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GEOSPATIAL IDENTIFICATION OF BUILT-UP STRUCTURES ALONG THE DISCERNED KAZAURE-KARAUKARAU-KUSHAKA-ILESHA SCHIST BELT

IDENTIFICAÇÃO GEOESPACIAL DE ESTRUTURAS EDIFICADAS AO LONGO DO CINTURÃO DE XISTO KAZAURE-KARAUKARAU-KUSHAKA-ILESHA DISCERNIDO

JONAH, Sunday Adole[1*]; ADEMU, Glory Ojone[2]; ABDULRASAQ, Ahmed Ayinde[3]; ADEOLA, Sheriff Sikiru[4]; BELLO, Abraham Oluwatobi[5]; BALOGUN, John Abiodun[6]; JOSHUA, Emmanuel Olorunleke[7]; SHOTONWA, Roagess John[8]; SAIDU, Salihu[9]

[1-8] Federal University of Technology, School of Physical Science, Department of Physics, Minna, Nigeria
[9]Federal University of Technology, School of Physical Science, Department of Geography, Minna, Nigeria.
**Corresponding author: s.jonah@futminna.edu.ng*
* ORCID: 0009-0002-2017-2611

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ABSTRACT

Background: The desire to create a database of research documents providing information about the tracts of gold deposits across the local geological province provides the impetus for a study of the kind being considered here. Geospatial identification of built-up structures within Phase I Development along the Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt, trending through Minna town and its outlying districts, constitutes the veritable reference material desired in this regard. **Methods:** This study began by segmenting the area of study for ground-based and remotely sensed attribute mapping, using the key reference map from a previous study as the area-of-study guide. A handheld Garmin GPSmap78® global positioning system unit and a standard smartphone with a built-in camera were the key equipment used for the fieldwork. Polygonal-format georeferenced coordinate information was collected at conveniently detached buildings, beginning with the cluster of residential homes at the Staff Quarters, for the ground-based survey. **Result:** Nine of the ten built-up structure clusters on the path of the Belt in Phase I Development were mapped for this study, as well as six neighborhoods in the Minna built-up area beyond Phase I. The nine clusters occupy almost 40% of the *circa* 2 km^2 areal extent of the Phase I Development. The belt's trend and structures were north-northeast. **Discussion:** The nine cluster structures in Phase I and the six neighborhoods of Minna identified in this study have been determined to align with the path of the belt. **Conclusion:** Having now determined that the trace of the belt exits the Campus at the northern sector of the Gidan Kwano village and trends in a long arc beyond the town, this study becomes the desired reference material to be archived and consulted for information relating to gold exploitation in the Minna Area geological province.

Keywords: *Gold; lineament; schist-belt; georeference; remote-sensed.*

RESUMO

Introdução: O desejo de criar uma base de dados de documentos de pesquisa fornecendo informações sobre os traços de depósitos de ouro ao longo da província geológica local fornece o ímpeto para um estudo do tipo aqui considerado. A identificação geoespacial de estruturas edificadas dentro do Desenvolvimento Fase I ao longo do Cinturão de Xisto Kazaure-Karaukarau-Kushaka-Ilesha que se estende através da cidade de Minna e seus distritos periféricos torna-se o material de referência verdadeiro que é desejado a este respeito. **Métodos:** Este estudo procedeu inicialmente com a segmentação da área de estudo para mapeamento de atributos baseado em solo e por sensoriamento remoto, por meio do qual o mapa de referência chave de um estudo anterior foi consultado como guia da área de estudo. Uma unidade portátil de sistema de posicionamento global Garmin GPSmap78® e um smartphone padrão com câmera embutida foram os equipamentos-chave empregados para o trabalho de campo. Informações de coordenadas georreferenciadas em formato poligonal foram coletadas em edifícios convenientemente isolados, começando no conjunto de residências no Alojamento de Funcionários para o levantamento baseado em solo. **Resultado:** Nove dos dez agrupamentos de estruturas edificadas no caminho do Cinturão no Desenvolvimento Fase I foram mapeados para este estudo, bem como seis bairros na área construída de Minna além da Fase I. Os nove agrupamentos ocupam quase 40% da extensão areal de aproximadamente 2 km² do Desenvolvimento Fase I. A tendência do Cinturão e das estruturas nele contidas foi uma inclinação resultante norte-nordeste. **Discussão:** Os nove agrupamentos de estruturas na Fase I e os seis bairros de Minna identificados neste estudo foram determinados como alinhados no caminho do Cinturão. **Conclusão:** Tendo agora determinado que o traço do Cinturão sai do Campus no setor norte da vila Gidan Kwano e se estende em um longo arco além da cidade, este estudo torna-se o material de referência desejado para ser arquivado e consultado para informações relacionadas à exploração de ouro na província geológica da Área de Minna.

Palavras-chave: *Ouro; lineamento; cinturão de xisto; georreferenciamento; sensoriamento remoto*.

1. INTRODUCTION

The vestigial petrographic signature of the Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt that is evidenced at the southern Phase II Development of the Gidan Kwano Campus, conveniently named "Jonahite" for future reference purposes (Jonah, 2021), is a geological lineament valued as the principal repository for gold deposits at the basement complex geological province of Nigeria (Obaje, 2009). Basically, the near-space of clusters of schist outcrops in a contiguous granitic basement environment is also suitable for groundwater accumulation (late Prof. P.I. Olasehinde, Department of Geology, personal communication).

The present built-up and ringed-off operational area of the Gidan Kwano Campus, conveniently termed the Phase I Development, was basically developed without much consideration for the "below-ground" geological nature of this tranche of the Campus. In hindsight, it can be argued that it was a factor of unfortunate circumstance that ensured that the knowledge-base that exists at the moment which indicates that the built-up Phase I Development is situated along a gold-bearing and groundwater-rich schist lineament was not available to the University at the moment the decision was made to develop what has become the present ringed-off land area where the core administrative and academic activities of the University are presently concentrated.

1.1 Research Question

Knowing that a body schist-rock lineament mapped in the predominant granitic mass of the basement complex rock of central Nigeria (especially those occurring west of longitude 8˚) is veritable gold repository (Obaje, 2009), could a dedicated study mapping the extension of one such linament through the built-up areas of Minna be the basis for re-calibrating to a higher degree of accuracy the gold-bearing character of Minna?

1.2 Aim

This study aims to carry out ground-based geospatial and remotely sensed mapping of built-up attributes along the Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt, including the ringed-off Phase I Development of the Gidan Kwano Campus, and in the northeast and southwest directions where this belt trends beyond the built-up Phase I Development.

1.3 Objectives

The objectives of this study are the following: implementing ground-based, "foot-on-the-ground" geospatial data collection and archiving of built-up structures on the Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt on its trending path through the Phase I Development, and applying remote-sensed satellite imaging techniques to extend the scope of attribute-identification techniques beyond the recognised Phase I Development identified for this study along the northeast path.

1.4 Expected Outcomes

The result of this study will be vital in the planning schedules for the near-term and long-term build-up development of the tranches of land areas contiguous to the presently-defined Phase I Development of the Gidan Kwano Campus as a useful guide to make informed decisions as to how to commit to groundwater-resources exploitation and setting a programme for eventual mining of solid minerals.

According to Jian and Philippa (2009), latitude can be defined as the angle between the equator and a line perpendicular to the ellipsoid, which ranges from 90° North or south of the equator. Latitude is commonly given the Greek symbol phi (ϕ), and longitude is lambda (λ). A line of constant latitude is known as a parallel. Parallels never meet since they are parallel to one another, whereas meridians (lines of longitude) converge at the poles. The authors also pointed out that longitude is more complex: only east-west measurements made at the equator are true; away from the equator, where approximately the cosine of the latitude increasingly shortens the lines of latitude, measurements decrease in length. This means that at 30° north (or south), shortening is about 0.866; at 45°, 0.707; and at 60 °, 0.5. At 60° north or south, 1° of longitude will represent 55 km ground distance.

The Universal Transverse Mercator (UTM) is a *geographic coordinate system* that uses a two-dimensional (2-D) *Cartesian coordinate system* to locate points on the surface of the earth. It is a *horizontal position representation*, that is, it is used to identify locations on the earth independently of *vertical position*, but differs from the traditional method of latitude and longitude in several respects. The UTM system is not a single *map projection*. The system instead divides the earth into sixty zones, each a six-degree band of longitude, and uses a secant *transverse Mercator projection* in each zone.

Jian and Philippa (2009) stated that a further modification of the Mercator allows the production of the Universal Transverse Mercator (UTM) projection system. It is again projected on a cylinder tangent to a meridian [as in the Transverse Mercator (TM)] and by repeatedly turning the cylinder, about its polar axis, the world can be divided into 60 east-west zones, each 6° longitude in width. The projection is conformal so that shapes and angles within any small area will be preserved. This system was originally adopted for large-scale military maps of the world, but it is now a global standard and is again useful for mapping large areas oriented north-south. Projected UTM grid coordinates are then established, which are identical between zones. Separate grids are also established for both northern and southern halves of each UTM zone to ensure there are no negative northings in the southern hemisphere. Hence, when quoting a UTM grid reference, it is essential to state eastings, northings, zone number and the hemisphere (north or south) to ensure clarity.

Ruihua *et al.* (2025) observed that by extending synthetic aperture technology from a microwave band to a laser wavelength, synthetic aperture ladar (SAL) achieves extremely high spatial resolution independent of target distance in long-range imaging. The authors pointed out that nonlinear phase correction is a critical challenge in SAL imaging. To address phase noise during the imaging process, they first analyzed the theoretical impact of nonlinear phase noise on imaging performance. Subsequently, a reconstruction and compensation method based on orthonormal complete basis functions was proposed to mitigate nonlinear phase noise in SAL imaging. The authors noted that the simulation results validate the accuracy and robustness of the proposed method, while experimental data demonstrate its effectiveness in improving system range resolution and reducing the peak side lobe ratio by 3 dB across various target scenarios. The authors concluded that this advancement establishes a solid foundation for the application of SAL technology in ground-based remote sensing and space target observation.

According to Yiqing *et al.* (2025), accurate, real-time, and dynamic monitoring of crop planting distributions in hilly areas with complex terrain and frequent meteorological changes is highly important for agricultural production. Thus, dual-polarization synthetic-aperture radar has significant application value in feature classification and crop distribution extraction due to its all-day, all-weather operation, large mapping bandwidth, and ease of data acquisition. The authors contended that to explore the feasibility and applicability of dual-polarization synthetic-aperture radar data in crop monitoring, their study was based on two basic methods of dual-polarization decomposition (eigenvalue decomposition and three-component polarization decomposition) to construct time series of crop dual-polarization radar vegetation indices; their study scope was full coverage analysis of crop distribution extraction in dryland mountainous areas of southeastern China. The authors noted that on the basis of the Sentinel-1 dual-polarization radar vegetation indices, the time-series classification and rapeseed distribution extraction impacts were compared using southern Hunan Province's principal rapeseed (*Brassica napus L.*) production area as the study area. The authors concluded that three-component polarization decomposition was more suitable than other methods for crop information extraction and remote sensing classification applications involving dual-polarized SAR data.

Jiaguo *et al.* (2025) remark that Spatial disparities in rangeland conditions across Kazakhstan complicate field-based assessments of livestock-carrying capacity (LCC), a critical metric for the country's food security and economic planning. Thus, the authors developed a geospatial livestock-carrying capacity (GLCC) modeling framework to quantify LCC spatio-temporal dynamics at the Oblast level, by integrating satellite-derived data on vegetation, water resources, and terrain with in situ measurements. The authors observe that by providing ground-truth observations and contextual details, field-based measurements complement remote sensing data, helping to validate estimates and improve the reliability of the GLCC model. The modeling framework was successfully applied and validated in a case study in the Akmola Oblast, Kazakhstan, to specifically map the spatial and temporal distributions of LCC, using publicly available MODIS NPP data and in situ data from 51 field sites. The authors reported that the modeling results showed distinct spatial patterns of LCC across the Oblast, reflecting variability in rangeland productivity with higher values concentrated in southern and southeastern regions (up to 0.5 animals/ha). The results also showed significant interannual LCC fluctuations (ranging from 0.099 to 0.17 animals/ha), possibly due to rainfall variability, and thus serve as an indicator of climate-related risks for livestock management. Whilst noting that there is still room for further improvement, particularly in model parameterization to account for grazing pressures, forage quality, and livestock species, the authors concluded that the GLCC modeling framework is a simple tool for mapping livestock-carrying capacity, a more meaningful indicator for rangeland managers. Further, this work underscores the value of integrating remote sensing with field-based observations to support data-driven rangeland management planning and resilient investment strategies.

2. MATERIALS AND METHODS

2.1 Materials

2.1.1 Handheld Global Positioning System (GPS) Unit

The handheld Garmin GPSmap78® global positioning system unit shown in Figure 1 was employed to georeference built-up areas of interest in polygonal formats that were occupied for this study. The GPSmap78® is a high-sensitivity GPS with proprietary HotFix® coordinate-fixing software, an in-built 3-axis compass, and a barometric altimeter. This GPS unit also features 1.7 GB of internal memory and up to 20 hours of battery life (dual AA batteries, that is).

***Figure 1**. Handheld Garmin GPSmap78®*

2.1.2 Phone with Built-in Camera

A standard smartphone with a built-in camera was used to capture images of the corresponding georeferenced built-up polygons, as shown in Figure 2.

***Figure 2**.. Standard smartphone with built-in camera*

2.2 Methods

2.2.1 Study Area Segmentation for Ground-based and Remotely-sensed Attribute Mapping

At the outset, the map from the work of Jonah (2021) showing fault-trace of fracture signatures inferred from a combination of the geoelectric cross-sections and the qualitative induced polarisation tables from that study on the satellite image map of the southern Phase II Development was consulted as area-of-study guide by which investigation proceeded in the northeast-southwest sense into the built-up Phase I Development that is also visible on the map. The northeast trace beyond the Phase I Development is the extent of the area of investigation by remote-sensing techniques. The map segmentation format is as shown in Figure 3.

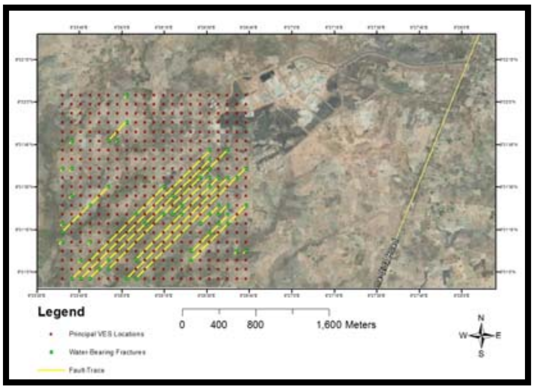

Figure 3*. Map segmentation format for ground-based and remotely sensed attribute mapping (Source: Jonah, 2021)*

2.2.2. Ground-Based Attribute Mapping

Using the map of Figure 3 as a guide, built-up attributes on the northeast extension of the maximum width of the yellow-colored parallel lines (*circa* 2200 width) were georeferenced in polygonal modes, beginning from the lecturers' quarters at the extreme southwest of the ringed-off Phase I Development to the University's administration block (that is, the Senate Building) at the northeast. To adequately capture the geographic attributes of a built-up structure, such as a building, in GIS space, it is necessary to represent its spatial extent by acquiring its coordinates at the typical four corners of the building (the tetragon). However, architectural design requirements mean that many built-up structures are not necessarily tetragonal but "multi-sided" or "polygonal"; hence, the requirement to also acquire geographical attributes at the corners of such buildings.

Georeferencing built-up structures for this study was not in an arbitrary format; the map in Figure 3 served as the guide, so that buildings along the discerned schist lineament were earmarked for geographic attribute survey. Since the width of the discerned schist lineament trending through the Phase I Development is *circa* 800 m, all built-up structures (100%) along this lineament were visited for the acquisition of geographic attribute data. These attributes were chiefly latitude and longitude information (the x- and y-coordinates) determined at the corners of the buildings by the handheld Garmin GPSmap78® global positioning system unit, plus information on the date and time of visit, weather, and a local-nomenclature identifier, rendering these buildings easy to identify. Information about elevation above mean sea level (the z-co-ordinate) was considered a redundancy factor and thus ignored.

The Garmin GPSmap78, being motion-sensitive, must be held at the point of measurement in static-motion mode to extract the x- and y- coordinate information.

2.2.3 Remoted-Sensed Attribute Mapping

Remotely sensed attribute mapping of the area beyond Phase I Development was aided by recourse to QuickBird satellite imagery with 0.65 m panchromatic resolution, acquired on 20th July 2023, sourced from Datanet Services, Minna, Nigeria.

3. RESULTS AND DISCUSSION

3.1. Results

Figure 3 and Figure 4 provide the platforms upon which the data presentation aspect of the study under consideration herein rests.

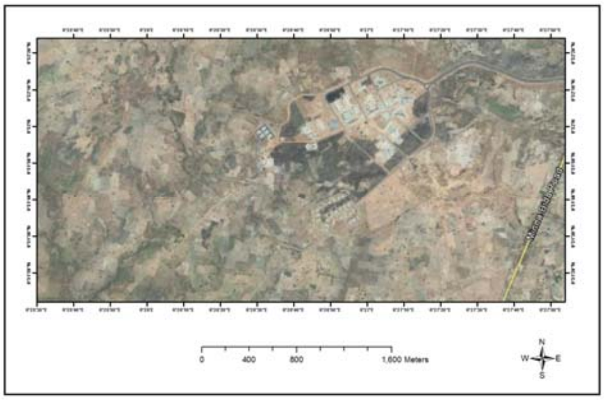

Figure 4*. Satellite imagery map of the Phase I Development (Source: Jonah, 2024)*

3.1.1 Ground-Based Attribute Mapping

3.1.1.1 Staff Quarters

In Figure 5, the apartments of the Staff Quarters (latitude-longitude degree-minute-second coordinates for apartments 1 to 4 only are provided in the attached tables) of the Gidan Kwano Campus, located between UTM 1053700:1054300 and 219500:220000 are identified as being on the route of the northeast-trending Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt.

3.1.1.2 Works Department

The Works Department complex shown in Figure 5, between UTM 1054300: 1054600 and 220000: 220500, although located just outside Phase I Development, lies along the northeast-trending Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt.

3.1.1.3 School of Information and Communication Technology

The School (that is, Faculty) of Information and Communication Technology (ICT) complex shown in Figure 5, between UTM 1054300: 1054900 and 220000: 220500, is located along the northeast-trending Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt.

3.1.1.4 School of Agriculture and Agricultural Technology

The School of Agriculture and Agriculture Technology complex shown in Figure 5, between UTM 1054600: 1055200 and 219500: 220500, is located along the northeast-trending Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt.

3.1.1.5 Senate Building

The Senate Building shown in Figure 5, between UTM 1054600: 1054900 and 220000: 220500, and just northeast of the School of Agriculture and Agriculture Technology complex, is located along the northeast-trending Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt.

3.1.1.6 Schools of Engineering Complex

The built-up complex of the School of Engineering and Engineering Technology and the School of Infrastructure and Process Technology, shown in Figure 5 between UTM 1054600: 1055200 and 220000: 220500, is located along the northeast-trending Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt.

3.1.1.7 School of Environmental Technology Complex

The built-up complex of the School of Environmental Technology and its adjunct Lecture Theatre, shown in Figure 5, between UTM 1054900: 1055200 and 220000: 220500, is located along the northeast-trending Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt.

3.1.1.8 Centre for Open and Distance e-Learning (CODeL)

The built-up complex of the Centre for Open and Distance e-Learning (CODeL), shown in Figure 5, between UTM 1054900: 1055200 and 219500:220000, is located along the northeast-trending Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt.

3.1.1.9 Chapel of Grace

The built-up Chapel of Grace shown in Figure 5 between UTM 1054900: 1055200 and 219000: 219500, located just outside the Phase I Development on the northwest corner, is not located along the northeast-trending Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt.

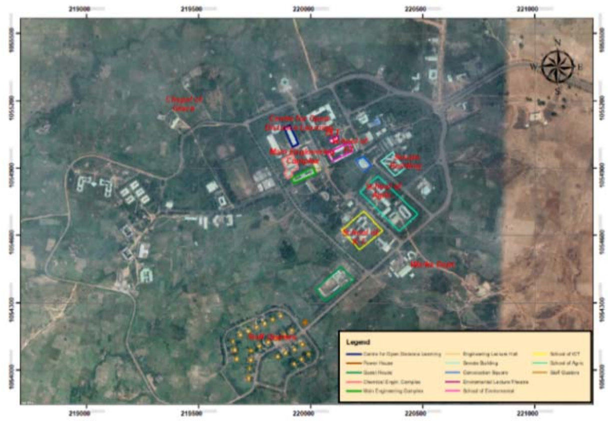

***Figure 5**. Identified built-up attributes along the diagonal vestigial trace of the Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt through the Phase I Development*

3.1.2. Remoted-Sensed Attribute Mapping

3.1.2.1 Northeast Sector Beyond Phase I Development

On an extended northeast trend of the schist belt beyond the Phase I Development, the next sector for this study is the northeastern sector of Phase I Development-cum-Minna-Bida Road-cum-northern sector of Gidan Kwano Village, as shown in Figure 6.

***Figure 6**. Northeastern sector of Phase I Development-cum-Minna-Bida Road-cum-northern sector of Gidan Kwano Village captured on satellite map*

3.1.2.2 Talba Housing Estate

On a further extended northeast trend of the schist belt beyond the "Northeast Sector Beyond Phase I Development," the next sector for this schedule of study is the Talba Housing Estate area, seen in Figure 7.

***Figure 7**. The Talba Housing Estate area captured on satellite map*

3.1.2.3 Minna South Area

On a futher extended northeast trend of the schist belt beyond the Talba Housing Estate, the next sector for this schedule of study is the Minna South Area seen in Figure 8.

***Figure 8**. Minna South Area captured on a satellite map in its relative position to the settlement of Kpakungu*

3.1.2.4 Central Minna

On a further extended northeast trend of the schist belt beyond the Minna South Area, the next sector for this study is the Central Minna area, as seen in Figure 9.

***Figure 9**. Central Minna area captured on a satellite map*

3.1.2.5 Maitumbi East

On a further extended northeast trend of the schist belt beyond the Central Minna area, the next sector for this study is the Maitumbi East neighborhood, seen in Figure 10.

***Figure 10**. Maitumbi East neighbouhood along the Minna Eastern Bye-Pass captured on satellite map*

3.1.2.6 Gwada

On a futher extended northeast trend of the schist belt beyond the Maitumbi East neighborhood, the next sector for this schedule of study is the Gwada Area seen in Figure 11.

***Figure 11**. Gwada Area is a veritable distant suburb lying northeast of the Maitumbi neighborhood*

3.2. Discussion

3.2.1. Ground-Based Attribute Mapping

3.2.1.1. Staff Quarters

The 25 units of housing in the Staff Quarters, forming neatly separated rows in a cluster and, albeit terribly short in number, to accommodate all academics, are located at the southern fringe of the built-up and ringed-off Phase I Development, about 600 m from the centerline of the discerned Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt.

3.2.1.2 Works Department

The Works Department complex, located on a straight northeast route from the southernmost fringe of the Staff Quarters some 500 m away across the University Golf Course and just outside the Phase I Development, is on the northeast extremity of the Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt about 600 m from the centerline.

3.2.1.3 School of Information and Communication Technology

The School of Information and Communication Technology is located on a straight northwestern course, 100 m from the Works Department and about 500 m from the centerline of the Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt.

3.2.1.4 School of Agriculture and Agricultural Technology

The School of Agriculture and Agricultural Technology (SAAT) is a relatively large complex of buildings across a secondary road, some 20-30 m to the northeast of the School of Information and Communication Technology complex. The northwesternmost edge of SAAT is about 300 m from the centerline of the Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt.

3.2.1.5 Senate Building

The Senate Building grounds are located some 50 to 60 m across a roadway from the SAAT complex, in a northeasterly direction, about 250 m from the centerline of the Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt.

3.2.1.6 Schools of Engineering Complex

The Schools of Engineering Complex, located some 300 m northwest of the School of Information and Communication Technology, lies on the centerline of the Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt.

3.2.1.7 School of Environmental Technology Complex

The School of Environmental Technology Complex, shown as the purple rectangle in Figure 5 and located some 50 to 60 m across a roadway from the Schools of Engineering Complex, is only *circa* 70-80 m away from the centerline of the Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt.

3.2.1.8 Centre for Open and Distance e-Learning (CODeL)

The grounds of the Centre for Open and Distance e-Learning (CODeL) is almost contiguous with the grounds of the Schools of Engineering Complex. The CODeL complex is located just northeast of the Schools of Engineering Complex, smack on the centerline of the Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt.

3.2.1.9 Chapel of Grace

The Chapel of Grace is clearly situated within the 2200 m generic width of the Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt, approximately 550 m northwest of the centerline, as illustrated in Figure 5. While the student hostel complex buildings also fall within this defined generic width, ground-based survey work in the vicinity and at the peripheries of these structures is generally inadvisable due to unsanitary conditions resulting from inadequate sanitation infrastructure and the resulting surface contamination with human waste around the buildings.

3.2.2. Dataset of Ground-Based Attributes

The information dataset for this study was recorded on a purpose-specific data sheet. The coordinate information from the ideal four-corner building was the targeted “polygon” sought. However, some rather large buildings are not exactly shaped like ideal tetragonal forms as determined by the architects, and for these and other built-up structures, coordinate information was obtained from the many-sided attributes of such buildings. Some of the attribute information for this study are presented in Tables 1 to 8. Some of the built-up structures, especially apartments, are more often than not restricted-access areas; thus, even for structures aligning in perfect north-south or east-west trends, slight variations are noticeable in their assumed geographic coordinate orderings.

3.2.3. Remoted-Sensed Attribute Mapping

3.2.3.1 Northeast Sector Beyond Phase I Development

In Figure 6, the Minna-Bida highway forms the principal backdrop for the clusters of shacks and hovels that comprise Gidan Kwano Village (the university campus was named in honor of this village, the *primus* settlement in those parts). The satellite imagery faithfully follows a northeast trend with great fidelity, aligning with the schist belt lineament to capture this sector for this study's schedule.

3.2.3.2 Talba Housing Estate

Figure 7 captures the broader area of the well-known Talba Housing Estate on the extended northeast trend of the schist belt, as the next sector for this study. This figure shows that the Minna-Bida highway follows the northeast trend of interest in this study. However, on both sides of this roadway are dense settlement clusters that lie along the Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt. The Talba Housing estate proper is opposite the Newgate College of Health Science nd Technology (now the Newgate University). Another prominent feature noted in Figure 7 is the approximate northwest-southeast course of a major seasonal stream that drains the northern segment of Minna town during the rainy season from May to October each year. Illegal gold mining by panning alluvial soil is characteristic of activities at the banks of the seasonal stream skirting the Talba Housing Estate.

3.2.3.3 Minna South Area

In Figure 8, it is observed that the course of the Minna-Bida highway terminates at the Kpakungu Roundabout from whence the southeast roadway leads to the neighborhoods of Barkin Sale, Sauka ka Kuta, Shango, Army Barracks, and Chanchaga. The opposite branch of the roadway, towards the northeast, leads to the neighborhoods of Oduoye Estate, Fadikpe, Dutsen Kura, Bosso, and, further out, to Maikunkele.

3.2.3.4 Central Minna

In Figure 9, the Eastern Bypass is now visible as the bold linear streak to the east of this illustration. The Central Minna built-up zone, as expected, is extensive, and attention in this study is focused on the rightward segment of the map in Figure 9, which is veritable east of town along the recognised northeast trend of the vestige of the Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt.

3.2.3.5 Maitumbi East

In Figure 10, the Eastern Bypass is now centrally located, terminating at a roundabout in the Maitumbi built-up neighborhood before proceeding northward to the Maikunkele neighborhood. Much of the land area in the lower right of Figure 10 (that is, the southeast) and the upper right (that is, the northeast) along a defined northeast course is presently a beehive of illegal gold-mining activities that the government periodically cracks down on.

3.2.3.6 Gwada

The Gwada area in Figure 11 is on a northeasterly course away from the built-up Maitumbi neighborhood, which every resident of Minna accepts as the “edge of town.” True to form, beyond the Maitumbi “edge of town,” Gwada and its environs are shorn of vegetation covers as extensive cultivation and poor land-use practices, plus heavy wood-cutting activities for household fuel needed mainly for cooking, combine to create the bleak landscape. The Gwada area is primarily an agrarian station for weekly markets, where the principal local staple, yam, is sold on weekends at the popular open-air Gwada Yam Market. Given the rustic, countryside setting, the adobe buildings of the built-up zone almost merge with the surrounding bleak landscape on satellite imagery. Nonetheless, beneath this bleak, Mars-like landscape are indications of gold-bearing veins, as illegal gold extraction has spilled over from the capital city of Minna into the Gwada area.

4. CONCLUSIONS

4.1 Ground-Based Attribute Mapping

The Staff Quarters and Works Department complexes at the Gidan Kwano Campus “sit” on ground beneath which lies the bodies of two valuable resources that the University should have archived in its repository of assets were it not for the structural developments at this location. This Staff Quarters cluster occupies *approximately 10% or less* of the land area of the Phase I Development. The School of Information and Communication Technology building complex is situated on a surface area above prospective groundwater and gold mineral deposits. The SAAT complex, the second-largest built-up complex of buildings after the Staff Quarters and thus less that 10% of the land area of the Phase I Development, is situated on grounds beneath which lies groundwater and gold-mineral deposits. The Senate Building grounds, located near the centerline of discerned subsurface fault-traces associated with substantial groundwater accumulation, should naturally correlate with the expectation that the subsurface regime of this administrative building is hydro-centric, with aquifers. This fact was mentioned in passing to the Vice-Chancellor in March 2023 by the lead author when a presentation of the results of Jonah (2021) was made to the Vice-Chancellor to establish the basis for exploring the prospect of university-government collaboration in order to exploit the groundwater resources at the locations to the southwest of the built-up Phase I Development.

The joke there, too was the Senate Building has covered up a “gold mine.” The location of the Schools of Engineering Complex, smack on the centerline of the fault-trace extensions in a northeasterly direction, corresponding to the Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt, leads to the conclusion that groundwater-prospecting locations should characterize the vicinity of this Complex.

In hindsight, the conclusion reached in Udensi *et al.* (2006) with respect to groundwater prospects identified in that study is validated by Jonah (2021) if the clusters of yellow line fault-traces are extended tthrough the area corresponding to “the north of the Staff Quarters and the east of the students’ hostels” (the area of study of Udensi *et al.,* 2006). That area, outside the study grid of Jonah (2021) and marshy-greenland, is still undeveloped but is now put to use as a veritable agronomic and botanical station. The conclusion in Udensi et al. (2006) was more upbeat about groundwater prospects than that in Udensi *et al.* (2005). The areas of study of Udensi *et al.* (2005) and Udensi *et al.* (2006) are effectively adjacent to one another. Alas, the nine identified groundwater prospect locations of Udensi *et al.* (2006) out of a total of sixty-six stations surveyed were not identified by georeferenced coordinates back then in the year 2006 (electronic GPS units were not available to investigators over here although traditional field triangulation and survey techniques should have been employed) and thus it becomes really difficult to integrate this information into the archive of database of groundwater prospects that S.A. Jonah is building for the developing portions of the Gidan Kwano Campus. From the Jonah (2021) study, gold-mineral prospects for the area of study by Udensi et al. (2006) can be inferred, information not included in the 2006 survey year.

The School of Environmental Technology (S.E.T.) complex, which currently houses the E-Exam Centre established in 2023, was not designated as "hydro-centric" in the aforementioned 2006 study due to the absence of significant fractures and insufficient thickness of the unconsolidated layer in this area. The representation in Figure 3, derived from Jonah (2021), supports this conclusion, as no yellow line fault-trace extends into the present vicinity of the E-Exam Centre.

The apparent terminations of yellow line fault-traces at the 15th stations of cross-traverses within the 2 km x 2 km grid of Figure 3 warrant clarification. During the survey campaign conducted between 2011 and 2014, which culminated in the Jonah (2021) publication, survey stations in proximity to the student hostel complex were deliberately excluded from the investigation. This decision was necessitated by health and safety considerations, as these areas were subject to unsanitary surface conditions resulting from inadequate sanitation infrastructure. The vertical electrical sounding methodology employed with the ABEM Terrameter SAS 4000 requires electrical cables to be laid along the ground surface over considerable distances to facilitate data collection at greater depths, making work in contaminated areas impractical and hazardous.

The assessment regarding gold-deposit potential applies equally to the E-Exam Centre area. Since schist bodies within the local geology constitute the favorable gold-bearing medium, the indication of granitic rock mass at this section of Phase I Development effectively eliminates the possibility of economically viable gold deposits in this tract of land.

The grounds of present-day CODeL, though located on the centreline of a schist lineament, is not crossed by extensions of yellow line fault-trace clusters (deciphered on Figure 3) in the manner that would lead to the conclusion that this complex is basically and essentially “hydro-centric.” In actuality, the fact on the ground is that in the northwest area of the CODeL grounds outside the beltway portion at this side is a spread of outcropping granitic rock masses in the general directions towards the north and northwest. It is remarkable to note here that examination of Figure 3 shows that there are virtually no remarkable yellow line fault-traces that are mapped on the far southwest side of these outcropping granitic rock masses located on the grid of the Jonah (2021) study, except for a scattering of mainly single-point prospect locations. Interestingly, this “far southwest side” encompasses the “$1\ \mathrm{km} \times \frac{1}{2}\ \mathrm{km}$ to the west of the students’ hostels at the Gidan Kwano Campus” study area of Salako and Udensi (2005).

The buildings of the students’ hostel complex on the northwestern end of Figure 5 were not captured for this study because they fall outside the route of the yellow line fault-traces and their extensions, that is, the vestigial trace of the Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt. Salako and Udensi (2005) conclude that “the aquifer system of the survey area can be located on the north-central and northeastern portions of the area of study.” The aquifer system identified by Salako and Udensi (2005) is validated by Jonah (2021) as corresponding to the “mainly single-point prospect locations" scattered throughout the northwestern portion of the grid shown in Figure 3, which is not encouraging for any plan to develop a groundwater exploitation and distribution system. No wonder Salako *et al.* (2010), which incorporated the seismic survey method, was designed as a follow-up study to Salako and Udensi (2005) to gain greater insights into the groundwater prospect regime in the study area. The conclusion of Salako *et al.* (2010) mirrors that of Salako and Udensi (2005). This fact is now unarguably a resounding validation of the principal conclusion of Jonah (2021) presented herein as Figure 3. Basically, the study areas of Salako and Udensi (2005) and Salako et al. (2010) are not suitable areas for prospecting for gold mineral deposits.

The Chapel of Grace is located on the larger "northwest area of the CODeL grounds outside the beltway portion" of the Phase I Development that is marked by "a spread of outcropping granitic rock masses." As can be seen in Figure 3, there are no clusters of yellow line fault-traces to the far southwest of the Chapel of Grace within the grid of the Jonah (2021) study shown in Figure 3 that would lead to designating the area of the Chapel with much confidence as "hydro-centric." This fact also eliminates any correlation with gold prospect occurrence.

4.2 Remoted-Sensed Attribute Mapping

The Northeast Sector remains largely undeveloped, free from the encroachment of informal settlements that characterize other areas. This zone presents significant potential for underground freshwater development schemes, as it has not yet been compromised by the widespread sanitary deterioration and environmental contamination that plague the larger Minna built-up area. The preservation of this sector's environmental integrity makes it particularly suitable for water resource development.

Activities of unauthorized miners along the banks of the seasonal stream bordering the Talba Housing Estate area have provided strong evidence of gold presence in this locality. Given the accelerating pace of structural development in these parts, further geological studies are warranted to delineate the extent of mineral prospects. Such investigations should be conducted promptly before development activities intensify further.

The extensive urbanization of the Minna South Area presents substantial challenges for gold prospecting assessment. The density of existing structures effectively precludes any large-scale mining operations, regardless of assay results. This reality underscores the importance of proactive resource planning in less developed sectors.

The portion of Central Minna designated for the "New Minna" development, as illustrated in Figure 9, remains relatively free from structural development. With construction activities currently stalled, a strategic opportunity exists to designate this zone for dedicated geological and resource studies. This window for intervention should be leveraged to establish protective measures before development resumes.

The areas of interest in Maitumbi East extend in a northeasterly direction, contiguous with the "New Minna" zone. Both areas show promise for gold occurrence and groundwater resources. The logical course of action involves designating this broader corridor as an exclusive resource zone, thereby protecting it from haphazard development while enabling systematic resource assessment.

Gwada has historically served as an agricultural service center for Minna, but Minna's urban influence has limited its growth into a major settlement. Recent findings confirm that Gwada lies along the Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt. Should further geological studies and assaying work indicate commercially viable gold deposits, the designation of the greater Gwada area as a dedicated economic zone becomes imperative for strategic resource development.

4.3 Recommendations

It is recommended that the Federal University of Technology, Minna, fully adopt the observations arising from this study to enhance or further refine physical development schemes for the University, especially in the built-up Phase I Development. Moreover, the University should integrate the observations made herein with in-house endeavors that have identified gold-mineral potential along the southwest extension of the trace of the Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt. In the same vein, the Niger State Government should fully adopt the observations arising from this study to enhance or further refine physical development schemes for the built-up Minna town. By this, then, prospective groundwater areas can be cleared and relocated so that large-scale exploitation of the continuous line of groundwater points can be initiated as a supplement to the insufficient surface-water supply system for Minna town. The areas on the trace of the Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt that have not yet been heavily built-up can be set aside as veritable and protected “economic-mineral zones” for modern mining activities.

5. DECLARATIONS

5.1 Study Limitations

Actually, the full diagonal traverse of the Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt across Nigeria is approximately 700 km (Jonah, 2021). Given the importance of this traverse for groundwater and gold repositories, a comprehensive study of the nature presented herein would have followed this traverse across various towns and villages in southwest Nigeria, from Ilesha to northeast Nigeria, at Kazaure, to highlight the previously unknown economic potential of these settlements. On the back of a full-body study such as this, it becomes even more crucial for security planners to narrow the banditry threat zones to specific corridors, as indications of alluvial gold deposits along this belt have attracted armed marauders to invade and engage in illegal mining. A federal government grant must necessarily sponsor a full-body study of this nature. In the absence of any such grant, this study has compiled the requisite information for the Minna Area geological province, which can be consulted by the Federal University of Technology, Minna, and the Niger State Government, whose administrative headquarters is located in Minna.

5.2 Acknowledgements

The authors express their sincere gratitude to the Federal University of Technology, Minna, for providing the institutional support and research facilities that made this study possible. We would like to acknowledge the Department of Physics, School of Physical Sciences, for granting us access to laboratory equipment and field research permissions on the Gidan Kwano Campus.

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In accordance with the principles of transparent scientific communication, we declare that this work was conducted using the research infrastructure and facilities provided by the Federal University of Technology, Minna, Nigeria. The University provided essential support through access to laboratory equipment, field research permissions within the Gidan Kwano Campus, and computational facilities. However, no direct financial support was allocated specifically for this project.

The authors confirm that no commercial interests, external funding bodies, or third-party organizations influenced the design, execution, or interpretation of this research. This independence ensures that all findings and conclusions presented herein reflect solely the scientific evidence gathered and analyzed by the research team, maintaining complete integrity in the research process and data interpretation.

In accordance with the ethical guidelines of the Southern Journal of Sciences, which do not allow donations from authors with manuscripts under evaluation (even when research funds are available) or in cases of authors' financial constraints, publication costs were fully absorbed by the journal under our Platinum Open Access policy, through the support of the Araucária Scientific Association (https://acaria.org/). This policy aims to ensure complete independence between the editorial process and any financial aspects, reinforcing our commitment to scientific integrity and equity in knowledge dissemination.

5.4 Competing Interests

The authors declare that there exists no conflict of interest whatsoever arising from the preparation of this manuscript for publication with any other competing interests, whether they be of the authors’ or of second parties and third parties thereof. The data employed in the enunciation of the textual material herein are original, having been duly acquired by the authors as part of the annual undergraduate schedule of project supervision here at the Federal University of Technology, Minna, Nigeria. This body of data field, duly archived for validation and reference purposes, are available for integrity checks anytime.

5.5. Open Access

5.6. Author Contributions

S.A.J. conceived the study design, conducted field surveys, and wrote the manuscript. G.O.A. contributed to data collection and GPS measurements. A.A.A. assisted with satellite imagery analysis and interpretation. S.S.A. and A.O.B. participated in field data collection and equipment calibration. J.A.B. and E.O.J. contributed to data analysis and manuscript review. R.J.S. assisted with remote sensing analysis. S.S. provided geographical expertise and manuscript review. All authors read and approved the final manuscript.

6. REFERENCES:

1. Adesoye, S.A. (1986). Master Plan of the Federal University of Technology’s Permanent Site, Minna, Adesoye and Partners, Kaduna, Nigeria.
2. Jiaguo, Q., Zihan, L., Weltz, M. A., Spaeth, K. E., Iskakova, G., Nesbit, J., ...Toledo, D. (2025). A geospatial livestock-carrying capacity model (GLCC) in the Akmola Oblast, Kazakhstan. *Remote Sensing, 17*(8), 1477. doi.org/10.3390/rs17081477
3. Jian, G.L., & Philippa, J.M. (2009). Essential Image Processing and GIS for Remote Sensing, Wiley-Blackwell, United Kingdom (UK).
4. Jonah, S.A. (2021). Series of 1-D ER and IP traverses reveal vestige of regional geological structure. Applied Journal of Physical Science, 3(2), 37-60. (Paper ID: EA9433402)
5. Jonah, S.A. (2024). Dual Geoelectrical Survey Regime to Profile Groundwater Occurrence at an East-Central Tranche of the Gidan Kwano Campus, Minna, Nigeria, Unpublished Synopsis for PhD Thesis, Federal University of Technology, Minna, Nigeria.
6. Obaje, N.G. (2009). Geology and mineral resources of Nigeria. In Lecture Notes in Earth Sciences. Springer-Verlag, Berlin.
7. Ruihua, S., Juanying, Z., Dong, W., Wei, L., Yinshen, W., Bingnan, W., & Maosheng, X. (2025). Nonlinear phase reconstruction and compensation method based on orthonormal complete basis functions in synthetic aperture ladar imaging technology. Remote Sensing, 17(8),1480.doi.org/10.3390/rs17081480
8. Salako, K.A., & Udensi, E.E. (2005). Vertical electrical sounding investigation of the western part of the Federal University of Technology, Minna. Proc: First Annual School of Science Education Conference (Federal University of Technology, Minna), 1, 69-78.
9. Udensi, E.E., Ogunbajo, M.I., Nwosu, J.E., Jonah, S.A., Kolo, M.T., Onoduku, U.S., ... Crown, I.E. (2005). Hydrogeological and geophysical surveys for groundwater at designated premises of the main Campus of the Federal University of Technology, Minna. Zuma Journal of Pure and Applied Science, 7(1), 52-58.
10. Udensi, E.E., Unuevho, C.I., Jonah, S.A., Ofor, P.N., Adetona, A.A., Salako, K.A., ... Gana, C.S. (2006). Geoelectrical survey for groundwater at the Gidan Kwano Campus of the Federal University of Technology, Minna. Environmental Technology and Science Journal, 1(1), 16-48.
11. Yiqing, Z., Hong, C., Shangrong, W., Yongli, G., & Qian, S. (2025). Rapeseed area extraction based on time-series dual-polarization radar vegetation indices. Remote Sensing, 17(8), 1479. doi.org/10.3390/rs17081479

Table 1. Attribute Information of Staff Apartment Number 1

DEPARTMENT OF PHYSICS
SCHOOL OF PHYSICAL SCIENCES
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE

Title of Project: Geospatial Identification of Built-up Structures in Phase I Development of the Gidan Kwano Campus and Beyond Along the Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt

Date: ………*8th July, 2023*………………. Time: ……*11:27 a.m*.……

Weather: ……*Fine*……………………

Principal Information:

1. **Geospatial Info**

Polygon 1

S/N	LATITUDE	LONGITUDE
1.	09˚31′31.50″	006˚26′49.70″
2.	09˚31′31.60″	006˚26′49.20″
3.	09˚31′32.10″	006˚26′49.40″
4.	09˚31′32.00″	006˚26′49.90″

2. **Location Attributes**
   Local-nomenclature Identifier:- *Staff Apartment Designated #1*

Table 2. Attribute Information of Staff Apartment Number 2

DEPARTMENT OF PHYSICS
SCHOOL OF PHYSICAL SCIENCES
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE

Title of Project: Geospatial Identification of Built-up Structures in Phase I Development of the Gidan Kwano Campus and Beyond Along the Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt

Date: ……… *8th July, 2023*……………………… Time: ………*11:34 a.m.*…………

Weather: ……… *Fine* ……………………….

Principal Information:

1. **Geospatial Info**

Polygon 2

S/N	LATITUDE	LONGITUDE
1.	09˚31′32.90″	006˚26′49.97″
2.	09˚31′32.80″	006˚26′49.97″
3.	09˚31′33.40″	006˚26′49.50″
4.	09˚31′33.30″	006˚26′50.00″

2. **Location Attributes**
   Local-nomenclature Identifier:- *Staff Apartment Designated #2*

***Table 3**. Attribute Information of Staff Apartment Number 3*

DEPARTMENT OF PHYSICS
SCHOOL OF PHYSICAL SCIENCES
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE

Title of Project: Geospatial Identification of Built-up Structures in Phase I Development of the Gidan Kwano Campus and Beyond Along the Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt

Date: ……… *8th July, 2023*……………………… Time: …………*11:43 a.m.*………………

Weather: ………… *Fine* …………………….

Principal Information:

1. **Geospatial Info**

Polygon 3

S/N	LATITUDE	LONGITUDE
1.	09˚31′33.60″	006˚26′49.90″
2.	09˚31′33.70″	006˚26′49.90″
3.	09˚31′35.00″	006˚26′50.00″
4.	09˚31′35.00″	006˚26′49.70″

2. **Location Attributes**
   Local-nomenclature Identifier:- *Staff Apartment Designated #3*

***Table 4**. Attribute Information of Staff Apartment Number 4*

DEPARTMENT OF PHYSICS
SCHOOL OF PHYSICAL SCIENCES
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE

Title of Project: Geospatial Identification of Built-up Structures in Phase I Development of the Gidan Kwano Campus and Beyond Along the Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt

Date: ……… *8th July, 2023*……………………… Time: ………*11:50 a.m.*………………

Weather: ………… *Fine* …………………….

Principal Information:

1. **Geospatial Info**

Polygon 4

S/N	LATITUDE	LONGITUDE
1.	09˚31′35.50″	006˚26′49.60″
2.	09˚31′35.90″	006˚26′49.40″
3.	09˚31′36.20″	006˚26′49.90″
4.	09˚31′35.70″	006˚26′50.20″

2. **Location Attributes**
   Local-nomenclature Identifier:- *Staff Apartment Designated #4*

__Table 5__. Attribute Information of SICT Complex

DEPARTMENT OF PHYSICS
SCHOOL OF PHYSICAL SCIENCES
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE

Title of Project: Geospatial Identification of Built-up Structures in Phase I Development of the Gidan Kwano Campus and Beyond Along the Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt

Date: …………*8th July, 2023*……………… Time: ………*1:26 p.m.*…………………

Weather: …………*Fine*…………………….

Principal Information:

1. **Geospatial Info**

Polygon 21

S/N	LATITUDE	LONGITUDE
1.	09˚31′50.60″	006˚27′08.70″
2.	09˚31′51.60″	006˚27′07.50″
3.	09˚31′52.20″	006˚27′08.00″
4.	09˚31′51.70″	006˚27′09.30″
5.	09˚31′51.40″	006˚27′09.30″

2. **Location Attributes**

Local-nomenclature Identifier:- *School of Information and Communication Technology (SICT)*

__Table 6__. Attribute Information of SET Complex

DEPARTMENT OF PHYSICS
SCHOOL OF PHYSICAL SCIENCES
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE

Title of Project: Geospatial Identification of Built-up Structures in Phase I Development of the Gidan Kwano Campus and Beyond Along the Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt

Date: …………*8th July, 2023*………………… Time: ……………*1:41 p.m.*……………

Weather: ……… *Fine* ……………………….

Principal Information:

1. **Geospatial Info**

Polygon 23

S/N	LATITUDE	LONGITUDE
1.	09˚31′03.0″	006˚27′0.08″
2.	09˚31′04.1″	006˚27′0.03″
3.	09˚31′05.3″	006˚27′03.5″
4.	09˚31′04.8″	006˚27′04.1″

2. **Location Attributes**

Local-nomenclature Identifier:- *School of Environmental Technology (SET)*

__Table 7__. Attribute Information of E-Exam Centre

DEPARTMENT OF PHYSICS
SCHOOL OF PHYSICAL SCIENCES
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE

Title of Project: Geospatial Identification of Built-up Structures in Phase I Development of the Gidan Kwano Campus and Beyond Along the Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt

Date: …………*8th July, 2023*………………… Time: …………*1:56 p.m.*………………

Weather: ………… *Fine*…………………….

Principal Information:

1. **Geospatial Info**

Polygon 25

S/N	LATITUDE	LONGITUDE
1.	09˚31′08.5″	006˚27′01.3″
2.	09˚31′09.2″	006˚27′00.7″
3.	09˚31′08.0″	006˚27′59.0″
4.	09˚31′07.5″	006˚27′59.2″
5.	09˚31′07.8″	006˚27′58.8″
6.	09˚31′09.7″	006˚27′58.3″
7.	09˚31′09.9″	006˚27′57.2″
8.	09˚31′09.9″	006˚27′57.7″
9.	09˚31′11.1″	006˚27′59.6″
10.	09˚31′11.3″	006˚27′59.6″
11.	09˚31′11.1″	006˚27′59.9″
12.	09˚31′11.5″	006˚27′59.9″
13.	09˚31 09.4″	006˚27′00.5″
14.	09˚31′09.2″	006˚27′01.6″

2. **Location Attributes**

Local-nomenclature Identifier:- *E-Exam Centre*

Table 8. Attribute Information of Chemical Engineering Complex

DEPARTMENT OF PHYSICS
SCHOOL OF PHYSICAL SCIENCES
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE

Title of Project: Geospatial Identification of Built-up Structures in Phase I Development of the Gidan Kwano Campus and Beyond Along the Kazaure-Karaukarau-Kushaka-Ilesha Schist Belt

Date: …………*8th July, 2023*…………………… Time: …………*2:37 p.m.*………………

Weather: ……… *Fine*……………………….

Principal Information:

1. **Geospatial Info**

Polygon 28

S/N	LATITUDE	LONGITUDE
1.	09˚31′00.6″	006˚27′54.6″
2.	09˚31′01.3″	006˚27′54.1″
3.	09˚31′03.3″	006˚27′53.8″
4.	09˚31′04.1″	006˚27′53.8″
5.	09˚31′02.0″	006˚27′55.2″
6.	09˚31′02.2″	006˚27′56.3″

2. **Location Attributes**

Local-nomenclature Identifier:- *Chemical Engineering Complex*