

PETROGRAPHIC REPORT

CLIENT: Trevor Burr, AngloGoldAshanti
PROJECT/PROPERTY: CR STUDY
SAMPLE NUMBER: 863680

BY: James R. Shannon, Ph.D.
SAMPLE TYPE: Polished Thin Section
DATE: 21-July 2017

HAND SAMPLE DESCRIPTION: Medium gray to greenish gray, very fine to fine grained mylonitic chlorite schist. Moderate chlorite foliation and S-C mylonitic fabrics are cut by calcite veins. The sample is nonmagnetic with a pencil magnet and has strong reaction to dilute HCl.

POLISHED-SECTION DESCRIPTION:

MINERAL	EST %	COMMENTS
DOMAIN I	[40]	Domain I is a chlorite-calcite mylonitic schist
Relict Carbonate	33	Abundant, anhedral, relict(?) carbonate grains; Highly turbid with tiny (carbonaceous?) inclusions; These may be dolomitic?
Relict Quartz	7	Anhedral, angular to subrounded grains up to 0.75 mm; Weak undulatory extinction; Not recrystallized; With calcite pressure shadows
Carbonate	25	Recrystallized calcite forming pressure shadows on relict carbonate and quartz grains
Chlorite	22	Foliated chlorite shear matrix
Quartz	10	Grains and patches of very fine quartz mosaics; Unclear what these are- relict chert grains?
Sulfide	3	Disseminated pyrite-unknown-chalcopyrite; Pyrite is elongated and flattened parallel to chlorite foliation
DOMAIN IIA	[15]	Domain IIA is transitional between Domains I and IIB with drastic reduction in the amount of relict, turbid carbonate which is replaced by recrystallized carbonate mosaic
Relict Carbonate	5	
Relict Quartz	7	
Carbonate	53	
Chlorite	22	
Quartz	10	
Sulfide	3	
DOMAIN IIB	[39]	Domain II is a post-deformation chlorite alteration or retrograde overprint on Domain I; All of the relict turbid carbonate and most of the recrystallized carbonate have been replaced by chlorite; Disseminated zircon grains may be detrital?
Relict Quartz	5	Slight reduction in the amount and size of relict quartz grains
Chlorite	76	
Quartz	12	
Carbonate	5	
Zircon	0.2	
Ilmenite	1	
Sulfide	0.5	

DOMAIN III	[6]	Domain III is a quartz-rich chlorite-quartz mylonitic schist; It lacks the relict quartz grains that are in Domains I, IIA and IIB; It appears to be a remnant quartz-rich inclusion(?)
Quartz	68	Recrystallized quartz mosaic with irregular chlorite shears
Chlorite	30	
Ilmenite	0.5	
Sulfide	0.3	
SULFIDES		Overall sulfide content about 2.5 percent- Includes: Pyrite 1.5 percent; Unknown 0.8 percent; Chalcopyrite 0.2 percent; and Pyrrhotite Tr
Pyrite		
Unknown		Light bluish-gray phase as subhedral inclusions in pyrite; Locally altered and pitted out; Has optical properties similar to Arsenian-pyrite?
Chalcopyrite		Minor disseminated, subhedral chalcopyrite is typically associated with relict turbid carbonate grains
Pyrrhotite		Minor anhedral inclusions in pyrite
VEINS	(7)	
Early Carbonate		Early carbonate veinlets in Domains I and IIA; Locally with foliated carbonate; Truncated at Domain IIB contact
Late Carbonate		3 mm thick calcite vein cuts across mylonitic fabric and foliation

TEXTURES

This is a complicated sample with variable mineralogy. The sample has a well-developed mylonitic deformation fabric with incipient to moderately developed C-S ductile mylonite textures and moderate foliation. The variable mineralogy is related to an alteration or retrograde overprint. Four domains are recognized and distributions are shown in the first digital image (Wide Field Thinsection Map). Domain I has abundant relict grains of turbid carbonate (originally dolomite?) and quartz. The regularity of grain sizes suggests they may be relict detrital grains (well sorted) from a sedimentary protolith. It has a well-developed mylonitic shear fabric with suggestions of S-C mylonite textures and moderate-strong chlorite foliation. Domains IIA and IIB are alteration or retrograde overprints where the carbonate component is successively replaced by chlorite. First the relict turbid carbonate is mostly replaced by fine-grained, recrystallized carbonate mosaic in Domain IIA and then the recrystallized carbonate is replaced by chlorite. The C-S mylonitic fabrics and chlorite foliation persist through all of these domains. Domain III is a distinct clast-like lens in Domain IIB. It does not have evidence of the relict quartz and carbonate grains and has a very quartz-rich composition. The C-S mylonitic fabrics and chlorite foliation are also present in Domain III.

The sample is cut by carbonate veins of at least two generations. Early carbonate veinlets are thin, irregular veinlets in Domains I and IIA. They are truncated at the Domain IIB replacement front contact where chlorite replaces most of the carbonate in Domain IIA. These veins post-date the mylonitic deformation and pre-date the alteration/retrograde overprint. Domain IIB has some weird clast-like inclusions of carbonate. One of these clasts has foliated carbonate suggesting there may be even earlier carbonate veins that were deformed by mylonitic shearing. Domains I,

IIA and IIB are cut by a late calcite vein that cuts across the mylonitic and foliation fabric at a high angle. This calcite veins clearly post-dates deformation and the overprinting event.

There is no evidence of biotite in the sample, so it is not clear if the chlorite has replaced earlier metamorphic biotite, or if it is part of the main metamorphic assemblage. There is no evidence of epidote, garnet or amphibole in the sample.

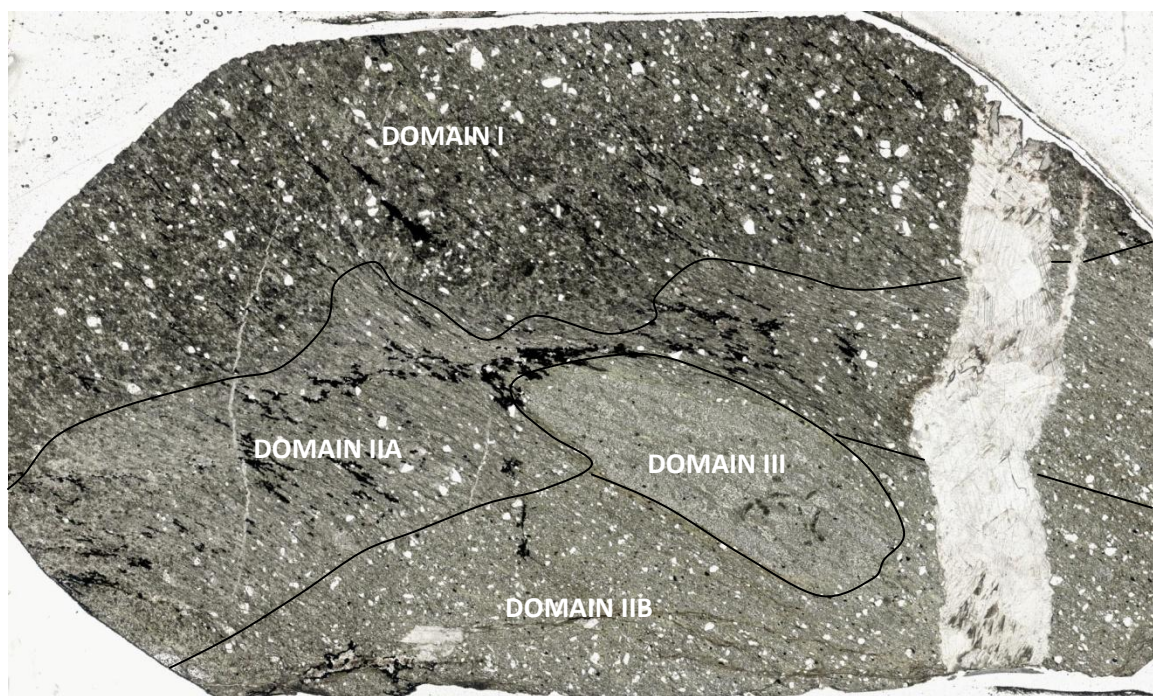
The sample has disseminated sulfides, mostly pyrite that is elongated and aligned parallel to chlorite foliations. The pyrite locally has abundant inclusions of an unknown sulfide phase that are locally altered and pitted. This unknown locally occurs in association with pyrrhotite inclusions. The unknown phase has light bluish to grayish bireflectance and dark bluish anisotropism. Potential candidates are marcassite or arsenian pyrite. The sample geochemistry might help resolve the unknown phase.

DEFORMATION/METAMORPHISM

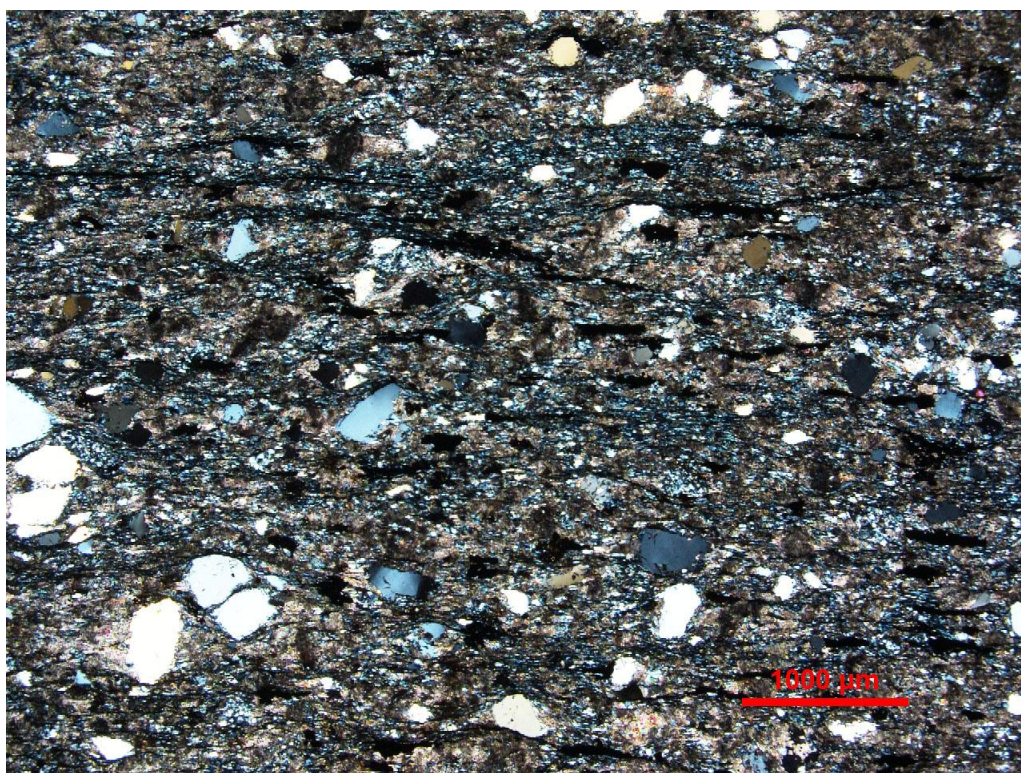
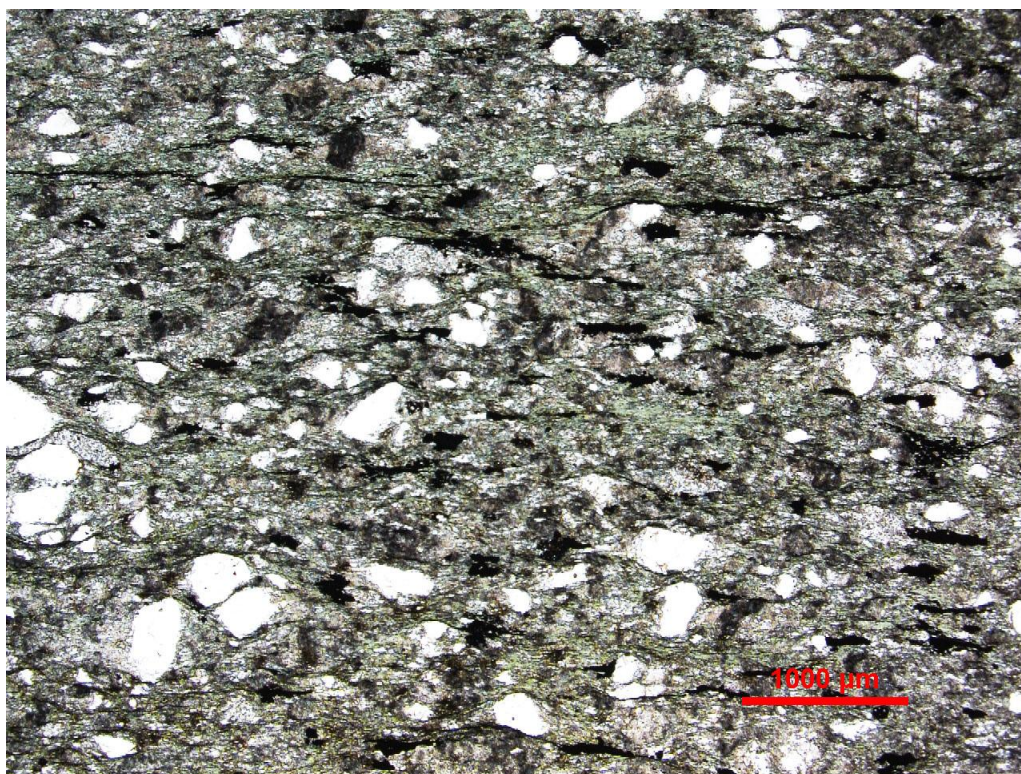
The sample has a well-developed C-S mylonitic deformation overprint that is present in all four domains. Chlorite is present in all four domains. The mylonitic fabric is dominated by chlorite shears representing the C-surfaces (shear). The metamorphic assemblage changes from relict-mineral dominated in Domain I to chlorite dominated in Domain IIB. This transition appears to be related to the increasing destruction of carbonate and formation of chlorite. The main metamorphic assemblage of chlorite-quartz in Domain IIB suggests a low grade of metamorphism equivalent to lower(?) greenschist facies. The chlorite assemblage may be the original metamorphic assemblage related to high carbonate content and possibly high Mg-content (from detrital dolomite component). It is also possible that chlorite has extensively replaced an earlier metamorphic assemblage with biotite.

ROCK NAME: Chlorite-Carbonate Mylonitic Schist

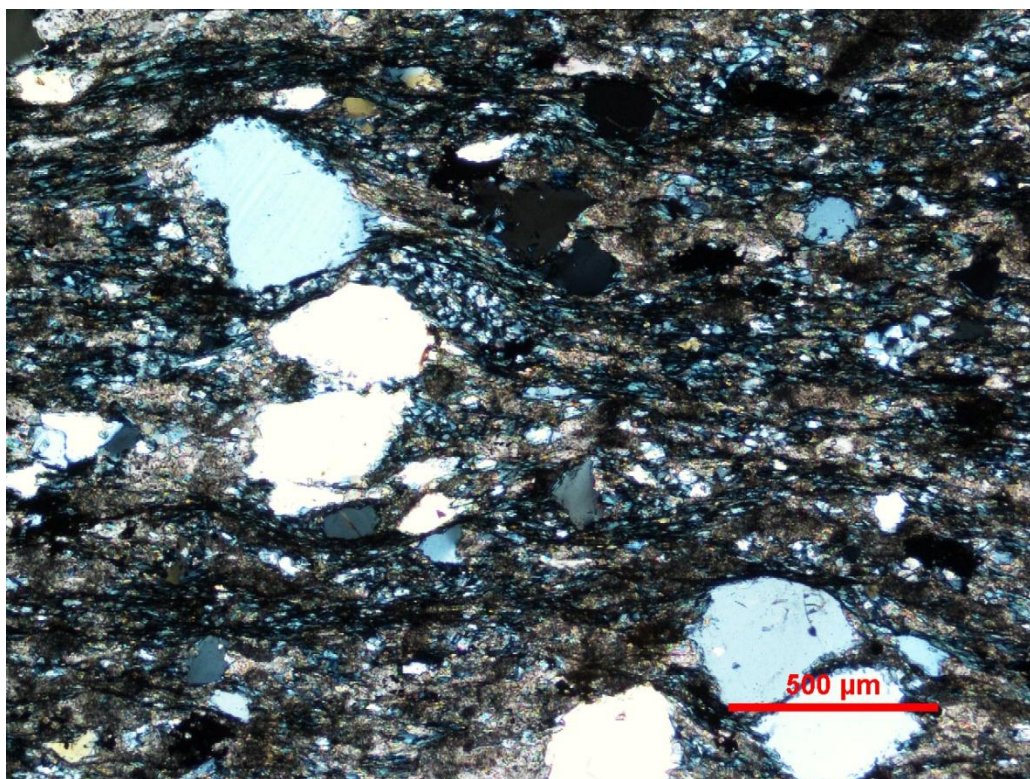
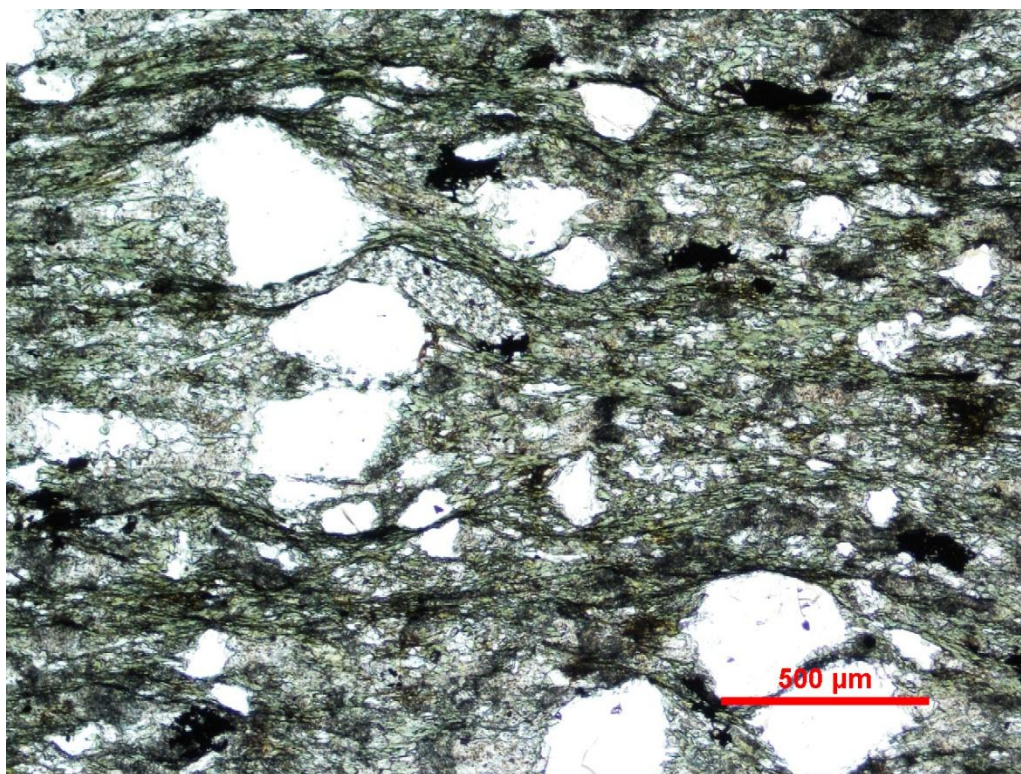
PROTOLITH: Uncertain Protolith; Relict Quartz, Carbonate, and Zircon Grains Support a Sedimentary Rock (texturally well sorted; mineralogically immature)

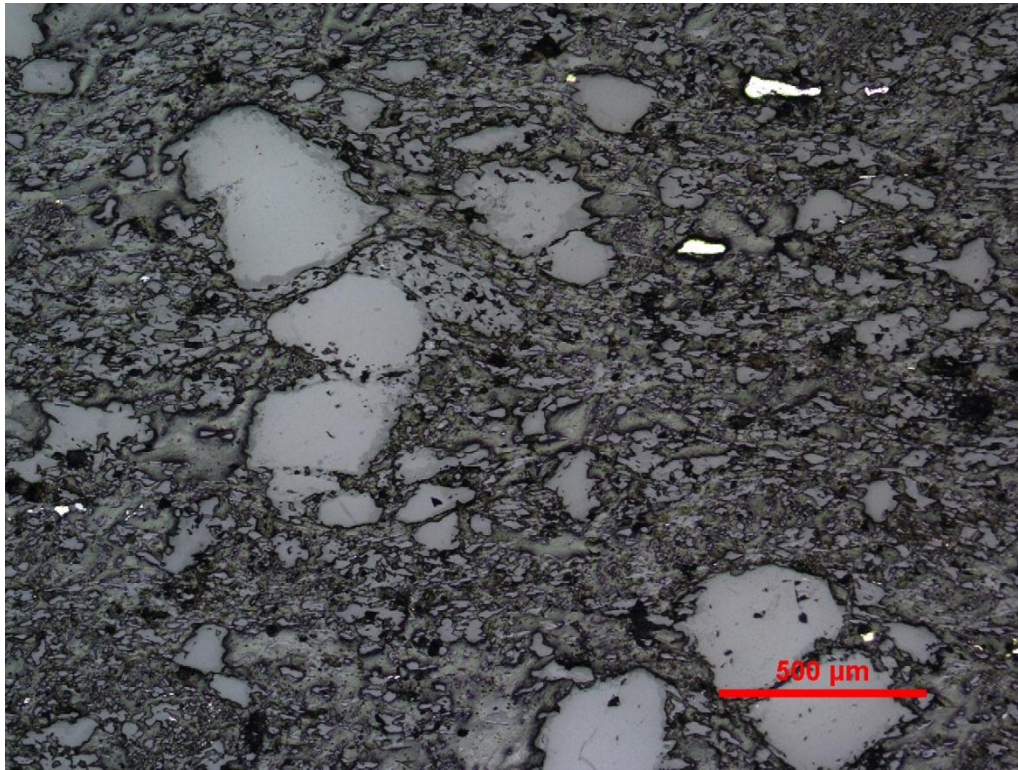


Sample 863680. Wide-field, full-thinsection view showing mylonitic schist with four mineralogical domains and calcite vein. Top- plane light; Bottom- crossed polarizers.

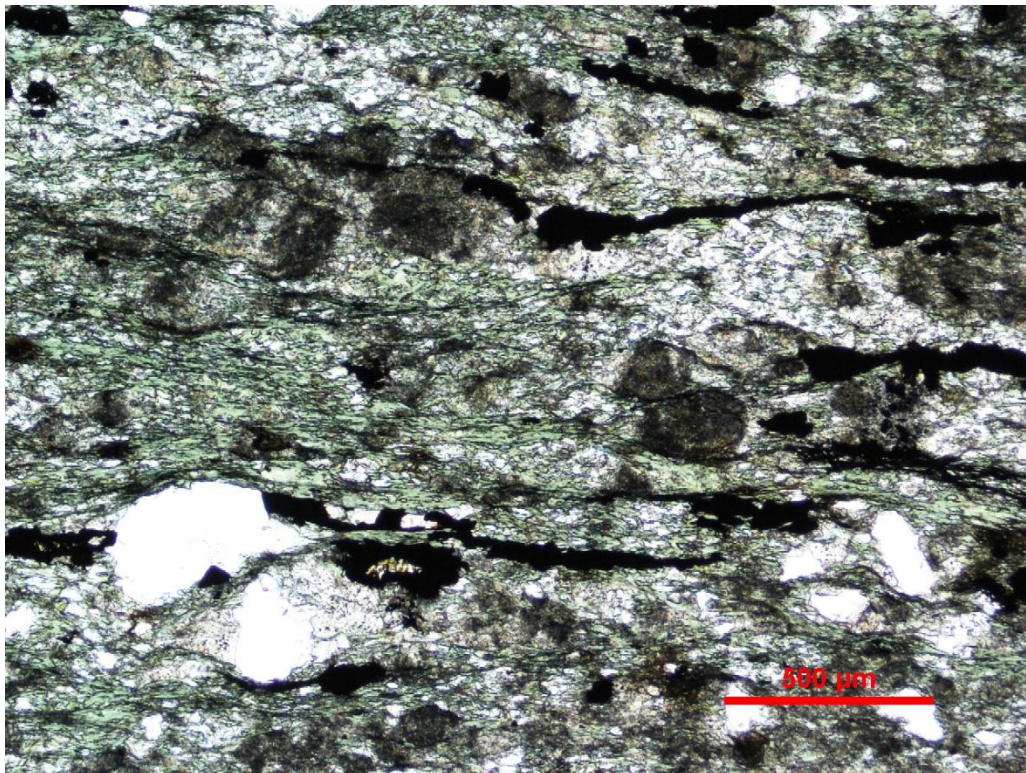


Sample 863680. Domain I with abundant calcite, remnant quartz grains, and foliated chlorite.
Top- plane light; Bottom- crossed polarizers.

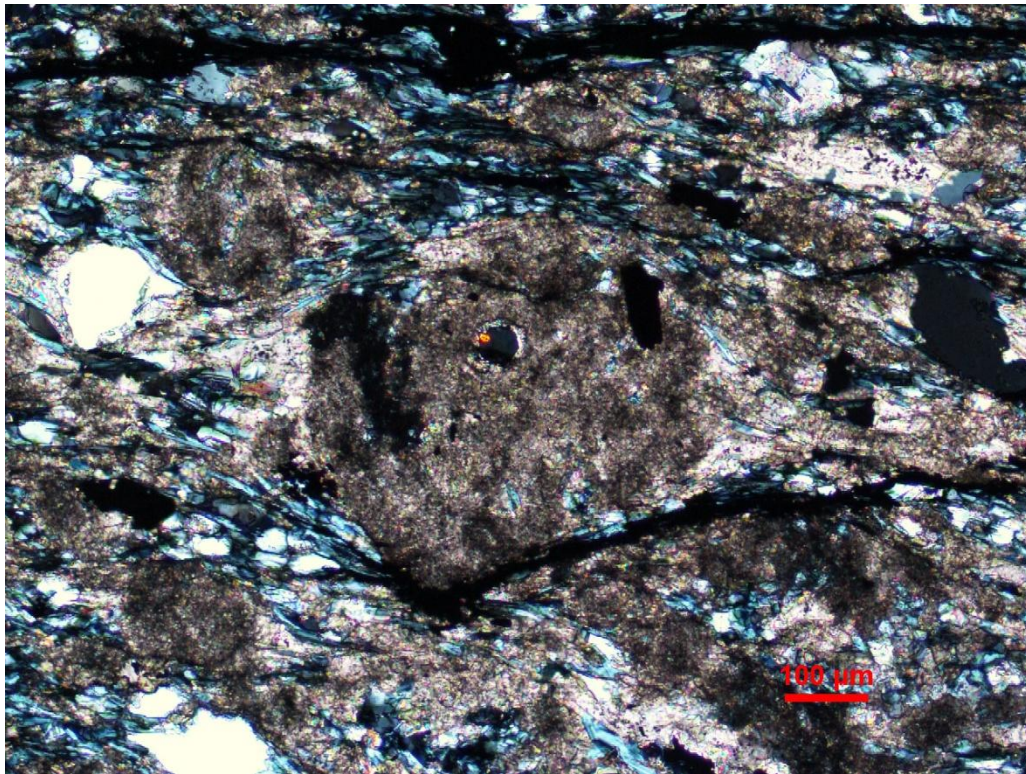
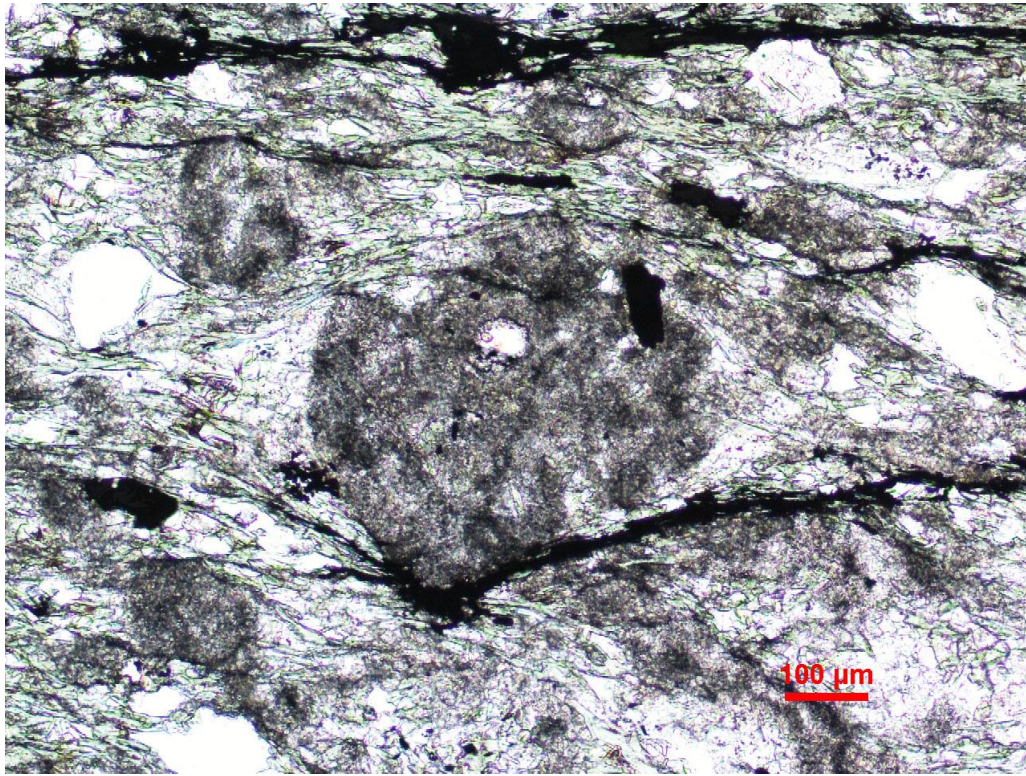




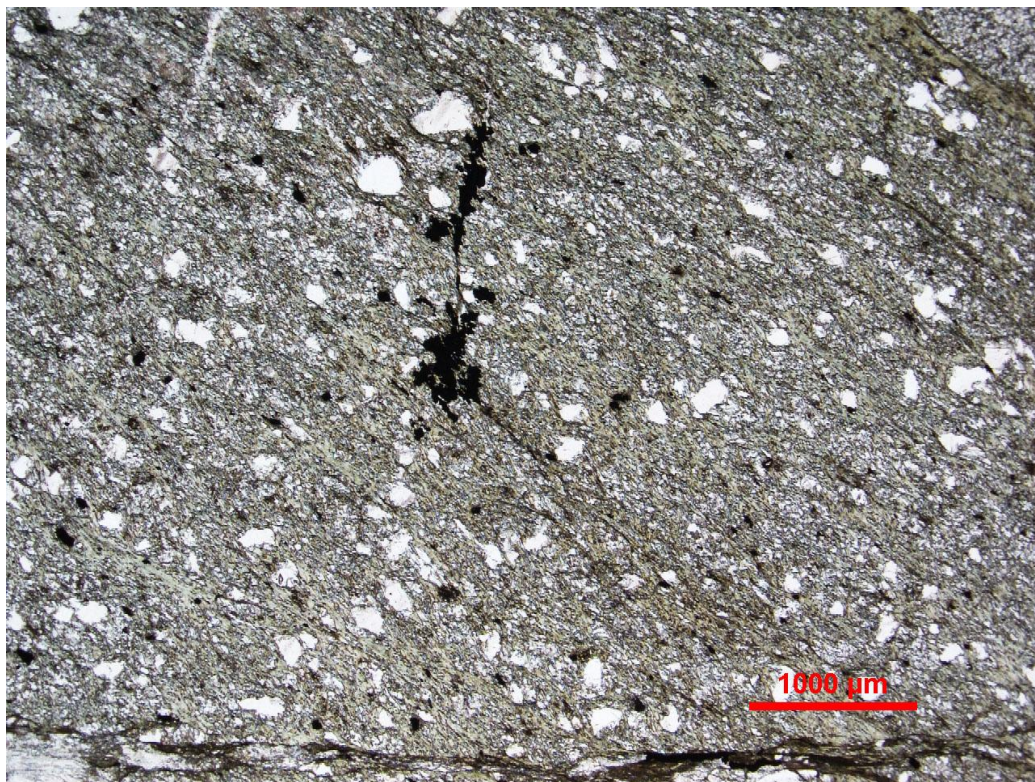
Sample 863680. Domain I with moderate foliation and weak S-C mylonitic fabric. Note disseminated pyrite is elongated parallel to foliation. Top- plane light; Middle- crossed polarizers; Bottom- reflected light.



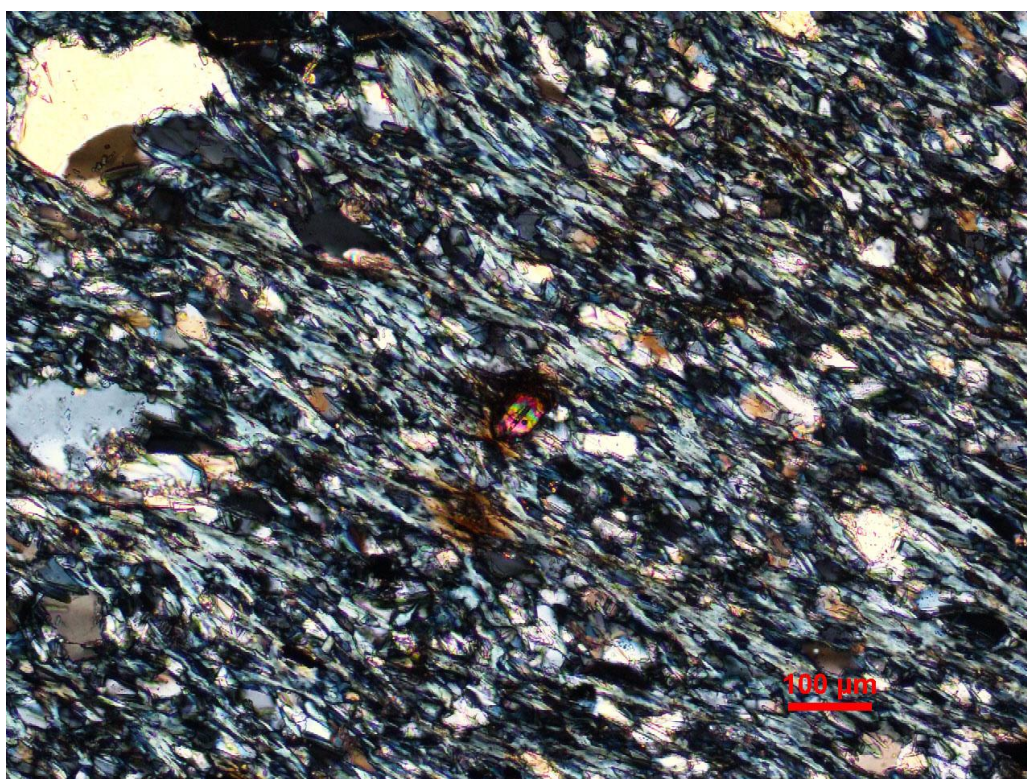
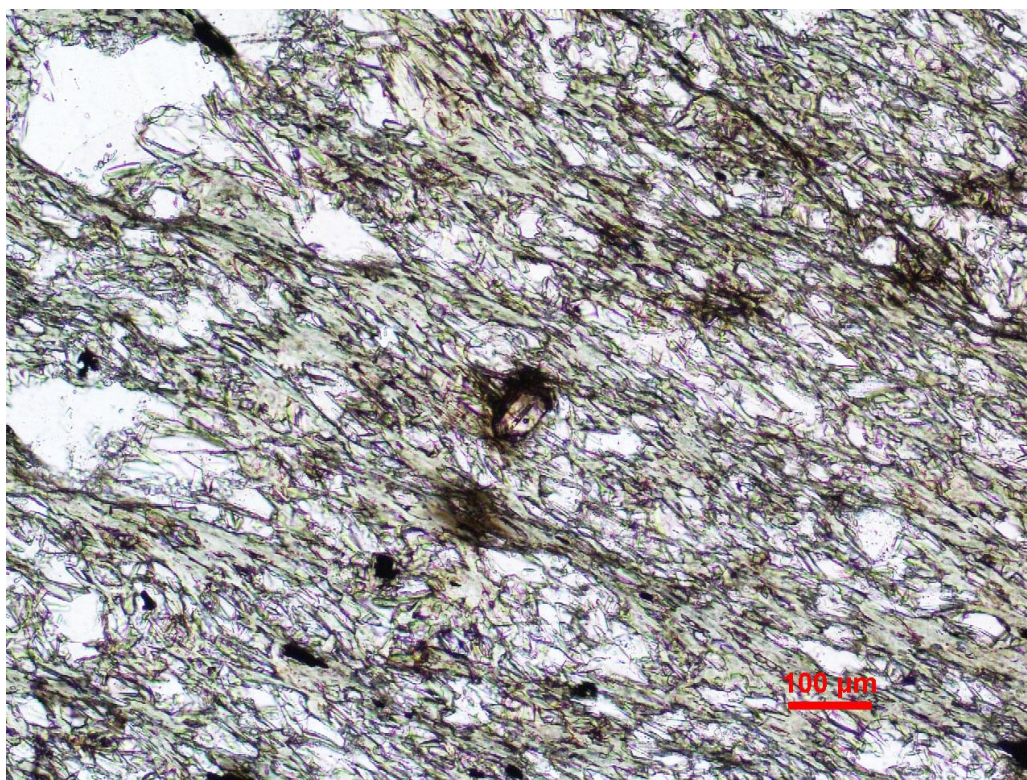
Sample 863680. Relic carbonate grains in Domain I. Grains are highly turbid with very fine inclusions (carbonaceous or graphitic?). Plane light.



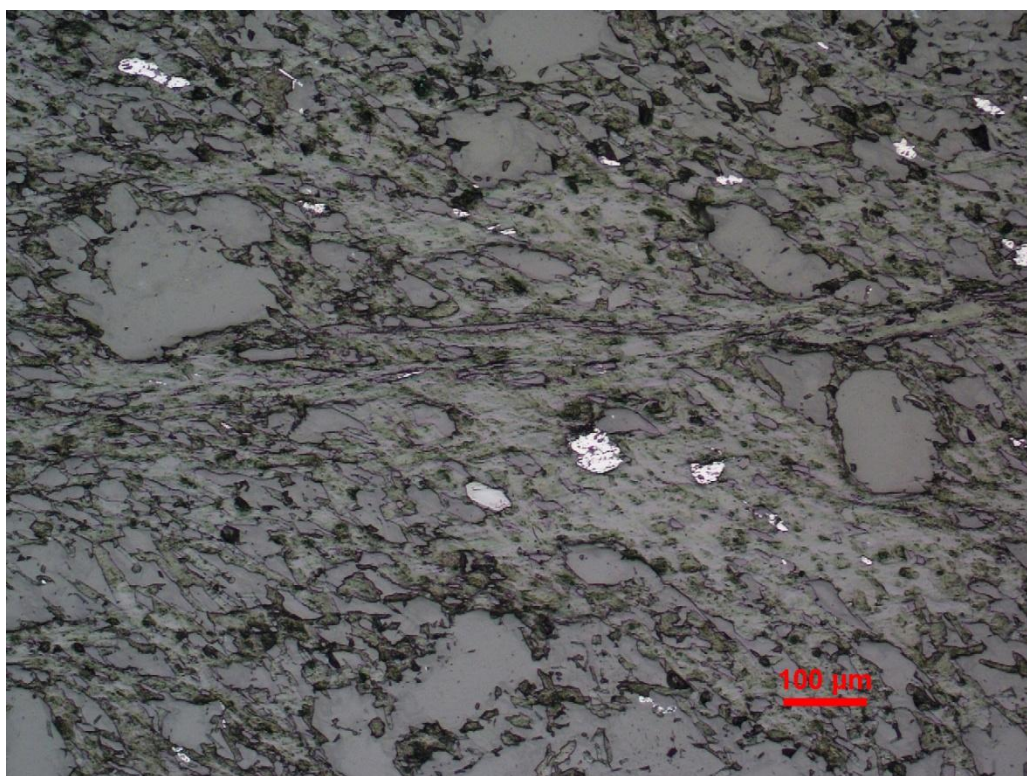
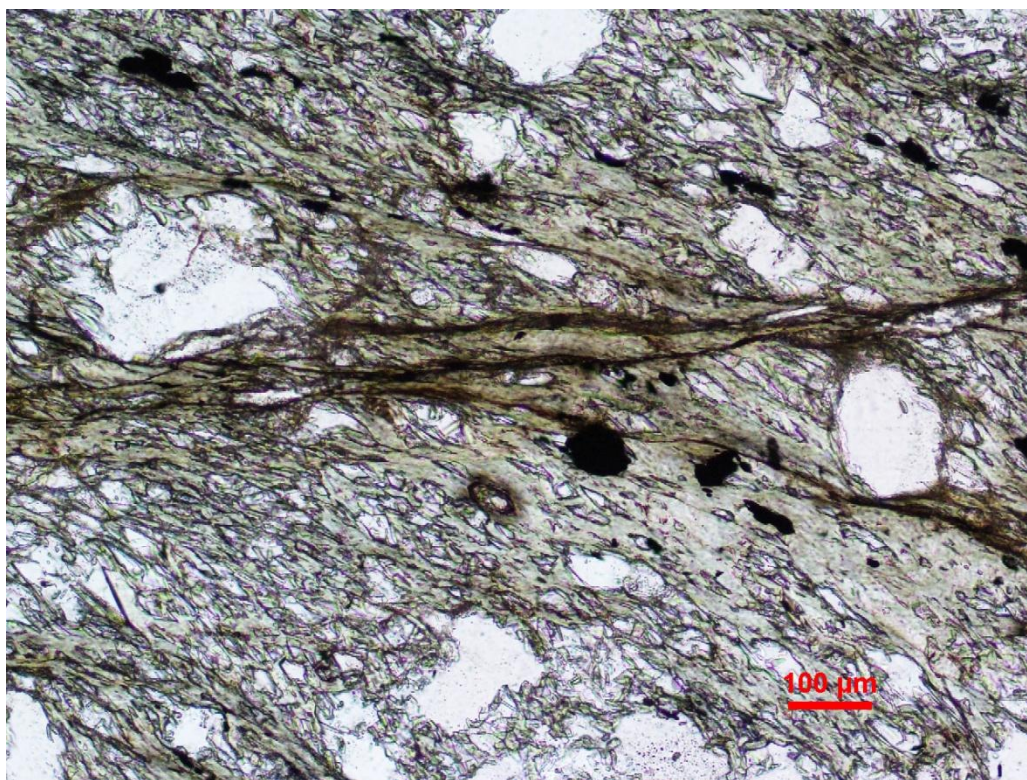
Sample 863680. Close up view of relict(?) carbonate grain in Domain I. Note clean carbonate pressure shadows on relict grains. Top- plane light; Bottom- crossed polarizers.



Sample 863680. Domain II with very abundant chlorite, minor carbonate and relict quartz grains in moderate-strong foliated mylonitic schist. Note contact with Domain I in upper left corner. Top- plane light; Bottom- crossed polarizers



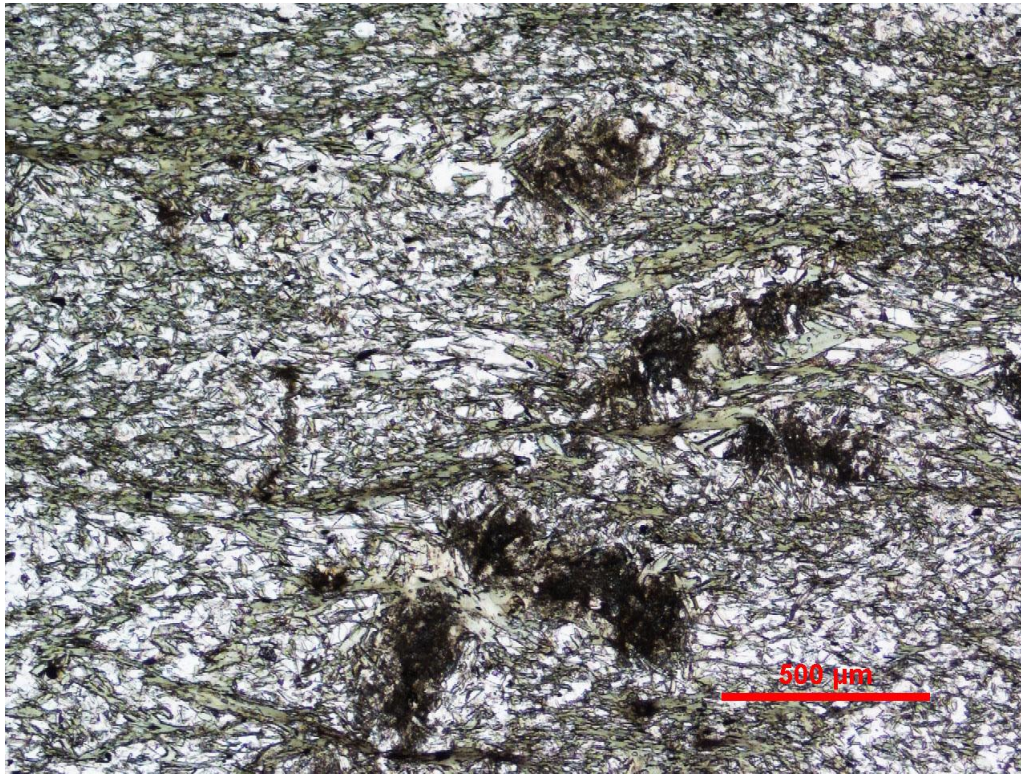
Sample 863680. Close up of Domain II with accessory zircon in strong foliated chlorite schist. Top- plane light; Bottom- crossed polarizers.



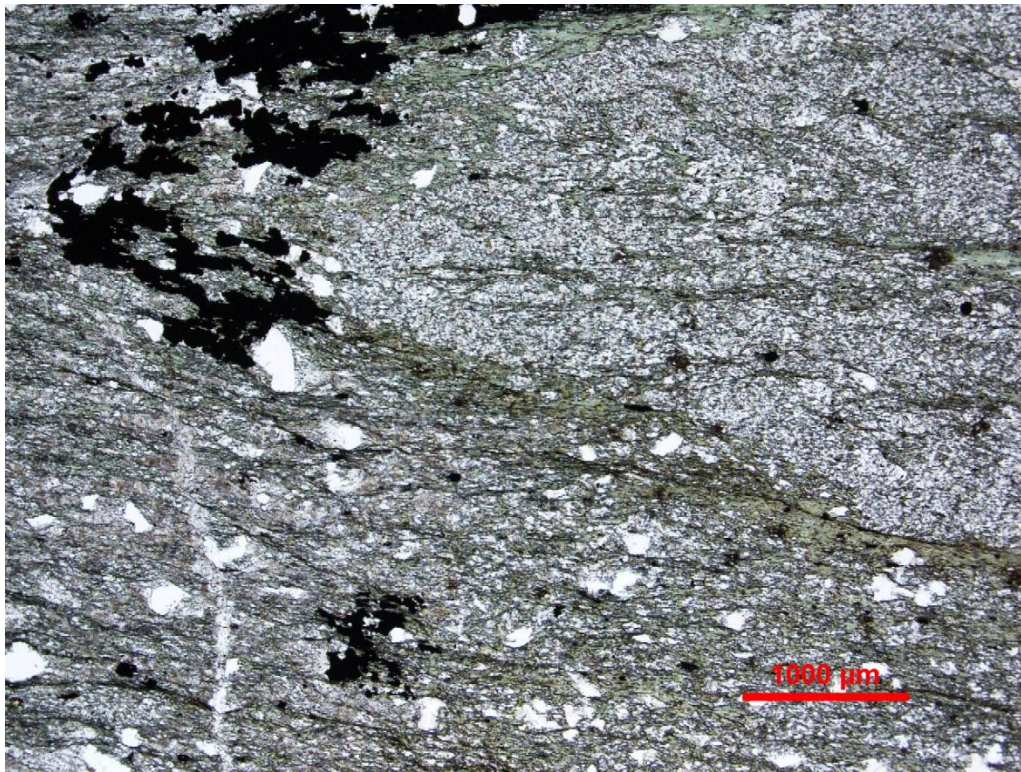
Sample 863680. Accessory zircon and ilmenite in Domain II with S-C mylonitic fabrics. Top- plane light; Bottom- reflected light.

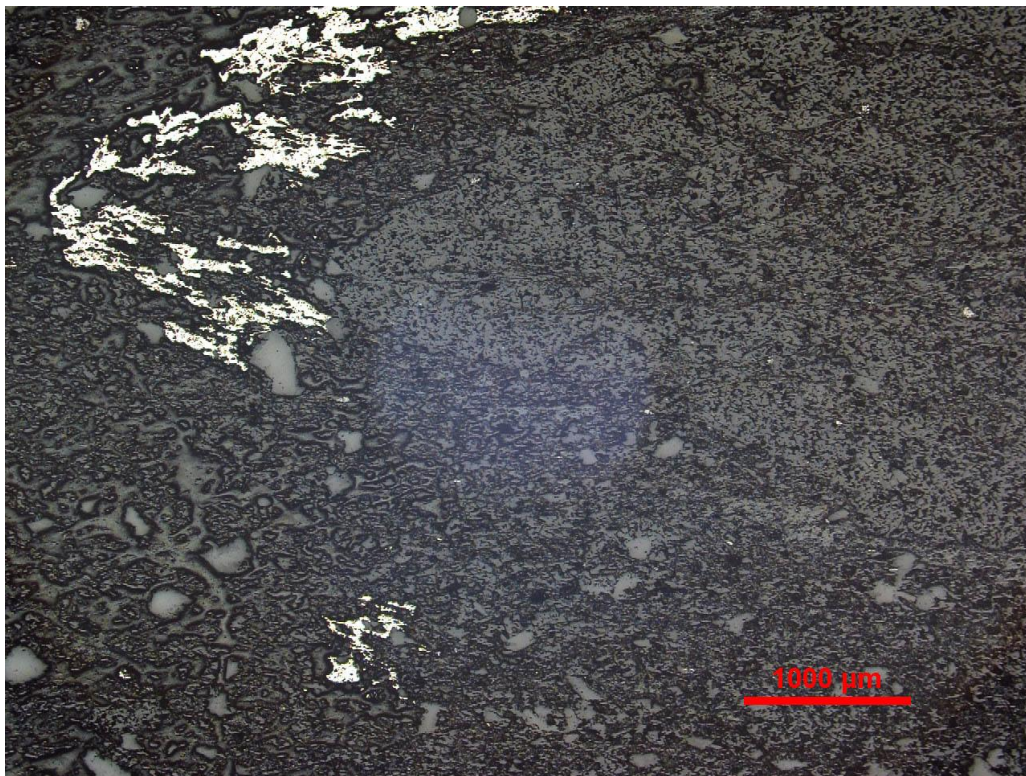
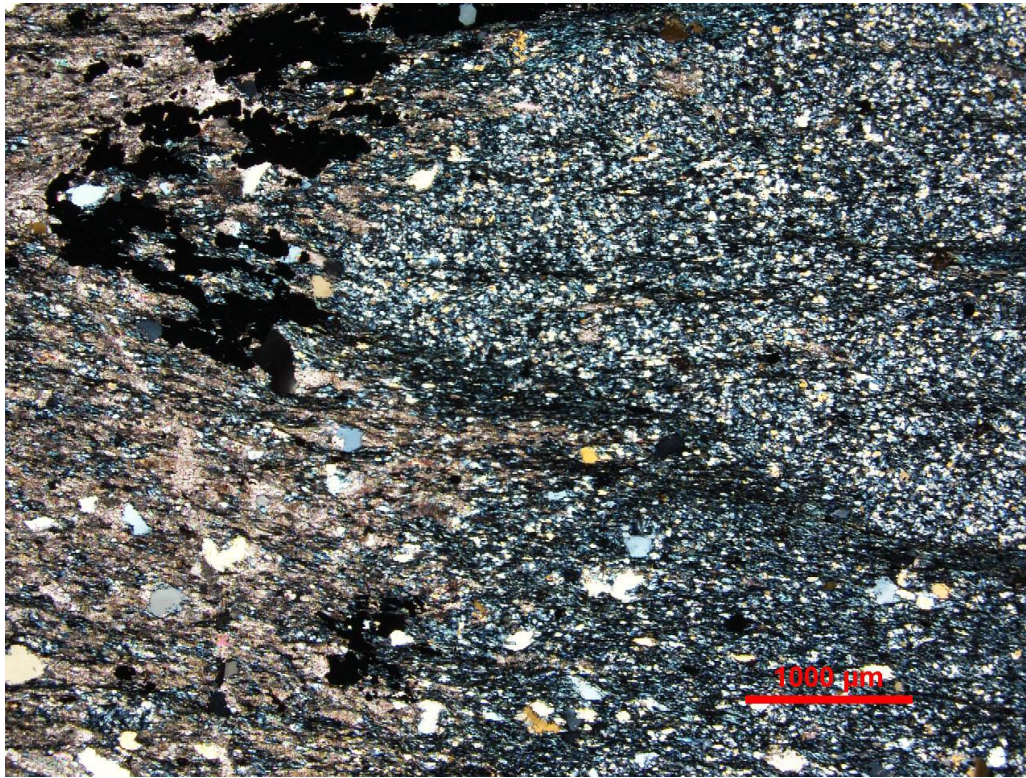


Sample 863680. Very quartz-rich, quartz-chlorite-ilmenite assemblage in Domain III. Note lack of relict quartz grains in this domain. Top- plane light; Bottom- crossed polarized.

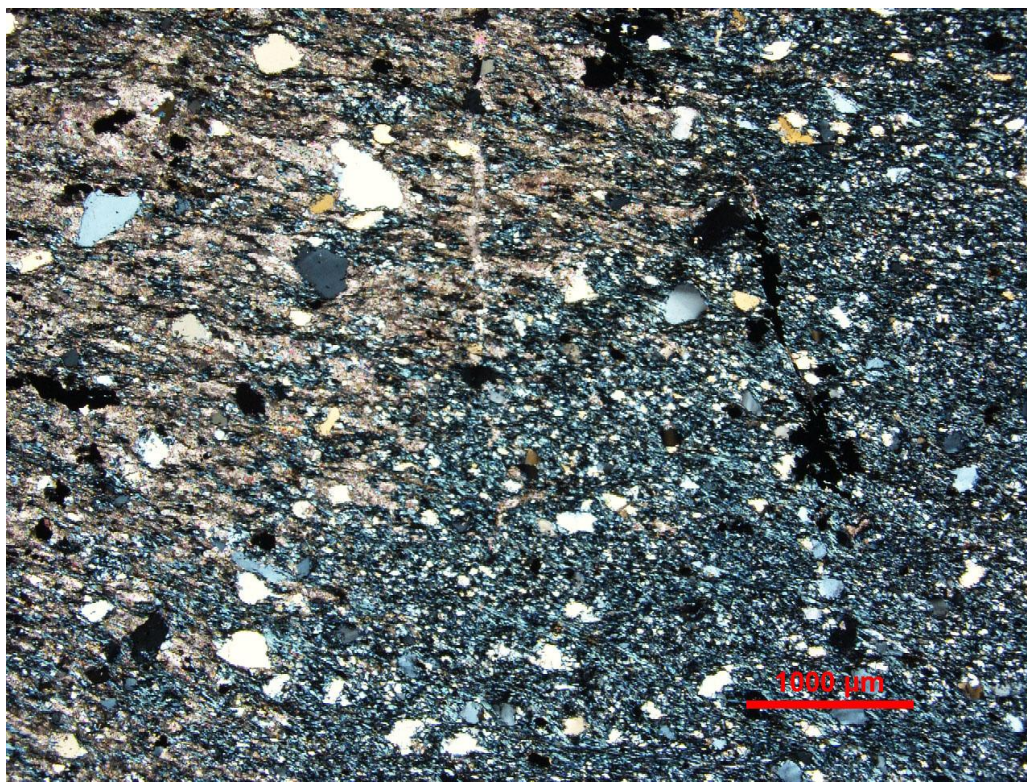
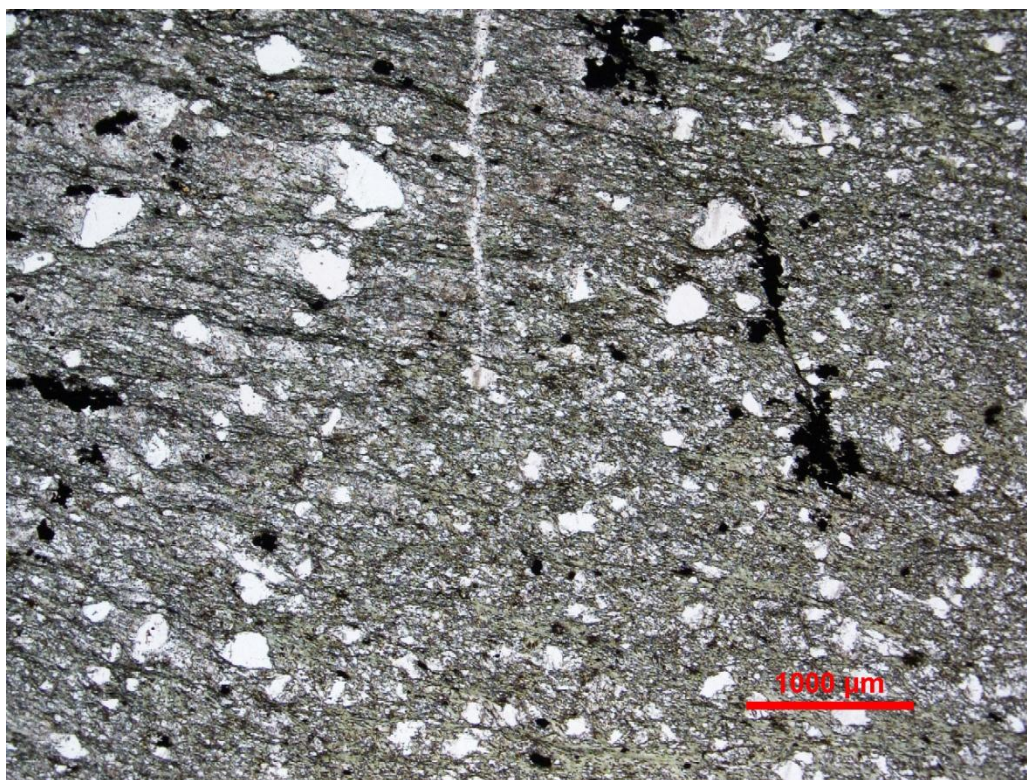


Sample 863680. Weak S-C mylonitic fabrics in Domain III. Plane light.

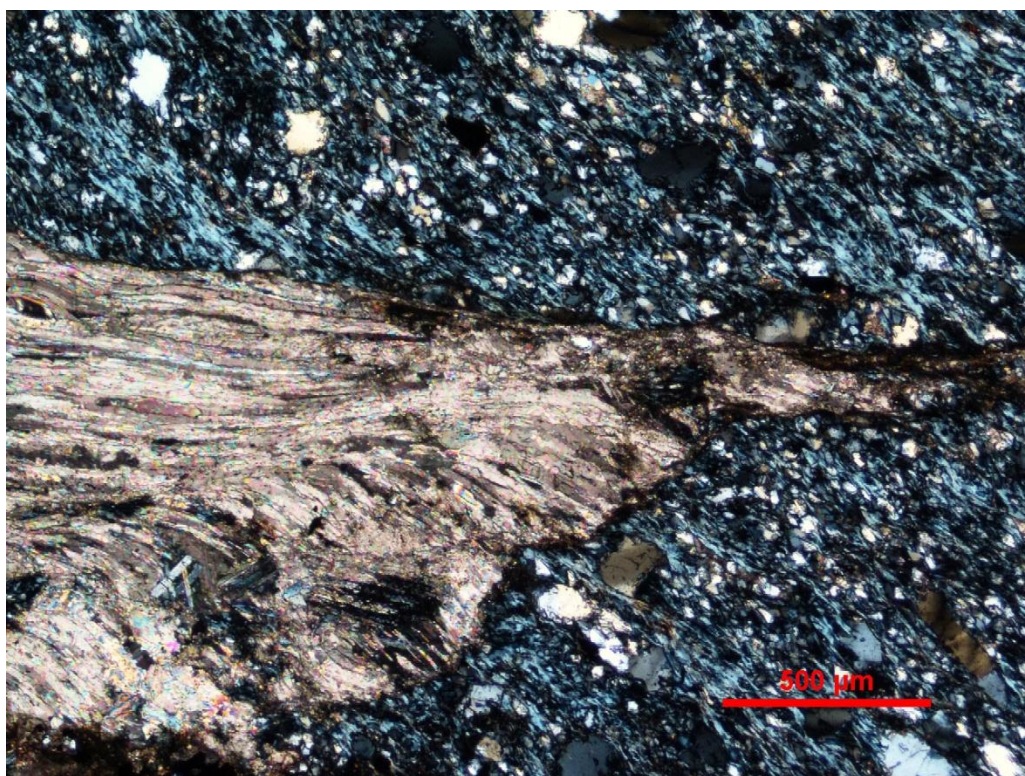
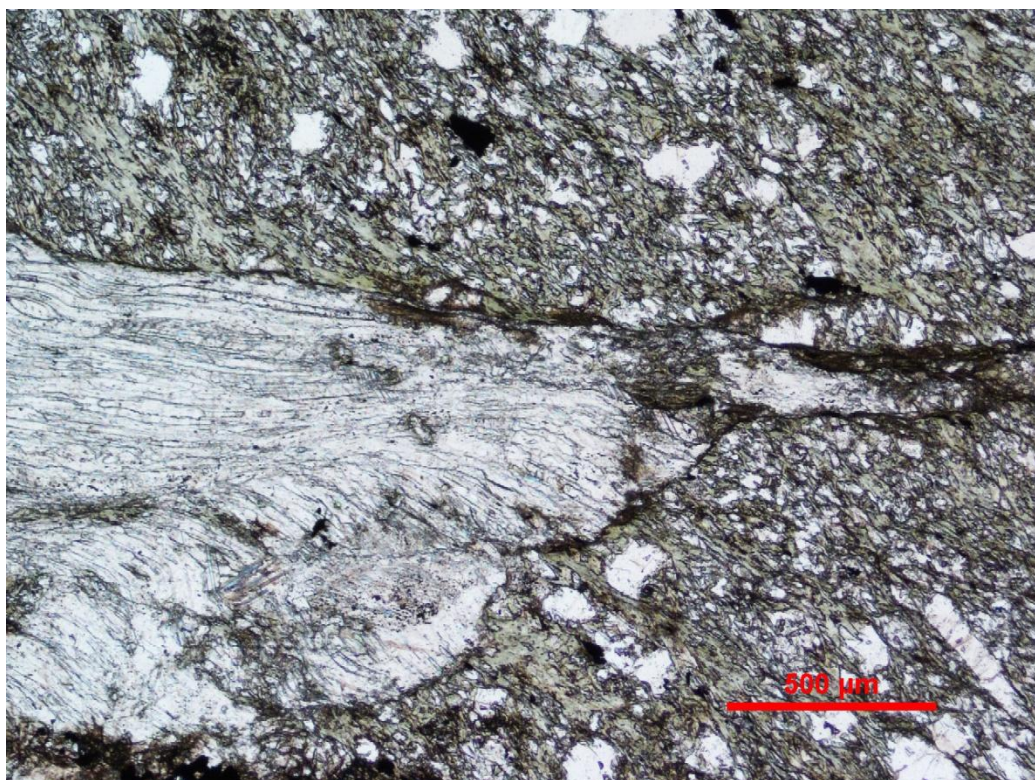




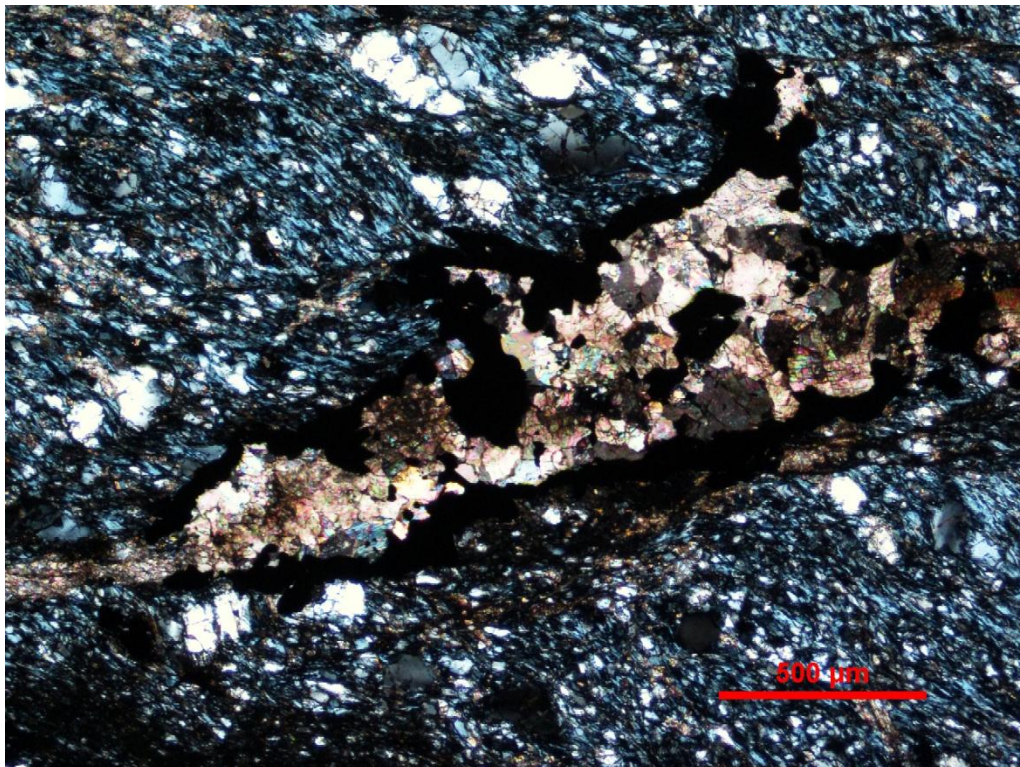
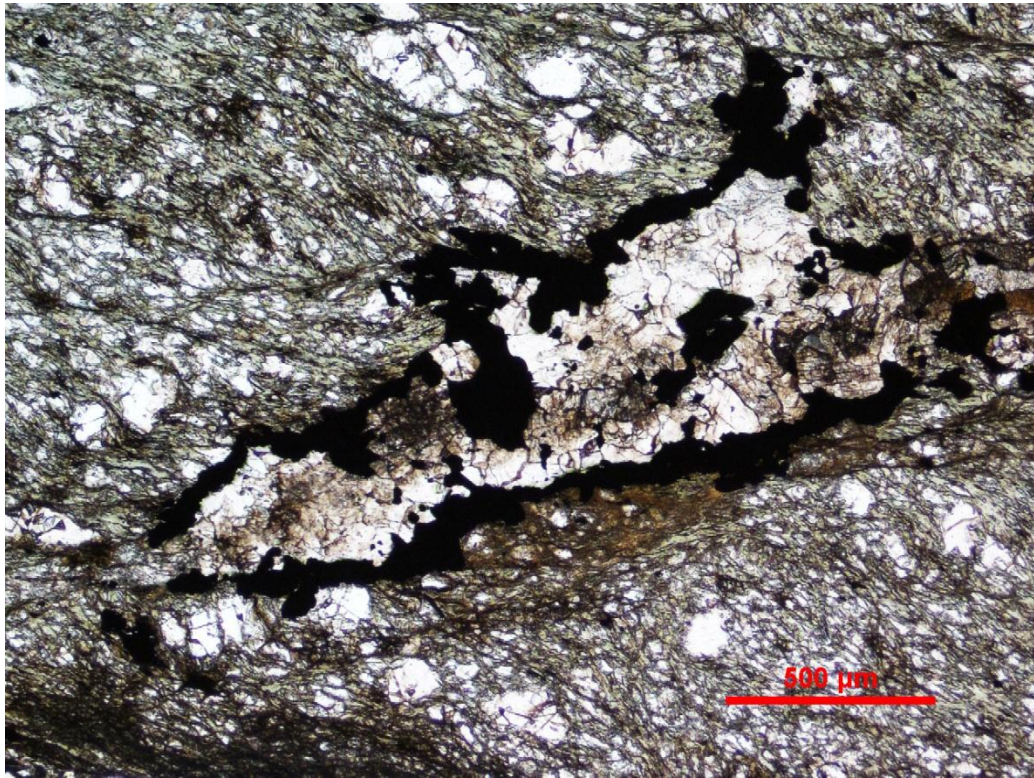
Sample 863680. Contacts between Domains I, II, and III showing consistent penetrative S-C mylonitic fabrics. Top- plane light; Middle- crossed polarizers; Bottom- reflected light.

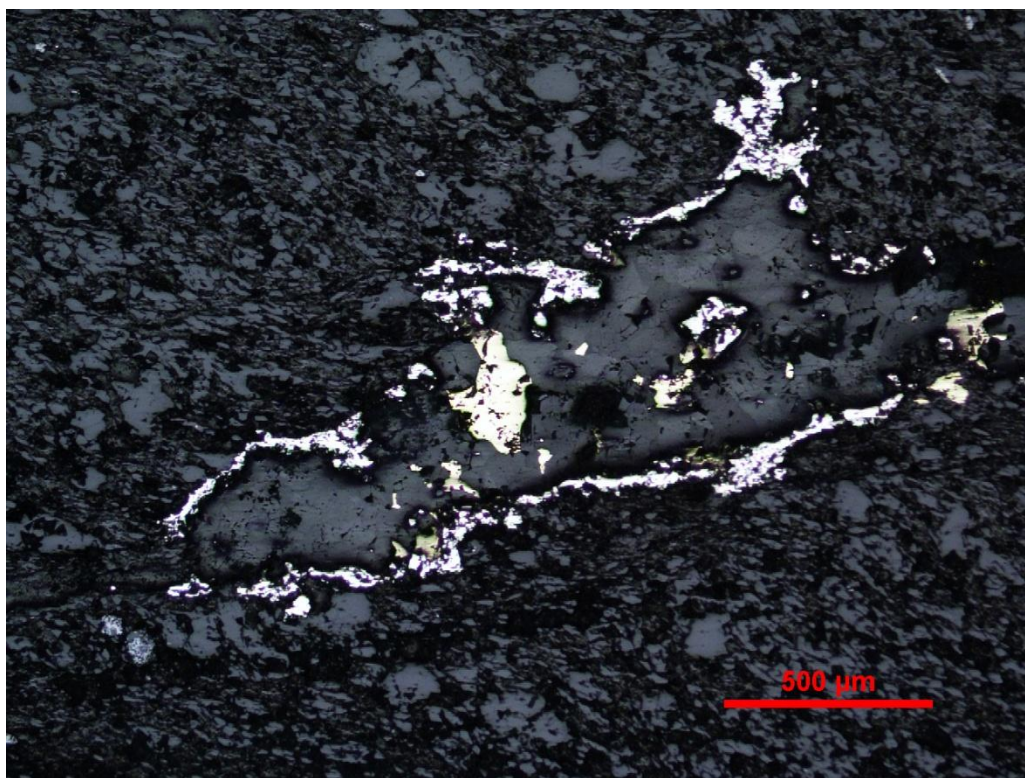


Sample 863680. Close-up view of contact between Domain I (left) and Domain II (right) showing chlorite in Domain II replaces calcite in Domain I. Note truncated carbonate veinlet in Domain I. Top- plane light; Bottom- crossed polarizers.

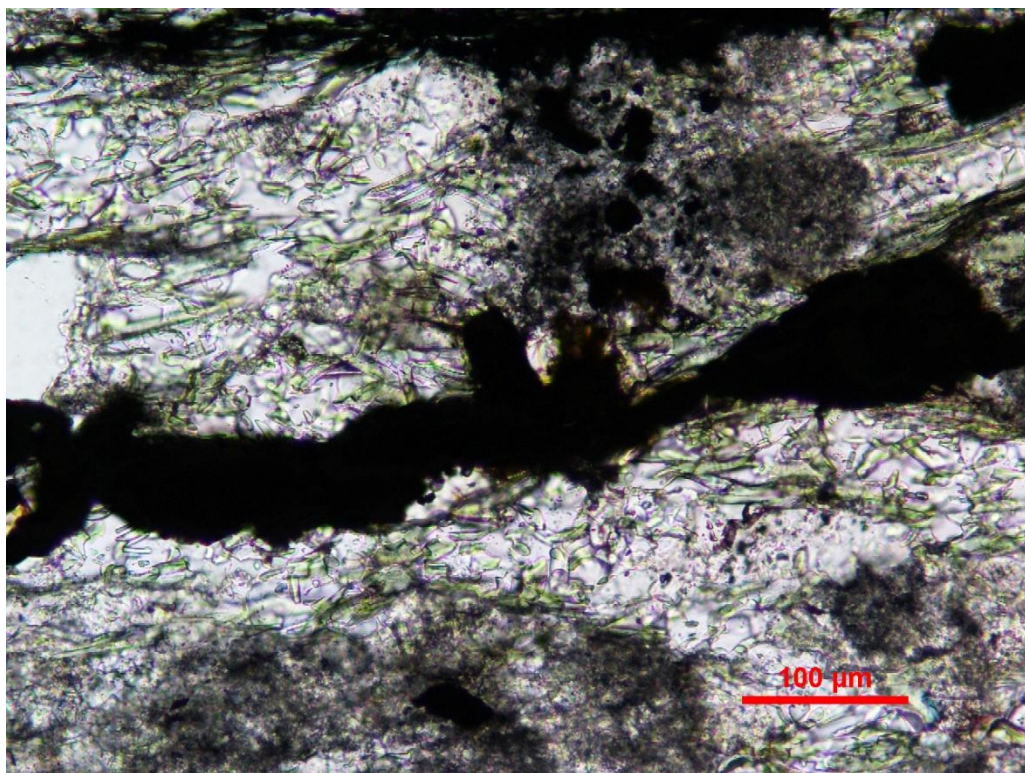


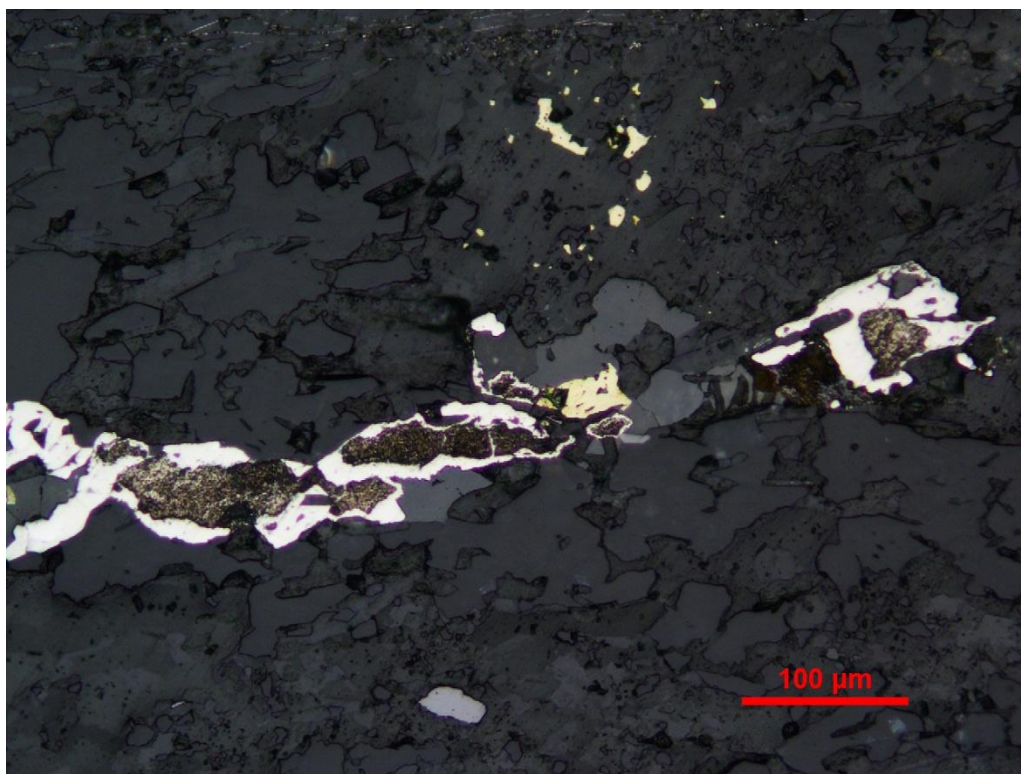
Sample 863680. Peculiar strongly foliated carbonate 'clast' in Domain II appears to cut across mylonitic foliation fabrics. Top- plane light; Bottom- crossed polarizers.



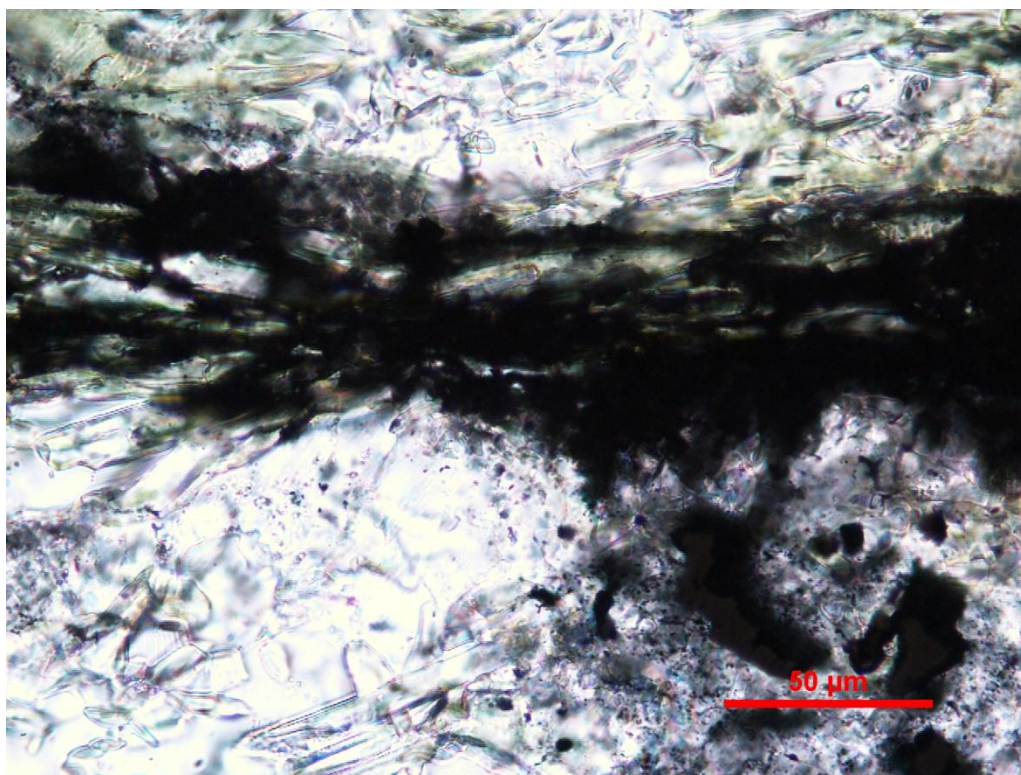


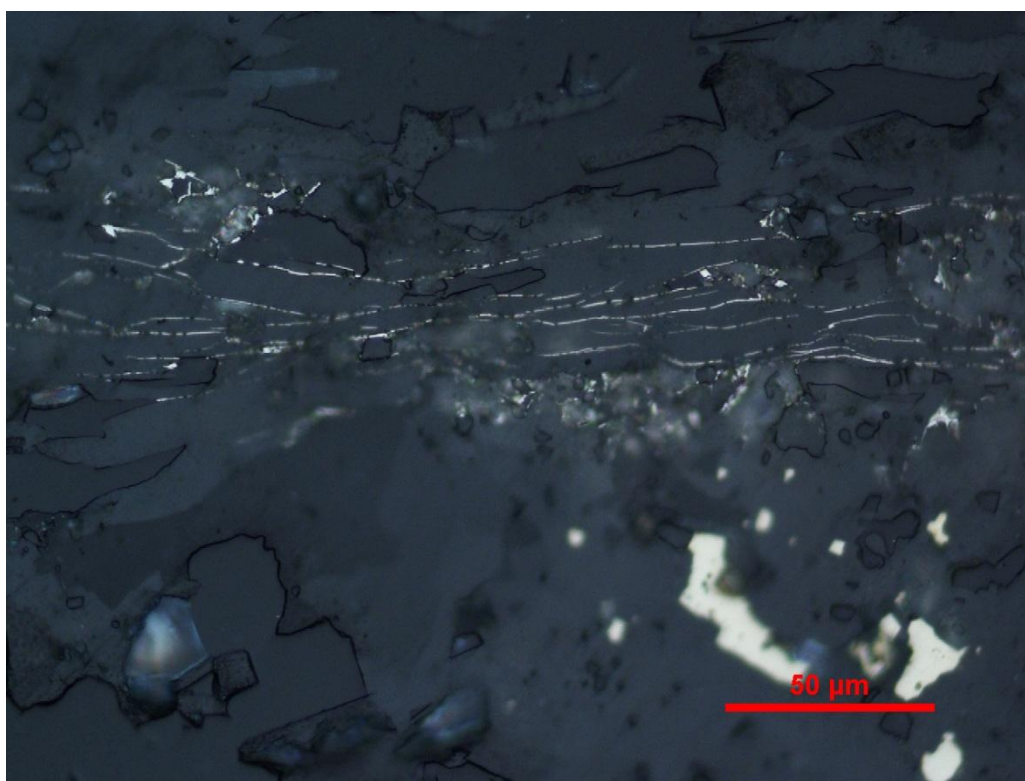
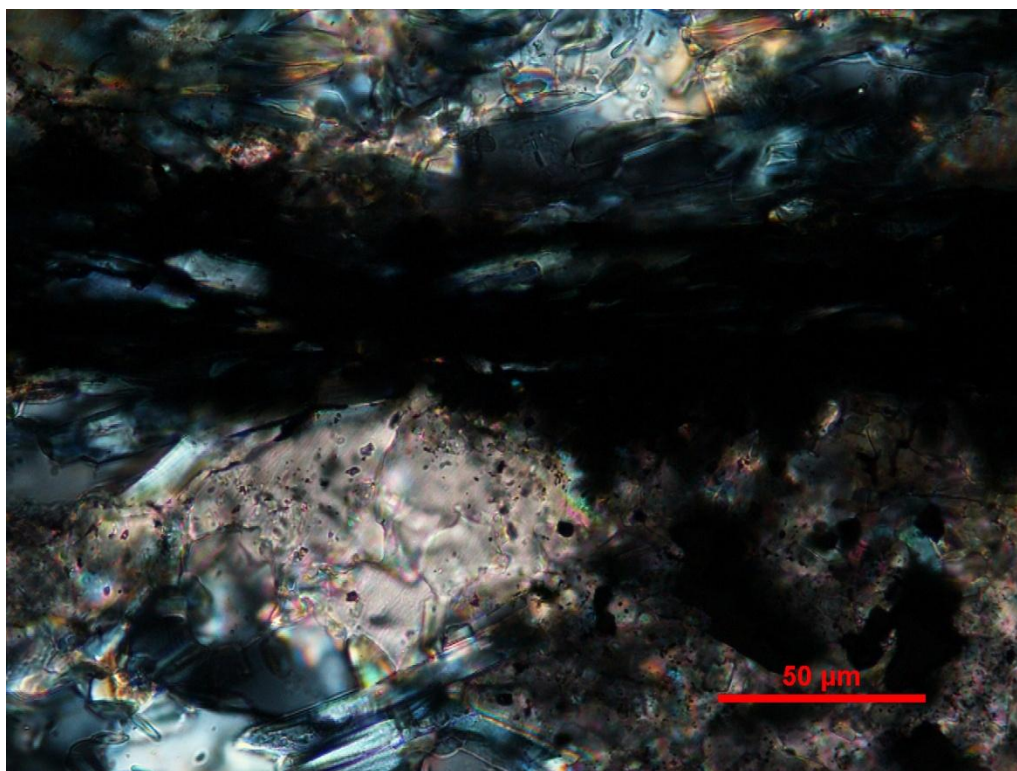
Sample 863680. Another 'clast-like' inclusion of carbonate rimmed by pyrite and chalcopyrite in Domain II. Top- plane light; Middle- crossed polarizers; Bottom- reflected light.



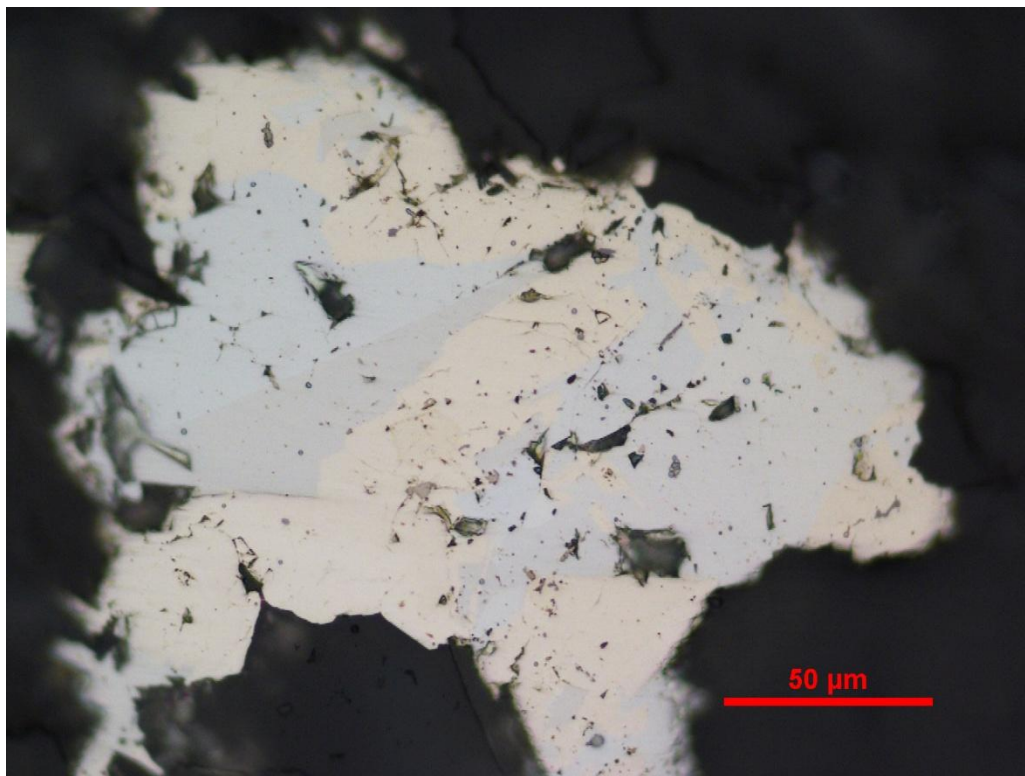
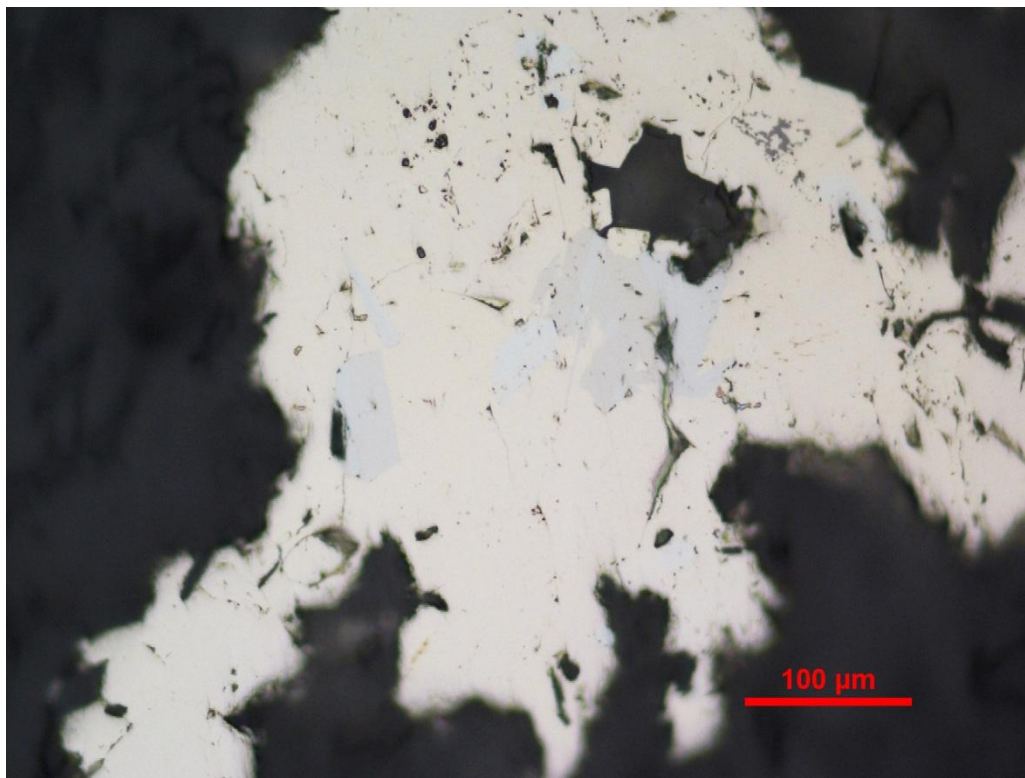


Sample 863680. Elongated subhedral-anhedral pyrite with altered cores and disseminated subhedral chalcopyrite associated with turbid carbonate in Domain II. Top- plane light; Bottom- reflected light.

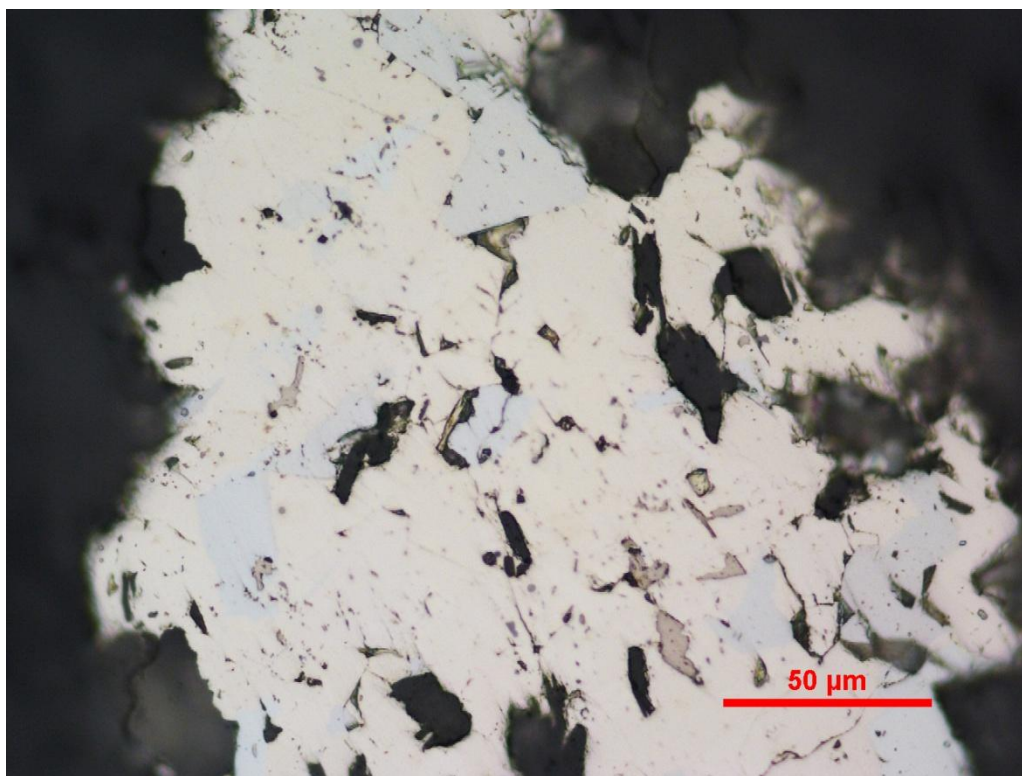




Sample 863680. Close-up view from above (inverted) showing fine pyrite intergrown with chlorite (upper) and subhedral disseminated chalcopryrite associated with turbid carbonate. Top- plane light; Middle- crossed polarizers; Bottom- reflected light.



Sample 863680. Close-up views showing inclusions of unknown phase (light bluish to grayish) in anhedral pyrite. Reflected light.



Sample 863680. Close-up view showing inclusions of unknown phase (bluish) and pyrrhotite (tan) in anhedral pyrite. Reflected light.