GOVERNMENT OF SIERRA LEONE
MINISTRY OF MINES AND MINERAL RESOUCES
AND
NATIONAL MINERALS AGENCY

SIERRA LEONE'S AIRBORNE GEOPHYSICAL SURVEY

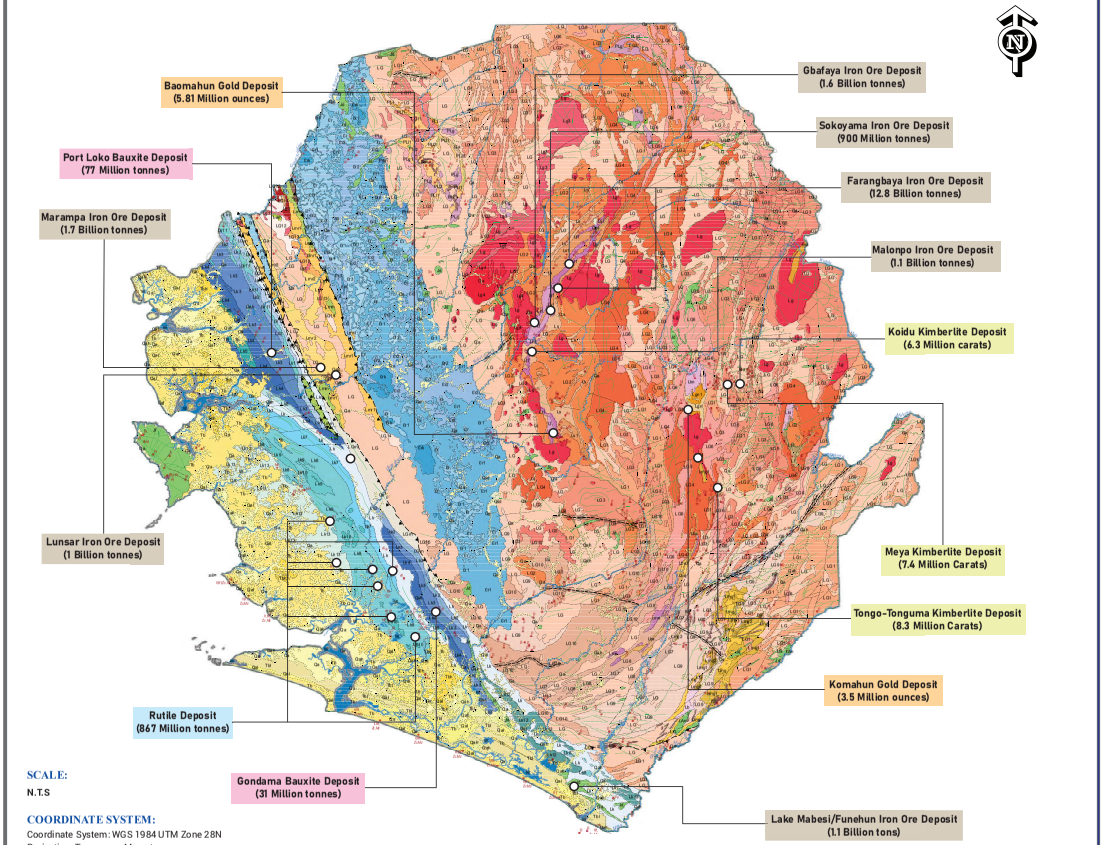
Revealing
Sierra Leone's Natural Resources

MINERAL RESOURCE MAP of Sierra Leone

NATIONAL MINERALS AGENCY
New England Ville, Freetown, Sierra Leone
W: www.nma.gov.sl; E: info@nma.gov.sl

LEGEND

- Districts
- Chiefdoms
- **Bullom Group** (Minerals: Lignite, Clay, Ilmenite, Rutile)
- **Freetown Basic Complex** (Minerals: Platinum, Bauxite)
- **Granite Greenstone Terrain** (Minerals: Diamond, Uranium, Gold)
- **Greenstone Belt** (Minerals: Gold, Iron Ore, Coltan, Chromite, Nickel, Copper, Molybderite, Syenite, Lead)
- **Kasila Group** (Minerals: Bauxite, Ilmenite, Zircon, Rutile, Heavy Minerals Concentrates)
- **Marampa Group** (Minerals: Iron Ore (Specularite Haematite Schist))
- **Rokel River Group** (Minerals: Bauxite)



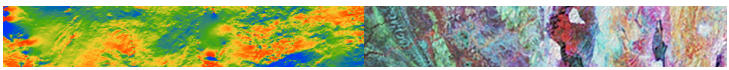
SCALE:
N.T.S

COORDINATE SYSTEM:
Coordinate System: WGS 1984 UTM Zone 28N
Projection: Transverse Mercator
Datum: WGS 1984

CONTENT

FLYING THE FLAG FOR SIERRA LEONE'S MINERAL RESOURCES

- Modern geophysical dataset
- Full country coverage
- Prospect scale resolution
- National geoscientific benchmark
- Sustainable future development



Background

The high-resolution airborne geophysical survey (Aeromagnetic and gamma spectrometry) was funded by the World Bank and supervised by the Ministry of Mines and Mineral Resources and the National Minerals Agency.

The design of the survey was done by a South African company, Geofocus (Pty) Limited. Data acquisition was done by a South African/Spanish contractor Xcalibur Airborne Geophysics with operational expertise in most African countries, the Middle East, Asia, and Canada. Survey supervision, including data QC was provided by Reid Geophysics Limited, a UK-based firm that has been providing geophysical consultancy services to the petroleum and mineral exploration sector worldwide for more than twenty years.

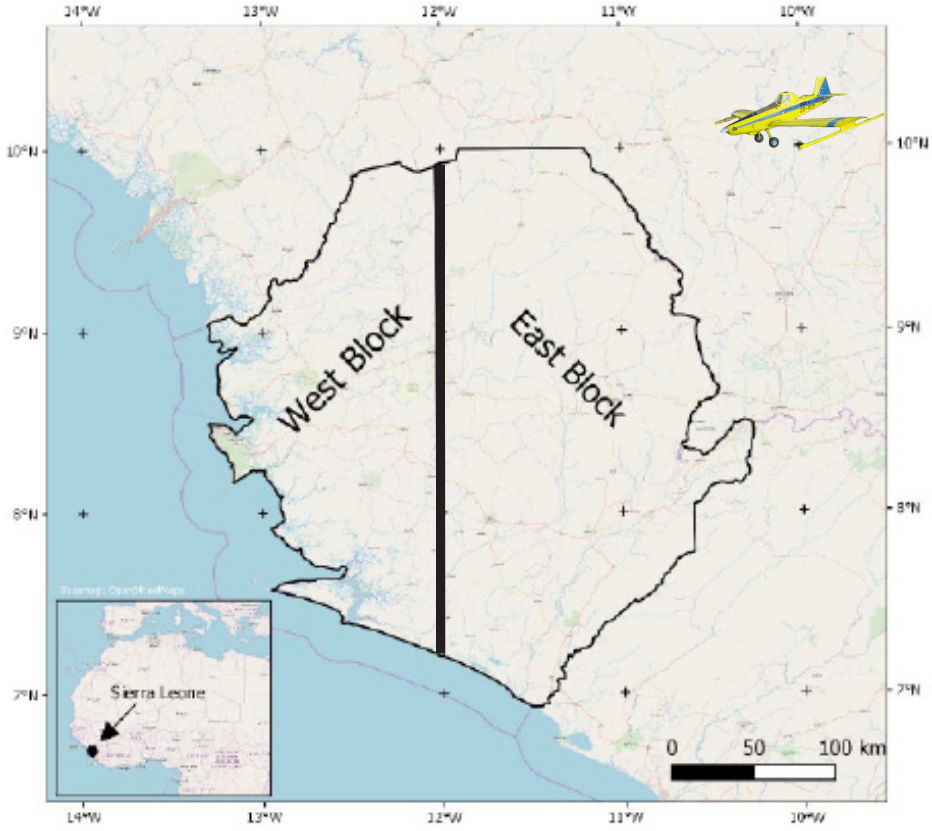
SURVEY OBJECTIVES

The primary objective of the survey is to acquire adequate geological data to enable profitable mineral development and maximize the value of Sierra Leone's mineral deposits.

The survey is the first step in helping to determine the full extent of the country's mineral potential, intending to attract foreign direct investments and put the Sierra Leonean government in a stronger bargaining position when negotiating mining contracts.

Technical Details

The survey area consists of two overlapping blocks (East and West Blocks) that provide complete data coverage over onshore Sierra Leone.



Map showing Survey Blocks

Aircraft and Equipment

Specialist survey aircraft with Eye-level navigation display

Wingtip Geometrics G-822 Cesium-Vapour magnetic sensors

Billingsley TFM100G2 ultra-miniature triaxial fluxgate magnetometer

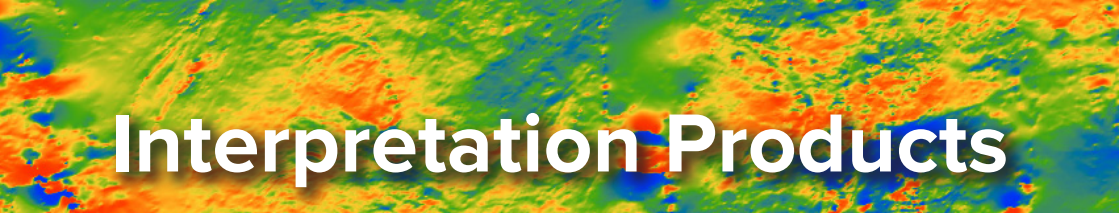
RMS Instruments AARC510 Adaptive Aeromagnetic Real-Time Compensator

MDL ILM 400 radar altimeter

RS-500 Advanced Digital Gamma-Ray Spectrometer with 1024 Channels.

NovAtel OEM6 series, 120 channel with NovAtel Correct/Omnistar DGPS correction GPS receiver.

SURVEY SPECIFICATIONS	
Item	**Description**
Geophysical methods	Magnetic
	Radiometric
Line spacing	150 meters
Tie Line spacing	1,500 meters
Terrain clearance	50 meters (nominal)
Line direction	West Block: NE-SW (west of 12°W)
	East Block: NW-SE (east of 12°W)
Total line kilometre	**543,460 km**



Interpretation Products

The High-resolution airborne magnetic and radiometric data, together with terrain, satellite imagery and geological datasets were interpreted for onshore Sierra Leone. The primary objective of the interpretation is to create preliminary geological and metallogenic maps at scales of 1:250,000, 1:500,000 and 1:750,000.

Interpretation Products

1	A surface geological map was produced for ten map sheets at 1:250,000 and countrywide at 1:750,000 scale.
2	A basement geology map was produced for four sheets at 1:250,000 and countrywide at 1: 750,000 scale.
3	Mineral favorability maps for gold, bauxite, rutile and nickel produced countrywide at 1: 500,000 scale
4	Manual kimberlite and iron target maps were produced countrywide at a 1:500,000 scale.

Deliverables	
Product	**Description**
Core geophysical grids	Total magnetic intensity (nT)
	Analytic signal (nT/m)
	TMI reduced to the equator (inverted) (nT)
	Dose rate (nGy/h)
	Potassium (%)
	Equivalent uranium (ppm)
	Equivalent thorium (ppm)
Processed SRTM and Landsat8 Data (Geotiff *.TIF)	Mosaicked Landsat 8 band 2, surface reflectance, cloud masked
	Mosaicked Landsat 8 band 3, surface reflectance, cloud masked
	Mosaicked Landsat 8 band 4, surface reflectance, cloud masked
	Mosaicked Landsat 8 band 5, surface reflectance, cloud masked
	Mosaicked Landsat 8 band 6, surface reflectance, cloud masked
	Mosaicked Landsat 8 band 7, surface reflectance, cloud masked
	Mosaicked Landsat normalized difference water index, cloud masked
	Mosaicked Landsat normalized difference vegetation index, cloud masked
	Landsat 8 true colour composite (R:band 4, G: band 3, B: band 2), balanced contrast enhanced, cloud masked
	Landsat 8 false colour composite, vegetation infrared (R:band 5, G: band 4, B: band 3), balanced contrast enhanced, cloud masked
	Landsat 8 false colour composite, urban (R:band 7, G: band 6, B: band 4), balanced contrast enhanced, cloud masked
	NASA SRTM Version 3.0 Global digital elevation model (m)
	SRTM slope facing direction (aspect) (deg)
	SRTM slope (deg)
	SRTM profile curvature (1/m)
	SRTM geomorphic phonotype

Deliverables	
Product	**Description**
Processed geophysical grids (Geosoft *.GRD / ERMapper *.ERS, Geotiff *.TIF)	First vertical derivative of RTEi (nT/m)
	Second vertical derivative of RTEi (nT/m^2)
	Vertical tilt angle from RTEi (radians)
	Horizontal tilt angle from RTEi (radians)
	Total horizontal derivative of RTEi (nT/m)
	X gradient of RTEi (nT/m)
	Y gradient of RTEi (nT/m)
	RTEi upward continuation, 200 m (nT)
	RTEi upward continuation, 1000 m (nT)
	RTEi upward continuation, 5000 m (nT)
	Residual of RTEi upward continuation, 200 m (nT)
	Residual of RTEi upward continuation, 1000 m (nT)
	Residual of RTEi upward continuation, 5000 m (nT)
	Equivalent uranium/equivalent Thorium
	Equivalent uranium/potassium (x 10^4)
	Equivalent thorium/potassium (x 10^4)
	Principal component analysis, first component
	Principal component analysis, second component
	Principal component analysis, third component
Semi-automated interpretation layers	Edges (contacts) derived from RTEi_TDX grid
	Peaks (positive responses) derived from RTEi_TDR grid
	Troughs (negative responses) derived from RTEi_TDR grid
	Keating correlation results from the analytic signal grid
	Keating correlation results from the TMI grid
	Keating results as Geosoft MAP
	Keating correlation coefficient model grids (TMI and AS) used in each sub-block
	Keating README file
	channel descriptions for Keating GDB

Deliverables	
Product	**Description**
Depth analysis layers	Database of calculated depth values and altimeter adjustments
	Gridded SPI depth below ground surface
	Database of Located Euler depth solutions
	Shapefile of Located Euler depth solutions (SI=1)
	Shapefile of Located Euler depth solutions (SI=2)
	channel descriptions for SPI GDB
	Euler README file
	channel descriptions for Euler GDB
3D Inversions	Packed Geosoft map of model block outlines and magnetic susceptibility at various depths and elevations
	Geosoft packed map containing nine susceptibility models and MVI vectors, merged susceptibility model and isosurface
	VOXI MVI model sessions for each of the nine individual blocks
	Packed Geosoft map of the nationwide block outline and magnetic susceptibility at various depths and elevations
	Geosoft packed map containing the nationwide susceptibility model, MVI vectors, and isosurface
	VOXI MVI model session for country wide inversion
	VOXI README file
	Geosoft 3D packed map containing the susceptibility model, MVI vectors, and isosurface for the Bagbe Alkali Complex, Freetown Complex, Gori Hills, Kambui Hills East & West, Lake Mabesi, Loko Hills, Magburaka area, Nimini Hills, Okra Hills, Pendembu area, Sembehun area, Tonkolili area
	Geosoft 2D packed map containing the block outline and magnetic susceptibility at various depths and elevations for the Bagbe Alkali Complex, Freetown Complex, Gori Hills, Kambui Hills East & West, Lake Mabesi, Loko Hills, Magburaka area, Nimini Hills, Okra Hills, Pendembu area, Sembehun area, Tonkolili area
	VOXI MVI model sessions for each of the 17 individual blocks
	Target Area VOXI README file
Interpretation Maps (GIS, Pdf)	Geophysical Interpretation - Surficial Geology for Batkanu, Daru, Freetown, Gbangbama, Kabala, Kissidugu, Magburaka, Moyamba, Pendembu, Pujehun at 250k
	Geophysical Interpretation - Basement Geology Freetown, Gbangbama, Pujehun, Moyamba at a scale1:250,000
	Geophysical Interpretation - Surficial Geology Sierra Leone at a scale1:750,000
	Geophysical Interpretation - Basement Geology Sierra Leone at a scale1:750,000
	Favourability Map for Bauxiteat, Gold, Iron, Kimberlite, Nickel, Rutile a scale1:500,000

Deliverables	
Product	**Description**
Kimberlite Targets	Interpretation maps README file
	East block targets
	West block targets
	Country wide targets
	Channel descriptions for east/west/shapefile/appendix
	Targeting report (pdf)
	Targeting report (word format)
	Targets
Mineral Favourability	Bauxite favourability images for Bauxiteat, Gold, Iron, Kimberlite, Nickel, Rutile
	Favourability README file
Technical reports	Acquisition and processing report (XAG)
	Acquisition and processing report - Appendix I - flight plan lines
	Acquisition and processing report - Appendix II - survey area boundary coordinates
	Acquisition and processing report README file
	Interpretation report (PGW)

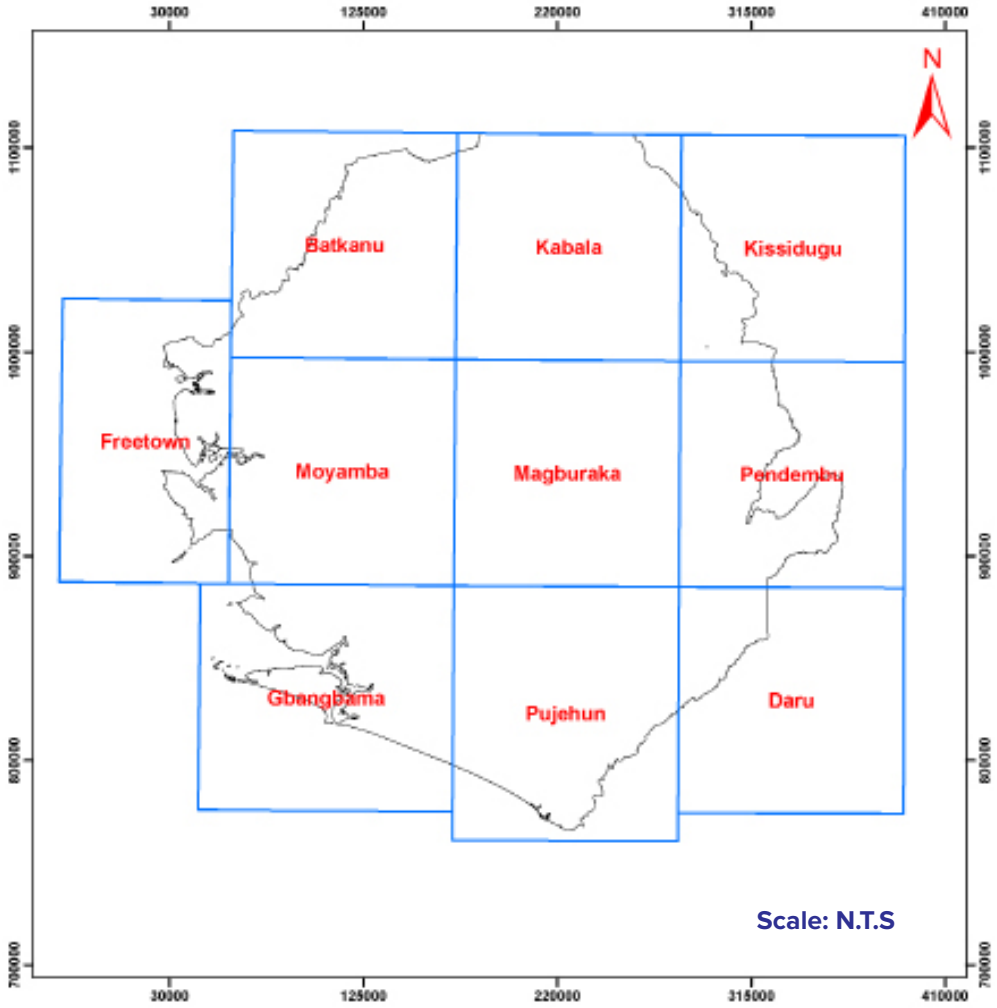
PRICING MODEL				
Tier	**Sheets**	**Data Coverage (sqkm)**	**Cost per sqkm**	**Total cost (USD)**
National	-	71,740	1.39	100,000
Sheet	Batkanu	7,990	2.05	16,380
	Daru	1,865	2.05	3,823
	Freetown	2,348	2.05	4,813
	Gbangbama	6,295	2.05	12,904
	Kabala	11,752	2.05	24,092
	Kissidugu	2,075	2.05	4,254
	Magburaka	12,213	2.05	25,036
	Moyamba	12,001	2.05	24,601
	Pendembu	6,142	2.05	12,591
	Pujehum	10,518	2.05	21,563
Block (50km x 50km)	-	2,500	4	10,000
Micro-block (10km x 10km)	-	100	10	1,000

DATA PACKAGES

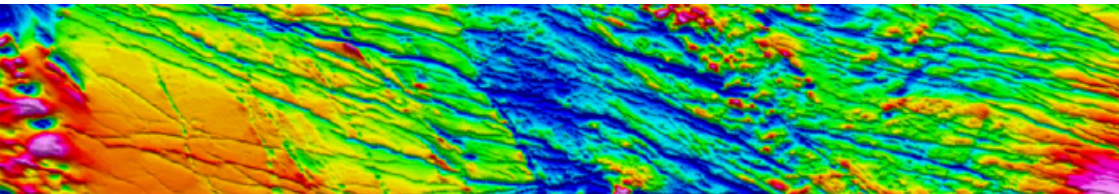
Product	Description	National	Sheet	Block/MB
Core geophysical grids		Y	SC	BC
Processed SRTM and Landsat8data		Y	SC	NS
Processed geophysical grids		Y	SC	NS
Processed geophysical images		Y	NS	NS
Semi-automated interpretation layers	Magnetic lineaments	Y	SC	NS
	Keating correlation	Y	SC	NS
Depth analysis layers	Source Parameter Imaging	Y	SC	NS
	Located Euler Deconvolution	Y	SC	NS
3D inversions	Area Of Interest VOXI inversion results	Y	NS	NS
	Blockwide VOXI inversion results	Y	NS	NS
	Nationwide VOXI inversion results	Y	NS	NS
Interpretation maps (PDF)	Geophysical interpretation - basement geology	Y	SC	NS
	Geophysical interpretation - surficial geology	Y	SC	NS
	Favourability maps	Y	NS	NS
Interpretation maps (GIS)	Geophysical interpretation - basement geology	Y	SC	NS
	Geophysical interpretation - surficial geology	Y	SC	NS
	Favourability maps	Y	NS	NS
Kimberlite targets	Kimberlite targets	Y	SC	NS
	Exploration report	Y	SC	NS
Mineral favourability	Favourability images	Y	SC	NS

Abbreviations | NS = Not Supplied | Y = Yes | SC= Sheet Clipped | BC=Block Clipped

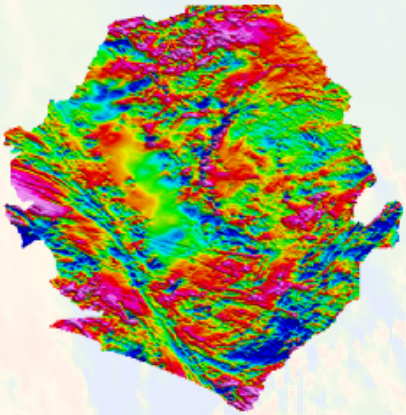
Interpretation Map Sheets



Please note these are not administrative boundaries

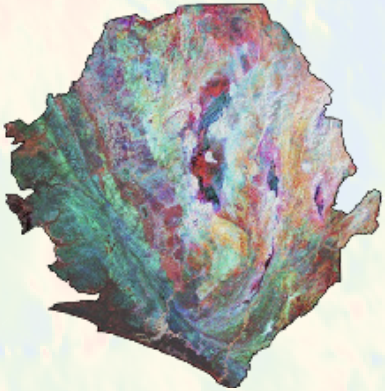


WHY USE MAGNETICS?



1. Aeromagnetic surveys map the Earth's magnetic field.
2. Maps the distribution of magnetic minerals.
3. Useful for various geological settings and mineral deposits especially magnetite, pyrrhotite, ilmenite and chromite.
4. Useful in mapping lithology, structure, and alteration.
5. Aeromagnetic surveys are cost-effective exploration tools, especially for early to mid-stage projects.
6. Applicable in all types of terrain

WHY USE RADIOMETRICS?



1. Maps the concentration and distribution of radioisotopes
2. All geological materials contain varying concentrations of the natural radioisotopes U, Th, and K.
3. Particularly effective for uranium, porphyries and Rare Earth Element (REE) exploration
4. Isotope ratios enhance detection of subtle features
5. Easily combined with magnetics

STEPS TO ACQUIRE THE DATA

Providing excellent national geosciene information to promote Sierra Leone's Mineral Potential

Can you afford to meet this detail?

CONTACTS
Directorate of Geological Survey
National Minerals Agency, New England Ville, Freetown, Sierra Leone

Phone: +23279999980/+23279250702/+23278221500
E-mail: nags@nma.gov.sl
Website: www.nma.gov.sl