TOWNEND
mineralogy laboratory

NEIL MARTIN 26-11-2015

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PREPARATION OF 36 POLISHED THIN SECTIONS OF THIRTY SIX DRILL CORES AND MINERAGRAPHIC/PETROGRAPHIC DESCRIPTIONS, INCLUDING SEM ANALYSES

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SUMMARY OF RESULTS

Thirty six drill core samples taken from twenty one drill holes represent a quite variable assemblage of sulphides and usually subordinate non-sulphide gangue. Thirty of the drill cores can be classified as massive sulphide and of these twenty seven contained significant mineralisation.

The ore mineralisation was dominated by sphalerite, with lesser quantities of chalcopyrite, tetrahedrite and usually accessory galena. Silver bearing gold, exceptionally reaching 40% silver (electrum) was detected in eleven cores. Silver was also present in tetrahedrite with typical values between 1 and 2% plus several examples of high silver tetrahedrite (freibergite)

Pyrite was the dominant gangue sulphide with lesser quantities of pyrrhotite, while oxides are represented by significant magnetite in one group of core. With the exception of pyrrhotite in some samples, the sulphides were fresh primary minerals. Pyrrhotite sometimes showed marked alteration to marcasite.

The very subordinate non-sulphide gangue within the massive ores was mainly carbonates, (ankerite, siderite >dolomite) and quartz with subordinate muscovite. There were three exceptional samples in which a lesser sulphide content was associated with either major barite or once the barium feldspar, celsian. There was a little silicate alteration with secondary phyllosilicates such as chlorite and kaolinite.

Textures of the massive sulphide cores usually featured a coarse banding due to variations in the percentage of the main sulphides. The textures of the main sulphides were relatively consistent with pyrite as euhedral crystals, contrasting the anhedral shape of the associated sphalerite, chalcopyrite, galena or pyrrhotite.

Probably the most dominant texture consists of major euhedral pyrite concentrations in an enclosing coarse matrix of sphalerite, plus or minus chalcopyrite. Pyrite grainsizes can vary between 50 and 500 µm but tend to be in the 100-200 µm range. Liberation sizes for sphalerite or chalcopyrite vary widely depending on the density of the pyrite concentration. In samples where pyrite becomes dominant, and semi-coalescent, the sphalerite and chalcopyrite forms very subordinate interstitial and relatively fine grains wrapped around the idiomorphic pyrite. In some cores where this occurs there is then a population of sphalerite, chalcopyrite and galena fines within the pyrite host.

Some of the sulphide bands may be deficient in pyrite and then either sphalerite or chalcopyrite is dominant with coarse liberation sizes. There are some massive samples where pyrrhotite is a major sulphide forming more complex textures with the sphalerite, chalcopyrite etc.

One group of massive sulphides, also contains major magnetite that tends to occur as subhedral grains of similar dimensions to pyrite, but within sphalerite. Uncommonly the magnetite may host fines of galena, chalcopyrite etc.

Another small group of massive sulphide contains chalcopyrite as the coarse dominant matrix with finer included pyrite, pyrrhotite and accessory sphalerite.

Three massive sulphide cores are dominated by pyrite, pyrrhotite and magnetite with low levels of sphalerite, chalcopyrite etc.

There are seven drill cores which contain minor to accessory quantities of sulphides. These are predominantly quartz muscovite chlorite schists that have vein mineralisation of base metal sulphides in siderite or dolomite. The sulphides are mainly pyrrhotite, pyrite with chalcopyrite and lesser sphalerite.

The drill cores reveal little evidence of a volcanic origin. They are essentially low grade metamorphic schists with sometimes oriented muscovite visible in massive sulphide.

One possible primary phenomena, is the presence of coarse albite in the schists and several of the massive sulphide cores. In the latter, there is a 1 cm mass of coarse polycrystalline albite i.e. albitite, in one sample (259 49.87). In another (203 101.3), numerous albites to 1.2cm, either fresh or part to completely altered, to a fine grained yellow brown phyllosilicate. Similar crystals, usually part altered at rims occur in most of the low sulphide schists. Albitites are common as wallrocks in both VMS and SEDEX deposits.

Based on mineralogy, the drill cores are classified into seven groups:

GROUP 1

160 153.3-153.6
202 11.66-11.84
226 149.45-149.55
236 99.4-99.52
267 154.74-154.86
274 85.15-85.28

Massive sulphides, dominated by euhedral pyrite, interstitial accessory sphalerite > galena, chalcopyrite, arsenopyrite, tetrahedrite. Gangue ankerite.

GROUP 2

227 34.19 -34.29
264 155.3-155.6
267 140-140.11

Massive to minor sulphides. Major euhedral pyrite, angular sphalerite, accessory tetrahedrite/ tennantite, chalcopyrite, galena and arsenopyrite. Gangue celsian or barite.

GROUP 3

240 51.35-51.48
243 176.57-176 74

Massive to major sulphides. Major euhedral pyrite, minor anhedral sphalerite tetrahedrite chalcopyrite, accessory galena arsenopyrite. Gangue ankerite, siderite, quartz and mica.

GROUP 4

144	78-78.11
202	16.33-16.46
203	102-76-102.87
203	122.23-122.38
207	83.2-83.34
240	47.57-47.67
264	156.56-156.7
274	59.22-59.36
278	136-136.13
284	171.92-172.05
287	50.98-51.23

Massive sulphides. Major euhedral pyrite, major to minor anhedral sphalerite, minor magnetite, minor to accessory pyrrhotite, accessory chalcopyrite galena. Gangue siderite quartz chlorite talc.

GROUP 5

203	101.3-101.4
259	49.87-49.5
264	149.32-149.45
273	95.62-95.76
273	91.55 -91.69

Massive sulphides dominant to major chalcopyrite, major to minor pyrite, minor to accessory pyrrhotite, accessory sphalerite. Gangue albite muscovite chlorite quartz siderite.

GROUP 6

236	81.5-81.6
267	143.52-143.62
273	98-98.12

Massive low grade sulphides. Dominant pyrite, minor pyrrhotite magnetite, accessory sphalerite chalcopyrite galena. Gangue siderite dolomite quartz,

GROUP 7

238	175.32-175.43
242	92.24-92.36
260	155.67-155.78
264	164.7-164.81
284	180.76-180.91
284	182.35-182.48

Sulphide poor chlorite muscovite schists with sulphide bearing quartz carbonate veins.

METAL DISTRIBUTION

ZINC
Zinc is mainly present as sphalerite, with measured iron content ranging from 5 to 10%. It is also present in all the tetrahedrite tennantite grains analysed, between 3 and 5% Fe.

COPPER
Copper is present as chalcopyrite and tetrahedrite/tennantite. There was a trace as bournonite as above, and once as the copper tin sulphide, stannite (243 176.57)

LEAD/SELENIUM
Lead is present as galena plus a trace as bournonite and an unnamed lead antimony sulphide in sample 144 78. Several galenas were analysed for selenium by SEM, which found up to 9%.

SILVER
The silver detected was mainly present in the tetrahedrite/tennantite group. Most examples had between 1 and 2% silver, but there were several silver rich grains, containing between 15 and 25% silver, equivalent to freibergite.

Silver was also present in gold, and in one sample was electrum with silver content around 40%.

GOLD
Gold was found optically in eleven cores, the majority in the first priority group. It was also silver bearing and one particularly high grade sample from the third priority group was electrum.

ARSENIC ANTIMONY
Arsenic was present as accessory arsenopyrite in a number of massive sulphide samples. It also occurred as an accessory element in tetrahedrite and once was dominant over antimony (tennantite). Antimony was present mainly in tetrahedrite, with values between 15 and 26%, and once in bournonite.

BISMUTH TIN
There are two examples of fine bismuth occurrences, with galena. Tin was detected once as fine stannite.

SAMPLE K15-273 98-98.12

DRILL CORE

POLISHED THIN SECTION

GANGUE	**10%**
CARBONATE	DOMINANT
SERICITE	MINOR
ORES	**90%**
PYRITE	70%+
PYRRHOTITE (MARCASITE)	20%
CHALCOPYRITE	5%
SPHALERITE	2%
MAGNETITE	TRACE
GALENA	TRACE

CLASSIFIED AS MASSIVE PYRRHOTITE PYRITE ORE CONTAINING CHALCOPYRITE AND LOW SPHALERITE.

This is a low grade massive sulphide sample with about 10% of interstitial rounded carbonate (siderite SEM) in a matrix of fine sericite.

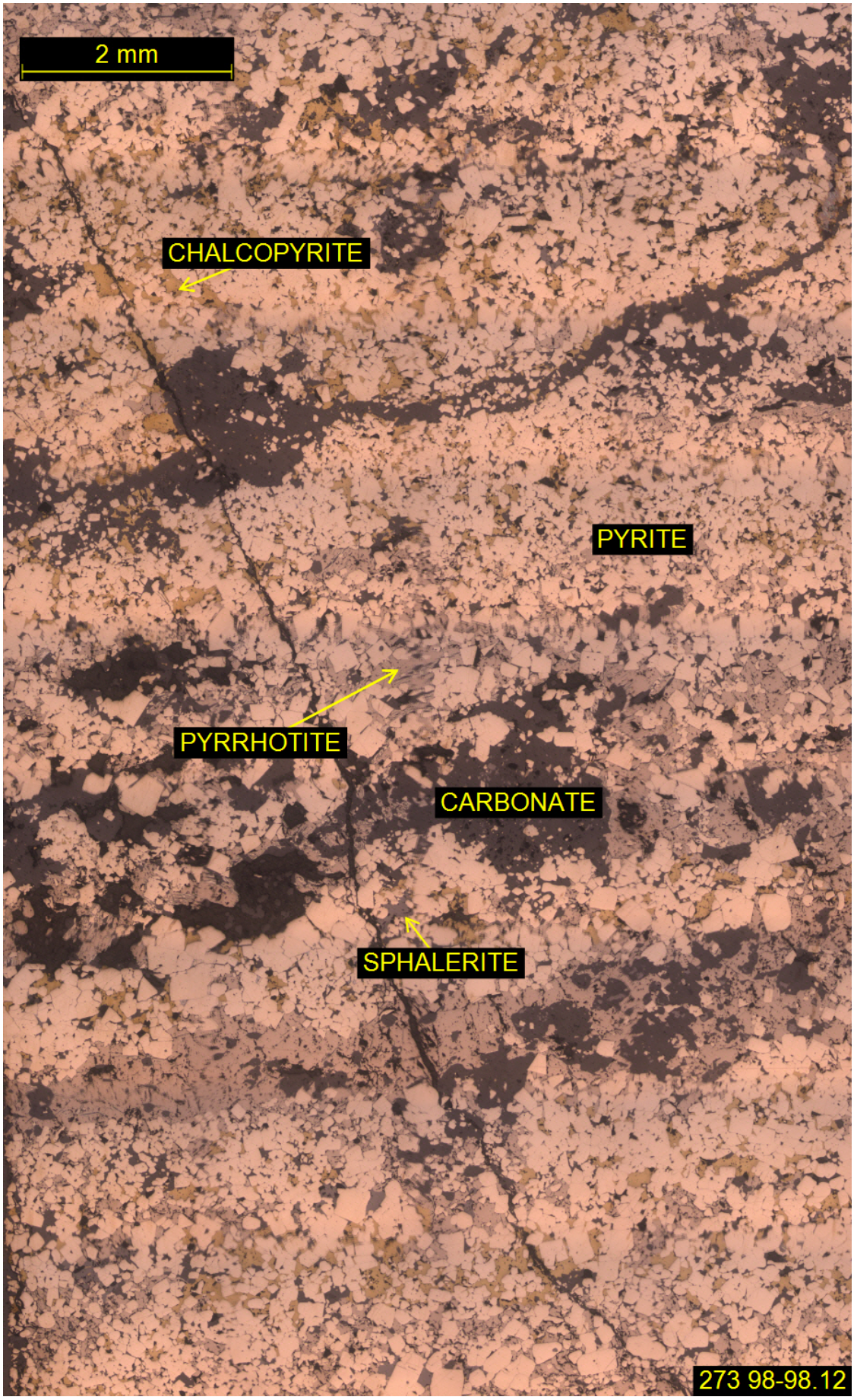
Pyrite is consistent throughout as semi coalesced to massive aggregates of euhedral pyrite with grainsizes mainly between 100 and 200 µm.

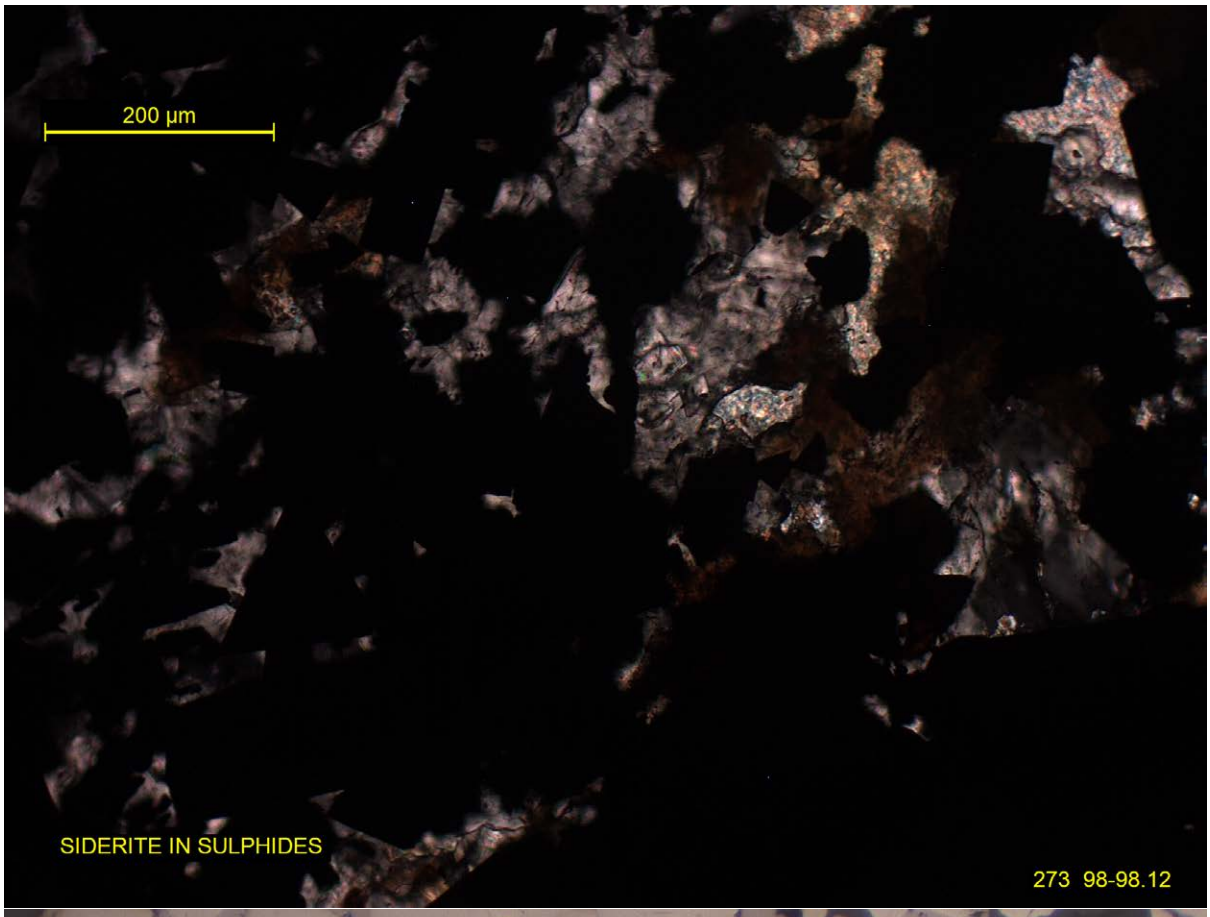
Major part of this pyrite is also accompanied by coarser pyrrhotite. In parts of the slide this pyrrhotite is part altered to a fibrolamellar marcasite, or is completely replaced.

Chalcopyrite is the major valuable ore mineral, that uncommonly is the main cement to part consolidated pyrite concentrations. Liberation sizes of chalcopyrite are less than 100 µm.

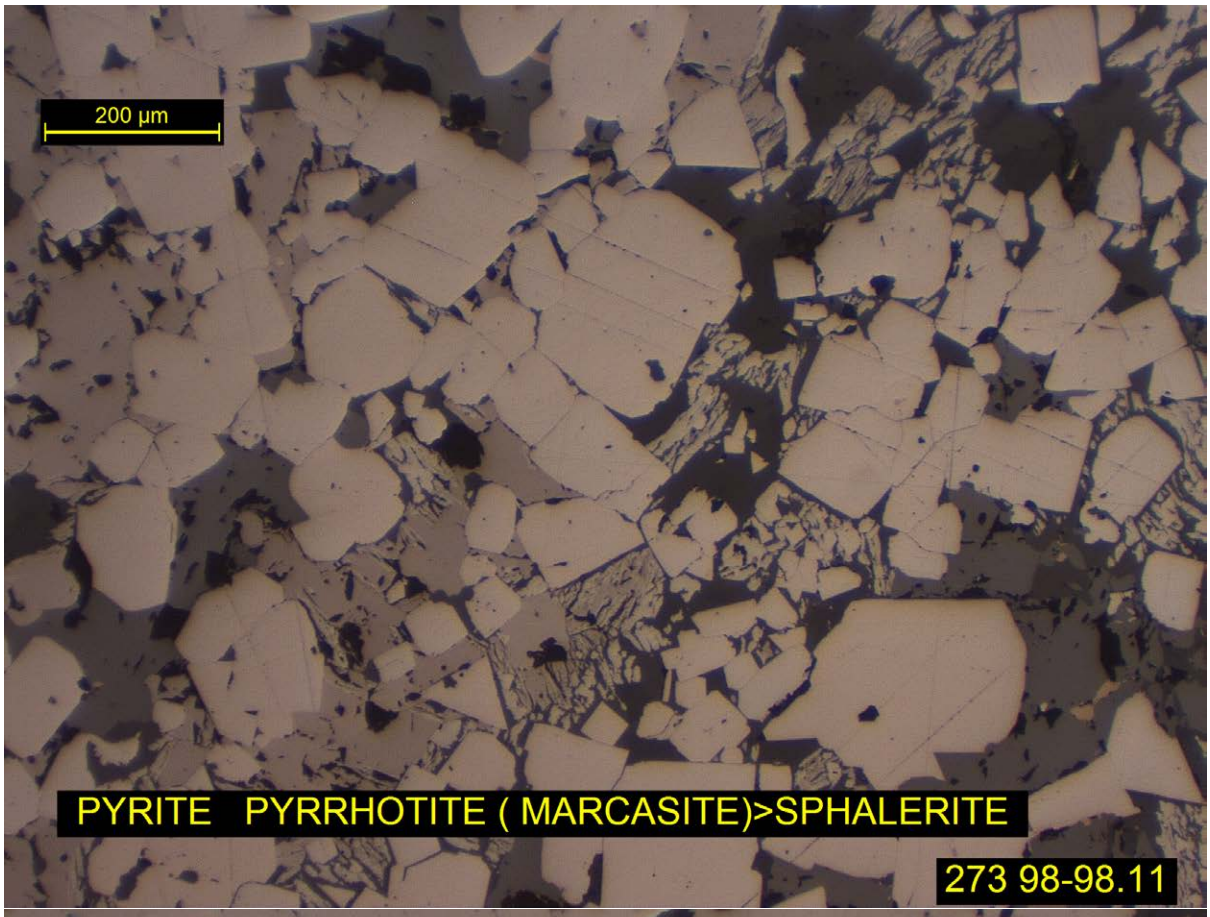
Rarely sphalerite is present as a matrix to the pyrite concentrations of similar character to the chalcopyrite. Rare galena is associated with the sphalerite.

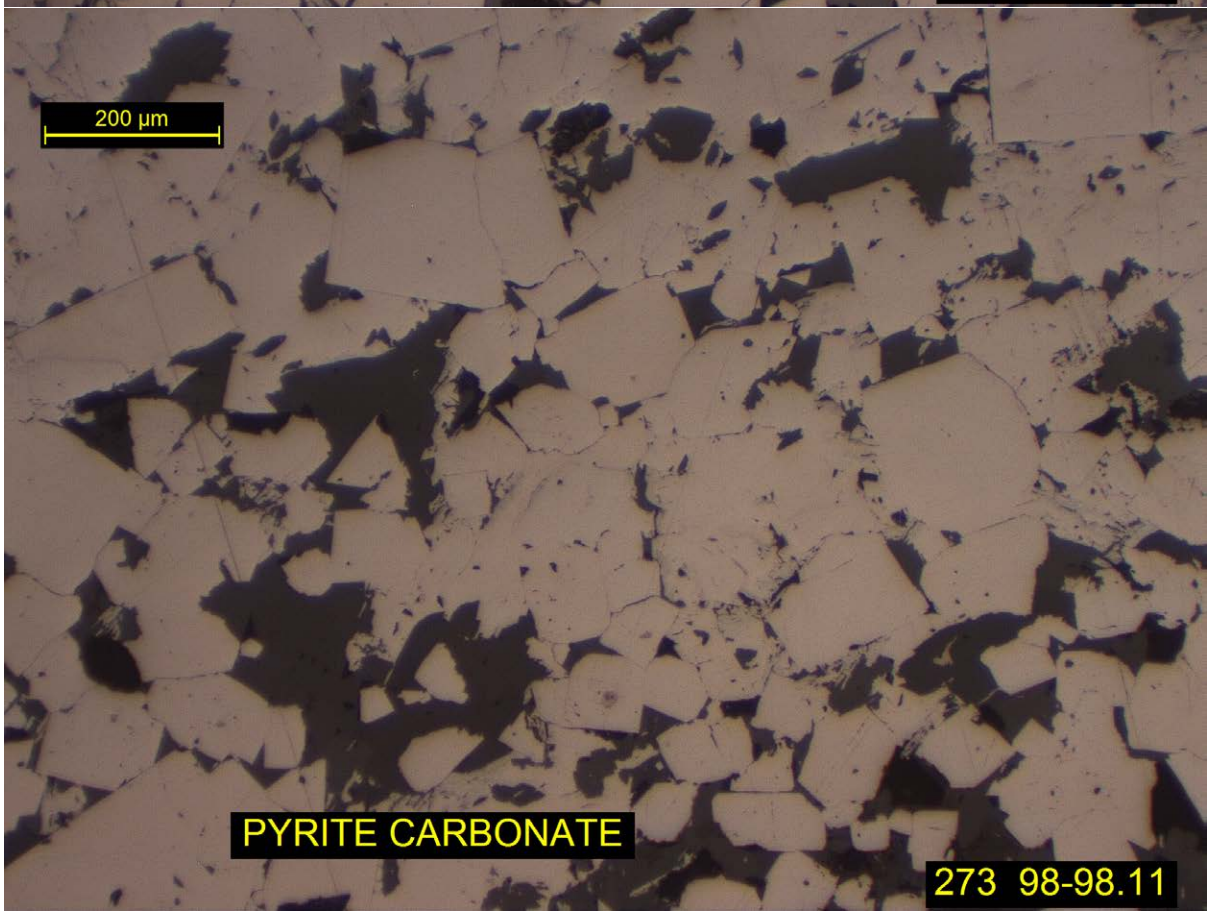
Relict habit magnetite was an uncommon component of the carbonate matrix, separate from the sulphides.

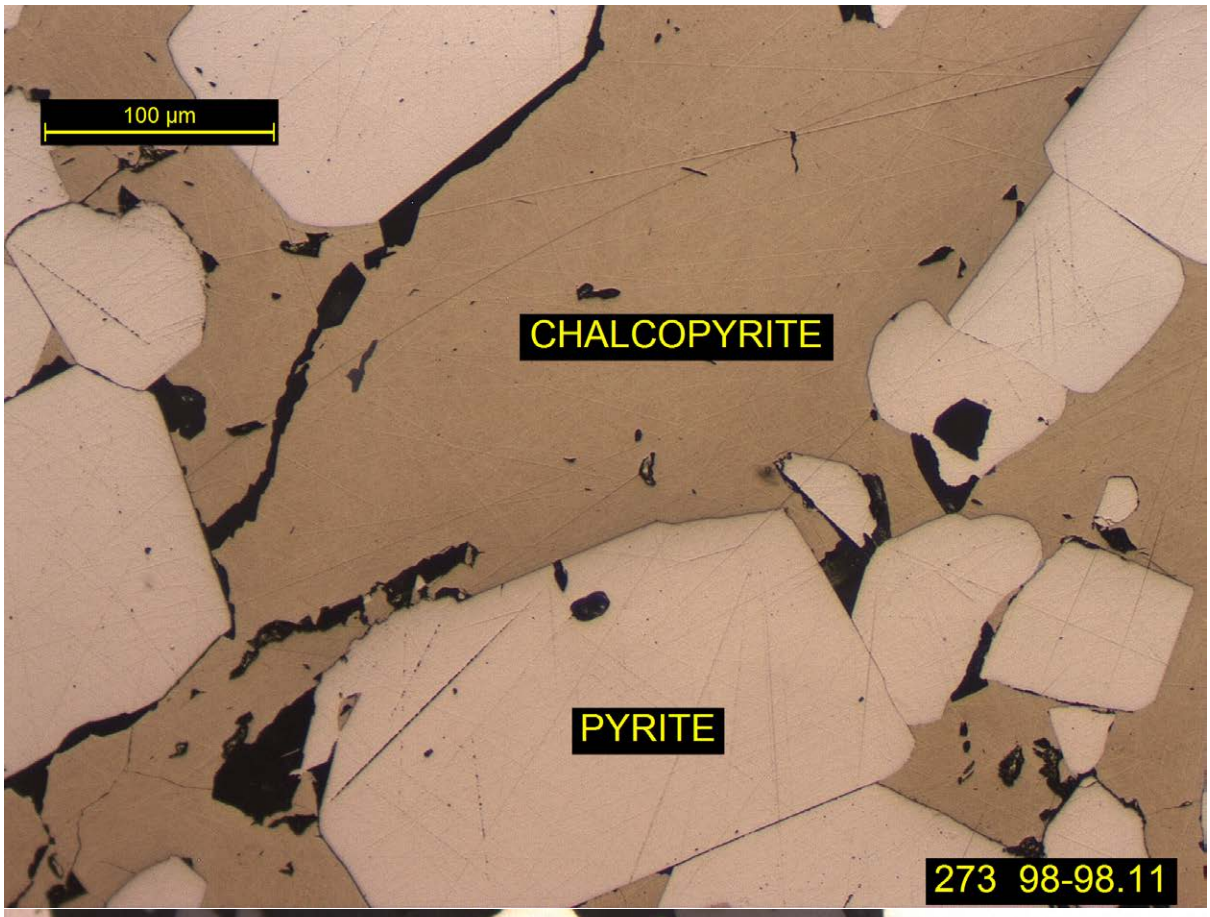

2 mm
CHALCOPYRITE
PYRITE
PYRRHOTITE
CARBONATE
SPHALERITE
273 98-98.12

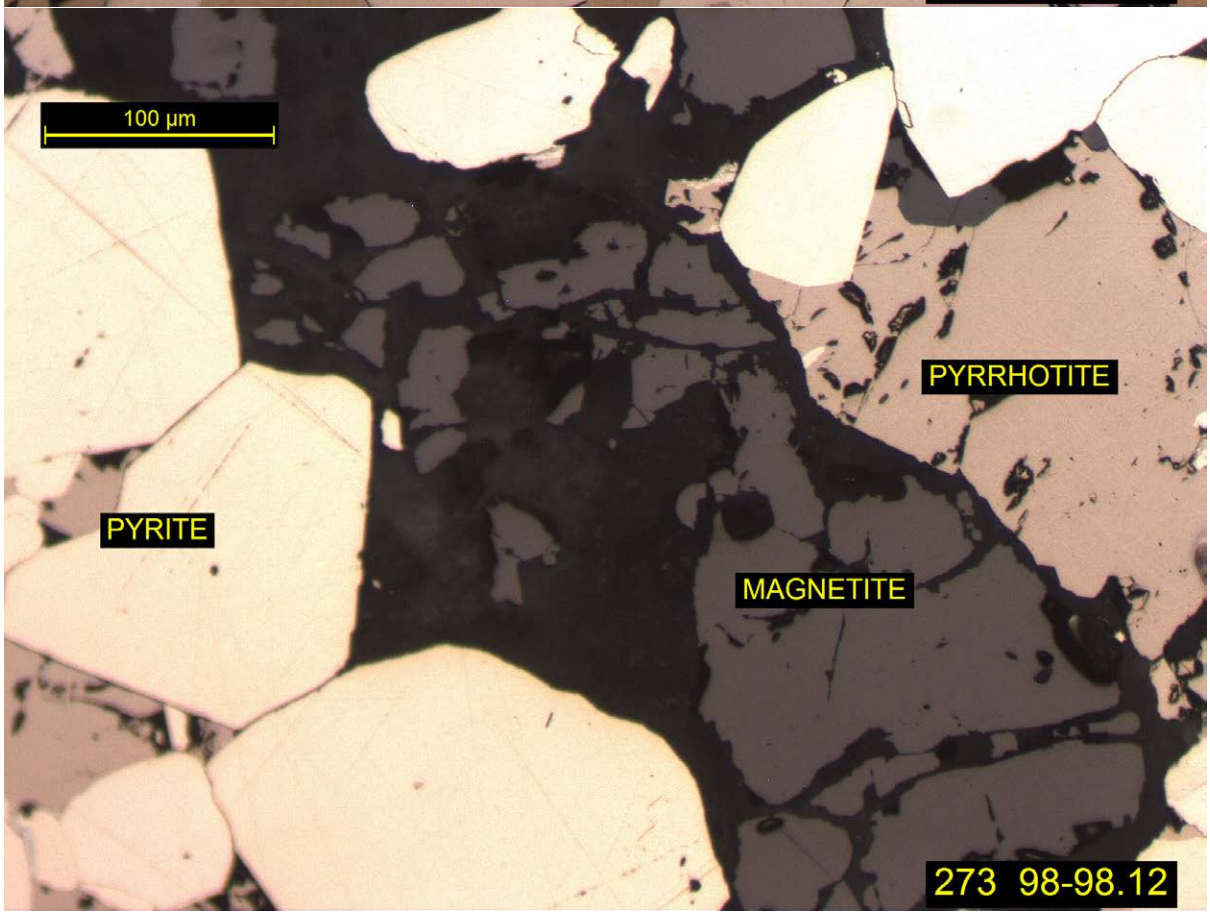

200 µm
SIDERITE IN SULPHIDES
273 98-98.12

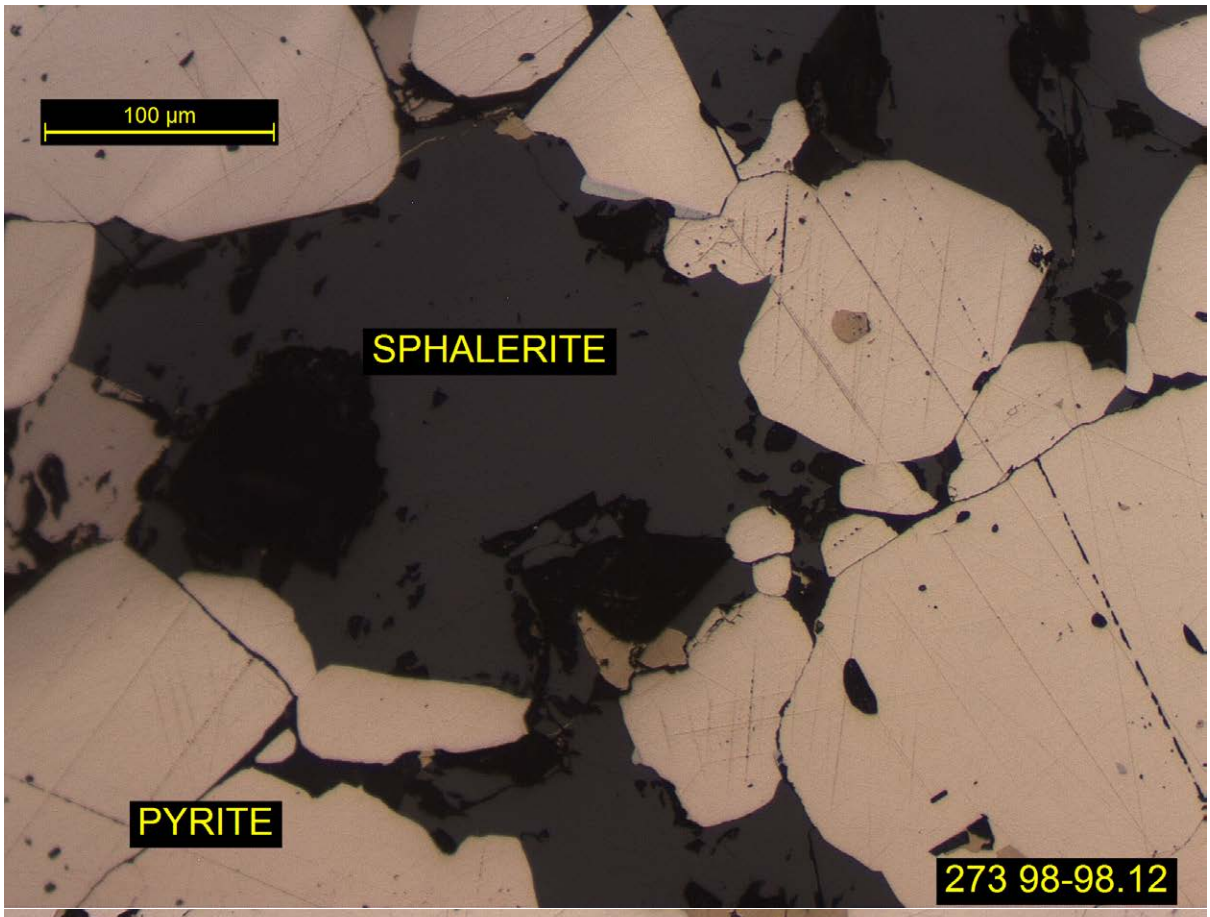

200 µm
PYRITE PYRRHOTITE CHALCOPYRITE
273 98.12

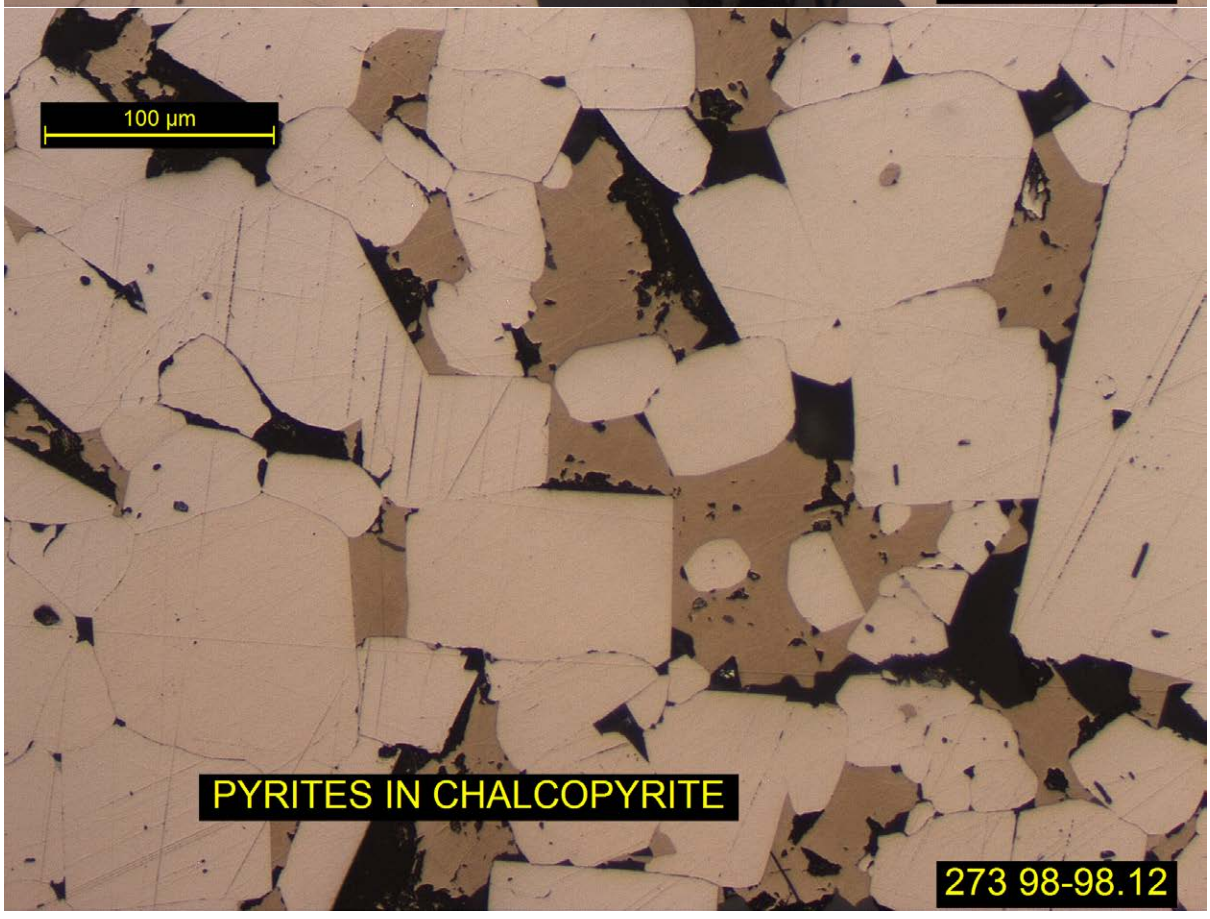

200 µm
PYRITE PYRRHOTITE (MARCASITE)>SPHALERITE
273 98-98.11

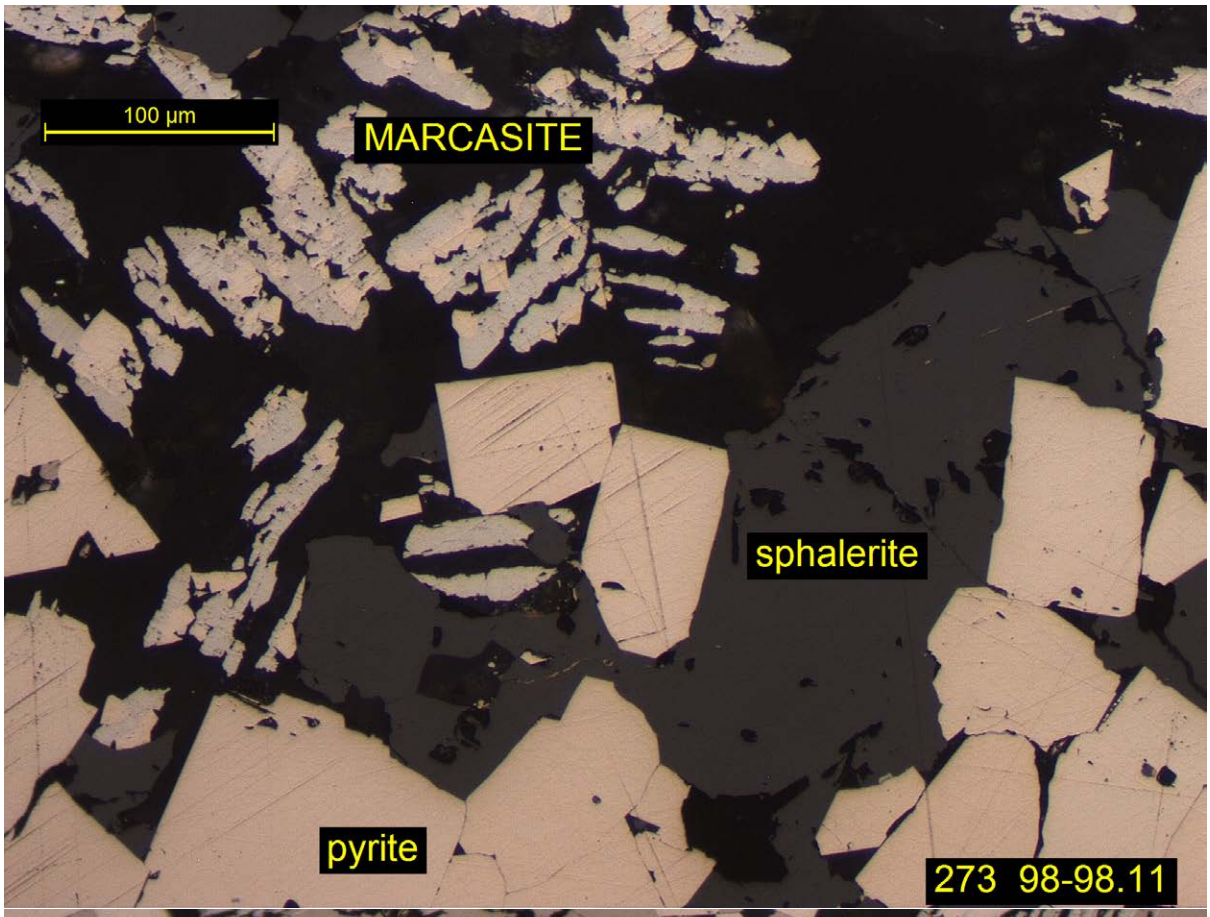

200 µm
PYRITE CARBONATE
273 98-98.11

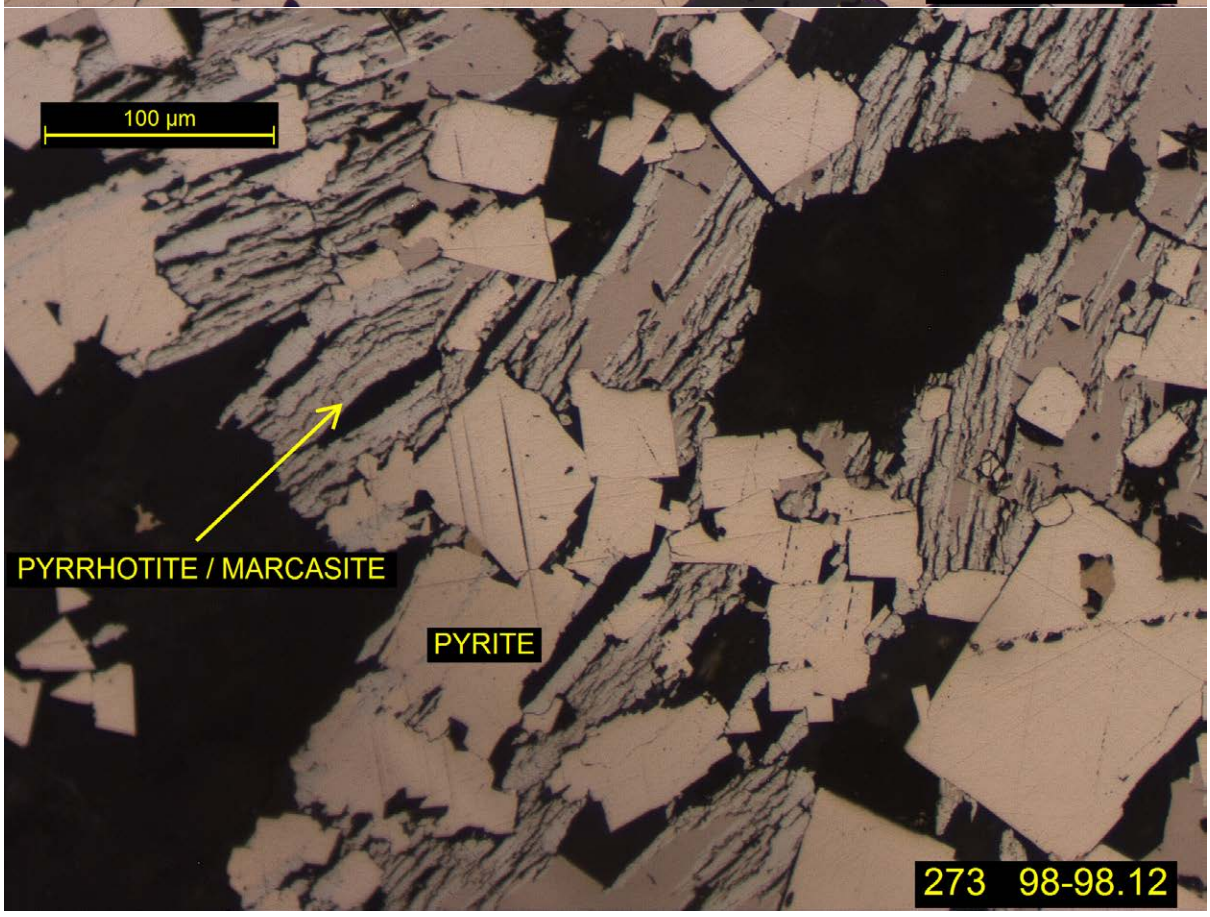

100 µm
CHALCOPYRITE
PYRITE
273 98-98.11


100 µm
PYRRHOTITE
PYRITE
MAGNETITE
273 98-98.12


100 µm
SPHALERITE
PYRITE
273 98-98.12


100 µm
PYRITES IN CHALCOPYRITE
273 98-98.12


100 µm
MARCASITE
sphalerite
pyrite
273 98-98.11


100 µm
PYRRHOTITE / MARCASITE
PYRITE
273 98-98.12

SAMPLE K15-273 95.62-95.76

DRILL CORE

POLISHED THIN SECTION

GANGUE	**5%**
SIDERITE (XRD)	35-45%
CHLORITE	35-45%
MICA	15-25%
BARITE	<1%
ORES	**95%**
PYRITE	50-70%
CHALCOPYRITE	20-30%
PYRRHOTITE	5-15%
MAGNETITE	5-15%
SPHALERITE	5-10%
GALENA	<1%
ARGENTIAN GOLD	TRACE

CLASSIFIED AS A MASSIVE PYRITE ORE WITH DISSEMINATED PYRRHOTITE, MAGNETITE AND CHALCOPYRITE, WITH SIDERITE VEINS

Massive pyrite with significant ubiquitous chalcopyrite that has formed a subordinate interstitial matrix relative to the pyrite framework. Chalcopyrite varies from sporadic fine grains (sub 100 µm), through to large (over a millimetre) interstitial masses, within pyrite. Pyrrhotite and magnetite are commonly disseminated within pyrite, whilst sphalerite's presence is somewhat sporadic. Gangue is mainly chlorite, mica and siderite which erratically pepper the massive pyrite, including thin siderite veins.

Magnetite forms primarily as spherical and irregular aggregates/clusters (~500 µm to ~2 mm) of allotriomorphic grains, disseminated fairly regularly across the pyrite. Often, thin siderite veins irregular crosscut these aggregates. Pyrrhotite similarly is found regularly disseminated across the massive pyrite, occurring in irregularly shaped to occasional equidimensional and elongate aggregates (30 µm to ~1.5 mm), comprised of allotriomorphic grains.

Sphalerite content is generally low, however it forms major to dominant components of particular zones. Rare sphalerite dominant layers host subordinate to significant discrete euhedral grains and aggregates of pyrite, in addition to sporadically disseminated pyrrhotite, chalcopyrite and galena. Sphalerite also forms in localized zones, as interstitial matrix to the pyrite framework.

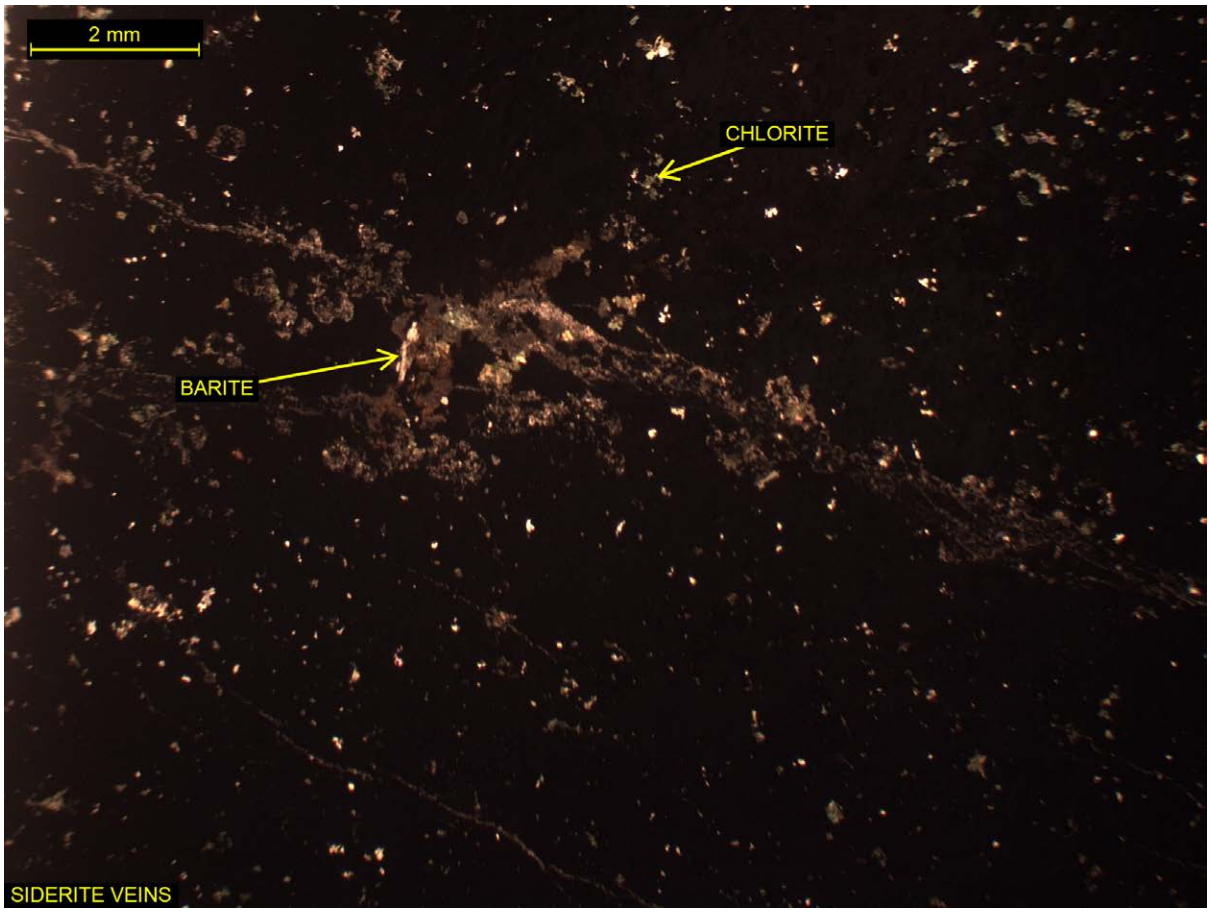
Galena occurs typically as randomly disseminated individual fine (microns to ~260 µm) irregular to equidimensional shaped grains, as inclusions within pyrite or subordinate sphalerite occasionally pyrrhotite, and frequently rimming pyrite, magnetite or lesser

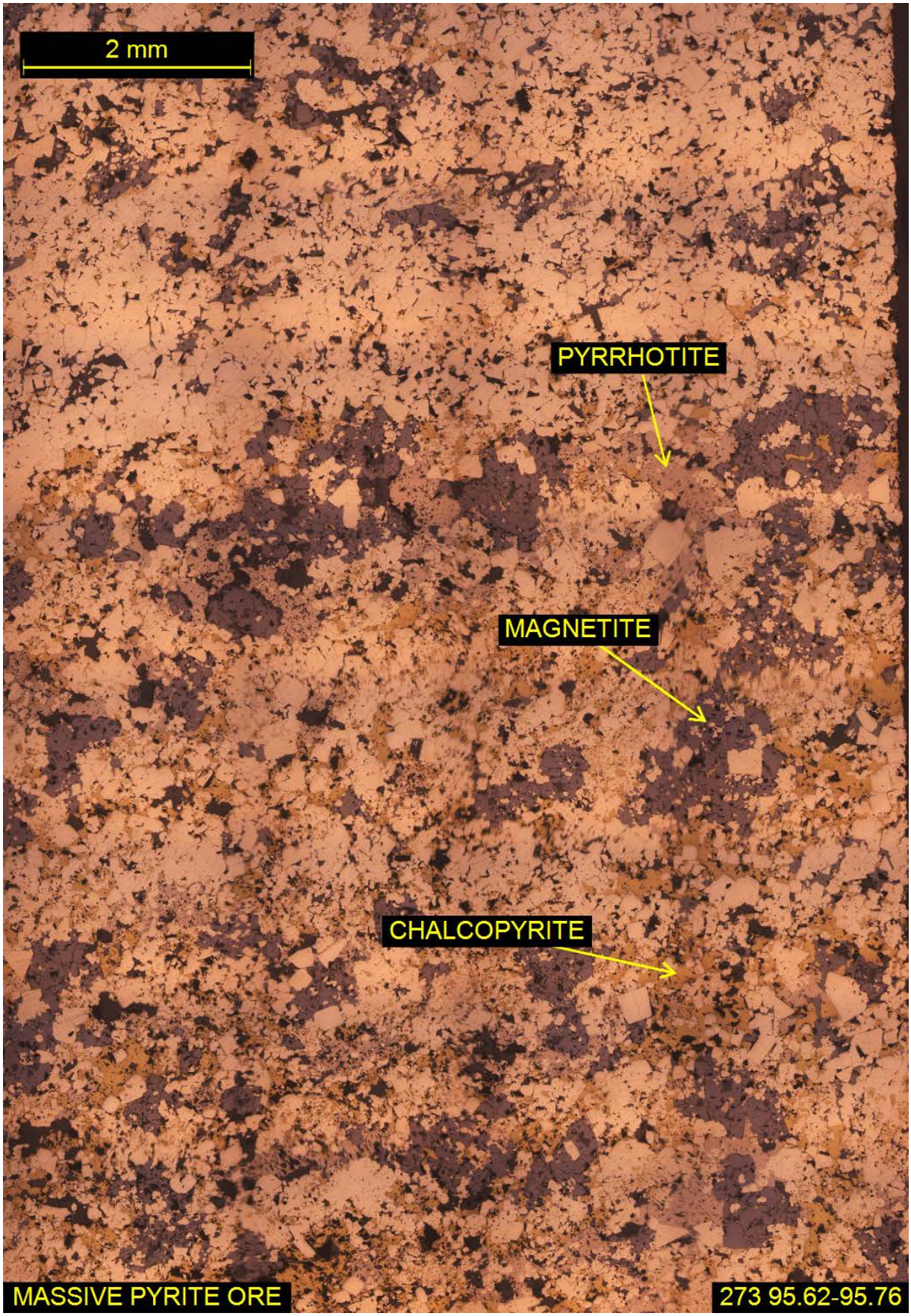
chalcopyrite. Occasionally a cluster of galena grains occurs in particular zones, forming along boundaries of sulphides with grain shapes dictated by adjacent ores.

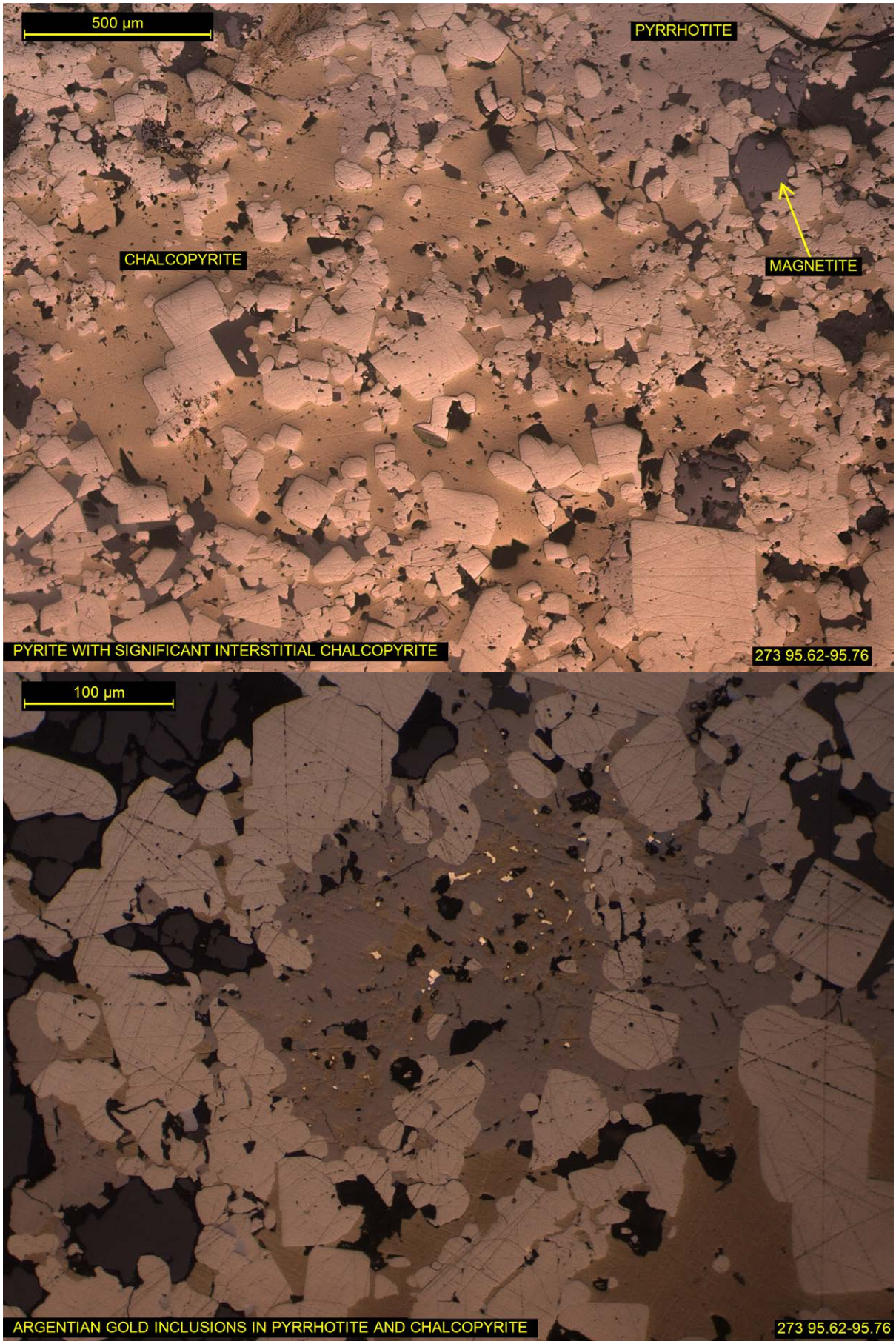
Gangue is comprised of siderite, chlorite and mica that occur in aggregates (50 to ~500 µm), sporadically throughout the massive pyrite. Chlorite occurs in aggregates of fine (~150 µm) flakes, whilst siderites are generally anhedral grains. A number of thin (sub ~150 µm) micritic siderite veinlets crosscut the pyrite. A very rare euhedral columnar barite aggregate (up to ~600 µm) was found within a siderite vein.

GOLD

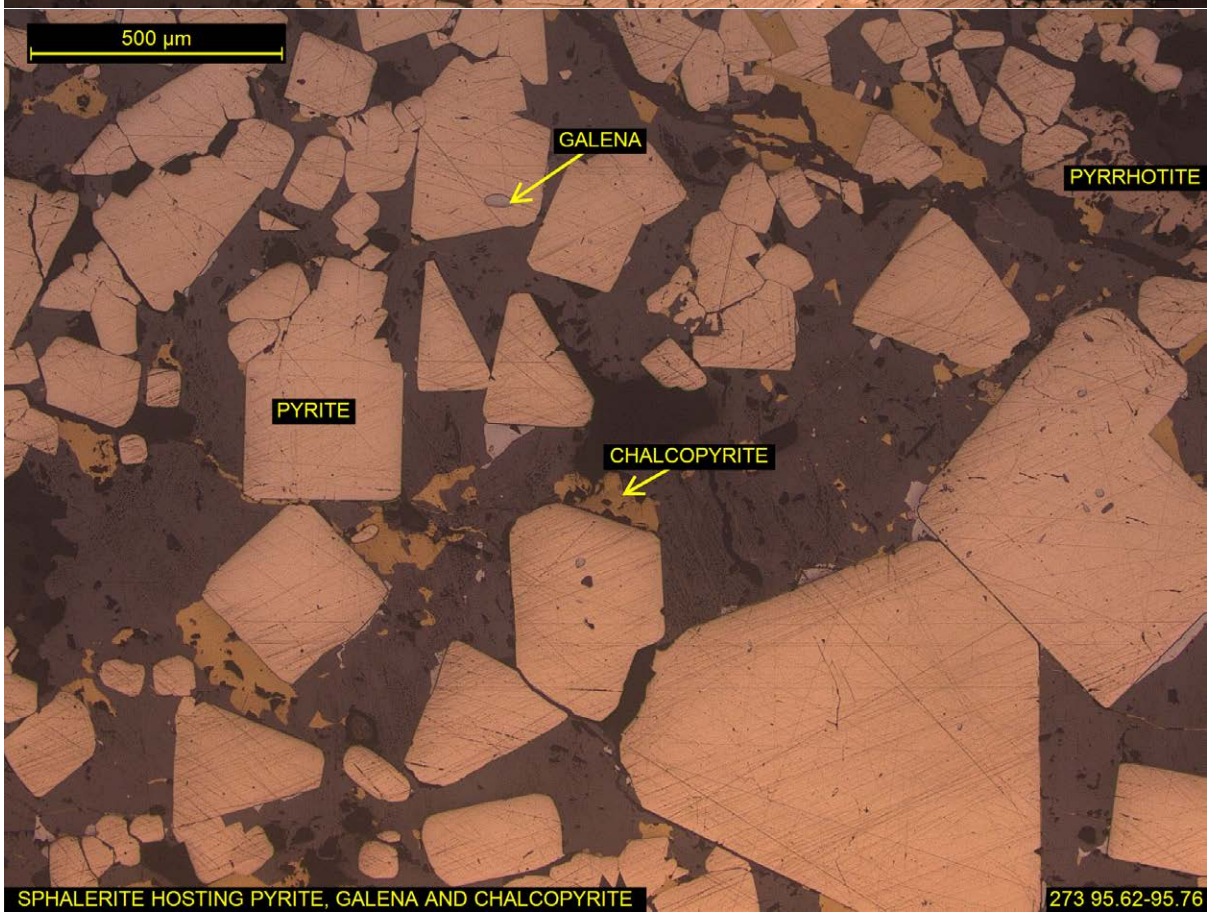
Approximately sixty grains of argentian gold were found in one location, as inclusions within chalcopyrite and subordinate pyrrhotite. The grains are equidimensional, irregularly shaped and slivers, ranging in size from less than a micron to ~16 µm.



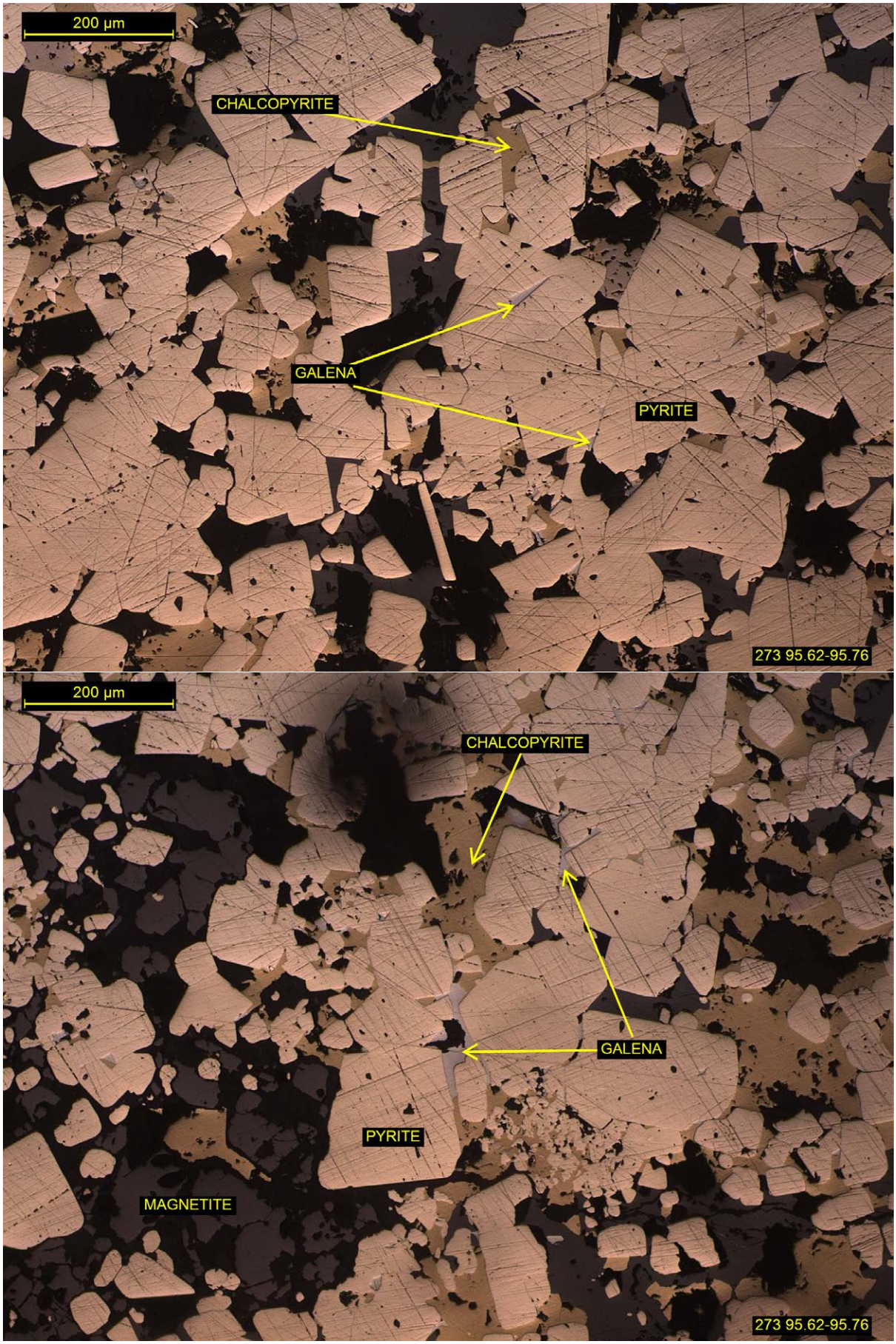

2 mm
PYRRHOTITE
MAGNETITE
CHALCOPYRITE
MASSIVE PYRITE ORE
273 95.62-95.76

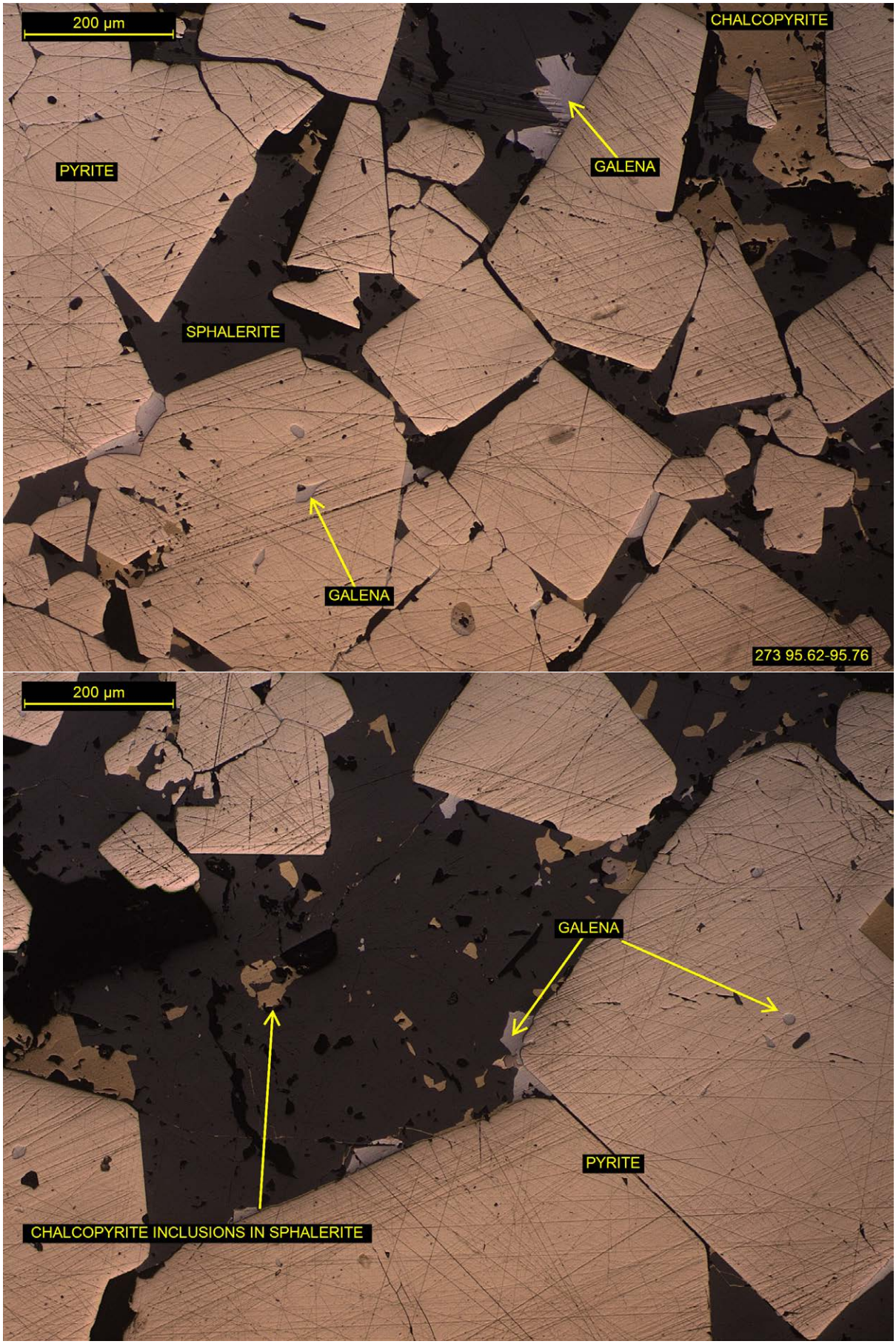

500 µm
PYRRHOTITE
CHALCOPYRITE
MAGNETITE
PYRITE WITH SIGNIFICANT INTERSTITIAL CHALCOPYRITE
273 95.62-95.76
100 µm
ARGENTIAN GOLD INCLUSIONS IN PYRRHOTITE AND CHALCOPYRITE
273 95.62-95.76

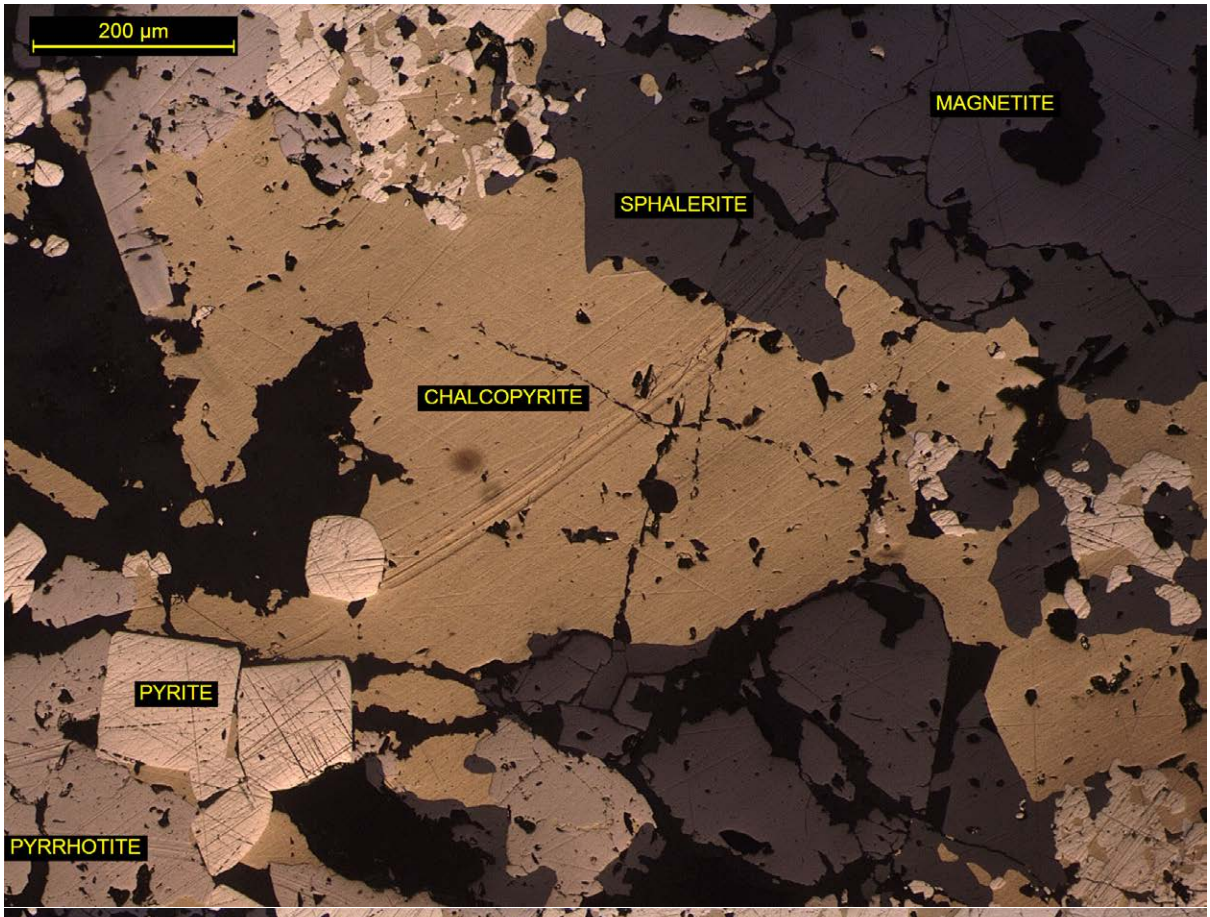

500 µm
VERY FINE CHALCOPYRITE INCLUSIONS IN PYRITE
273 95.62-95.76

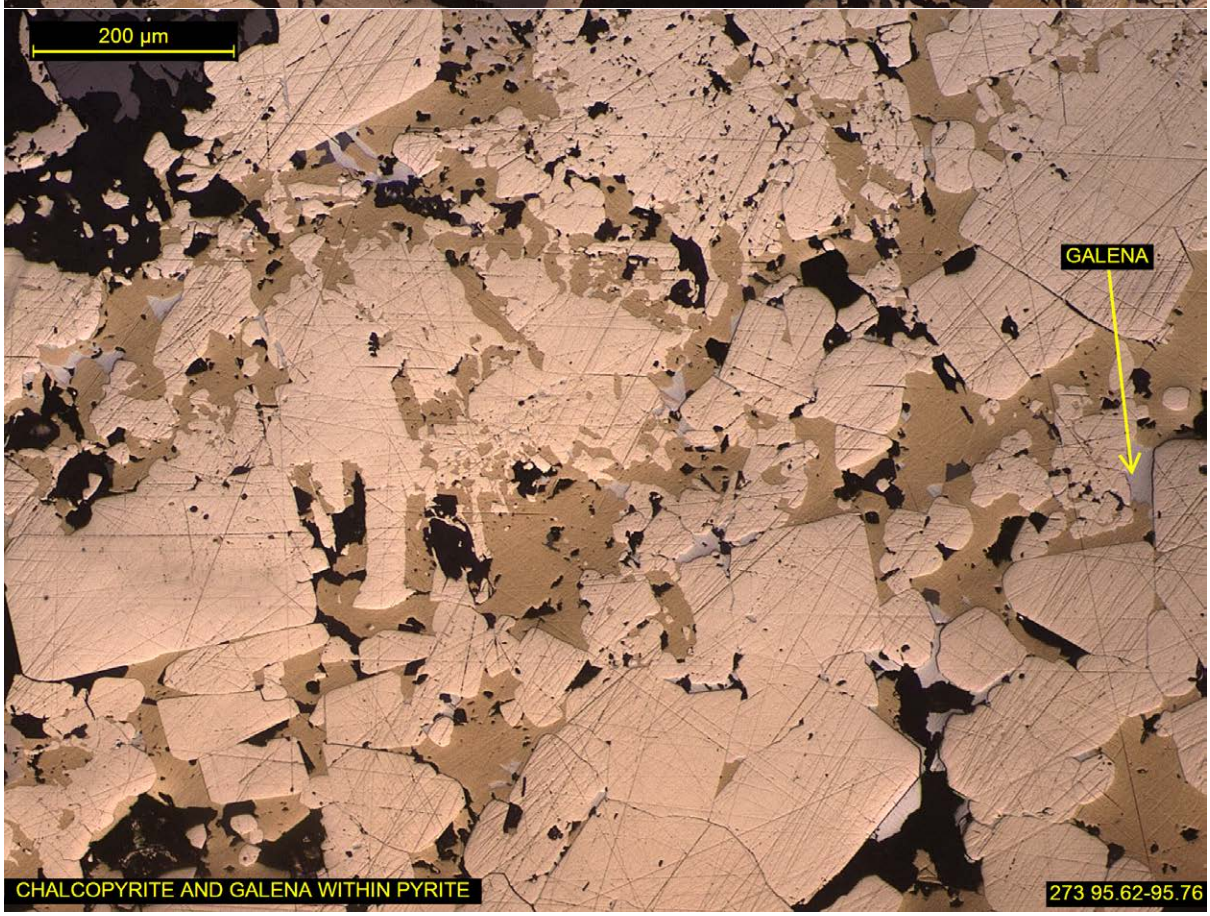

500 µm
GALENA
PYRRHOTITE
PYRITE
CHALCOPYRITE
SPHALERITE HOSTING PYRITE, GALENA AND CHALCOPYRITE
273 95.62-95.76

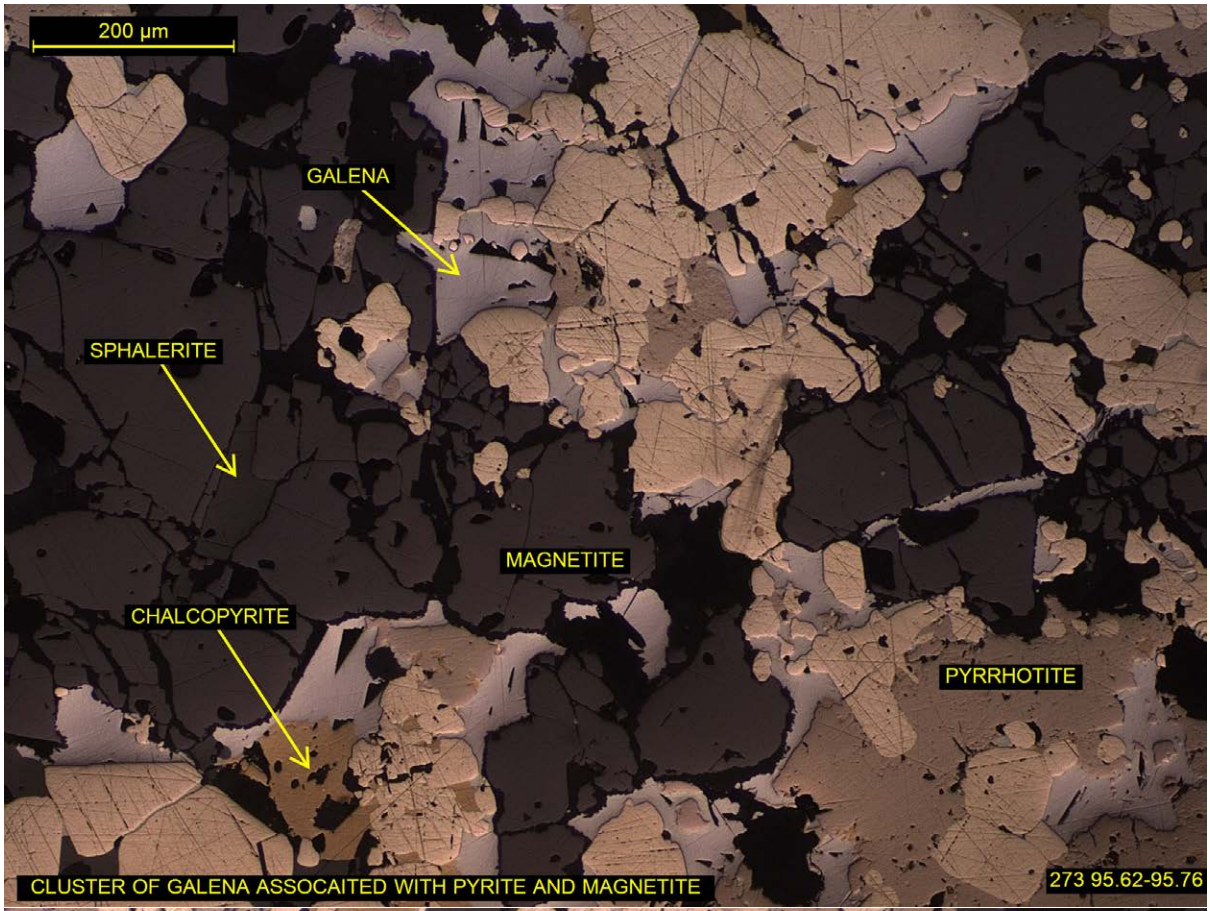

500 µm
PYRRHOTITE
CHALCOPYRITE IN PYRITE
MAGNETITE
PYRRHOTITE
MAGNETITE, PYRRHOTITE AND CHALCOPYRITE IN PYRITE
500 µm
SPHALERITE + PYRITE
PYRRHOTITE
CHALCOPYRITE
273 95.62-95.76

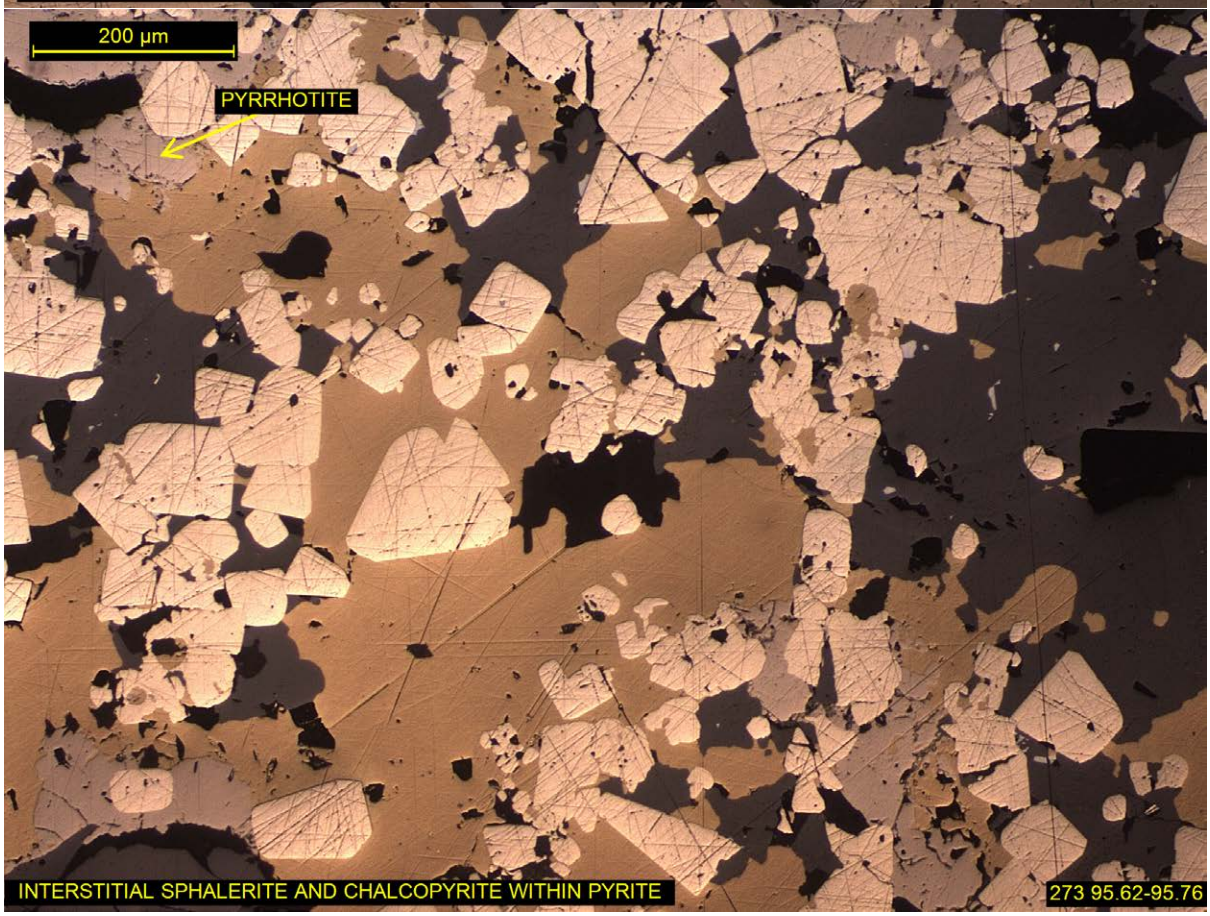

200 µm
CHALCOPYRITE
GALENA
PYRITE
273 95.62-95.76
200 µm
CHALCOPYRITE
GALENA
PYRITE
MAGNETITE
273 95.62-95.76

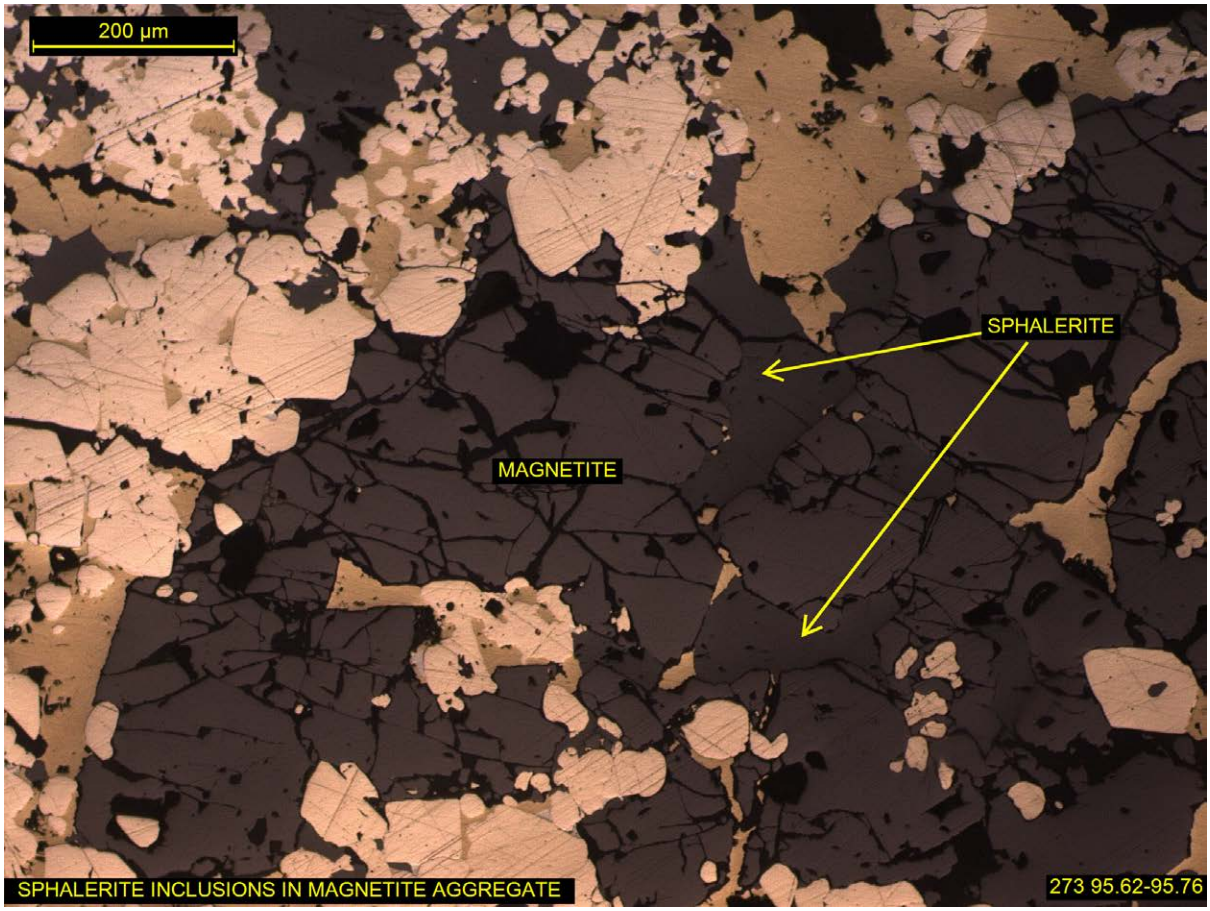

200 µm
CHALCOPYRITE
PYRITE
GALENA
SPHALERITE
GALENA
273 95.62-95.76
200 µm
GALENA
PYRITE
CHALCOPYRITE INCLUSIONS IN SPHALERITE


200 µm
MAGNETITE
SPHALERITE
CHALCOPYRITE
PYRITE
PYRRHOTITE


200 µm
GALENA
CHALCOPYRITE AND GALENA WITHIN PYRITE
273 95.62-95.76


200 µm
GALENA
SPHALERITE
MAGNETITE
CHALCOPYRITE
PYRRHOTITE
CLUSTER OF GALENA ASSOCAITED WITH PYRITE AND MAGNETITE
273 95.62-95.76


200 µm
PYRRHOTITE
INTERSTITIAL SPHALERITE AND CHALCOPYRITE WITHIN PYRITE
273 95.62-95.76


200 µm
SPHALERITE
MAGNETITE
SPHALERITE INCLUSIONS IN MAGNETITE AGGREGATE
273 95.62-95.76

SAMPLE K15-273 91.55-91.69

DRILL CORE

POLISHED THIN SECTION

GANGUE	**5%**
SIDERITE	70-80%
TALC	10-20%
CLAY	5-10%
CHLORITE	1-5%
ORES	**95%**
CHALCOPYRITE	40-50%
PYRITE	30-40%
MAGNETITE	10-20%
PYRRHOTITE	10-20%
SPHALERITE	5-10%
MARCASITE	<1%
GALENA	TRACE

CLASSIFIED AS A MASSIVE PYRITE CHALCOPYRITE ORE WITH BANDED MAGNETITE PYRRHOTITE AND DISSEMINATED SPHALERITE WITH A SIDERITE OVERPRINT

A sample that is primarily comprised of chalcopyrite and pyrite, the latter occurring mainly as subhedral discrete grains (~100 to ~300 µm) and subordinate aggregates sitting in a significant (equal to greater) interstitial host semi-massive chalcopyrite matrix.

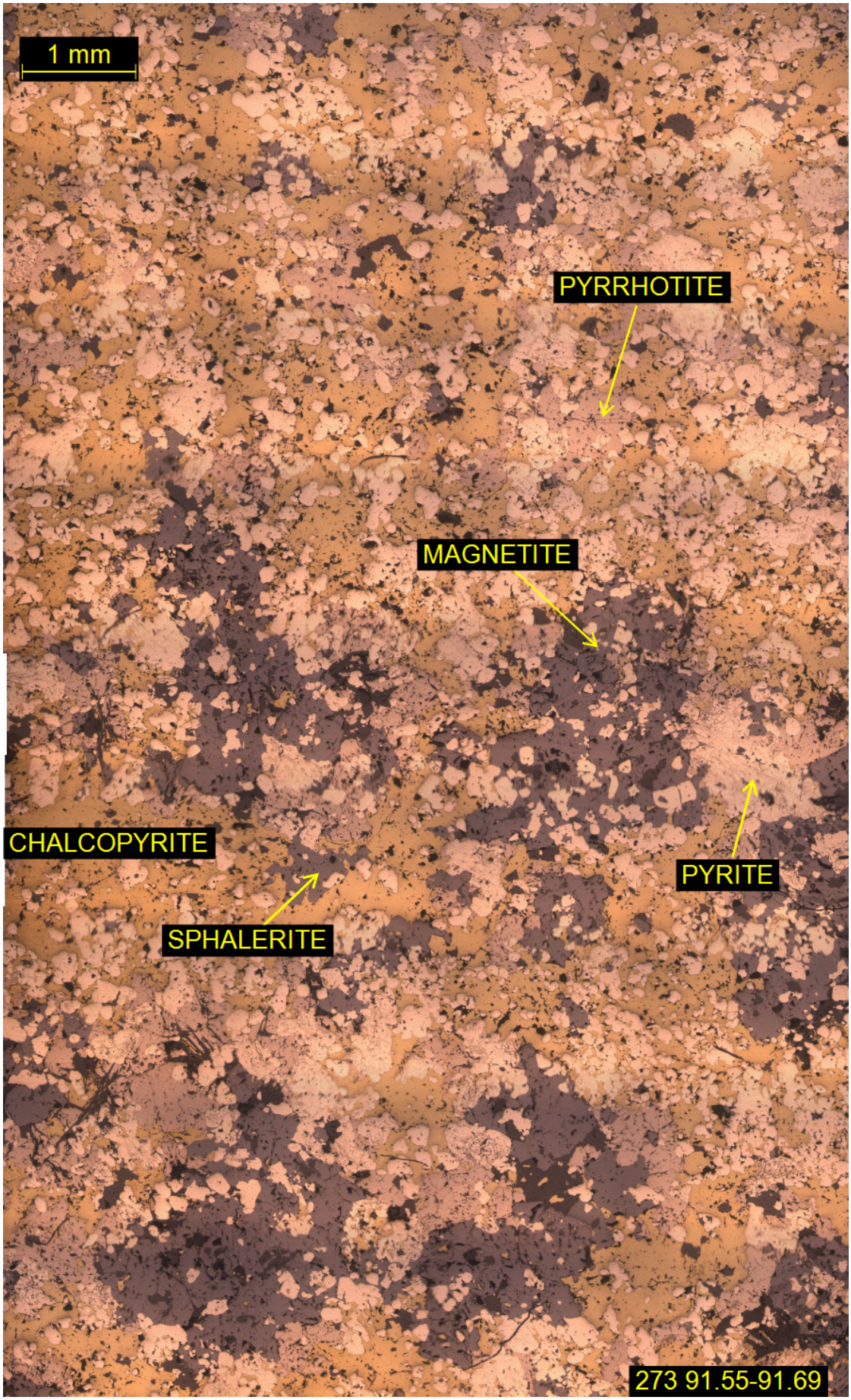
A roughly banded texture is defined by intermittent pyrrhotite rich and magnetite rich bands. Discrete irregular aggregates of (~150 to ~850 µm) pyrrhotite are found disseminated within pyrite/chalcopyrite. Rare incipient alteration of pyrrhotite to marcasite was observed.

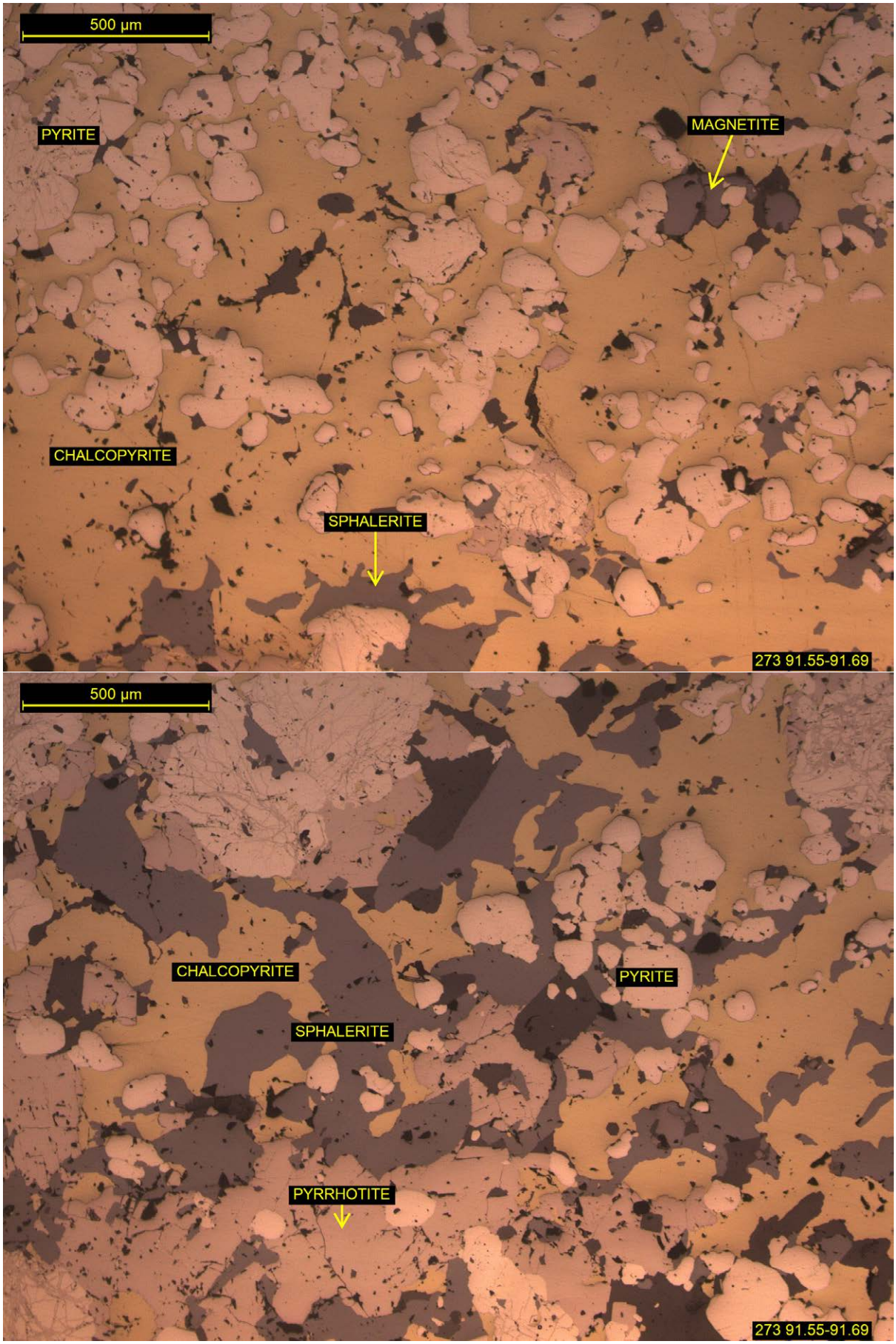
Similarly, particular bands contain numerous large irregular magnetite allotriomorphic masses (~300 µm to ~2.5 mm), that typically contain pyrite inclusions that have a sub-round form. Associated with these magnetite masses is generally a subordinate sphalerite component. Sphalerite also occurs in zones of up to ~3 mm, as interstitial matrix host to numerous sulphides.

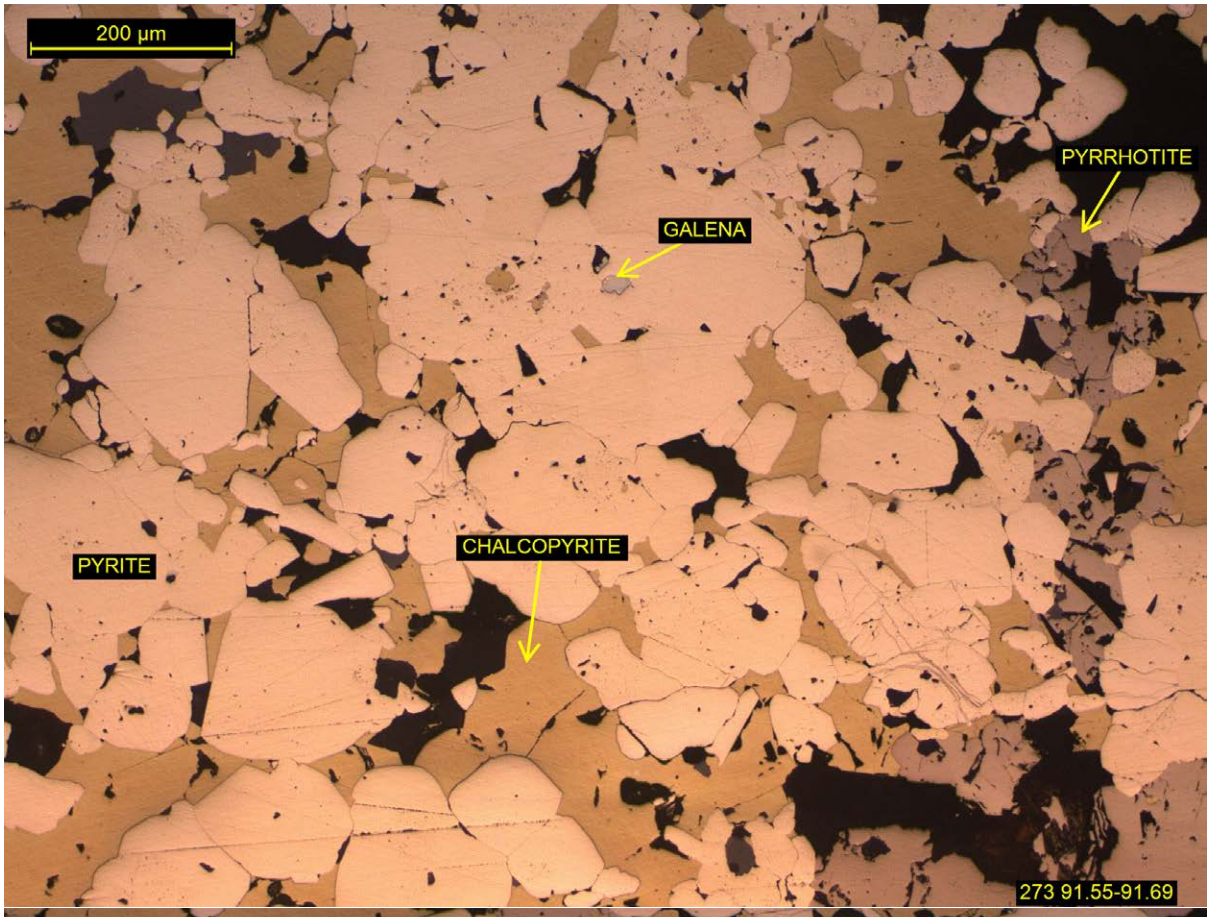
Fairly often pyrite aggregates were intricately veined by pyrrhotite (single pyrrhotite grain). Occasionally large coalesced masses of pyrite are present, with subordinate fine (sub 120 µm) chalcopyrite interstitial inclusions. Most pyrites though, are free of chalcopyrite inclusions.

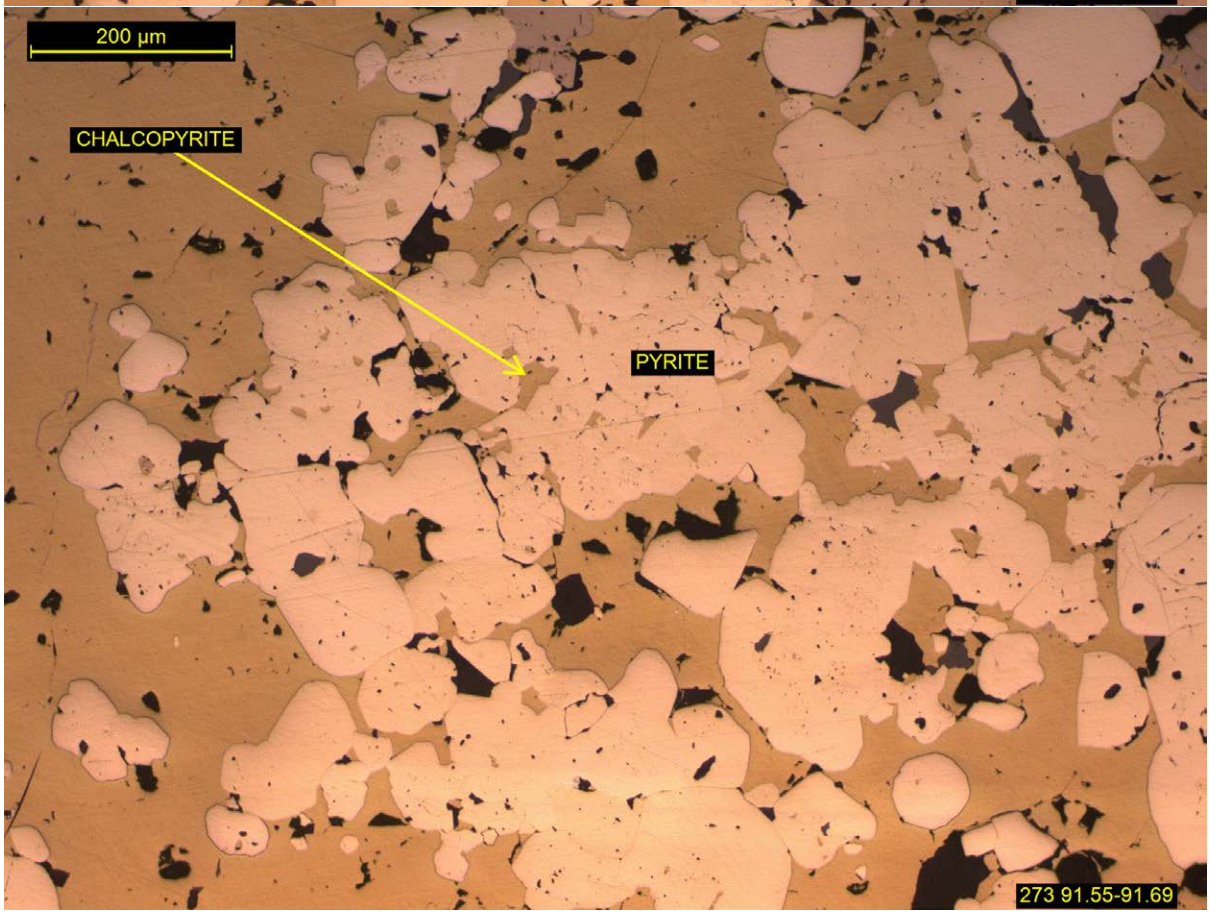
Galena content is almost negligible, only several grains found across the entire thin sections. These were fine (~30 µm) grains, found within pyrite and sphalerite.

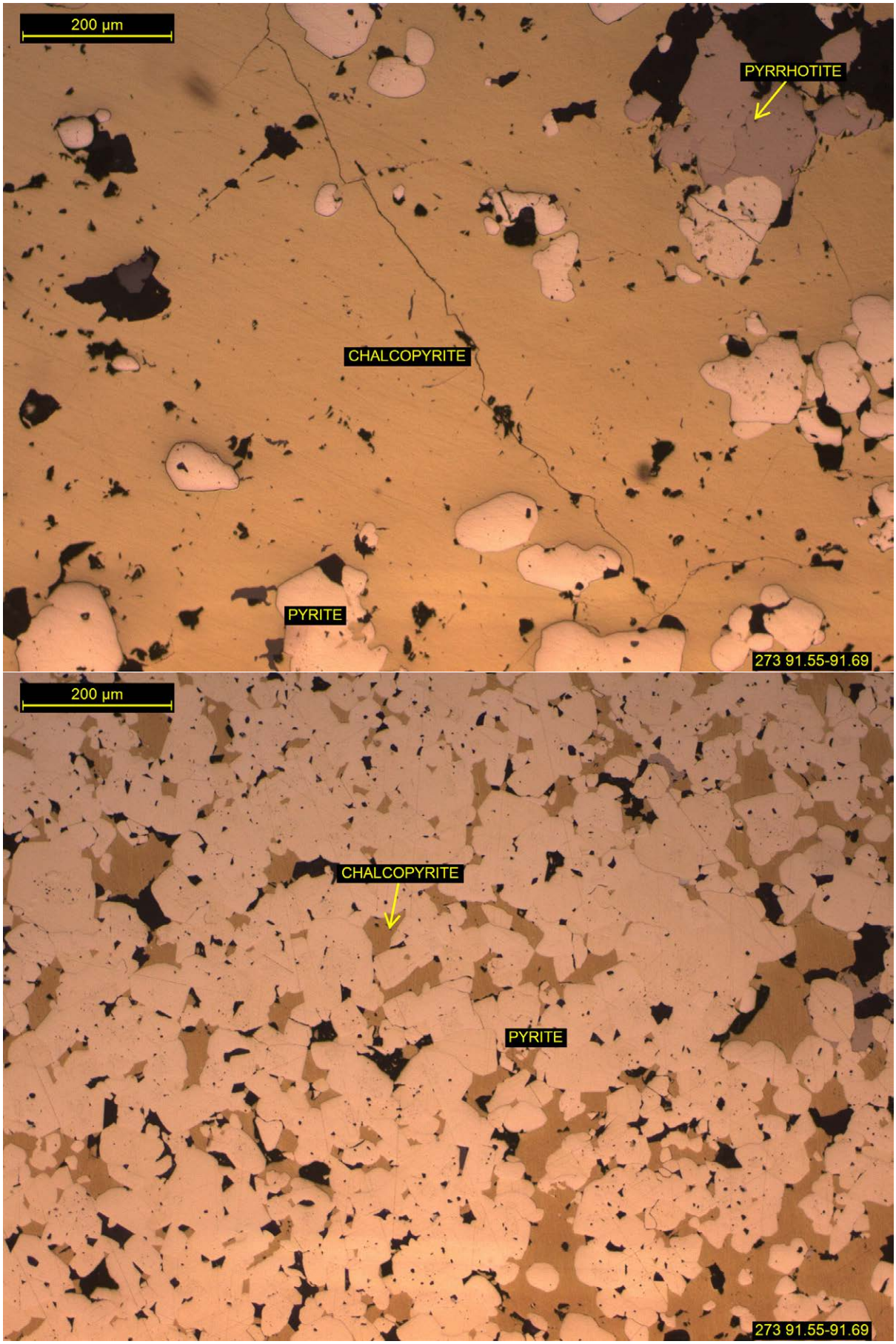
The gangue component is comprised of small pockets (~100 to ~600 µm) of primarily polycrystalline siderite, and discrete grains and aggregates of talc and chlorite. XRD indicates the possibility of trace clay. In particular instances angular fine (~10 to 200 µm) chalcopyrite grains are intimately intergrown with the phyllosilicates.

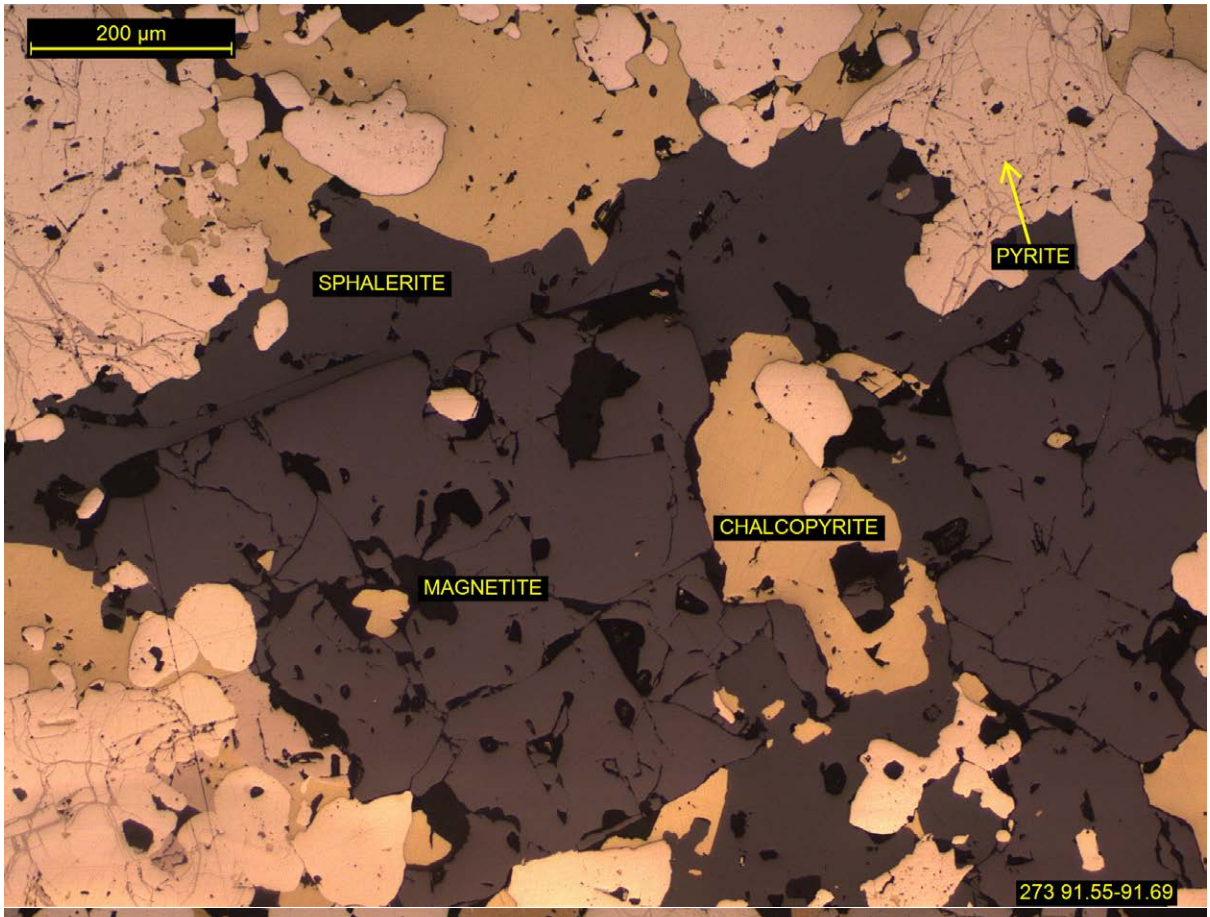

1 mm
PYRRHOTITE
MAGNETITE
CHALCOPYRITE
PYRITE
SPHALERITE
273 91.55-91.69

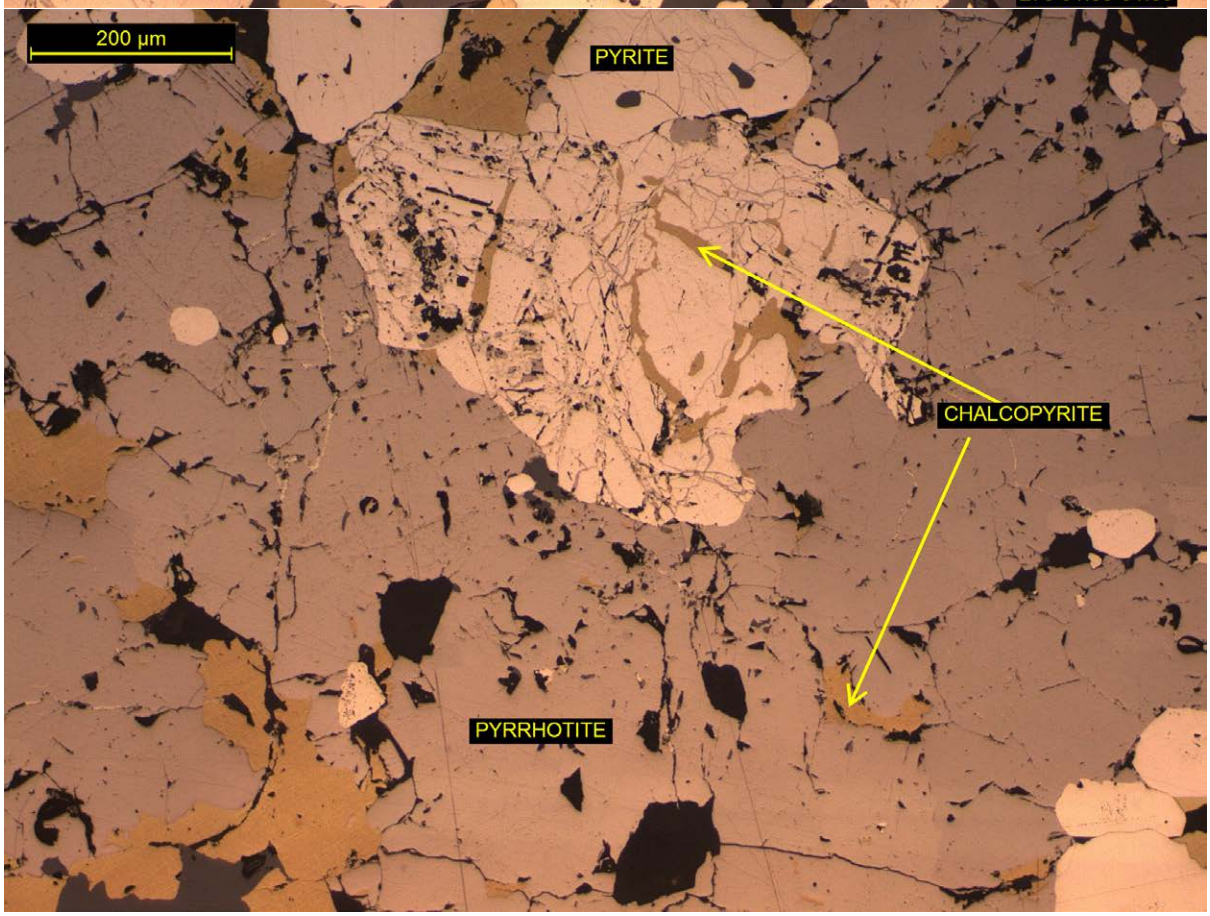

500 µm
PYRITE
MAGNETITE
CHALCOPYRITE
SPHALERITE
273 91.55-91.69
500 µm
CHALCOPYRITE
PYRITE
SPHALERITE
PYRRHOTITE
273 91.55-91.69

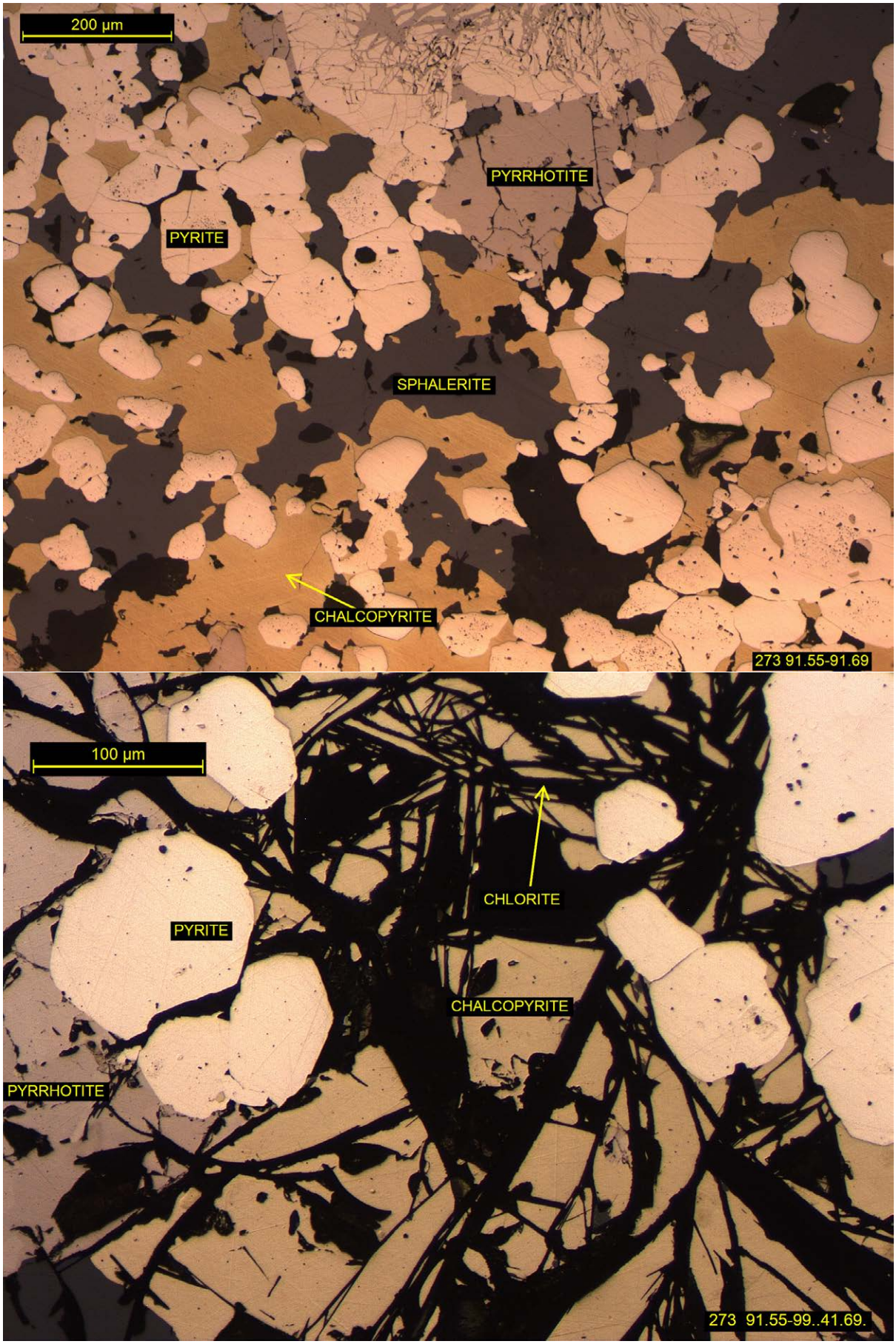

200 µm
PYRRHOTITE
GALENA
PYRITE
CHALCOPYRITE
273 91.55-91.69

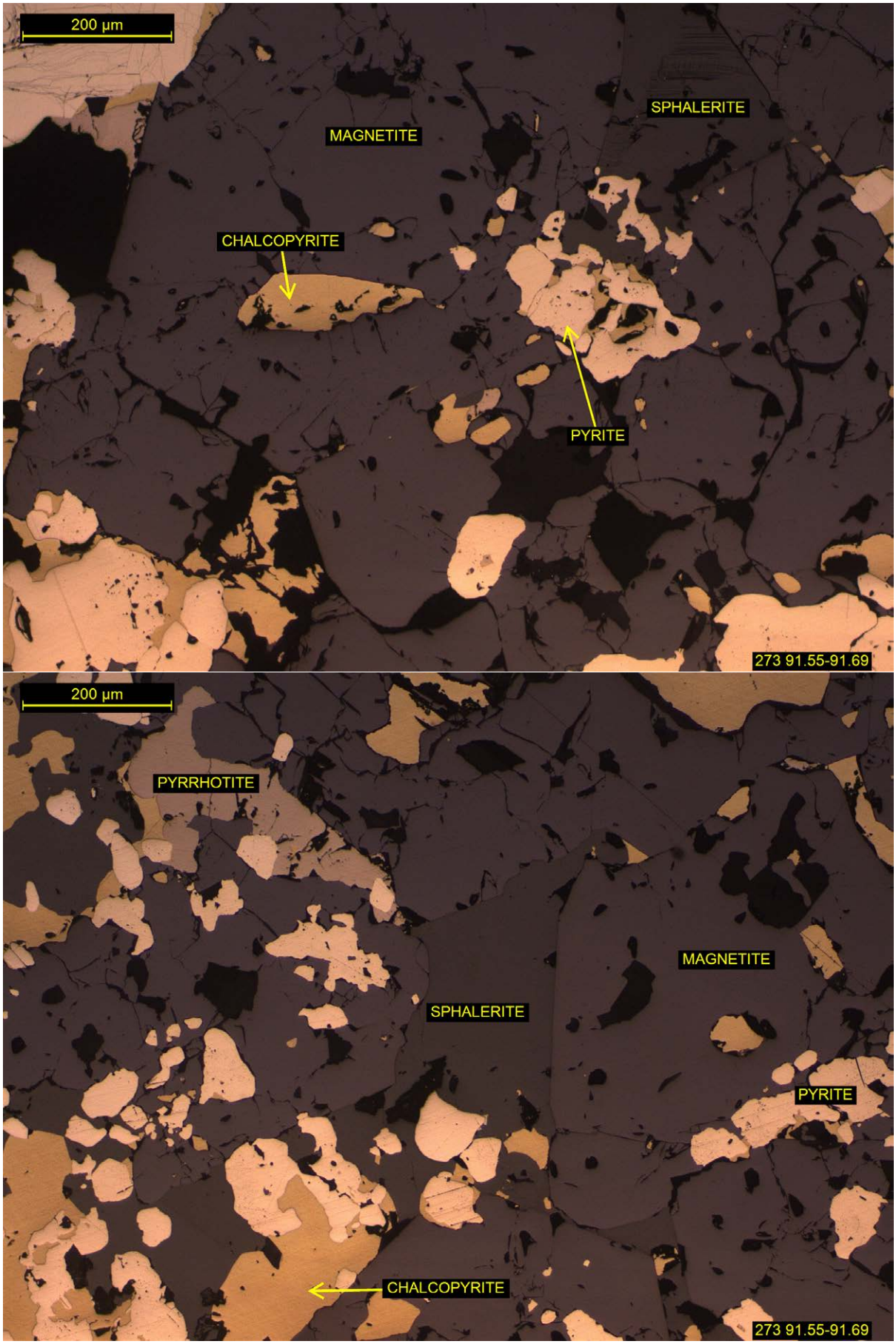

200 µm
CHALCOPYRITE
PYRITE
273 91.55-91.69

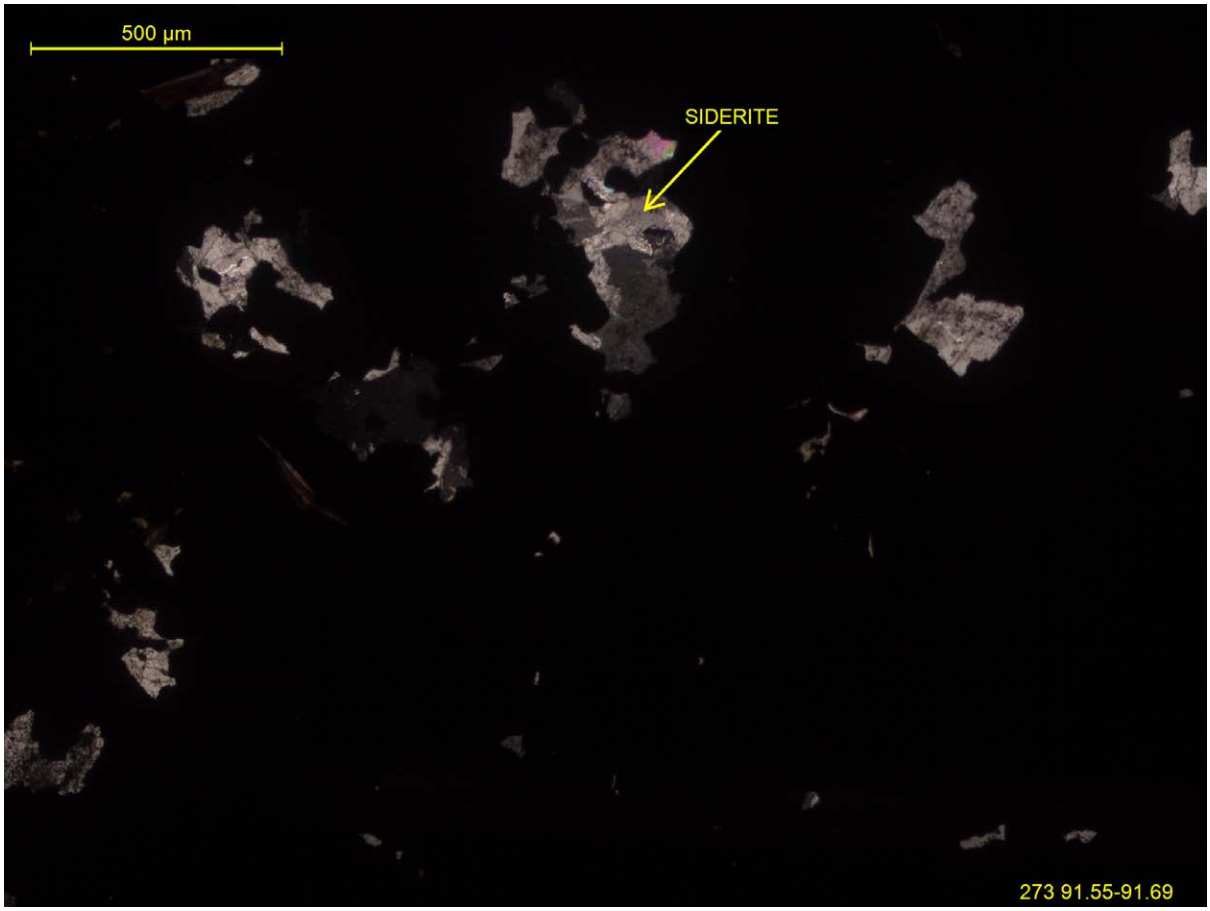

200 µm
PYRRHOTITE
CHALCOPYRITE
PYRITE
273 91.55-91.69
200 µm
CHALCOPYRITE
PYRITE
273 91.55-91.69


200 µm
SPHALERITE
PYRITE
CHALCOPYRITE
MAGNETITE
273 91.55-91.69


200 µm
PYRITE
CHALCOPYRITE
PYRRHOTITE


200 µm
PYRRHOTITE
PYRITE
SPHALERITE
CHALCOPYRITE
273 91.55-91.69
100 µm
CHLORITE
PYRITE
CHALCOPYRITE
PYRRHOTITE
273 91.55-99..41.69.


200 µm
MAGNETITE
SPHALERITE
CHALCOPYRITE
PYRITE
273 91.55-91.69
200 µm
PYRRHOTITE
MAGNETITE
SPHALERITE
PYRITE
CHALCOPYRITE
273 91.55-91.69


500 µm
SIDERITE
273 91.55-91.69