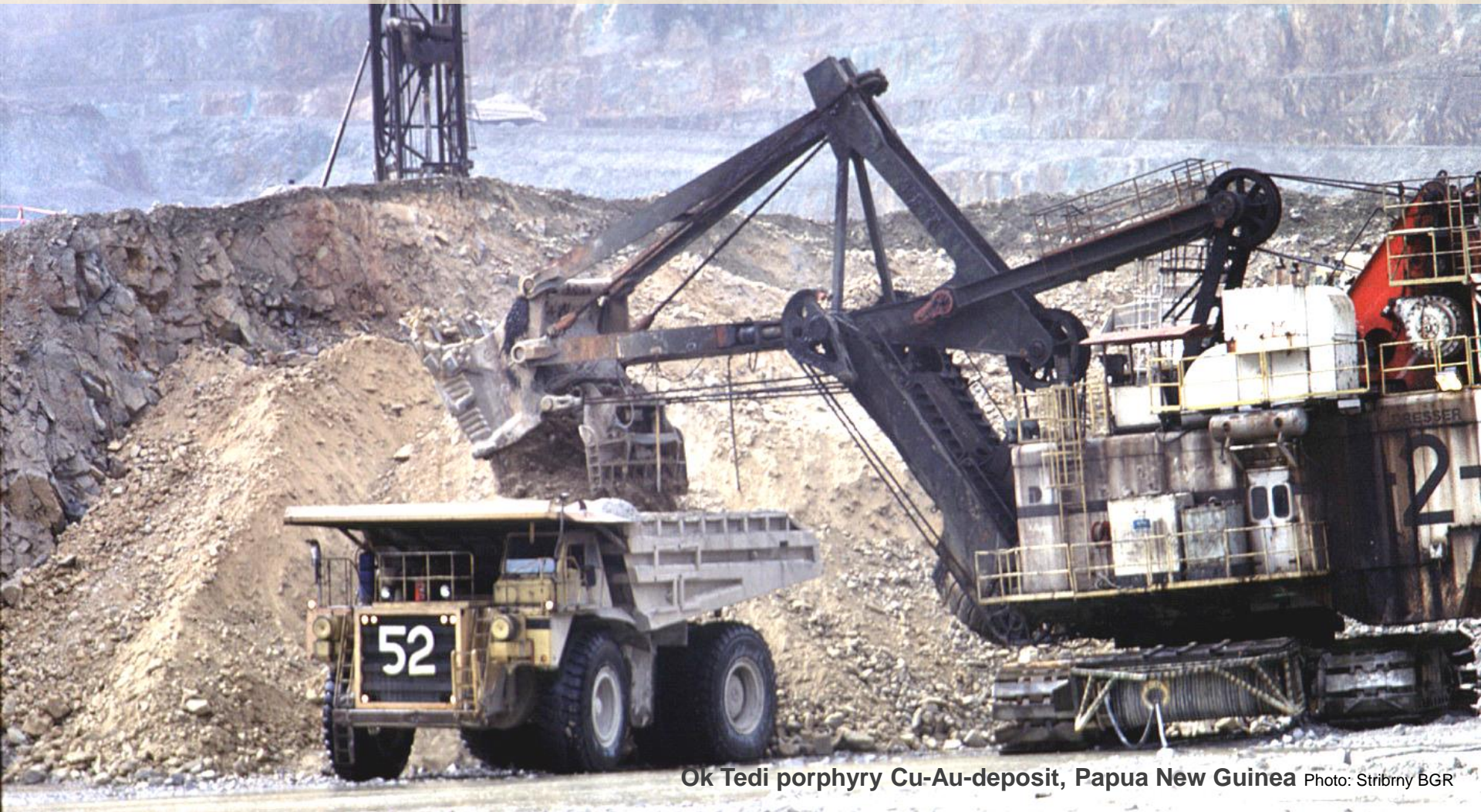


# International Co-operation and Exploration of Mineral Resources.



Ok Tedi porphyry Cu-Au-deposit, Papua New Guinea Photo: Stribny BGR

**Prof. Dr. Bernhard Stribny**  
**BGR Geoscientific Information, International Co-operation**  
**EGU Congress, Vienna, 12.-17.4.2015**

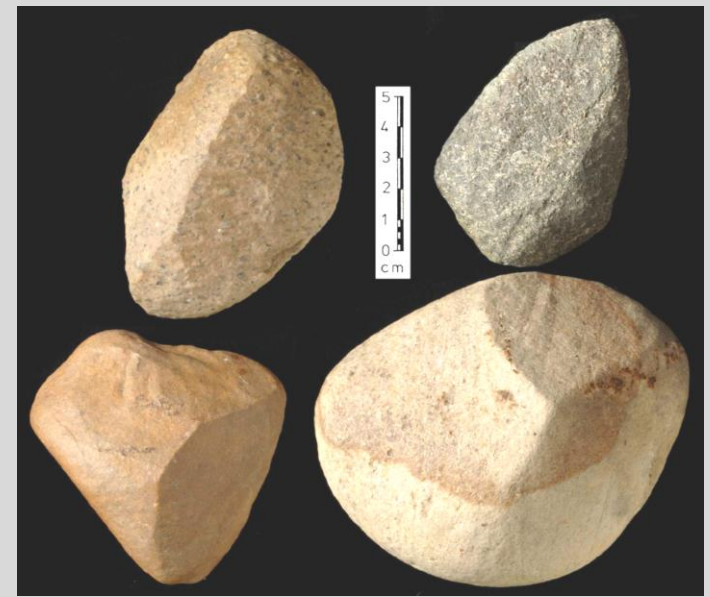
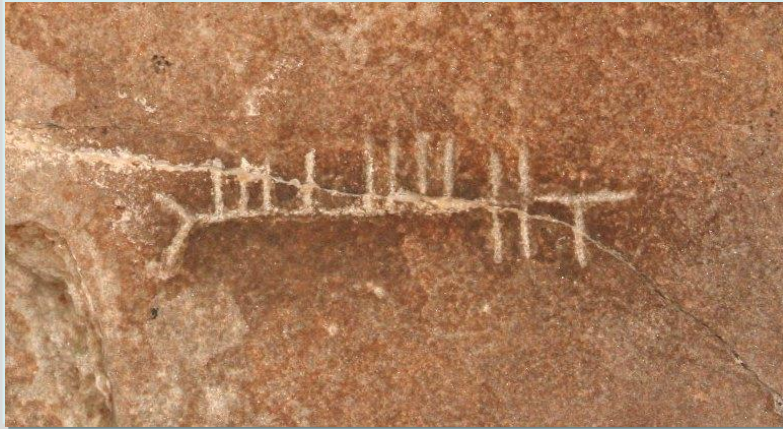


Bundesanstalt für  
Geowissenschaften  
und Rohstoffe

**GEOZENTRUM HANNOVER**



There would not have been a  
Stone Age without **rocks!**



# Raw material consumption in Germany during a lifetime of 80 years (~ 1000 t)

Sand & Gravel	245 t	Kaolin	4,0 t
Crushed Rock	215 t	Aluminium	3,0 t
Brown Coal	170 t	Copper	2,0 t
Petroleum	105 t	Peat	2,0 t
Natural Gas (1000 m <sup>3</sup> )	95	Bentonite	0,7 t
Limestone, Dolomite	70 t	Zinc	0,7 t
Hardcoal	65 t	Potash (K <sub>2</sub> O)	0,6 t
Crude Steel	40 t	Sulfur	0,5 t
Cement	27 t	Lead	0,4 t
Rocksalt	14 t	Fieldspar	0,4 t
Clay	12 t	Fluorspar	0,4 t
Silica Sand	9 t	Barytes	0,3 t
Gypsum	7 t	Phosphates	0,1 t

(Data 2008) Source: BGR



Photos: Stribny BGR

The average German raw material consumption of 40 kilos per head and day lies ten times higher than in developing countries.

**20 % of world population consumes 80 % of the natural resources.**



# If it can't be grown, it has to be mined.

A mineral deposit is an enriched accumulation of minerals or rocks, out of which minerals or metals can be extracted economically.



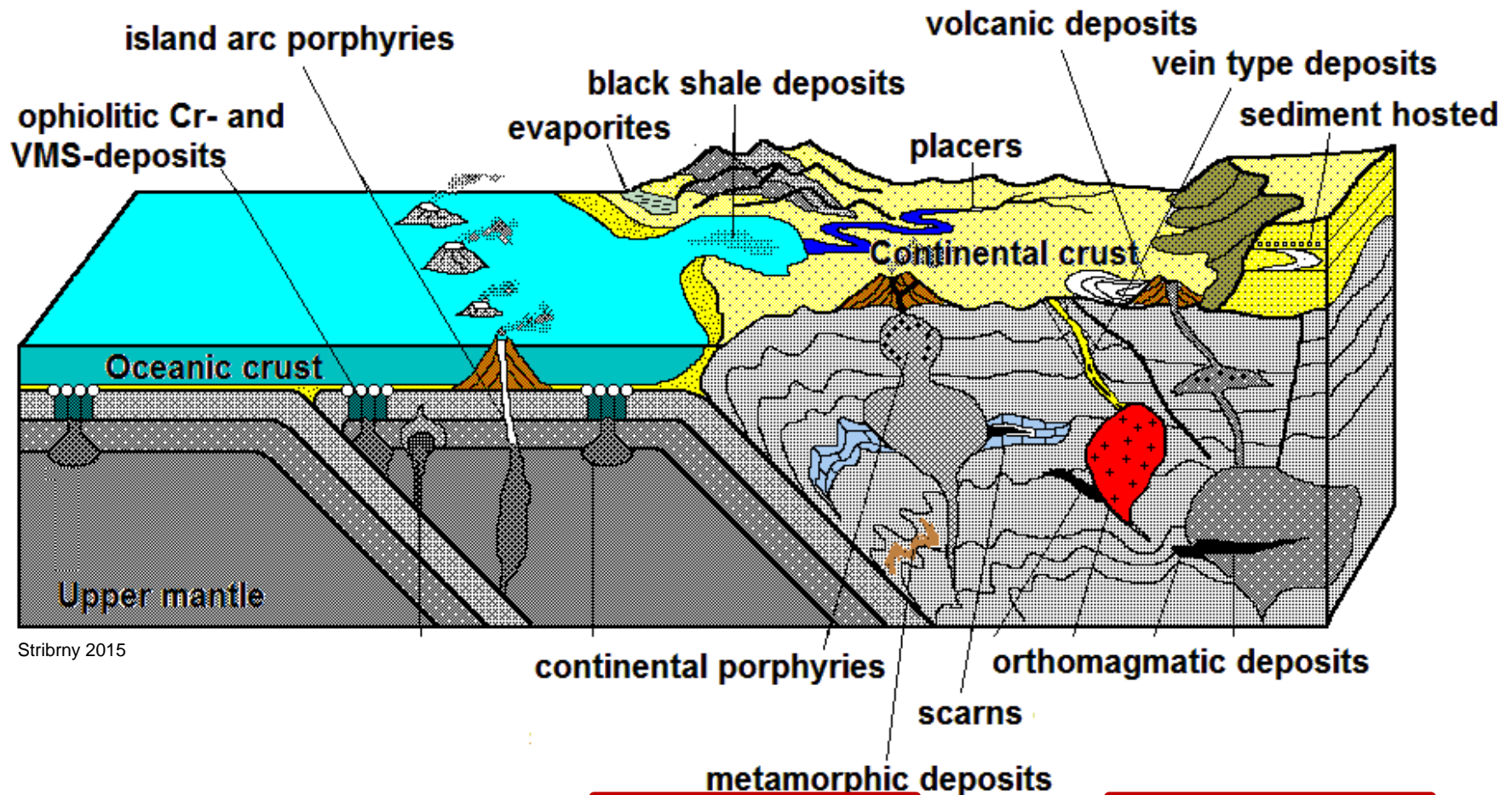
Ore vein, Harz, Germany



**Today:** High tonnage, low grade  
**Past:** Low tonnage, high grade

# Mineral deposits result from ore forming processes

## Sedimentary



Stribny 2015

## Metamorphic

## Magmatic



Bundesanstalt für  
Geowissenschaften  
und Rohstoffe

GEOZENTRUM HANNOVER

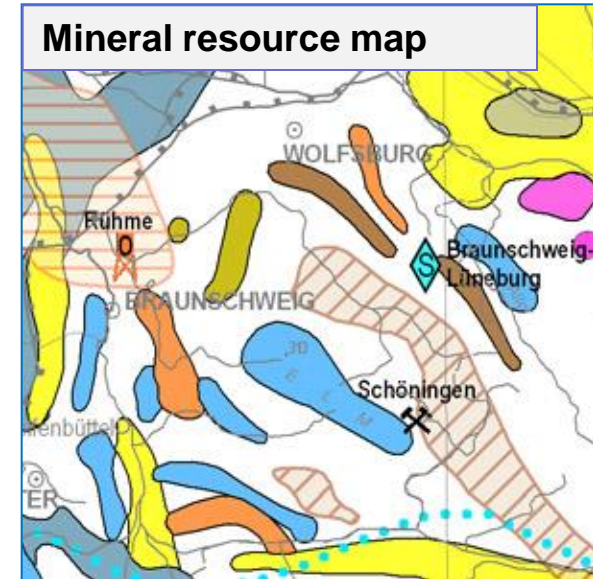


# Mineral exploration

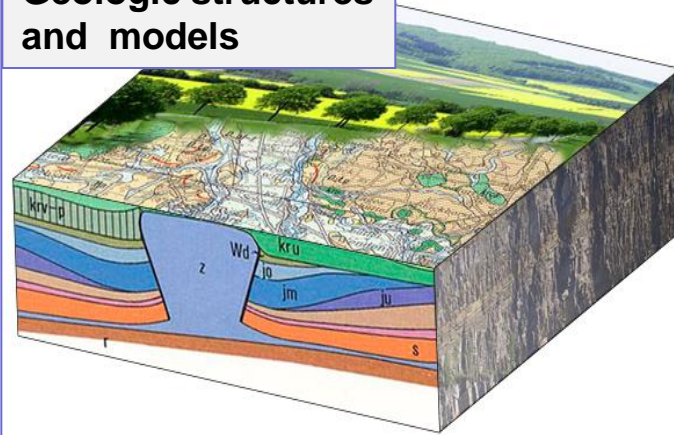
**Exploration strategy: Where are prospective areas?**

**What are new targets with sufficient grades and tonnages?**

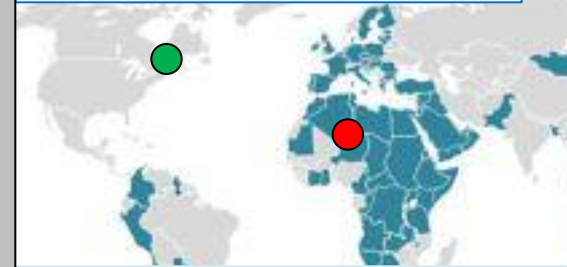
**Mineral resource map**



**Geologic structures and models**



**Geographic and political situation, markets, infrastructure**

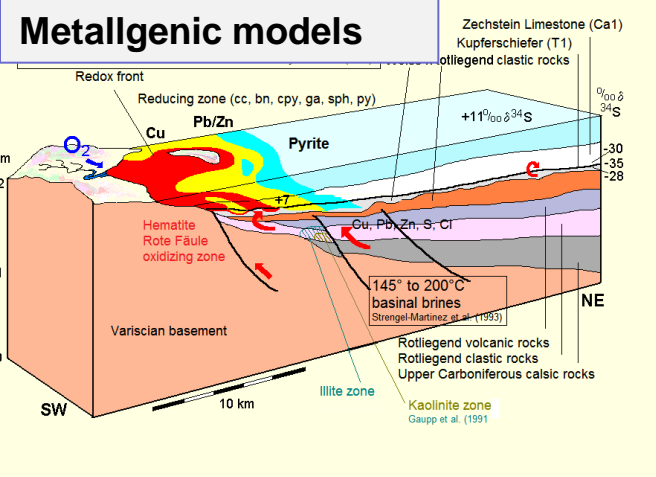


**Data + Expert knowledge**

**Validation**

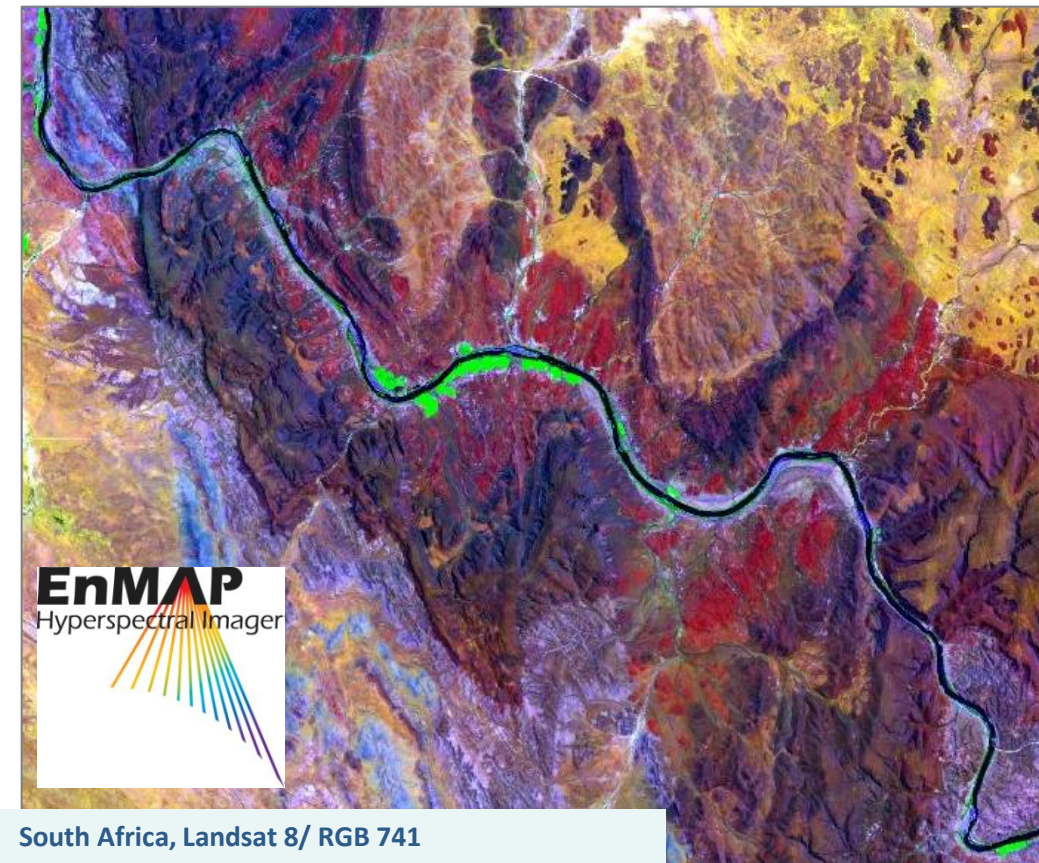
**Exploration concept and target areas**

**Metallgenic models**



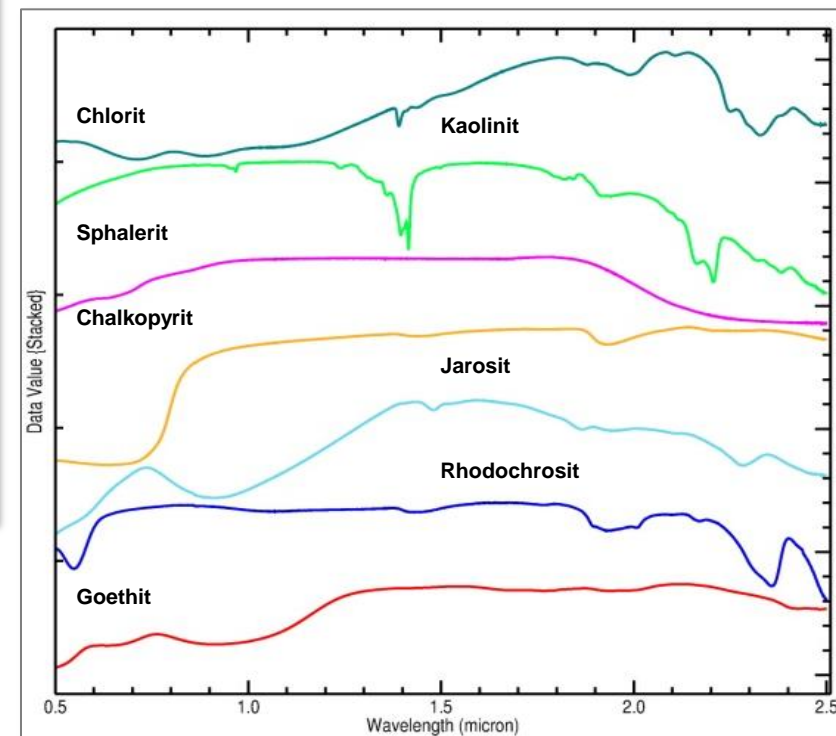
# Exploration methods: Satellite borne remote sensing

## EnMAP Germany's first Hyperspectral Satellite



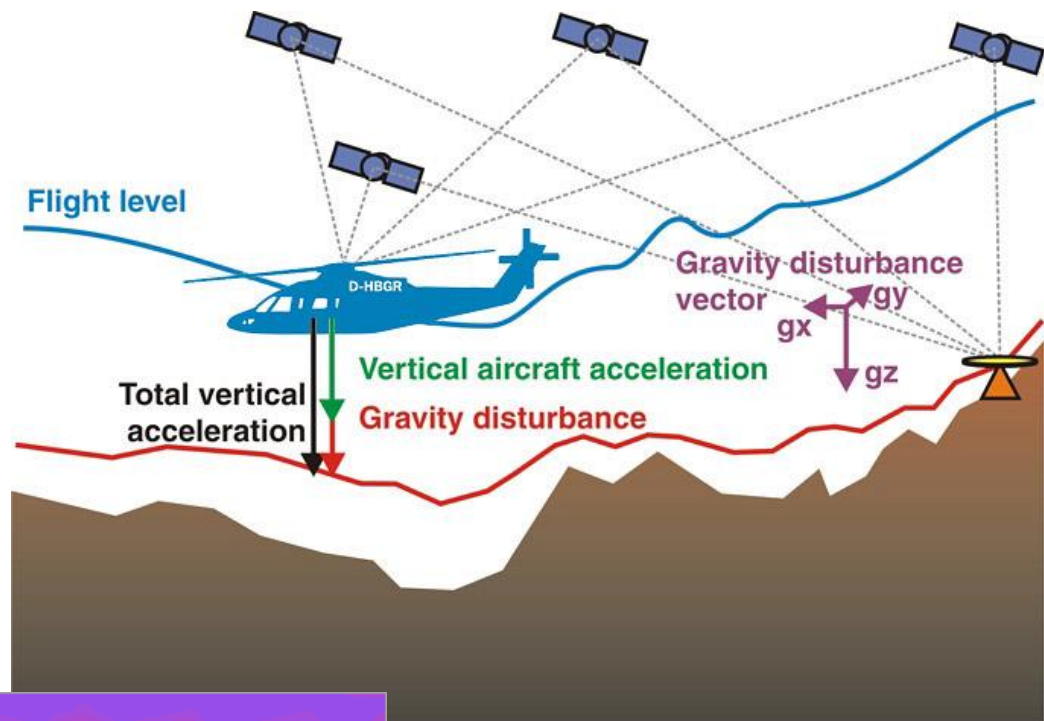
Spectra of minerals  
characteristic for  
mineral deposits and  
alteration zones

- Spectroscopic characterization of mineral deposits
- Expert systems for remote sensing based mapping of mineralogy, lithology and alteration zones.

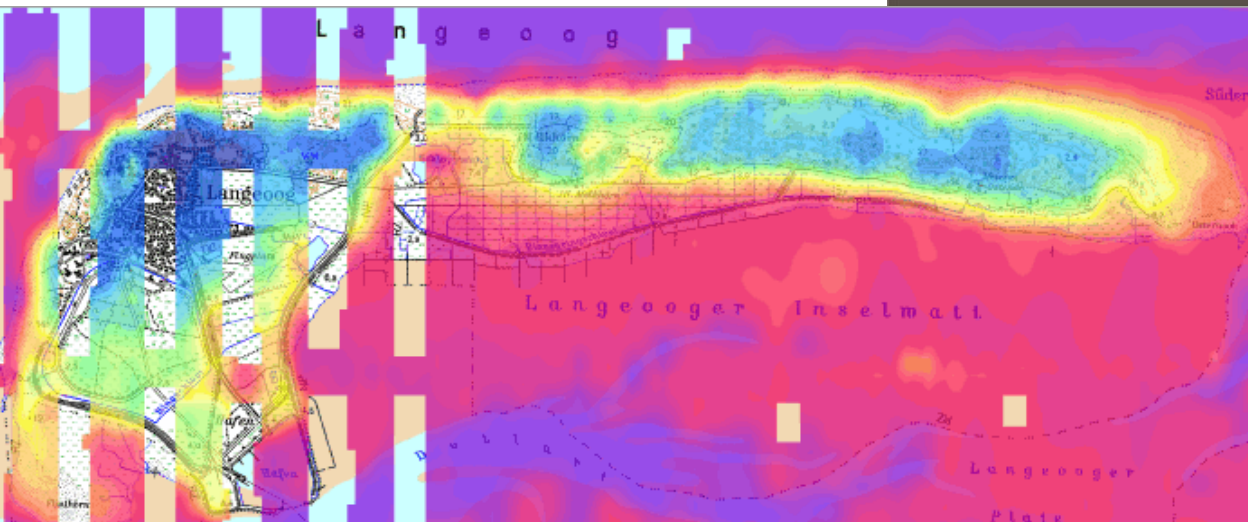




# Exploration methods: Helicopter borne remote sensing



## Results of helicopter electromagnetics, Langeoog island, North Germany



## Principle sketch of helicopter gravimetry



Bundesanstalt für  
Geowissenschaften  
und Rohstoffe

GEOZENTRUM HANNOVER

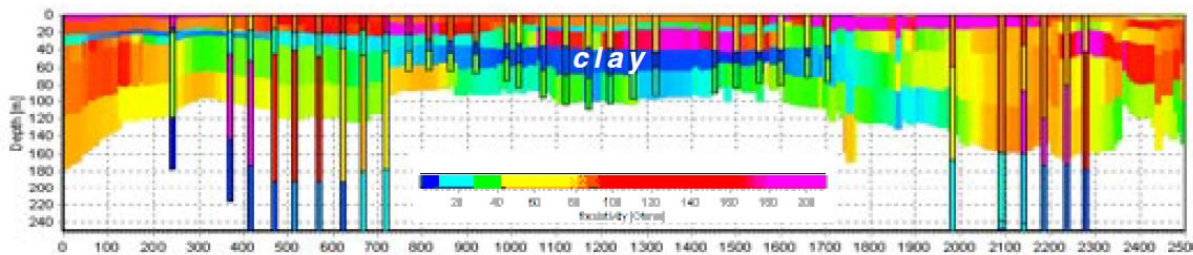


# Exploration methods: Ground geophysics

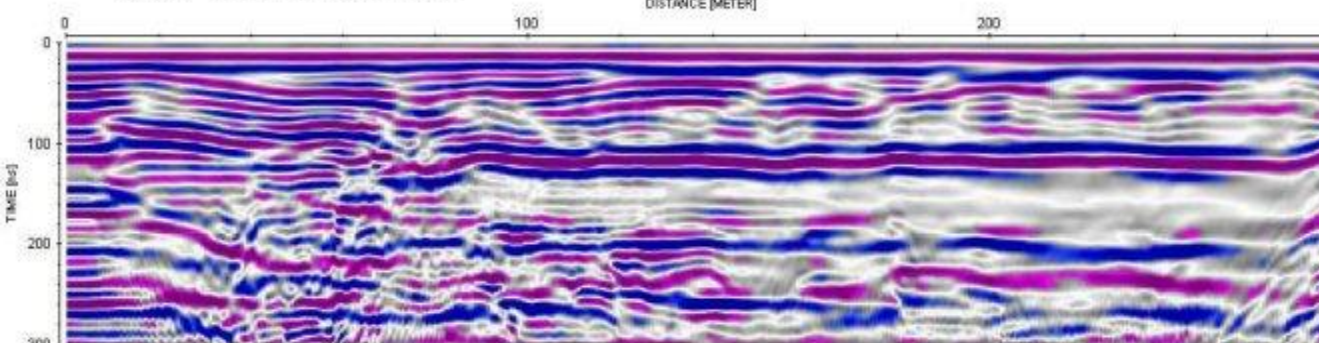


**Transient electromagnetics (TEM) is an exploration method to illuminate near surface electrical properties**

*Clay infill in a glacial valley derived from TEM and HEM data*



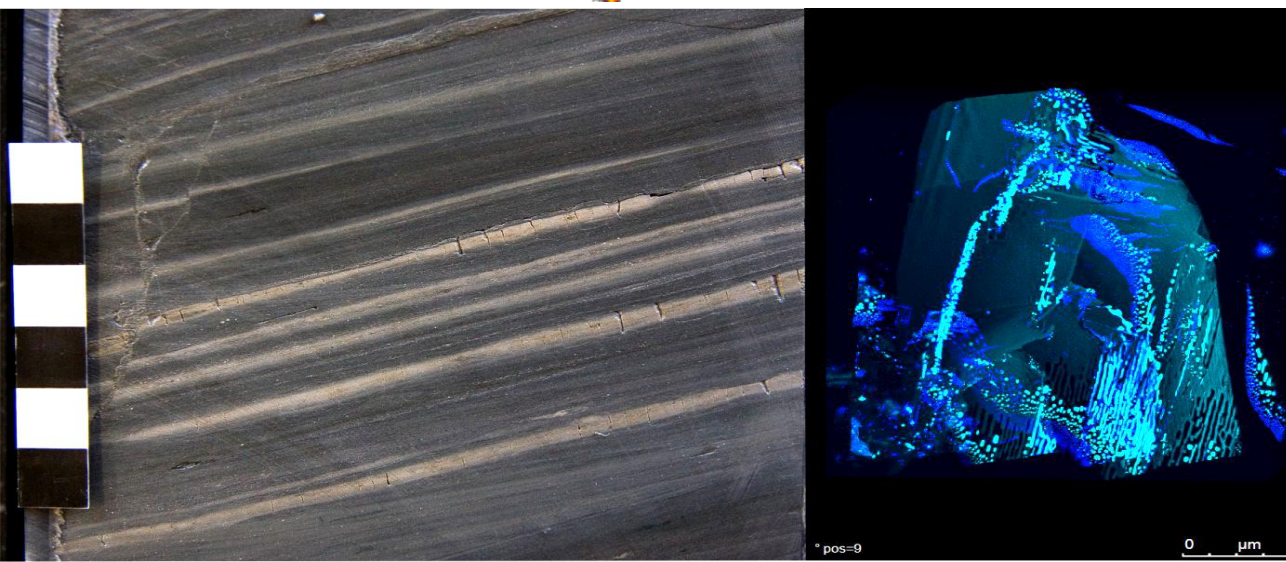
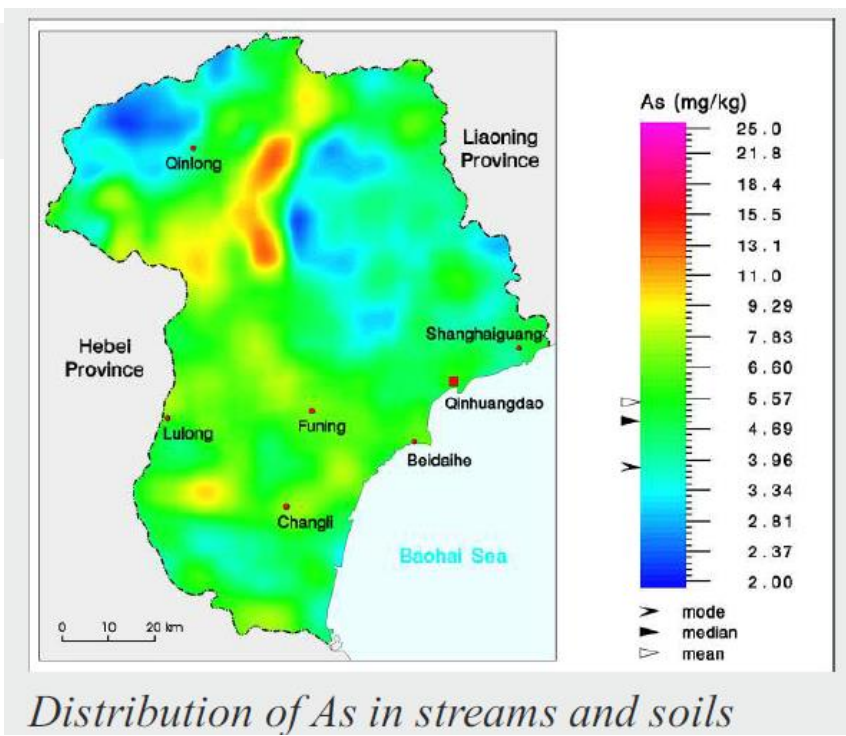
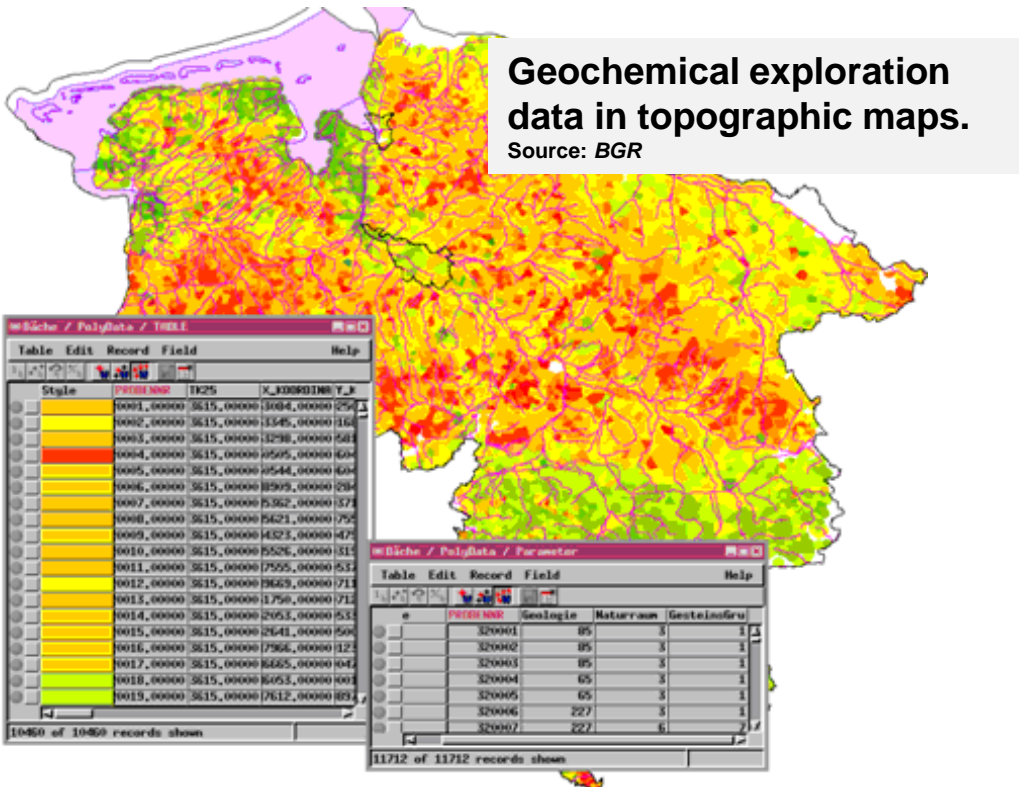
GSSI 40 MHz Antenne



**Surveying near-surface structures using ground radar**



# Exploration methods: Ground geochemistry



**Left:** Sediment core with abundant organic carbon;  
**Right:** Fluorescent hydrocarbon inclusions in a rock sample

Source: BGR

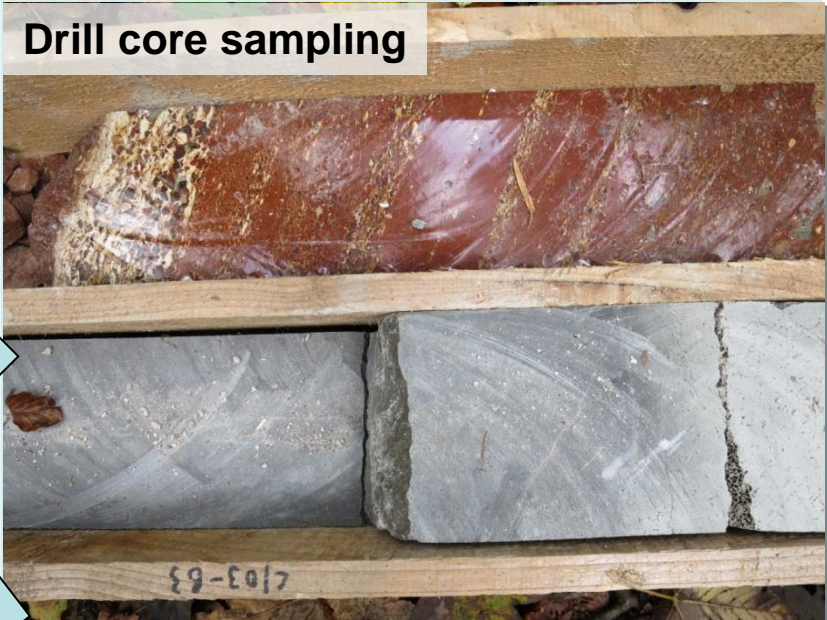


# Exploration methods: Drilling and sampling

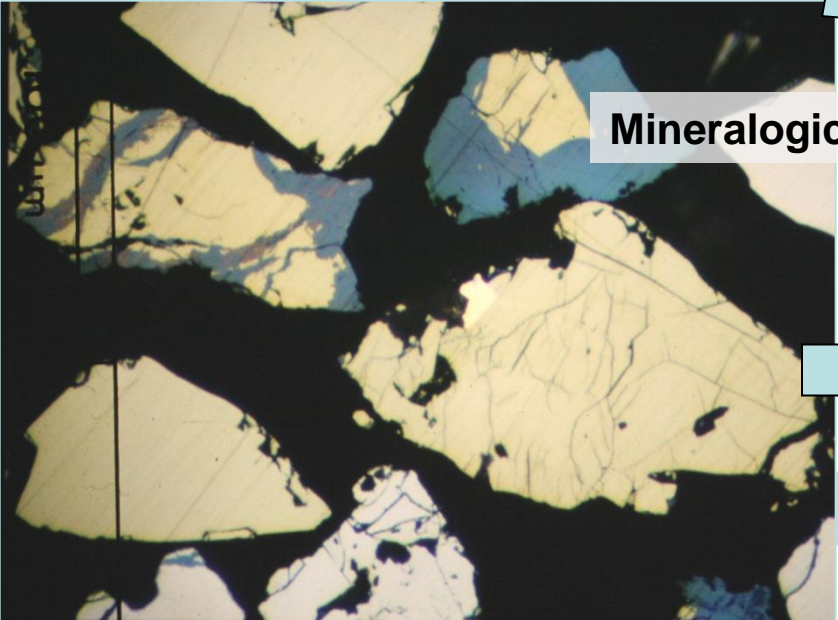
Drilling rig, Iceland



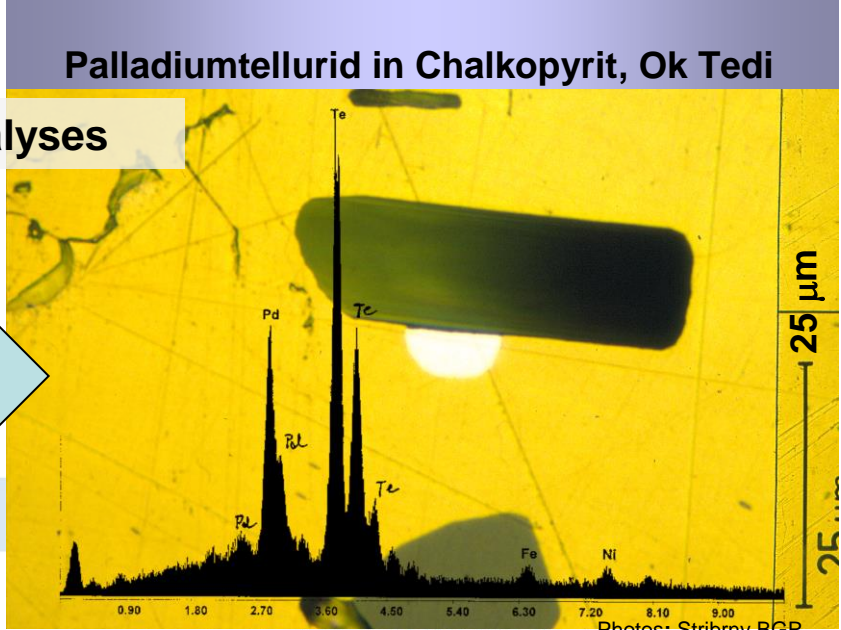
Drill core sampling



Mineralogical analyses



Palladiumtellurid in Chalkopyrit, Ok Tedi



Photos: Stribny BGR

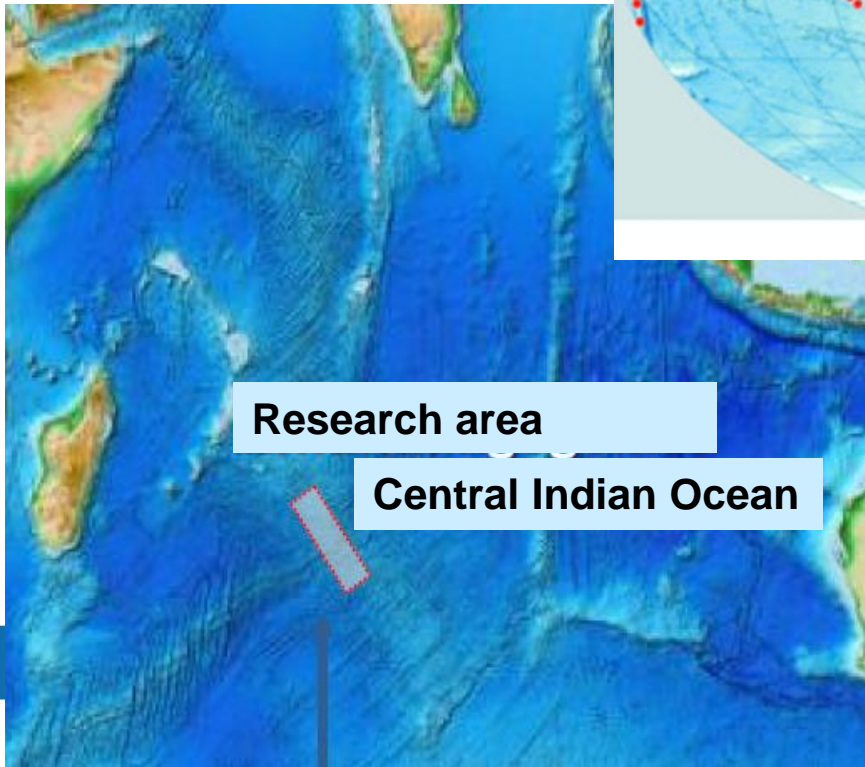
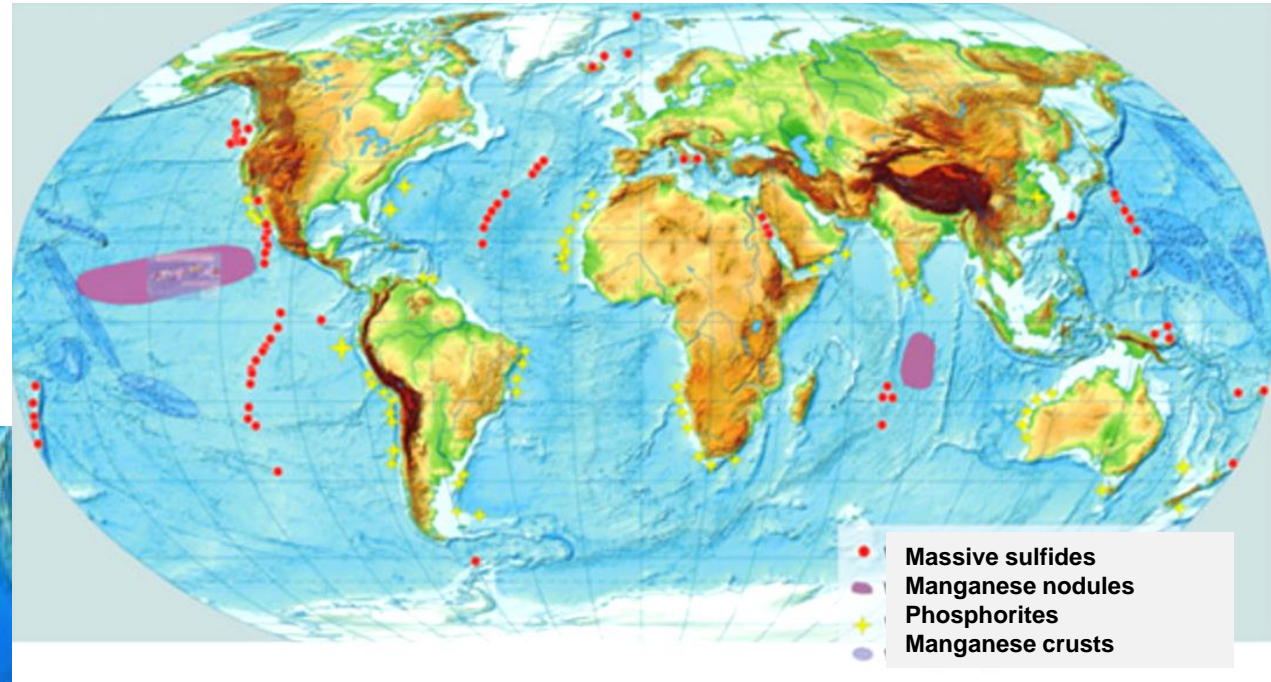


# Exploration of marine mineral resources

1. Geoscientific research on ore-forming processes
2. Development of exploration methods and technologies



Research vessel „Sonne“

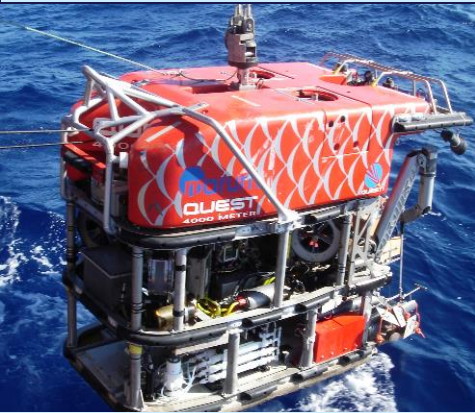


Polymetallic Sulfides Indian Ocean (INDEX 2013)

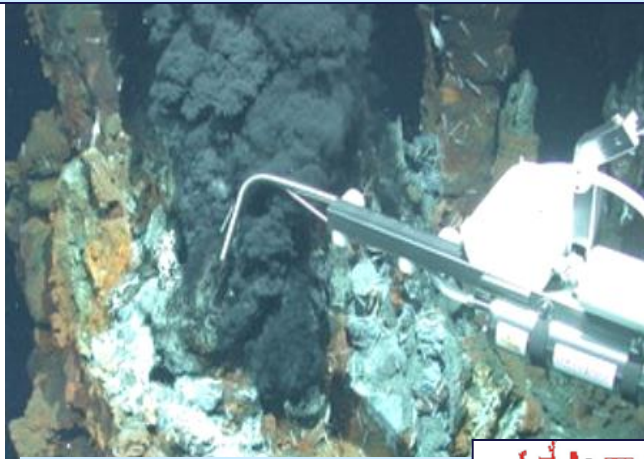




# Metallogenic Research: Polymetallic Sulfides Indian Ocean (INDEX 2013)



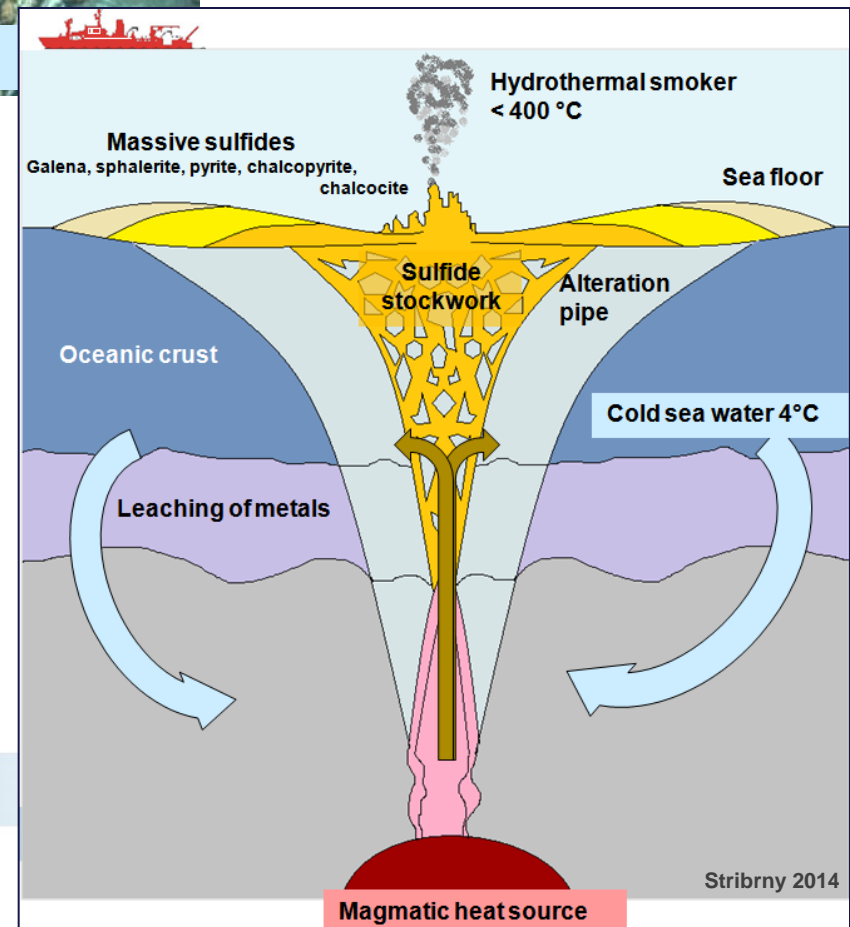
**ROV**  
Remote Ocean Floor Vehicle



**Black smoker 400 °C**



**Vertical section of a Black Smoker**







## Manganese nodules

- Chemical concretions in and upon the sediment
- Metal supply from the sea and pore water
- Growth rate 2 to 100 mm per million years



## Co-bearing Fe/Mn-crusts

- Layered chemical precipitation on top of volcanic seamounts
- Metal supply from sea water,
- Growth rates 1 to 7 mm per million years



# Metallogenic Research: Manganese nodules Pacific Ocean



Photo: Stribny BGR

Concentric layers of a manganese nodule, 4 500 m depth



Bundesanstalt für  
Geowissenschaften  
und Rohstoffe

GEOZENTRUM HANNOVER



# Resource curse or paradox of plenty

Phukam Cu/Au-mine, Laos Photo:Stribny

**Some regions with abundant mineral resources tend to have:**

- **less economic growth,**
  - **worse development outcomes**
  - **and higher environmental impacts**
- than those with fewer natural resources.**

**Reasons:**

- **economy focused on one sector,**
- **global commodity market swings**
- **ineffective, unstable or corrupt institutions and administrations**



# Environmental impacts of mining and smelting



**Petchenga, Nickel-sulfide deposit Kola peninsula, Russia** Photos: Stribny



# Environmental impacts of mining and processing

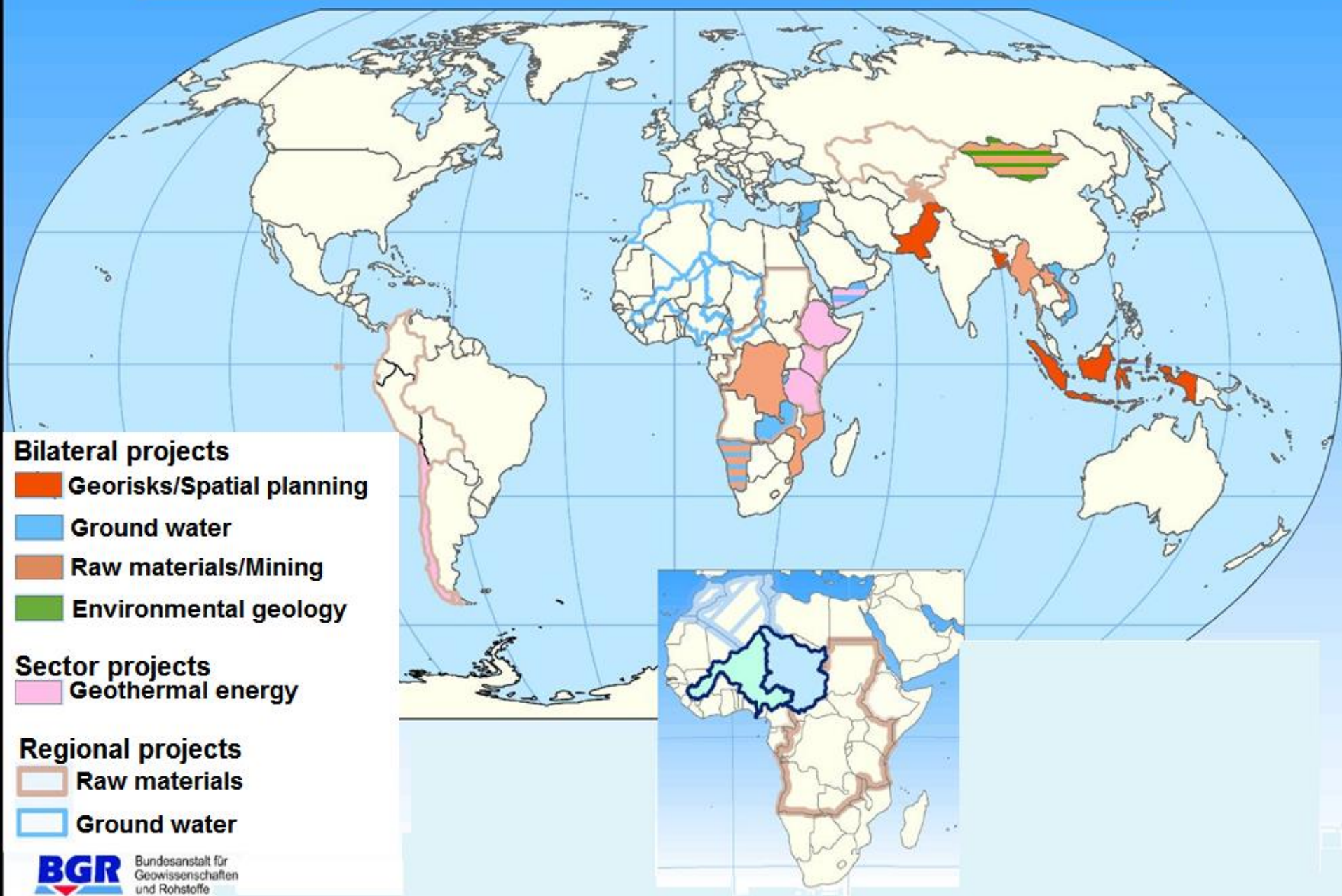


**Tailings pond**

**Mamut Copper Porphyry Deposit, Malaysia** Photos: Stribny



# BGR: Technical Cooperation Projects 2013/2014





# Mozambique

## Strengthening institutional capacities in the mining sector

- Information for technical planning and decision making
- Capacity building in government agencies responsible for the development and regulation of the mining sector
- Improving technical capacity with regard to environmental protection and mine closure, appropriate taxation
- Implementing of safety standards

Illegal gold mining Muhene, Province Manica



Artisanal miners of Munhena, in Manica Greenstone Belt



Bundesanstalt für  
Geowissenschaften  
und Rohstoffe

GEOZENTRUM HANNOVER

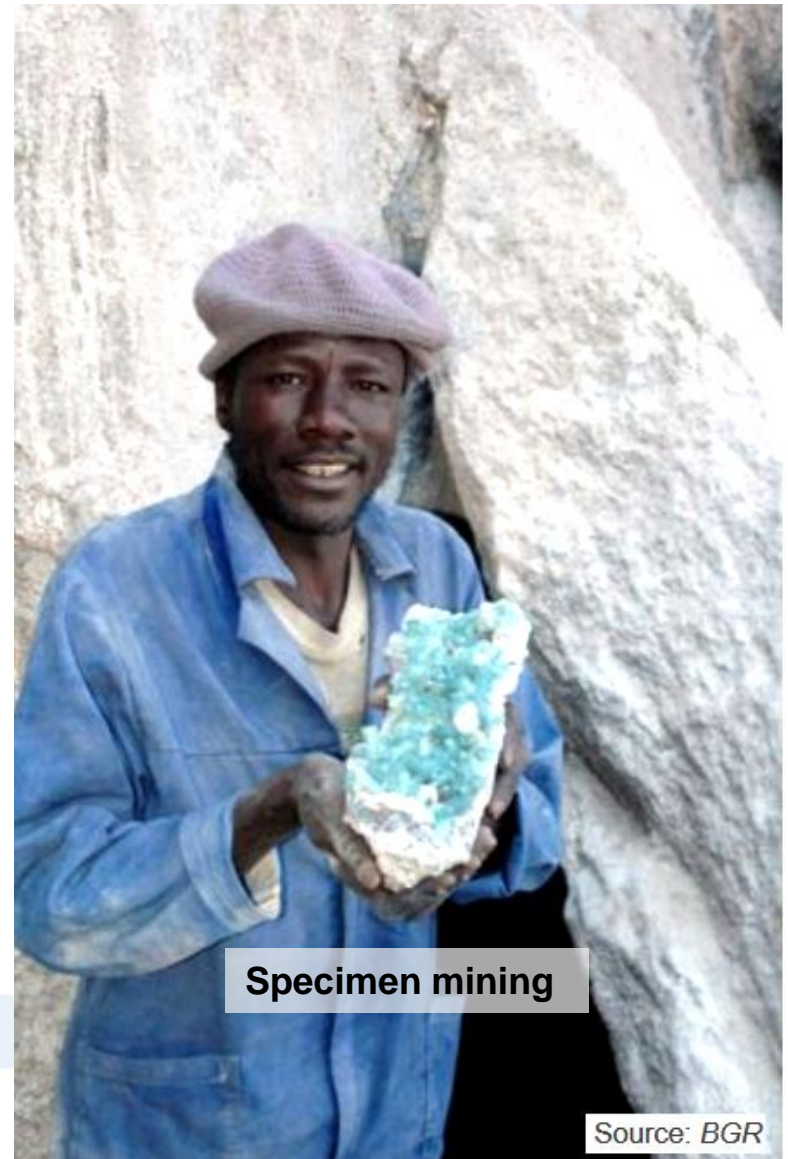
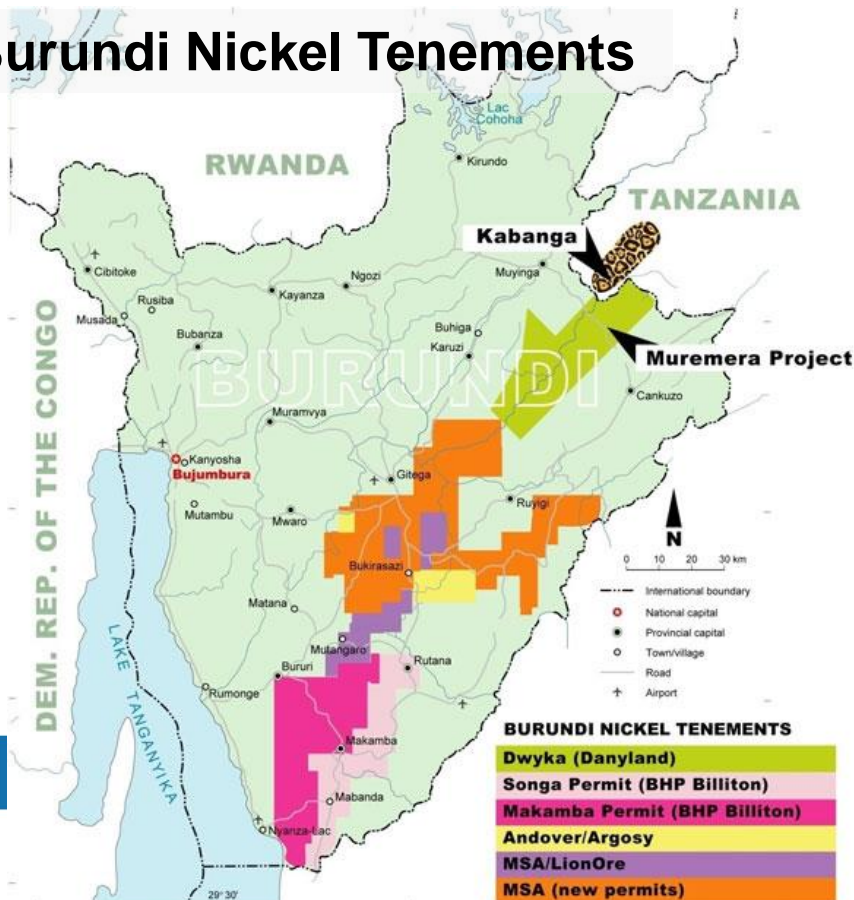


# Burundi

## Good Governance in the mining sector of Burundi (Phase I)

- improving the technical capacities in the Burundian Ministry of Energy and Mines
- establishing a mineral resources database, a digital mineral mining cadastre
- capacity building in the field of environmental aspects of the mining sector

### Burundi Nickel Tenements



Specimen mining

Source: BGR

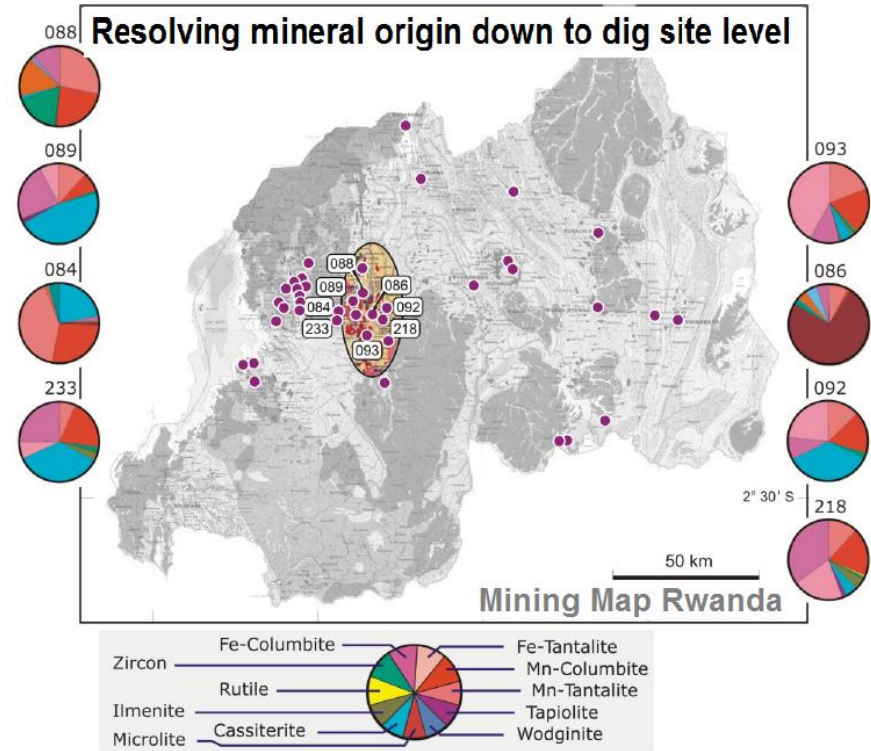


# Supraregional Africa

## Support for a Regional Certification Mechanism

### International Conference on the Great Lakes Region (ICGLR)

- Regional certifications system of the Int. Conference of the Great Lake Region
- National certification system for tin, tungsten, tantalum and gold
- Certified trading system for the origin and the ethical quality of minerals



The analytical fingerprint is an analytical method developed by BGR.

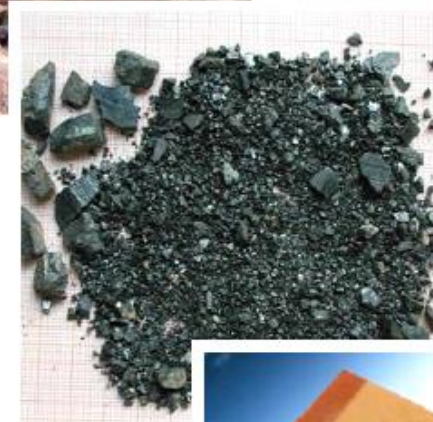
It verifies the origin of conflict minerals by laboratory data similar to "DNA" test in humans.



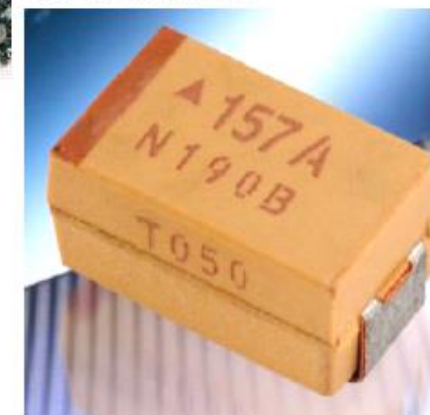
# DR Congo

## Development and Implementation of a Certification System for Mineral Raw Materials

- supporting the Congolese Mining Ministry to certificate tin-, tungsten-, tantalum-ores and gold.
- enabling the mining sector to register the volume of exploited and traded resources:
  - to confirm their provenance
  - to control the payment of taxes



1 cm



Miniaturization and raw material efficiency by 100nF tantalum-condensers



# BGR-CCOP Workshop „Management of Mining Activities in ASEAN Countries“



**Coordinating Committee for Geosciences Programmes in East and Southeast Asia (CCOP) 12 Mitglieder:**

**Kambodscha, China, Indonesien, Japan, Korea, Malaysia, Papua Neu Guinea, Philippinen, Singapur, Thailand, Vietnam, Timor Leste**



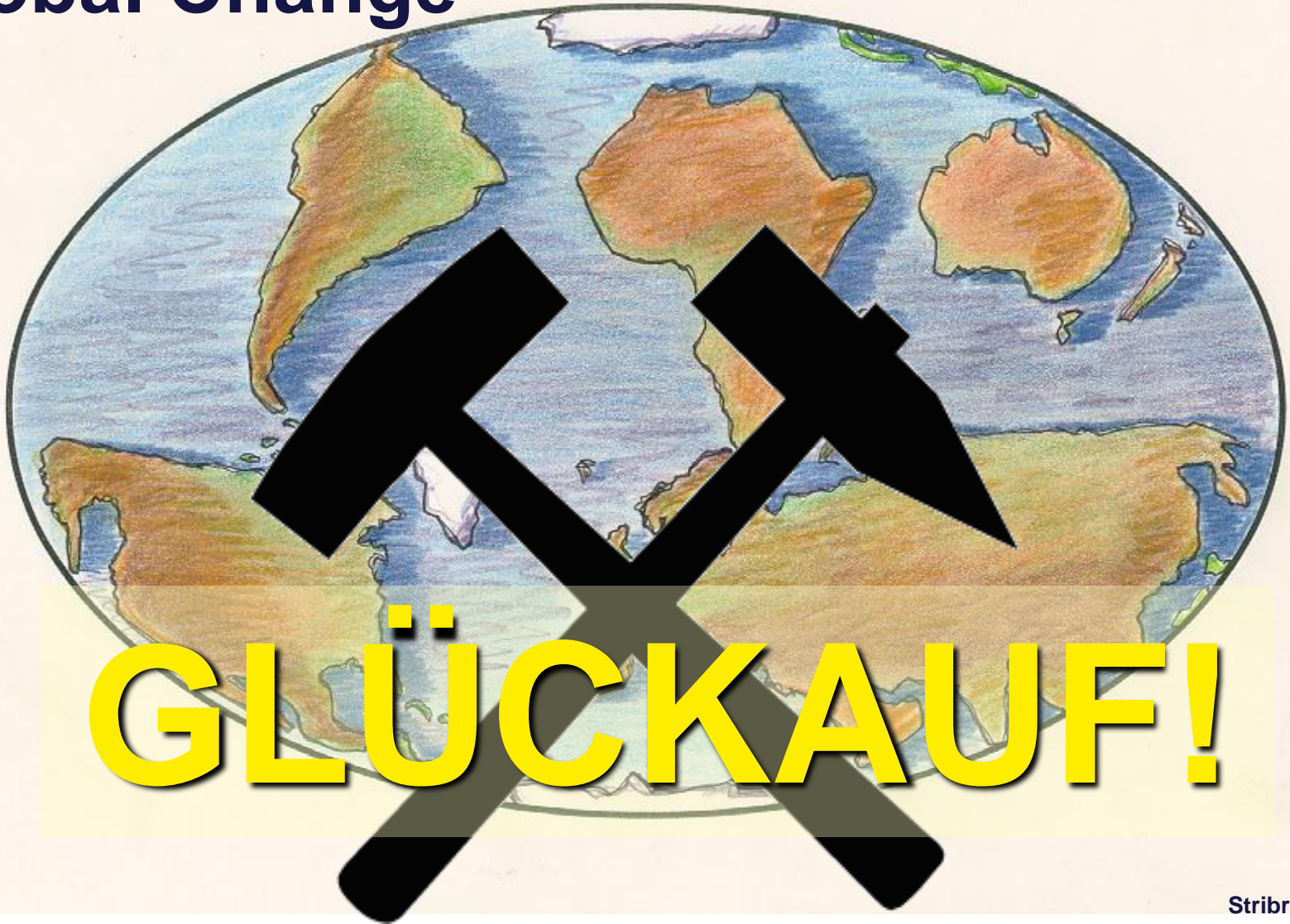
# Conclusion

- We all need natural and mineral resources – every day.
- Most of the mineral resources are not renewable.
- „Green“ or sustainable mining *sensu stricto* is not possible.
- But there are ways:
  - For a responsible use of natural resources,
  - for meeting common goals and creating shared values,
  - for increasing the recycling by „urban and waste mining“ and
  - for respecting nature and environment.





# „Global Change“



Stribny 1998