Graphite critical mineral reconnaissance field work, Petauke District, Eastern Province, Zambia, July-August 2025

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Graphite critical mineral reconnaissance field work, Petauke District, Eastern Province, Zambia, July-August 2025

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Front cover

Graphite gneiss outcrop, Chiso area, Petauke, Eastern Province, Zambia.

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Foreword

This report summarises the visit from 23rd July to 5th August 2025 by Clive Mitchell, Industrial Minerals Geologist, and Dr David Currie, Mineral Resources Geologist, British Geological Survey (BGS) to Zambia as part of BGS research on African graphite resources for use as a battery raw material.

The main purposes of the visit were to 'ground truth' the potential presence of graphite occurrences identified by remote sensing and to further develop a graphite reconnaissance methodology based on field work experiences in the Petauke District of Eastern Province in Zambia. The field work was a follow up to the graphite reconnaissance carried out in June 2023 (Mitchell & Currie, 2023).

The work formed a key component of the 'Critical Mineral Resources – Zambia' research project which is part of the BGS International Geoscience Research and Development (IGRD) programme. This is funded by the BGS International NC programme 'Geoscience to tackle Global Environmental Challenges', NERC reference NE/X0062.

This work is fully aligned with the BGS project 'Supporting resource capability for critical minerals in Zambia' which is funded by the Growth Gateway under the Green Inclusive Growth Centre of Expertise 2025-2026 of the Foreign, Commonwealth & Development Office (FCDO).

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- Gerald Mwila, Director, Charles Mbelenga and David Mwila from the Geological Survey Department (GSD), Ministry of Mines and Minerals Development (MMMD), Lusaka, Zambia,
- His Excellency Chief Mumbi and Her Excellency Chieftainess Mumbi of the Nsenga people in Petauke District,
- Roy Tembo, our guide and Patrick Banda, Jonathan Daka, Bernard Mwale, Peter Phiri, Masauso Tembo, and Matthews Zulu, our field assistants in Petauke District.

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1 Summary

Zambia is a major producer of minerals and is seeking value-addition from the exploitation of its indigenous mineral resources. Alongside copper, cobalt and gemstones, the Zambian Government has prioritised the development of critical and battery raw materials, including graphite, to support the global transition to a low-carbon economy. This focus is reflected in the National Critical Minerals Strategy 2024–2028 and in growing international collaboration to improve geological knowledge a resource potential.

As part of this effort, the British Geological Survey (BGS), in collaboration with the Geological Survey Department of Zambia (GSD) and Copperbelt University (CBU), is undertaking research to assess the graphite resource potential of Zambia. The work forms part of the BGS International Geoscience Research & Development (IGRD) programme and builds directly on earlier graphite reconnaissance fieldwork carried out in Petauke District in June 2023. The July–August 2025 visit aimed to further develop and test graphite reconnaissance methodologies, with a particular focus on integrating remote sensing with field-based observations.

Graphite in Zambia is known to occur predominantly as flake graphite within Paleoproterozoic metasedimentary gneiss and schist units across Central and Eastern Zambia. Petauke District, Eastern Province, was selected for the 2025 fieldwork based on previously reported graphite occurrences and the opportunity to evaluate satellite-derived targets in an area characterised by extensive lateritic cover. Fieldwork was undertaken between 23 July and 5 August 2025, with appropriate engagement of national, provincial and district authorities and with the support of the Nsenga traditional leadership.

Remote sensing analysis using Sentinel-2 multispectral data was used to identify potential graphite targets for ground truthing. Over five days of fieldwork, 20 sites were visited across the Kalobe, Kalindawalo Farm, Chimwele-Agripa, Mulalo, Chiso and Damiano areas. Trenching at many target sites intersected lateritic soils and ferricrete with no graphite identified to depths of up to one metre. In contrast, graphite was commonly observed in drainage channels and erosion features where bedrock exposure was present, highlighting the strong control of tropical weathering on graphite detectability.

Graphite mineralisation was confirmed as crystalline flake graphite hosted mainly in paragneiss, occurring disseminated through the rock matrix or concentrated in graphite-rich bands. Samples of graphite-rich gneiss and weathered material were collected, with duplicate sets retained in Zambia and by BGS for further laboratory characterisation. Engagement with local communities, particularly potters who use graphite for polishing ceramics, provided valuable insights into the distribution of near-surface graphite and proved an effective reconnaissance indicator.

The reconnaissance fieldwork demonstrated that satellite remote sensing alone has limited effectiveness in areas where graphite is largely concealed beneath lateritic cover, but that it can support field targeting when combined with geomorphological observations and local knowledge. Overall, the field campaign successfully confirmed graphite occurrences in Petauke District and further refined a practical reconnaissance approach that will contribute to future prospectivity analysis and to strengthening national capability for critical mineral assessment in Zambia.

2 Introduction

Zambia has a well-established mining sector that contributes significantly to the country's gross domestic product (GDP), tax revenues and export earnings. The United Party for National Development (UPND) government has ambitious plans to significantly increase the output of the mining sector with the introduction in July 2024 of the National Three (3) Million Tonnes Copper Production Strategy by 2031, and the National Critical Mineral Strategy 2024 to 2028 (PwC, 2024). In 2024, there were significant increases in the production of copper (up 12% from 2023 to 820,676 tonnes), cobalt (up 40% to 3142 kg), nickel (up 164% to 21,040 tonnes), manganese (up 102% to 134,933 tonnes) and emerald (up 113% to 31,578 kg) (MMMD, 2025).

The continuing and growing demand to supply the critical and battery raw materials needed for the energy transition to a low-carbon society has led to increasing global pressure to find these resources. The British Geological Survey (BGS) has been supporting the Zambian Geological Survey Department (GSD) to enable it to contribute to the discovery and development of these critical and battery raw material resources within Zambia. This support has focused on the geological understanding of resources, reconnaissance exploration, laboratory characterisation and freely accessible publication of minerals information and maps. This has been carried out as part of successive projects funded by the BGS International Geoscience Research & Development (IGRD) programme and the Foreign, Commonwealth & Development Office (FCDO) Green and Inclusive Growth and Growth Gateway programmes. The research has been actively supported by the British High Commission (BHC) to Zambia in Lusaka.

In May 2022, a small team from the BGS visited the Copperbelt University Africa Centre of Excellence for Sustainable Mining (CBU-ACESM) in Kitwe, Zambia to explore the potential for joint research on critical minerals in Zambia (Hamilton *et al.*, 2022). A follow-up visit in November 2022 was carried out to start planning a research project on graphite resources in Zambia involving BGS, CBU & the GSD (Mitchell, 2022). Multiple visits to Zambia were carried out by BGS project teams up to 2025 which included graphite reconnaissance field work (June 2023), training at the GSD (February 2024), critical mineral workshops in Lusaka (March 2024), presentations at the Zambian International Mining and Energy Conference (ZIMEC) in Kitwe (in November 2022 and March 2024) and engagement with mining sector stakeholders (September 2024 and March 2025). In June 2025, the 'Critical minerals potential guide of Zambia' was published as a joint publication by the GSD and BGS (Sinkana *et al.*, 2025). This guide summarised the geology, occurrences, exploration and mineral production of the following eleven metals and minerals highlighted by the Zambian 'National Critical Minerals Strategy 2024 to 2028' (Table 1):

Table 1. Zambian critical minerals.

Cobalt	Lithium	Sugilite
Columbite-tantalite ('coltan')	Manganese	Tin
Copper	Nickel	Uranium
Graphite	Rare earth elements	

From 23rd July to 5th August 2025, Clive Mitchell, Industrial Minerals Geologist, and Dr David Currie, Mineral Resources Geologist, British Geological Survey (BGS) participated in geological fieldwork to 'ground truth' the potential presence of graphite occurrences identified by remote sensing and to further develop a graphite reconnaissance field work methodology based on field work experiences in the Petauke District of Eastern Province in Zambia (Table 2). This was a follow-up to the graphite reconnaissance carried out in June 2023 (Mitchell & Currie, 2023). The field work in 2025 was a continuation of the collaboration between the BGS, CBU and the GSD.

The graphite field reconnaissance team is shown in Fig. 1. The team members are as follows:

Top left to right:

- Charles Mbelenga, Geologist, GSD
- Clive Mitchell, Industrial Minerals Geologist, BGS
- Dr Nelly Chunda Mwango, Project Manager, CBU-ACESM
- Professor Kakoma Maseka, Dean, School of Mathematics and Natural Sciences, CBU
- Dr Edward Chisakulo, Geologist, CBU

Bottom left to right:

- David Mwila, Geologist, GSD
- Roy Tembo, local field guide
- Dr David Currie, Mineral Resources Geologist, BGS

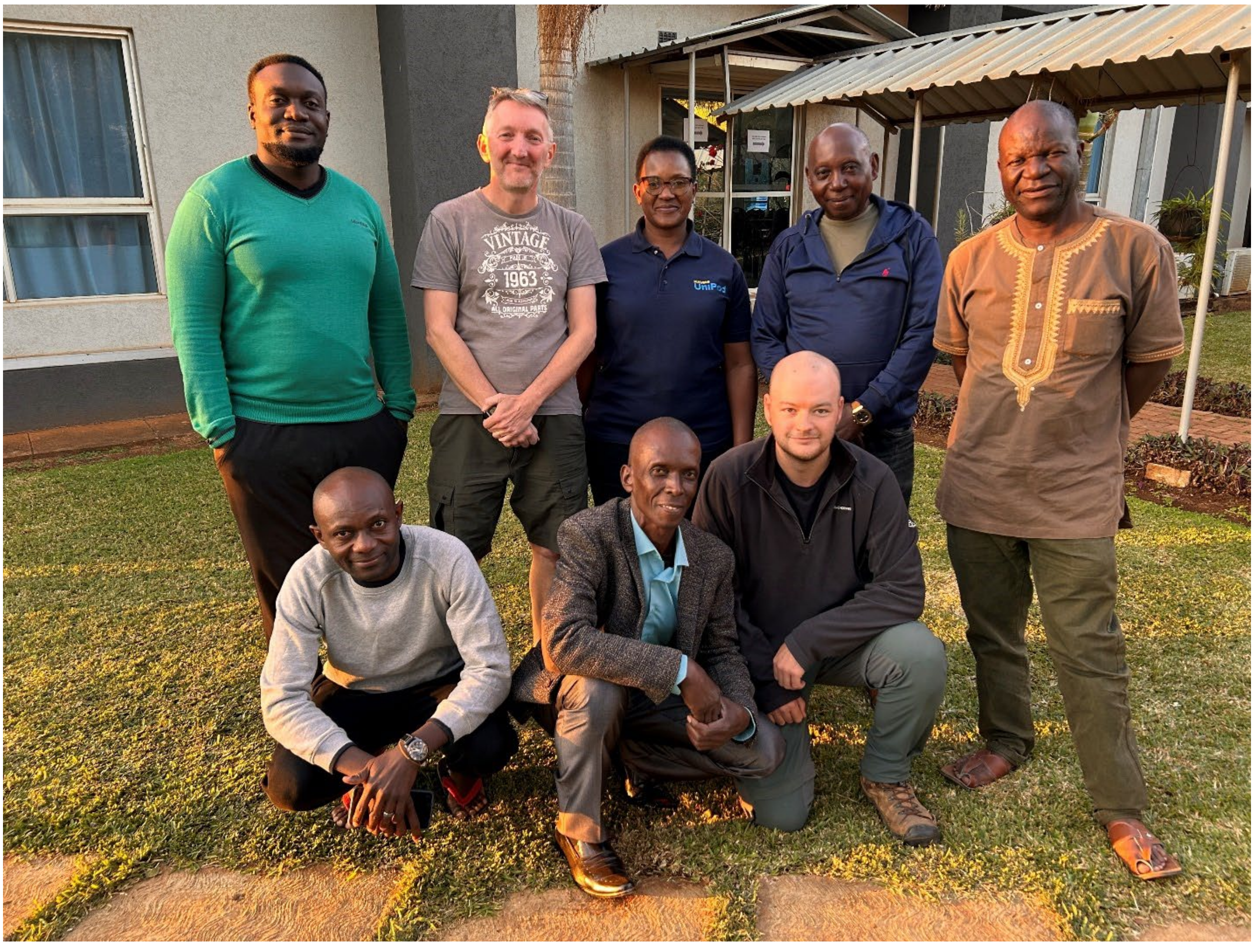

Figure 1. Graphite reconnaissance team meeting in Petauke, Eastern Province, Zambia.

3 Visit itinerary

Table 2. Itinerary for visit to Zambia in July to August 2025.

Date	Activity
Wednesday 23rd & Thursday 24th July 2025	Travel from the UK to Lusaka, Zambia (2 flights; Birmingham to Dubai, United Arab Emirates (UAE); Dubai to Lusaka).
Friday 25th July 2025	AM: Meeting with the field team at the GSD in Lusaka; meeting with Evaristo Kasumba, Chief Geologist, Economic Geology, GSD. PM: BGS team working at the GSD.
Saturday 26th July 2025	Travel from Lusaka to Petauke (400km; 7-hour journey)
Sunday 27th July 2025	Rest day.
Monday 28th July 2025	Fieldwork day one: AM: Travel from Petauke to Chipata to inform Provincial Government of research team activities and then travel back to Petauke (each way 175km; 2-hour drive). PM: Travel into Petauke town to inform District Government.
Tuesday 29th July 2025	Fieldwork day two: Meeting with Chieftainess Mumbi of the Nsenga people. Initiate graphite reconnaissance fieldwork.
Wednesday 30th July 2025	Fieldwork day three.
Thursday 31st July 2025	Fieldwork day four.
Friday 1st August 2025	Fieldwork day five. Farewell meeting with Chief Mumbi of the Nsenga people in Petauke.
Saturday 2nd August 2025	Travel from Petauke to Lusaka (400km; 7-hour drive).
Sunday 3rd August 2025	Rest day. 97th Agricultural & Commercial Show of Zambia.
Monday 4th August 2025	National Holiday (Farmers Day). AM: worked at hotel, PM: Travel from Lusaka to Dubai
Tuesday 5th August 2025	Travel from Dubai to the UK.

4 Graphite reconnaissance fieldwork

4.1 GRAPHITE EXPLORATION METHODOLOGY

Flake graphite occurs associated with Paleoproterozoic metasedimentary gneiss and schist units found in a substantial area across central and eastern Zambia (further detail on the geology of Zambia and the graphite resources is given in Mitchell & Currie, 2023). Graphite encountered during the field reconnaissance in June 2023 was either found in saprolitic/ lateritic soil horizons (e.g. Kalobe and Dominico village areas) or as surface rock exposures (e.g. Dominico and Sichombwe-Changwe village areas).

Graphite mineralisation is predominantly hosted in paragneiss, with only minor occurrences found in quartzofeldspathic pegmatitic to granitic rocks. In these rock types, graphite is typically concentrated along grain boundaries of quartz and K-feldspar. Within the paragneiss, the leucosomal sections are composed of quartz, albite, albite-anorthite series plagioclase feldspar, K-feldspar, and minor biotite. Crystal sizes of these rock-forming minerals range from a few microns to over 15 mm, particularly in pegmatitic samples. The mesosomal portions of the paragneiss are characterised by biotite and graphite, both of which exhibit crystal orientations aligned with the gneissose fabric.

Across all analysed samples, graphite occurs as crystalline flake graphite. It is hosted within several mineral phases, most notably biotite and jarosite, but can also be distributed randomly throughout the rock matrix. In biotite, graphite is either enclosed within or aligned along cleavage planes. In jarosite, graphite may be fully encapsulated, and in weathered or near-surface conditions, it tends to expand along its sheet-like cleavage planes.

Graphite flakes often contain inclusions of other mineral phases such as jarosite, K-feldspar, feldspars, clays, quartz, and titanium oxides, especially where cleavage planes have separated. In contrast, graphite that remains intact within biotite cleavage planes typically shows minimal to no inclusions.

Accessory mineral phases identified across all samples include Ti-Nb oxide (possibly ilmenorutile), zircon, monazite, xenotime, rutile, apatite, Fe-sulfide, titanite, clays (illite, smectite, potassic varieties), grossular garnet and gypsum. Additional phases such as chlorite, rhodochrosite, and dolomite were detected via X-ray diffraction (XRD), although they were not observed under optical microscopy or scanning electron microscopy (SEM)

4.1.1 Remote sensing targets

Multispectral analysis of graphite samples from Petauke District was used to calibrate multispectral data from Remote Sensing surveys of the Petauke District area. Potential occurrences of graphite were identified from the remote sensing data and used to create targets for 'ground truthing' field work.

Sentinel 2 satellite data was downloaded for the region of interest where field work had occurred, and field samples had been collected previously. The multispectral satellite data is free to download and cloud free data was available for the area of interest. Various image processing techniques were applied to the data. A combination of band ratios, Minimum Noise Function (MNF) and principal components analysis (PCA) was found to give most discrimination of different materials at surface in the area of interest.

Spectral signatures of graphite rich soils gathered in the field were measured using a Quality Spec Trek spectrometer. The locations of these field samples were then precisely located in the sentinel 2 imagery so that the spectral signature at these locations could be determined. Each pixel determined as containing graphite rich soil, based on the field locations and samples taken, was then selected as a target to base supervised classifications on.

Various supervised classifications were used to map the spectral signature of known graphite pixels throughout the rest of the imagery. Spectral Angle Mapper (SAM) and Parallelepiped supervised classifications provided several points of interest for ground truthing. The points mapped using the supervised classification were then graded to narrow down the number of field locations for the ground truthing exercise.

Appendix 1 shows the targets identified in selected areas within Petauke District; these target areas were split into five areas for the field work. The aim was to visit and 'ground truth' the presence of graphite at the locations identified. Over the course of the field work a total of 20 sites were visited.

4.1.2 Local knowledge

In the reconnaissance field work in June 2023, potters were encountered in Manjolo village that use graphite to polish earthenware pots. The graphite-rich sand they use was sourced from the nearby area of Kalobe. In the current field work, potters encountered in the villages of Agripa, Damiano and Kalindawalo Farm provided valuable local knowledge of graphite resources present in their area that they used for polishing pots and decorating their homes (Fig. 2).

Figure 2. Graphite coated pot in potters' hands in Agripa village, Petauke District, Zambia.

4.2 FIELDWORK DAY ONE: CHIPATA AND PETAUKE

Morning: A delegation from the field team was dispatched to Chipata (the capital of Eastern Province) to deliver formal letters to inform the Provincial Government offices of the research team activities. The letters were delivered to the Permanent Secretary for Eastern Province Provincial Administration and the Commissioner of Police (Divisional Commander), Zambia Police Service headquarters for Eastern Province.

Afternoon: A delegation from the field team was dispatched to Petauke (the administrative centre of Petauke District, Eastern Province) to deliver formal letters to inform Martha Evans, District Commissioner, Petauke District and the Officer in Charge (Senior Superintendent), Zambia Police Service.

4.3 FIELDWORK DAY TWO: MUMBI AND KALOBE AREAS

Morning: The full field team was invited back for a meeting with Martha Evans (District Commissioner) for a full briefing on the planned research activities. Also, in attendance was Severian Lungu (UPND parliamentary candidate for Petauke Central).

The field team was received by Her Excellency Chieftainess Mumbi of the Nsenga people in Petauke District (who was delegated in the absence of Chief Mumbi) (Fig. 3). Chieftainess

Mumbi was supportive of the graphite reconnaissance work but highlighted the need to ensure that any future developments would benefit the people of Petauke District.

Local guide Roy Tembo was assigned to support the work. A local group of six field assistants was recruited for the duration of the field work in Petauke District; Jonathan Daka, Patrick Banda, Bernard Mwale, Peter Phiri, Masauso Tembo and Matthews Zulu (part of the group shown in Fig. 4).

Figure 3. Graphite team with Chieftainess Mumbi, Mumbi village (third from right, top row).

Figure 4. Local guide and field assistants in Petauke District, Zambia.

(Clockwise from top left: Roy Tembo, Bernard Mwale, Patrick Banda and Mattews Zulu).

Afternoon: Full field team visited the first set of sites identified by remote sensing to 'ground truth' the presence of graphite; these will be referred to as 'sites' with the corresponding ID (identification) number (as listed in Appendix 1). The sites visited on this afternoon are in the map shown in Fig. 5 and the general landscape is shown in Fig. 6. Trenches were dug at each location in the Kalobe area to a maximum depth of 1 metre, as follows:

Kalobe area sites

Site 1490 *S14°25'15.3" E031°19'48.9" (dig site)*

Agricultural land, lateritic soil, no graphite.

Site 1493 *S14°25'13.1" E031°19'59.6" (dig site)*

Agricultural land, lateritic soil, no graphite.

Site 1503 *S14°25'20.5" E031°20'21.4" (dig site)*

Agricultural land, lateritic soil, no graphite, magnetite/ hematite present.

Site 1517 *S14°25'32.9" E031°20'29.0" (dig site)*

Agricultural land, lateritic soil, no graphite.

Site 1531 *S14°25'59.0" E031°19'59.0" (dig site)*

Agricultural land, lateritic soil, graphite sampled collected.

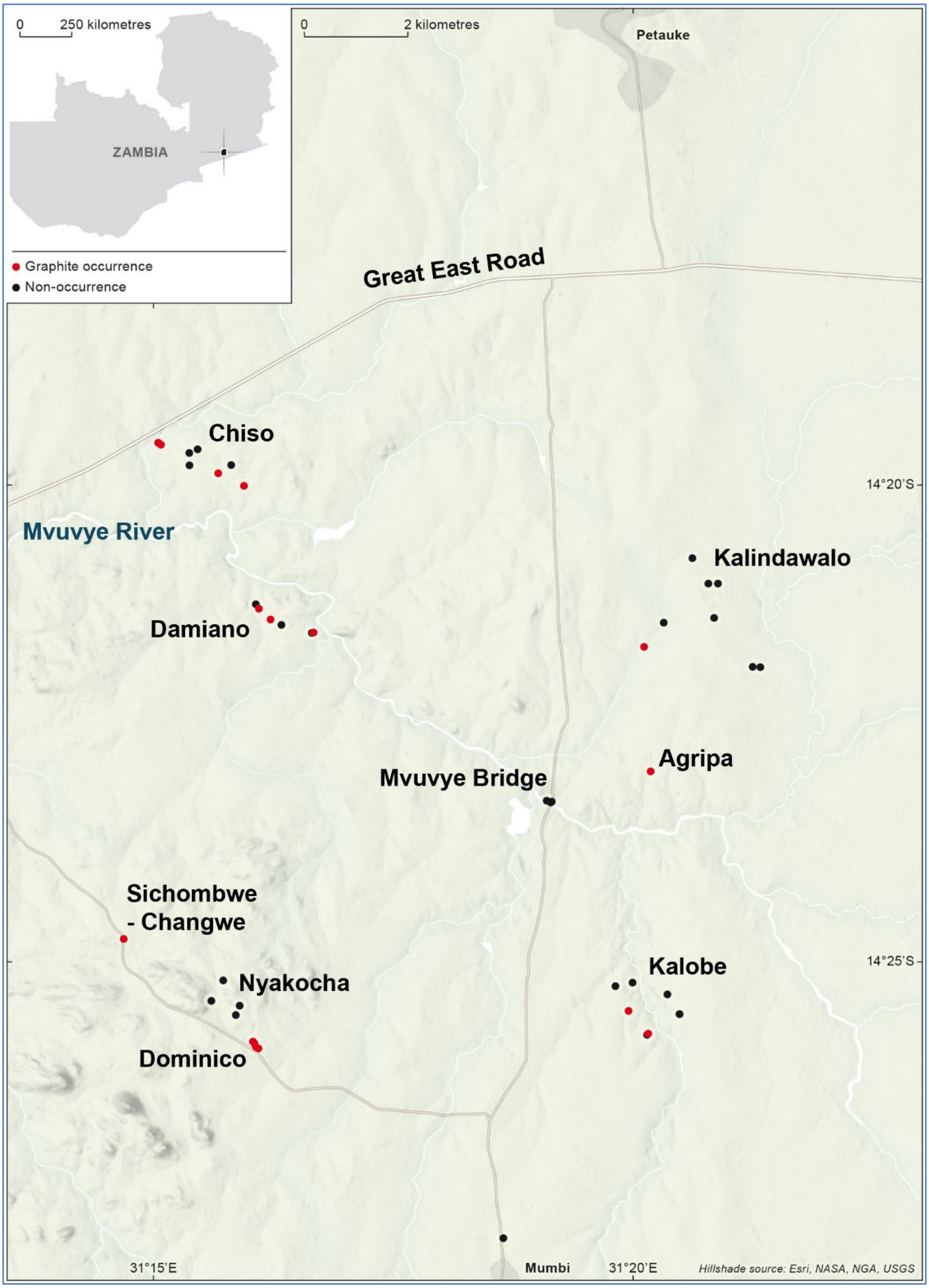

Figure 5. Graphite sample locations, Petauke District, Eastern Province, Zambia.

Basemap Hillshade source: Esri, NASA, NGA, USGS.

Figure 6. Field team walking to site location in Kalobe area, Petauke District, Zambia.

Other sites were investigated in the Kalobe area. These were typically drainage channels on relatively steep slopes where the lateritic soil cover has been washed away to reveal graphite-rich gneiss outcrops. Samples of graphite rich gneiss were taken at two locations:

Kalobe 1 *S14°25'30.9" E031°19'57.1"*

Local track, graphite-rich gneiss outcrop (sample taken).

Kalobe 2 *S14°25'45.2" E031°20'09.4"*

Local track, graphite-rich gneiss outcrop (sample taken)

4.4 FIELDWORK DAY THREE: KALINDAWALO FARM AREA

Morning: Full field team set out to Kalindawalo Farm area (for sites on Day 2 map). Headman and local potter consulted at Kalindawalo Farm village. Sites investigated this morning in the Kalindawalo Farm area were typically drainage channels or relatively steep slopes where the lateritic soil cover has been washed away to reveal graphite-rich gneiss outcrops.

Kalindawalo 1 *S14°21'41.8" E031°20'06.8"*

Small dry drainage channel, graphite-rich gneiss exposure, source of graphite for potter from Kalindawalo Farm village (sample taken, Fig. 7).

Kalindawalo 2 *S14°21'26.6" E031°20'19.1"*

Local track, very fine-grained biotite gneiss outcrop with potential graphite (unidentified at hand sample scale) (no sample taken).

Figure 7. Graphite-rich gneiss sample, Kalindawalo Farm area, Petauke District, Zambia.

<u>Afternoon</u>: Field team split into two sub-teams to cover more sites in Kalindawalo Farm area.

<u>Kalindawalo Farm area sites</u>

Site 1360	*S14°20'46" E31°20'37"' (dig site)*
	Agricultural land, lateritic soil, with underlying ferricrete, no graphite encountered (possibly at depth). Bulk sample of anthill taken by GSD.
Site 1369	*S14°21'2" E31°20'47" (dig site)*
	Agricultural land, lateritic soil, with underlying ferricrete and pegmatitic clasts, no graphite encountered (possibly at depth).
Site 1370	*S14°21'2" E 31°20'53" (dig site)*
	Agricultural land, coarse quartz grains in sandy gravel soil which became ferricrete below surface, no graphite encountered (possibly at depth).
Site 1381	*S14°21'23.6" E031°20'50.6" (dig site)*
	Bush, grassy with small bushy trees, lateritic soil, with underlying ferricrete, no graphite encountered (possibly at depth).
Site 1393	*S14°21'54.4" E031°21'14.7" (dig site)*
	Agricultural land, lateritic soil, with underlying ferricrete, no graphite encountered (possibly at depth).

Site 1394 *S14°21’54.6” E031°21’19.5” (dig site)*

Agricultural land, lateritic soil, with underlying ferricrete, no graphite encountered (possibly at depth).

4.5 FIELDWORK DAY FOUR: CHIMWELE-AGRIPA AND MULALO AREAS

4.5.1 Chimwele-Agripa area

Morning: Full team set off to the Chimwele-Agripa area in the Day 3 map area. Consulted head man at Sipela village and head woman at Agripa village. Consulted potter from Agripa village who directed the field team to her source of graphite. This was a short walk southwards from the village to a dry drainage channel which aligned with a shear zone in the underlying gneiss.

Agripa 1 *S14°23’00.2” E031°20’10.9”*

Drainage channel, graphite-rich gneiss outcrop (sample taken).

4.5.2 Mulalo area

Afternoon: Full field team visited site located in map 5.

Mulalo area sites:

Site 1320 *S14°19’39.8” E031°15’22.4” (dig site)*

Agricultural land, lateritic soil, no graphite.

The team visited the Damiano village area to capture sites 1374, 1384, and 1386, but the route planned was not possible due to poor roads. We instead switched focus and ended the afternoon by reaching site 1320 and scoping out the Chiso area to plan for the next morning.

4.6 FIELDWORK DAY FIVE: CHISO AREA

Full field team travelled to Chiso area. Graphite occurrence identified in drainage channel alongside track leading south from Great East Road.

Chiso 1 *S14°19’33.4” E031°15’03.0”*

Drainage channel, graphite-rich gneiss outcrop (sample taken, Fig. 8).

Figure 8. Trenching at target site, Chiso area, Petauke District, Zambia.

Full field team split into two groups to cover more sites in the Chiso area.

Site 1318	*S14°19’37.5” E031°15’27.6” (dig site)*
	Agricultural field, lateritic soil (60cm) and ferricrete (to >1m depth), no weathered graphite-rich gneiss encountered (potentially at depth).
Site 1323	*S14°19’47.6” E031°15’22.5” (dig site)*
	Edge of agricultural field, lateritic soil (50cm) and ferricrete (to >1m depth), no weathered graphite-rich gneiss encountered (potentially at depth).
Site 1324	*S14°19’47.4” E031°15’48.6” (dig site)*
	Edge of agricultural field, lateritic soil (25cm) and ferricrete (to >0.5m depth), no weathered graphite-rich gneiss encountered (potentially at depth).
Site 1326	*S14°19’52.6” E031°15’40.5” (dig site)*
	Agricultural field, lateritic soil (40cm) and ferricrete (to >0.7m depth), no weathered graphite-rich gneiss encountered (potentially at depth). NB small amount of graphite gneiss encountered in nearby drainage channel approximately 3m lower than dig site.
Site 1329	*S14°20’00.5” E031°15’56.6” (dig site)*
	Edge of agricultural field, lateritic soil (15cm) and ferricrete (to 0.5m depth) overlying weathered graphite-rich gneiss (sample taken).

Graphite occurrence identified in drainage channel along track north to Great East Road.

Chiso 2 *S14°19’34.6” E031°15’04.7”*

Drainage channel, graphite-rich gneiss outcrop (sample taken).

Damiano 1 *S14°19’33.4” E031°15’02.9*

Drainage channel, graphite-rich gneiss outcrop (sample taken).

Site 1386 *S14°21’33” E031°16’39*

Agricultural field, lateritic soil (60cm) with coarse quartz and feldspar clasts, and ferricrete (to >1m depth), no weathered graphite-rich gneiss encountered (potentially at depth). Walked down slope towards Mvuvye River and found graphite-rich gneiss in draining multiple draining ditches at S14°21’32.8” E031°16’40.1. Outcrops of graphite-rich gneiss continues throughout the drainage channel, but sampling was deemed an unnecessary risk due to steepness of draining channel banks. (no sample taken).

Damiano 2 *S14°21’24.6” E031°16’13.2”*

Drainage channel, graphite-rich gneiss outcrop extending entire 70 m downslope in drainage channel (sample taken).

Damiano 3 *S14°21’17.8” E031°16’05.9”*

Drainage channel, graphite-rich gneiss (fine grained) outcrop in contact with quartzofeldspathic pegmatite in drainage channel (no sample taken, friable).

Site 1374 *S14°21’15” E031°16’04” (dig site)*

Agricultural field, lateritic soil (~1.5 m depth based on channel depth to bedrock), extensive slash and burn. No weathered graphite-rich gneiss encountered (potentially at depth as all surrounding drainage ditches had graphite in them).

Site 1384 *S14°21’28” E031°16’20” (dig site)*

Agricultural field, lateritic quartz clast rich soil, extensive slash and burn. No weathered graphite-rich gneiss encountered (potentially at depth as all surrounding drainage ditches had graphite in them).

This concluded the fieldwork. The team led by Dr David Currie (Fig. 9) crossed the Mvuvye River, a feat not possible by vehicle in 2023, to meet Clive Mitchell’s team (Fig. 10) near Lusowe Primary School.

The full field team was received by His Excellency Chief Mumbi of the Nsenga people in Petauke District to learn about the progress of the team and wish them farewell.

Figure 9. Graphite sub-team lead by Dr David Currie

Figure 10. Graphite sub-team lead by Clive Mitchell

4.7 GRAPHITE SAMPLES

The graphite-rich gneiss samples collected are summarised in Table 3 and representative photos of the field sampling are shown in Fig. 11 and Fig. 12:

Table 3. Sample list

Sample site	**Location**		**Description**
	Latitude	Longitude	
Kalobe area			
Site 1531	*S14°25'59.0"*	*E031°19'59.0"*	Graphite-rich gneiss
Kalobe 1	*S14°25'30.9"*	*E031°19'57.1*	Graphite-rich gneiss
Kalobe 2	*S14°25'45.2"*	*E031°20'09.4"*	Graphite-rich gneiss
Kalindawalo Farm area			
Kalindawalo 1	*S14°21'41.8"*	*E031°20'06.8"*	Graphite-rich gneiss
Chimwele-Agripa area			
Agripa 1	*S14°23'00.2"*	*E031°20'10.9"*	Graphite-rich gneiss
Chiso area			
Chiso 1	*S14°19'33.4"*	*E031°15'03.0"*	Graphite-rich gneiss
Chiso 2	*S14°19'34.6"*	*E031°15'04.7"*	Graphite-rich gneiss
Site 1329	*S14°20'00.5"*	*E031°15'56.6"*	Graphite-rich gneiss
Damiano area			
Damiano 1	*S14°19'33.4"*	*E031°15'02.9*	Graphite-rich gneiss
Damiano 2	*S14°21'24.6"*	*E031°16'13.2"*	Graphite-rich gneiss

Figure 11: Representative images of sampling sites in Kalobe, Kalindawalo and Agripa areas.

a) ‘Kalobe 1’ site with graphite-rich gneiss exposed in drainage channel. White dashed back is location of image b. b) ‘Kalobe 1’ outcrop with selected grains of disseminated flake graphite highlighted. c) ‘Kalindawalo 1’ site with graphite-rich gneiss exposed in a drainage ditch below around 1 m of soils. A quartz (qz) – feldspar (fsp) pegmatite was noted to intrude along bedding plane of the gneiss at this location. d) ‘Agripa 1’ site used by the Agripa Village potters. Large (>1m^2) outcrops of graphite-rich gneiss were identified under the tree.

Figure 12: Representative images of field sampling sites in Chiso and Damiano areas.

a) ‘Chiso 1’ site showing graphite-rich gneiss outcrop in a drainage ditch beside a dirt track road. graphite-rich bands are around 2 mm in thickness, but graphite is also disseminated to an extent across entire outcrop. b) example of >2 m drainage ruts/ditches in the Damiano area. c) ‘Damiano 1’ site showing graphite-rich gneiss from bottom of drainage ditch near where the photographer was stood in image b. d) ‘Damiano 2’ site showing Zambian colleagues recording sample details with outcrop sampled coming from the drainage ditch adjacent to Patrick Banda (sitting).

5 Conclusions

The graphite reconnaissance fieldwork undertaken in Petauke District during July-August 2025 demonstrated that a systematic and collaborative approach continues to be effective, with graphite mineralisation successfully identified and sampled at multiple locations. The close collaboration between the BGS, GSD and CBU, together with appropriate engagement with national, provincial and traditional authorities, enabled efficient field operations and culturally respectful engagement with local communities.

The integration of multispectral satellite remote sensing with field-based reconnaissance provided valuable insight into the controls on graphite detectability in deeply weathered terrains. Ground truthing of Sentinel-2-derived targets showed that extensive lateritic soil and ferricrete cover across much of Petauke District significantly limits the effectiveness of remote sensing where graphite is not exposed at surface. Trenching to depths of up to one metre commonly failed to intersect graphite mineralisation beneath continuous laterite. The spatial resolution of the satellite data used, at $10m^2$ per pixel, may not be ideal.

In contrast, graphite mineralisation was consistently identified in drainage channels, erosion features and trackside exposures where regolith had been removed. These observations confirm that geomorphology plays a critical role in graphite exposure and that reconnaissance strategies in tropical weathering environments should prioritise drainage systems and natural erosion features. Local knowledge proved particularly valuable, with potters sourcing graphite for ceramic polishing providing reliable indicators of shallow graphite occurrences.

Graphite mineralisation observed during the fieldwork comprises crystalline flake graphite hosted mainly within Paleoproterozoic paragneiss, occurring both disseminated through the rock matrix and concentrated in graphite-rich bands aligned with gneissose fabric. Samples of graphite-rich gneiss and weathered material were collected, with duplicate sets retained in Zambia and by the BGS for further laboratory characterisation. Overall, the 2025 field campaign successfully refined a practical, transferable graphite reconnaissance methodology and contributes to improved understanding of Zambia's graphite resource potential.

Recommendations for future work

- Further refinement of reconnaissance methodologies, with emphasis on drainage networks and geomorphological controls in areas of extensive lateritic cover.
- Targeted geological mapping in areas where graphite mineralisation has been confirmed, to better define host lithologies and structural controls.
- Continued collaboration between BGS, GSD and CBU to support capacity building in graphite resource assessment and sample characterisation.
- Ongoing engagement with local communities, recognising the value of indigenous knowledge as an effective reconnaissance tool.

Appendix 1 Remote sensing targets

ID	Latitude	Longitude	Priority	Day
970	-14.4174724	31.3562339	2	1
973	-14.4181905	31.3332449	2	1
980	-14.4189085	31.324346	2	1
981	-14.4189085	31.3332449	2	1
1007	-14.4224987	31.3332449	2	1
1010	-14.4232167	31.3488181	2	1
1013	-14.4239348	31.3399192	2	1
1016	-14.4246528	31.3391776	2	1
1019	-14.4253709	31.3406607	2	1
1021	-14.4260889	31.3250876	2	1
1022	-14.4260889	31.3280539	2	1
1026	-14.4268069	31.3414023	2	1
1029	-14.427525	31.3280539	2	1
1030	-14.427525	31.3428855	2	1
1037	-14.4289611	31.3480765	2	1
1038	-14.4289611	31.3488181	2	1
1044	-14.4296791	31.3443686	2	1
1053	-14.4311152	31.3480765	2	1
1058	-14.4318332	31.3339865	2	1
1059	-14.4318332	31.3510429	2	1
1066	-14.4325513	31.3399192	2	1
1067	-14.4325513	31.3488181	2	1
1073	-14.4332693	31.352526	2	1
1078	-14.4339873	31.3495597	2	1
1079	-14.4339873	31.3532676	2	1
1082	-14.4347054	31.3325034	2	1

ID	Latitude	Longitude	Priority	Day
1083	-14.4347054	31.3451102	2	1
1084	-14.4347054	31.3465934	2	1
1086	-14.4354234	31.3436271	2	1
1093	-14.4361415	31.3399192	2	1
1107	-14.4390136	31.3317618	2	1
1108	-14.4390136	31.3503013	2	1
1112	-14.4397317	31.3332449	2	1
1116	-14.4411677	31.3369528	2	1
1119	-14.4418858	31.3273123	2	1
1122	-14.4426038	31.3273123	2	1
1123	-14.4426038	31.3287955	2	1
1126	-14.4440399	31.3325034	2	1
1131	-14.446194	31.3310202	2	1
1490	-14.4196265	31.3302786	1	1
1493	-14.4203446	31.3332449	1	1
1503	-14.4224987	31.3391776	1	1
1504	-14.4224987	31.3532676	1	1
1512	-14.4239348	31.3236044	1	1
1515	-14.4246528	31.324346	1	1
1517	-14.4260889	31.3414023	1	1
1522	-14.4296791	31.3354697	1	1
1524	-14.4311152	31.3532676	1	1
1531	-14.4332693	31.3332449	1	1
1534	-14.4339873	31.3451102	1	1
1535	-14.4339873	31.352526	1	1
1549	-14.4390136	31.3510429	1	1
1553	-14.4426038	31.3362113	1	1
1556	-14.4447579	31.3287955	1	1

ID	Latitude	Longitude	Priority	Day
1558	-14.445476	31.3280539	1	1
1559	-14.446194	31.3332449	1	1
1562	-14.4483481	31.3332449	1	1
481	-14.3348978	31.3391776	2	2
482	-14.3348978	31.3465934	2	2
483	-14.3348978	31.347335	2	2
485	-14.3356159	31.3414023	2	2
487	-14.3363339	31.3354697	2	2
488	-14.3363339	31.3458518	2	2
492	-14.3370519	31.3465934	2	2
497	-14.33777	31.3369528	2	2
498	-14.33777	31.3399192	2	2
499	-14.33777	31.3480765	2	2
500	-14.338488	31.338436	2	2
506	-14.3392061	31.3354697	2	2
510	-14.3399241	31.3332449	2	2
511	-14.3399241	31.3421439	2	2
512	-14.3399241	31.3510429	2	2
517	-14.3406421	31.3310202	2	2
534	-14.3442323	31.3406607	2	2
541	-14.3449504	31.329537	2	2
546	-14.3456684	31.3302786	2	2
547	-14.3456684	31.3376944	2	2
551	-14.3463865	31.3302786	2	2
558	-14.3471045	31.3317618	2	2
564	-14.3478225	31.3310202	2	2
568	-14.3499767	31.3458518	2	2
576	-14.3514127	31.3436271	2	2

ID	Latitude	Longitude	Priority	Day
582	-14.3528488	31.3310202	2	2
586	-14.3535669	31.3265707	2	2
587	-14.3535669	31.3302786	2	2
588	-14.3535669	31.3443686	2	2
592	-14.3542849	31.3265707	2	2
593	-14.3542849	31.3273123	2	2
600	-14.3550029	31.3458518	2	2
601	-14.3550029	31.3488181	2	2
603	-14.355721	31.3273123	2	2
604	-14.355721	31.347335	2	2
605	-14.355721	31.3532676	2	2
606	-14.356439	31.3436271	2	2
607	-14.356439	31.3465934	2	2
612	-14.3571571	31.3517844	2	2
618	-14.3578751	31.329537	2	2
623	-14.3585931	31.3443686	2	2
629	-14.3593112	31.352526	2	2
646	-14.3614653	31.3488181	2	2
647	-14.3614653	31.352526	2	2
648	-14.3614653	31.3532676	2	2
667	-14.3643375	31.3503013	2	2
668	-14.3643375	31.3517844	2	2
669	-14.3643375	31.3554923	2	2
1327	-14.3320257	31.3362113	1	2
1331	-14.3348978	31.3480765	1	2
1334	-14.3370519	31.347335	1	2
1335	-14.338488	31.347335	1	2
1336	-14.3392061	31.3510429	1	2

ID	Latitude	Longitude	Priority	Day
1345	-14.3413602	31.3458518	1	2
1348	-14.3427963	31.3369528	1	2
1350	-14.3435143	31.3325034	1	2
1351	-14.3449504	31.3317618	1	2
1352	-14.3449504	31.3339865	1	2
1360	-14.3463865	31.3436271	1	2
1369	-14.3506947	31.3465934	1	2
1370	-14.3506947	31.3480765	1	2
1375	-14.3542849	31.329537	1	2
1377	-14.3550029	31.3258291	1	2
1379	-14.355721	31.329537	1	2
1381	-14.356439	31.347335	1	2
1383	-14.3571571	31.3310202	1	2
1393	-14.3650555	31.3540092	1	2
1394	-14.3650555	31.3554923	1	2
440	-14.3234092	31.264278	2	3
447	-14.3248453	31.2650196	2	3
451	-14.3269994	31.2561206	2	3
454	-14.3277174	31.2546375	2	3
455	-14.3277174	31.2576038	2	3
456	-14.3277174	31.2635364	2	3
460	-14.3291535	31.2568622	2	3
464	-14.3298715	31.2538959	2	3
465	-14.3298715	31.255379	2	3
475	-14.3327437	31.2635364	2	3
480	-14.3348978	31.264278	2	3
591	-14.3542849	31.2650196	2	3
596	-14.3550029	31.2724354	2	3

ID	Latitude	Longitude	Priority	Day
611	-14.3571571	31.2776264	2	3
615	-14.3578751	31.2702106	2	3
616	-14.3578751	31.2709522	2	3
617	-14.3578751	31.2746601	2	3
621	-14.3585931	31.2739185	2	3
628	-14.3593112	31.2761433	2	3
634	-14.3600292	31.2702106	2	3
1318	-14.3269994	31.2576038	1	3
1320	-14.3277174	31.2561206	1	3
1323	-14.3298715	31.2561206	1	3
1324	-14.3298715	31.2635364	1	3
1326	-14.3313076	31.2613117	1	3
1329	-14.3334617	31.2657612	1	3
1374	-14.3542849	31.2679859	1	3
1384	-14.3578751	31.2724354	1	3
1386	-14.3593112	31.2776264	1	3
45	-14.2293459	31.1856705	2	4
48	-14.2315001	31.1782547	2	4
49	-14.2315001	31.2086595	2	4
50	-14.2315001	31.2205248	2	4
51	-14.2329361	31.1841874	2	4
58	-14.2350903	31.2145921	2	4
62	-14.2365263	31.2160753	2	4
63	-14.2365263	31.2190416	2	4
67	-14.2393985	31.2220079	2	4
1213	-14.230064	31.1797379	1	4
1215	-14.230782	31.1827042	1	4
1216	-14.230782	31.1834458	1	4

ID	Latitude	Longitude	Priority	Day
1217	-14.2329361	31.2086595	1	4
1218	-14.2329361	31.2138506	1	4
1221	-14.2379624	31.2190416	1	4
1223	-14.2408346	31.2234911	1	4
906	-14.4067018	31.1167036	2	5
911	-14.4074199	31.1204115	2	5
918	-14.409574	31.1115125	2	5
919	-14.409574	31.1204115	2	5
920	-14.409574	31.1307936	2	5
927	-14.410292	31.1055799	2	5
928	-14.410292	31.1085462	2	5
929	-14.410292	31.130052	2	5
930	-14.410292	31.1330183	2	5
938	-14.4117281	31.1063215	2	5
939	-14.4117281	31.1270857	2	5
944	-14.4124461	31.1278273	2	5
948	-14.4131642	31.1285689	2	5
1047	-14.4311152	31.0751751	2	5
1048	-14.4311152	31.078883	2	5
1054	-14.4318332	31.0751751	2	5
1055	-14.4318332	31.0759167	2	5
1056	-14.4318332	31.087782	2	5
1060	-14.4325513	31.0885235	2	5
1074	-14.4339873	31.0662761	2	5
1087	-14.4361415	31.0685009	2	5
1094	-14.4368595	31.0633098	2	5
1096	-14.4375775	31.0640514	2	5
1097	-14.4375775	31.0825909	2	5

ID	Latitude	Longitude	Priority	Day
1100	-14.4382956	31.0714672	2	5
1101	-14.4382956	31.0773998	2	5
1102	-14.4382956	31.0781414	2	5
1104	-14.4390136	31.0766583	2	5
1105	-14.4390136	31.0892651	2	5
1113	-14.4404497	31.087782	2	5
1124	-14.4433219	31.0751751	2	5
1125	-14.4440399	31.0729504	2	5
1127	-14.4447579	31.0744335	2	5
1462	-14.4074199	31.1085462	1	5
1466	-14.4088559	31.1144788	1	5
1468	-14.409574	31.1196699	1	5
1469	-14.409574	31.1315352	1	5
1470	-14.410292	31.1233778	1	5
1473	-14.4110101	31.1174452	1	5
1476	-14.4124461	31.1352431	1	5
1523	-14.4303971	31.0907483	1	5
1528	-14.4332693	31.0796246	1	5
1532	-14.4339873	31.0773998	1	5
1536	-14.4347054	31.078883	1	5
1542	-14.4368595	31.0640514	1	5
1543	-14.4368595	31.0907483	1	5
1545	-14.4382956	31.0655346	1	5
1548	-14.4390136	31.0722088	1	5
1550	-14.4397317	31.0803662	1	5

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