

PETROGRAPIC REPORT

CLIENT: Trevor Burr, AngloGoldAshanti
PROJECT/PROPERTY: CR STUDY
SAMPLE NUMBER: CR-0003

BY: James R. Shannon, Ph.D.
SAMPLE TYPE: Polished Thin Section
DATE: 19-June 2017

HAND SAMPLE DESCRIPTION: Large piece of drill core from 51.50 m showing a very fine to medium grained, dark gray, mafic-rich augite-biotite gabbro. No preferred deformation fabrics. There appears to be some alignment of elongated plagioclase and biotite related to igneous lamination. The rock is non magnetic and has weak to moderate effervescence indicating the presence of carbonate.

POLISHED-SECTION DESCRIPTION:

MINERAL	EST %	COMMENTS
PRIMARY	(96)	Slightly porphyritic with small olivine, clinopyroxene and biotite phenocrysts in a fine-grained disbasic matrix with elongated plagioclase laths
Plagioclase	66	Subhedral elongated grains up to 1 mm; albite twinning and normal zoning; very weak local alteration to anhydrite(?) and sericite
Augite	16	Subhedral grains (small phenocrysts) up to 0.8 mm; commonly clustered and some grains consist of a mosaic of small euhedral to anhedral crystals; minor suggestions of zoning
Biotite	8	Anhedral grains up to 3 mm; locally poikilitic with plag and cpx inclusions
Olivine	5	Anhedral-subhedral small phenocrysts and grain clusters; weak alteration to brownish iddingsite with unknown phase
Hornblende	0.3	Minor, small (up to 0.1 mm) subhedral grains with green-brown pleochroism
ACCESSORY	(3.5)	
Titanomagnetite	3	Anhedral grains up to 0.3 mm with minor ilmenite exsolution lamellae; Looks like isotropic magnetite- nonmagnetic supports titanomagnetite
Apatite	0.5	Fairly abundant as euhedral-subhedral elongated crystals up to 0.25 mm; locally clustered
ALTERATION	(4)	The rock is generally fresh with very weak alteration; Alteration of olivine to iddingsite could be late magmatic/deuteric; Minor calcite and trace sericite alteration after plagioclase
Carbonate	3	Mostly worn from thinsection during polishing; weak-moderate effervescence with dilute HCL shows significant calcite was in interstitial voids between plagioclase laths
Iddingsite	0.5	Orangish to reddish brown alteration of olivine along fractures; looks like biotite; locally associated with unknown phase (tiny yellowish flakes)

Unknown	0.3	Colorless, low relief, biaxial (+) 2V +60; max brief 0.022; optical properties suggest anhydrite-gypsum
Unknown	Tr	Very fine, subhedral, flakes intergrown with iddingsite along fractures in olivine; Probably a Ni-bearing phase?
Hematite	Tr	Minor alteration of chalcopyrite and pyrrhotite
SULFIDES	(0.3)	Minor disseminated sulfides including pyrrhotite, chalcopyrite and composite grains; mostly associated with biotite and plagioclase; some grains have spherical shapes suggestive of magmatic sulfides
Pyrrhotite	0.2	Anhedral to spherical grains up to 0.12 mm; commonly as composite grains with chalcopyrite
Chalcopyrite	0.1	Anhedral grains common as composite grains with pyrrhotite; minor alteration/replacement by hematite; also occurs as tiny rod-shaped inclusions in plagioclase

TEXTURES

The sample displays a slight, (micro-) porphyritic texture with small phenocrysts of augite, biotite and olivine in a fine-grained, diabasic matrix of elongated plagioclase laths. There are some suggestions of alignment of elongated biotite and plagioclase grains (magmatic lamination) due to flowage. The flow layering is not consistent and locally wraps around clusters of phenocrysts. Both olivine and augite phenocrysts are locally clustered (glomeroporphyritic) and some augite grains show subhedral outlines and consist of mosaics of small subhedral-anhedral grains. The biotite 'phenocrysts' are anhedral patchy grains with inclusions of plagioclase and augite. The textures suggest biotite is later, and probably part of a late-magmatic, hydrous suite of minerals that probably include minor hornblende and some sulfides.

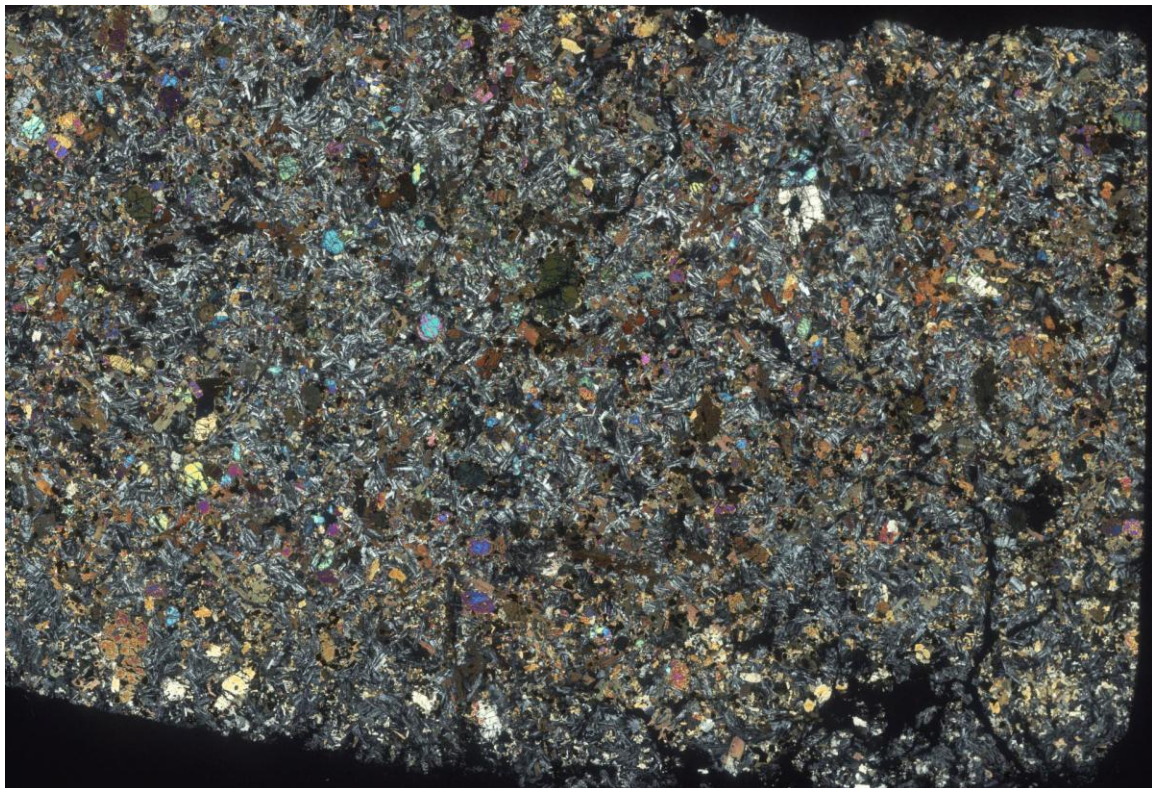
The rock has disseminated accessory titanomagnetite with minor ilmenite exsolution. There is relatively abundant accessory apatite. Minor disseminated pyrrhotite-chalcopyrite appear to be primary magmatic sulfides, indicated by composite nature of grains, local spherical shapes and associations with primary magmatic phases plagioclase and biotite. There is no evidence of pentlandite (a common magmatic sulfide) in the sample.

The sample is remarkably fresh and does not have evidence of a metamorphic overprint (commonly development of bluegreen actinolitic amphibole). There is very weak (hydrothermal or deuteric) alteration including weak iddingsite alteration of olivine and very weak sericite and anhydrite-gypsum alteration of plagioclase. Significant calcite is disseminated in the rock (indicated by effervescence in hand sample) but has been worn away in thinsection. The calcite must occur in small voids in interstitial areas between plagioclase laths. The calcite does not appear to replace plagioclase.

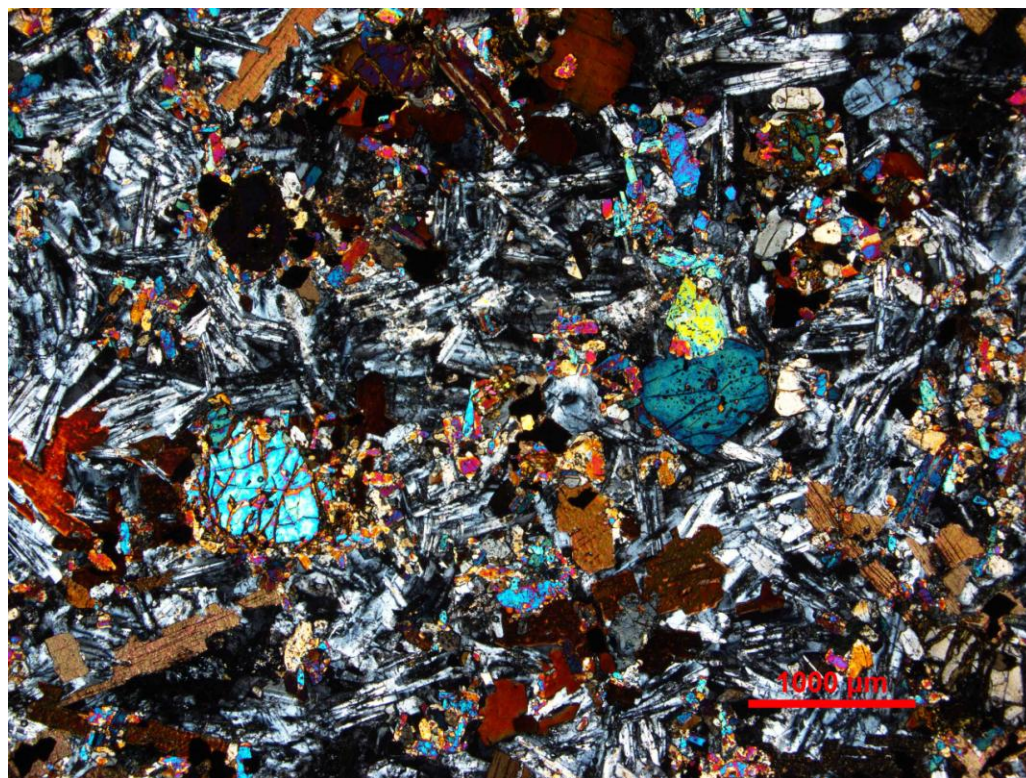
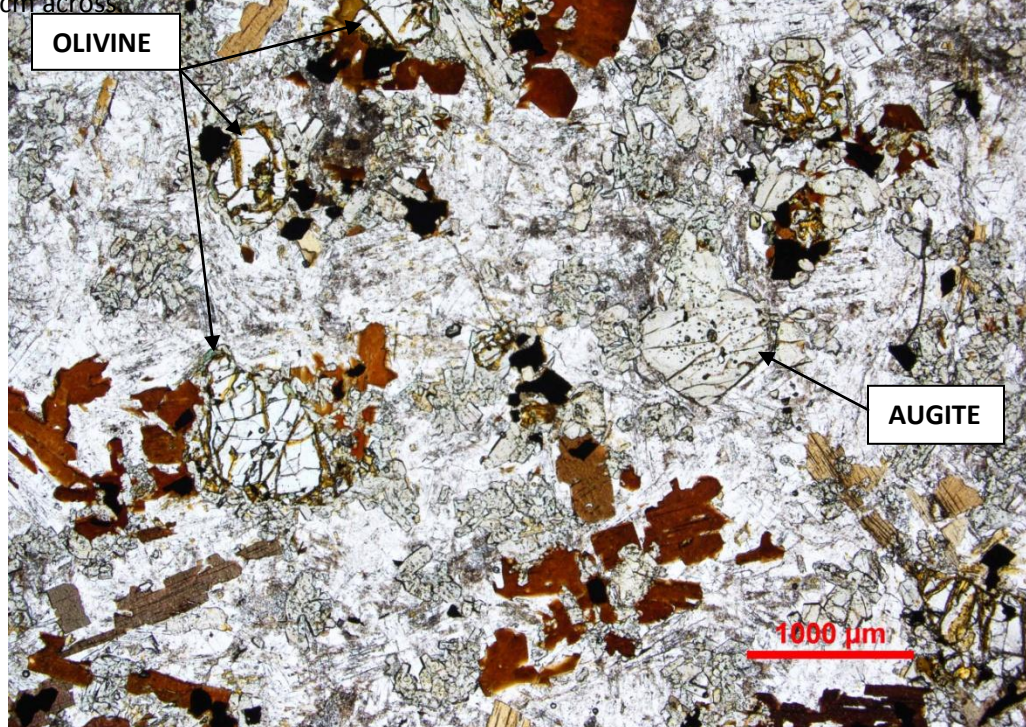
COMMENTS

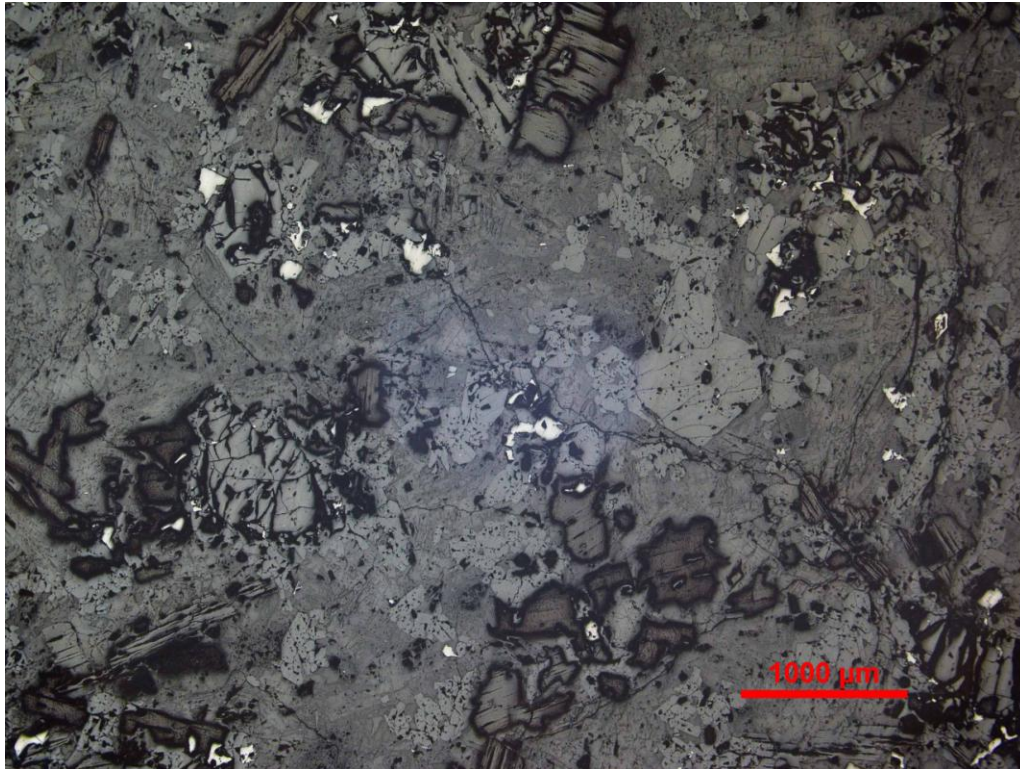
The overall fresh nature of this sample and lack of evidence of metamorphic overprinting suggest this may be a Keweenaw mafic-ultramafic rock. The overall character is similar to Keweenaw olivine-augite diabase dikes in UP Michigan. The micro-mosaic augite texture is present in these dikes. It is an interesting and puzzling texture that seems most likely related to early clustering of augite seed crystals (rather than localized grain size reduction).

ROCK NAME: Augite-Biotite-Olivine Microporphyritic Diabase

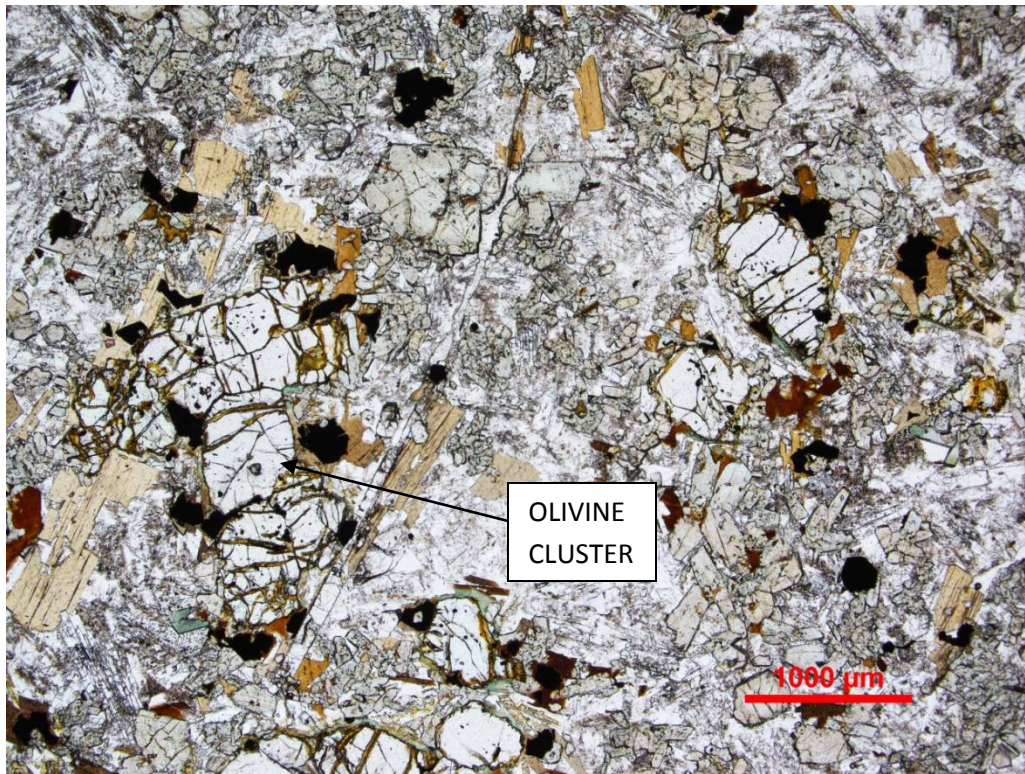


Sample CR-0003. Wide-field, full-thinsection view showing very fine to medium grained, slightly porphyritic mafic-ultramafic rock with diabasic texture. Top: plane light; Bottom: crossed polarizers. 3.6 cm across.

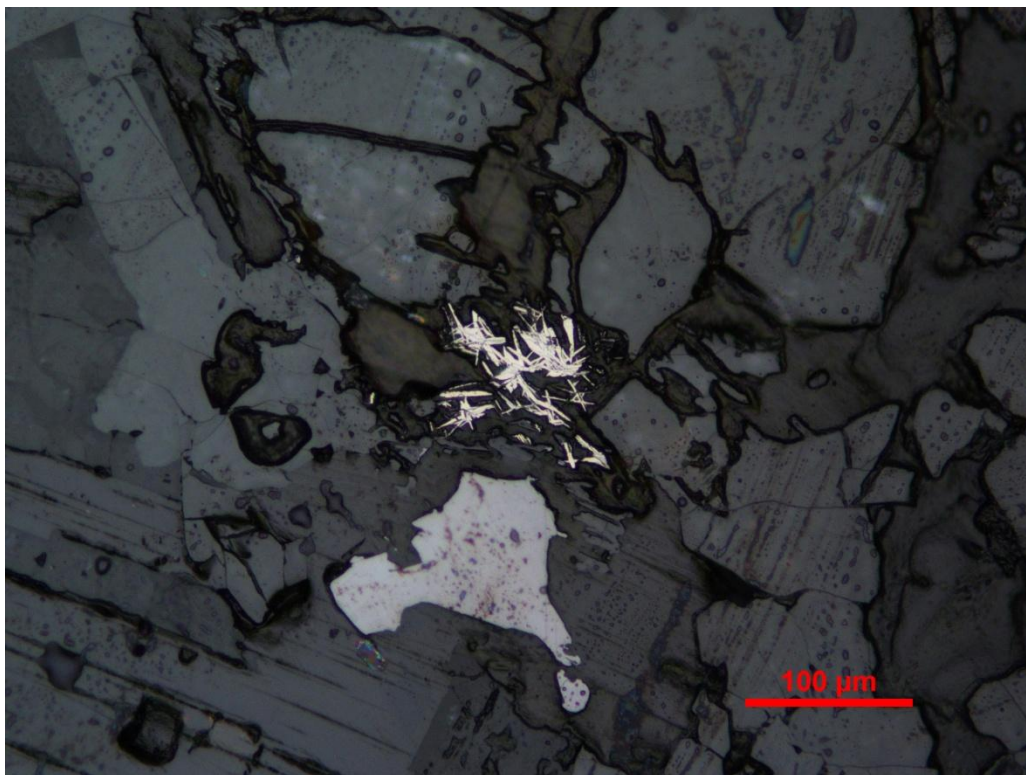
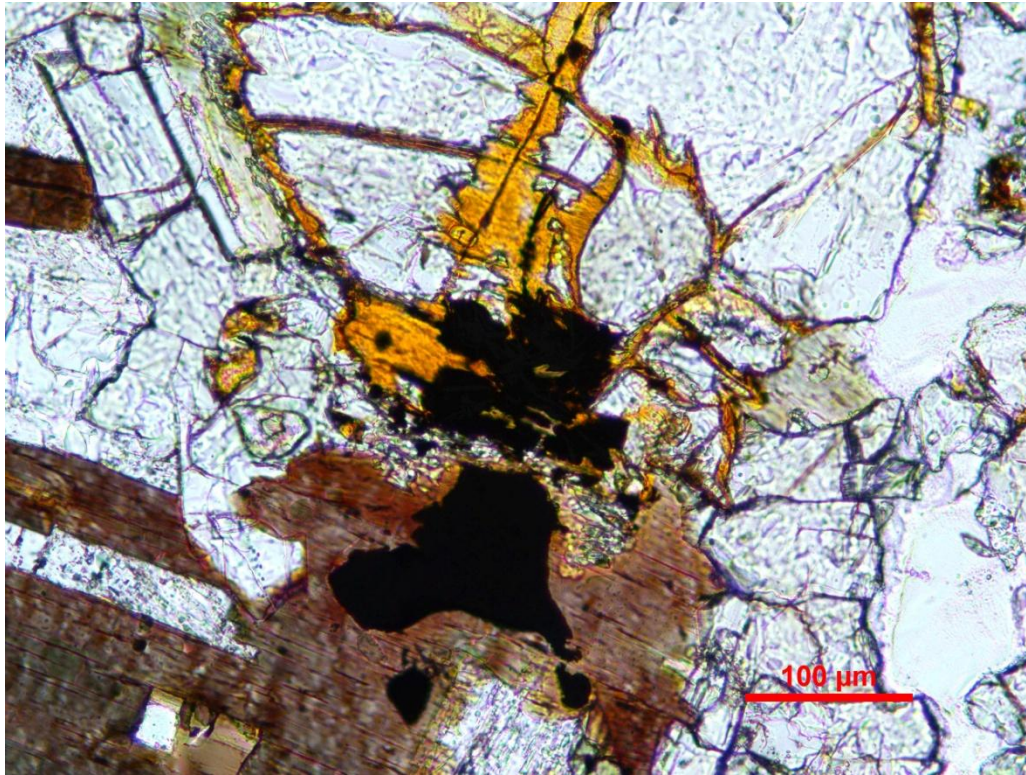




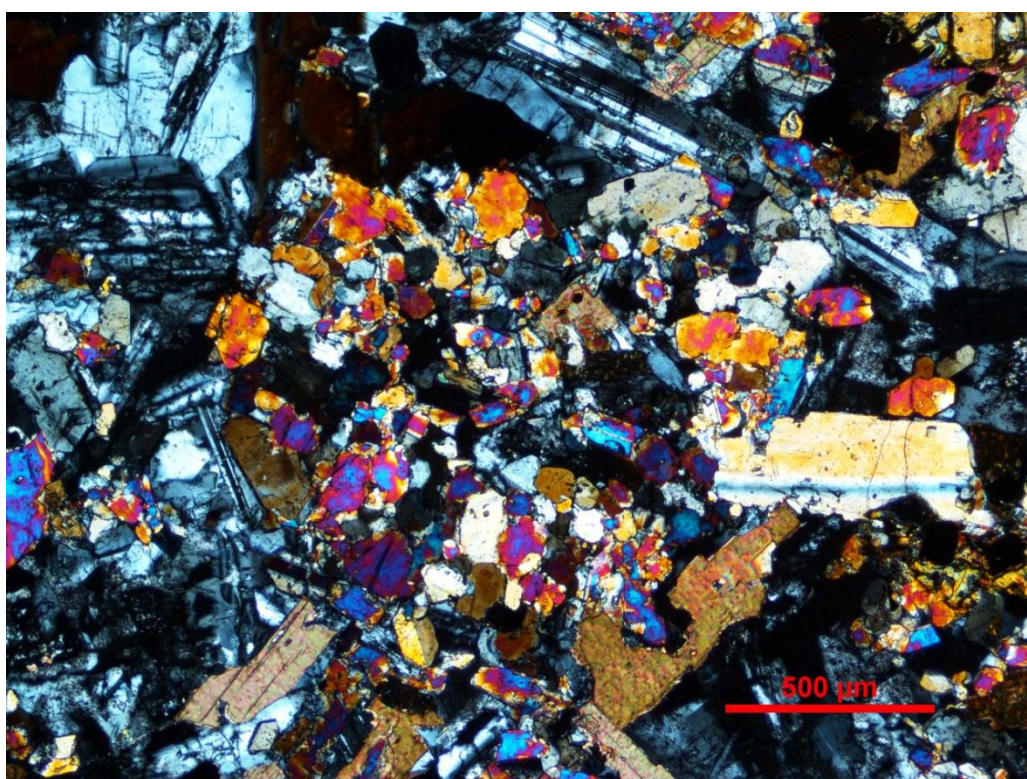
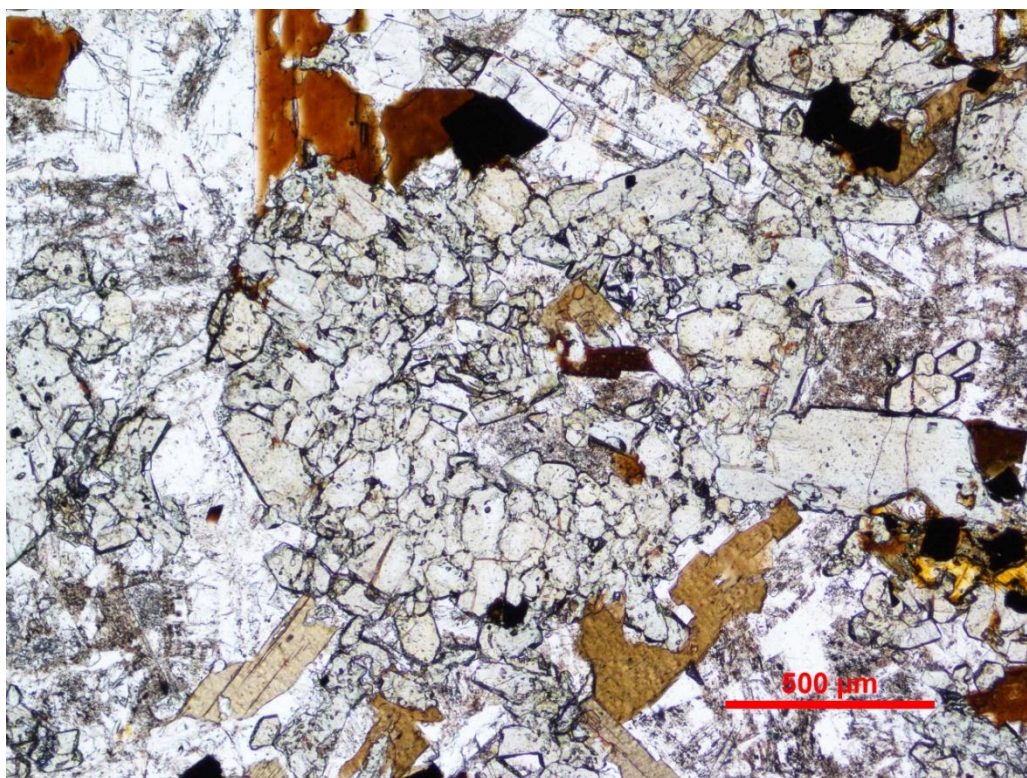
Sample CR-0003. Small olivine, augite, and biotite phenocrysts in fine grained diabasic matrix of elongated plagioclase grains. Accessory titanomagnetite (opaque) is disseminated in the rock. Top- plane light; Middle- crossed polarizers; Bottom- reflected light.



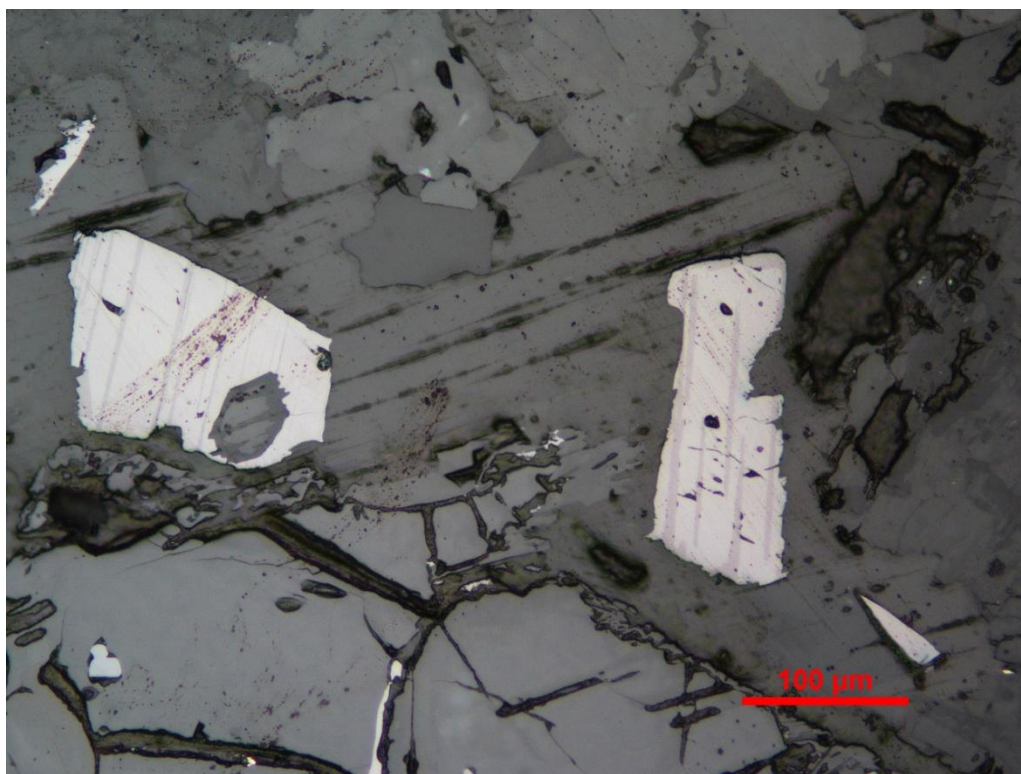
Sample CR-0003. Olivine phenocrysts and phenocryst clusters with weak iddingsite (brownish) alteration along fractures. Top- plane light; Bottom- crossed polarizers.



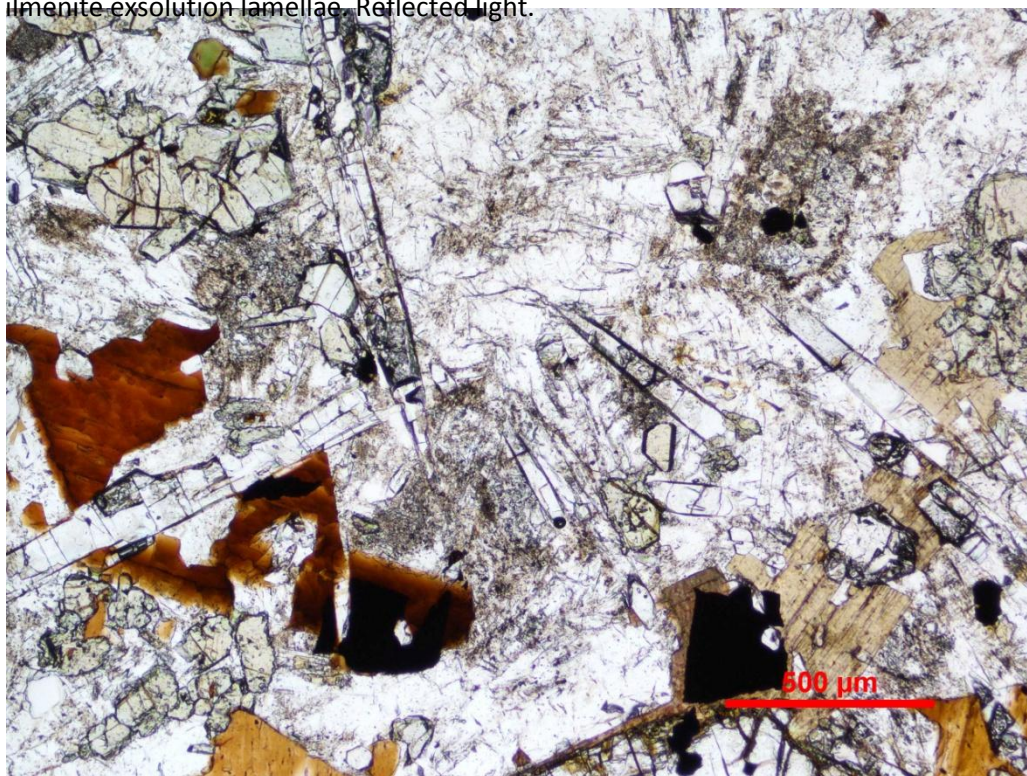
Sample CR-0003. Unknown phase associated with iddingsite (orangish) alteration of olivine.
Top- plane light; Bottom- reflected light.

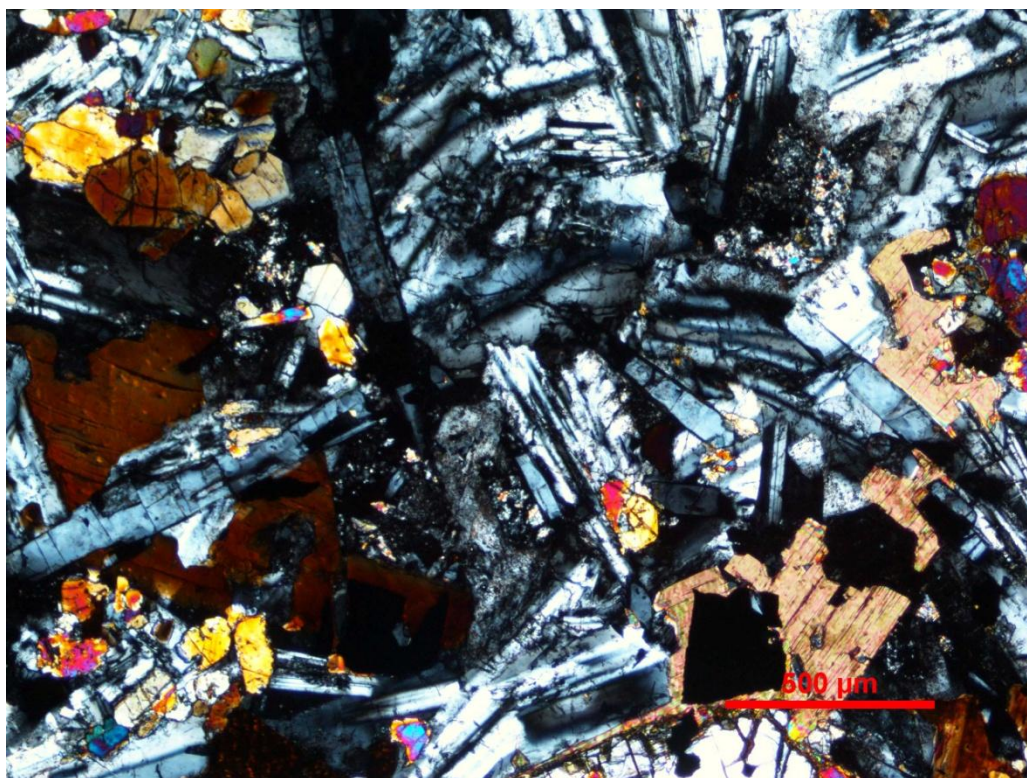


Sample CR-0003. Peculiar augite 'phenocryst' with subgrain mosaic texture (discussed in text). Note fresh, albite-twinned plagioclase in diabasic matrix. Top- plane light; Bottom- crossed polarizers.

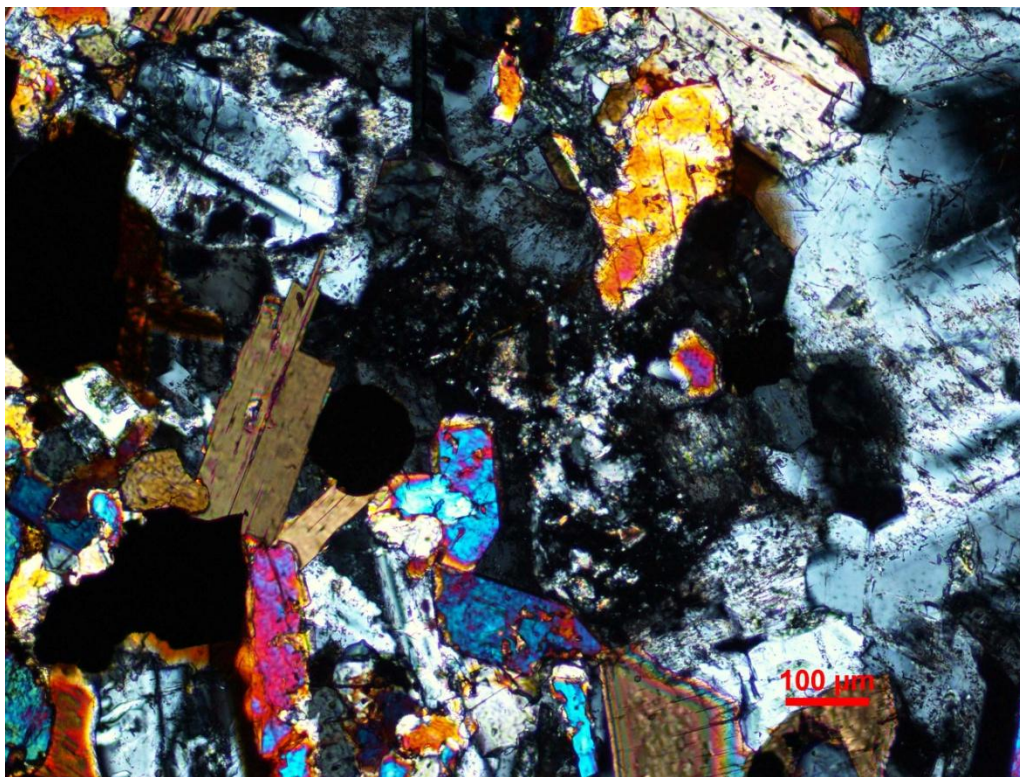
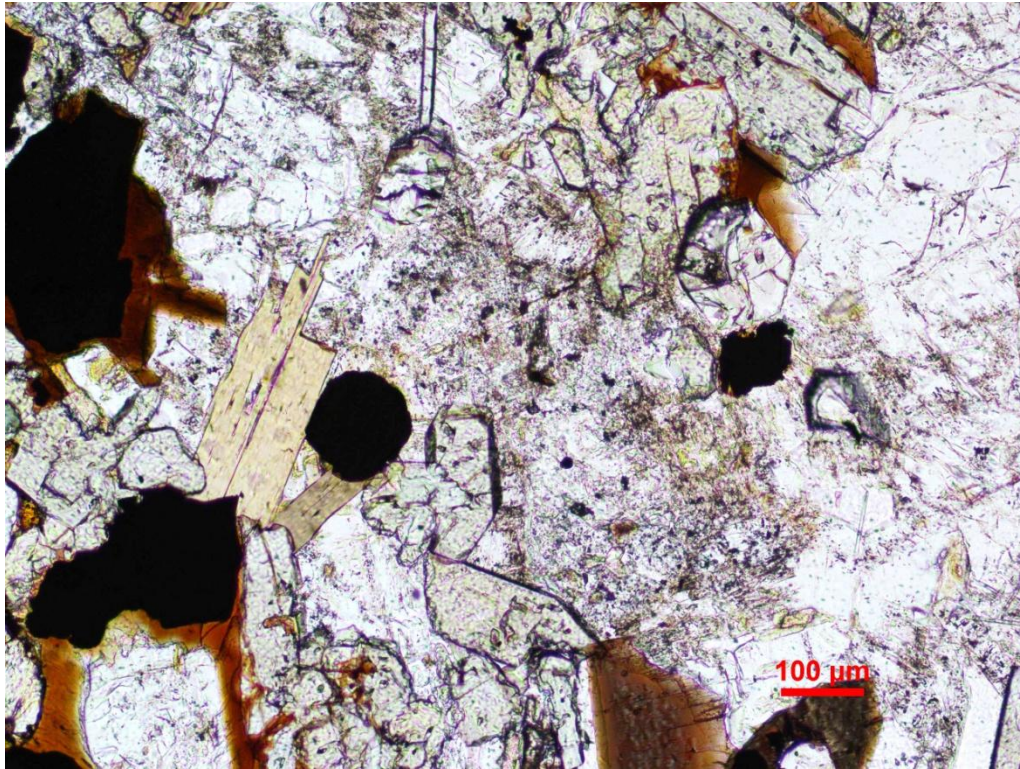


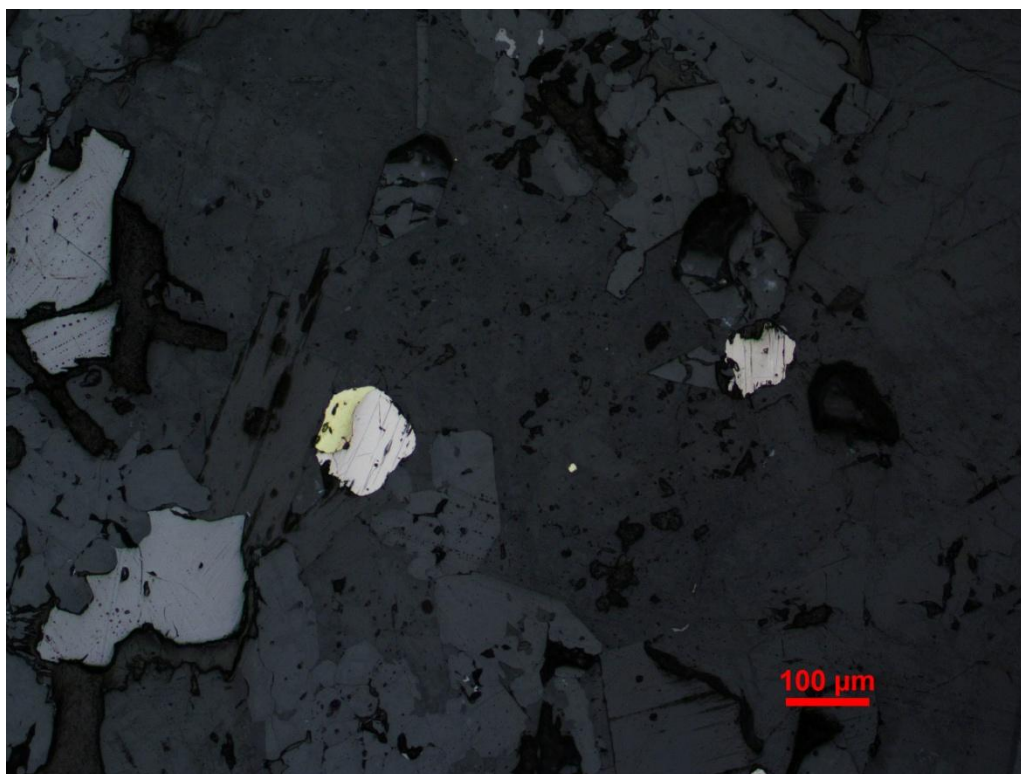
Sample CR-0003. Close-up of accessory probable titanomagnetite (pinkish) with slightly darker ilmenite exsolution lamellae. Reflected light.



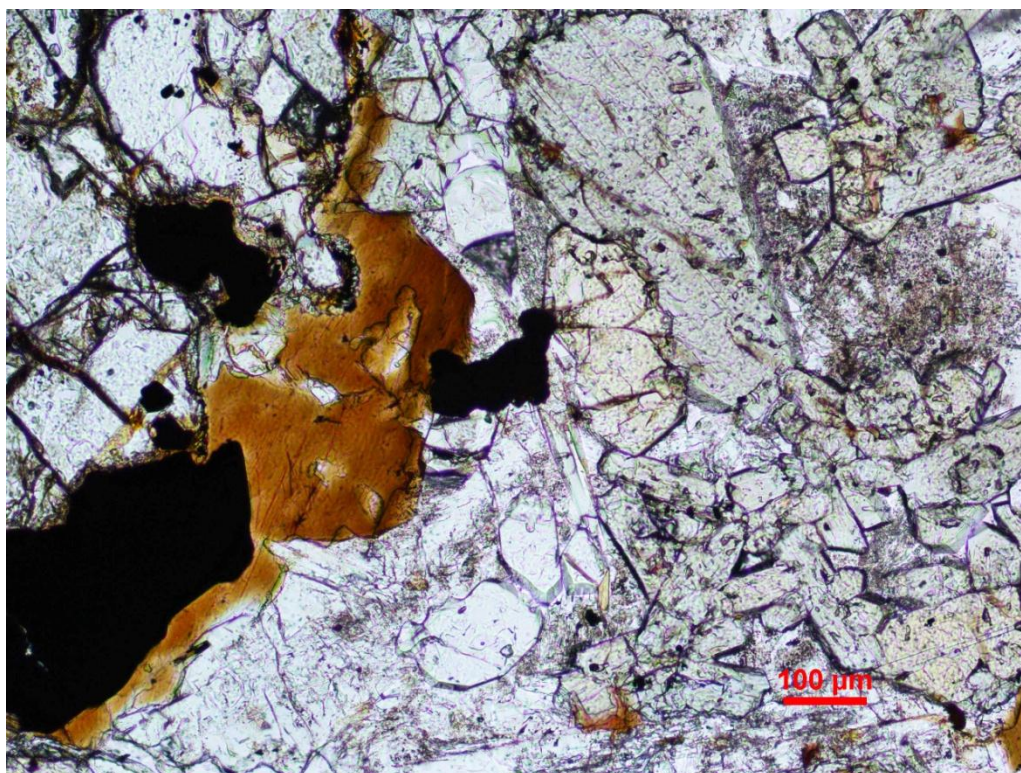


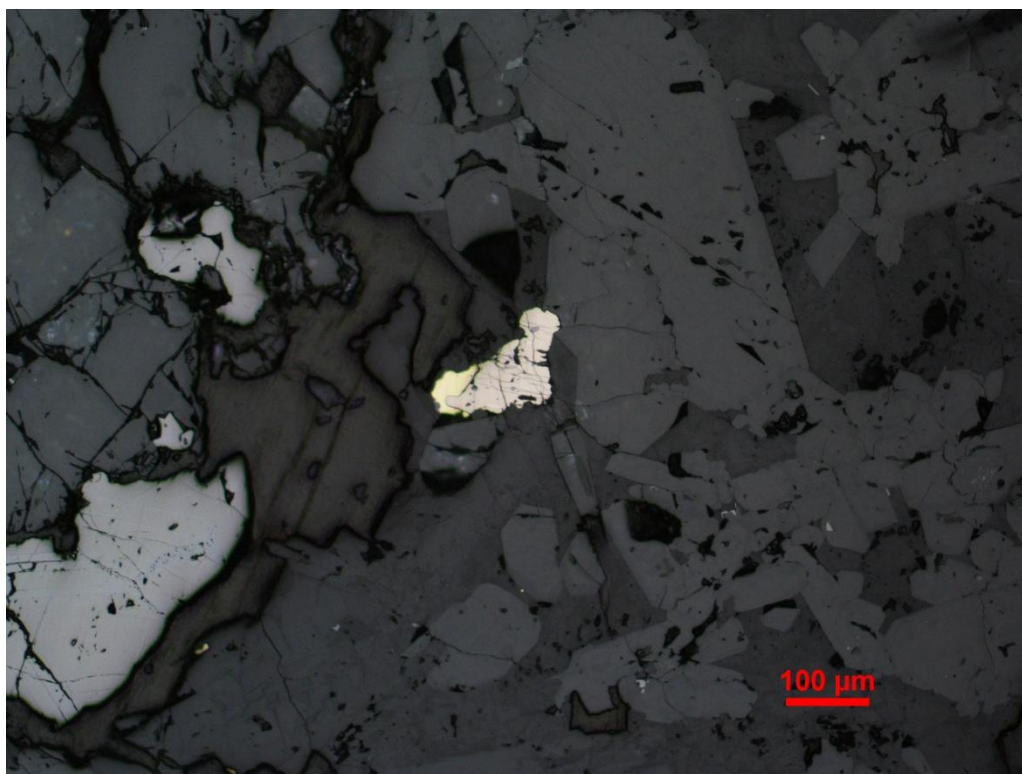
CR-0003. Abundant, euhedral, elongated, accessory apatite (high relief, gray birefringence) crystals and titanomagnetite (gray, bottom). Top- plane light; Bottom- reflected light.



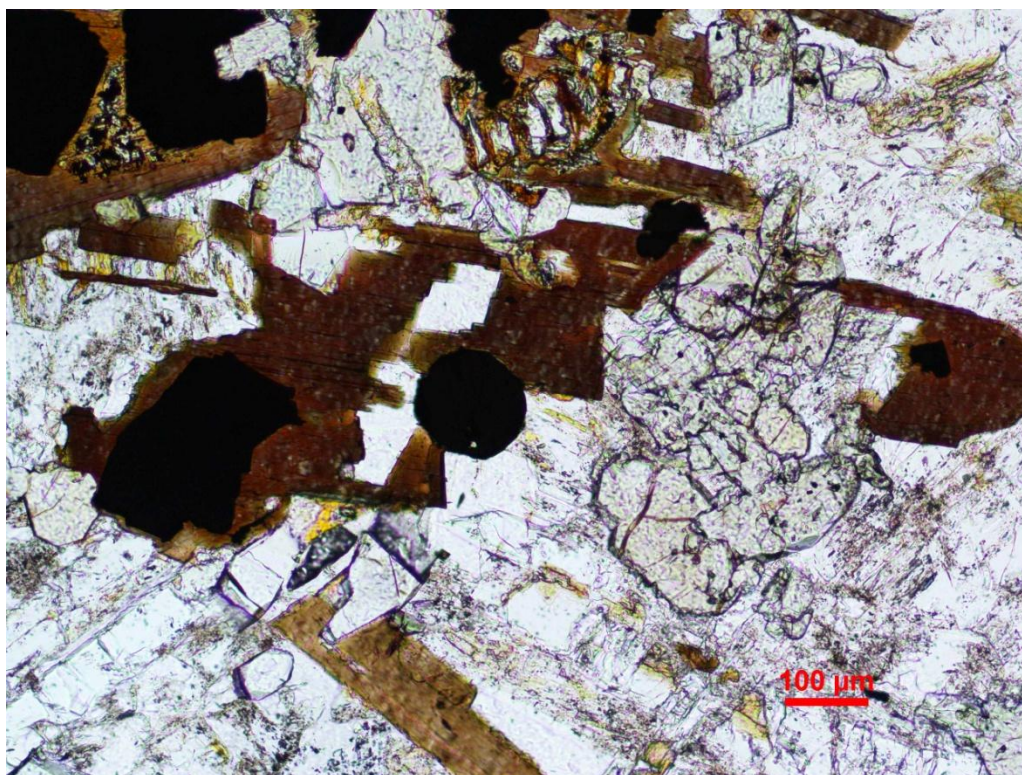


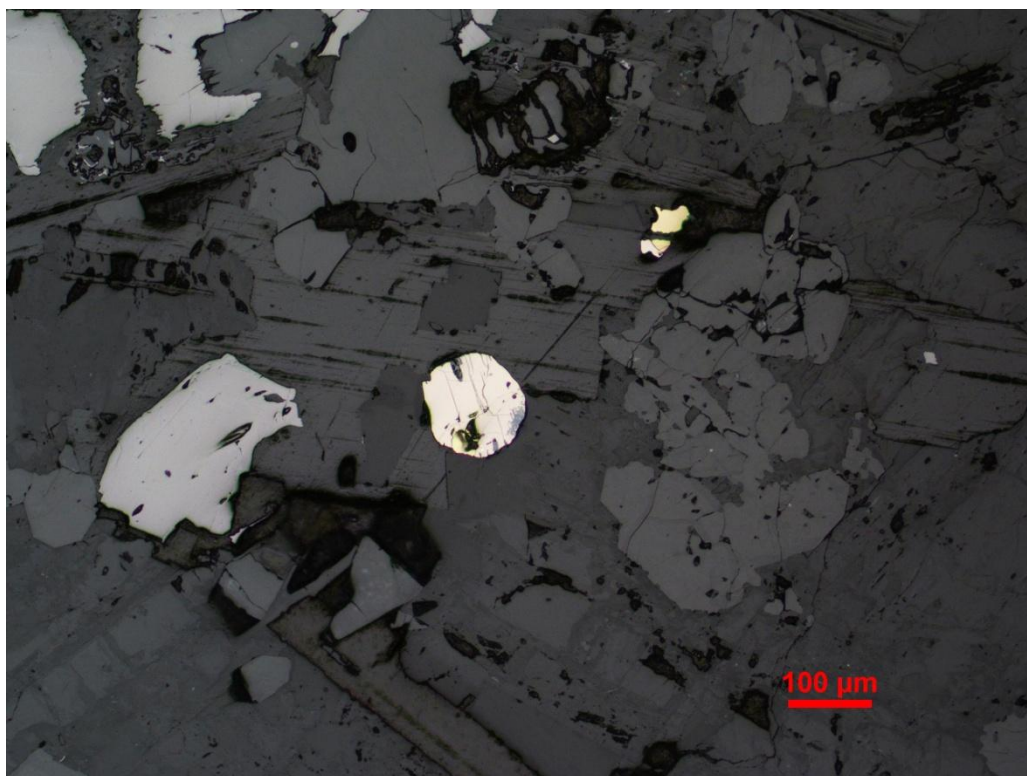
Sample CR-0003. Composite Po-Cpy grain (left center) and Po grain (right) on edges of worn calcite site. Top- plane light; Middle- crossed polarizers; Bottom- reflected light.



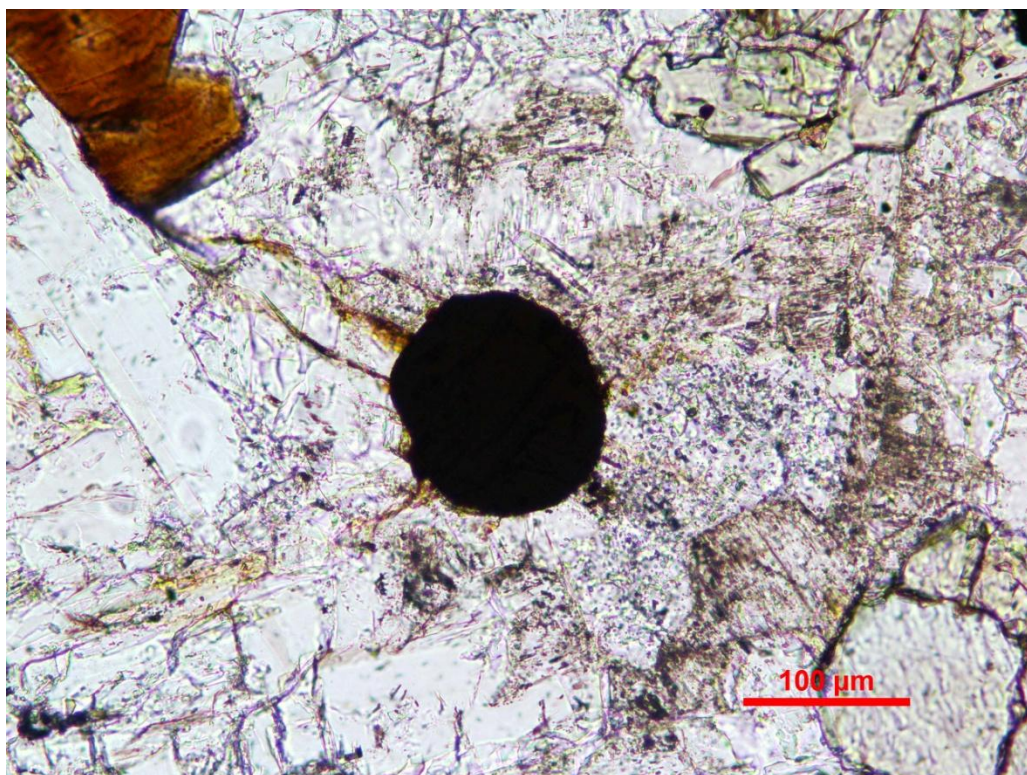


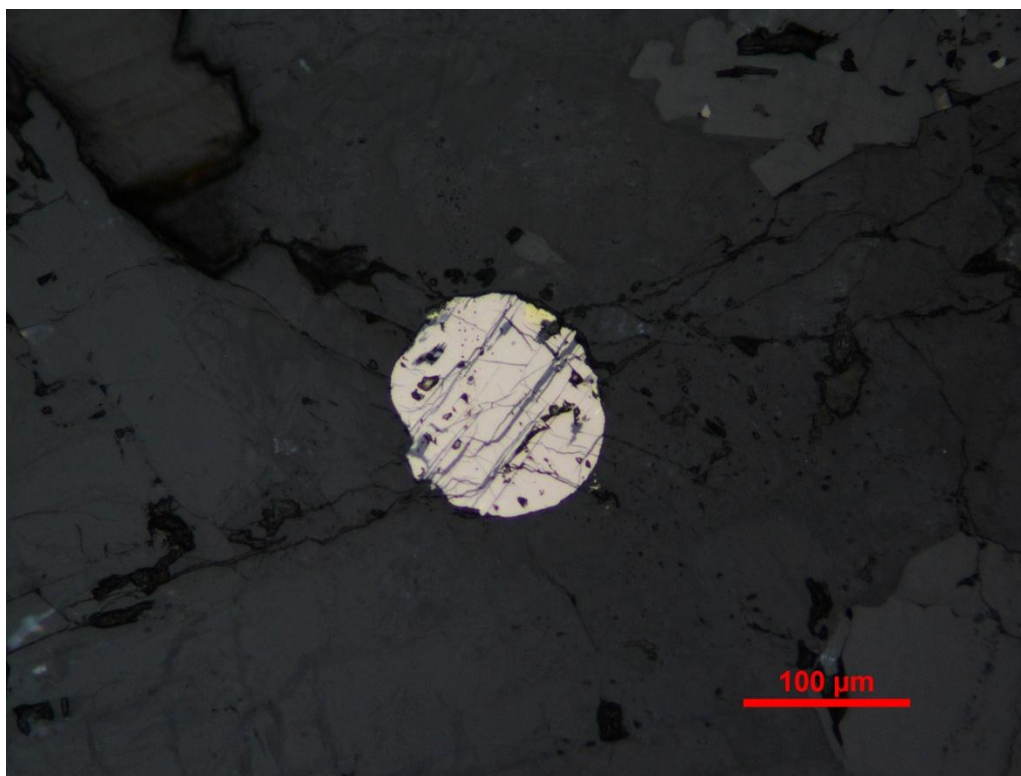
Sample CR-0003. Composite Po-Cpy grain (center) and titanomagnetite associated with biotite. Top-plane light; Bottom- reflected light.



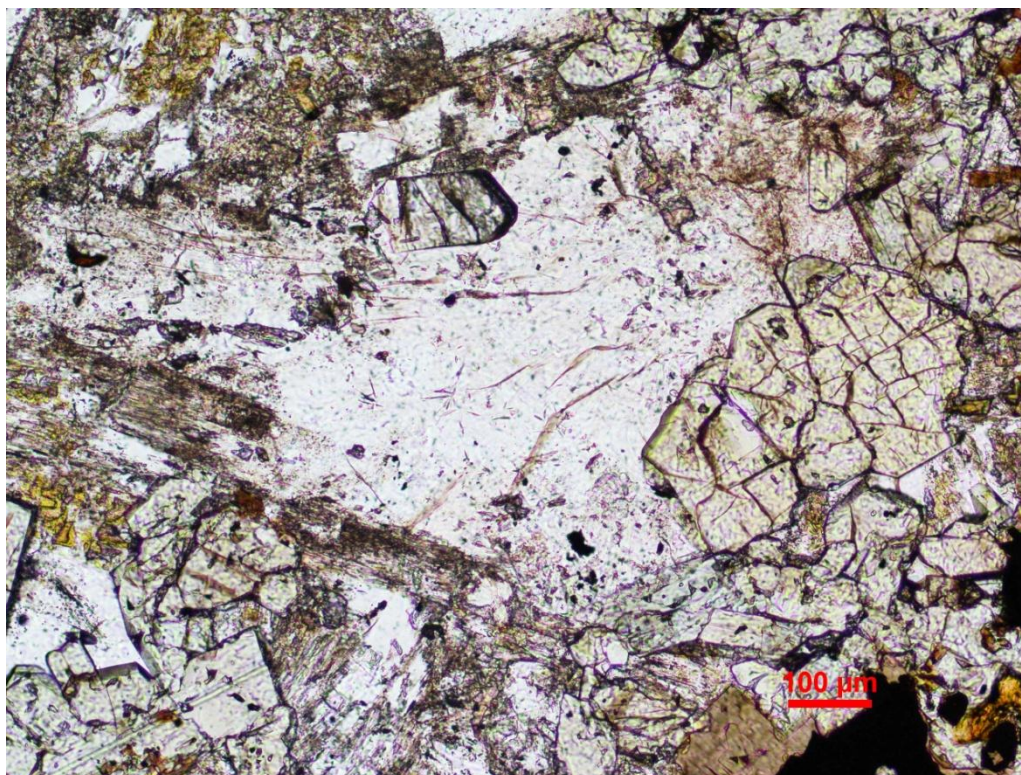


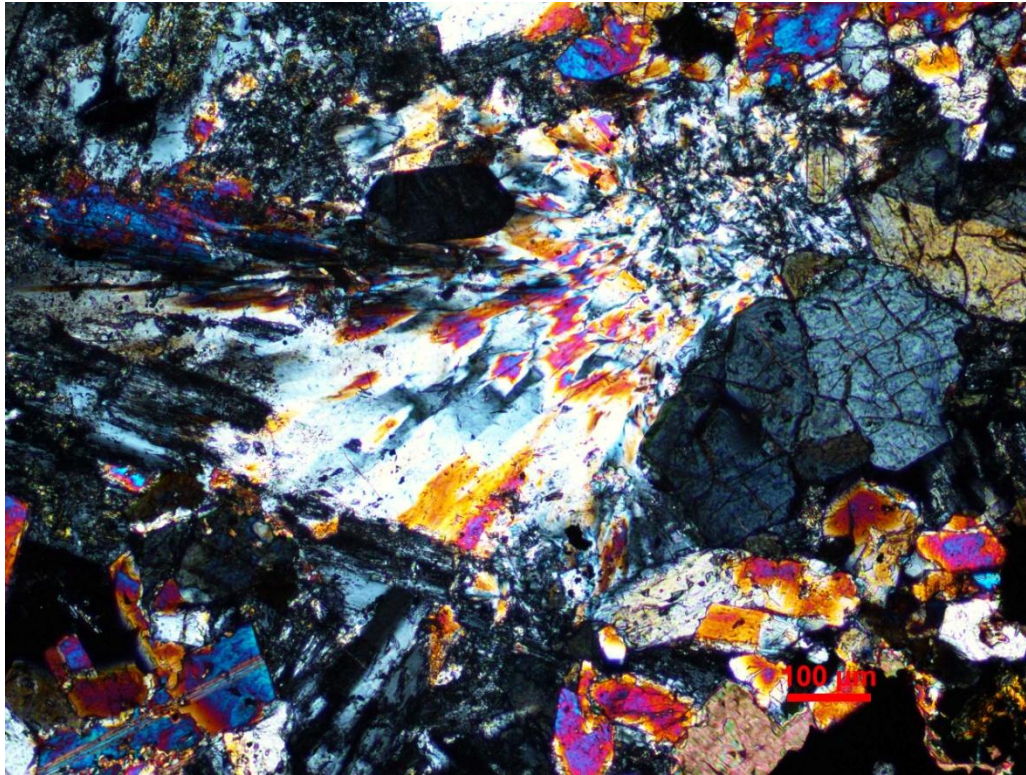
Sample CR-0003. Titanomagnetite (gray) and composite Po-Cpy and Cpy-Po grains associated with biotite. Note spherical shape of Po-Cpy grain (center). Top- plane light; Bottom- reflected light.





Sample CR-0003. Spherical composite Po-Cpy grain associated with plagioclase. Top- plane light; Bottom- reflected light.





Sample CR-0003. Unknown (anhydrite-gypsum?) colorless, low relief, moderate birefringent phase locally replacing plagioclase. Top- plane light; Bottom- crossed polarizers.