Cobalt mineralization in the Stara Kamienica Range, SW Poland

The presentation was prepared by mgr inż. Paulina Skirak under the supervision prof. dr hab. inż. Adam Piestrzyński

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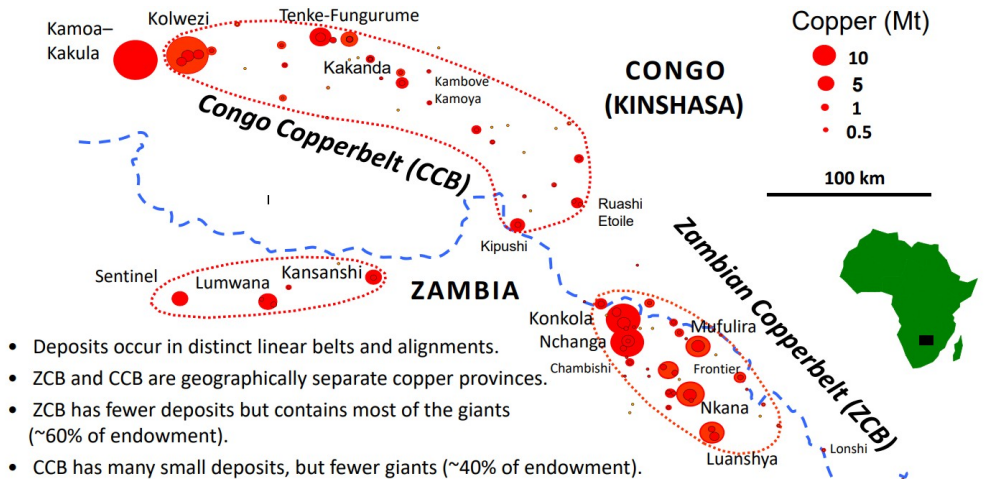
Introduction



- Deposits occur in distinct linear belts and alignments.
- ZCB and CCB are geographically separate copper provinces.
- ZCB has fewer deposits but contains most of the giants (~60% of endowment).
- CCB has many small deposits, but fewer giants (~40% of endowment).

Fig.1: Location of sediment-hosted deposit Copperbelt in Africa

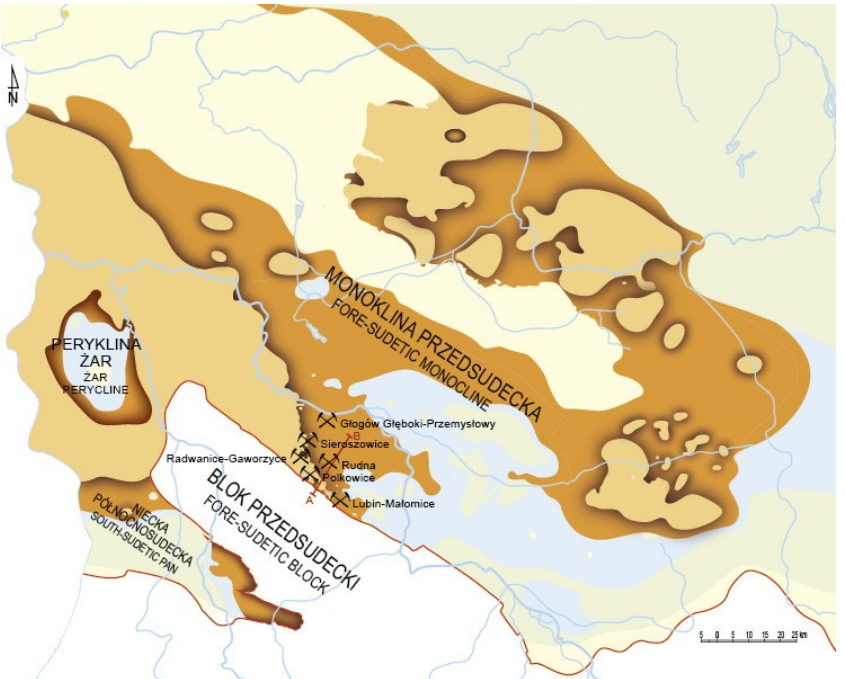
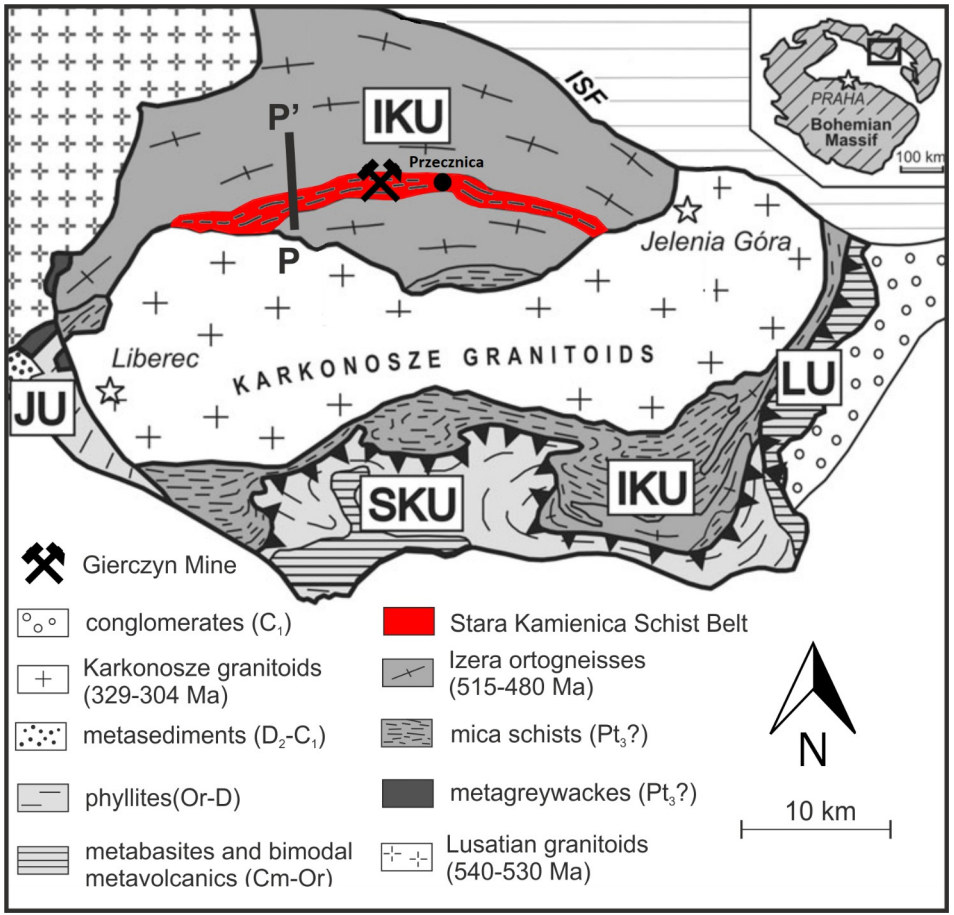


Fig. 2: Location of sediment-hosted deposit in Poland

Location and geology

The Kamienica Range is geographically located in south-western Poland in the Western Sudety Mountains, on the border of the Izerskie Plateau and the Izera Mountains.



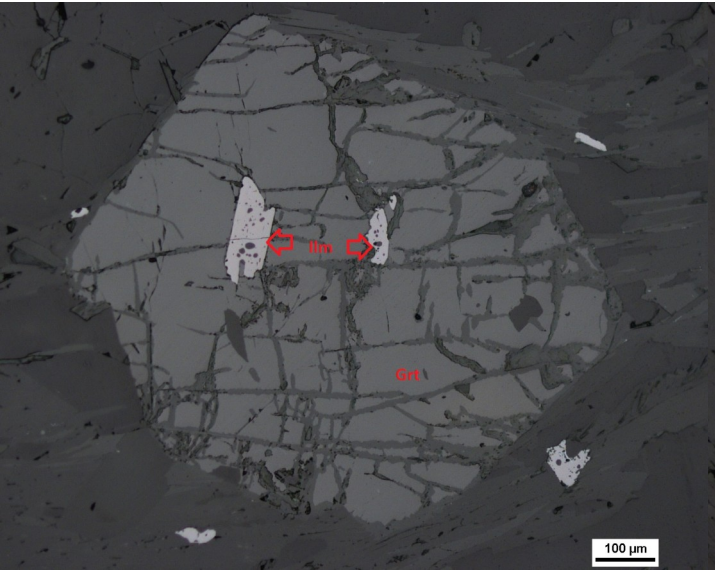
Unique Sn & Co mineralization:

-tin occur most commonly in greisen-type pneumatolitic formations.
-cobaltites occur mostly in alkaline rocks in hydrothermal type formations

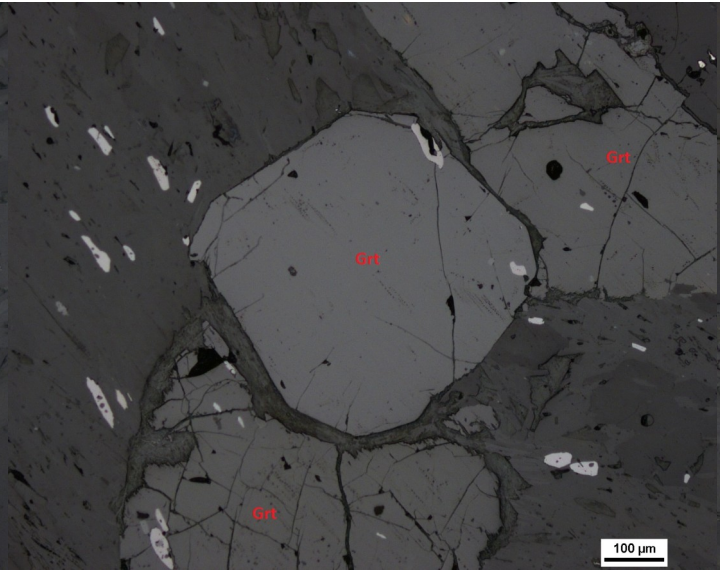
Characteristics of the study area

Samples were collected from the heap at the Anna Maria collapse adit. The heap is completely covered with trees and vegatation. Single dumps of rock from which samples were taken are visible.

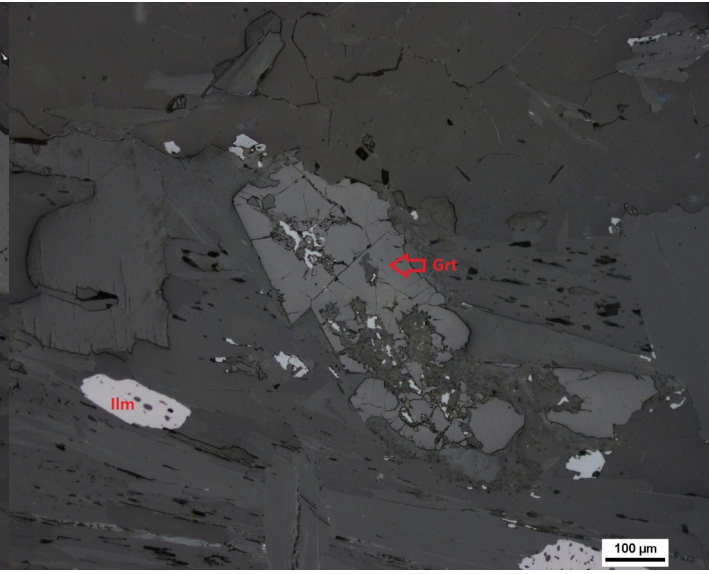
Characteristics of garnets



Ilmenite inclusion in the first generation of garnet (RL)

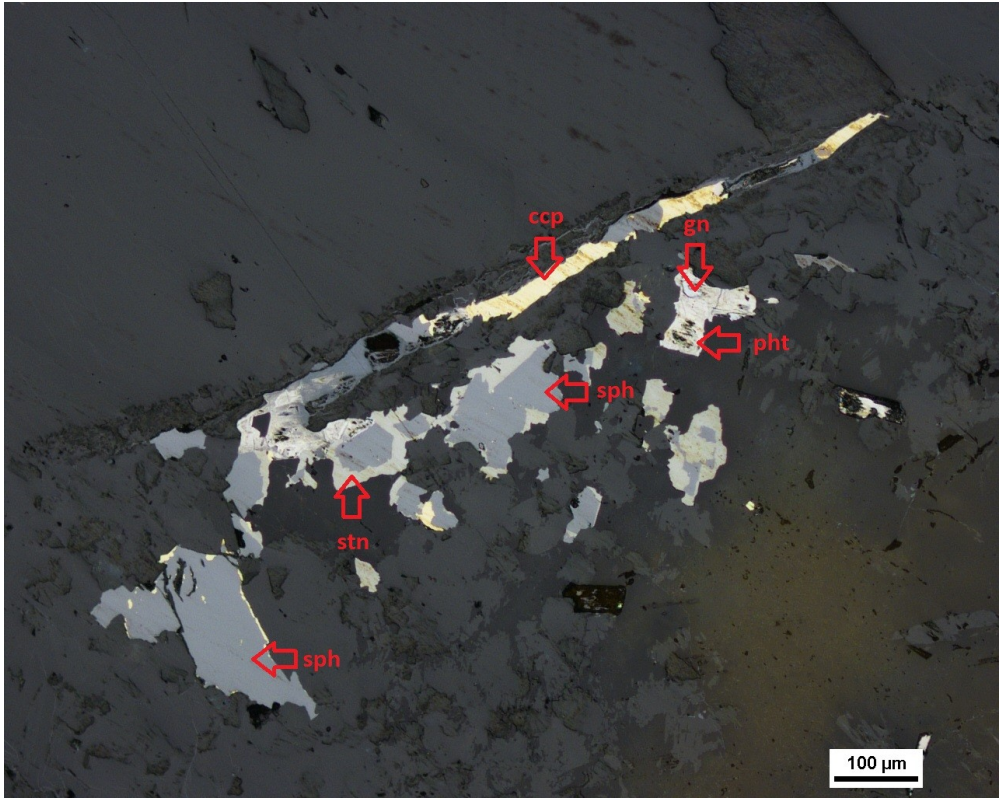


Idiomorfic crystal of second genaration garnet (RL)



Third (hydrothermal) generation garnet (RL)

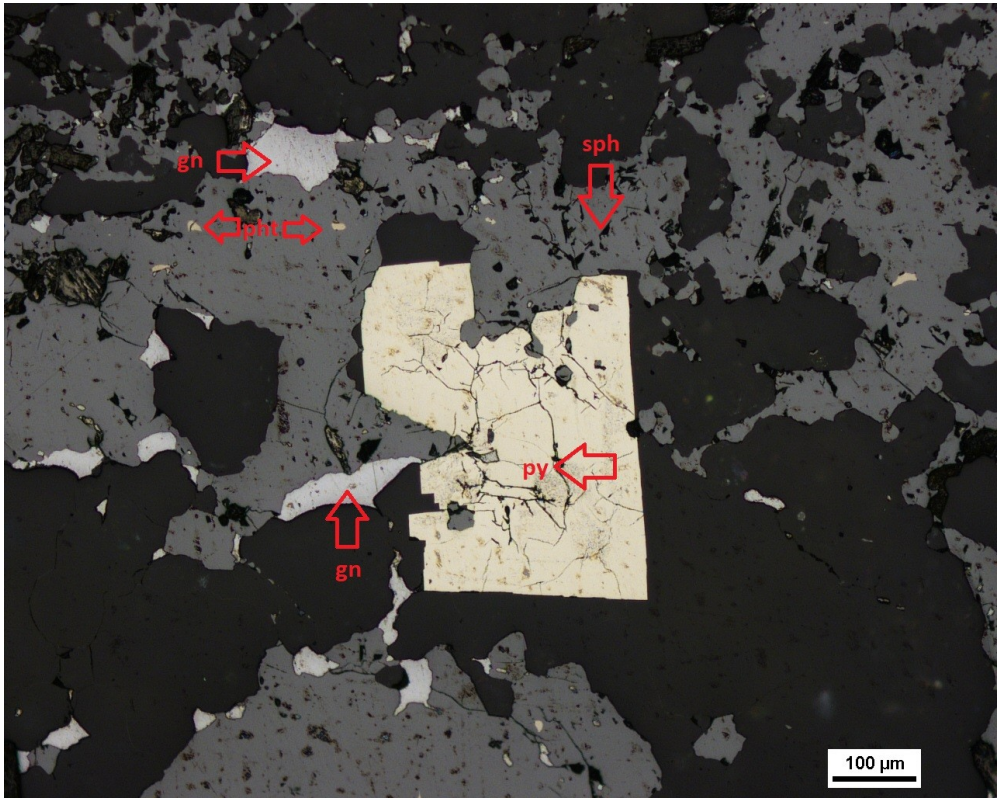
Sulphide mineralization



The main minerals: chalcopyrite, spharerite, stannite, pyrrhotite, galena

Vein-impregnation mineralization, according to schist foliage

The arrangement and interrelationship of the minerals indicates a similar time of formation, during the same process - **mineral paragenesis**

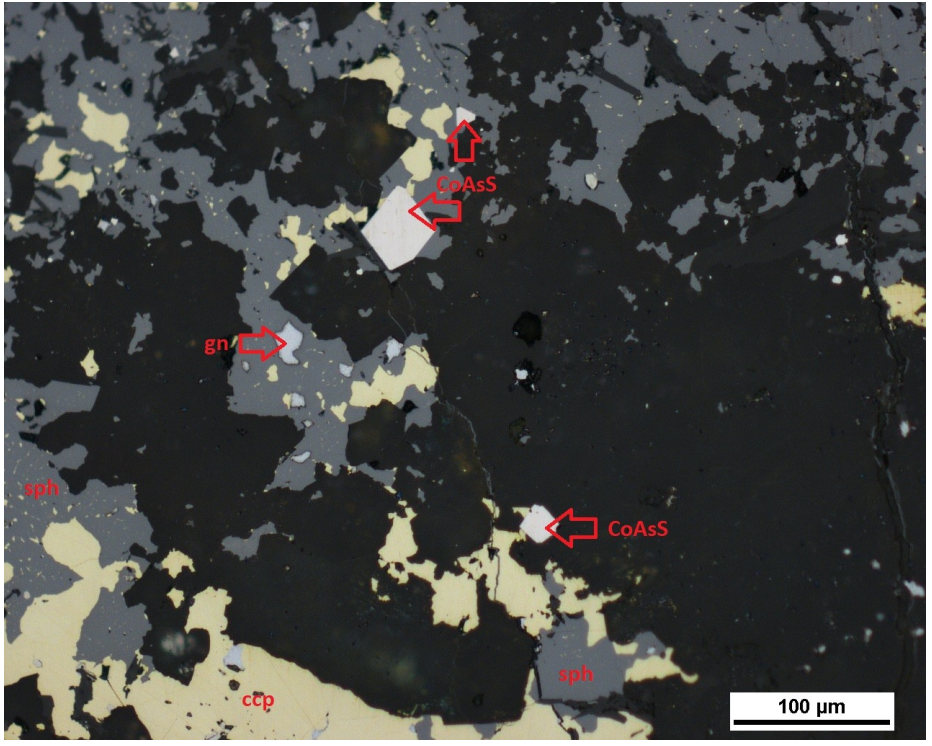


Idmiomorphic pyrite crystal on a background composed of xenomorphic sphalerite crystals with pyrrhotite inclusion and galena.

The proper formation of the pyrite crystal suggests that it formed prior to the sphalerite-galena mineral association, which crystallized in voids to form xenomorphic assemblages

Cobalt-bearing minerals

Cobaltite

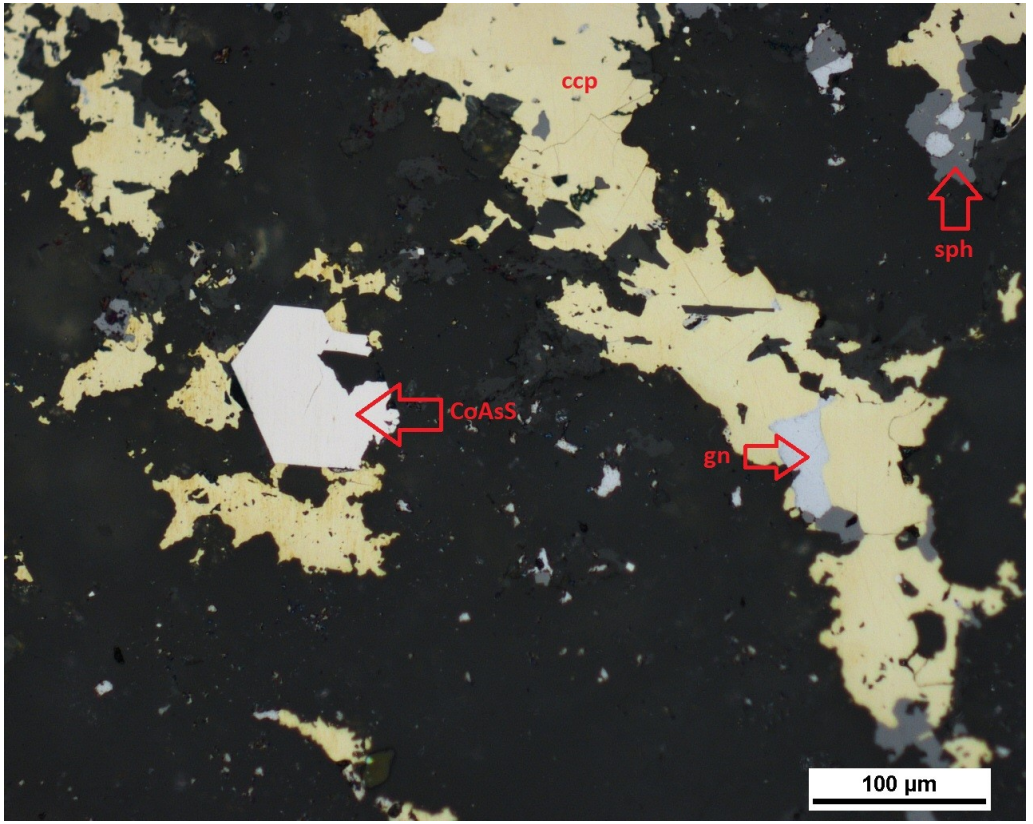


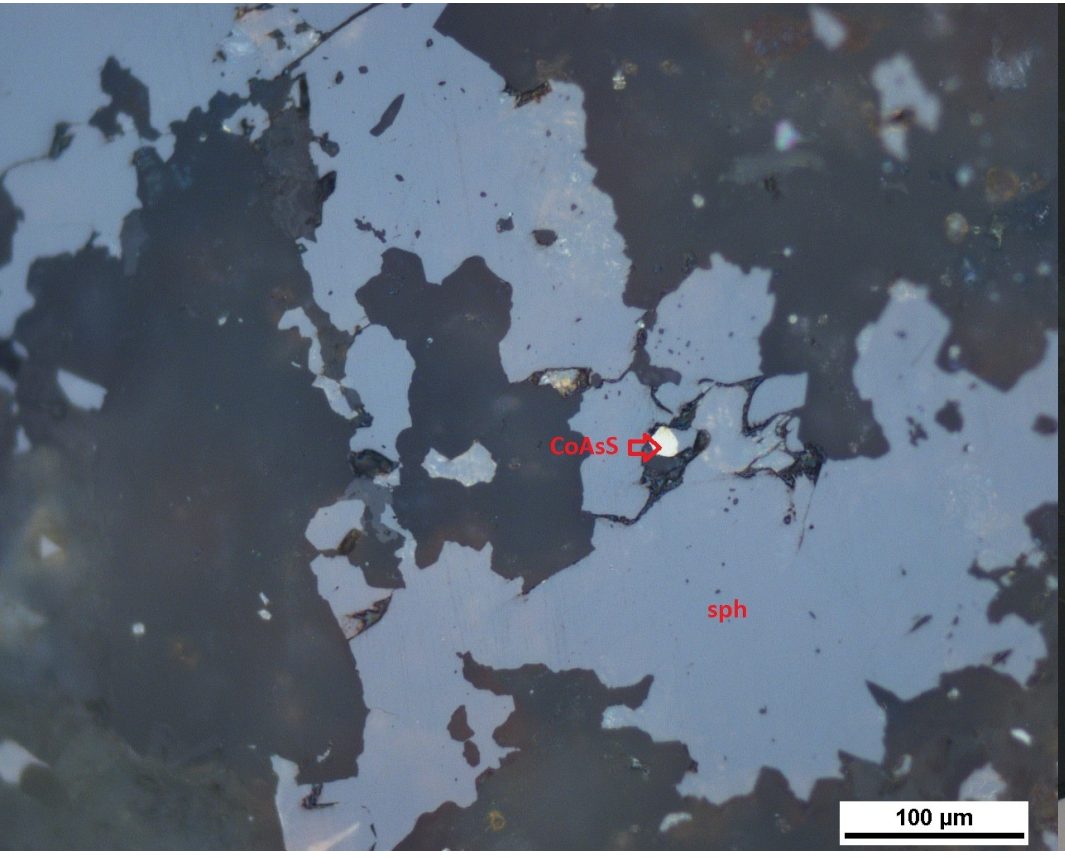
Idiomorphic cobaltite crystals have a characteristic pentagonal formation.

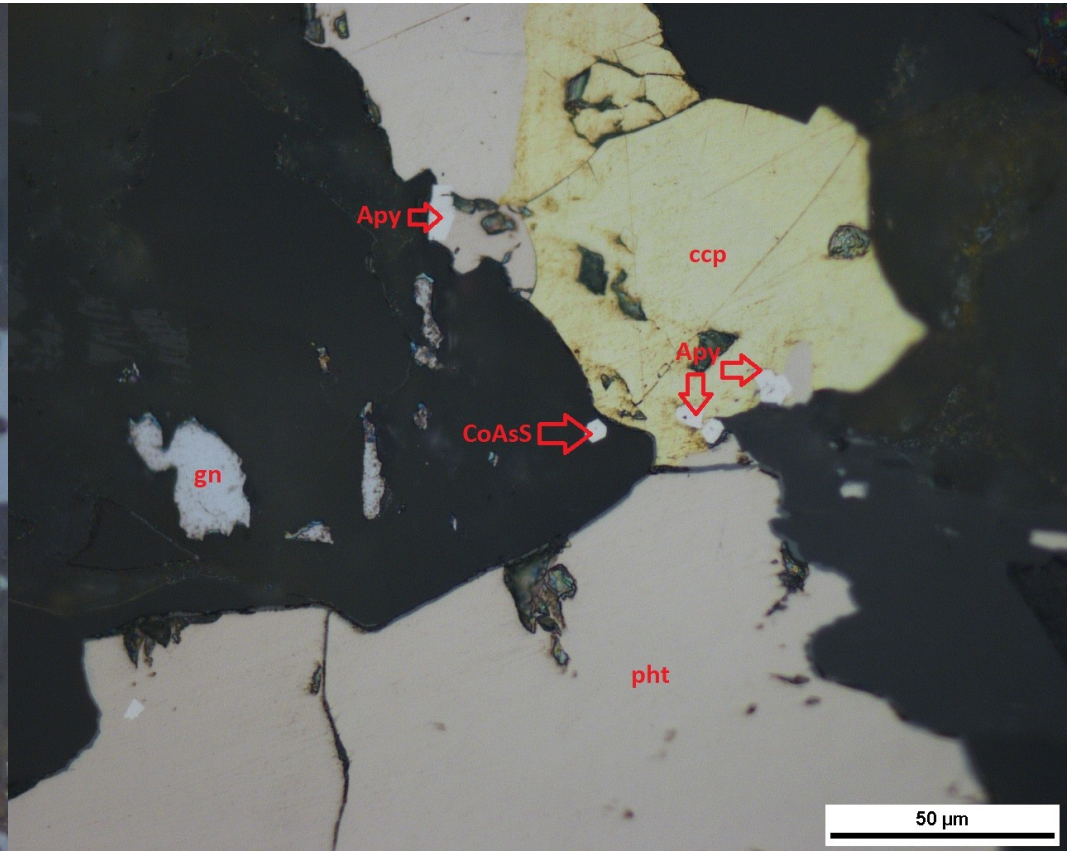
Under an optical microscope in reflected light there is a high anisotropy, which indicates that they were formed at a very high temperature, about 600-700 degrees Celcius.

Cobaltites from the Anna Maria are more creamy-grey than creamy-pink in color and have a relatively low relief as for this mineral.

The formation of the CoAsS crystal and its relationship to the surrounding chalcopyrite clusters suggest that it formed earlier and took place to develop a shape consistent with the crystallographic arrangement.

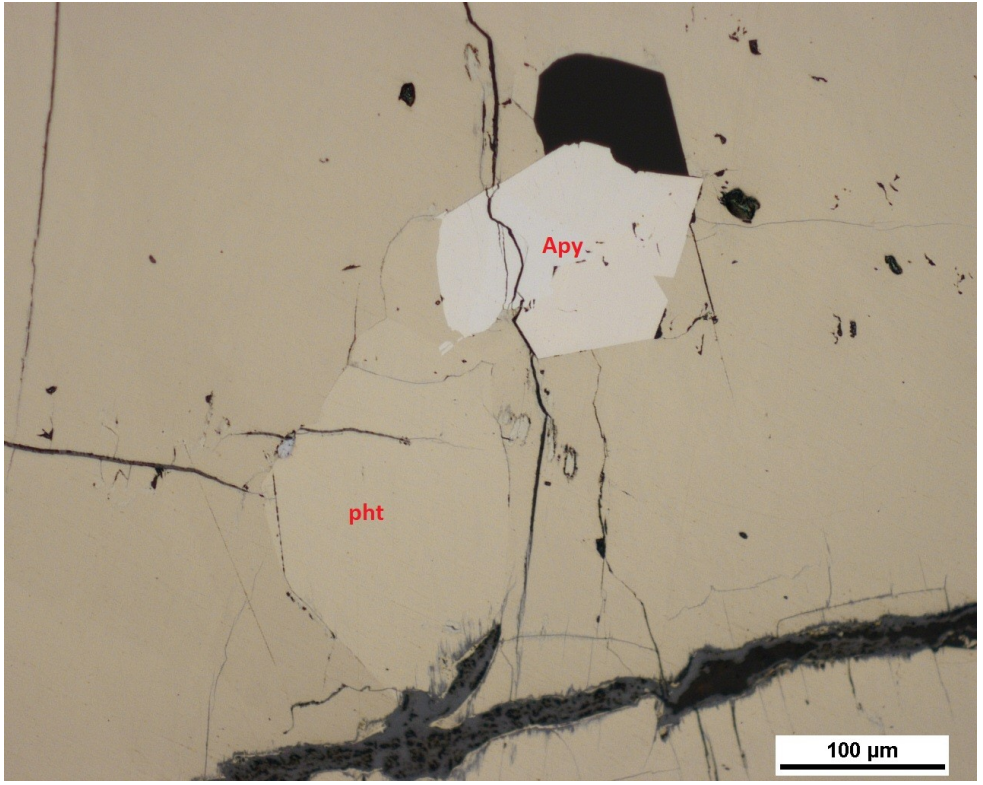


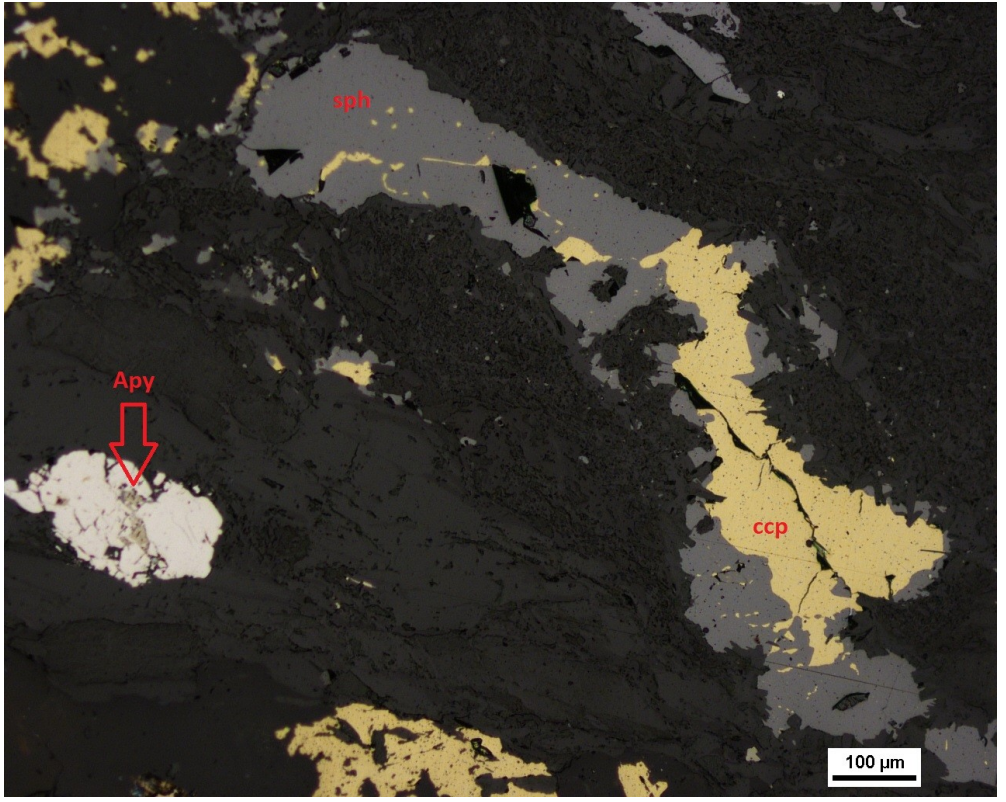

CoAsS
sph
100 µm

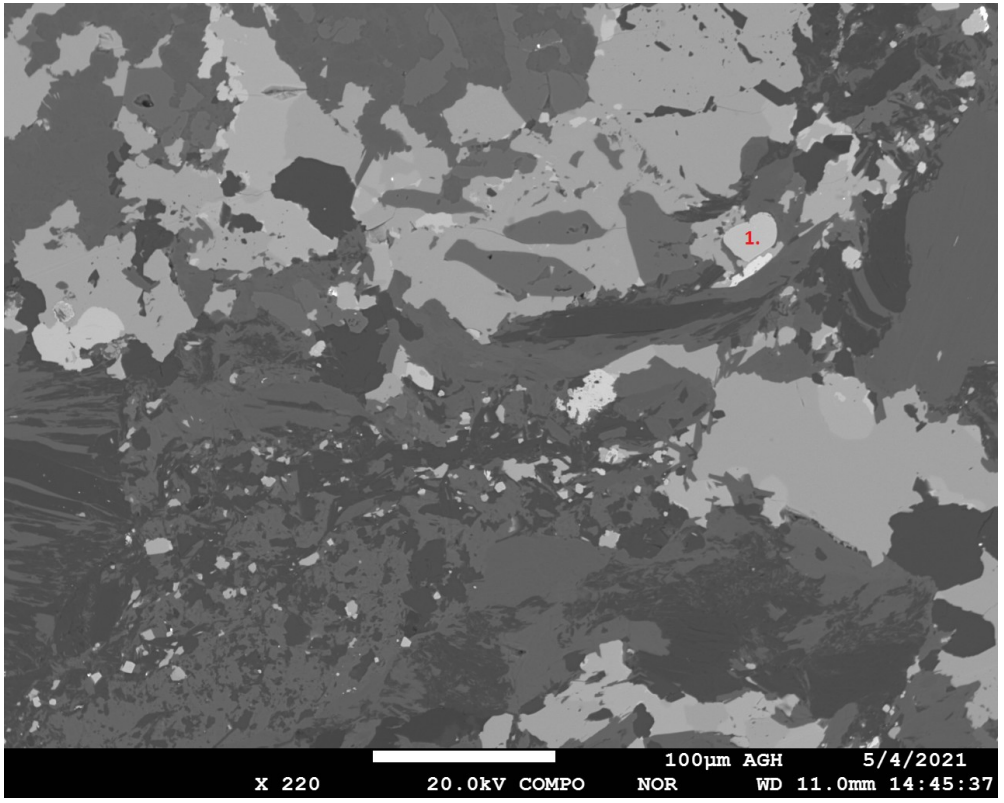

Apy
ccp
Apy
CoAsS
gn
pht
50 µm

Cobalt-bearing minerals

Co-arsenopyrite







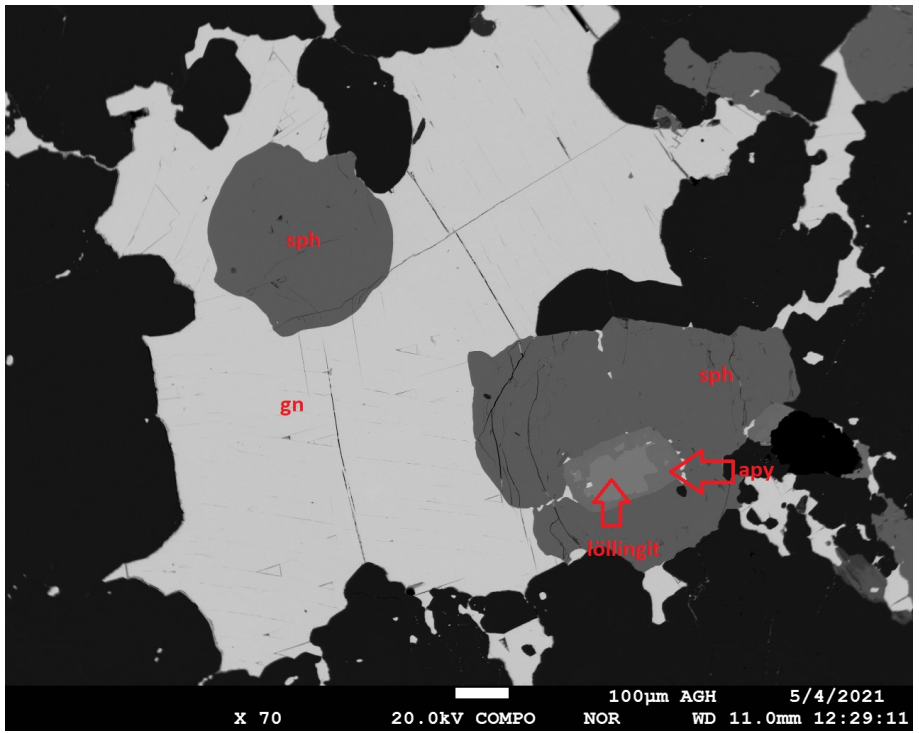
BSE Image: Number 1 is Co-arsenopyrite, which contains 6.42 wt% cobalt.

Cobalt is found arsenopyrite as an isomorphic dopant

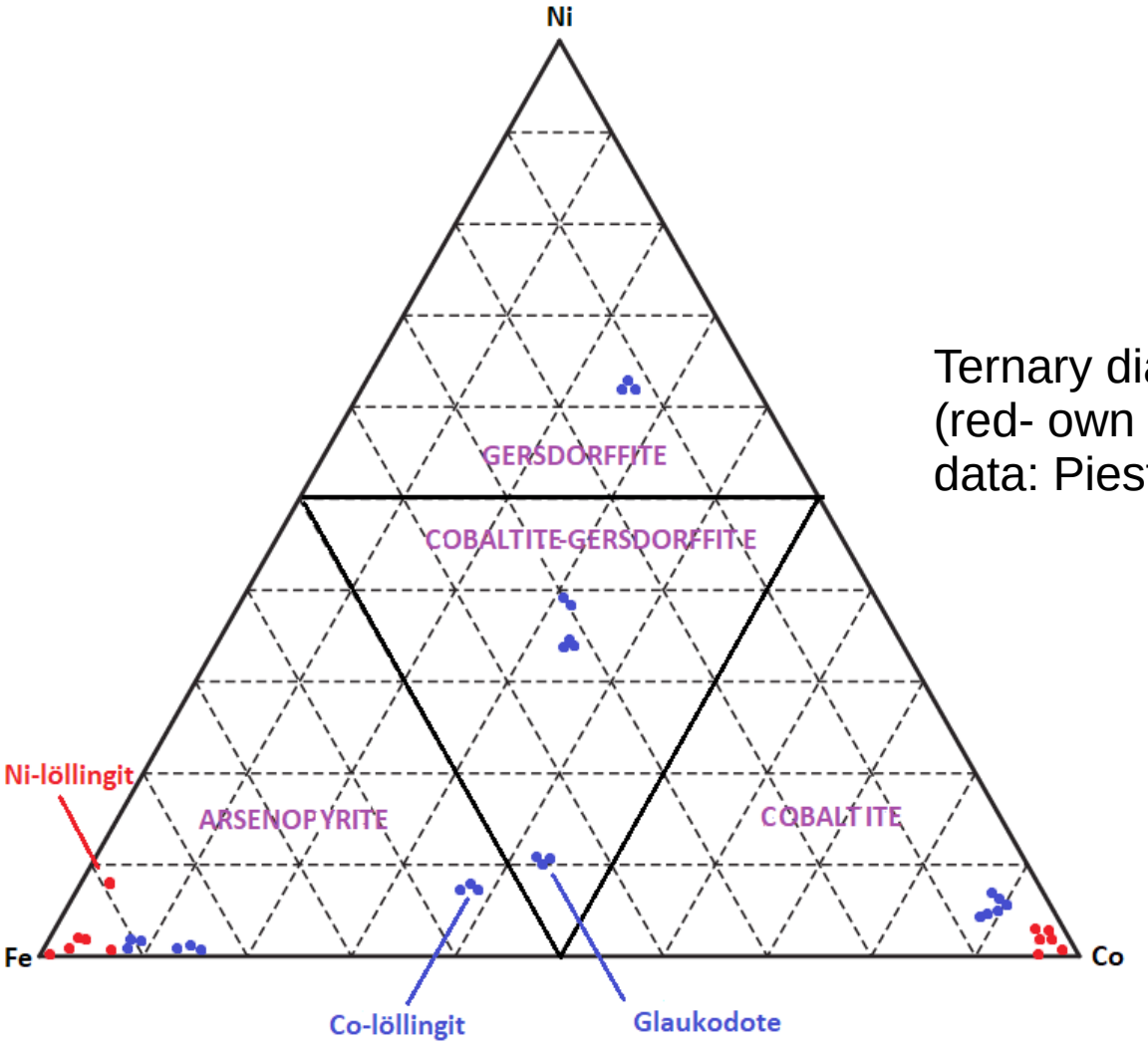
Two generations of arsenopyrite have been recognized. Generation one contains elevated cobalt contents above 2,5 wt%. It is associated with local high-temperature hydrothermal processes. These are cobalt-bearing arsenopyrite. The formation of the second generation is connected with medium-temperature hydrothermal processes related to the intrusion of the Karkonosze granite. The second generation of arsenopyrite contains on average about 0.5 wt% of cobalt.

Cobalt-bearing minerals

Co-löllingit



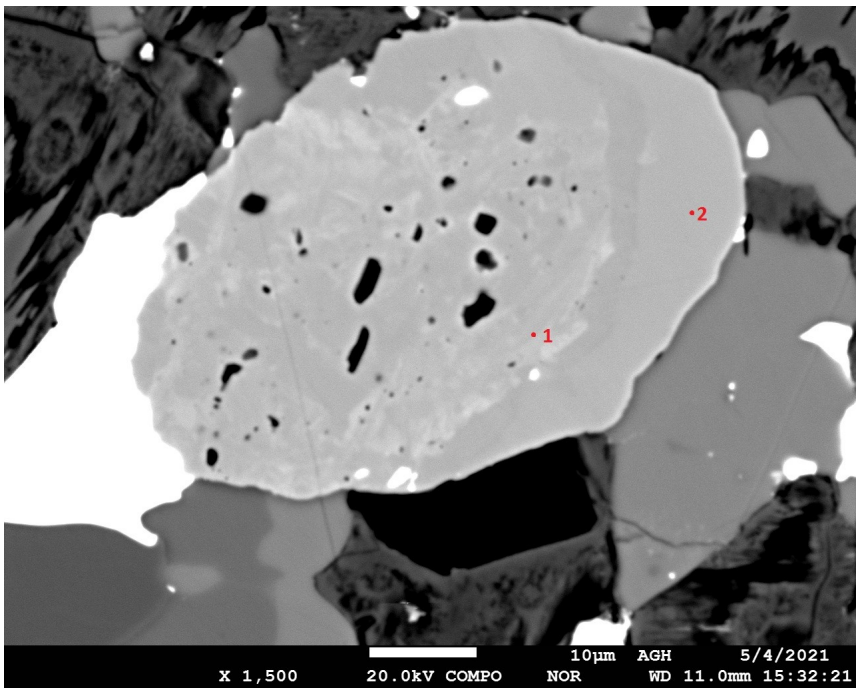
The lelingite transitions smoothly into arsenopyrite (BSE Image) Using electron microprobe, it was determined that the lelingite contains elevated nickel (9.4 wt%) and cobalt (2.5 wt%), while the crystal of arsenopyrite contains elevated cobalt (2 wt%)

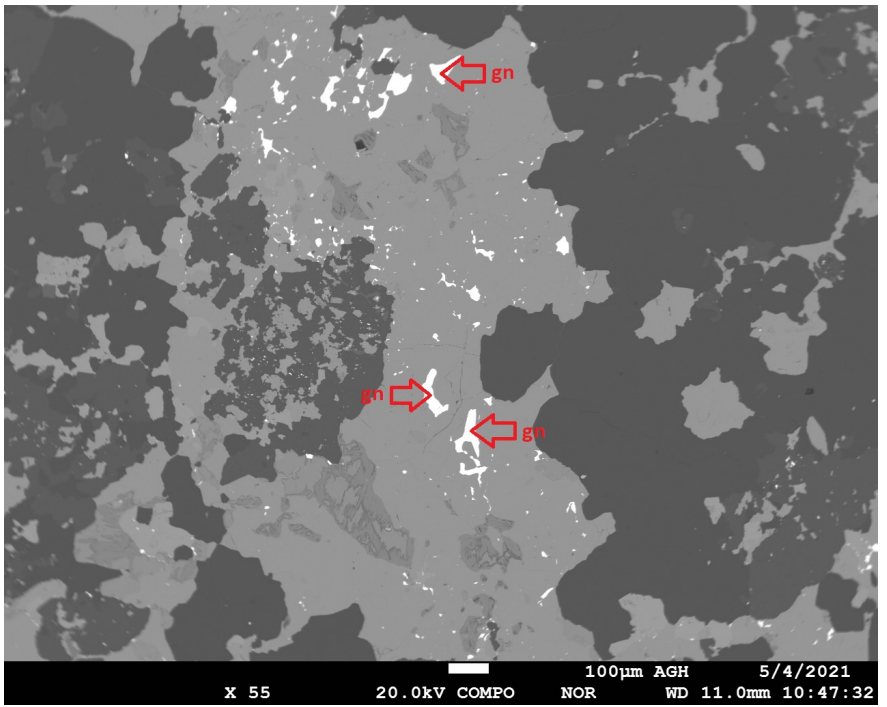


Ternary diagram for phases with cobalt (red- own research, blue- existing data: Piestrzyński et al., 1992)

Isomorphic admixtures in minerals

The BSE Image shows the variation of antimony content in the arsenopyrite crystal. In the center of the crystal (point number 1) the Sb content is 3.28 wt%. In the periphery of crystal the content does not exceed 0.1 wt% (point number 2).



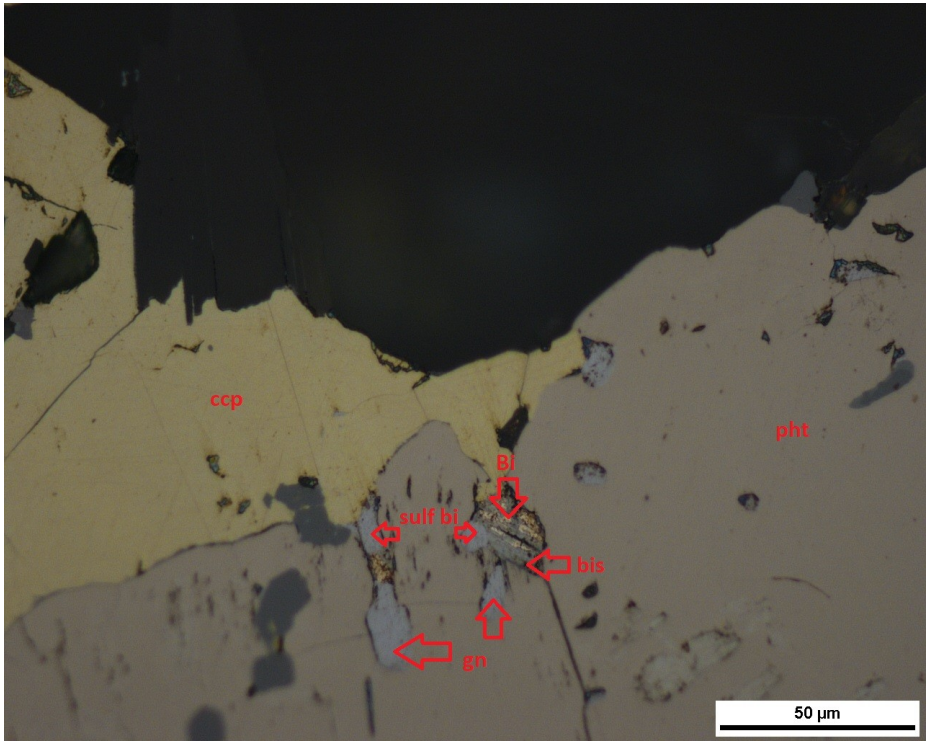


The silver content of the galena crystals exceeds 1% wt.

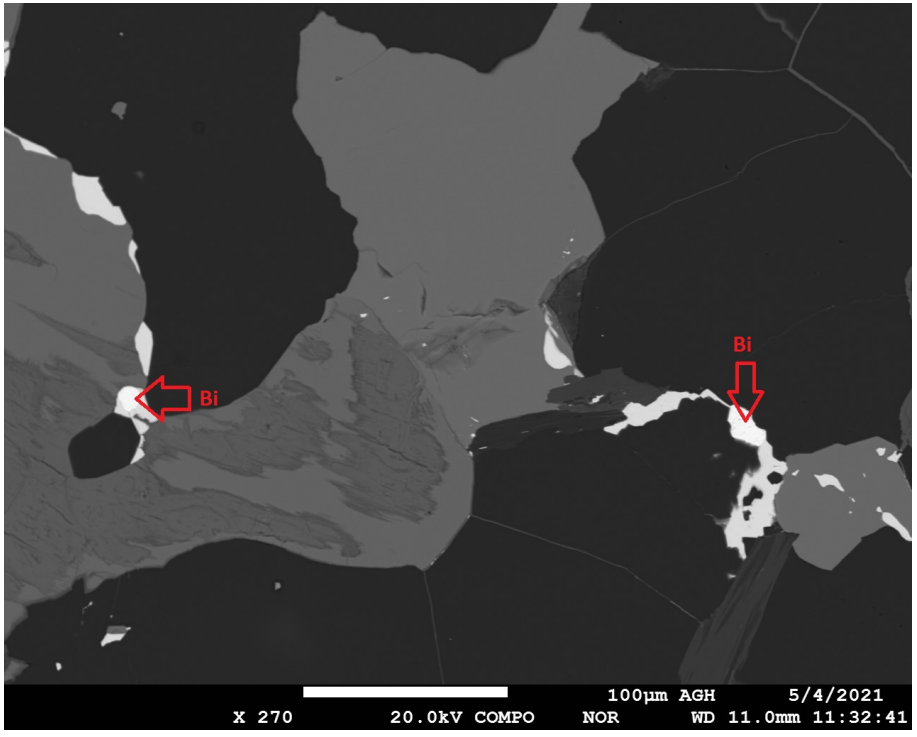
Table 1: Maximum contents [% by weight] of chemical element admixtures in aggregate minerals measured on electron microprobe

Mineral [wt %]	Co	Fe	Cd	Zn	Sb	As	Ni	Ag	Au	Ga	In
Cobaltite	34,5	4,25	0,07	3,04	1,84	44,52	2,35	0,01	0,03	-	-
Arsenopyrite	6,42	34,95	0,08	2,11	3,28	50,18	0,58	bdl	0,06	-	-
Lelingite	1,95	18,79	0,04	0,02	0,09	70,23	8,23	bdl	bdl	-	-
Chalcopyrite	0,06	30,56	0,06	0,31	0,02	bdl	-	0,11	0,06	-	bdl
Pyrite	0,86	46,64	0,59	0,11	0,149	0,35	-	bdl	0,03	-	-
Sphalerite	0,68	9,68	0,47	59,89	bld	0,35	bdl	0,02	bdl	0,41	0,14
Pyrrhotite	0,16	59,90	bdl	0,15	bdl	bdl	0,05	bdl	0,07	bdl	bdl
Stannite	-	14,13	bdl	5,3	-	bdl	-	0,08	-	0,04	0,34

Bismuth mineralization



Microphotography 1: Native bismuth, busmuthinite and bismuth sulfides in pyrrhotite



BSE Image: Native bismuth crystals in pyrrhotite

Conclusion

- Cobalt mineralization occur in the E part of the Stara Kamienica Schist Belt.
- Cobaltite, Co-arsenopyrite and Co-löllingite were identified as cobalt carriers.
- The formation of cobalt-bearing minerals is connected with local occurrence of high-temperature hydrothermal processes connected with regional metamorphism.
- High-temperature processes preceded the formation of medium-temperature mineralization related to the intrusion of the Karkonosze granite.

Geological and mining conditions

- polymetallic nature of the deposits
- high content of arsenic in the ore
- very high collapse of rock layers and deposits
- complex structure and form of the deposit
- no continuity of deposit
- insufficient exploration
- large thickness of the deposit at the depth which does not allow exploitation at the current state of mining techniques

Thank you for your attention