

Application of AMREC and Developing Case Studies

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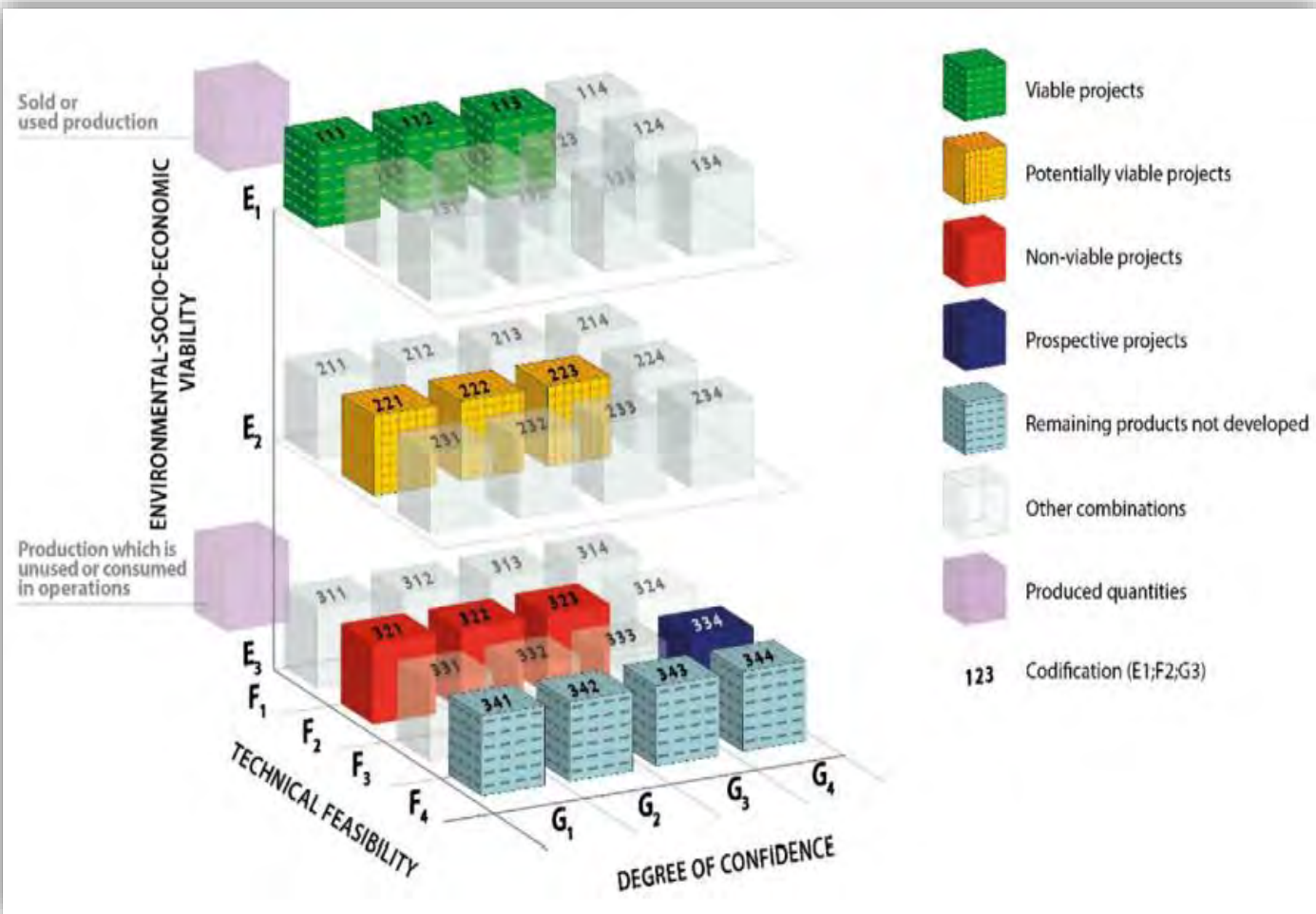
The UNFC Classification Framework

Overview

- Universal system for classifying, managing and reporting mineral, petroleum, renewable energy, anthropogenic resources and injection projects
- Project-based and principles based classification system
- Applies to all minerals and energy resources
- Resource quantities are classified on the basis of three fundamental criteria (E, F and G)

Primary Classes

Total Products	Produced	Sold or used production			
		Production which is unused or consumed in operations ^a			
		Class	Minimum Categories		
			E	F	G ^b
	The project's environmental-socio-economic viability and technical feasibility has been confirmed	Viable Projects ^c	1	1	1, 2, 3
	The project's environmental-socio-economic viability and/or technical feasibility has yet to be confirmed	Potentially Viable Projects ^d	2 ^e	2	1, 2, 3
		Non-Viable Projects ^f	3	2	1, 2, 3
	Remaining products not developed from identified projects ^g		3	4	1, 2, 3
	There is insufficient information on the source to assess the project's environmental-socio-economic viability and technical feasibility	Prospective Projects	3	3	4
	Remaining products not developed from prospective projects ^g		3	4	4



Stage 2: Resource Classification

Sub-classes defined by Sub-categories

UNFC Classes Defined by Categories and Sub-categories							
Total Products	Produced	Sold or used production					
		Production which is unused or consumed in operations					
	Class		Sub-class		Categories		
					E	F	G
	Known Sources	Viable Projects	On Production		1	1.1	1, 2, 3
			Approved for Development		1	1.2	1, 2, 3
			Justified for Development		1	1.3	1, 2, 3
		Potentially Viable Projects	Development Pending		2 ^b	2.1	1, 2, 3
			Development On Hold		2	2.2	1, 2, 3
		Non-Viable Projects	Development Unclassified		3.2	2.2	1, 2, 3
Development Not Viable			3.3	2.3	1, 2, 3		
Remaining products not developed from identified projects		3.3	4	1, 2, 3			
Potential Sources	Prospective Projects		[No sub-classes defined]		3.2	3	4
	Remaining products not developed from prospective projects		3.3	4	4		

E-Axis definition

E1: Development and operation are confirmed to be environmentally-socially-economically viable.

E2: Development and operation are expected to become environmentally-socially-economically viable in the foreseeable future.

E3: Development and operation are not expected to become environmentally-socially-economically viable in the foreseeable future or evaluation is at too early a stage to determine environmental-socioeconomic viability.

F-Axis definition

F1: Technical feasibility of a development project has been confirmed.

F2: Technical feasibility of a development project is subject to further evaluation.

F3: Technical feasibility of a development project cannot be evaluated due to limited data.

F4: No development project has been identified.

G-Axis definition

G1: Product quantity associated with a project that can be estimated with a high level of confidence.

G2: Product quantity associated with a project that can be estimated with a moderate level of confidence.

G3: Product quantity associated with a project that can be estimated with a low level of confidence.

G4: Product quantity associated with a Prospective Project, estimated primarily on indirect evidence.

- NIGERIAN CASE STUDY

- Uranium mineralization in the Nigerian
- Basement and sedimentary basins:
- Case study of North-Eastern Nigeria—
- Application of UNFC-AMREC as a standard for sustainable energy in Nigeria

- Uranium deposit discoveries

- The uranium anomalies that were identified in north-east Nigeria occur in basement rocks around
 - the Gumchi,
 - Gabrunde,
 - Mika areas,
 - sedimentary rocks
 - Mayo-lope
 - Zona areas of the Benue Trough sedimentary area
- Most of the anomalies and mineralized occurrences of most interest are located in basement rock areas and are associated with rhyolite dykes.

- Uranium Mineralization in Basement Rocks

- *Gumchi Prospect*

- The rocks that host the uranium anomalies are fine-grained porphyritic granite and mylonitized sheared and brecciated quartzites.
- The brecciated zone extends for over 15 km and is associated with lamprophyres. The breccia is highly silicified.
- The uranium anomaly is mostly associated with silica cementing the breccias.
- A very-lowfrequency(VLF) survey was carried out in the area.
- A total of 65 holes were drilled in the area; a total of 5,679 m of drill samples were recovered and logged. The Reasonably Assured Resource (RAR) for the deposit was determined to be 100 t of U oxide. The geochemical
- analysis indicated an average uranium concentration of 2000 parts per million (ppm).
- TheGumchi area is the best prospect among the different mineralized areas underlain by the basement areas.

- *Gabrunde Prospect*

- In the Gabrunde area, uranium mineralization is hosted by Pre-Cambrian granites.
- Reportedly, the largest deposit is composed of uraniferous pyrochlore, an ore of niobium
- with small amounts of U and Th, hosted within peralkaline granite. The uranium concentration
- was at 215 ppm. The Reasonably Assured Resource (RAR) is estimated at 60 t U oxide.

Mika Prospect

- In the Mika area, the mineralization is associated with Pan-African tectonized granites within a major northeast-southwest-trending shear zone.
- A total of 14,173 line-km of airborne (by helicopter) gamma-ray spectrometric radiometric survey was conducted.
- Additionally, 15 total-count scintillometers (Spp2), two GR 410 spectrometers, and one Scintrex spectrometer were used for ground radiometric surveys.
- Uraniferous rhyolites of Jurassic age occur as dykes, which were emplaced within Pan African Granite.
- The uranium resource in the Mika deposits was estimated based on the drilling results of 23 holes, with a total of 434.8 m of drill cores samples collected and logged.
- The geochemical analysis showed that the average uranium concentration is 540 ppm over 130 m in thickness. The Reasonably Assured Resource (RAR) estimate for the deposit is 52 t U oxide.

• Sedimentary Unconformity-Related Uranium Mineralization

- Mayo-Lope and Zona Prospects
- The Benue Trough sedimentary area is located in the southern and northern limbs of the Mayo-lope Syncline (Ogedengbe, 1984). Uranium mineralization in the Mayo-lope
- and Zona areas is associated with the Cretaceous Bima Sandstone, which lies directly and - 126 -
- . The anomaly is hosted around Bille and Passam Hills, both located in the southern and northern limbs of the Mayo-lope Syncline
- (Ogedengbe, 1984). The Bille anomalous uranium concentration is essentially channel-fill. Geochemical analyses indicated a U concentration of 1826 ppm. The Passam Hill anomaly is also in channel fill. The analyses of samples showed a concentration of 2375 ppm U.
- The mineralization occurs in both sections of hills as ferruginized conglomerates lying on top of the Lower Bima Sandstone. The Bille and Passam Hills contain a layer that shows
- evidence of a break in sedimentation. The deposition of uranium in the area was not trace to any fracture since both deposits occur in the same formation. Stratiform occurrences of
- uranium lie at 200–350 m of depth. A hydrogeochemical survey was conducted. Three holes were also drilled (a combined depth of 257.86 m). The Bima Sandstone uranium deposit
- (the Mayo-lope Syncline) has the best potential as a viable uranium resource within the sedimentary rocks.

- **The Zona uranium** deposits also occur within Bima Sandstone in the Mayo-lope Syncline. It is a structurally-controlled deposit, unlike the Mayo-Lope.
- The Zona mineralization is hosted near a vertical fault line cutting across three types of Bima Sandstone—finegrained brecciated, medium-grained, and coarse-grained arkosic sandstones (Ogunleye and Okujeni, 1993).
- Chemical analysis indicated U concentrations between 0.01 and 128ppm. The Reasonably Assured Resource (RAR) estimated in the Zona deposit is 130 t Uoxide.
- **The Bima Sandstone uranium deposit** (the Mayo-lope Syncline) has the best potential as a viable
- uranium resource within the sedimentary rocks.
- The Zona uranium deposits also occur within Bima Sandstone in the Mayo-lope Syncline. It is a structurally-controlled deposit, unlike the Mayo-Lope. The Zona mineralization is hosted near a vertical fault line cutting across three types of Bima Sandstone—fine-grained brecciated, medium-grained, and
- coarse-grained arkosic sandstones (Ogunleye and Okujeni, 1993). Chemical analysis indicated U concentrations between 0.01 and 128 ppm.
- The Reasonably Assured Resource (RAR) estimated in the
- Zona deposit is 130 t U oxide.



GEOLOGICAL MAP
LOCATION OF MAIN DISCOVERIES
MIKA MONKIN GHUMCHI GUBRUNDE KALTUNGO
MAYO LOPE SOUTH CHAD BASIN

1:1,250,000

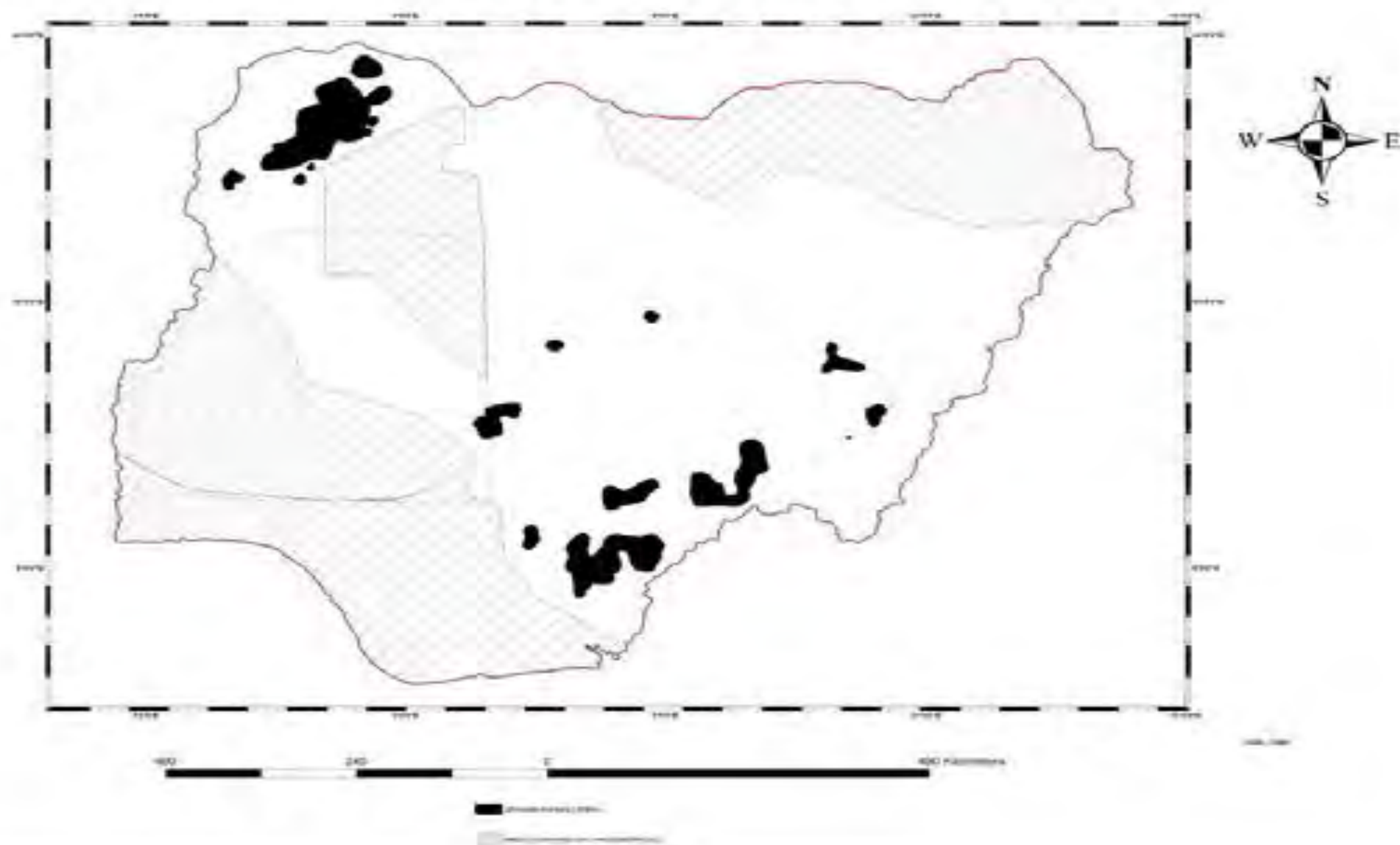
Legend

- Basalt
- Granite
- Cretaceous Sediments
- Migmatites
- Jurassic Alkaline Granite
- Quartz Sediments
- Tertiary Sediments
- Volcanics
- Jos Granite
- Tectonics
- River
- Towns

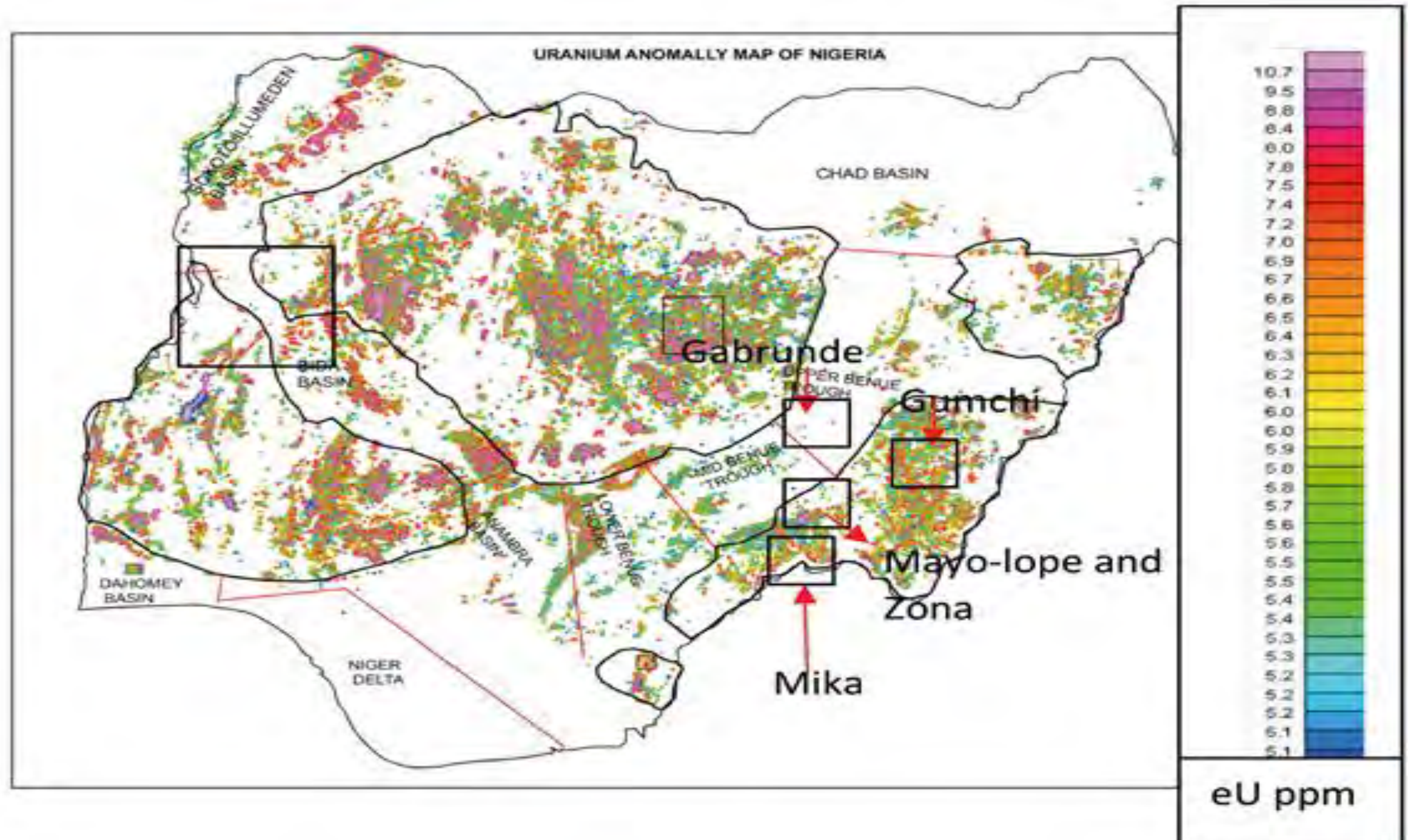


40 20 0 40 80 120 Kilometers

AIRBORNE GEOPHYSICALLY SURVEY AREAS OF URANIUM ANOMALIES



High resolution map air borne radiometric data 2003-2010



	Project and location	Geology	Quantity of U resource	Average U grade in ppm	UNFC-Class	E	F	G	Remarks (COMMENT ON PRIORITY DELINEATED AREAS AND GRADE)
1.	Gumchi prospect, northeast Nigeria	Uranium in anomalies in brecciated, silicified and mylonitized porphyritic granites	100 t U	2000 ppm	Non- Commercial Project				
2.	Mayo- lope syncline—Zona prospect, northeast Nigeria	Uranium in Cretaceous Bima Sandstone	130 t U	1826 ppm and 2375 ppm	Non- Commercial Project				
3.	Mika prospect, northeast Nigeria	Uranium mineralisation in rhyolite	52 t U	540 ppm	Non- Commercial Project				
4.	Gabrunde prospect, northwest Nigeria	Uranium-bearing pyrochlore mineralization in	60 t U	215 ppm	Exploration project				

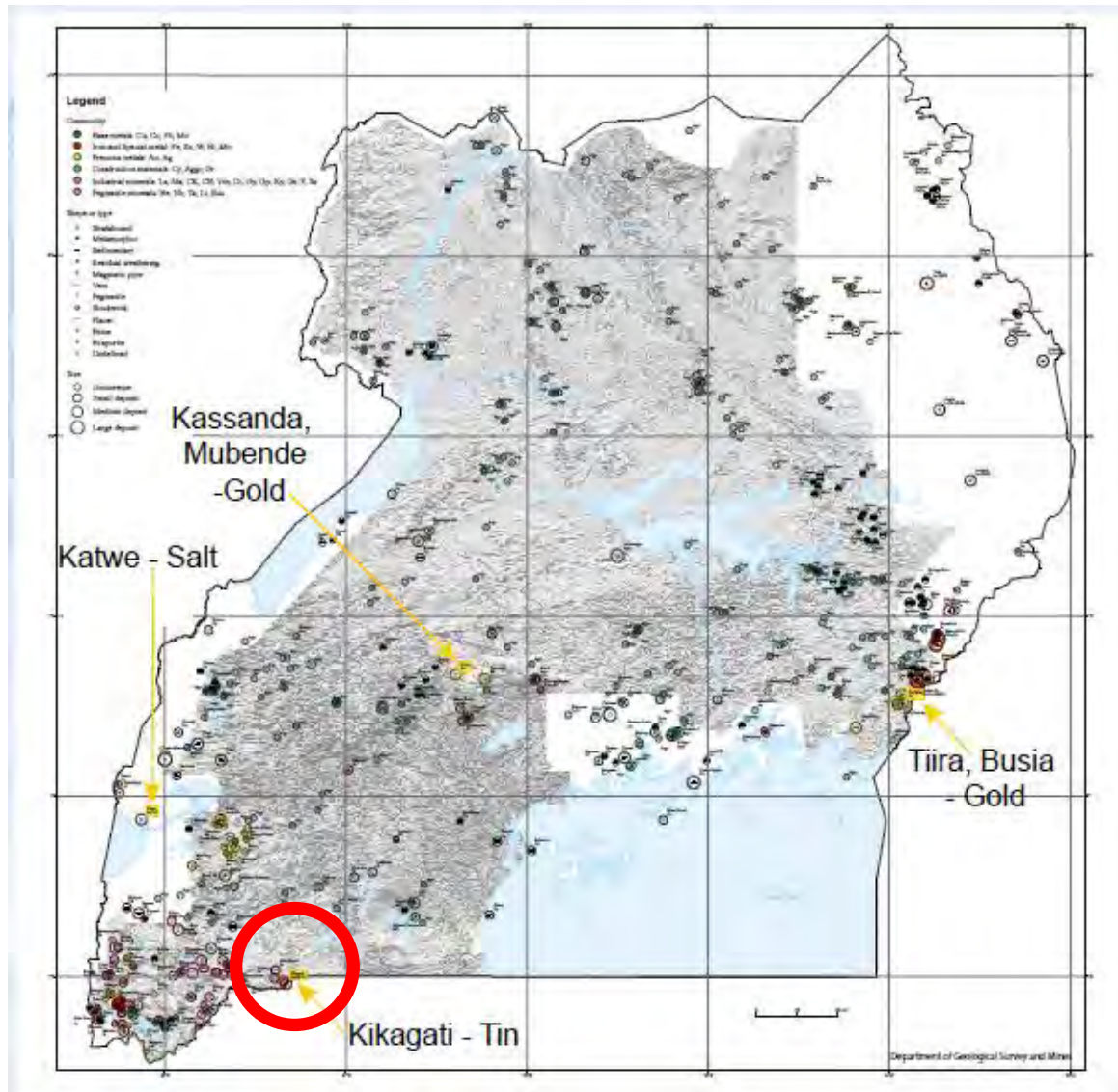
Conclusions

- UNFC has been applied to provide a better understanding and quantifying of uranium
- resources in Nigeria. The resource classification system is being adapted as a tool for decisionmaking,
- economic management and government planning of Nigeria's uranium and other solid
- mineral resources. Application of UNFC, shown in Table 1, indicated that uranium in Nigeria so far
- can be classified as Non-Commercial and Exploration Projects. However, with the newly available
- high-resolution airborne radiometric data covering the entire country, it indicates that discoveries
- can be anticipated through ground radiometric surveys, geological mapping, mineral evaluation and
- complimentary geochemical analyses in the target areas that exhibit high radiometric anomalies

UGANDAN CASE STUDIES

The Uganda Case Studies

Example: Tin— Kikagati, Insingiro, Uganda



Project Milestone & Decision gate (Meets Expectation)

- Project conforms and has an approved ESIA with a mine closure plan, feasibility with a long-term plan was also approved

Value Addition & Beneficiation (Below Expectation)

- Separation of tin from mined rubble is the highest notable value addition, extracted tin is exported as an unprocessed raw material, lack of tin smelting blamed on huge electricity requirement

Economic Diversification (Below Expectation)

- Remains limited, activities restricted to tin mining only although some support like pipe water is given to the community

Comprehensive Resource Recovery (Meets Expectation)

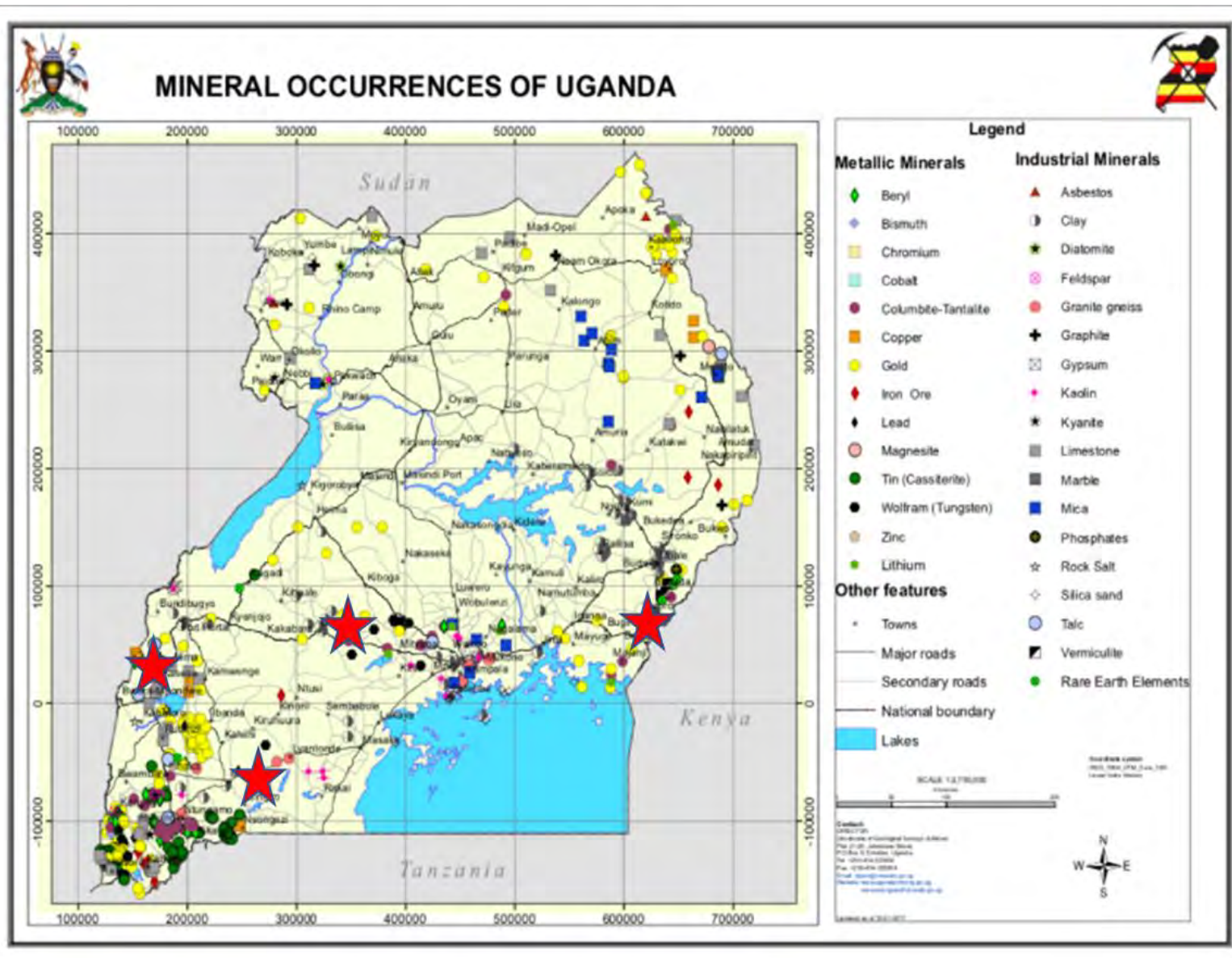
- Plausible evidence, in addition to tin, iron is also harvested during the separation process. Importantly, the non-mineralised rocks are washed and separated into aggregates of gravel and sand used in other construction works

Zero Waste (Average)

- Satisfactory, the only waste output is muddy water, which drains into the River Kagera, part of this “wastewater” is re-used for repeated phases in the ore separation process.

The Uganda Case Studies

Overview of Minerals Project



Projects studied

- Gold Mining in Tiira, Busia, Eastern Uganda
- Gold Mining in Kassanda, Mubende, Central Uganda
- Tin Mining in Isingiro, Western Uganda
- Salt Mining in Lake Katwe, Kasese, Western Uganda

Sustainability test

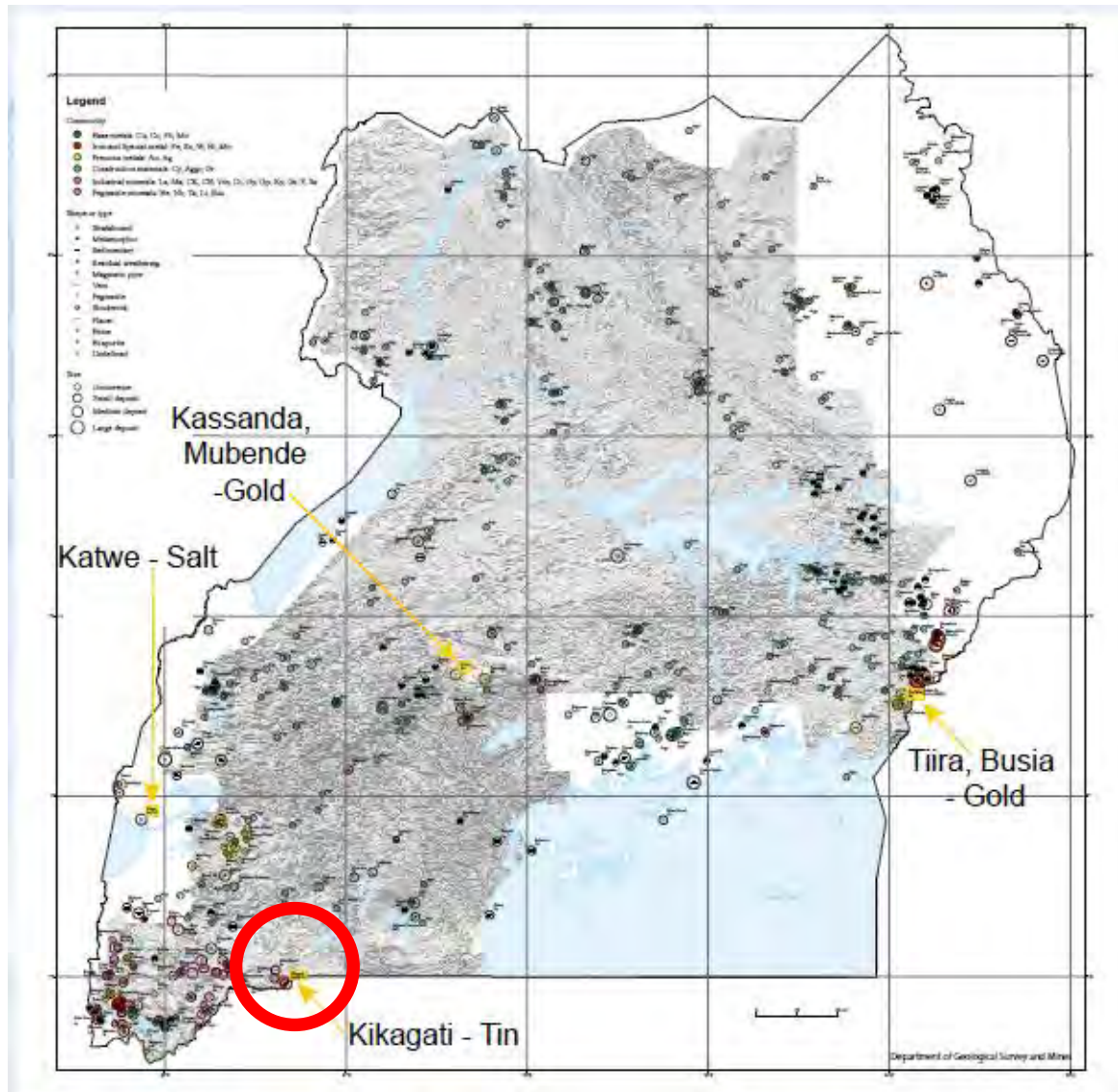
- Each project was assessed on how they conform to the critical controlling factors.
 - ✓ Project Millstone & Decision gate
 - ✓ Value addition and beneficiation
 - ✓ Economic diversification
 - ✓ Comprehensive resource recovery
 - ✓ Zero waste concept

Criteria

Meets Expectation = greater than 70% conformity
Average = at least 50% conformity
Below Expectation = Less than 50% conformity

The Uganda Case Studies

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The Uganda Case Studies

Summary of Sustainability testing

These results guides classification on the E and F axis of the UNFC

Critical Controlling Factors	Project A	Project B	Project C	Project D
1. Project milestones and decision gates	Below expectations	Meets expectations	Average	Below expectations
2. Value addition and beneficiation	Below expectations	Below expectations	Below expectations	Below expectations
3. Economic diversification	Below expectations	Below expectations	Average	Average
4. Comprehensive resource recovery	Average	Meets expectations	Below expectations	Below expectations
5. Zero waste concept	Below expectations	Average	Below expectations	Below expectations

The Uganda Case Studies

Re-Evaluation Stage

Project A

	Critical Controlling Factors	Project A
1.	Project milestones and decision gates	Below expectations
2.	Value addition and beneficiation	Below expectations
3.	Economic diversification	Below expectations
4.	Comprehensive resource recovery	Average
5.	Zero waste concept	Below expectations

+

E	F	G
1.1	1.3	1

Is it still Justified for Development?

Project C

	Critical Controlling Factors	Project C
1.	Project milestones and decision gates	Average
2.	Value addition and beneficiation	Below expectations
3.	Economic diversification	Average
4.	Comprehensive resource recovery	Below expectations
5.	Zero waste concept	Below expectations

+

E	F	G
2	2.2	3

Is it still Development on Hold?

Project B

	Critical Controlling Factors	Project B
1.	Project milestones and decision gates	Meets expectations
2.	Value addition and beneficiation	Below expectations
3.	Economic diversification	Below expectations
4.	Comprehensive resource recovery	Meets expectations
5.	Zero waste concept	Average

+

E	F	G
1.1	2.1	2+3

Is it still Development Pending?

Project D

	Critical Controlling Factors	Project D
1.	Project milestones and decision gates	Below expectations
2.	Value addition and beneficiation	Below expectations
3.	Economic diversification	Average
4.	Comprehensive resource recovery	Below expectations
5.	Zero waste concept	Below expectations

+

E	F	G
3.2	3	4

Is it still a Prospective Project?

Thank you!