

WP-B Training 20 Nov. – 1 Dec. 2022



Lubango, Angola

## PanAfGeo

Pan-African Support  
to Geological Sciences and  
Technology Africa-EU Partnership

Appui panafricain aux géosciences  
du partenariat Afrique-UE

Apoio pan-africano às geociências  
da parceria África-UE

## PanAfGeo -2 WP-B Avaliação do Potencial em Recursos Minerais: Safeguarding of mineral deposits, data management, rules for determining prospective and prognostic areas

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Polish Geological Institute



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# Principles of determining prospective and prognostic areas of mineral deposits

## What is a deposit of mineral resources?

- The concept of a deposit of mineral resources is not a geological concept, but an economic one. The practical definition of a deposit: it is such an accumulation of useful mineral components that can be economically exploited in a place and time.

In Poland, there is a division of undiscovered, undocumented resources into **alleged, prospective and prognostic**, formulated in the *Principles of Documenting Solid Mineral Deposits (Principles, 2002)*.

The division introduced in the *Principles (2002)* is not of a normative nature, but is a set of methodological guidelines on how to proceed, in accordance with the principles of geological knowledge and ethics, in the process of forecasting mineral deposits.



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# Principles of determining prospective and prognostic areas of mineral deposits

**Elleged deposits**, predicted on the basis of direct and indirect evidence of their occurrence without specifying the location of a possible deposit. On the basis of analogies with the explored areas, mineral resources possible to be discovered are estimated.

**Prospective deposits and resources**, predicted on the basis of localized evidence of a deposit, unambiguous interpretation of geophysical or geochemical anomalies, isolated points of finding a mineral or its weathering products, and geological, petrographic or mineralogical indicators of its proximity. Probable deposit boundaries and resources are estimated on the basis of general geological data, interpretation of geophysical surveys, and by analogy.

**Deposits and prognostic resources**, estimated on the basis of a few rare excavations or natural exposures as well as geophysical data allowing to determine approximately the possible area of the deposit and the type and quality of the mineral. Probable deposit boundaries are determined by interpolation or extrapolation. The probable resource estimation error can be over 40%.



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## The role of the state in the identification and documentation of mineral deposits in Poland

- Until the political and economic changes in 1989, the Polish Geological Institute, acting as the state geological survey, conducted research into the geological structure of the country, supervised all geophysical works and research, and documented deposits of strategic deposits of mineral resources: metals, chemical raw materials and energy resources. Detailed documentation of the deposits was carried out by state-owned geological enterprises;
- After 1989, the state resigned from documenting mineral deposits and adopted the principle that an investor who wants to exploit a deposit must document the deposit;



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## The role of the state in the identification and documentation of mineral deposits in Poland

- **If a private entrepreneur wants to exploit a deposit that has been previously documented by the state (during the period of the so-called centrally planned economy), the entrepreneur is obliged to purchase geological information;**
- **Access to geological information is free of charge: anyone with an ID card can come to the Central Geological Archives and get acquainted with the geological documentation of the deposit. If someone decides to start a business and wants to exploit a documented deposit - he must buy geological information - he must pay for documenting the deposit.**



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## **Who issues concessions for exploration and exploitation of mineral resources in Poland?**

- **Exploration and extraction of basic mineral deposits (metallic, energy, chemical, amber, carbonate minerals for the cement industry) is licensed by the Minister of Climate and Environment;**
- **Exploration and extraction of deposits of the so-called of common minerals (including sands and gravels, clay raw materials for construction ceramics) is licensed by the Marshal of the Voivodeship or the Poviast Starost (deposits with an area of up to 2 ha).**



## **The current role of the Polish Geological Institute as the state geological survey:**

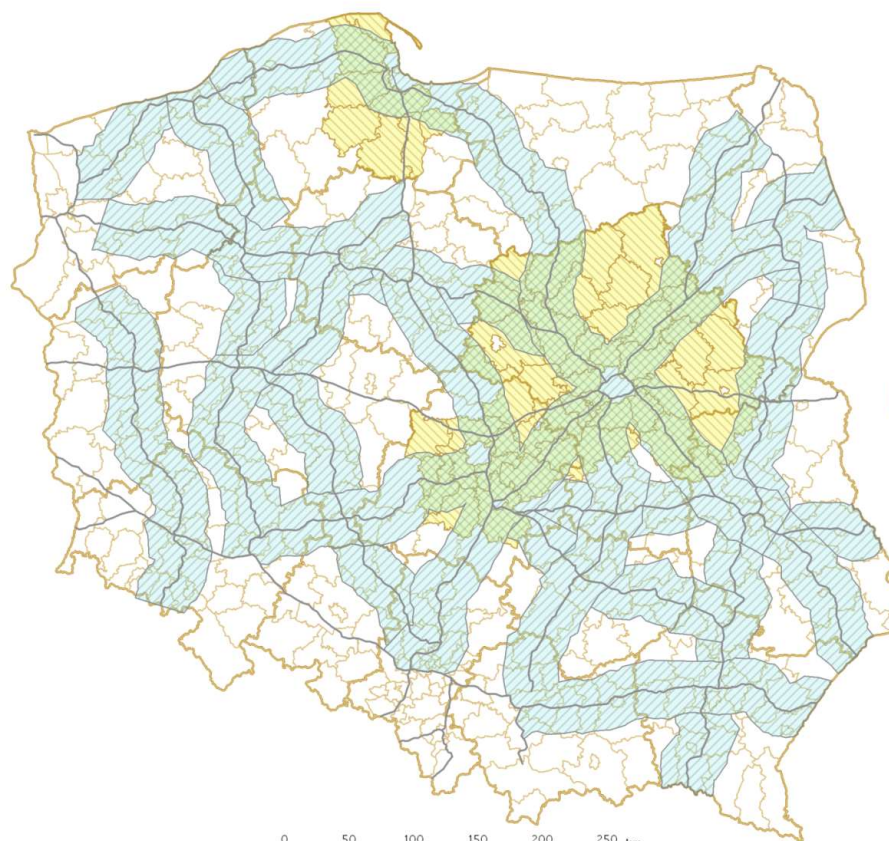
- **Initiating research aimed at recognizing the geological structure of Poland, including continuous exploration of the raw material potential;**
- **Development of various geological maps at various scales;**
- **Management of the Central Geological Archive;**
- **Annual preparation of the Balance of Mineral Deposit Resources in Poland;**
- **Periodic preparation of the Balance of Poland's prospective mineral resources;**
- **Maintaining the register of mining areas;**
- **Collecting, processing and sharing geological information;**
- **Geological education;**
- **Initiating activities in the field of protection of geological heritage objects;**
- **etc.**



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# Determination of prognostic areas for the occurrence of **natural aggregate** along the planned sections of **motorways and expressways** as well as around the **largest agglomerations**

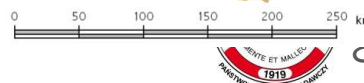
Zweryfikowane obszary prognostyczne kruszywa piaskowo - żwirowego



Obszary badań dla udokumentowania zweryfikowanych obszarów prognostycznych kruszywa piaskowo-żwirowego:

-  korytarze wzdłuż wybranych odcinków autostrad (A1, A4) oraz dróg ekspresowych (S3, S5, S7, S10, S11, S12, S17, S19, S61, S74), badania wykonane w latach 2008-2015
-  powiaty wokół aglomeracji miejskich, badania wykonane w latach 2008-2012
-  autostrady, drogi ekspresowe i inne drogi krajowe (odcinki eksploatowane, w budowie oraz planowane)

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## Results of research:

### along linear investments:

In 2008-2015: 415 AREAS = 40,369.76 ha were studied;  
92.5% of the areas met the requirements of the prognostic  
areas for the presence of natural aggregate;

**Documented mineral resources: 6.7 BILLION TONS**

### around urban agglomerations:

In 2008 – 2011: 207 AREAS = 14,232.17 ha were studied;  
94.5% of the areas met the requirements of prognostic  
areas for the presence of natural aggregate;

**Documented mineral resources: 2.3 BILLION TONS**

**In total, 9 BILLION TONS of sand and gravel aggregates have been documented under one project**



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# Principles of the Polish Geological Survey (PSG) project "Monitoring of openpit mining of minerals" dedicated mainly to the monitoring of the exploitation of raw materials without the required license

**1. Main goals:** to collect coherent and consistent information for the entire country about:

- scale of unlicensed exploitation,
- irregularities in the exploitation of licensed deposits;

**2. Subject of work:**

- Inventory of the places of exploitation in the last 5 years without a license, both outside the boundaries of the deposits and within the boundaries of the deposits,
- verification of the actual state of deposit development against the one reported to the MIDAS,
- database the state of reclamation on deposits where exploitation has been abandoned,
- waste deposited in mining and post-mining excavations



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## Principles of the Polish Geological Survey (PSG) project "Monitoring of openpit mining of minerals" dedicated mainly to the monitoring of the exploitation of raw materials without the required license

### 3. The sites of mineral extraction that met the following criteria were subject to registration:

- the period of extraction up to 5 years back: visible fresh signs of exploitation (as exploited), and others up to 5 years old according to satellitic images. – as abandoned),
- the excavation area is larger than 1 are (100 m<sup>2</sup>) or the length of the wall in the slope exposure is at least 10 m,
- Deposits, including abandoned and balanced

### 4. Taking into account the excavations being the subject of the work of the District Mining Offices (DMO) and the mining notifications received on the so-called own needs (2015-2020)



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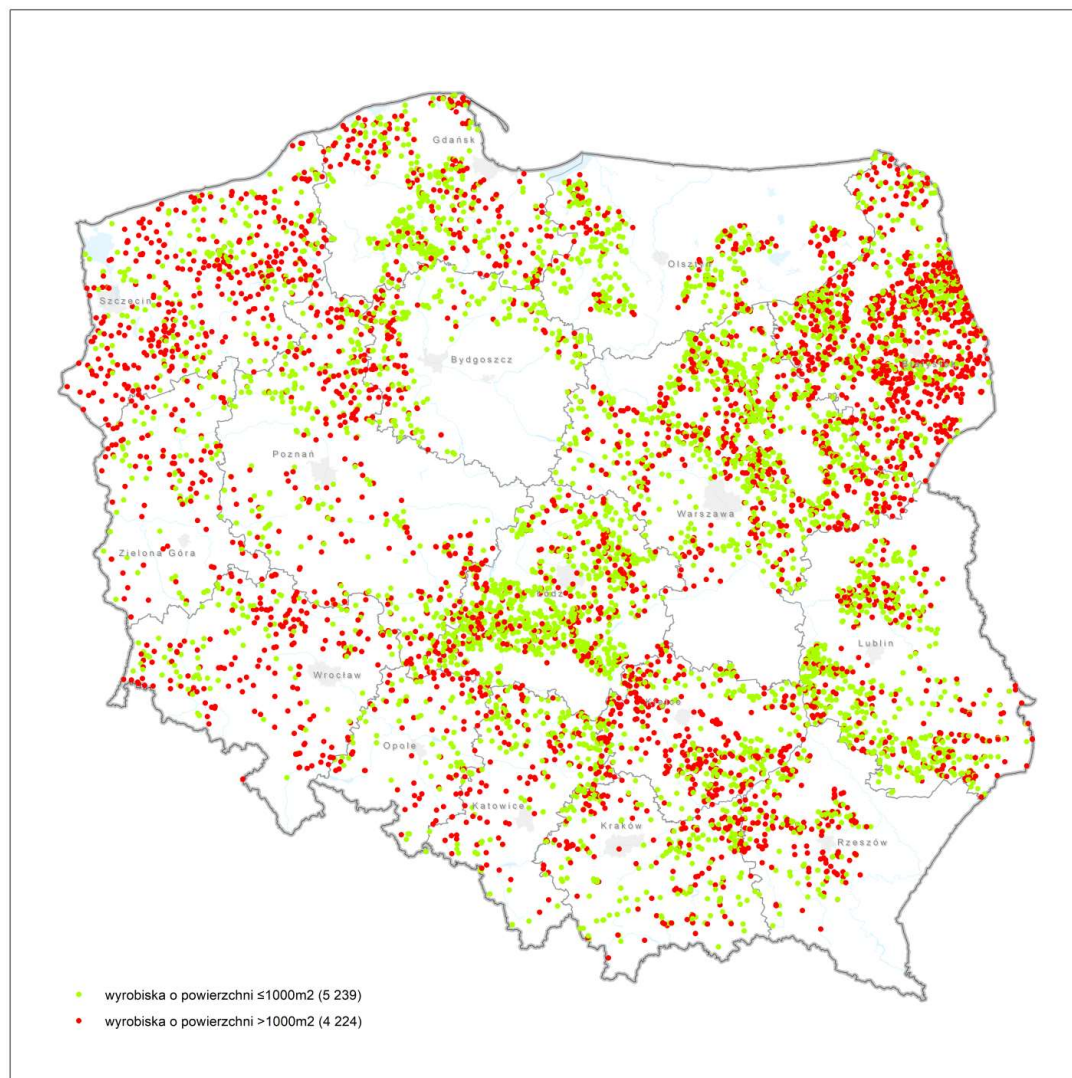
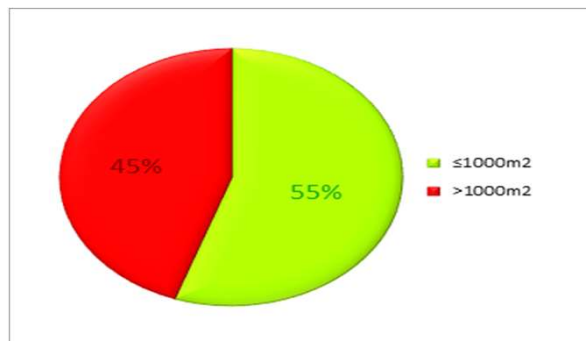
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# The results of the inventory of illegal exploitation sites, especially sands and gravels

Number of registered illegal excavations:

2009-2015: **3684**

2019-2021: **9463**



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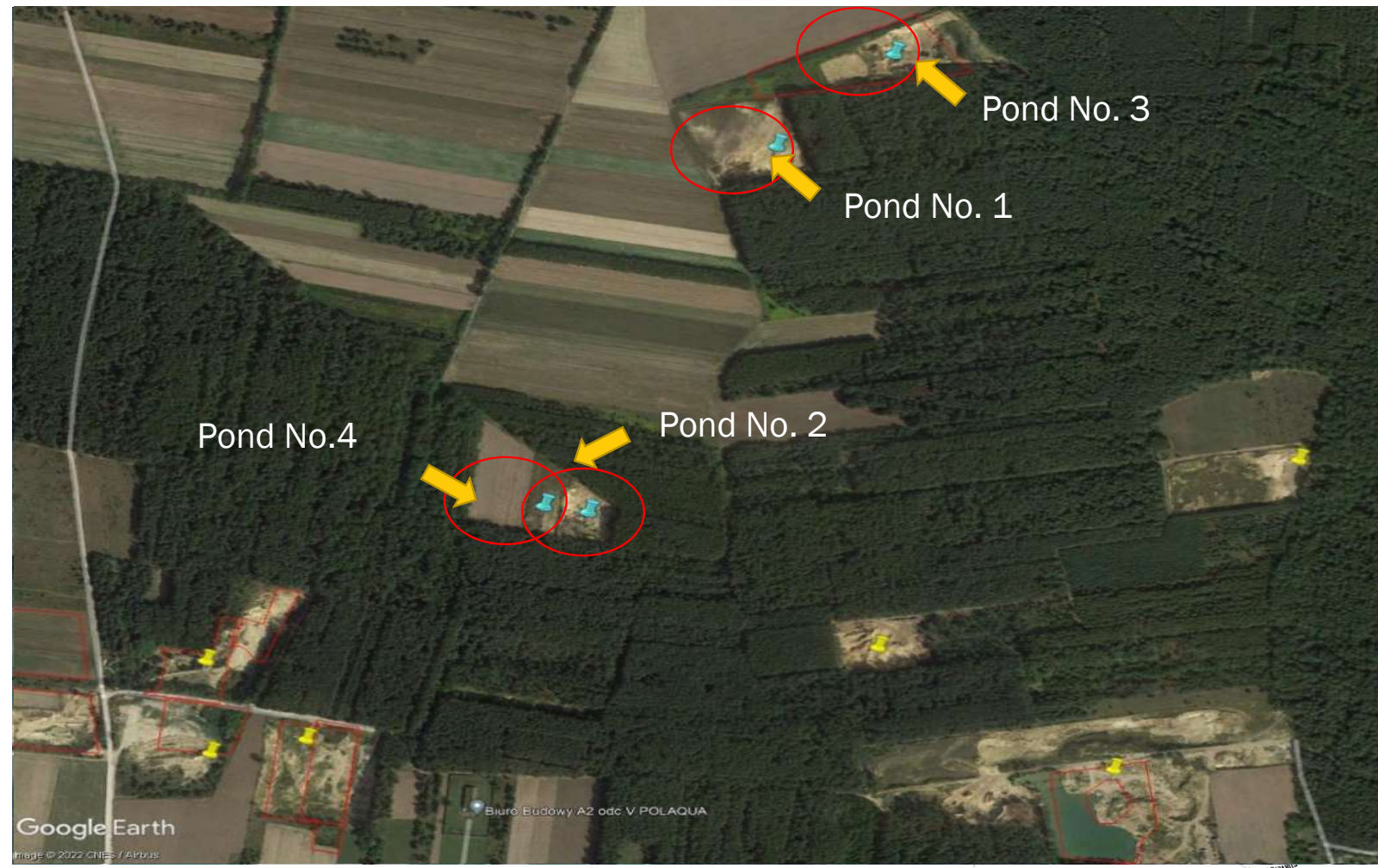


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# Illegal extraction of natural sands and gravels of other investments: **Water investments - construction of breeding fish ponds**

**Situation in 2018-2019**



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Pond No. 1



Pond No. 2

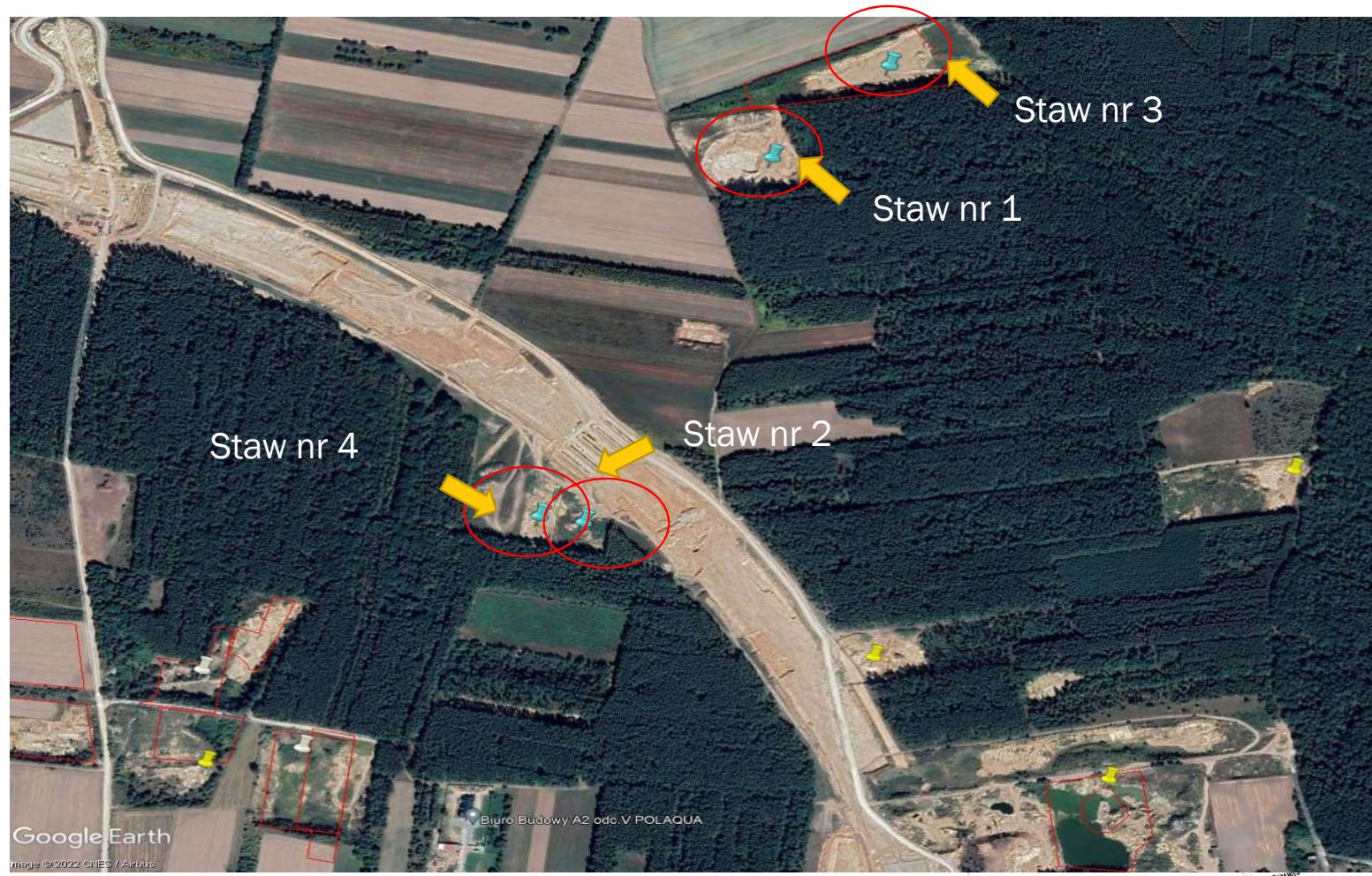


Pond No. 3

**According to the information obtained in the field, "the water table at a depth of 1 m from the ground surface" - the excavation is 10 meters deep and there is no water....**

## The reason for building "breeding fish ponds"

2021:  
**Construction of a ring road for a nearby large city**



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The Geological Surveys of Europe



## Illegal extraction of natural sands and gravels of other investments: **CONSTRUCTION GARAGE**



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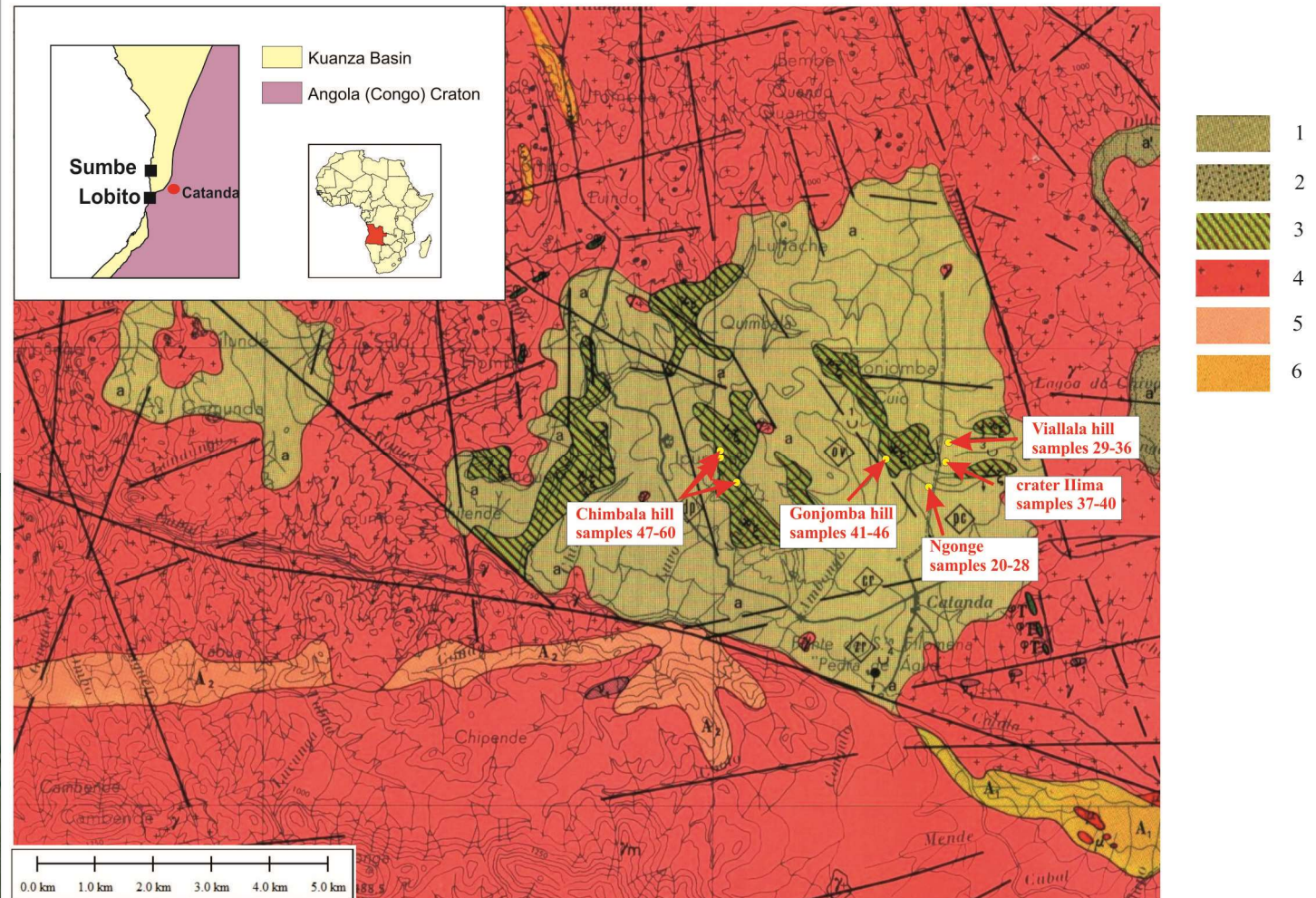
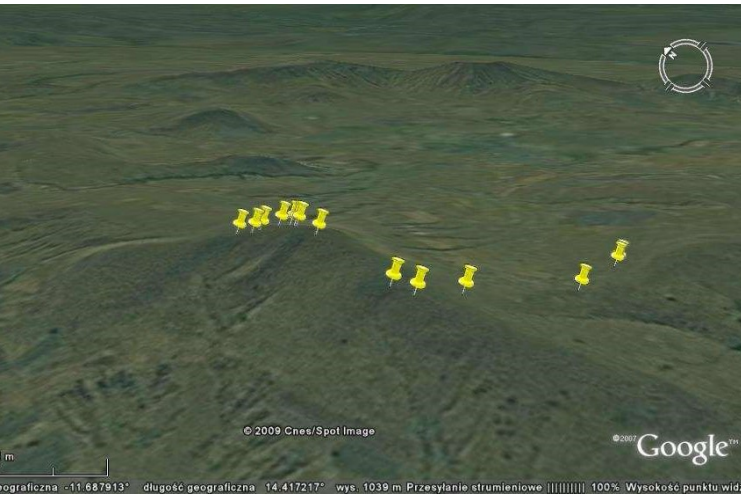
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## Angola: a few examples of potential areas of prognostic occurrence of mineral deposits

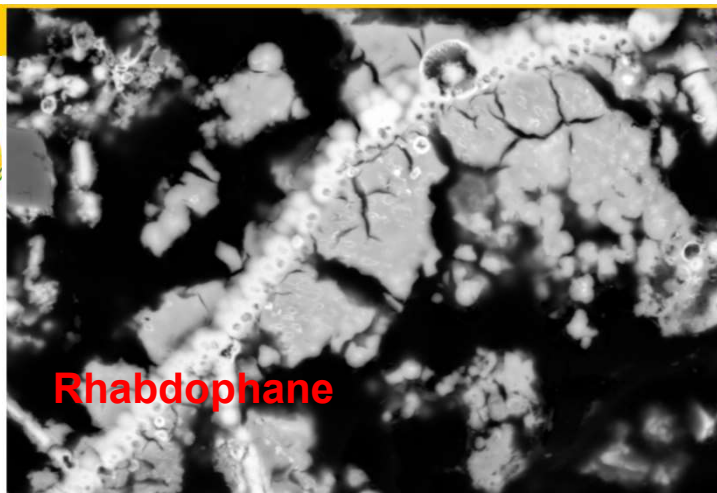
**Recognizing the raw material potential requires extensive knowledge, cleverness, but a bit of luck can also come in handy...**







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**Rhabdophane**

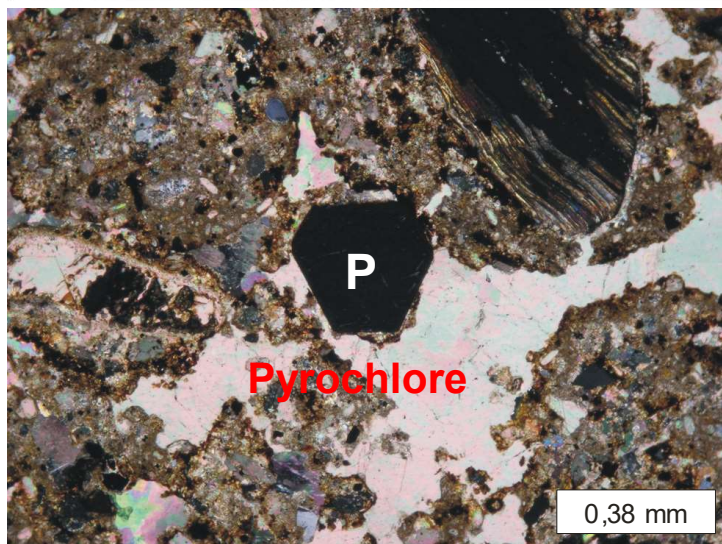
10 µm

Katanda pr.7

EHT = 20.00 kV  
Signal A = BSD

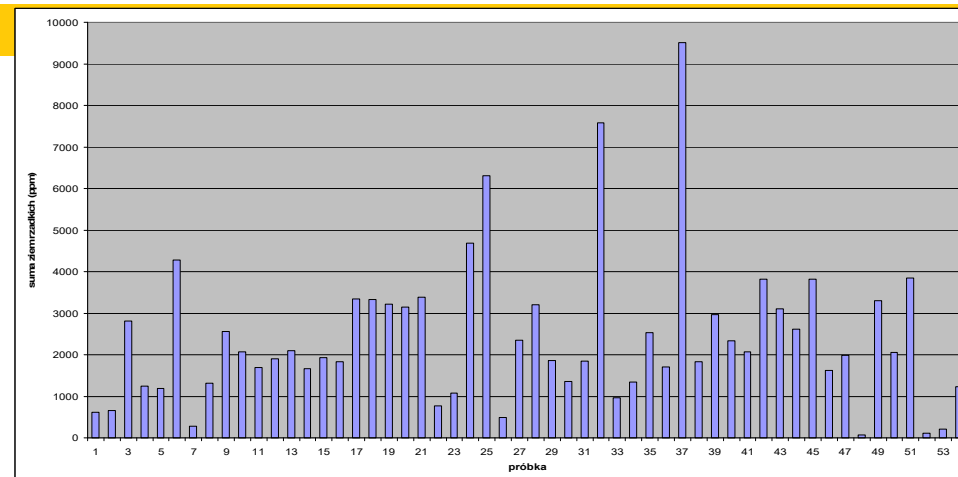
WD = 21 mm  
Mag = 3.71 K X

Date :2 Jul 2010  
Leszek Giro

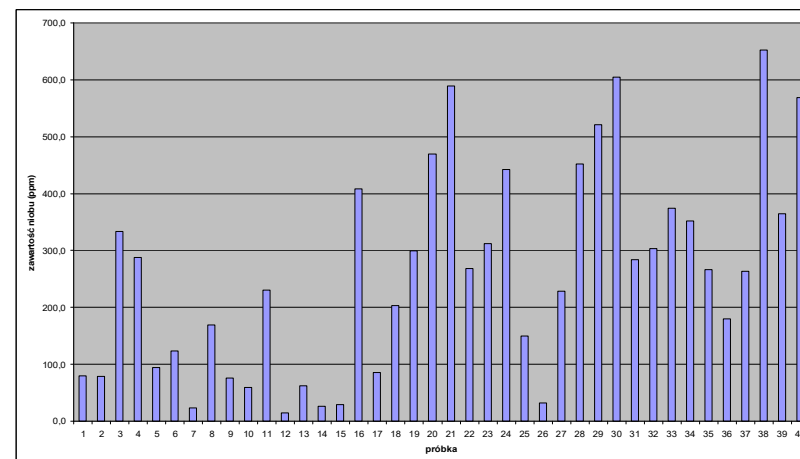


**Pyrochlore**

0,38 mm



Variation of the REE sum content in samples collected in the area of the carbonatite outcrop in the Katanda massif.



Variation of niobium content in samples collected in the area of the carbonatite outcrop in the Katanda massif.



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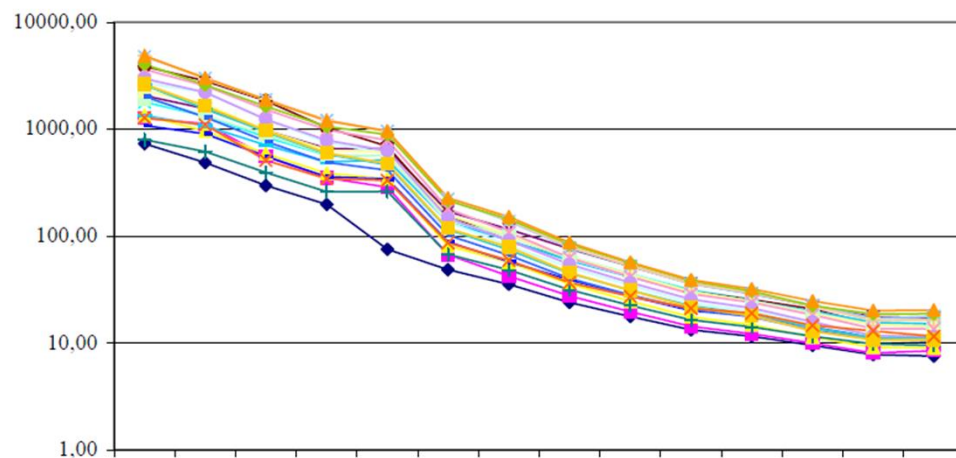
## Statistic parameters of REE content in lavas and tuffs in samples from Catanda carbonatitic massif

	lavas (n=22)					Tuffs (n=18)				
	Mean	Geom. mean	Median	Min	Max	Mean	Geom. mean	Median	Min	Max
Sc	12,1	11,8	11,8	8,1	17,9	11,8	11,1	10,4	6,3	23,0
Y	38,6	36,9	38,9	21,0	54,6	45,0	42,8	45,4	23,1	75,1
La	590,7	509,9	514,2	173,2	1152,6	865,6	724,5	627,9	344,5	2455,9
Ce	1061,6	945,2	953,1	299,4	1849,0	1683,4	1415,2	1229,9	699,5	4837,3
Pr	97,5	85,9	89,1	27,6	176,4	157,8	130,9	104,4	62,9	516,0
Nd	307,0	272,8	270,9	90,5	557,9	472,7	402,0	328,5	193,8	1526,9
Eu	7,8	7,2	7,8	2,7	12,8	9,8	9,2	9,7	5,0	19,2
Sm	32,0	29,3	31,9	11,2	54,2	42,9	39,4	38,5	20,8	104,1
Gd	17,9	16,6	18,0	7,1	30,2	21,0	20,1	21,2	11,5	33,9
Tb	1,98	1,87	2,05	0,87	3,14	2,341	2,244	2,429	1,311	3,73
Dy	9,26	8,78	9,63	4,37	14,02	10,73	10,28	11,14	6,09	17,66
Ho	1,45	1,38	1,49	0,73	2,14	1,62	1,56	1,59	0,95	2,73
Er	3,53	3,39	3,63	1,85	5,16	3,96	3,81	4,01	2,31	6,50
Tm	0,42	0,40	0,42	0,24	0,61	0,49	0,47	0,49	0,29	0,78
Yb	2,16	2,09	2,14	1,25	3,25	2,24	2,07	2,24	0,61	4,00
Lu	0,33	0,32	0,32	0,19	0,50	0,37	0,35	0,35	0,22	0,62
REE	2184,2	1944,1	2015,3	658,7	3911,0	3331,5	2835,4	2383,6	1389,1	9564,4
LREE	2096,5	1854,4	1916,9	604,5	3784,6	3232,1	2727,6	2310,8	1326,5	9459,4
HREE	75,6	71,9	77,1	37,6	113,6	87,7	84,0	90,6	49,9	143,5

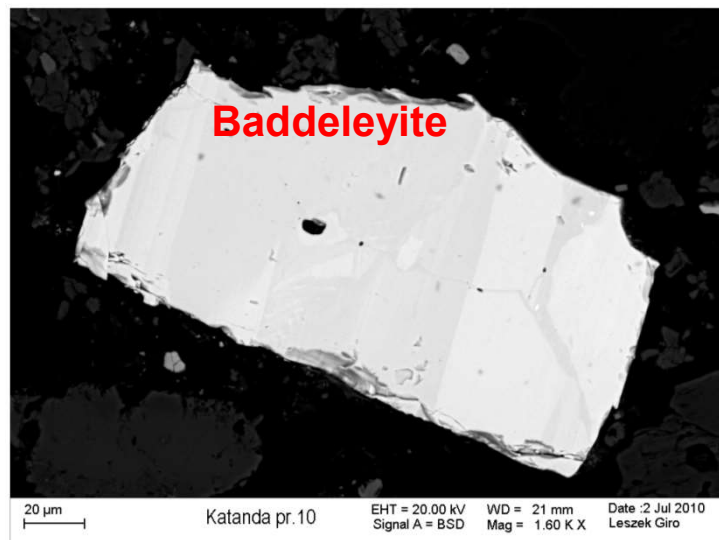
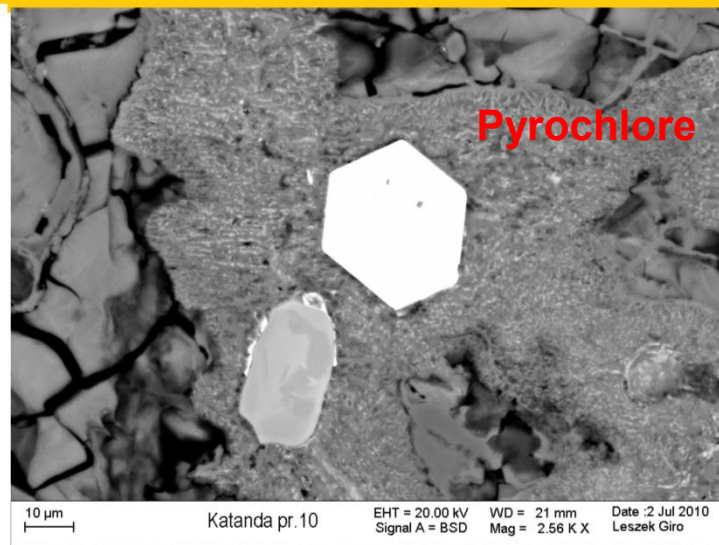
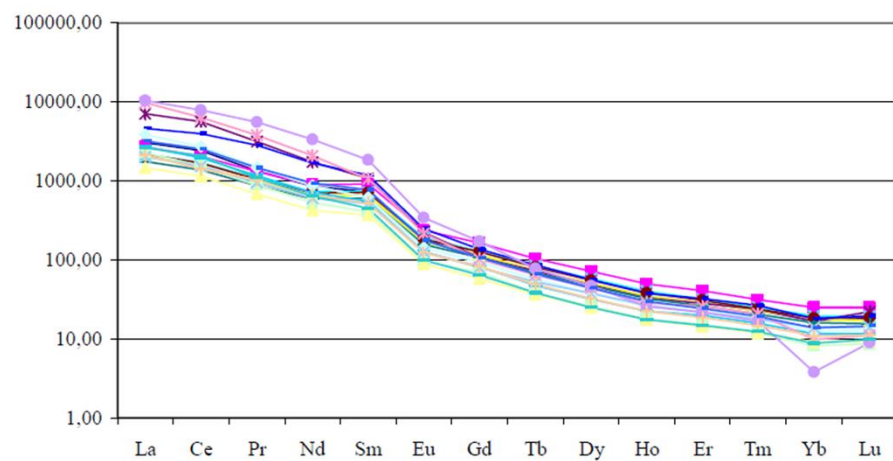


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## Lavas



## Tuffs



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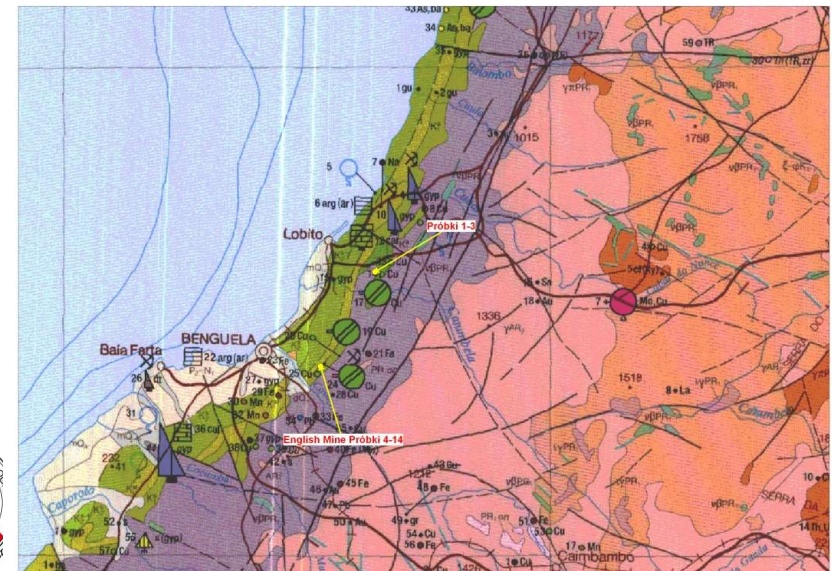
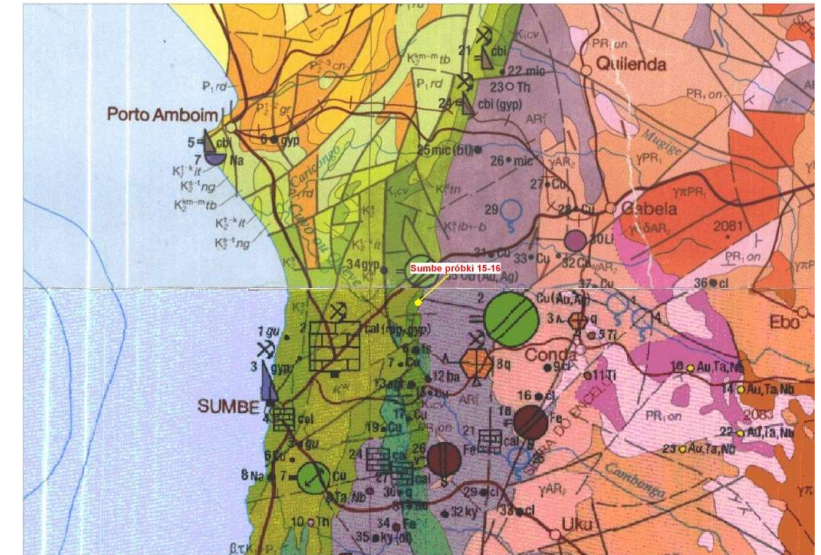
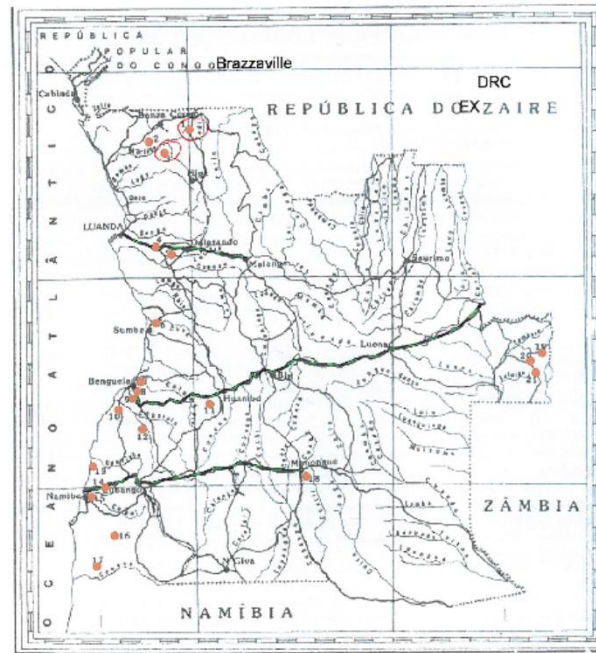


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# Copper potential

- Coastal Basin (Lower Cretaceous);
- Hydrothermal occurrences in the region of Mavoyo (Teletu) – Permian;
- Lifilian Arc area - continuation of the Copperbelt resource series (Zambia)

## COPPER OCCURRENCES IN ANGOLA



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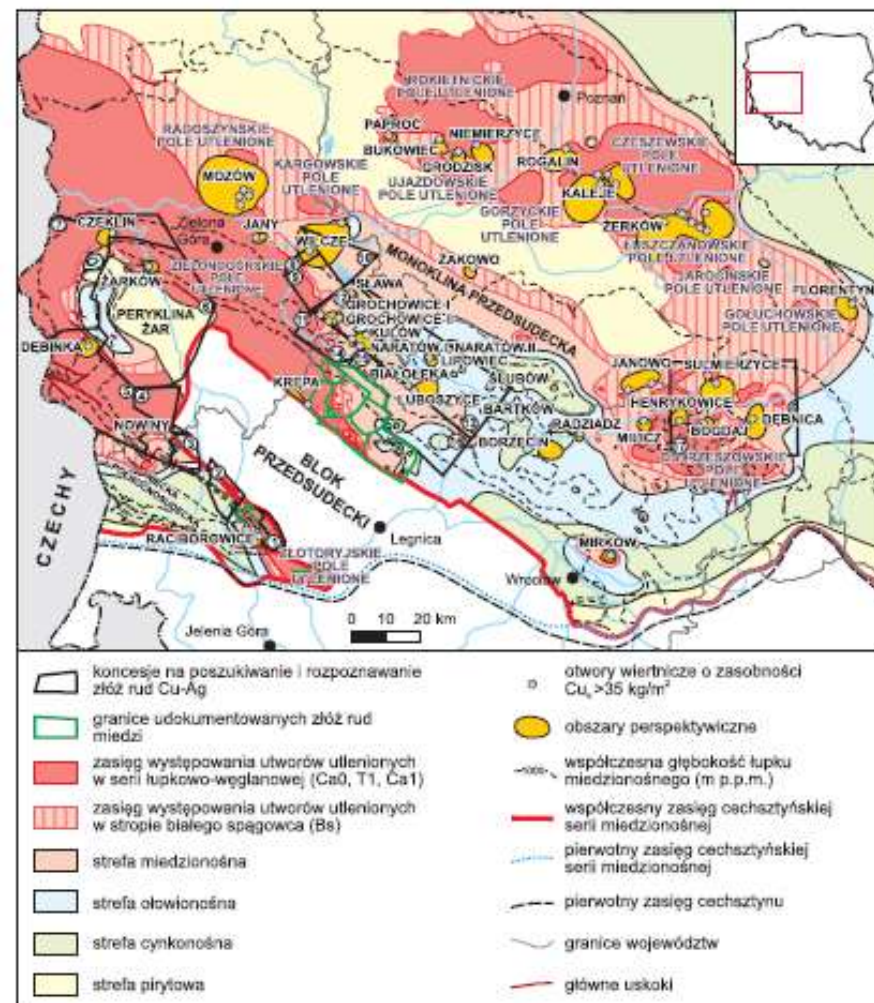
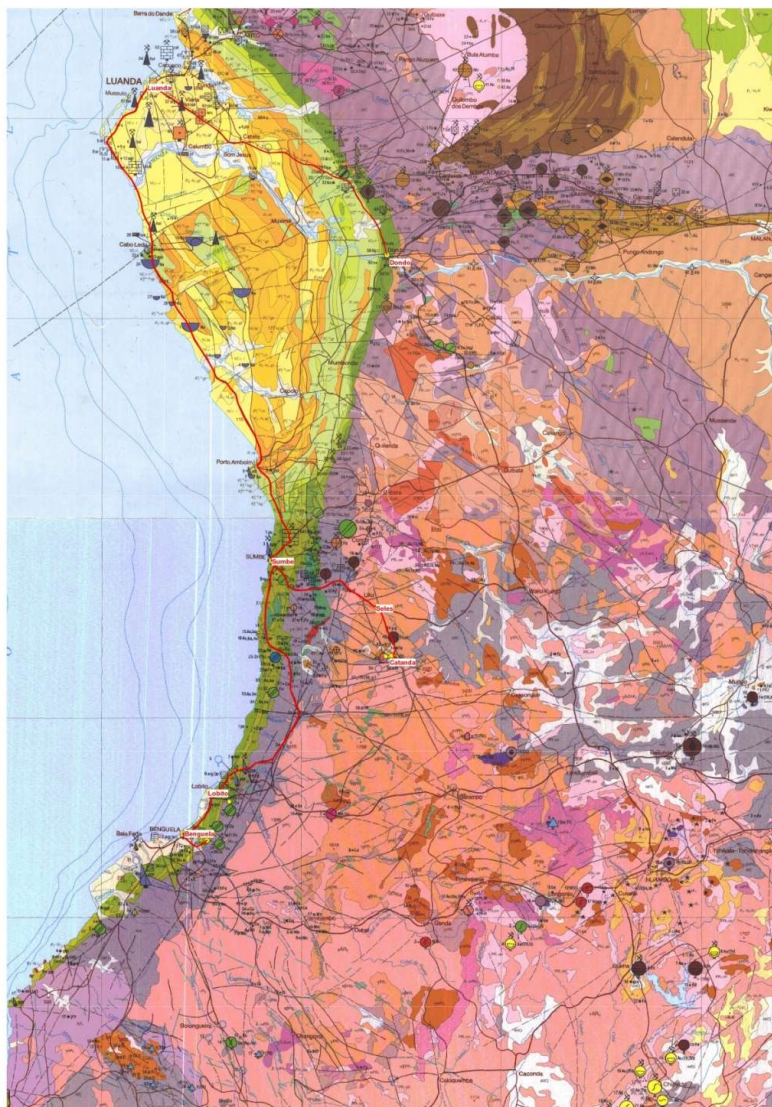


Fig. 8.1. Obszary perspektywiczne na tle rozmieszczenia utworów utlenionych i strefowości metalicznej w utworach cechsztyńskiej serii miedzionośnej SW Polski (wg Oszczepalskiego i in., 2016b, zmiany wg stanu na 31.12.2018 r.)



Co-1  
Cofi  
Co-1



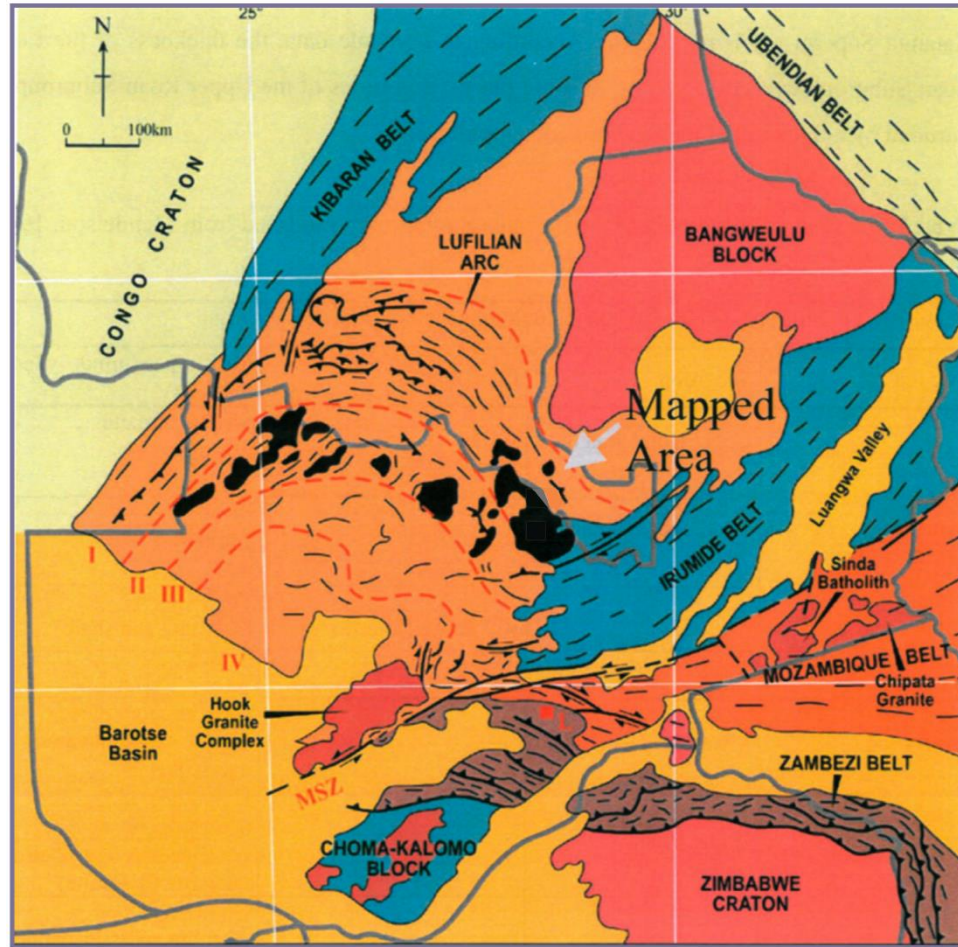
Geological Institute of the Polish Academy of Sciences





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# Eastern Angola



		Environment of deposition	Lithology		Ore minerals
Continental	Marine	Supratidal	Argillite Dolomite	Hangingwall formation	Minor pyrite Chalcocopyrite and bornite Specularite
		Sabkha	Argillite quartzite Gypsum		Minor Bornite and Chalcocopyrite
		Interidal Flats	Carbonaceous quartzites Grey Quartzites	*A* Orebody	Chalcocite Bornite and minor Chalcocopyrite Cuprite Native Malachite
		Continental	Pink quartzite Arkose Grit	Inter A/B	Minor Chalcocite and Native Copper
		Supratidal	Banded shale - Quartzites		
	Transgression	Sabkha	Dark Shales Shale Dolomite Dolomite Gypsum	*B* Orebody	Minor Bornite and Chalcocite
		Intertidal	Grey Quartzite Carbonaceous quartzites Bioherm		Bornite Minor chalcocite and Chalcocopyrite Malachite
		Flats	Pink Quartzite Arkose	Inter B/C	Bornite Chalcocopyrite Pyrite
		Supratidal	Banded shale & Quartzite		
		Sabkha	Shale - Dolomite Dolomitic Siltstones	*C* Orebody	Chalcocopyrite Bornite Minor Chalcocite and Pyrite
Regression	Footwall formation	Intertidal flats	Carbonate Grey Quartzite CaSO <sub>4</sub>		
		Continental	Dunes Aqueous Quartzite Arkose Basement Complex Granite		Chalcocopyrite Chrysocolla Malachite



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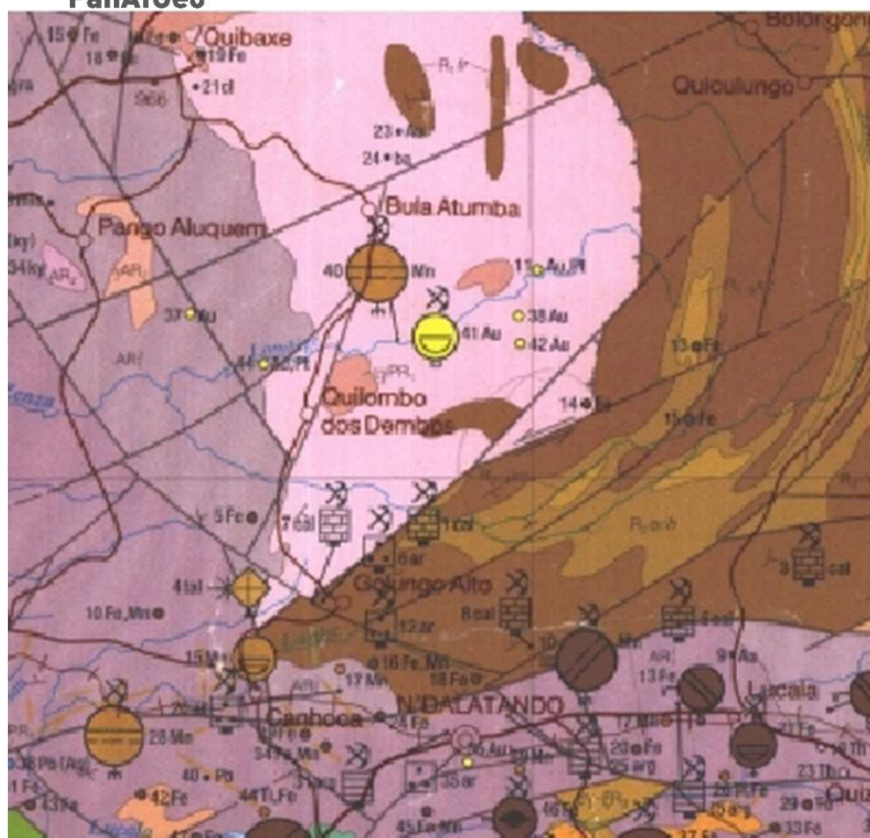
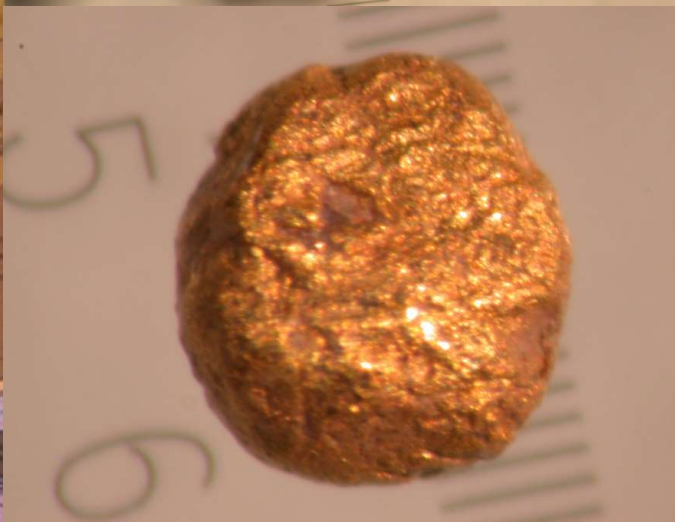
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# GOLD!!!



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## View of the Catanda carbonatite massif



Muito obrigado pela atenção



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