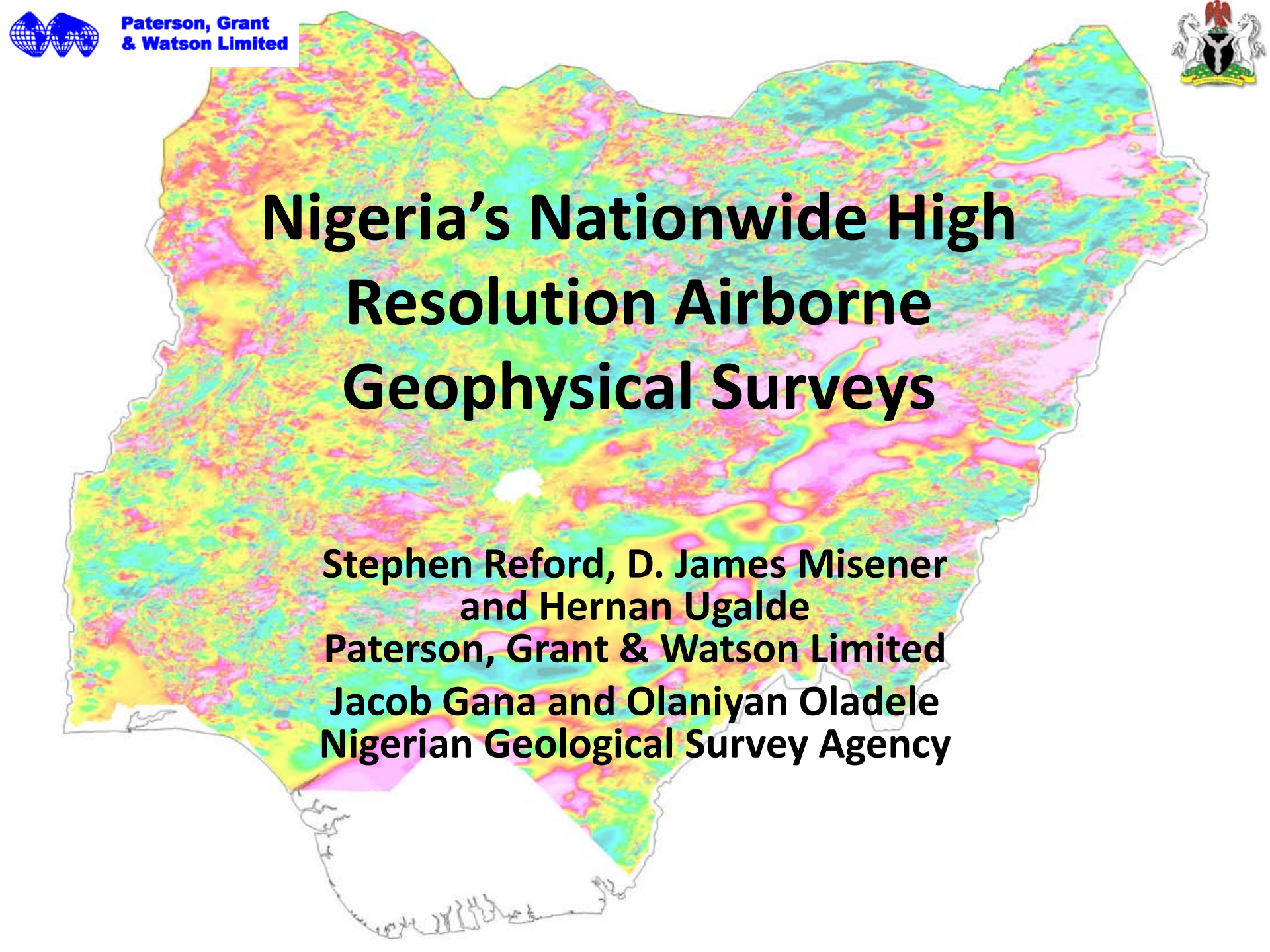


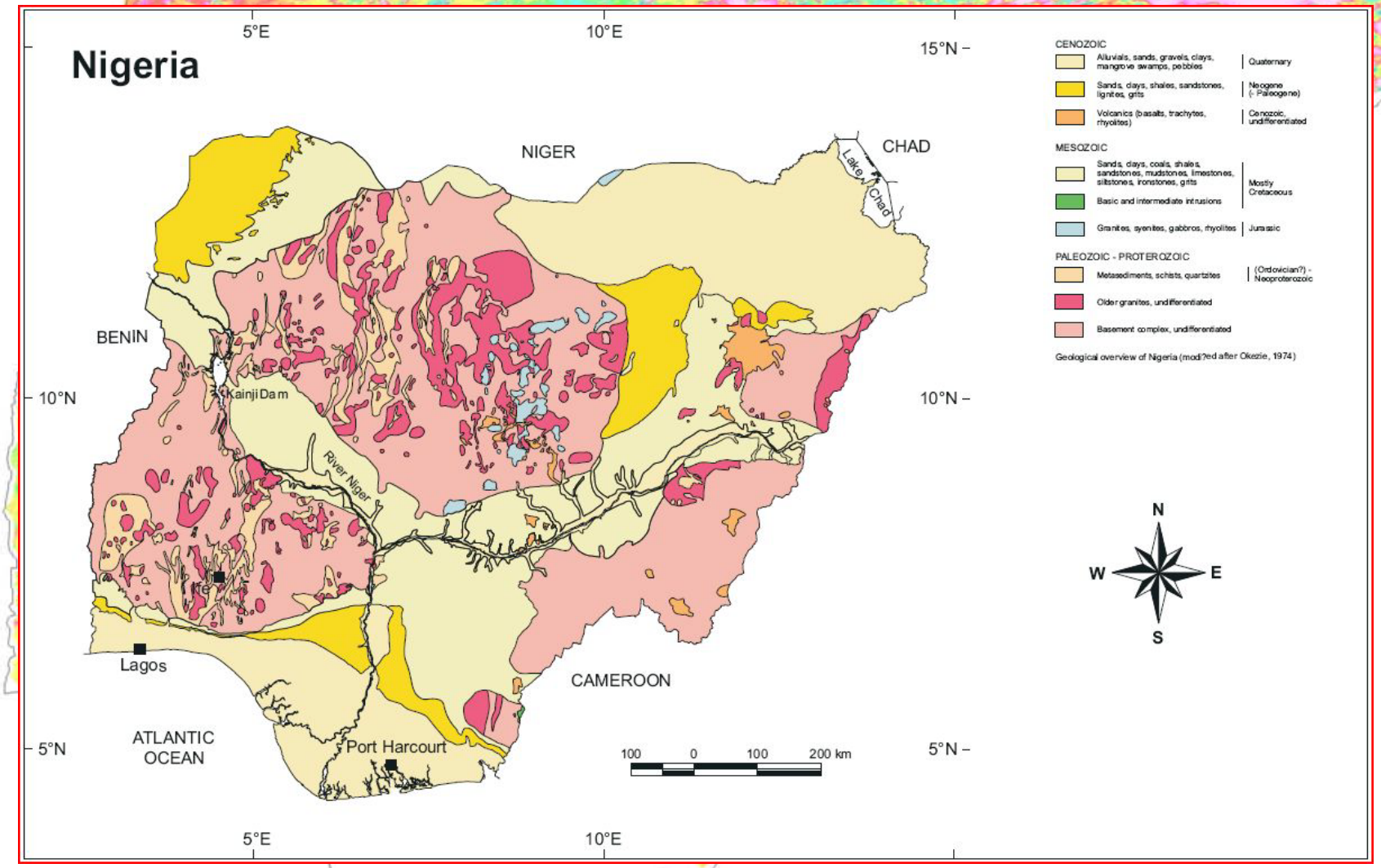
Nigeria's Nationwide High Resolution Airborne Geophysical Surveys

Stephen Reford, D. James Misener and Hernan Ugalde
Paterson, Grant & Watson Limited

Jacob Gana and Olaniyan Oladele
Nigerian Geological Survey Agency

Paterson, Grant & Watson Limited

Nigerian Geology



Survey Index

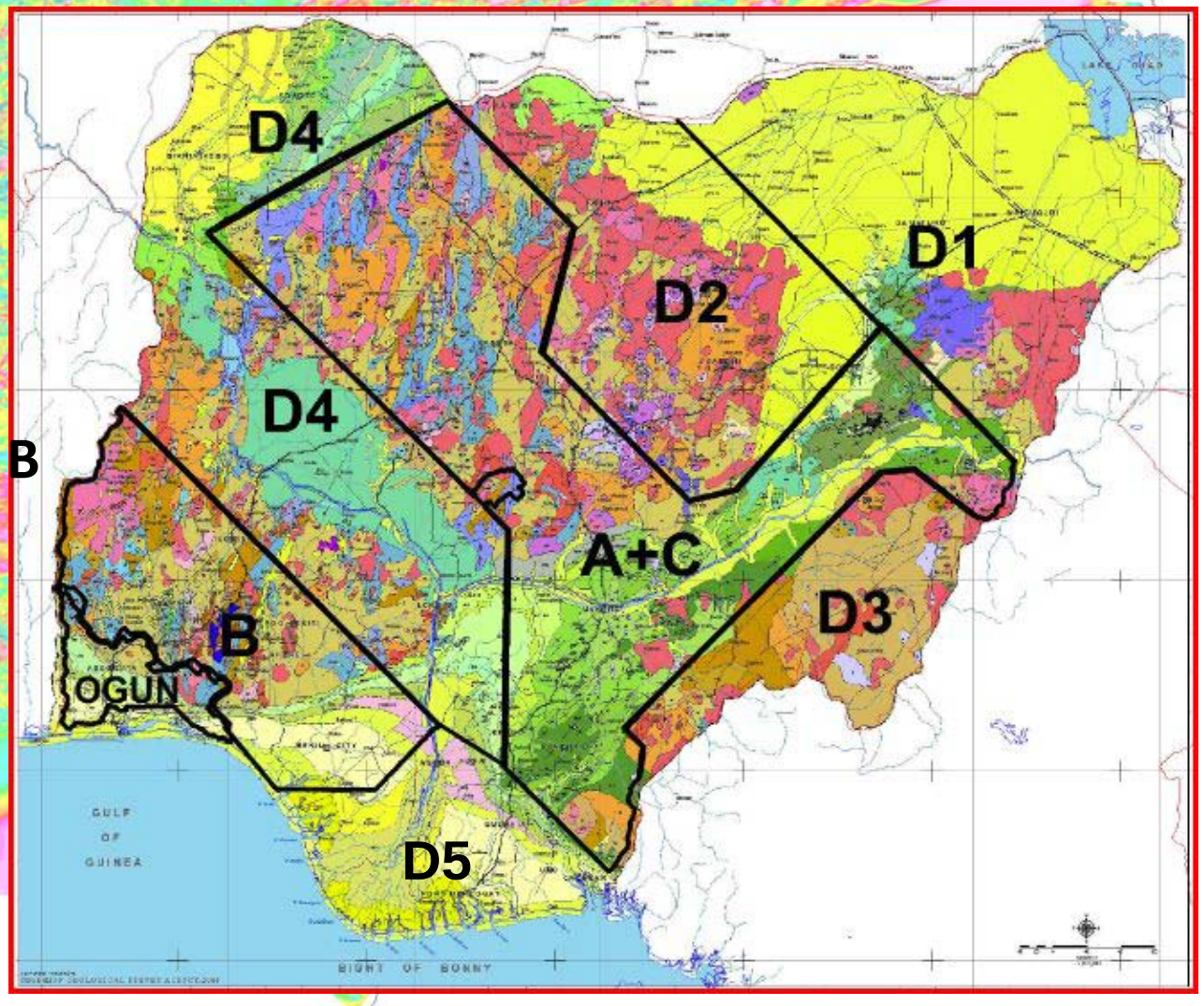
All flown by Fugro Airborne Surveys

>2 million line-km

Mag/Spec
2003 – Ogun State
2005-07 – A+C and B
2007-09 – D1, D2, D3 and D4

Mag/Grav
2010 – D5

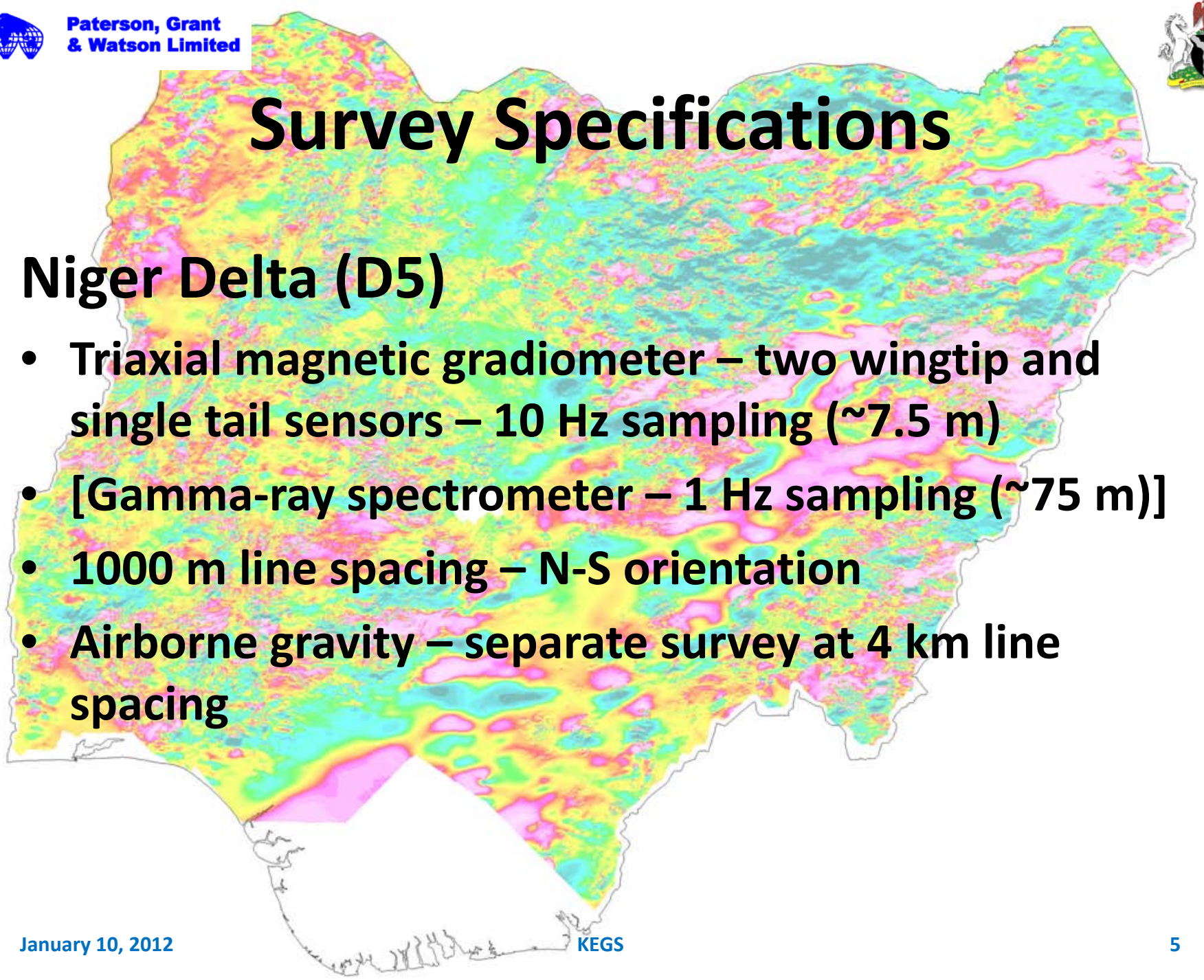
EM blocks in selected areas



Survey Specifications

- Triaxial magnetic gradiometer – two wingtip and single tail sensors – 10 Hz sampling (~7.5 m)
- Gamma-ray spectrometer – 1 Hz sampling (~75 m)
- 500 m line spacing – NW-SE orientation
- 5 km control line spacing – NE-SW orientation
- Nominal 80 m terrain clearance on pre-planned drape surface
- Measured horizontal gradients and gradient-enhanced gridding
- Radiometric NASVD noise reduction

Survey Specifications



Niger Delta (D5)

- Triaxial magnetic gradiometer – two wingtip and single tail sensors – 10 Hz sampling (~7.5 m)
- [Gamma-ray spectrometer – 1 Hz sampling (~75 m)]
- 1000 m line spacing – N-S orientation
- Airborne gravity – separate survey at 4 km line spacing

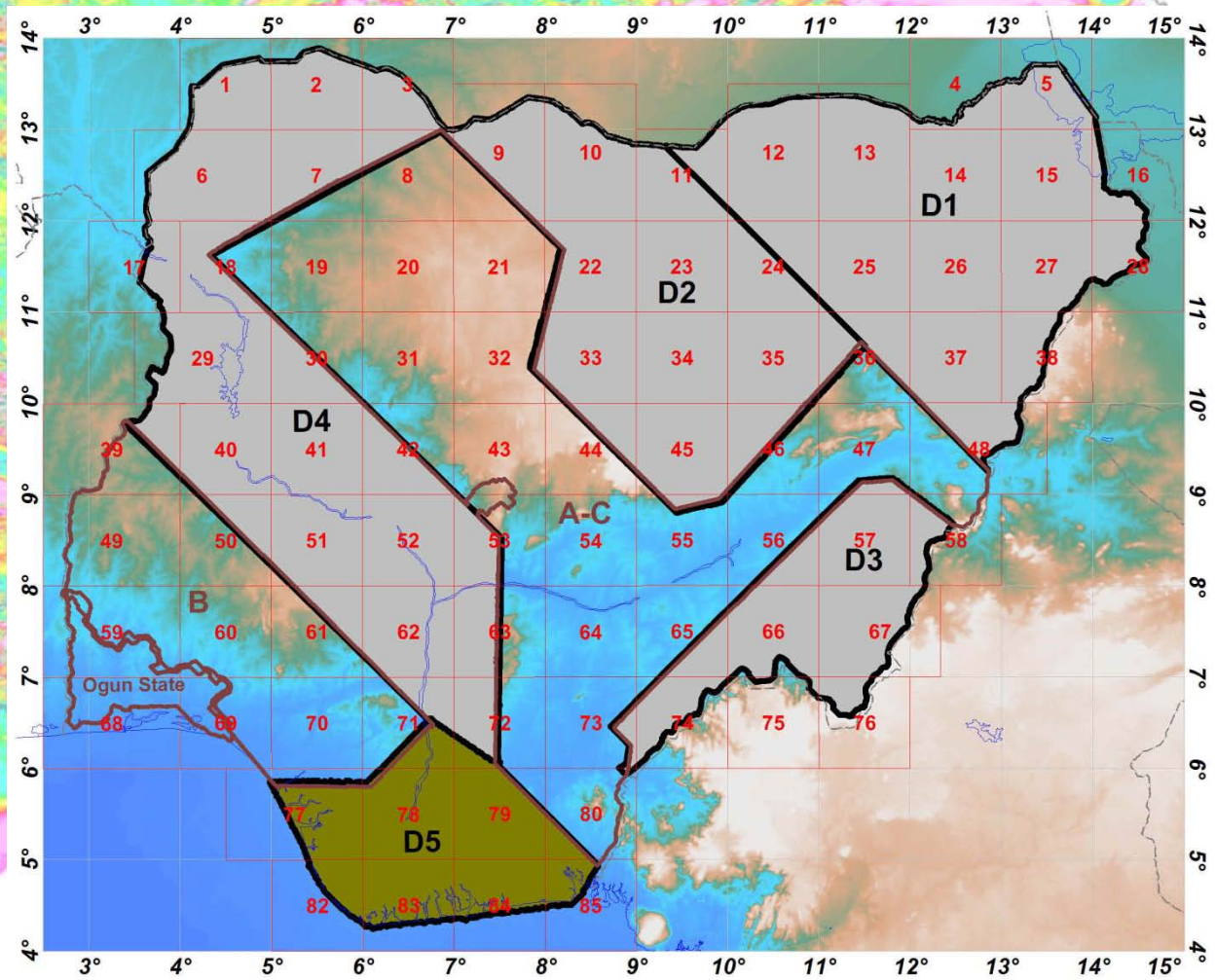
Interpretation Index

Phase I – Fugro
A+C and B

Phase II – PGW
D1, D2, D3 and D4

D5 – PGW

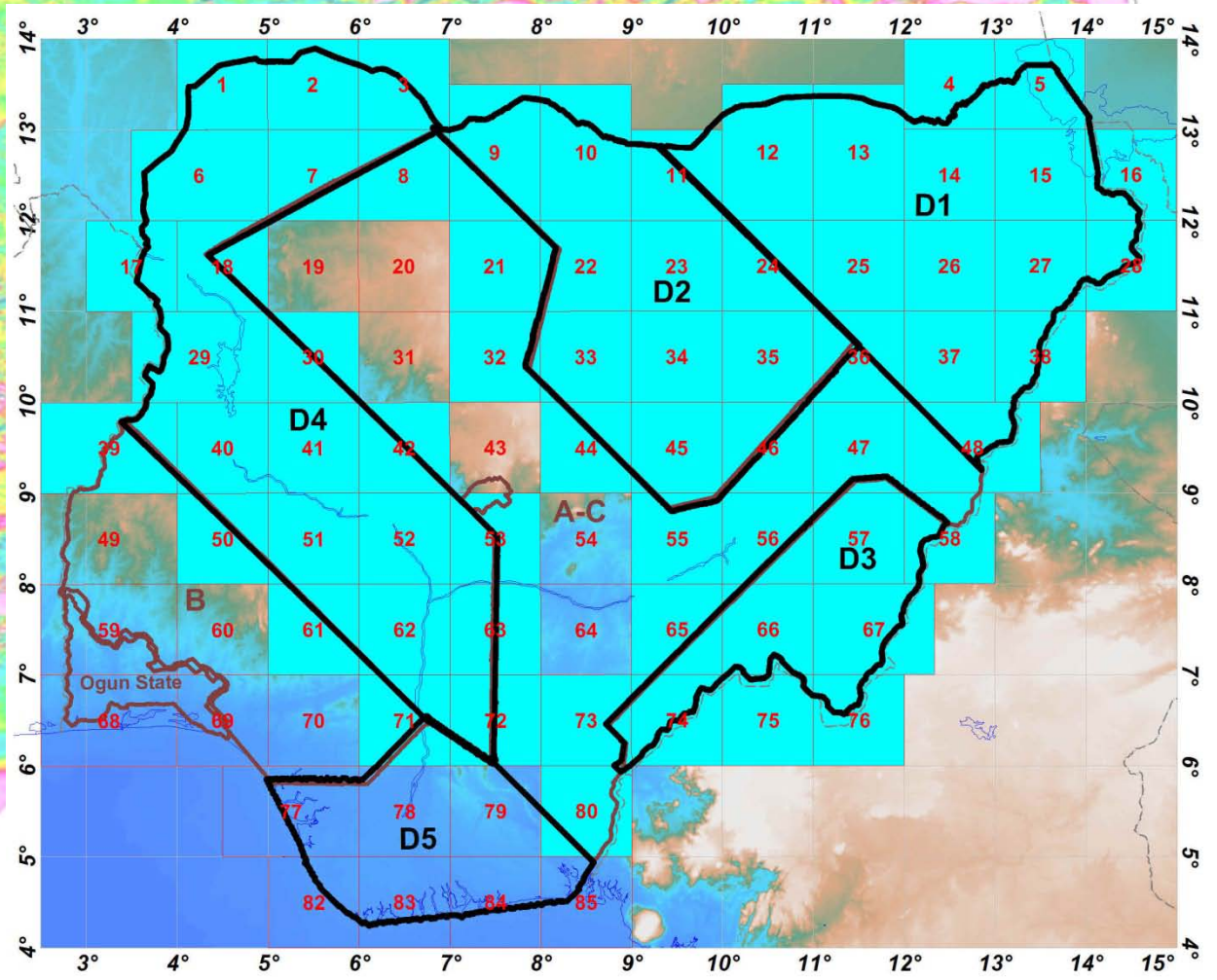
Integration – PGW
Phase 1, Phase 2
and Ogun State



Geophysical Map Index

1:250,000

- 5 magnetic products
- Ternary radiometric image
- Litho-structural interpretation
- Regolith interpretation
- Report for each sheet
- Niger Delta treated separately



PGW Interpretation Project

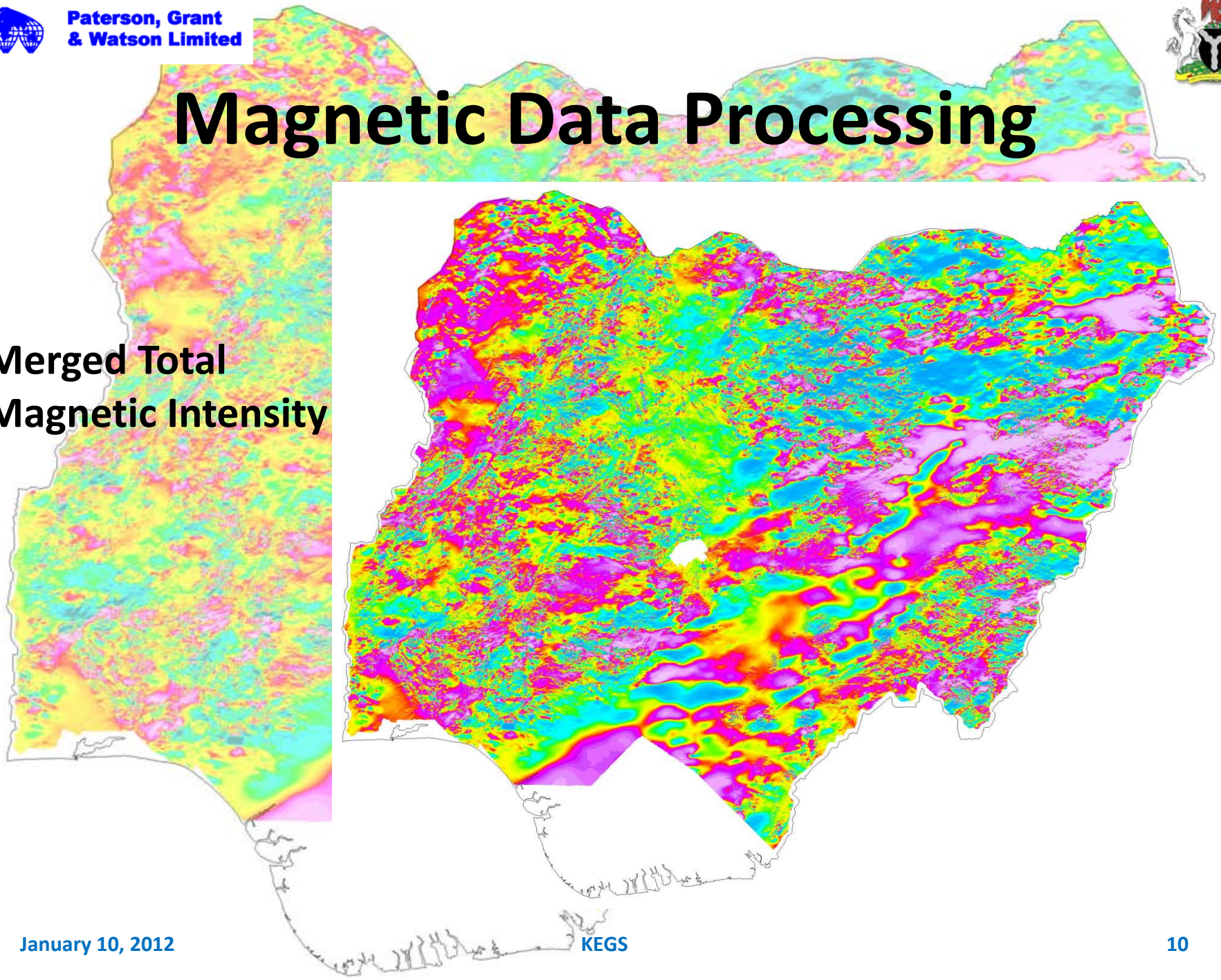
- Process magnetic data to assist interpretation
- Prepare derived products from magnetic, radiometric, terrain and Landsat data
- Grid-based magnetic modeling
- Phase II blocks interpreted at 1:250,000 scale
- Nationwide merging of geophysical grids
- Synoptic nationwide interpretation at 1:1 million scale

PGW Training

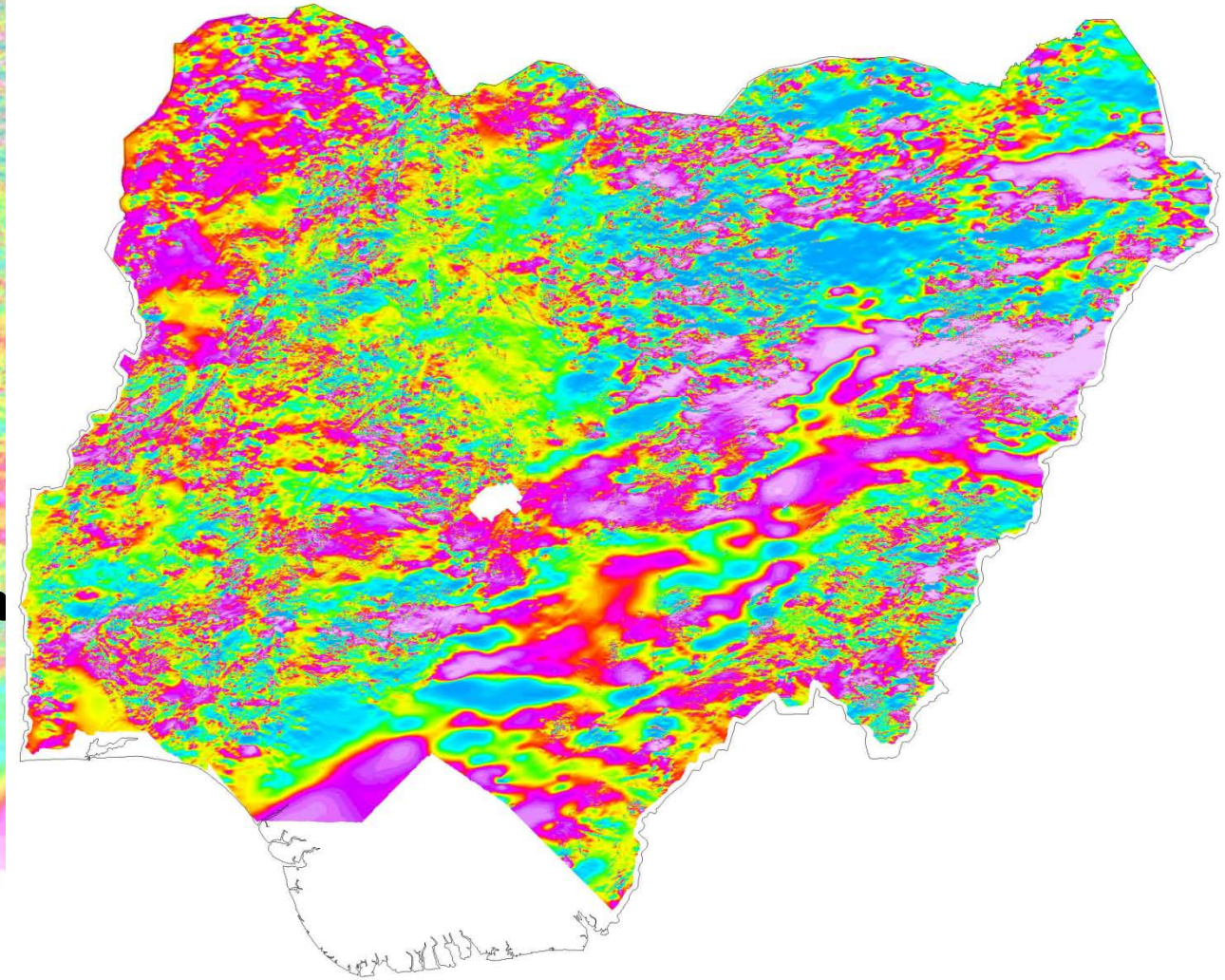
- Processing and modeling of geophysical data
- Interpretation of geophysical data
- Hand's-on (Abuja, Kaduna, Toronto)
- GIS and cartography related to geophysical interpretation
- Ground truth of selected geophysical anomalies and geological features

Magnetic Data Processing

Merged Total Magnetic Intensity



Magnetic Data Processing

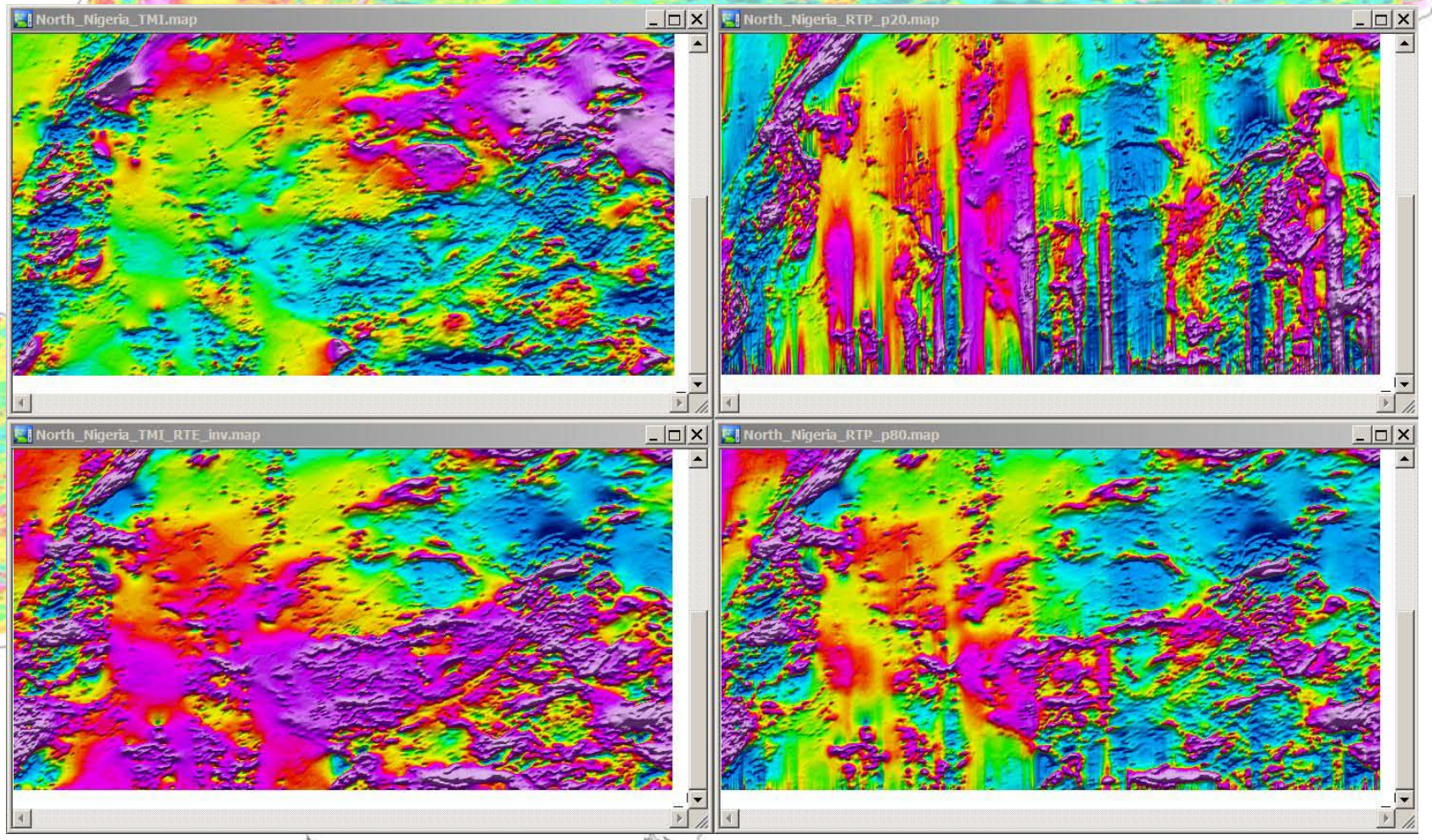


Magnetic Intensity Reduced-to-Equator

Accounts for variable inclination and declination

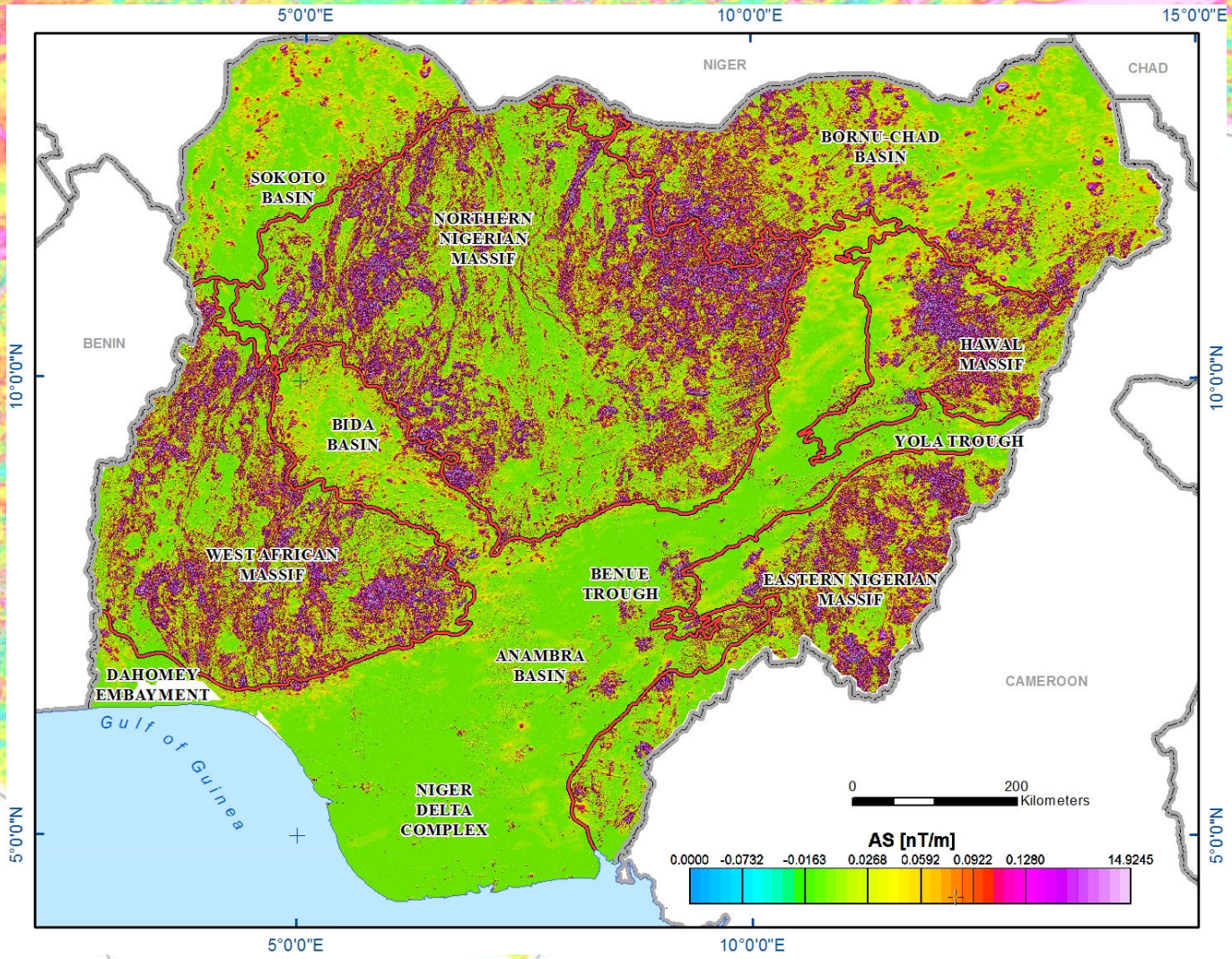
Magnetic Data Processing

RTP vs RTE



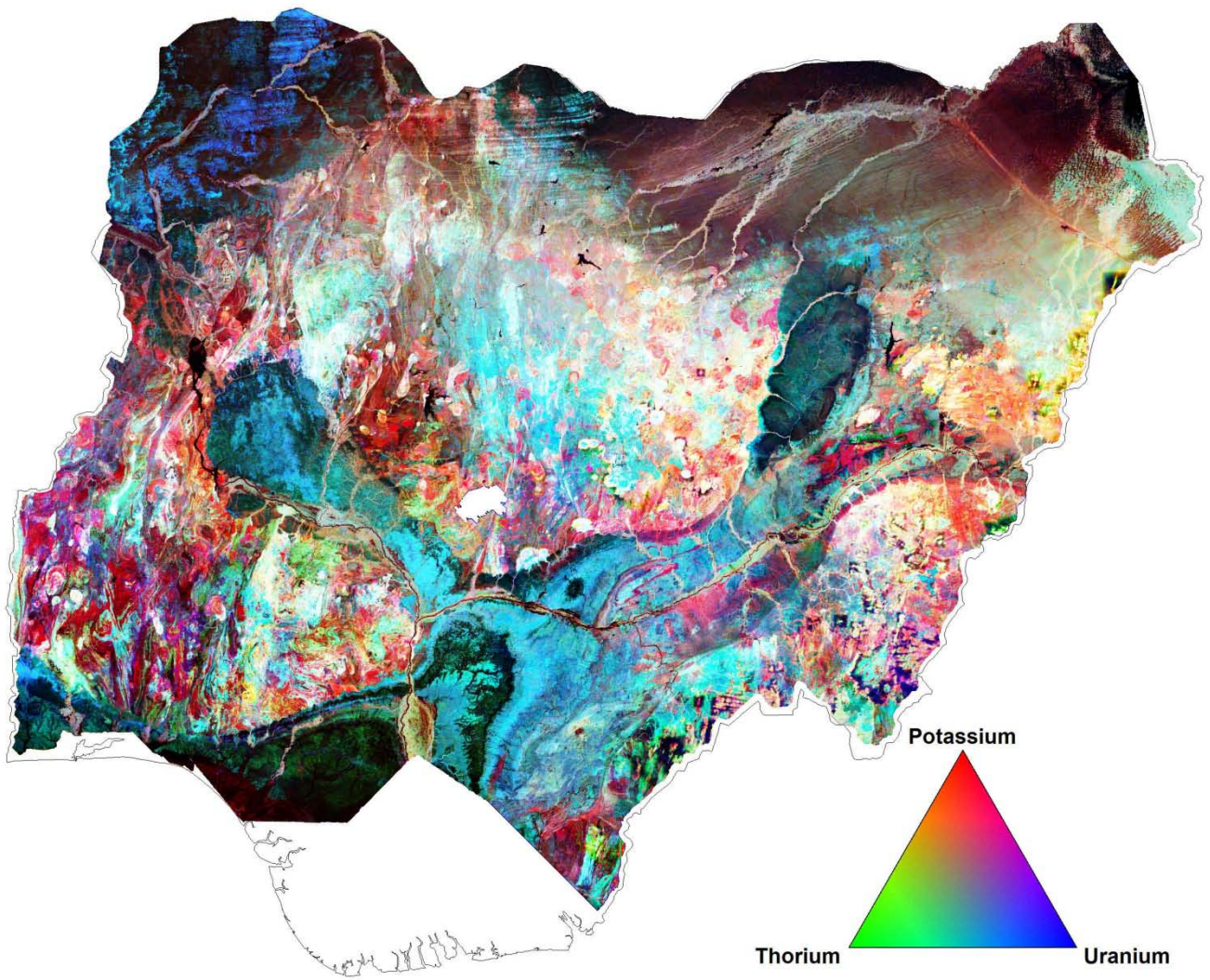
Magnetic Data Processing

Major Geological Terrains Over Analytic Signal



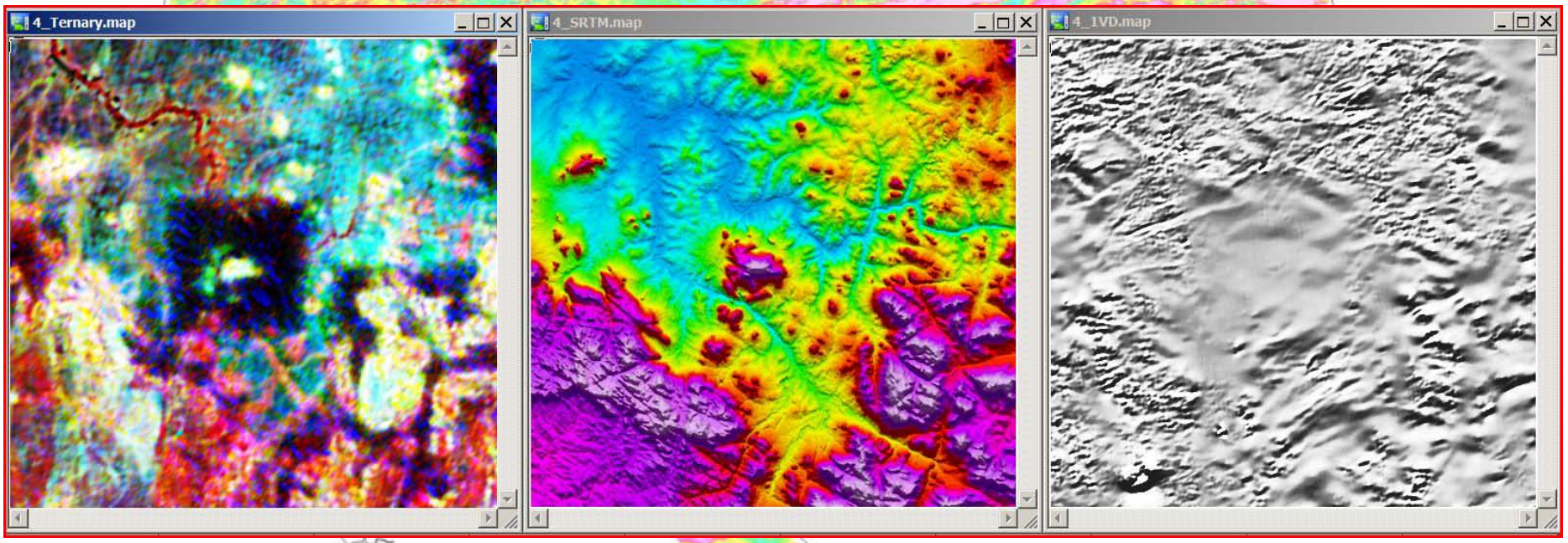
Radiometric Data Processing

Radiometric Ternary Image



Radiometric Data Processing

Effect of drape surface in rough terrain:
Halo of null response over steep slopes



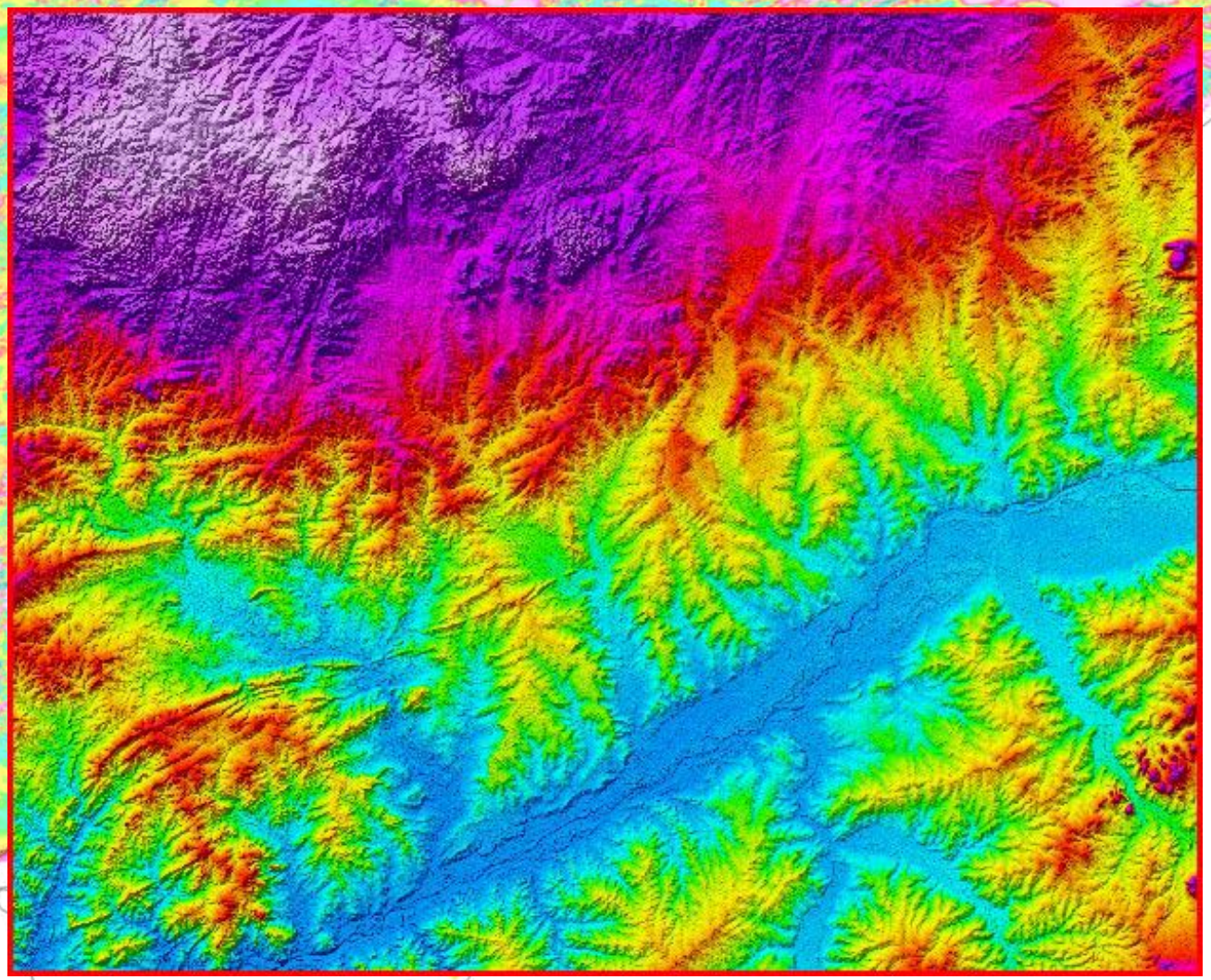
Radiometric Data Processing

Radiometric Ternary Image

Useful within the sedimentary basins in addition to hard rock

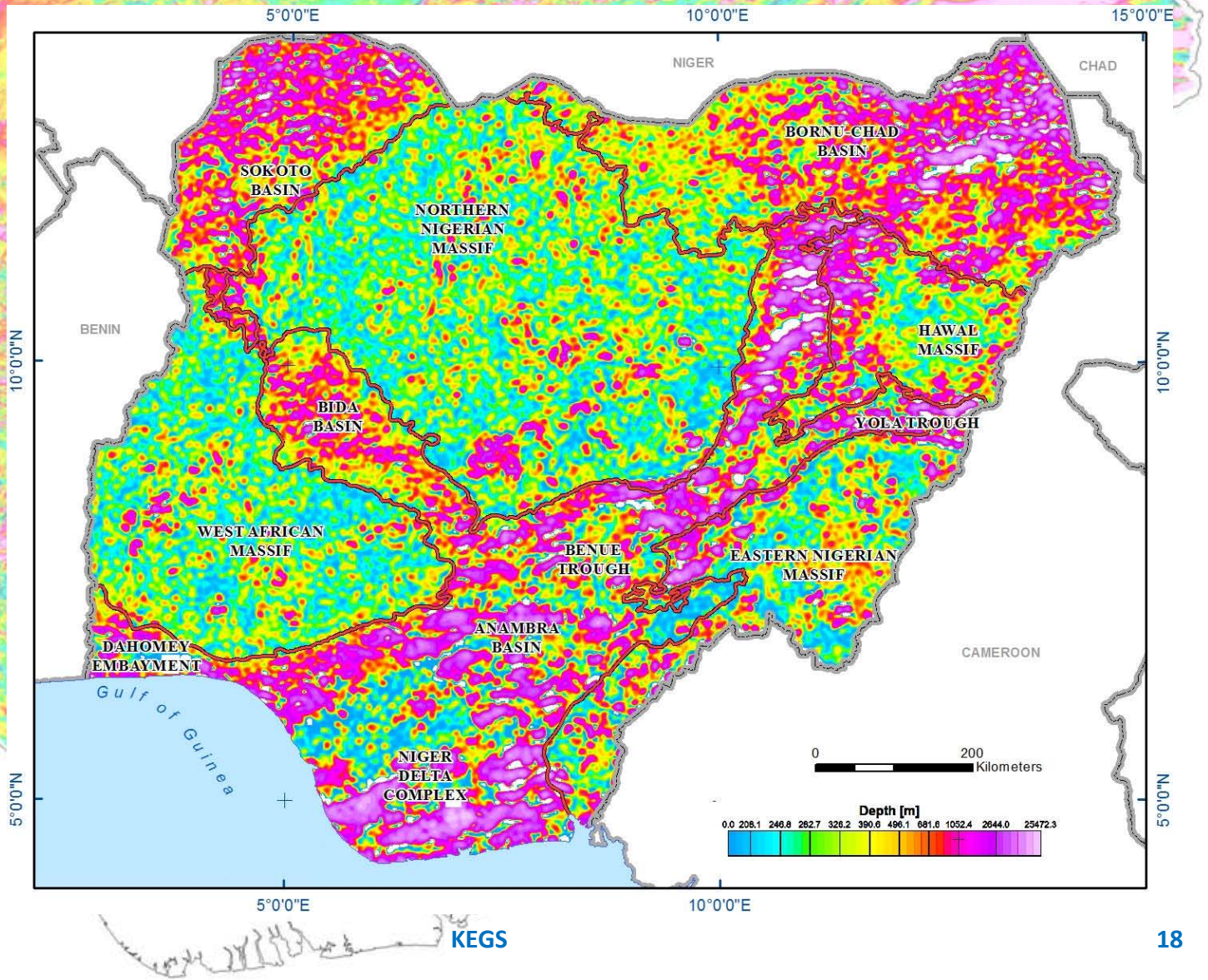
Radiometric Data Processing

SRTM Digital Topography



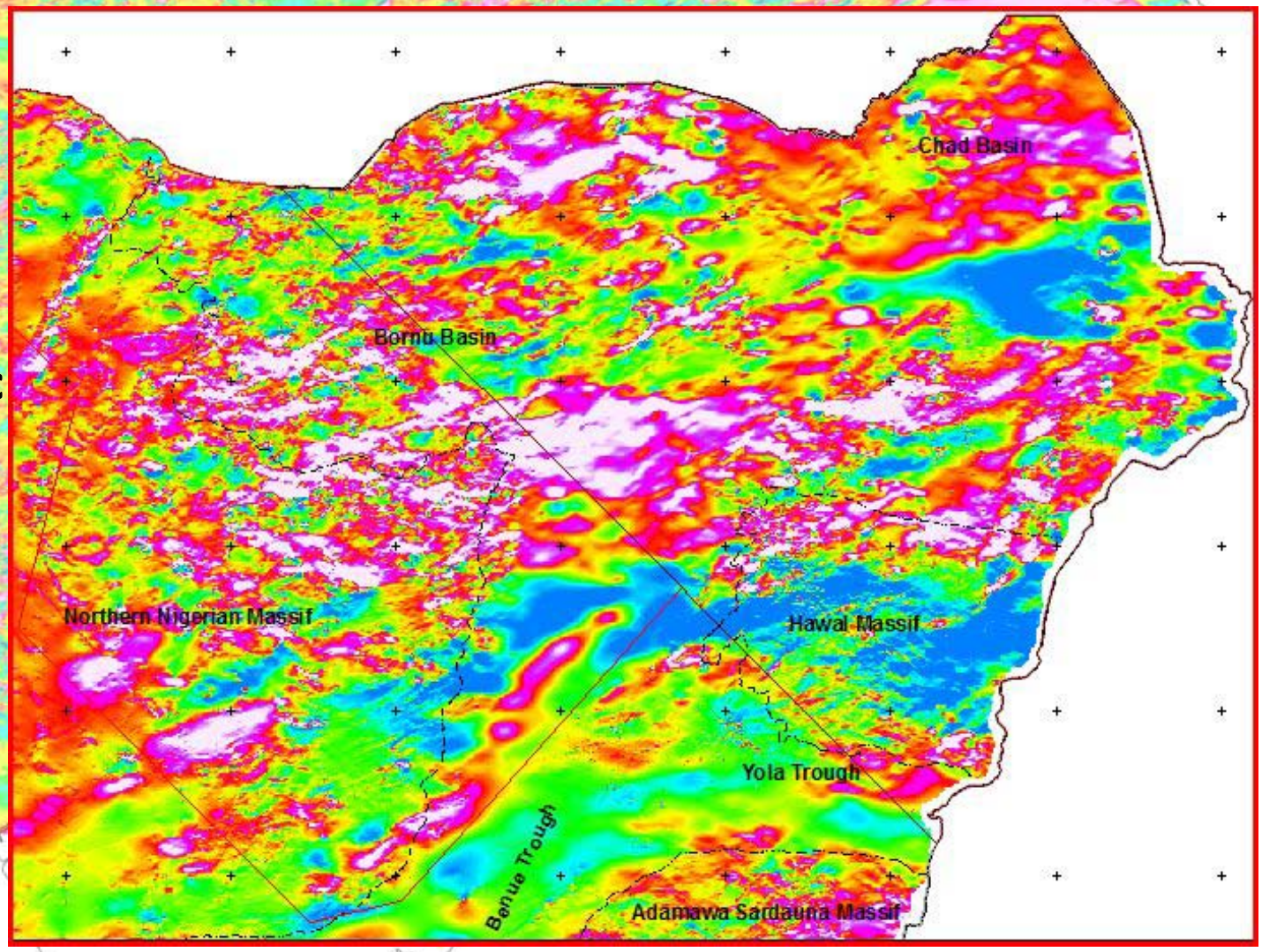
Depth to Magnetic Sources

Deeper sources in red - basins



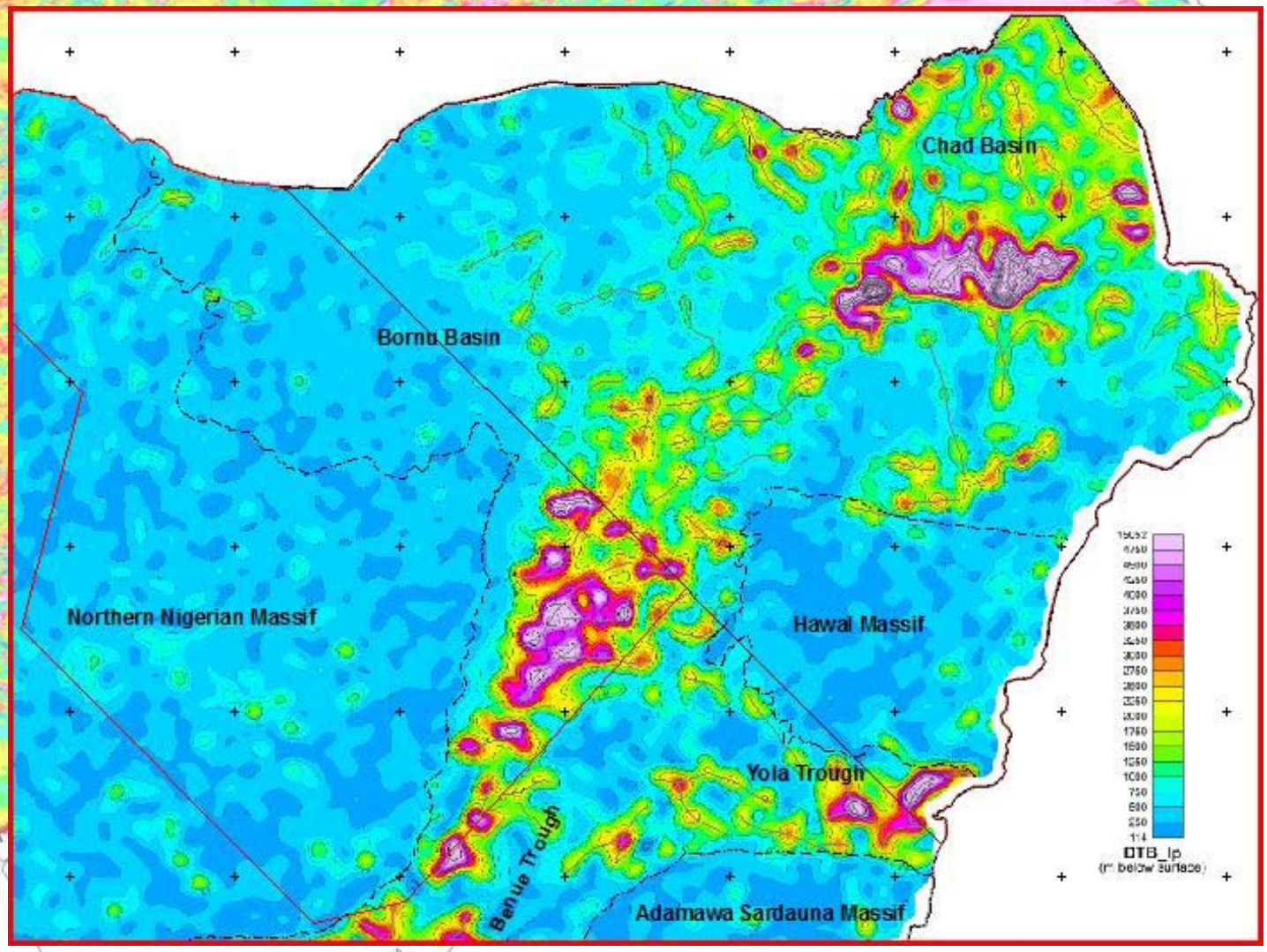
Depth to Magnetic Sources

Northeast Nigeria – Total Magnetic Intensity

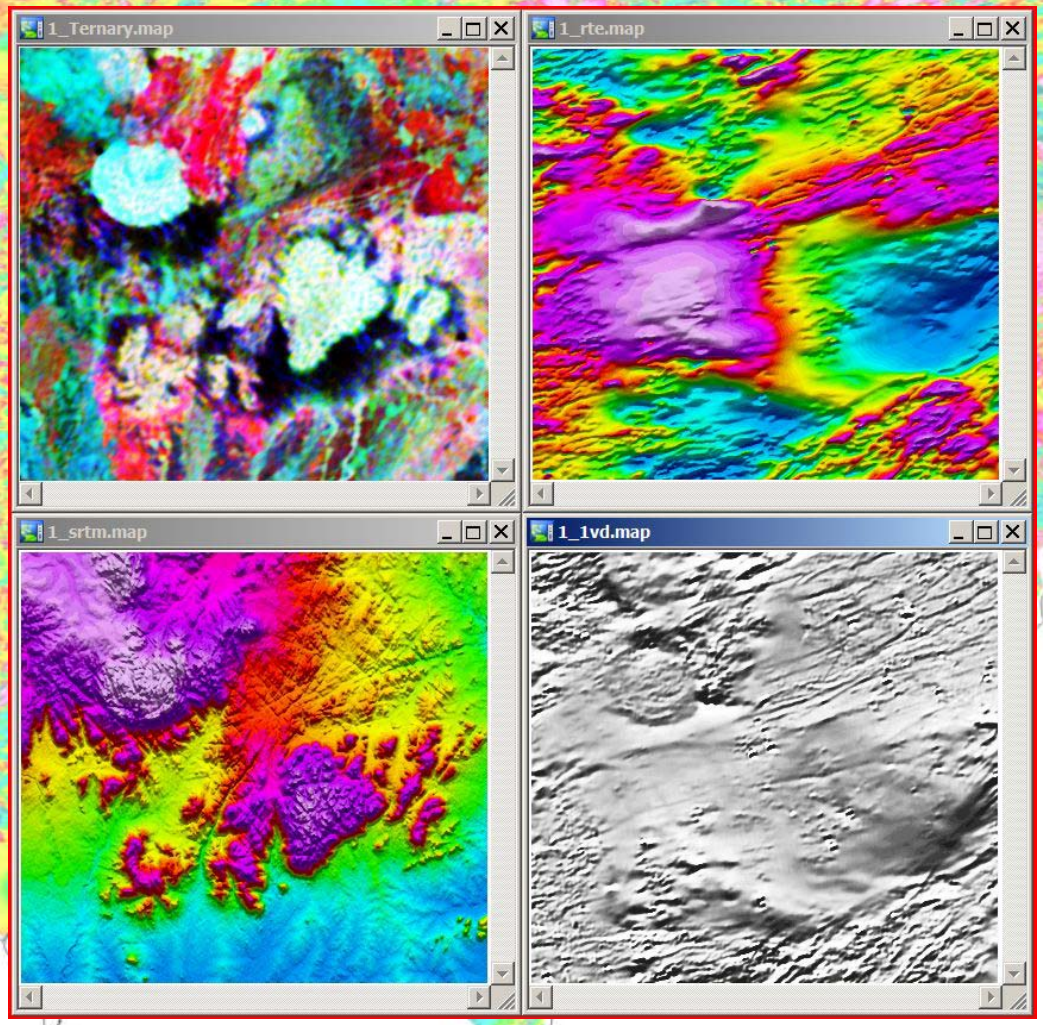


Depth to Magnetic Sources

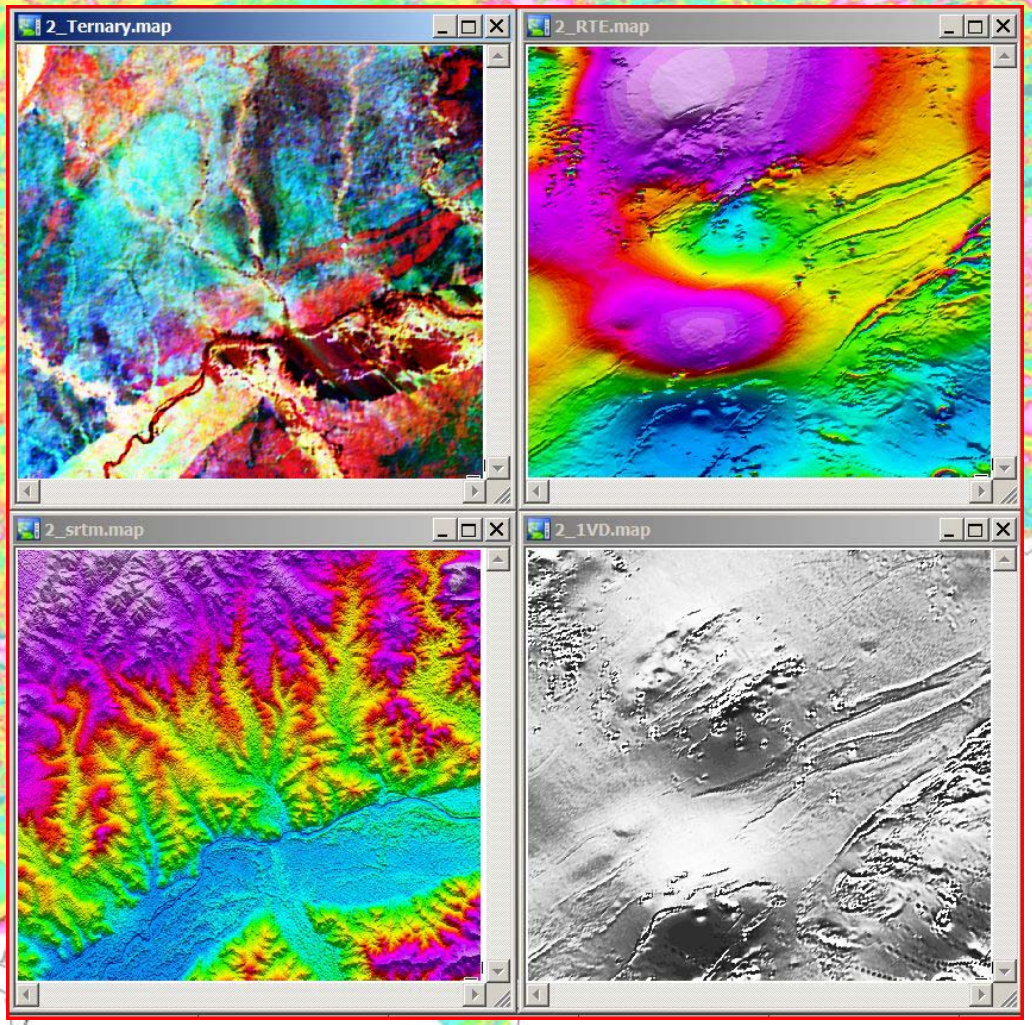
Northeast Nigeria – Depth to Magnetic Sources



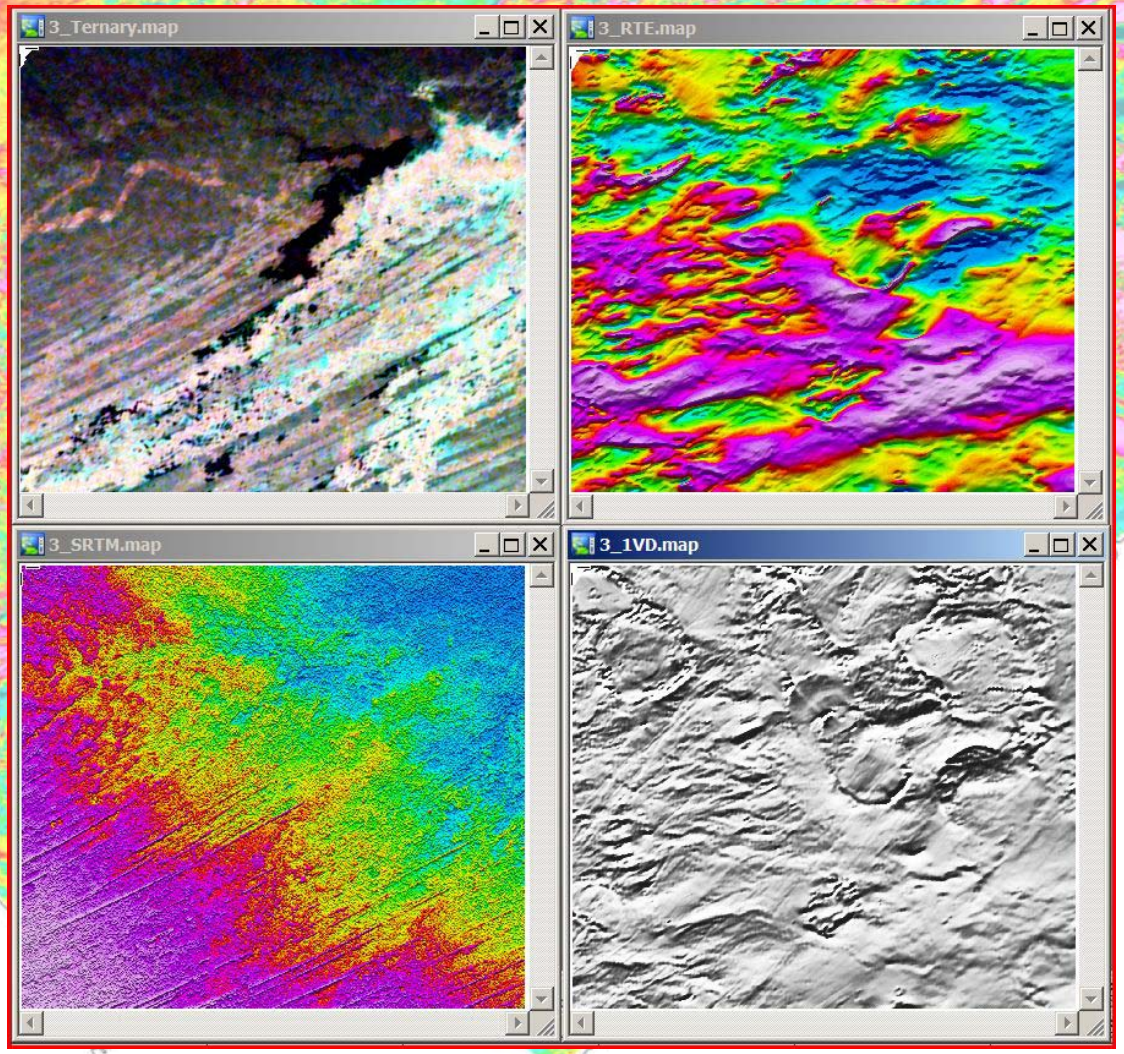
Basement Responses



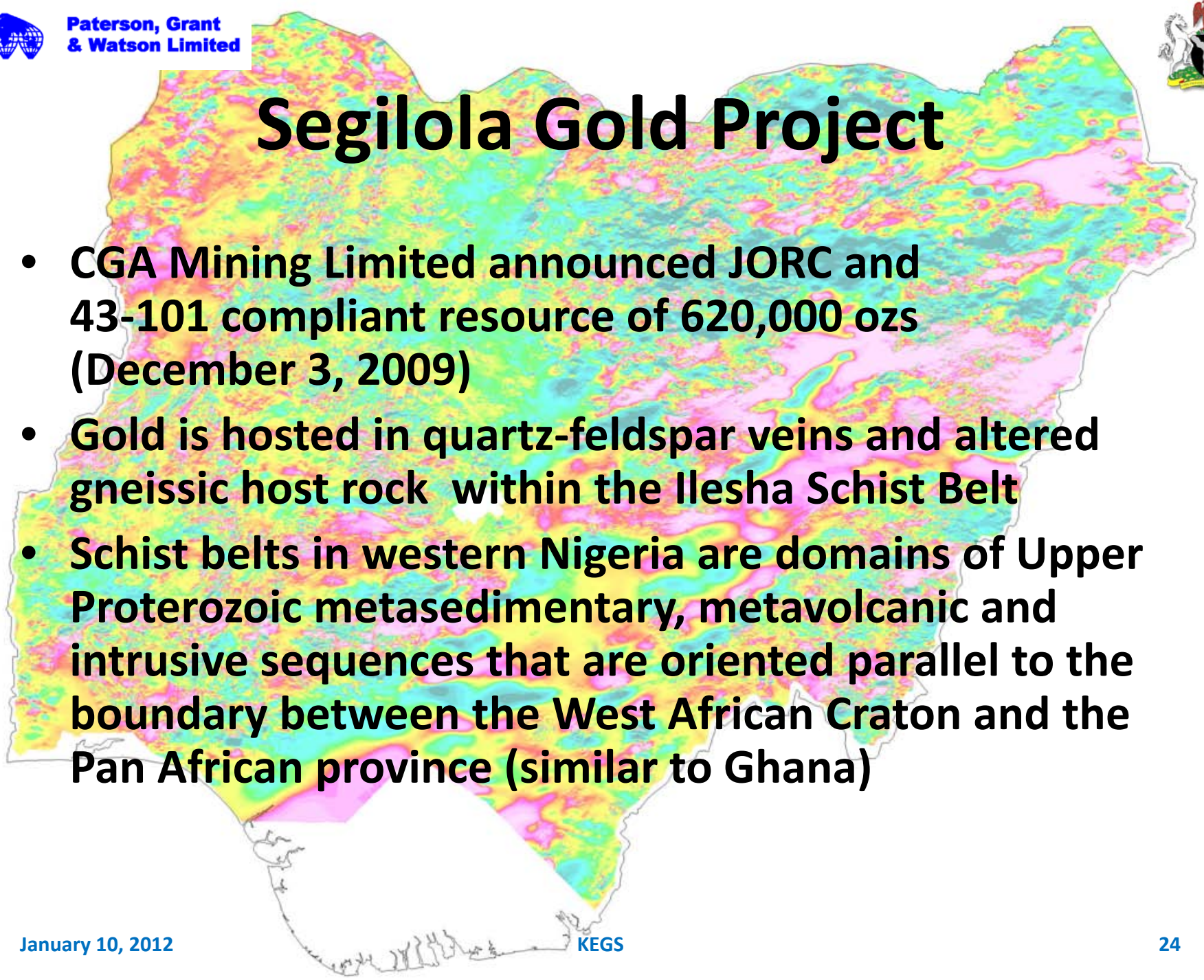
Basin Responses



Shallow Basin Responses



Segilola Gold Project



- CGA Mining Limited announced JORC and 43-101 compliant resource of 620,000 ozs (December 3, 2009)
- Gold is hosted in quartz-feldspar veins and altered gneissic host rock within the Ilesha Schist Belt
- Schist belts in western Nigeria are domains of Upper Proterozoic metasedimentary, metavolcanic and intrusive sequences that are oriented parallel to the boundary between the West African Craton and the Pan African province (similar to Ghana)

Paterson, Grant & Watson Limited

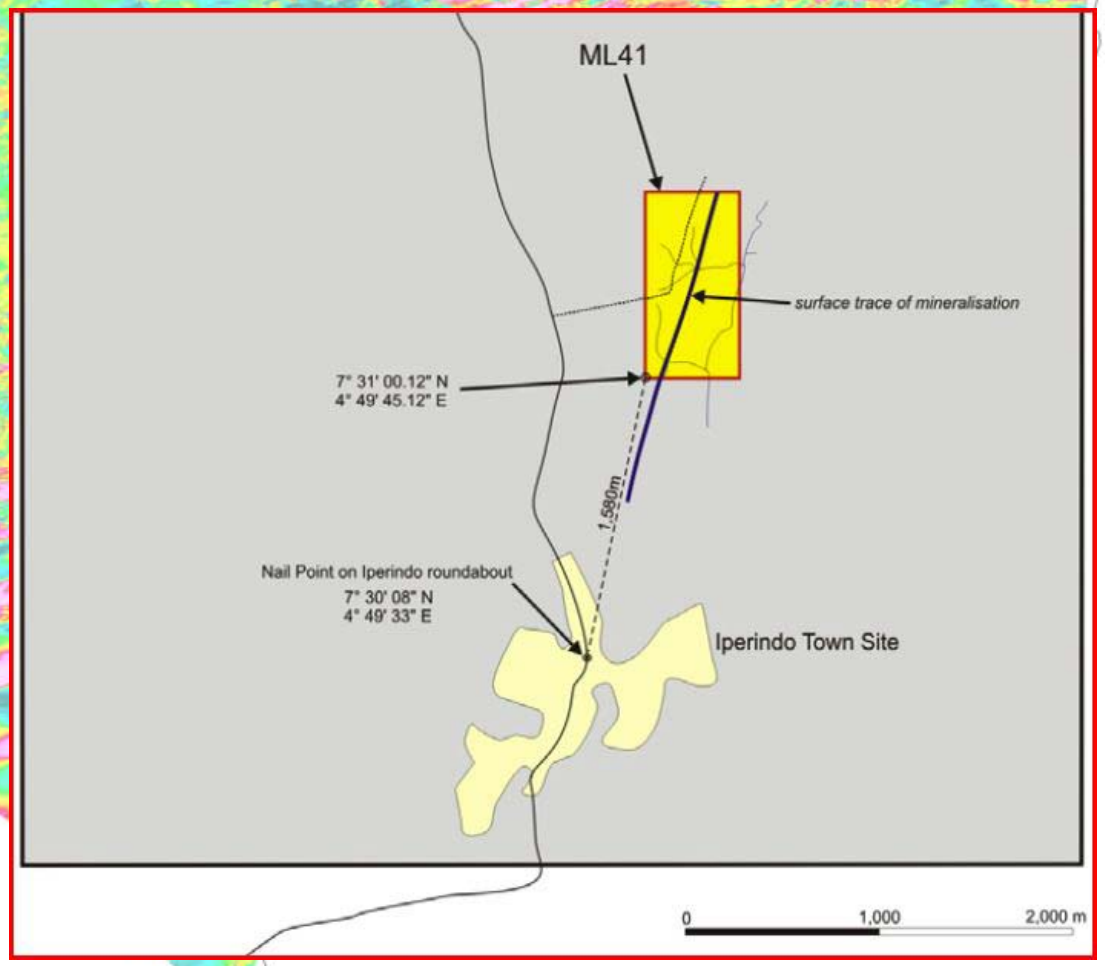
Segilola Gold Project

Located in Osun State, SW Nigeria

Northeast of Lagos

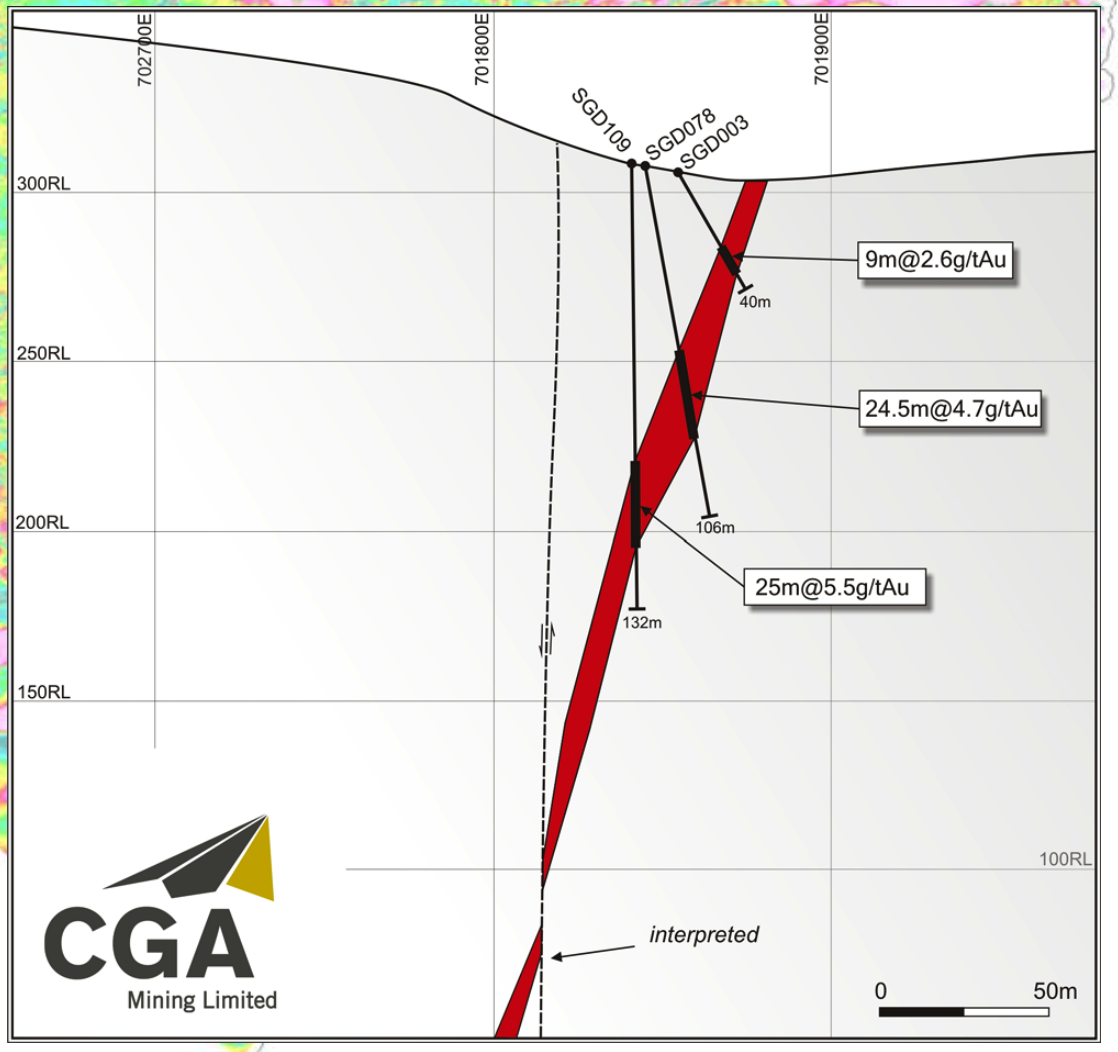
Segilola Gold Project

NNE trace of mineralized zone oriented along the strike of the Ilesha Schist Belt

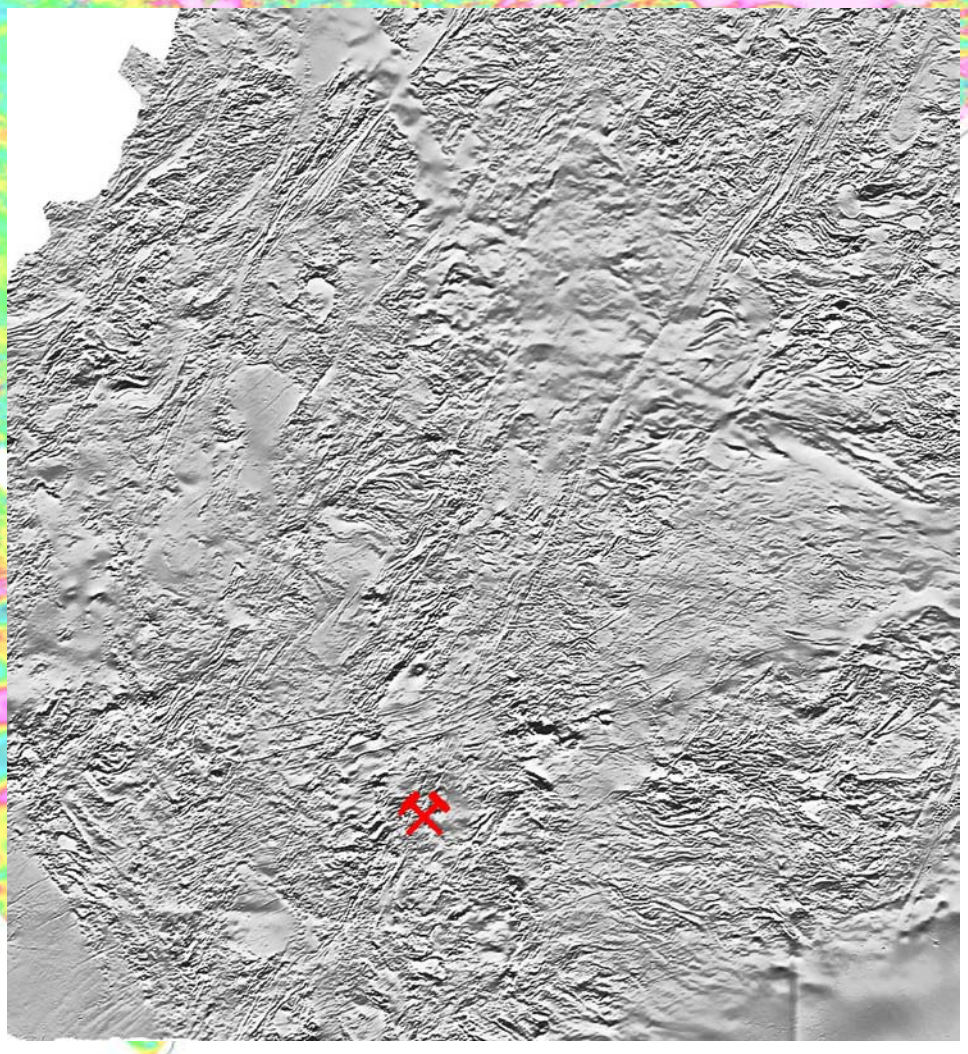


Segilola Gold Project

Mineralization in steeply dipping shear zone showing good continuity along strike and down-dip



Segilola Gold Project



Reduced-to-equator magnetic field

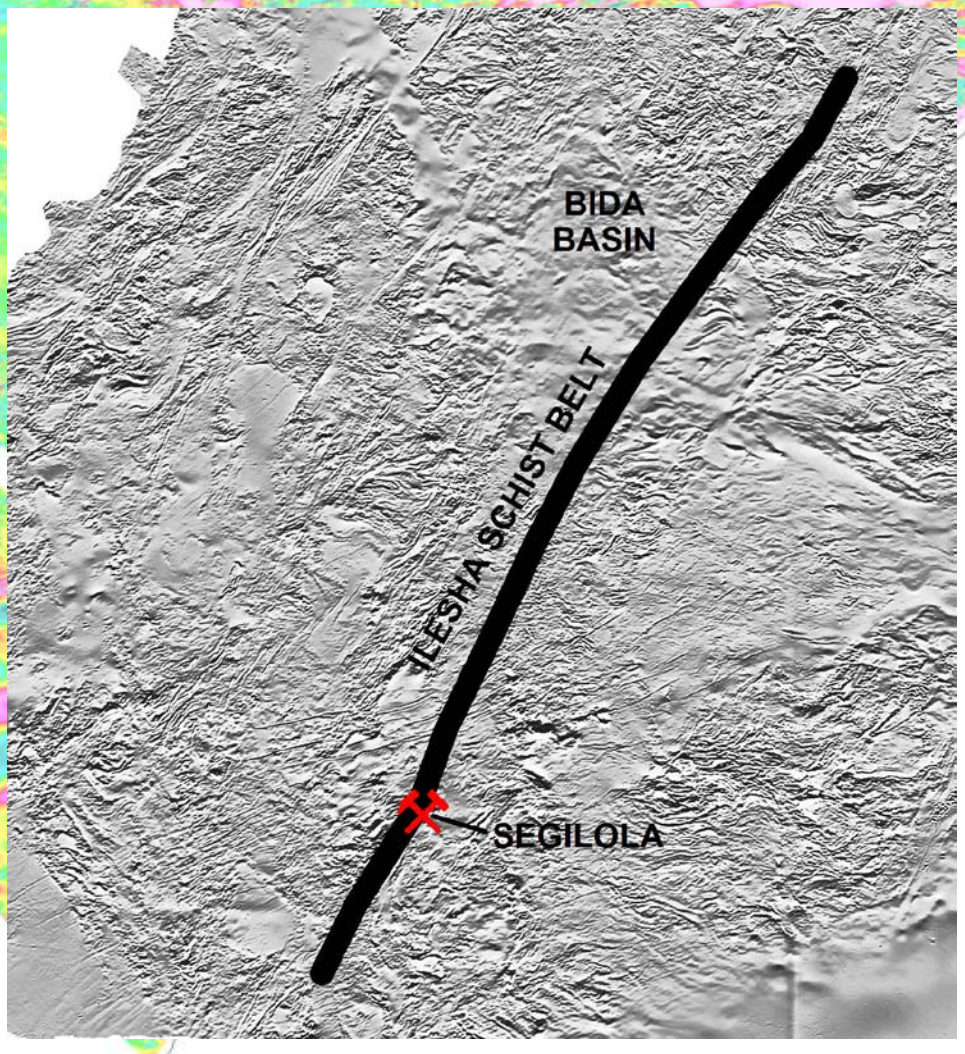
Deposit located on NNE-striking magnetic lineament

Segilola Gold Project

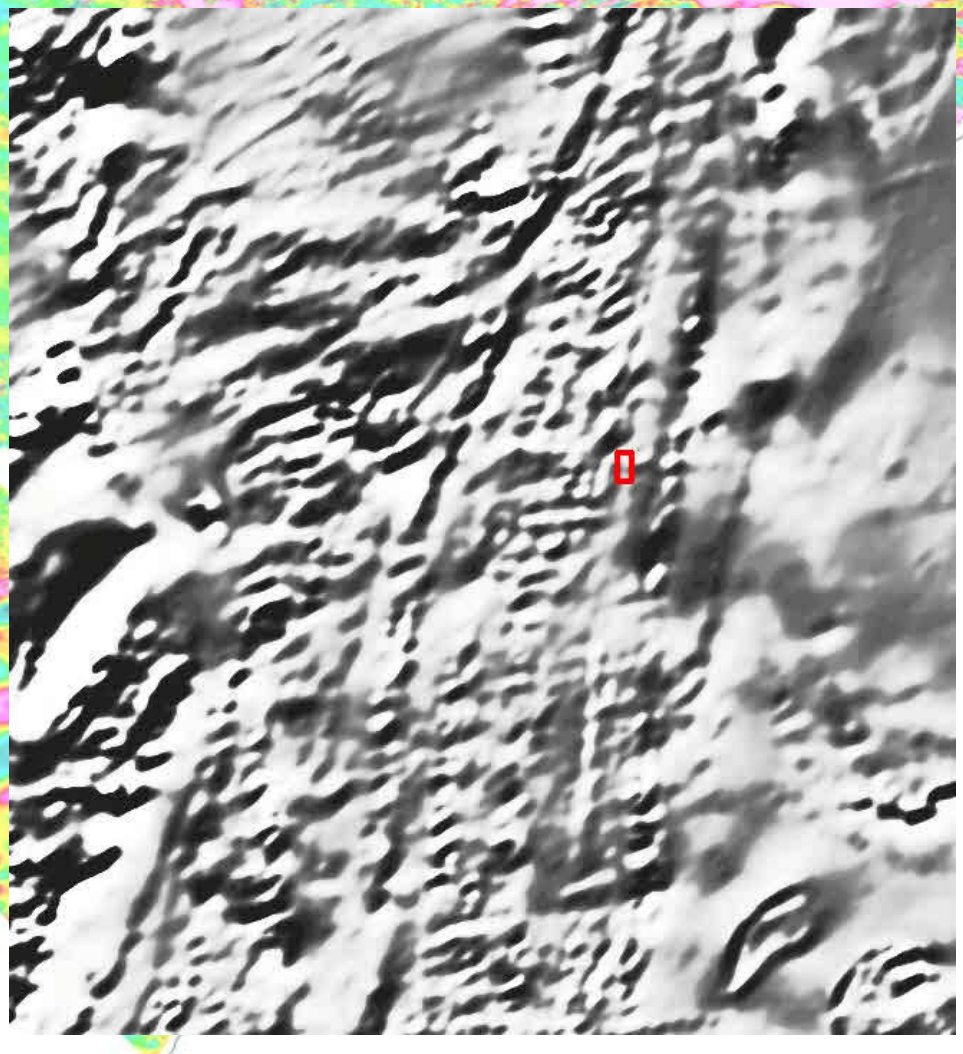
Ilesha Schist Belt continues for more than 400 km

Runs beneath Bida Basin

Several parallel schist belts and shear zones



Segilola Gold Project



Magnetic first vertical derivative

NNE-striking shear

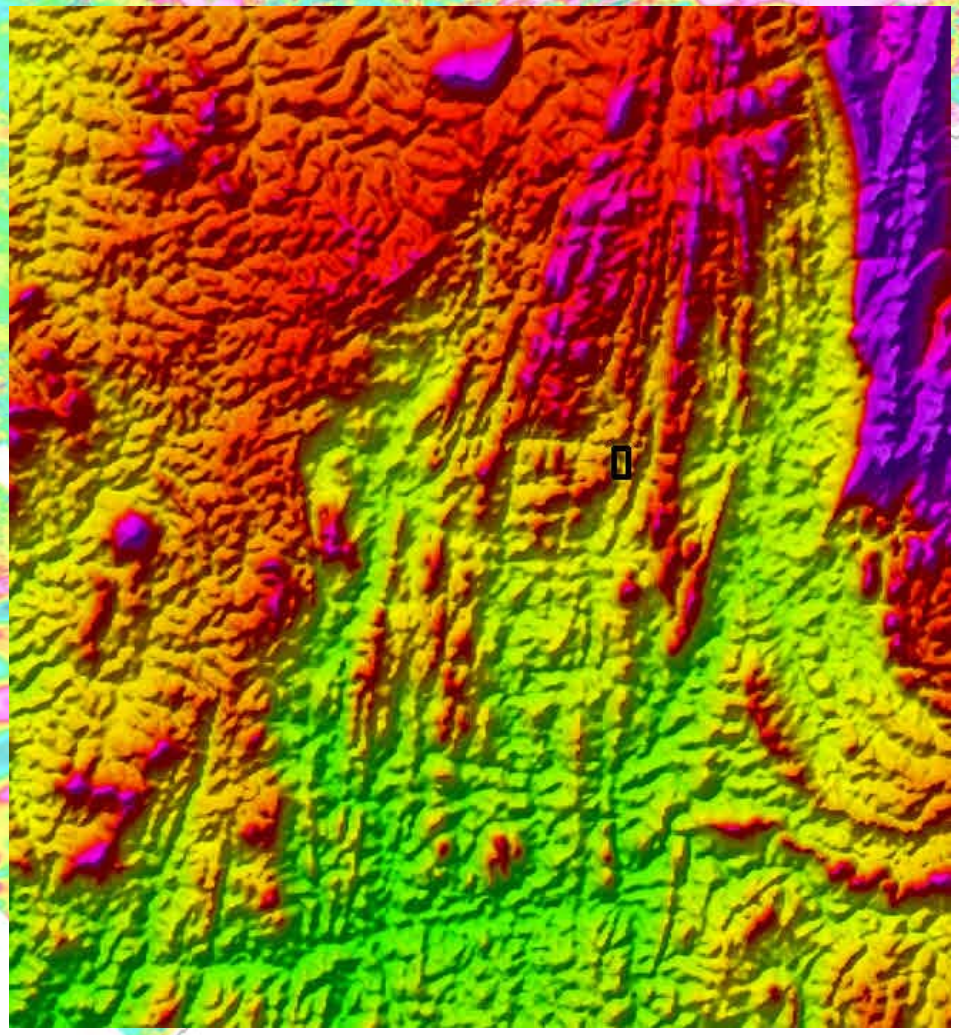
NE- and E-striking crosscut structures

Segilola Gold Project

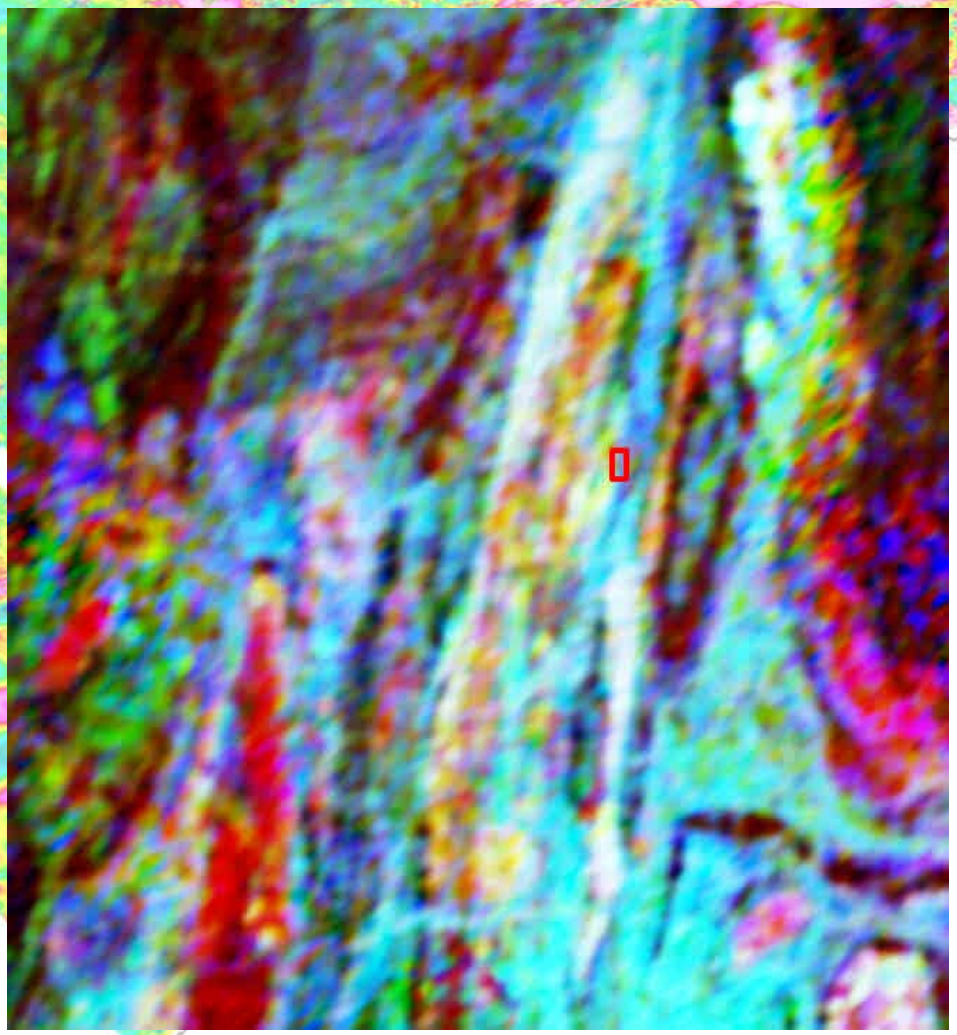
SRTM topography

Horizons and structures quite evident on surface

Good for surface exploration – geochemistry, trenching, etc.



Segilola Gold Project



Radiometric ternary image

Mapping of individual horizons

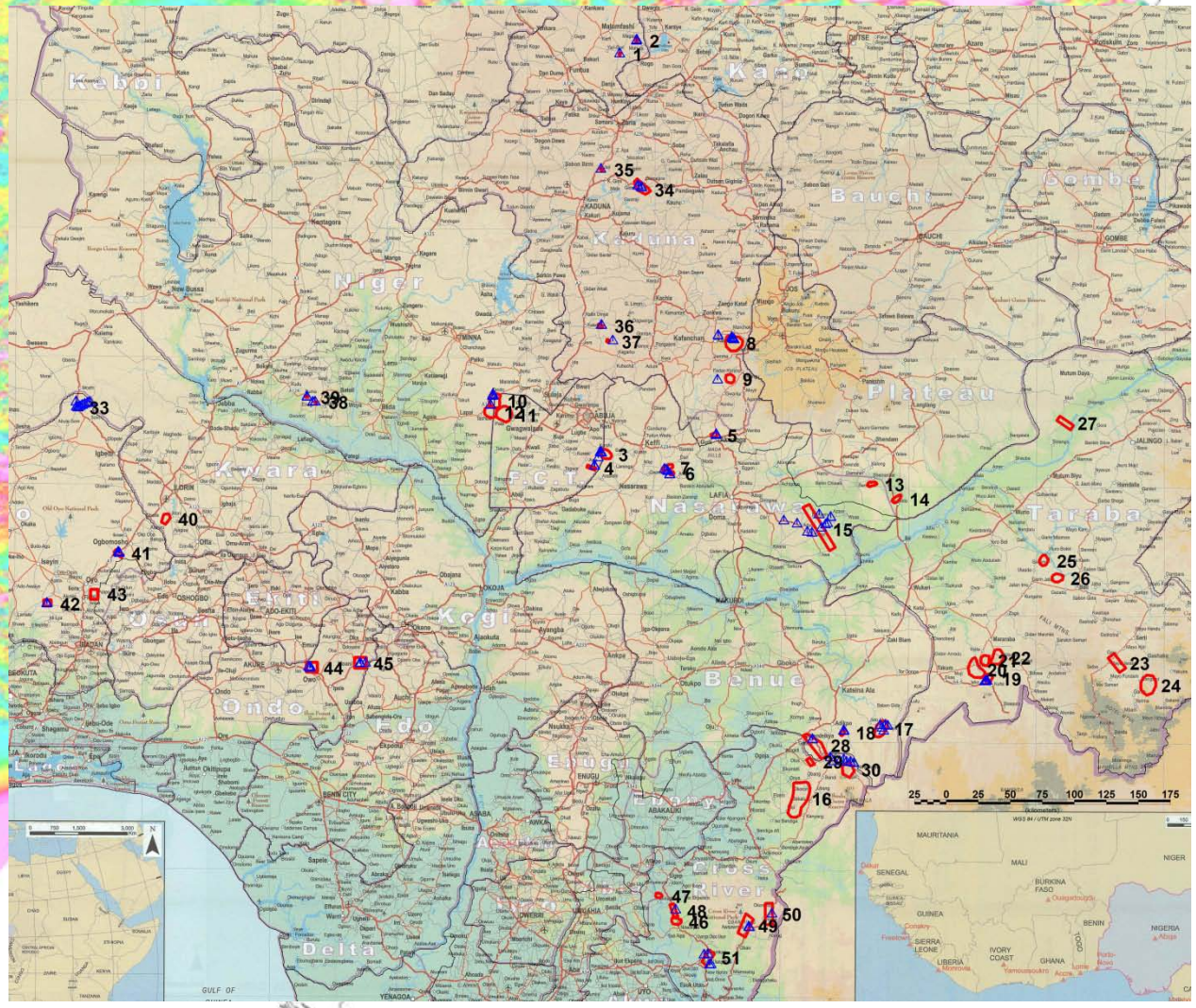
Possible alteration

Paterson, Grant & Watson Limited

Ground Truth

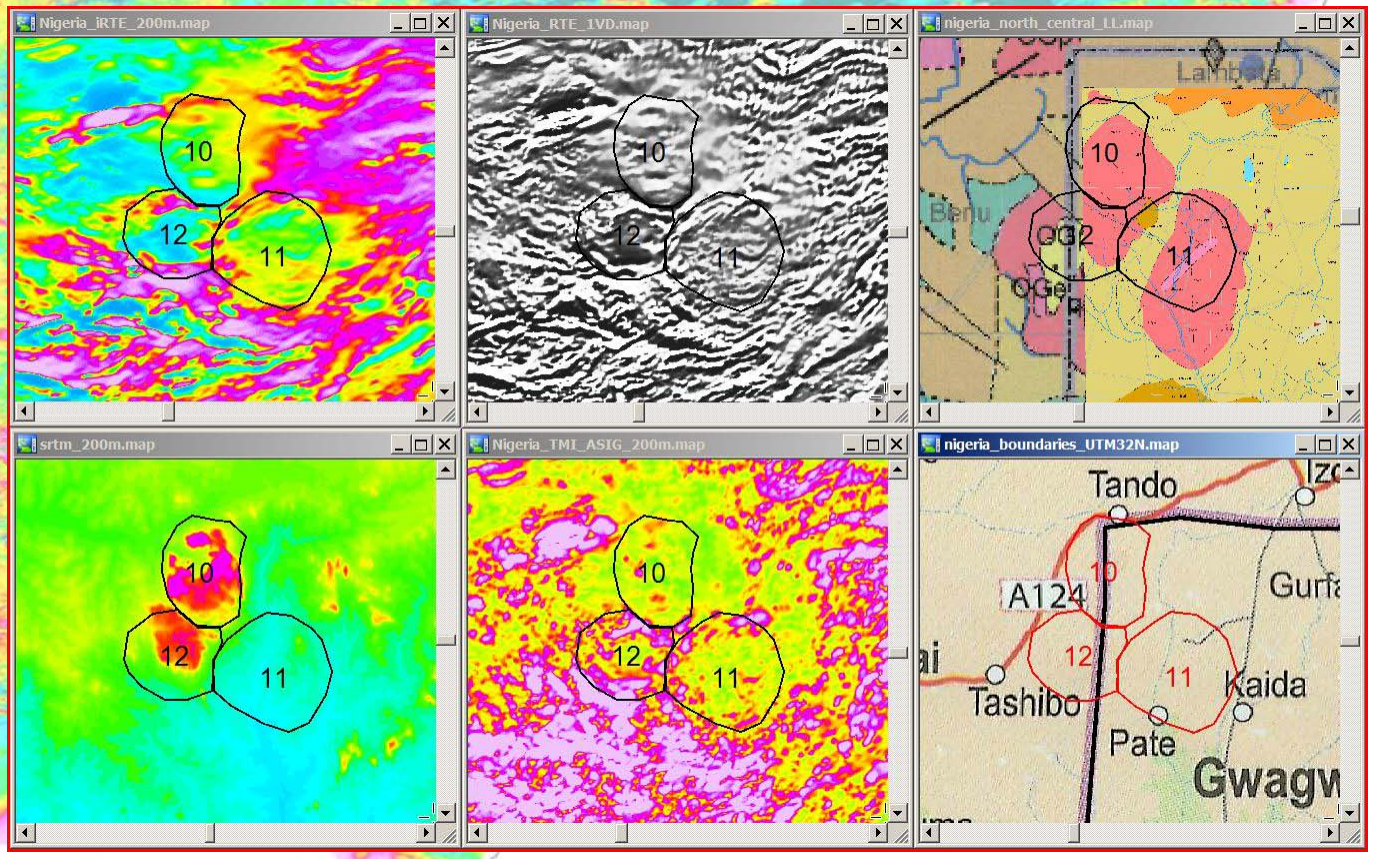
Red – sites selected on basis of geology, DEM, radiometrics and magnetics

Blue – sites completed in one month



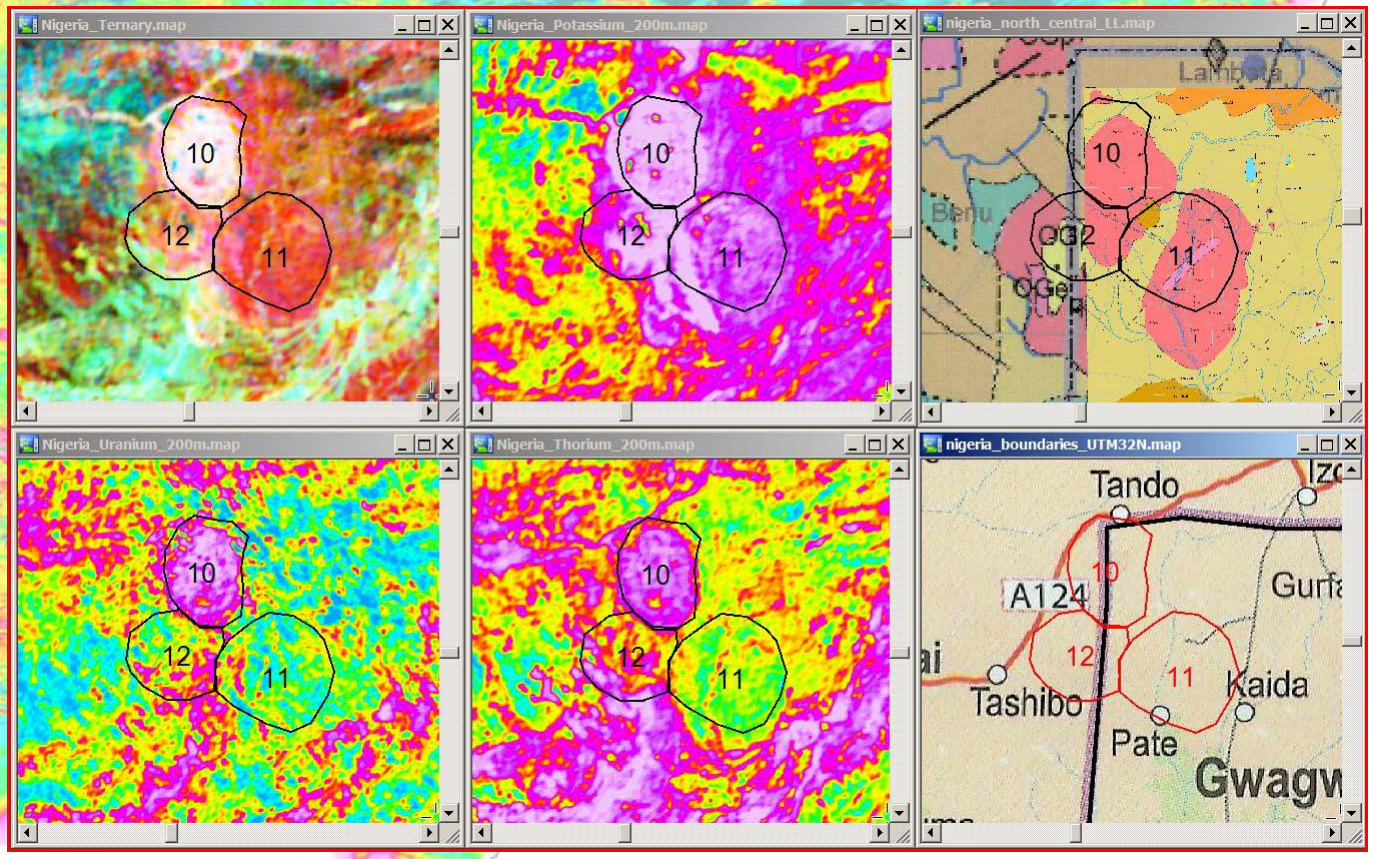
Ground Truth

Geology, DEM and magnetics



Ground Truth

Geology, DEM and radiometrics



Ground Truth

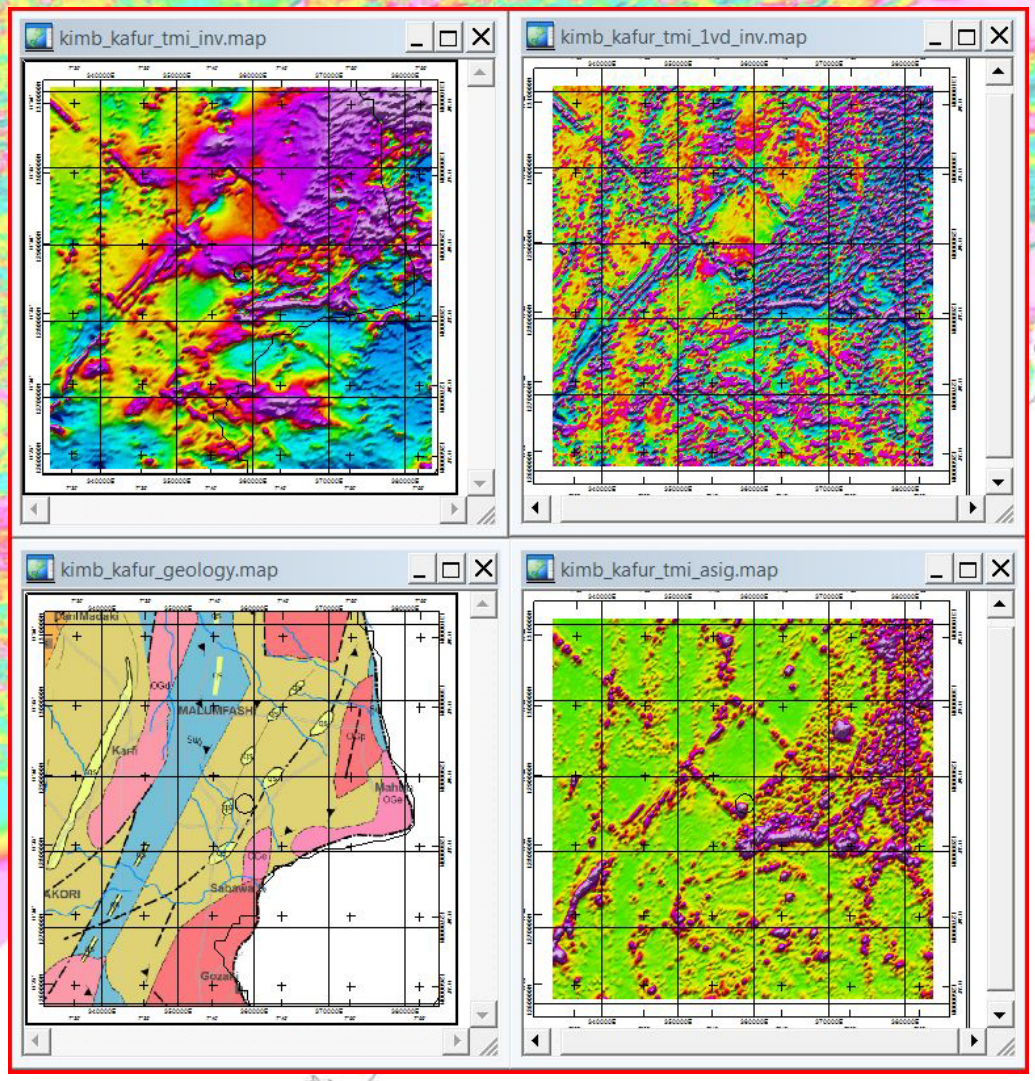
Unmapped basalt and sulphides

Figure: a) Coarse-grained granite with a weak foliation. b) Strongly foliation biotite-gneiss. c) Pyroxene rich, gabbroic-textured rock (at back). d) Fine-grained basalt with sulphide minerals.

Kafur Kimberlite Pipe

Regional Magnetics and Geology

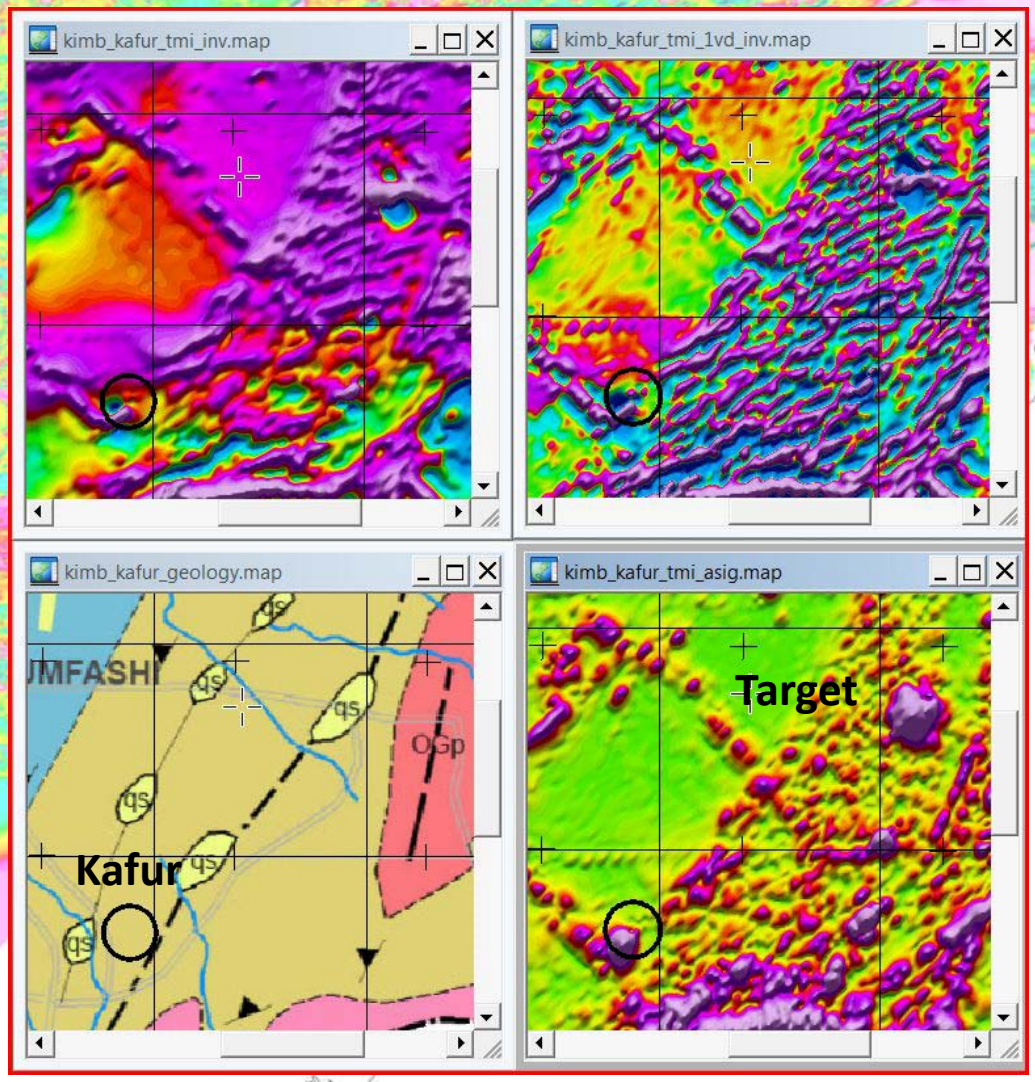
Cross-cutting dykes and fractures



Kafur Kimberlite Pipe

Local Magnetics and Geology

Well-defined magnetic response, especially analytic signal



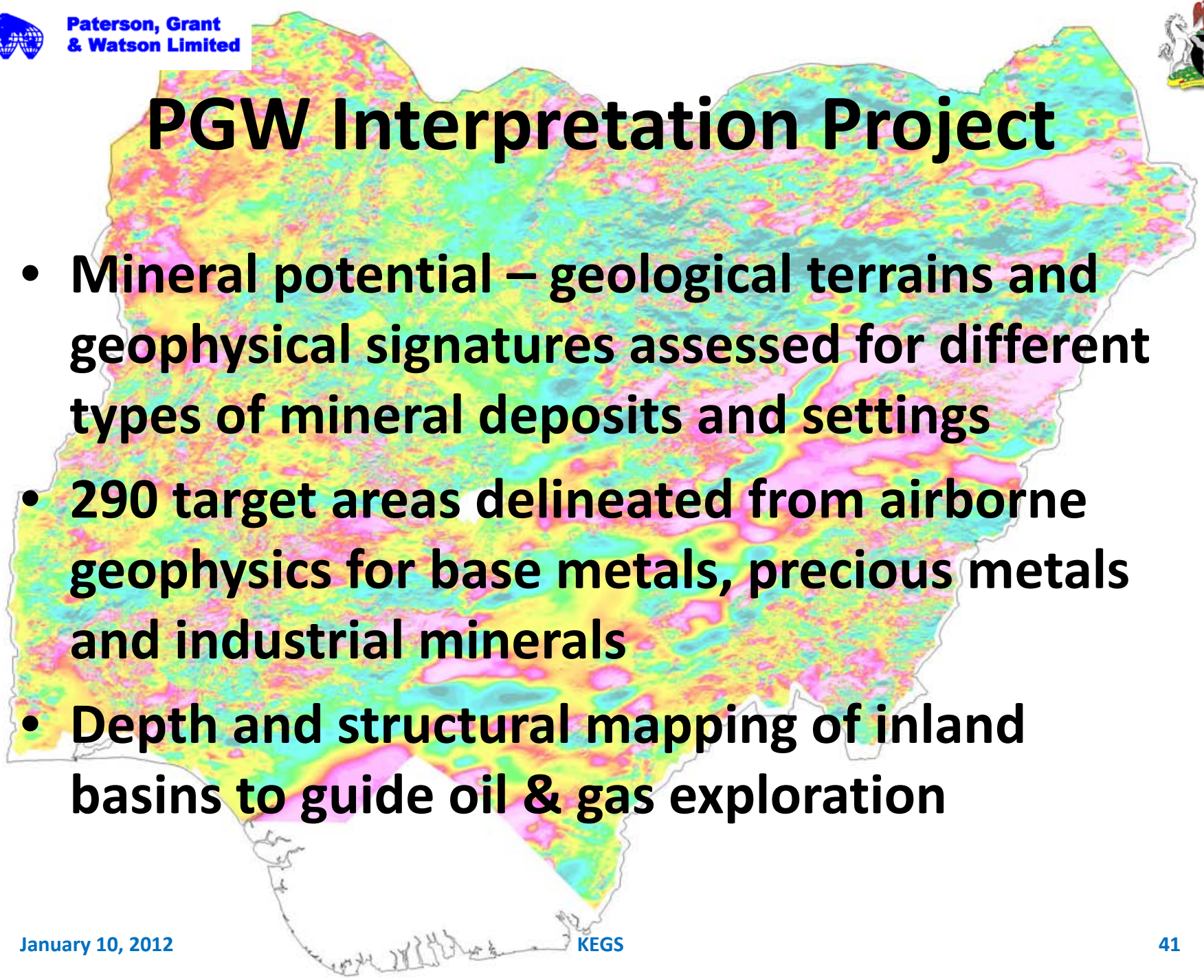
Kafur Kimberlite Pipe

Ground truth
- Previously bulldozed
- No kimberlite on surface
- Magnetic granodiorite nearby

PGW Interpretation Project

- Regolith Interpretation – reflects surface geology, soils and landforms
- Bedrock Interpretation – delineates lithology and structure of hard rock (basement), intrasedimentary igneous sources and some sedimentary sources
- Processed grids and images, magnetic models – illustrate and quantify the interpretation
- Structural and basement interpretation of the Niger Delta and offshore to assist petroleum exploration

PGW Interpretation Project



- Mineral potential – geological terrains and geophysical signatures assessed for different types of mineral deposits and settings
- 290 target areas delineated from airborne geophysics for base metals, precious metals and industrial minerals
- Depth and structural mapping of inland basins to guide oil & gas exploration