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INSIDE:

Joint CGS-DMRE two-day workshop and visit to the National Borehole Core Depository

Figure 1. Representatives from various DMRE mineral regulations branches across the country conduct a walk-about of the CGS National Core Library on day two of the CGS-DMRE workshop. (Front row from the left: Ms Shallati Banyini, Mr Khangwelo Mphaphuli, Mr Vinesh Devchander and Ms Yanathi Tau from the DMRE).

Following commitments made at the 2022 CGS Geoscience Summit, the CGS and the Department of Minerals and Energy (DMRE) sought to forge relations and to provide further insight to the Mineral and Petroleum Regulation Branch of the Department, in respect of work that is being undertaken by the CGS National Borehole Core Depository, the developed Geoscience Digital Portal, and the implementation of the Geoscience Act Regulations.

On 18–19 April 2023, the CGS held a joint workshop with representatives from the Mineral and Petroleum Regulation Branch of the DMRE. During the workshop, discussions were held to identify areas of improvement for servicing all stakeholders while ensuring the compliance of prospecting rights holders with Section 21 of the Mineral and Petroleum Resources Development Act (MPRDA) (2002), as amended. The event was attended by mine economists from the Mineral and Petroleum Regulation Branch, under the guidance of Ms Motlatso Kobe, Chief Director: Mineral and Petroleum Regulation Branch in the Minister's office.

Ms Magda Roos, Manager: Knowledge Management, welcomed all participants to the workshop. She reflected on the culmination of this engagement as the first interaction between the Mineral and Petroleum Regulation Branch and various CGS business units. The purpose of the workshop was to strengthen relations between the CGS and the DMRE.
Ms Motlatso Kobe acknowledged the insights gained from CGS presentations which have helped DMRE delegates to better understand South Africa's mineral resources.

Given that the CGS is a key DMRE key stakeholder, it is important that the two entities engage in regular discussions. Ms Motlatso Kobe emphasised the importance of the two organisations working together with a view to aligning processes and playing a more prominent advisory role to enable the sustainable management of our country's resources.

Scientists from the CGS Technical Services and Knowledge Management business units gave presentations on the access to geoscientific data through the CGS Geoscience Data Portal https://maps.geoscience.org.za. Other topics covered included the implementation of the gazetted Geoscience Act Regulations, their implementation, and an overview of the hyperspectral scanner housed at the CGS National Borehole Core Depository.

On the second day of the workshop, delegates visited the CGS National Borehole Core Depository, and attended a demonstration on core handling and logging at the facility. Moreover, the operation of the hyperspectral scanner was demonstrated. One of the major take-home messages from the workshop was the need for the CGS to collaborate with the DMRE to ensure that the required geoscientific data and information to be submitted to the CGS adhered to the requirements of such submissions. The DMRE urged the CGS to share information on any undertakings made by stakeholders to dispose of borehole core. Given that the DMRE regional offices work closely with rights holders, the DMRE colleagues expressed their willingness to assist the CGS in ensuring the compliance of the holders of data, and especially of prospecting rights and to submit drill-hole core once permits have lapsed or have been abandoned.
The DMRE and CGS undertook to continue discussions on how to ensure the optimal management of the anticipated volumes of geoscience data and information submissions. Overall, the workshop was extremely beneficial to the CGS and the DMRE alike.

Figure 2. Mr Clement Ndou (CGS scientist) demonstrates the recently acquired core splitter housed at the CGS National Borehole Core Depository.

Figure 3. Mr Clement Ndou demonstrates the CGS hyperspectral scanner, located at the CGS National Borehole Core Depository.

Figure 4. Group photo of the CGS and DMRE staff who participated in the two-day workshop.

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Exploring the Molteno and Elliot Formations: a first-time mapping geologist's journey

The main Karoo Basin is a geological marvel, known for its complex and diverse landscapes that hold a wealth of ancient secrets. As a first-time mapping geologist, I had the incredible opportunity to undertake an expedition to the Karoo, where I delved into the depths of this remarkable terrain.

Mapping the Karoo involved meticulous observation, documentation and interpretation of the exposed rock formations belonging predominantly to the Molteno and Elliot Formations. Equipped with essential tools like a compass, field notebook, geological hammer, and Clino, a smartphone app used for field mapping, I ventured into the field. Traversing through rugged terrains and enduring the scorching sun, I immersed myself in the vastness of the Karoo Basin.

Figure 1. Fossilised plant (tree bark) in the Molteno Formation.

The Molteno Formation comprises alternating creamish-, yellowish-grey to light-grey, “glittering”, fine to coarse-grained sandstones and pale to grey to olive mudstones generally forming upward-fining cycles. The mudstones frequently transition into dark-grey shale that occasionally contains fossil plant remnants (Figure 1).

The thickness of the Molteno Formation ranges from 450 m southeast of Elliot to 400 m in the Cala–Indwe area, and from 335 m to 290 m west and northwest of Sterkstroom. When compared to thicknesses reported by Turner (1975) and Johnson (1976), these thicknesses are significantly lower. This discrepancy is primarily ascribed to the differing opinions on where to place the Molteno–Elliot contact.

The Molteno exhibits typical upward-fining cycles with thicknesses of 20–30 m. The base of each cycle depicts a surface that has been scoured. The cycle typically starts with a thin, rather coarse-grained layer interspersed with quartzite pebbles and boulders and numerous mudstone clasts that have been eroded from the material below. This layer is overlain by coarse-grained sandstone which progressively becomes finer upwards and which is, in turn, overlain by mudstone. The contact between the mudstone and the sandstone is gradational. Additionally, shale is found in the upper portions of some cycles and coal is infrequently formed towards the top. The sandstones display a tabular shape. According to Bordy et al. (2005), the geometries of the sandstone are tabular because they indicate a braided fluvial depositional system, under seasonally warm to humid climatic conditions. Molteno sandstones display planar and trough cross-bedding. Iron nodules are present in some places. The dip of the strata is fairly horizontal and ranges from 1–5°W to WNW.

Figure 2. Upward-fining cycles with prominent sandstone units in the Elliot Formation.

The Elliot Formation is a "red-bed succession" comprising alternating fine- to medium-grained sandstones and predominantly greyish to maroon mudstones and siltstones occurring as upward-fining cycles (Figure 2). According to Johnson (1984), the thickness of the formation varies from roughly 500 m in the Indwe–Elliot area to an average of 380 m in the Sterkstroom–Molteno–Jamestown–Rossouw area, decreasing to about 300 m in the Burgersdorp area.

The upward-fining cycles of the Elliot Formation are estimated to range

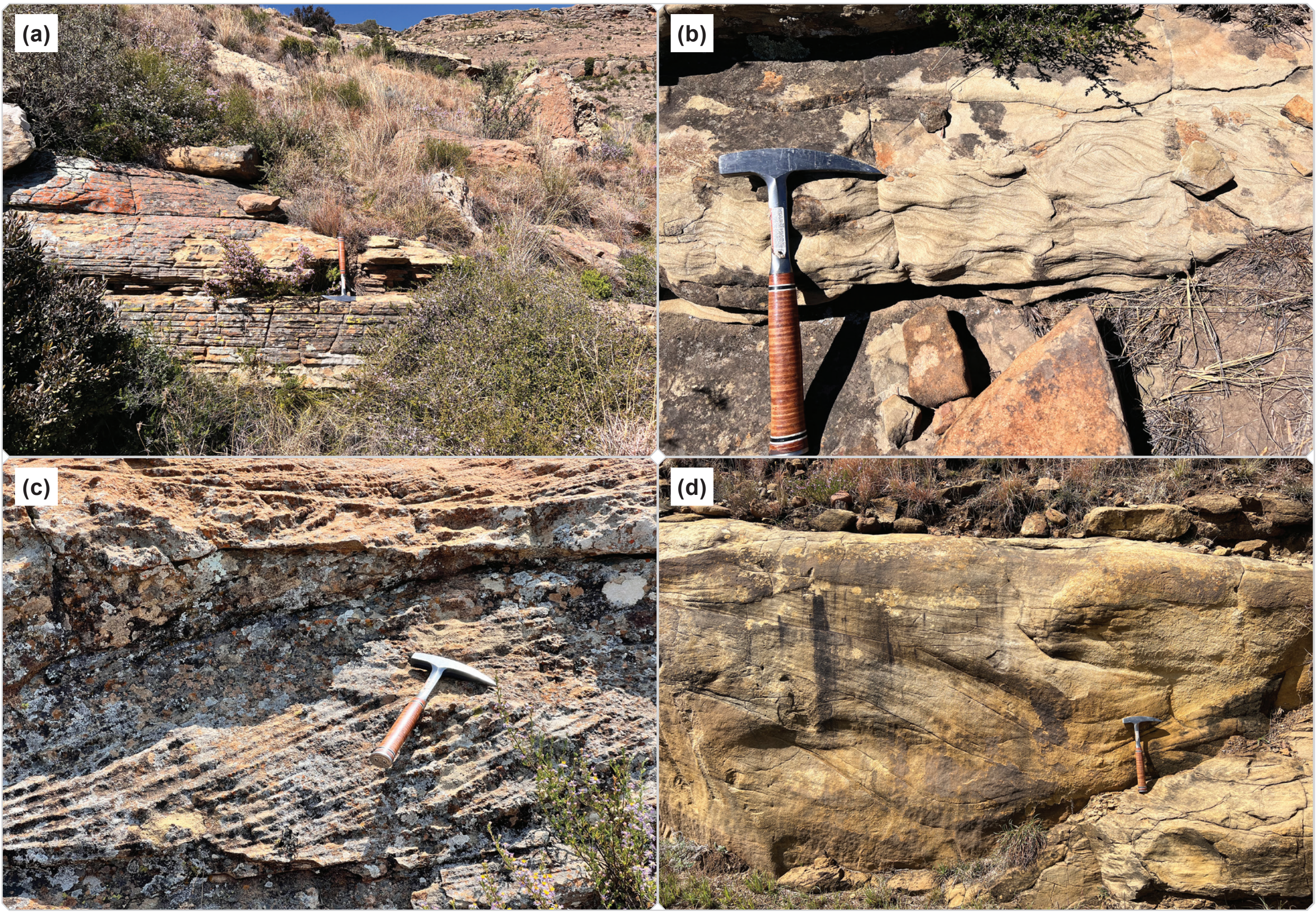

Figure 3. Elliot Formation. (a) Planar bedding. (b)—(d) Trough cross-bedding.

in thickness from 10–30 m, with a maximum thickness of roughly 50 m. Sandstones are typically between 3 and 15 m thick. The majority of the sandstones are fine to medium grained, with some coarse-grained material. They are predominantly yellowish in colour and occasionally ferruginous. Planar and trough cross-bedding is ubiquitous in the sandstones (Figure 3). According to Bordy et al. (2005), the sandstones of the Elliot Formation are characterised by lateral accretion surfaces. In the present fieldtrip, these were not observed. Sandstones had a more tabular and sheet-like appearance. The mudstones of the Elliot Formation are grey to maroonish in colour and heavily jointed. The dip of the strata is horizontal and ranges from 1–5° with a variable dip direction, probably due to the influence of the dolerite sills and dykes.

The nature of the Molteno–Elliot contact is poorly understood. The contact has previously been defined using a combination of lithological and palaeontological parameters. According to Johnson (1984), the emergence of the “red facies” of the Elliot Formation marks the contact, suggesting that the main distinction between the two formations is a change in the colour of the mudstones. However, Eriksson (1984) contends that there is no evident or abrupt change from one formation to the other and thus presents the contact as being gradational.

Bordy et al. (2005) present a compelling argument that the contact between the Molteno and Elliot Formation can be defined by lithological change, gross and internal geometries of the sandstone units and contained lithofacies associations, the presence/absence of coal seams, sandstone composition and grain-size variations. The two lithological units, the Molteno and Elliot Formations, are known to have developed in various fluvio-depositional and climatic environments. The Molteno Formation is considered to have formed in a large, perennial braided system connected to small-scale braid plain areas under conditions that were seasonally warm to humid. The presence of plant remains in the Molteno also indicates wetter, reducing conditions. In contrast, the lower portion of the Elliot Formation formed in a perennial, moderately meandering river system that was associated with large overbank areas and that evolved in a semi-arid climate that became progressively drier over time, as evidenced by the appearance of red beds, suggesting oxidation associated with subaerial exposure.

Spending time in the Karoo was a transformative experience that left a lasting impression on my geological understanding and appreciation for the intricate sedimentary processes that have shaped the breathtaking landscape of this region. The picturesque, rolling mountains of the Karoo bear witness to a rich geological history, from braided to meandering rivers, to vast floodplains and arid deserts.

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Bird’s eye view of the Northern Cape pegmatites

The CGS and the South African Air Force (SAAF) accompanied exploration team members from the Helmholtz Institute Freiberg for Resource Technology (HIF), a division of the Helmholtz-Zentrum Dresden Rossendorf, Germany, to the Northern Cape, from 10 to 20 February 2023. HIF aims to create innovative technologies in the minerals and metalliferous raw materials industry to ensure more economical and effective use of these materials. HIF team members comprised Dr René Booysen (also affiliated with the University of Witwatersrand), Ms Yuleika Mardiz, Mr Junaidh Fareedh and Dr Richard Gloaguen. CGS team members included Mr Dirk Grobbelaar, Ms Gabrielle Janse van Rensburg, Ms Noluvuyo Dudumashe and Mr Shane Doggart (Figure 1). Lt Col. Terence Turnbull, from the SAAF, was the pilot in command for the duration of the trip, allowing the

Figure 1. HIF and CGS team members on the final day of the survey. From left to right: Lt Col. T. Turnbull, Mr D. Grobbelaar, Dr R. Gloaguen, Dr R. Booysen, Ms N. Dudumashe, Mr J. Fareedh, Ms Y. Mardiz and Ms G. Janse van Rensburg.

HIF to conduct the drone survey under military supervision. The goal of the field trip was to test the Mjolnir hyperspectral camera fitted on a drone and tripod in operational conditions, to survey the area for possible future sites and research, and to investigate the viability of hyperspectral imaging for detecting different types of pegmatites in various settings (such as weathered outcrop and excavated digging sites).

The sites visited are located in the Orange River Pegmatite Belt (ORPB) of the Namaqua-Natal Metamorphic Province and were surveyed in two stages. The first stage included sites close to Vioolsdrif in the western section of the ORPB (Figure 2a). The sites of the second stage are located close to Kakamas in the eastern section of the ORPB (Figure 2b). In total, the team visited six study sites for the sensing of pegmatites. Pegmatites are igneous rocks containing coarse to large crystals that can reach submetre scale (Figure 7). The pegmatites in the Northern Cape are known to contain economically viable critical metals such as lithium and rare-earth elements that are important for the generation of products associated with the Fourth Industrial Revolution. The two types of pegmatites encountered here are lithium-caesium-tantalum and niobium-yttrium-fluorine.

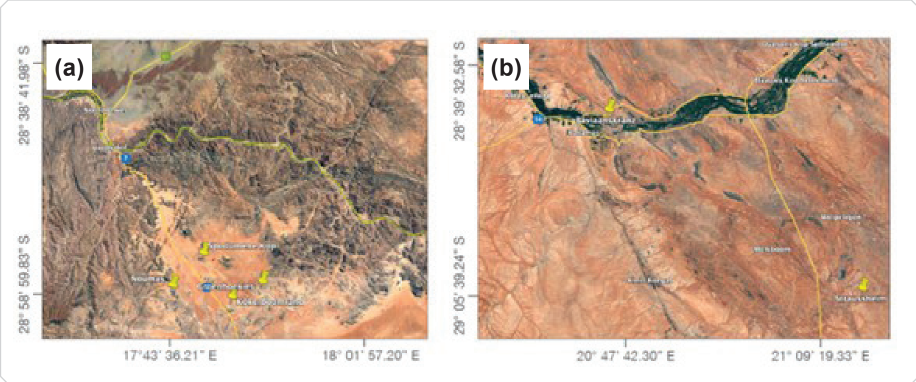

Figure 2. Locations of sites visited during the Northern Cape field trip. (a) Sites near Vioolsdrif in the western section of the ORPB. (b) Sites near Kakamas in the eastern section of the ORPB.

The efficacy of the remote sensing equipment depended on the accessibility and formation of the pegmatite body — i.e. whether the pegmatite body was outcropping at the surface, trenched or mined, or unmined. The hyperspectral camera was either mounted on a ground-based tripod or the unmanned aerial vehicle (UAV), depending on the ground conditions (Figures 3 and 4). The hyperspectral data drone-based photogrammetry was acquired using an accurate GPS base and rover ground control points (Figures 5 and 6). The 3D point-cloud result from the photogrammetry was then used like a mesh onto which the hyperspectral data would be projected and displayed. Rock samples were collected for validation purposes.

Overall, the survey was successful and enlightening. Tasks were shared between the HIF and CGS team together with a lively exchange of knowledge. As with every field campaign, the team faced numerous challenges that were overcome with perseverance and quick problem solving. Among many lessons learned, we realised that both man and machine are susceptible to the hot summer temperatures of the Northern Cape (Figure 5). The hyperspectral sensor and lithium batteries reached their limit and did not operate efficiently in temperatures exceeding 40 °C. Nevertheless, the survey yielded promising results and further collaboration with the HIF is planned for future studies.

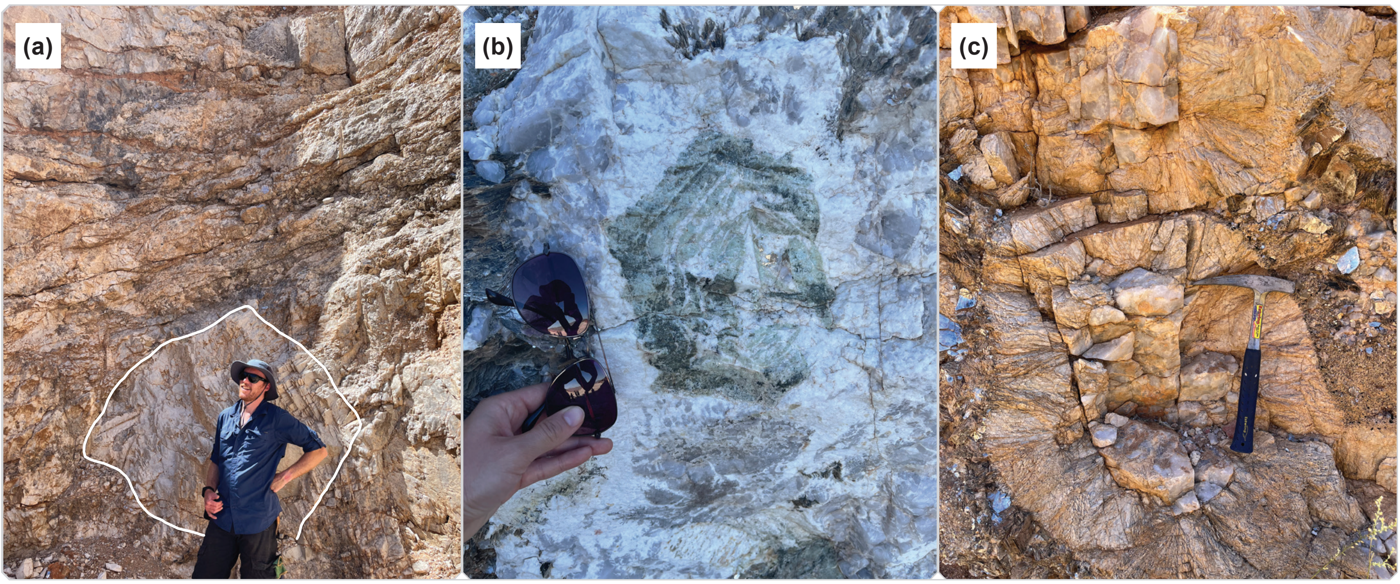

Figure 3. Examples of pegmatite crystals. (a) A large feldspar (relative shape outlined) with Mr S. Doggart for scale. (b) Cross-section of a beryl crystal surrounded by a quartz and feldspar mantle. (c) Typical zoning feature of pegmatites with a quartz core, feldspar and quartz mantle, and muscovite-rich feldspar and quartz rim (zone within a complexly zoned pegmatite).

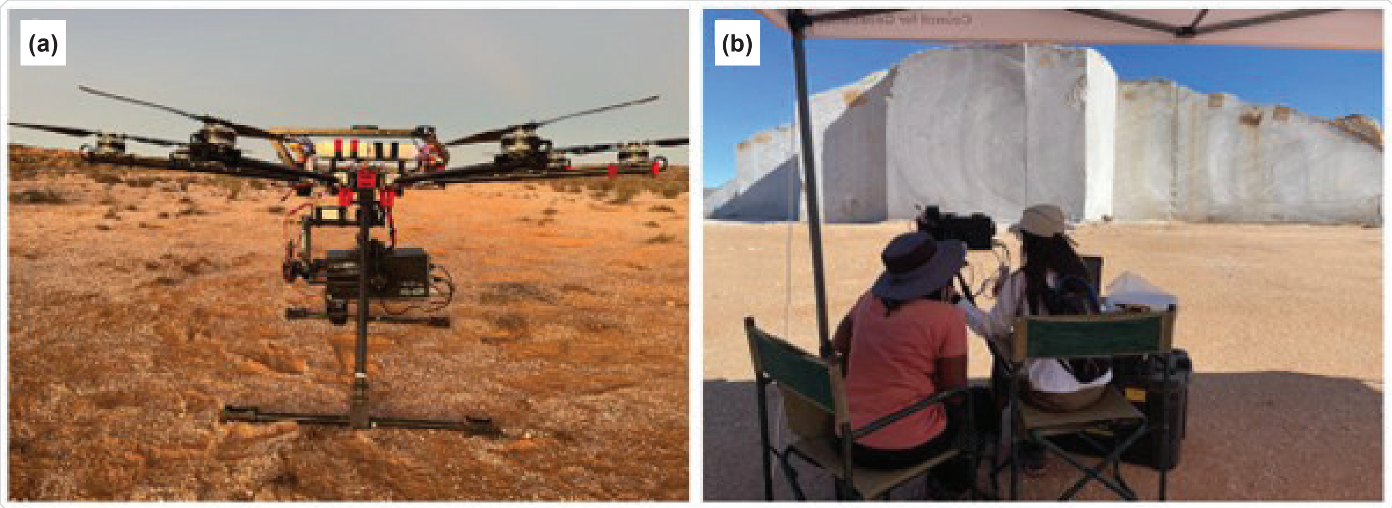

Figure 4. (a) Custom-built octocopter UAV with HySPEX Mjolnir camera attached by means of a gimbal. (b) HySPEX Mjolnir camera mounted on the tripod.

Figure 5. Custom-built octocopter UAV and HySPEX Mjolnir camera with the pilot for scale.

Figure 6. Equipment setup for the UAV and tripod hyperspectral survey with the GPS system for accurate ground control point measurements.

Figure 7. Base and rover GPS ground control measuring tools.

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The PanAfGeo-2 project: mid-term meeting, Republic of the Congo

PanAfGeo-2 (2021–2024) is a continuation of the well-recognised PanAfGeo-1, which took place between 2016 and 2019. PanAfGeo-1 provided 42 training sessions for 1 068 geoscientists from 49 African countries and generated notable impacts on a continent-wide institutional and technical capacity level. PanAfGeo-2 aims to continue strengthening African geological surveys by developing innovative geoscientific training programmes in partnership with the Organisation of African Geological Surveys (OAGS).

The PanAfGeo-2 mid-term meeting was held in the Republic of the Congo, Brazzaville, from 15 to 16 May, 2023. The CGS and the OAGS were represented by Mr Willem Meintjes, Dr Souleymane Diop, Ms Ndivhuwo Cecilia Mukosi and Ms Furaha Anzuluni. The purpose of the meeting was to assess the progress of the project, which is expected to be completed in June 2024. Government officials, African geological survey representatives, European Union representatives, European geological survey representatives, the United Nations Educational Scientific and

Cultural Organisation, the African Association of Women in Geosciences, the African Association of Women in Mining in Africa, the African Minerals and Geosciences Centre, and the Geological Society of Africa attended the meeting. In addition, His Excellence, Pierre Oba, Minister of State, Minister of Mining Industries and Geology of the Republic of the Congo, attended the meeting.

The Work Package (WP) leaders and co-leaders of the PanAfGeo-2 project presented the progress of their respective work packages, highlighting the successes and challenges of each. On day two, participants had the opportunity to attend the first workshop of Work Package F, which focussed on governance, demonstrating the importance of governance structures in geological surveys.

In conclusion, since the inception of phase two of the project in June 2021, approximately 384 participants from different African geological surveys have been trained in different PanAfGeo-2 work packages (Figure 5). These sessions were hosted in ten African countries, with workshops conducted in English (48%), French (33%) and Portuguese (19%) to accommodate different African countries/regions. The project aims to host a total of 30 workshops and to train 750 scientists from approximately 20 African countries (Figure 4).

For more information regarding upcoming geoscientific training, please visit the PanAfGeo website https://panafgeo.eurogeosurveys.org/. Progress on the PanafGeo-2 project is also published on social media platforms – LinkedIn -PanAfGeo Project Phase -2; Twitter: @PanAfGeo; Facebook – PanAfGeo.

Figure 1. Participants of the PanAfGeo mid-term meeting overseen by His Excellence, Pierre Oba, Minister of State, Minister of Mining Industries and Geology of the Republic of the Congo.

Figure 2. (a) Mr Willem Meintjes of the CGS presenting during the WP-F Governance workshop. (b) Dr Souleymane Diop of the CGS addressing the assembly during a plenary session. (c) Ms Ndivhuwo Cecelia Mukosi of the CGS presenting the current progress of WP-H: Communication, Dissemination & Dialogue.

Figure 3. PanAfGeo mid-term meeting participants: from left to right: Ms. Gloria Namwi Simubali (Geological Survey of Namibia, Vice-President for the Southern Region); Dr Rokhaya Samba (Director-General, Geological Survey of Senegal, OAGS President), Prof. Ezzoura Errami (President, AAWG), Prof. Aberra Mogessie (PanAfGeo Advisory Board Member), Mr Ibrahim Shaddad (African Minerals and Geosciences Centre), Ms. Balbine Pascaline Makani Omgba (Vice-President, African Association of Women in Mining), Mr Tunde Arisekola (African Minerals and Geosciences Centre), Prof. Gbenga Okunlola (President, Geological Society of Africa), Ms N.C. Mukosi (CGS and OAGS Representative), and Mr Franck Dixon Mugyenyi (PanAfGeo Advisory Board Member).

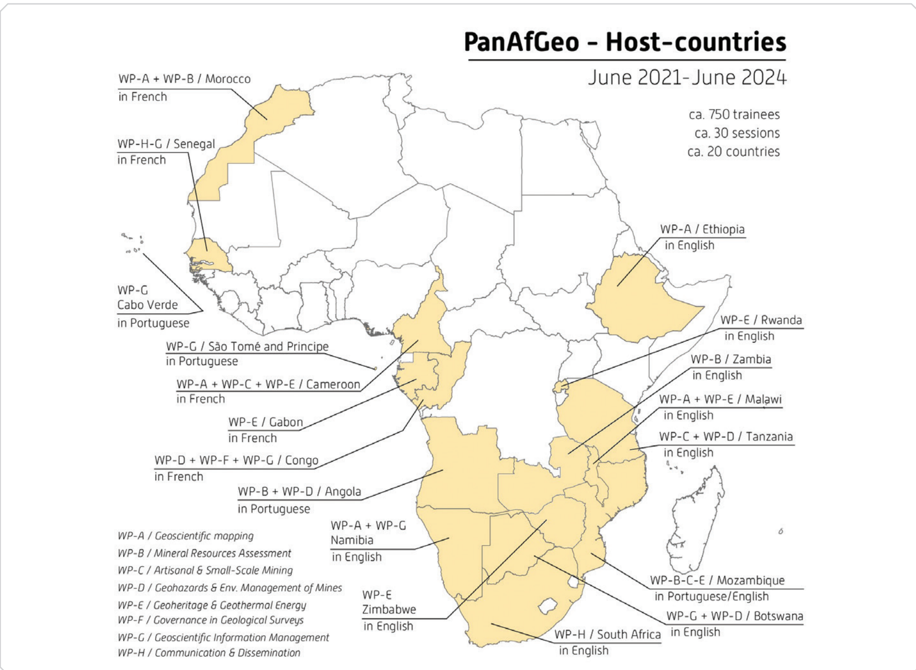

Figure 4. Map of Africa to show the proposed host countries for the different work package workshops.

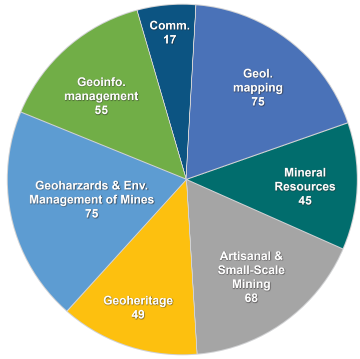

Figure 5. Number of participants in the different work packages.

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