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INSIDE:

CGS takes first place at the JOGMEC 2023 competition

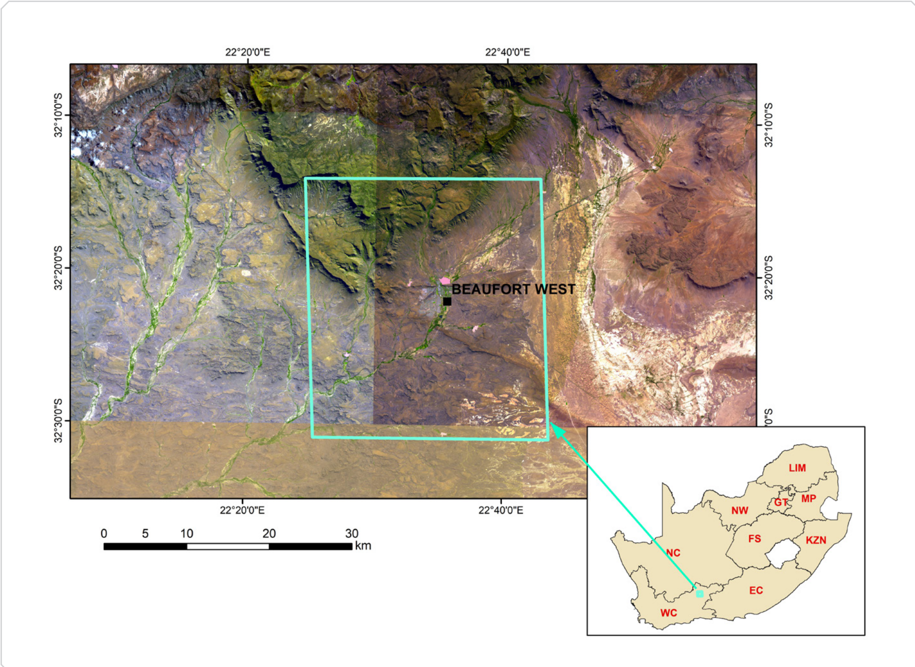

Figure 1.1. Locality of the study area surrounding the town of Beaufort West, Western Cape, South Africa.

The Japan Organisation for Metals and Energy Security (JOGMEC) held its annual JOGMEC and southern Africa remote sensing event from 23 January–10 February 2023. This event consisted of a remote sensing competition (23–27 January 2023), an online workshop (30 January–8 February) and a seminar (10 February). The main aim of the JOGMEC geological remote sensing project is to build win-win relationships between Japan and Southern African Development Community (SADC) countries in the mineral resources sector through capacity building and the promotion of mineral exploration in each geological survey. This approach enables skills transfer and contributes to economic growth and the sustainable development of the mining sector.

Twenty-seven (27) participants from thirteen (13) SADC countries competed in the event, which was designed to improve and upgrade the participants' technical skills. Dr Haajierah Mosavel and Mr Andisani Makhado from the CGS represented Team South Africa. Their project was titled "Remote sensing as a tool to assist with uranium exploration in

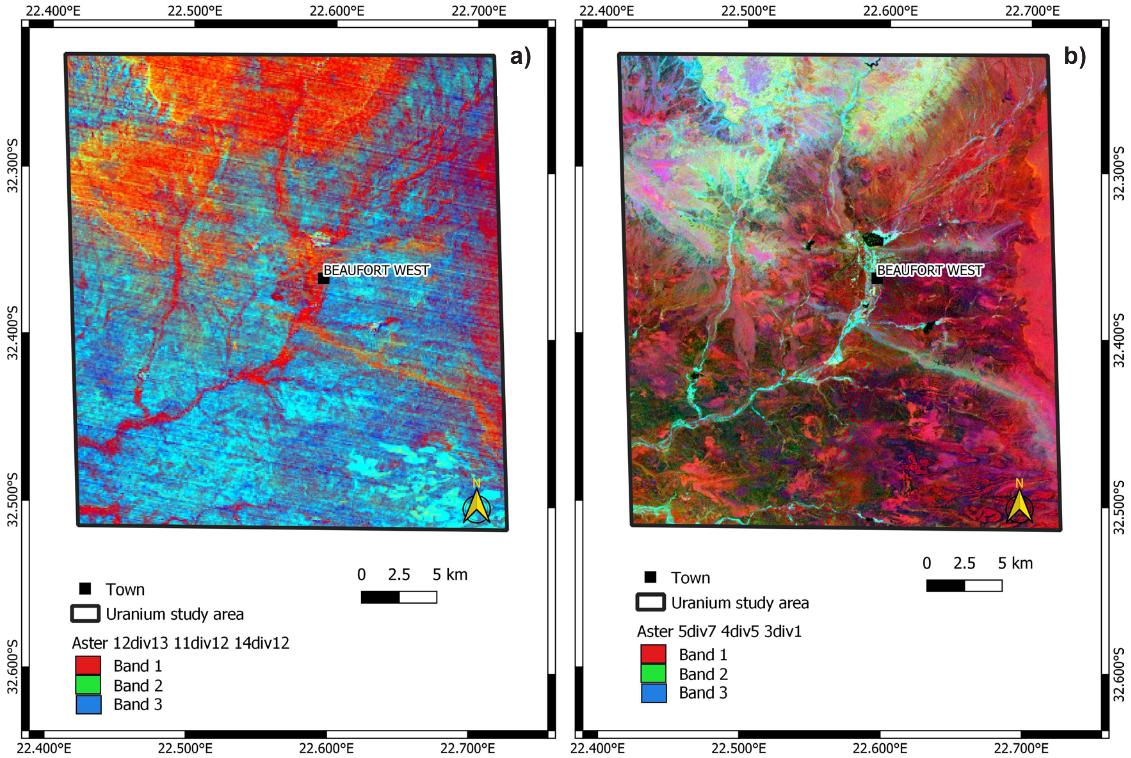

Figure 1.2. Remote sensing results of ASTER images. a) ASTER band ratios 12/13, 11/12, 14/12 and b) 5/7, 4/5 and 3/1 of the Beaufort West area.

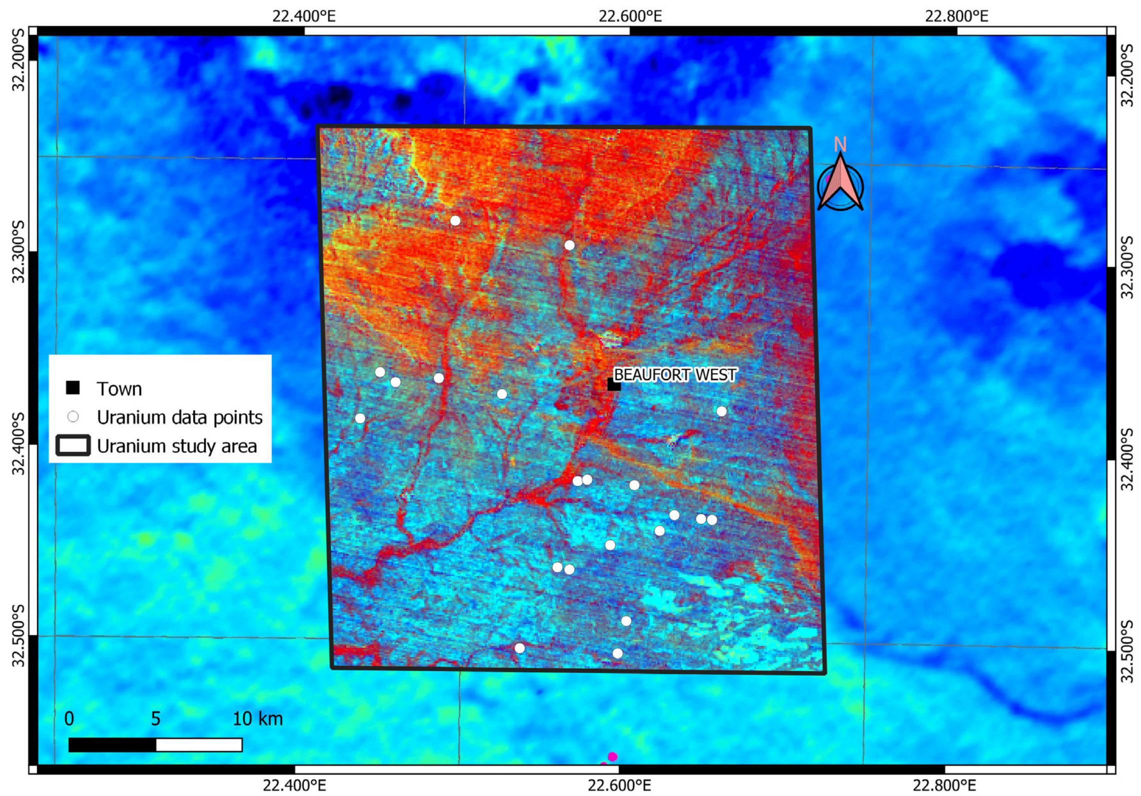

Figure 1.3. Airborne and ground radiometric data used to correlate with the ASTER silica band ratio for uranium anomalies in the Poortjie Member of the Middleton Formation.

Figure 1.4. Twenty-seven (27) participants from thirteen (13) SADC countries took part in the JOGMEC competition, pictured here with JOGMEC staff.

Figure 1.5. From left to right: Dr Haajierah Mosavel, the Japanese Ambassador to Botswana, His Excellency Mr Ohmori Setsuo, Ms Andisani Makhado and Ms Mutinta Syafunko from Team Zimbabwe.

the Beaufort West area, South Africa". The results of their study can be used in an integrated assessment and combined with other datasets to produce targeted areas for uranium mineral exploration. The discovery of mineral exploration areas can assist with reviving mining activities in underexplored mineral reserves in poverty node areas. The competing teams processed various satellite images using QGIS open-source software and presented their findings on the final day of the competition. Team South Africa took first place, followed by Namibia, Malawi and Zimbabwe, respectively.

Dr Mosavel and Mr Makhado travelled to Botswana to attend the seminar in person. At this seminar, Mr Makhado presented the "JOGMEC project west of Pofadder, Northern Cape, South Africa". This work forms part of a collaborative project between the CGS and JOGMEC, and aims to promote mineral exploration in South Africa using remote sensing data. Dr Haajierah Mosavel also showcased the team's competition presentation. Dr Chiedza Musekiwa attended the workshop and seminar and Ms Rebekah Singh attended the online seminar.

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Social events at the CGS Bellville regional office

In commemoration of Valentine's Day, women colleagues at the CGS Bellville regional office hosted a tea on 14 February 2023. Cake, tea and refreshments were served during the tea break (Figure 2.1) and staff dressed in red and pink.

On 17 February 2023, CGS staff participated in the Childhood Cancer Foundation of South Africa (CHOC) Flip Flop Day (Figures 2.2 and 2.3). The theme was "Have a heart and wear a sole" and the idea was to purchase a sticker and wear flip flops on the day. Each sticker cost R10 and the proceeds of the sales went to the Childhood Cancer Foundation of South Africa (CHOC) https://choc.org.za/.

Figure 2.1. CGS staff hosted a Valentine's Day tea at the Bellville regional office on 14 February 2023.

Figure 2.2. CGS staff at the Bellville regional office participated in the Childhood Cancer Foundation of South Africa (CHOC) Flip Flop Day. From left to right: Ms Wahiebah Daniels, Ms Yasmeen Fortune, Dr Talicia Pillay, Ms Zininzi Phikiso, Ms Avril Johnson, Ms Nicky Flint, Ms Nokuthula Booi, Ms Chiedza Musekiwa, Ms Zine Masoka, Mr Willem Kupido, Ms Takalani Sikhipha, Mr Edowe Domingo, Ms Cynthia Yanta, Ms Phakama Magele, Ms Eloise Ely and Ms Lebogang Nhleko.

Figure 2.3. CGS Bellville staff putting their best foot forward for the CHOC Flip Flop Day.

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Visit to Tohoku University in Japan: synopsis of a SATREPS project by a South African research team

Carbon dioxide (CO_2) is a major contributor to greenhouse gas emissions that result in rising temperatures and climate change. Global CO_2 emissions must be controlled to promote environmental sustainability and limit the global temperature increase to 2 °C by 2030 and 1.5 °C by 2050. As a member of the global community, South Africa is committed to contributing to the reduction and/or control of CO_2 emissions. In 2021, the South African government published a roadmap to achieve its fair-share contribution to CO_2 emissions. In its Nationally Determined Contribution (NDC), the South African government has set its 2030 CO_2 emission target at a maximum of 350 million tonnes carbon dioxide equivalent (Mt CO_2 eq).

Figure 3.1. South African and Japanese senior researchers working on the MCCU3 experiment at Tohoku University.

Various research initiatives are investigating suitable carbon utilisation, storage and mitigation strategies to bring emissions to acceptable levels and to reduce the rate of rising global temperatures. The CGS is involved in a collaborative project titled “Development of a carbon recycling system towards a decarbonised society by using mineral carbonation” with institutions of higher education. These include the University of the Western Cape (UWC), the Cape Peninsula University of Technology (CPUT), the University of Cape Town (UCT), and Tohoku University in Japan. The project investigates the feasibility of beneficiating waste material, such as waste concrete, using CO_2 to produce a reusable by-product. The aim is to demonstrate a technology that can assist in reducing CO_2 emissions to produce a raw material (calcium/magnesium carbonate) for use in downstream applications such as in the construction industry.

The project forms part of the Science and Technology Research Partnership for Sustainable Development (SATREPS) programme between researchers from Japan and developing countries. The SATREPS project, which aims to tackle global issues, is supported by the Japan Science and Technology Agency and the Japan International Cooperation Agency. On the South African side, the project is coordinated by the Department of Science and Innovation, with CPUT as the lead institution. The research is aligned with the scope of the CGS's Water and Environment and Geoscience Mapping Programmes. The project is coordinated by Dr Viswanath Vadapalli with the assistance of Dr Henk Coetzee, Dr Thakane Ntholi, Mr Koena Ramasenya and Ms Sisanda Gcasamba.

In September 2022, senior researchers from the South African team (Dr Viswanath Vadapalli and Dr Henk Coetzee from the CGS and Prof. Tunde Ojumu from CPUT) undertook a research trip to Tohoku University where they met with stakeholders in Japan. The host team (Prof. Atsushi Iizuka, Dr Hsing-Jung Ho, and Dr Yoshito Izumi) arranged a series of stakeholder engagements that began with a visit to the offices of the Japanese partner agencies to discuss matters relating to the project. The team also visited Nippon Concrete Industries Co. Ltd, which generates an alkaline waste stream from the production of different concrete products. The waste is processed and carbonated using indirect mineral carbonation and utilisation (MCCU2) technology to produce reusable by-products such as phosphorous adsorbent derived from concrete sludge (PAdeCS) and calcium carbonate ($CaCO_3$). The technology is aligned with the project objective to determine its suitability for the South African concrete and cement industries.

Figure 3.2. South African junior research team in front of the MCC pilot plant. From left to right: Mr Sibulele Zide, Mr Koena Ramasenya, and Dr Babatunde Oladipo.

Figure 3.3. Junior researchers from South Africa working on the pilot plant.

The most recent stakeholder engagement involved a visit to the Japan Oil, Gas and Metals National Corporation for an overview of the acid mine drainage passive and active treatment plants. The insights gained,

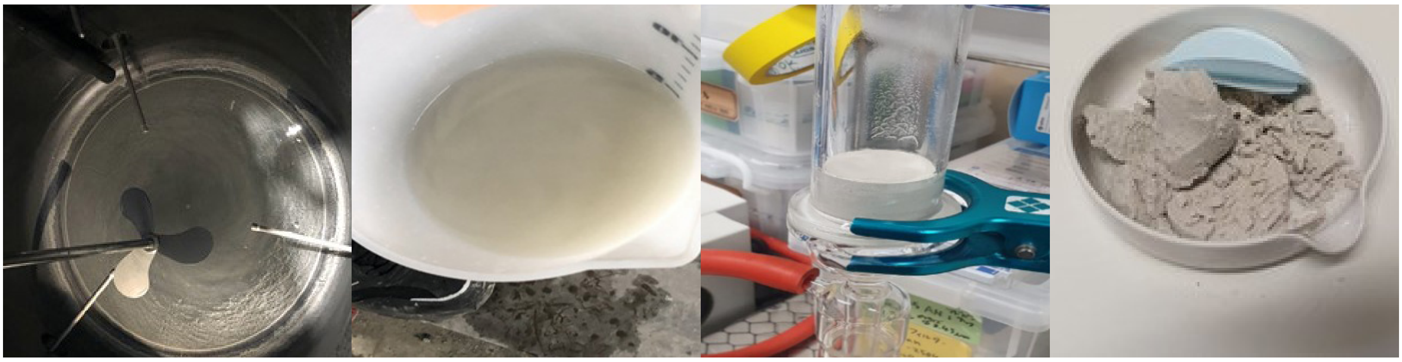

Figure 3.4. From left to right: precipitate in the reactor, slurry collected, filtration of slurry in the laboratory, and slurry residue collected.

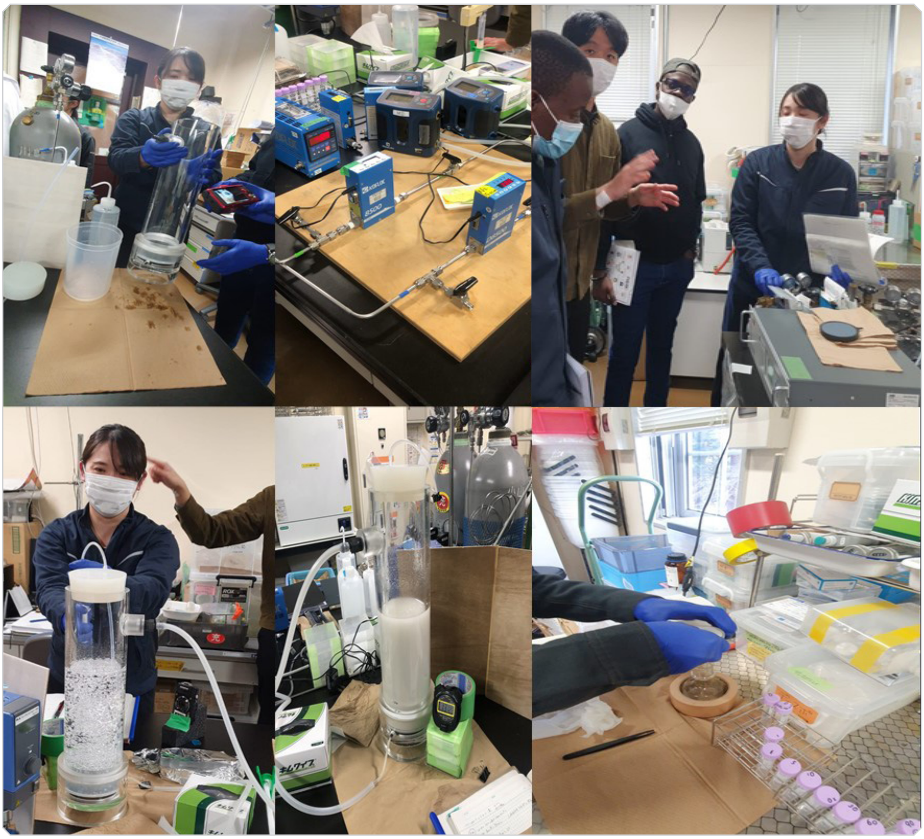

Figure 3.5. Students with laboratory staff conducting MCCU1 and MCCU2 experiments.

especially regarding microbial and plant design, will help to resolve some of the challenges encountered at the CGS passive treatment plant in Carolina, Mpumalanga Province. The South African team participated in direct mineral carbonation and utilisation (MCCU1) and circular indirect mineral carbonation and utilisation (MCCU3) laboratory-scale research at Tohoku University (Figure 3.1). Robust scientific discussions regarding the experiments and literature review paper authored by Dr Ho and Prof. Iizuka, and discussions regarding future student and research exchange visits ensued.

In February 2023, Mr Koena Ramasenya (an MSc candidate at UCT), Mr Sibulele Zide (an MSc candidate from CPUT), and Dr Babatunde Oladipo (a postdoctoral fellow from CPUT) visited Tohoku University (Figure 3.2). The trip was part of the planned project activities to enhance skills development and networking, and to expose young scientists to international projects. The main objective of the trip was to equip the researchers with the necessary expertise to operate the Mineral Carbon Capture (MCC) pilot plant, to conduct mineral carbonation research and to operate analytical equipment.

The first part of the training entailed hands-on operation of the pilot plant. The team conducted an MCC pilot plant test, using waste concrete sludge and cement as calcium-rich alkaline material over two days. The plant was operated at ambient temperature under specific conditions based on the solid:liquid ratio, stirring rate and sedimentation time. On the third day, the team conducted cleaning and maintenance of the pilot plant.

In-depth discussions were held during the operation of the pilot plant. The students and host team (Prof. Iizuka, Dr Ho, and Dr Izumi) made comments and recommendations based on the performance of the plant. White ($CaCO_3$) precipitate and $CaCO_3$ slurry were observed during carbonation (Figure 3.4).

Samples were taken during and after the experiment and thereafter submitted to the Tohoku University laboratory for analysis. An aliquot of 3 L of slurry was collected from a 1 000 L tank for filtration at the laboratory.

The second part of the training involved close observation of the laboratory staff as they conducted MCCU1 and MCCU2 experiments at laboratory scale (Figure 3.5).

Detailed scientific discussions were held during the experiments which included assembling the bipolar membrane electrodialysis (BMED) equipment (Figure 3.6). Bipolar membranes are a special type of layered ion exchange membrane. They consist of two polymer layers carrying fixed charges, one of which is permeable for anions and the other for cations. Combining the BMED technique with the MCCU2 technique

Figure 3.6. Discussions on the BMED setup and operation.

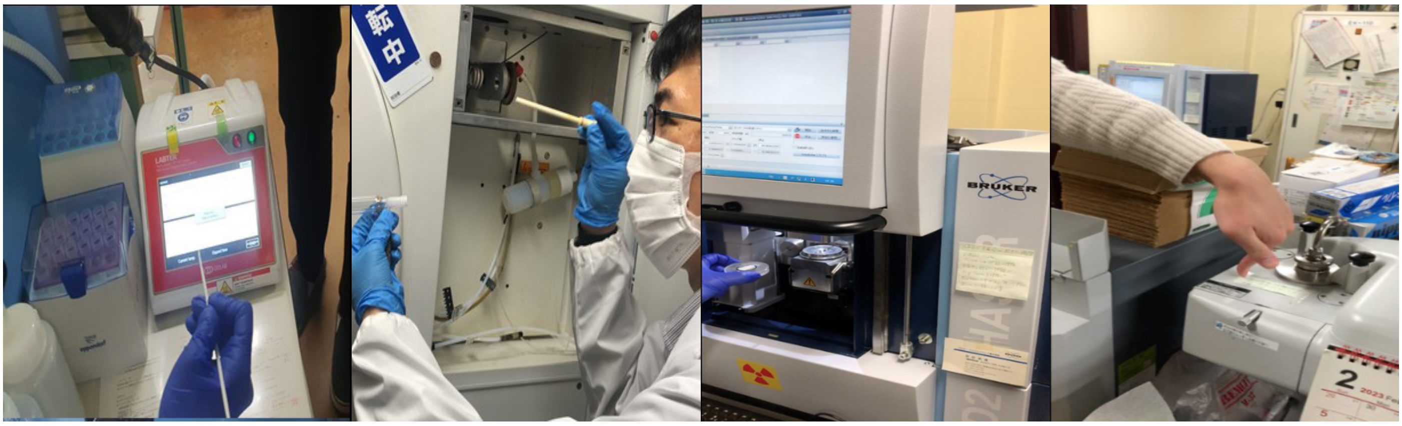

Figure 3.7. From left: ECOPRE digestion programme, cleaning of ICP torch, placing of sample onto XRD plate and explanation of PSD operation.

resulted in the generation of a new technique — MCCU3.

By shadowing the laboratory staff working on the analytical equipment (Figures 3.5 and 3.6), young researchers were exposed to equipment such as inductively coupled plasma atomic emission spectroscopy (ICP-AES), used for the precise determination of the elemental composition of the samples; X-ray diffraction (XRD), used for phase identification and material structure; particle size distribution (PSD), used to determine the size and range of a particle in a given material; and ECOPRE, used for digesting solid samples for trace and ultra-trace analysis of elements. ECOPRE is an interesting digestion technique that uses small amounts of acid and reduces sample contamination and potential health and safety hazards. The process is carried out in a semiclosed vessel that uses a trap solution to prevent atmospheric vapour emissions, thereby preventing damage to fume hoods.

The objectives of the trips were successfully met. The skills and knowledge acquired can be applied in various geoscientific fields such as engineering geology for infrastructure, water and environmental studies for mine-influenced water treatment, geoscience mapping for CO_2 sequestration, and expanding the scope and techniques of the CGS Analytical Services Unit.

Acknowledgment

The research team would like to thank the Japan International Cooperation Agency for organising and funding the trip to Japan. The team also appreciates the efforts and support of the Japanese project team and the meticulous planning of the project coordinator. The team thanks the CGS, CPUT, UWC, and UCT for the opportunity.

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Geological mapping in central KwaZulu-Natal revises previously undifferentiated Pongola Supergroup stratigraphy of the Buffalo River Gorge

As part of the CGS National Onshore Mapping Programme, the central KwaZulu-Natal geoscience mapping project aims to constrain the lithostratigraphy of the Pongola Supergroup in the Nkandla subbasin developed on the southeastern margin of the Kaapvaal Craton. Since 2018, the project team, comprising Dr Nigel Hicks, Mr Mawande Ncume, Ms Nangamso Dunga and Dr Greg Botha, has mapped thirteen 1:50 000-scale topocadastral sheets covering ~90% of the Pongola Supergroup exposures in the central KwaZulu-Natal region. The team also enlisted the help of Ms Rebekah Singh for remote sensing analysis, and external experts Dr D. Gold and Dr J. Dixon, for stratigraphic oversight.

Current mapping has focussed on the Mesoarchean Pongola Supergroup stratigraphy within the Buffalo River Gorge Inlier, which is exposed in the 2830BC (Rorke's Drift) and 2830DA (Collessie) mapped areas. Although initially mapped by Dr Alex du Toit in 1919, and then by Dr Dixon in the 1980s; to date, the Mesoarchean stratigraphy of the inlier is largely undifferentiated and lacks a clear lithostratigraphic framework. Multidisciplinary research using remote sensing and geophysical data was combined with field mapping to define composite stratigraphic reference profiles for the inlier. Sedimentological comparisons have aided regional lithostratigraphic correlations with currently accepted subdivisions in the Nkandla region and the main Pongola basin.

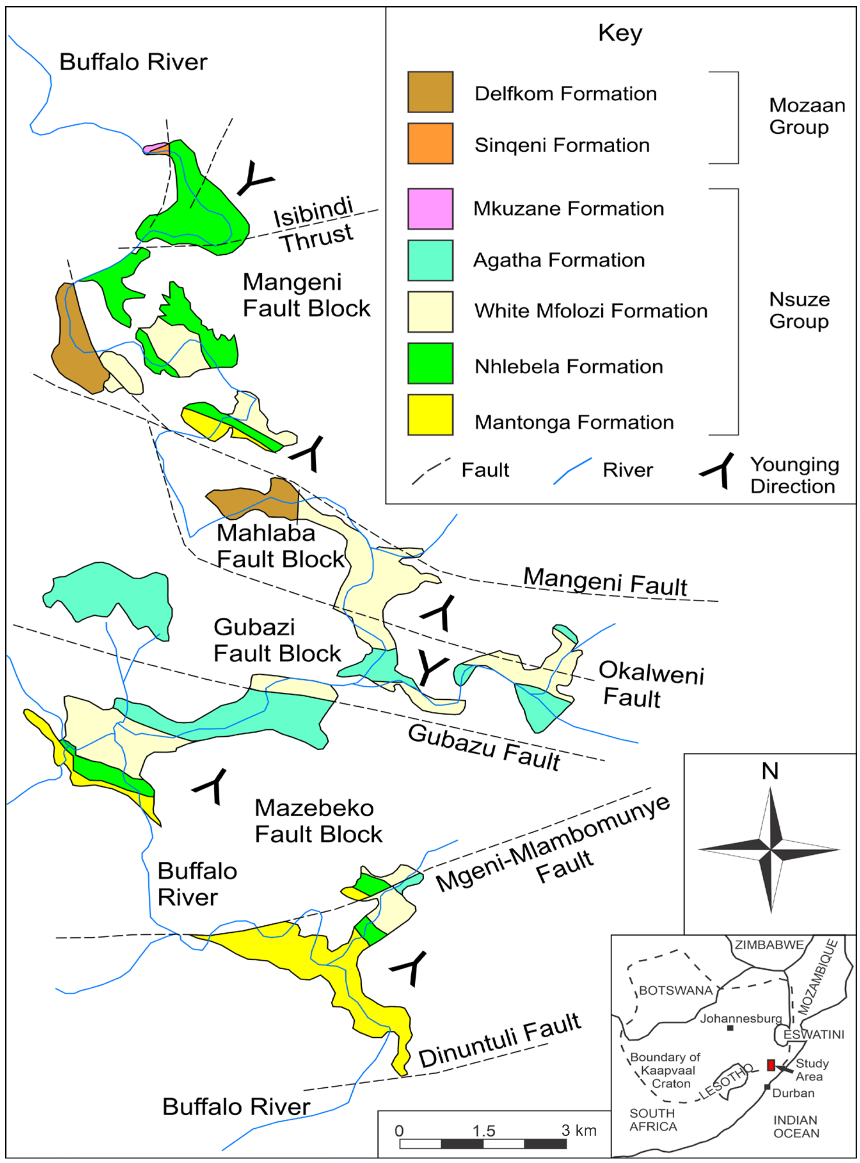

Figure 4.1. Generalised lithostratigraphic map of the Buffalo River Gorge Inlier showing new stratigraphic subdivisions.

The Mesoarchaean Pongola Supergroup in southeast Africa represents one of the earliest well-preserved supracratonic, volcanosedimentary sequences in the world. The lithological grouping crops out in a north–south-trending, 260 km x 60 km intracratonic basin on the Kaapvaal Craton and is subdivided into the lower Nsuze and upper Mozaan Groups. Exposures occur from Amsterdam in Mpumalanga Province through southern Eswatini, with the locus of deposition in the Hartland region west of Paulpietersburg. To the south, in KwaZulu-Natal, exposures are restricted to numerous isolated inliers, the most extensive of which occur in the White Mfolozi, Mhlatuze, Nsuze and Buffalo Rivers.

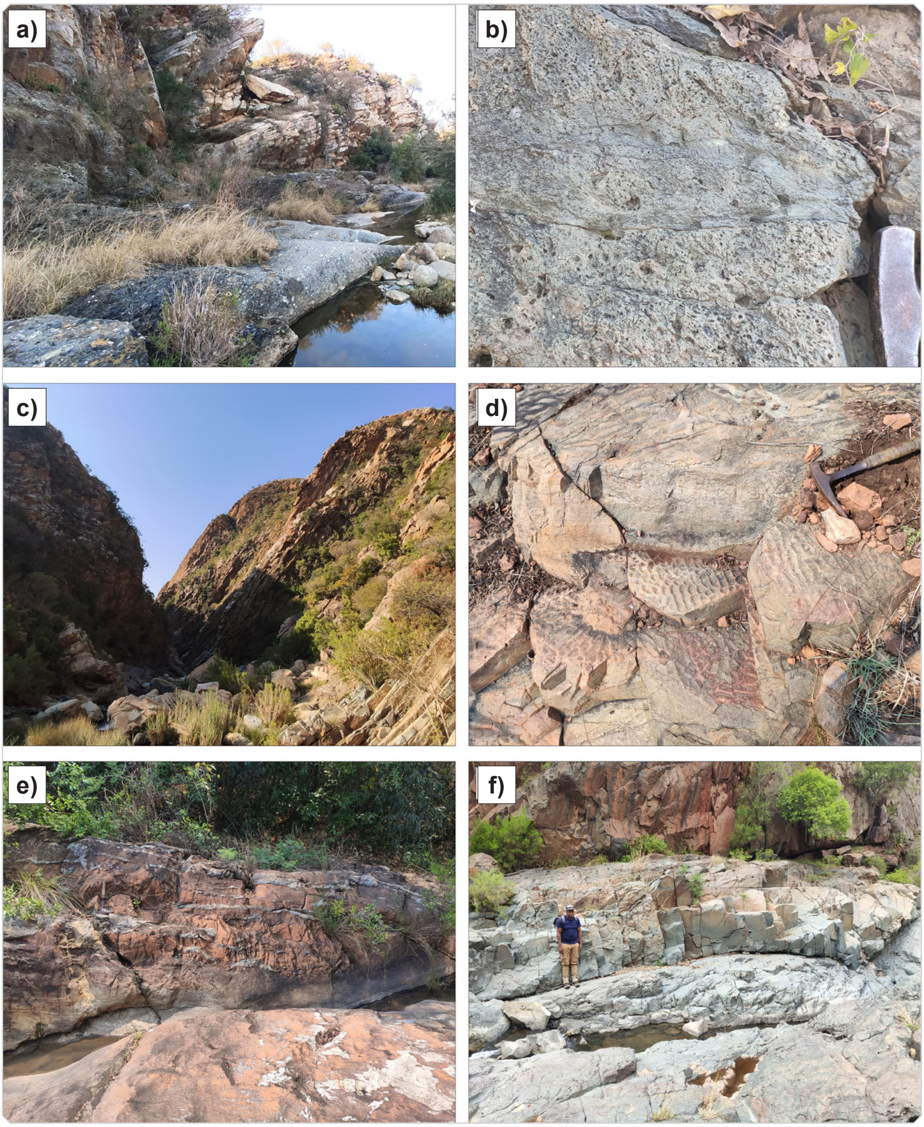

Figure 4.2a) Blue-grey diamictite underlying quartz arenites of the Mantonga Formation in the Mazebeko Fault Block. b) Highly amygdaloidal volcanics of the Nhlebela Formation. c) Northerly dipping quartz arenites of the White Mfolozi Formation in the Mazebeko Fault Block. d) Multidirectional symmetrical ripple marks in the White Mfolozi Formation. e) Stromatolitic dolomite exposed in the Mangeni Fault Block. f) Stacked lava flows of the Agatha Formation.

The Buffalo River Inlier represents the southwesternmost exposure of the Pongola Supergroup, cropping out within four highly fragmentary, compartmentalised fault blocks defined as the Mazebeko, Gubazi, Mahlaba and Mangeni blocks (Figure 4.1). The boundaries of each block are defined by thrusts and/or strike slip faults, with folding and faulting further disrupting the internal stratigraphy. Although previous researchers proposed that no direct correlations could be made with the stratigraphy in the main Pongola basin, new sedimentological interpretations suggest lithostratigraphic correlations with both Nsuze and Mozaan Group stratigraphies (Figure 4.1). Current research has indicated that the Nsuze Group includes the complete lithostratigraphic sequence from the basal Mantonga Formation to the upper Ozwana Subgroup. Although lithological variations occur in the volcanic units, with increased volcaniclastic deposition compared to the main basin, genetic correlations apply to the sedimentary units. The stratigraphy of the Mozaan Group, however, is far more fragmentary, unlike the Nkandla Inlier to the east, which hosts 90% of the Mozaan Group lithostratigraphic profile. The Buffalo River area appears to host lower and upper Mozaan Group stratigraphy in isolated thrust stacks in the Mahlaba and Mangeni Fault Blocks.

The Nsuze Group dominates the stratigraphy of the inlier, with the basal Mantonga Formation forming a thick sedimentary package of quartz arenite, subordinate arkose and laterally discontinuous diamictite, nonconformably overlying the ~3.2 Ga granitoid basement. In many regions, a laterally discontinuous diamictite is developed along the basal contact (Figure 4.2a), sharply overlain by a basal matrix-supported medium- to large-pebble conglomerate. The remainder of the succession comprises well-bedded quartz arenites and arkoses (Figure 4.2a) which host planar and trough cross-beds and rare dune bedforms.

The lowermost volcanic package the Nhlebela Formation is well exposed in the Mazebeko and Mangeni Fault Blocks, where it comprises a succession of dark-green to grey amygdaloidal lavas interlayered with pillow lavas and volcanic breccia (Figure 4.2b). Northwards through the inlier, the unit appears to become more volcaniclastic in nature, with a thick sequence exposed in the Mangeni Fault Block. Although distinct, similar air-fall tuffs, welded ash flows, agglomerates and volcanogenic sedimentary rocks are known from the sequence in the main basin, a correlation can still be supported.

The White Mfolozi Formation is the most widespread unit in the Buffalo River Inlier and a key lithostratigraphic marker of the Nsuze Group within the Nkandla subbasin. Although it has been suggested that the use of Precambrian stromatolite occurrences is generally of little value for detailed stratigraphic correlation, the restricted nature of the carbonates within the White Mfolozi Formation means that the unit can serve as a formation-scale regional stratigraphic marker. The sequence comprises a thick succession of fine- to medium-grained quartz arenite (Figure 4.2c) with interbedded calcareous sandstone, wacke, diamictite and subordinate stromatolitic dolomite. Sedimentary structures comprise symmetrical and asymmetrical ripple laminations (Figure 4.2d) as well as planar and trough cross-bedding indicative of a

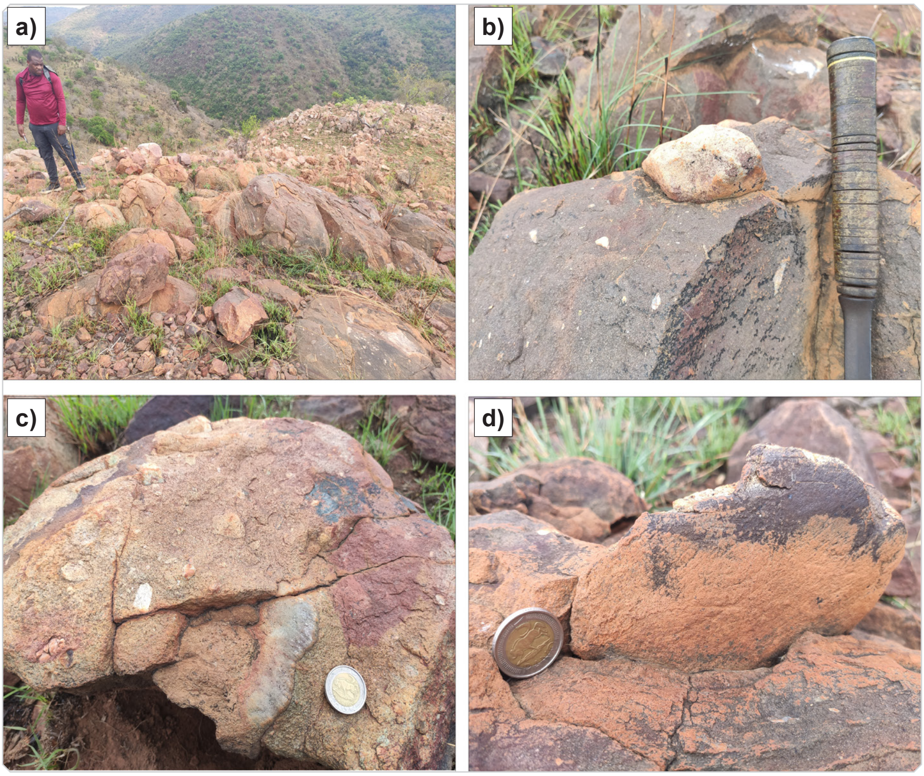

Figure 4.3. a) Diamictite of the Klipwal Member overlying quartz arenite and maroon shale of the Delfkom Formation. b) Close-up of diamictite showing large variations in clast size. c) Striated clast next to a five rand (R5) coin in the diamictite. d) Striated surface on a clast in the diamictite.

tidal flat environment. Carbonate units comprise highly silicified, well-laminated silicified dolomite (Figure 4.2e), sandy carbonate and calcareous sandstone which exhibit accretionary stratiform sedimentary structures consistent with stratiform biostromes.

The Agatha Formation is the uppermost volcanic package within the Nsuze Group, comprising a sequence of stacked amygdaloidal lava flows (Figure 4.2f) of predominantly basaltic and basaltic-andesite composition which exhibit AA and ropey lava textures. Although the Agatha Formation was initially not well exposed within the Mazebeko Fault Block to the south of the inlier, new infrastructure development in the region has opened an excellent road cutting through the unit with a sequence of basal tuffs and volcanic breccias overlain by amygdaloidal volcanics. The uppermost Nsuze Group stratigraphy is only exposed in the northern region of the Mangeni Fault Block. Here, the unit is dominated by banded tuffaceous siltstone which is very similar to the unit in the Ndikwe thrust segment of the Nkandla Inlier.

Dr J. Dixon was the first to allude to the possible presence of Mozaan Group lithologies in the Buffalo River Inlier. Mozaan Group stratigraphy with direct correlations to the main basin occurs within the Mahlaba and Mangeni Fault Blocks. The lowermost Sinqeni Formation crops out in only one exposure in the northern sector of the Mangeni Fault Block, where it comprises a laterally discontinuous, polymictic basal conglomerate overlain by coarse-grained quartz arenite. No lateral correlations exist as the unit is faulted out. Within the Malanga syncline, in the northern extremity of the Mahlaba Fault Block, a distinctive sedimentary sequence of interbedded quartzite, maroon shale and diamictite is exposed (Figure 4.3a–c). Striated clasts identified in the diamictite (Figure 4.3d) suggest that the unit is likely the equivalent of the glaciogenic diamictite of the Klipwal Member of the Delfkom Formation in the upper Mozaan Group, although further research is needed to conclusively determine this correlation. However, the identification of possible upper Mozaan Group stratigraphy in the Buffalo River Inlier is in accordance with the 2 924 ± 7 Ma detrital age obtained for quartz arenites in the Ndikwe thrust segment adjacent to the inlier.

While further research is needed to fully comprehend and accurately revise the lithostratigraphy of the Buffalo River Inlier, these results have allowed for preliminary lithostratigraphic subdivisions and correlations with the Pongola Supergroup in the main basin.

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Remote sensing research and development in support of onshore mapping

The CGS onshore mapping programme includes mapping South Africa at a scale of 1:50 000 using state-of-the-art remote sensing and GIS techniques. Satellite multispectral (MS) and superspectral (SS) remote sensing datasets are frequently used because they are readily accessible from the internet and most are free. Multispectral data have a few spectral bands (generally 3 to 10), with each channel being sensitive to radiation within a narrow wavelength band, e.g. SPOT and Landsat. Superspectral data have more spectral channels than a multispectral sensor (typically >10) and the bands have narrower bandwidths, enabling finer spectral characteristics of the targets to be captured, e.g. Sentinel-2 data. However, MS and SS data are constrained by their low spectral and spatial resolution, which do not provide the level of detail required to map at small scales. Hyperspectral sensors that acquire images in 100 or more contiguous spectral bands are ideal. Airborne hyperspectral datasets therefore provide the best spectral and spatial resolution, but the cost of acquisition limits their use (Figure 5.1).

In 2018, the CGS collected airborne hyperspectral data covering three areas in the Northern and Western Cape Provinces. This was the first regional survey of its kind in South Africa. The MS, SS and hyperspectral datasets, in combination with geophysical data, geochemical data and existing geological knowledge, provide first-pass base maps for geological fieldwork and the compilation of 1:50 000-scale geological maps. Table 5.1 shows a comparison of the various datasets used and Figure 5.2 depicts the loss in the level of detail with decreasing spatial resolution for different images at the same display scale.

A range of image processing techniques was applied to the raw satellite data to enable discrimination between lithological units, highlight and enhance structural features, and show areas of hydrothermal alteration. These techniques included band ratios and vegetation indices such as the normalised difference vegetation index, principal component analysis (PCA) and minimum noise transform (MNF). The processing was primarily done using PyGMI open-source software (http://patrick-cole.github.io/pygmi/wiki.html) developed in-house at the CGS. Erdas Imagine, ENVI and ArcGIS were also used to process, integrate and analyse the data. The results of the band ratios, PCA and MNF processing were displayed as colour composites for geological interpretation (Figures 5.3, 5.4 and 5.5). Owing to the low resolution of the data, the similarity in response of the materials on the ground,

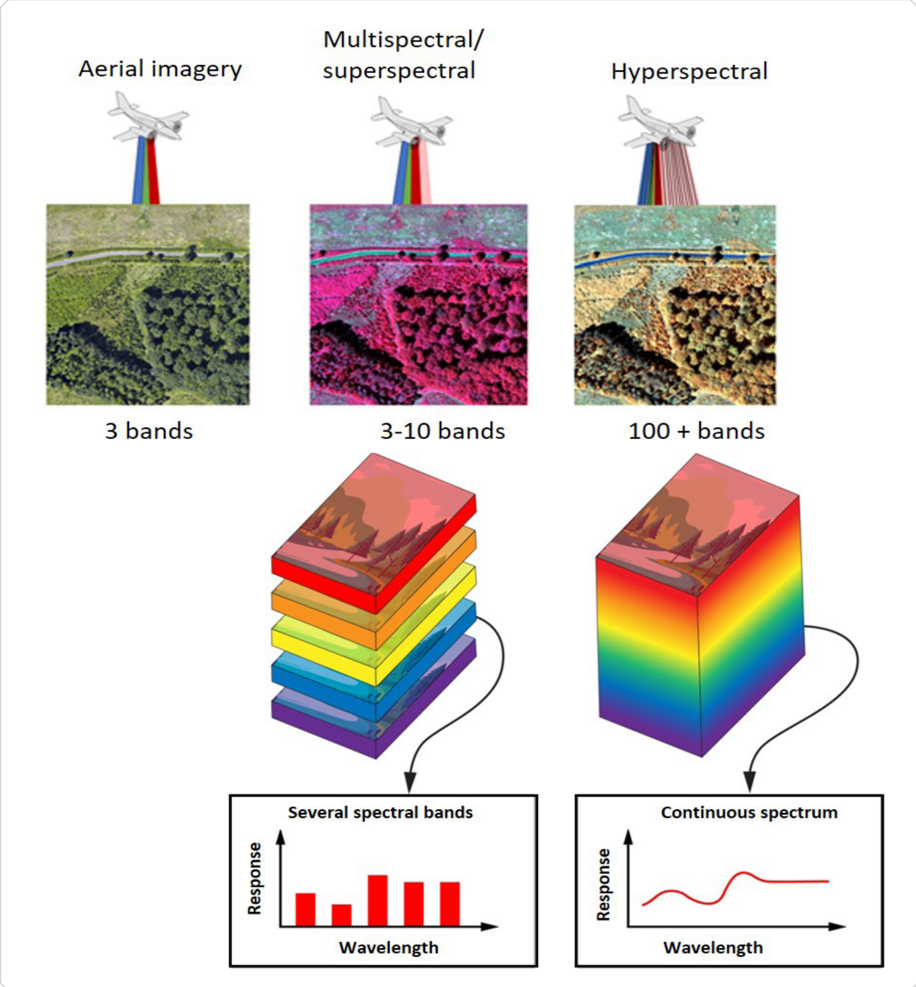

Figure 5.1: Comparison of multispectral, superspectral and hyperspectral images.

Table 5.1. Satellite imagery dataset comparison.

IMAGERY	SPATIAL RESOLUTION	SPECTRAL RESOLUTION (NUMBER OF BANDS)
ArcGIS online world imagery	Varies depending on availability (30 cm–1 m)	3
SPOT 6 data	1.5 m (panchromatic), 6 m (multispectral)	5
Landsat 8 data	15 m (panchromatic), 30 m, 100 m	11
ASTER satellite imagery	15 m, 30 m, 90 m	14
Sentinel 2 data	10 m, 20 m, 60 m	12
Hyperspectral imagery	3 m	322

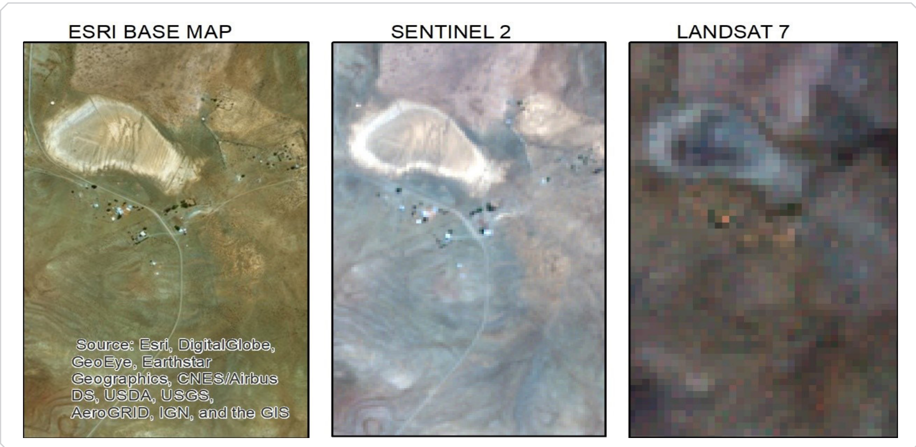

Figure 5.2. Comparison of ArcGIS base imagery (highest spatial resolution), Sentinel 2A imagery and Landsat 7 data (lowest spatial resolution).

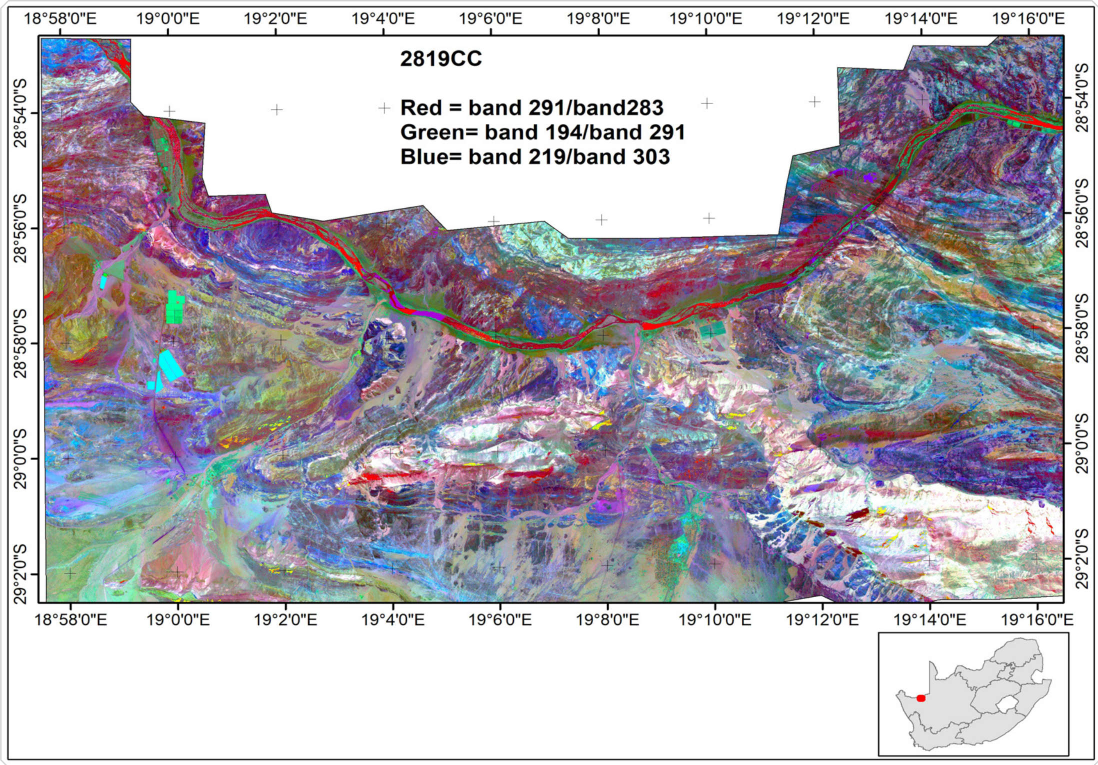

Figure 5.3. Hyperspectral band ratio colour composite of the 1:50 000-scale Pelladrif map.

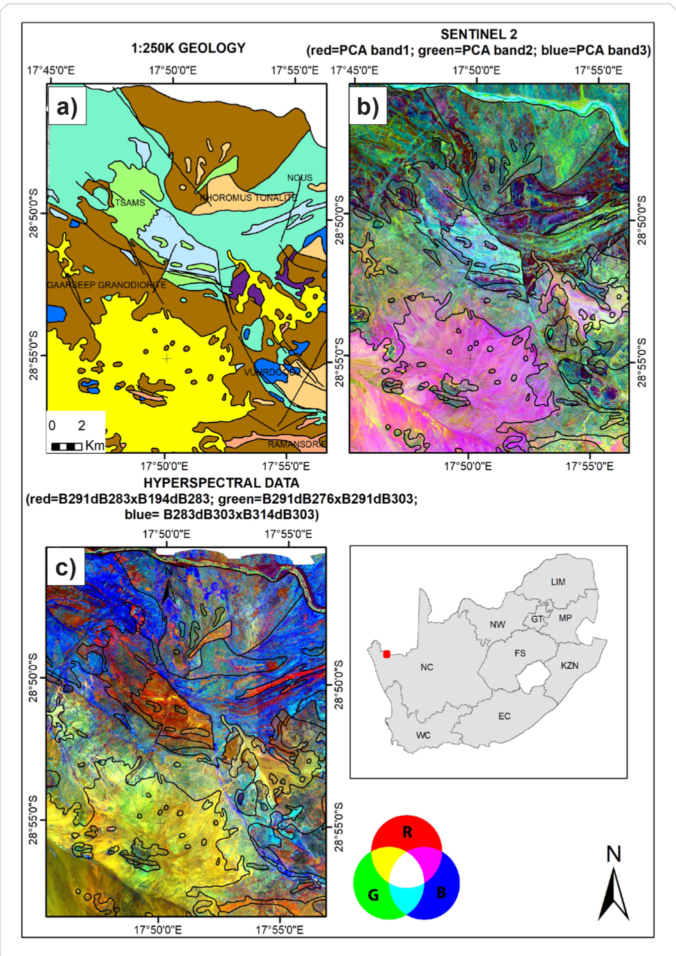

Figure 5.4a) 1:250 000-scale geological map. b) Sentinel-2 colour composite comprising PCA bands. c) Hyperspectral band ratios displayed as colour composites.

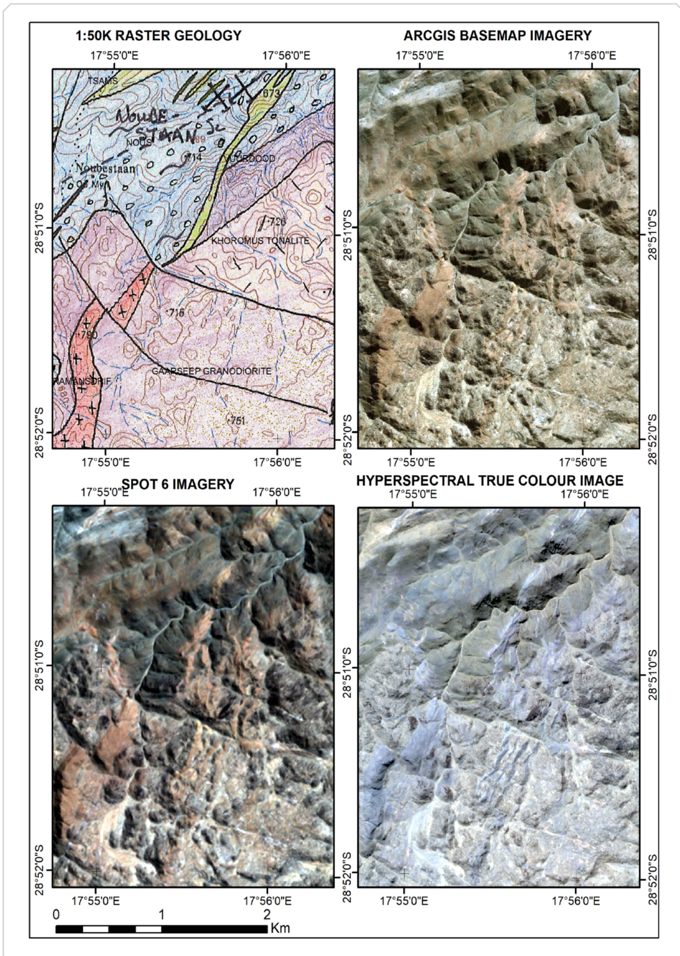

Figure 5.5. ArcGIS basemap imagery, SPOT 6 and hyperspectral data are useful for highlighting structural features.

and the availability of vegetation, the results from pure remote sensing should be used with caution because they are not conclusive. Geological knowledge and fieldwork are required to verify the results before the final map is created.

The results obtained are comparable to the geological map and, in some cases, the processed imagery provides more detail than the original map. The results can be used to focus on areas for field investigations and to save costs and time spent on mapping. However, challenges remain regarding the use of remote sensing in highly vegetated and irrigated areas, and research on its application in such areas is an ongoing exercise.

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Groundwater Division presents a Geohydrology Practical Skills Course

The Groundwater Division (GWD) of the GSSA was established in 1978 with the goal of upholding and promoting professionalism among its members in the groundwater sector. The GWD is a body of scientists and technicians directly or indirectly involved and interested in the optimal development of South Africa's groundwater as a limited natural resource, and the preservation of groundwater quality.

The GWD hosted a Geohydrology Practical Skills Course at the University of Pretoria's Future Africa Campus from 21–24 February 2023. The course focussed on imparting best-practice skills presented by specialists in the field of geohydrology. Presentations on basic field practical skills such as drilling, hydrocensus, data management, sampling, field analyses, hydraulic testing and the calculation of hydraulic parameters (K, T, S, Sy) aimed to enhance attendees' understanding and promote the sensible use, management and protection of groundwater resources. The course included a series of lectures in addition to field components and field tests using University of Pretoria boreholes located within walking distance of the course venue. The course was well attended by delegates form the Department of Water and Sanitation, the National Nuclear Regulator's Centre for Nuclear Safety and Security, Kumba Iron Ore, ABS Africa, the University of Pretoria, the University of the Free State, the University of Limpopo and the CGS, represented by Ms Sisanda Makubalo from the Water and Environment unit.

Figure 6.1. Delegates attending the GWD Geohydrology Practical Skills course.

The four-day Geohydrology Practical Skills course was divided into six sessions:

1. Soil profiling, infiltration tests and interpretation;
2. Water-level data and downhole loggers;
3. Borehole siting: a multidisciplinary approach;
4. Aquaread probe and downhole hydrochemistry;
5. Department of Water and Sanitation and National Groundwater Archives database queries, data extraction and data manipulation;
6. Stable and radon isotopes, meteoric water line calculations; and
7. Radon alpha decay 7 metre and field radon testing.

Ms Sisanda Makubalo from the CGS gave a talk on some of the basic practical skills she has acquired while working on CGS hydrogeology projects over the years. She emphasised that water is one of the most vital elements for human survival, and water resources globally are in a state of decline due to the rapidly expanding human population and increasing consumption of natural resources. Ms Makubalo also underscored the importance of undertaking integrated research in order to understand, discover and protect groundwater resources.

Figure 6.2. a) Prof. Matthys Dippenaar from the University of Pretoria demonstrating soil profiling to delegates. b) and conducting an infiltration test with students. c) and d) Students conducting a downhole hydrochemistry analysis using the Aquaread probe in one of the boreholes located at the University of Pretoria.

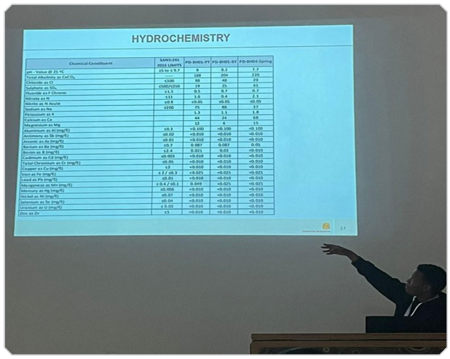

Figure 6.3. Ms Sisanda Makubalo giving a talk at the GWD Geohydrology Practical Skills course.

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