Silver Shaft Mine VMS mineralization and hydrothermal alteration: Petrographic examples from core hole PDSS-3, Rowan and Cabarrus counties, North Carolina

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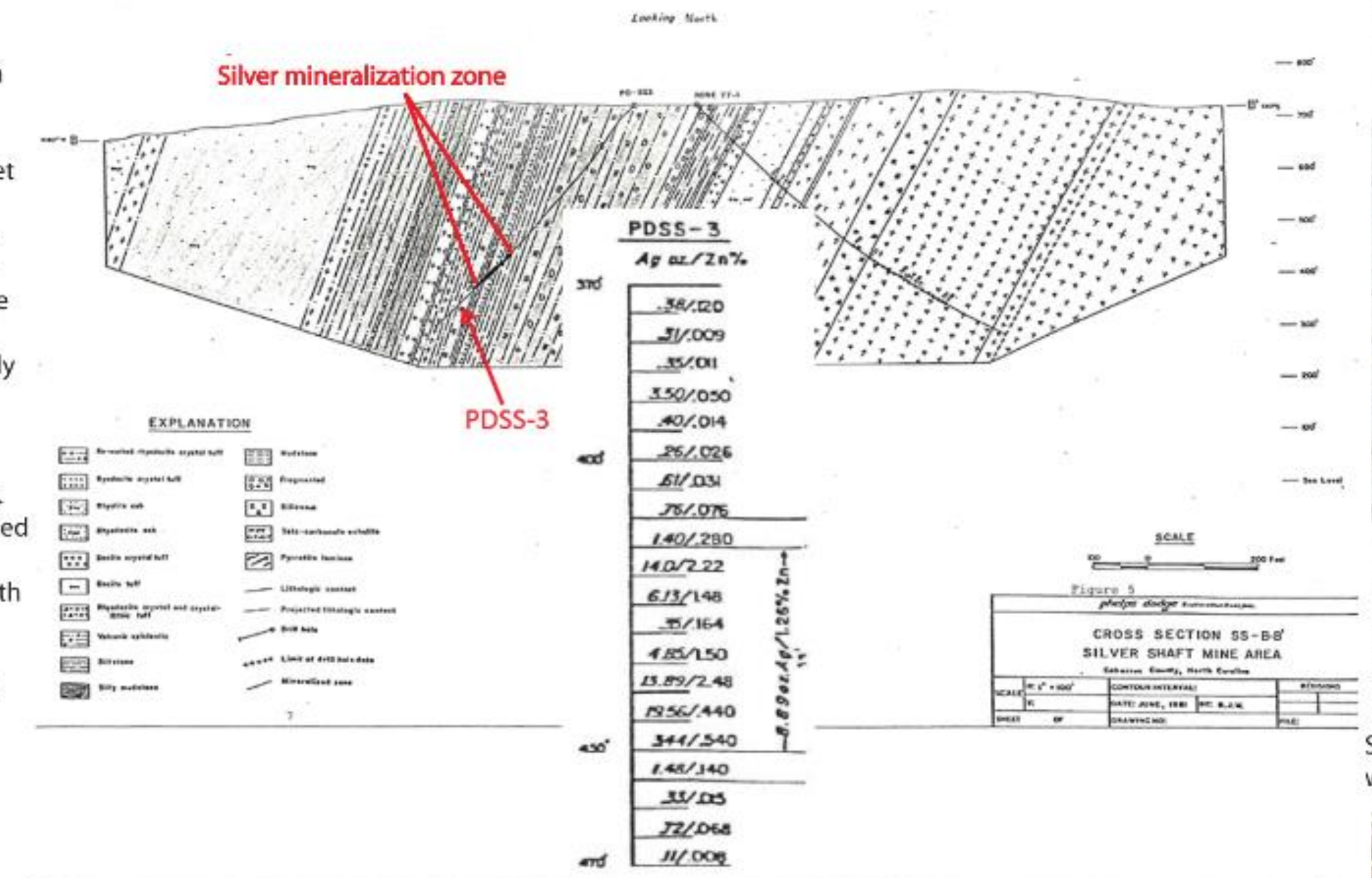
ABSTRACT

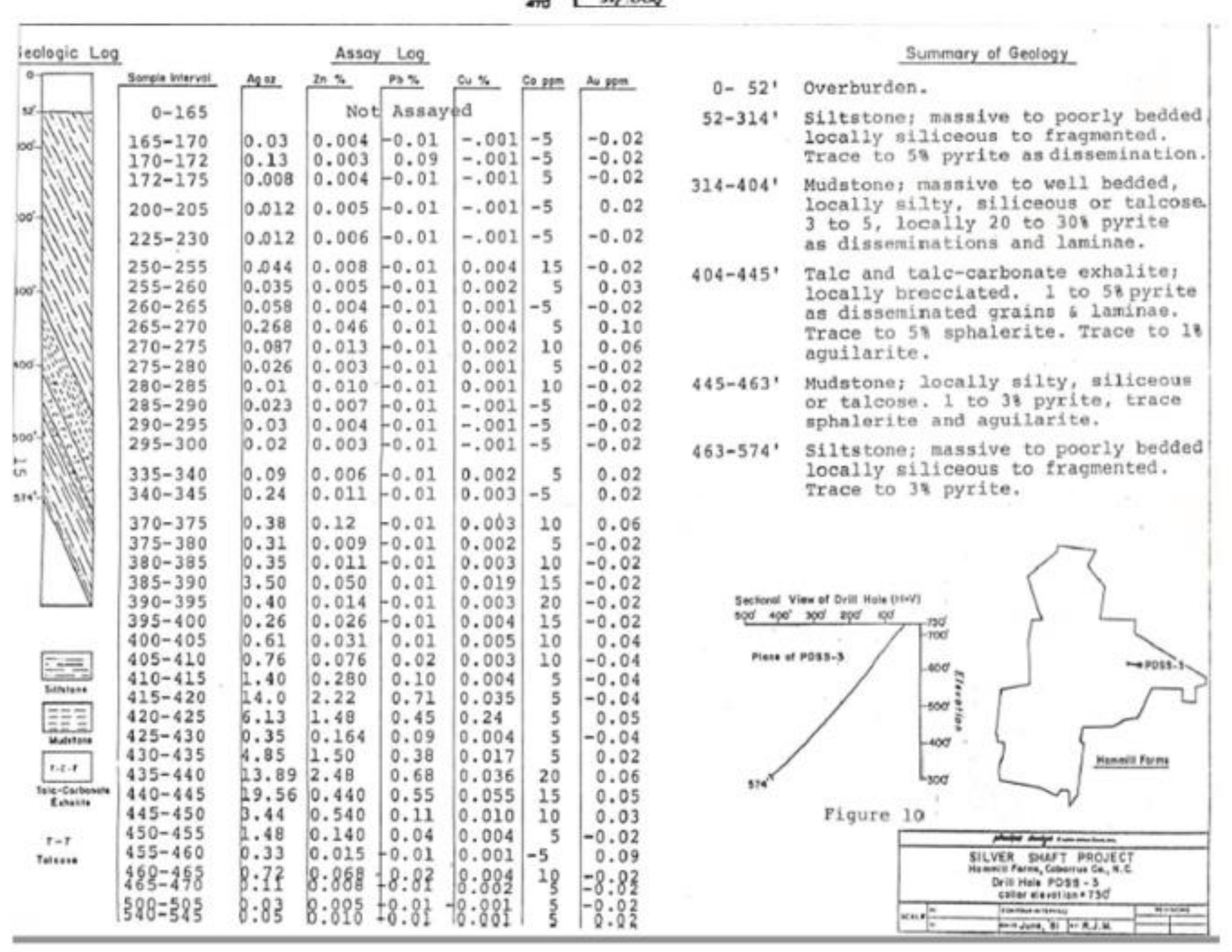
Core hole PDSS-3 intersected late Proterozoic VMS mineralization of the Silver Shaft (McMakin) Mine deposit in the Gold Hill District. A drill hole cross section with assays is presented, along with core photographs and petrographic studies of the mineralization and hydrothermal alteration.

From the surface to 574-foot total drilled depth the hole cored: 0-52 feet (overburden); 52-314 feet (massive to poorly bedded siltstone, that is locally siliceous to fragmented with a trace to 5% disseminated pyrite); 314-404 feet (massive to well bedded mudstone that is locally silty, siliceous or talcose with 3-5% pyrite and locally up to 20-30% pyrite); 404-445 feet (talc and talc-carbonate mineralization that is locally brecciated with 1-5% disseminated pyrite as grains and laminae, trace to 5% sphalerite, and trace to 1% aguilarite); 445-463 feet (mudstone, locally silty, siliceous or talcose containing 1-3% pyrite, and trace sphalerite and aguilarite); 463-574 feet (massive to poorly bedded siltstone, locally siliceous to fragmented with a trace to 3% pyrite).

The mineralized horizon's primary mineral assemblage is talc+carbonate+sulfides+barite. The primary ore minerals are pale-colored low-Fe sphalerite and a silver sulfide identified as aguilarite. Primary pyrite is preserved as individual framboids and laminae that may be stretched, micro-folded and dismembered by shearing. Spongy pyrite cores representing vestiges of primary (?) mineralization are surrounded by metamorphic (recrystallized) poikiloblastic pyrite metacrysts with clean rims. Disseminated pyrite is strung along the tectono-metamorphic fabric with very strong foliation and likely shearing and sphalerite and galena are strongly remobilized. Possible banded and crustiform carbonate features enclose small amounts of barite and represent a portion of the primary "sulfide mound" textures formed in channel ways.

The metamudstone fabric is strongly foliated, sheared, transported and recrystallized. It is overgrown by poikiloblastic pyrite metacrysts with spongy cores. Minute amounts of sphalerite were emplaced along fractures in the pyrite.





Sample Interval	Ag oz	Zn %	Pb %	Cu %	Co ppm	Au ppm
0-165	Not Assayed					
165-170	0.03	0.004	-0.01	-.001	-5	-0.02
170-172	0.13	0.003	0.09	-.001	-5	-0.02
172-175	0.008	0.004	-0.01	-.001	5	-0.02
200-205	0.012	0.005	-0.01	-.001	-5	0.02
225-230	0.012	0.006	-0.01	-.001	-5	-0.02
250-255	0.044	0.008	-0.01	0.004	15	-0.02
255-260	0.035	0.005	-0.01	0.002	5	0.03
260-265	0.058	0.004	-0.01	0.001	-5	-0.02
265-270	0.268	0.046	0.01	0.004	5	0.10
270-275	0.087	0.013	-0.01	0.002	10	0.06
275-280	0.026	0.003	-0.01	0.001	5	-0.02
280-285	0.01	0.010	-0.01	0.001	10	-0.02
285-290	0.023	0.007	-0.01	-.001	-5	-0.02
290-295	0.03	0.004	-0.01	-.001	-5	-0.02
295-300	0.02	0.003	-0.01	-.001	-5	-0.02
335-340	0.09	0.006	-0.01	0.002	5	0.02
340-345	0.24	0.011	-0.01	0.003	-5	0.02
370-375	0.38	0.12	-0.01	0.003	10	0.06
375-380	0.31	0.009	-0.01	0.002	5	-0.02
380-385	0.35	0.011	-0.01	0.003	10	-0.02
385-390	3.50	0.050	0.01	0.019	15	-0.02
390-395	0.40	0.014	-0.01	0.003	20	-0.02
395-400	0.26	0.026	-0.01	0.004	15	-0.02
400-405	0.61	0.031	0.01	0.005	10	0.04
405-410	0.76	0.076	0.02	0.003	10	-0.04
410-415	1.40	0.280	0.10	0.004	5	-0.04
415-420	14.0	2.22	0.71	0.035	5	-0.04
420-425	6.13	1.48	0.45	0.24	5	0.05
425-430	0.35	0.164	0.09	0.004	5	-0.04
430-435	4.85	1.50	0.38	0.017	5	0.02
435-440	13.89	2.48	0.68	0.036	20	0.06
440-445	19.56	0.440	0.55	0.055	15	0.05
445-450	3.44	0.540	0.11	0.010	10	0.03
450-455	1.48	0.140	0.04	0.004	5	-0.02
455-460	0.33	0.015	-0.01	0.001	-5	0.09
460-465	0.72	0.068	-0.02	0.004	10	-0.02
465-470	0.11	0.008	-0.01	0.002	5	-0.02
500-505	0.03	0.005	-0.01	-0.001	5	-0.02
540-545	0.05	0.010	-0.01	0.001	5	0.02

Summary of Geology

0- 52' Overburden.

52-314' Siltstone; massive to poorly bedded, locally siliceous to fragmented. Trace to 5% pyrite as dissemination.

314-404' Mudstone; massive to well bedded, locally silty, siliceous or talcose. 3 to 5, locally 20 to 30% pyrite as disseminations and laminae.

404-445' Talc and talc-carbonate exhalite; locally brecciated. 1 to 5% pyrite as disseminated grains & laminae. Trace to 5% sphalerite. Trace to 1% aguilarite.

445-463' Mudstone; locally silty, siliceous or talcose. 1 to 3% pyrite, trace sphalerite and aguilarite.

463-574' Siltstone; massive to poorly bedded locally siliceous to fragmented. Trace to 3% pyrite.

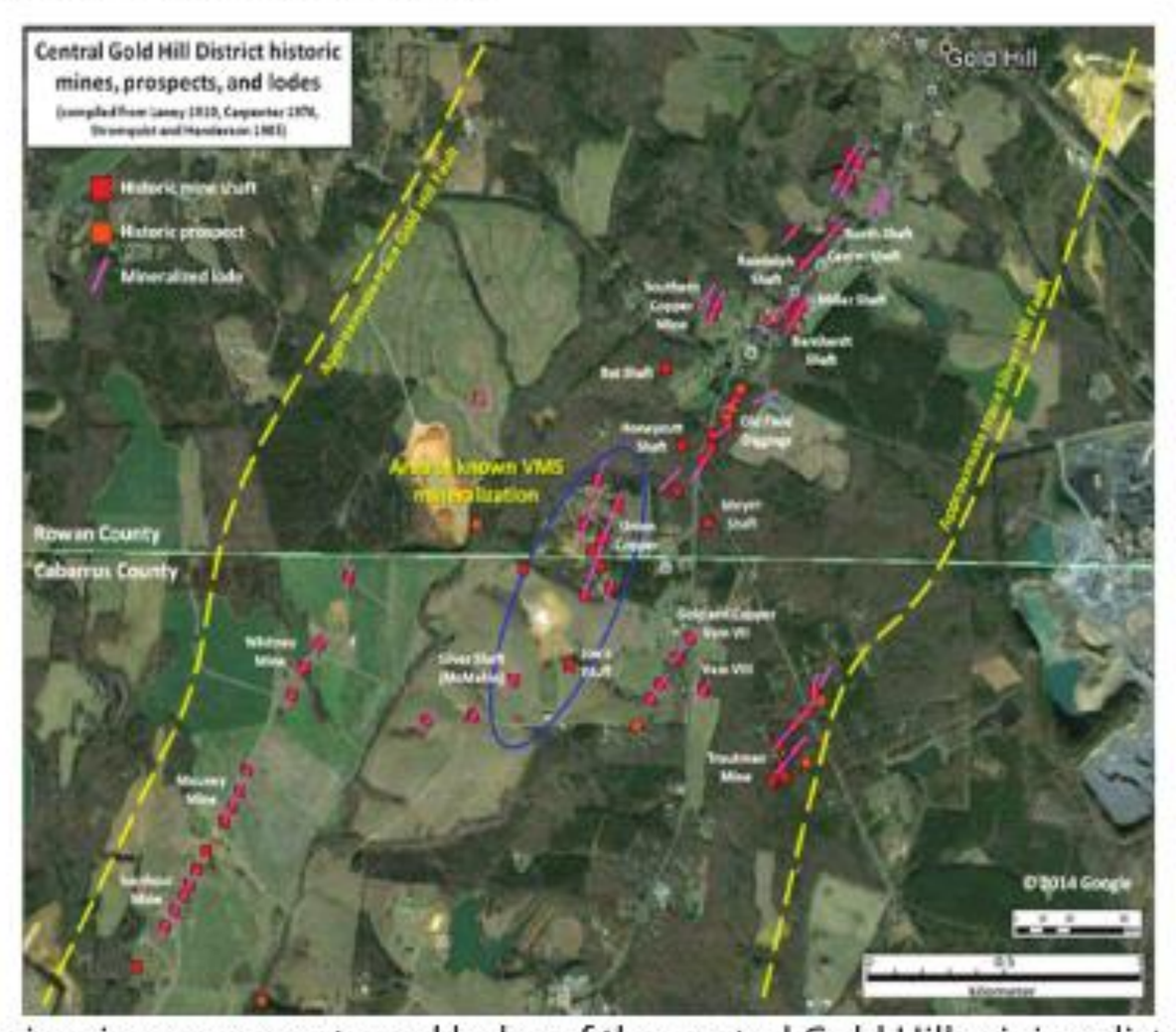
Figure 10

SILVER SHAFT PROJECT

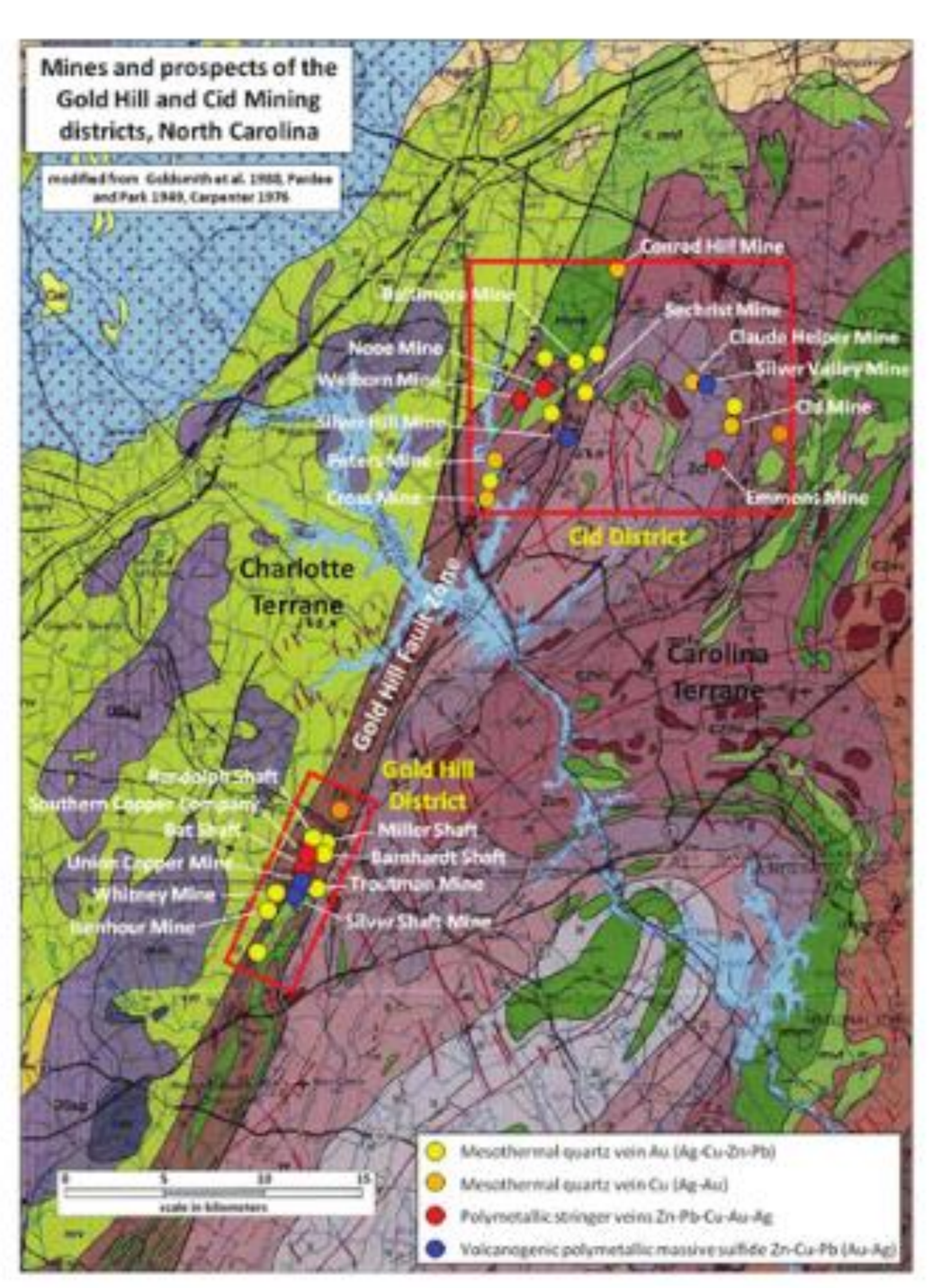
Drill Hole PDSS-3

Summary of mineral and other abbreviations used:

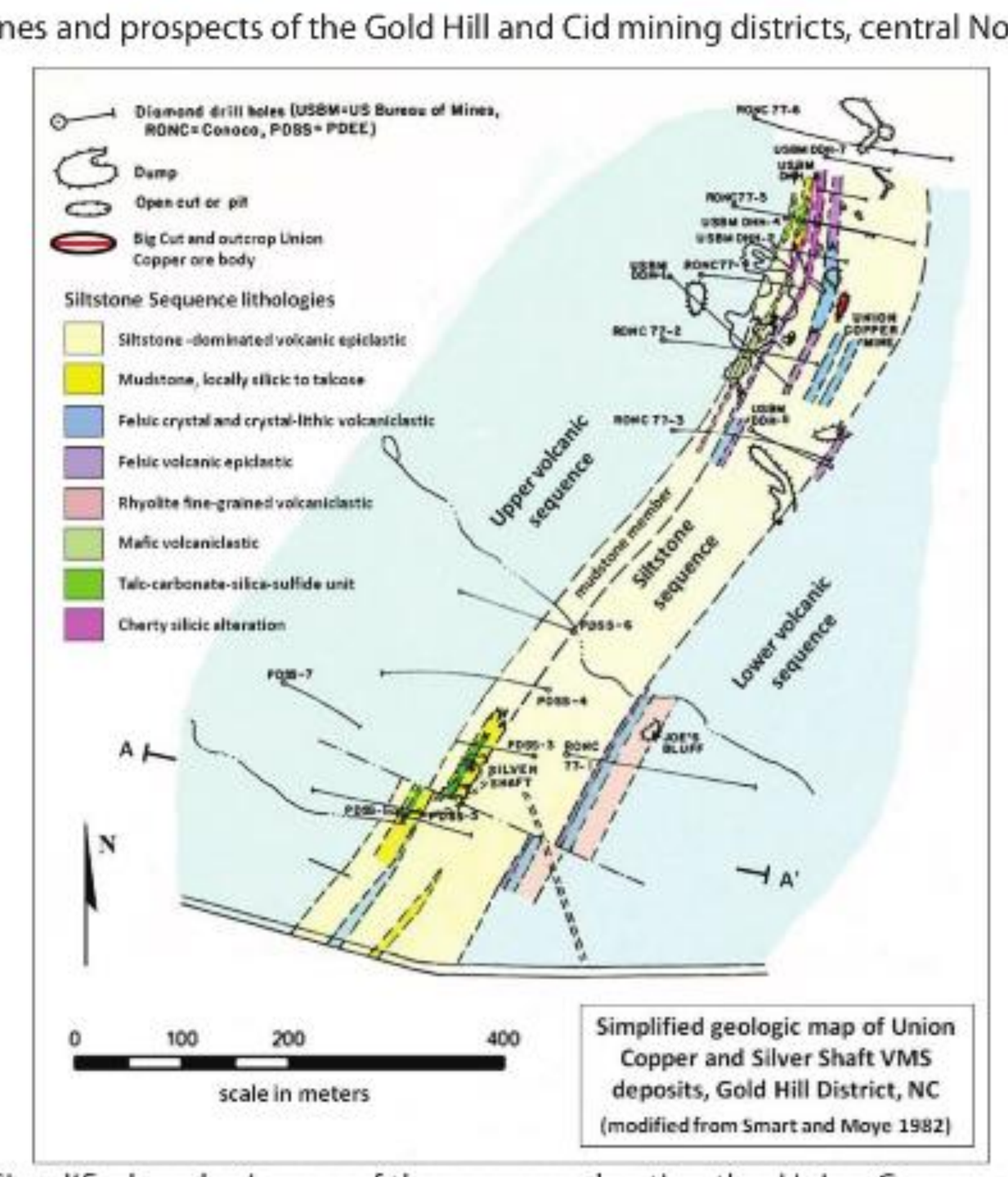
Tc = Talc; Pyr rim = Pyrite rim; Pyr core = Pyrite core; Pyr = Pyrite (other as noted in caption); Qtz = Quartz; Gal = Galena; Sph = Sphalerite; Carb = Carbonate; Bar = Barite; Cpy = Chalcopyrite; Ser = Sericite; FOV = Field of view (width in mm)



Historic mines, prospects and lodes of the central Gold Hill mining district, Rowan and Cabarrus counties, North Carolina.



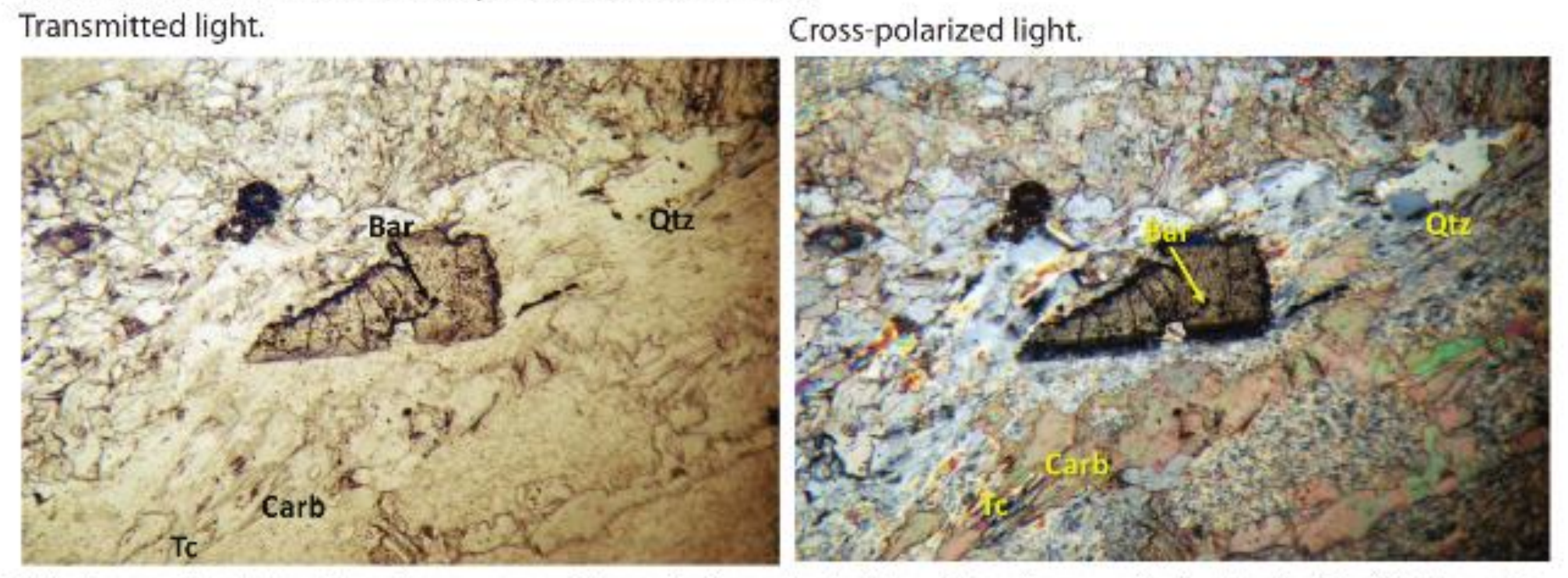
Mines and prospects of the Gold Hill and Cid mining districts, central North Carolina.



Simplified geologic map of the sequence hosting the Union Copper and Silver Shaft VMS deposits, Gold Hill district, North Carolina.

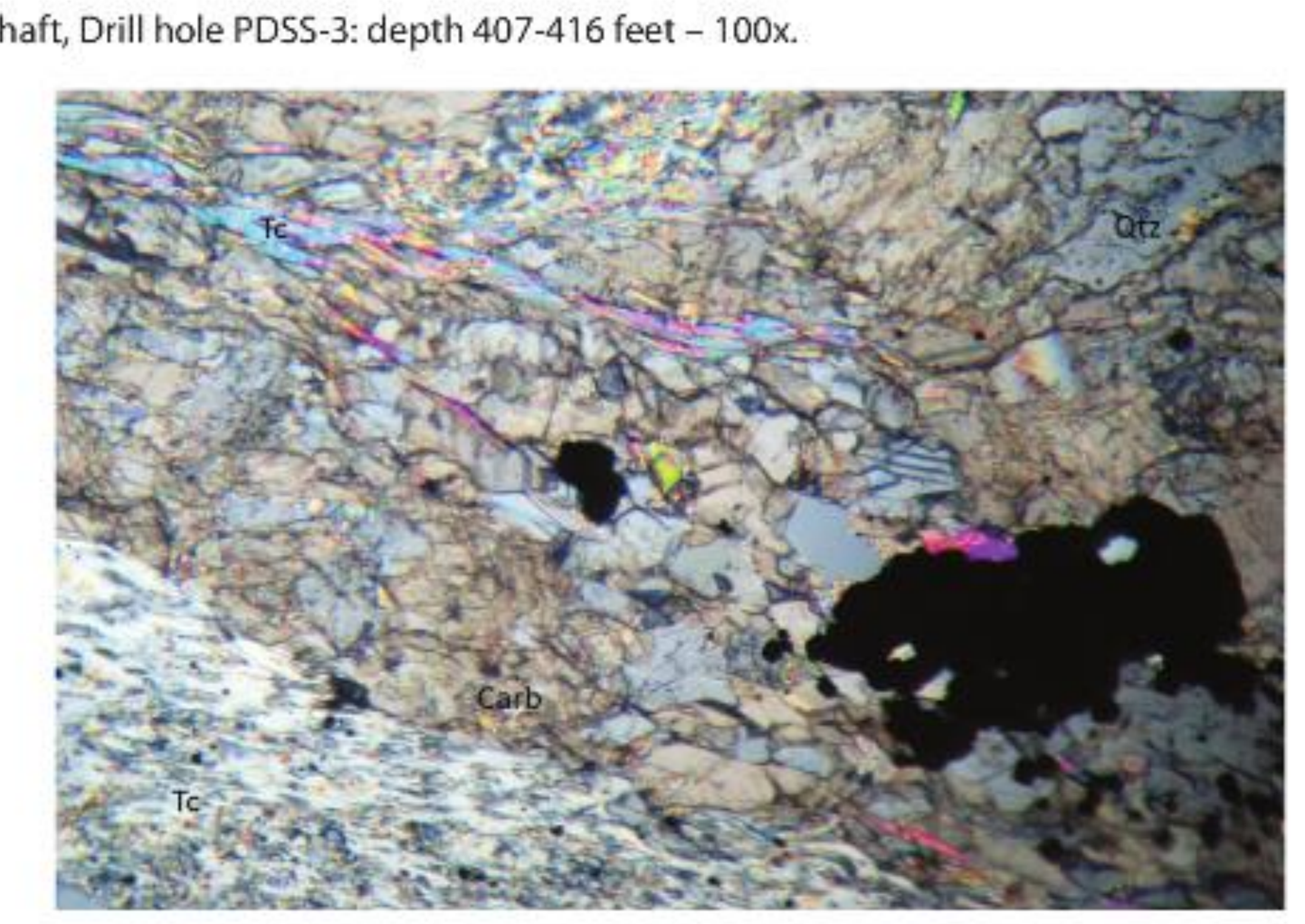
Silver Shaft, Drill hole PDSS-3: depth 407-416 feet – 100x.

Transmitted light. Cross-polarized light.

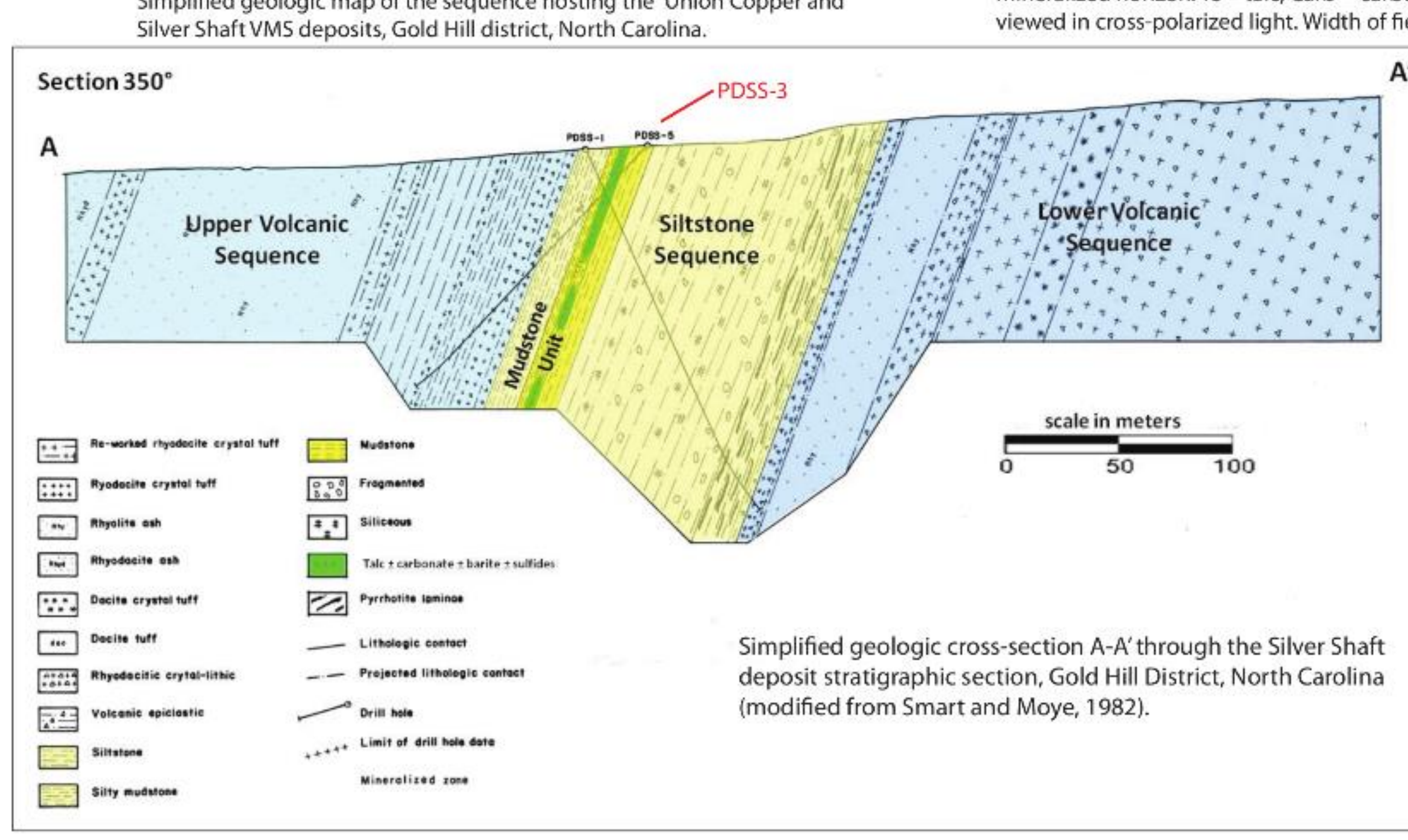


This image illustrates the primary assemblage (carbonate+talc+sulfides [opaque]) plus barite (Bar) in the main mineralized horizon. The quartz flanking the barite may be a metamorphically recrystallized in a pressure shadow. Tc = talc, Carb = carbonate, Qtz = quartz, sulfides (opaque in this view). 100x viewed in cross-polarized light. Width of field of view (FOV) = 1.2 mm.

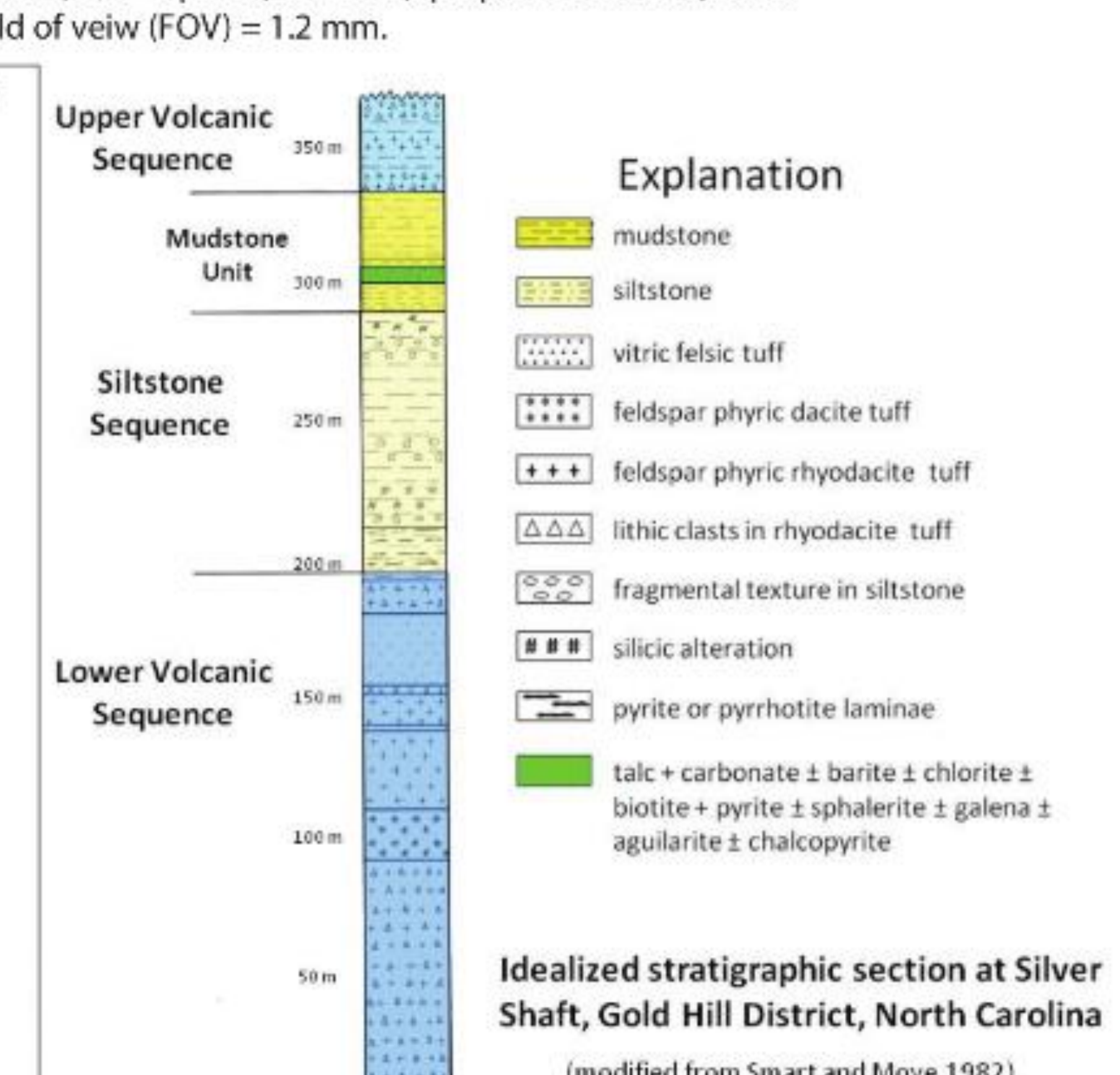
Silver Shaft, Drill hole PDSS-3: depth 407-416 feet – 100x.



This image illustrates the primary assemblage (carbonate+talc+sulfides [opaques]) in the main mineralized horizon. Tc = talc, Carb = carbonate, Qtz = quartz, sulfides (opaque in this view). 100x viewed in cross-polarized light. Width of field of veiw (FOV) = 1.2 mm.



Simplified geologic cross-section A-A' through the Silver Shaft deposit stratigraphic section, Gold Hill District, North Carolina (modified from Smart and Moye, 1982).



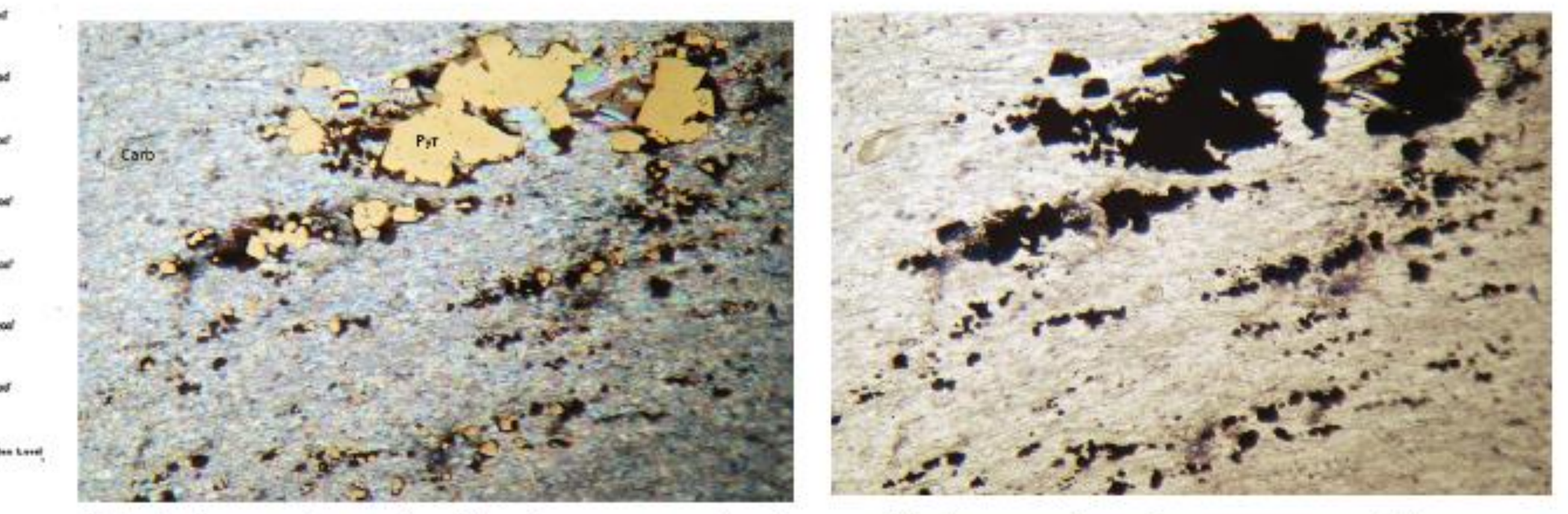
Idealized stratigraphic section at Silver Shaft, Gold Hill District, North Carolina

(modified from Smart and Moye 1982)

Idealized stratigraphic section hosting the Silver Shaft deposit, Gold Hill District, North Carolina.

Silver Shaft, Drill hole PDSS-3: depth 416 feet -100x; simultaneous reflected and cross-polarized light. Width of field of view (FOV) = 1.2 mm.

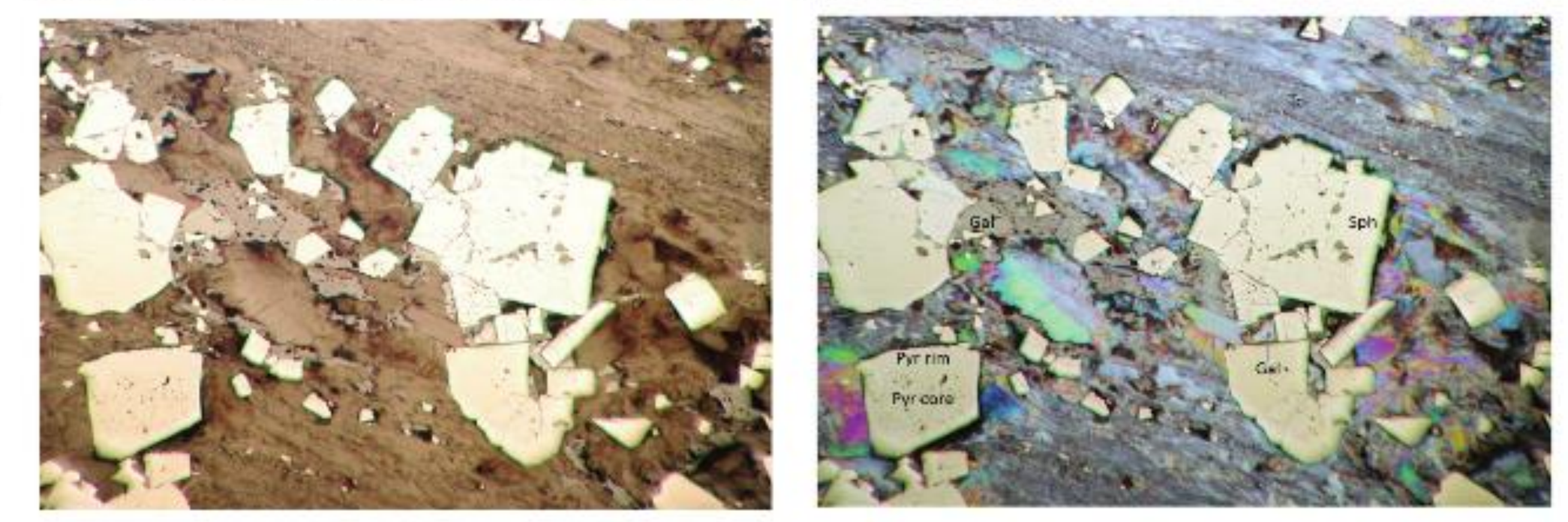
Transmitted light. Same sample as view to the left. Width of field of view (FOV) =1.2 mm.



Talc dominates the matrix with minor quartz and carbonate. The larger pyrite grains are surrounded by pressure shadow growths of coarser-grained quartz, talc, and carbonate. Most of the pyrite is recrystallized metamorphic overgrowths; vestiges of a spongy core (primary ?) is present in some grains. This image illustrates the primary assemblage (carbonate+talc+sulfides) in the main mineralized horizon. Other recrystallized sulfides fringe the larger pyrite grains. Sericite and minor sphalerite form inclusions in one of the larger recrystallized pyrite grains.

Silver Shaft, Drill hole PDSS-3: depth 424-426 feet – 40x; width of field of view (FOV) = 2.9 mm. Reflected light.

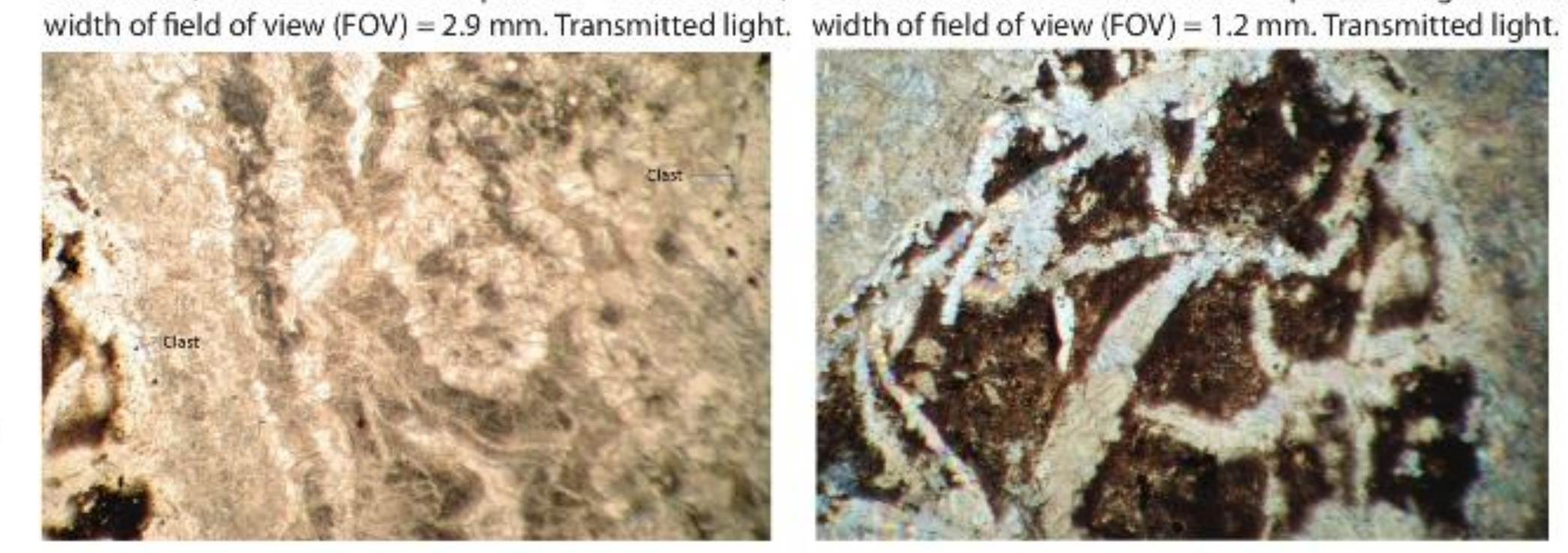
Cross-polarized light and reflected light. Same sample as view to the left.



The primary assemblage (carbonate+talc+sulfides) with variable quartz forms the main mineralized horizon. With the possible exception of spongy poikiloblastic pyrite cores, these textures are not primary. Heterogeneous strain is characterized by narrow zones of intense foliation and shear enclosing lower strain domains. Galena and sphalerite are typically remobilized into low pressure sites (e.g., the lee of the pyrite crystals and fractures in the crystals). It is uncertain if the outer pyrite layers are overgrowing the foliation, or if they are being rotated and abraded by the shear. Width of field of view (FOV) = 2.9 mm.

Silver Shaft, Drill hole PDSS-3: depth 426-446 feet – 40x; width of field of view (FOV) = 2.9 mm. Transmitted light.

Simultaneous reflected- and crosss-polarized light - 100x; width of field of view (FOV) = 1.2 mm. Transmitted light.

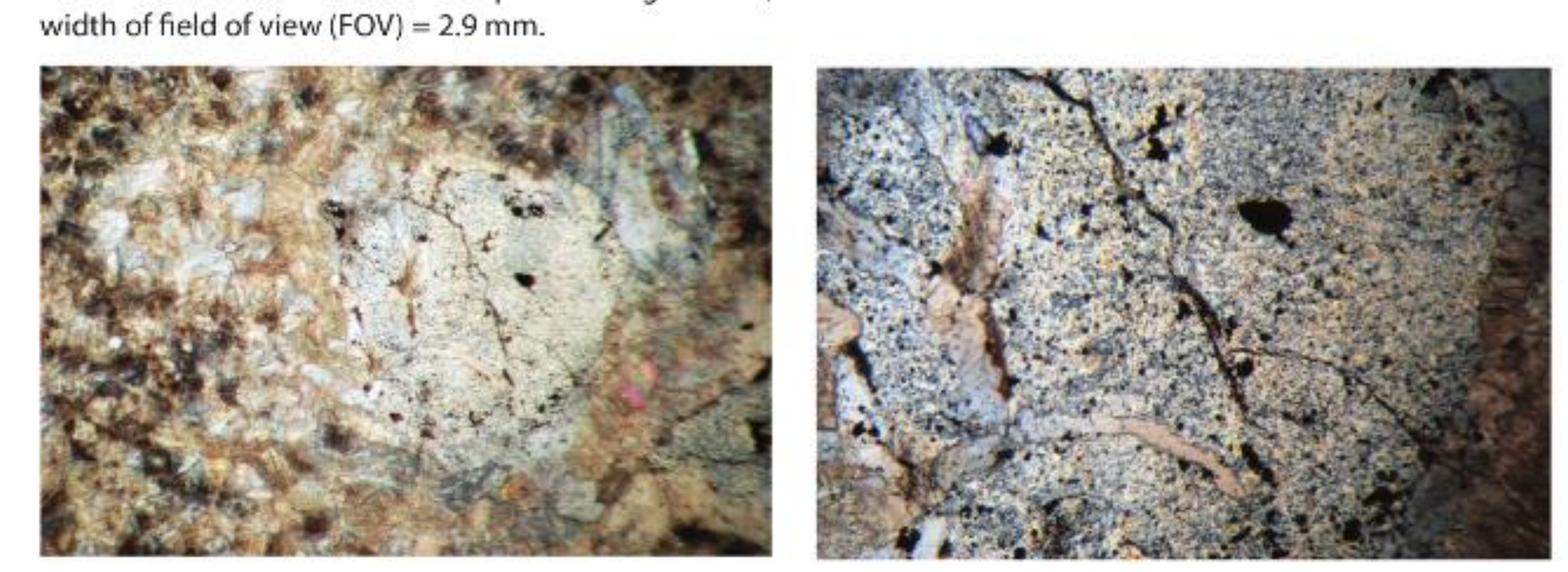


(Left) Possible primary textures consisting of banded and crustiform features – essentially all carbonate. Two clasts are present (one in the upper right corner, the other in the lower left corner), both enclosed by crustiform carbonate containing small amounts of barite (top right center). This may represent a portion of primary "sulfide mound" textures formed in channel ways at the base of a mound. (Right) The very-fine grained pyrite (opaque) may be primary. This is a view of the clast in the lower left corner of the transmitted light image. Width of field of view (FOV) = 2.9 mm.

Silver Shaft, Drill hole PDSS-3: depth 426-446 feet.

Simultaneous reflected and cross-polarized light – 40x; width of field of view (FOV) = 2.9 mm.

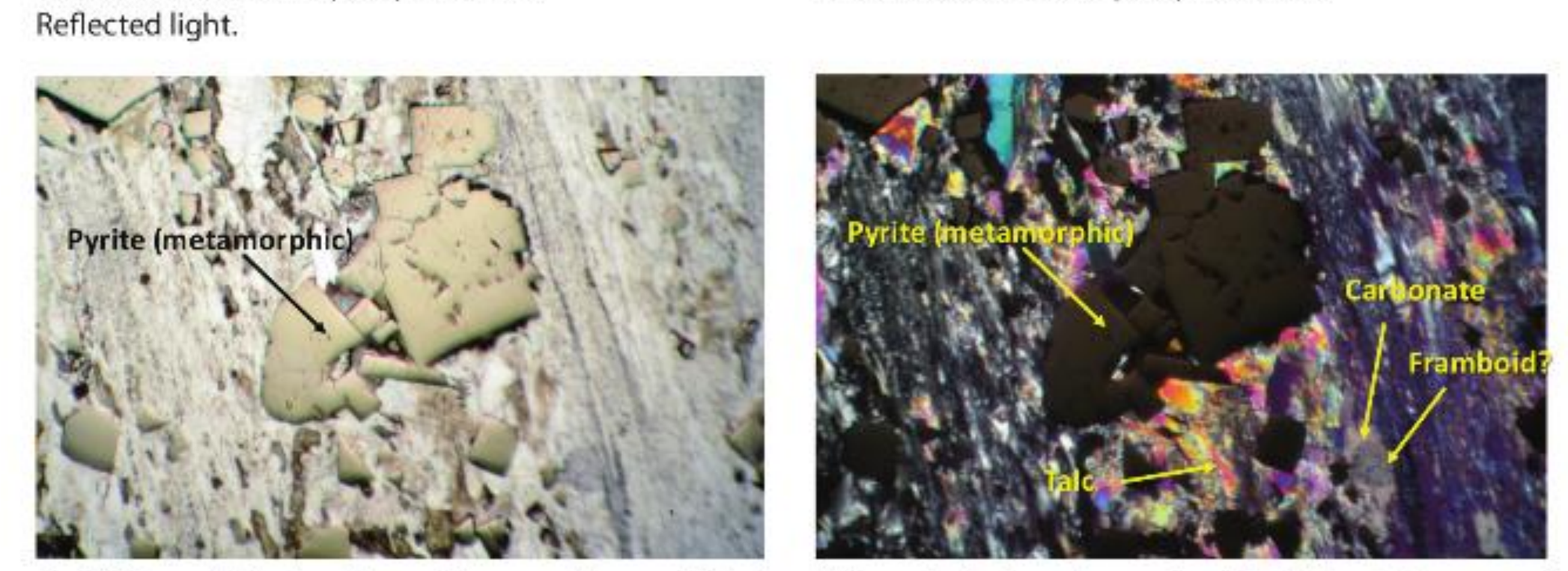
Simultaneous reflected and cross-polarized light – 100x; width of field of view (FOV) = 1.2 mm.



(Left) This clast (partly visible in the upper right corner of the previous slide) is enclosed by the crustiform, banded growths of carbonate. This may be a mineralized hydrothermal breccia formed at the vent site – see very fine banding in lower left. Fine-grained pyrite (opaque) may be primary. (Right) Magnified portion of the in the left image. It is enclosed by the crustiform, banded growths of carbonate. This may be a mineralized hydrothermal breccia formed at the vent site. Fine-grained pyrite (opaque) may be primary in a highly altered hydrothermal breccia clast with later syn-metamorphic fracture-filling carbonate and sulfide veins.

Silver Shaft, Drill hole PDSS-3: depth 442-452 feet – 40x. Width of field of view (FOV) = 2.9 mm. Reflected light.

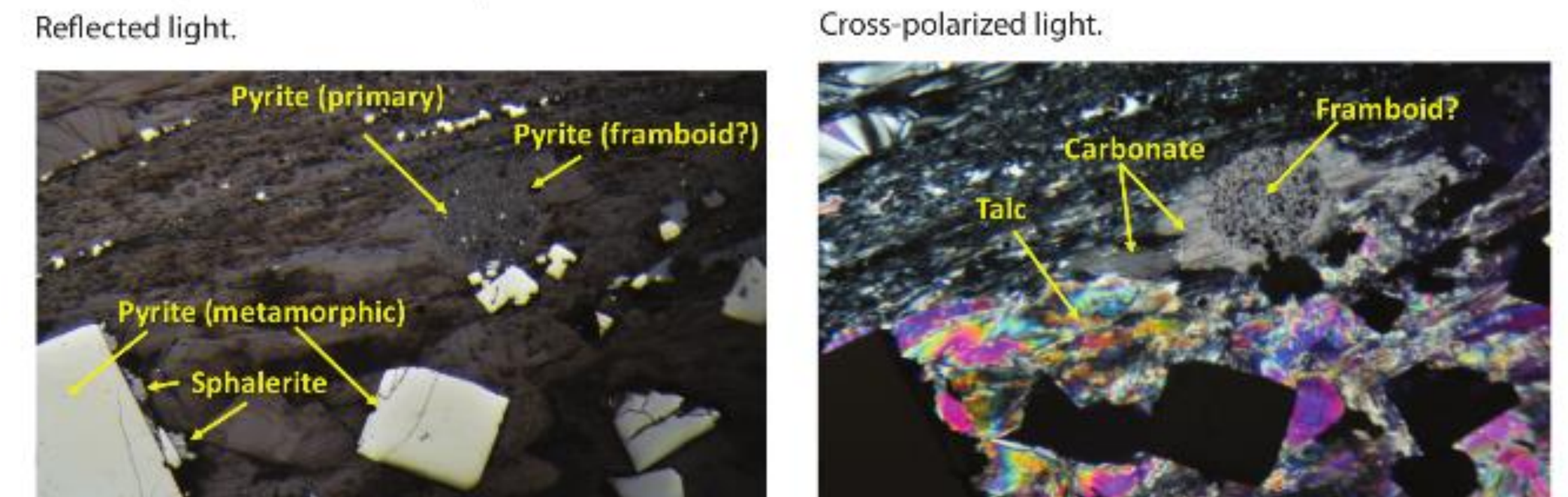
Simultaneous reflected light and cross-polarized light. Width of field of view (FOV) = 2.9 mm.



(Left). Recrystallized pyrite and transposition rock fabric with low-strain domains enclosed by high-strain zones of intense foliation and shearing. A few spongy, poikiloblastic pyrite cores remain, some containing inclusions of sphalerite. Talc and carbonate are common. Sericite and quartz comprise the matrix. See following image pair for sphalerite fringing the larger pyrite grain.

Silver Shaft, Drill hole PDSS-3: depth 442-452 feet – 40x

Reflected light. Cross-polarized light.

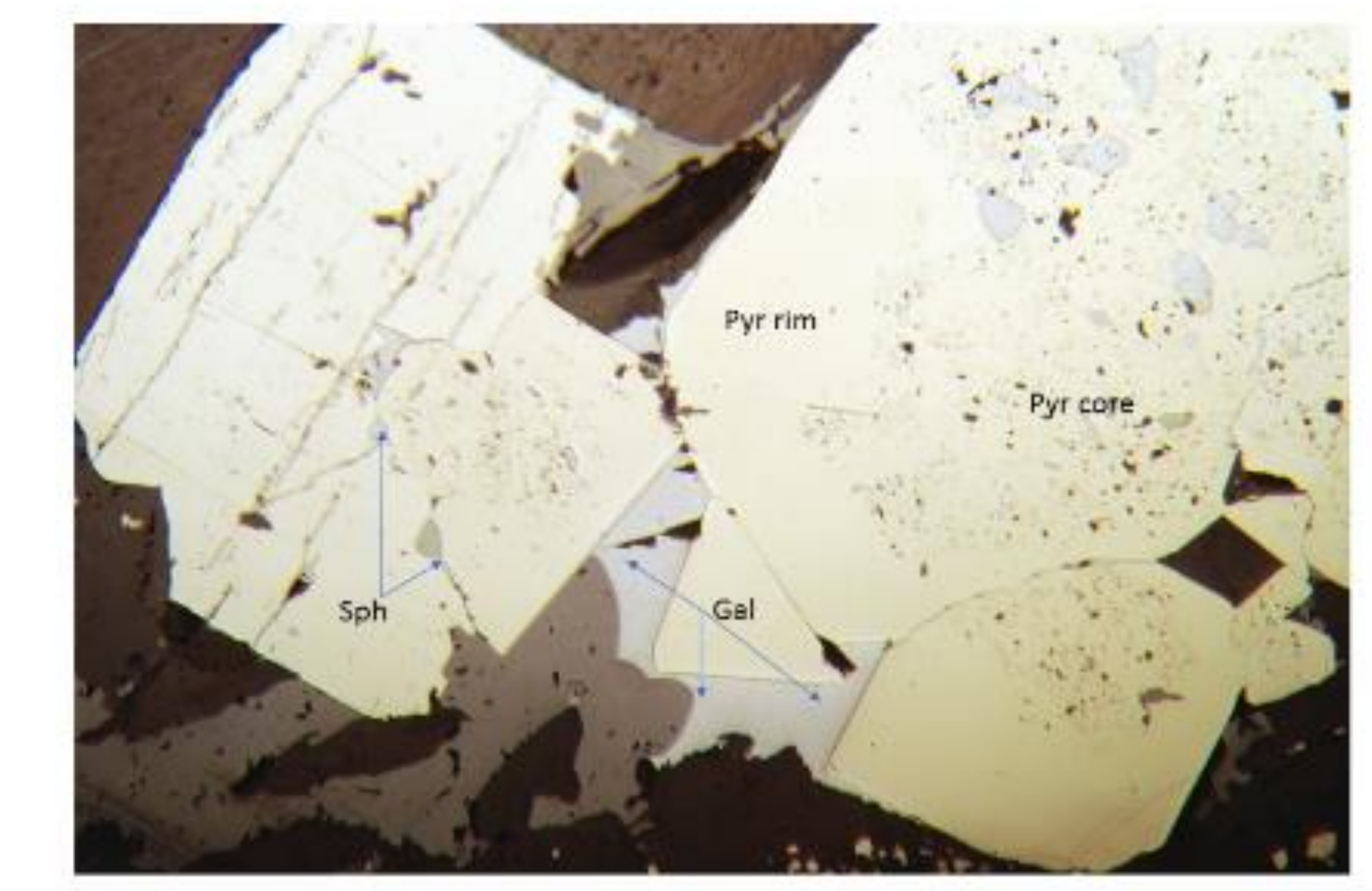


Detail of previous slide from near the base of the Silver Shaft mineralized horizon: talc+carbonate+pyrite assemblage with clean, coarse-grained, euhedral metamorphically recrystallized pyrite and a possible primary framboid composed of very fine-grained pyrite. Talc is coarsely recrystallized in pressure shadows around euhedral pyrite crystals.

Silver Shaft, Drill hole PDSS-3: depth 442-452 feet – 40x Simultaneous reflected light and cross-polarized light. Width of field of view (FOV) = 2.9 mm.

Transmitted light. Same sample as view to left.

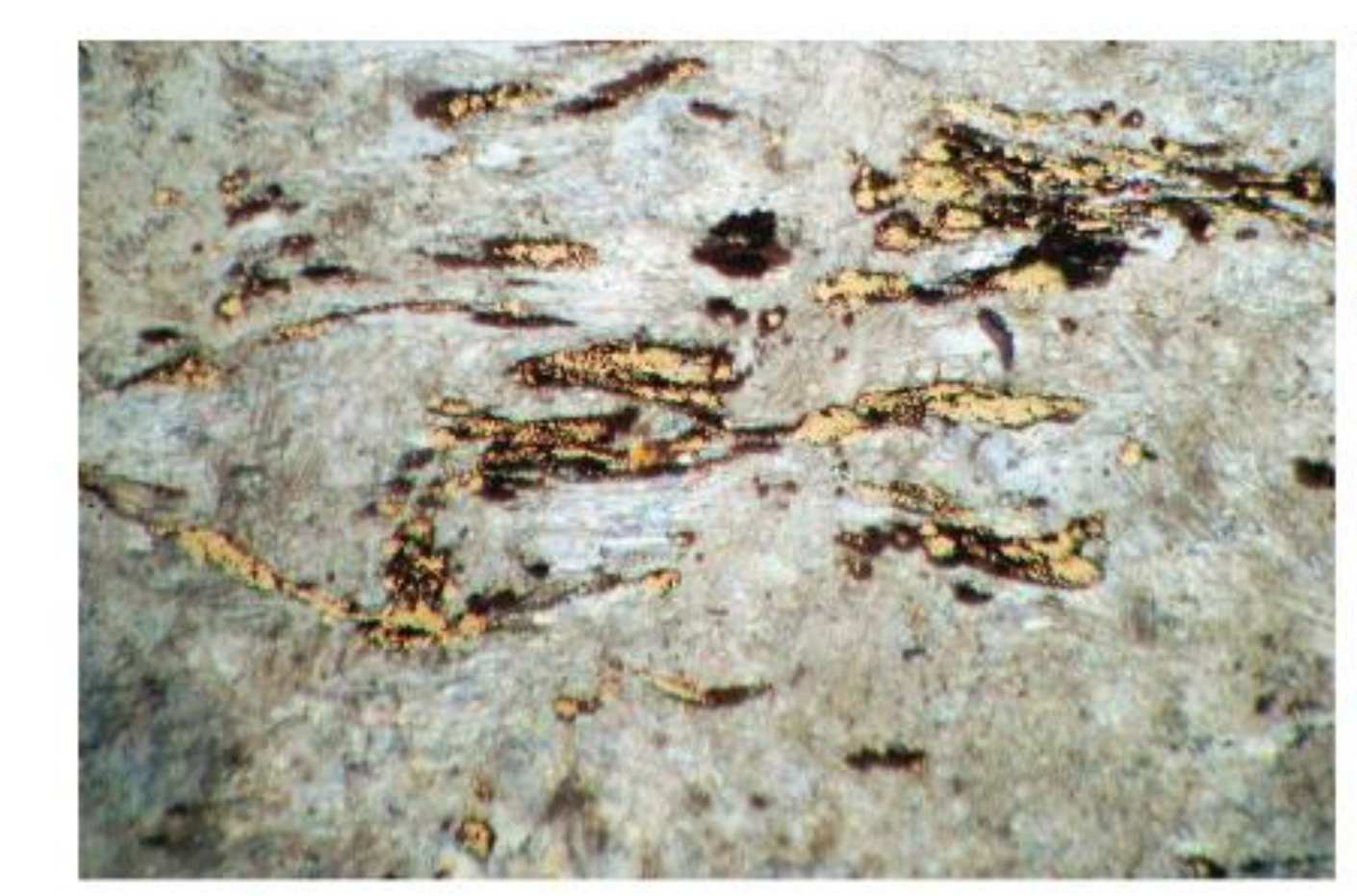
(Left). Clean, euhedral, metamorphic pyrite over-growths on spongy, poikiloblastic cores that cutting across a high-strain rock fabric. Pyrite and sphalerite are the dominant sulfides with barite common. Sericite and quartz with subordinate talc comprise the matrix. (Right). Opaque minerals are sulfides; barite is the pale brown, high relief mineral elongate parallel to the foliation.



Silver Shaft, Drill hole PDSS-3: Depth 442-452 feet - 100x; width of field of view (FOV) = 1.2 mm. Viewed in simultaneous reflected and cross-polarized light.

This detail of the previous image shows clean metamorphic pyrite rims overgrowing spongy, poikiloblastic, possibly primary pyrite cores and cutting across the foliation fabric, suggesting their growth is largely post deformation. Galena is strongly remobilized and fringes the clean pyrite rims, possibly in pressure shadows. Minute amounts of late recrystallized sphalerite were emplaced along fractures in the pyrite.

The blue blobs (previous images) in the spongy pyrite cores (primary pyrite) is blue-dyed epoxy; these appear gray in reflected light.



Silver Shaft, Drill hole PDSS-3: depth 452-460 feet. Simultaneous reflected and cross-polarized light - 40x; width of field of view (FOV) = 2.9 mm.

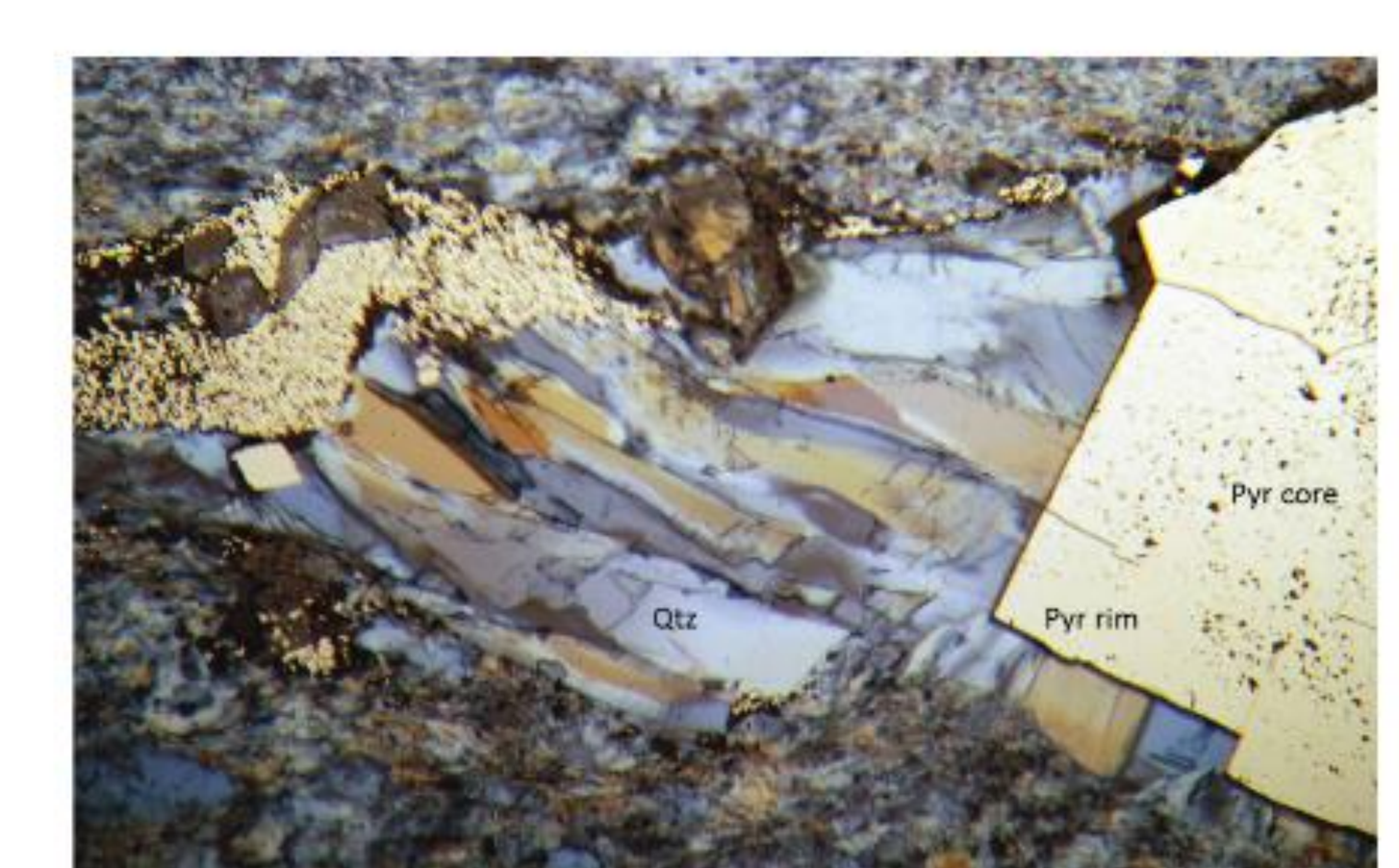
Possibly primary pyrite laminae or elongated framboids that are micro-folded and dismembered by shearing. The matrix is primarily carbonate.

Silver Shaft, Drill hole PDSS-3: depth 468-477 feet. Simultaneous transmitted and cross-polarized light - 100x; width of field of view (FOV) = 1.2 mm.

This appears to be a clast of mudstone containing primary mineralization in the form of fine-grained aggregates or framboids of pyrite.

The clast forms an augen in strongly a strongly foliated/sheared schistose matrix.

The fracture-fill sulfides are metamorphic remobilizations.



Silver Shaft, Drill hole PDSS-3: dept 468-477 feet. Simultaneous reflectedand cross-polarized light - 100x. Width of field of view (FOV) = 1.2 mm.

The finer-grained, possibly framboidal pyrite in the upper left corner of this image resembles the fine-grained, spongy, poikiloblastic cores overgrown by clean, euhedral pyrite in the large pyrite metacryst to the right. Both may represent primary mineralization.

The coarse-grained, elongated quartz grains are a pressure shadow growth and not of primary origin.

For further information:

Moye and others, 2017, provide additional information on the volcanogenic massive sulfide deposits (citation below).

Acknowledgement:

This report documents the volcanogenic massive sulfide deposits (VMS) drilled during past exploration. It also documents the results of the Phelps Dodge Exploration East's exploration 1975-1982 program to make those result available to future exploration geologists interested in the potential for VMS discoveries in North Carolina's Piedmont. This report contains exploration reports, geologic maps and cross sections, results of diamond drill coring, core descriptions, and analytical data. We gratefully acknowledge Freeport-McMorRan's permission to publish these Phelps Dodge Exploration's data including that acquired from Conoco.

References:

Moye, Robert J.; Reid, Jeffrey C., and Lee, David F., 2017, Volcanogenic polymetallic massive sulfide deposits (VMS) of the Carolina Terrane in central North Carolina: New perspectives and historical reports and data from the files of Phelps Dodge Exploration East (1975-1982): North Carolina Geological Survey, Special Publication 11, 456 p.

Smart, W.V., and Moye, Robert J., March 1982, Review of exploration activity at the Silver Shaft Project, Cabarrus County, North Carolina, Phelps Dodge Exploration East, Inc., 24 p.

Accompanies Abstract Number: 311846