

Sample Selection for Geometallurgical Characterization in the Rajapalot Deposit

BATCircle Project Report 02 – WP1 Task 1.2

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GEOLOGICAL SURVEY OF FINLAND

DOCUMENTATION PAGE

Date / 23/02/2021

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| Authors Milena Farajewicz Nick Cook | Type of report Open File Work Report Commission by BATCircle Project WP1.2 |
| Title of report Sample Selection for Geometallurgical Characterization in the Rajapalot Deposit | |
| Abstract <p>Mawson Resources submitted set of samples for BATCircle metallurgical study. They represent typical mineralization styles found in Raja (four samples) and Palokas (two samples) prospects which are part of Rajapalot Au-Co project located in Lapland, ca. 35 km west of Rovaniemi. Rajapalot mineralization, hosted by Paloproterozoic supracrustal rocks of Perapohja Belt, is stratabound, structurally-controlled and forms several bodies plunging in NW direction. At Raja mineralized zones are of two main lithochemical styles, albitic and potassic.</p> <p>Albitic style is characterized by albitite with minor biotite, chlorite and Mg-Fe amphiboles, often fractured and brecciated. Potassic (K±Fe) style refers to foliated metapellites (mica-quartz schists) and psammopelites (mica quartzites). Pyrrhotite occurs either as foliated and folded layers or more massive veins and breccia matrix. Palokas mineralization is characterized by presence of Mg-Fe orthoamphiboles-cordierite rocks and chlorite-amphibole-tourmaline ± red garnet rocks as most common lithological styles. Sulfides occur as more massive pyrrhotite (±chalcopyrite and pyrite) veins or breccia matrix.</p> <p>Across whole project, free gold grains occur as inclusions in or are attached to silicates, sulfides, uraninite, scheelite and tourmaline. Cobalt is hosted by cobaltite (when As content high), linnaeite and Co-pentlandite (when As-poor). Cobaltite forms euhedral grains disseminated in silicates and pyrrhotite. Linnaeite and Co-pentlandite occur only in pyrrhotite in three textural context:</p> <ol style="list-style-type: none"> 1. as primary exsolutions, 2. rather large, anhedral, strongly fractured grains (likely secondary after Co-pentlandite) or 3. rare primary euhedral grains. <p>Additionally, Co-bearing pyrite was found in Palokas only. Gold mineralization, especially in Raja potassic host is associated with scheelite and uraninite. A recent liberation study demonstrated very good recovery of gold grains and cobaltite, but not linnaeite/Co-pentlandite. Thus grouping samples based on cobaltite vs linnaeite content rather than other features might be beneficial.</p> | |
| Keywords cobalt, critical metals, battery metals, geometallurgy | |
| Geographical area 35 km west of Rovaniemi, Lapland, Finland | |

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|---|----------------------------|--|-------------------------------|
| Map sheet N/A | | | |
| Other information N/A | | | |
| Report serial 9/2021 | | Archive code | |
| Total pages 29 | Language English | Price N/A | Confidentiality N/A |
| Unit and section Economic Minerals | | Project code | |
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This report was written for the BATCircle project by Milena Farajewicz and Nick Cook (Mawson Minerals, a BATCircle partner). It was submitted to GTK by Simon Michaux as a BATCircle report.

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1 INTRODUCTION

As part of the BATCircle project, Mawson Resources submitted set of samples from its flagship Rajapalot project for two types of metallurgical tests. This report describes sampling for large-scale metallurgical orientation study conducted at GTK Mintec in Outokumpu. A parallel small-scale metallurgical testing is currently carried out by Aalto University.

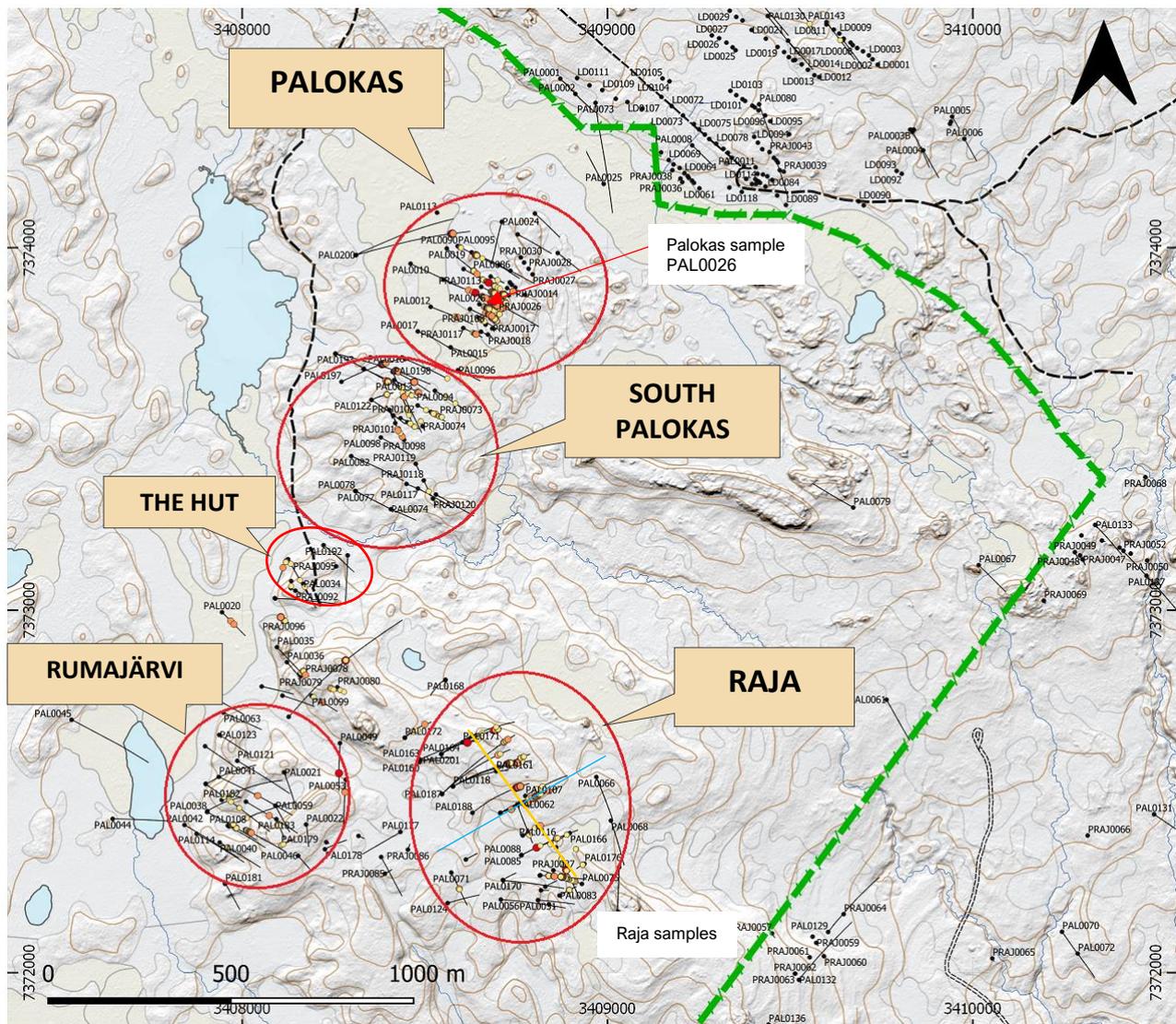


Fig.1. Rajapalot project with five main prospects, drill core traces and collars. Natura 2000 boundary in green dashed line. Blue line within Raja prospect represents cross-section shown as striplog in fig.4, yellow line in long section along which Raja sample were collected.

Rajapalot Au-Co project, 100% owned by Mawson, is located in Southern Lapland, at the border of two municipalities, Ylitornio and Rovaniemi, ca. 35 km west of the city of Rovaniemi. The currently drilled area is approximately 2.5 km by 2 km and includes following prospects: Raja, Rumajärvi, the Hut, South

Palokas and Palokas (fig.1). Original Mawson exploration target, Rompas project with U-associated nuggety gold, is located ca. 7.5 km west of Rajapalot.

The area lies in northern part of the Peräpohja Belt that consists of Paleoproterozoic supracrustal rocks. Au-Co mineralization is hosted by amphibole-facies metasedimentary rocks which were subjected to several episodes of deformation and metasomatic events during Svecofennian Orogeny (Ranta et al, 2018). Mineralization is predominantly of disseminated style, especially in Raja, and more sulphidic and massive in Palokas. Ore bodies are strata-bound and plunge in NW direction. There seem to be strong structural control and mineralization is interpreted to concentrate in fold hinge zones. On a drill core scale, there is clear association of sulphides and drag fold hinges. Native gold and cobalt minerals are spatially associated with pyrrhotite, gold grades are rather spotty, whereas cobalt shows better continuity and wider enrichment. Pyrite occurs in barren halo around mineralized units. The origin of mineralization is ambiguous, most likely multistage, with Co and sulphides forming earlier than gold. Source of cobalt and timing of its deposition are unknown. Gold mineralization could be associated with late to post-orogenic 1.79 Ga tourmaline granitic rock cropping out north of the project area (Ranta et al., 2018, N. Cook, personal communication, 2019).

During most recent 2018/2019 drilling season several extremely rich Co-bearing intervals were intersected down-plunge in both main prospects: 1 m at 1.5% Co (hole ID: PAL0194) in Palokas and 1 m at 0.9% Co (hole ID: PAL0163) in Raja, showing great potential for high-grade Co mineralization present in deeper parts and across strike of ore bodies and vastly expanding estimated Co tonnage reported in Inferred Mineral Resource Estimation conducted in autumn 2018 by AMC Consultants Pty Ltd.

2 DRILL CORE LOGGING AND PROCESSING

2.1 Logging

All drill holes were drilled, logged and assayed between 2016 and 2019, the oldest ones that were samples for this study (PAL0023, PAL0048, PAL075) were re-logged prior to last drilling season in accordance with currently used logging system (including e.g. simplified lithologies). Drill holes with IDs starting with "PAL" have core diameter of 50.7 mm (NQ2); "PAL" stands for Palokas (first drilling location for that diameter) and similarity to fire assay method PAL1000 is accidental.

The logging procedure is conducted at Mawson's Rovaniemi facility by Mawson personnel with occasional additional input from consultants. Each drill core is oriented, and subsequently geotechnical and geological logging is carried out. Geotechnical logging includes petrophysics (e.g. magnetic susceptibility, conductivity, radioactivity) and geotechnical parameters such as core recovery; whereas geological logging includes lithological classification, alterations, mineralogy and structural measurements. Portable XRF is used to aid rock type and mineral determination. UV lamp is also used to search for scheelite due to its spatial association with gold. Based on visible or expected mineralization, samples are chosen and marked for assays. Sampling procedure is as follows: preferred interval length is 1m for mineralized part and 2m for barren rock, minimum length is 40 cm which is determined by minimum material needed for assay. Lithological boundaries should be respected thus, some intervals end up being longer or shorter than 1 or 2m. The intervals are chosen in a mineralized zone first, with buffer of at least 10m above and below it zone. Additionally, type samples of barren

rocks are taken to improve understanding and modelling of lithological units as well as to improve consistency in logged rock type classification. As part of QA/QC procedure, standards (for both gold and ME), blanks (for both gold and ME) and field duplicates are inserted, either with a fixed frequency or after most mineralized interval.

2.2 Cutting

After logging is finished, the drill core is photographed dry and wet, and then transported to the GTK core facility in Rovaniemi. During cutting half core with orientation mark is saved for reference and the other half is bagged, labelled and brought back to the Mawson core shack, where the cut samples are shipped to a designated laboratory by commercial couriers or Mawson staff.

2.3 Assaying

All selected samples are assayed for gold, additionally sulphidized and lithological type samples are assayed for multi-elements as well. Currently samples are sent to CRS Minlab Oy facility in Kempele for gold analysis with PAL1000 method by AAS of cyanide leachate (detection limit is 0.05 ppm, not suitable for refractory gold) and preparation for multi element analysis. From there smaller pulverized samples are shipped to MS Analytical in Toronto, Canada where cobalt and other elements are analyzed with ICP-MS (IMS-230 method). In previous drilling seasons some samples were sent to ALS preparation facility in Sodankylä, from where prepared samples were shipped to ALS facility in Vancouver, Canada. ALS has used MS61 method for multi-element analysis, and fire assay with ICP-AES for Au (ICP21 or ICP22 method, 0.001 ppm detection limit). All the used facilities have their own QA/QC procedures. The processing for assays produces coarse rejects and small amount of pulverized material that have been returned to Mawson Rovaniemi core shack.

3 CO MINERALOGY

Known Co mineralization in all prospects consists of cobaltite, linnaeite and Co-pentlandite. Additionally, minor cobaltiferous pyrite (Co up to 7%) found in only Palokas samples.

Cobaltite, CoAsS , is an endmember of Ni-Fe-Co solid solution, with gerssdorfite (Ni endmember) and arsenopyrite (Fe end-member). These two minerals can be thus cobaltiferous, and one grain of Co-bearing gerssdorfite was identified by EPMA (Taipale, MSc Thesis, 2018). Few visible grains of arsenopyrite were found in 1m interval in one drill hole, but these grains were not further analyzed, so potential Co content is unknown. Cobaltite tend to form euhedral grains and it is easily recognized under the microscope due to its habit and high brightness.

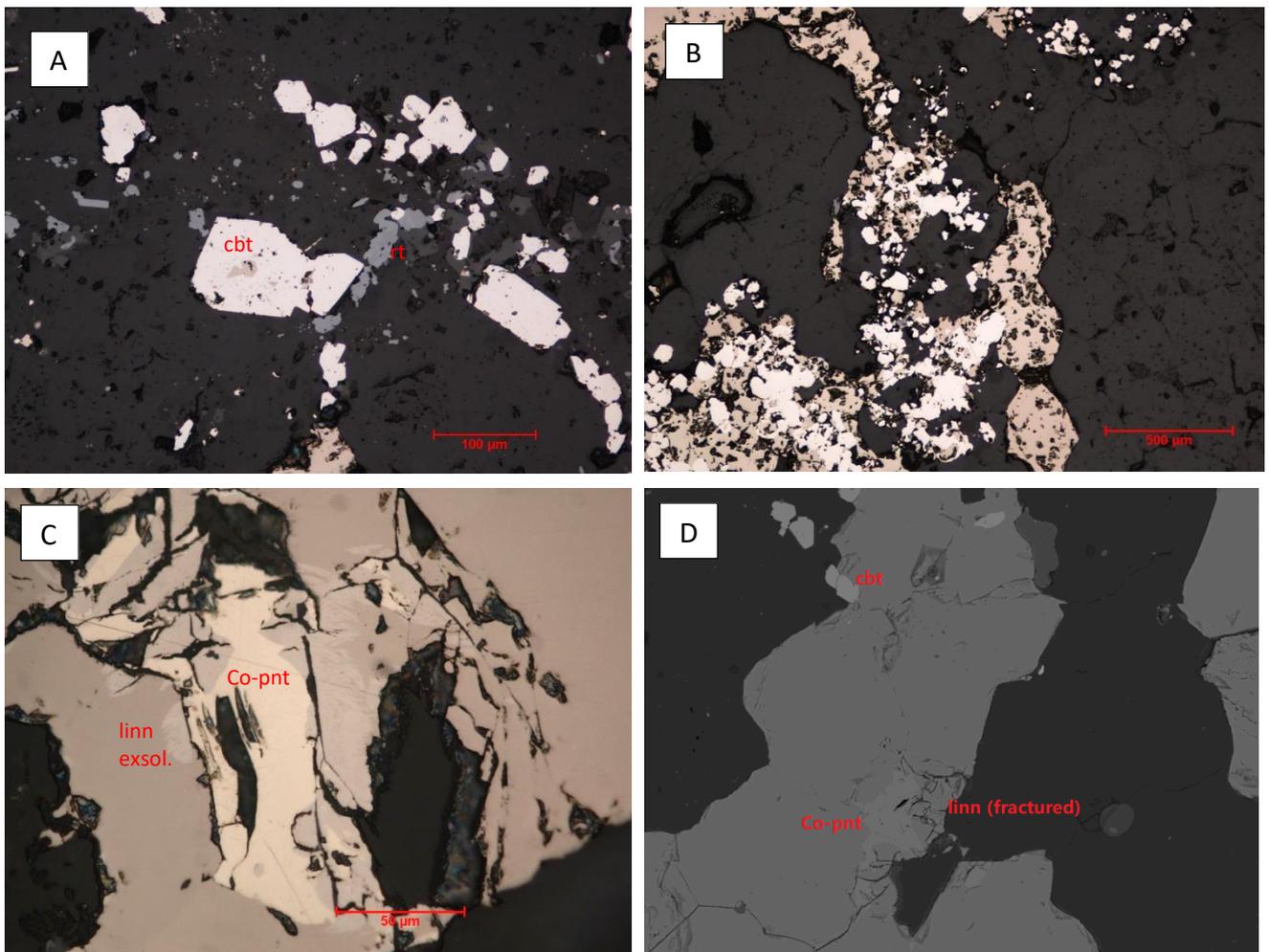


Fig.2. A) Cobaltite with rutile, disseminated in albite (PAL0048, Raja), B) cobaltite intergrown with pyrrhotite (PAL0048, Raja), C) Co-pentlandite exsolution with blade-like linnaeite exsolutions, D) BSE image of cobaltite, Co-pentlandite and linnaeite in albite breccia from Raja (PAL0048). Linnaeite has the same brightness as host pyrrhotite, but its network of fractures is clearly visible

Linnaeite is Co-bearing member of linnaeite (Co_3S_4) group series also known as thiospinels (Craig et al., 1979; Craig and Higgins, 1975). They have general formula $(\text{Co},\text{Ni},\text{Fe},\text{Cu})_3\text{S}_4$. Best known member of this group is violarite FeNi_2S_4 , most commonly occurring as low-temperature secondary mineral after pentlandite. Thiospinels form three series: carrollite-linnaeite, siegenite and polydimite-violarite (Ostwald, 1978). Linnaeite can be formed as primary phase with cobalt pentlandite during phase separation from Co-bearing Co-*mss* below 474°C (Farrell and Fleet, 2002) or as a secondary phase after Co pentlandite (Xia et al. 2008). Linnaeite has been found in several locations in Finland, for instance in certain Au-Co-Cu deposits of Kuusamo schist belt or in skarns of Outokumpu district (Vähätalo, 1953).

Cobalt pentlandite is a Co-end member of Ni-Fe-Co pentlandite solid. Co content in pentlandite varies highly what is reflected by names such as: Co-bearing pentlandite (up to few % Co), cobaltian pentlandite ($< 20\%$ Co or $\text{Co}/\text{Ni}<1$). Pure Co end-member can have Co content of up to 67.40 % based on ideal formula (Anthony et al., 1990).

Due to their small sizes, they are not, with few exceptions, visible by naked eye, but can be inferred from geochemical assay data with high As as proxy for cobaltite and low As, elevated Ni for linnaeite/Co-pentlandite.

Cobaltite have been noticed with a naked eye in few core samples from high Co intervals, thanks to its distinctive, pinkish color. It forms euhedral grains, often occurring in clusters, disseminated in silicates and pyrrhotite. Grains are usually of similar size, the bigger ones contain visible inclusions of pyrrhotite or rutile. When disseminated in pyrrhotite, cobaltite grains can be quite resorbed.

Co-pentlandite can be found most commonly as blade or flame-like exsolutions in pyrrhotite exsolving along crystallographic boundaries, fractures or grain boundaries. It often occurs together with linnaeite exsolution (fig.2 C). It can be distinguished from the latter due to its higher reflectance under reflective light (Co-pen can be described as bright and creamy in color, whereas linnaeite is less bright, but still slightly brighter than host pyrrhotite).

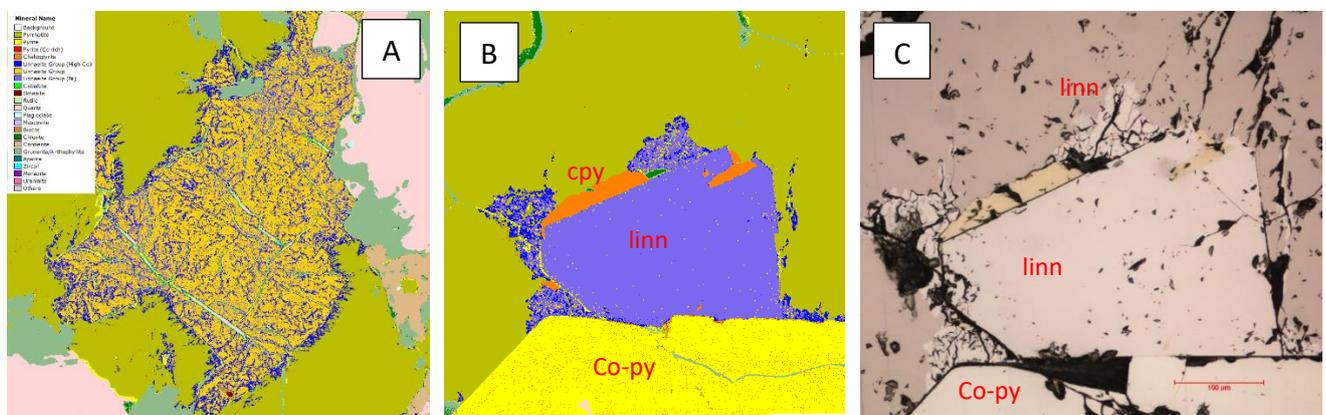


Fig.3. A) Three types textural types of linnaeite: flames (linn + Co-pnt) exsolving around fractured granular linnaeite (dark yellow), and B) and C) single euhedral grain of linnaeite (violet) that differs chemically – higher Ni content. Also visible pyrite (yellow) with red pixels (Co-bearing pyrite).

Presence of linnaeite was determined by QEMSCAN in 2018 in high Co sample from Raja (Farajewicz, MSc Thesis, 2018). Previously any linnaeite was misclassified as Co-pentlandite due to similar optical properties, chemical composition and textural context. Apart from 1) primary exsolution (blades or irregular blobs), linnaeite forms relatively 2) coarse grains with distinctive network of fractures (fig.3.). There are subtle, but detectable differences in chemical composition of these forms, mostly in Ni content. That form is inferred to be secondary and its appearance resembles shrinkage textures observed in secondary violarite replacing common pentlandite. It is possible that this of linnaeite is a replacement product after Co-pentlandite, since linnaeite with such a texture was obtained experimentally from Co-pentlandite (Xia et al. 2008). 3) Third type of linnaeite, individual euhedral crystal, was observed in thin section chloritized tourmaline-orthoamphibole rock (lithocode name: CLAPR – chlorite-amphibole-pyrrhotite rock) from Palokas. Only a single grain of this form was found, but only one thin section from that kind of lithology was prepared, thus its relative occurrence is unknown.

Neither Co-pentlandite nor linnaeite have been identified in a hand specimen. Co-pentlandite is too small for a human eye, whereas linnaeite cannot be distinguished from host pyrrhotite, although even the relatively large grains are probably too small to be seen.

Some, but likely insignificant amount of Co is hosted by pyrite. Pyrite grains from Palokas sample analyzed with EDS were found to contain up to 7% of Co. Few grains of Co-bearing gersdorffite (NiAsS) were determined by Taipale (2018). EPMA analysis revealed two populations, one with few % of Co and another with ca. 17% of Co.

| Mineral | Formula | Co % | Occurrence | Hardness (Mohs) | Density (g/cm ³) |
|----------------|---|-------|---|---|------------------------------|
| Co-pentlandite | C ₉ S ₈ | 67.40 | Primary exsolutions in po, so called flames | n.d. * VHN = 278–332 (100 g load) | 5.22 |
| Linnaeite | Co ²⁺ Co ³⁺ ₂ S ₄ | 57.95 | Primary exsolutions in po; secondary (?) anhedral fractured coarse grains within or in contact with po; primary euhedral grains | 4.5-5.5 | 4.5-4.8 |
| Cobaltite | CoAsS | 35.52 | Euhedral grains disseminated in silicates/po | 5.5 | 6.33 |

Tab.1 Cobalt minerals found in Rajapalot deposit. Size ranges based on limited QEMSCAN work; hardness and density after handbookofmineralogy.org

4 MINERALIZATION CHARACTERISTIC

4.1 Raja

Raja mineralization is dominated by two major host lithologies 1) albite, often brecciated and 2) foliated and microfolded mica (muscovite-biotite) schist. Within a drill core the boundary between those two styles are quite well defined (fig.4). Mineralization extends into both lithologies with best grades often at the boundary, which suggest importance of the rheological difference for fluid flow and precipitation of ore minerals in this system. Important common geochemical feature in both mineralized lithologies is deficiency in Ca. In both Raja styles cobaltite is main Co mineral. As content is good proxy for presence of cobaltite. Linnaeite and Co-pentlandite can be inferred when Co content is much higher than As. Together these two types represent nearly 100% of Raja body, any Palokas-like style zones are volumetrically insignificant.

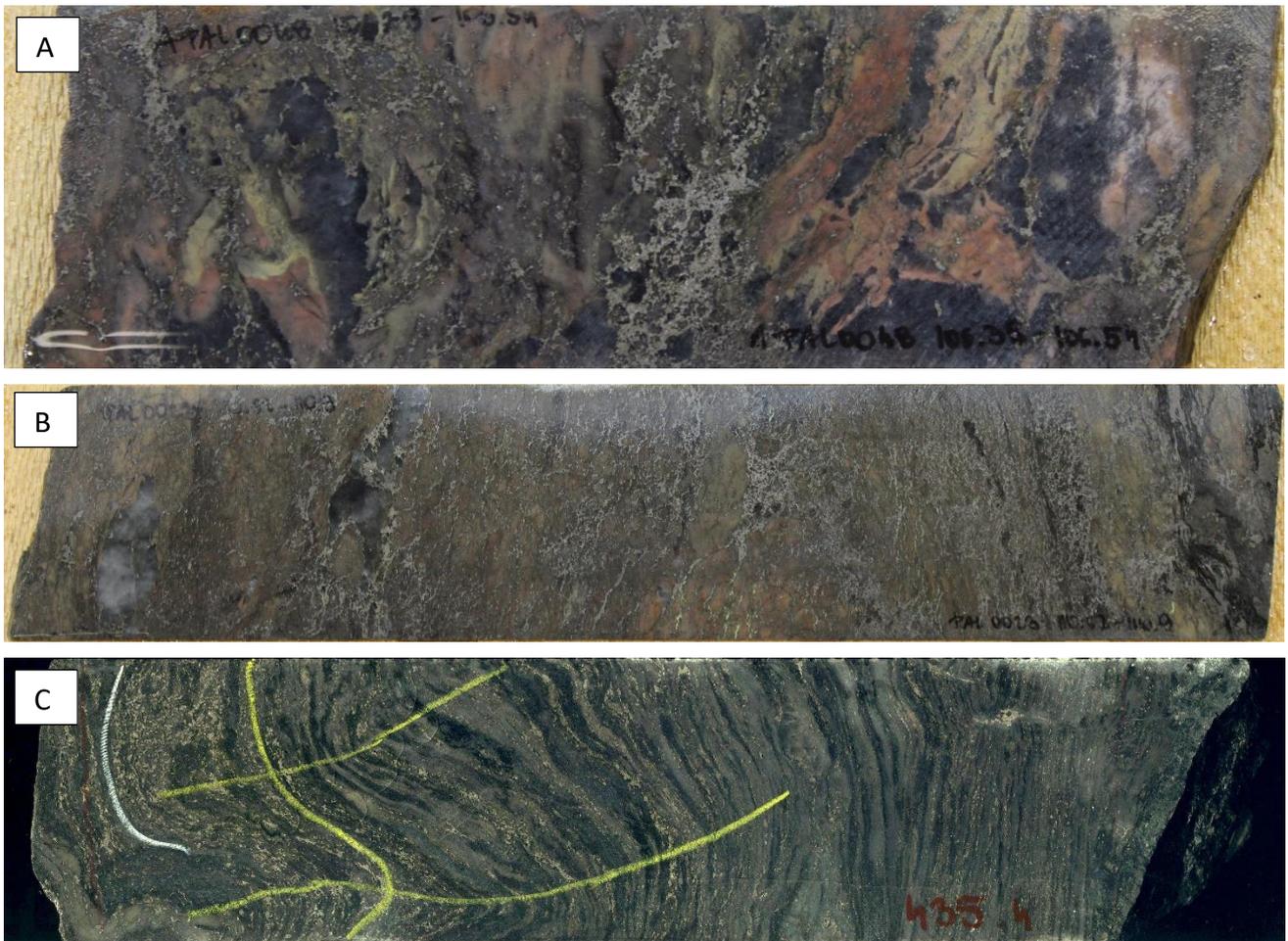


Fig.5 A) Albitite varieties PAL0048 breccia (sampled for this study as Cluster 5, B), PAL0023 (sampled as Cluster 2-albite), PAL0150 laminated and folded, each core diameter is 5 cm.

Albitite is a metasedimentary albite-quartz-rich rock with sulphides occurring either as fractures-controlled veins, breccia matrix or as disseminated grains. Brecciation and fracturing are common, but more ductile deformations like open folds can be seen as well (fig.). Albitite occurs in various colors, from nearly white through yellowish and tan to pink or brick red. Mineralized albitite is usually grey, interpreted as a reduced type. However, some partly pink albitite can be highly mineralized as well (fig.5 A). Sheet silicates such as chlorite, biotite, muscovite/sericite occur interstitially to albite clast/grains, but generally their content is low (few %) Sometimes randomly oriented pale acicular orthoamphiboles (anthophyllite-gedrite series) can be seen in enough quantity to warrant classification as Mg-Fe-amphibolite. Gold content is usually lower than in potassic style. Cobaltite is most common host for Co, in some intervals linnaeite is expected to dominate. Co-pentlandite is a minor phase. Pyrrhotite is most important sulphide volumetrically; in brecciated albitite it fills the fractures, in non-brecciated ones it forms foliated seams or fine laminations (fig.5 C). Chalcopyrite and pyrite are present as minor phases. Typical accessory minerals include rutile, ilmenite, sphene, apatite, monazite, tourmaline and uraninite. Rutile is especially abundant and commonly forms clusters with cobaltite crystals. Few examples of visible cobaltite grains have been noticed during logging.

Geochemically, this style is characterized by enrichment in Na and low K content, thus it can be described as sodic. If pale acicular orthoamphiboles are present, then it is reflected by elevated Mg in geochemical data.

Mica (muscovite/sericite \pm biotite) schist is dominant form of K \pm Fe sulphidic style (also called "Rumajärvi style" where it occurs widely and where it was encountered first). It is a strongly deformed, medium to coarse grained, K- and Al-rich metapelite. Its main components are quartz and albite porphyroclast with enveloping micas, muscovite/sericite \pm biotite. Some potassic mineralized rocks are very quartzitic and thus they are classified as metasiltstone. Amount of biotite varies from minor to dominant (fig.6 B). Chlorite often occurs as replacement product of biotite, especially in faulted and sheared zones. Typical accessory minerals include magnetite, zircon, monazite, apatite, rutile, sphene and tourmaline. Co is hosted by cobaltite with minor linnæite and Co-pent, although some intervals are poor in As indicating low cobaltite content and linnæite as a main Co phase instead. Gold occurs as disseminated grains (5-20 μ m) at grain boundaries or as inclusions within various minerals. Occasionally visible grains of

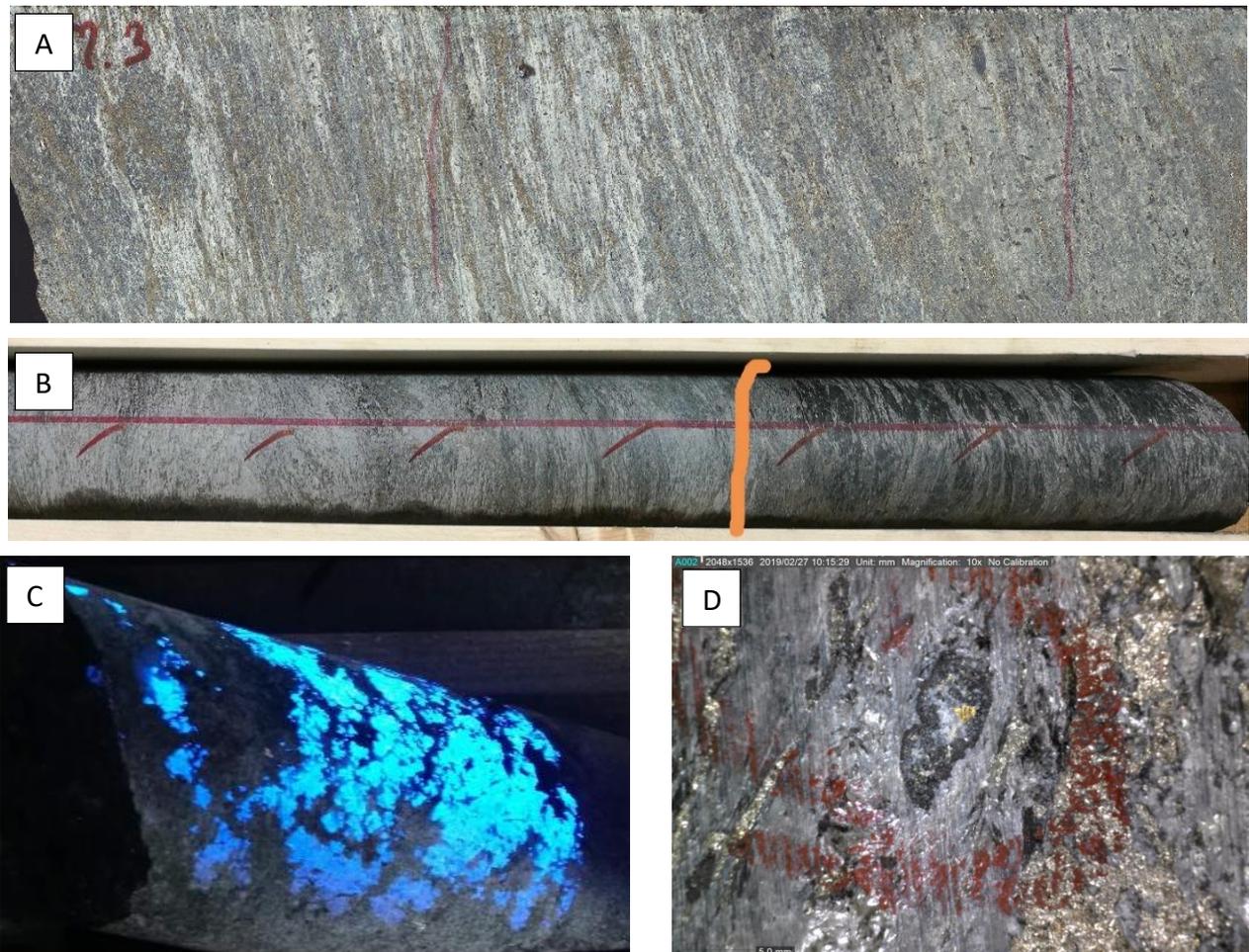


Fig.6. A) PAL0159 muscovite schist B) Clear boundary between muscovite (K) and biotite schists (K-Fe) in PAL00159. C) Scheelite in muscovite schist under UV light in PAL00188, D), Gold inclusion in scheelite-wolframite grain(?) in potassic schist (PAL0173).

gold have been noted (fig.6 D). Molybdenite, scheelite, uraninite and bismuth tellurides are important pathfinder minerals for gold in this lithological type. Scheelite, which occur in small amount in other lithologies, is especially common in gold-rich micaceous units. It occurs in clusters that are easy to see under the UV light due to its bright blue luminescence (fig.6 C)). Uraninite, at the logging stage is detected with a scintillometer and can provide clue where to expect high gold content. Small amount of galena usually accompanies uraninite due to radioactive decay producing Pb. Molybdenite on the other hand is rarely seen, and its association with gold is known from geochemical data and detailed mineralogical research. Sulphide mineralization consists mostly of foliated pyrrhotite with minor pyrite. Thicker masses of pyrrhotite tend to concentrate in microfold hinges. Co minerals are not visible with a naked eye, with exception of few cobaltite grains noticed during detailed logging.

In terms of geochemistry these metasedimentary lithologies are enriched in K ± Mg and poor in Na, thus overall style is often described as potassic to include non-schistose rocks. W, U and Mo are elevated reflecting presence of scheelite, uraninite and molybdenite. Bi, Te and Sb correlate well with Au.

4.2 Palokas

Palokas style mineralization is hosted by more versatile rock types than Raja's. Most common types are:

- pale Mg-Fe orthoamphibole-cordierite rock (lithocode MFA – Mg-Fe amphibolite), orthoamphiboles belong to gedrite-anthophyllite series and form characteristic, randomly oriented acicular crystals that appear to overprint other mineral phases (fig.7 C).
- green chlorite-amphibole-pyrrhotite rock (lithocode CLAPR), composed of silvery-green chlorite matrix replacing original phases and randomly oriented black amphibole of actinolite (decussate texture) ± other components, such as tourmaline (fig.7 A, B)

Tourmaline, black amphibole, biotite, plagioclase, quartz and red garnet are common rock-forming phases adding to versatility of host lithologies. Accessory minerals include rutile, ilmenite, magnetite, uraninite, zircon, monazite and apatite. Sulphide mineralization is dominated by po, with minor, but locally quite significant chalcopyrite and pyrite. Main rock-forming silicates and pyrrhotite are slightly to strongly foliated, however pyrrhotite can also occur in late textures, such as qz-po veins, breccias, fractures crosscutting dominant foliation. When folds are visible in a core, pyrrhotite can be seen concentrating in fold hinges. Co is hosted by linnaeite, Co-pent and pyrite. Cobaltite content is usually rather low (low As), except for extremely cobaltite-rich interval with highest Co content found so far (1 meter with 1.5% Co in PAL0194).

Both MFA and CLAPR lithologies are Ca-poor, although green CLAPR to a lesser degree. But it could be related to late fracture-filling calcite (±quartz) veins that have been noted in Palokas rocks. Barite was recognized in similar textural context (late fracture infill) as well.

Palokas mineralization style is more sulphidic than Raja, oftentimes pyrrhotite occurs as semi-massive to massive texture especially in veins or filling fold hinges, what is reflected in stronger geophysical response. Disseminated gold grains occur as inclusion or at grain boundaries of all types of minerals: silicates (tourmaline, quartz), scheelite, uraninite and sulphides (pyrrhotite, cobaltite).

In submitted samples from PAL0026 and PAL0027 both of those main style occur intercalated with each other and in combination with garnet. Geochemical differences are rather subtle and gradual, so they don't provide any distinctive boundaries to determine groups. Hence dominant mineralogical assemblage in given mineralized interval was a basis for distinguishing 4 samples.

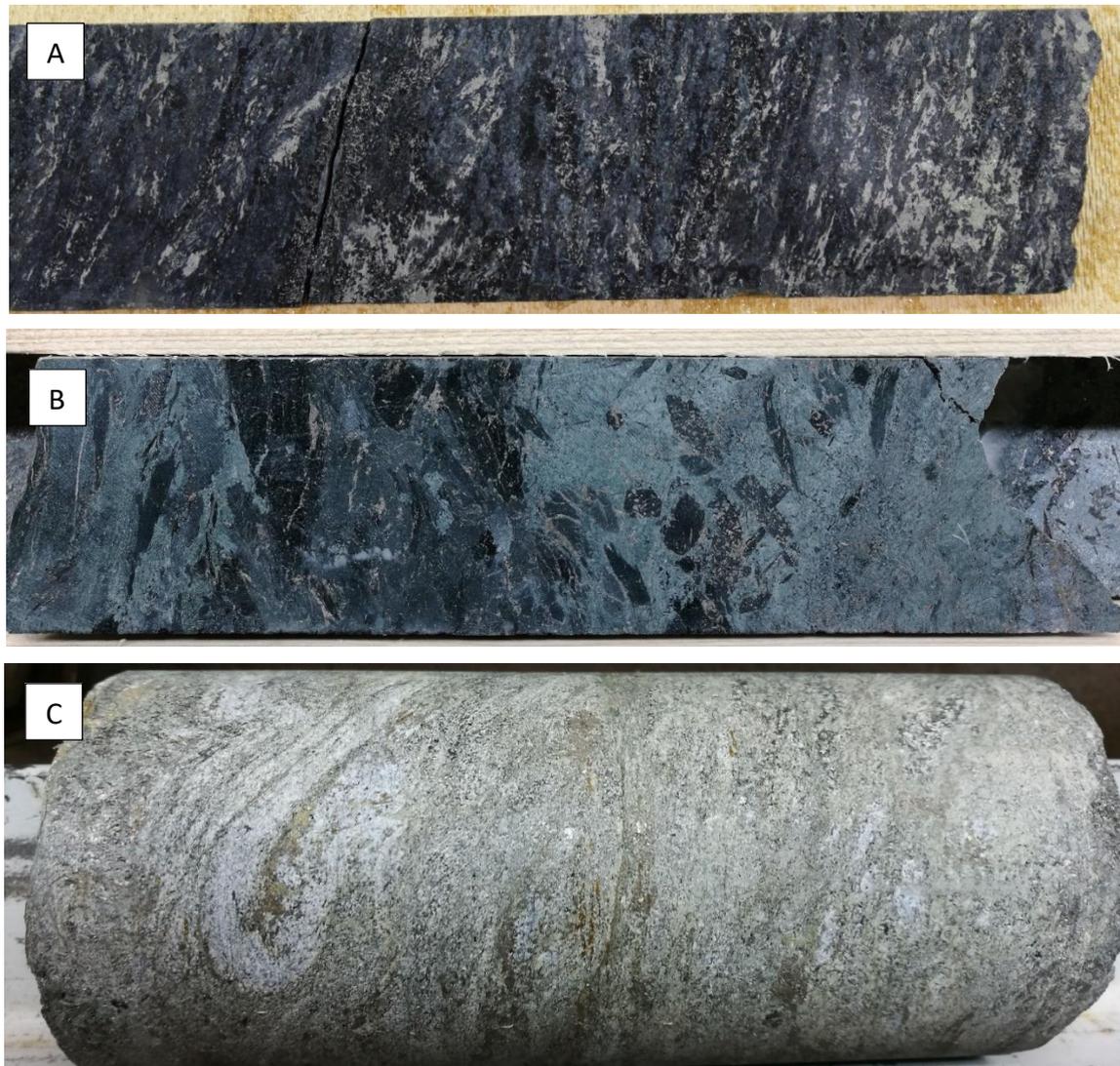


Fig.7. Examples of Palokas host lithologies: A) orthoamph-chlorite-tourmaline-plg-qz rock (PAL0090), B) intensely chloritized amphibole-tourmaline rock (PAL0027), C) pale orthoamphibole-qz-pl-cordierite? (PAL0026)

In this drilling season, significant amount of Raja-type mineralized mica schist was found deeper down plunge in Palokas/south Palokas as well. At this stage it is impossible to estimate what fraction of Palokas and South Palokas ore bodies this style makes up.

5 SAMPLING PROCEDURE FOR BATCIRCLE

5.1 Sample selection and preparation

Samples from 14 drill holes representing two main target areas were prepared by Mawson for BATCircle geometallurgical orientation study:

Palokas

The goal was to utilize a whole intact core from hole PAL0026 which has a twin hole PAL0027 drilled 2 m away. Due to drilling error, PAL0026 was not assayed as new twin hole PAL0027 was drilled, which was then properly logged and assayed. Intervals with high Co content were selected in PAL0027 assay results. PAL0026 was re-logged in attempt to correlate any distinctive features within same/similar ones in PAL0027 and approximately find corresponding high Co intervals in PAL0026. Based on logged lithology and observed minerals as well as Co content in assay data, four bulk samples were selected. $\frac{1}{4}$ of the core were cut off and save for future reference and remaining $\frac{3}{4}$ was designated for the metallurgy study. The core samples were placed in 4 large plastic bags marked with corresponding sample names, internal sample IDs and depth intervals and subsequently shipped to the GTK's Outokumpu facility.

Raja

The goal was to select assayed intervals representative for Raja-style mineralization. The selection was based on geochemical classification (as described in section 3.2) of assayed intervals, reflecting lithological styles used in core logging. These lithological styles can be roughly described as brittle albite breccia (sodic) and ductile mica schist (potassic). Such different host rock mineralogy and rheology are likely to have impact on metallurgical processes. Following four clusters were distinguished: Cluster 2, Cluster 5, Cluster2_Muscovite and cluster $Ti > 0.35$. From those grouped populations, samples were selected based on Au cut-off grade of 0.2 ppm. However, some samples with Au above 0.1 ppm, but rich in Co were included if they were part of the same mineralized unit with other samples. Archived boxes with half cores were recovered, selected samples were marked on the boxes for the saw operator's convenience and to minimize risk of a mistake. Some intervals could not have been sampled; they already had been sampled for research or previous metallurgical test and only quarter core or slice of core left. Cutting took part on Thursday 6th and Friday 7th of June at the GTK cutting facility in Rovaniemi. The goal was to cut it further half, so that one quarter core with orientation mark remains for reference and other quarter core is bagged. Each quarter sample was put to an individual bag with corresponding sample ID, hole ID, depth from-to written on each bag. Additional sample tickets were inserted to each bag with the same information and color-coded cluster name.

Once in Mintec facility in Outokumpu, one bigger composite group from Palokas and four groups from Raja were prepared taking into consideration amount of material needed for the metallurgical study (20-30 kg). These are listed in tables 2 and 3 together with corresponding mineralization styles further described in section 4.

5.2 Geochemical Discrimination

Material for Raja samples was selected based on one geochemical classification and geostatistical analysis tools available in ioGAS.

Geochem plotting and simple data analysis/stats for to discriminate most obvious trends and patterns. This method has been successful in distinguishing various types of mafic rocks, but many non-mafic rocks, including hosts for mineralization, don't show clear-cut patterns. Thus, for selecting Raja samples, unsupervised data classification method, K-mean clustering, was used by Dr. Nick Cook (President for Mawson). In result groups were divided according to Na vs K content reflecting already recognized mineralization styles (Fig.8 A, B).

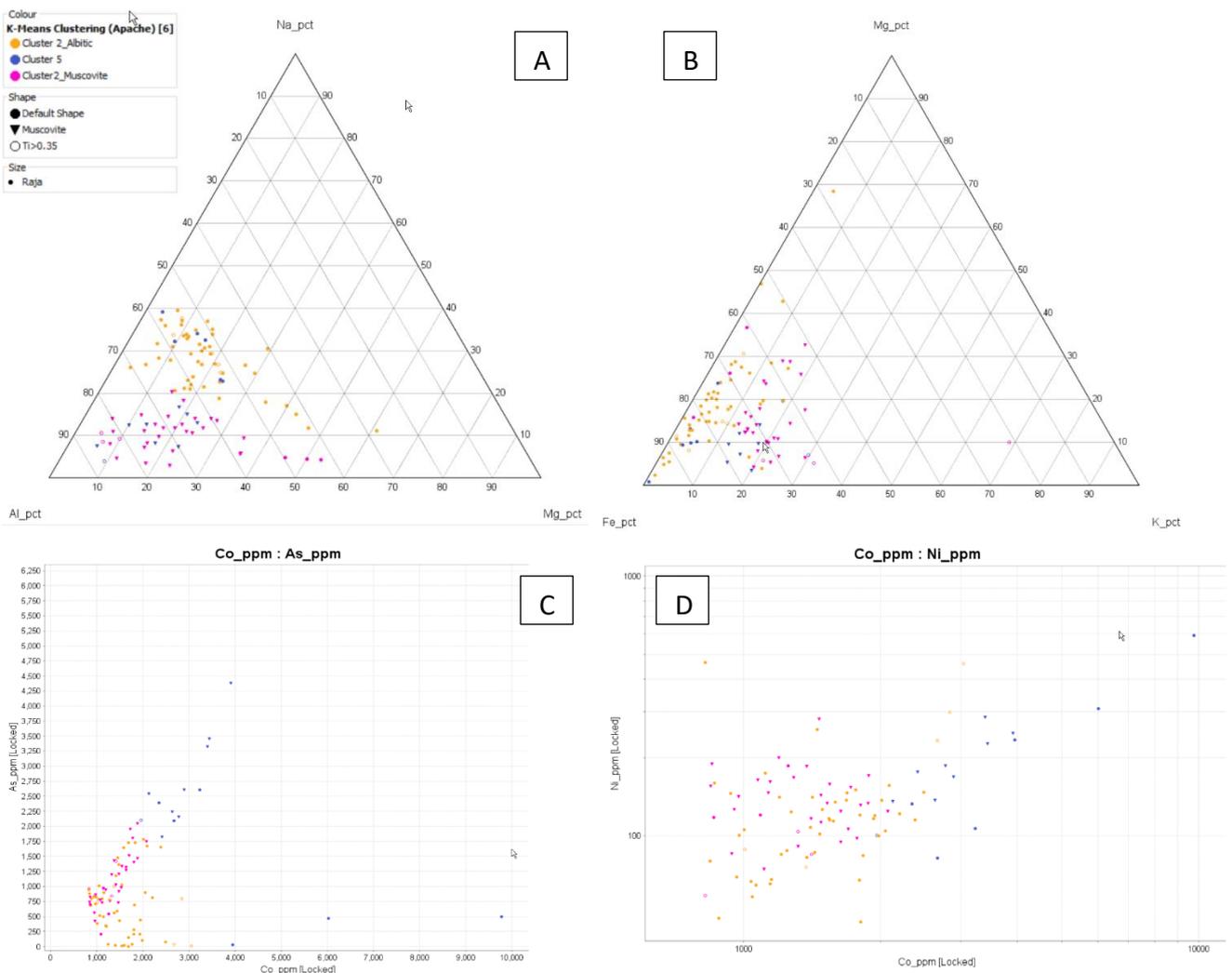


Fig.8. A) Al-Mg-Fe and B) Fe-K-Mg plots showing two distinct populations representing sodic-albitic (yellow) and potassic-micaceous (pink). Blue points are high Co members of those two populations, C) Co vs As plot, cobaltite trend visible with high-Co blue population; points outside of the cbt trend are lower in As indicating linnaeite, D) Co vs Ni, blue population Ni-rich.

Further division was based on Co content, intervals with Co above 2000 ppm and with consistently elevated Ni were assigned to Cluster 5 (Fig.8 C, D). Correlation matrix (Spearman's) shows very high correlation coefficient (0.94) between Co and Ni, but still that cluster is high in As, hence cobaltite must be main co phase.

Forth group called $Ti > 0.35$ was distinguished from Ti probability plot based on a break in trend around 0.35 ppm. It was assumed that elevated Ti content indicated mafic signature. After attributing assayed samples to those groups, they were further selected based on initially 0.2 ppm threshold on Au probability plot, however some high-Co samples with Au between 0.1 and 0.2 ppm were included as well to preserve continuity of mineralized units.

6 SAMPLE DESCRIPTION

6.1 Raja sample

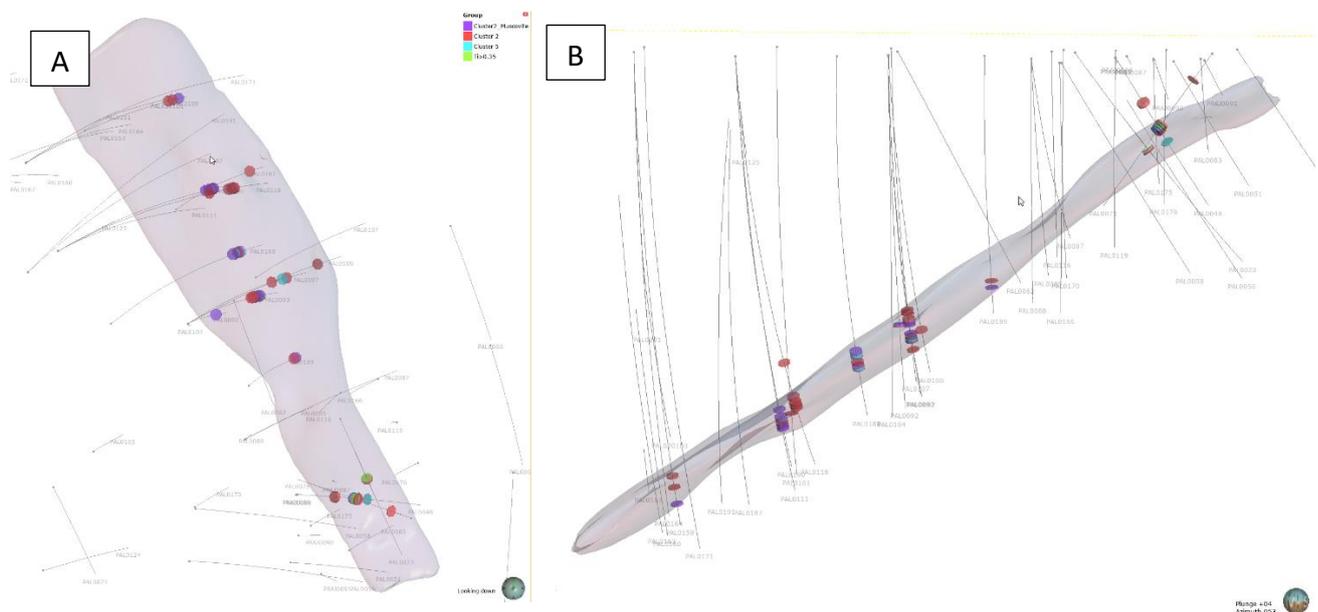


Fig.9 A) Plan view of Raja drill holes, position of BARCircle samples and modelled Raja body, B) NW-SE long section.

Four groups of sample were collected from 13 drillholes at Raja prospect. Position of these samples in Raja body is shown at fig.9. The host lithologies and most important assay data are summarized in table 2. They represent lithochemical styles described in chapter 4.1. Methodology of choosing the groups and attributing core samples to them are described in chapter 5.2. Some of the collected samples were previously sampled for research purpose, what allows for more detailed and objective characterization of material submitted to BATCircle project.

| Mawson Sample | BATCircle Code | Petrographic Description | Mass kg | Av. Co ppm | Av. As ppm | Av. Ni ppm |
|--------------------|----------------|---|---------|------------|------------|------------|
| Cluster2_muscovite | MR-MP | Muscovite/sericite-biotite schist (potassic), ductile, rich in sheet silicates | 43.6 | 1385 | 1090 | 143 |
| Cluster 2 | MR-AY | Albite breccia (sodic), brittle/competent, low in sheet silicates | 69.7 | 1514 | 720 | 112 |
| Cluster 5 | MR-B | Mostly albite breccia with highest Co grades, highest Ni | 35.2 | 2814 | 2753 | 180 |
| Ti>0.35 | MR-T | Either mica schist or albite breccia, but with elevated, potentially mafic Ti content | 14 | 1928 | 1032 | 149 |

Tab.2. Raja composite samples submitted for BATCircle study.

Fig.10 shows example of **Cluster2_Muscovite/MR_MP** (PAL0093 at 256.15 m, Co 1805.5 ppm, As 1404.7 ppm, Ni 131.1 ppm) analyzed by μ XRF. It is a muscovite-biotite-quartz schist, with these three minerals making up 75 wt% of the imaged sample. Pyrrhotite is dominant sulphide (22 wt%) and pyrite was not detected. Cobaltite (0.93 wt%) is main Co mineral and is concentrated predominantly in silicates (especially quartz) as shown on Fig.10 C. Neither linnaeite nor Co-pentlandite was found, most likely due to too low scanning resolution. Accessory minerals include scheelite, tourmaline (schoerl), molybdenite, apatite/monazite/xenotime.

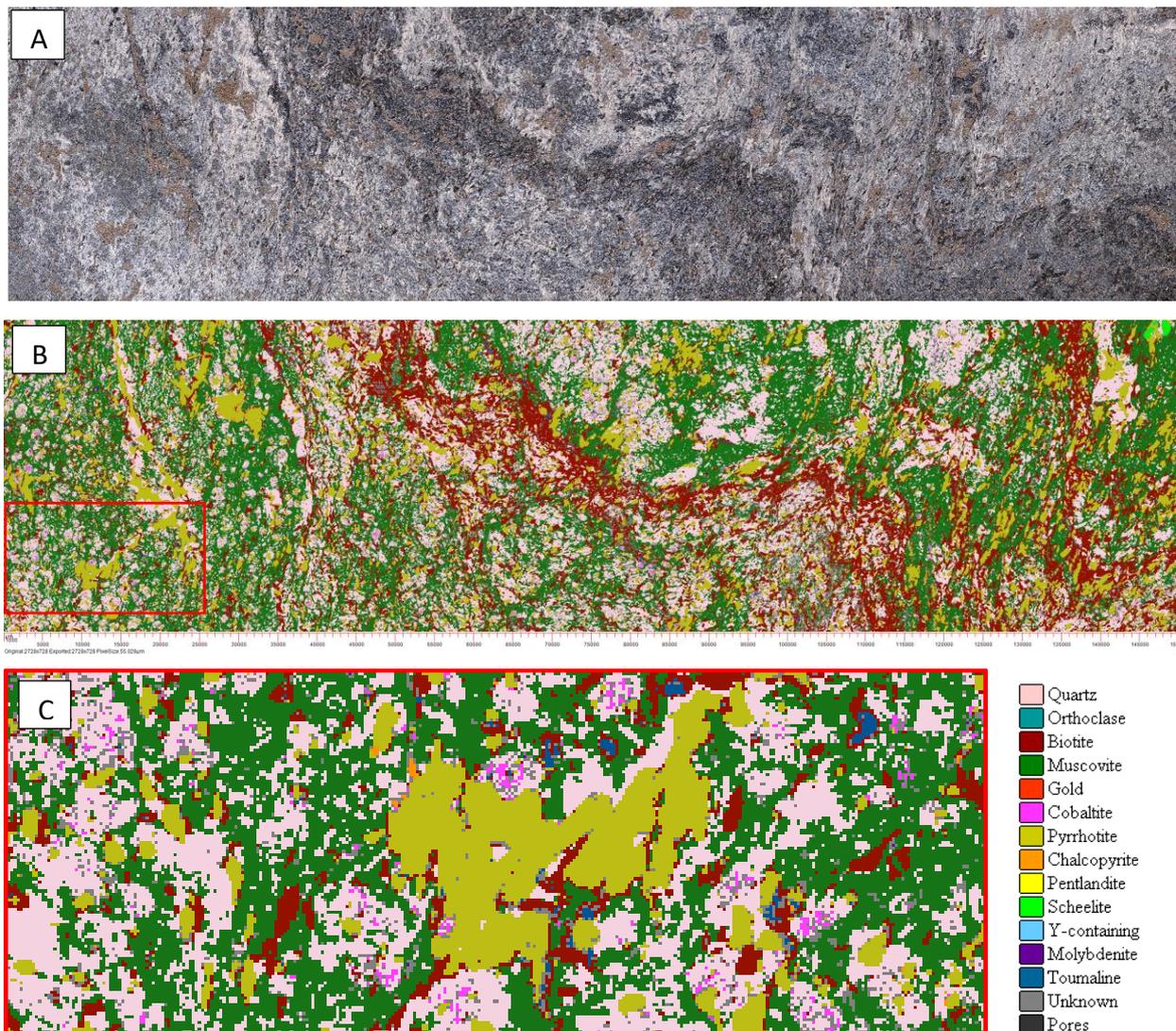


Fig.10. A) Photograph of the half core piece, B) MicroXRF false colour map of the same piece of half core confirming classification as uscovite-bt-qz schist. C. Close-up of cbt crystals dissem in predominantly qz grains. Images produced by Pieter Botha, Hippo Geoscience.

Example of albitic **Cluster 2** PAL0023 at 110.6 m (Co 2200 ppm, As 816 ppm, Ni 121.5 ppm) is shown in fig. 11. Since As content is considerably lower than Co, it can be expected that linnaeite/Co-pentlandite occur in significant amount. Thin section was prepared from chlorite-rich domain (fig.11 C, bottom right). Based on assay results – relatively low As content, linnaeite (and Co-pentlandite) is main Co phase followed by cobaltite. Linnaeite was observed only as irregular, blob-like primary exsolution together with Co-pentlandite (fig.11 B) and often chalcopyrite, whereas cobaltite (fig.11 A) is disseminated in albite and to a lesser degree pyrrhotite.

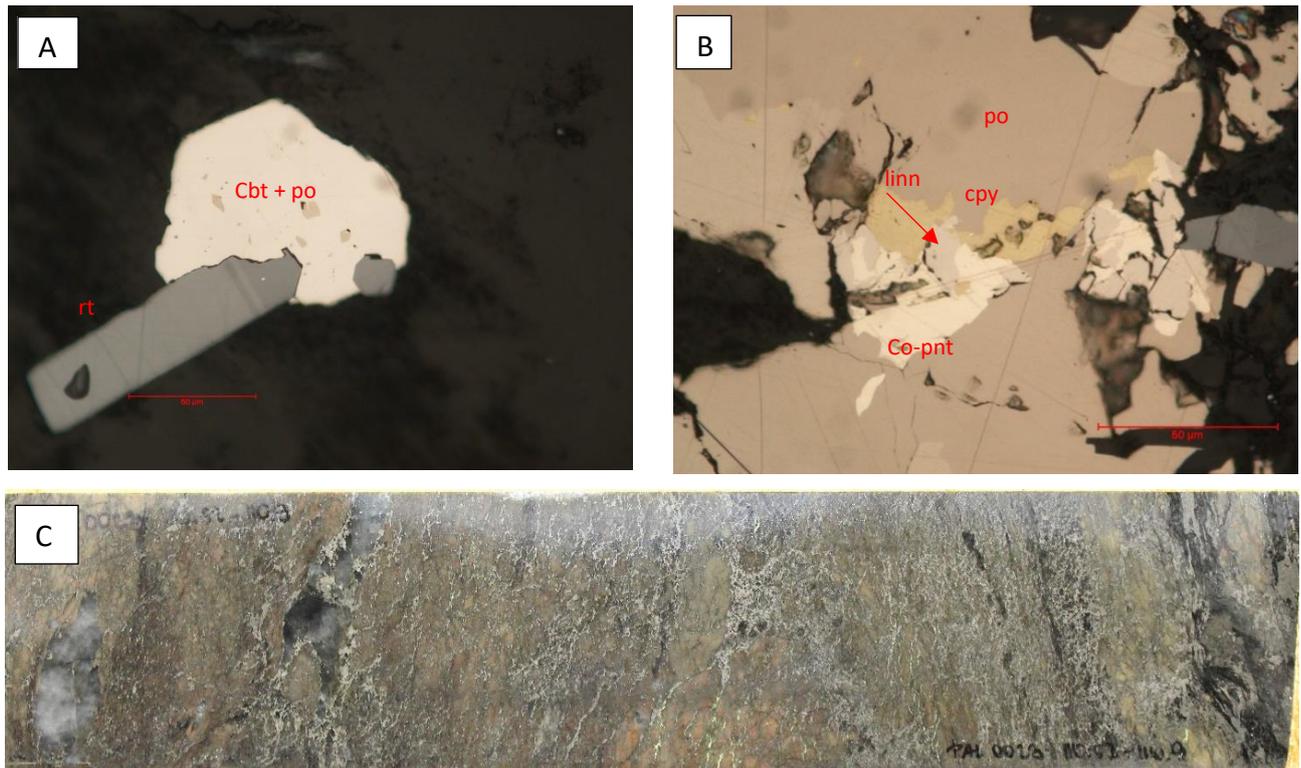


Fig.11. PAL0023 A) Cobaltite grain intergrown with rutile, B) Linn (greyish), Co-pent (creamy bright) and cpy exolutions in po, usually along individual grain boundaries or fractures, C) Greyish-tan alb with localized bt-rich section (thin section).

Example of **Cluster 5** is shown in fig.12. The thin section was prepared from PAL0048 at 87.65 m (Co 2890 ppm, As 2610 ppm, Ni 168.5 ppm) and analyzed by QEMSCAN. It shows muscovite-albite-quartz schist with minor biotite, but due to high Co and elevated Ni, the sample was assigned to Cluster 5. Nevertheless, this is an example of the same lithochemical style as Cluster2_Muscovite. Quartz, muscovite, albite and biotite comprise on average 30 wt%, 28 wt%, 14 wt% and 10 wt%, respectively. Pyrrhotite is main sulfide (18 wt%) and pyrite occurs as trace mineral. Co is hosted almost exclusively by cobaltite with average grain size ca. 35 µm. Cobaltite is most strongly associated with and disseminated in pyrrhotite and albite. Linnaeite was unknown when this QEMSCAN analysis was conducted.

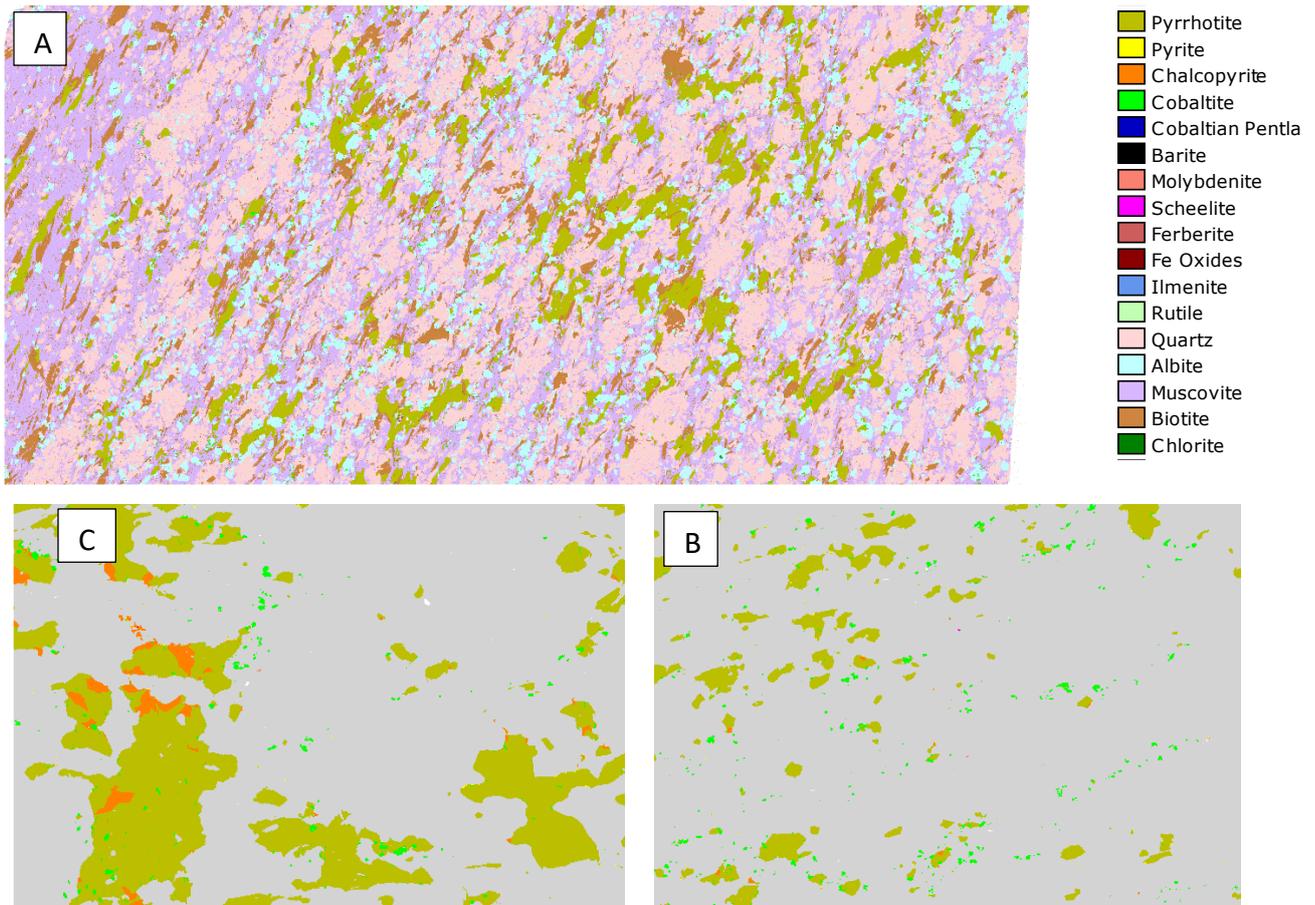


Fig.12 A) QEMSCAN false colour mineral map of a thin section from PAL0048 (note different scale and chosen colours from microXRF). Muscovite (+bt)-albite-qz schist with qz and minor alb prophyroblast enveloped by micas, B) and C) Close-up of sulphides only image with cbt disseminated in silicates (in particular along albite grain boundaries – oriented with foliation) or within large po grains/cluster of grains. Amount of Co-pent is insignificant, and presence of linn is unknown, but it would be classified as Co-pent at the time when this map was produced. Images come from Butcher et al. (2018) internal company report regarding gold mineral relationships.

Fig.13 shows example of **Ti >0.35 group/MR-T** (PAL0075 at 85.4 m, Co 1960 ppm, As 2100 ppm, Ni 100.5 ppm). In terms of rock forming minerals and over style, this sample is consistent with potassic muscovite-biotite schist. Elevated Ti is clearly explained by abundance of sphene and rutile with the former being replaced by the latter (fig.13 E).

Since As content is higher than Co, it can be expected that nearly all Co resides in cobaltite, although minor amount of Co-pentlandite was observed under the microscope (fig.13 D). Potential arsenopyrite as inclusions in larger pyrite grains was noticed as well. Cobaltite grains are disseminated mostly in silicates.

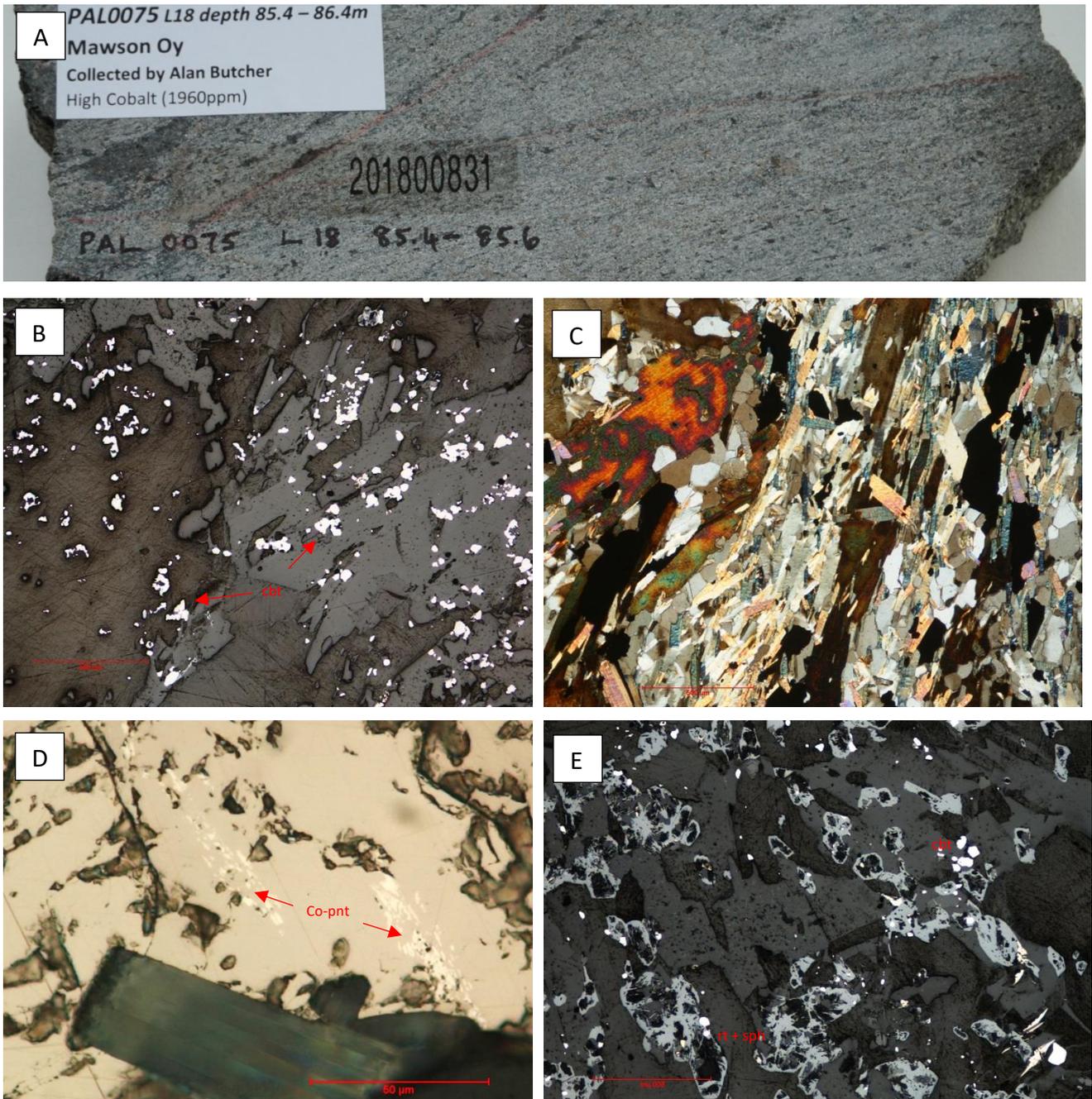


Fig.13 A. Half core sample of muscovite-biotite-albite schist, B. Cbt grains disseminated in silicate (alb and bt) and showing some sort of pattern in distribution, C. Bt-musc-alb schist texture, D. Small crystallographically-controlled bladed exsolution of Co-pnt – this small amount of Co-pnt and no linn is representative for that sample, E. Sphene grains being replaced by rutile, cobaltite can occur as inclusions or be attached to their surfaces.

6.2 Palokas samples

PAL0026 drill hole have been re-logged alongside its twin hole PAL0027 to ensure correlation of logged features is as good as possible. In terms of geochemistry the chosen intervals for sampling were not that different from each other, therefore selecting four samples allowed for further grouping e.g. based on potential rheological or metallurgical properties influenced by sheet silicates (chlorite, possibly talc). Sample 1 and 2 contain more chlorite than Sample 3 and 4, hence, after arrival at GTK Mintec facility, sample 1 and 2 were merge into one labelled as MP-1. Grt-bearing 3 and 4 seem more competent, thus were merged into second blend labelled as MP-2 (tab.3).

| Mawson Sample | BATCircle Code | Petrographic description |
|---------------|----------------|--|
| Sample 1 | MP-1 | predominantly Mg-Fe amphibolite (MFA) with considerable chlorite content |
| Sample 2 | | predominantly CLAPR rock (green chlorite, green/black/pale amphiboles and tourmalines) |
| Sample 3 | MP-2 | grt-bearing grey amphibolite |
| Sample 4 | | grt-bearing green amphibolite |

Tab.3. Palokas samples submitted for BATCircle study.

Palokas samples described here represent low grade ore. Co content is generally below 1000 ppm, with estimated average Co between 344 and 617 ppm Low As in geochem data indicate absence of cobaltite, elevated Ni suggest presence of Co-pent +/- linn.. However, recent liberation study conducted with material from twin hole PAL0027 found only minor amount of cobaltite and no linnæite/Co-pentalndite (see section 6.3).

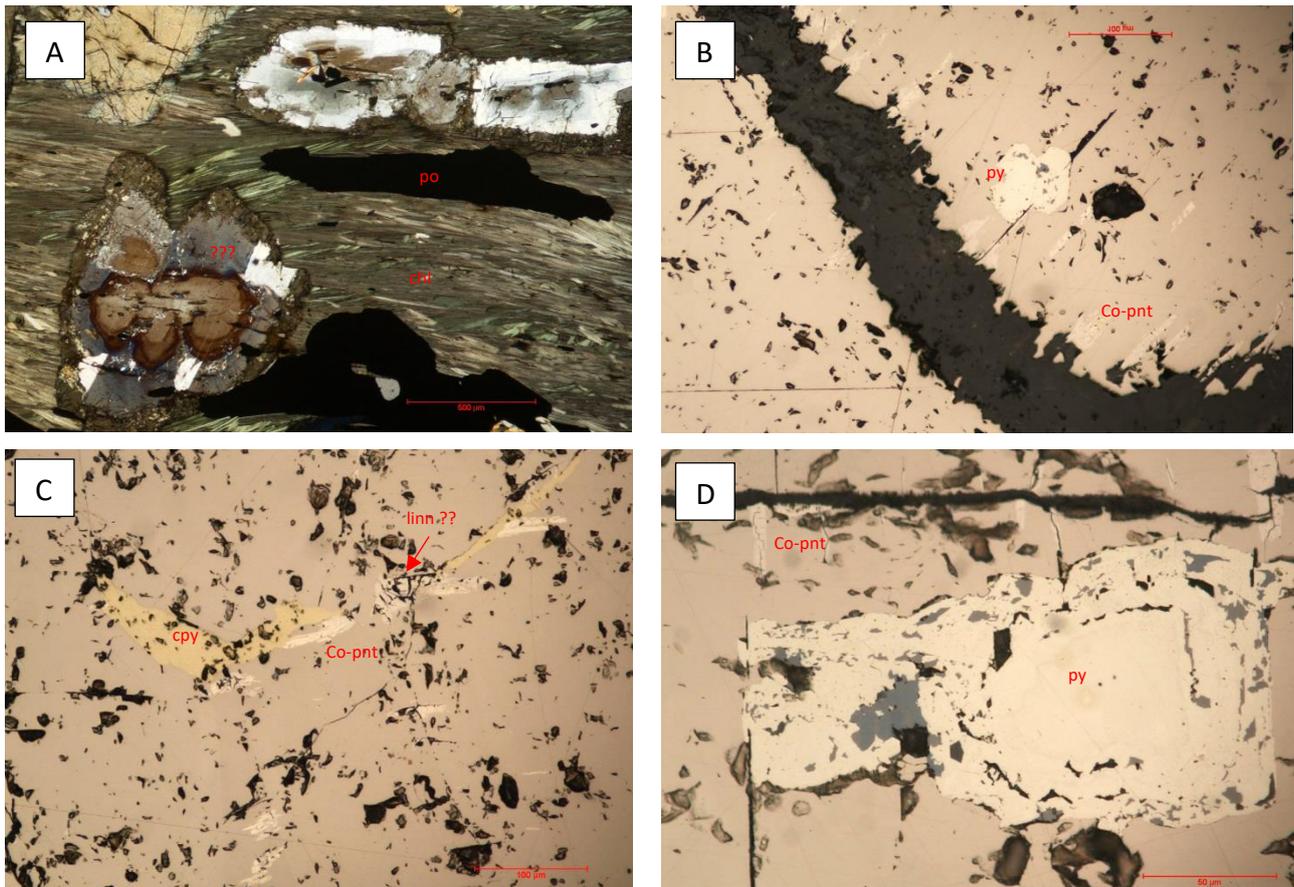


Fig. 14 A) Example of CLPAR lithology (Sample 2, MP-1): chlorite rich groundmass with po, amph and unidentified zoned plg-like phase (cordierite?), B) Crystallographically controlled Co-pnt exsolution in po and cross-like py grain, C) Co-pnt and cpy exolutions in po, potentially also linn – slightly less bright and fractured, D) Co-pnt exsolution perpendicular to fracture and peculiar anhedral py with zonal inclusions. This type of py might hosts some Co.

One thin section from Co-richest interval in PLA0027 at 35.05-35.30 (chlorite-amph lithology, Co 1080 ppm) was previously prepared (Fig.14). Cobaltite was not observed, presence of linnaeite is suspected based on slightly lower brightness of some exsolutions (fig.14 C, D). Co-pent occurs as small flames and blade-like exsolutions of in pyrrhotite; peculiar large grains of zoned pyrite (fig.14 D) were noted that may contain some Co, considering small amount of Co-pent and lack of other Co-minerals. However, none of the observed minerals were analyzed. These observations are consistent with the results of the liberation study which showed considerable loss of Co (section 6.3).

6.3 Previous and current metallurgical tests

Two liberation studies were conducted so far, one test on early shallow Palokas samples in 2014 and recently, another one on Raja and Palokas samples.

First gold-only metallurgical testing was carried out in 2014 by SGS Mineral Services UK in Cornwall, UK, on samples from Palokas shown non-refractory and 95% pure gold with excellent recovery of

97% on average by gravity separation and cyanide leaching (Hudson and Cook, 2018). At that time cobalt was not a metal of interest, therefore cobalt minerals were not subjected to testing.

Recently, a liberation study was conducted at GTK Outkumpu Facility. Five composite samples were collected either as a quarter core or coarse-grained leftover from assays, four from Raja and one from Palokas. Some samples from that study overlap with material submitted for the BATCircle study. Among samples analyzed in the liberation study was core from PAL0027 which is a twin hole to PAL0026 used in this BATCircle study. This sample represented Mg-Fe amphibolite with low-grade Co and very low As content. As expected from the geochemical data, cobaltite was found only as accessory mineral in heavy mineral fraction (5.9%) and in trace amount in sulfide fraction (0.6%), however no linnaeite or Co-pentlandite was found. Recalculated Co content was approximately 10x smaller than chemically measured. Therefore, it is likely that pyrite is a host to some of Co. Linnaeite/Co-pentlandite were expected to be present due to elevated Ni content, but absence of these minerals means that some other phase, such as pyrite, must be a host for Ni.

Also, four composite samples from three different holes from Raja were tested. It confirmed mineral associations, good liberation and recovery of gold, which was found to occur predominantly (96%) as free coarse grains, only small fraction (4%) of gold formed tiny inclusions, mostly in uraninite, molybdenite, Bi-telluride cobaltite and pyrrhotite. Cobaltite was well liberated (89-98%). Importantly linnaeite was not found in significant amount in any composite, despite Co, As and Ni content implying its major presence in some collected intervals. Thus, recalculated Co content was several times smaller than assayed. Linnaeite behavior during comminution should be investigated. This is an important finding for recovery of Co and design of Co extraction process.

As part of the BATCircle project, parallel small-scale metallurgical testing is currently carried out by Aalto University. The subject of the testing are two samples from Raja and Palokas prospects with highest Co grade with contrasting mineralization styles and Co mineralogy. Raja sample (PAL0163, 0.9% Co) is a laminated highly sulphidic albitite, Co is hosted by linnaeite, cobaltite is present in minor amount. Palokas sample (PAL0194, 1.5% Co) contains visible cobaltite grains disseminated in chlorite-amphibolite rock, however this sample have been only observed with a hand lens, hence precise mineralogy is unknown. The goal of the study is to analyze in details physical properties of Co minerals during froth flotation, in particular their interaction with bubbles of frothing agent.

7 SUMMARY AND CONCLUSIONS

Total of six samples were prepared from representative mineralized horizons at Raja and Palokas prospects. Summary of Rajapalot mineralization features is provided in table 4.

Four composite samples collected from 13 drill holes across Raja prospect represent two main Au-Co-hosting lithochemical styles, potassic (K±Fe) and sodic (albitite) with medium to high grades. Both lithologies are Ca deficient.

Presence of neighboring potassic and sodic mineralized zones is a characteristic feature of raja ore body. It is unclear whether these K and Na signatures are primary or secondary features or whether they are related genetically. Best grades often occurring at the boundary of both lithologies. It is also a competence boundary between brittle and ductile rocks which is considered important for fluid flow

and metal precipitations in various mineral systems, such as orogenic one. Both styles account for >95% mineralized rocks in Raja prospect.

Albitic host lithology is often more Co than Au rich, brittle textures such as breccia are common and association of mineralization with minerals like scheelite and tourmaline is not that strong. Cobaltite or linnaeite can be dominant Co host phase. Albite and quartz are main gangue minerals. Some Mg-Fe silicates, such as amphiboles or biotite/chlorite occur subordinately.

Four Palokas samples from one drill holes were prepared and subsequently blended into two groups. They represent typical variations of Palokas Fe-Mg-rich styles and are of low Co grade. Sampled material differs mineralogically, but not so much geochemically. The initial four samples were merged into two bigger groups based on sheet silicate content – less competent strongly chloritized one (green in color) and more competent, less chloritized garnet-bearing one (grey).

Palokas styles do not show much variation in potential rheological properties, and ductile deformations are typical for both chlorite/mica-rich and more chlorite/mica-poor rocks. Apart from typical Mg-Fe mineralization styles (represented either by orthoamphibole or chlorite-rich rocks), Raja-type K-Fe mica schist was intersected in Palokas and South Palokas prospects.

To assess proportions between different Palokas style variants more drilling down and across plunge is needed. In densely drilled, shallow parts of Palokas and South Palokas ore bodies, MFA and CLAPR rocks dominate. However deeper parts have only been reached with few drill holes so far.

Type of Co mineral can be predicted from assay results. The lower the As content compared to Co, the more linnaeite (and possibly Co pentlandite) must be present. In Palokas rocks, some small fraction of Co might be hosted by pyrite. Across Raja and Palokas prospects cobaltite and gold can be seen disseminated in all kinds of minerals. Linnaeite and Co-pentlandite are associated exclusively with pyrrhotite.

Previously conducted liberation study shows good recovery of cobaltite in albitic-potassic blend and lack of linnaeite resulting in significant loss of Co where this mineral was expected to be dominant Co host. Fate of linnaeite in liberation process should be investigated. This suggest that dividing samples based on main Co phase, cobaltite (high As) or linnaeite (low As) should be considered.

Scheelite, uraninite and to a lesser degree tourmaline are spatially associated with gold and cobalt enrichment especially in potassic, micaceous style. Muscovite, biotite and chlorite can comprise up to 50% of this style. Quartz ± albite occur as porphyroblasts/clasts. Cobaltite is main Co mineral.

| Min style | Host rock | Co minerals | Ore minerals | Gangue minerals | Special minerals | Geochem signature | % in whole system |
|----------------|------------------------------------|--------------------|-------------------------------|--|---|--|-------------------|
| Raja | | | | | | | |
| Albitic | Brecciated grey/tan albitite | Cbt, linn ± Co-pnt | Po, cpy, py, gold | Alb, qz, amph, bt, chl, msc, zr, mnz, ap | Rutile, uraninite, tourmaline | Na, Co, As, Ni, U, low/no Ca | 30-40 |
| Potassic | Muscovite-biotite schist | Cbt, linn | Po, py, cpy, gold, mbd, Bi-tr | Msc, ser, bt, alb, qz, mgt, mnz, ap, zr | Scheelite, uraninite, Bi-telluride, molybdenite | K, Co, As, W, Mo, U, Bi, Te, low/no Ca | 60-70 |
| Palokas | | | | | | | |
| MFA | Mg-Fe amphibolite | Linn, Co-pnt | Po, py, cpy, gold, mbd | Amph, crd, alb, qz, chl, grt, ilm, mgt | Radially growing pale amph, uraninite | Mg, Fe, Ni, Cu, low/no Ca | - |
| CLAPR | Chlorite-amphibole-pyrrhotite rock | Linn, Co-pnt, cbt | Po, cpy, py, gold, mbd | Chl, alb, qz, tou, amph, crd, bt, ilm, ap, mnz, cal, brt | Green chl, tourmaline | Fe, Mg Co, Cu, Ni, ±As | - |

Tab.4. Summary of lithochemical styles and mineral assemblages in Rajapalot project.

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