanning the field. The databases used for this project are three Dimensional (3D) seismic cube, base map, six well data in LAS format and check shot data for only one well. The results show the identified hydrocarbon bearing zones are Sands D, E1, E2, H and J as interpreted from gamma-ray and resistivity logs. The sand correlation across the field showed uniform sand development from well to well. The checkshot is interpreted as good because of the absence of outliers or spurious values. The results from the structural Interpretation, sixteen faults (F1-F16) were interpreted across the field as seen on seismic section. Faults in the field trend in the East-West (E-

W) direction with majority of them dipping north except for faults F4 F6, F7 and F9 dipping south. In the conclusion, the 3D structural analysis of Otio Field in the Niger Delta enhanced understanding of its structural styles and hydrocarbon traps.

Keywords: Niger Delta, seismic, interpretation, petrophysical analysis, hydrocarbon prospects, Otio Field.

Abstract ID: T1_002

Integration of Remote Sensing and Geological Mapping for Mineral Exploration in Marimanti Area, Tharaka-Nithi County, Kenya

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Abstract

This study aims to integrate and combine geological and remote sensing methodology to assess hydrothermal alteration and mineralization potential in the Marimanti area of Tharaka-Nithi County, Kenya. The study utilizes Landsat 8/OLI data to detect diverse altered lithological zones through band combinations, band ratios, and lineament extraction. The results after validation will be improved through geological field mapping and geochemical sampling of mineralized outcrops. Laboratory analysis using X-ray fluorescence will be performed to characterize geochemical composition. Statistical analysis will be conducted using R 4.5.1(2025), integrating correlation matrix and multivariate methodology to define elemental associations and potential hydrothermal sources. The study seeks to describe the structural controls on mineralization, gauge the spatial association between alteration zones and mineral deposits, and generate a predictive base for exploration. The project aims at delineating three principal alteration facies via Landsat 8 OLI band-ratio analysis—(i) clay-rich (hydroxyl) zones (band-ratio 6/7), (ii) ferric-iron (oxidation) zones (4/2), and (iii) ferrous-iron (reduced) zones (6/5). XRF analysis for geochemical validation is expected to show elevated Al_2O_3/

K_2O in clay zones, Fe_2O_3/TiO_2 in ferric zones, and FeO/MgO enrichments in ferrous zones. Statistical analysis (correlation matrices and multivariate clustering) should ascertain these elemental patterns, while overlaying lineament data will explain structural paths controlling alteration and mineralization. The project will enhance Marimanti geological maps, improve knowledge of mineralization processes in the Neo-Proterozoic basement rocks of Marimanti, and recommendations for future mineral exploration in the region.

Keywords: Remote sensing, Proterozoic, Landsat-8/OLI, X-ray fluorescence, hydrothermal alteration, mineral exploration, R 4.5.1(2025)

Abstract ID: T1_003

Migmatite as a Possible Source of Rare Earth Elements, Gold and Copper

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Abstract

This project investigates migmatites in Nigeria as potential sources of rare earth elements (REEs), gold, and copper—critical metals essential for modern technologies and the green energy transition. The study focuses on the Neoproterozoic migmatitic terrains within the Pan-African Basement Complex of Northern Nigeria. It explores the REE-bearing minerals crystallize within migmatites, particularly where felsic magmatism—such as rhyolite intrusions, basaltic dykes and other pegmatite bodies interacts with metatexite migmatites. These migmatites display diverse internal structures, including leucosomes, melanosomes, and stromatic fabrics, which may act as conduits and traps for mineralizing fluids. By integrating field mapping, petrography, geochemistry, mineralogy, and fluid inclusion analysis, the research

aims to understand the lithological, structural, and magmatic controls on mineralization. Conducted over 30 months in collaboration with Nigerian and international institutions, this study will generate new insights into ore-forming processes in high-grade terrains and support mineral exploration strategies across Africa.

Keywords: Rare earth, migmatites, gold, copper

Abstract ID: T1_004

Rhyolite as a Possible Source of Monazite Mineralization within Metatexite Migmatites of Bauchi North East Nigeria

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Abstract

This study investigates the potential genetic relationship between monazite mineralization within Pan-African metatexite migmatites and Cretaceous rhyolitic magmatism in the Bauchi region of northeastern Nigeria. Preliminary geochemical analyses of pegmatites hosted in the metatexite migmatites reveal significant enrichment in rare earth elements (REEs)—notably cerium (Ce), lanthanum (La), and neodymium (Nd)—along with thorium (Th), with concentrations ranging from <0.001 to 89 ppm (Ce), <0.001 to 92 ppm (La), <0.001 to 76 ppm (Nd), and <0.001 to 223.6 ppm (Th). In contrast, geochemical data from associated Cretaceous rhyolites show Ce values ranging from 30.55 ppm to below detection, La between 0.044 and 0.770 ppm, and Th ranging from <0.001 to 12.54 ppm, while Nd remains below detection limits. Although the rhyolites exhibit lower overall REE contents, especially in La and Nd, their Ce and Th levels suggest a potential role in hydrothermal mobilization. Field observations and geochemical signatures indicate that hydrothermal fluids linked to the rhyolitic intrusions may have reactivated pre-existing fracture systems in the host rocks, facilitating

REE transport and monazite deposition. This study combines field mapping, petrographic analysis, and geochemical characterization to propose a model of REE enrichment and monazite mineralization influenced by multi-phase magmatic activity. The findings provide insights into the tectono-magmatic evolution of the region and offer a framework for REE exploration in similar geological settings.

Keywords: Rhyolite, Monazite, Metatexite, Bauchi, Nigeria

Abstract ID: T1_007

Characterizing Submarine Groundwater Discharge and Its Importance for Mangrove Ecosystems in Lamu Island, Kenya

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Abstract

Mangrove ecosystems are highly influenced by porewater salinity (PWS) and nutrient fluxes, both of which are driven by submarine groundwater discharge (SGD). In coastal environments, SGD is affected by the mixing of seawater, freshwater, and surface runoff carrying anthropogenic nutrients, which affects mangrove productivity. Key factors regulating these interactions include tidal inundation, hydraulic gradients, aquifer properties, waves, storms, and seasonal changes. Although evidence of tidal inundation in Lamu County's mangrove creeks exists, the role

of SGD in shaping these ecosystems remains poorly understood. This study aims to characterize SGD and assess its effects on mangrove biomass by analyzing groundwater and porewater for stable isotopes (oxygen and deuterium), physicochemical properties, and nutrient dynamics using a Picarro Water isotope analyzer, inductively coupled plasma–atomic emission (ICP-AES, P-E Optima 3300 and HACH DR 2800 spectrophotometer, respectively. Additionally, tidal inundation, groundwater levels, porewater salinity were monitored in nearby wells using Installed data loggers along with mangrove allometry to establish groundwater flow pathways and nutrient influences on biomass. Analytical solutions from the Bioenergetics, Electron Transport, Thermodynamics Integrated Network Analysis (BETTINA), and Groundwater Modeling System (GMS) simulated the groundwater dynamics. Mangrove forest provide numerous functions to the coastal ecosystem and inhabitant around such as they provide breeding grounds for fish and shellfish, prevent siltation of coral reefs and contribute organic matter and nutrients to primary and secondary productivity of the coastal ecosystems. They provide timber as building material for boats and houses, firewood, salt, tannins and dyes. Mangroves plays an important role in stabilization and protection the coastlines.

Keywords: Submarine groundwater discharge, Mangrove ecosystem

Abstract ID: T1_012

Petrography and Preliminary Geochemistry of the North Idjwi Island Granitoids (South Kivu, DRC) with a View to Lithium Exploration

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Abstract

With the advent of electrical cars, battery metals such as tin and lithium, key metals in the energy transition, are increasingly sought-after, sparking renewed interest in the exploration of tin-bearing granites and lithium-cesium-tantalum (LCT) pegmatites. This study therefore focuses on the petrography and preliminary geochemistry of the granitoids of North Idjwi (South Kivu, DRC) with a view to exploring for lithium. To this end, rock samples were collected, described macroscopically and microscopically, and analyzed for preliminary geochemistry using a handheld XRF. These granitoids, rich in schorl-type tourmaline and cassiterite, are granites and pegmatites that have intruded sericite schists. Tourmaline is found predominantly in quartz veins and sometimes disseminated in granitoids, while cassiterite, rarely disseminated, is found as streaks on the walls of quartz veins (very little visible in the middle of these veins). Besides tourmaline, quartz, orthoclase, microcline, and plagioclase are the other abundant minerals. The Sn (81.1-115.4 ppm), Zr (36-143.9 ppm), and V (253.7-478.9 ppm) contents are high. These granitoids are comparable to the LCT, lithium-bearing, and S-type peraluminous granitoids described in the region and worldwide.

Keywords: North-Idjwi, Petrography, Geochemistry, Granitoids, Lithium

Abstract ID: T1_014

Appraisal of The Structures, Alteration and Deformational Phases of the Rambi Gold Target, Western Kenya

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Abstract

Rambi gold prospect is located in southwest of Busia-Kakamega Greenstone Belt. The target lies at the intersection of latitude 0° 3′ 59.53″N longitude 40° 19′ 6.80″E and has been worked for gold since

the 1930s. As promulgated by the colonialists, the mineralization model conforms to a quartz-vein-hosted gold system lying within a shear zone. Besides this compact historical information, Rambi as a target lacks sufficient geological information to advance mineral exploration. This study was set to appraise the gold prospectivity of Rambi as a target through an integrated modernized exploration approach. This approach was aided majorly by assessing the Airborne magnetic and geochemical datasets. Through the investigation of magnetic data, geological structural pattern encompassing mineralization was realized through enhancement of the primary images. Geochemically, X-Ray Diffraction analysis of eight representative samples in this study were successfully carried out to investigate alteration minerals. Illite and kaolinite stand out as major clay alteration minerals over the sheared/altered potential zones. Petrographic analysis of altered rock samples elucidated the alteration level of the rocks. Shear lineaments reveal two main deformation episodes in the area as supported by analysis from the fabric diagrams (Rose Diagram). Majorly, the lineaments are grouped into Deformation-1 (D1), Deformation-2 (D2) and Deformation-3 (D3) following the different deformational phases in relation to one another. Major finding are the two main internal shear structures of approximately 1Km strike length, located within the main shear. Similar comparative structures have been attributed to many of the world-class ore deposits, e.g. the Kundana Goldfield in Western, Australia.

Keywords: Gold, Structure, Alteration, Deformational phases, Greenstone Belt, Western Kenya

Abstract ID: T1_018

Origin and the Possible Industrial Application of Adi Hano Kaolin Resources, Northern Ethiopia

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Abstract

The majority of commercial kaolin deposits in Ethiopia originate from felsic igneous rock. On the other hand, the Adi-Hano kaolin deposit is a recently recognized kaolin deposit that was formed from sandstone. Nevertheless, this provides insight into potential deposit occurrences in the region's sedimentary sequence. This study aims to characterize the genesis, quality, quantity, and potential industrial uses of Adi-Hano kaolin deposit. It was carried out by integrated field geological descriptions, thin-section interpretation, physical testing, mineralogical (X-ray diffraction, XRD), and geochemical investigations. An Inductively Coupled Plasma Mass Spectrometer (ICP-MS) and an Inductively Coupled Plasma Atomic Emission Spectrometer (ICP-AES) were used to analyze the geochemistry. The main mineral phases in the deposit are quartz and kaolinite, while the minor mineral phases are rutile, cristobalite, and tridymite. The elevated value of quartz, limits the quality of kaolin being as an impurity for its industrial use. The integrated result indicates that insitu weathering followed by leaching of the arkosic sandstone played a great role in kaolin deposit formation. The average Chemical Index of Alteration (CIA; 94.18%) also shows that the source rock has experienced strong weathering and alteration. The deposit contains minor concentrations of Sr + Ba and Fe2O3+ TiO2, and high concentrations of Y + Ce + La and Nb + Cr values, which are indicative of a supergene type origin. Following treatment of the deposit, its similar grain size distribution, color, relatively high Al2O3, relatively low TiO2, Fe2O3, and alkali components make it suitable for a variety of industrial uses, such as ceramics, refractory, paper coating, and paint.

Keywords: Adi-Hano area, Kaolin deposit, Alteration, Sandstone, Supergene

Abstract ID: T1_019

Petro-structural and Geochemical Analysis for the Valorization of the Phlogopite Deposit of Ampandrandava (Southern Madagascar)

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Abstract

The Ampandrandava mine is one of the oldest underground mines in Madagascar, dating from before the colonial period. It is the only mine still accessible in depth and in quasi-activity with various still promising levels. Apart from its specificity for its underground exploitation, various minerals including the unique phlogopite also characterize this mine. Despite its age, the deposit is not yet exhausted but its exploitation is no longer rational as before and leads to the waste of the deposit. Geochemical analyzes on a few samples at the surface and at depth of the mine were made to determine the elements SiO2, TiO2, Al2O3, Cr2O3, FeO, MnO, MgO, BaO, K2O, NaO2, F and Cl in the phlogopites in the area. In determining the composition of the mineral, the results showed that Ampandrandava's phlogopites are highly rich in SiO2, Al2O3, MgO and K2O, it is of the aluminous-magnesian type. Iso-content maps on the distribution of these elements in the exploited areas make it possible to correlate the geological and structural formations with the geochemical property of the area for the development of the resource with a view to rational exploitation.

Keywords: Ampandrandava, mica, phlogopite, fluorescence-X, underground mine.

Abstract ID: T1_020

Africa Awakening in the Natural Mineral Resources Sector

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Abstract

Africa has over the years been associated with the paradox between resource abundance and economic stagnation, however, various global dynamics have led to the awakening of this "sleeping giant." Africa is experiencing a significant awakening in its natural resources sector, a transformation driven by global economic shifts, environmental consciousness, and technological advancement. The continent's abundant mineral resources such as coal, iron ore, gold, manganese, lithium, tantalum, platinum group metals, cobalt, and rare earth elements have received heightened attention as the globe transcends towards more renewable energy systems. As many developed countries devise systems to reduce carbon footprints and eradicate the use of combustion vehicles, Africa stands at the forefront of supplying "their" critical minerals needed for the transition. However, this surge in demand raises questions about whether the continent can leverage its resources for its sustainable economic growth or if it will fall into patterns of the resource curse seen in the past. This paper delineates the agenda and role of the Africa Mining Vision in ensuring that resource extraction contributes to sustainable development. It also details how the establishment of the African Union fosters regional cooperation within African countries. An investigation into the root causes of mineral wars in Africa will be conducted, outlining their effect on development. The research will also delve into the extent to which the concept of circularity benefits mineral-endowed Africa, exploring the benefits and possible negative impacts of the implementation of carbon tax in Africa.

Keywords: Natural resources, Sustainable development

Abstract ID: T1_027

Geochemical Analysis of Rocks from The Nasia Basin, Northeastern Ghana

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Abstract

Geochemical analysis of sandstone samples from the Nasia basin, a sub-basin within the Neoproterozoic Voltaian Supergroup, was conducted to deduce its paleoenvironmental conditions and evolution. Using XRF, XRD, and SEM, the study identified micaceous mudstones and poorly sorted arenites as major rock types.

The samples showed high average SiO_2 (65.8 wt.%) and Al_2O_3 (16.04 wt.%) contents. XRD analysis revealed a mineral assemblage dominated by quartz, feldspars (anorthite, albite, microcline), and micas (biotite, muscovite).

Geochemical proxies from major oxides and trace elements were used to interpret the basin's history. The data indicates a felsic igneous provenance for the sediments, deposited in a passive margin tectonic setting. A Chemical Index of Alteration (CIA) value of 68.84 suggests a moderate intensity of paleoweathering. Furthermore, the geochemical indices point to a semi-humid paleoclimate during the deposition of these sediments. This research contributes to understanding the evolutionary processes of the Voltaian Supergroup.
Keywords: Geochemistry, Nasia basin, Voltaian Supergroup, Depositional settings

Abstract ID: T1_030

Manganese Mineralisation and its Economic Viability in Kilifi County

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Abstract

Manganese occurrence along the Kenyan coast spans the Permo-Triassic (Karroo) and Jurassic terranes, with mineralization confined within the Jurassic Kambe limestone zone, which stretches approximately 40 km in a north-south direction and 3 km in width, forming a karstic manganese deposit belt. The project aimed to

delineate the extent of this mineralized belt and evaluate its economic potential. To achieve this, a combination of geological field mapping, aerial images interpretation, geological mapping, and analysis of existing trench data was employed. Geological field mapping involved systematic field traverses, identification of lithology, structural measurements, and sample collection across the target zones. This allowed for the direct observation of outcrops, structural orientations, and identification of manganese-bearing zones. Aerial photographic interpretation provided valuable insights into regional geomorphology and lineaments associated with karstic features and fault systems that potentially control mineralization. Existing trenches and dug-out pits, particularly at the Ganze-Kachorororoni prospects, were analysed to evaluate ore continuity and thickness, exposing Mn-bearing layers ranging from 1 to 5 meters thick with ore grades equal to or exceeding 35% MnO. Mineralization occurs downdip in dolomitic pouches, with sratabound occurrences observed in paleosol profiles. The ore consists of manganese pebbles and nodules embedded in a matrix of fine sand and laterites, with individual blocks reaching ≥ 0.3 meters. Three distinct zones—Ganze, Kachorororoni-Bamba, and Mavueni-Kiwara were delineated, with the Ganze zone exhibiting the highest ore grades. The prospect demonstrates substantial manganese resources. Its strategic proximity to the port and potential for co-existing mineral resources underline its economic viability, supported by robust geological data and the potential for scalable mining operations.

Keywords: Manganese deposit in Kenya

Abstract ID: T1_032

Suitability of Thulamela Clays for Use in The Ceramic Industry: A Case Study in Thulamela Municipality, Limpopo Province, South Africa

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Abstract

This study investigated the physical, chemical, and mineralogical properties of clay samples from Thulamela Municipality, focusing on their suitability for ceramic applications. Forty (40) samples were collected from eight villages, with five samples per village; each sample weighed five kilograms. Tests used to analyze the ceramic properties of the clay samples included particle size analysis, hydrometer analysis, Atterberg limits, X-ray Fluorescence (XRF), and X-ray Diffraction (XRD) of raw data and fired samples at 300°C, 700°C, 800°C, 900°C, and 1150°C, and water absorption and linear shrinkage tests. The results revealed that the predominant clay minerals are kaolinite, quartz, anorthite, and orthoclase, with varying concentrations of SiO_2, Al_2O_3, and Fe_2O_3. The study found that Ha-Matsika, Lwamondo, Muledane, and Dzingahe clays exhibit optimal ceramic properties with moderate to low water absorption rates and stable linear shrinkage behavior. These clays are suitable for high-quality ceramic applications such as refractory ceramics, sanitary ware, tableware, artistic ceramics, and ceramic sculptures. In contrast, Ngwenani, Madadani, Tshilungoma, and Tshino clays are more suitable for producing ceramics with less stringent requirements such as pottery and associated earth ware. The study recommends optimizing Ha-Matsika, Lwamondo, Muledane, and Dzingahe clays for ceramic production and encourages further research to enhance the properties of Ngwenani, Madadani, Tshilungoma, and Tshino clays. The ceramic industry can benefit from utilizing local clay resources while promoting sustainable practices and developing high-quality ceramic products.

Keywords: Clay Suitability, Mineralogy, Ceramic Applications

Abstract ID: T1_034

Stratigraphic Correlation Between Supergroups of The Mesoproterozoic Karagwe-Ankole Belt Across the Kivu Rift - A Review and New Data from The Nya-Ngezie, Kalehe and Idjwi Sectors in Eastern DRC

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Abstract

The Karagwe-Ankole Belt (KAB) forms the basement of the Great Lakes region of Central Africa. The KAB comprises Mesoproterozoic and Neoproterozoic stratigraphic sequences, metamorphic complexes and magmatic intrusions, as well as minor Paleoproterozoic units and a Neoproterozoic tectonic overprint. The KAB units are relatively well mapped in Rwanda, and, to a lesser extent, in Burundi, where they have been mapped at the 1/100.0000 scale. Instead, in the Kivu and Maniema regions of East DRC, KAB units are less well known and occur in isolated areas, making difficult to propose a unified stratigraphy.

In the frame of recent investigations in Kivu and Burundi, and due to new insights from the revised geological map of Rwanda, we have re-examined the geological evolution of the region by proposing new lithostratigraphic correlations between the Eastern and Western sides of Lake Kivu. East of the lake (Rwanda & Burundi), the Mesoproterozoic formations are assembled in the Akanyaru Supergroup and west of the lake (North and South Kivu, DRC), the correspond to the Kivu Supergroup. The Neoproterozoic Itombwe Supergroup, well defined in Kivu, is also present in Rwanda, showing that its extension is not limited to the Itombwe 'syncline', but that it was deposited over a wider region. The geochronological framework has also been revised based on recently published and new Ar-Ar and U-Pb ages. Altogether, we propose a new time-frame for the stratigraphic, magmatic, metamorphic and tectonic evolution of the Karagwe-Ankole basin, from the Rodinia amalgamation and breakup to the Pan-African reactivations.

Keywords: Karagwe-Ankole belt, Mesoproterozoic, Lithostratigraphy, Magmatism

Abstract ID: T1_037

Geometallurgical Ore Classification in The Katanga Copperbelt (DRC): Implication in The Ore Control and Exploration Perspective

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Abstract

The Neoproterozoic-Cambrian Katanga Copperbelt in the central Africa hosts most Cu-Co deposits. Historically, limited technology led to some ores being considered barren or low-grade reserve. This was due to the ore classification based on the ratio of Total Cu and Co versus CaO and MgO, without an advanced geometallurgical investigation. Additionally, other metals that could be associated with Cu- (Co, Pb, Zn) mineralization are often not analyzed by major mining companies. In the present study, a bulk mineralogy analysis on a representative sample collected in the shale from the Nguba Group based on the QEMSCAN revealed that a total Cu distribution is from the Cu ore (chalcopyrite, chalcocite, Cu oxide, pseudomalachite, malachite, brochantite, chrysocolla) and the gangue

minerals (chlorite, barite, biotite, muscovite, Fe oxides). This provide an evidence that certain metals are still present in several mineral waste abandoned by mining companies to economically recoverable quantities and could constitute future reserves of minerals. In this perspective, embedding the geometallurgical approach in geological exploration and ore control proves of paramount importance in the ore classification in the KCB.

Keywords: Base metal, ore classification, copper

Abstract ID: T1_038

Lithium and Rare Metal Enrichment in the Pegmatites of Boundiali, Côte d'Ivoire: Implications for the Energy Transition

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Abstract

In Côte d'Ivoire, pegmatite occurrences have been the subject of limited studies. Fifteen zones of interest have been identified, with only those in the Issia locality-formed from differentiated residual fluids associated with the crystallization of the Issia peraluminous granite having undergone rigorous study, revealing columbite tantaliferous deposits with limited lithium enrichment. Recent petrographic investigations in the Boundiali region identify a variety of rare-metal-rich pegmatites that are highly prospective, especially for lithium mineralization. These pegmatites intrude into the Birimian (Paleoproterozoic) formations, which are found within the parametamorphic units, primarily consisting of amphibolites or within granitic bodies. Thin section analyses identified five primary types of pegmatite: spodumene-bearing pegmatites, lepidolite-bearing pegmatites, green-mica-rich pegmatite, garnet-rich pegmatite, and barren pegmatite. The mineral assemblages and textural features

suggest a complex geological history involving (i) magmatic crystallization (including quartz, feldspar, spodumene, and muscovite minerals), followed by (ii) regional metamorphic decompression and metasomatic fluid interactions, which entail chemical exchange between spodumene and fluids, leading to the formation of SQI texture (vermicular intergrowth with small quartz crystals) and myrmekite textures; (iii) hydrothermal alteration, such as sericitization and montmorillonite replacement; and (iv) surface weathering, evidenced by eucryptite, which indicates potential lithium mobility, along with hematite and rutile formation. The abundance of metasomatic features (sericitization, myrmekite, SQI texture) highlights the importance of fluid recirculation and the redistribution of rare metals (Li, Be, and Cs).

Keywords: energy-transition, rare-metal, pegmatite, Côte d'Ivoire

Abstract ID: T1_041

A Jurassic Oddity: Ni-Cr-enriched Olivine Gabbros Emplaced into The Lower Karoo Supergroup, South Africa

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Abstract

A multidisciplinary investigation into a series of soil geochemical anomalies revealed elevated nickel and chromium concentrations in a sparsely exposed, topographically subdued region of South Africa. These anomalies are spatially associated with flat plains mantled by black, coarse-grained pyroxene-olivine-rich sands and clusters of gabbroic boulders. Field mapping, petrography, and geochemistry indicate that these boulders represent olivine microgabbro and olivine gabbronorite, interpreted as the weathered residuum of shallow, sheet-like mafic intrusions. Stratigraphic relationships demonstrate that these mafic intrusions postdate the Mesoproterozoic Namaqua Metamorphic Complex and were emplaced

both along the Namaqua–Karoo unconformity and into the lower units of the Karoo Supergroup, implying a post-Karoo or possibly Jurassic age. Geochemically, the olivine microgabbros differ markedly from typical Karoo dolerites in silica, alkali, and MgO content, plotting within tholeiitic to komatiitic fields—suggesting a distinct magmatic lineage. Historical airborne magnetic and radiometric data, supported by ground magnetic and electromagnetic profiling, reveal several shallow mafic-ultramafic bodies underlying the anomaly areas. Magnetic lows and low radiometric signatures (K, Th, U) correspond with the mapped geochemical patterns. In addition, recent magnetotelluric (MT) surveys have imaged conductive zones at depths of less than 1 km, consistent with the presence of subsurface mafic bodies. Collectively, these results support the interpretation that the anomalies are linked to deeply weathered mafic-ultramafic intrusions emplaced into the basal Karoo strata and along the regional unconformity. Ongoing studies aim to refine the age and character of these intrusions, which represent a geologically unusual and poorly understood magmatic event in this part of South Africa.

Keywords: Ni-Cr anomalies; olivine gabbro; Karoo Supergroup; mafic intrusions

Abstract ID: T1_050

Geochemical characterization of the Cenomanian - Campanian Red sandstone Group of SW Tanzania: implications for provenance, Climate and Paleo-ambient Redox Conditions

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Abstract

Trace, major element compositions and rare earth elements (REEs) are presented for the Cretaceous Red Sandstone Group of the Songwe basin, SW Tanzania, in order to elucidate source rocks composition,

paleo-weathering intensities, climatic variations and paleo-ambient redox conditions during. In interpreting the obtained trace element data, it was assumed that elemental ratios such as La/Sc, Th/Sc, Cr/Th, Th/Co, La/Co and REEs in the detrital silicate fraction of the samples behaved as a closed system during weathering, transportation and eventual deposition in the basin. Negative Eu* anomalies, The shales show less fractionation of REE (LaN/YbN = 0.28 – 4.43; mean = 1.33). These ratios are lower than the Post-Archean Australian Shale (PAAS) [(La/YbN)PAAS = 9.5, and can be attributable to a more felsic protolith for the Red Sandstone Group rocks. Furthermore, the trace element ratios of La/Sc, Th/Sc, Y/Ni, Cr/Th and Th/Co indicate a more felsic source than that for the Upper Crust Compositions (UCC) and (PAAS). Discriminant diagrams of Co/Th vs La/Sc and Cr/V vs Y/Ni enabled to make inferences of source rocks to be the meta-anorthosites of the Ubendian and Cratonic granites around and to the NE of the basin. The calculated Chemical Indices of Alteration (CIA) indicate mainly intermediate magnitudes, suggesting sporadic variations of climates. Considerations on Al/Na and CIA values point to prevalent warm-humid climates during deposition of the Red Sandstone Group rocks. On the other hand, [V/(V + Ni], V/Cr, Nii/Co and calculated Mn* redox proxy parameters demonstrate an overall well oxygenated/oxic environment during when the sediments were deposited in the Songwe basin

Keywords: Provenance, Climate, Anoxia

Abstract ID: T1_051

The Application of Geophysical Methods for Delineation of Structure Controlling Gold Deposits at Nyang'wale-Geita, Tanzania

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Abstract

The Nyang'wale in north-eastern Tanzania is a favourable geological setting for Gold mineralization and extension of the existing gold deposit.

This delineation was done using induced polarization and a magnetic method. The extension of gold deposits in the Nyang'wale village can revitalize the mining sector and enhance Tanzanian's position as a gold exporter. The study employs the application two geophysical methods particularly Magnetic survey and Induce polarization method (IP). The Magnetic data was used to identify areas with anomalous alterations which can be associated with hydrothermal fluids. Ip data was used to delineate structural features and potential fluid zones, that often serve as pathways for mineralization. and later approaches were supplemented by Geological data, including lithological units and structural features, to identify target areas for potential Gold. Therefore, the integration of induced polarization, and magnetic data led to the identification of different target areas with a probability of hosting gold mineralization. The results of this study provide a robust foundation for future exploration activities. Further investigations, including ground truthing of the deskwork, follow up EM survey and drilling programs which are necessary to confirm the resource potential and assess the economic viability of the deposit. This research aligns with the broader theme of sustainable development through geological exploration in Africa. By applying geophysical methods to delineate gold-controlling structures in Nyang'wale, Geita, it supports the responsible utilization of mineral resources, contributing to economic growth, environmental stewardship, and local empowerment.

Keywords: Geophysical method for delineation

T1- S4 Policy and Governance in Mineral Resource Development

Abstract ID: T1_044

General Scope, Principles of The Pan African Resource Reporting Code (PARC) and the Contribution to Mineral Resource Development of Africa

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Abstract

The Pan-African Resource Reporting Code (PARC) is the AMREC based code for public reporting for resources under relevant financial and security regulations in Africa. The fundamental purpose of PARC is to promote confidence to shareholders as well as stakeholders and ensure alignment of minerals and energy reporting to the Africa Mining Vision, Agenda 2063, and good social, environmental and economic benefits for Africa. In this code, all reporting entities will find guidance on general reporting requirements for reporting minerals and energy resources and reserves, guidance on competent persons requirements, guidance on reporting of economic results and social benefits, requirements for environmental and social reporting together with reporting of Artisanal and Small-scale mining projects. The relevant constituency that PARC addresses include investors (shareholders) and stakeholders such as local communities, governments, operators, employees, suppliers and professional bodies. Resource reporting under PARC shall be based on the available AMREC mineral inventory information. Only the AMREC classes and sub-classes, with their numerical codes as discussed for each resource type shall be used for public reporting. The main principles governing the operation and application of PARC are good social, environmental and economic benefits as called for in the African Mining Vision, including transparency, materiality and competence. This code which has since been approved by the African Union Commission and the administrative control domiciled in The African Mineral Development Centre (AMDC) is expected to correct to a large extent age-long lopsided development which has been to the disadvantage of the Mining industry of Africa

Keywords: Resource, Reporting, African Mining vision

Abstract ID: T1_024

Mineralogy and Geochemical Characterization of Geophagic Clays In the Zambezi Region.

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Abstract

Geophagy, purposeful eating of earth material, is a common sub-culture in the sub-Saharan Africa region, including Namibia's Zambezi Region. Its extensive prevalence has been under-investigated as far as mineralogical and geochemical composition of geophagic clays and their potential health impacts are concerned. This study aims at investigating the mineralogical and geochemical composition of geophagic clays in some study locations in the Zambezi Region. Clay samples will be collected from termite mounds and community-sourced locations, and X-ray diffraction (XRD), X-ray fluorescence (XRF), and Inductively Coupled Plasma Mass Spectrometry (ICP-MS) laboratory analysis will be conducted. The research will focus on establishing the dominant mineral phases, major and trace element determinations, and determination of potentially toxic elements (PTEs). In offering scientific basis for the composition of geophagic clay, the study contributes to SDG 4 (Quality Education) through generating new scientific knowledge and awareness of geophagy, and SDG 3 (Good Health and Well-being) by providing evidence of correlation between the consumption of clay and potential nutritional benefits and health risks. Ultimately, the findings will lend themselves to meaningful contribution to culturally appropriate practice and facilitating sustainable development and sound public health decision-making in Namibia.

Keywords: Geophagy, Zambezi region, Mineralogy

Abstract ID: T1_025

From Waste to Resource: Geochemical and Mineralogical Analysis of The Uis Pegmatite Tailings for the Circular Economy

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Abstract

The successful development and adoption of clean energy technologies essential for the global energy transition depends on critical raw materials/elements such as lithium, tin, tantalum, and rare earth elements. The Namibian Uis pegmatite deposits are known to host a substantial amount of these elements. However, extracting such elements generates huge amounts of waste tailings that pose significant environmental and human health risks. This study focuses on the geochemical and mineralogical characterization of waste tailings from the Uis lithium/tin-bearing pegmatite deposit in Namibia, with the aim of evaluating their potential for resource recovery and circularity. Through fieldwork expeditions, we identified three distinct types of tailings on and around the Uis mine: the first category consisting of clay material, the second category consists of a mix of fine-to-medium-grained rock material, and the third category consists of coarse-grained gravel-like waste material from the initial pegmatite over-burden. The mineralogical-chemical properties of Uis Pegmatites Tailings (UPTs) were investigated in a grounded powder form using X-ray diffraction (XRD) and X-ray fluorescence (XRF) spectroscopy to determine the quantitative constituents of the major mineral compounds and elements respectively. All tailing types exhibit a homogeneous mineralogical composition, primarily consisting of quartz, albite, K-feldspar, illite, and

mica, and reveal the presence of economically valuable lithium-bearing minerals such as spodumene and petalite. The geochemistry results further indicate elevated concentrations of tin, tantalum, manganese, iron, rubidium and niobium. The results suggest that UPTs could be utilized as an alternative above-ground source of critical raw materials for the energy transition and, further, be used for repurposing in the construction industry of fired bricks, ceramics, and cement production.

Keywords: Uis, tailings, geochemistry, circular economy

Abstract ID: T1_035

Post-mining and Post-processing Waste Dumps in Africa as Anthropogenic Mineral Deposits: A Case Studies

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Abstract

The implementation of the PanAfGeo Project benefits both parties involved, young geologists from the African Geological Survey as well as experienced European geologists. The invaluable added value of this project is the opportunity to learn about mineral deposits, their exploitation and processing within Africa. In this study, two rather different cases are analysed: a tailings dump in the Zambian Copperbelt and a manganese ore tailings dump in the Moanda-Franceville region (SE Gabon). The history of Cu ore mining and processing in Zambia dates back to the early 20th century. The result of this mining and smelting activity is tailings dumps covering several tens of km2. These facilities are often subjected to reclamation activities, which in a number of cases appear to be unhelpful due to the fact that these works are costly, do not fully eliminate the negative impact on the environment, and the

deposited waste usually contains around 1% Cu and 0.0X% Co. In European conditions, such Cu contents are considered for geological exploration. The form of Cu occurrence in post-processing waste means that the recovery of useful components should be of interest primarily to large metallurgical companies with appropriate processing technologies. Manganese ore tailings dumps in Gabon present a significantly different problem. A high-grade concentrate is produced on site and commercially traded, while the remainder of the ore, which does not meet the requirements of acceptance, is sent to large-scale dumps located in favourable terrain conditions. Deposited waste material consists mainly of Mn ore crumbs. Taking into account local economic conditions this recovery could be carried out by local people after appropriate health and safety training, based on an agreement between the local authorities, who would be responsible for organising groups of workers accordingly, and the company that owns the landfill, which would be obliged to bring back the separated raw material.

Keywords: PanAfGeo, waste valorisation, copper, manganese

T2- S1 Petroleum resources in Africa

Abstract ID: T2_003

Bouguer Anomaly Disintegration for Subsurface Exploration: Case Study at Magadi Basin, Southern Kenyan Rift Basin

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Abstract

The greatest puzzle in gravity interpretation is the disintegration of regional and residual anomalies. Qualitative and quantitative gravity data interpretation require Bouguer gravity anomaly to be disintegrated to isolate gravity effects of smaller, localized mass distributions (residual) and widespread and deep-seated mass distributions (regional). This study applies Various Geosoft Schemes to Bouguer gravity anomaly from Block T11 of the Magadi Basin, southern segment of the Kenyan rift, an active continental part of the Gregory Rift shaped by Volcano-Tectonism and Sedimentation processes. The schemes tested include Non-linear Filtering, Low-pass Filtering, Polynomial Trends, Upward-Continuation, High-pass filtering and Bandpass filtering. These schemes are essentially non-unique and subjective. Comparative Scheme results shows that Non-linear filtering scheme is reliable for gravity data decomposition because it is easy to determine its cut-off length by virtual inspection of the data. The results of residual gravity anomaly grid from preferred decomposition demonstrates enhanced delineation of geological features. For the study area, the appearance of the southern sags were only enhanced under specific circumstances, indicative of a shallower depth compared to other sag, or it could result from high anomaly values associated with significant geological extensions or anomalies in the region. Furthermore, intrusions, basin edges, geological contacts, structural trending and faults controlled high and lows have been isolated. The application of filtering enhanced subsurface heterogeneities that are prospective for hydrocarbon

petroleum system. More broadly, this approach offers complement to petroleum subsurface exploration in less effective seismic survey areas like Magadi Basin, supporting petroleum resource development in structurally complex Africa's rift system.

Keywords: Bouguer Anomaly, Schemes, Residual Anomaly

Abstract ID: T2_004

Foraminiferal Biostratigraphy and Paleoenvironmental Analysis of HNS-01 Well, Coastal Swamp Depobelt, Niger Delta Basin, Nigeria

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Abstract

The foraminiferal biostratigraphy and paleoenvironmental analysis of the Agbada Formation in the Coastal Swamp Depobelt of the Niger Delta Basin were conducted using ditch-cutting samples from well HNS-01. The study aimed to establish the age, biozonation, and paleoenvironment of deposition. Ninety-two (92) ditch cutting samples from the interval 3,240 – 8,718ft. composited at 60ft interval of the HNS-01 well were processed for micropaleontological studies. The samples were subjected to standard micropaleontological sample processing techniques. First Downhole Occurrences (FDOs), Last Downhole Occurrences (LDOs), and faunal abundance and diversity peaks were employed in dating and biozonation of the studied section. Biostratigraphic correlation with established Neogene planktonic foraminiferal biozones indicates that the well spans the Middle Miocene to Late Miocene. The paleoenvironmental interpretation, based on the abundance, diversity, and ecologic preferences of benthic foraminifera, suggests a depositional setting ranging from coastal deltaic to middle neritic environments, reflecting a fluctuating but predominantly shallow marine influence. This study enhances the understanding of Neogene

paleoceanographic conditions in the Niger Delta Basin and provides valuable data for hydrocarbon exploration.

Keywords: Foraminifera, Biostratigraphy, Paleoenvironment, Miocene, Agbada.

Abstract ID: T2_005

Diagenesis of Sandstones from the Neoproterozoic Kwahu-Bombouaka Group of the Voltaian Supergroup: Implications for Reservoir Quality Characterization.

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Abstract

The diagenesis of sandstones within the Kwaku-Bombouaka Group of the Voltaian Supergroup plays a critical role in determining their reservoir quality and potential for the exploration of natural resources. This paper investigates the diagenetic processes affecting these sandstones, focusing on their mineralogical, textural, and geochemical transformations. Through a combination of petrographic analysis, scanning electron microscopy (SEM), X-ray diffraction (XRD), and geochemical analysis, this study elucidates the diagenetic pathways and their impact on porosity and permeability. Preliminary petrographic analysis indicates the sandstones are quartz arenites, ferruginous sandstones, subarkoses, and lithic arenites, each exhibiting distinct textural and mineralogical characteristics. Authigenic minerals include quartz (existing as overgrowths on detrital quartz grains), clay minerals, carbonates and hematite. The diagenetic processes that have affected these sandstones include cementation, compaction, recrystallization, replacement, mineral overgrowths and dissolution. These processes have passed through early, late and uplift- related diagenesis. Understanding these diagenetic processes is essential for accurate reservoir quality

characterization, as they directly affect the storage and flow properties of fluids within the sandstones as reservoir rocks within a petroleum system. This paper provides valuable insights into the diagenetic evolution of the Kwahu-Bombouaka sandstones and offers implications for improved exploration and exploitation strategies in similar geological settings. The findings highlight the crucial role of comprehensive diagenetic studies in improving predictions of reservoir quality and optimizing the recovery of resources, including water, mineral reserves, and hydrocarbons.

Keywords: Diagenesis, Reservoir quality, Porosity, Permeability.

Abstract ID: T2_006

Diamondoid Geochemistry of Bitumen from Eastern Dahomey Basin, Nigeria

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Abstract

Twenty extracts samples from outcrops, cores and seepages of bitumen of Dahomey Basin were subjected to Quantitative diamondoid and biomarker analyses for assessing source, thermal maturity, biodegradation, oil mixing and cracking. GCMS was carried out on the saturated hydrocarbon fractions for diamondoid and biomarkers. Source parameters, C27C29 regular steranes, were significantly altered by biodegradation. Abundance of pregnane and homopregnane indicate iron in detrital clays while pregnane/homopregnane established the varying degrees of biodegradation. Diasterane ratios suggests derivation from clay-rich clastic rocks. Diasterane index suggest high thermal maturity and the plot of C29 sterane isomerization revealed early to peak maturity. High contributions of marine organic matter was inferred from C24T/C26 while C25/C26 confirm marine oils. The plot of C19/C19+C23 against C24T/C24T+C23 support derivation from marine organic matter. Sterane and hopane biomarkers revealed heavy to severe biodegradation

with the presence of C25 norhopane in all samples. Diamondoid organic facies parameters DMDI1 and EAI revealed TypeII marine source rocks while TypeII marine siliciclastic facies was inferred from the relative distribution between 3,4DMD, 4,8DMD and 4,9DMD diamondoid parameters. Diamondoid thermal maturity parameters, MAI and MDI, revealed very high maturity, with equivalent vitrinite reflectance of 1.1-1.6%. Adamantanes and its alkyl groups 1MA, 2MA, 1EA and 2EA were absent in samples IDC, IWC,OKC,ELC,AJC and OHC while samples ILT and AET lacks adamantane resulting from evaporative fractionation and selective biodegradation. Significant changes in MA/A ratios occurred with variations as biodegradation increases while MD/D ratios revealed slight changes at higher levels of biodegradation. Oil cracking indicator, 3+4methyldiamantane, revealed highly cracked bitumen increasing eastward. The bitumen samples revealed mixed accumulation of cracked and uncracked oils.

Keywords: Marine, diamondoids, biomarkers, adamantane, biodegradation

Abstract ID: T2_007

Compound Specific Isotope Analysis of Carbon in Characterizing Suite of Complex Oils from the Niger Delta Depobelts, Application of Nigeria

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Abstract

The Niger Delta is one of the world's most prolific oil basins, shaped by complex geology and diverse crude oil types. Understanding oil sources and composition is essential for reservoir correlation, improving recovery strategies, and resolving challenges around oil mixing and post-generation alterations, issues often inadequately addressed by traditional geochemical methods. This study analyzed 26 oil samples from nine fields across four depobelts (onshore and offshore) using gas

chromatography–isotope ratio mass spectrometry (GC-IRMS) to better trace oil sources and detect mixing. Distinct isotopic patterns emerged, revealing three main petroleum systems in the basin. Oils from three fields in the Northern Delta depobelt and Field 'J' in the Coastal Swamp depobelt exhibited negatively sloping n-alkane $\delta^{13}C$ profiles, indicating terrestrial-deltaic sources. In contrast, oils from the Greater Ughelli depobelt showed reversed isotopic trends beyond nC23, reflecting a mix of mature, intensely cracked oils and less altered terrestrial input. Field 'K' oils (Coastal Swamp) had flat profiles, consistent with a marine-derived origin from kerogen with uniform isotopic signatures. Offshore fields showed "saw-tooth" $\delta^{13}C$ patterns, typical of pro-deltaic deepwater systems. Comparative analysis revealed isotopically heavier oils in Field 'N' than in Field 'O', possibly due to source material differences or thermal maturity. These results highlight three distinct petroleum systems: terrestrial-deltaic, marine, and mixed (terrestrial-marine), with the Greater Ughelli depobelt showing hybrid characteristics. The study demonstrates the effectiveness of compound-specific isotope analysis (CSIA) in detecting subtle geochemical variations missed by conventional techniques. This approach enhances oil-source correlation and offers valuable insights into petroleum system evolution, aiding exploration, reservoir management, and development planning in the Niger Delta.

Keywords: Oil mixing, hybrid oil, isotope

Abstract ID: T2_011

Structural Interpretation and Sequence Stratigraphy of Kolmani Basin, Northeast Nigeria, Using 3D Seismic Data and Well Log Data for Enhanced Hydrocarbon Prospectivity

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Abstract

Kolmani Basin is one of the inland basins located within the Gongola arm of the Upper Benue Trough, Northeast Nigeria, with a potential for hydrocarbon exploration. Historically, it has recorded limited exploration chance of success owing to the evasive nature of the structural geology, stratigraphy, and environment of deposition related to the Santonian Tectonic episodes of the study area. However, this study focused on the structural interpretation and the sequence stratigraphy of Kolmani Basin using 3D seismic data and well log data. The lithological interpretation indicates sands and shales as the dominant lithologies with minor occurrence of limestones and marls. The delineated reservoir sands (Res A, Res B, Res C) mapped within Pindiga Formation are of limited thickness (6.13m, 3.17m, 5.68m, respectively) with oil as the type hydrocarbon. The structures encountered in this study area are faults (normal, reverse, synthetic, antithetic listric, and conjugate faults), folds (drag, detachment, synclinal, and rollover anticlinal folds), unconformities (disconformity and angular unconformity), horsts, grabens, and shale diapirs. These structures, the majority of which trend mainly in the northeastern direction, served as seals, migration pathways, and traps for the generated hydrocarbon. The sequence stratigraphy analysis revealed that the Bima Sandstone and Kerri-kerri formations were deposited by a fluvial system. On the other hand, the Yolde Formation and Gombe Sandstone were deposited in a transitional environment, while Pindiga Formation was deposited in a marine environment. The delineated reservoir units were deposited during the low stand system tract and the seismic sequence stratigraphy indicated downlap, onlap, toplap structures, and incised valley. However, six prospects bounded by northeast-trending faults were identified for further hydrocarbon exploration.

Keywords: Structural framework, Stratigraphy, Benue Trough

Abstract ID: T2_023

Characterization of Agbaja and Okobo Coals, Southern Bida and Northern Anambra Basins Respectively, Nigeria

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Abstract

The Bida and Anambra basins in Nigeria are part of the West Africa Rift system with Upper Cretaceous sediments. In this study, the coals from the Okobo, Anambra Basin and the newly discovered coals from Agbaja Plateau, Bida Basin are characterized using the palynological, geochemical and mineralogical techniques. The land derived palynomorphs obtained is composed of Proteacidites otaminiriensis, Zlivisporis blanensis, Tricolporopollenites sp., Cingulatisporites ornatus, Echitriporites trianguliformis, Retidiporites magdalenensis and Monocolpites marginatus. The assemblage suggests Maastrichtian age for the coals and a diverse vegetation typical of humid tropical conditions. The XRD analysis also reveal the presence of quartz, k-feldspar, calcite, and clay mineral components such as kaolinite, smectite and illite. The FTIR spectrum of the coal is characterized by a weak carbonyl C=O stretch at ~1700 cm^{-1} suggesting low oxygen condition. The prominent absorption peaks at 2925 cm^{-1} and 2850 cm^{-1} point to the presence of long-chain aliphatic compounds. The organic matters are classified as Type II and the TOC is moderately high with values ranging from 50.7-55.7wt%. The HI and Tmax range from 178.71 to 217.00 mgHC/g and 4050C to 4300C respectively indicating that the organic matter is mainly of type III and II and of low thermal maturity. The proximate data shows that samples have high fixed carbon ranging from 41.08 to 47.01% and high calorific values ranging from 21.96 to 23.51J/Kg respectively, indicating their suitability for electricity and cement production. The high volatile matter and moisture contents of the coals,

ranging from 36.47 to 45.82% and 5.91 to 11.03% respectively exceed the threshold and make them less suitable for metallurgical applications. Generally, this study indicates that the coals are sub-bituminous rich in organic matter and may offer rare earth metals bearing potential that may impact on green energy with implications on climate change.

Keywords: Okobo, Agbaja, Anambra, sub-bituminous, humid

Abstract ID: T2_024

Beyond South Lokichar: Visualize the Bigger Picture of Exploring Multiple Kenya Basins

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Abstract

Kenya's hydrocarbon exploration has been dominated for over a decade by the South Lokichar sub-basin, yet the nation's petroleum potential extends across multiple underexplored frontiers. Four basins—the Anza, Lamu, Mandera, and other Tertiary sub-basins—present distinct but promising petroleum systems that could reshape Kenya's energy future. The Anza Basin hosts 2,000–8,000m of Cretaceous sediments with organic-rich lacustrine and fluvial shales. Data from wells such as Chalbi-3 and Sala-2 confirm Type I and III kerogens, supported by oil and gas shows. The Lamu Basin contains 3,500–10,000m of onshore and up to 12,000m offshore sediments, with plays in the Sabaki, Tana, Coastal, and Karoo groups. Onshore Lamu remains lightly explored, while offshore efforts are more advanced. The Mandera Basin, with up to 5,000m of sediments and shows oil presence in Tarbaj-1 seep, though exploration remains limited. Additional rift basins—including Lotikipi, Turkana, Suguta-Magadi, South Kerio, and Nyanza—feature interbedded sands and lacustrine shales, pointing to favorable source-reservoir-seal systems. Despite this diversity, exploration has been heavily concentrated in South Lokichar. Kenya's upcoming licensing round offers an opportunity to redirect focus toward these frontier basins. The

National Oil Corporation of Kenya (NOCK) is already advancing activity in the Magadi Basin, reinforcing multi-basin potential. While discoveries in northwestern Kenya confirm commercial viability, the country continues to rely on imported oil. Broadening exploration across basins could unlock new reserves, attract investment, and strengthen energy security. With appropriate policy support and investor engagement, Kenya is well-positioned to emerge as a multi-basin hydrocarbon hub in East Africa.

Keywords: Petroleum, Source-Rock, Potential, Reservoir

Abstract ID: T2_025

Petrophysical Characterization and 3D Seismic Interpretation of Reservoir Units of the Sokor-1 Formation, Fana Low Uplift, Termit Basin, Southeastern Niger

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Abstract

The petroleum system of the Termit Basin is complex, shaped by multi-phase tectonic activity from the Early Cretaceous to the Paleogene. The Sokor-1 Formation of Paleo-Eocene age, a key hydrocarbon-bearing unit in southeastern Niger, consists of five sand groups, namely E-1 to E-5, interbedded with mudstones. However, variations in depositional environments, diagenetic processes, and structural complexity create uncertainties in reservoir quality and hydrocarbon reserve estimation. This study integrates petrophysical evaluation and 3D seismic interpretation to address these challenges. A 3D seismic dataset covering 38,610 acres and well log data from six wells F-1 to F-6 were analyzed using Petrel and Interactive Petrophysics software. Correlation of reservoir units revealed

significant lithological heterogeneity, with sandstones as the dominant lithology of reservoirs. Tectonic controls on sedimentation resulted in lateral thickness variations and thicknesses, with wells F-1 and F-2 showing the most significant deformation. Structural analysis identified transtensional fault blocks and a few transpressional faults, forming grabens, half-grabens, and horsts. Fault intensity decreases from the E-5 sand group toward the E-1 sand group, influencing hydrocarbon accumulation. Some faults penetrated the Yogou Formation, leading to secondary hydrocarbon enrichment in Sokor-1 reservoirs. Reservoir quality varies across sand groups, with E-1 exhibiting the best properties (porosity 29.9%, permeability 91 mD), while E-5, despite lower reservoir quality (porosity 27.3%, permeability 51 mD), holds the highest hydrocarbon saturation (45.5%). The estimated hydrocarbon reserves amount to 655,809.2 MMB, with well F-5 contributing the highest share (37.97%) and F-6 the lowest (1.25%). The findings confirm that the Fana Low Uplift hosts promising reservoirs and significant hydrocarbon potential, making uplifted zones key exploration targets.

Keywords: Reservoir quality, Petrophysical evaluation

Abstract ID: T2_027

Reservoir and Rock Physics Analysis in "ADE" Field Offshore Niger Delta

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Abstract

Formation evaluation analysis, rock-physics models, and log-facies classification are powerful tools to link the physical properties measured at wells with petrophysical, elastic, and seismic properties. Data used were well logs and 3D seismic volume. The Interactive Petrel Software was used in the Interpretation. The main aim of the study is to use rock physics and structural models to understand the behavior and potential hydrocarbon recovery with well logs. Therefore, it is imperative to evaluate the targets (pay zone) within the available fields to determine

the extent of the known reservoirs for assessment and development. An integration of well and seismic data in conjunction with time-depth relationship was employed to identify where the hydrocarbon bearing sands from well, post on the seismic sections. Good tie was obtained for well to seismic data. The study analyzed different petrophysical parameters and elastic properties for thirteen (13) reservoir units using well log data from four (4) wells.

Potential productivity of each reservoir unit was analyze from petrophysical parameters. The findings showed that each unit has varying values porosity, water saturation, thickness of sand, percentage of shale, Net to gross. Most of the reservoirs have good porosity range from (20% to 25% respectively), compared to other reservoirs. The time and depth structural maps revealed anticlinal structural closures that are hydrocarbon prospects. It was viewed and evaluated of tested traps was to characterise the reservoirs. Cross-plots of different elastic and rock physic parameters (Young's Modulus, Shear Modulus, Bulk Modulus, mhu rho, acoustic impedance) and 3D structural models reveal, the state and quality of hydrocarbon bearing sands and shale with respect to fluid in place. It is therefore recommended that ADE's field is prospective and should proceed to further stag.

Keywords: Petrophysical, Reservoir, Prospect, Hydrocarbon

Abstract ID: T2_028

Integrated Organic and Inorganic Geochemistry for Assessing the Hydrocarbon Potential of Upper Jurassic-Lower Cretaceous Sediments in the Senegalo-Mauritanian Basin, West Africa.

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Abstract

This study integrates organic and inorganic geochemical analyses

to evaluate the hydrocarbon generative potential of Upper Jurassic-Lower Cretaceous (UJLC) sediments in the Senegalo-Mauritanian (SM) Basin. Representative limestones from Upper Jurassic to Early Aptian, along with shales, and limestone from the Aptian to Albian Ages, have been characterized using Rock-Eval pyrolysis and LECO, as well as Inductively Coupled Plasma Mass Spectrometry (ICP-MS). The Total Organic Carbon (TOC) values of Jurassic, Neocomian, Aptian, and Albian sediments range, respectively, between 0.11 and 0.438 wt%; 0.10 and 0.76 wt%; 0.12 and 0.86 wt%; and 0.2 and 2.43 wt%. Based on the HI values, the UJLC samples of the SM Basin suggest a higher terrigenous contribution, indicating type III kerogen. However, 15.38% of the Albian samples and 33% of Neocomian samples show the presence of type II/type I kerogen. Cross plots of Hydrogen Index (HI) versus Tmax show that the majority of Albian samples are within the mature zone with the potential to generate oil and little gas. The Aptian sediments are present in equal proportion between immature and mature zones, while Neocomian and Jurassic sediments are partly within the immature zone. Compared to the Jurassic and Neocomian samples, Albian and Aptian samples present fair hydrocarbon generative potential. The Low HC generative potential of the UJLC sequence may be related to the moderate-to-low primary productivity observed from Ba/Al and Ni/Al proxies, or to the oxic environment of deposition, which does not favor organic matter preservation. Incorporating organic matter proxies into source rock evaluation is highly beneficial to the assessment of the petroleum potential of the studied basin. It reduces exploration uncertainty and provides guidance for future resource development in this underexplored margin.

Keywords: Kerogen, Organic matter, TOC, Senegalo-Mauritanian Basin, ICP-MS, Geochemical Analysis Geochemistry, Hydrocarbon, West Africa

Abstract ID: T2_029

Multidisciplinary Characterisation of the Guba Seam, South Africa: Implications for Coal Utilisation

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Abstract

The Molteno Coalfield in South Africa, part of the Late Triassic Stormberg Group, remains under-characterised in terms of its coal quality and utilisation potential. This study presents a multidisciplinary investigation of the Guba Seam using coal petrography, geochemical analysis, and washability testing to evaluate its beneficiation prospects and energy use potential. A total of 13 samples were collected using channel grab sampling, targeting both upper and lower seam intervals. Initial float-sink analysis established a wash density of 1.70 g/cm³ as optimal, which was then applied to all samples. Analytical results reveal the coal is high in ash and low in volatile matter, carbon, and calorific value, with washed samples showing improved but still sub-spec Eskom value(~9–21 MJ/kg CV and <35% ash). Maceral analysis indicates a dominance of inertinite (raw: 57%, washed: 51%) and a rise in vitrinite post-washing (raw: 43%, washed: 48%). Mean vitrinite reflectance values (RoVmr% = 2.18) classify the seam as high-rank C anthracite. Mineral matter is predominantly clay-bound, necessitating fine grinding for effective liberation. The palaeoenvironmental interpretation suggests deposition under fluctuating water tables and varying oxidation states, accounting for maceral variability. The coal's physical and chemical limitations restrict its utilisation in national power stations but create opportunities for decentralised mine-mouth modular power stations, a concept already applied in other coal-producing counties. Although South Africa's official transition strategy is strongly focused on renewables, such pilots may ease grid strain and serve nearby industries and communities. Additionally, the coal exhibits no coking potential due to a Free Swelling Index of zero, precluding metallurgical applications. However, its low sulphur and moderate ash fusion temperature make it suitable for domestic heating applications and small-scale industrial boilers.

Keywords: coal petrography, coal utilisation, anthracite,

Abstract ID: T2_032

Time – Frequency Based Techniques for Imaging Hydrocarbon Prospective Zones and Associated Structures in a Niger Delta Basin Offshore Field, Nigeria

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Abstract

To address the bandwidth resolution problem of the BOK field 3D seismic dataset and to illuminate the hydrocarbon prospective areas and their associated structures for detailed reservoir characterization of the field, we present two time-frequency domain based techniques of the Fast Fourier Transform (FFT) and the Continuous Wavelet Transform (CWT). Pre-processed 3D post-stack depth migrated seismic volume and custom software was used. After the data was conditioned using structural smoothing, zones of interest were identified. Three prominent frequencies; 10 Hz, 25 Hz, and 32 Hz were chosen and color-coded (Red - 10 Hz, Green - 25 Hz, and Blue - 32 Hz). The resulting volume was a mixture of these three dominant frequencies after these frequencies were color blended using an RGB mixing procedure. After analysis, we imaged a number of channels, flood plains, crevasse splay deposits, and faults related to hydrocarbon prospective zones on two time slices taken at -2000ms and -1800ms. Some of the channels were fault-controlled, and were meandering, low-sinuosity channels. At the shallow time-slice, the crevasse splay deposits were much larger and numerous. The crevasse splay deposits were observed to be deposited on floodplains and bifurcating fault lines suggests that they are younger than the faults. Channel migration was from S-N of the BOK field, and channel flow was from E-W. A multistory stacked channel system is suggested by the seismic data's increasing number of channels from the base to the top. The CWT technique was more effective in enhancing major and minor faults, whereas the FFT decomposition technique was the most

effective in enhancing channels and crevasse splays. This study has demonstrated how helpful these time-frequency approaches could be in resolving the bandwidth resolution problem related to imaging hydrocarbon prospective areas and their associated structures.

Keywords: Time-Frequency, Fourier Transform, Faults

T2- S2 Role of Fossil Fuels in Africa's Energy Transition to carbon neutral economies

Abstract ID: T2_013

Sealing the Deal: CO_2 Storage in the Pletmos Basin

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Abstract

Geological storage of carbon dioxide (CO_2) in sedimentary basins is a promising strategy to reduce emissions and mitigate climate change. The current study investigated the sealing potential of major Pletmos Basin faults using integrated subsurface data, notably 3D seismic interpretation and shale volume petrophysical logs. Two main approaches were applied: the juxtaposition triangle method and the Shale Gouge Ratio (SGR). The triangle diagram assessed lithological contacts across fault planes, identifying sand-sand and sand-shale juxtapositions that influence CO_2 leakage risk. The SGR method quantified clay content along fault planes, providing a direct measure of sealing capacity.

Faults were grouped into three categories: non-sealing (SGR 0–0.2), moderately sealing (0.2–0.4), and highly sealing (0.5–1.0). Results show that faults F-2, F-3, F-7, and the Superior Fault fall within the moderately sealing range, suggesting partial effectiveness as barriers. Fault F-11, with an SGR of 0.5 and limited sand-sand juxtapositions, was classified as highly sealing. Importantly, all analyzed faults exceeded the 0.2 SGR thresholds, pointing to generally favourable sealing conditions across the basin.

Overall, this research advances understanding of South Africa's CO storage potential and emphasizes the critical role of fault analysis in early-stage carbon capture and storage (CCS) assessment. By

pinpointing sealing faults that can maintain storage integrity, the study supports informed decision-making for future offshore CCS projects in the region.

Keywords: Juxtaposition, Fault Seal, Shale Gouge.

Abstract ID: T2_016

Investigation of Natural Gas Manifestation Within the Kenya Rift System

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Abstract

Natural gas in the East African Rift System is catching the attention of scientists and energy investors now more than ever. For a long time, natural gas was largely overlooked because most efforts focused on exploring and producing oil. However, with increasing awareness of climate change and a move toward cleaner energy sources, natural gas has emerged as a promising transitional fuel. Back in 1957, during some of the first test drillings near Kijabe on the edge of Kenya's Central Rift, explorers discovered shallow pockets of natural gas. This gas was used to power a generator for research activities, showing early on that the Rift could hold valuable energy resources. Since that finding, natural gas seeps and occurrences have been discovered at several locations along the eastern border of the Rift, including Kipeto, Solai, and Kabartonjo. These locations stretch along a clear north-to-south line and reveal a pattern of natural gas manifestations in water wells and from ground seepages. Recent tests of gas samples from Kipeto and Kabartonjo have been encouraging. Methane has been confirmed to make up about 30% of the natural gas, a good sign for potential energy production. The detection of trace helium at around 0.29% in Kipeto adds to the potential economic value of these resources. A similar phenomenon is witnessed at Lake Kivu within the broader East African Rift, where natural gas is already being used commercially to produce electricity. Kenya has a real chance to develop these natural gas

resources in a way that supports cleaner energy goals. Methane burns cleaner than coal or oil, which means it can help the country reduce greenhouse gas emissions while meeting growing energy demands. Moving forward, it is essential to conduct more detailed studies to better understand these gas deposits and determine the most responsible ways to develop them, ultimately enhancing Kenya's energy future and economy.

Keywords: Gas Seep, Methane, Helium, Transition

Abstract ID: T2_017

Geochemical and Mineralogical Secrets of Cretaceous - Cenozoic Coals in the Upper Benue Trough, Nigeria.

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Abstract

The rising global demand for strategic minerals and rare earth elements (REEs), coupled with supply shortages, has necessitated exploration of unconventional sources (coal seams and coal beds). This study aims to investigate the mineralogical composition, trace elements, and rare earth elements in the sample area, Upper Benue Trough (UBT), Nigeria, using seven coal samples were collected from four localities. Samples were subjected to mineralogical and geochemical analyses at the University of Witwatersrand. Thermogravimetric analyzer (TGA) was used for proximate analysis, calorific value (ISO 1928:2009 and SANS 17247:2006/ISO 17247:2005 standards). The solutions were analyzed for inductively coupled plasma mass spectrometer (ICP-MS). The proximate analysis revealed moisture content of 6.8 wt.%, volatile matter of 27.7 wt.%, fixed carbon (FC) of 48.4 wt.%, and ash yield of 17.6 wt.%. The calorific value is 24.11 MJ/kg, (dry, ash-free basis). These findings indicate that the Cretaceous coals of the UBT are characterized by low ash, sulfur, and moisture contents. Mineralogical analysis identified quartz, kaolinite, gismondine (hydrated aluminosilicate), cadmium

cyanide (Cd (CN)2), and zinckenite (lead antimony sulfide) as major constituents. These results were compared to certified values of SARM 18. Coal ash processing could offer an economical and environmentally sustainable approach to supplement traditional mining methods.

Keywords: Critical minerals, Rare Earth Elements

Abstract ID: T2_030

The Importance of Structures in a Helium Gas Field in the Mpumalanga Province, South Africa

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Abstract

The Council for Geoscience is undertaking research aimed at supporting South Africa's just transition to a low carbon economy. This involves identifying natural gas resources such as hydrogen and helium that can serve as alternative energy sources. In viable natural gas plays faults and fractures often form good migration pathways from the source rocks to the eventual trap sites. Delineating potential faults and fractures is therefore a fundamental part of natural gas exploration. Geological maps show faults that are visible at the surface, but overburden, vegetation and anthropogenic activity can obscure these features. There may also be deeper-seated structures that do not reach the surface. Magnetic data are very effective in delineating potential faults and fractures. Furthermore, the data can also be used to map potential source rocks if they contain magnetic minerals. The South African Minerals Database (SAMINDABA) recorded 62 helium occurrences around Secunda and Bethal in the Mpumalanga Province of South Africa. Airborne magnetic data collected at a line spacing of 200 m was used for lineament interpretation. Most of the recorded helium occurrences were clustered along a ~20 km long curvilinear east-west

trending structure and a 14 km long WNW-ESE striking lineament. Since the distance to a structure may affect the natural gas concentration, a simple proximity analysis was done. The analysis revealed that 40 helium occurrences were within 2 km of a lineament, with 13 closer than 500 m. This is encouraging considering that in large fields in other parts of the world economic helium deposits were concentrated within ~2.5 km of faults, with helium molar percentage decreasing with distance from the fault. A 3D geological model constrained by the surface geology, detailed lithology logs from legacy borehole data, the CCUS-01 borehole at Leandra and lineaments supported the notion of the lineaments as possible migration pathways.

Keywords: Helium; Lineaments; Natural gas

Abstract ID: T2_031

Serpentinization and Fairy Circles: Implication for the Green Hydrogen Project in Namibia

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Abstract

In this study, we discuss fairly circles which occur in Southern Namibia, as pathfinders to natural hydrogen occurrence in rocks which may to contribute to the nascent green hydrogen project in the country. We combine our field studies with literature available in the public domain for the study. Fairy circles are pockmarks that occur in arid grasslands, often in a distinct spatial arrangement of a repetitive circular and elliptical geometry of barren land, surrounded by vegetation. The diameter of these empty gap circles can vary from 4 to 10 m or higher values. Serpentinization, a rock diagenesis process, can lead to a continuous generation of hydrogen. Seepages of the hydrogen escaping from the crust to the surface are thought to initiate the formation of the circles. The green hydrogen project in Namibia relies on electrolysis of water from the Atlantic Ocean to produce hydrogen. The production process is energy intensive, with implications on costs, and greenhouse gas emissions. An alternative production option is to harness the native hydrogen which occurs naturally in rocks due to serpentinization, a geologic process involving the hydrous alteration of olivine-rich ultramafic rocks under suitable T-P conditions. The fairy circles are found in the study areas which are underlain by the Kairab Formation consisting of mixed gneiss and amphibolite, and the Barby Formation which comprise rhyolites, basaltic and volcanoclastic rocks. These may be pathfinders to native hydrogen which can be a significant vector in the sources of the gas, for economy and zero-emissions. Apart from its very high mass density of energy, hydrogen is a solution to manage the intermittency of solar and wind energy. In this presentation, we have examined the link between serpentinization, gas seeps and fairy circles. Information in this presentation may add to the knowledge database of green hydrogen managers and stakeholders in Namibia for informed additional decisions.

Keywords: Namibia, fairy circles; serpentinisation, hydrogen,

T2- S4 Carbon Capture, Utilization, and Storage (CCUS): A Path to Decarbonization

Abstract ID: T2_019

Mining Waste, Climate Gains!

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Abstract:

South Africa remains heavily dependent on coal, with approximately 95% of electricity derived from fossil fuels, resulting in nearly 400 million tonnes of CO_2 emissions annually. A promising opportunity to mitigate these emissions lies in utilizing ultramafic mine tailings, which are abundant byproducts of the country's platinum, nickel, and copper industries.

Mineral carbonation is a proven, environmentally sustainable process in which CO_2 reacts with magnesium, iron, and calcium silicate minerals in ultramafic tailings, forming stable carbonates. These carbonates not only provide permanent CO_2 storage but also hold potential for industrial applications in brick-making, road construction, landfills, and agriculture. This dual benefit positions mineral carbonation as both a climate change mitigation strategy and a pathway for generating valuable byproducts.

This study assesses the suitability of South African mine tailings facilities for CO_2 sequestration by considering six critical factors: total tonnage, mineralogical composition, particle size, surface area, carbonation capacity, and proximity to major CO_2 sources such as Secunda. A theoretical ranking framework was developed using two algorithms to prioritise facilities with the highest potential.

For example, the O'okiep copper mine dam, despite its considerable distance from Secunda (1,302 km) and relatively low surface

area (1.596 m^2/g) and carbonation capacity (6.31 t/ton CO_2), was ranked unsuitable for immediate sequestration. Nevertheless, future developments in local CO_2 supply could enhance its viability.

The current research highlights the significant potential of South African mine tailings as long-term CO_2 storage sites while offering an evaluative framework for prioritising facilities. These findings provide critical insights for advancing mineral carbonation initiatives in the South Africa.

Keywords: Sequestration, CO_2 Fixation, Tailings Utilization

Abstract ID: T2_026

Integrating Geophysics and Remote Sensing for Site Characterization for Geologic Carbon Storage: Insights from the Kenya Rift Valley

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Abstract:

With the intensifying impacts of climate change, geologic carbon storage (GCS) has emerged as a vital strategy for long-term CO_2 sequestration through mineralization. The Kenya Rift, defined by active tectonics and extensive basaltic units, presents significant but underexplored potential for GCS. Here, we integrate Sentinel-2 remote sensing with ground magnetic and transient electromagnetic data to characterize the region's basalt formations and evaluate their suitability for CO_2 storage. We identified distinct basalt units—including the Kirikiti and Elementaita basalts—and assess their potential and estimated storage capacities for CO_2 storage. Our analysis highlights heterogeneous basalt formations of variable thicknesses intercalated with thick Quaternary sediments that might act as caprocks to stratigraphically store CO_2. This study demonstrates a scalable, cost-effective approach

to subsurface assessment in data-scarce regions and advances the global understanding of GCS viability in continental basalt provinces beyond well-characterized sites like Iceland. By outlining the storage potential of Kenya's Rift basalts, our findings provide an evidence base that can inform national strategies for deploying carbon storage technologies. This work supports integration of GCS into Kenya's climate action roadmap and long-term decarbonization pathways, aligning scientific advances with policy frameworks for achieving the country's emission reduction commitments

Keywords: Climate-Change, Remote-Sensing, Geophysics, Rift, Kenya

T3- S1 Geothermal Exploration and development

Abstract ID: T3_002

Harnessing Geothermal Energy in Antsirabe, Madagascar: A Path Towards Sustainable Development

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Abstract

Madagascar has ten geothermal regions, classified into three main categories: volcanic terrains, fault zones and sedimentary basins. The Antsirabe region, south of the capital, is influenced by a complex geological structure and is home to a geothermal reservoir with temperatures ranging from 75°C to 152°C. However, to date, these resources have only been exploited for thermal treatments, and remain under-exploited. The Ankaratra volcanic system, with medium to high energy potential, plays a key role in the region's thermal dynamics, and an in-depth study could stimulate structured exploration. The Antsirabe basin has a geological context marked by strombolian volcanoes, basaltic flows, and tectonic fractures. Several approaches will be used to assess its potential. Geological mapping and structural analysis, supported by drone-based photogrammetry, satellite imagery, and in-field data, will identify structures favorable to the circulation of hot fluids and clarify the role of fractures and faults in controlling local geothermal energy. These combined results will enhance system characterization, enable the construction of a conceptual geothermal reservoir model, and guide proposals for sustainable resource valorization. Identifying the main geological formations and heat sources will also contribute to a better understanding how these geothermal deposits have formed and evolved. Beyond the scientific aspect, this study will also take into account economic and environmental dimensions, in order to propose viable solutions for the development of geothermal energy. Ultimately,

this research aims to transform geological knowledge into concrete action, to encourage sustainable development and promote the use of geothermal energy in Madagascar. This study could even respond to the urgent need for Madagascar to meet the growing energy challenges caused by its heavy dependence on fossil fuels.

Keywords: Geothermal- Ankaratra -volcanic- sustanaible development

Abstract ID: T3_004

Influence of Mantle Plumes in Controlling Geothermal Fluid Flow in the East African Rift System.

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Abstract

The East African Rift System (EARS) is one of the world's most tectonically and volcanically active zones, offering vast geothermal potential for sustainable energy development. Increasing evidence highlights the central role of mantle plumes in shaping this geothermal resource base. Seismic tomography and geodynamic modeling reveal that the EARS overlies a complex mantle plume head, extending from East Africa to Arabia, characterized by interconnected low-velocity anomalies that indicate elevated temperatures and partial melt zones. This plume-lithosphere interaction enhances lithospheric thinning, drives widespread magmatism, and establishes long-lived heat anomalies critical for geothermal activity. This study investigates how mantle plumes influence geothermal fluid circulation and reservoir development by combining geophysical imaging, geochemical signatures of geothermal fluids, and numerical simulations of heat and fluid transport. The findings suggest that mantle plumes not only provide sustained crustal heat but also promote fracture permeability through plume-related magmatism and faulting, thereby controlling fluid pathways. Spatial

variability in plume intensity and lithospheric response may explain the heterogeneity of geothermal productivity across the rift, particularly in high-potential regions such as Olkaria, Menengai, and Baringo. Understanding the coupling between deep mantle dynamics and shallow geothermal systems provides predictive insights for exploration, guiding drilling strategies, and de-risking investments in East Africa's geothermal sector. Beyond regional applications, these results underscore the broader significance of plume-driven geothermal systems worldwide, where deep Earth processes act as critical enablers of sustainable energy transitions.

Keywords: Thermodynamics, Geothermal, Rift Valley

Abstract ID: T3_005

New Horizons in Geothermal Exploration and Development Across Africa

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Abstract

In Africa, work in the field of renewable energy, including hydroelectric, geothermal, wind and bioenergy, continues, particularly in the areas of electricity generation and clean cooking. Geothermal energy, one of the continent's significant energy sources, has yet to have its full potential determined, and geothermal exploration is needed in most regions. However, it is noteworthy that Kenya ranks among the world's top 6 countries in geothermal energy, with an installed capacity of approximately 1 GWe. Considering its high-capacity factor, increasing energy demand and enabling integrated facilities, geothermal energy is important for the continent in energy transformation. In particular, Kenya, Ethiopia and Tanzania are pioneering geothermal energy investments, while there are also very ambitious capacity estimates across the

continent. The mechanisms of geothermal systems across Africa are examined, and the potential geothermal applications and required geoscience studies are addressed within the scope of the work. It is noticeable that geothermal systems across the continent are generally controlled by volcanism and volcano-tectonic activity. Accordingly, in volcanic regions, MT, gravity, magnetic, and micro-seismic monitoring for fluid pathways, and temperature profiles must be obtained using slim-hole wells. However, since surface geothermal indicators are important in these systems, conducting MT and geochemical studies in conjunction with geology would be an efficient starting point. In geothermal systems where tectonic effects are dominant, determining heat flow by producing gradient maps to monitor deep circulation, hydrogeological modeling, and geochemical studies are meaningful studies in reservoir characterization. The use of artificial intelligence algorithms to enable predictions based on remote sensing and acquired data will also be important in understanding potential of the continent as a whole.

Keywords: Geothermal, reservoir geology, renewable

Abstract ID: T3_006

Reverse Osmosis in Geothermal Systems

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Abstract:

Reverse osmosis (RO) is a water purification process that uses a semi-permeable membrane to separate water molecules from other dissolved or suspended substances, and is used in industrial processes for production of potable water.

RO retains the solute / large molecules on the pressurized side of the membrane and the purified solvent passes to the other side. R.O. differs from filtration in that the mechanism of fluid flow is reversed, as the solvent crosses membrane, leaving the solute behind. RO involves

solvent diffusion across a membrane that is either nonporous or uses nanofiltration with pores 0.001 micrometers in size.

Geothermal power plants use large volume of geothermal water. Brine or condensates are usually reinjected back into the reservoir as a way of disposing it or maintaining reservoir pressure. There have been cases of blockage in the reinjection wells, and scaling and corrosion in equipment caused by precipitation of salts out of the brine. This can be reduced by desalinizing the water through R.O. Therefore, after electricity production, the waste water, can be passed through an RO membrane to desalinize the water for recycling. The waters should undergo pre-treatment steps like filtration to remove larger particles that could clog the membrane.

A pump applies significant pressure to the geothermal water, overcoming the natural osmotic pressure and pushing the water through the membrane. The rejected contaminants, like salts and minerals, become increasingly concentrated on the "feed" side of the membrane, forming a brine that is typically disposed of or further treated depending on the application. Predicting and preventing sediment precipitation in membrane systems is a key aspect of their operation, therefore several commercially antiscalants are usually applied.

It is important to take care of the membrane by increasing its life span so as to serve the cause effectively.

Keywords: Reverse Osmosis, Geothermal, Membrane

Abstract ID: T3_008

Monitoring the Growth Rate of Silica Colloids Through Immersion Experiments at the Olkaria Geothermal Field, Naivasha Kenya

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Abstract:

The Olkaria geothermal field is a high-temperature field located on the floor of the Kenyan Rift Valley that is hosted within a volcanic complex

characterized by numerous rhyolitic domes with major N-S normal faulting. Production in the field began in 1981 with a 15 Mwe plant, currently at 799 Mwe, generated from several power plants within the 202 km2 concession area. In this contribution, we present the experimental results of different tests that we conducted in the Olkaria geothermal field to understand the process of silica colloid formation. From the results, Si is the most abundant element, increasing continuously from the 1st hour to the 42nd day. In addition to Si, the other significant elements at the onset include Al, Na, and K. A strong correlation exists between Si, Al, Na, and K. The thickness of the scale is estimated to be 15.71 µm in the very early stages, such that by the 42nd day, a massive scale deposition covers the entire test piece surface with an estimated thickness of about 949.38 µm. The immersion experiments revealed the increase of the silica and other elements with time and association of these metallic elements in the silica deposition process. These experiments are critical to the operation of geothermal power plants in that they estimate the rate of silica deposition in two phase pipelines. This is important as it then helps predict the maintenance programs as the rate at which the deposits could form is known.

Keywords: Silica, Colloids, Immersion, Experiment

Abstract ID: T3_014

Sustainable Exploitation of Geothermal Energy: Case Study of the Olkaria East Geothermal Field, Olkaria, Kenya

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Abstract:

Geothermal Energy remains one of the best green sources of energy in Kenya as it contributes over 40% of all the Energy in Kenya. Currently, KenGen PLC leads in terms of Geothermal Energy generation as it contributes close to 800MW which is about 80% of the Kenya's geothermal energy. For this geothermal energy to continue being

useful and sustainable, prudent reservoir (resource) management is encouraged. KenGen PLC has been generating geothermal power since 1981 in their Olkaria geothermal field. Its generation has increased from the initial 15MW to the current 797MW. This development has been done step wise with major development being undertaken in the last 10 or so ease in managing its geothermal resource, KenGen has subdivided the Olkaria field into several subfields: These includes the Olkaria East, Olkaria Central, Olkaria Northeast, Olkaria Northwest, Olkaria Southeast and the Olkaria Domes. Olkaria Southwest, which hosts Olkaria III is being run and managed by an Independent Power Producer (IPP), Orpower 4 Inc, which is part of the larger Ormat Inc. It is noted that KenGen has managed the oldest geothermal power plant in Kenya, Olkaria I since 1981. Olkaria East Geothermal field boasts of being a unique field. It not only hosts the youngest recorded lava flow in the country but also hosts both the oldest plant (44-year-old plant), Olkaria I and the biggest single power plant (under one roof), the Olkaria I Additional units 4, 5 and 6 that totals to over 223MWe (being netted to the grid). For this to happen, KenGen has initiated a number of strategies in ensuring the sustainability of this resource. These strategies have included geothermal fluid re-injection (both cold and hot), tracer tests, periodic production wells monitoring and modelling, systematic exploitation of the resource and implementation of innovation ideas that make use of efficient technologies in steam field management and power plant generation.

Keywords: Geothermal, Sustainability, Exploitation, Reservoir Management

Abstract ID: T3_015

Exploration of Geothermal Resources Using Seismic Ambient Noise Tomography

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Abstract:

Geophysical surveys play a crucial role in the successful exploration of geothermal resources. However, their implementation can be costly due to equipment expenses and field deployment challenges. Budget constraints often limit the density of instruments and the spatial extent of these surveys, restricting their effectiveness. To overcome these limitations, adopting innovative, low-cost geophysical exploration techniques is essential. One such approach is seismic ambient noise tomography, a cost-effective method particularly well-suited for geothermal exploration. This technique utilises naturally occurring background seismic noise, collected during passive seismic monitoring, to image and characterise the Earth's subsurface structures and properties. Unlike conventional methods, it operates independently of active seismic sources or earthquake events and requires only a minimal set of instruments or seismometers.

In this study, we demonstrate the application of seismic ambient noise tomography in exploring geothermal resources within the Olkaria geothermal field. Our findings illustrate how this technique can effectively identify regions with high geothermal potential, offering valuable insights for resource development.

Keywords: geothermal, exploration, seismic, tomography

Abstract ID: T3_016

Integrated Geophysical Methods to Constrain Subsurface Structure of Tulu Moye-Bora-Bericha Axial Volcanic Complex, Main Ethiopia Rift: Implications for Geothermal

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Abstract:

The Main Ethiopian Rift (MER) is a major continental rift characterized by silicic caldera complexes, stratovolcanoes, fissural basalts, and abundant normal faults. Within its central sector lies the Tulu Moye–Bora–Berecha volcanic complex, which includes the Tulu Moye geothermal prospect. To investigate its subsurface structure and geothermal potential, we applied a combination of gravity and magnetic techniques. Gravity data were processed to generate regional and residual anomaly maps, along with a complete Bouguer anomaly map. Magnetic data were reduced to the equator (RTE) to minimize dipolar effects associated with the equatorial location. Depth estimates of anomalous sources were obtained using Euler deconvolution and spectral analysis. Joint 2D forward models along three profiles were developed with GM-SYS in Oasis Montaj.

The integrated results reveal that: (1) the crystalline basement is uplifted around and west of the Salen ridge; (2) the primary heat source of the geothermal system is located near the Salen ridge at a depth of ~4–5 km; (3) beneath the Gnaro obsidian dome, volcanic layers are relatively thin and a regional fault acts as the main conduit for fluid circulation; and (4) both gravity and magnetic anomalies consistently indicate the presence of a large caldera system encompassing the Tulu Moye, Bora, and Berecha volcanic centers.

Keywords: Forward model, Euler depth solution

Abstract ID: T3_017

Geothermal Potentialities of Northern Algeria: Mapping of Geothermal Gradient

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Abstract:

Given the potential energy highlighted by high temperature values determined during geothermometric and hydrogeochemical studies as well as surface manifestations of different hot springs that rise to very significant temperatures (up to 98 ° C), the drawing up of the geothermal gradient map, is a key to understanding the hydro-geothermal systems of deep reservoirs in northern Algeria. The map of geothermal gradient was drawn as part of a research work developed to characterize and evaluate the geothermal potential of northern Algeria. Established from the correction of 198 Bottom Hole Temperatures (BHT) measured during logging operations deep boreholes and temperatures obtained in drill steam tests (DST), this map shows essentially three areas with high geothermal gradients related to geological structures in depth:

1. The thermal anomaly of eastern Algeria, bounded by the gradient curve 4°C/100m and oriented SW-NE, is the largest anomaly where the high value of the gradient is due to the "Numidian Batholith" supposed by works of EURAFREP and those of ENEL-SONELGAZ. This anomaly is evidenced by numerous hyperthermal and mesothermal springs often with an abundant release of CO_2.

2. In the center, at the bibanic area, the gradient reached 4.27°C/100m. This high value is mainly due to the large multi-kilometric deflexure staking the bibanic and sub-bibanic area with a direction of WE. This deflexure appears clearly on the satellite photo and it becomes a clearly fault at the depth and affects the entire sedimentary series and part of the crystalline basement whose proximity is evidenced by the strong positive gravimetric anomaly.

3. With a gradient of 4.29 ° C/100m, the west thermal anomaly would result to the high seismic activity in the region. Active sinistral faults with NE-SW direction and dextral faults EW affecting these sectors serve as upward drains to thermal waters.

Keywords: Deep reservoirs, BHT-DST, Geothermal gradient

Abstract ID: T3_018

Thermal Springs of Northern Algeria: Hydrogeochemical Characterizations

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Abstract:

This study was performed as part of a research work developed to characterize and evaluate the geothermal potential of northern Algeria. In order to determine the mineralization process of thermal waters of northern Algeria, geochemical analyzes (major and trace elements) were performed on 70 hot springs and wells. With emergence temperatures reaching 98°C, the thermal waters are of predominantly chloride and sulphate type, and to a lesser degree bicarbonate type. Waters are characterized by a high salinity (TDS range from 0.8 to 36.5 g/L). The study highlights the different interactions between thermal waters and rocks. It shows that the origin of the mineralization of each water facies could define a type of reservoir rocks. Indeed, analysis of the regional geology and review of the literature indicate that thermal waters in northern Algeria are strongly influenced by the geological and hydrogeological environment, with springs located near the main structural features and reservoirs of the Jurassic and Cretaceous carbonate and sandstone formations. Deep water circulation and contact with clay, marl and evaporitic formations often lead to exchanges that would completely alter the original mineralization of the water acquired in the reservoir. Furthermore, many thermal springs appear related to currently tectonically active fault systems. Modeling performed with PHREEQC software indicates that saturation indexes measured can be explained by the dissolution of calcite, and also by the dolomitization process associated with the precipitation of gypsum within the thermal aquifer. The geothermometric study showed that silica-based and especially quartz-based geothermometers provide

matching temperatures of 60 to 120°C for all springs. The Na-K-Mg ternary diagram and the saturation index (SI) method also provide temperatures in the same range (80 to 140°C).

Keywords: Thermal waters, Geochemistry, PHREEQC, Geothermometry

T4- S1 Exploring Geoscience Education Across Africa

Abstract ID: T4_001

Development Minerals and Their Opportunities as an Alternative Livelihood for Women Artisanal Small-scale Gold Mining

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Abstract:

Artisanal and small-scale gold mining (ASGM) has historically provided, and continues to provide, livelihoods for millions of people worldwide, including a significant number of women (Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development [IGF], 2018). Women play a crucial, yet often under-recognized, role in the ASGM sector and therefore face substantial challenges. This underscores the necessity for alternative livelihood options that promote sustainable development. However, such alternatives—such as vocational skills training and farming—frequently prove unsustainable due to factors such as lower income generation, limited market access for products, and misalignment with miners' priorities (Hilson, 2009).

In light of these challenges, this paper examines how geoscience education on Development Minerals has been leveraged as an alternative livelihood pathway for women in ASGM through a training workshop. It defines Development Minerals, explores their opportunities, and discusses potential avenues for value addition. Furthermore, the paper highlights the importance of diversifying from gold to Development Minerals, such as clay and gemstones, particularly through value addition in jewelry production.

Keywords: Development Mineral, Women, alternative livelihoods

Abstract ID: T4_003

Capacity Building and Partnerships in Geoscience in Africa: The PanAfGeo Project

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Abstract:

The AMV and the Green Deal set out objectives that can be addressed through initiatives between the European Union and the African Union. To help to meet these challenges, a partnership OAGS-EuroGeoSurveys, initiated in 2015, led to the implementation of a pan-African action, PanAfGeo, a long-term strategic cooperation between African and European Geological Surveys. PanAfGeo for "Pan-African Support to Geological Sciences and Technology Africa-EU Partnership" is a 2-phase project, training geoscientific staff from African Geological Surveys. Cofunded by the EU and 13 European Geological Surveys, coordinated by BRGM, PanAfGeo contributed to a more sustainable management of natural resources. PanAfGeo is an innovative training programme in different geoscientific skills. It aims to make the African Geological Surveys and the OAGS more effective in supporting national, regional and continental policymaking and planning. PanAfGeo (2016-2024) carried out 72 training sessions exclusively in Africa, in English, French, and Portuguese, and thanks to the support of 22 host-countries. More than 1,770 geoscientists from geological surveys from across the African continent were trained, making PanAfGeo a unique pan-African geoscience-training programme. Courses were carried out by African/European experts. Many stakeholders are involved, including

UNESCO, GSAf, AMDC, AMGC, AWIMA. A geoscientific network exists on both continents and can contribute to sustainable management of geological resources in Africa and promote EU-African partnership in geosciences. The new PanAfGeo+ (2025-2029) aims to strengthen Africa-EU institutional partnerships on Geosciences at continental, regional and national levels; to strengthen African Geological Surveys and the OAGS in terms of geoscientific intelligence and national, regional and continental support to policymaking and planning processes; create OAGS Expert Network; promote EU-Africa economic partnerships on raw materials value chains.

Keywords: Africa, geological-surveys, geoscience-training, OAGS, EuroGeoSurveys

Abstract ID: T4_004

The Role of Geoscience Education in Sustainable Development

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Abstract:

Geosciences comprise a wide range of disciplines that study the Earth, its resources, how to harness them, and even how to understand and prevent disasters. This makes education in geosciences not only beneficial to society economically, but also helps preserve and sustain environments efficiently for proper land-use. Ultimately, it plays a crucial role in fostering sustainable development by equipping professionals with the needed knowledge and skills that promote growth in any society. Demand for energy, minerals, and water will continue to grow, and as such, education provided by geosciences will remain essential for resource harnessing, environmental sustainability, and infrastructural development. This paper discusses the role of geoscience education in promoting development by showcasing its impact on various sectors and industries of society, which include energy, mining, agriculture,

water resources management, medical/medical sciences, disaster management and risk reduction, and so on. Naturally, this insight when properly translated into positive impact, is reflected in progressive policies that lead to strategic planning and development of society. A major interest to highlight that affects society in the relatively recent years is climate change, with particular interest on how to have human existence and the biodiverse ecosystems of the earth adapt to these changes for optimum thriving and disaster preparedness and reduction. Geoscience education, however, faces multiple challenges, especially in developing nations like Nigeria. Much of the sub-sectors such as mining and value addition, energy, water resource management, climate change management, etc, remain largely under-developed, and in some cases, non-existent. Factors such as limited funding, inadequate infrastructure, insecurity, and a limited number of trained professionals/lack of trained educators, hinder progress on a large scale. The paper concludes by advocating for policy reforms, increased investment in geoscience education, and stronger collaborations and partnerships between academic institutions, governments, and private establishments in the various industries, so that the impact of geoscience education can be maximized for sustainable development.

Keywords: Geosciences, Education, Sustainable Development

Abstract ID: T4_008

Graphical Interface Visualisation of Geology of Africa: Database Perspective.

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Abstract:

In response to the longstanding need for a unified digital repository of African basins, the AfricaLex Suite emerges as a pivotal resource. This free, public database encompasses the vast geologic formations of African onshore and offshore basins. Our primary goal is to establish an online, integrated Time-scale and Earth-history Database Visualization System tailored for the geoscientific community. AfricaLex Suite is an extensive platform that offers entries on type sections, lithology, regional distribution, fossil records, and age range interpretations, with graphical illustrations of the stratigraphic makeup. The database includes data from the Volta, Congo, and Sud Province basins, alongside the established NigerLex and NigeriaLex sub-suits. Its map-based graphical interfaces enable users to explore composite stratigraphic columns with ease, accommodating both expert geoscientists and others interested in Africa's rich geology. With digitised regional extents of each formation, users can effortlessly plot individual formations or time-slices over three plate reconstruction models, enriched with lithologic facies patterns, enhancing both usability and scientific engagement.Our mission with AfricaLex Suite is to ease access to detailed geoscientific data across Africa, making it an indispensable tool for professional geoscientists, students, and industry experts. It serves as quick-access educational resource, an authoritative database for industries and institutions, and a platform for knowledge synthesis across African nations. By integrating with other stratigraphic and paleogeographic databases and UNESCO's Geologic Map of Africa through the Deep-Time Digital Earth platform of the International Union of Geologic Sciences, AfricaLex offers a simple understanding of African sedimentary basins in deep-time. This is vital for energy and sustainable natural resource exploration, aligning with sustainable development goals centered on georesources and geodynamics.

Keywords: Database, DDE, Time-scale, Stratigraphy, Basins

Abstract ID: T4_010

Geoscience Education in Africa: Leveraging Geological Museums and Innovative Approaches

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Abstract:

This paper examines geoeducation in Africa, focusing on Ghana, and highlights the transformative potential of geological museums. Geoeducation encompasses formal and informal learning about Earth systems and is essential for fostering geoethical awareness, promoting geoheritage, and ensuring geoconservation [1]. In Africa, geoscience programs face challenges like limited resources and accessibility. Geological museums offer a unique platform for enhancing Earth science literacy [2]. Through interactive exhibits and community engagement, they bridge educational gaps and inspire understanding [3]. These museums are hubs for informal education, providing hands-on learning about tectonics, rock cycles, and fossilization [4]. They are critical for public outreach, showcasing geological history and promoting environmental awareness [5]. For example, [6] emphasize their role in fostering scientific literacy through immersive exhibits. Similarly, [3] show museum visits enhance literacy by complementing classroom teaching. In Ghana, institutions like the Department of Earth Science Museum have significant potential to offer educational programs and workshops. This paper also explores strategies for leveraging museums, including technology integration (e.g., virtual tours, augmented reality), interdisciplinary approaches (e.g., geo-art, geo-storytelling), and incorporating local and indigenous knowledge [6]. Case studies from successful global museums provide valuable insights for African contexts. In conclusion, actionable goals are needed to transform Africa's geological museums into dynamic educational hubs, emphasizing collaboration, stakeholder engagement, and sustainable funding. By

adopting these strategies, museums can play a pivotal role in fostering geoethical awareness, promoting sustainability, and inspiring the next generation of geoscientists.

Keywords: Geoeducation, Geological Museums, Environmental Sustainability

Abstract ID: T4_013

African Hydrology Through Citizen Science in South Africa, Ghana, and Kenya

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Abstract:

African communities rely on river, spring, reservoir, and boreholes for domestic purposes, yet the hydrology of these water sources is poorly understood, increasing geohealth risks, especially among women and children. This research develops a citizen science approach for surface and groundwater monitoring, initiated in Eastern Cape of South Africa, Ghana, and Western Kenya. The goal is to engage communities in reflecting on their water resources and collecting water samples systematically. In South Africa, fieldwork focuses on dams and canals of the Gamtoos and Sundays Rivers, springs, and boreholes in the central Karoo basin. Initial roundtable meetings with community members including municipality officials, Chiefs, Headmen, women and youth, help build trust, identify concerns and guide collaborative water sampling with scientists. Reported concerns include water shortages; horrible taste; brackishness, livestock loss and skin infections. Laboratory analysis reveal Total Organic Content (TOC) values of 3-9 ppm, within South Africa's limit of ≤10 and high Electrical Conductivity (EC) of 1000–2000 µS/cm is measured in groundwater. In Ghana, community

members along the Densu River reported health issues possibly caused by pollution from artisanal gold mining. TOC values are elevated, 8-45 ppm in major cities near Sunyani, Kumasi and Accra. In Kenya, informal interviews associate health concerns with malaria outbreaks. Along with elevation gradient of the Nzoia River drainage, water samples results show changes in Temperature, pH and TOC (from 1-11 ppm). In localities, low to moderate levels of 4–8 ppm of Nitrate and 0.5–1 ppm of Phosphate are detected. Further analysis explores correlations between water quality, Anopheles mosquito larvae presence and disease risk. Field and laboratory results are shared with participants, while a responsive website and customised App are being developed to support a common method for water monitoring.

Keywords: Citizen Science, Geohealth, Geochemistry

Abstract ID: T4_051

A Peek into the Past and a Peep into the Future: The Role of the International Geoscience Education Organization

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Abstract:

Geoscience Education (Earth Science Education) studies how humans learn about and understand the Earth's dynamic systems, including interactions between the geosphere, atmosphere, cryosphere, hydrosphere, and biosphere. The International Geoscience Education Organization (IGEO) was formed in 2000 at the 3rd International Conference on Geoscience Education in Sydney, Australia. The aims and objectives of the International Geoscience Education Organization (IGEO) are to promote geoscience education internationally at all levels, to work for enhancement of the quality of geoscience education internationally and to encourage developments, and raising public

awareness of geoscience, particularly amongst younger people. IGEO also oversees and supports the annual International Earth Science Olympiad (IESO). The purpose of this paper is therefore to emphasize the past, present and future significance of Geoscience Education (ESE), especially in the developing countries. Geoscience Education (ESE) encompasses the wise use of geological resources for sustainable economic development. Extraction and harnessing (wise use) of Earth resources should therefore form the central part of Earth Science Education. These resources (including water, both surface and groundwater; metals and the REE and non-metals; bulk minerals for fertilizer, cement, glass, construction, fossil fuels and natural gas; and nuclear minerals especially uranium, thorium and renewable energy sources like geothermal, wind, solar, wave, tidal, current, thermal and salinity gradient) are the essential material for industrialization, and well-being of humanity and life on Earth. It is therefore proposed herein that it is imperative that Geoscience Education (Earth Science Education) should be a major stand-alone subject in education curriculum not only in Kenyan Competency Based Curriculum (CBC), but in Africa, the continent endowed with vast Earth resources that are essential for sustainable economic development.

Keywords: IGEO, Resources, Competency Based Curriculum

Abstract ID: T4_007

Geoscientific Determination of Contamination Potential Around Mpape Dumpsite, Abuja, Central Nigeria.

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Abstract:

Environmental contamination from open dumpsites is a major concern in many developing countries due to inadequate waste management. This study assessed the contamination potential of the Mpape dumpsite, Abuja, Central Nigeria, through integrated geophysical and geochemical techniques.

A two-dimensional electrical resistivity tomography (ERT) survey was conducted using a Wenner array with an ABEM SAS 300 Terrameter. Three profiles were acquired across and around the dumpsite and processed with RES2DINV and ArcGIS. Soil and leachate samples were also collected for geochemical analysis to complement geophysical data.

RT results revealed low resistivity zones (17.8–65.3 Ωm) interpreted as leachate plumes, particularly along Profiles 2 and 3, coinciding with waste accumulation. Conductive anomalies at shallow depths (1.5–5.0 m) suggested leachate-impacted zones, consistent with stressed vegetation and odour. Geochemical analysis confirmed contamination, with soil pH of 4.6–6.8 and heavy metals such as iron and lead exceeding WHO limits. Spatial mapping indicated accumulation of Pb, Cd, and Zn along the central axis of the dumpsite, reflecting surface runoff patterns during rainfall.

Geotechnical results showed clayey soils with medium–high plasticity

and low permeability, offering partial attenuation but limited long-term protection. Plasticity indices ranged from 17–32%, and moisture content reached 28% in saturated zones. Microbial analysis revealed high coliform counts, indicating biohazard risks to nearby communities.

These findings demonstrate that although clay layers reduce vertical migration, the Mpape dumpsite poses an active threat to the subsurface environment. Integrating geophysical and geochemical methods effectively mapped pollution pathways and assessed risk. Adoption of engineered sanitary landfills, periodic soil monitoring, enforcement of buffer zones, and public health surveillance are recommended to protect groundwater and community health.

Keywords: Mpape Dumpsite, Contamination Potential,

T5- S1 Hydrogeology and water sustainability under a changing climate

Abstract ID: T5_001

Using Field Surveying and Modelling Tools to Assess Groundwater Resources for Sustainable Development Under a Changing Climate: A Case Study from Lamu Island, Kenya

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Abstract:

Groundwater is the sole source of freshwater on Lamu Island in Kenya, nested in shallow unconfined sand aquifers. The groundwater system is highly vulnerable to climate change due to limited recharge sources and sea level rise. The groundwater resources are not well mapped or quantified, affecting sustainable management of this invaluable resource. This research assesses the groundwater resources for sustainable development under climate change. Geophysical surveys conducted reveal that the dune aquifer, the main water source, is underlain by a sandstone aquifer approximately 100 m thick, while the shallow aquifer in the flat coastal area is very thin and underlain by seawater trapped in a clay lens of about 50 m. Four fieldwork campaigns were conducted in 2024 and 2025, with in situ data collected from 228 wells. The measurements taken were water rest levels, electrical conductivity, pH, temperature, and salinity. An increase in water levels of 0.3 m in the wells was observed in June and July, following the long rains in April and May. This was followed by an island-wide drop in groundwater levels of approximately 0.4 meters between July 2024

and February 2025, highlighting the aquifer system's sensitivity to precipitation variability and Abstraction. An increase in EC was also observed in the wells during this period, particularly close to the sea and in populated areas. Preliminary results reveal the sensitivity of aquifers in the island to climate variability and Abstraction. The research will advance to numerical modelling using MODFLOW, incorporating the preliminary results and data from geological and geophysical surveys to define aquifer layers and properties, boundary conditions, and the distribution of Abstraction and recharge. Model simulations will then evaluate the long-term impacts of Abstraction, sea-level rise, and climate change under multiple scenarios, providing actionable insights on sustainable groundwater management strategies for the island.

Keywords: groundwater, geophysics, climate change, MODFLOW

Abstract ID: T5_014

Water Quality Monitoring of the Nzoia River Drainage and Lake Victoria in Kenya, East African Rift System

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Abstract:

East Africa is the most populated region of the continent, with urbanisation predicted to increase dramatically along perennial rivers and lake shorelines, which increase geohealth risks linked to freshwater systems. This study establishes a water quality baseline across 28 sites in the Nzoia River drainage and northwest Lake Victoria, Kenya, to assess water quality amid emerging risks from climate change, urbanisation, and agriculture. Sampling was conducted during the dry season in February 2025. Physical hydrochemical parameters were assessed onsite, while further laboratory analysis by anion chromatography, heated persulfate

wet-oxidation carbon analysis and inductively coupled plasma-optical emission spectrometry measured major anions, cations dissolved organic carbon (DOC). An average pH of 8 is recorded across the Nzoia drainage, with a pH of 9 at Lake Victoria. Water temperatures range from 12.5-18 °C at elevations of 1800–2300 m, but reach ≥25 °C near urban centres (Eldoret, Bungoma, Mayoni). EC range from 35-200 µS/cm and TDS from 17-220 mg/L. The levels of major anions of chloride (Cl^-), nitrate (NO_3^--N), sulphate (SO_4^{2-}) and cations of sodium (Na), calcium (Ca), magnesium (Mg), and silicon (Si) recorded across the drainage system are typical of freshwater systems. Trace amounts of phosphates (PO_4^{3-} ≤ 1mg/L) are also detected in some sites. DOC values range from 1 - 11 mg/L, while nitrate concentrations vary between 1-8 mg/L. The Nitrate levels are within the World Health Organisation's drinking water limit (≤11 mg/L NO_3^--N). However, the spatial variation in water quality parameters suggests inputs from natural and anthropogenic sources. Further fieldwork and laboratory analyses are needed to better understand the hydrochemical cycle and the impact of human activities. Efforts are also underway to involve local communities in the monitoring process to support regular sampling.

Keywords: Water, geohealth, Anions, Cations, hydrochemical

Abstract ID: T5_051

Water Czars and Groundwater Diplomacy: Skills, Scales and Sustainability

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Abstract:

A culture of peace is desirable when sharing resources. This culture does not only include matters of lifeways, behavior, values, and patterns of belief, but importantly, consistency with institutional arrangements. Our diminishing water resources call for water preservation and accountability for every drop. Past research shows that water

management and governance structures require strengthening, to address the pressures associated with imbalances in water supply and demand, characterized by water conflicts in the 21st century. Groundwater management practices are basically challenged by governance issues that not only require prioritization, but importantly, standardization. However, fragmentation in water governance and management remains a barrier due to a lack of coordination between agencies across borders. The strong leadership of interdisciplinary and transdisciplinary water professionals has been suggested to address this problem of fragmentation. This study investigated water czars as interdisciplinary and transdisciplinary water professionals who advance governance through their skills by promoting coordination and collaboration. Research findings indicate that water czars possess the following characteristics: government experience, authority, governance skills, diplomatic and technical expertise, a strong personality, visionary or innovative thinking, and legal training. Their scales of service include state/national, basin, aquifer, lake, transboundary and UN levels. Therefore, institutionalization of groundwater czars is recommended to address fragmentation in groundwater governance and management. They should embody characteristics similar to those of water czars in order to promote the sustainable management of groundwater resources at the aquifer level. This research promotes sustainable peace and development in the management of shared groundwater resources by strengthening cooperation under the IWRM framework and advancing aquifer governance.

Keywords: interdisciplinary, transdisciplinary, groundwater czars

T5- S2 Groundwater Quality

Abstract ID: T5_009

Hydrogeochemical Assessment of Coastal Water Resources in Parts of Southwestern, Niger

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Abstract:

The coastal aquifers of Ilaje, Ondo State, Southwestern Nigeria, within the Eastern Dahomey Basin, face increasing threats from waterborne pathogens, posing significant public health risks and socio-economic vulnerabilities. Various studies have confirmed groundwater contamination from indiscriminate waste disposal, open defecation, and other anthropogenic activities. Shallow aquifers, the primary water source for residents, are especially vulnerable due to their proximity to the surface. This study aims to enhance existing knowledge on groundwater contamination by analyzing factors influencing shallow aquifer susceptibility. Physico-chemical parameters of 84 groundwater samples (62 wells, 22 boreholes) collected during the dry season were measured in situ, alongside bacteriological analysis using Nutrient, MacConkey, and Eosin Methylene Blue agars, and heavy metal analysis via an HM Metalyser 5000. Results showed significant spatial variability in water quality, with EC ranging from 21–26,600 µS/cm, indicating localized saline intrusion. About 64% of samples met acceptable pH levels, but elevated salinity and TDS levels, notably in Igbokoda, signaled seawater intrusion. Heterotrophic bacteria were present in 92% of samples (average 82.4 cfu/100 ml), coliforms in 52% (average 0.6 cfu/100 ml), and E. coli in 8.3%. Fecal coliform counts were low, likely due to reduced water levels in the dry season. PCA of heavy metals

identified three components, reflecting geogenic and anthropogenic influences. Geochemical plots, including Piper and Gibbs diagrams, identified dominant water types to be Ca-Mg-HCO_3 and Na-Cl water types resulting from processes such as carbonate weathering, and seawater mixing. The study highlights poor water quality concerning bacteriological contamination and trace metals, underscoring a critical gap in meeting SDG6 and WASH goals, and calls for routine monitoring to ensure improved water quality for environmental and public health sustainability.

Keywords: Groundwater, Hydrogeochemistry, Coastal aquifers, Saltwater

Abstract ID: T5_016

Enhancing Groundwater Quality in Marsabit County, Kenya: a Framework for Sustainable Management and Nature-based Solutions

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Abstract:

In the arid county of Marsabit, Kenya, groundwater quality is critical for sustaining communities and economic activities, yet it faces major challenges, notably fluoride (0.2-1.8 mg/L), conductivity (588-3610 µS/cm), and total dissolved solids (TDS) (365-2238 mg/L) levels. With an aridity index of 0.03 – 0.2 and 60% of the population depending on groundwater sources, sustainable quality management is urgent. This study focuses on the North-Horr watershed draining into Kalacha from the North (15282 Km2) and the South (14300 Km2). Identifying suitable sites for runoff water barriers will enhance infiltration and improve water quality in the aquifer through natural dilution processes over time. Methods applied include satellite-based imagery analysis (INSAR, LANDSAT 8, SRTM-2000), geological map delineation, watershed characterization, literature review, and groundwater quality assessment

from eight boreholes analyzed by the Water Resources Authority (WRA). Preliminary findings reveal localized spikes in fluoride 1.8 mg/L for (Tiniqo-North-Horr) and conductivity >3000 µS/cm around Bubisa based on KEBS: KS EAS 12:2018 standards, highlighting critical areas for intervention. The following variables have a high correlation: conductivity, total hardness, total alkalinity, chloride and total dissolved solids (0.8 to 0.99). The research proposes a framework for groundwater quality improvement based on nature-based solutions comprising sand dams, monitoring networks, and policy intervention through community engagement. By forming a baseline for continuous monitoring and promoting nature-driven interventions through satellite monitoring every 3 years, the study contributes towards achieving Sustainable Development Goal 6 (Clean Water and Sanitation) and provides a replicable model for managing groundwater quality in other arid and semi-arid environments in the Horn of Africa using the multi-criteria approach used for this study area.

Keywords: Watershed, Nature-based solution, fluoride, conductivity

Abstract ID: T5_012

Assessment of Water Quality and Health Risks in Beaufort West, Province of the Western Cape, South Africa

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Abstract:

This study aimed to evaluate concentrations of potentially harmful elements (PHEs) in groundwater and surface water, identify factors controlling water chemistry, and assess potential health risks in Beaufort West. The study area lies within the uranium-rich Karoo Basin and includes uranium ore stockpiles and abandoned open pits. Samples were collected from 23 sites (19 groundwater, 4 surface water). Analyses included pH, electrical conductivity, total dissolved solids, major cations and trace elements (ICP-MS), and anions (ion chromatography). Groundwater and surface water were slightly alkaline and mostly within WHO (2017) and SANS (2015) limits. Electrical conductivity and total dissolved solids exceeded guidelines in several groundwater samples and one surface water sample. Concentrations of Fe (≤0.4 mg/L), SO42- (32-615 mg/L), Cl- (22-538 mg/L), NO3- (0.1-95 mg/L), F^- (0.4-3 mg/L), Na^+ (41-392 mg/L), K^+ (1-14 mg/L), Zn (2-508 µg/L), and U (4.7-36 µg/L) exceeded permissible limits in some groundwater samples, while in surface water only Na^+ (16-388 mg/L), Mg^{2+} (8.6-75 mg/L), Fe (≤1.1 mg/L), SO42- (14-744 mg/L), Cl- (11-558 mg/L), and Zn (1.7-10.6 µg/L) exceeded guidelines. Groundwater facies were dominated by Na-Cl-SO_4-HCO_3 and Na-Ca-Mg-HCO_3-SO_4, while surface water was Ca-Mg-Na-HCO_3, reflecting local geology and anthropogenic inputs. Spearman

correlation suggested that PHE concentrations are influenced by chemical weathering, ion exchange, mineral dissolution, agriculture, and industrial activities. Non-carcinogenic risks were higher for F- and Fe in infants; NO3-, F-, Fe, As, and U in children; and NO3-, F-, and Fe in adults. Lifetime cancer risks from U and As exceeded permissible limits in infants and children. The results of this study highlight the need for local authorities to treat water, particularly groundwater, before consumption to reduce potential health risks from PHEs in the region.

Keywords: Beaufort West, groundwater-and-surface water

Abstract ID: T5_013

Hydrogeodetic Monitoring of Groundwater Mining Induced Subsidence Within the Nairobi Aquifer System Using Insar

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Abstract:

The Nairobi Aquifer System (NAS), a critical groundwater source for the Nairobi metropolitan area, has in recent decades been experiencing water-level declines due to a shift from sustainable groundwater abstraction to groundwater mining. Considering globally such declines lead to aquifer compaction(subsidence), this study employed PSInSAR to assess subsidence spatiotemporally from 2019 to 2023 using Sentinel-1 images. A 200 km² area was mapped as experiencing subsidence, with a maximum subsidence rate of 57 mm/yr recorded at Kilimani. Additional hotspots were mapped at Kasarani, Fedha, Ruaka, Eastleigh, Syokimau, Kamakis, Ongata Rongai, Juja, Rioki, Mutomo, and Kiambu. All hotspots were characterised by borehole clustering. A case of non-revenue (no WRA permit) water was detected at Mutomo, which illustrates the high ratios of permitted/authorised boreholes reported in Kilimani-Westlands (10,000/25,000 m³/day) and Eastleigh (1,000/7,500 m³/day). Interannual rainfall influenced subsidence pattern, with no impact from intra-annual rainfall. High water per capita (300 l/

day) amplified subsidence in Kilimani areas, while high population density was the main driver in Kasarani and Eastleigh. Geologically, aquifers within the Kerichwa and Athi series, interbedded sediments, and old land surfaces were susceptible. The findings emphasise the need for thorough NAS aquifer characterisation studies, non-revenue water audit, and managed aquifer recharge. There is also a need to expand interbasin water imports to ease NAS reliance. There is also a need for instrumentation enhancement through the IoT-enabled sensors, borehole extensometers, CORS-GNSS, and InSAR to detect deteriorating zones. Infrastructure, drainage, and sewerage agencies must incorporate subsidence hazards into their civil and structural designs. Given that NAS subsidence threatens both the built and natural environments, as well as climate resilience, a coordinated multi-agency response is urgently needed.

Keywords: Nairobi-Aquifer-System, Subsidence, InSAR, Groundwater-Mining, Hydrogeodecy

Abstract ID: T5_018

Hogging in Basement Slabs: Case Study of X Towers, Nairobi, and Implications for Groundwater Management in the National Building Code

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Abstract:

Basement structures in rapidly urbanizing cities face increasing challenges from groundwater-related pressures, particularly in areas underlain by low-permeability volcanic formations. This case study examines X Towers, a 13-storey commercial building in Nairobi, Kenya, where hogging and persistent flooding occurred in the lower basement four years after construction. The issue was ultimately traced to seasonal rises in a perched water table, leading to hydrostatic uplift

pressures beneath the basement slab. To better understand the sources and movement of shallow groundwater, nitrate concentration data from 95 boreholes were analyzed. The results showed elevated nitrate levels downstream of Kikuyu town, with concentrations increasing gradually toward the Nairobi Central Business District. This trend closely mirrored the layout of the city's sewer network, strongly suggesting leakage and loading of groundwater by sewer effluent. Such leakage creates pathways for methane and other harmful gases, compounding the risk of subsurface hazards in basements. Initial remedial measures, including temporary pumping, proved inadequate as inflows rose. A controlled relief well system was then installed by breaching the slab and introducing high-capacity drainage pumps, effectively lowering the water level and mitigating uplift pressures. This case highlights the importance of incorporating hydrogeological assessments into early building design to anticipate seasonal water table fluctuations and subsurface contamination. It further demonstrates the need to update Kenya's building codes to include groundwater management and gas hazard mitigation, aligning with international best practices. Preventive design remains more cost-effective and reliable than post-construction retrofits.

Keywords: Groundwater hazard, hogging, uplift, relief

T6- S1 UNESCO Global Geoparks

Abstract ID: T6_003

Geology and History of Potential Geoparks within the Kwahu-Bombouaka Group of the Voltaian Sedimentary Basin, Bono-East Region, Ghana.

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Abstract

Unique geological formations have long been a source of attraction to tourists worldwide. Geo-tourism, a form of tourism that focuses on the natural and cultural heritage of a destination, has gained significant attention in recent years due to its potential to promote sustainable development. The Kwahu-Bombouaka Group within the Voltaian Sedimentary Basin in the Bono-East region, Ghana presents significant cultural, geological and historical landmarks that qualify as potential geoparks. This study explores the geology and history of three unique potential geopark sites; Fuller and Kintampo waterfalls and the Kunsu Slave Caves. These sites fall within the Kwahu-Bombouaka Group comprising mainly of different sandstone types formed around ca.959 Ma. Representative rock samples from these sites were collected during a detailed geological sampling project to determine their petrographic characteristics. Discovered in 1988, the Fuller Falls (~173m above sea level) fall gently over a series of cascades along Oyoko River (a tributary of the Black Volta). The Kintampo Waterfalls (formerly the Sanders Falls) discovered in the 18th century is one of Ghana's highest waterfalls located along the Pumpum River (a tributary of the Black Volta). The Kintampo Waterfalls is made up of three main drops, with the highest drop measuring 25metres (82 ft), followed by several steps, cascades, and the river, which falls at 70 metres (230 ft). The Kunsu Slave Caves, though underexplored, are a major part of the slave trade history in the

town of Kunsu representing the mediating route of slave transportation from Salaga to the Elmina and Cape Coast Castles. By integrating geological, historical, and environmental factors, this study underscores the need for conservation and sustainable management of these sites, advocating for their designation as geoparks. This approach not only promotes scientific research and education but also fosters local economic development through geo-tourism.

Keywords: Geo-tourism, Geoparks, Local Economic Development.

Abstract ID: T6_007

Geo-tourism and the Potential of Aerial Cable Cars in Kenya

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Abstract:

Geo-tourism, a specialized form of sustainable tourism, focuses on the appreciation and conservation of a region's geological heritage, including its landscapes, landforms, and geological features. Kenya, with its rich and varied geodiversity stemming from the Great Rift Valley, presents immense potential for geo-tourism development. This paper explores the concept of geo-tourism in Kenya and proposes an approach to enhance visitor experience and accessibility at key geologically significant sites: Olkaria, Menengai Crater, and Tsavo National Park.

The current geo-tourism offerings at these locations, while valuable, are often limited to traditional activities like hiking, game drives, and nature walks, which can be physically demanding and inaccessible for some visitors. This study posits that the cable cars could significantly improve tourism at these sites. At Olkaria, a cable car could offer a panoramic view of the geothermal fields, showcasing the powerful geodiversity of the area and the country's clean energy initiatives. At Menengai Crater, a cable car system could provide a safe and unique way to descend into the crater and a birds-eye view of the caldera, a feature currently only accessible via a difficult hike. In Tsavo Park, a cable car could offer a

new perspective on the park's diverse landscapes, including the Shetani Lava Flow and Mzima Springs, while reducing the environmental impact of traditional vehicle-based safaris in certain areas.

Therefore, this **Abstract** argues that well-planned and sensitively implemented cable car projects can be a sustainable solution. By providing an alternative to conventional transport, they can reduce road traffic, minimize soil erosion from footpaths, and offer a unique, awe-inspiring experience that highlights Kenya's geodiversity. This promotes a deeper understanding of the geological and ecological wonders of these destinations, allowing sustainable geo-tourism and enable the conservation of Kenya's natural heritage.

Keywords: Geo-tourism, Geological-Heritage, Great-Rift-Valley, Sustainable Tourism

Abstract ID: T6_019

Proposed Nomination of the Miocene Paleontological Site of Napak as a Global UNESCO Geopark

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Abstract:

The Miocene paleontological site of Napak is located in northeastern Uganda, within the Karamoja region, Napak district, Iriri Village. The village of Iriri is surrounded by several mountains and hills that are remnants of a huge extinct Napak volcano: Moruangeberr, the plug is formed of carbonatite. Aleklilek: A remnant of the extinct volcano located in Alekilek Village, also known as a gateway to the Karamoja region. The main massif of Napak: It is composed of multiple layers of extrusive lava and agglomerate, which formed the edifice of the paleovolcano. Akisim: The lower slopes comprise fossiliferous ashes and paleosols. The stratigraphic sequence of Napak is defined at Akisim. On the African continent, Napak provides one of the longest stratigraphic

sequences of Miocene age, sectioned into the Iriri Member (ca. 20.5 Ma) at the volcanic base, followed by the Lomorutoit lava, which is overlain by the Napak Member (20 Ma) and topped by the Akisim Member (16 Ma). The strata of Mountain Akisim have yielded most of the fossil mammal remains from Napak. The Napak Member yielded the renowned Ugandapithecus skull (a remote cousin of Hominidae), which was buried in the volcanic ash at NAP XV. It is associated with abundant fossil plant and animal remains, which provide information that the paleoenvironment in the Miocene Period was forested. The site was nominated by the International Union of Geological Sciences in 2021 among the First 100 IUGS Geological heritage sites. It is as well a national site, gazetted by the Museums and Monuments Act, Cap 149. The area is inhabited by the Karamoja people, who are dominantly semi-nomadic. They collect firewood from the mountain, settle, and conduct subsistence farming at the basement of the extinct volcano and in the plains. The area is endowed with unique plants, some of which have potential for tourism product development as well as medicinal uses. In addition, archaeological materials, including Late Stone Age lithics, exist

Keywords: Miocene, Karamoja, extinct

Abstract ID: T6_020

Enhancing Geo-Heritage and Sustainable Tourism Through Geo-Site Development in Northeastern Nigeria

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Abstract:

Geo-sites are increasingly isolated within industrial, urban, and educational landscapes, often overshadowed by development priorities. Historically, nature was seen as independent of society, fostering the misconception that human activities have little effect on global natural processes. Yet, in many countries, geo-conservation is still narrowly defined as biodiversity protection, despite the fact that the environment includes both biodiversity and geodiversity. This paper highlights selected potential geo-sites in Northeastern Nigeria, assessing their value for geo-heritage and contributions to geo-tourism within the framework of sustainable development. The sites were identified through field visits conducted over the past decade, based on geological significance, scientific value, and potential use as geo-heritage resources. In Bauchi State, key examples include migmatite morphologies and the unique olivine-bearing quartz-monzonite, Bauchite. Another important site is the Yankari warm spring, maintaining a constant 31°C year-round, which is both a tourist attraction and a potential geothermal resource. In Gombe State, notable sites include the flower structure, columnar basalt, Dadiya syncline, and Tula Gate. Borno and Taraba States feature the Biu Plateau with crater lakes and the Mambilla Plateau, Nigeria's highest point. Developing these as geo-sites offers multiple benefits: strengthening conservation, diversifying local economies, enhancing education, and promoting sustainable tourism through integrated biological and geological conservation.

Keywords: Geo-sites, Geo-heritage, Geo-tourism, Development, Nigeria

Abstract ID: T6_027

Study of Four Remarkable Karsts in the DRC and the Republic of Congo: Towards a Potential Transboundary UNESCO Global Geopark in Central Africa?

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Abstract:

In Mbanza Ngungu region (DRC), two tourist caves (Dimba and Ngovo) have already yielded abundant archaeological material leading to their inclusion on the UNESCO Provisional List in 1997 for recognition as important sites. Recent works have further enhanced our knowledge of these remarkable caves. Ngovo, now recognized as the longest known cave in Central Africa, is also notable for being home to the rare endemic fish species Caecobarbus geertsii. Currently, two archaeological teams are conducting new excavations in these two caves.Since 2019, the GEORES4DEV project team, composed of Congolese and Belgian geologists, supported by volunteer speleologists, has been studying karst system in carbonated rocks of the Neoproterozoic Schisto-Calcaire in both the DRC and the R. Congo (RC). The geological investigations have focused not only on previously documented areas, but have also led to the discovery of new cavities. To date, four regions have been explored: Mbanza-Ngungu, Lovo (DRC), and Madingou, Kidamba (RC). These areas host numerous caves. However, the karsts in each region exhibit distinct morphologies reflecting different evolution in a humid tropical climate. The host rocks lithology, along with the geomorphological and hydrological conditions of each zone, has been compared to explain their different karstic evolutions. Currently, caves in the Mbanza-Ngungu and Madingou regions are under active monitoring to reconstruct the paleoclimatic evolution of the region. Complementary biospeleological and archaeological studies have also been initiated, following the

discovery of high-quality artifacts. Together, the four studied regions highlight a set of exceptional karst landscapes. Their geological, biological, archaeological, and cultural value makes them strong candidates for renewed recognition by UNESCO, potentially paving the way for the establishment of IUGS Geological Heritage Sites and a transboundary UNESCO Global Geopark in Central Africa.

Keywords: Geopark, karst, Congo, tourism, caves

Abstract ID: T6_050

Unlocking Geo-Heritage Potential: Integrating the Role of Geoeducation Towards Sustainable Conservation of the UNESCO Global Geoparks in Tanzania

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Abstract

Tanzania is endowed with globally significant geological sites that hold scientific, cultural, and economic value, yet many remain underutilized and vulnerable. The Ngorongoro-Lengai UNESCO Global Geopark illustrates this potential, featuring Ol Doinyo Lengai the world's only active carbonatite volcano shifting dunes, prehistoric footprints, and fossil-rich layers. Other sites such as Tendaguru fossil beds, Olduvai Gorge, Mt. Meru, Amboni Caves, Mbozi Meteorite, and Lake Natron also contribute to biodiversity, heritage, tourism, and research. However, threats from encroachment, climate change, and population growth strain ecological and cultural capacity, while restricted zones crucial for biodiversity and fossil preservation face limited research access. A key challenge is low geoeducation among tourists and residents, who often overlook deeper geological significance. Although internationally recognized, the Geopark is underrated due to lack of accessible, structured geo-information, which limits sustainable use and conservation. Addressing these issues requires a multi-layered framework. Community-driven geoeducation programs can train local

"Geo-ambassadors," fostering stewardship and authentic interpretation. Digital documentation, including open-access databases, 3D models, and indigenous knowledge archives, would enhance accessibility. Integrated land-use planning and increased government support under the National Sustainable Tourism Strategy are essential for site protection. Capacity building through curriculum integration, research incentives, and partnerships with international geopark networks can strengthen knowledge and conservation. Promoting geo-branded products such as volcanic soaps, fossil replicas, and cultural crafts can also diversify local livelihoods while reducing unsustainable land use. These measures can safeguard Tanzania's geo-heritage, advance sustainable tourism, and ensure communities benefit from their unique geological legacy.

Keywords: Geoheritage, Geoparks, Geodiversity ,Conservation, Tanzania

T6-S2: Geoheritage and Geodiversity Conservation and Management

Abstract ID: T6_004

Exploring the Role of Indigenous Knowledge in the Conservation of African Geodiversity

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Abstract

The diverse geological architecture of Nigeria includes sacred landscapes where Indigenous Knowledge Systems (IKS) and cultural traditions have long governed conservation, a practice also evident across Africa. This study explores how indigenous practices intersect with geodiversity at seven Nigerian geo-sites chosen for their geographic spread, cultural diversity, and multi-dimensional significance. A mixed-methods approach was applied, combining ethnographic fieldwork, semi-structured interviews, geological observations, visual documentation, and a detailed literature review. Data were thematically analyzed to find patterns of indigenous stewardship, ritual governance, and community engagement in conservation. Our findings reveal that each geo-site integrates geology with cultural narratives and spiritual practices. Iyake Lake is protected through taboos and fertility rites; Iyamopo Hill links ancestral memory with annual festivals; and Agbele Hills embodies myths of maternal sacrifice reinforced by symbolic pilgrimages. Zuma Rock is revered as a geomorphic monolith with protective powers, while Gurara Waterfalls is tied to deities Gura and Rara. On the Jos Plateau, Shere Hills serves as a spiritual landmark and cultural training ground, while Mafara Waterfalls sustains traditions of healing rituals and

annual festivals. Geologically, the sites span Precambrian to Jurassic formations, with features such as jointing, exfoliation, and hydrological cascades enhancing their scientific and aesthetic value. Despite their resilience, these landscapes face pressures from urbanization, extractive industries, and policy neglect. We propose an integrative geo-conservation framework that positions indigenous custodians as co-managers, blending ecological intelligence with geospatial analysis, legal protection, and education. This inclusive approach provides a culturally grounded pathway for safeguarding the geo-heritage of Nigeria and Africa.

Keywords: Indigenous, Knowledge, Geodiversity, Conservation, Narratives

Abstract ID: T6_008

Geologic Characterization and Cultural Significance of Geo-heritage Sites in West Africa: A Case Study of Olumo Rock in Abeokuta, Southwestern Nigeria.

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Abstract:

Olumo Rock, a prominent outcrop within the Precambrian Basement Complex of southwestern Nigeria, represents both a cultural landmark and an underexplored geo-site of scientific importance. The main aim of this study is to reconstruct the evolutionary history of Olumo Rock and explore its use as a specialized, sustainable, educational, and commercial tourism site.

This study applies detailed geological field mapping, petrophysical analysis, and structural measurements to characterize the lithology, mineralogy, and geomorphological features of the site. Detailed characterization of fractures such as joints, veins, faults, and intrusions helped determine their geometric and kinematic interactions. The

geological mapping results indicated the existence of four primary types of rocks: porphyroblastic granite, granite gneiss, porphyritic granite, and pegmatite. Porphyritic granite is the dominant rock type in the area, forming a central section of rocks that are surrounded by rims consisting of porphyroblastic granite and pegmatite.

Joints are the most common type of fracture seen in the region, and extensional fractures are the primary feature of the rock structures there. With two principal orientations noted in the NNW-SSE and ENE-WSW directions, rosette diagrams generated by the data collected suggest that these joints are oriented in all directions.

Beyond its cultural relevance, these geological attributes define Olumo Rock's significance as a geo-site: it provides insights into Precambrian tectonics, serves as a natural laboratory for studying granite emplacement and weathering processes, and offers accessible exposure for teaching and research in structural geology and geomorphology. By establishing the geoscientific value of Olumo Rock, this study underscores the need for systematic documentation of Nigerian geo-sites as part of Africa's geo-heritage, thereby promoting geo-tourism, conservation, and broader appreciation of Earth's history.

Keywords: Geo-sites, Geo-tourism, Olumo Rock

Abstract ID: T6_009

The Canary Islands Volcanoes (Spain): Assessment of Geo-heritage, New Technologies, and Geo-tourism

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Abstract:

Volcanoes from the Canary Islands have the greatest scientific value and recognition by society. Furthermore, these icons of the geo-heritage

have contributed significantly to the declaration of international recognition and sustainable development of UNESCO figures. The Canary Islands, destiny of Volcanoes' Project has been launched to develop a science-based tourism product. From the 300 geo-sites listed in the Spanish Geo-heritage Inventory for the Canary Islands (https://info.igme.es/ielig/), a specific methodology has been developed to select the 50 best geo-sites using the standard heritage assessment method. Geo-sites have been selected by their high scientific value, favourable conservation status, low fragility, good accessibility, and a spectacular volcanic landscape that makes them a tourist destination. The 50 volcanoes selected comply with the eight main pillars of volcano geo-tourism: 1) The diversity of volcanoes. 2) Historic active volcanoes that are safe and accessible. 3) Two UNESCO Global Geoparks: i) El Hierro and ii) Lanzarote and Chinijo Islands. 4) Volcanic landscapes for active tourism and hiking. 5) Scientific tourism around volcanoes. 6) Much more than volcanoes. 7) Volcanoes, archaeology and traditional uses. 8) Water and volcanoes. Exceptional use of groundwater on volcanic islands. Fifty geo-sites are being developed with new technologies that improve accessibility, generate new jobs, diversify the tourism sector, lower the carbon footprint, and support the sustainability of natural resources. Virtual and augmented reality (VR and AR) are immersive tools that enable users to interact with digital content in three-dimensional (3D) environments. These technologies allow people to explore the volcanoes of the Canary Islands and to recreate past processes and sounds that are no longer visible today.

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Keywords: Geo-tourism, Geological-Heritage, Great-Rift-Valley, Sustainable Tourism

Abstract ID: T6_010

Geo-Heritage in Africa: Capacity Building in the Geological Surveys Through the PanAfGeo Project

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Abstract:

Africa is a continent of remarkable geodiversity, with geo-sites of international relevance. To date, however, geo-heritage remains a little-known and little-recognised discipline in Africa. In 2025, only 2 UNESCO Global Geoparks are in Africa. Only 24 Geological Heritage sites recognised by the IUGS represent Africa. Inventories are patchy or non-existent in many African countries. Developing knowledge of Africa's geo-heritage and its conservation must involve raising the awareness of geoscience stakeholders. A partnership between OAGS and EuroGeoSurveys, initiated in 2015, led to a pan-African action, PanAfGeo, a long-term strategic cooperation between African and European Geological Surveys. PanAfGeo for "Pan-African Support to Geological Sciences and Technology Africa-EU Partnership" is a 2-phase project, training geoscientific staff from African Geological Surveys. Cofunded by the European Union and 13 European Geological Surveys, it is coordinated by the French Geological Survey. About 1,770 geoscientists from all African countries were trained, making PanAfGeo a unique pan-African geoscience-training programme. Courses were carried out by African/European experts. Many stakeholders are involved, including UNESCO and GSAf. From 2016 to 2024, almost 200 African geoscientists from 41 countries have been trained in geo-heritage and its conservation. The 6-day session encompasses theory and practical fieldwork (definitions and concepts of geodiversity and geo-heritage, inventory, assessment and geoconservation within the protected

natural areas, and promotion). Links between geo-heritage and cultural heritage, mining activities and geohazards are also presented. UNESCO presented its actions and objectives for Africa through the International Programme for Geoscience and Geoparks, and the Global Geopark label. PanAfGeo contributed to raise awareness of geoconservation in Africa, and in some countries has led to the launch of geo-heritage activities.

Keywords: geo-heritage, geo-conservation, Africa, capacity-building, PanAfGeo

Abstract ID: T6_013

Geo-Heritage Sites of Nigeria: A Call for Sustainable Development

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Abstract:

Within the regional geologic setting of the African continent, West Africa in particular Nigeria is situated within the active Pan African region which is considered to be a mobile belt in the eastern flank of the stable West African Craton. Geo-heritage sites in Nigeria are genetically related to global geologic episodes that affected the African continental crust. Nigeria possesses diverse geo-heritage attractions that hold significant potential for geo-tourism. This paper explores the identification, classification and assessment of the various sites emphasizing their contribution to environmental education, heritage preservation and sustainable economic growth. Key geo-heritage sites were identified and systematic classification and evaluation of these various sites using scientific, aesthetic, cultural and recreational values is presented. We highlighted the need for educational initiation to raise awareness among local communities and stakeholders regarding the significance of geo-heritage and its potential for sustainable development. Commercialization strategies are discussed focusing on community involvement partnership with local government, non-

governmental organization and private sector. The study advocates for the implementation of geo-tourism frameworks that promotes responsible travel practices while ensuring that local communities benefit economically. Integration of geo-heritage into national and regional development plans is recommended to enhance infrastructure, accessibility and marketing efforts. Environmental degradation, inadequate funding and lack of regulatory framework are challenges acknowledged alongside proposed solutions to mitigate those issues. The paper concludes that the identification and commercialization of geo-heritage sites not only preserves the country rich geological legacy but also serves as a vital component in the promotion of sustainable development.

Keywords: Nigeria, Geo-heritage, Geo-tourism, Identification, Classification,

Abstract ID: T6_014

A Bibliometric Perspective on the Status and Future of Digital Geo-Heritage Research in Africa

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Abstract:

This study examines the status and trends of geo-heritage research in Africa, with particular focus on the integration of digital tools for geo-heritage conservation and geo-tourism. Despite the widespread adoption of digital technologies in UNESCO Global Geoparks globally, Africa lags in this regard, hampering the preservation and promotion of its geo-heritage. Using data retrieved from Scopus and Web of Science, we analyzed research outputs on geo-heritage, geo-tourism, and geo-conservation, emphasizing both global trends and regional keywords such as Africa, South Africa, Tanzania, Morocco, Ethiopia, M'Goun, Ngorongoro, Victoria Fall, Vhembe, Nigeria, and Egypt. Our findings

show a significant rise in digital innovation in geo-heritage research over the past 25 years, with approximately 900 global articles covering technologies such as GIS, remote sensing, 3D modeling, mixed reality, and blockchain. However, related research works in Africa are limited, with only about 30 relevant articles found, primarily from Morocco, Egypt, and South Africa. Moreover, we noticed a global shift toward digital geo-tourism and geo-heritage post-2012, yet African research is still sparse, with limited institutional involvement and external funding sources, predominantly from European and international bodies. We recommend a strategic approach to enhance the participation of Africa in digital geo-heritage research, including fostering international collaboration, building local capacity, and developing supportive policies. Importantly, our work provides a roadmap for advancing digital geo-heritage preservation in Africa, advocating for increased investment and awareness to ensure sustainable development and global contribution to geo-heritage conservation.

Keywords: Geo-heritage, Digital, Geo-tourism, Bibliometric, Africa

Abstract ID: T6_015

Beyond the Surface: Unleashing the Rich Geo-Heritage of Africa Through Emerging Technologies

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Abstract:

The vast and diverse geo-heritage of Africa holds invaluable scientific, cultural, and economic significance, yet many of these geo-sites remain underexplored, under-documented, and inaccessible to the global audience. Traditional methods of geo-heritage research have relied been reliant on physical field studies and static documentation, which often fall short in capturing the full depth of these geological wonders. This talk advocates for the urgent integration of emerging technologies

such as Geographic Information Systems (GIS), Geospatial analyses, Artificial Intelligence (AI), Mixed Reality (MR), drone photogrammetry, and cloud computing into the geo-heritage research framework of Africa. African researchers can create high-resolution 3D models, immersive virtual tours, and AI-driven predictive analyses that enhance the documentation, conservation, and public engagement of geo-sites by employing these contemporary tools. This approach not only democratizes access to the rich and diverse geo-heritage of Africa but will also drive sustainable geo-tourism, empowering local communities while preserving sites for future generations. A case study from an amazing waterfall from Nigeria is used to illustrate how digital innovation can transform geo-heritage into an interactive and monetizable asset. Importantly, we challenge geoscientists, policymakers, and technologists to reimagine Africa's geo-heritage beyond static maps and textbooks. The fusion of geoscience and technology can redefine exploration, conservation, and storytelling, propelling Africa's geo-heritage onto the global stage and ensuring its legacy in the digital era.

Keywords: Geo-heritage, Digitization, Emerging, Technologies, Conservation

Abstract ID: T6_021

Geoheritage Inventory for Baringo County, Kenya: Assessment of Geosite RV-BC-007, Hot Springs of Lake Bogoria

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Abstract

The county of Baringo (Kenya) is aspiring to be recognized by UNESCO as a Global Geopark, and one of the requirements is geoheritage of international relevance. For this purpose, a systematic inventory of geoheritage is being developed by the international cooperation (i-COOP) project "Geoheritage inventories for UNESCO Global Geopark proposals in Africa: the Baringo County pilot study (Kenya)" (Geo-Kenia project, 2024-2025). This project is funded by the Spanish National Research Council (CSIC) for joint collaborative research between the Directorate of Geological Surveys (State Department for Mining, Kenya) and the Geological Survey of Spain (IGME CSIC). We herein present some of the first results of this geoheritage inventory, focusing on the assessment of Geosite BC007: Hot Springs of Lake Bogoria.

Lake Bogoria is an endorheic saline alkaline lake located along the eastern wall of the Gregory Rift Valley at approximately 963 meters above sea level. The lake and its surroundings provide a remarkable natural laboratory for studying active tectonics, volcanism, hydrogeology, mineral deposition, and biological adaptation to extreme environments. More than 200 hot springs and geysers with water temperatures exceeding 90°C feed the lake, influenced by fault-controlled hydrothermal circulation. The presence of Holocene stromatolites, travertine terraces, and silica-rich mineral deposits reveal past climatic fluctuations and geothermal activity. The site is internationally recognized as a Ramsar site since 2001 and part of a protected National Reserve since 1973. The methodology applied in the assessment of the geosite's value and vulnerability under the Geo-Kenia project follows García-Cortés et al. (2019), adapted from the PanAfGeo project (Díaz-Martínez et al., 2019, 2023) and recently calibrated to Kenya's characteristics. Assessment results indicate very high scientific, educational, and touristic values, with a low susceptibility to degradation, but high fragility due to the delicate nature of hot spring deposits. Recommendations include establishing controlled visitor access and enhancing education on site preservation. The outstanding representativity (scientific, educational, and touristic values) and recognition of the geosite at the international level, together with the presence of a number of published scientific research

of the geosite result in an international relevance, strongly supporting Baringo's aspirations for UNESCO Global Geopark recognition.

Keywords: Lake Bogoria, hot springs, geoheritage

Abstract ID: T6_022

Geo-Heritage Inventory for Baringo County, Kenya: Assessment of Geo-Site RV-BC-006, Quaternary Volcanic Edifice, and Caldera at Paka

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Abstract:

Baringo County (Kenya) is pursuing UNESCO Global Geopark recognition, which requires geo-heritage of international relevance. To support this, a systematic geo-heritage inventory is underway through the international cooperation (i-COOP) project "Geo-heritage inventories for UNESCO Global Geopark proposals in Africa: The Baringo County pilot study (Kenya)" (Geo-Kenia project, 2024–2025). Funded by the Spanish National Research Council (CSIC), the project involves joint research between Kenya's Directorate of Geological Surveys and the Geological Survey of Spain (IGME-CSIC). This report presents initial results from the inventory, focusing on Geo-site BC006: a Quaternary volcanic edifice and caldera in the Northern Kenya Rift Valley. The edifice comprises over 600 meters of volcanic deposits, with a summit marked by arcuate collapse structures and a central caldera. Holocene magmatic activity is evident in intra-caldera craters, and geothermal features such as fumaroles and altered grounds are seasonally active. The site's assessment follows the methodology of García-Cortés et al. (2019), adapted through PanAfGeo trainings (Díaz-Martínez et al., 2019, 2023) and calibrated to Kenyan conditions. Results indicate very high scientific and educational value, high touristic potential, low vulnerability to natural threats, high

vulnerability to anthropic threats, low susceptibility overall, and low risk of degradation. These findings highlight the need for administrative and financial efforts to improve site accessibility and recommend strict control of industrial activities to ensure sustainable use for science, education, and tourism. The geo-site's representativity within the Rift Valley system, combined with existing scientific publications, confirms its international relevance—making it a strong candidate for inclusion in the UNESCO Global Geopark framework.

Keywords: Baringo, geo-heritage, aspiring geopark, Kenya

Abstract ID: T6_023

Geo-Heritage Inventory for Baringo County, Kenya: Assessment of Geo-Site RV-BC-009: Quaternary Fluvial Carbonate Tufas at Maji Moto, Baringo

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Abstract:

The county of Baringo is aspiring to be recognized by UNESCO as a Global Geopark, and one of the requirements is geo-heritage of international relevance. For this purpose, a systematic inventory of geo-heritage is being developed by the international cooperation project (Geo-Kenia project, 2024-2025). We herein present some of the first results of this geo-heritage inventory of Geo-site RV-BC-009. The local geology consists of of a porous tufa, consisting of fossils, moulds of macrophytes, leaves and wood. The formation is associated with warm or ambient springs that occur along fractures on volcanic rocks at Maji Moto. The Geo-site is located on a river cutting where the tufa layer, approximately 5 meters thick is exposed. It overlies well-consolidated volcanic tuffs and Hannington trachyphonolites. The deposit is fluvial and not lacustrine as it occurs mainly within the present that drainage channels and is

absent in the lake Bogoria basin. The methodology which is applied in the assessment of the geo-site's value and vulnerability under the Geo-Kenia project is that of García-Cortés et al. (2019). The assessment yielded the following results: very high educational values, high scientific and touristic values, low vulnerability due to natural threats, intermediate vulnerability due to anthropic threats, low susceptibility to natural and intermediate anthropic threats, and low risk of degradation. These results clearly show that while the site is currently well preserved and intact, there is need for urgent administrative, physical and legal protection of the site, given its proximity to the road, and strongly recommend that the proper measures are implemented for sustainable use. The site has potential educational value for explaining the sedimentary processes behind fluvial carbonate tufa formation and hold scientific potential for paleoenvironmental reconstruction research.

Keywords: Baringo, Geopark, UNESCO

Abstract ID: T6_025

Moving "Africa Alive Corridors" Forward

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Abstract:

Africa Alive Corridors is a modern approach to Earth Stewardship Science in Africa. 20 corridors explore the geo-biological and cultural heritage. Each corridor reveals a specific lens through which to investigate rich scientific narratives embedded within it. For example, AAC 1 runs from Barberton through the Cradle of Humankind to Pretoria. This corridor explores the evolution of life since 3.5 Ga. AAC 2 extends from SW Angola through Namibia to NW South Africa to include Cryogenian sequences of the Sturtian (717-661 Ma) and Marinoan (646-635 Ma) glaciations. This trail looks at early microbial life during Snowball Earth. AAC 4 is

along the Cameroon Line (70-10 Ma), extending from the islands of São Tomé and Príncipe to Cameroon and NE Nigeria, and which has influenced many aspects of the people and cultures. AAC 5 covers the continental collision in Algeria, Morocco, and Tunisia. On average 30 major earthquakes are recorded yearly, resulting in a detailed seismic hazard model. AAC 6, in Madagascar, highlights the influence of plate tectonics on co-dispersal of plants and lemurs between 90 and 30 Ma. AAC 7 straddles the equator across national parks of the Congo Basin where, possibly, the genetic split between Homo and Pan first occurred around 8-7 Ma. AAC 9 links the Great Lakes of the Western Rift Valley. Seismo-volcanic activity is persistent, and a rich biodiversity has developed, but rapid deforestation and urbanization is predicted by 2050. AAC 10 explores early food systems, habitat quality, and permanent settlement of modern human along the south coast. AAC 15 follows education and trade routes across the Sahara during the 13th century, covering Senegal, Nigeria, Mali, Ghana, Benin, Togo, Burkina Faso, Côte d'Ivoire, Liberia, Sierra Leone, Guinea, Guinea Bissau, and The Gambia. AAC 16 focuses on archaeology and cultural landscapes of Mapungubwe-Great Zimbabwe, 1200 to 600 BP. Here, music provides an ideal platform for discovering this heritage.

Keywords: Africa's autobiography, Transdisciplinarity, Geo-heritage

Abstract ID: T6_026

Geo-Heritage and Geo-Tourism Resources of the Katanga Copperbelt: A Way of an International Perspective Related to Education in Africa

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Abstract

The Democratic Republic of Congo (DRC) exposed several sites of Earth's geological resources and are naturally well preserved. Although the geo-heritage is considered as key element for geo-tourism, in DRC its practice is still poorly developed. Consequently, DRC which is a vast country located in the central Africa remains touristically disconnected to the remaining parts of the continent where geo-tourism is well established. Three sites in the Katanga Copperbelt as case example are highlighted as linking to the geo-heritage within the development of the copper and cobalt mine in DRC. The first site is the Lufilian arc within the Cu-Co deposit. Many of these unique structures are disappearing because of mining operations. The second site is a transition zone along the tectonic unconformity between the fold-thrusted Lufilian arc and the tabular Katanga foreland in the southern part of the Biano Plateau. As for the third site, it is composed of mineral waste and tailings let aside during ores processing and beneficiation operations since 1909. The conservation of some sites is expected to help promoting geo-tourism through the creation of geoparks along the Katanga Copperbelt and especially in DRC for the educational benefit of the next generations. Furthermore, extending the geo-tourism itinerary to sites located in the Katanga Copperbelt will be beneficial to the DRC and the whole central Africa region.

Keywords: Geo-heritage, geodiversity, Katanga Copperbelt, education,

Abstract ID: T6_028

Preliminary Overview of Some Geopark Sites in the Democratic Republic of Congo (DRC): A Potential Geo-Heritage for Promoting Geo-Tourism and Education in Africa

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Abstract

The Luishia Principal is one of the largest Cu-Co (U) deposit located in the central part of the Katanga Copperbelt. A previous preliminary genetic model of the florencite formation in the Roan Group at Kabolela Cu-Co deposit supports two main processes: i) hydrothermal alteration and ii) weathering process in the supergene zone. Recent fieldwork completed at Luishia deposit, following by a detailed mineralogy and geochemistry analysis under scanning electron microscope and energy dispersive spectrometers, the florencite have been identified in the dolomitic shale of the Kinsevere Formation. The florencite crystals in thin section are hexagonally prismatic or pseudocubic rhombohedra (200 to 400 mμ) disseminated in the host rocks and occurred in the veins. Mineral mapping and cross sections through the florencite crystals show an internal zonation and complex distribution of RRE in each overgrowth zone. HREE (Sm, Y, Gd, Dy) are concentrate in the body of the florencite crystals while the LREE (La, Ce, Nd) increase in its external growth zone. The origin of the florencite at Luishia deposit is a result of the diagenesis and the evolution of the Cu-Co hydrothermal fluid rich in REE migrated during the Lufilian orogeny and its post period. The occurrences of florencite as well as both monazite and apatite control the distribution of the REE in the Katanga Supergroup and are linking to the Cu-Co mineralization stages.

Keywords: Geopark, Katanga, Luizi impact, Nyamulagira

Abstract ID: T6_029

Inventory and Assessment of Rwandan Geo-Heritage Sites for Sustainable Geoconservation

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Abstract

Rwanda, known as the "Land of a Thousand Hills," hosts a rich and diverse geo-heritage shaped by its position along the western branch of the East African Rift System and the Precambrian Karagwe-Ankole Belt. This study provides a scientific evaluation of key geo-sites that reflect the country's tectonic, volcanic, and sedimentary evolution. Using field investigations, GIS-based mapping, qualitative assessments, and stakeholder consultations, the research identified and assessed geo-sites based on their scientific, educational, cultural, and geo-tourism value. Notable sites include the Virunga Volcanic Complex, with its active and dormant volcanoes and monogenetic craters, which are important for volcanic hazard monitoring. Lake Kivu offers insights into rift dynamics and gas stratification. Additionally, geothermal features such as the Nyamyumba and Bugarama hot springs are indicative of active tectonism. Other sites, including Ndaba, Kamegeri, Ngarama, and Bigogwe Rocks, integrate geological interest with cultural heritage. Basaltic lava tubes further contribute to understanding Rwanda's volcanic history. A geo-site ranking system places the Virunga Volcanic Province at the top, followed by Lake Kivu and other key sites. The findings highlight the potential of Rwanda's geo-heritage to advance geoscientific research, environmental education, sustainable tourism, and long-term geo-conservation. Protecting these geo-sites is crucial for preserving the country's geological heritage and promoting socio-economic development.

Keywords: geo-site, geo-tourism, conservation, Rwanda

Abstract ID: T6_030

Evaluation of Geo-Sites in Homabay County, Kenya as Areas of Potential Geopark Development

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Abstract

Geoparks act as a model for conserving natural heritage while promoting social and economic growth, bridging the gap between conservation and development. Despite the geological diversity in Africa, there are only two geoparks, making the need to assess more areas urgent. Homabay, located in western Kenya, is an area of geodiversity, biodiversity and cultural diversity with rocks ranging from Archaean age to Quarternary age. The study aims to evaluate sites of geo-tourism relevance in Homa Bay through geo-site assessment methodologies to provide data-driven decision-making in geoconservation and sustainable tourism. The study followed four procedures: desktop study, identification and selection of sites of geological interest, geo-sites and geo-morpho sites assessment using the Brilha Method, and qualitative analysis using Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis for sustainable development strategies of geo-tourism, respectively. Fifteen (15) potential geo-sites were identified and evaluated. All sites have low degradational risks with medium to high potential for geo-tourism, scientific and educational potential relevant to local sustainable development, holistic and socially constructive abilities touching on conservation, economic growth and community empowerment. Lake Simbi Nyaima stands out for its relevant educational, scientific and touristic values of 335, 330, 315, respectively. These assessments highlight Homabay County as a potential geopark destination of international significance.

Keywords: Geopark, Geo-site, Geo-conservation, Homa Bay

Abstract ID: T6_052

Geo-Heritage Inventory for Baringo County, Kenya: Assessment of Geo-Site RV-BC-001, Quaternary Hominin Footprints at Lung'ok

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Abstract:

Baringo county (Kenya) is an aspiring UNESCO Global Geopark, and one of the requirements is geo-heritage of international relevance. A systematic inventory of geo-heritage is being developed by the international cooperation project "Geo-heritage inventories for UNESCO Global Geopark proposals in Africa: The Baringo County pilot study (Kenya)" funded by the Spanish National Research Council (CSIC) for collaborative research between DGS (Kenya) and IGME CSIC (Spain). We present the first results of this geo-heritage inventory on Geo-site BC001: Quaternary hominin footprints at Lung'ok. Local geology consists of Pleistocene lacustrine and playa-lake deposits with animal footprint traces (tetrapods and bipeds), including at least five traces of a group of hominins, probably Homo erectus. The substrate consists of mudstone and fine-grained sandstones cropping out on the almost horizontal surface of a step-fault tectonic block, which is affected by erosion from extreme flash flood events during the rainy season. The methodology applied in the assessment of value and vulnerability under the Geo-Kenia project is modified after García-Cortés et al. (2019) and calibrated to Kenya's characteristics. The assessment of this geo-site yielded the following results: high scientific, educational and touristic values, very high vulnerability due to natural threats, high vulnerability due to anthropic threats, high susceptibility to both natural and anthropic threats, and very high risk of degradation. These results clearly show the need of urgent administrative and economic efforts towards the physical and legal protection of the geo-site, and strongly recommend that proper measures be implemented onsite for its sustainable use. The representativity and rareness (uniqueness) of the geo-site, together with the lack of scientific research of the geo-site result in a national relevance, which might be international once the geo-site is properly studied and the corresponding results are published.

Keywords: The Kainaini Swamp Bouncing Phenomenon

Abstract ID: T6_051

Source Rock Evaluation and 1D Basin Modelling in the Ruvuma Basin, Southeast Tanzania

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Abstract

Source rock evaluation and basin modeling play an important role in understanding hydrocarbon potential in any sedimentary basin. Currently, there is limited research focusing on source potential in the sediments of Ruvuma Basin; most studies rely on a few samples. As a result, the variability in organic matter types and quality with respect to basin evolution has not been well constrained. In an effort to better understand the source rock potential in the Ruvuma Basin, this study was carried out using geochemical analysis of cutting samples (n=48) along with 1D Basin Modeling performed by PetroMod (Version 2012) across stratigraphy in Lukuledi well -1 including Karoo and Mtumbei formations. Geochemical analysis reveals that both organic matter content and quality vary across stratigraphy. The organic richness in the sediments of the Mtumbei Formation fluctuates from 0.05 wt% to 0.14 wt%, with an average of 0.08 wt%. In the sediments of the Karoo Formation, TOC values fluctuate along stratigraphy as follows: in the upper part, TOC values range from 0.23 wt% to 2.79 wt%, with an average of 0.85 wt%; in the middle part, they range from 0.23 wt% to 7.53 wt%, with an average of 2.35 wt%; and in the lower part, they range from 0.4 wt% to 78.74 wt%, with an average of 24.08 wt%. This variability indicates varying hydrocarbon generating capabilities. The organic matter is exclusively made of kerogen types II and III, which has been subjected to a wide range of thermal alterations ranging from immature to post mature (oil to gas prone). The burial history curve reveals that the sediments of Ruvuma Basin have undergone different tectonic phases,

accompanied by seven major episodes of deposition, uplifting and erosion events from 293 Million years ago until recent times. The thermal maturity model agrees with rock pyrolysis data interpretation (Tmax, Vr%), both providing insight into the thermal evolution of the basin.

Keywords: Source Rock, Basin Modelling, Tectonic

T7- S1 Innovation and integrated approaches in Geophysics

Abstract ID: T7_002

Spectral Interpretation of Minerals

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Abstract:

Hyperspectral Image Spectroscopy (HIS) has revolutionized the spectral interpretation of minerals by providing non-destructive, high-resolution spectral data for precise mineral identification and mapping. This study explores the application of HIS in determining the wavelength of minimum reflectance, a critical spectral parameter for distinguishing minerals based on their unique absorption features. Wavelength mapping using HIS enhances the accuracy of mineral classification and spatial distribution analysis, making it a valuable tool in geological exploration and remote sensing applications. Compared to traditional analytical techniques such as X-ray Diffraction (XRD) and X-ray Fluorescence (XRF), HIS offers a rapid, large-scale, and non-invasive means of mineral characterization. While XRD is highly precise in identifying crystalline structures and phase compositions, it requires physical samples and extensive laboratory preparation. The integration of HIS with XRD and XRF provides a comprehensive approach to mineral characterization, leveraging the spectral mapping capabilities of HIS alongside the structural and elemental insights offered by XRD and XRF. This synergy enhances the accuracy of geological interpretations and supports advanced mineral exploration and environmental studies. This study was focused on the analysis of a lithium pegmatite rock sample and the findings underscore the growing importance of hyperspectral data in complementing conventional mineralogical techniques for more efficient and precise geoscientific analyses. The minerals that were identified from the sample included; Lepidolite, Muscovite, Topaz, Quartz and Albite.

Keywords: Hyperspectral Image Spectroscopy, Wavelength Mapping

Abstract ID: T7_013

Revealing Pervasive Intrabasin Faulting in the Volta Basin: Evidence of a Regional E-w Structural Fabric in the West African Craton

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Abstract:

Recent geophysical investigations of Ghana's Volta Basin reveal a pervasive east–west (E–W) fault network that reflects a broader tectonic fabric across the West African Craton (WAC). These findings underscore the influence of inherited basement structures and their reactivation in shaping basin evolution and sedimentation patterns. Magnetic, electromagnetic (EM), radiometric, and Shuttle Radar Topography Mission (SRTM) datasets were integrated to characterise fault geometries. The analysis highlights steeply dipping (89–90°) magnetic lineaments averaging 40 km in length and spaced 5–15 km apart. These appear as linear, anastomosing, and isolated features that truncate geophysical domains, define low-conductivity corridors, and coincide with topographic breaks, often aligned with drainage. Results highlight key structures including the Ketesso Fault, which reorients locally into NNE–SSW directions, linking to basement faults such as the Pru Fault in the Sefwi Belt. In the eastern Volta Basin, a horsetail splay structure truncates fault arrays and separates contrasting gravity domains, indicating transtensional and strike-slip regimes possibly associated with dyke intrusions. Magnetic modelling suggests anomalies are controlled by contrasts in sediment thickness, susceptibility, and depth, similar to features in the Albuquerque Basin of

the Rio Grande Rift. Regional comparison shows strong analogues with the Markoye Fault Zone in Burkina Faso and the Sassandra Shear Zone in Côte d'Ivoire, both long-lived E–W fabrics of the WAC. These correlations reinforce the role of inherited structural trends and tectonic reactivation in controlling basin development. The study provides new insights into the tectonic framework of the Volta Basin with implications for mineral and hydrocarbon exploration in cratonic basins.

Keywords: Volta Basin, tectonic inheritance, transtensional regimes, West African Craton, basin analogue

T7- S2 Advances in geochemical exploration techniques, data interpretation and integration

Abstract ID: T7_003

Petrogenesis of Basalt and Associated Silicic Rocks From Upper Omo Valley Volcanic Section, Southwestern Ethiopia

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Abstract:

Field, petrography, major and trace element analyses of mafic and silicic rocks from upper Omo valley volcanic section, Southwestern Ethiopia are presented to determine petrogenetic evolution. The analyzed rocks belong to the basaltic and rhyolitic suites within the sub-alkaline group and these suites are linked via fractional crystallization as evidenced by occurrence of intermediate rocks (basaltic andesite and andesite rocks). Plagioclase, pyroxene, and Fe–Ti oxide minerals are the prominent phenocryst in basaltic rocks, while alkali feldspar phenocrysts are abundant in rhyolitic rocks. Sixteen samples of mafic and felsic rocks were analyzed for major and trace elements. Major element correlations indicate fractional crystallization played a significant role in the evolution of the upper Omo volcanic rocks. The rhyolitic rocks show general enrichment of light rare earth element (LREE) and depletion of heavy rare earth element (HREE). Strong negative anomalies in Sr, P and Ti, and low Ba/Nb, La/Nb, and Th/Nb ratios indicate that they were formed through low-pressure fractionation of basaltic lava derived from the depleted mantle with unremarkable crustal input. Correspondingly, REE abundances and incompatible trace element (e.g., Zr/Nb, Nb/Y ratios as well as plots of Nb/Yb vs. Th/Yb) suggest that rhyolite rocks

were derived from basalt magma source which resemble ocean island basalt (OIB)-like magma. The source area features and the similarity of melting conditions suggest that the ascent and development of mantle diapirs is the key to elucidate the volcanic activity in the upper Omo valley volcanic section. The geochemical features of these volcanic rocks are similar to those found in the northwest Ethiopian plateaus (such as LT and HT1-type basalt, Lima Limo and Wegel Tena rhyolitic ignimbrite). However, the crustal materials involvement in the genesis of LT-type basalt and Lima Limo rhyolite, Northwestern Ethiopian plateau were determined.

Keywords: Petrogenesis, Fractional crystallization, Assimilation

Abstract ID: T7_004

Integrated Geochemistry, Geostatistics, and Sedimentology to Identify Gold-bearing Zones at Bipindi, Southern Cameroon

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Abstract:

A petrographic, sedimentological and geochemical study, as well as geostatistical modelling, were conducted in the Bipindi area to evaluate distribution of gold and its mineral suite. The rocks identified include pyroxene and epidote gneisses, epidotized amphibolites, and quartzites, with major mineral associations such as Qtz + Kfs + Px + Amp + Bt ± Op for the gneisses and Qtz + Amp ± Ep + Op for the epidotized amphibolites. The granulometry study reveals a predominance of fine

particles (0.5 mm to 0.063 mm), with moderately good classifications, except for BIP-04 and BIP-10, which display very good classifications and have very angular forms (36 to 92%). Major element composition exhibits reduced concentrations of Al_2O_3 (< 2.31%) and TiO_2 (0.05 to 0.19%), with Al_2O_3/TiO_2 ratios and Fe_2O_3 lower in the downstream sectors, where the CIA is high (64.96% to 95.99%) and the ICV greater than 1. Cr, V, and Zn concentrations are high upstream, whereas Zr, Sr, La/Sr, Th/Sc, and Rb/Sr are elevated downstream. PGEs show Au concentrations ranging from 0.0001 to 0.243 ppm, Pt ≤ 0.001 ppm, and Pd ≤ 0.003 ppm, with Pd/Au (0.83 to 15 ppm) and Pt/Au (0.45 to 3.33 ppm) ratios reflecting metallic contrasts. The chondrite-normalised Cr, Ga, Zr, and Hf exhibit negative anomalies, whereas Th, U, and Ba show positive anomalies. These patterns persist consistently even following normalization using the PASS. The analysis reveals strong positive correlations between Al_2O_3-Fe_2O_3 (r2 = 0.93) and P_2O_5-Al_2O_3 (r2 = 0.80). Conversely, the CIA displays negative correlations with Pd (r2 = -0.76), CaO (r2 = -0.66), and Na_2O (r2 = -0.60). The sediments are immature (ICV > 1) and submitted to moderate to intense weathering (CIA > 70%), originating from quartz and mafic rocks with Th/U ratios higher than those of the upper continental crust.

Keywords: Sedimentology; Geochemistry; Gold-distribution; Geostatistical-modelling; Bipindi-Cameroon.

Abstract ID: T7_005

Exploration Model for an Intrusion-related Gold Deposit; Anomaly 482, West Kenya

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Abstract:

Intrusion-related gold deposits are those that are spatially and genetically associated with small intrusions of intermediate to felsic composition. They are classified as large tonnage, low to medium grade deposits that form at accretionary orogens. The formation of intrusion-

related deposits involves a CO2 and SO2 rich ore fluid exsolved from felsic magma at depth and rises to shallow crustal levels where it alters genetically related porphyritic intrusions and country rocks. Anomaly 482 is a prospective target within the Busia-Kakamega greenstone belt in western Kenya. The geology of the area includes Nyanzian mafic and intermediate volcanics to the south, and sandstone, greywackes and graphitic shales to the north that are unconformably overlain by Kavirondian sediments. Intermediate feldspar and quartz-feldspar porphyries intrude the Nyanzian volcanic and sedimentary units and are probably associated with mineralization. A major regional structure cuts across the target, trending approximately east-west and dipping south. Second order structures that trend approximately NW-SE cut the regional structure. Drill testing was carried at the target in 2024, and mineralization was observed being hosted in greywacke, mudstone, diorite, intermediate feldspar porphyry and intermediate volcanics. Mineralization is associated with quartz veins in greywacke, diorite and intermediate feldspar porphyry, and shear zones in mudstone and intermediate volcanics. Free gold has been observed in quartz veins within second order structures and is associated with fine disseminations of sulphides. Mineralization hosted in Nyanzian sediments and porphyries is characterized by silicification while that hosted in intermediate volcanics is characterized by sericite, biotite and silica-albite alteration. Based on the mineralogical, geochemical and structural observations, an intrusion-related genetic model is adopted for gold deposition in Anomaly 482.

Keywords: Exploration, Gold, Intrusion-related, Geochemistry, Alteration

Abstract ID: T7_007

Integrating Geological Mapping, Geochemistry, and Remote Sensing to Unveil Mineral Potential in the Kunene Complex, Northwestern Namibia.

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Abstract:

The Kunene Complex, spanning northwestern Namibia and southwestern Angola, is among the world's largest Proterozoic anorthosite bodies and a frontier for undiscovered mineral resources. Map sheets 1813AD and 1813 CA despite hosting promising lithologies remain critically underexplored due to fragmented data and minimal field verification. This study targets these data poor zones by applying a multidisciplinary exploration approach that combines traditional geological field mapping, geochemical anomaly analysis, hyperspectral remote sensing, and geophysical methods. Leveraging legacy datasets and satellite imagery, we aim to identify and validate mineralization patterns associated with anorthosite-leucotroctolite sequences and peripheral mafic to ultramafic intrusions. Hyperspectral data for instance (Sentinel-2, ASTER) and geophysical signatures will be synthesized using advanced GIS tools like ENVI, and Geosoft, and geochemical assays will refine prospectivity models. This approach enables the identification of subtle but critical geochemical and structural controls on mineral deposition, with an emphasis on rare earth elements, base metals, and magmatic Ni-Cu-PGE systems. Our findings are expected to reveal new exploration targets, reduce geological uncertainty, and demonstrate the utility of data-driven, scalable workflows in underexplored terrains. This work not only supports national mineral development goals but also exemplifies how frontier geology and modern analytics can synergize to uncover the next generation of economic minerals in Africa.

Keywords: Ore characterization, mineral exploration

Abstract ID: T7_018

Advancing Cost-effective Mineral Exploration Through Hyperspectral Imaging: A Case Study from the Council for Geoscience

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Abstract:

As mineral exploration costs continue to rise, the need for innovative and cost-effective technologies within the mining value chain has become increasingly urgent. In response, South Africa's Department of Mineral and Petroleum Resources gazetted a national exploration strategy in April 2022 to attract investment and stimulate discovery. A cornerstone of this strategy is the provision of high-quality geoscientific data, with the Council for Geoscience (CGS) playing a central role.

The CGS has adopted Hyperspectral Imaging (HSI) across its geoscientific programmes to enhance data acquisition and interpretation. HSI captures the interaction of electromagnetic radiation with matter, enabling the detailed characterisation of geological materials. Two core data processing approaches are employed by the CGS: an automated spectral library matching method using Pearson Correlation to produce supervised dominant mineral maps, and Self-Organizing Maps (SOM), an unsupervised clustering method that trains neurons to effectively represent subsets of the dataset.

To ensure data reliability, spectral interpretation results are quality-checked using Intellicore® software, addressing misclassifications due to overlapping spectral features. Spectra are validated against established libraries from the USGS, Johns Hopkins University, and TerraCore.

The application of HSI by the CGS has directly identified economically valuable minerals such as REE-hosting apatite/fluorapatite in the Bushveld and Schiel complexes and spodumene in LCT pegmatites. In indirect mineral detection, HSI data has proven effective in mapping alteration mineral assemblages associated with gold and copper porphyry systems. Additionally, SOM-based borehole imagery has supported lithological interpretation in carbon capture studies, enhancing consistency and accuracy in core logging.

HSI offers a non-destructive, rapid, and repeatable approach to mineral exploration, reducing costs and turnaround times.

Keywords: Hyperspectral Imaging, mineral exploration, Africa

Abstract ID: T7_011

Rutile U-Pb Ages and Implications for the Extension of the Timing of the Eburnean Overprint in the Ntem Complex (Southern Cameroon) Portion of the Congo Craton

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Abstract:

To gain an understanding of the tectono-metamorphic evolution of the Congo Craton in the southern Cameroonian Ntem Complex, alluvial rutile EPMA geochemistry and LA-ICP-MS U-Pb geochronology were carried out, and for the first time, robust rutile ages are obtained in that section of the Congo Craton. Concentrations of Nb vary from 287 to 7074 ppm and those of Zr and Cr from 7 to 592 ppm, and from 75 to 5836 ppm, respectively. These data suggest Minto alluvial rutile was sourced from mainly metapelitic and accessorily metamafic rocks. The Zr-in-rutile thermometer indicates a range of temperatures between 430 and 720°C, with an average temperature of 613°C. This suggests that the alluvial rutile rock sources were formed under conditions of amphibolite facies metamorphism. Five alluvial rutile grains yield overlapping and concordant ages of 1974 ± 8.8 Ma, 1987 ± 13 Ma, 1992.2 ± 8.4 Ma, 1989.1 ± 8.3 Ma, 1985.1 ± 12.1 Ma, respectively. These results are all consistent with a single Paleoproterozoic metamorphic growth event. The rutile ages suggest that Minto, in the southern part of the Ntem Complex, was subjected to Eburnean thermal rejuvenation. Therefore, our findings extend the timing and location of the Eburnean overprint in the Cameroonian Congo Craton portion beyond the previously recognised spatiotemporal window.

Keywords: Rutile, Geochronology, Eburnean, Craton, Cameroon

Abstract ID: T7_016

Hydrothermal Alteration in Diénéméra-Gongondy Paleoproterozoic Porphyry Copper Deposit, Burkina Faso, West African Craton

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Abstract:

Diénéméra-Gongondy copper-gold deposit is one of the rare Paleoproterozoic porphyry copper deposit of West African Craton. Like most of the Precambrian porphyry copper deposits, the mineralization of Diénéméra-Gongondy copper-gold deposit still remains controversial. The studies were conducted on thirteen drill cores of "Projet Minier Gaoua" where one hundred and ten representative samples were taken. We used a polarizing and metallographic microscope for sample description and analyses. Twenty-nine rock samples were analyzed for whole rock geochemistry and four with microprobe on hydrothermal minerals. However, δ34S isotopic analyses has been also conducted on these samples in order to determine the source of fluids associated to the minéralisation. Petrographic study revealed a complex lithology encompassing a wide range of subvolcanic to volcano-plutonic rocks variable in mineralogy and texture, dominated by several facies of microdiorites which host the mineralization. This mineralization is affected by several phases of hydrothermal alteration dominated at Diénéméra by propylitization and at Gongondy, by phyllitic-carbonate alteration type. The geochemical study of alteration minerals confirmed the presence of these alterations, but noted the lack of potassic alteration, probably destroy by late alteration or metamorphism events. The δ34S isotopic analyses on four samples of pyrite and chalcopyrite showed that the δ34S values range from -4.1 to 4.7. These values are in accordance with a magmatic origin of the fluids, with a probable little

contribution of late hydrothermal or meteoritic fluids. In definitive, all the results show that the Diénéméra-Gongondy copper-gold deposit is a porphyry type of birimian age affected by late stage magmatic, structural and hydrothermal events.

Keywords: West African Craton, Birimian, Porphyrycopper, Hydrotherm alteration

T8- S1 Data - Driven Discovery in Geoscience

Abstract ID: T8_001

Geostatistical Modelling and Data-Driven Prospectivity of Radiothermic Carbonatites Using Python

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Abstract:

Rare earth elements (REEs) are critical to global technological innovation and the transition toward carbon-free energy systems due to their unique magnetic, catalytic, and luminescent properties. In East Africa, REEs are predominantly concentrated in alkaline carbonatite complexes, which often exhibit high total rare earth oxide (TREO) grades and are spatially associated with Rift Valley structures, reflecting their mantle-derived magmatic origin. These carbonatites are frequently enriched in thorium- and uranium-bearing minerals, making them radiothermic and important both for REE and radioactive element exploration. However, despite extensive geological surveys, gaps remain in understanding the structural, geochemical, and hydrothermal controls governing REE enrichment. Traditional exploration methods struggle to capture the complex multivariate relationships within these systems. This study proposes a machine learning (ML)-driven, data-integrated approach for REE prospectivity modelling in East Africa, with a case study at Ruri Hills, Kenya. Multisource datasets will be incorporated, including spatial coordinates of samples, geochemical anomalies, mineralogical signatures, and structural/lithological data. Supervised ML algorithms such as Support Vector Regressor (SVR), K-Nearest Neighbors (KNN), and XGBoost will be implemented in Python to analyze and classify mineralization potential. Model accuracy will be evaluated through training-testing splits and cross-validation, with performance assessed using precision, recall, F1-score, and ROC-AUC metrics. The best-

performing algorithm will then be applied to generate predictive, high-resolution prospectivity maps for Ruri Hills. By integrating geological and computational methods, this approach aims to reduce exploration costs, refine targeting strategies, and provide new insights into the mineralization processes of carbonatite-hosted REE deposits in the East African Rift system.

Keywords: Machine Learning, Geostatristic,REES,Radiothermic Carbonatites, Python

Abstract ID: T8_003

A Machine Learning Approach for Classifying Lithological and Hydrothermal Zones from Geological Well-logs: a Case From the Olkaria East Geothermal Field, Kenya

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Abstract:

Accurate classification of lithological and hydrothermal zones from geological well logs is essential for effective geothermal wellbore characterization. Traditional approaches rely heavily on geologists' interpretation, which can be subjective. This study applies supervised machine learning techniques, Random Forest and Support Vector Machines, implemented in Python, to classify rock types and hydrothermal features using well-log data from 10 wells in the Olkaria East Geothermal Field, Kenya. Keyword-based features extracted from lithological and mineralogical descriptions were used to train and test the models. The best-performing model achieved an 85% classification accuracy, significantly enhancing consistency and reducing interpretational bias. Key lithological markers such as the Olkaria Basalts and Plateau Trachytes were effectively identified, improving the delineation of productive geothermal zones. This study demonstrates that machine learning, guided by geological expertise, can offer a robust and scalable

approach for improving geothermal exploration and well-site decision-making.

Keywords: Machine Learning, Geological Well-Logs, Classification

Abstract ID: T8_004

Machine Learning in Oil and Gas Data Management: a Case of Well Log Prediction

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Abstract:

The oil and gas industry faces significant challenges in managing the vast amounts of data generated during exploration, drilling, and production activities. These data, derived from seismic surveys, well logs, production records, and reservoir simulations, present complexities in processing, analysis, and storage. Traditional management techniques struggle to keep pace with the growing volumes, resulting in inefficiencies and missed opportunities for optimization. Machine Learning (ML) and Artificial Intelligence (AI) have emerged as transformative technologies, providing advanced solutions for data handling, analysis, and decision-making. This study presents the use of ML to predict missing well logs, which represent a major data management challenge. Well logs are critical for reservoir characterization and drilling decisions, offering valuable insights into subsurface geology. However, due to the costs and time associated with well logging, many wells, both legacy and modern, contain incomplete logs. These gaps limit formation characterization, reduce dataset consistency, and weaken integration of information across reservoirs. To address this, ML models were trained on complete datasets from nearby wells to predict missing logs in a sample well. Long Short-Term Memory (LSTM) networks proved particularly effective in capturing temporal and spatial characteristics of well-log data. Random Forests, Gradient Boosting, and LSTM networks achieved high accuracy, with root mean square error (RMSE) values below 5%. This

precision enabled the integration of older wells with incomplete logs into modern workflows.

By predicting historically unavailable data, ML improved efficiency, revealed underlying trends, and ensured timely access to critical information. Alongside broader uses in geophysical interpretation, drilling optimization, and reservoir analysis, ML is positioned as a key enabler for the future of data management in the industry.

Keywords: AI, Machine Learning, Data Management

Abstract ID: T8_006

Machine Learning for Rare Earth Elements Prospectivity in Africa

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Abstract:

Rare earth elements (REEs) are critical to global technological innovation and the transition toward carbon-free energy systems due to their unique magnetic, catalytic, and luminescent properties. In East Africa, REEs are predominantly concentrated in alkaline carbonatite complexes, which often exhibit high total rare earth oxide (TREO) grades and are spatially associated with Rift Valley structures, reflecting their mantle-derived magmatic origin. These carbonatites are frequently enriched in thorium- and uranium-bearing minerals, making them radiothermic and important both for REE and radioactive element exploration. However, despite extensive geological surveys, gaps remain in understanding the structural, geochemical, and hydrothermal controls governing REE enrichment. Traditional exploration methods struggle to capture the complex multivariate relationships within these systems. This study proposes a machine learning (ML)-driven, data-integrated approach for REE prospectivity modelling in East Africa, with a case study at Ruri Hills, Kenya. Multisource datasets will be incorporated, including spatial coordinates of samples, geochemical anomalies,

mineralogical signatures, and structural/lithological data. Supervised ML algorithms, Support Vector Regression, K-Nearest Neighbors (KNN), and XGBoost will be implemented in Python to analyze and classify mineralization potential. Model accuracy will be evaluated through training-testing splits and cross-validation, with performance assessed using precision, recall, F1-score, and ROC-AUC metrics. The best-performing algorithm will then be applied to generate predictive, high-resolution prospectivity maps for Ruri Hills. By integrating geological and computational methods, this approach aims to reduce exploration costs, refine targeting strategies, and provide new insights into the mineralization processes of carbonatite-hosted REE deposits in the East African Rift system.

Keywords: Rare earth elements ,Machine Learning,Prospectivity

Abstract ID: T8_007

Reimagining Earth Learning with Machines

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Abstract:

Artificial intelligence (AI) is rapidly reshaping industries worldwide, and geoscience is no exception. However, for AI to be fully integrated in this field, its models will require training on adequate corpora to ensure accuracy. When applied effectively, AI has the potential to transform how geoscientific data is analyzed, interpreted, and applied to address Africa's resource curse. Globally, countries like South Korea are advancing AI for mine safety through innovations like "Mine Safety DX," which tracks worker's fatigue. In Africa, prominent use cases include Zambia, where AI was used to identify copper deposits via analysis of geological datasets to pinpoint the best sites with high precision. In the hydrogeology sector, the International Water Management Institute (IWMI) is deploying AI-driven tools across Africa's most water-stressed regions so as to assist the government in managing the water crisis. Despite this, AI adoption in geosciences faces persistent challenges of hallucinations, biasness,

confidentiality concerns, and the inability to reproduce results from an AI-based system. To counter this, institutions like the Council for Geoscience in South Africa have adopted a targeted strategy of applying AI in three select domains; water quality in mines, dolomite studies, and the identification of seismic waves. By narrowing the scope, they aim to produce precise and reliable tools tailored to Africa's unique geological complexities. Equally important is the development of "home-grown" AI platforms that reflect Africa's realities rather than relying solely on external models that may lack transparency, censors state data or participates in copyright infringement. With deliberate effort, Africa has the opportunity to not only harness AI for geoscientific innovation but also to set new benchmarks for ethical, transparent, and sustainable applications of emerging technologies in resource management.

Keywords: SandAI, Artificial intelligence, machine learning

Abstract ID: T8_008

Deep Learning for Seismic Hazard Assessment and Resource Exploration

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Abstract:

Seismic hazard assessment and resource exploration require fast, accurate interpretation of subsurface signals to support safe operations and sustainable development. Traditional approaches, such as the Short-Term Average/Long-Term Average (STA/LTA) algorithm, are effective but often limited by sensitivity to noise and rigid detection thresholds, resulting in false alarms and reduced reliability. This study introduces deep learning models, specifically Recurrent Neural Networks architectures into seismic workflows to improve event detection, phase picking, and anomaly recognition. Real and synthetic waveform datasets were used to train the models, enabling them to capture temporal dependencies and spectral features that conventional methods overlook.

The results demonstrate that deep learning significantly enhances detection accuracy, reduces false positives, and strengthens robustness in noisy environments. Importantly, the same frameworks provide feature extraction for subsurface characterization, showing strong potential in resource exploration, by reducing interpretation uncertainty and improving imaging resolution. These advancements highlight the value of AI-driven seismic analysis; supporting early warning systems for hazard mitigation while accelerating decision-making in exploration projects. By integrating scalable, and adaptive deep learning models, seismic monitoring can evolve into a more reliable, automated, and industry-ready solution.

Keywords: Deep learning in seismic analysis

Abstract ID: T8_015

Hyperspectral Remote Sensing and Convolutional Neural Networks for Enhanced Exploration of Industrial Minerals: a Case Study of Limestone and Kaolin Clay Deposits

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Abstract:

The growing demand for sustainable alternatives to Portland cement has prompted interest in clay- and laterite-rich deposits as potential substitute cementitious materials (SCMs). This study examines the application of Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) shortwave infrared (SWIR) data, combined with fuzzy c-means (FCM) clustering, to distinguish between kaolin-, illite-, and laterite-bearing zones. SWIR-derived spectral indices were integrated into the FCM framework to enable soft partitioning of mineralogical classes, thereby allowing for an improved representation of compositional overlaps common in clay–laterite systems. Field validation was conducted using X-ray fluorescence (XRF) geochemistry,

with zonal statistics extracted over 100 m buffers around each sampling point to bridge spatial discrepancies between field and satellite data. Correlation analysis revealed strong associations between Al_2O_3 and kaolin–illite indices, and between Fe_2O_3 and laterite indices, confirming the relevance of SWIR-based proxies for SCM exploration. In contrast, spectral indices alone exhibited limited separability; fuzzy clustering, however, captured transitional mineralogical zones more effectively, thereby improving the delineation of target materials. This integrated approach demonstrates that ASTER SWIR data, when combined with FCM clustering and geochemical validation, provides a cost-effective tool for mapping clay and laterite deposits. The results highlight the potential of kaolinitic and illitic clays, as well as laterites, as SCM feedstocks, offering pathways to reduce clinker dependency and support low-carbon cement production in the region.

Keywords: Remote Sensing, Machine Learning, CNNs

Abstract ID: T8_018

The Prediction of Uranium Occurrence Using GIS Based Geostatistical Algorithms in Erongo Region

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Abstract:

Mineral resources are central to Namibia's socio-economic development and critical to the national and global energy transition. The Erongo region hosts substantial uranium reserves that have supported mine development and continue to present opportunities for further exploration. Accurate mapping of uranium occurrences is therefore essential for effective resource management and planning. This study evaluates the performance of interpolation methods for predicting uranium distribution using ArcGIS 10.6. A dataset of seventy documented uranium occurrences was applied to develop predictive models. Deterministic techniques—Radial Basis Function and Inverse

Distance Weighting—were compared with geostatistical approaches, including kriging and Empirical Bayesian Kriging (EBK). Model accuracy was assessed using average standard error, root mean square error, root mean square standardized error, and mean square error. Results show that EBK with a linear semivariogram outperformed Universal Kriging and provided the most robust representation of spatial variation. Overall, geostatistical interpolation, particularly EBK, proved more accurate and reliable than deterministic methods for mapping potential uranium deposits in the Erongo region. These findings underscore the value of advanced geostatistical methods in mineral exploration. Improved predictive accuracy enables more efficient targeting of exploration activities, reducing costs and environmental risks while strengthening the evidence base for sustainable resource management. The methodological insights extend beyond Namibia, offering practical relevance for exploration in other mineral-rich regions. By integrating precise spatial modeling into policy and planning, governments and industry can better align resource development with long-term economic and environmental goals.

Keywords: Uranium, GIS, Kriging, Geostatistical

Abstract ID: T8_050

A Dam Based Water Resources Management Planning for Makutupora Basin in Tanzania Using Google Earth Engine.

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Abstract:

This deficit can be addressed by tapping the surface water resources of the region by constructing a suitable dam for managing the regional water resources. For construction of dam, a proper water resource management planning is crucial to ascertain the optimal location and geometrical characteristics of the proposed dam sites. Thus, a dam

focused water resources management planning exercise has been performed here for this basin using Analytical Hierarchy Process (AHP) method. AHP yields a raster that is generated by taking a weighted sum of multiple criteria considered in this study. Here, six criteria - Stream density, rainfall, land use land cover, geological layer, soil types and slope have been selected on the basis of literature review. Thematic layers corresponding to these criteria are generated using Google Earth Engine (GEE) and QGIS followed by the implementation of AHP, resulting in a dam site suitability raster. This raster elucidates the relative suitability for dam construction and two suitable locations are derived from this map. Furthermore, the raster is classified into four discrete categories viz 1) low 2) moderate 3) high 4) very high suitability, with the last category encapsulating the location of the planned dam site in the northeastern part of the basin. Different heights of dam have been considered and the corresponding and characteristics of dam such as the inundated and volume are then computed using topographical information. This proposed dam has a height of 7 m, an inundation area of 6 km2 and a storage capacity of 25.2 MCM. The results of this study will facilitate water resources planning of the study region.

Keywords: Google Earth Engine, Makutupora Basin,

Abstract ID: T8_051

Advances in Geocomputation and Geospartial Artificial Intelligence for Mapping

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Abstract:

Geocomputation and geospatial artificial intelligence (GeoAI) have essential roles in
advancing geographic information science (GIS) and Earth observation to a new stage.

GeoAI has enhanced traditional geospatial analysis and mapping, altering the methods for
understanding and managing complex human–natural systems.

Keywords: nan

Abstract ID: T8_009

AfricaMaVal - Mineral Potential Mapping Study of European Critical Raw Materials (ECRM) of Africa

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Abstract:

The AfricaMaVal project, a 3.5-year initiative coordinated by the French Geological Survey (BRGM), fosters sustainable EU–Africa partnerships in the critical raw materials (CRM) sector. With 18 partners from 11 countries, it promotes responsible mineral sourcing for European industries while supporting Africa's sustainable development. Work Package 1 (WP1), "Supply Potential," led by the Portuguese Geological Survey (LNEG), assesses and maps African supply potential for European Critical Raw Materials (ECRM) through a harmonized, INSPIRE-compliant database. BRGM has developed machine learning (ML) algorithms for mineral resource assessment over the past 20 years, applied at scale since 2022. Within WP1, prospectivity maps for selected ECRMs were generated in ten countries, drawing on BRGM datasets, including 1:10M geological and structural maps and over 55,000 mineral occurrences. However, data resolution and coverage vary widely, with some countries lacking geoscientific information. Initial tests using the 1:10M BRGM/CCGM map highlighted its coherence but insufficient resolution for identifying precise mineralization zones or correlating mineral systems with geological events. To overcome this, modelling with BRGM's higher-resolution 1:2M map was undertaken. Geological domains (orogenic belts, basins) and events (Archean–Cenozoic) were classified, enabling ML to detect underexplored areas with potential for most 2020-listed ECRMs. The method leverages cross-border geological similarities to compensate for missing data and identifies favourable or unfavourable factors for

mineralization. The project delivers multi-thematic maps integrating mineral potential with infrastructure, protected areas, and small-scale mining. These serve as first-order exploration guides and support balanced decisions between economic opportunities, environmental constraints, and social considerations.

Keywords: Africa, Mineral Potential Mapping

Abstract ID: T8_010

Geostatistical and Machine Learning Based Groundwater Level Modelling in Southern Ethiopia: Current State and Near Prospects; Can Artificial Intelligence Help?

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Abstract:

Our current project focused on groundwater resources in southern Ethiopia is struggling with lack of reliable data. 82 water wells available in the study area are not evenly distributed, there are large areas without any information on ground water levels. Thus more sophisticated geostatistical methods using as explanatory independent variables 82 parameters such as Precipitation, DEM, Slope, TWI, Distance from rivers, LULC, NDVI, iSDA soil composition, Summer Land Surface Temperature and Evapotranspiration. Results of EBK regression are relatively satisfactory with RMS 35.9, but there are still quite many wells with error bigger than 50%. This method is still problematic for future drilling campaigns. Problem is non-linear behavior of some variables and lack of correlation of important ones. Better results were achieved with prediction using two machine learning methods: 1] Random Forest Regression (R-squared = 0.642) still exhibited a relatively high spread of (measured/predicted) difference values, reaching up to 593%, also 14 wells showing error bigger than 30%. 2] Best results are realized with Gradient Boosted Regression demonstrating robust predictive capability despite data scarcity and

non-linearity. Parameter optimization revealed that learning rate 0.3, 100 runs, 10% well data used for validation, and 100 trees yielded best results. Comparing predicted and measured water depths, we found only two wells with differences bigger than 30% (42% and 30.4% respectively). Currently we are focusing on 1] predictions of groundwater yield, which is more required by stakeholders than just static water level, first results are promising since we have around 1000 water wells with yield data; and 2] enhancing the set of independent explanatory variables and integrating more advanced Artificial Intelligence methods such as Deep learning using Neural networks.

Keywords: groundwater; Ethiopia; machine learning; geostatistics

Abstract ID: T8_011

Machine Learning Methods for Groundwater Level Prediction in the Main Ethiopian Rift

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Abstract:

Groundwater level prediction is crucial in water-scarce regions, particularly where data scarcity hinder effective resource management. Machine learning offers a promising avenue to address this challenge. The Bilate watershed, a 5250 km² area located 80 km north of Arba Minch, southern Ethiopia, exemplifies water-stressed regions in Africa with limited well data. This study aims to develop a robust predictive model for groundwater levels, enabling strategic drilling of shallow boreholes for subsistence irrigation in the Bilate watershed, a region facing significant water demand and well data scarcity. Employing static water level data from 84 boreholes, we developed and compared Random Forest Regression and Gradient Boosting Regression (GBR) models. Drawing inspiration from Wanru et al.(2023), which utilized 20 independent variables, we refined an initial set of 62 variables to

20 key predictors, including distance from streams, soil types, NDVI, satellite-derived precipitation, precipitation interpolated from ground station meteorological data (using Kriging and IDW), and land use snd land cover. GBR outperformed Random Forest, achieving an average R-squared of 0.648 in predicting rasterized groundwater levels, demonstrating robust predictive capability despite data limitations. Parameter optimization revealed that learning rate 0.3, 100 runs, 10% well data used for validation, and 100 trees yielded optimal results. Comparing predicted and measured water depths, we found only two wells with differences bigger than 30% (42% and 30.4% respectively). This study demonstrates the potential of machine learning to provide actionable insights for groundwater management in water-stressed regions, even with limited data. The successful application of GBR in the Bilate watershed suggests its potential transferability to similar areas in Sidama and Gamo, supporting sustainable irrigation and drinking water resource management.

Keywords: Machine learning, Random-forest and Gradient-Boosted Regression.

Abstract ID: T8_013

Monte Carlo-based Probabilistic Risk Analysis of Toxic Elements in Mining Soils: Source-specific Insights from Southwestern Ghana

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Abstract:

This study evaluates the impact of mining on soil contamination by conducting a source-specific probabilistic health risk assessment of Potentially Toxic Elements (PTEs) in Southwestern Ghana. Using an Energy Dispersive X-ray Fluorescence (ED-XRF) spectrometer, 720 soil samples were analysed for elemental concentrations. The PTEs with the highest frequency above their Critical Concentration Allowance (CCA) were As (100%), Ba(13%), Cr(5.8%), Pb(2.7%), Co(2%), V(2%), Cu(0.4%) and Zn(0.4%). Correlation, Self-Organising Maps (SOM) and Principal Component Analysis (PCA) identified three groups of PTEs, which are geochemically linked elements (Ba, Cr, Cu, Ni, V), anthropogenically influenced As, and a group with low correlations (Co, Pb). Results indicate that anthropogenic activities, such as gold extraction, partly drive As distribution. Geoaccumulation and Pollution Indices reveal varying levels of pollution in As, Cr, and Pb. Health risk assessments, using deterministic and probabilistic methods, found that while non-carcinogenic risks were within safe limits for adults (Hazard Index [HI] <1), children faced higher risks (HI >1) for As, Cr, Co, and V. Carcinogenic risks for both groups were within the acceptable threshold (10^{-4}–10^{-6}), with children at greater risk. Ingestion was identified as the primary exposure pathway. The study highlights the higher susceptibility of children to PTE pollution, emphasising the need for interventions to mitigate risks from PTEs.

Keywords: Pollution; geochemistry; Heavy Metals

Abstract ID: T8_014

Large Language Models in Palynological Taxonomy

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Abstract:

In the last year, the Deep-time Digital Earth (DDE) program, in association with the Zhejiang lab in China, have developed a Large Language Model

for the geosciences called GeoGPT. A Large Language or Generative Pre-trained Transformer (GPT) model is a type of artificial intelligence that can generate language and classify information. It's trained on large amounts of data, such as text from the internet, and uses neural networks (inspired by the systems in the human brain) to understand how words, characters, and sentences work together. A recent paper by Microsoft (Microsoft Research AI4Science, 2023) using their GPT-4 LLM showed the potential to analyse scientific literature, help researchers visualize large datasets, uncover trends in complex data, create code from text, and even develop novel hypotheses. Most scientists agree that LLMs are likely to have a big impact on how science in general is done. A new case study for GeoGPT is whether it can help with palynological taxonomy. Could a palynologist sitting by their microscope get some help from an LLM in determining a species? It turns out that palynology very much lends itself to developing a professional LLM that might be very useful in teaching taxonomy to apprentice palynologists, or to professionals, in environments that require expertise in many areas of palynology. It could also have particular use in Africa which has a significant number of academic centres specialising in Quaternary palynology for palaeoclimate research, and significant numbers of commercial professional palynologists working in stratigraphy for the oil and gas industry, for example in Nigeria and Angola. A small prototype called 'Taxonomy Assistant' has already been created and published. So far its performance is quite good. A larger system that covers most Phanerozoic palynological genera just completed will be demonstrated at the CAG conference. This will open access and free to all users.

Keywords: artificial intelligence, palynology, taxonomy

T9- S1 Pan African Orogeny

Abstract ID: T9_002

Mesoproterozoic Orogeny in Malawi – The Irumide Event

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Abstract

The Mesoproterozoic Irumide Belt is a paired orogen with two contrasting segments. The northern Irumide Domain comprises reworked Palaeoproterozoic crust and Mesoproterozoic igneous rocks, while the southern South Irumide Domain is built of juvenile, arc-related Mesoproterozoic crustal blocks. A sharp tectonic suture between them is marked by abrupt changes in lithologies, magmatism, and isotopic signatures. The Irumide Domain is subdivided into the Mzimba, Kasungu, and Mchinji subdomains, each containing high-grade paragneisses that post-date the ~2 Ga Ubendian orogeny. Two paragneiss sequences are distinguished: an older assemblage correlated with the Muva Supergroup (including the Mafingi Group in Malawi), and a younger suite with detrital zircon input from ~1100 Ma sources unknown in Zambia. Together with ~1080 Ma granitoid orthogneisses, these provide evidence for a short-lived Mesoproterozoic active margin along the southern Congo–BaNy Craton. The first Irumide orogenic phase, linked to arc accretion of the Irumide and South Irumide Domains to the Congo Craton, is dated at 1069 ± 9 Ma by syntectonic anatexis within the suture. Subsequent closure of the Irumide Ocean and docking of the Proto-Kalahari Craton at ~1045 Ma represents the main tectono-metamorphic event, accompanied by voluminous ~1040 Ma syn-

collisional magmatism derived from mixing of reworked Ubendian crust with mantle-derived South Irumide material. Structurally, the Irumide Domain is sandwiched between South Irumide rocks below and the Congo Craton above, implying north-directed subduction of the Irumide Ocean followed by south-directed nappe transport during collision. This revised model indicates that southern Africa's main crustal framework was established in the late Mesoproterozoic, rather than solely during the Neoproterozoic Pan-African/East African orogeny, and suggests only limited opening of the Damara–Lufilian–Zambezi basin in the Neoproterozoic.

Keywords: Mesoproterozoic orogeny, Malawi

Abstract ID: T9_003

A Petrographic and Geochemical Survey Over Mafic Rocks of the Bomu Craton (DRC)

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Abstract

The Great Congo Craton (GCC) is an under-investigated amalgamation of Archean Ntem, Angola, Kasai, Tanzania and Bomu blocks, as well as the detached Sao Francisco block in South America. According to a review, 97 potential mafic igneous provinces have been identified within the African part of the GCC, of which only 14 have been precisely dated. Thus, making the GCC an important missing LIP barcode puzzle piece in ancient plate reconstructions. No mafic igneous remnant was identified in the past for Bomu craton across north-eastern DRC, representing the focus of this study. The Bomu craton's greenstone-granitoid terrane is relatively well mapped, with more detailed studies of the craton's gold-mineralized greenstone belts, as well as a comprehensive geochronological and petrological survey, focusing mostly on the craton's granitoids.

Following upon 335 effective days of field work in 2020-2021, the first author collected 273 rock samples from across much of the Bomu Craton. 260 mafic samples were selected and processed for bulk rock geochemistry at its Central Analytical Facility, and a selection of 87 polished thin sections were prepared for petrographic studies from the first statistical analyses of geochemistry data. A first-order distinction can be made between amphibolites and relatively pristine dolerites (basalt-gabbro), although an intermediate range of more or less metamorphosed meta-dolerites makes it difficult to separate all into two groups. More pristine dolerite samples were likely collected from mafic dykes, and even if there are field evidence for the presence of at least three different trending dyke swarms were identified around Bunia, these do not appear to exhibit any diagnostically different geochemical signatures. Nevertheless, more analyses might be done to demonstrate the economic interest of the mafic samples.

Keywords: igneous, petrology, dolerite, amphibolite, Congo

Abstract ID: T9_004

Late Panafrican Metamorphic Evolution of Garnet-bearing Graphitic Micaschists in the West Congo Belt (Boma Region, Kongo Central, Democratic Republic of Congo)

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Abstract

The Panafrican West Congo Belt (WCB, West DRC) is the African counterpart of the Araçuaí-West Congo Orogeny (AWCO), which formed during Western Gondwana assembly in the Ediacaran-Cambrian. The AWCO also includes Archaean to Rhyacian-Orosirian amphibolite-granulite facies and gneissic-migmatitic basement, which in Kongo Central, is known as the ca. 2.1 Ga Kimeza Supergroup, affected by the Tadilian (Eburnean) orogeny. This study focuses on the Boma region, located in the westernmost tectono-metamorphic domain of the WCB, where polyphased Paleoproterozoic gneiss-migmatite domes occur, e.g. the 2069 Ma western Boma and the 2036 Ma eastern Mao domes. In between both domes, undated serpentinites as well as aluminosilicate-bearing metaquartzites, amphibolites and metapelites ascribed to the late Stenian-early Tonian precursor basin to the AWCO are exposed in a complex synform. Garnet-bearing graphitic micaschists (east of Boma town) contain staurolite, tourmaline, white mica, biotite, quartz, plagioclase and ilmenite. Garnets are millimetric and strongly zoned, with cores containing quartz and ilmenite in sigmoid structures, and homogeneous, inclusion-free rims. Chemical mapping reveals two garnet generations. Garnet zoning may be influenced by high graphite content, affecting metamorphic reaction progress.Two carbonaceous material (CM) types are observed: diffuse CM (Type I) and shiny flake-like CM (crystalline graphite; Type II). Raman spectroscopy indicates Type I formed at ca. 562±50°C, and Type II at > 650°C. As graphitization is irreversible, Type II thus records peak metamorphic temperatures. In situ U–Pb dating on monazite (matrix and garnet-hosted) yields a

concordia age of 531.6±2.2 Ma, which marks a late thermal metamorphic peak. This thermal event postdates AWCO main collision, dated in the WCB at 590-570 Ma. Our results show a complex Panafrican evolution in Boma with deep amphibolite facies, unlike eastern WCB where Kimeza rocks retrogressed to greenschist.

Keywords: WestCongoBelt - Panafrican orogen - graphitic micaschist

Abstract ID: T9_006

Tectonometamorphic History of Precambrian Rocks in Gato Area, Southwestern Ethiopia

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Abstract

A combination of field structural mapping and metamorphic study from thin sections were performed on rocks of the Gato area, Southwestern Ethiopia, and the tectonometamorphic history of the region is described. The study area comprises of extensively exposed high grade gneiss and migmatites in the north and tectonically mixed low grade rocks forming a tectonic melange in the south. These are separated by highly sheared garnetiferous hornblende gneiss. Field structural mapping and microstructural analysis show that the Precambrian rocks of Gato area is affected by four phases of Precambrian deformations; designated as D1 to D4. The major fabric in the area trends generally E-W in south, NE-SW in the north and moderately to steeply dipping to S and SE directions respectively. Shear sense indicators (asymmetric folds, stretching lineations) show N to NW sense of vergence. The overall structural configuration indicates that the major deformation is a result of NNW-SSE directed oblique compression. These Precambrian structures are superposed by rift related structures (D5). Three metamorphic events (M1, M2 and M3) are differentiated and are associated with the first three progressive deformation events (D1, D2 and D3). These include peak prograde granulite facies (M1), post-peak near-isothermal decompression amphibolite facies (M2), and late lower amphibolite to

upper greenschist facies retrogressive assemblages (M3). This study reveals that the Precambrian rocks in the Gato evolved following a clockwise P–T path with decompression and cooling after peak granulite-facies metamorphism driven by crustal thickening by thrusting, uplift and exhumation, and subsequent shearing and cooling.

Keywords: Precambrian, Microstructural, Tectonometamorphic, P–T path

Abstract ID: T9_007

New National Geological and Hydrogeological Map of Ethiopia at a Scale of 1:1,200,000

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Abstract

The foundation of geological knowledge lies in the systematic mapping of the Earth's subsurface. This process provides essential insights into geological structures, lithological patterns, and hydrogeological parameters. The resulting data are crucial for the sustainable management of water resources, agriculture, infrastructure development, and the assessment and mitigation of geological hazards. New national geological and hydrogeological map of Ethiopia, at a scale of 1:1,200,000, presents a comprehensive synthesis of geological, lithological, petrological, geochemical, and tectonic parameters. It offers a refined perspective on Ethiopia's lithostratigraphic framework, incorporating remote sensing data and gravity modeling. Compiled using existing maps of varying scales, extensive datasets, published literature, and new field verifications in key areas, this work addresses critical gaps in geological knowledge. Conducted between 2019 and 2024 as part of a Development Aid Project funded by the Czech Republic through the Czech Development Agency, the project delivers

an up-to-date and detailed geological resource, particularly valuable for groundwater assessments—a pressing issue in Ethiopia's natural resource management due to growing demand. Ethiopia's geological history is remarkably diverse, spanning from the East African Orogeny in the Precambrian to Mesozoic continental and marine sedimentation, culminating in the formation of the East African Rift System and associated volcanic activity from the Eocene to the present. The accompanying hydrogeological map integrates geological data with hydrological parameters, providing a robust tool for sustainable groundwater resource management. A comprehensive understanding of Ethiopia's geological environment is fundamental to the efficient and sustainable utilization of natural resources such as land, water, and minerals.

Keywords: Geological map, Hydrogeological map, Ethiopia

Abstract ID: T9_015

Characterization of Carbonate Rock Facies of the Cryogenian Ondole Sequence Using Carbon Isotopes, Opuwo, NW Namibia

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Abstract

The Neoproterozoic Era, the final era of the Proterozoic Eon experienced the most severe glaciations recorded on Earth, particularly during the Cryogenian Period. This period was marked by dramatic climate shifts, often referred to as Snowball Earth. Opuwo, located in Northwest

Namibia has unambiguous evidence of paleoclimates. Although geology of the northern platform (NP) of the Otavi Group, which is also northwest of Namibia is properly defined and is often well correlated to the Opuwo region, there is still quite a gap. The carbonate rock facies in this area remain understudied, making it difficult to accurately define several formations in the area. In turn, making it difficult to link them with other regional and global formations without using informal lithological classifications. Carbon isotope ratios in carbonate rocks can be used to define the multiple stratigraphic nomenclatures present within the Cryogenian Abenab Subgroup, revealing substantial paleoenvironmental changes linked with the two long-lasting glacial periods - Sturtian and Marinoan. This research aims to fill that hiatus, by investigating the distinct $\delta^{13}C$ and $\delta^{18}O$ variations found in the carbon-rich rocks of the Cryogenian 'Ondole' Formation. The fieldwork will include mapping, stratigraphic section measurements and systematic sampling of carbonate units, followed by laboratory analysis to measure $\delta^{13}C$ and $\delta^{18}O$ values using MultiCarb system in line with a GV IsoPrime mass spectrometer. Furthermore, these results will then be contrasted with other well-defined formations, such as the Ombaatjie, Gruis and Gauss. Thereby advancing our knowledge of the stratigraphic and geochemical history of the area, and most importantly assigning defined formation names for the lithologies within the study area. By bridging existing knowledge gaps, this study enhances the broader geological understanding of the Cryogenian record in Namibia and its relevance to global Neoproterozoic correlations.

Keywords: Paleoclimates, Cryogenian, Neoproterozoic, stable isotopes.

Abstract ID: T9_022

Geological and Structural Evolution of the Phikwe Complex, NE Botswana

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Abstract

This work is on the Phikwe Complex of the Limpopo Belt, which forms part of the Central Zone in NE Botswana. The study presents petrography, structure, geochemistry and new LA-ICP-MS U-Pb Zircon dating of lithological units of the Phikwe Complex. The results of this study show that the majority of lithologies observed throughout the Phikwe Complex are predominantly metatonalites, which, in some areas, have been affected by metasomatism. Other lithologies include meta-anorthosites and meta-gabbros, which form the metamorphosed layered igneous complex units which are common throughout the Phikwe Complex. In terms of deformation and structure, the Phikwe Complex is a high-grade gneissic terrain that underwent granulite facies metamorphism, followed by retrogression to amphibolite facies metamorphism. The rocks in this region were subjected to 3 or 4 deformation events (D1 to D4). Structures found in the Phikwe Complex include pervasive foliation, lineation, boudin structures, crenulation structures, and major and minor folding. Geochemical analyses suggest rocks in the Phikwe Complex evolved in a subduction-type setting, leading to the emplacement of volcanic arc and within-plate granites. The U-Pb zircon dating of the Phikwe Complex suggests that the units were emplaced around 2.6 – 2.4 Ga, and were affected by metamorphism at ca. 2.0 – 1.9 Ga.

Keywords: Phikwe Complex, K-metasomatism, U-Pb zircon

Abstract ID: T9_023

Petrological and Geochronological Study of the Paleoproterozoic Kimeza Supergroup in The Matadi Region (Kongo Central, D.R. Congo)

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Abstract

The Kongo Central Province contains geological formations ranging from the Paleoproterozoic to the Cenozoic. This study focuses on various lithologies of the Kimeza Supergroup (gneiss, migmatite, amphibolite, marble) located east of Matadi. These rocks are interpreted as remnants of a Paleoproterozoic collisional belt linked to the Columbia supercontinent assembly.

In the Matadi area, migmatitic gneisses from Mpozo-Tombagadio yielded U–Pb ages of 2088 ± 91 Ma and further west, in the Boma region, migmatites, yielded a similar age of 2087 Ma (Delhal & Ledent, 1976; Cahen et al., 1984). More recently, an orthogneiss from the Boma block was dated at 2069 ± 17 Ma using the U-Pb method on zircons (Tack et al., 2024).

The petrological study from the gneisses, amphibolites and marbles indicate polyphase metamorphism with two distinct episodes. The first episode (related to the Eburnean orogeny) was characterized by amphibolite-facies metamorphism. The second episode (related to the formation of the West Congo Belt in the Pan-African) was characterized by greenschist-facies metamorphism.

In situ U–Pb dating on titanite from the marbles yielded an upper intercept age of 1971 ± 19 Ma based on 27 analysis. This age, slightly younger than that of the surrounding gneisses, may reflect re-homogenization, linked to the emplacement of the Mpozo syenomonzonite (1.95–1.99 Ga; De Grave et al., 2025) or a late-orogenic metasomatic event. The absence of re-homogenization during the Pan-African event, indicates that the Neoproterozoic metamorphism did not exceed the greenschist facies, consistent with our observations.

Nevertheless, further west towards Boma, new U-Pb ages on amphibolite-facies metamorphic rocks (François et al., 2025) reveal a Pan-African age, demonstrating that metamorphism was more intense in the west and that the internal domain of the West Congo Belt was located in

the present-day western Congo Craton and adjacent São Francisco Craton.

Keywords: Eburnean, Orogeny, Paleoproterozoic, metamorphism, Kongo Central

Abstract ID: T9_025

Sapphire and Ruby Deposits Associated with Shear Zones in the Granulite Terrains of Southern Madagascar

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Abstract

Madagascar's complex geological history, shaped by successive orogenic events from the Archean to the late Neoproterozoic, accounts for the diversity of its mineral resources. The formation of gem-quality corundum (sapphire and ruby) deposits in southern Madagascar is thought to be closely linked to tectonic processes that occurred during the Neoproterozoic. These deposits are found along both major and minor shear zones within the granulitic terrains of southern Madagascar. Ruby deposits in the Vohibory Domain, associated with mafic and ultramafic complexes, are aligned with the major Ampanihy shear zone. Blue sapphire-bearing skarn deposits in the Tranomaro-Andranondambo region are found along the minor shear zones of Tranomaro, Silama, and

Ranopiso. Feldspathic gneiss-hosted multicolored sapphire deposits at Zazafotsy and Sahambano are associated with the Zazafotsy and Lamboany shear zones. Phlogopite-rich cordieritites and pyroxenites hosting corundum at Iankaroka and Ambatomena are located within the active core of the Beraketa shear zone. Fluid circulation along lithological and structural discontinuities led to the in-situ transformation of rocks such as sakénites and corundonites, as observed in the minor Sakeny shear zone. The granulitic basement of southern Madagascar was primarily affected by a second deformation phase (D2) during the late Neoproterozoic, characterized by E–W shortening. This D2 deformation phase was synchronous with folding, shear zone development, alkaline metasomatism (notably mica alteration), hydrothermal veining, and magmatism in the granulitic domains. Fluid–rock interaction played a key role in the formation of metasomatic assemblages and the genesis of corundum deposits. The circulation of fluids facilitated the remobilization of certain chemical elements within metamorphosed, highly aluminous protoliths, ultimately leading to the crystallization of sapphires and rubies.

Keywords: Shear Zones, Sapphire, ruby, Madagascar

Abstract ID: T9_026

Petrogenesis, Geochemistry, and U-Pb Geochronology of the Granites from Mahalapye Complex: Implications for Metasomatism, Regional Metamorphism, and the Tectonic Evolution of the Central Zone of Limpopo Mobile Belt in Eastern Botswana

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Abstract

The Mahalapye Complex is an integral component of the Central Zone (CZ) of the Limpopo Belt in southern Africa that experienced a complex geological and tectonic evolutionary history. Despite numerous studies conducted on the Mahalapye Complex, there are

still scientific debates on the origin of the granites within the complex. The debate is centered between two hypotheses; magmatic origin and metasomatic (non-magmatic) origin. Thus, this study was conducted to develop a comprehensive model for the origin and evolution of the granites within the Mahalapye Complex using a multidisciplinary approach involving petrological, mineralogical, geochemical, and geochronological analyses. The field investigations revealed complex deformation structures involving boudinage, isoclinal folding, and pervasive foliation, which characteristically reflect a tectonically active history. Petrographic analyses indicated progressive K-metasomatism from fresh tonalitic/dioritic rocks to the most intensely altered granites, dominated by the replacement of plagioclase by microcline. This large-scale metasomatic alteration was supported by the whole-rock geochemical data, which showed K2O enrichment (from ~0.45% in fresh rocks to ~6.99% in altered samples) and MgO, FeO, and CaO depletion caused by fluid-rock interactions. The metasomatic alteration was caused by deep-seated K-rich fluids that migrated through shear zones and fractures. These processes were observed to occur after the regional deformation processes and can therefore be referred to as Post-metamorphic K-metasomatism.

The U-Pb zircon dating indicated that the Mahalapye "Granites" magmatic crystallization took place in the Paleoproterozoic between 2055.8 ± 4.7 Ma and 2022.5 ± 6.8 Ma. The existence of some inherited Archean (~2500 Ma) zircons suggests that crustal recycling processes simultaneously occurred with the primary magmatic activities.

Keywords: Mahalapye Complex, metasomatism, petrogenesis, Granites

Abstract ID: T9_029

Updated Understanding of the Karoo System in Malawi

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Abstract

The epicontinental Paleozoic–Mesozoic rocks of the Karoo Supergroup in Malawi are preserved in the large Lengwe-Mwabvi Basin in the south and several smaller northern basins, mostly forming grabens and half-grabens related to the Cenozoic Malawi Rift system. However, sequence stratigraphy indicates that crustal extension began in the Late Carboniferous–Early Permian, with local fault-bounded depocentres during deposition of the Dwyka Group glaciogenic beds. Late Permian tectonics may also have influenced sedimentation, explaining rapid variations in thickness and facies across basins.

Based on revised mapping and new palynological data, a lithostratigraphy correlating with the Main Karoo Basin in South Africa is proposed, including the Dwyka, Ecca, Beaufort, Stormberg, and Drakensberg groups. In the southern Lengwe-Mwabvi Basin, the Dwyka basal beds (K1) are overlain by coal-bearing Ecca sequences (Kc, Kt, Km), followed by the Red Beds Formation (Kr) of the Beaufort Group. The Stormberg Group is represented by the Upper Sandstone Formation (Ku), while Drakensberg flood basalts (Chikwawa Basalts) mark the northernmost Karoo LIP occurrence.

In northern Malawi, Karoo deposits include the Dwyka, Ecca, and Beaufort Groups. The basal Dwyka beds (K1) are locally preserved and fault-bounded, overlain by Ecca sandstones and shales with coal seams (K2). The upper Ecca comprises arkosic sandstones and reddish shales (K3), followed by Beaufort marls and calcareous sandstones (K5–K7). Drakensberg volcanics are absent in the north.

These new observations challenge previous models suggesting a diachronous evolution of northern and southern Malawi basins.

Keywords: Karoo, Stratigraphy, Malawi

Abstract ID: T9_030

Thermal Evolution, Deformation and Melting in Southern Madagascar During the Orogeny - Insights from Numerical Models

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Abstract

In Southern Madagascar, between 600-500 Ma, the amalgamation of Gondwana resulted in substantial crustal deformation. Conditions during this deformation reached (ultra)high temperatures (750-950 °C) that lasted over ~100 Myr. The heat required for the development of such extreme thermal conditions has been ascribed to several sources: increased radiogenic heating in the thickened crust, melt intrusions, foundering (delamination) of the mantle lithosphere and ascent of the hot asthenosphere. The (ultra)high temperature conditions resulted in partial melting of the crust that played a key role in shaping the final deformation pattern. Melt ascended along steeply-dipping crustal-scale shear zones, causing complex interactions between melting, melt migration, metamorphism and deformation.

We study the thermal evolution and deformation of the crust during the orogeny by means of numerical simulations. As a tool, we use open-source finite-element software ASPECT. In the first step, we use a one-dimensional model setup to evaluate the impact of various processes on the time evolution of the geotherm in the orogen. The studied processes are: crustal thickening, which results in increased radioactive production in the crust, removal of upper crustal layers by erosion and thinning of the mantle lithosphere by lithospheric foundering. We discuss the modelled thermal evolution in the frame of observed pressure-temperature-time data. Our results highlight the importance of erosion for the development of high-temperature conditions in the middle crust. In the second step, we use the computed thermal profiles as the initial condition in two-dimensional models that simulate coupled deformation, thermal evolution and melting. We study the thickening of

the hot orogen, the evolution of pre-existing high-strain zones and their interplay with the partially molten region. We compare the modelled deformation styles with observations from the high-strain region in Southern Madagascar.

Keywords: Madagascar, orogeny, melting, numerical model

Abstract ID: T9_031

Schist Belts of the Benin-Nigeria Shield Reveal a Neoproterozoic History

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Abstract

Belts of metasedimentary rocks (schist belts) in the Benin-Nigeria Shield (BNS) are investigated for the first-time using U-Pb dating and Lu-Hf isotope analysis of detrital zircons. We report maximum depositional ages that place their deposition firmly into the Neoproterozoic and link them with strata in the Dahomeyide Belt, the central African fold belt, and the Borborema Province in South America. The detrital zircon age distribution also includes Archaean dates and is dominated by ~ 2.1 Ga zircons. The latter are derived from juvenile granitoids, likely forming much of the basement of the BNS. We bracket the detrital zircon data with U-Pb dates and Lu-Hf isotope data of both the oldest (Kaduna Gneiss, 3571 ± 3 Ma) and youngest (Maradun Group rhyolite and related granitoids, 586 ± 2 Ma) Precambrian rocks of the BNS. By doing so we highlight a 3-billion-year-old record of crustal evolution in central Africa.

Keywords: Benin-Nigeria Shield, schist belt

Abstract ID: T9_036

Melt Migration in the Crustal-scale Shear Zones in Southern Madagascar

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Abstract

Southern Madagascar is characterized by an anastomosing network of shear zones that crosscut the Neoproterozoic UHT/HT basement and developed between ca. 600 and 500 Ma during Pan-African Gondwana Supercontinent Assembly and are coeval with melting and UHT/HT metamorphism. It is suspected that the shear zones act as conduits for melt transfer at a trans-crustal scale. However, the mechanism for this melt transfer is unclear. Here we focus on the Ihosy shear zone, where mostly metagranitoids are present and peak metamorphic conditions were established at ~750°C and ~5 kbar. The shear zone reveals a gradual transition from orthogneiss with U-Pb zircon ages of ca. 800Ma into isotropic nebulite with U-Pb zircon ages of ca. 550-600Ma, with intermediate granite types preserving relics of the original gneissic fabric. All rock types consist of quartz+plagioclase+K-feldspar+biotite ±garnet±cordierite±sillimanite. Orthogneiss is characterized by well-defined, straight grain boundaries, large feldspars and small amount of interstitial grains. Towards the nebulite original grains are getting more corroded and amount of the new interstitial grains is increasing. Presence of former melt was documented in all four rock types. We suggest that the transition from the orthogneiss to nebulite is a result of melt migration in the shear zone and the different rock types reflect

different degrees of equilibration between the host rock and the passing melt. We propose that the shear zone is the site of a large melt transfer from the depths. This melt infiltrates the surrounding rocks both as discrete bodies and also pervasively at grain-scale, progressively fluxing the host rock and changing its macro- and microscopic appearance.

Keywords: Madagascar, shear zone, melt migration

Abstract ID: T9_013

Geomorphological Evolution of Northeastern Somalia

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Abstract

This study reconstructs the geomorphological and tectonic evolution of northeastern Somalia (Puntland), a key region for understanding passive margin development from initial continental rifting to ocean basin formation. The area records two major tectonic phases: the older Cretaceous–Palaeocene margin linked to the Indian Ocean, and the younger Oligocene–Miocene margin associated with the Gulf of Aden. Stratigraphic sequences are divided into pre-rift (Dogger–Eocene), syn-rift, and post-rift (Oligocene–Miocene) deposits, exposed in narrow fault-bounded basins along the coast. During the Lower Oligocene, intense faulting generated WNW–ESE-oriented syn-rift basins, separated by transfer zones. Continued crustal extension led to oceanic spreading centers and the formation of morpho-structures such as horsts, grabens, fault scarps, and uplifted terraces. These features reflect the deep tectonic architecture and paleogeographic evolution of the region. Key structural domains include the Boosaaso Basin, which acts as a transfer zone with fault polarity reversal; the Ras Antara Horst, interpreted as a continental ribbon exposing basement and Meso–Cenozoic rocks; and the Qandala–El Gal Basin, marked by asymmetric depressions, Pliocene volcanism, and fault reactivation. The Ahl Bari Plateau and Aluula Basin show rollover folds, listric faulting, and post-rift uplift. Seven tectonic stages define the region's evolution: initial rifting (Late Triassic–Jurassic), left-lateral shearing (Late Cretaceous–Palaeocene), NE–SW extension (Upper Eocene–Lower Oligocene), major rifting (Lower Oligocene), syn-rift oceanic spreading, full oceanic separation, and post-rift uplift

with volcanism. With minimal post-drift sediment cover, northeastern Somalia offers exceptional surface exposure, making it a globally significant natural laboratory for studying passive margin evolution and the long-term impact of tectonic processes on continental crust and surface morphology.

Keywords: Morpho-tectonic, Morpho-structure, Gulf Of Aden, NE Somalia

Abstract ID: T9_033

Transpressive Strike-slip Faulting and Cave Development in the West Congo Supergroup: Insights from the Mbelo Caves in the Madingou Region, Republic of Congo

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Abstract

The karst region of Madingou, Republic of Congo, hosts several cave systems, including the Mbelo network composed of three caves (Mbelo 1, Mbelo 2, and Mbelo 3) developed within a conical hill (kegelkarst) and extending over ~1,000 meters. These caves formed in Neoproterozoic carbonate rocks of the Schisto-Calcaire Group, part of the West Congo Supergroup. This study investigates structural controls on cave development and broader karst features in the region. Fieldwork combined detailed cave mapping, structural measurements within

caves, and surface surveys to assess the regional tectonic framework. These data were compared with a lineament analysis of the Madingou region. Structural measurements enabled reconstruction of paleostress fields and their relation to tectonic events influencing cave formation. Results show that both caves and surrounding terrain are affected by brittle deformation. Fractures with kinematic markers, especially extensional ones in relay zones, dip 70–90° and correspond to strike-slip faults. Dominant orientations are NE-SW and NW-SE. In the Mbelo system, active fractures define a deformation pattern of NE-SW left-lateral and NW-SE right-lateral faults. Surface fractures show the same characteristics, consistent with regional lineaments and cave passage orientations, confirming a genetic link. Kinematic analysis indicates a transpressional strike-slip regime with extensional openings in relay zones. Paleostress analysis (PBT tensor) reveals a σ_1 axis-oriented N-S. This deformation is attributed to inversion of the African continental margin during the Maastrichtian, caused by N-S compression from Africa-Eurasia collision (Nokdia, 2024). Consequently, NE-SW left-lateral and NW-SE right-lateral fractures acted as conduits for karstification, initiating cave development. This study chronologically links speleogenesis to a major tectonic event, providing new insights into the geodynamic evolution of the region.

Keywords: Tectonics, Speleogenesis, Republic of Congo

Abstract ID: T9_034

Epeirogeny and Sea-level Changes of Southern Africa

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Abstract

Southern Africa is tectonically unique in that it is entirely surrounded by passive margins. Uplift and subsidence result from epeirogeny but linking these vertical movements to sea-level changes is challenging. Field mapping of the Karoo Large Igneous Province in Lesotho and South Africa has identified pillow lava sections at elevation above 1800 m. Analysis of vesicles size and abundance suggests that these erupted 500 m below sea level. Measured 87Sr/86Sr values are scattered around ca. 0.708, consistent with Early Jurassic seawater. Ti-V ratios are similar to those of mid-oceanic ridge basalts, whereas Th/Yb ratios indicate derivation from subduction-related mantle, and Nd-Sr isotope relationship suggests assimilation of 10-15% of continental crust. Together with TIMS U-Pb zircon dates, the results reveal that the pillows erupted <185.5 Ma in a rift system linked to fragmented continental lithosphere surrounded by ocean spreading domains, like today in the Afar region. The Karoo pillows were subsequently buried beneath >1500 m of flood basalts and intruded by dolerite between 183.122 and 183.042 Ma, adding significant thickness over a short time. The lavas were then exhumed to near-present elevations around 140-100 Ma, as determined by thermochronology and offshore sedimentation studies. Thus, in contrast to the Ethiopian Highlands, which formed about 30-40 Ma before the opening of the Red Sea and Gulf of Aden, southern Africa reached its high elevated topography more than 30-40 million years after the initial break-up. More recent marine inundations are recorded between 30 and 350 m in South Africa, Mozambique, and Tanzania. Strontium isotope stratigraphy indicates age estimates of 33-27 and 7-5 Ma, correlating with other deformation events and highlighting significant vertical movements of southern Africa.

* We are grateful to late Professor Maarten de Wit for sharing his passion for field geology and his wisdom in the evolution of the Africa Plate.

Keywords: Gondwana, Karoo Basin, Kalahari epeirogeny

Abstract ID: T9_016

Widespread Mafic Sill and Effusive Magmatism in the Karagwe-Ankole Belt, East Africa: A Large Igneous Province?

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Abstract

The Karagwe-Ankole belt (KAB) of East Africa is formed of a Neo-archaean to Paleoproterozoic gneissic basement, overlain by Proterozoic volcano-sedimentary sequences that have been thermally reworked in the later Mesoproterozoic and Neoproterozoic. The economic importance of this geological domain lies in its mineral deposits of Sn-W, Nb-Ta, Li and Ni-Cu, the latter of which are hosted in mafic to ultramafic intrusive bodies, the Kabanga-Musongati Alignment. Although the mineralized bodies have been well-characterized by commercial exploration, the broader picture of mafic magmatism in the KAB and its structural and stratigraphic controls is less well understood.

Here, I present a review of mafic magmatism in the KAB based on my own research and that of published and other public domain data. Bedding-concordant intrusions (metadolerite sills) are especially prominent in the east of the belt where their sill-like nature is evident in the gently warped Bukoba Group metasandstones. Thinner examples of mafic sills are also found throughout the Kagera Supergroup (SG) stratigraphy and into the Akanyaru SG to the west (dated 1340 - 1420 Ma).

Extensive amphibolitic rocks occur in western Burundi and Rwanda within the Pindura Group of the Akanyaru SG. These are interpreted on the basis of preserved textures (amygdular and fragmental textures) and field relations as forming locally thick metabasaltic effusive rocks, distinct from later, interleaved metadoleritic sills. These mafic rocks are undated by direct methods but they are geochemically related to the

Ni-Cu bearing mafic intrusions further east (1390-1402 Ma).

The mineralized intrusions, the widespread sills and the amygdular metabasalts are thus broadly coeval, and extend over more than 100 000 km2. Together with the Lake Victoria dyke swarm on the Tanzanian craton, they can be inferred to be components of a large igneous province (LIP) , which has strongly influenced mineral deposition of the region.

Keywords: Mafic, sills, volcanic, Mesoproterozoic

Abstract ID: T9_017

A Tectonic Model for the Juxtaposition of Granulite- and Amphibolite-facies Rocks in the Eburnean Orogenic Belt (Sassandra-Cavally Domain, Côte d'Ivoire)

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Abstract

The Sassandra-Cavally (SASCA) domain (SW Côte d'Ivoire) marks the transition between the Archean Kenema-Man craton and the Paleoproterozoic Baoule-Mossi domain. It is characterized by the tectonic juxtaposition of granulite-facies and amphibolite-facies rocks. Here we are presenting field based structural observation with metamorphic petrology and geochronology to investigate the tectonic evolution of the SASCA. We show that lithologies consisting of migmatitic grey gneisses, garnet–cordierite–sillimanite migmatitic paragneisses and garnet–staurolite-bearing mica schists reached peak pressure conditions ranging from 6.6kbar at 620°C to 10kbar at 820°C. These conditions are associated with the first recorded deformation D1 and

correspond to a Barrovian apparent geothermal gradient of 25°C/km. Subsequent exhumation, associated with second deformation D2, was marked by decompression followed by cooling along apparent geothermal gradients of □40°C/km. A D3 deformation phase is marked by folding and local transposition of the regional S1/S2 foliation into E-W trending shear zones. LA-ICP-MS U–Pb dating of monazite, which displays complex internal structures, reveals four age groups: (1) ca.2400–2600Ma, rare relictual dates at the Archean-Paleoproterozoic transition; (2) ca.2037Ma attributed to D2; (3) ca. 2000 Ma, and (4) dates spreading from ca.1978 to 1913Ma, documented for the first time in the West African Craton. The ages of the latter two groups are similar to the ones identified in the Guiana Shield, and could be attributed to a disturbance by fluids, to a periodic opening of U–Pb system or to an episodic crystallization of monazite during slow cooling lasting several tens of Myrs. These data allow to propose a model for the tectonic evolution of the SASCA whereby crustal thickening is achieved by crustal-scale folding and is followed by and concomitant with lateral flow of the thickened partially molten crust accommodated by regional transcurrent shear zones.

Keywords: Archean-Paleoproterozoic, geochronology, West African Craton

Abstract ID: T9_041

Structural and Architectural Constraints on the Intrusion of the Eastern Lebowa Granite Suite of the Bushveld Complex, South Africa

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Abstract

The Lebowa Granite Suite (LGS) of the Bushveld Complex (BC) hosts polymetallic deposits comprising Sn–Mo–W–Cu–Pb–Zn–As–Au–Ag–Fe–F–U–REE assemblages. The LGS intruded earlier components of the

BC encompassing the Rooiberg Group and Rustenburg Layered Suite in addition to the older Transvaal Supergroup. The LGS facies in the eastern limb of the BC include the Nebo, Makhutso, Verena and Balmoral granites which are distinguished by mineralogy and field-relations. Each facies is surrounded by physical boundaries encompassing older BC components, Transvaal Supergroup and the Wonderkop Fault tectonic lineament. Although having distinct ages variations, disparate geochemistry and mineralogy within individual granites and physical tectonic-compartmentalisation, the LGS facies are commonly regarded as a single pluton. This study reevaluates historical geophysical data and new structural field mapping to investigate the structural settings of the LGS, with the aim of elucidating the emplacement mechanisms of each pluton and deciphering any connectivity among them.

Bouguer Gravity data review suggests that the western and eastern limbs of the BC are separated along the Wonderkop Fault. Structural field mapping in Transvaal inliers, including Dennilton and Marble Hall Domes, and Stavoren Fragment, demonstrates multiple-deformation phases attributed to regional tectonism and BC magmatism prior LGS emplacement. These structural architectures of the deformed-inliers and pre-existing lineaments channelled LGS emplacement into individual tectonic-compartments forming chonolith-like plutons. Structural fabrics along inlier-pluton contacts exhibit contrasting morphologies. Some contacts are characterised by imbricate quartz-veins and well-preserved primary structures in the country rocks, while others exhibit localized extensional strike-slip faulting, but not attributed to ductile displacement. These structural elements preclude connectivity amongst the plutons, and the paucity of conformable structural fabrics also suggests that each pluton was emplaced and evolved independently and thus hosts disparate mineralogies. Hence, the occurrence of polymetallic mineralisation should be assessed independently.

Keywords: Bushveld Complex, Lebowa Granite_Suite, emplacement mechanisms, structural constraints, polymetallic mineralization

Abstract ID: T9_018

Geodynamic Evolution of the Main Ethiopian Rift; Timing and Spatial Distribution of Volcanic and Tectonic Activity

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Abstract

Continental rifting is a fundamental process in plate tectonics. Rift zones play a crucial role in shaping landscapes, influencing climate, and serving as sources of mineral and hydrocarbon resources, as well as geothermal energy. Additionally, they provide valuable insights into Earth's internal processes. The East African Rift System (EARS) is a textbook example of this phenomenon. Over the past 50 million years, Ethiopia has undergone major volcanic and tectonic changes linked to the EARS, with rift-related volcanic and volcano sedimentary deposits covering about half of its surface. A key segment, the Main Ethiopian Rift, records distinct phases of the rifting process, making it an ideal site for research. The northern flank of the Southern Main Ethiopian Rift (SMER) is a critical for understanding the tectono-volcanic evolution associated with continental rifting. This region provides significant insights into rifting mechanisms observable in volcanic features, tectonic structures, and geophysical data. Continuous extension between the Nubian and Somalian plates produced characteristic rift-related tectono-magmatic evolution, with SMER volcanism occurring in three phases: (a) pre-rift (Eocene to Oligocene: 56 to 23 Ma), (b) early-rift (Miocene: 23 to 5 Ma) and (c) late-rift (Pliocene–Pleistocene: 5.3 Ma to present). The pre-rift phase began with extensive fissure eruptions of

flood tholeiitic to alkaline basalts and trachybasalts, driven by mantle plume activity, which led to the formation of the Ethiopian Plateau. This was followed by the shield-building stage, marking the transition to the early-rift phase, characterized by bimodal volcanism linked to the initial stages of rift evolution. The late-rift phase was dominated by magma-driven extension and bimodal volcanism, producing felsic eruptions, pyroclastic deposits, lava domes, flows, maars, cinder cones, calderas, alongside alternating alkaline–subalkaline sequences during advanced continental rifting.

Keywords: Continental Rifting, Volcanic Activity, Tectonics

Abstract ID: T9_019

Petrogenesis of Archean Crustal Rocks in the Man-Leo Shield (Western Côte d'Ivoire): Insights into Paleoarchean Crustal Accretion Processes

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Abstract

The Man region (Man-Leo Shield) represents a key area for understanding the formation and evolution of Archean crust in West Africa. This study combines zircon U-Pb LA-ICP-MS dating, whole-rock geochemistry, and Lu-Hf and Sm-Nd isotopic data to constrain crustal growth episodes, mantle and crustal sources, and associated petrogenetic processes. The investigated lithologies include granulitic grey gneisses (GGGs), migmatitic grey gneisses (MGGs) intruded by pink granulites, a granitic intrusion, and biotite-bearing pink migmatites. The grey gneisses are subdivided into (i) an aluminum-rich group (Al_2O_3 >15%) and (ii) an aluminum-poor group (Al_2O_3 <15%), both exhibiting TTG (Tonalite-Trondhjemite-Granodiorite) signatures: high SiO_2, low MgO, Cr, and Ni concentrations, along with elevated (La/Yb) N and Sr/Y ratios, suggesting derivation from partial melting of subducted oceanic crust. Samples SOUE-1 and DANT-1 display high Mg#, Cr, and Ni, indicating mantle wedge interaction. The lack of correlations between Sr/Y and Dy/Yb or

(La/Yb) N and Dy/Yb, combined with negative Nb-Ta and positive Zr-Hf anomalies, as well as variable Dy/Yb, Nb/Ta, Zr/Hf, and Zr/Sm ratios, imply high-pressure melting (>45 km) with a garnet-amphibolite and rutile-bearing eclogite residue.

Keywords: ManLeoShield, LeonianTTG, Crustal evolution, Liberian orogeny

Abstract ID: T9_020

Enhancing Earthquake Monitoring in the Southern Main Ethiopian Rift: Insights from a Newly Established Seismic Network in Arba Minch

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Abstract

Ethiopia, located in the East African Rift System, is seismically active due to both magmatic intrusions (mainly in Afar) and tectonic extension in the Southern Main Ethiopian Rift (SMER). Historically, strong earthquakes (M ≥ 6.0) occurred about twice per decade until 1992, but recent activity is limited to smaller events (M 4–5).

Seismic monitoring is constrained by the lack of permanent stations; currently, only the FURI station near Addis Ababa contributes to global networks. This limits earthquake localization and hazard assessment. To improve coverage, a three-station network (Arba Minch – ARBM, Dorze – DORZ, and Nech Sar National Park – NECH) was installed in the Arba Minch region, where seismicity has intensified. Equipped with short-period sensors and real-time data transfer, the network effectively detects local earthquakes, with NECH yielding the best data quality.

Initial results show seismicity clustering near Lakes Abaya and Chamo and along the western rift margin, consistent with gravity-based fault models. Combining gravity and seismic data enhances fault interpretation, as demonstrated by the corrected location of the MW 4.9 event of May 12, 2024, which now well aligns with a density interface. Historical earthquake clusters also correlate with deep-seated faults related to the Arabian-Nubian Shield and Mozambique Ocean closure.

The new network substantially improves earthquake monitoring in southern Ethiopia, providing better localization and fault mapping. These advances highlight the value of integrating seismic and gravity data and underscore the need to revise hazard maps to ensure accurate risk assessments for rapidly urbanizing regions such as Arba Minch.

Keywords: Main Ethiopian Rift; seismology; gravity

Abstract ID: T9_021

A Review of Seismicity and Seismotectonics of the Kenyan Rift Valley and the NW-SE Trending Rift Zones

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Abstract

The Kenya rift valley (KRV) is a classical example of an active intra-continental ridge system comprising an axial rift zone. Its central and southern parts form a 50 to 80 km wide rift valley with high escarpments and en echelon fault steps (Ibs-von Seht et al., 2008). The Kenya rift valley extends into the Indian Ocean where it is known as the Davie Ridge (Chorowicz, 2005), a relic fracture zone extending ~2200 km-long and cutting across the West Somali Basin (Mougenot et al. (1986, Coffin and Rabinowitz, 1987, 1988; Grimison and Chen, 1988). Its width ranges between 30 and 120 km, with a west-facing scarp along the lower half of its length that rises ~2300 meters above the sea floor (Mougenot et al., 1986; Scrutton, 1978). Earthquakes as deep as 40 km have been recorded

below the Davie Ridge. However, recent seismic data shows that Mw 4.0 -5.0 earthquakes at crustal depths ($10 \leq d \leq 30$ km) are common along the Kenya rift valley, the Davie Ridge and the Mozambique channel. The earthquake focal mechanism indicate that the Kenya rift and Davie ridge are characterized by normal faulting with occasional oblique faulting. On the mainland Kenya, the KRV is dissected by the NW-SE-trending rift/fault zones, which include the Anza Rift Zone and the Aswa Fault Zone, extending into Kenya from southern Sudan as the Aswa-Nyangia Fault Zone. The seismicity in Kenya can be classified as moderate and associated with he divergence of the Kenya rift valley and the Davie Ridge. Earthquake focal mechanism is purely due to tensional crustal forces on the KRV. On the contrary, a review of seismicity in Kenya show that the NW-SE trending rift zones exhibit strike-slip faulting and these continue to be the foci of the largest earthquakes in Kenya and the East African Region. This study is based on seismic events dating from 1900 to 2022 and comprehensive results and presentation will be made during CAG30 meeting.

Keywords: Review, seismicity, seismotectonics, Rift zones

Abstract ID: T9_040

Soil Mapping as a Tool for Understanding Nutrient Release from Volcanic Rocks in the Southern Part of the Main Ethiopian Rift

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Abstract

The Ethiopian Rift is characterized by rugged topography and diverse lithology, resulting in varied physico-chemical properties of the soils. We describe the different soil types found in the Sidama region, including Luvisols, Nitisols, Alisols, Vertisols, Cambisols, and Leptosols, across various altitudes. We also identify the key factors influencing soil characteristics and nutrient availability throughout the study area. Variations in rock geochemistry and different levels of weathering affect soil nutrient availability. During natural weathering processes, chlorite, clay minerals, and iron hydroxides gradually replace primary minerals and volcanic glass. In the saprolite from the Ethiopian Highlands, kaolinite is the dominant clay mineral, often with variable amounts of smectite. The Ethiopian Highlands, which rise to elevations of up to 1,800 meters above sea level, typically feature soils that have undergone a relatively advanced stage of development on volcanic substrates. Most aluminum and iron released through the incongruent dissolution of rock-forming minerals remain in the soil profile as kaolinite and goethite. In contrast, the Holocene to Pleistocene acid pyroclastic materials deposited on the floor of the Ethiopian Rift alter the physical and chemical properties of the soil profiles in that area. High levels of exchangeable calcium and magnesium in these soils are associated with Vertisols and Cambisols, which are characterized by the presence of glassy-rich pyroclastic

materials. The soils on the rift floor contain kaolinite, varying amounts of smectite and chlorite, volcanic glass (pumice), feldspar, quartz, and iron hydroxides. The gradual breakdown of volcanic glass and rock-forming minerals provides smectites with essential mineral nutrient base cations. The geochemical characteristics of parent rocks and topography significantly affect soil chemical and textural variability in the Sidama region.

Keywords: Ethiopia, Soil maps, Weathering, Mineralogy

T10- S1 Metallogeny and Ore Deposits in Africa

Abstract ID: T10_002

Magmatic Ore Potentials of Supercontinental Assembly Versus Break-up LIPs

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Abstract

A review of southern African large igneous provinces (LIPs) shows that more prominent candidates (including the Bushveld Complex) formed during supercontinental assembly rather than break-up. Yet, LIPs are often preconceived as related to mantle plume magmatism during break-up. This discrepancy between Phanerozoic break-up LIPs and Precambrian assembly LIPs is best explained by break-up LIPs having a poorer preservation potential, because their magmatism concentrates into volcanic rifted margins, exposed to greater destruction inside subsequent orogens; reducing potential ore-discoveries in Precambrian break-up LIPs. Since the Bushveld Complex is such an unparalleled magmatic ore deposit, it begs the question of whether assembly-type LIPs are superior in generating chromitite and Cu-Ni-PGE sulphide deposits? Investigating this difficult question, I wish to emphasize how break-up LIPs appear driven by hot plumes of potentially more pristine lower mantle, enriched by recycled oceanic lithosphere. Continental break-up increases the decompressional melting of such plumes and thereby their contributions to, e.g., layered intrusions, together with less lithospheric mantle melting these plume impacts also trigger. Below unruptured continents (like the Siberian Traps), however, proportions of plume versus lithospheric melts reverse and assembly LIPs may – even in the absence of lower mantle plumes – form more exclusively from lithospheric mantle sources, e.g., through hydration, thermal capping and/or local upper mantle advection (acting as a heat- rather than melt source) below supercontinents. The question thus boils down

to how much more fertile a lithospheric mantle is compared to an asthenospheric mantle plume, with regards to those metals we strive to explore for.

Keywords: Lithospheric mantle, Petrogenesis, Base metals

Abstract ID: T10_004

The Ree-rich Felsic Cenozoic Volcanism of the Hoggar: Petrogenesis and Setting Context

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Abstract

Cenozoic volcanism in the Hoggar Massif, Algerian Sahara, exhibits a complex geochemical evolution linked to the Africa–Europe collision around 35 Ma. Magmatism ranges from early Oligocene tholeiitic to transitional basalts, through Neogene alkaline basalts, to peralkaline felsic lavas, showing increasing silica undersaturation and La/Yb ratios over time. A subset of felsic volcanic rocks is strongly peralkaline (Na + K > Al), with high alkali contents (10.8–13.6 wt% $Na_2O + K_2O$) and exceptionally enriched in REE (ΣREE = 550–2000 ppm), an uncommon feature in Cenozoic Central Hoggar volcanism. Certain aegirine-augite-bearing lavas display extremely high incompatible trace-element contents, while Sr and Ba are depleted due to extensive feldspar fractionation. Silica-saturated trachytes contain the highest concentrations of LILE (Rb, Th, U), REE, HFSE (Nb, Ta, Zr, Hf), and Pb; Zr and REE often exceed 1000 ppm, making them minor rather than trace elements. Negative correlations between incompatible elements and the differentiation index suggest fractionation of a Th–U–Nb–Ta–Zr–Hf–Pb–bearing, Ti-free accessory mineral assemblage. Zircon, eudialyte, and låvenite are already identified in trachytes and phonolites. Peralkaline trachytes of the silica-saturated trend (ΣREE = 1150–1700 ppm) contain two to three times more REE than those of the silica-undersaturated trend (560–580

ppm). Chondrite-normalized REE patterns show weaker fractionation in agpaitic silica-saturated samples [(La/Yb)N = 8.7–9.4] compared with Tihilafine peak samples [(La/Yb)N = 25] and silica-undersaturated rocks [(La/Yb)N = 24–27]. MREE–HREE patterns are nearly flat, while trachytes display stronger negative Eu anomalies (Eu*/Eu = 0.29–0.37) than phonolites (Eu*/Eu = 0.65). New chemical data demonstrate that such peralkaline felsic compositions are widespread in the central Hoggar Massif, underscoring the importance of accessory mineral fractionation in shaping their geochemical evolution.

Keywords: Hoggar, Peralkaline volcanism, REE, felsic

Abstract ID: T10_005

Tectonic Setting and Metallogenesis of the Kédougou-Kéniéba Inlier: Exploration Implication

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Abstract

The Kédougou-Kéniéba Inlier (KKI) consists of volcano-plutonic greenstone belts alternating with metasedimentary series deformed and metamorphosed during the Eburnean orogeny. Several gold deposit types have been described and occurred during the end of the tectonic accretionary orogenic system. The KKI displays four deformation phases. D1 corresponds to the transposition of the magmatic bedding associated with F1 isoclinal folds with vertical axial planes and subvertical fold axes into a WNW to NW striking schistosity, and shear zones. D1

results from a NNW-SSE shortening in bulk coaxial deformation regime. D2a is manifested by upright N to NE trending folds with steep fold axes and NNW to NNE-trending shear zones and faults. D2b correlated with NE-SW oriented asymmetric F2b folds and subvertical dextral shear zones. D2a results from an E-W horizontal shortening, in bulk coaxial deformation regime, and a NW-SE shortening in noncoaxial tectonics regime for the D2b. D3 is manifested by N-S oriented anastomosed sinistral shear zones and faults. D3 marked a NNW-SSE shortening in non-coaxial sinistral transcurrent regime. The intersection between earliest and D3 structures created very prospective zones for Au mineralization. D4 is compatible with an E-W subhorizontal shortening leading to the formation of cross-cutting conjugate subvertical dextral NE and sinistral NW-trending ductile-brittle faults and E-W dextral faults/fractures. Tectono-magmatic and metamorphic data suggest a tectonic model starting with the formation of a mafic crust with minor felsic component, followed by deformation and metamorphism, a peak orogenic phase associated with crustal delamination concluding with collapse and final exhumation of the Saraya metamorphic aureole. Gold deposits are commonly localized along deformation zones at the boundary domains between volcanic sequences and metasedimentary series. D2b and D3 structures served as pathways for ore-fluid infiltration and gold deposition

Keywords: Western Mali, Tectonic, Metallogeny, Deposit

Abstract ID: T10_007

An Investigation of a Precious and Base Metal Stockwork Deposit Within a Suspected Kimberlite Body, at Bala Hot-Spring Area, in Homa Bay County, Kenya.

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Abstract

The paper describes the work done in an area measuring about 16

square kilometers in Bala area, Kakdhimu East Location, Homa Bay County, Kenya. The area is bound by Eastings 667000 and 671000 and Northings 9951000 and 9955000 UTM Zone 36M. Physiographically, the area is relatively flat with a few hills and faults cutting through it. This work was a follow up on an earlier reconnaissance magnetic survey that was conducted in 2008 (Waita, 2008). The 2008 survey located a magnetic anomaly within a quarry site where magnetite veins are being exploited for road graveling and cement manufacture. Main lithological units encountered were carbonatite and rhyolite but intercepted by smaller but unique rock units comprising diorite, pillow basalt, syenite, dolerite and a suspected kimberlitic rock. Bala iron ore is a magmatic vein-type deposit, emplaced in zones of weaknesses associated with a north-west trending and extensive shear zone. The veins have been mined for a long time by road companies and locals who gather the fragments for sale to be used by cement manufacturing companies. Analysis of magnetic data from the Bala iron ore quarry site shows that the causative body is a late-stage intrusion into an existing fault or shear zone. This has been confirmed by geological observations. The magnetic Vertical Gradient map isolated near-circular anomalies pointing to possible existence of igneous plugs or pipe-like bodies suspected to be kimberlite pipes. In hand specimen abundant vermiculite was observed in the rock. Preliminary analysis of rock samples collected from the area by X-Ray Fluorescence (XRF) and Atomic Absorption Spectrometry (AAS) show anomalous values for iron oxide (Fe2O3, 62%), nickel (Ni, 235.1ppm), thorium (Th, 93.7ppm), copper (Cu, 263.1ppm) and gold (Au, 19.7ppm). The existence of minerals like vermiculite, magnetite and nickel points to a possible magmatic emplacement of the Bala deposit.

Keywords: Precious-metals, Stockwork, Kimberlite, Hot-Spring, magmatic

Abstract ID: T10_008

Elemental and Boron Isotope Fingerprints of Metamorphic Fluid Origin in Dravitic Tourmaline from Bakoshi, Northwestern Nigeria

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Abstract

In the Bakoshi-Gadanya area of NW Nigeria, tourmaline and gold mineralization are spatially associated, though their genetic relationship remains uncleared. This study investigates the boron isotopic and geochemical compositions (major and trace elements) of tourmalines from the Bakoshi-Gadanya to understand the characteristics and origins of the hydrothermal fluids responsible for their formation and their potential role in gold mineralization. The methods used were laser ablation multicollector inductively couple plasma mass spectrometry (LA-MC-ICP-MS) and electron probe microanalysis (EPMA). Four types of tourmalines are identified: altered granite-related (Tur I), wallrock-hosted (Tur II), Gadanya Tourmalinite (Tur III), and Shanono Tourmalinite (Tur IV). These tourmalines primarily belong to the alkali group, with dravite (Mg-rich) compositions. Except for Tur I, which is enriched in Rb (0.02–21.9 ppm) and Cs (0.01–0.63 ppm) due to intense fluid-rock interaction, the tourmalines are enriched in Cr (2.0–3908 ppm), Ni (5.0–222 ppm), Co (0.05–27.4 ppm), Sr (41.8–3031 ppm), Sc (1.6–281 ppm), V (32.0–701 ppm), Al (0.01–0.35 apfu), Fe (0.59–1.47 apfu), and Mg (0.67–2.43 apfu), indicating contributions from metasedimentary sources. Boron isotope values show two distinct populations: –16.8 to –12.0 ‰ (Tur II to IV) and –23.0 to –19.0 ‰ (Tur I). The study suggests that greenschist to amphibolite facies metamorphism during the Pan-African Orogeny caused devolatilization of metapelitic country rocks, generating metamorphic-hydrothermal fluids responsible for tourmaline formation. However, these metamorphic-derived tourmalines appear unrelated to the magmatic-hydrothermal fluids associated with gold mineralization. Consequently, the findings indicate that tourmalines from the Bakoshi-Gadanya area may not be reliable indicator minerals for gold exploration in the Bakoshi-Gadanya Goldfield in Northwestern Nigeria.

Keywords: Tourmaline, Boron isotope, Dravite

Abstract ID: T10_017

The West African Exploration Initiative Project – What Did We Learn And Where Do We Go?

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Abstract

Since 2006, the West African Exploration Initiative (WAXI) ((https://waxi4.org) has aimed to enhance the exploration potential of the Leo-Man Shield (southern part of the West African Craton) and reduce data and information gaps in mineral exploration geoscience, particularly related to tectonics, geophysics, geochemistry, geochronology, and regolith evolution. Our goal is to assist exploration companies in focusing their activities in areas of maximum prospectivity and local governments and Geological Surveys in the region in their role of providing pre-competitive data. The research outcomes are presented in more than 120 peer-reviewed publications and an extensive 950 GB database shared with the project partners. The Leo-Man Shield is built of an Archean nucleus (3.6-2.6 Ga) tectonically adjacent to Paleoproterozoic domains (2.4-1.9 Ga). In terms of ore potential, the Archean part of the WAC seems to be largely underexplored, while the Paleoproterozoic domain is one of the most endowed metallogenic terrains in the world. The

WAXI integrated research and training program, is managed by AMIRA Global, co-funded by the international mining industry, as well as by the governments of Australia and France. Participants have benefited from a network of 75 institutions, including universities, mining companies, geological surveys, and NGOs. Our goal is to maximize the collaborative involvement of local researchers and students. In cooperation with the NGO Agate Project (https://agate-project.org), WAXI has supported the training and education of over 170 students (MSc, PhD). The WAXI project has proven to be a powerful model for collaboration among academia, industry, and government, significantly impacting the West African geoscientific community. The SAXI (South American Exploration Initiative) has already replicated this model, illustrating how this approach could be expanded to other regions, such as East Africa, through a future East African Exploration Initiative.

Keywords: West African Craton, Metallogeny, Precambrian

Abstract ID: T10_019

Prospectivity for Cu-Ni of Mafic-Ultramafic Intrusive Bodies in the Mbinga Area, Tanzania

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Abstract

The Mbinga area in southern Tanzania is situated at the meeting point of three major Proterozoic mobile belts: the Ubendian Belt of Orosirian age, the Unango-Marrupa terranes of Stenian age, and the Neoproterozoic Mozambique Belt. Recent reconnaissance geochronological work indicates that the area has been affected by all three tectonic-metamorphic episodes, with prominent igneous peaks at 1950, 1020 and 730 Ma. To complement these preliminary geochronologic data, I present petrographical and geochemical descriptions of several suites of mafic intrusive rocks from the Mbinga area. The work is derived in part from a grassroots Ni-Cu exploration program carried out in the period

2001-2009 by the Albidon/BHPB joint venture. The exploration work included stream sediment and rock geochemical surveys, as well as high-resolution airborne geophysical surveys, resulting in the definition of three main target prospect areas linked with mafic-ultramafic intrusions, from north to south: Kitai, Mbinga, Liparamba. The petrological study found that the gabbronoritic rocks of the Liparamba and Mbinga prospects have similar subalkaline compositions with relatively flat rare earth element (REE) patterns and moderately primitive cumulate minerals (Mg# 65 to 75), associated with an aluminous chromite. The gabbroic rocks at Kitai, in contrast, have an alkali and Ti rich composition, with a relatively steep, negative REE profile and slightly more primitive cumulates (Mg# 68 to 78) associated with a more Fe-rich chromite and ilmenite. Placing the mafic magmatism in the regional context, it is most likely that the mafics of the Mbinga and Liparamba prospects are associated with end-Stenian post-collisional magmatism and high-T metamorphism of the Unango terrane, with a moderate potential for Cu-Ni mineralization, whereas that of the Kitai prospect is associated with Cryogenian anorogenic magmatism of the Txitonga terrane of northern Mozambique, with a lower Cu-Ni potential.

Keywords: Mafic, intrusion, nickel, copper, Tanzania

Abstract ID: T10_022

Characterization of the Gold- and Tin-Bearing Vein System in Twangiza-Namoya Gold Belt Within the Mesoproterozoic-Neoproterozoic Chain, Kivu (DR Congo)

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Abstract

The Twangiza–Namoya Gold Belt (TNGB), located within the Neoproterozoic (Itombwe) and Mesoproterozoic (Kivu) Supergroups in the DRC, is

interpreted as resulting from tectono-metamorphic events (Büttner et al., 2016; Reid, 2019; Walemba, 2001; Chuwa, 2016). The textures and the coexistence of gold and tin mineralization observed in the veins of the TNGB have always been described as exhibiting significant complexity. The present study aims to clarify the understanding of the vein textures within the TNGB, while characterizing the relationship between its gold and tin mineralization. Structural and lithogeochemical analyses reveal the presence of two distinct vein families: The first, an older assemblage composed of Quartz + Tourmaline + Muscovite, includes tourmaline-bearing pegmatite veins and quartz-tourmaline veins. It is associated with tin-bearing mineralization, genetically linked to magmatism and hydrothermal activity within the Kivu Supergroup. The second, a younger hydrothermal gold-bearing type, consists of Quartz + Iron (Hematite) + Sulfides and encompasses hydrothermal breccias, stratiform veins, and stockworks. This family outcrops in both the Itombwe and Kivu Supergroups, where it crosscuts and reactivates the veins of the first family. Furthermore, strike-slip movements have been identified in the outcrops of the second vein family, which could indicate previously poorly documented tectonic events.

Keywords: Twangiza-Namoya Gold Belt Vein Textures

Abstract ID: T10_025

The Evolution of Phosphates and Associated Mineral Assemblages at Mrima Hill Carbonatite, SE Kenya

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Abstract

Mrima hill is a Cretaceous age carbonatite intrusive complex in SE Kenya,

that hosts manganese ores, niobium ores and phosphates enriched in rare earth elements (REEs). The complex evolution is influenced by magmatic, hydrothermal/metasomatic and supergene processes. This study aimed at understanding the paragenesis of the phosphates in the carbonatite, through chemical and mineralogical characterization of different phosphate phases and associated mineral assemblages, using a combination of scanning electron microscopy, Raman spectrometry, cathodoluminescence and electron probe micro-analysis. The complex facies bear euhedral fluorapatite, anhedral fluorapatite, acicular and granular monazite. The primary euhedral fluorapatite occurs in association with calcite, dolomite, wollastonite, augite, barite, magnetite, pyrochlore and strontianite. The secondary anhedral fluorapatite and monazite are associated with barite, quartz, hematite, chlorite and hollandite. The anhedral fluorapatite and monazite occur at the rim and the surface of the euhedral fluorapatite, indicating a transition from a primary to a secondary phosphate generation. This is confirmed by the enrichment of light REEs from the euhedral fluorapatite, to anhedral fluorapatite and is highest in the monazite. The Mrima hill phosphates evolve from the primary magmatic euhedral flourapatite hosted in the fresh carbonatite rocks to the hydrothermal/metasomatic anhedral fluorapatite in the altered carbonatite and the latest generation is the supergene monazite in the weathered carbonatite.

Keywords: Mrima Hill, Carbonatite, phosphates

Abstract ID: T10_026

A Review of Critical Factors Responsible for Witwatersrand Gold Mineralisation

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Abstract

The exceptional gold mineralisation in quartz pebble conglomerates of the Witwatersrand Basin is attributed to a combination of factors. These factors are linked to the co-evolution of the atmosphere, hydrosphere, lithosphere and biosphere, at a very specific time in Archaean geological history and the evolution of the Kaapvaal Craton. Following craton stabilisation and its subaerial emergence, intense chemical weathering and erosion of large volumes of granitoid-greenstone basement released detrital and dissolved gold. Shallow-marine reworking in a long-lived and slowly subsiding basin subjected to episodic compressional deformation and relative sea-level oscillations led to sedimentary concentration of detrital gold. The interaction between acidic, anoxic, and sulfurous surface runoff and more oxidizing marine waters in a near-coastal oxygen oasis supported microbially mediated diagenetic pyrite formation and incorporation of dissolved gold in the pyrite crystal lattice. Erosion and reworking of diagenetic pyrite gave rise to detrital pyrite that characterize most reefs. Abundance of detrital uraninite in conglomerates, derived from erosion of Mesoarchaean granites, and episodes of hydrocarbon migration through sedimentary strata during deep burial set the scene for further enhancement of gold grades in the reefs. Granular and seam pyro-bitumen formed by radiation-induced polymerisation of hydrocarbons around detrital uraninite. Gold dissolved in migrating hydrothermal fluids was then reduced and precipitated upon interaction with the reef pyro-bitumen during hydrothermal placer modification.

Keywords: Archaean, Gold, Witwatersrand, Placer

T10- S3 Geological characterization and ore genesis of critical metals

Abstract ID: T10_012

Genesis and Geochemical Characteristics of the Epunguwe Copper-Silver Prospect, Opuwo District, Kunene Region, Namibia

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Abstract

The Epunguwe copper and silver prospect is located in Kaoko Belt, Kunene region, Namibia. Mineralization is traced over 3 km along a reverse fault dipping 45o to the southwest, hosted by Nosib Group sandstone and conglomerate superimposed over the carbonate rocks of the Devede Formation, Ombombo Subgroup. Mineralized sections with grades of 0.3 to 2.8 wt% Cu and 2 to 171 g/t Ag occur as syngenetic-diagenetic and epigenetic mineralization. Syngenetic-diagenetic mineralization is pyrite dissemination in conglomerate and sandstone, with average concentrations of 0.28 wt% Co. Epigenetic mineralization comprises quartz-calcite-sulfide stockwork veins (stage 1) crosscut by quartz-

calcite veins (stage 2) with chalcopyrite, bornite and minor galena. Hypogene mineralization was overprinted by supergene chalcocite, covellite, malachite, hematite and goethite. Bulk chemical compositions of the ores show Cu, Ag, Pb, Zn and Co average concentrations of 0.2 wt%, 240 ppm, 283 ppm, 40.8 ppm, and 9.83 ppm for syngenetic-diagenetic mineralization, 1.1 wt.%, 7.65 ppm, 219 ppm, 43.1 ppm, and 10.9 ppm for stage 1, and 2.0 wt%, 88.3 ppm, 6748 ppm, 25.2 ppm, and 1.53 ppm for stage 2, respectively. δ34SCDT values of sulfides range from +13.0 to + 27.0 ‰ for pyrite, chalcopyrite, and chalcocite, and -3.2 ‰ for galena. Positive δ34SCDT values of the former suggest sulfur source of the Neoproterozoic sedimentary sulfides, sulfate and seawaters, while negative δ34SCDT value of the latter implies magmatic sulfur or isotopic fractionation. Fluid inclusion microthermometry for the quartz veins suggest that mineralization occurred at >1.1-1.3 MPa and >190-200 oC in stage 1, and >0.2-0.5 MPa and >150-160 oC in stage 2. Variation of salinity, Δ salinity= 13.9 -14.5 wt.% NaCl eq. of the fluid inclusions suggests fluid mixing and cooling processes. Bulk gas compositions of fluid inclusions suggest hydrothermal fluids with an origin of shallow meteoric water or seawater with a magmatic contribution.

Keywords: Epunguwe-Cu-Ag-prospect, Syngenetic-diagenetic, Reverse-fault, Epigenetic, Supergene-mineralization.

Abstract ID: T10_020

Mineralogy and Geochemistry of the Florencite from Luishia Principal Cu-Co (U) Deposit (Katanga Copperbelt, DRC): Genetic Implication

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Abstract

The Luishia Principal is one of the largest Cu-Co (U) deposit located in the

central part of the Katanga Copperbelt. A previous preliminary genetic model of the florencite formation in the Roan Group at Kabolela Cu-Co deposit supports two main processes: i) hydrothermal alteration and ii) weathering process in the supergene zone. Recent fieldwork completed at Luishia deposit, following by a detailed mineralogy and geochemistry analysis under scanning electron microscope and energy dispersive spectrometers, the florencite have been identified in the dolomitic shale of the Kinsevere Formation. The florencite crystals in thin section are hexagonally prismatic or pseudocubic rhombohedra (200 to 400 mμ) disseminated inthe host rocks and occurred in the veins. Mineral mapping and cross sections through the florencite crystals show an internal zonation and complex distribution of RRE in each overgrowth zone. HREE (Sm, Y, Gd, Dy) are concentrate in the body of the florencite crystals while the LREE (La, Ce, Nd) increase in its external growth zone. The origin of the florencite at Luishia deposit is a result of the diagenesis and the evolution of the Cu-Co hydrothermal fluid rich in REE migrated during the Lufilian orogeny and its post period. The occurrences of florencite as well as both monazite and apatite control the distribution of the REE in the Katanga Supergroup and are linking to the Cu-Co mineralization stages.

Keywords: Florencite, Monazite, Apatite, Copper and Cobalt

Abstract ID: T10_016

Petrogenesis and Critical Minerals Chemistry of Pegmatites in Embu County, Kenya

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Abstract

Pegmatites are the major sources of critical minerals containing rare metals such as tantalum, beryllium, and lithium, which are required for green energy and modern technologies. Granitic pegmatites are common in the Mozambique Belt, part of the East African Orogen; some are rare-element pegmatites, including those in Embu County of Kenya. Here, we present the petrogenetic model for Embu pegmatites using geochronology data and mineral chemistry of two groups of critical minerals. The undeformed pegmatites are concordant to the regional geology, trending in the N-S direction in an approximately 15 km long corridor. Rb-Sr mineral isochrons and U-Pb dating of columbite/tantalite show emplacement ages between 520 Ma and 618 Ma, with the majority emplaced at ~577 Ma. 87Sr/86Sri signatures are highly variable, indicating different crustal sources of the pegmatite melts. The chemistry, obtained by SEM-EDS and EPMA analytical methods of rare minerals occurring in these pegmatites, gives insight into their petrogenesis. Beryl occurs in seven of the twelve sampled pegmatites. Most of the beryl occurs as its blue variety, aquamarine, often in gem quality. Beryl is commonly associated with low-temperature pegmatite melts, typically crystallising at ≤600 °C. The presence of Nb and Ta-bearing minerals is confirmed in six pegmatites. These minerals include columbite, ilmenorutile, tantalite, microlite and tantaeuxenite-Y. Ta is more soluble in pegmatitic melts than Nb; hence, the Ta-rich pegmatites will represent a more evolved pegmatitic melt. In the plate tectonic and geochronological context, the Embu pegmatites form during a late-orogenic extensional phase, related to post-collisional crustal collapse.

During crustal decompression, partial melting of the lower crust enriched in incompatible elements led to the formation of the Embu rare-metal pegmatites.

Keywords: Pegmatites, critical minerals, beryllium, tantalum.

Abstract ID: T10_027

Incremental Emplacement and Metasomatic Overprinting of the Giant Manono-Kitotolo Spodumene Pegmatites, Democratic Republic of the Congo

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Abstract

The Manono-Kitotolo pegmatites in the DRC form the world's largest known LCT pegmatite system, extending NE-SW over 13.5 km with a thickness of 250-300 m and unknown extent at depth. They comprise subparallel sheets, including Roche Dure, Kyoni, Mpete, Tempete (Kitotolo sector), and Carrière De L'Est and Malata (Manono sector). The alluvial and eluvial parts of the pegmatite were industrially mined for cassiterite and columbite-tantalite between 1915 and 1985. Recent exploration led to a resource estimate of 842 million tonnes at 1.61 wt% Li2O, 709 ppm Sn, and 37 ppm Ta (AVZ, 2024).

Here we present new geological and mineralogical data from fieldwork and drill cores, providing a full cross-section of the pegmatites and host rocks. Spodumene is the dominant Li mineral, occurring as large tabular crystals (<40 cm), fine needles, and symplectite spodumene-quartz intergrowths. Accessory minerals include columbite-tantalite, cassiterite, wodginite, uranmicrolite, apatite, lithiophilite-triphylite, and

tourmaline. Spodumene alteration includes kaolinization and local lepidotization.

Outcrops show meter-scale layering; drill cores reveal greisen, aplite, and alternating quartz-, albite-, and spodumene-rich zones. While internal zonation is poorly defined, textural zoning recurs at meter to decimeter scale. Geochemical assays show multiple high-grade zones (>2% Li_2O), dipping parallel to pegmatite sheets, possibly representing core zones. This suggests incremental emplacement of smaller pegmatite bodies.

The pegmatites intrude amphibolite-facies Kibaran metasediments and metadolerite. Metasediments contain quartz, muscovite, siderophyllite, tourmaline, and accessory garnet, zircon, apatite, and chloritoid. Metadolerite consists of amphibole, sericitized plagioclase, quartz, Fe-Ti oxides, apatite, zircon, monazite, and xenotime. Ongoing U-Pb and Lu-Hf dating and thermobarometry aim to clarify the metamorphic history and pegmatite-related metasomatism in the Kibara Belt.

Keywords: lithium, pegmatites, Manono, metasomatism, spodumene

T11- S1 Cross disciplinary Geo techniques for infrastructure resilience

Abstract ID: T11_001

Improving Household Preparedness in Multi-hazard Contexts

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Abstract

Here we profile and share preliminary results from an ongoing impact-focused research project, aiming to strengthen resilience to multiple interrelated hazards by supporting the development and uptake of multi-hazard preparedness assessments for households in low-income contexts. Our work combines both analysis of global datasets and diverse (physical and social sciences) literatures with localised case-study work, collecting data through interviews and workshops with households and hazard professionals. Case study work is focused on the urban context of Nakuru, Kenya, affected by a range of hazard types (e.g., flooding, earthquakes, ground collapse), with potential interrelationships between these (e.g., heavy rain triggering ground collapse). Through this mixed methods, multi-scale work we (i) identify and synthesise understanding of gaps in the preparedness literature, (ii) advance work on multi-hazard interrelationships in Kenya, (iii) develop a comprehensive examination of the trade-offs and synergies of different preparedness actions for different natural hazards, and (iv) integrate these outputs to develop a methodology and toolkit (e.g., scorecard) to improve household preparedness in multi-hazard contexts. The toolkit is aimed at both households and organisations working with households, with a particular focus on small to medium urban centres in the Global South. This project aligns with the Sendai Framework for Disaster Risk Reduction, which advocates for multi-hazard approaches to risk reduction and notes that household preparedness plans are a vital part of resilient communities. This project also aligns with the

ambitions of UN Sustainable Development Goal 11 (sustainable cities and communities). Activities are being delivered by a collaboration involving Cardiff University King's College London, and the Technical University of Kenya.

Keywords: Preparedness, Multi-Hazards, Sendai Framework, Nakuru

Abstract ID: T11_003

From Detection to Preparedness: Ghana's Progress in Earthquake Monitoring and Risk Reduction

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Abstract:

Over the past decade, Ghana has transitioned from earthquake detection to proactive risk reduction by integrating seismic monitoring with community sensitization and preparedness initiatives. This study highlights how the transition from analog to digital seismic network since 2012, comprising eight broadband seismographs and three dam-mounted accelerographs has not only recorded 460 earthquakes (magnitudes 1.0-4.1 Ml) but also catalyzed nationwide disaster awareness programs. Key findings reveal seismic activity concentrated along the Akwapim Range and Coastal Boundary Fault systems, with Accra's southwestern suburbs identified as high-risk zones. Additionally, the approximate depth of most of the events is less than 10 km depth meaning shallow earthquakes and this has implications for disaster risk. The seismic network provided critical data to design targeted sensitization campaigns, including school drills, public workshops, and media collaborations in vulnerable communities. The Ghana Geological Survey Authority leveraged these insights to develop awareness and preparedness education, evacuation drills, while real-time data sharing with emergency agencies improved response coordination. Despite progress, challenges persist such as limited public engagement in rural areas and gaps in northern part coverage hinder equitable preparedness. To address this, (1) the network density should be increased including ocean bottom seismometers and early warning systems; (2) intensify

public sensitization and (3) integrating earthquake preparedness into national education curricula. Ghana's experience demonstrates how harmonizing technical monitoring with grassroots engagement can transform seismic data into life-saving action, offering a blueprint for disaster-resilient societies.

Keywords: Microseismic, sensitization, earthquake disaster resilience

Abstract ID: T11_005

Rapid Assessment of Landslide in Tectonically and Climatically Vulnerable Region: A Call for Integrated and Comprehensive Disaster Management Strategy

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Abstract

A catastrophic landslide hit the southwestern region of Ethiopia on July 23-24, 2025, taking the lives of over 300 people within minutes. This tragedy occurred in Kencho, in the Geze Gofa district of the Gamo Zone in the South Ethiopia Region following continuous rains. The rapid and massive scale of the disaster attracted global attention, instigating several investigations into the circumstances that led to the catastrophe. As part of an ongoing efforts to create maps for natural resource management and development in Ethiopia, we conducted a preliminary, rapid assessment of slope instability in the area impacted by the Geze Gofa landslide. This assessment is based on freely accessible satellite radar data from Sentinel-1 images taken before and after the landslide, high-resolution Google Earth imagery, and extensive field reconnaissance across the landslide-prone areas of the Gofa Zone. The region is located on the western edge of the NE-SW trending broadly rifted zone, which is a lateral extension of the Main Ethiopian Rift. It lies at high elevation often subjected to heavy rainfall, contributing to the formation of deeply weathered saprolites in the vast volcanic rocks.

Beyond the typical physical conditions associated with landslides, our preliminary survey highlights the significant role of climatic factors and emphasizes the lessons that can be drawn to prevent similar disasters in the future. This reinforces the need for countries facing similar challenges to develop a dynamic and self-sustaining disaster management system, relying on active collaboration between multiple stakeholders. Such a system should adopt a comprehensive strategy comprising of prevention (mitigation), preparedness, response, and recovery, that accommodates multiple hazards.

Keywords: Landslides, Sentinel-1, tectonics, climatic-factors, disaster-management

Abstract ID: T11_010

An Integrated Geological and Geophysical Investigation of the Umgababa Landslide, Kwazulu-Natal, South Africa

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Abstract

Landslides are destructive natural hazards that damage infrastructure and cause loss of life. In April 2022, rainfall triggered landslides in eThekwini Metropolitan Municipality, KwaZulu-Natal Province (KZN), South Africa, resulted in ~448 fatalities and ~1.9 billion rands worth of damage to infrastructure. The landslide events caused widespread concern and prompted the Council for Geoscience to investigate the predisposing factors and their impact. This study aimed to assess the influence of geological structures on the uMgababa landslide. The methodologies employed included geological and structural mapping, and Seismic Refraction Tomography (SRT) and Electrical Resistivity Tomography (ERT) techniques across the landslide area. The SRT data were acquired along N–S and E–W trending profiles using 2 Geometrics Geodes and 48 geophones at 2 metre intervals. The ERT data were

collected along N–S and E–W trending traverses utilising the Iris Syscal Pro instrument with 36 electrodes spaced at 5 metres. Geologically, the uMgababa landslide area is characterised by interbedded shale and sandstone of the Vryheid Formation, Ecca Group (Karoo Supergroup). The formation is truncated by numerous fractures. Outcrop-scale field mapping revealed a remaining rock wall representing the eastern margin of the area from which the landslide detached. This outcrop exhibits northward-dipping sub-horizontal bedding, sub-vertical systematic joints and moderate E–W normal and steep N–S dextral strike-slip faults, all pre-dating the uMgababa landslide. The SRT and ERT data analyses suggest that eastern and western margins of the landslide correlate with moderate to steep E–W and ~N–S oriented sub-surface normal faults. These findings suggest that pre-existing fractures were crucial to the initiation and propagation of the landslide. This research contributes to understanding the critical role of geological structures in landslide initiation within KwaZulu-Natal.

Keywords: landslide, geological fractures, geophysical techniques

Abstract ID: T11_012

Modelling Hydrological Response to Urbanization: Case Study Syokimau - Katani Area

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Abstract

High rates of infrastructural development brought about by rapid urbanization increase areas of impermeable surface. This in turn raises runoff volumes in the area, leading to urban-related flooding problems. Such problems can be averted by informed planning policies based on the understanding of the area's basin hydrological response. A basin's hydrological response can be defined by the spatial distribution of its runoff coefficient. This runoff coefficient is affected by the basin's physical properties i.e. topography, soil type and land use, and climatic factors such as incident soil moisture and the amount of precipitation received within a particular duration. Unfortunately, the rates at which land use changes render empirical methods of runoff coefficient determination both costly and time-consuming. It is for this reason that a rapid prototyping approach is needed that involves the use of readily available data and physically-based distributed hydrological simulations validated by geophysical methods to simulate runoff coefficients for areas with high rates of urbanization. The Syokimau-Katani area is a notable example of an area prone to the aforementioned problem. An analysis of its basin's physical properties was given as input for the hydrological simulation of the area's runoff coefficient values, and a theoretical framework to assist in results interpretation was developed.

Keywords: Urbanization, Flooding, Modelling

Abstract ID: T11_009

Geotechnical and Geochemical Characterisation of Some Termite Reworked and Residual Lateritic Soils in the Polytechnic, Ibadan, South-Western Nigeria

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Abstract

Termite activity significantly alters the properties of soils, potentially enhancing their geotechnical and geochemical characteristics. This study revealed similarities between the soil types. Samples from termite mounds and 1-meter depths were analyzed for specific gravity, grain size, Atterberg limits, compaction, UCS, CBR, and major elements via AAS. Results highlighted the comparable properties of both soil types. The liquid limit result for the residual lateritic soil ranges from 32.6% -43.1% compared to the termite reworked soil samples which ranges from 25.5%-33.1%, which implies that the termite reworked soil samples have a lower percentage of liquid limit in relative comparison to residual lateritic soil. The MDD values of residual lateritic soil ranges from 1800kg/m3-1940km/m3 compared to termite reworked soil which ranges from 1961kg/m3-2130kg/m3, this indicates that there is a significant increase in the compaction parameters of the termite reworked soils. The average value of the California bearing ratio (CBR) test for residual soil is 33% compared to the termite reworked soil samples which indicates an average value of 75%. The geochemical analysis result indicates an increase in iron and aluminum contents (Fe2O3 and Al2O3) in the termite reworked soils which is; as a result of the actions of termites. From the results displayed in this study, it was inferred that the geotechnical and geochemical properties of the residual lateritic soils were improved by action of termites during the construction of termitarium. This study revealed that termite reworked soils can also be used as sub-base, subgrade, base course, including other construction materials.

Keywords: Residual-soil, Termite-rewords-soil, Geotechnical-analysis and Geochemical-analysis.

Abstract ID: T11_020

Cross-Disciplinary Approaches in Development of Resilient Infrastructure in Erosion-Prone Areas: The Mwache Multipurpose Dam Case Study, Kenya

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Abstract

The Kenya Water Security and Climate Resilience Project (KWSCRP) was initiated to implement sustainable solutions for water resource management and distribution across Kenya. Its primary aims are to expand access to irrigation water for beneficiaries and to strengthen institutional frameworks, thereby enhancing national capacity for water security and improving resilience to climate change through regionally targeted initiatives. As part of KWSCRP, the Coastal Water Security and Climate Resilience Project centered on the Mwache Multipurpose Dam in Kwale County to address the Coastal region's growing water demands. During site selection, concerns regarding erosion and potential land degradation were identified, prompting the integration of a greening initiative into the project's objectives. However, this technical paper focuses on the integrated geo-technical and engineering strategies implemented in the design and construction of the Mwache Multipurpose Dam. Using the case study, this paper examines the extensive site investigations conducted, including strategically drilled boreholes to characterize subsurface conditions. It highlights the comprehensive geotechnical characterization of the Duruma Sandstone Series unique to the region and evaluates the structural integrity of the formation through specialized interface shear testing performed both locally and internationally. Detailed geological, geotechnical, structural and

economic assessments established during investigations point to attainment of optimal design parameters for a Roller Compacted Concrete (RCC) gravity dam, selected after rigorous comparative analysis of various dam types. Further described in the paper is the investigation encompassing foundation enhancement through geological assessment and rock classification, slope stability analysis, and grouting strategies. These measures are noted to be critical in the development of a sound and resilient infrastructure when combined with the innovative design of a spillway incorporating sediment management features, and the implementation of comprehensive instrumentation systems for structural monitoring. The results demonstrate successful foundation treatment, evidenced by progressive improvement in Lugeon values from primary to tertiary grouting stages, and satisfactory strength parameters across critical structural interfaces as revealed by interface shear testing. This case study thus serves as a model for future infrastructure development in Kenya, showcasing the value of cross-disciplinary integration in enhancing dam resilience in erosion-prone environments.

Keywords: Mwache-Dam, RCC-Gravity Dam, Infrastructure Resilience

Abstract ID: T11_033

Discrimination Between Anthropogenic and Natural Earthquakes with Emphasis on Geothermal Fields and Carbon Storage Projects in the Kenya Rift Valley

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Abstract

Geothermal fields and carbon storage projects rely on fault-controlled permeability. The Kenya Rift Valley is an active rift; any activity on the rift may cause anthropogenic earthquakes. Earthquakes are disastrous events that may lead to the closure of billions of projects.

This paper highlights the methods used in discriminating between anthropogenic and natural earthquakes. The discriminants include event location, magnitude determination (mb: Ms criteria), and focal mechanism solution. Discriminating these events has been a challenge in seismology, especially in the geothermal fields and carbon sequestration projects, where the extraction/injection of fluids may induce seismicity. Results show that natural events have larger values of Ms-mb than anthropogenic earthquakes. Hypocentral parameters reveal that most of the anthropogenic events occur within 2km of injection sites, while natural events are more dispersed >10km. Additionally, the focal mechanism shows that induced events align with local stress changes. The adoption of these discriminants will enable effective characterization, enhancing risk mitigation for sustainable project operations.

Keywords: Earthquakes, magnitude, and active rift.

T13- S1 GIS and Remote Sensing Applications

Abstract ID: T13_004

Two Decades of Land Use and Land Cover Dynamics: Assessing the Ecological Status of the Sakumono Ramsar Site, Ghana

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Abstract

The Sakumono Ramsar Site is a vital coastal wetland in Ghana. It has suffered major ecological damage from rapid urbanization and land-use changes. Wetlands offer key ecosystem services including water purification, flood control, and species habitat. Human activities like urbanization, agriculture, and infrastructure development increasingly threaten these areas. This study analyzes Land Use and Land Cover (LULC) changes from 2000 to 2023, focusing on Built-up, Floodplain, Vegetation, and Water. Landsat imagery and GIS tools were used to quantify LULC changes, with ecological impacts assessed using NDVI and NDWI. Results show a dramatic rise in Built-up areas from 1.06% in 2000 to 45.26% in 2023. Floodplain areas shrank from 82.22% to 21.72%. Water areas decreased from 5.62% to 2.02%. Vegetation areas increased from 11.10% to 30.99%. 74.01% of Water areas became Vegetation. 51.35% of Floodplains became Built-up areas due to urbanization. NDVI and NDWI showed declining vegetation health and water availability. This was clear in the open lagoon and floodplain areas, even with an overall increase in Vegetation cover. There is a small improvement in freshwater marsh, however, the overall wetland health worsened. This leads to less biodiversity, changed water flows, and damaged ecosystem services. This study underscores the need for sustainable management strategies to mitigate the adverse impacts of urbanization on the Site. Even though

national and international conservation laws exist, enforcement and community-based initiatives have struggled with sustainability. This suggests the need for active community and stakeholder involvement to preserve and protect the wetland's ecological integrity. To achieve this, a mixed-methods approach that combines quantitative LULC, NDVI, and NDWI data with qualitative data collected through community workshops, stakeholder talks, and participatory mapping activities is recommended.

Keywords: Ramsar Site, Ecological health, Sustainability

Abstract ID: T13_054

Remote Sensing-based Geological Mapping of The Sangu-Ikola Carbonatite Complex, Southwestern Tanzania

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Abstract:

Carbonatites are rare carbonate-rich igneous rocks that host critical metals like Rare Earth Elements (REEs), niobium (Nb), and phosphate. This study focuses on the Sangu-Ikola carbonatite complex in southwestern Tanzania, utilizing advanced remote sensing techniques for geological mapping. Integrated use of ASTER, Sentinel-2, and Landsat 8 data enabled improved lithological discrimination by leveraging ASTER's SWIR bands, Sentinel-2's resolution, and Landsat's calibrated spectral data.

A key innovation involved using an Analytical Spectral Device (ASD) spectroradiometer to extract spectral endmembers from field samples before remote sensing analysis. ASD spectroscopy identified key carbonatite minerals calcite, dolomite, apatite, ankerite, and siderite offering diagnostic fingerprints that enhanced lithological mapping using Principal Component Analysis (PCA). PCA revealed spectral contrasts linked to carbonatites, while Digital Elevation Model (DEM)

analysis highlighted NW–SE and NE–SW trending lineaments that structurally control carbonatite emplacement.

By integrating spectral and structural data, a comprehensive RS-based geological map was generated, showing spatial relationships between carbonatite bodies and tectonic features. The study confirms that Sangu-Ikola intrusions are structurally controlled by pre-existing faults tied to regional rift tectonics. Economically viable zones rich in REEs, Nb, and phosphate were delineated, emphasizing the area's mineral potential.

This research showcases a cost-effective, robust remote sensing workflow suitable for tropical, vegetated terrains. The pioneering use of ASD in Tanzania also demonstrates a reliable methodology applicable to similar mineral exploration contexts.

Keywords: Carbonatites, Sangu-Ikola, Tanzania, REEs

Abstract ID: T13_009

GeoPlan-LLM: Automating Geoscience Research Workflow Planning via Large Language Model Training on Literature-mined Task Sequences

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Abstract

The rapid growth of geoscience literature has made it increasingly difficult for researchers to synthesize and replicate methodological workflows across studies. This challenge hinders efficient knowledge transfer and slows scientific progress in the geoscience community. To address this issue, we propose GeoPlan-LLM, a novel framework that leverages large language models (LLMs) to automatically extract, formalize, and generate research workflows from geoscience publications. The framework consists of two key components: (1) a task sequence database constructed through literature mining, capturing typical geoscientific workflows—such as data collection, preprocessing, modeling, validation, and result interpretation; and (2) a fine-tuned LLM capable of generating personalized research plans based on user-defined research goals, data types, and regional contexts.Experiments demonstrate that GeoPlan-LLM effectively reconstructs standardized workflows from diverse publications and provides accurate, context-aware research planning suggestions. The use of Qwen-32B enables high-quality plan generation with strong adaptability to different research scenarios. The fine-tuned model achieves over 80% in both semantic similarity and term-level alignment when evaluated on geoscientific workflow construction tasks. Our results suggest that GeoPlan-LLM holds great potential for enhancing methodological synthesis, improving research transparency, and accelerating scientific progress in geoscience.

Keywords: Geoscience, workflow, Large Language Model

Abstract ID: T13_010

High-performance Paleogeographic Reconstruction of Hybrid Vector-raster Data Using a Client-side Rendering Framework

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Abstract

This study develops a client-side framework to overcome key limitations in web-based paleogeographic tools, specifically addressing the misalignment between dynamic tectonic plate models and static raster tiles, as well as performance issues with global-scale data in browsers. The proposed "Tile-Plate Quadtree" architecture links raster tiles to plate polygons via hierarchical spatial indexing. By embedding plate metadata into quadtree nodes and using GPU-accelerated reprojection, the system enables real-time raster transformation across geological time. A viewport-driven rendering method filters visible tiles, reducing computation by 60–80% compared to conventional methods. Integrating WebGL and Cesium, the framework supports on-the-fly reconstruction of high-resolution global paleogeographies, incorporates major plate models (e.g., PaleoMap), and enables hybrid visualization of vector data over dynamic basemaps. It achieves 25–40 FPS with 10-million-point datasets, outperforming existing tools like WebGPlates (8–15 FPS), with under 100ms latency in coordinate calculations. Applications in paleoclimate and stratigraphy demonstrate improved revelation of spatiotemporal patterns. This open-source solution bridges desktop and web-based geovisual analytics, offering enhanced interactivity and efficiency for cross-disciplinary research, and provides a foundation for deep-time data exploration under the Deep-time Digital Earth (DDE) program.

Keywords: Paleogeographic Reconstruction, Client-Side Rendering Optimization

Abstract ID: T13_011

A Serverless, Multi-level Parallel Architecture for Scalable Remote Sensing Data Processing

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Abstract

The unprecedented growth of remote sensing data demands processing architectures that combine elasticity with computational efficiency. This research introduces a serverless, multi-level parallel architecture for large-scale remote sensing workflows. At the highest level, containerized processing tasks are executed as serverless functions, enabling automatic resource provisioning and management in response to workload fluctuations without manual intervention. Within each function, the computational core employs shared-memory multithreading and single instruction, multiple data vectorization to accelerate pixel-level operations. A lightweight software layer orchestrates data movement with object storage services and exposes HTTP APIs for seamless task invocation. When evaluated on a multi-decade Landsat dataset processing task, the architecture delivered more than an eightfold reduction in processing time compared to an unoptimized baseline. This evaluation confirms that the proposed solution achieves high efficiency and scalability for environmental monitoring and other data-intensive remote sensing applications. The modular, cloud-native design supports cost-effective deployment and can be extended to address emerging challenges in remote sensing analysis.

Keywords: Serverless computing, Remote sensing

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DCM-TF: A Unified Triplet Framework for Data, Knowledge, and Model Integration in Geoscience

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Abstract

Deep-earth exploration is constrained by heterogeneous data fusion, inefficient cross-modal knowledge conversion, and weak model coupling in complex geological settings. We propose DCM-TF (Dynamic Coupled Data–Knowledge–Model Triplet Framework), which uses OWL-DL–based semantic linking to integrate multi-source geoscience and remote-sensing data into an extensible knowledge graph, reducing fusion time by 40%. It employs knowledge distillation with fine-tuned geological large language models to achieve bidirectional mapping between raw data and decision-support knowledge. A hybrid graph-database indexing approach combines formal ontologies with distributed storage to enable millisecond-scale inferential queries on stratigraphic relationships. Fuzzy description-logic–enhanced ontology operators ensure robust model interoperability. Experiments show DCM-TF reduces model invocation latency by 40%, improves inference accuracy by 12%, and doubles interdisciplinary collaboration efficiency over conventional methods. This concise, scalable framework offers a novel solution for mineral potential mapping, seismic hazard assessment, and analogous complex geological scenarios worldwide.

Keywords: Triplet Representation, Knowledge, Data, Model

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PanAfGeo+ – Country Window Uganda: Cooperation on Geological Exploration of Critical Raw Materials

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Abstract

Uganda has a variety of critical raw materials that are becoming increasingly important for global technology, energy transition, and economic development. Uganda's new Mining and Minerals Act (2022) focuses on transparency, sustainability, and governance. Uganda has diverse geology characterized by rocks up to 3,100 million years old, which favours the discovery of world-class mineral deposits. The currently known metallic mineral resources are beryllium, copper, cobalt, columbite, tantalite, gold, iron, lead, lithium, manganese, platinum group metals, rare earth elements, tin, uranium, tungsten, and zinc. Mineral exploration in Uganda has grown in recent years, driven by the strategic initiatives to attract investment. The PanAfGeo+ project, a continuation of the Pan-African Support to Geological Sciences and Technology initiative co-funded by the European Union and a consortium of European Geological Surveys, aims to further enhance the geoscientific capacities of African countries, including Uganda, through comprehensive knowledge exchange and collaboration, as well as through a dedicated action entitled Uganda Country Window. The overall objective of the Uganda CW action is to promote Uganda's mineral endowment focussing on mineral prospects for further potential

development in line global standards on environmental, social, technical, and governance. The specific objectives are: data collection to evaluate Uganda's critical and strategic mineral deposits; strengthening the capacities of the Geological Survey Department in exploration; and promotion of the evaluated mineral prospects to attract investment. Over the next four years, collaboration between the Ugandan Geological Survey Department and several European Geological Surveys in the collection of data on mineral deposits, capacity building and promotion of assessed targets will increase and lead to future detailed nexploration and mine developments.

Keywords: CRM, Uganda, capacity building, PanAfGeo+

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Work on the Preparation of the Monograph Geosciences in Africa Is Time to Start

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Abstract

The implementation of the two phases of the PanAfGeo Project, which were implemented between 2016 and 2024, is very well received by the African geoscience community. Nearly 2,000 young geoscientists had the opportunity to receive training on a very wide range of topics covered by the broader geological sciences. Training was provided in geological mapping, geology of mineral deposits, geochemistry, artisanal and small scale mining, geohazards, including those induced by human activity, geoheritage, geothermal energy or the application of IT methods in data collection and processing. Over the course of the project, the increasing participation of African trainers teaching the classes was marked. The participation of a cadre of professors from universities in the delivery of training was also not insignificant. Already during the second phase of the Project, the concept of a comprehensive monograph with the working title Geology of Africa emerged, which would contain scientific

articles on geological structure, natural resources, including those induced by human activity, geoheritage potential, water resources, and would be authored by geologists from all 54 African countries. This concept has already been presented at the 29th Colloquium of the African Geological Society and at other scientific and technical conferences. The acceptance of this idea has resulted in the inclusion of the preparation and publication of this monograph, under the slightly modified title: Geosciences in Africa, in the tasks of the third phase of the Project - PanAfGeo+. Thus, it is time to move from the planning and promotion phase of the idea to its implementation.

Keywords: Monograph Geosciences in Africa, PanAfGeo+

Abstract ID: T13_021

Exploring Strategic Communication Approaches in Multi-Sectoral Collaboration for Carbon Capture, Utilisation, and Storage (CCUS) Advocacy in South Africa: Challenges and Solutions

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Abstract

The achievement of South Africa's national climate goals requires the successful implementation of multiple climate change mitigation strategies, including Carbon Capture Utilisation and Storage (CCUS) technology. However, despite its potential to significantly reduce carbon emissions, CCUS adoption remains due to slow adoption. Several have indicated that CCUS implementation in South Africa remains slow due to poor coordination among key stakeholders such as government, industry, academia, and NGOs; with the major challenges being fragmented communication and conflicting messaging among the stakeholders.

This study aims to identify and analyse key components and challenges in managing multisectoral collaboration and stakeholder relations in

CCUS advocacy in South Africa. It seeks to uncover coordination gaps and contribute to developing practical communication approaches that promote effective collaboration, ultimately enhancing the impact and success of CCUS advocacy efforts across diverse stakeholder groups. This study used a mixed-methods exploratory design, using a standardised questionnaire to gather data from purposively sampled CCUS experts across sectors. Analysis, guided by Stakeholder Theory, Diffusion of Innovations, and the Technological Innovation Systems framework. The methodology employed in this study informed the development of tailored communication strategies to strengthen stakeholder engagement and CCUS implementation in South Africa.

The results of this study revealed important insights into communication and collaboration among stakeholders involved in CCUS advocacy in South Africa. A total of 23 participants from different sectors within the CCUS value chain participated in the study, with majority being from academia and research institutions, the participants had varying levels of experience in CCUS. Most respondents reported being part of climate change and CCUS advocacy initiatives. Communication strategies were seen as only moderately effective (56.5%), and 43.5% indicated frequent collaboration. However, there were challenges that were identified, including regulatory gaps, limited awareness, funding constraints, and low stakeholder engagement. Most supported the adoption of standardised communication by all CCUS stakeholders, though few supported their existing approaches. The study's findings highlight the need for improved multi-stakeholder communication strategies support to enhance CCUS advocacy in South Africa.

In conclusion, the study recommends customised, inclusive multistakeholder communication strategies to align stakeholder messaging, enhance collaboration, and promote science-based CCUS narratives, supporting policy adoption and coordinated effort to support South Africa's carbon reduction goals.

Keywords: Communication Frameworks; Science Communication; Carbon Capture, Utilisation, and Storage; Climate Change Mitigation.

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