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Sveriges geologiska undersökning
Geological Survey of Sweden

NEW BOLIDEN

TEXTURAL AND CHEMICAL CHARACTERIZATION OF SULPHIDES FOR IMPROVED BENEFICIATION AND EXPLORATION, SKELLEFTE DISTRICT, SWEDEN

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11 of November 2020

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Motivation

- Limited data on the distribution of trace elements in sulphides in Swedish VHMS deposits.
 - Precious elements (e.g. Ag, Au)
 - Deleterious elements (e.g. Sb, Cd, Hg, Mn)
 - Critical elements (e.g. In, Bi, Ga, Ge)
- Finding VHMS deposits using classical exploration methods can be challenging.
 - Graphite and pyrrhotite in the Vargfors group (Skellefte district) complicates geophysical detection of blind VMS deposits.
- The use of a mineralogical approach for the control of element deportment in beneficiation products.



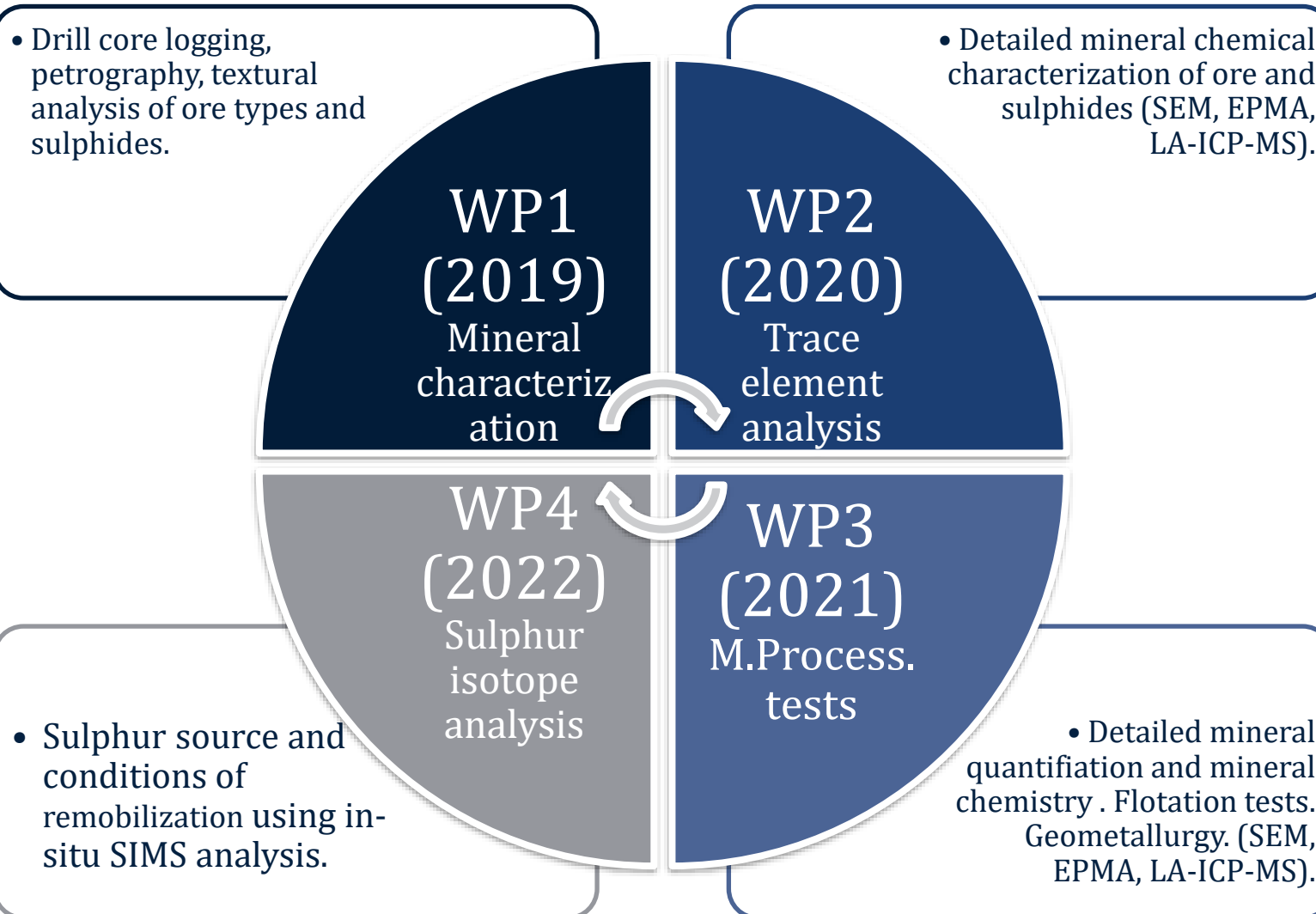
Project Overview

- A 4 year PhD project at LTU (2019-2023).
- Funded by Boliden Mineral and SGU.
- Main topic: Distribution of trace elements (critical, precious and deleterious) in and around a Palaeoproterozoic VMS deposit.
- Main objectives:
 - **Geological:** Improved understanding of the trace element distribution in Swedish VMS deposits.
 - **Exploration:** New tools for finding blind massive sulphide deposits by understanding associated sulphide haloes.
 - **Beneficiation:** Improved recoveries, including better understanding of trace element deportment.

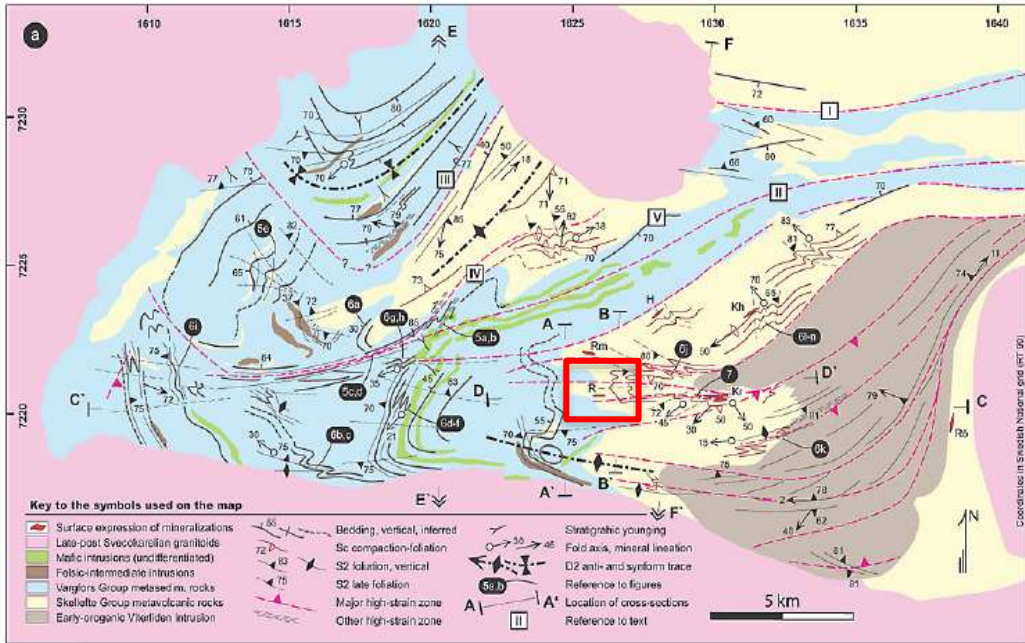
Research group

Luleå University of Technology		Role
<u>Jonathan Rincon</u>		<u>P.hD. student</u>
Assoc. Prof. Nils Jansson		Project leader, main supervisor
Prof. Christina Wanhainen		Associate supervisor
Dr Helen Thomas		Associate supervisor
Boliden Mineral AB		Role
Dr Christiane Kaiser		Coordinator and advisor, Exploration
Iris McElroy		Coordinator and advisor, Process Technology
Mac Fjellerad Persson		Coordinator and advisor, Exploration
Rickard Långström		Coordinator and advisor, Process Technology

Work packages

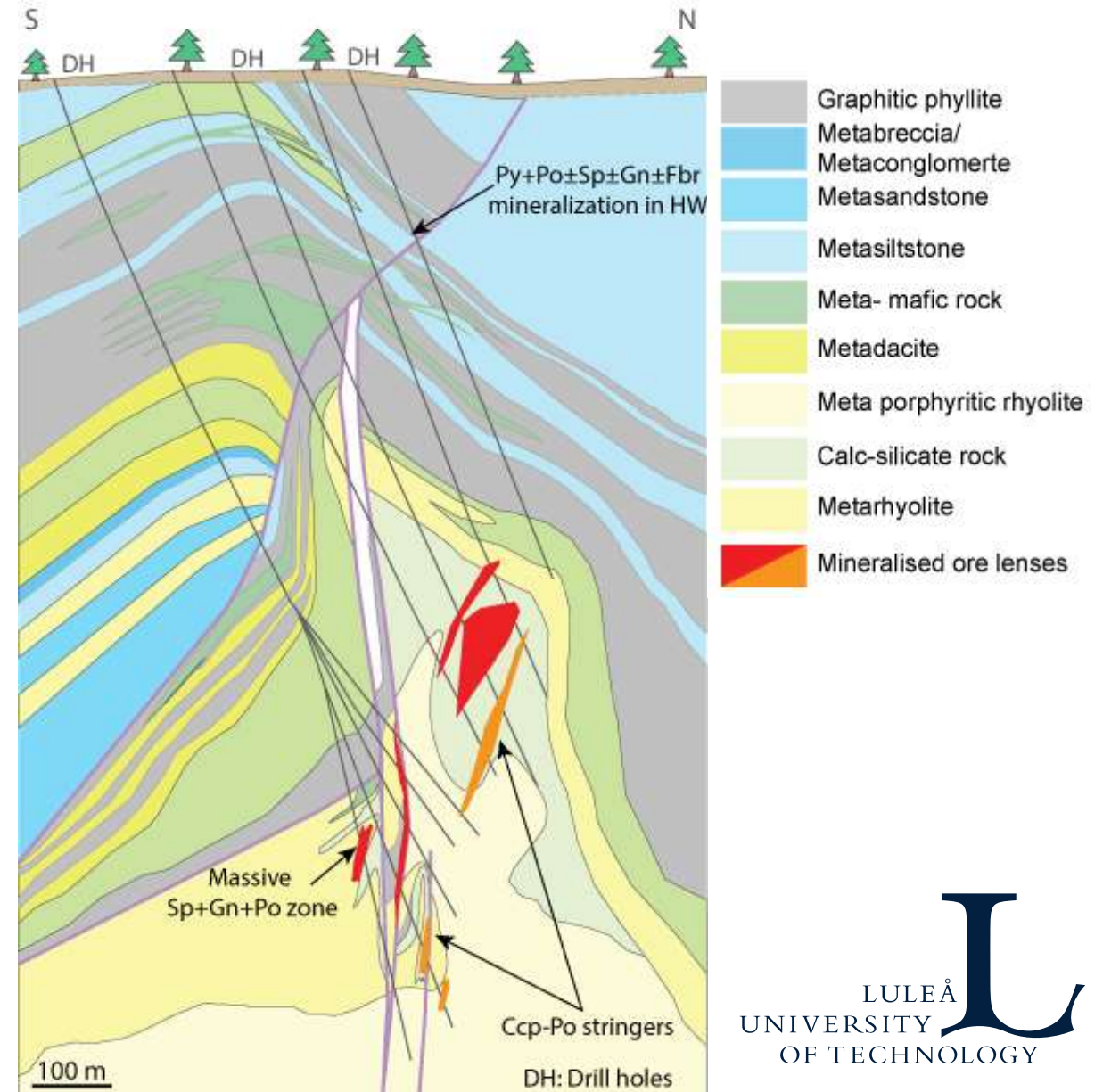


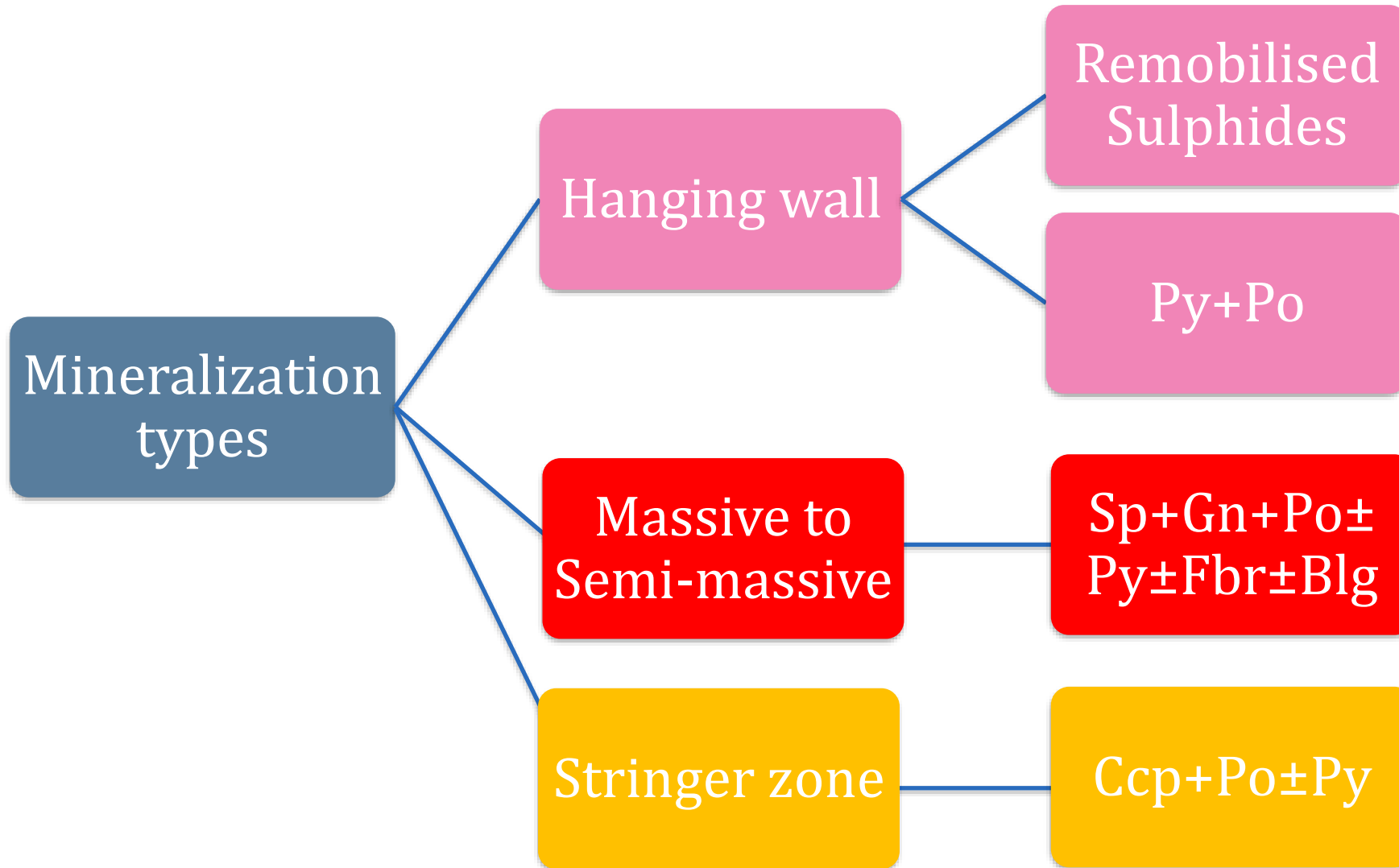
Rävliden North



Regional geological map after Skyttä et al. (2012)

- 'Rävliden horizon': Syngenetic VMS deposit at the Skellefte group-Vargfors group contact.
- Greenschist to lower amphibolite facies.
- Hosted in a west plunging antiform.

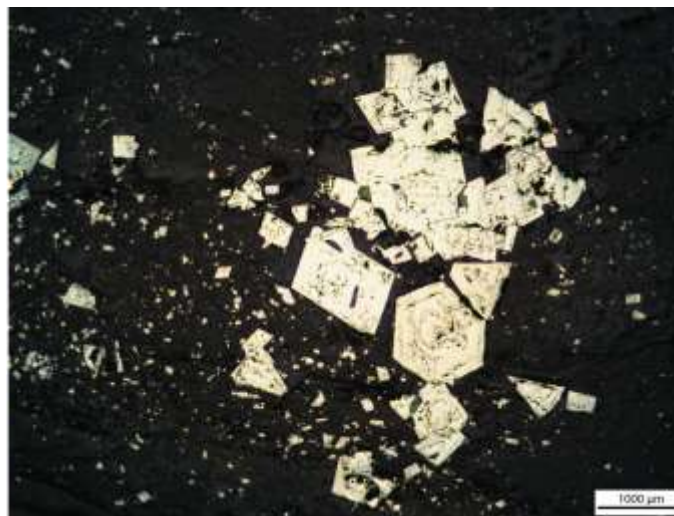
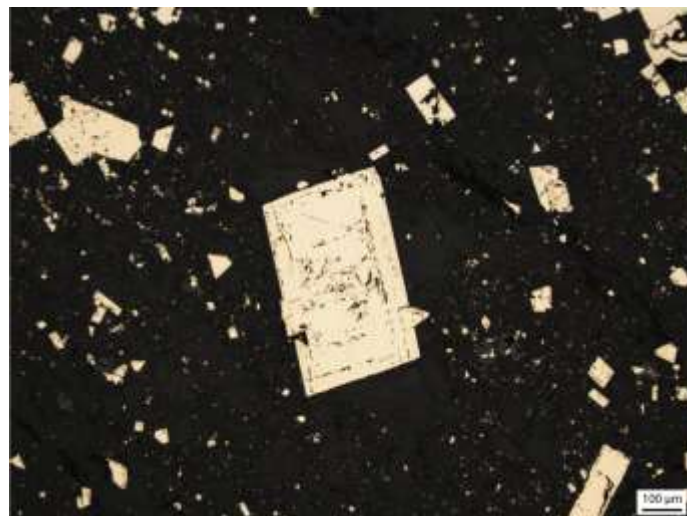
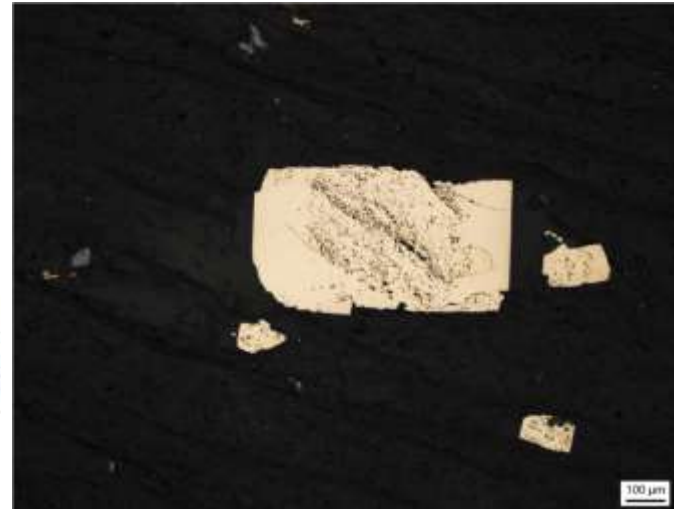




Mineralogy and textures

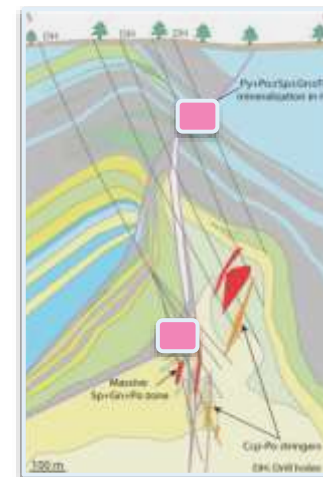


5 cm



Py+Po

- Zoned pyrite mineralization in graphitic phyllites.
- Inter-tectonic to syn-tectonic pyrite porphyroblasts in shear zones.



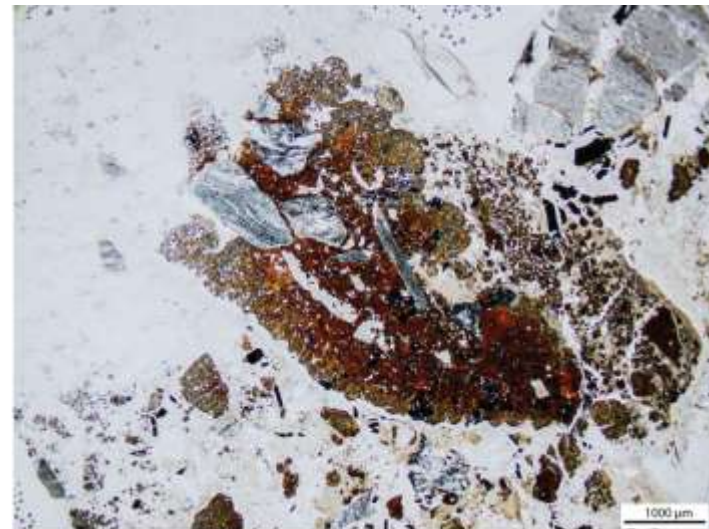
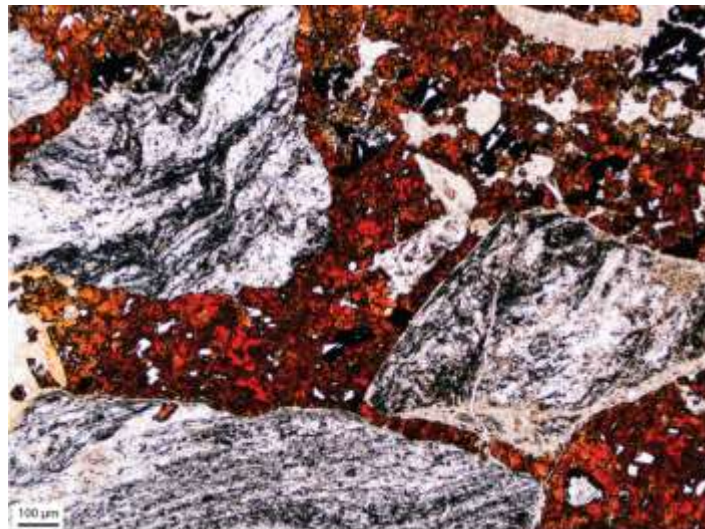


2.5cm



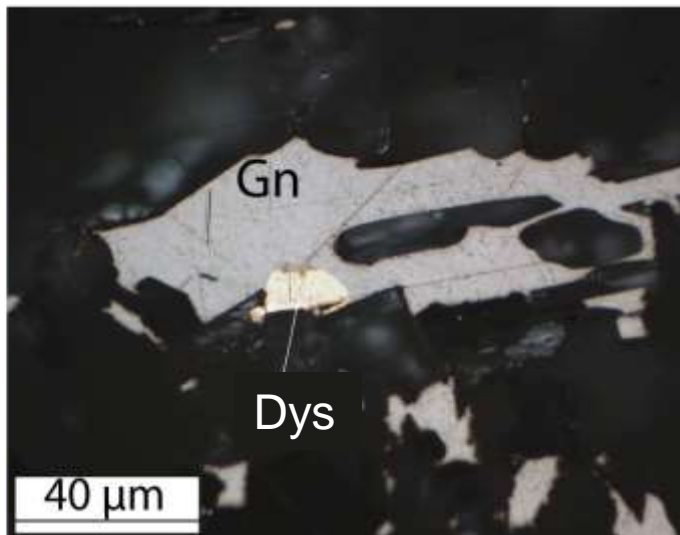
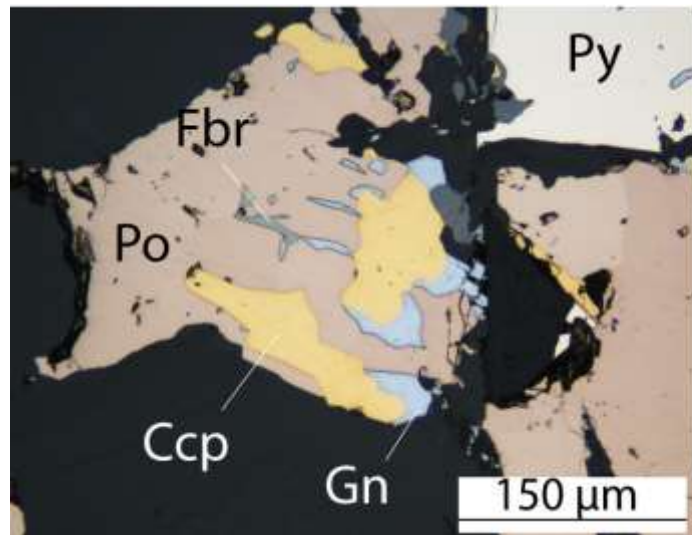
Remobilised Sulphides

- Sphalerite+galena+pyrrhotite – cemented breccias.
- Sulphide-rich veins.
- Hessite (Ag_2Te) as inclusions or intergrowths in galena.



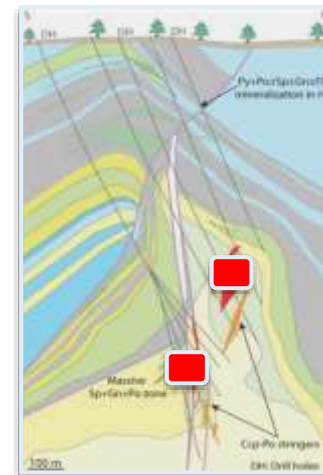


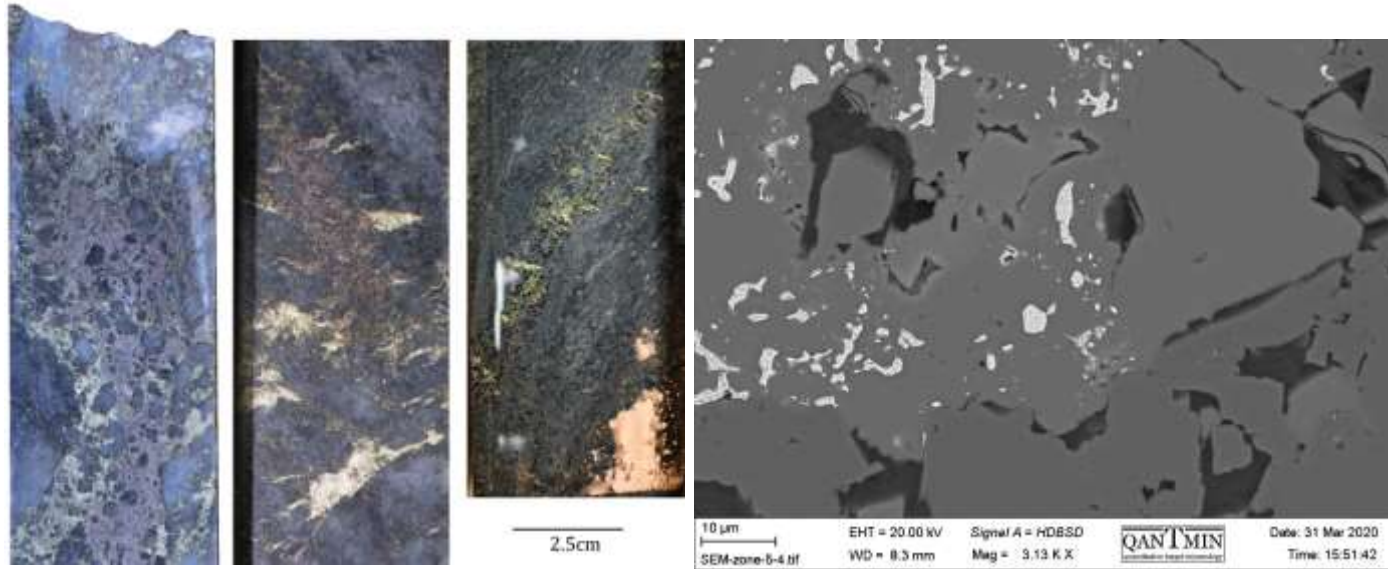
2.5cm



Massive Sp+Gn+Po±
Py±Fbr±Blg

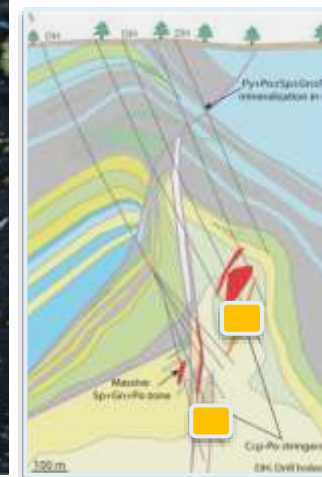
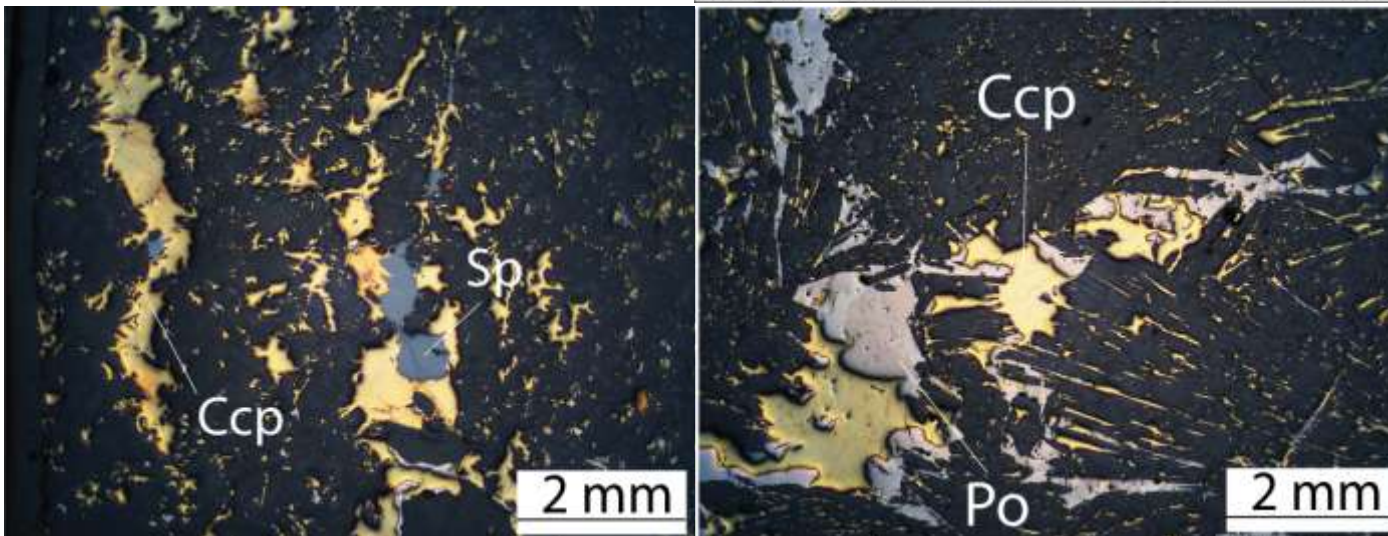
- Durchbewegt and foliated textures.
- Galena filling piercement veins and tension gashes.
- Silver-Sb sulphosalts (e.g. dyscrasite, freibergite) in galena.
- Euhedral pyrite porphyroblasts, some of them zoned.





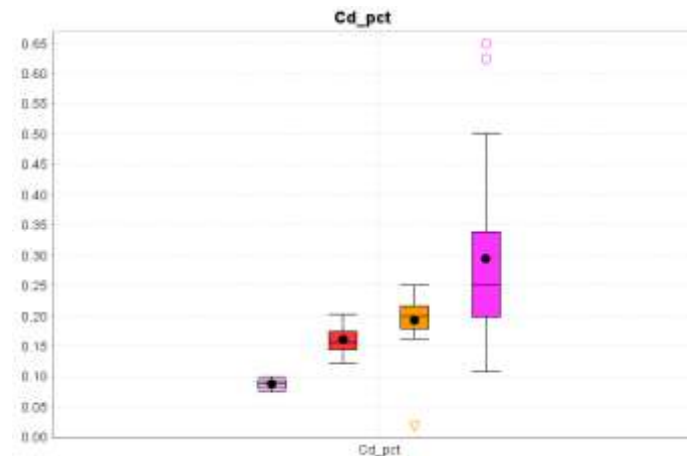
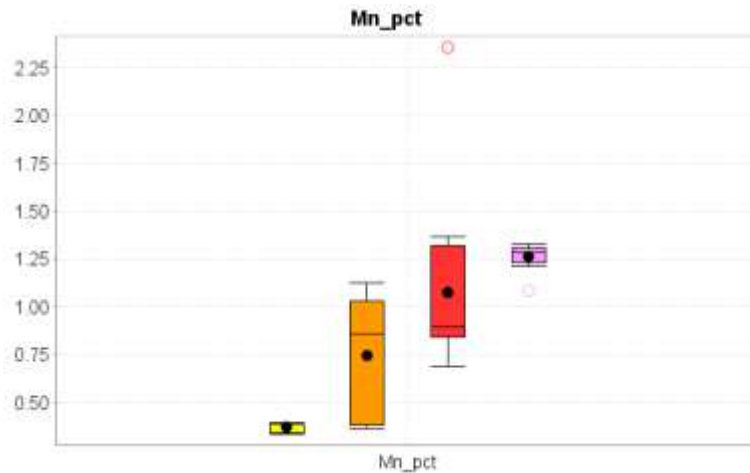
Ccp+Po±Py 'stringers'

- Ccp+Po±Sp in piercement veins.
- Breccia and durchbewegt textures.
- Ag-Hg amalgams in pyrrhotite, chalcopyrite, and sphalerite.



EMPA results

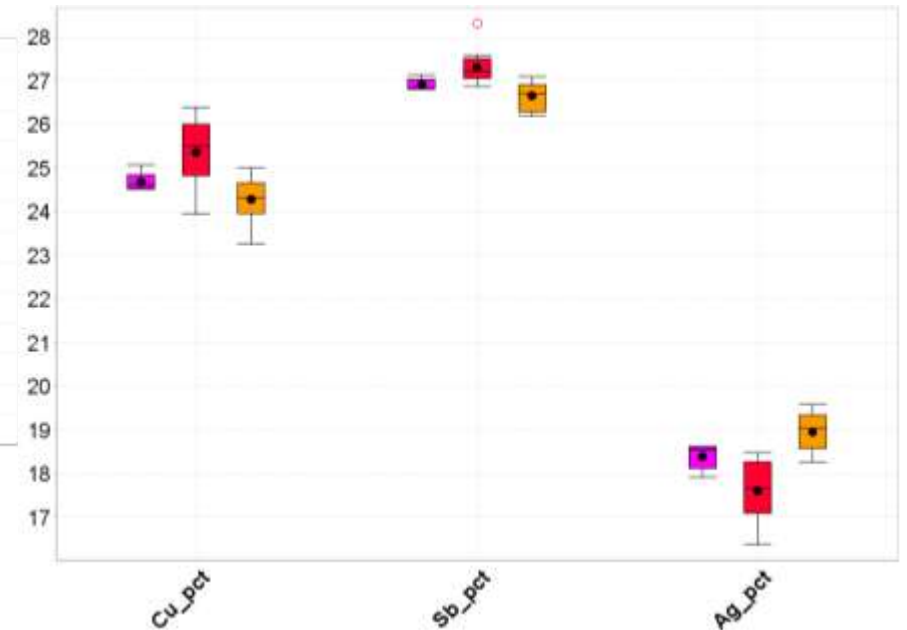
Sphalerite



- Manganese content in sphalerite is highest in the hanging wall and massive Sp+Gn+Po mineralisation.
- Cadmium content in sphalerite is highest in the hanging wall and Ccp+Po mineralisation.

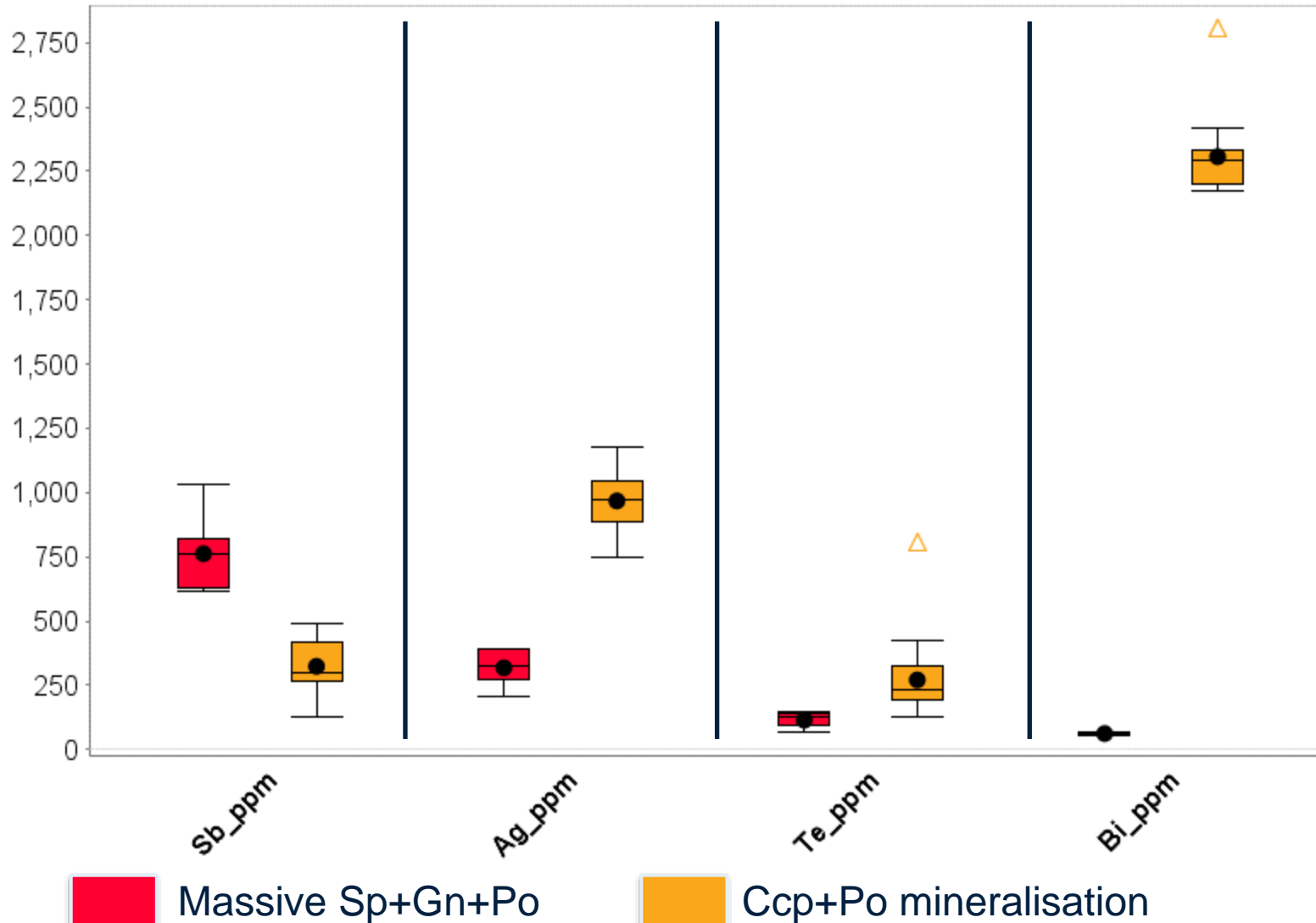


Freibergite



- Copper and antimony content in freibergite are highest in the massive Sp+Gn+Po mineralisation.
- Silver content in freibergite is highest in the Ccp+Po mineralisation.

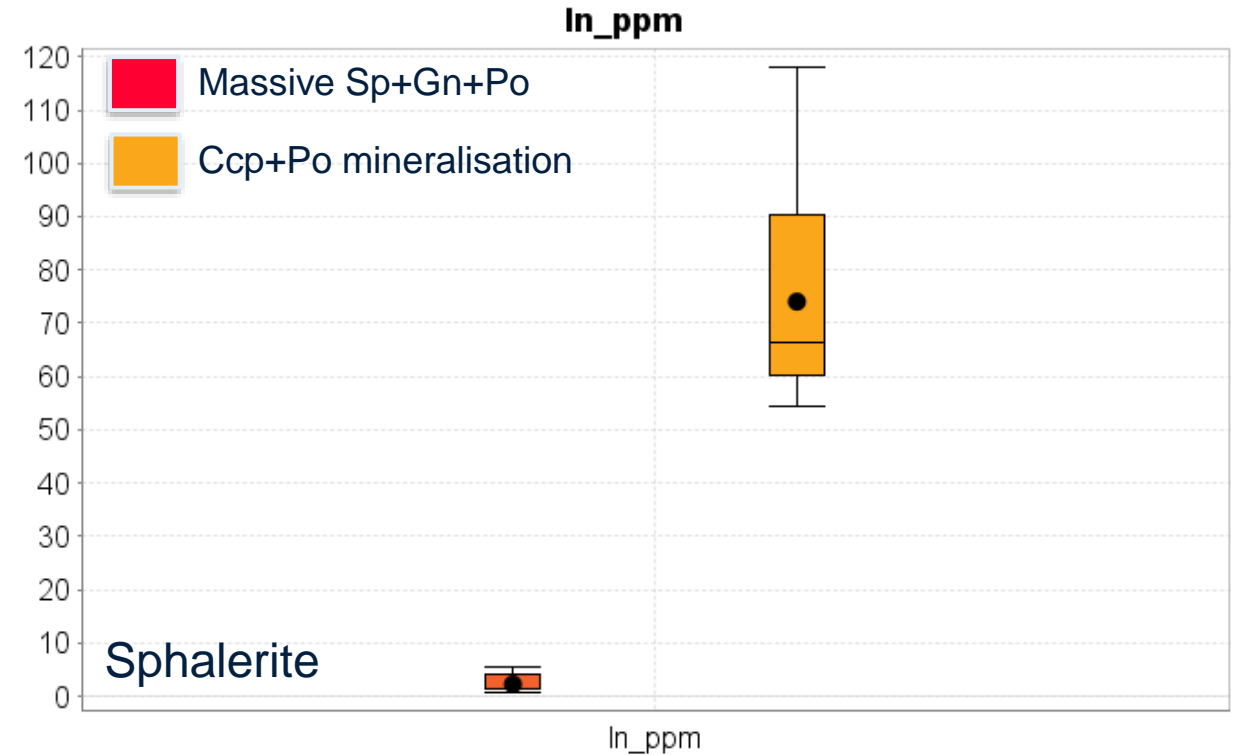
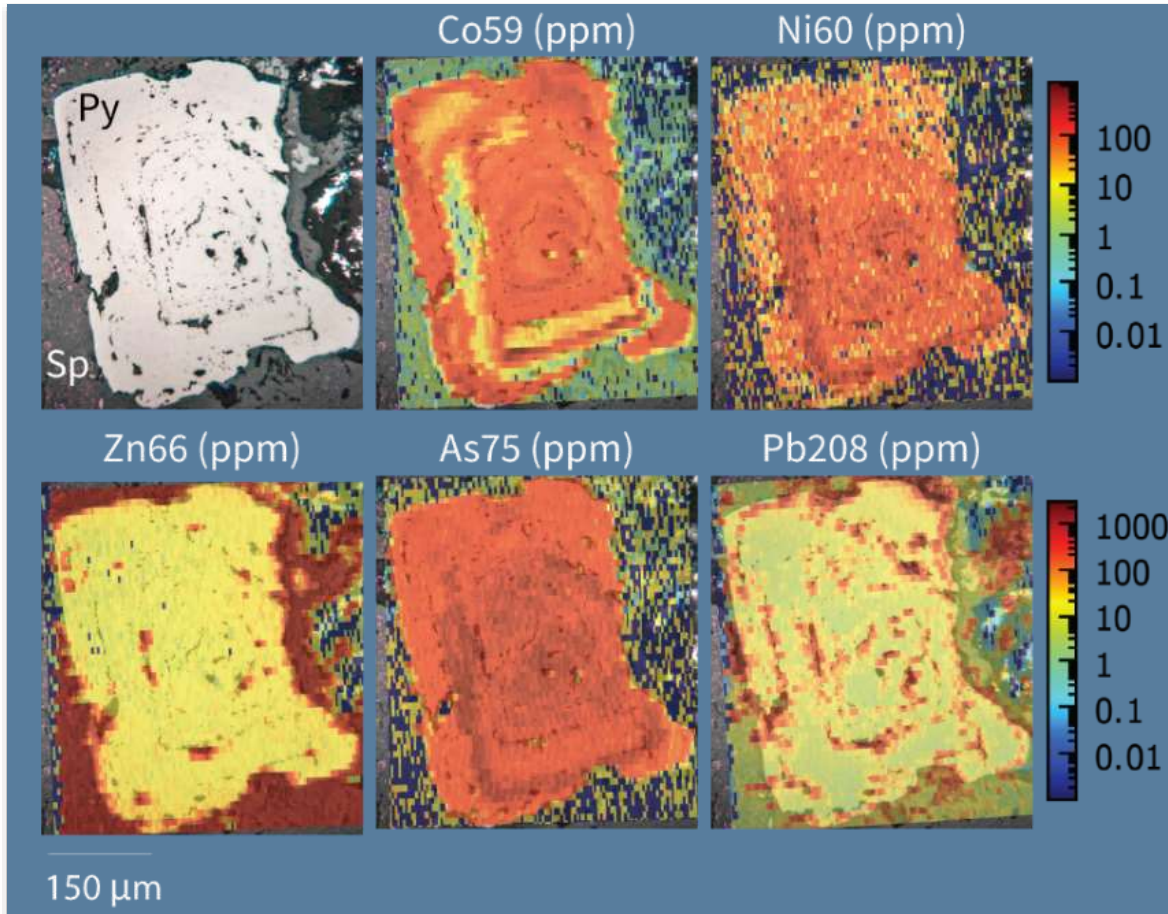
LA-ICP-MS results



Trace-elements in galena:

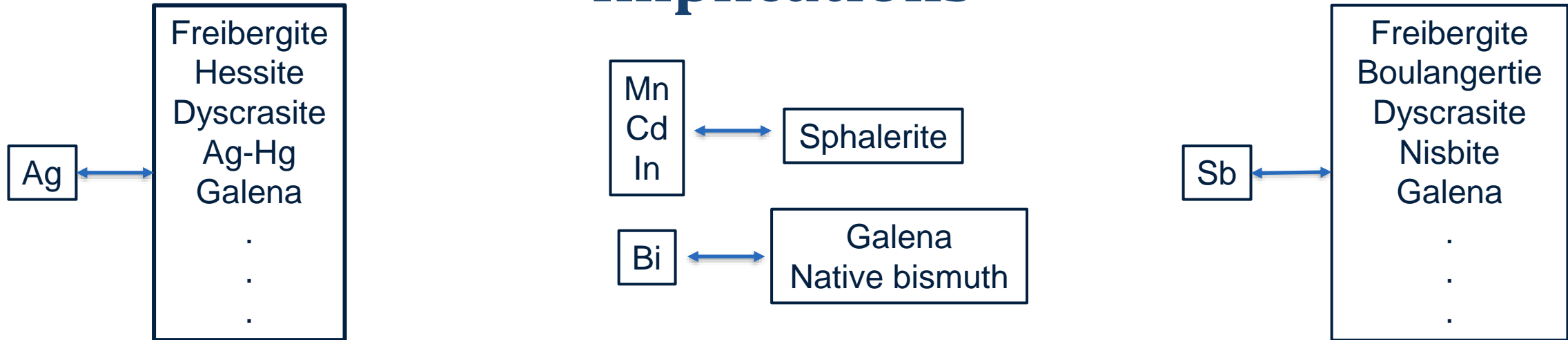
- Antimony content is highest in the massive Sp+Gn+Po mineralisation.
- Ag, Te, and Bi are highest in the Ccp+Po mineralisation.
- Median bismuth content is 2289 ppm in the Ccp+Po mineralisation.
 - Micro- to Nano-inclusions of bismuth minerals in galena.

LA-ICP-MS results



- Indium median content in sphalerite:
 - 1.2 ppm in massive Sp+Gn+Po mineralisation.
 - 66.3 ppm in Ccp+Po mineralisation.
- Pyrite concentric trace element zonation.
 - Sulphide cemented breccia in the hanging wall.

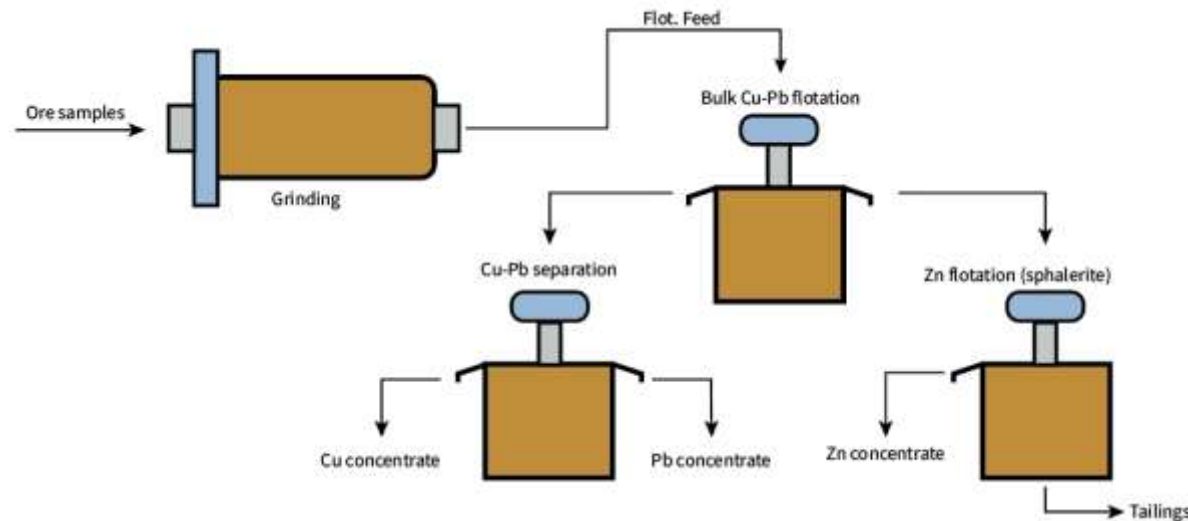
Implications



- Potential use for exploration near Rävliden North or in similar VHMS deposits in the district.
- Knowledge of elements and minerals recovered in different flotation products.
- Variability at deposit scale.

Future work

- Flotation and comminution tests.
 - Sphalerite Fe content can be detrimental for flotation (reduced efficiency in collector adsorption) (Boulton et al. 2005).
 - Talc and tremolite are problematic gangue minerals (Farrokhpay et al. 2018, Mishra et al. 2013).



- More LA-ICP-MS analyses in samples from each mineralisation style, and in flotation products.

Project sponsored by

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