Blut im Handy?

Wegee zur Rohstoffzertifizierung in Zentralafrika

Frank Melcher

Lehrstuhl für Geologie und Lagerstättenlehre
Montanuniversität Leoben

german cooperation
DEUTSCHE ZUSAMMENARBEIT

INTERNATIONAL CONFERENCE ON THE GREAT LAKES REGION
CONFERENCE INTERNATIONALE SUR LA REGION DES GRANDS LACS

BGR Bundesanstalt für Geowissenschaften und Rohstoffe
GEOZENTRUM HANNOVER

GEOZENTRUM HANNOVER

Personnel: 725 staff
Budget: € 75 million

Bundesanstalt für Geowissenschaften und Rohstoffe

Personnel: 200 staff

Landesamt für Bergbau, Energie und Geologie

Personnel: 100 staff

Leibniz-Institut für Angewandte Geophysik

1. Energy Resources, Mineral Resources

- Marine Resource Exploration
- **Resource Geology**
- Resource Geochemistry
- Economic Geology of Energy Resources
- Economic Geology of Mineral Resources

2. Groundwater and Soil Science

- Geophysical Exploration, Resources and Surface Processes
- Basic Information, Groundwater and Soil
- Groundwater Resources, Quality and Dynamics
- Soil as a Resource, Properties and Dynamics

3. Underground Space for Storage and Economic Use

- Geological-geotechnical Exploration
- Geological-geotechnical Site Assessment
- Subsurface Use, Geological CO_2 Storage
- Geological-geotechnical Safety Analyses

4. Geoscientific Information, Internat. Cooperation

- **International Technical Cooperation**
- Geodata, Geological Information, Stratigraphy
- CTBT, Central Seismological Observatory
- Geo-Hazard Assessment, Remote Sensing

- Economic background: Metals in mobile phones
- Political background in central/eastern Africa
- Certification initiatives

- Ta, Sn and W in rare-element pegmatites and granites
- Geology of central/eastern Africa
- Analytical fingerprinting methods for Ta-Sn-W ores

Products of the consumer electronics industry

Sales in Germany:
113 million phones, 12 million smartphones (2011)
Global production 1.75 billion mobile phones (2012)

Element	mg in mobile phone
Cobalt	3200
Palladium	8
Gold	21
Silver	215
Tantalum	40

Raw material	percent
Plastics	56
Glass/ceramics	16
Metals	28

About 60 metals are needed

Annual demand for mobile phones:

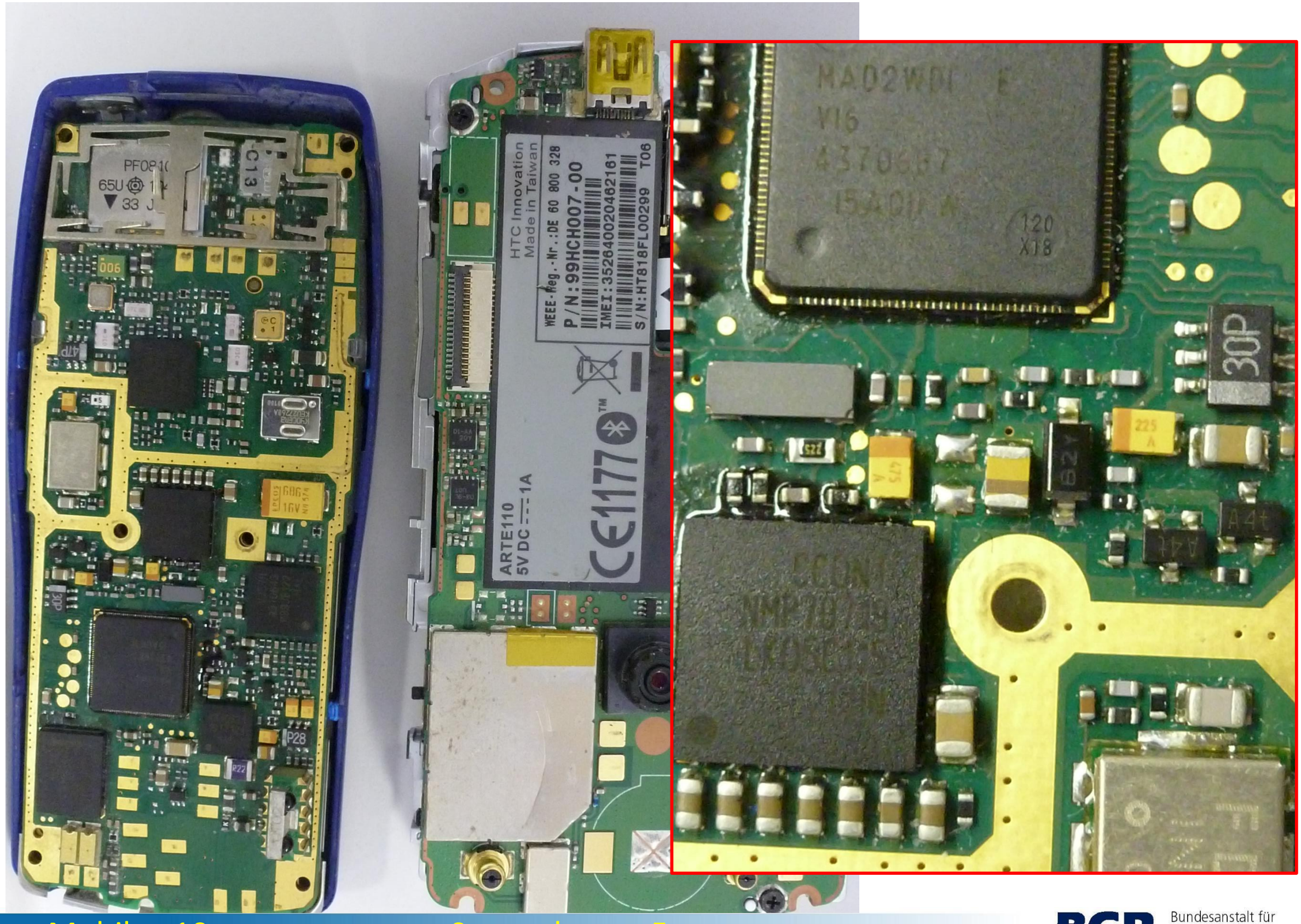
5650 tons cobalt = 15 % WP

14 tons palladium = 13 % WP

36 tons gold = 3 % WP

375 tons silver = 3 % WP

70 tons tantalum = 3 % WP

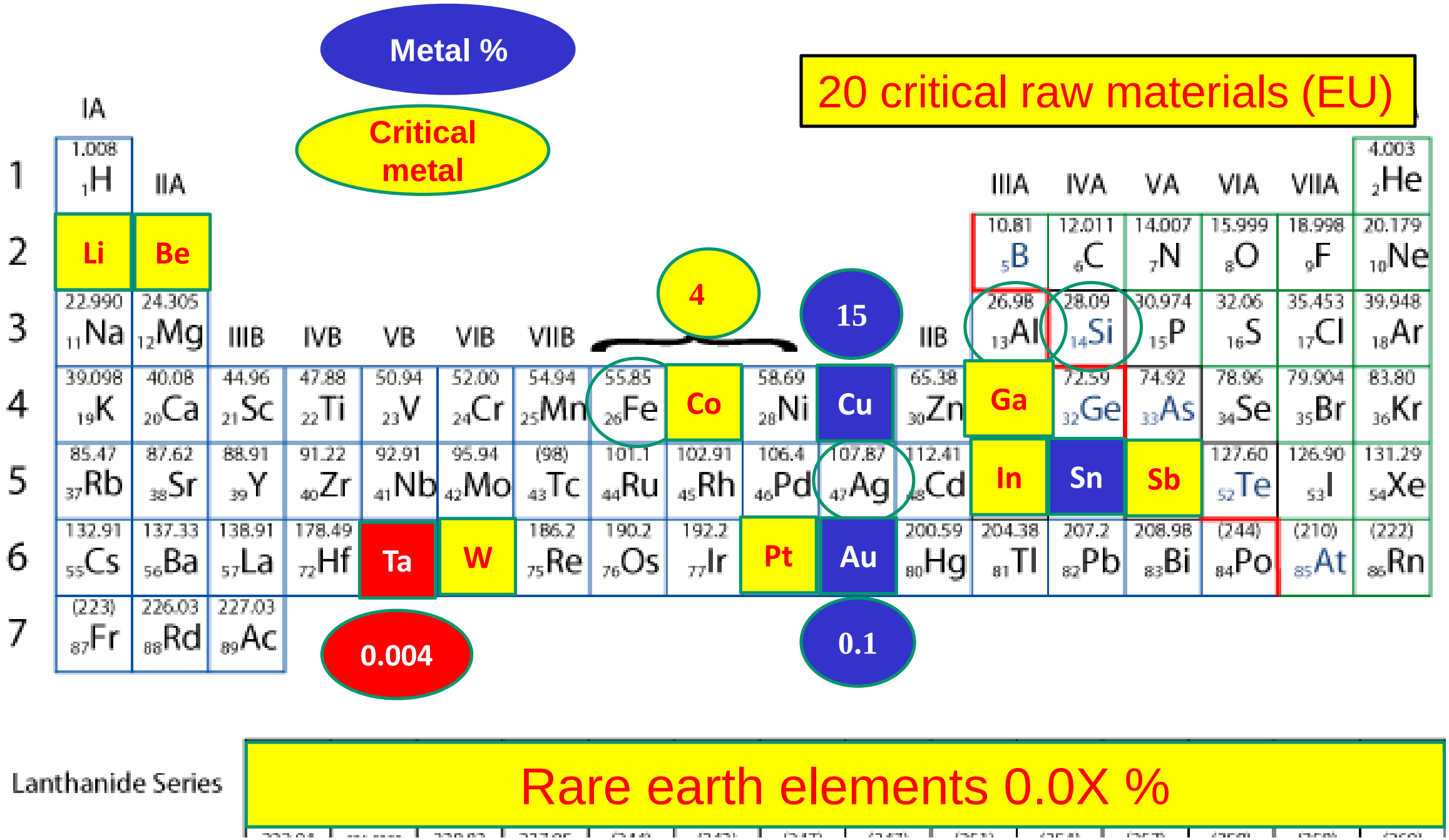


Mobile >10 a

Smartphone <5 a

BGR Bundesanstalt für Geowissenschaften und Rohstoffe
GEOZENTRUM HANNOVER

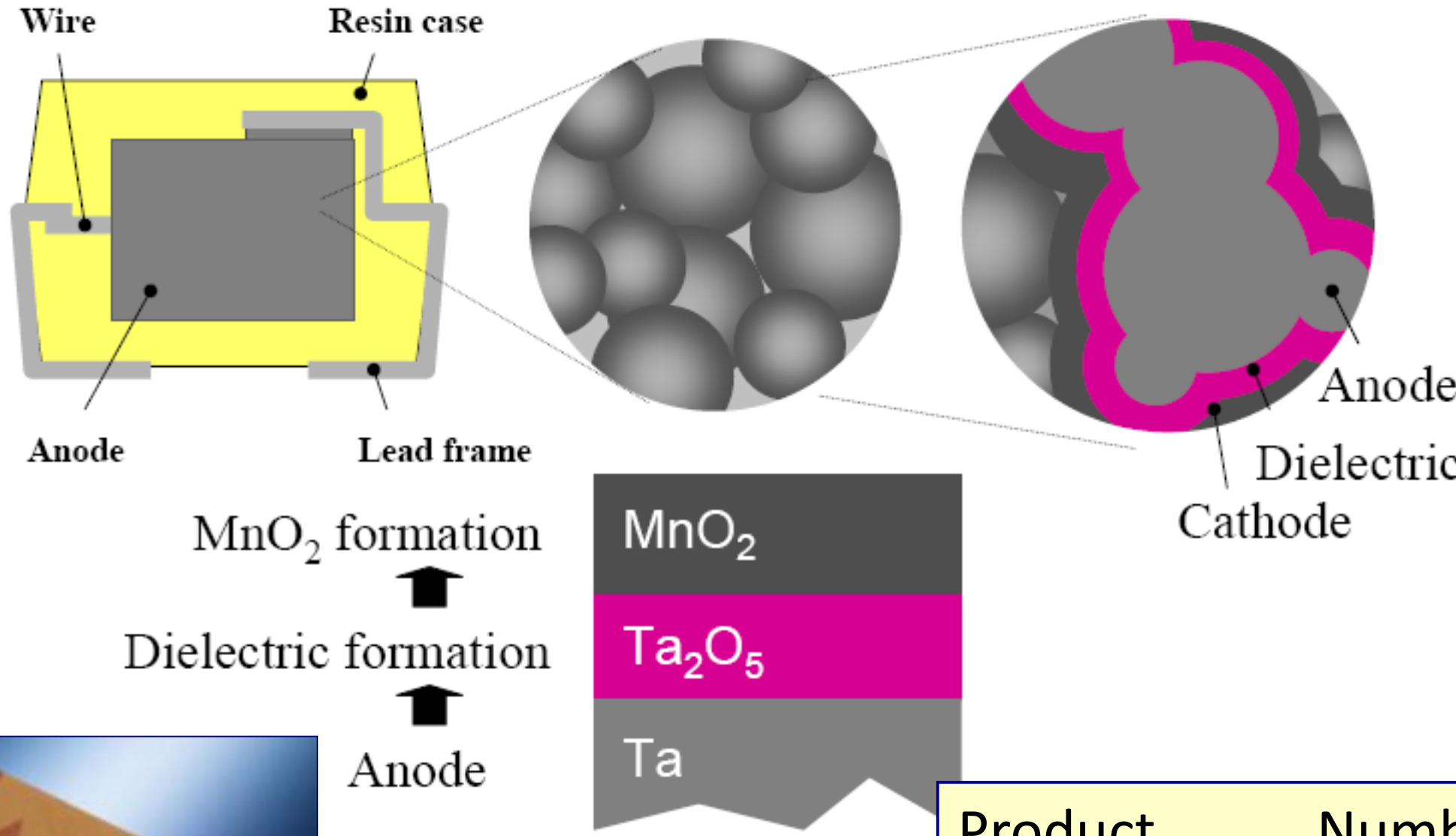
Metals in mobile phones



Lanthanide Series

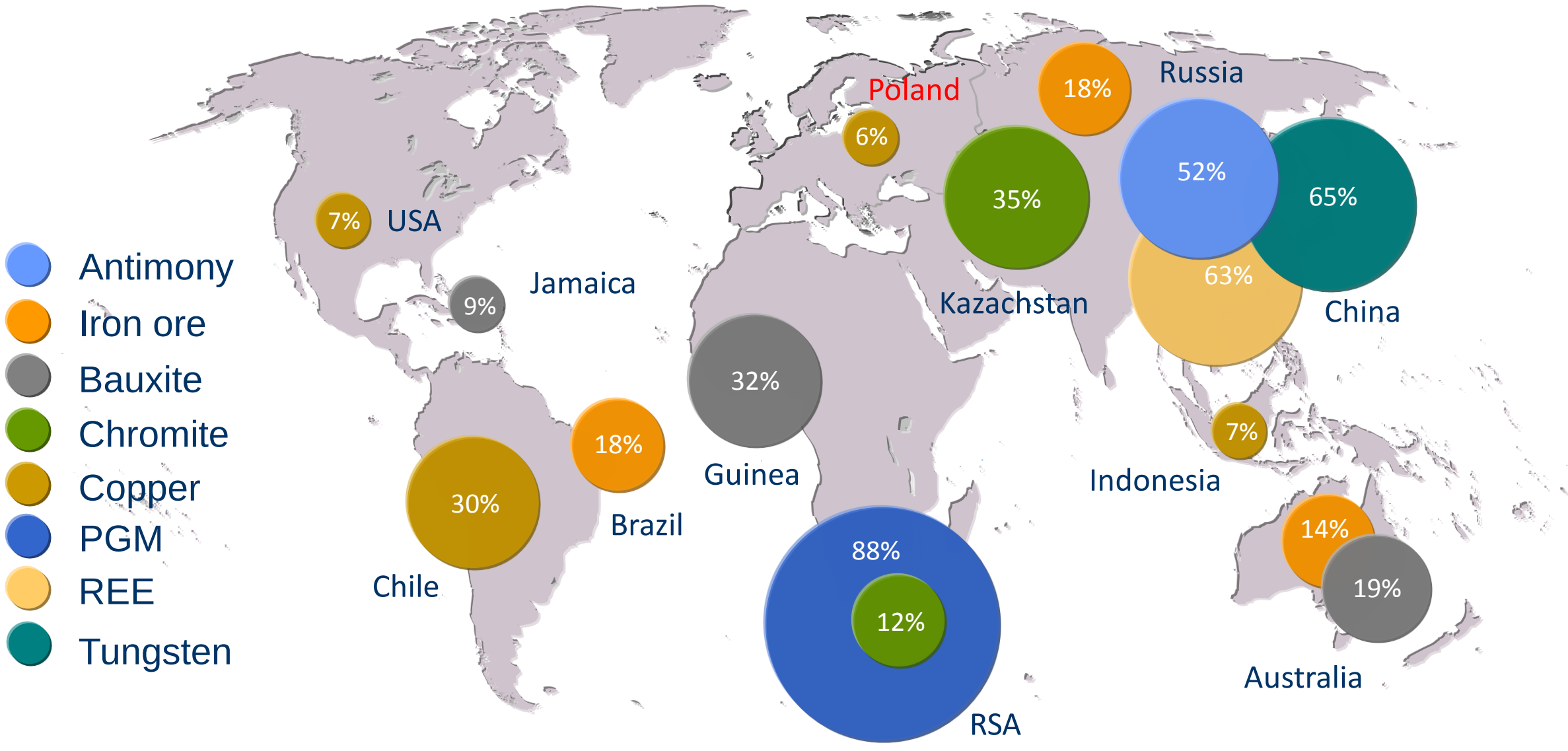
Rare earth elements 0.0X %

Tantalum capacitor construction

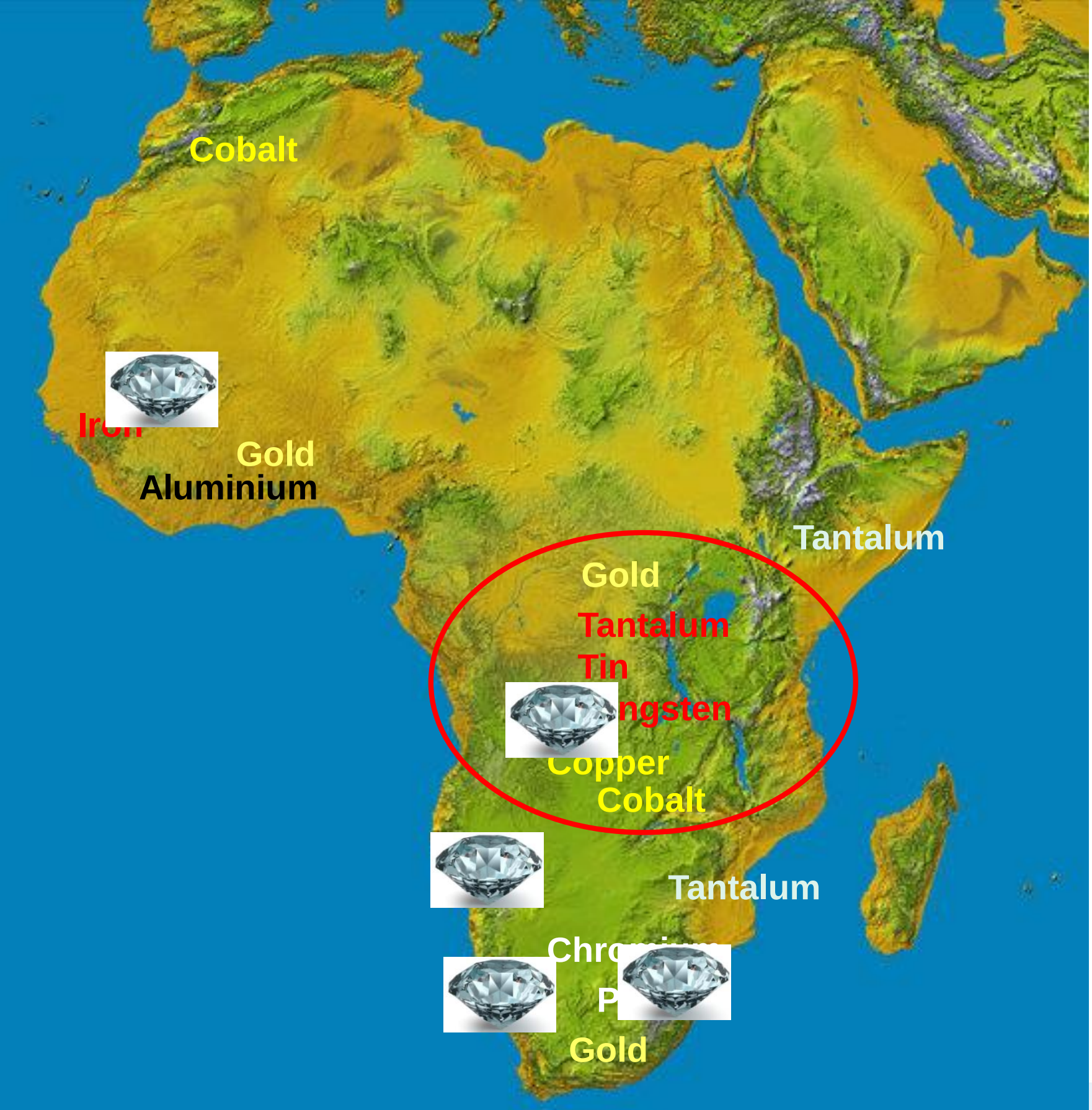


Product	Number of capacitors
Mobile phone	260
Digital camera	310
Computer	700
Car	1700

Sources of raw materials



BGR-Datenbank, USGS



Great Lakes Region

- DR Congo
- Rwanda
- Burundi
- Uganda
- Tanzania
- Zambia
- Kenia
- Malawi
- Soudan
- Ethiopia

BGR Bundesanstalt für Geowissenschaften und Rohstoffe
GEOZENTRUM HANNOVER

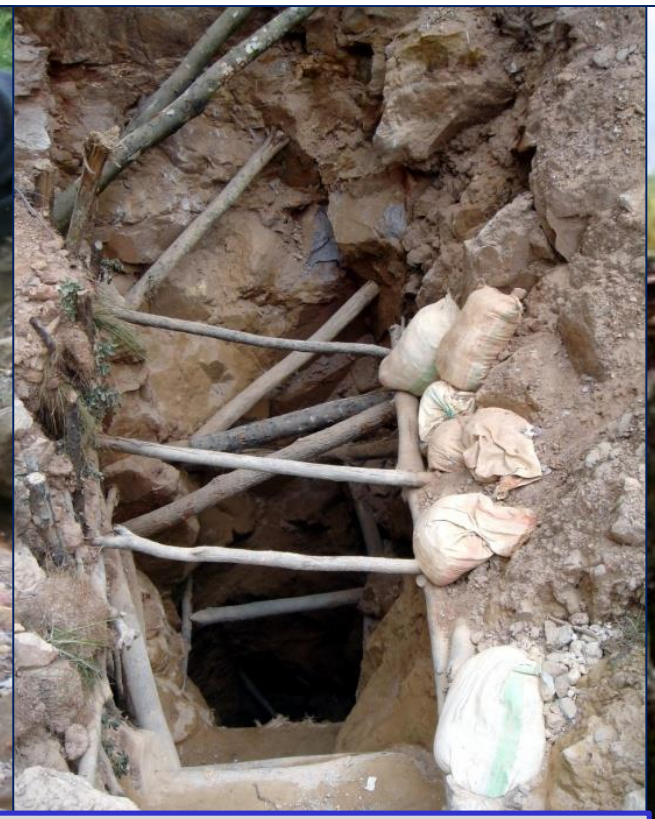
TTT – Africa´s black minerals

- Tantalum (Ta)
  - Coltan (columbite-tantalite concentrate [$(Fe,Mn)(Nb,Ta)_2O_6$]
  - Share of African production is 60-80%
  - AfrikaUse: > 60% electronics industry (capacitors)
- Tin (Sn)
  - Cassiterite concentrate (SnO_2)
  - African production ca. 5-6% (DR Congo, Rwanda, Nigeria)
  - Use: 53% electronics industry (solder material)
- Tungsten (W)
  - Wolframite und scheelite [$(Fe,Mn)WO_4$ und $CaWO_4$]
  - African production 4% (Rwanda, DRC)
  - Use: tools (hard metal), steel, weapons

Kenticha, Ethiopia

…some of the raw materials are bought from less developed countries, and also from conflict regions
e.g. tantalum, tin and gold from the DR Congo

Child labour | Security | Conflicts | Environment

250 million children work (<15 y)
0.9 % work in mining
(Bundeszentrale für politische Bildung)

Artisanal mining in the South Kivu province

BGR Bundesanstalt für Geowissenschaften und Rohstoffe

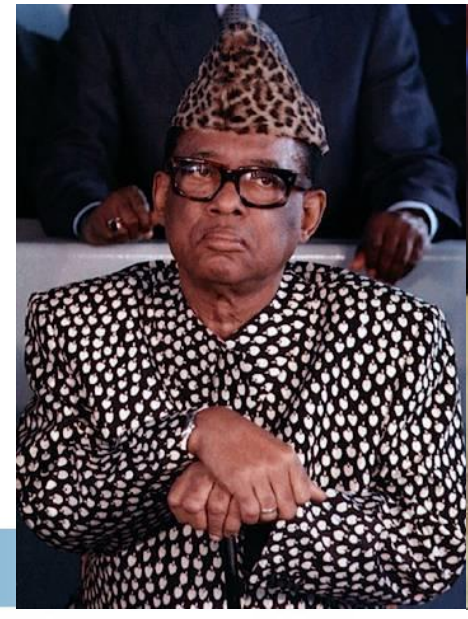
GEOZENTRUM HANNOVER

Political background

- **Genocide in Rwanda (1994)**
  - 0.8 – 1 million victims, 1.25 million refugees into eastern Congo
- **Civil wars in the DRC (since 1996)**
  - 1st civil war 1996-1997: Mobutu disempowered, Laurent-Désiré Kabila becomes President
  - 2nd civil war ("African world war") 1998-2003; Joseph Kabila 2001; elections 2006
  - 3rd civil war in North Kivu (2007-2009), FDLR ↔ CNDP
  - Continued unrest (M23) since summer 2012 in North Kivu

Genocide graves in Rwanda

Mobutu



1930 - 1997

L. Kabila

1939 - 2001

J. Kabila

**1971*

Current situation in the Great Lakes Region

- **Civil wars and armed conflicts are partly financed by mineral trade**
- **UN Expert group on the DRC: Conflict Minerals**
- **US American "Dodd-Frank Act": Conflict Minerals**
- **Regional mineral certification**
  - **Political (ICGLR, OECD)**
  - **Industry (ITRI, EICC)**

Coltan (Ta-Nb ore)
Cassiterite (Sn ore)
Wolframite (W ore)
Gold

iTSCi - Tagging

2010 United States legislation, Dodd-Frank Wall Street Reform and Consumer Protection Act SECTION 1502. CONFLICT MINERALS

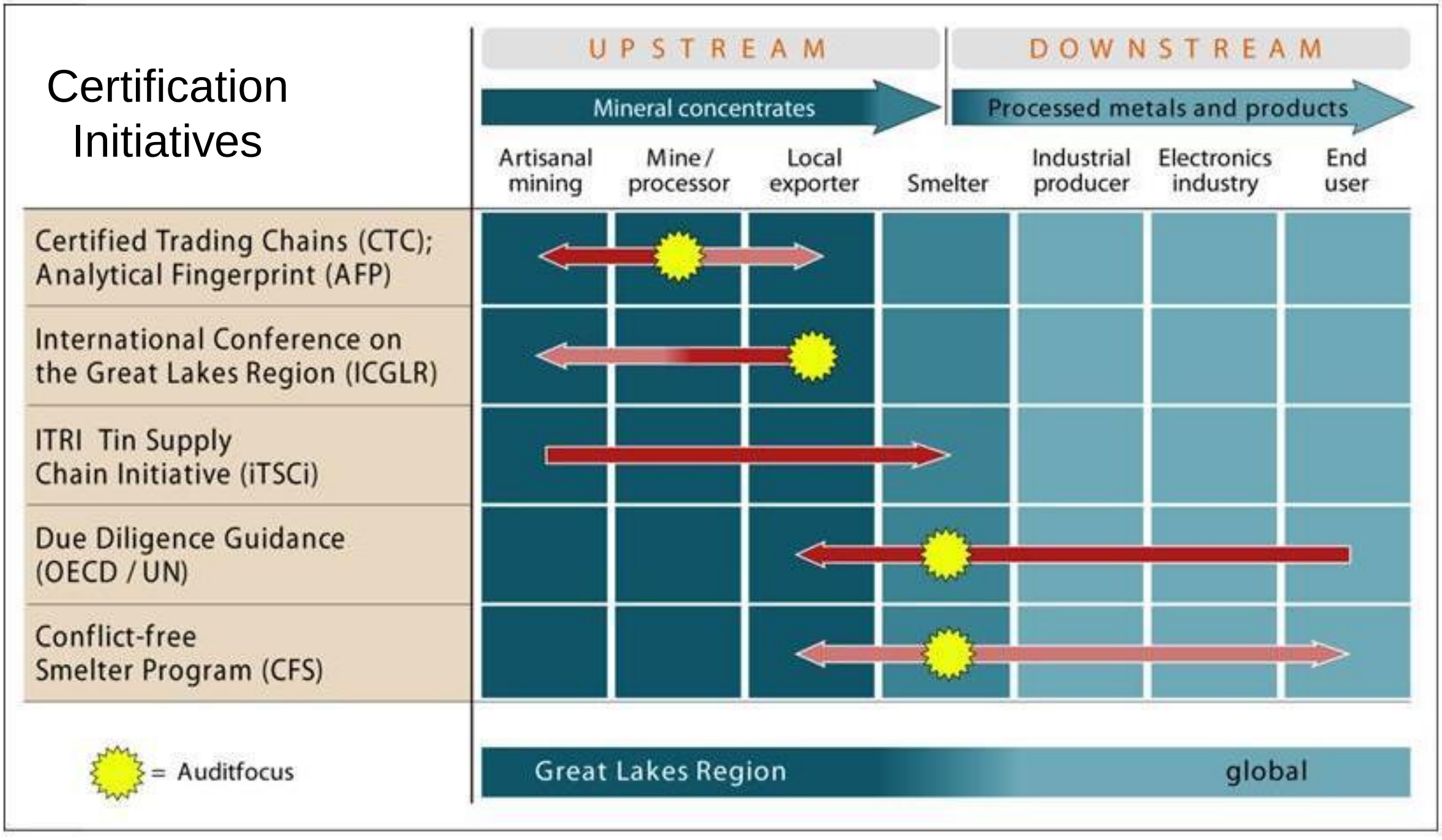
…any person ….to disclose annually, … whether conflict minerals …, did originate in the Democratic Republic of the Congo or an adjoining country and, …, submit to the Commission a report that includes

— a description of the measures taken by the person to exercise due diligence on the source and chain of custody of such minerals,…

— description of the products manufactured or contracted to be manufactured that are not DRC conflict free

DRC CONFLICT FREE—….a product may be labeled as 'DRC conflict free' if the product does not contain conflict minerals that directly or indirectly finance or benefit armed groups in the Democratic Republic of the Congo or an adjoining country

Supply Chain Initiatives



PPA (Public-private alliance for responsible mineral trade) (GeSI)

ITRI TIN SUPPLY CHAIN INITIATIVE

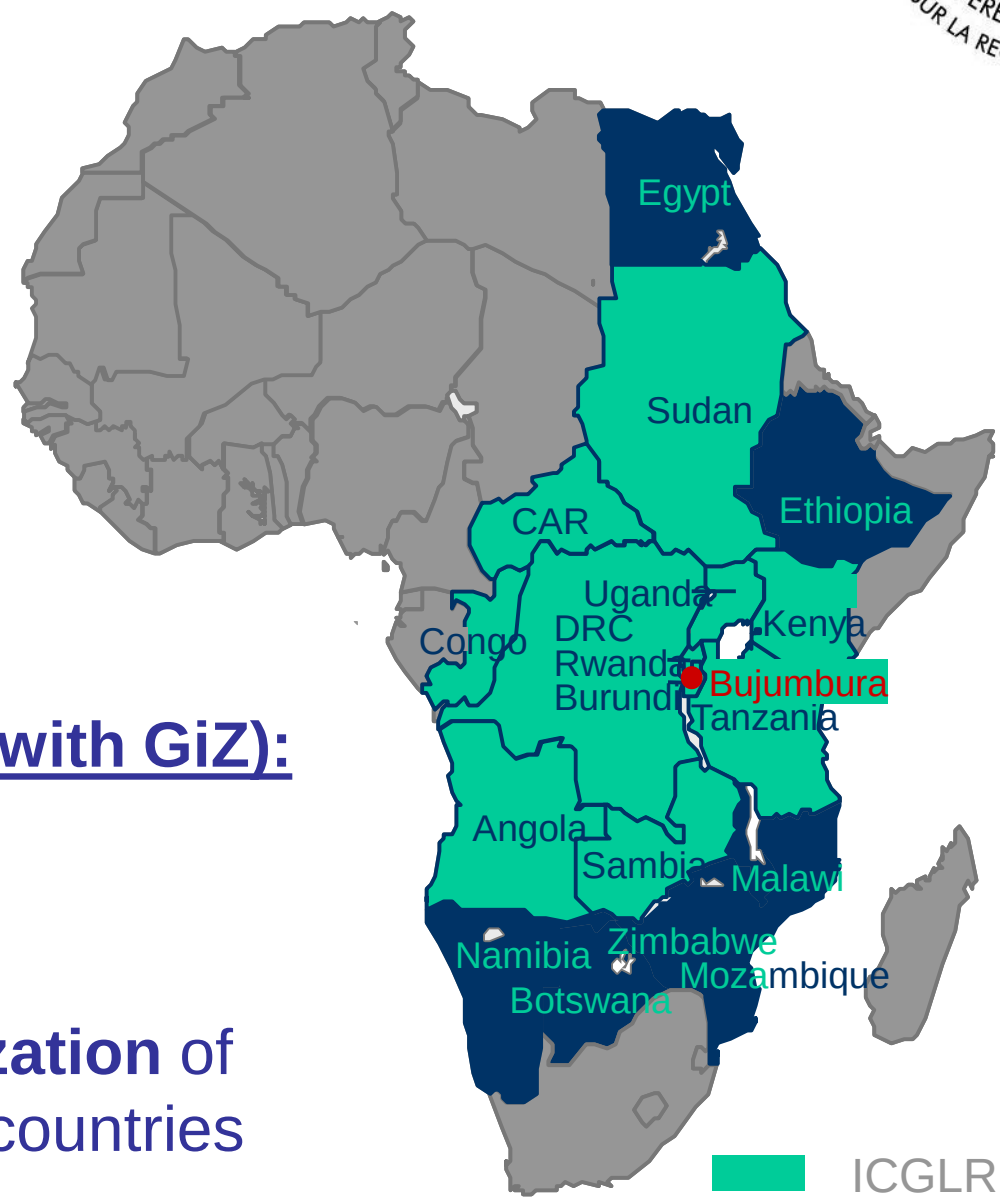
- ITRI = International Tin Research Institute, England

„Bagging & Tagging“

Support to ICGLR Regional Certification

ICGLR ratified **Regional Certification Mechanism (RCM)** in Lusaka declaration (Dec. 2011)

- aligned with requirements of OECD Due Diligence Guidance
- Analytical Fingerprint integrated as monitoring tool

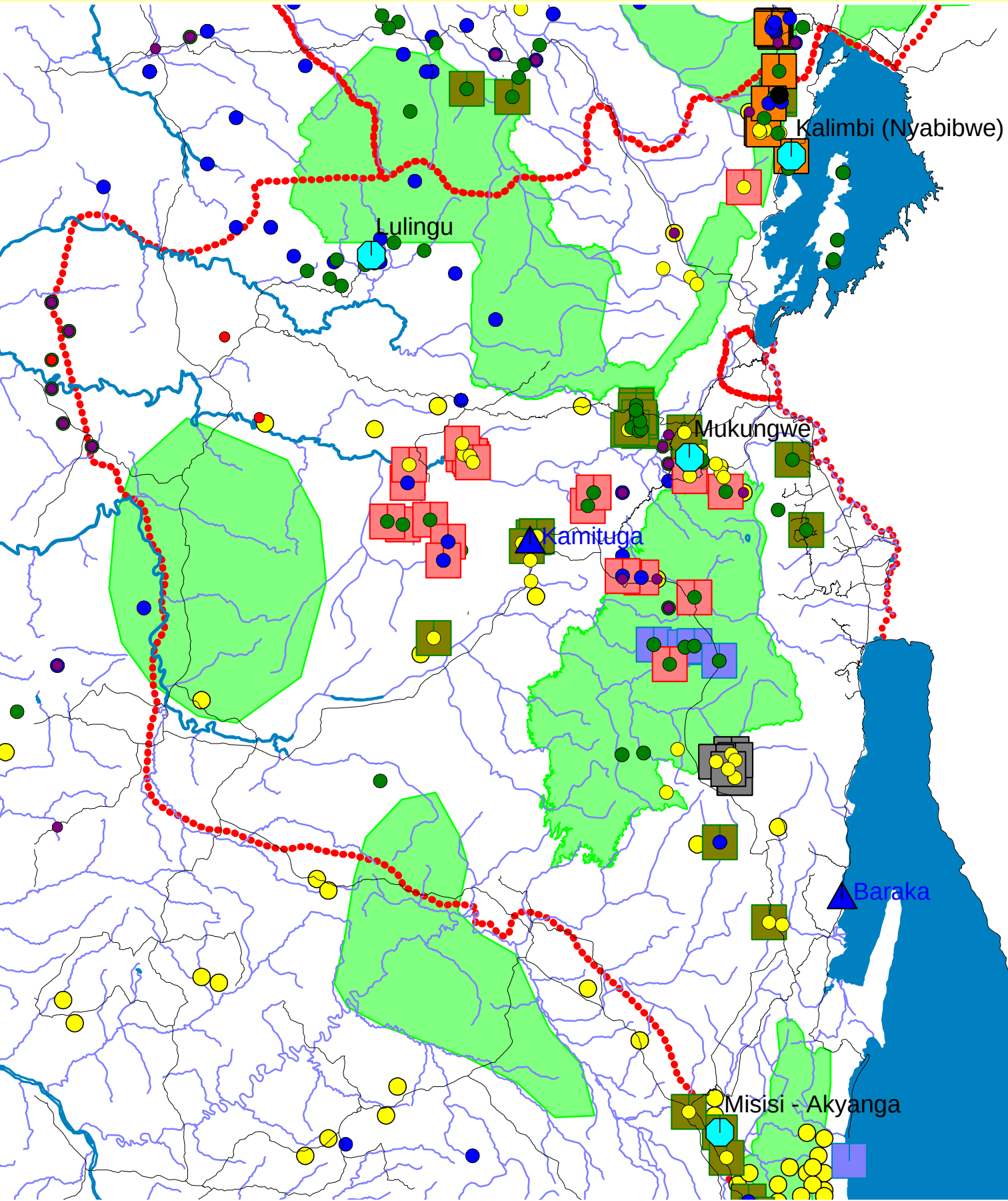


BGR support (joint German program with GiZ):

1. Integration and application of the **Analytical Fingerprint (AFP)** in RCM

2. Implementation of **RCM and formalization** of artisanal mining in selected member countries

Artisanal mine sites in the South Kivu Province, March 2012



ASM and conflicts

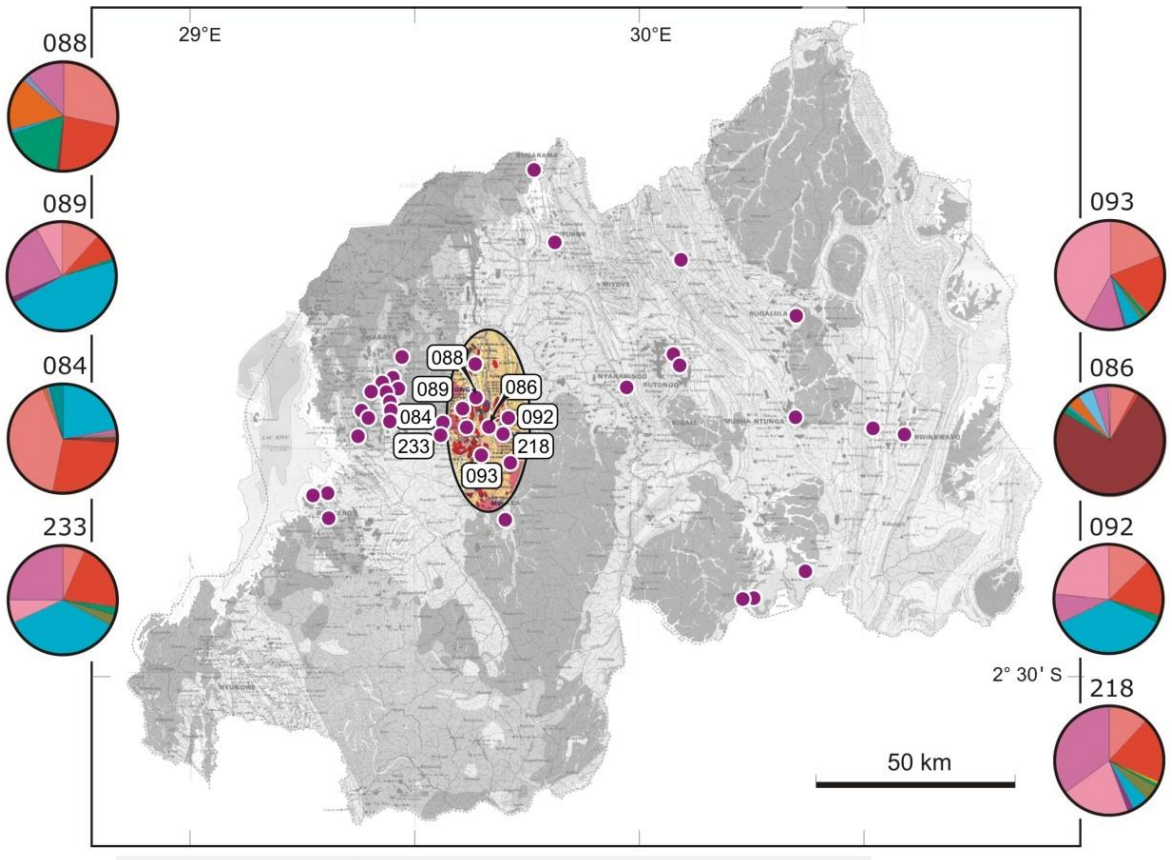
Legend

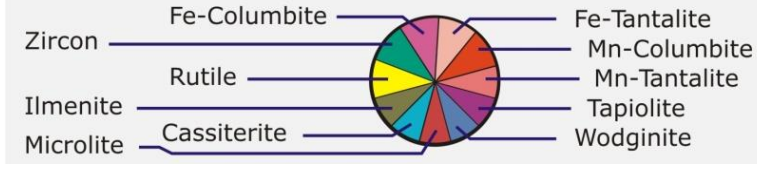
- Mines FDLR
- Mines FARDC
- Mines CNDP
- Mines Mayi Mayi
- Mines FLF
- Centre de Negoce
- Mine d'or
- Mine de coltan
- Mine de cassiterite
- Mine de wolframite
- Mine de diamant
- Mine de manganese
- Mine Pilote

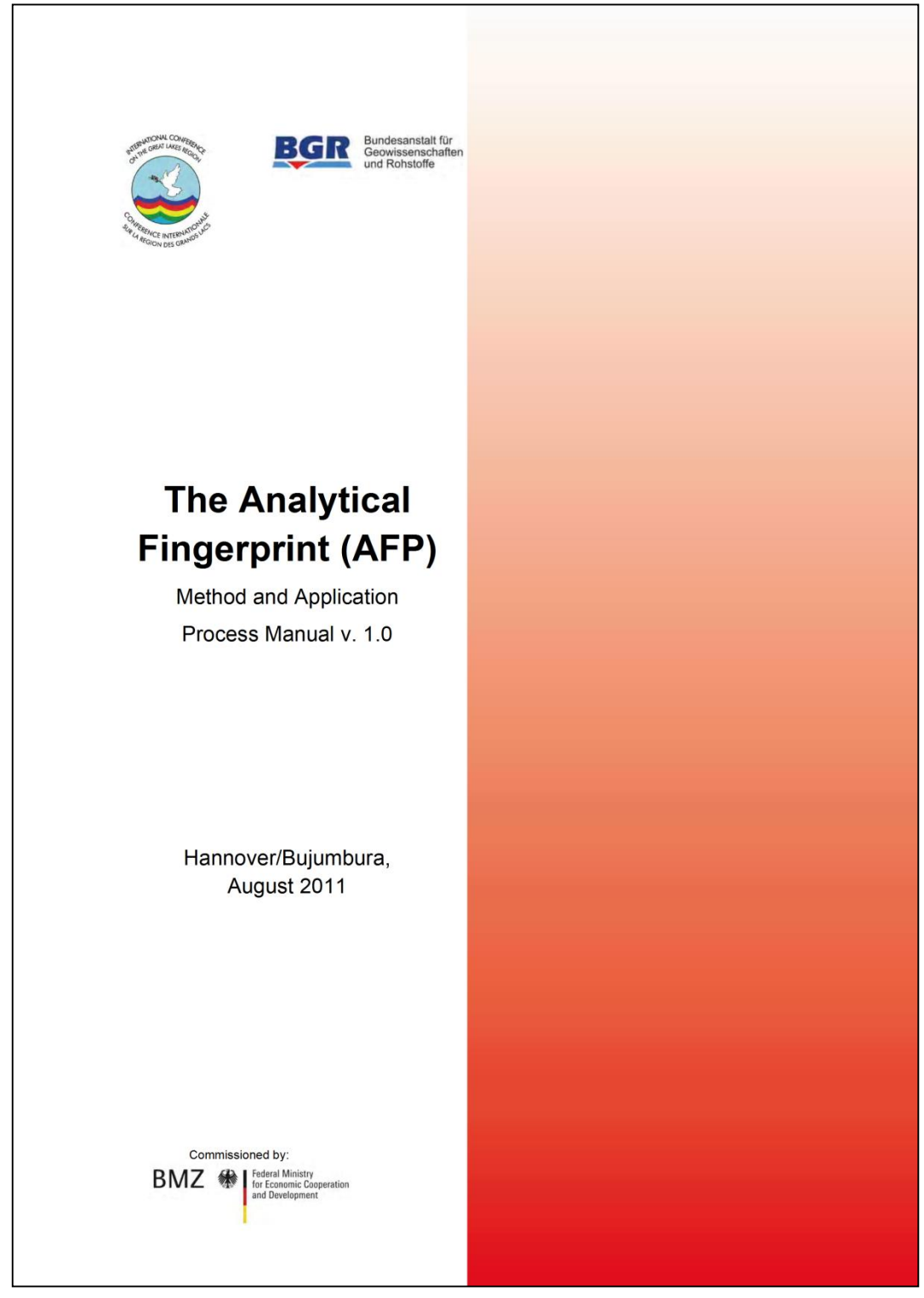
BGR, CEEC, SAESCAM

Analytical Fingerprint (AFP) – Additional Credibility

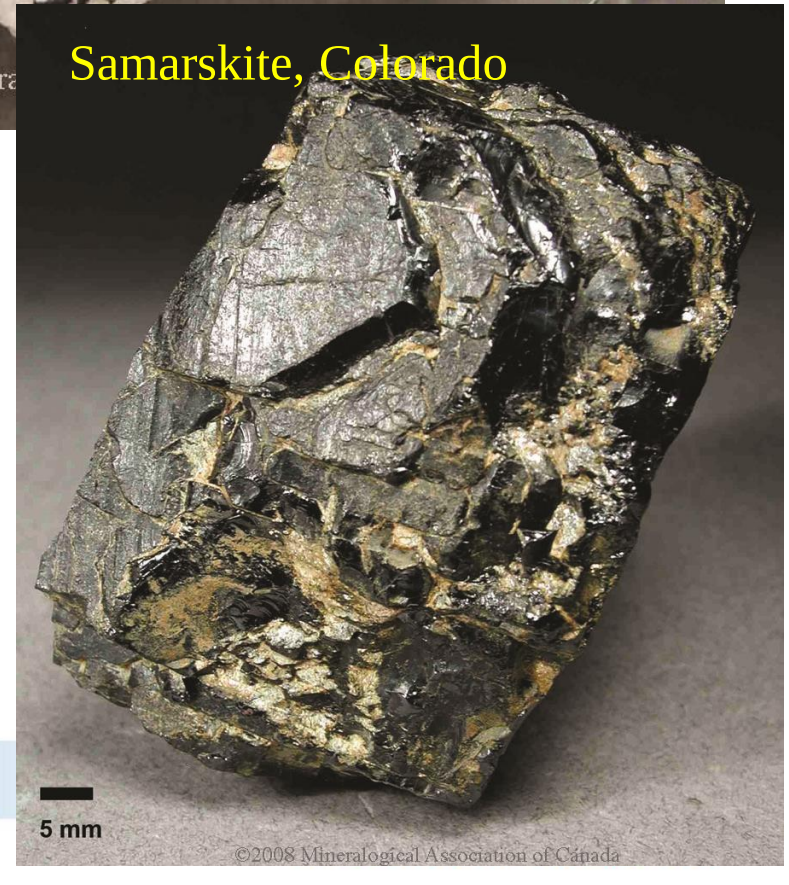
- Optional forensic tool to constrain the origin of minerals (tantalite, cassiterite, wolframite)
- completely independent line of evidence
- Broad reference worldwide database available
- Succeeds in resolving mineral origin down to individual dig site level





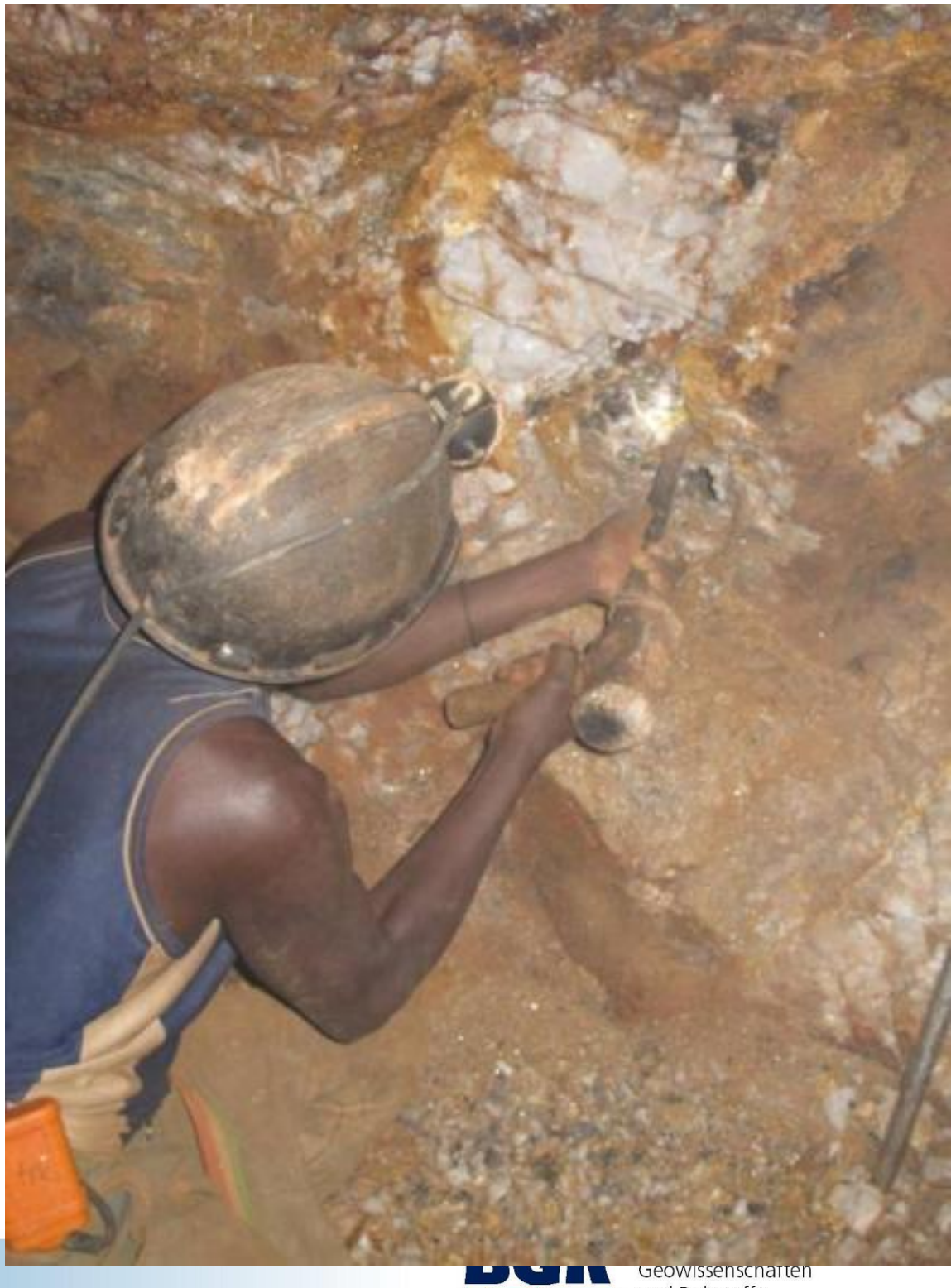


Tantalum deposits are largely confined to granite pegmatites (rare-element pegmatites) and specialized granites (rare-metal granites)



Typical rare-element minerals in pegmatites (Nb, Ta, Sn, W, U, REE, Li, Be, Cs, Rb, F)

Quartz veins carry cassiterite or wolframite



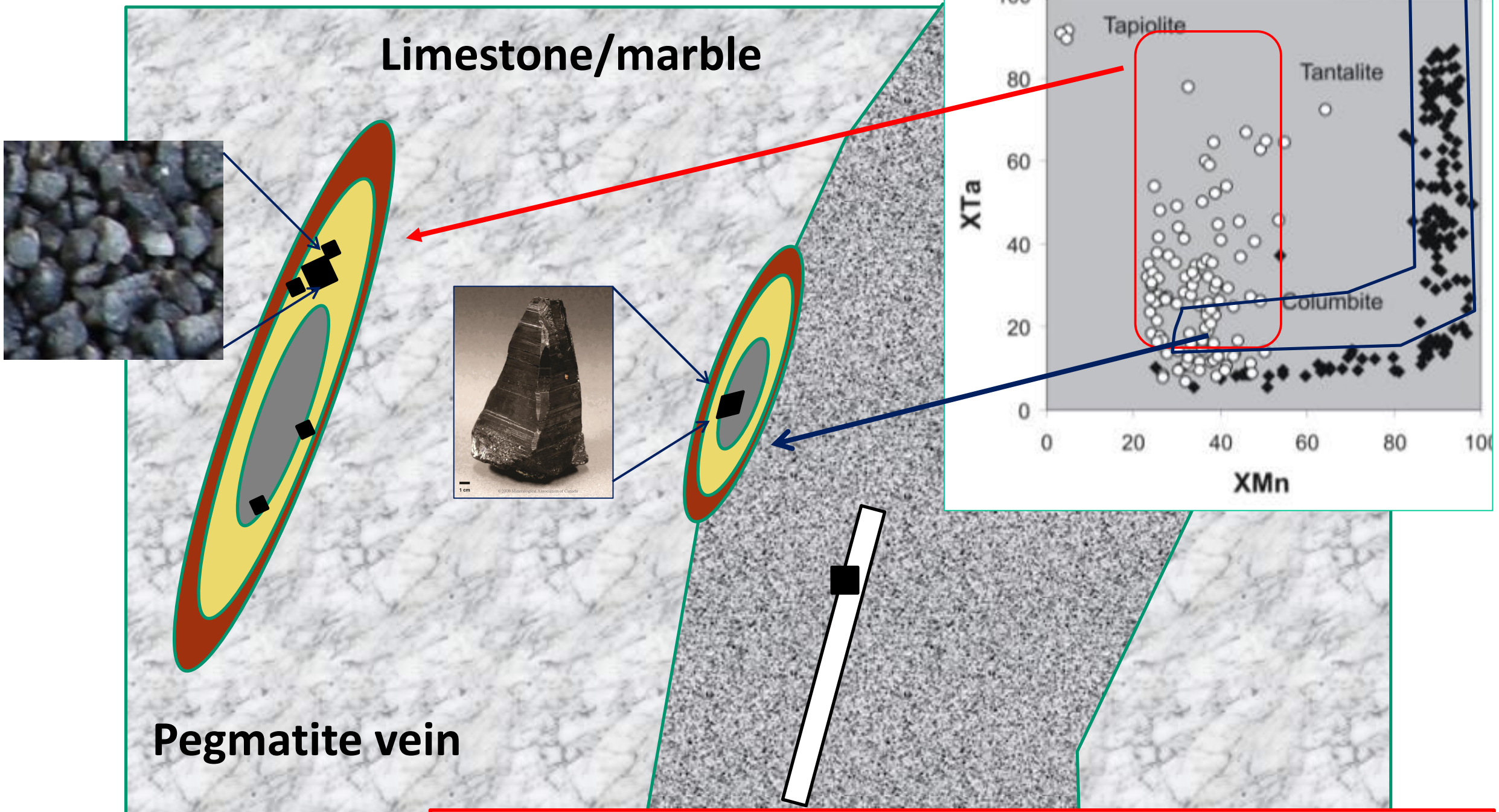
Rutongo, Rwanda
Annual production ca. 1000 t SnO_2

Fingerprint – why and how does it work?

Ore concentrate

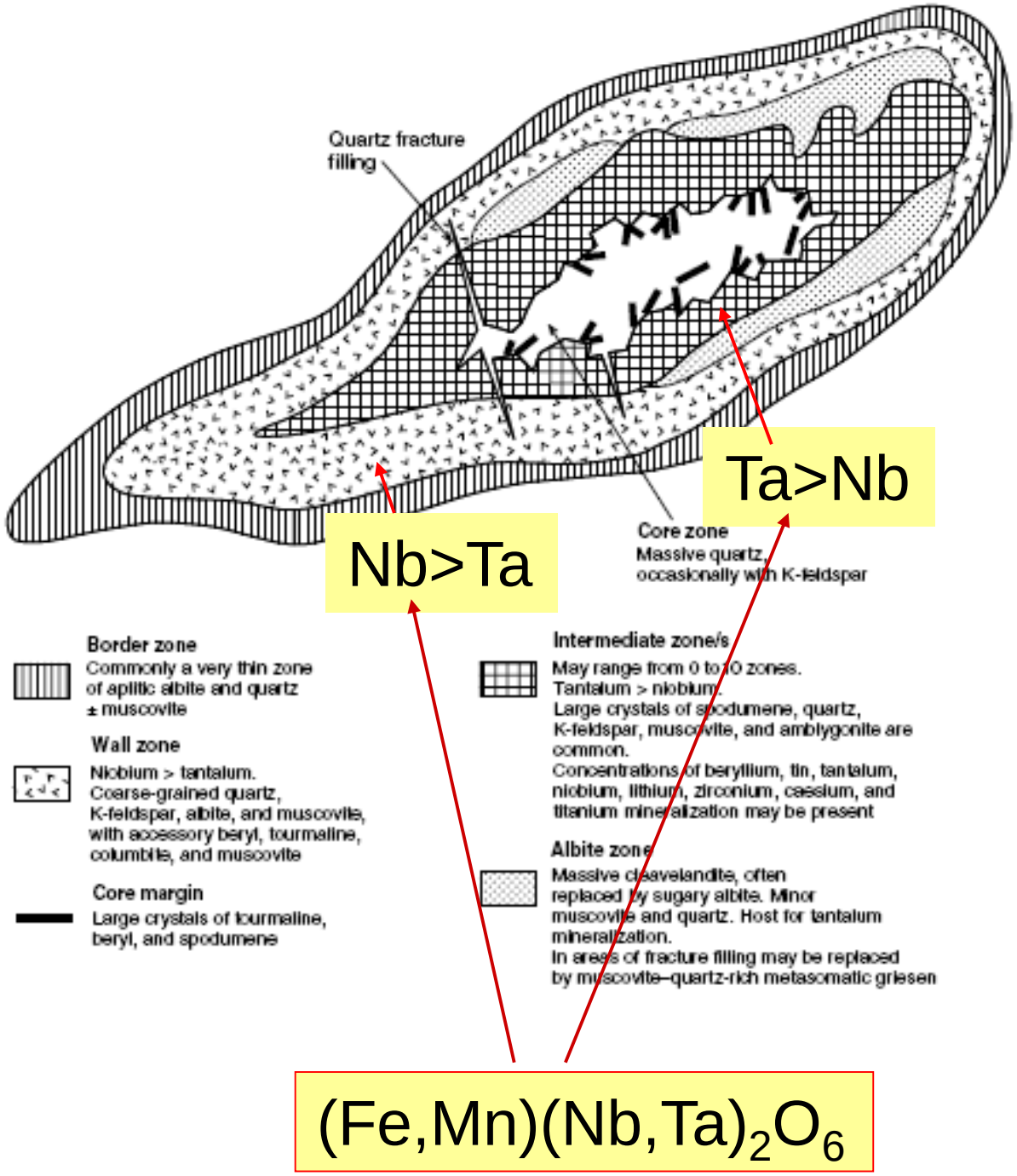
Cassiterite

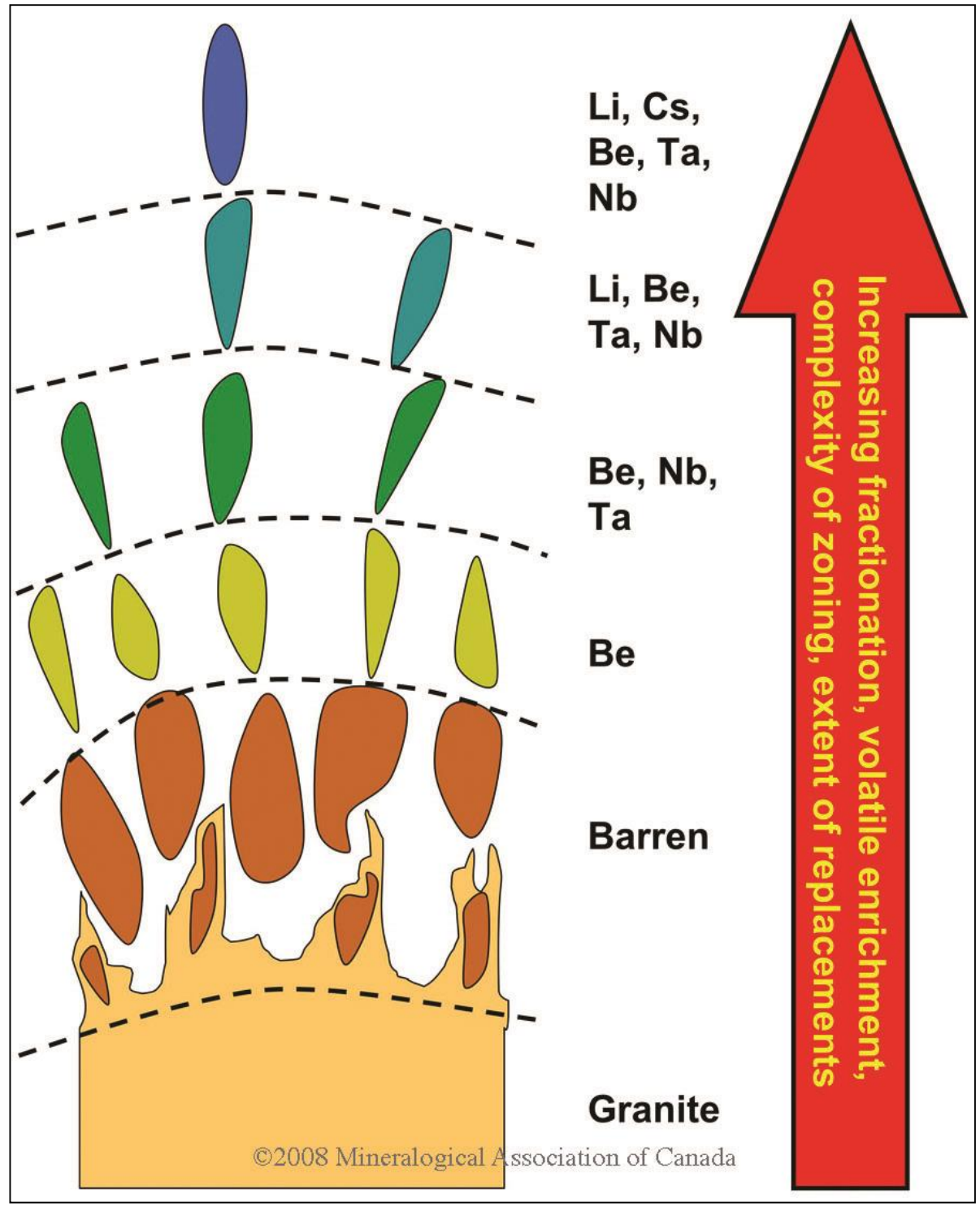
- Main principles
  - Ore minerals (cassiterite, columbite, wolframite) crystallize from melts (>500°C) or hot aqueous solutions (<500°C)
  - Parameters of formation are stored in the minerals (Mineral-DNA)
  - Thus, if conditions of formations differ, minerals may be suitable for fingerprinting



- Host rock (granite, schist, limestone,….)
- conditions during formation (temperature, pressure)
- Composition of melt/fluid

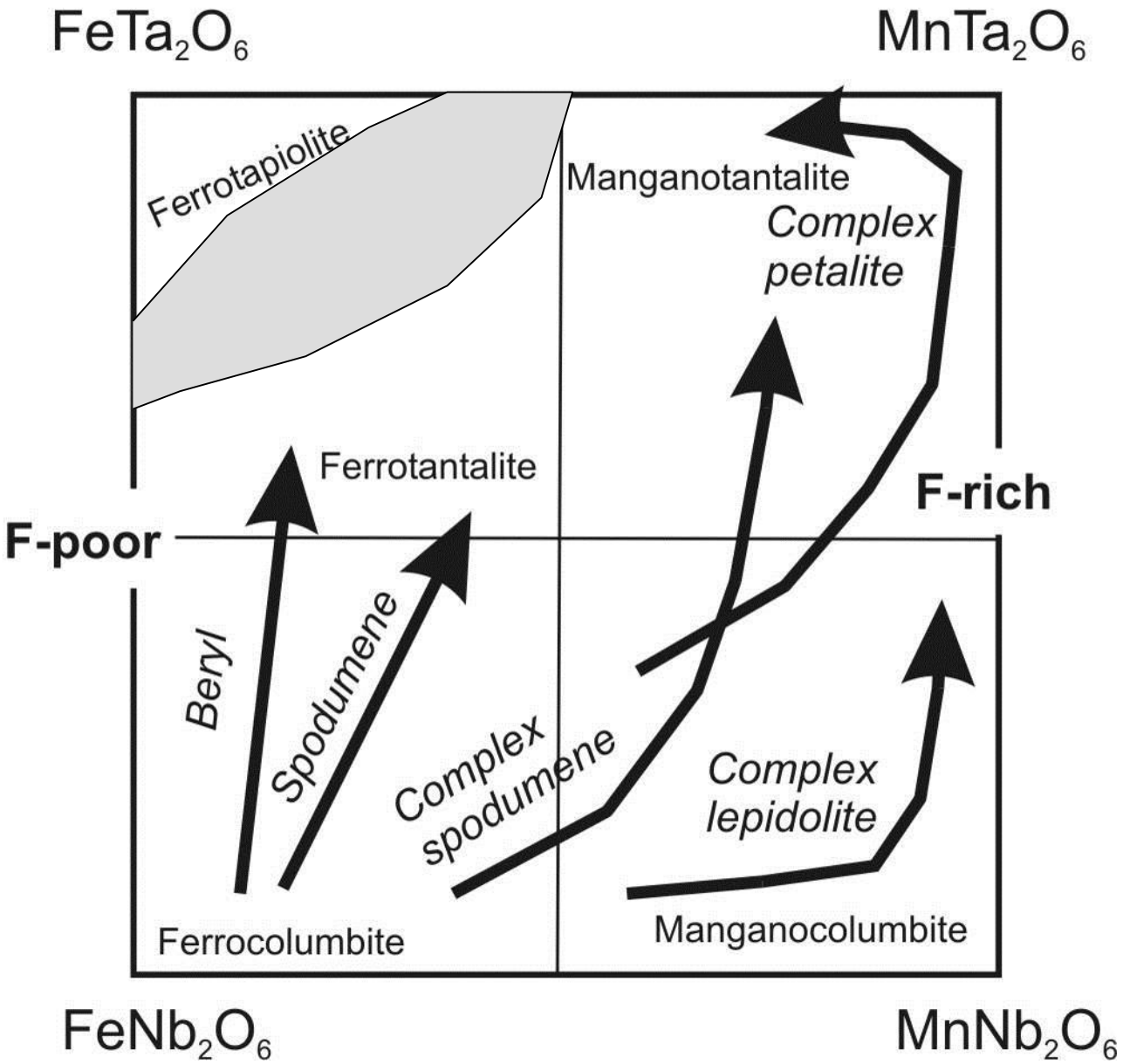
Concentrically zoned “Rare-metal“ Pegmatites

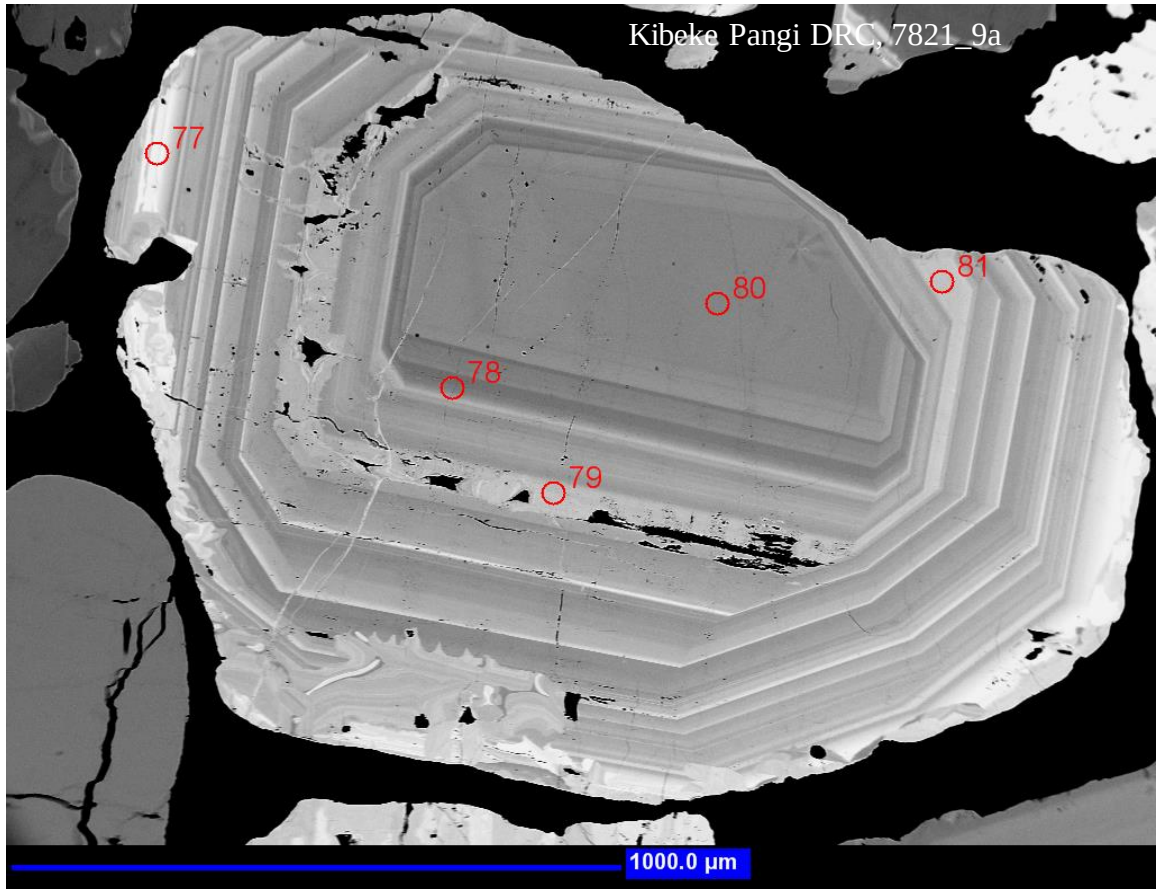




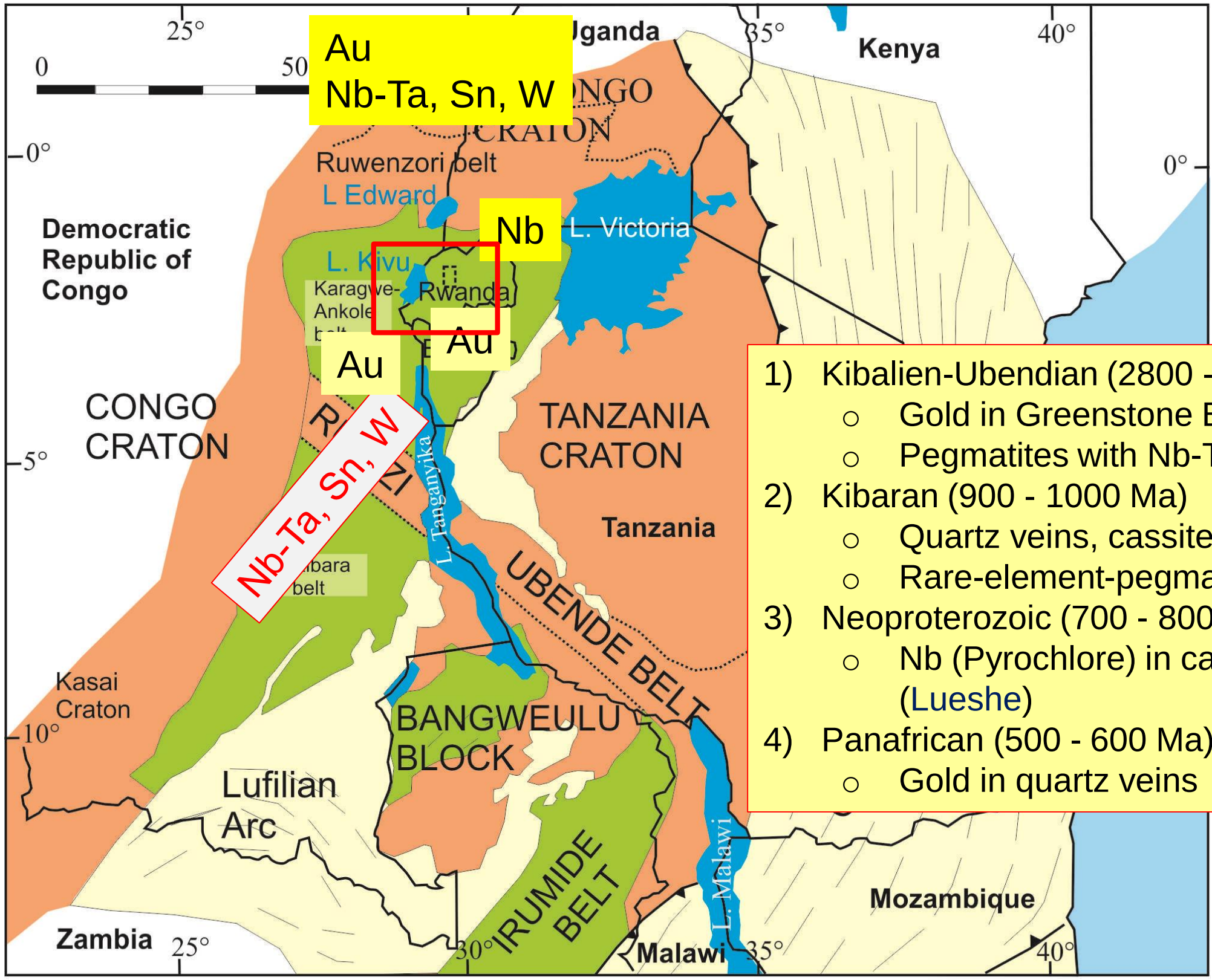
GSWA, Mineral Resources Bulletin 22 (2004)

Behaviour of CGM in Pegmatites





Chemical heterogeneity
- Within a deposit
- Within a concentrate
- Within a crystal



1) Kibalien-Ubendian (2800 - 2000 Ma)
   - Gold in Greenstone Belts
   - Pegmatites with Nb-Ta, Sn, W
2) Kibaran (900 - 1000 Ma)
   - Quartz veins, cassiterite, wolframite
   - Rare-element-pegmatites (Ta-Sn)
3) Neoproterozoic (700 - 800 Ma)
   - Nb (Pyrochlore) in carbonatites (Lueshe)
4) Panafrican (500 - 600 Ma)
   - Gold in quartz veins

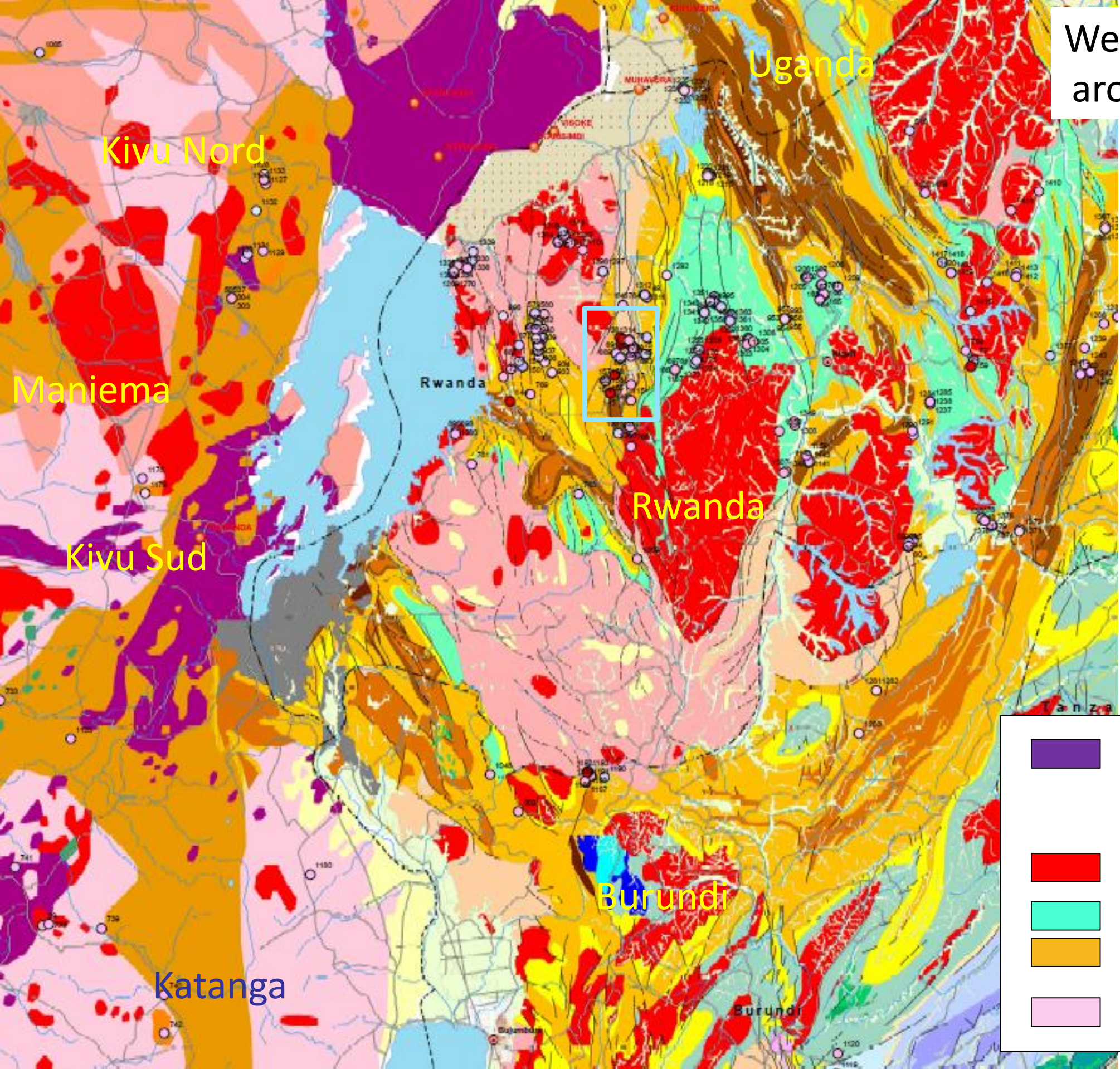
Areas dated older than > 1800 Ma

Areas dated between 1800Ma - 1000Ma

Pan-African terrains

Bundesanstalt für Geowissenschaften und Rohstoffe
GEOZENTRUM HANNOVER

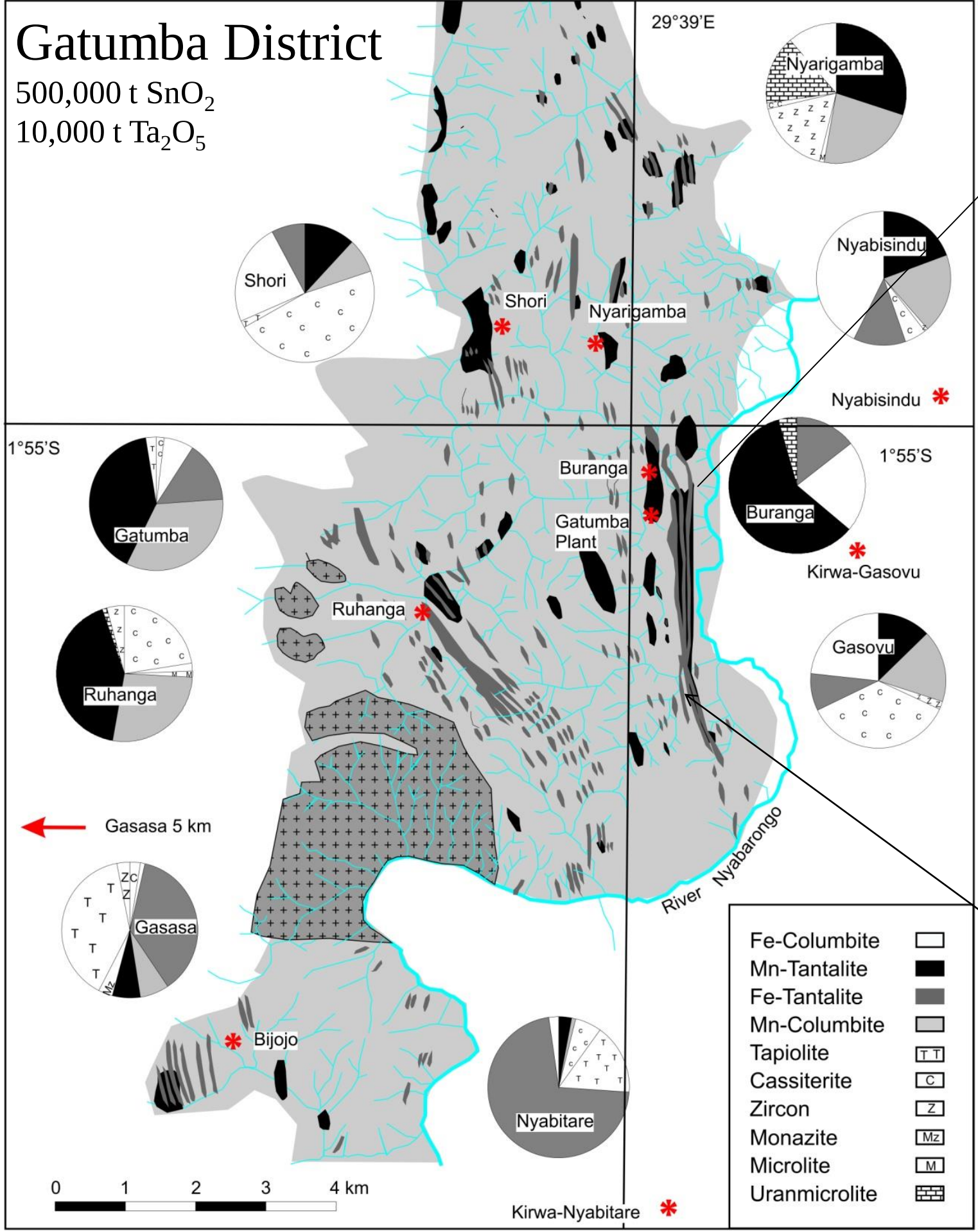
Western Rift Zone around Lake Kivu

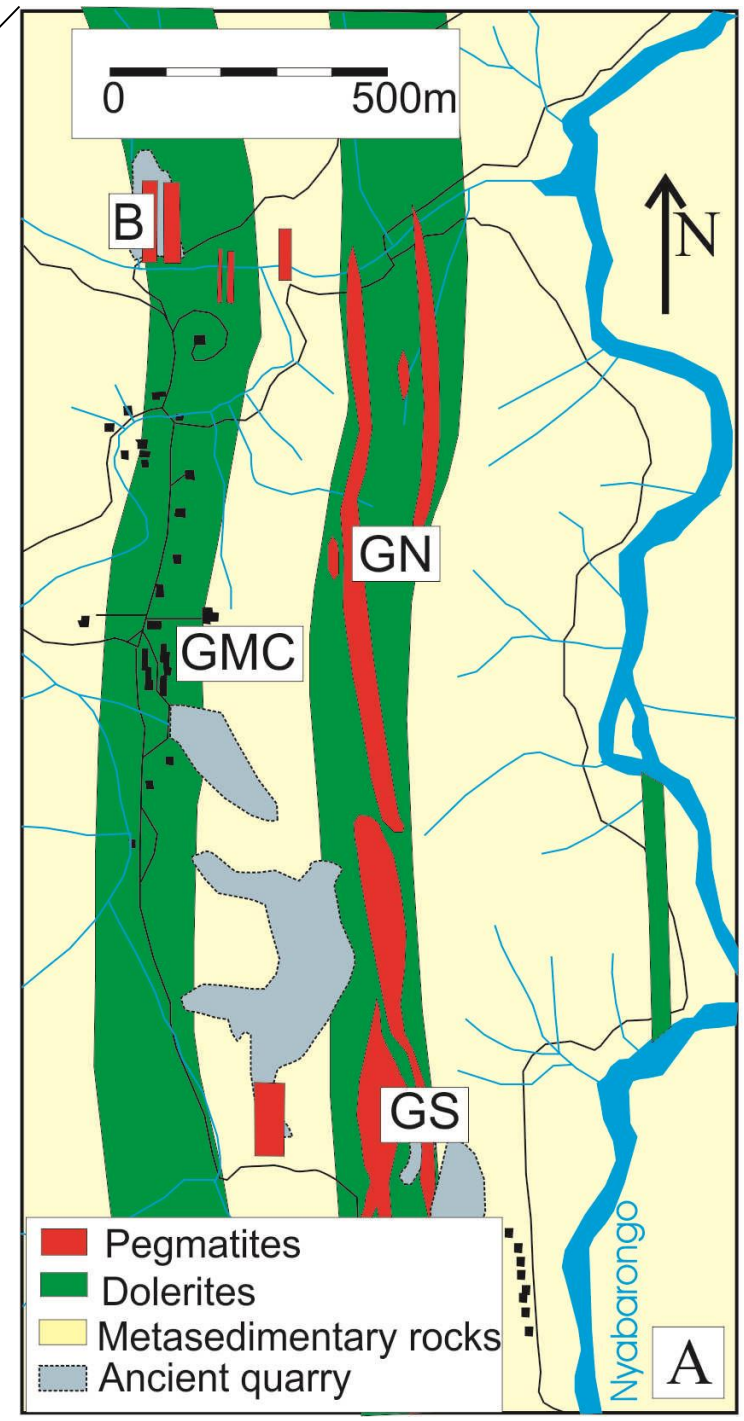


Gatumba District

500,000 t SnO_2

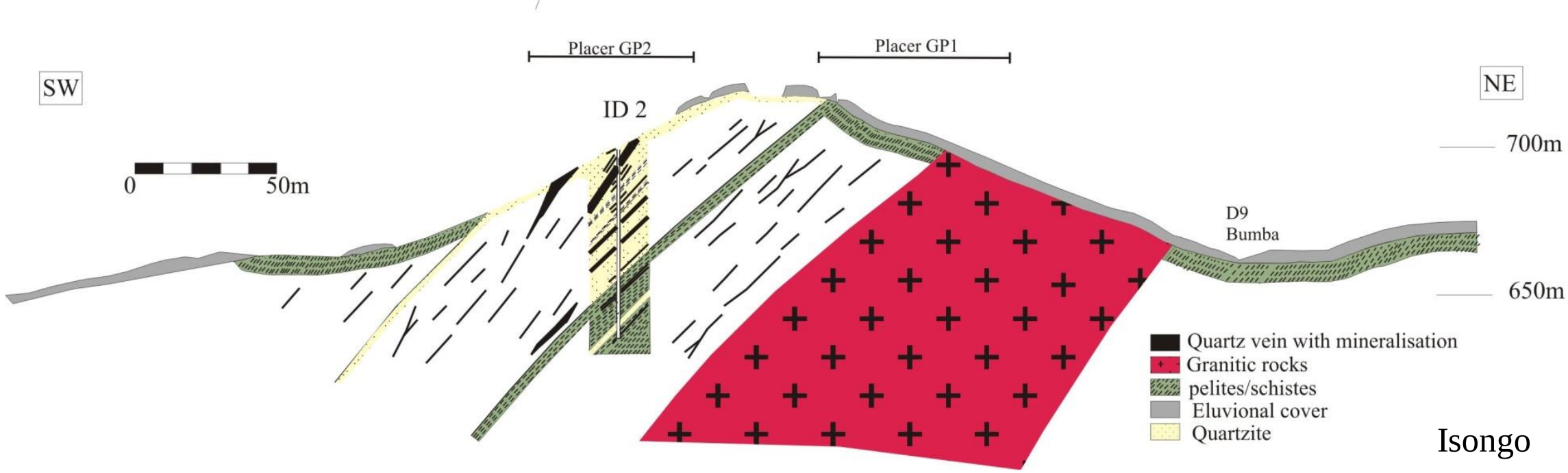
10,000 t Ta_2O_5





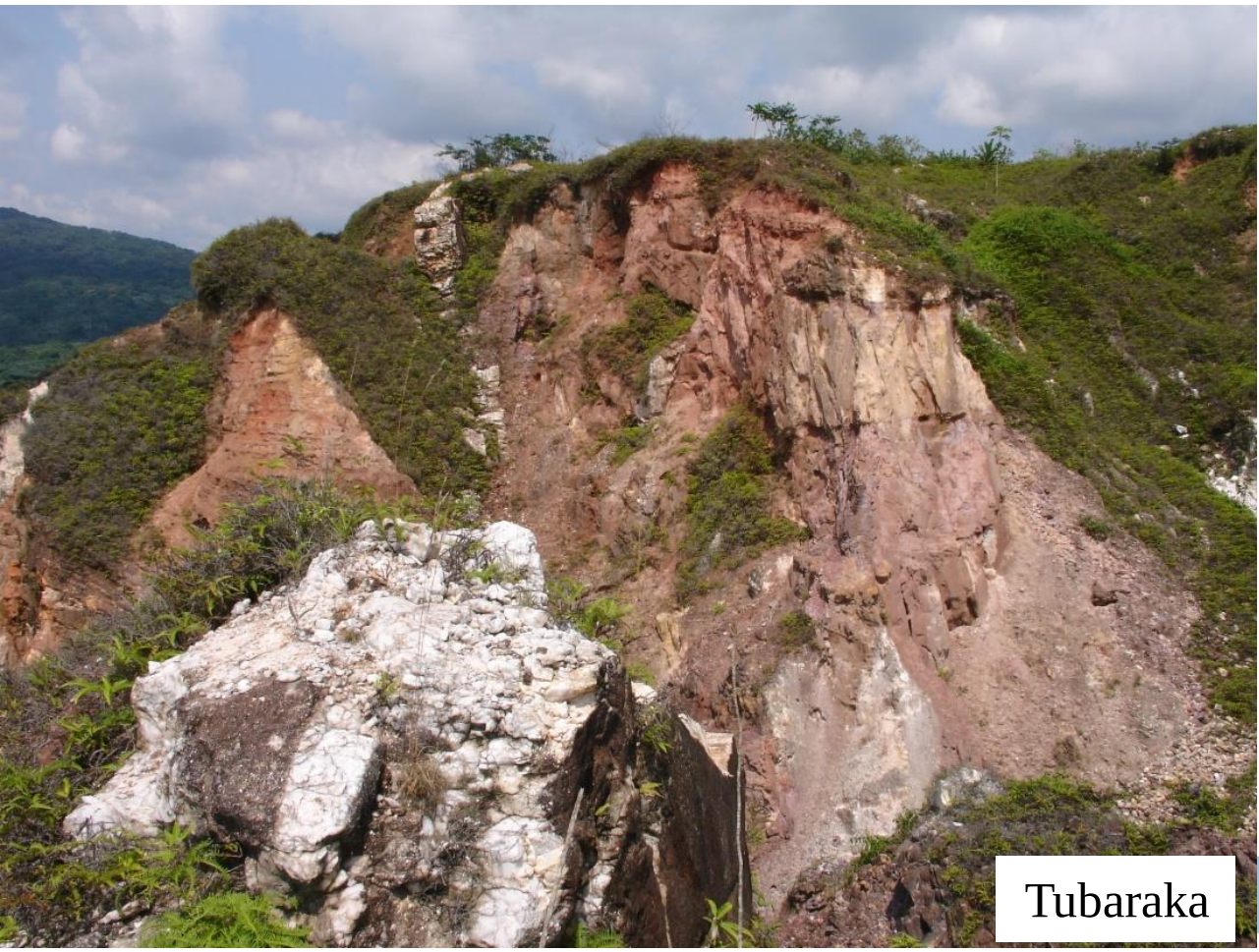
26 Mt @ 70 g/t Ta, 153 g/t Sn

BGR Bundesanstalt für Geowissenschaften und Rohstoffe
GEOZENTRUM HANNOVER



Isongo

Mineralized quartz veins



Tubaraka

1. Veins // foliation in metasediments external to granite massifs

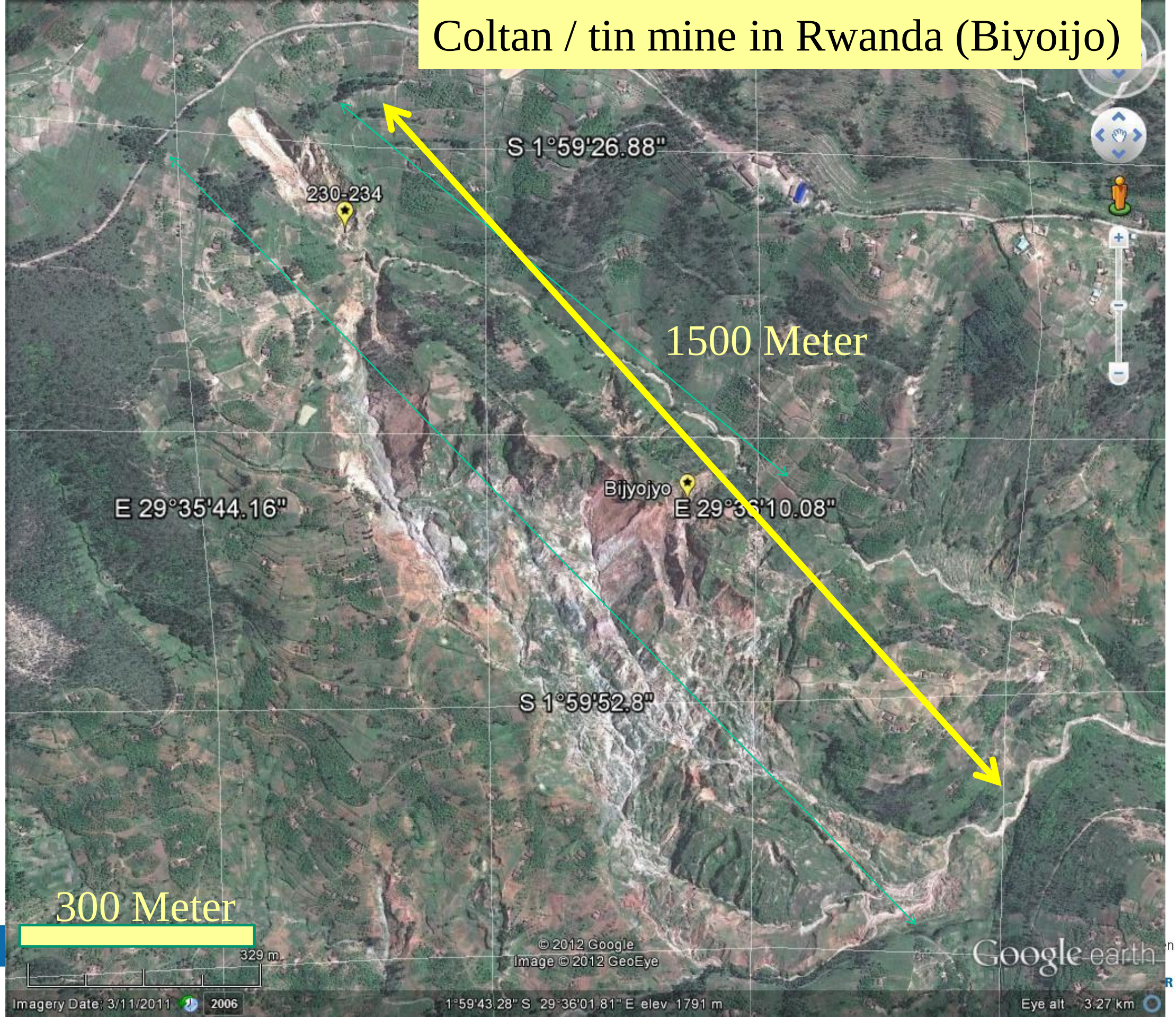
⇓

2. Tin granites + RE pegmatites
   Post-tectonic
   Post S2
   ca. 990-930 Ma

LCT pegmatites
Gatumba, Rwanda

Coltan / tin mine in Rwanda (Biyoijo)

Coltan / tin mine in Rwanda (Biyoijo)



Placer mining of tin and coltan in Lulingu, South Kivu

Analytical Fingerprint (AFP) – method

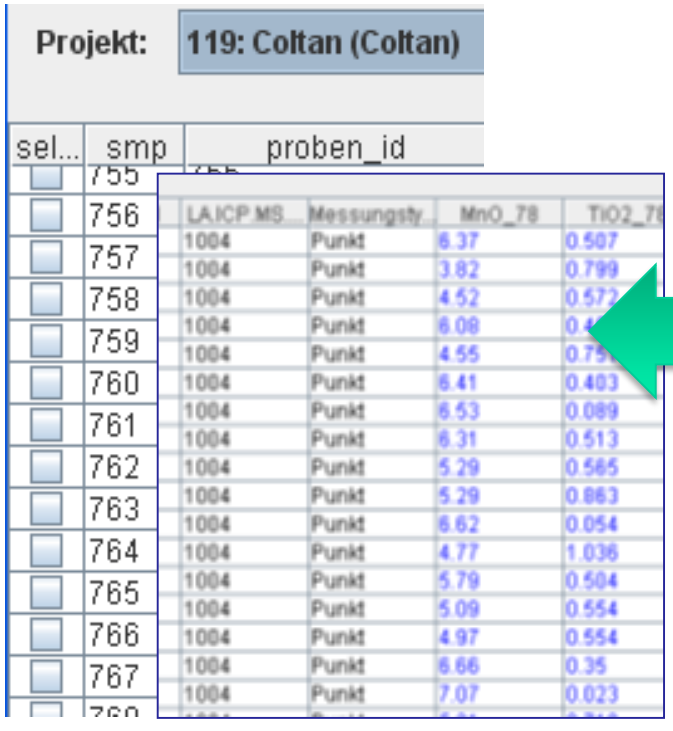
Ore concentrate (reference or control sample)

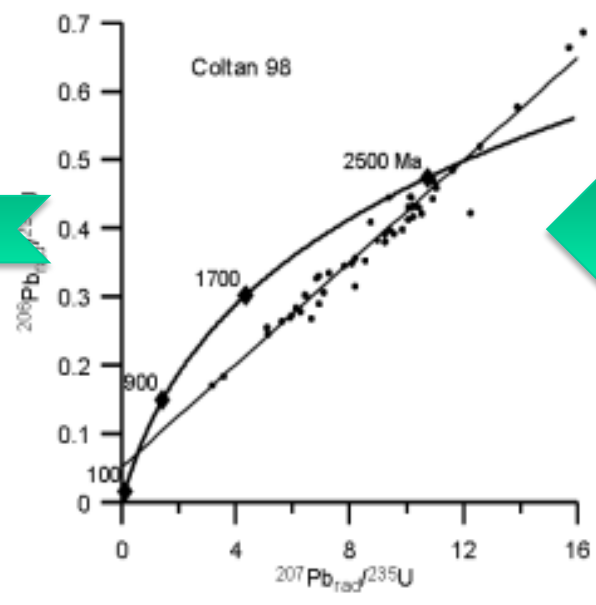
Polished section 3 x 3 cm

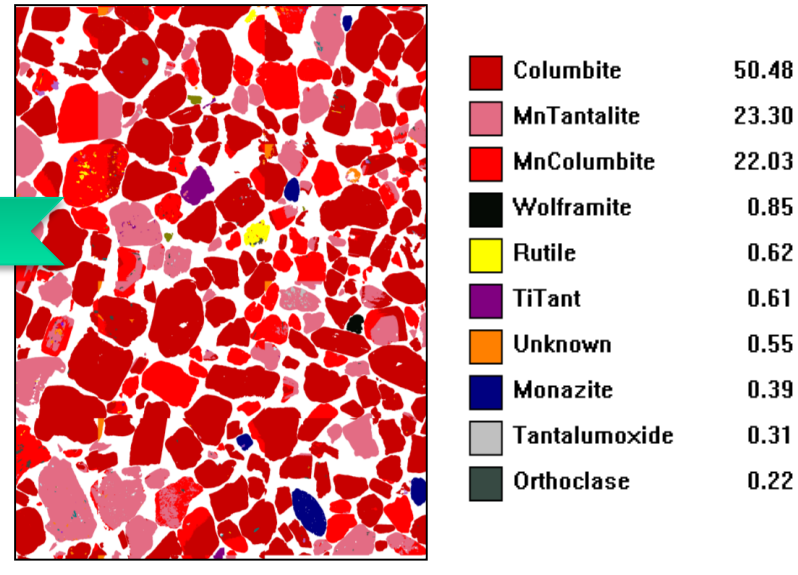
Reference Data Base

Grain-based mineral chemistry and formation age

Quantitative mineralogy

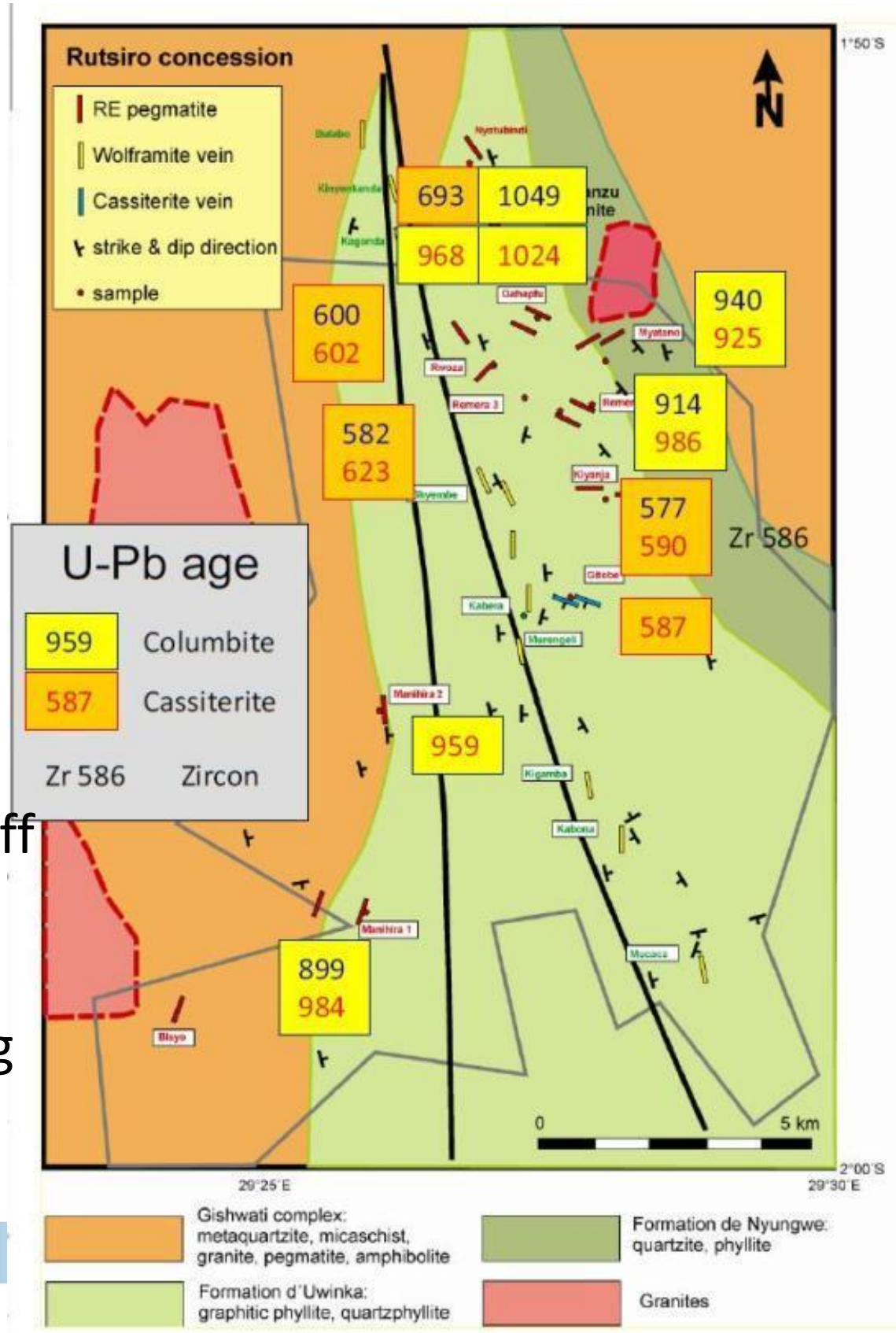






AFP Sampling

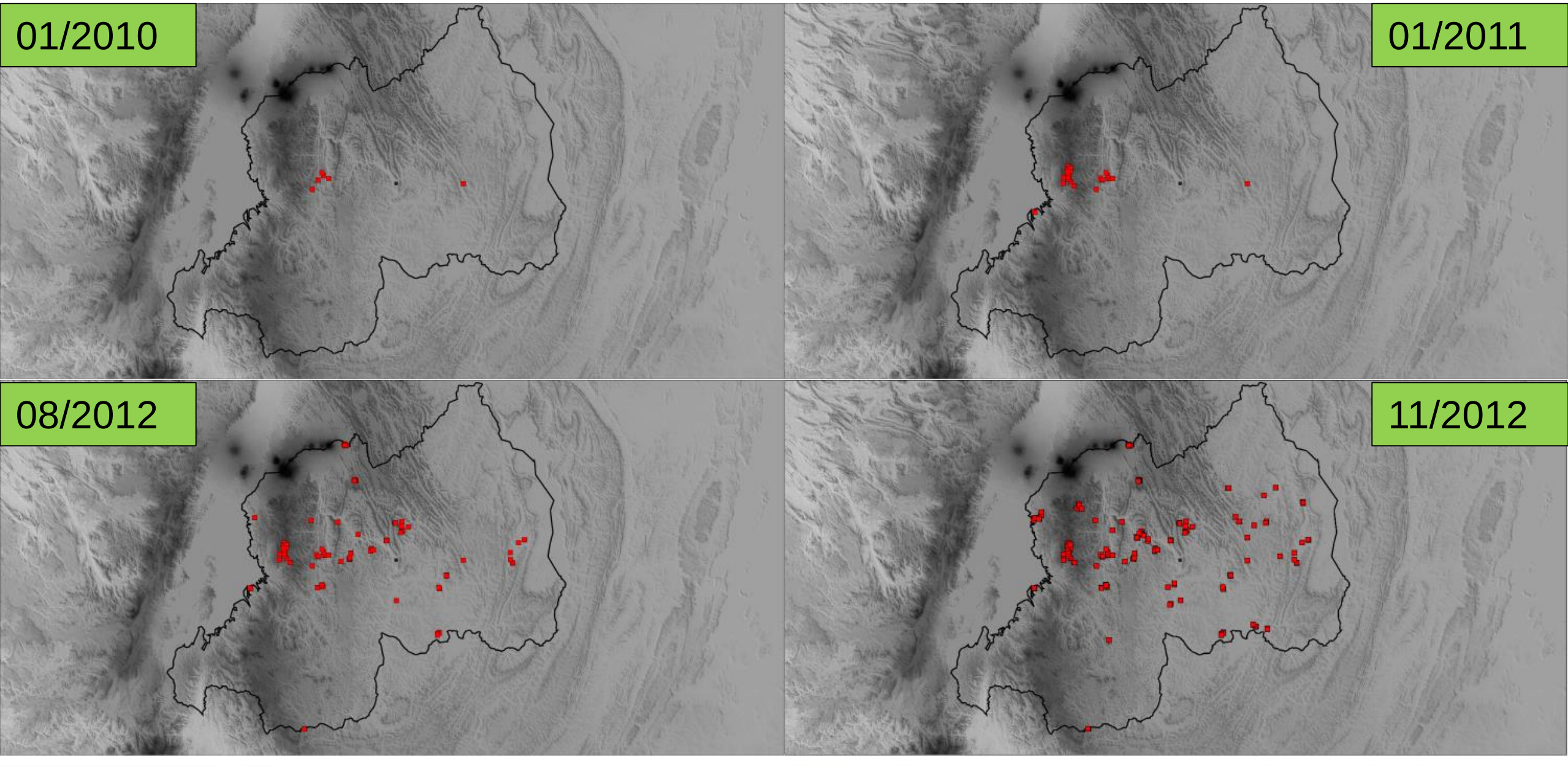
- Sampling protocol
- Documentation
- Data base
- Trained, reliable staff
- Witnessed sampling



Rwanda AFP Reference Sampling Progress

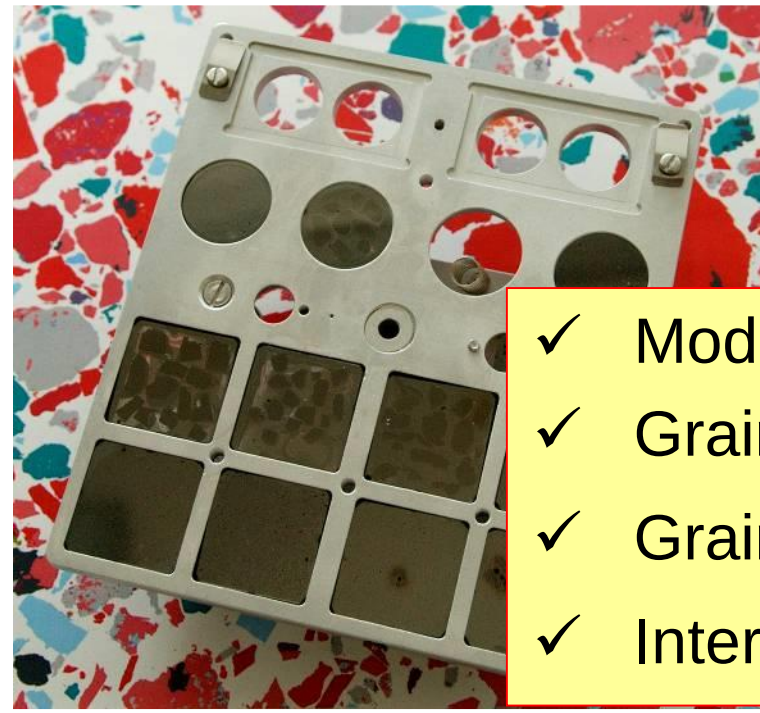
Global TTT reference data base
50 countries
>1400 samples, 635 mines

Great Lakes Region
>620 samples, 340 mine sites



Sample preparation & polishing

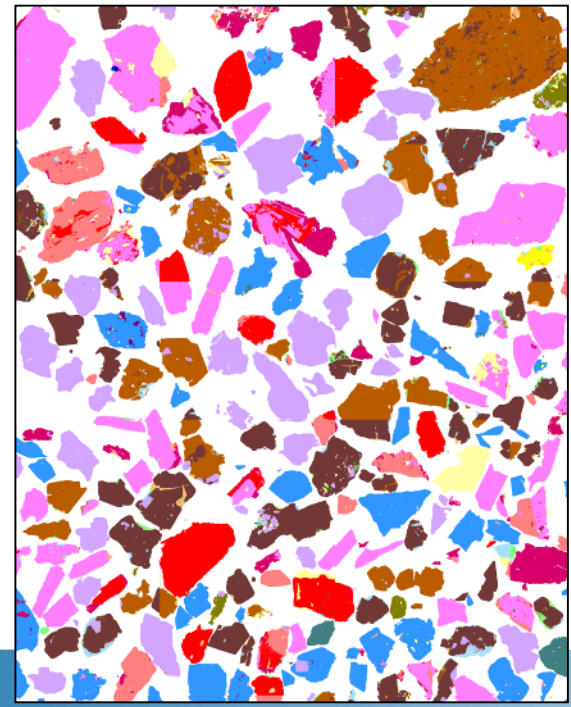
Mineral identification using SEM-based Mineral Liberation Analysis



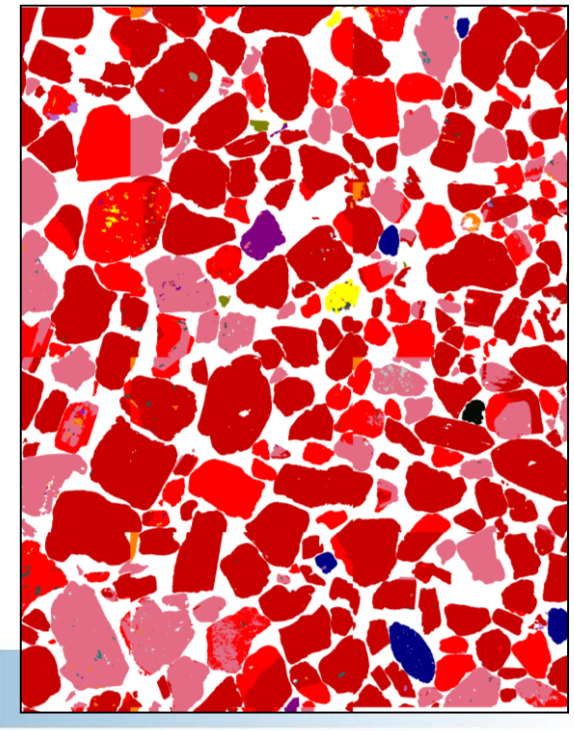
- ✓ Modal mineralogy
- ✓ Grain size distribution
- ✓ Grain shape
- ✓ Intergrowths

Bijyojo, Ruanda

Quartz	17.43
Cassiterite	16.54
Haematite	16.22
FeColumbite	12.91
Geothite	11.91
MnColumbite	9.36
MnTantalite	4.92
FeTantalite	2.46



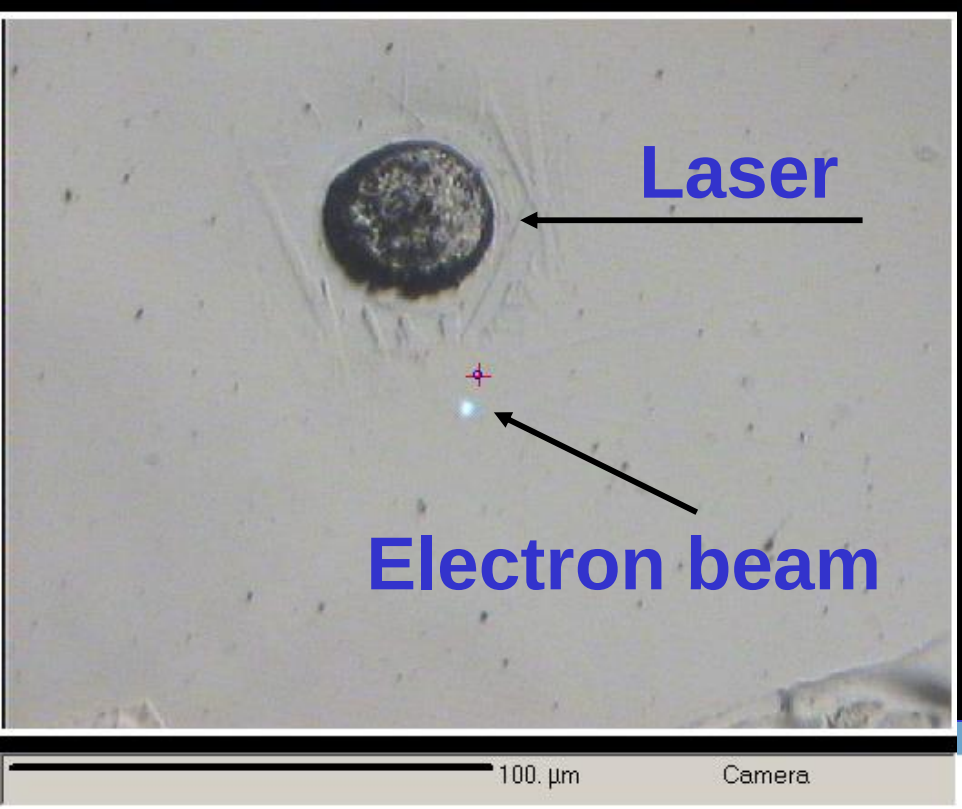
Pangi, Kongo



Columbite	50.48
MnTantalite	23.30
MnColumbite	22.03
Wolframite	0.85
Rutile	0.62
TiTant	0.61
Unknown	0.55
Monazite	0.39
Tantalumoxide	0.31
Orthoclase	0.22

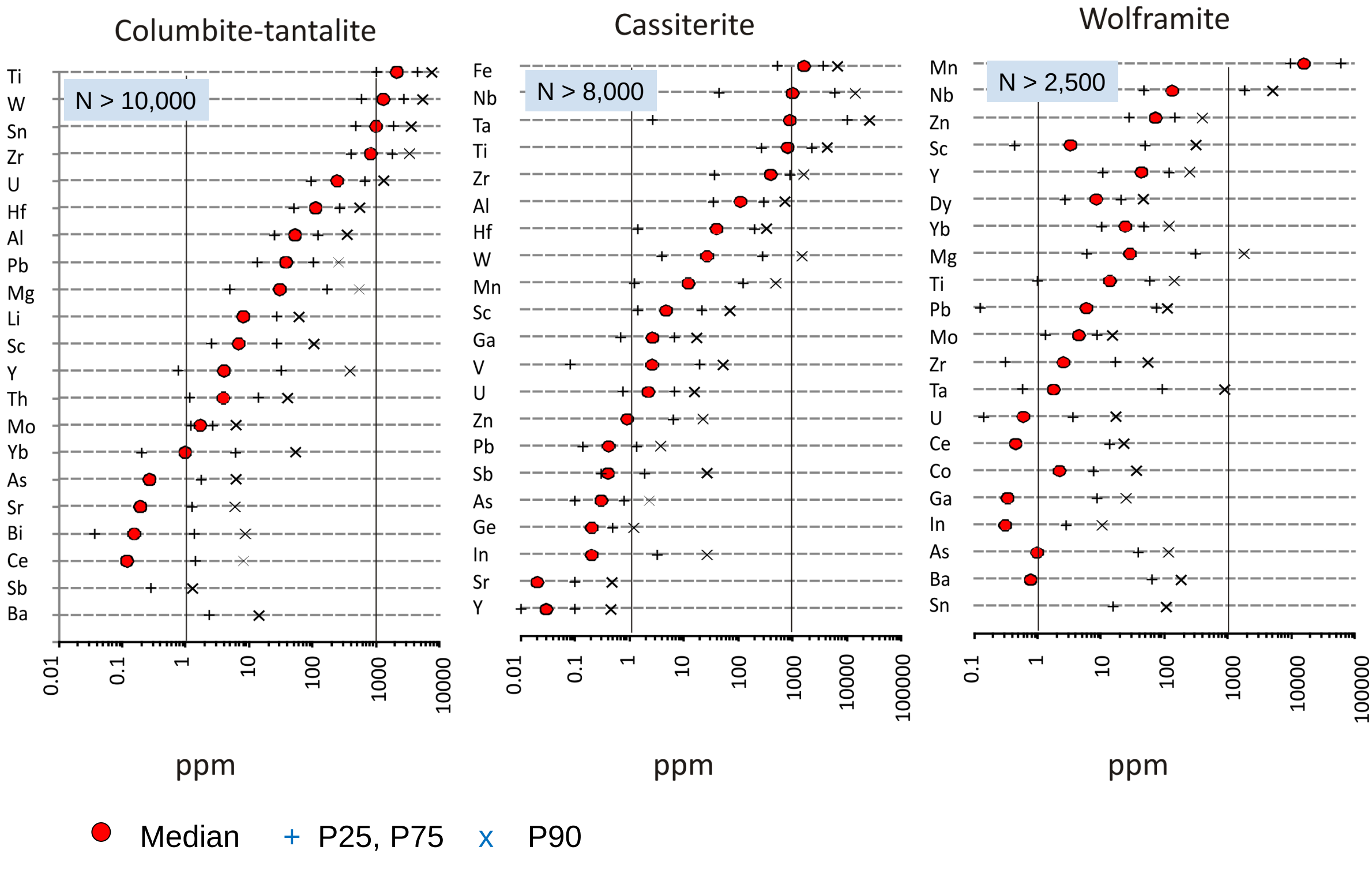
BGR Bundesanstalt für Geowissenschaften und Rohstoffe
GEOZENTRUM HANNOVER

Laser ablation – ICP – Mass spectrometry

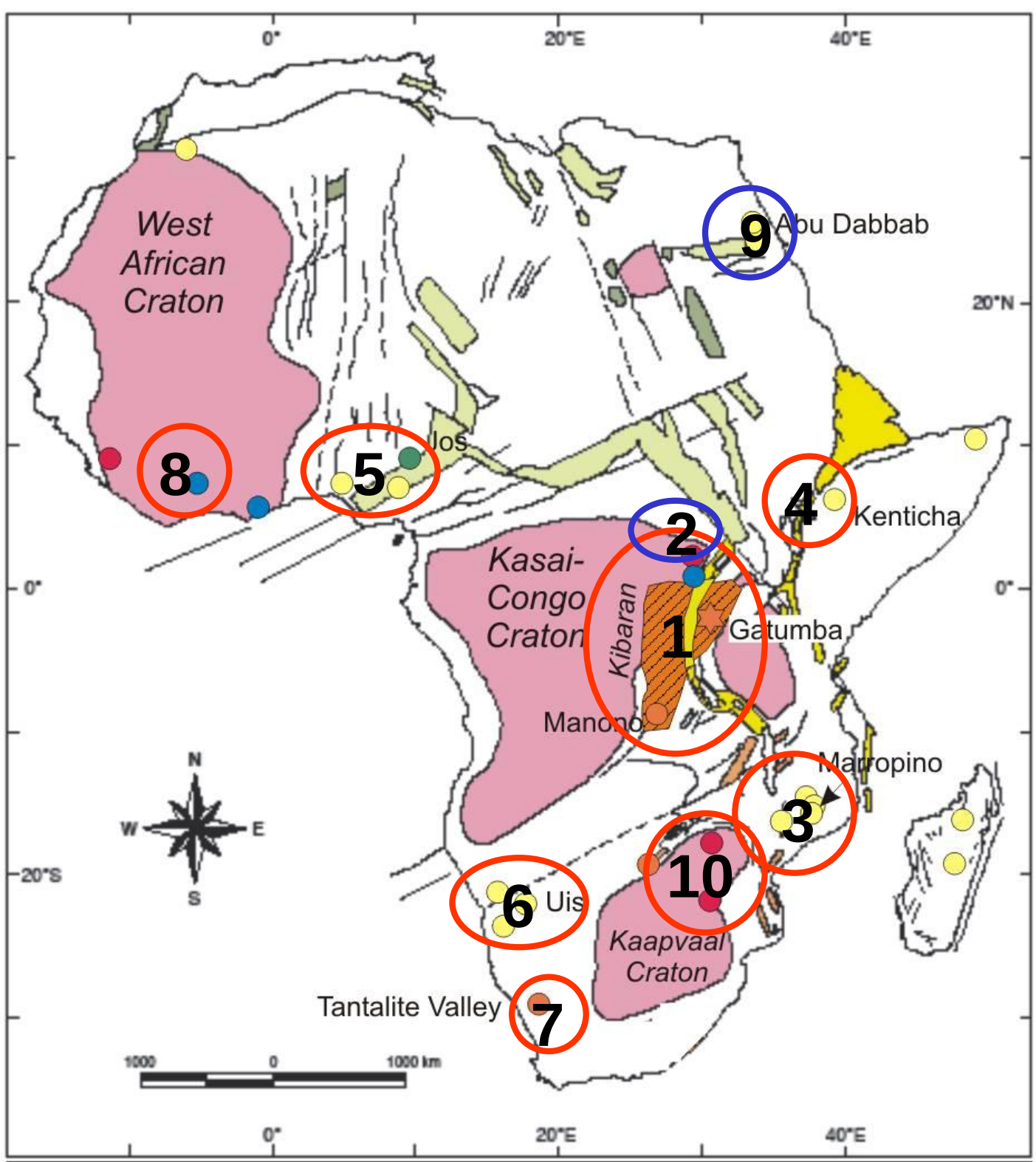


und Rohstoffe
GEOZENTRUM HANNOVER

AFP scientific background: variable composition of TTT minerals

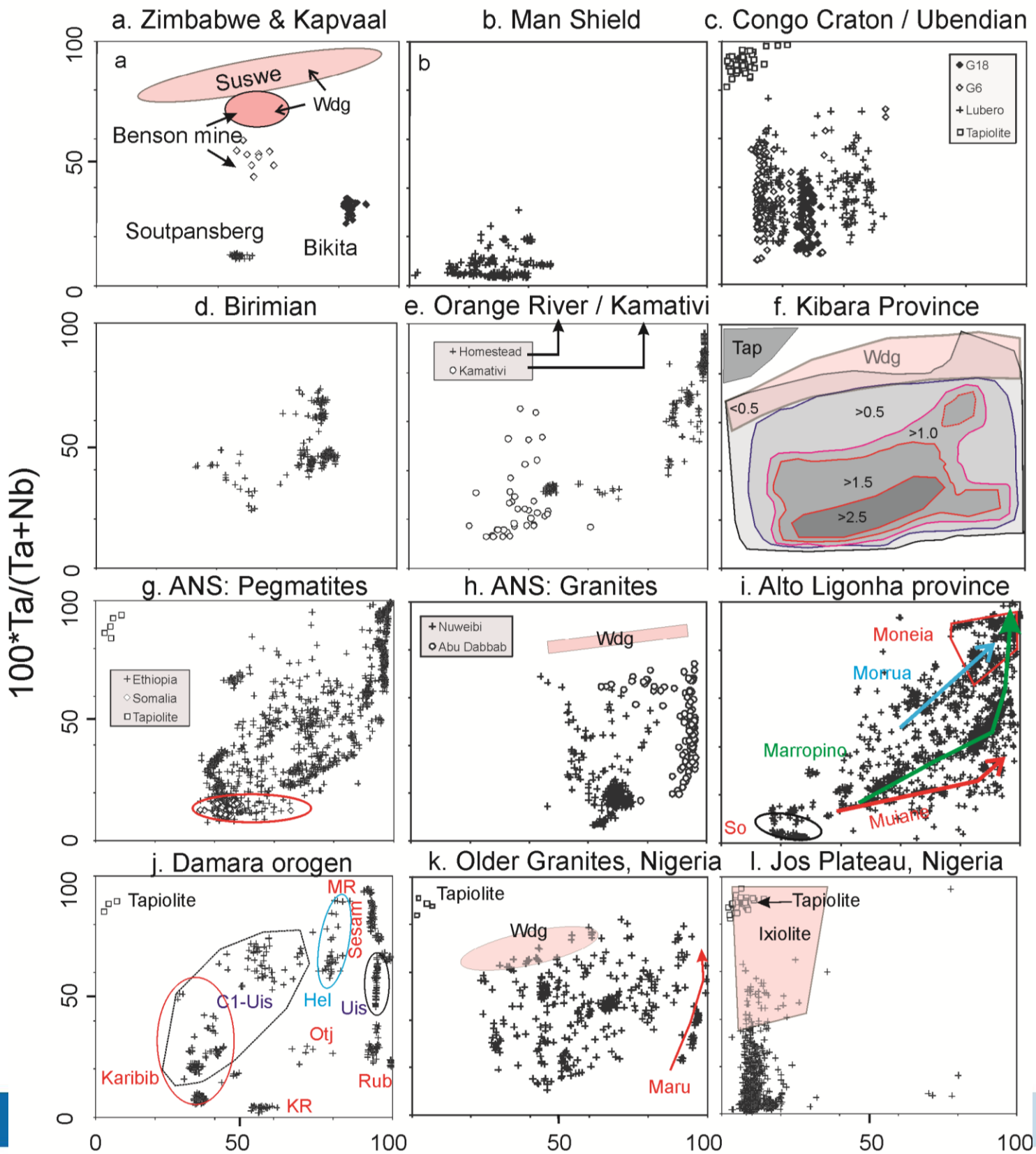


African TTT provinces



1) Kibara belt
2) North Congo Craton
3) Alto Ligonha province
4) Adola Belt
5) Nigeria
   - Panafrican pegmatites
   - Younger granites
6) Damara belt
7) Namaqualand
8) Birimian, West Africa
9) Eastern Desert, Egypt
10) Zimbabwe Craton

AFP scientific background: fractionation trends in Ta oxides

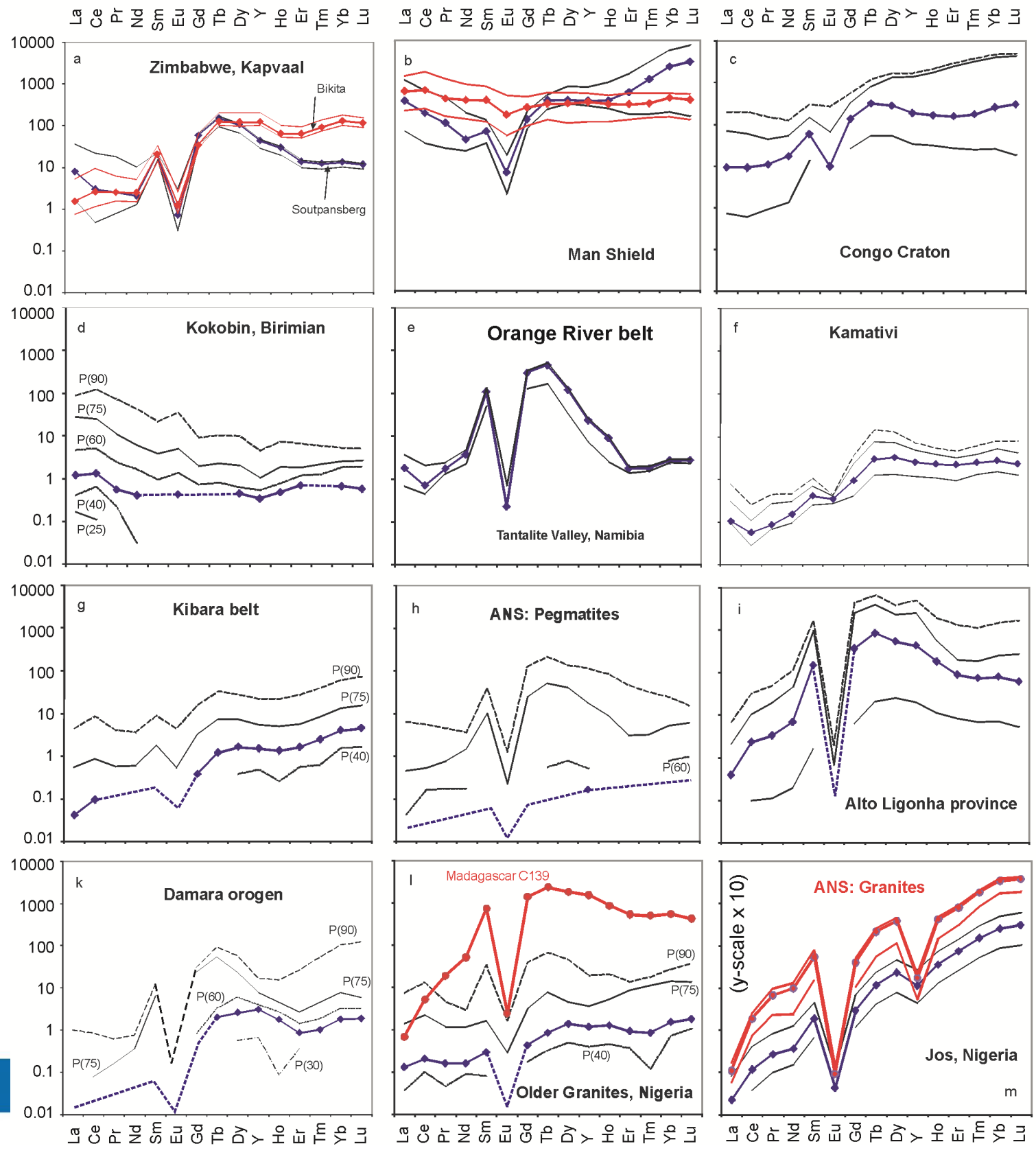


– Pegmatite types

– Degree of fractionation

– Contamination

AFP scientific background: rare earth element variations



– Pegmatite types

– Degree of fractionation

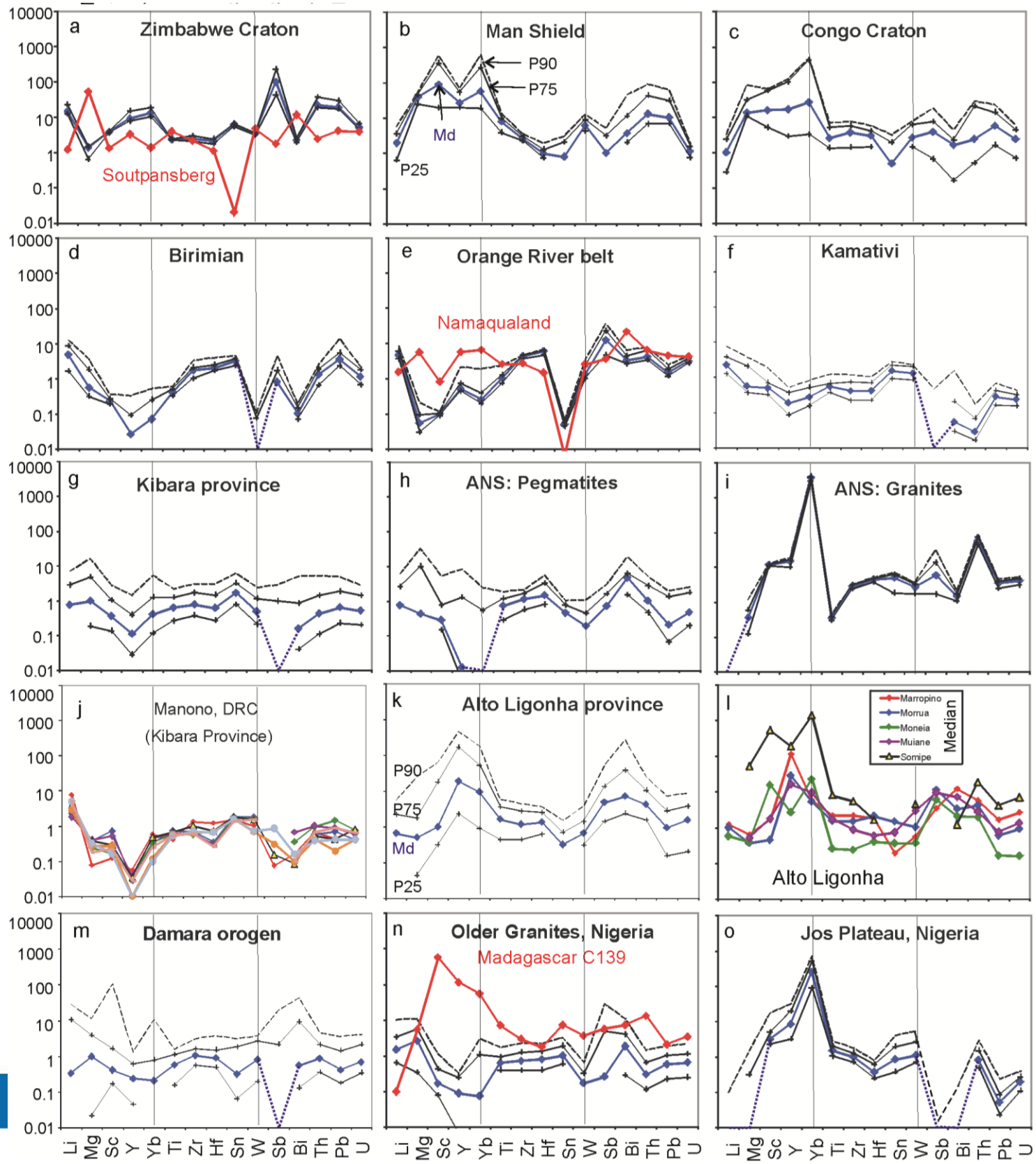
– Contamination

– Source

– Co-crystallizing phases

(crystallization sequence)

AFP scientific background: trace element variations



– Pegmatite types

– Degree of fractionation

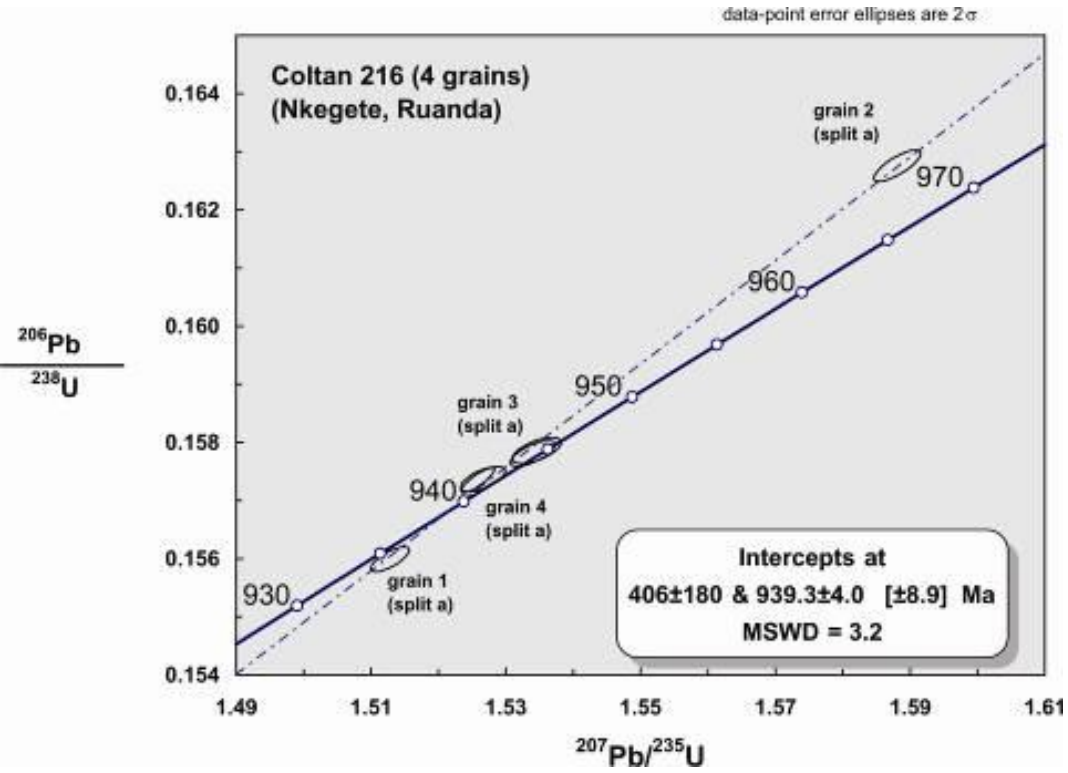
– Contamination

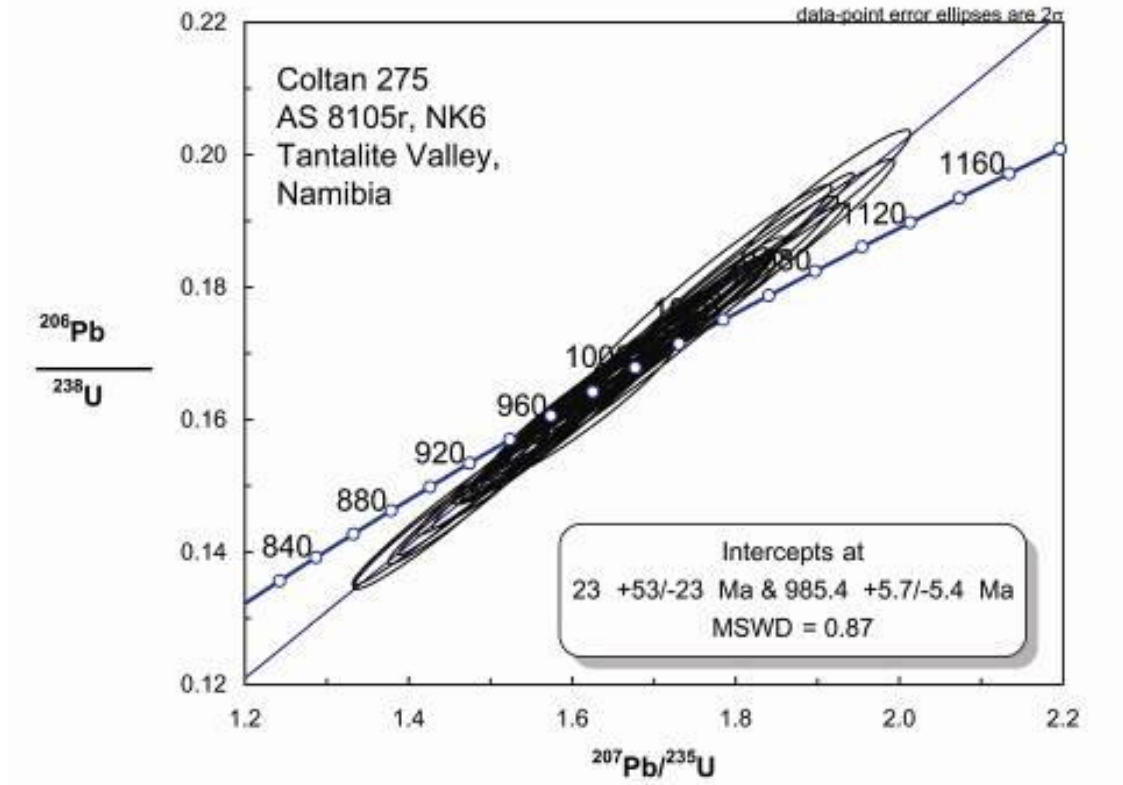
– Source

– Co-crystallizing phases

(crystallization sequence)

AFP scientific background: direct U-Pb dating possible





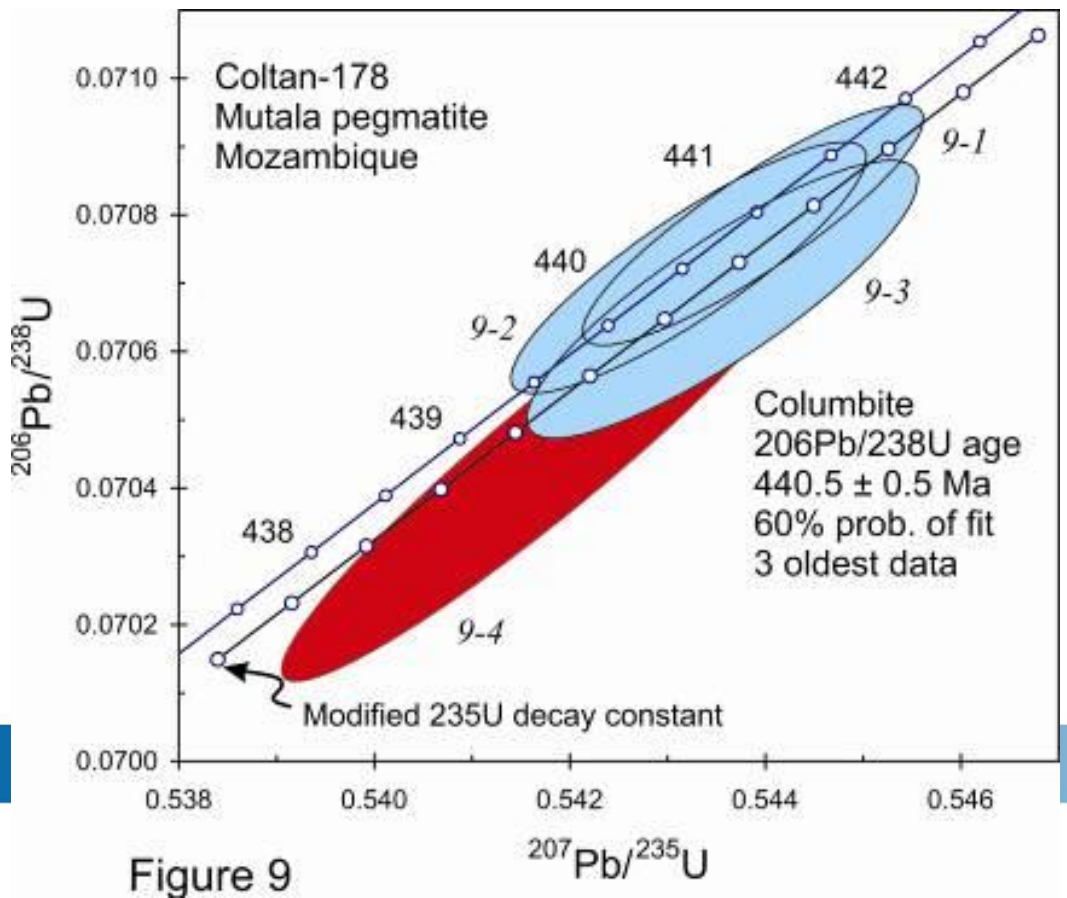


Figure 9

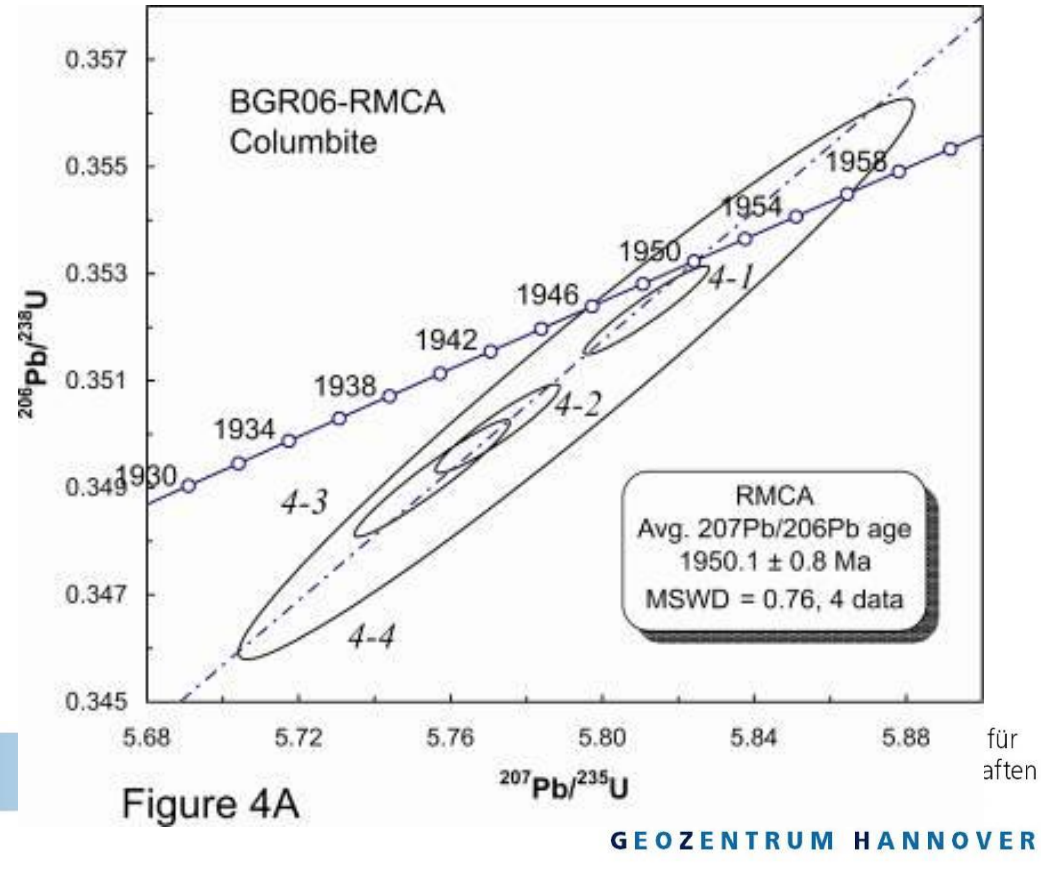
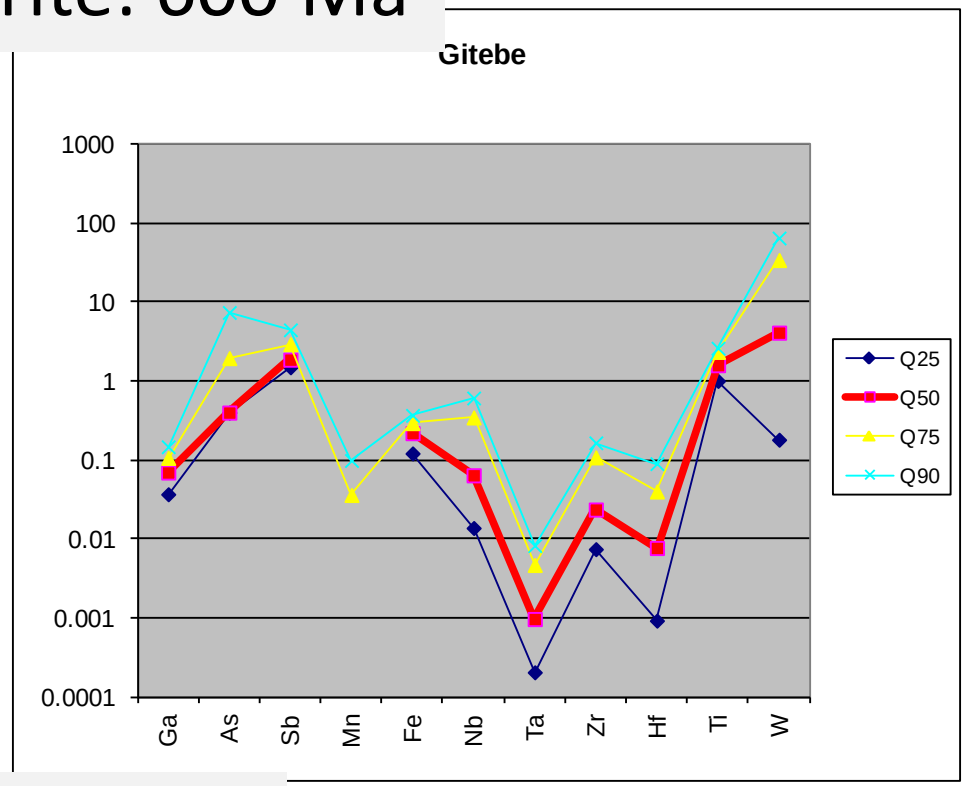


Figure 4A

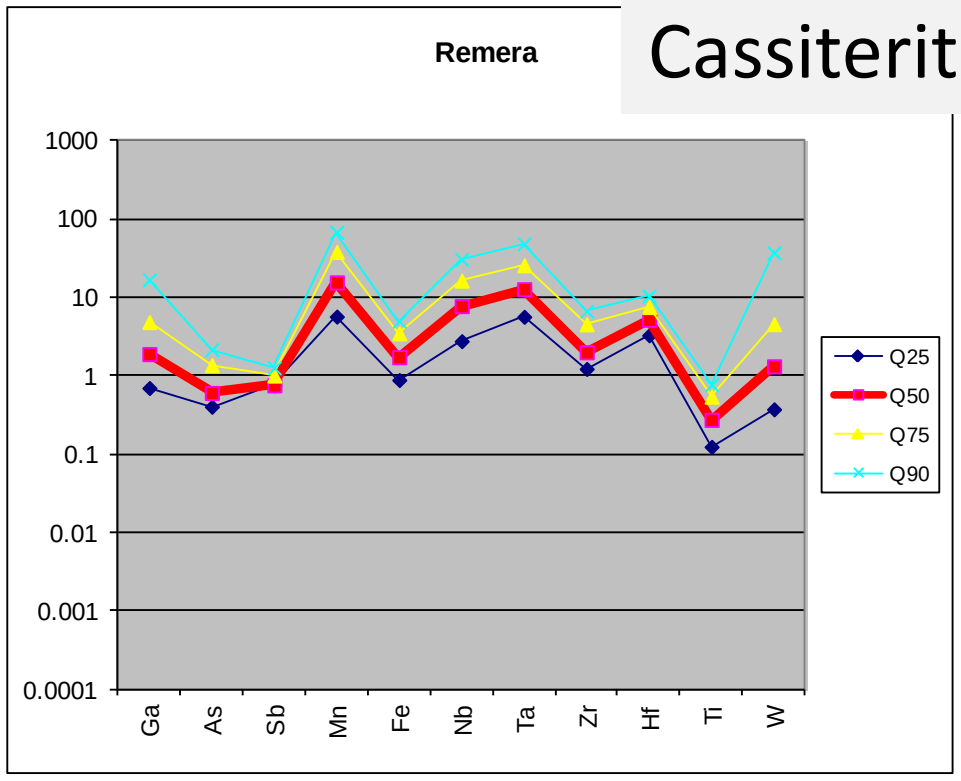
für
aften

Distinction of individual mine sites within an ore district

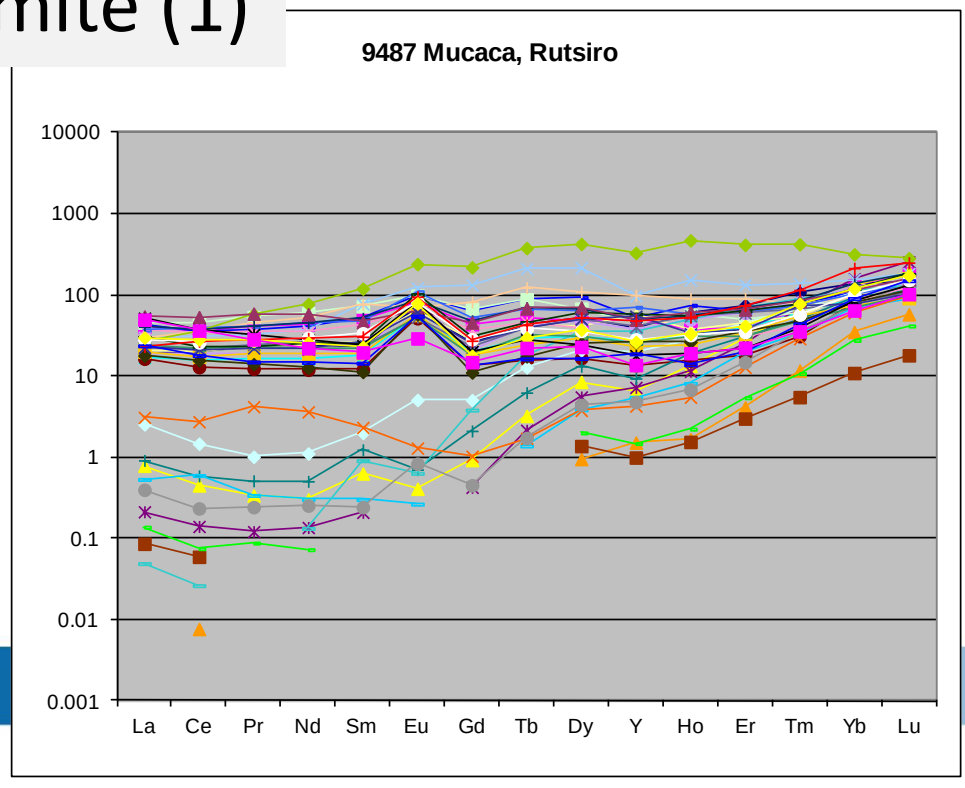
Cassiterite: 600 Ma



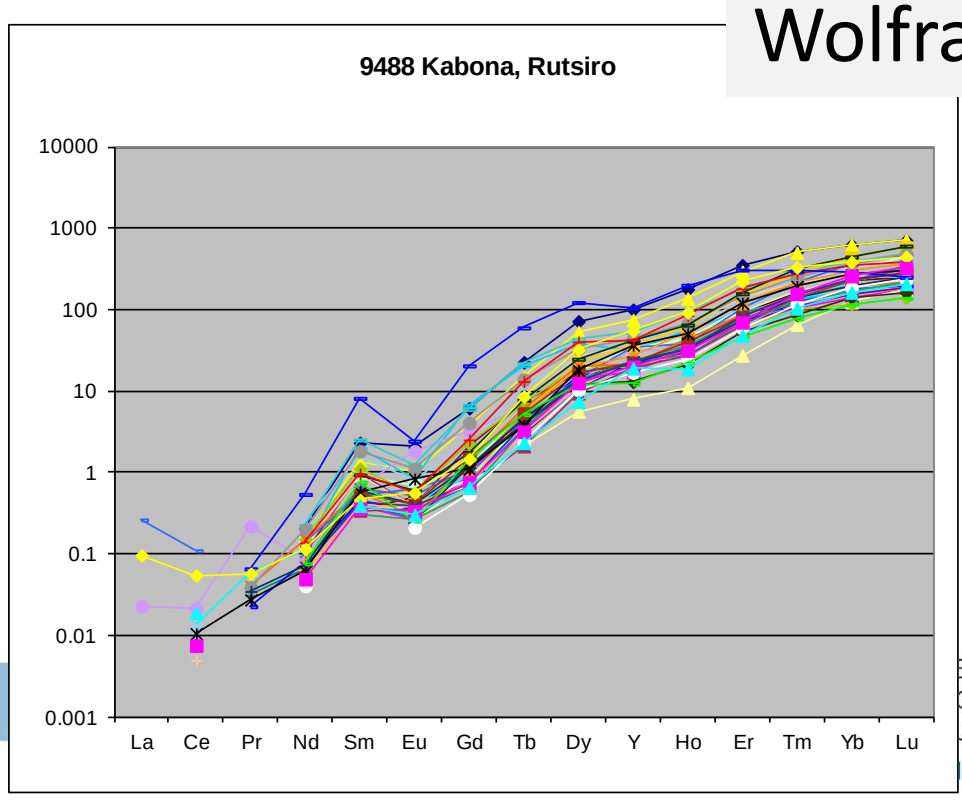
Cassiterite: 950 Ma



Wolframite (1)



Wolframite (2)

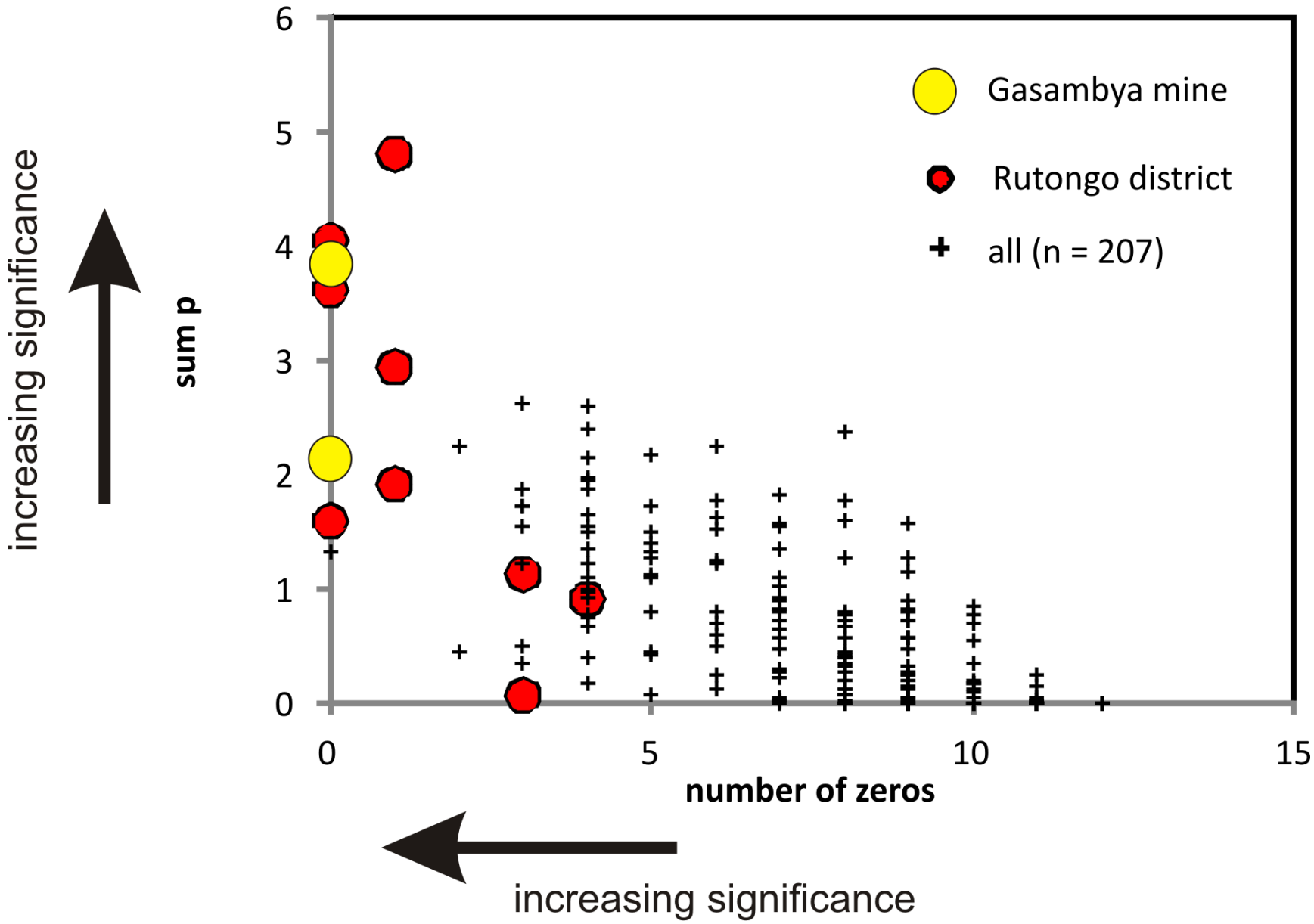


AFP application: statistical data evaluation

Gasambya mine/Rutongo
12RRU-09 (1187)

12 elements tested: Ga, Nb, Ta, W, U, Sc, V, Mn, Fe, Zn, Zr, Pb

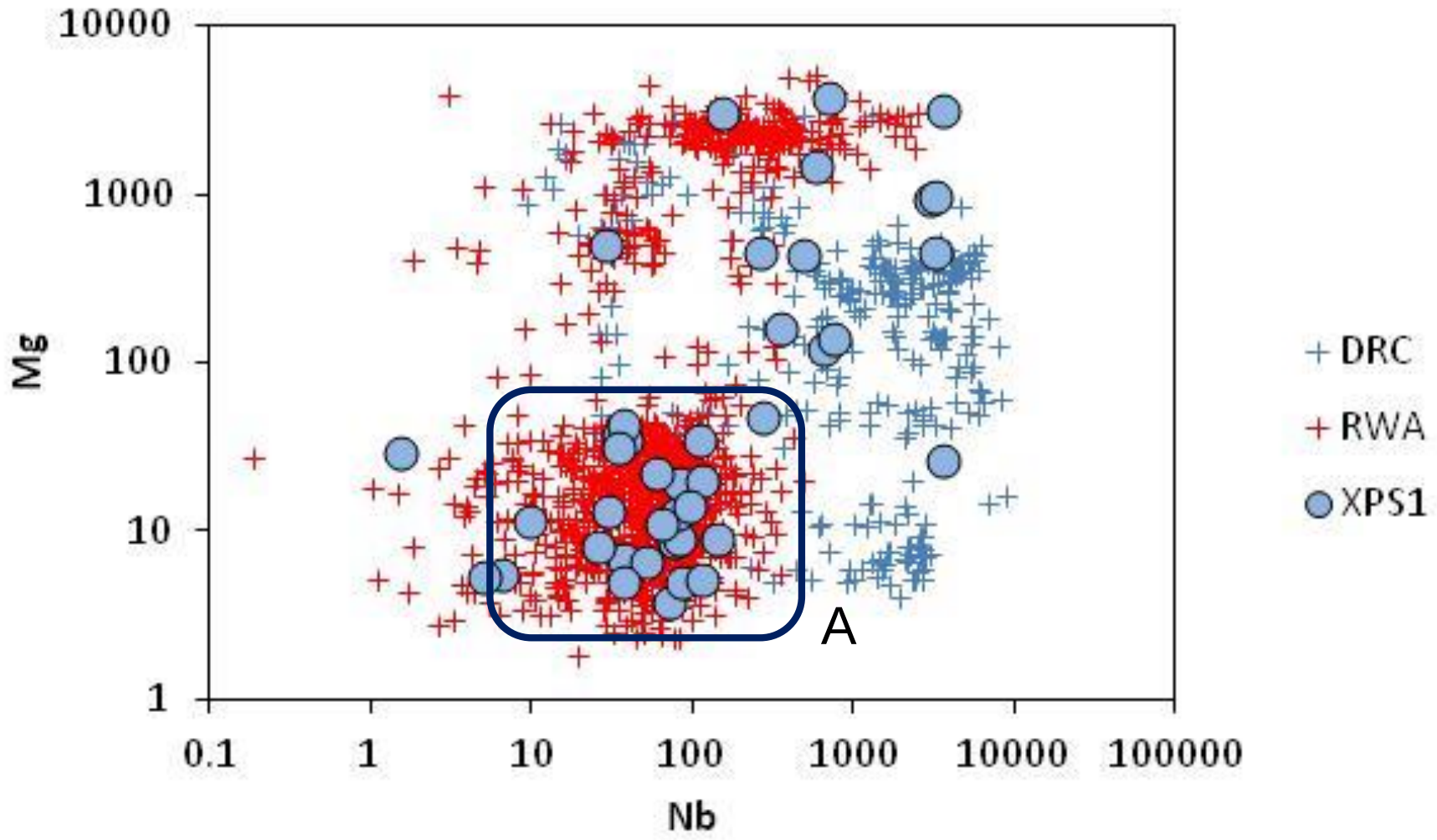
Wilcoxon rank-sum test
for cassiterite concentrates



AFP application: example

Export container of wolframite from Rwanda

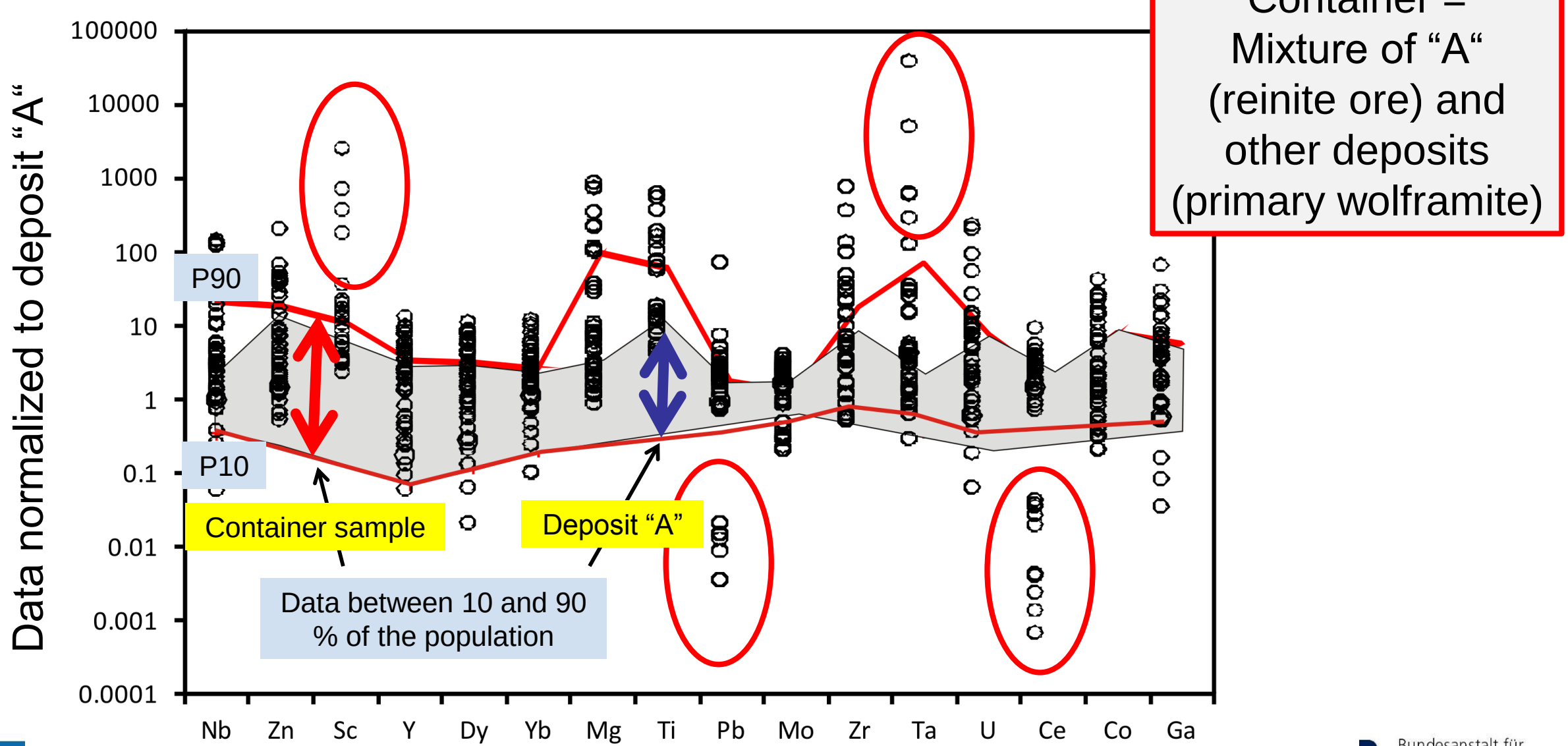
Does the material originate from deposit “A”?
What is the proportion from mine site “A”?



AFP application: example

Export container of wolframite from Rwanda

Does the material originate from deposit “A”?
What is the proportion from mine site “A”?



Container =
Mixture of “A“
(reinite ore) and
other deposits
(primary wolframite)

Bundesanstalt für
Geowissenschaften
und Rohstoffe
RUM HANNOVER

AFP Concept

ICGLR

Independent Mineral Chain Auditor

RINR Certification Unit

Bujumbura, Burundi

Recommendation

3

AFP Management Unit

Analytical data

2

Analytical laboratory

Tanzania

Sample data

Polished blocks

1

Sample storage & preparation facilites

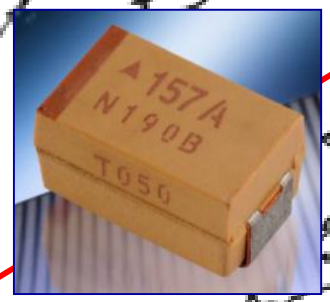
Rwanda
Burundi
DR Congo

Samples

Mine sites | Traders | Centres de Négoce | Comptoirs

Tantalum: transparent production and trading chain
“Solutions for Hope” (SfH) (Motorola)

OEM manufacturer
AVX



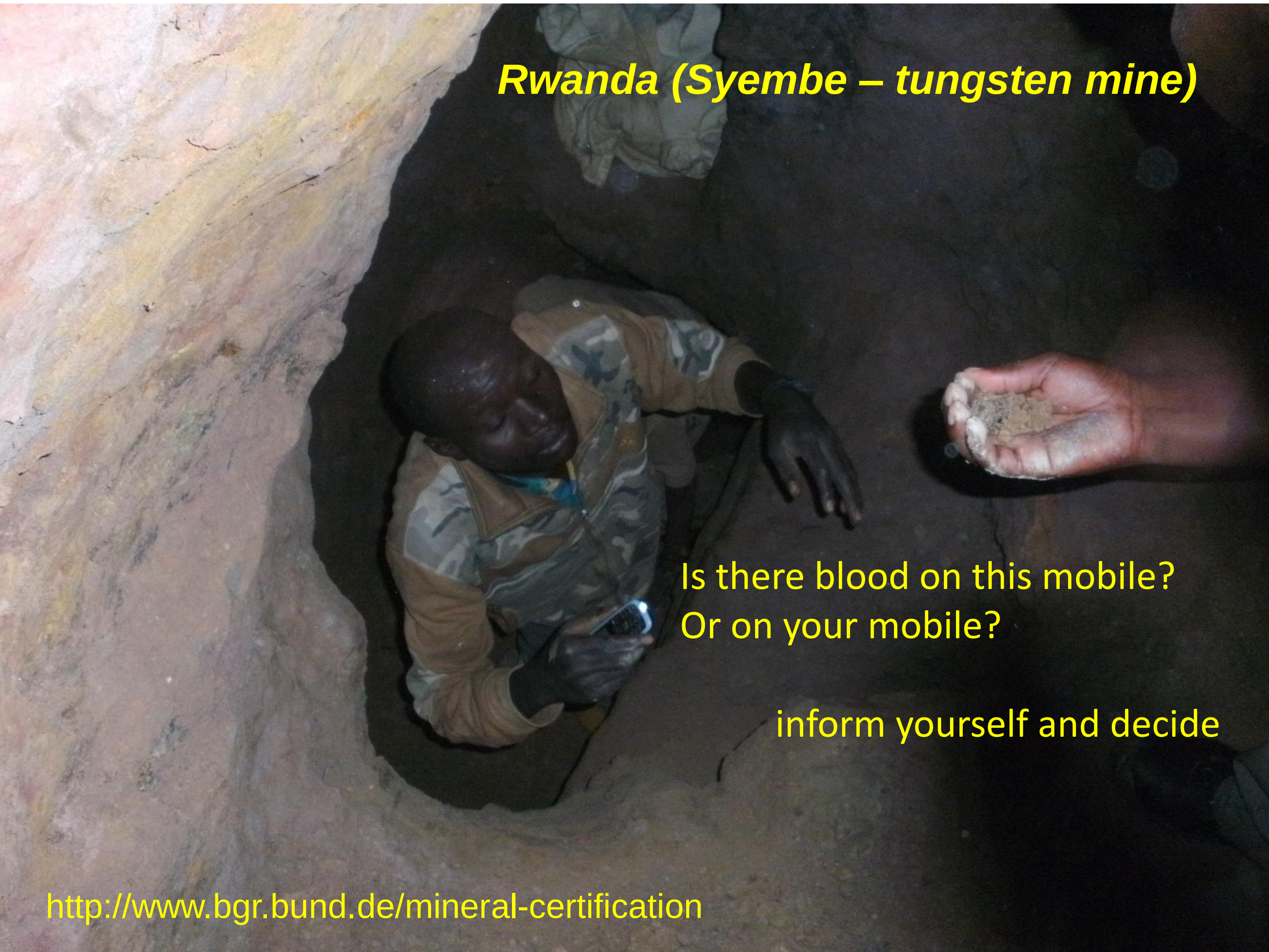
Mobile phone assembler
Motorola

Powder manufacturer
F&X Electro Materials

Depot
Kalemie, DRC

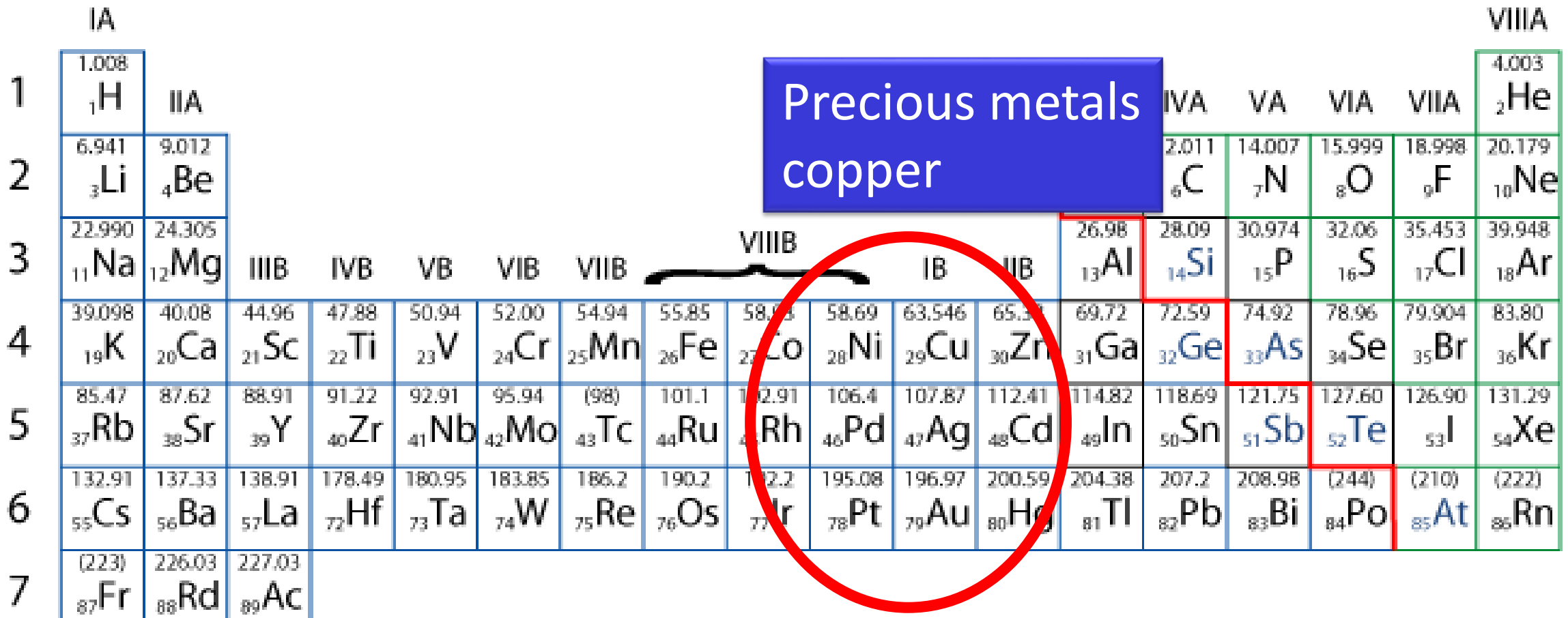
Tantalum mine
Katanga, DRC
Owner: MMR
Contractor: CDMC

- Industrial production
- artisanal production
- Conflict region


Rwanda (Syembe – tungsten mine)
Is there blood on this mobile?
Or on your mobile?
inform yourself and decide
http://www.bgr.bund.de/mineral-certification

Metal recycling from mobile phones

17 metals may be recycled



83 million used mobile phones in Germany

1,66 tons gold = 67 Mio €

15 tons silver = 11 Mio €

644 tons copper = 4 Mio €

50 kg palladium = 0.8 Mio €

BGR Bundesanstalt für Geowissenschaften und Rohstoffe
GEOZENTRUM HANNOVER