REPORT ON THE 2011 EXPLORATION PROGRAM,

STEWART PROPERTY, SKEENA MINING DIVISION

NORTHWESTERN BRITISH COLUMBIA

LATITUDE 56° 36' 30 NORTH

LONGITUDE 129° 30' WEST

NTS 104 A52, 53, 54, 62, 63, 64

FOR

FRONTLINE GOLD CORPORATION

BY

GEOFINE EXPLORATION CONSULTANTS LTD.

BOOK 2 OF 3: APPENDIX B

A Combined MLA/Petrographic Study of Historic Drill Cores DDHDC07-04, DDHDC07-03 & two Rock Samples, Deltaic Grid, Stewart Property, NW BC

April, 2012

Mineralogy Services
Geometallurgy–MLA Dept
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A Combined MLA/Petrographic Study of Historic Drill Cores DDHDC07-04, DDHC07-03 and Two Rock Samples, Deltaic Grid, Stewart Property, NW BC.

For: Frontline Gold Corporation

Attention: Geofine Exploration Consultants Ltd.

Test Report Certified By:

Approved By: *Chris Hamilton, M.Sc.*
Department Manager

Introduction & Objectives

One rock sample and seventeen (17) core samples were provided for the preparation and analysis of thin sections by MLA and their counterpart pulps to be analysed by both XRD and MLA. A pulp from a second rock sample was also analysed by XRD and MLA. A mineralogical characterization of the samples, alteration assemblages, sulphide-mineralogy and structural fabric was sought to attempt to determine the relative position of the samples in the Au-Cu calc-alkalic porphyry system associated with the Delta Intrusion. Sample details are summarized in Appendix 1 as provided by Geofine Exploration Consultants Ltd.

Methods Used

Areas on each of the core samples were demarcated for thin section preparation and corresponding off-cuts were pulverized for pulps. The pulps were submitted to X-ray Diffraction (XRD) analysis and polished sections prepared for analysis by MLA as well. MLA is an acronym for **M**ineral **L**iberation **A**nalyser, a quantitative mineralogy technology whereby the mineralogy of samples were determined by combined Image Analysis and mineral identification and quantification by rastering the electron beam over thin sections at a pre-determined magnification, pixel-to-pixel point resolution and micro-analysis.

XRD was used to validate the crystalline mineralogy as MLA mineral identifications are based solely on relatively short-count EDS (Energy Dispersive X-ray spectrometer) micro-analysis. (Discrimination between epidote and clinozoisite, certain calc-silicate minerals, as well as polymorphic mineral species cannot be made by MLA.)

A Quanta 600F MLA was used at an accelerating voltage of 25 kV and a spot size of 6. MLA measurements are made in line-san (XMOD) mode employing a combined process of BSE (back scattered electron) imaging and EDS analysis using two Bruker 5010 detectors and the Esprit 200 Software package.

Thin sections were prepared by Vancouver Petrographics in Vancouver, British Columbia. MLA/XRD was used by Actlabs to determine the mineral composition of the samples and thin section descriptions were performed by Actlabs and Dr. Eva Schandl of GeoConsult, Pty, Ltd.

Pages 1 through 43 present results of the work completed by Actlabs. The Petrographic Report by GeoConsult is attached as Appendix 6.

RESULTS

Actlabs Modal Analysis: Appendix 2 gives the modal analyses (by MLA) of both thin sections and pulps, while Appendix 3 gives the mineralogy as confirmed qualitatively by XRD. Based on the MLA mineralogy, calculated assays are presented in Appendix 4. In conjunction with XRD and MLA, this calculation permits reconciliation against the whole rock chemistry, providing a first-order measure of confidence in the mineralogical data.

Actlabs Thin Section Analysis: Appendix 5A gives a very brief petrographic description for each sample, based on a consistent magnification view of a portion of each thin section using SEM/MLA. Appendix 5B illustrates representative fields with sulphide mineralization from selected samples only, with emphasis placed on textures and accessory sulphide mineralogy.

The Petrographic Study of Drill Core by GeoConsult is attached as Appendix 6.

SUMMARY OF SIGNIFICANT FINDINGS - MINERALOGICAL

MLA Measurements, supported by XRD analysis, reveals the following salient characteristics:

I. DDHDC07-03 Core Samples

1. The alteration mineral assemblage is distinctly **phyllic (albite/orthoclase, sericite/muscovite/illite-pyrite-chalcopyrite.** The assemblage has low carbonate contents, albite-dominant, and potassic alteration evidenced by sericite and patchy development of mixed feldspars (albite/K-feldspar) replacing the host dacitic rock and phenocryst assemblage.

2. As with the Core DDHDC07-04 samples, Al levels are consistent (average at 8 %), indicating a common parent volcanic suite, and epidote/feldspar veins frequently replace and overprint laumontite. Laumontite is an indicator of a tuffaceous/extrusive precursor and its persistence in the presence of residual albite suggests a late stock work carbonate veining rather than wholesale metasomatic-style, illitic replacement evident in DDHDC07-04 core samples.

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3. Ragged biotite and interstitial secondary biotite is variably replaced by chlorite where visible, which together with K-feldspar, and sericite, provides evidence of potassic alteration.

4. Sulphide textures are distinctly more vein- and stock work-like, and chalcopyrite is a common accessory sulphide accompanying pyrite. Traces (< 0.1%) of sphalerite were encountered in one of 12 core samples. No microscopic gold was detected in this study of cores; however, being of a scoping nature and given the relatively low grades, this result is not surprising. Chalcopyrite is ubiquitous, though ranging from minor (< 2 %) to trace, consistent with assay values for Cu.

5. Sulphide veining is commonly accompanied by calcite-rich selvages, with evidence of active reaction between early deposited sulphide and carbonate bordering gangue/silicate. Vein- and stock work-like sulphide textures, the greater abundance of sulphides, brecciation and replacement of coarser, early pyrite, as well as Fe-staining of accompanying sericite associated with intense brecciation and advanced sericitization, petrographic evidence indicates a more active hydrothermal alteration and sulphidation style for DDHDC07-03 core samples relative to DDHDC07-04 core samples. Even in early pyrite formation two stages of crystal growth is indicated, with porous, central cores and late-stage, euhedral rims.

II. DDHDC07-04 Core Samples

1. The alteration assemblage is distinctly propylitic (sericite/muscovite/illite-carbonate-quartz-pyrite-sphalerite-galena). The propylitic alteration, together with order of magnitude higher metal values for Zn, Pb, As and Ag, (but lower Cu) relative to DDHDC07-03 core samples, may well represent a more distal, metal-enriched, **propylitic porphyry alteration halo or zone**. We note that laumontite is absent from this sample suite relative to DDHDC07-03 core samples, probably indicative of a late stage alteration even in DDHDC07-03.

2. These are veined, volcanic-breccias with high carbonate contents with calcite the chief carbonate. Ankerite accompanies galena and sphalerite in sample CO11648 (sample 15) which also has 5 % kaolinite. The kaolinite appears to be an extreme alteration of feldspars and sericitization accompanying sulphide infilling.

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3. Illite and pyrite are present in both cores, indicating a potassic, sericitic-sulphide alteration style. While carbonate-alteration does accompany sulphidation, the texture of carbonate is indicative of flood-fill propylitic style of hydrothermal alteration.

4. By contrast with the upper four samples in this core, sample 17/Rock CO11651 is more similar to samples of core DDHDC07-03 but has been subjected to a different mechanical style of alteration. In particular, the carbonate alteration is more of a flood-fill style in rock C011651 (as is evident in all DDH-04 rocks) versus wispy, vein-like and breccia-infill distributions of calcite in DDH-03 core. It also has a high albite content and minor to moderate laumontite contents reflected in DDH03 rocks. However, while carbonate does accompany sulphide alteration, the textural features of carbonate is indicative of flood-type alteration, suggesting a propylitic phase.

III. DDH-03 Versus DDH-04: A Comparison

1. The shared attributes of sample CO11651 between the drill holes provides an obvious link between these two drill cores, the first of which was covered in point 4 above and the second relates to a spatial correlation between this lowest DDH-04 core and core samples from DDH-03.

2. Based on sections I and II above, there are two distinct alteration assemblages represented by the two core intersections. That of -03 appears to be more proximal, perhaps **phyllic**, based on the mineralogy and sulphide component. In -04, the alteration assemblage may be more distal, being more **propylitic** with a stronger calcite alteration overprint (8 – 21 % calcite, vs. < 5 % in -03 core) and has a prominent Zn-enrichment signature.

IV. Rock Sample C011652 – Snowpatch Creek

1. The mineralogical composition for this sample is given in Appendix 2. Mineralogically, it is remarkably similar to Core DDHDC07-03 samples, and the orange coloration is imparted by goethite replacing magnetite. It also has all three carbonate minerals, calcite, dolomite and ankerite, indicative of possible hydrothermal overprinting.

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V. Rock Sample C011653 – N. Delta Grid

1. Rock sample C011653 (sample 18 in this study) is an ankerite-dolomite veined, quartz-rich lithology barren of pyrite, showing strong evidence of Cu-staining in the form of malachite. ICP analysis returned a S value of 0.67%, 2.01 % Cu and Fire Assay a value of 91 ppm Ag (duplicates of 89 and 95 ppm). Gold levels are very low, at under 0.03 ppm.

2. Mineralogical findings are consistent with these values, with Cu a factor 3 over S, and a calculated Ag level of 200 ppm. An overestimation of the Cu, S and Ag values by mineralogical analysis is a consequence of underreporting carbonates, as well as erratic vein- and clot-like mineralization. Ag reports largely as acanthite (about 80%) and minor enargite (15 % of Ag). Traces of as-yet unresolved Ag minerals may also be present.

3. In addition to silver, one grain of electrum and one native platinum grain were detected. The electrum was associated with acanthite in chalcocite/bornite, while the Pt was found as an isolated inclusion within ankerite. The presence of Pt is consistent with PGE credits known to be associated with Calc-Alkalic porphyries.

4. The Cu-sulphide mineralogy is dominated by chalcocite, lesser bornite, enargite and covellite, with only a trace of chalcopyrite. Bornite and chalcopyrite are replaced by chalcocite.

5. This rock is very different from the remaining sample suite, being barren of pyrite, having a different carbonate assemblage, and unique Cu-mineralization (core samples have chalcopyrite as the dominant Cu carrier and Cu/Au ratios of between 3,000 and 18,000; average of 7,300). Given the presence of Pt and a very low Au content (i.e. extremely high Cu/Au ratio, at > 30,000), rock sample C011653, would appear to reflect a pyrite-absent, Cu-enriched, very late stage hydrothermal alteration vein-style distal to – or capping - a porphyry mineralization system.

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SUMMARY OF SIGNIFICANT FINDINGS – STRUCTURAL & PETROGRAPHIC

1. Petrographic work by GeoConsult provides optical evidence of the porphyritic nature of the rocks, how pervasively and intensely both the phenocryst assemblage and rock matrix is altered, as well as a more visual representation of how strongly the sulphidation is associated with rock matrix and the paragenesis of the sulphide in relation to alteration, brecciation and veining.

2. Broadly speaking, pyrite, illite, carbonate and quartz contents based on optical estimates are consistent with MLA results. However, owing to the fine grained alteration products of plagioclase - as is evident from optical work describing mottled replacement textures with variable silicification, sericitization and carbonation - it is difficult to establish exactly how much fresh, relict plagioclase remains. This explains an apparent discrepancy between MLA and optical estimates of plagioclase and albite.

3. One benefit of the MLA analysis lies in the ability of the MLA to do X-ray microanalysis traverses across crystals and groundmass at a micron scale spatial resolution. This permits the identification and quantification of minor to trace minerals, specifically laumontite, biotite, chlorite and trace sulphides. As laumontite was verified by XRD, and the effects of alteration are severe, it is considered that the MLA thus provides a more detailed account of the mineralogy and that early albitization and the difficulty in optically resolving fine grained minerals is masked by the alteration effects. The second benefit of the MLA analysis is that BSE Images (Appendix 5-A) allow veining and related alteration fabric to be viewed independently of the porphyritic igneous fabric.

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APPENDIX 1.

Sample Details as provided by Geofine exploration Consultants Ltd.

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DDHDC07-03					
Sample #	**Core out of box**	**RX TYPE**	**DESCRIPTION**	**GFX SAMPLE #**	**This Report**
727552	70.0 - 70.15	ASH TUFF VBX	well devel struct fabric c/w vns stringers, frag replace of sulfs, frags to 3x2.5cm; sulfs as rims, loc well devel net text; qtz carb +/- sulf;	CO11630	1
727553	71.40 - 71.50	ASH TUFF VBX	loc well devel sulf net text around frags up to .7x.6cm, sulfs forming rims & stringers as 2-3% sulfs (py)	CO11631	
727554	73.57 - 73.76	ASH TUFF VBX	strong micro qtz carb fabric +/- sulfs, macro crackle to vns c/w stringers of sulfs; sulfs as anamos vns, diss & tarnished, minor net text, loc 3-4% sulfs (py) gen 2-3%; frags up to 1.2x1cm subrnd; irrid covellite?	CO11632	2
727555	74.53 - 74.69	ASH TUFF VBX	micro macro frags up to 1.4x.8cm; 1-2% sulfs as frag replace, loc net text poorly devel, diss, micro fract fills (py); well devel struct fabric	CO11633	3
727592	125.75 - 125.88	ASH TUFF VBX	mod well devel micro fabric of qtz carb, 1-2% sulfs mainly as diss, loc blebs frag replace and loc net text; mod fract	CO11634	4
727593	126.8 - 126.9	ASH TUFF VBX	mod well devel micro fabric of qtz carb, 1-2% sulfs mainly as diss, loc blebs frag replace and loc net text; mod fract; irreg ang lense of SM sulfs (py & gran sulfs?) up to 3x2cm loc 20-30% sulfs	CO11635	5
727594	128.31 - 128.48	ASH TUFF VBX	frags up to 2x1.5cm rnd to subang with SM sulf replace, loc well devel sulf net text, 2-3% py, tarnished sulf; frags in sil +/- carb mtx; sulf rims up to 4mm	CO11636	6
727595	128.80 - 128.93	ASH TUFF VBX	well crackled c/w qtz +/- carb, macro fabric with gry wh and wh qtz vns up to 4cm rimmed by bl chl stringers & py; py as diss, loc well devel net text of chl around frags & xtals, <1% sulfs.	CO11637	7
727596	130.59 - 130.73	ASH TUFF VBX	frags up to 2.5x3cm c/w sulf rims 2-3mm, frag replace of SM sulfs with py, fi diss, SM sulf vns; very well devel fabric as vns, rims, stringers, stwk; tr mal	CO11638	8
727605	141.14 - 141.26	ASH TUFF VBX	1% sulfs loc 1-2% as rims & fi diss assoc with bl chl; loc well devel net text of bl chl? & sulfs.	CO11639	9
727606	143.02 - 143.14	ASH TUFF VBX	fi sulf diss assoc with gry bl sil, forming rims? & hosting gry wh qtz +/- carb frags; 2-3% py	CO11640	10
727607	144.51 - 144.71	ASH TUFF VBX	well devel net text around frags, <1% fi diss sulfs in gry bl sil, partial sulf replace of frags	CO11641	11
727608	146.54 - 146.71	ASH TUFF VBX	sulfs as diss, assoc with gry sil mtx, loc well devel net text; frags up to 1.5x1.5cm fract c/w with SM stringers, sulf rims to 2mm, 1-2% sulfs loc 2-3% py	CO11642	12
DDHDC07-04					
Sample #	**Core out of box**	**RX TYPE**	**DESCRIPTION**	**GFX SAMPLE #**	
727773	168.46 - 168.70	ASH TUFF VBX	well devel macro and micro fabric c/w qtz carb vns up to 1cm, anamos vns, stringers, loc well devel stwk and qtz carb vns; loc sulf repace frags, patchy sulfs with qtz carb, mm sulf rims; 3-4% sulfs; int sil carb flooded, orthog fabric & stwks	CO11644	13
727776	170.06 - 170.22	ASH TUFF VBX	sil carb flooded as vns, anamos, patches; diss sulfs, minor SM sulf stringers up to 1 mm, qc rims on frags, up to 1.5x1cm frags partially replace by sulfs; loc 1-2% gen 1% sulfs (py)	CO11646	14
727778	173.80 - 174.0	ASH TUFF VBX	gry bl sil mtx c/w sulfs as blebs, diss, anamos vns & stringers, sulf replace of frags, qc replace of frags, irreg patches of wh qtz gry carb SM sulfs up to 6cm; blebs & diss gal, red-brn sphal; 4-6% py, gal; well devel frabric and well sulf; loc well devel net text.	CO11648	15
727779	175.07 - 175.24	ASH TUFF VBX	wk-mod sil flood as vns, patches, anamos,, diss sulfs, loc some well dev net text c/w 3mm SM sulf rims; SM sulf strings, qtz strings, gry blu stringer + well devel fabric; 2-3% sulfs; gry blu qtz carb xtals	CO11649	16
727781	177.60 - 177.73	ASH TUFF VBX	wk sil floded of vns & stringers, loc well devel struc fabric up to 2mm stringers with sulf core +/- sil c/w rims chl;fi diss sulfs; loc well evel micro net text around xtals (chl/sulf)	CO11651	17
SNOWPATCH CRK					
428152 REP		ALT CTVBX w: tan-org brn f: gry wh -bl	aphan-frags; fragmental, brecc sugary text; str sil, str fract, well sulf; wh sil frags up to 4.5x1cm and 5x2cm with micro rims of bl sil & micro xtals qtz & feld in frags in bl sil mtx; well devel net text, well sulf as blebs up to 1cm, as fi diss, SM vns, loc frag replace by py, tr cpy, tr gal; well fract c/w +/- fi sooty py. Comp: 85% sil, 2-3% carb, 2-3% feld, 2-3% chl, 1% oxid as lim on fracts & w surfaces, 2-3% sulfs	**CO11652**	18
N Delta Grid					
REP 18		ALT QTZ MON?	Alt Delta Intrusion?: w: org brn-grn wh; from Deltaic grid; wh qtz as vns (to 1cm), lenses, frag replace (up to 3.5x3cm); mal on fracts & as rims; gry metallic irried covellite?, tr cpy in vns & rims, bornite, loc sulf/mal bx as frag replace; 3-5% mal, 2-3% sulfs gen 3-5% mal + sulfs, 2-3 oxide, 78 sil, 3-5 feld, 2-3 carb; 1-2 ser, 3-5 feld,	**CO11653**	

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APPENDIX 2. *Modal Mineralogy determined by MLA on thin sections. Core samples over page and rock samples this page.*

Sample C011653

Mineral	18
Illite	0.78
Kaolinite	4.08
Quartz	84.63
Laumontite	0.07
Plagioclase	0.17
Albite	0.48
Feldspars	0.17
K-Feldspar	0.17
Calcite	0.05
Ankerite	4.67
Dolomite	1.25
Apatite	0.04
Pyrite	n.d.
Chalcopyrite	n.d.
Bornite	0.58
Chalcocite	1.38
Covellite	0.34
Enargite	0.36
Argentite_Acantite	0.11
Malachite	0.11
Goethite_Cu	0.05
Other	0.52
Total	100.00

Mineral/s	C011652/428152
Chlorite	6.15
Biotite	3.17
Illite	5.1
Kaolinite	1.7
Quartz	22.21
Laumontite	1.33
Albite	28.31
Plagioclase	6.68
K-Feldspar	0.02
Sericite/Albite	5.01
Clinozoisite	0.76
Epidote	2.93
Calcite	2.44
Ankerite	2.92
Dolomite	0.93
Apatite	0.19
Pyrite	6.79
Chalcopyrite	0.06
Goethite	2.41
Titanite	0.5
Other	0.39
Total	100.00

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	CO11630	CO11632	CO11633	CO11634	CO11635	CO11636	CO11637	CO11638	CO11639	CO11640	CO11641	CO11642	CO11644	CO11646	CO11648	CO11649	CO11651
Mineral	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
Chlorite	0.91	2.45	2.15	8.52	6.26	2.49	3.03	1.58	2.39	1.55	3.89	2.45	0.21	1.56	1.80	1.68	6.69
Biotite	0.48	0.89	1.50	2.65	1.70	1.94	1.80	0.80	1.10	0.89	1.61	1.28	0.16	1.56	1.07	1.22	2.86
Illite	11.38	9.04	7.16	12.47	6.50	18.59	16.67	13.39	19.57	15.17	16.96	18.37	14.70	25.09	24.83	36.06	7.65
Kaolinite	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	5.15	0.00	0.02
Quartz	18.51	14.99	6.06	11.89	10.73	14.60	23.09	8.53	19.06	33.05	21.01	18.99	57.88	37.13	17.85	34.67	18.74
Laumontite	2.88	6.00	7.39	4.21	6.99	3.10	2.93	12.65	4.01	9.61	0.87	6.73	0.08	0.04	0.21	0.01	0.95
Plagioclase	5.48	5.89	4.41	6.64	2.52	6.75	5.50	1.98	7.42	3.75	8.02	6.28	0.01	0.02	0.49	0.01	6.75
Albite	33.14	30.09	30.28	28.95	25.43	22.98	21.94	14.93	29.87	16.36	29.70	24.27	0.00	0.00	0.12	0.00	31.32
Plagioclase/sericite	8.70	8.38	8.98	8.20	4.53	9.30	7.84	6.03	5.77	5.73	6.14	6.22	0.61	1.73	5.11	2.18	7.75
K-Feldspar	5.81	7.12	14.26	3.21	0.28	4.90	2.57	0.26	0.79	0.85	0.84	1.00	2.68	4.84	3.79	3.25	1.80
Epidote/Clinozoisite	0.11	0.30	0.22	0.61	0.72	0.35	0.55	1.02	0.45	0.63	0.41	0.56	0.08	0.20	0.78	0.17	1.06
Calcite	1.19	2.24	1.03	2.99	3.86	2.18	4.29	1.84	2.65	2.58	3.02	2.20	18.63	20.88	7.95	12.15	10.72
Ankerite	0.00	0.00	0.01	0.04	0.06	0.02	0.03	0.03	0.03	0.02	0.03	0.02	0.01	0.10	1.47	0.09	0.52
Dolomite	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.01	0.00
Apatite	0.19	0.36	0.68	0.40	0.67	0.30	0.62	0.19	0.40	0.21	0.29	0.29	0.11	0.26	0.21	0.22	0.39
Pyrite	9.87	10.77	14.31	6.84	26.16	10.63	7.18	33.58	4.39	6.94	5.22	9.06	3.28	5.04	7.50	6.75	0.91
Chalcopyrite	0.04	0.02	0.12	0.12	1.10	0.16	0.08	1.70	0.21	0.75	0.37	0.13	0.00	0.00	0.54	0.00	0.01
Galena	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	6.25	0.00	0.00
Sphalerite	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.04	0.55	0.09	13.91	0.01	0.00
Titanite	1.02	0.87	1.04	1.53	1.12	1.10	1.00	0.66	1.24	0.97	1.09	1.09	0.12	0.14	0.06	0.10	0.25
Rutile	0.08	0.06	0.07	0.09	0.07	0.05	0.03	0.08	0.04	0.05	0.04	0.07	0.05	0.10	0.18	0.15	0.08
Other	0.19	0.51	0.32	0.65	1.29	0.56	0.84	0.76	0.60	0.85	0.46	0.97	0.82	1.09	0.68	1.26	1.51
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

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APPENDIX 3. *XRD Analysis of Pulps (Thin section off-cuts)*

Semi-quantitative estimates only; accuracy is affected by the degree of crystallinity as well as mineral overlaps, which may be severe in the presence of laumontite and clinozoisite in particular.

	CO11630	CO11632	CO11633	CO11635	CO11636	CO11637	CO11639	CO11640	CO11641	CO11642
	1	2	3	5	6	7	9	10	11	12
Quartz	**	**	**	**	**	**	***	***	***	***
Albite	***	***	***	***	***	***	***	**	***	***
K-Feldspar	*	**	**	*	*	*	*	*	*	*
Mucovite/Illite	**	**	**	**	**	**	**	**	**	**
Chlorite	*	*	*	**	**	**	*	*	**	*
Kaolinite	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Laumontite	**	**	**	*	*	*	*	**	*	**
Calcite	*	*	*	**	*	*	**	**	*	**
Ankerite	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Pyrite	*	*	*	*	**	*	*	*	*	**
Sphalerite	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.

Note: *** = major; ** = minor; * = trace; n.d. = not detected

	CO11644	CO11646	CO11648	CO11649	CO11653
	13	14	15	16	18
Quartz	***	***	***	***	***
Albite	n.d.	n.d.	*	n.d.	*
K-Feldspar	n.d.	n.d.	*	*	n.d.
Mucovite/Illite	**	**	***	***	*
Chlorite	*	*	**		n.d.
Kaolinite	n.d.	n.d.	n.d.	n.d.	*
Laumontite	n.d.	n.d.	n.d.	n.d.	n.d.
Calcite	**	***	**	**	*
Ankerite	n.d.	n.d.	n.d.	n.d.	*
Pyrite		*	**	*	n.d.
Sphalerite	n.d.	*	**	n.d.	n.d.

APPENDIX 4. *Assay Reconciliation Data*

Caclulated Assay Data for pulp-MLA results. S values are higher than original pulps due to the TS areas being pyrite-rich.

	CO11630	CO11632	CO11633	CO11634	CO11635	CO11636	CO11637	CO11638	CO11639	CO11640	CO11641	CO11642	CO11644	CO11646	CO11648	CO11649	CO11651
Element	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
Ag	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Al	7.50	8.56	8.57	7.89	7.99	7.48	7.76	7.09	7.35	7.07	7.73	7.85	3.94	3.13	7.19	6.71	6.83
Ca	2.36	2.98	2.73	2.48	3.56	2.02	2.86	2.67	2.48	3.13	2.39	2.79	6.09	12.56	3.67	4.92	4.01
Cu	0.01	0.10	0.12	0.10	0.07	0.02	0.03	0.33	0.13	0.31	0.03	0.00	0.00	0.00	0.00	0.00	0.04
Fe	4.41	5.06	4.18	7.97	4.90	8.16	4.80	9.08	5.01	3.31	5.66	7.32	4.96	4.96	6.29	3.63	3.16
K	1.12	1.38	2.23	1.28	1.17	1.44	1.30	0.69	0.90	0.96	0.92	1.27	1.29	1.21	2.19	2.11	1.30
Mg	0.31	0.48	0.58	1.00	1.37	1.11	0.93	0.52	0.67	0.64	0.85	0.63	0.71	0.40	0.89	0.88	1.44
Mn	0.00	0.01	0.01	0.02	0.03	0.02	0.02	0.02	0.01	0.06	0.02	0.04	0.07	0.04	0.09	0.09	0.07
Na	3.71	3.61	3.42	3.01	3.13	2.38	2.73	2.51	2.79	1.58	2.83	1.99	0.04	0.07	0.19	0.08	1.86
S	4.82	5.44	4.40	8.29	4.62	8.60	4.82	10.01	5.20	3.32	5.88	7.85	5.33	5.54	6.48	3.40	2.60
Si	29.82	27.77	28.40	25.41	26.87	25.59	28.19	25.99	28.83	31.40	28.20	26.19	28.15	21.91	25.59	27.27	29.71
Zn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.42	0.37	0.00	0.00	0.00

APPENDIX 5-A.

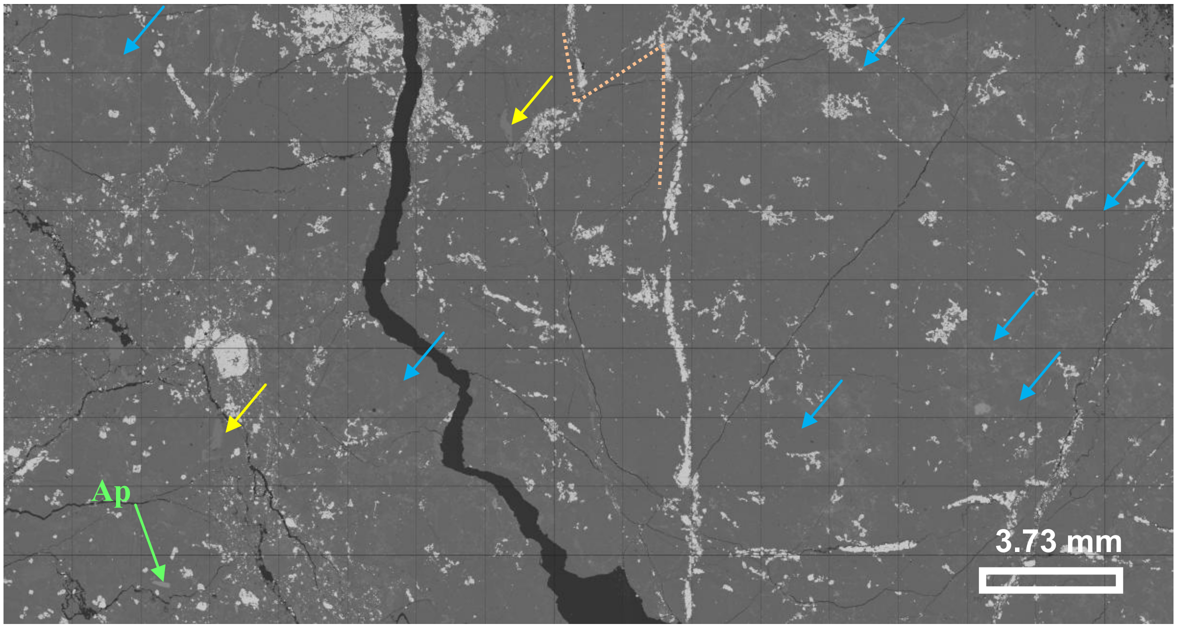
MLA Thin Section Images and Preliminary Petrographic Notes.

Select BSE Image-Montages for each of the samples in thin section (TS) as collected by MLA.

Each square field is 1.865 mm. by 1.865 mm.

(Approximately twice the size of the average phenocryst size, or similar to glomerocrysts.)

Sample 1 / C011630 / 727552



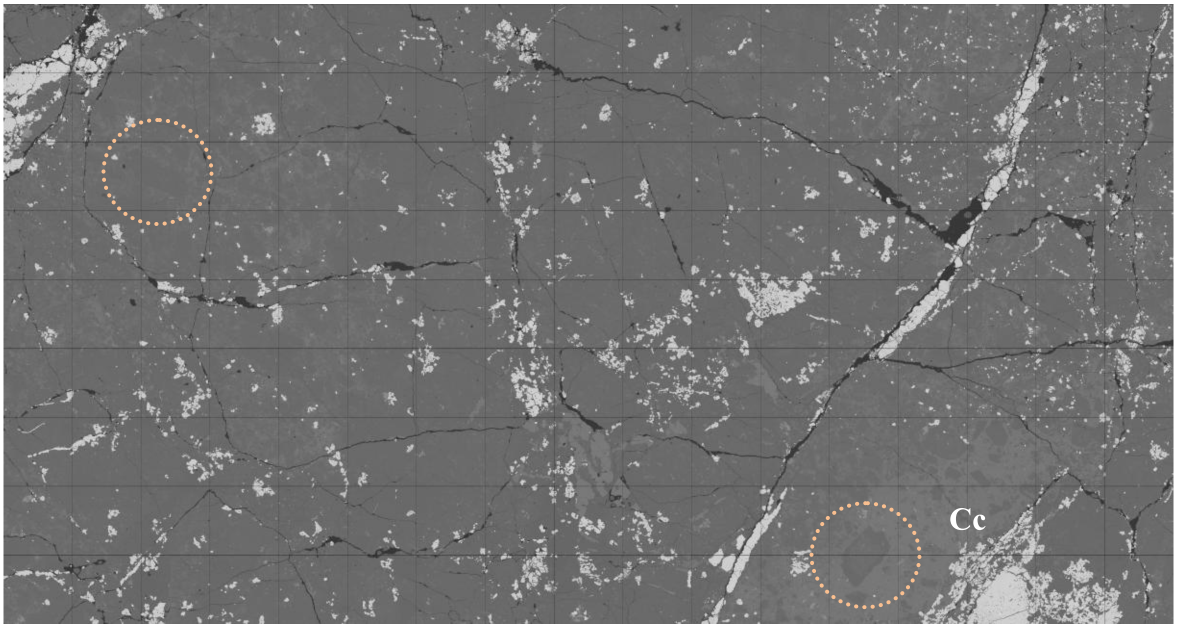
Pyrite (10%) as variably sized disseminated grains, patches and veinlets (network textures) in a rock composed mostly of albite (38%), quartz (11%) and illite (9%). Minor calcite (yellow arrows) and laumontite veining accompanies pyrite stringers. The laumontite indicates a probable tuffaceous precursor lithology, or early veining accompanying pyritization/sericitization, the laumontite and calcite representing only local remobilization of Ca due to plagioclase replacement.

Albitized plagioclase phenocrysts are visible as 1 to 3 mm. sized crystals (blue arrows) in a fine-grained, illite-quartz matrix. Trace apatite (green arrow) is also present.

At the upper termination of the crack running through the section, brecciation of the rock by sulphide is quite distinct, as well as veining and offsets (orange stippled line).

The rock is a sulphidized (9% pyrite) and sericitized, brecciated crystal tuff or feldspar porphyry intrusive breccia.

Sample 2 / C011632 / 727554



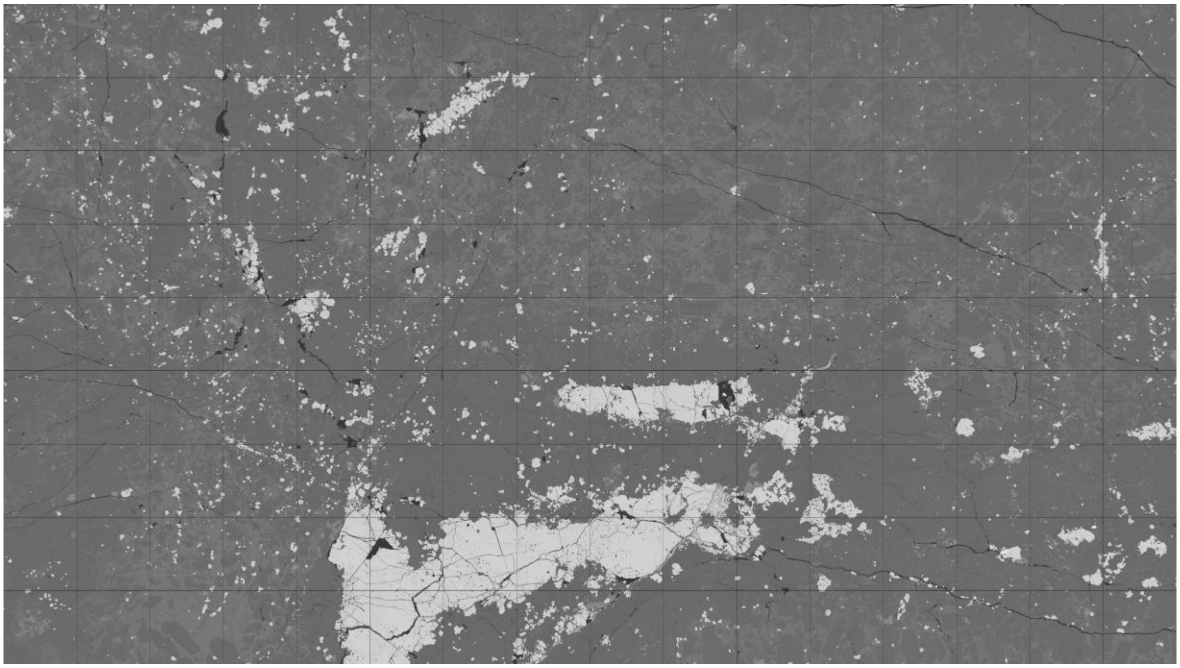
Pyrite as disseminated grains, patches and veinlets in a matrix composed mostly of feldspars, quartz and illite. A calcite (Cc) rich patch annotated in bottom right corner between sulphide and rock matrix contains a distinct crystal (encircled) with an illite core and an albite rim, the morphology and size suggesting a K-feldspar pseudomorph. The crystal encircled in the upper left region of the field of view is likely an albitized/sericitized plagioclase feldspar.

Laumontite is present adjacent to calcite/quartz in pyrite-rich stringers.

Of interest is the fact that at the lower right corner of the field of view, a poikiloblastic, massive central pyrite (with fine chalcopyrite inclusions) is surrounded by a graphic pyrite-replacement of or rock groundmass.

The rock is similar to sample 1 in terms of mineralogy, structure and alteration. It is a sulphidized crystal tuff or intrusive breccia, more likely the latter.

Sample 3 / C011633/727555



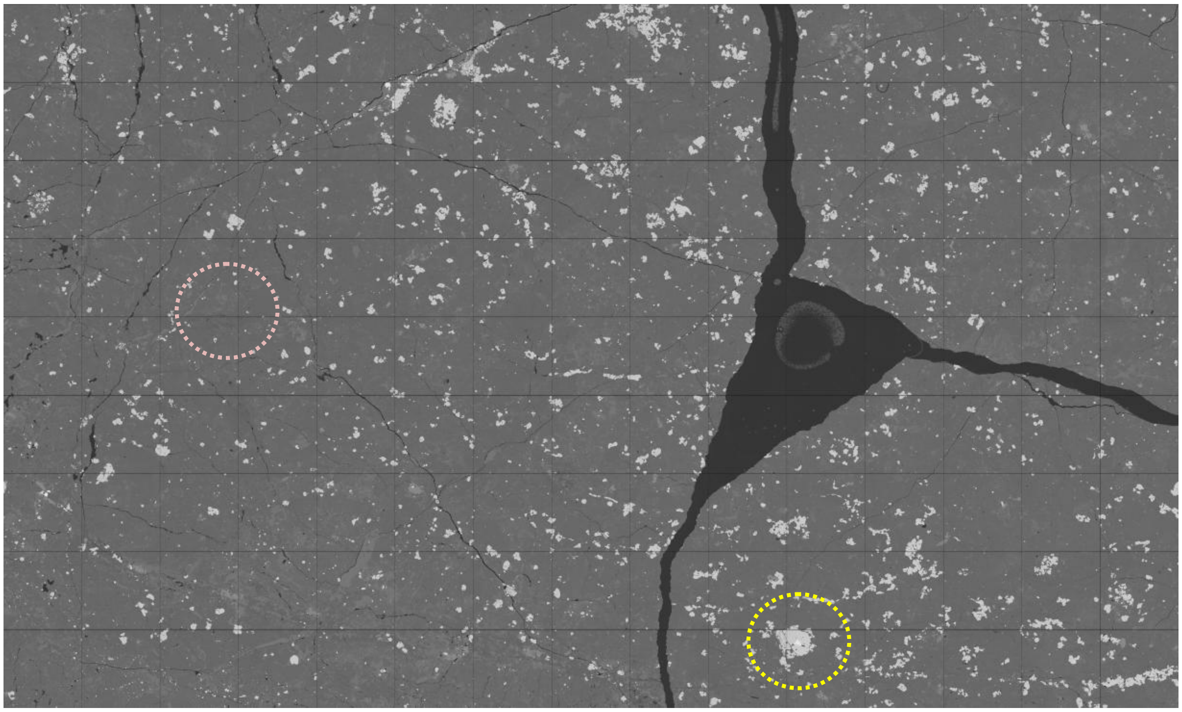
Pyrite as disseminated grains and as semi-massive, vein-pyrite showing fracturing. Adjacent to sulphide, albite is coarse, whereas the rock elsewhere is composed of sub-rounded albite set within a K-feldspar rich, illite-quartz-laumontite-calcite matrix.

This rock has less quartz and significantly more K-feldspar than the previous samples, indicating more advanced potassic alteration.

Pyrite in the lower central view is coarse with adjacent albite, whereas pyrite within the fine-grained rock matrix is fine-grained and disseminated.

The alteration is somewhat more advanced-propylitic than samples 1 and 2. A brecciated phyric intrusive with vein sulphide and illite-carbonate replacement.

Sample 4/C011634/727592

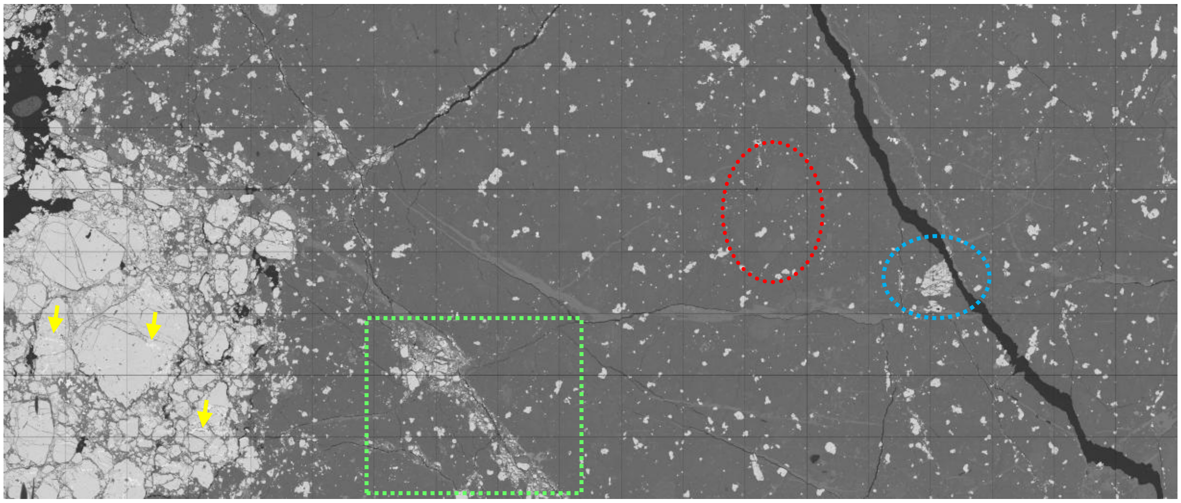


Pyrite mostly as disseminated grains and blebs in a matrix composed mostly of feldspars, quartz and illite. Alteration and mineralogy is thus similar to samples 1 and 2, but with significantly more combined biotite and chlorite (11 % vs. < 4%). The pink circle denotes a cluster of several chloritized biotite crystals.

The rock appears somewhat finer grained than previous samples and pyrite (largest of which contains central chalcopyrite; yellow circle) is distinctly subhedral and disseminated.

A brecciated, sulphidized feldspar porphyry.

Sample 5 / C011635 / 727592



A lens of crackled and brecciated pyrite with chalcopyrite and disseminated pyrite in a matrix composed mostly of albite with minor quartz, laumontite, illite and chlorite. Calcite veinlets run through the matrix and brecciated pyrite.

In the red circle, two illite/albite-replaced plagioclase phenocrysts are demarcated.

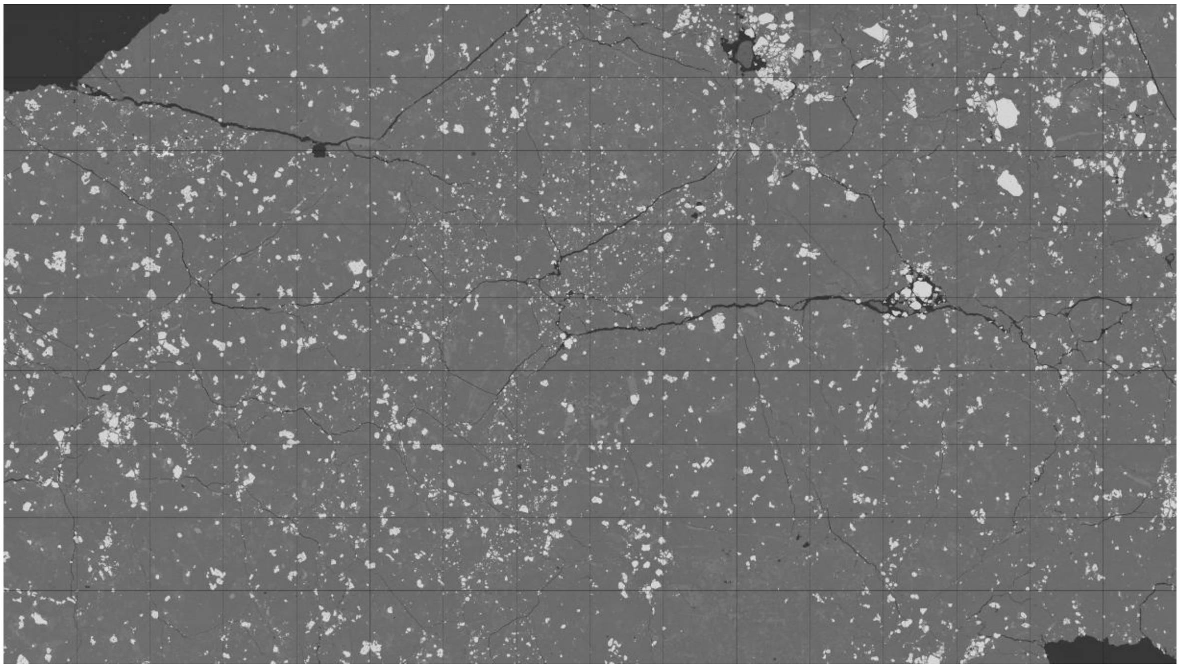
In the massive pyrite, veinlets and inclusions of chalcopyrite are common (yellow arrows).Brecciation and fracturing of massive pyrite, as well as milling/fragmentation (green stippled box) of vein-pyrite accompanying carbonate veining.

It is interesting that fracturing of pyrite even in the far right coarse aggregate (blue stippled circle) is sub-parallel with fracture in the coarse pyrite-rich domain and locally parallel with carbonate veining, suggesting hydraulic fracture control.

This rock is similar to sample 4 /CO11634, but with locally massive and fragmentary pyrite.

A sulphidized, veined, intrusive feldspar porphyry breccia.

Sample 6 / C011635 / 727593

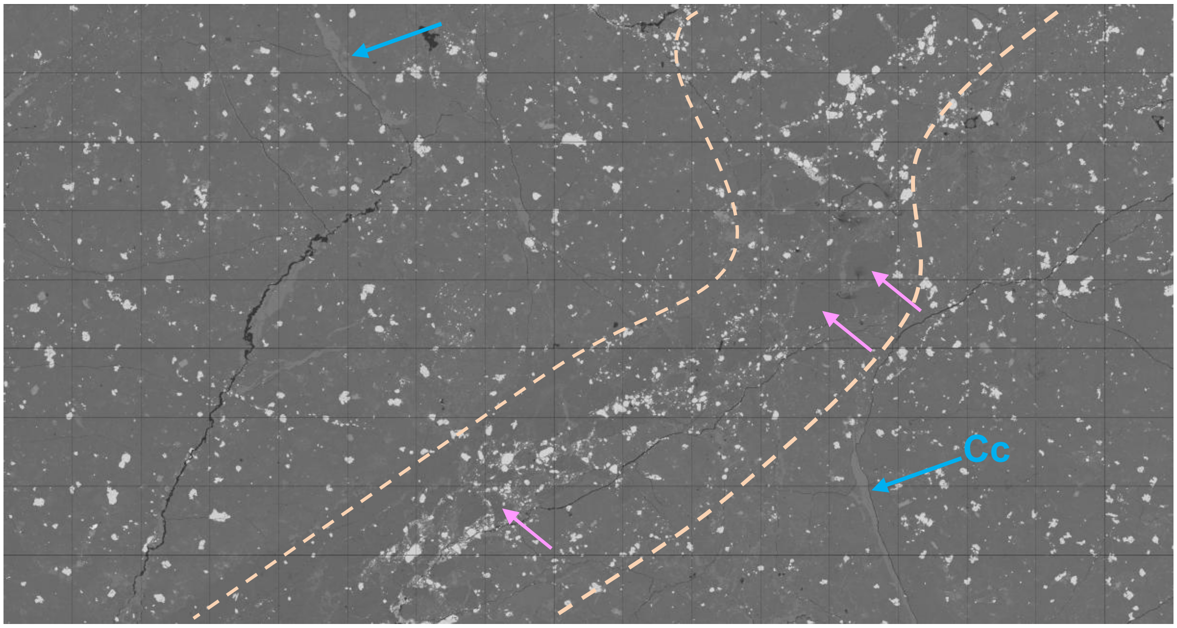


Pyrite mostly as disseminated grains in a matrix of feldspars, quartz and illite. Some of the pyrite is in the form of angular fragments. K-feldspar and illite are almost equally abundant.

This rock is again similar to the coarser rocks C011631 to C01163, but with slightly less albite and more illite.

Alteration mineralogy and style matches to sample 4. A sulphidized, veined, intrusive feldspar porphyry breccia.

Sample 7 / C011636 / 727594

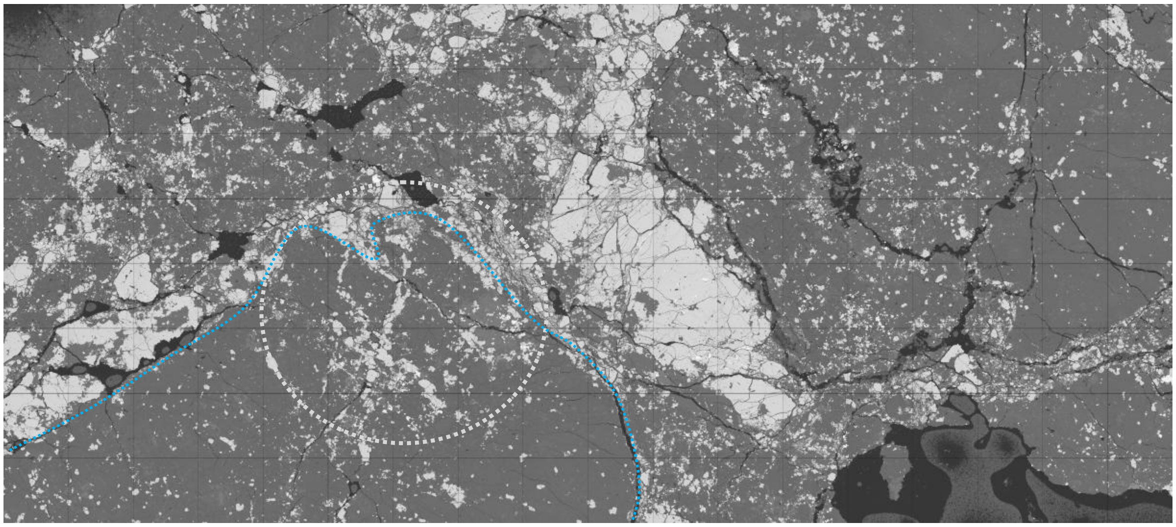


Pyrite mostly as disseminated grains in the rock matrix. In the central band (outlined with broken tan lines), angular quartz accompanies stringer-like pyrite and shows quite distinct against calcite and illite. Outside of this domain, the rock is similar to previous, feldspar porphyry samples. Lenticular to vein-like and wispy calcite (Cc veins, annotated) is common.

Modal analysis by MLA shows quartz to be more abundant than in previous samples; in this regard, the angular and lenticular grains (pink arrows) accompanying vein-pyrite is therefore significant. Also, sulphide accompanying the quartz shows both subhedral forms and angular, fragmental pyrite, the latter probably due to shearing accompanying silicification.

A sulphidized, veined, intrusive feldspar porphyry breccia.

Sample 8 / C011637 / 727594



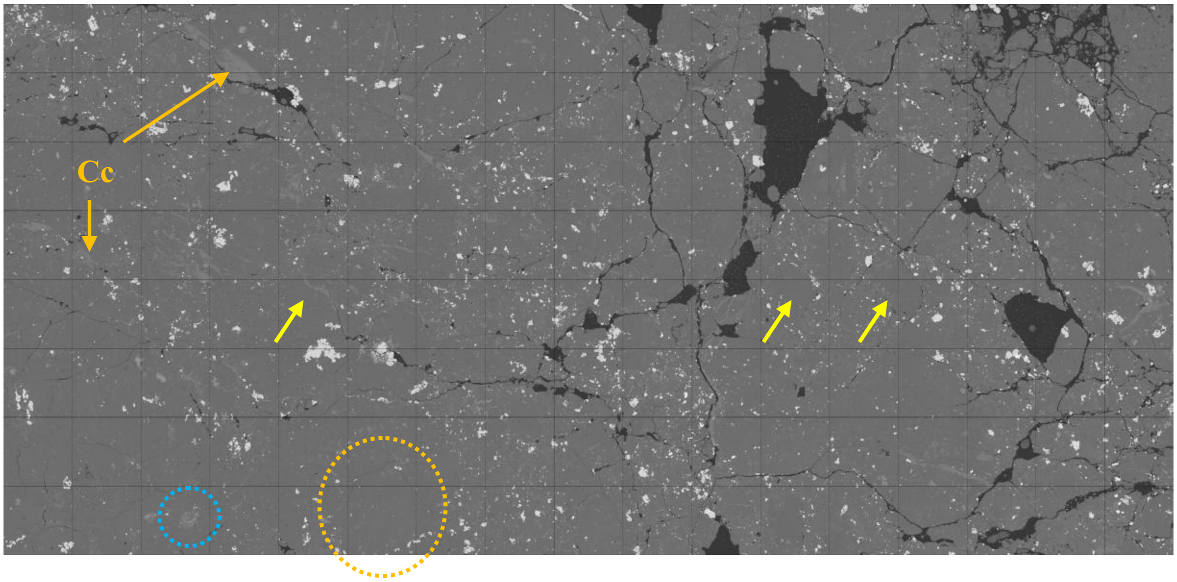
Semi-massive crackled and brecciated pyrite, as well as anastomosing veinlets and sulphide disseminated into the rock matrix of albite, illite and quartz. Laumontite occurs adjacent to fractures and accompanying sheared pyrite; laumontite in this high sulphide sample is the highest of all samples. It also has the lowest quartz content, indicating that Si is probably not added to the system, but that quartz represents a re-crystallization product.

Pyrite is also present in the form of disseminated grains and stringers within the volcanic host rock. The lower left breccia fragment (outlined in blue) is invaded, fractured and replaced by sulphide infill, providing evidence of active re-working/milling accompanying brecciation/veining.

(Black/grey area to lower right is a pluck-out and resin-fill void.)

A sulphidized, veined, intrusive feldspar porphyry breccia.

Sample 9 / C011639/ 727605



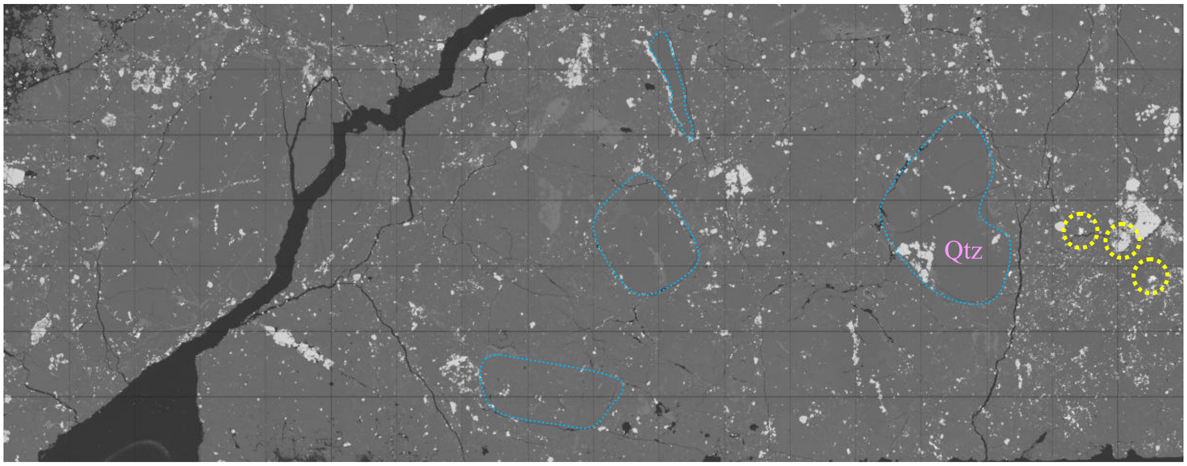
Disseminated pyrite in a breccia matrix of albite, quartz, illite and calcite. A possible flow banding aligned north-west/south-east is suggested by calcite/illite fabric and finely disseminated pyrite stringers. In addition, a weak, rounded-ovoid-lensoid fabric is apparent, with pyrite-carbonate infill representing less than 10 % of the rock.

Highly albitized plagioclase crystals are visible throughout the rock (sub-rounded grains; yellow arrows), and a very large crystal is inscribed by the yellow circle. In the blue circle, a mixture of chloritized biotite and illite is present.

This sample has the highest albite content of all samples in DH-03 cores and closely matches with sample 17/C011651 of DH-04

A sulphidized, veined, intrusive feldspar porphyry breccia.

Sample 10/ C011640/ 727606



Pyrite as disseminated grains and veinlets in a matrix of feldspars, quartz (darkest), laumontite, illite and calcite. Some evidence of milling and fracturing can be seen in the upper left corner, indicative of active brecciation.

Fracturing and compartmentalization of different domains indicates distinct brecciation; several silicified compartments are outlined in blue, which suggest a possible radial arrangement of quartz replacement (Si-flooding?).

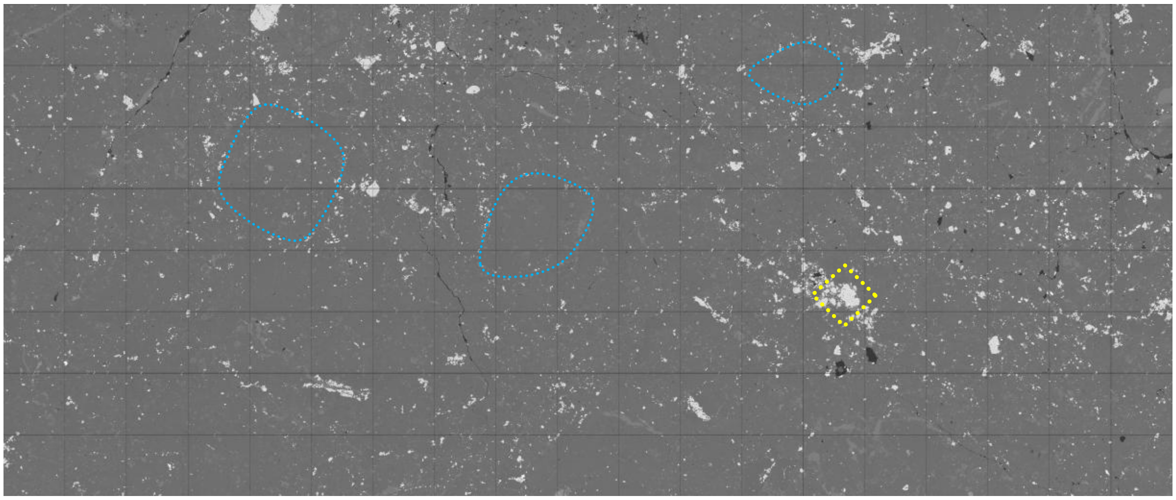
Silicified breccia fragment (annotated by Qtz.) is distinct from pyrite-albite matrix to right, and a high laumontite content again corresponds with abundant fracturing.

Chalcopyrite rims pyrite and occurs as disseminated grains in the two circled regions inscribed in yellow.

With the highest quartz content in this suite of DH-03 rocks, (33%),

A sulphidized, veined, intrusive feldspar porphyry breccia.

Sample 11/ C011641/ 727607



Disseminated and vein-fill pyrite in a matrix of feldspars, quartz, illite and calcite. Again, a flow banding is evident, as well as extensive albitization. The rock is similar to sample 9 (CO11639) with high albitization and lesser sulphidation.

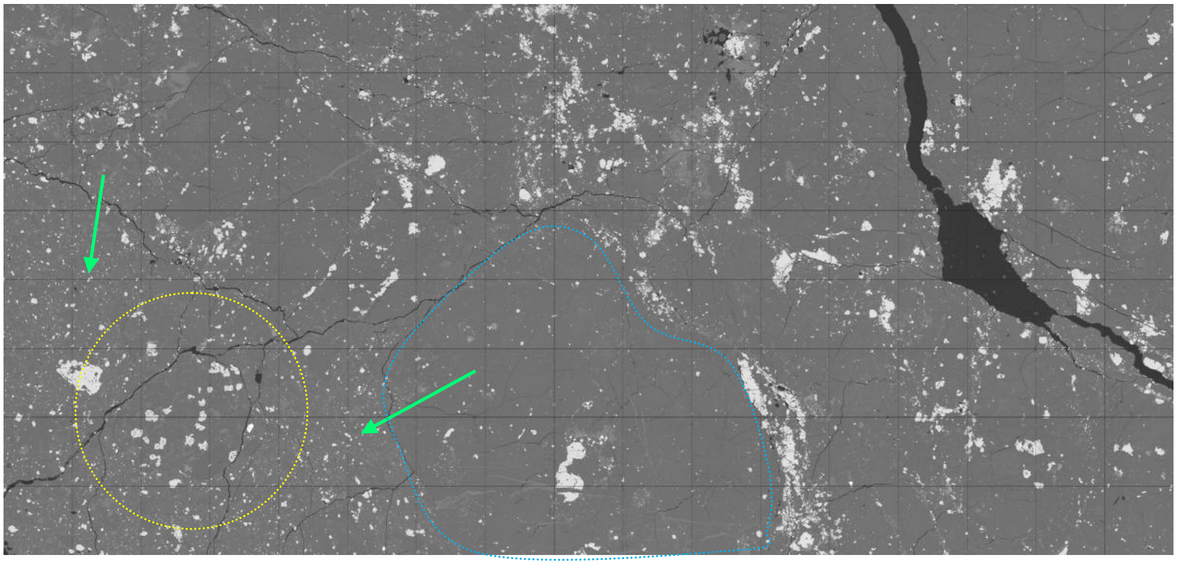
Chalcopyrite and galena were noted in association with pyrite, and there is a distinct flow-banding again identifiable by calcite-pyrite stringers.

Stippled blue outlined ovoids are rounded, almost nodular features which appear to represent clasts of brecciated rock as defined by a combination of pyrite-rich, illitized matrix, fractures and calcite veinlets. In the left-most such clast, carbonate-replaced plagioclase phenocrysts are visible. An optical image of such a clast is also reflected on page P-44. This rock may, on this basis, reflect a welded crystal-tuff or a highly sericitized and mildly sheared intrusive breccia.

The optical photomicrograph for this sample (Petrographic Report; page 85) is of the region outlined in yellow, where chalcopyrite inclusions in pyrite are featured.

A sulphidized, veined, intrusive feldspar porphyry breccia.

Sample 12/ C011642/ 727608



Pyrite as disseminated grains and as cracked and brecciated fragments in a brecciated rock matrix.

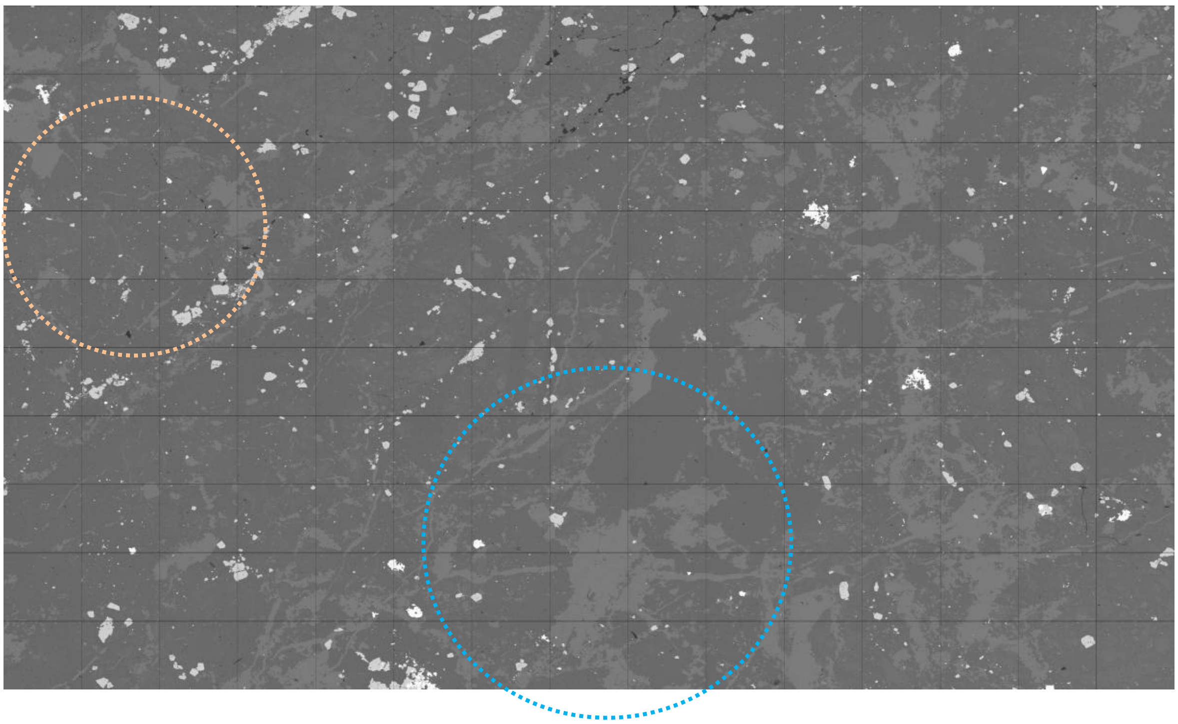
Development of different breccia clast-types is distinct, with a coarser pyrite mineralized clast at left (circled), as well as a large feature centre-bottom (blue stippled outline), which has a contorted pyrite infill vein within it. Between these clasts, the typical illite/albite/carbonate infill with finely disseminated pyrite is evident (green arrow). This assemblage is indicative of advanced sericitization and carbonation of the felsic rock matrix mineralogy. Advanced silicification of the coarse clasts is also indicated by their mineralogy and low BSE (back scattered electron energy/intensity).

The brecciation of pyrite may be related to re-juvenation of fracture/shearing accompanying silicification and later-stage, Cu-rich mineralization.

A sulphidized, veined, intrusive feldspar porphyry breccia.

Historic Core DDHDC07-04

Sample 13/ C011644/ 727773



Disseminated euhedral to subhedral pyrite and irregular bodies of sphalerite in a matrix of quartz, calcite and illite.

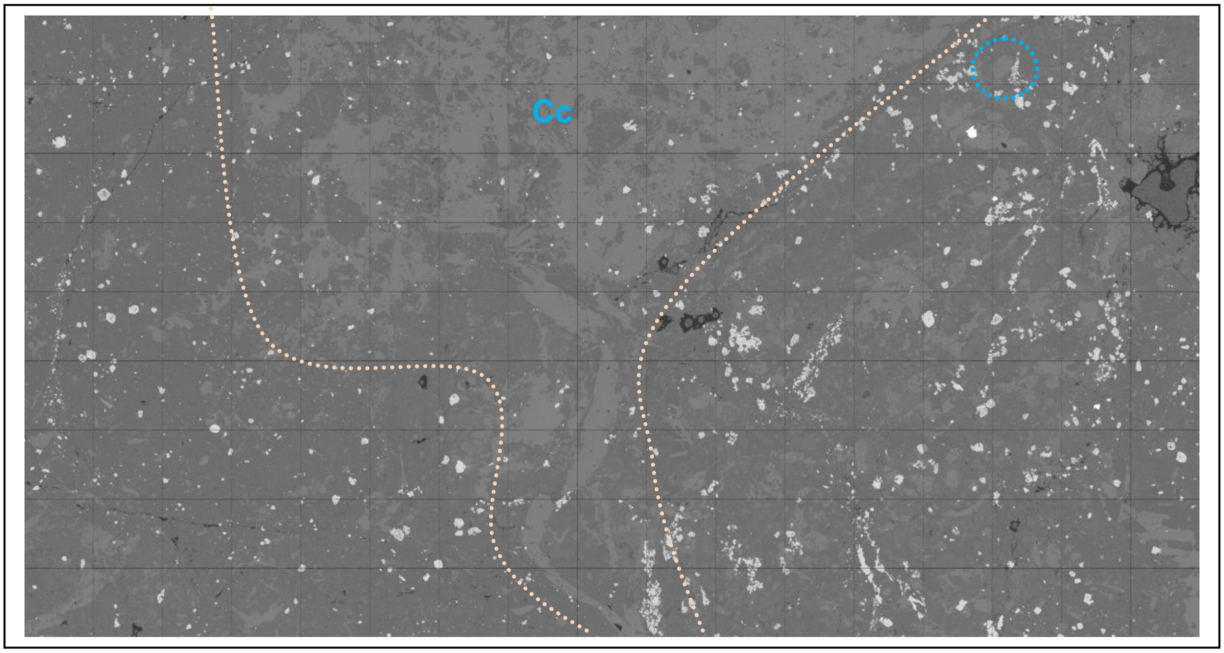
Calcite occurs as patches and anastomosing veinlets, often contorted between illite-quartz breccia (stippled area outlined as an example.). The general texture is chaotic, and it is also significant that the silicified breccias fragments within the blue outlined area are also radially arranged relative to the central calcite, indicating that carbonate alteration postdates brecciation.

Some 'ghosting' of quartz-replaced phenocrysts is suggested by the finer and less chaotic region outlined by the tan stippled circle. This domain resembles the igneous fabric of other samples in this study, suggesting that this rock is a highly flood-filled, carbonate altered analogue where almost all original fabric is destroyed. Late euhedral, recrystallized quartz is present within calcite veins.

It is significant that there is no albite in this and the successive three rocks (CO11646/48/49), indicating a distinctly different alteration style from core DH-03 rocks.

Based on the biotite pseudomorphism, and relative paragenesis of alteration, it is interpreted this rock is also volcanic and probably similar to associated rocks of the sample suite. **It is suggested that it is a sericitized, carbonatized and silicified (i.e. extreme hydrothermal), brecciated porphyritic amphibole-feldspar lithology.**

Sample 14/ C011646/ 727776



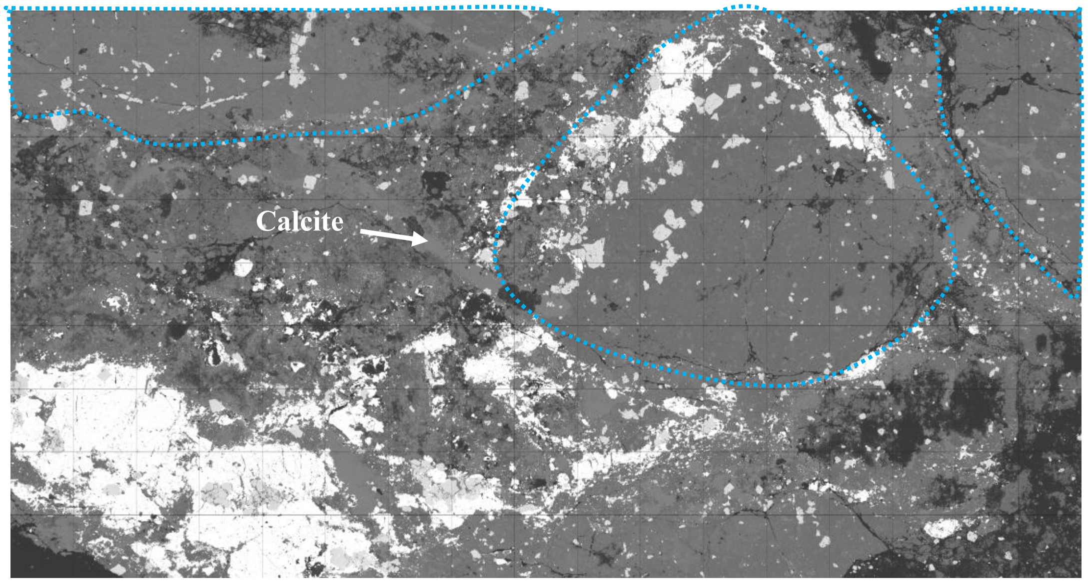
Pyrite as disseminated euhedral to subhedral crystals and veinlets in a matrix of sericite/quartz and felt-like to vein-calcite. Stringers of calcite splay out to a calcite-rich domain top-centre (Cc), while pyrite stringer development occurs in an arcuate vein parallel to the right margin of the calcite 'swell'.

A pseudomorphic phenocryst with fine grained biotite is outlined in the stippled blue circle. It has rutile and apatite inclusions, and is altered to a mixture of sericite and calcite. It is unclear whether this is biotite-replacement after feldspar or altered biotite; however, it is evidence of potassic alteration. Once again, a ghost porphyritic texture is evident in places, indicating that although highly altered, not all evidence of the volcanic protolith is destroyed. Unlike DH-03 rocks, there is not the compartmentalization and rounded/ovoid fragmentation. Together with the coarser carbonate, this texture is indicative of dilational, crackle-style brecciation.

With combined chlorite and biotite representing 3% of the rock, and the highest measured K-feldspar content in DH-04 rocks, it is more potassic than the previous sample but obviously similar. It appears more intensely altered, as ghost phenocrysts are still discernable in the petrographic descriptions.

The rock is thus interpreted to represent a more pervasively K-metasomatized analogue of the previous sample. Less quartz would suggest less recrystallized vein-quartz is present relative to sample 13/C011642.

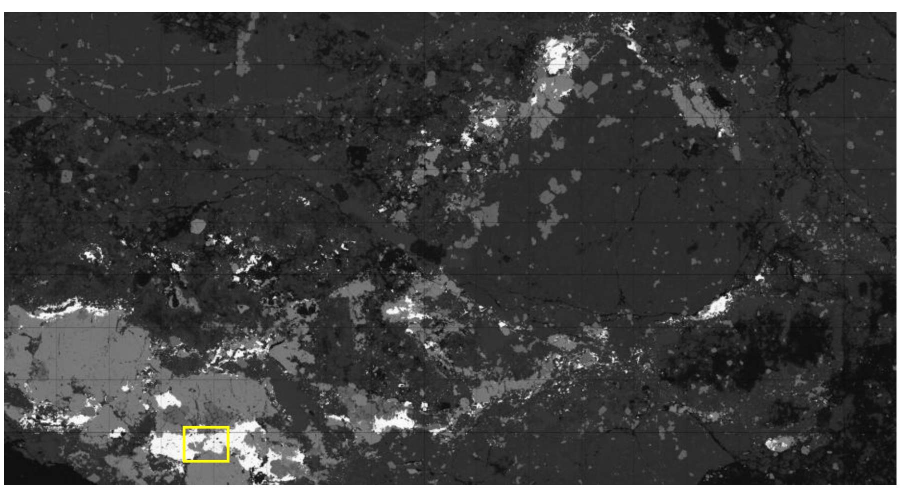
Sample 15/ C011648/ 727778



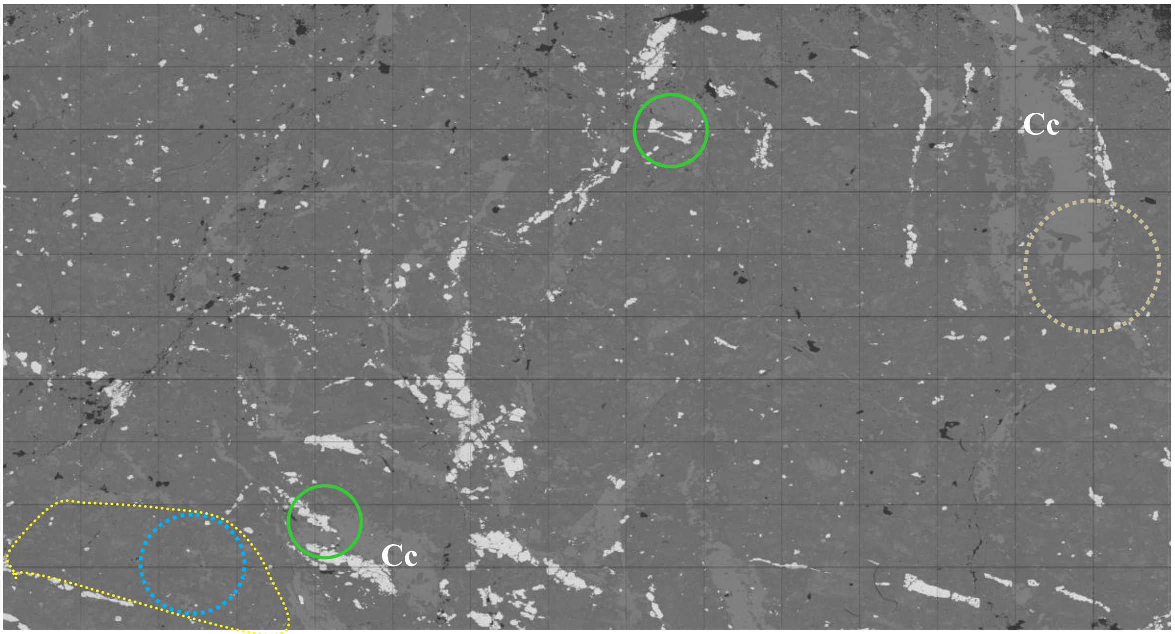
Patches and stringers of sphalerite associated with pyrite and galena. (WRA gives 0.82 % Zn, 0.37 % Pb) Galena is interstitial to fragmented pyrite and in cracks in sphalerite. Veinlets and patches of calcite are present. Rounded breccia clasts (blue stippled outlines) are evident which, like compartmental textures in DH-03 rocks, probably indicate a welded-tuff fabric. Much like sample C011637/Sample 7, the central fragment shows sulphide ingress and replacement in the upper apical region. The upper left region, although truncated, is rich in both illite and K-feldspar, probably representing secondary, K-feldspar veining. **Sulphide mineralogy by MLA is**: 13.9 % sphalerite; 7.5 % pyrite, 6.3 % galena and 0.5 % chalcopyrite.

Highly sericitized, and mineralized welded-tuff breccia or fragmental intrusive breccia.

Below: Same view as above, but at enhanced brightness/contrast to provide detail of galena, sphalerite and pyrite. The chaotic domain immediately north of the massive sulphide also shows lenticular 'augen', suggestive of shearing, while gangue in the sulphide is angular, supporting this interpretation. Yellow box denotes area of galena/pyrite detailed on page 38, Figure D.



Sample 16/ C011649/ 727779



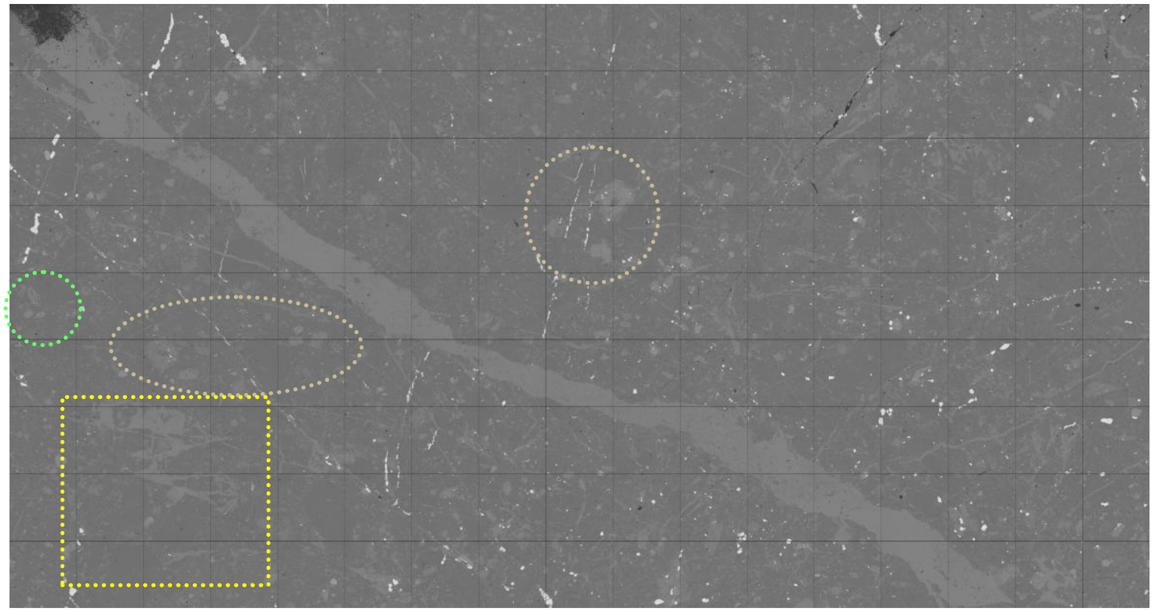
Pyrite as disseminated grains in a matrix of quartz and illite and as fractured pyrite clusters cross-cut by calcite veinlets. Veinlets are two-directional, one almost north-south, and the other almost orthogonal, indicating a stock work vein style.

The texture is very similar to sample 14/C011646 and breccia fragments are replaced by quartz. Again, quartz crystals are evident within the lenticular calcite vein to the upper right (tan circle). Replaced feldspar phenocrysts (blue stippled circle) within the lower left breccia fragment are vaguely discernable, although bordering the calcite veins, comb- and mosaic-quartz is common.

The fragmental, crystal-breccia texture witnessed in this fragment is overprinted by the carbonation and silicification alteration in general. The rock appears to be more fragmental in nature than in previous examples, but dilational infill by calcite and silicification is still remarkably similar. Formation of pyrite trails adjacent to calcite and wrap-around sulphide bordering carbonate and illite (see green circles) indicates early pyrite accompanying sulphidation and carbonation.

Highly sericitized and hydrothermally altered crystal breccia porphyry.

Sample 17/ C011651/ 727781



Minor pyrite as disseminated grains and associated with carbonate stringers in a matrix of albitized and sericitized, brecciated feldspar-phyric rock. A late calcite vein barren of sulfides is oriented NW-SE across the section.

Mineralogically, this sample resembles sample 4/C011634/727592 in DDHDC07-03 Core samples but has exceptionally low sulphide content, a more illitic alteration fabric and significantly less fracturing.

Chlorite-replaced mafic phenocrysts (probably amphibole or biotite), now almost completely altered to calcite are depicted in the tan-coloured circle. In the green circle, calcite-after-plagioclase phenocrysts are visible, with attached and included apatite crystals.

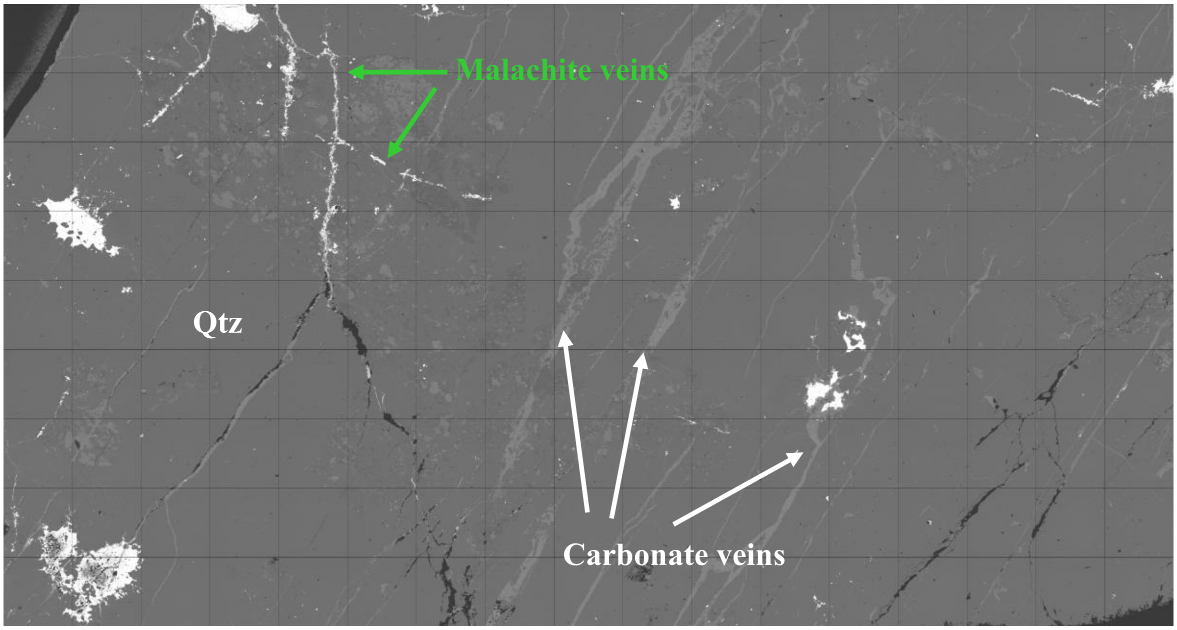
The yellow stippled outlined box shows a calcite-rich flooded domain in which angular breccia fragments have been silicified.

With highest Na_2O content in this drill core suite, and the finest grain size, the alteration style includes illitization and albitization, whereas albite is absent from other DH-04 rocks.

The rock texture is nonetheless not dissimilar from other DH-04 rocks, but fragmentation appears to be more angular (and akin to samples 14/C011646 and 16/C011649). It is similar to DH-03 rocks in terms of rock type and alteration mineralogy; the DH-04 brittle style fracture therefore overprints this rock but lithologically and mineralogically, it belongs to the albitization/illitization alteration style.

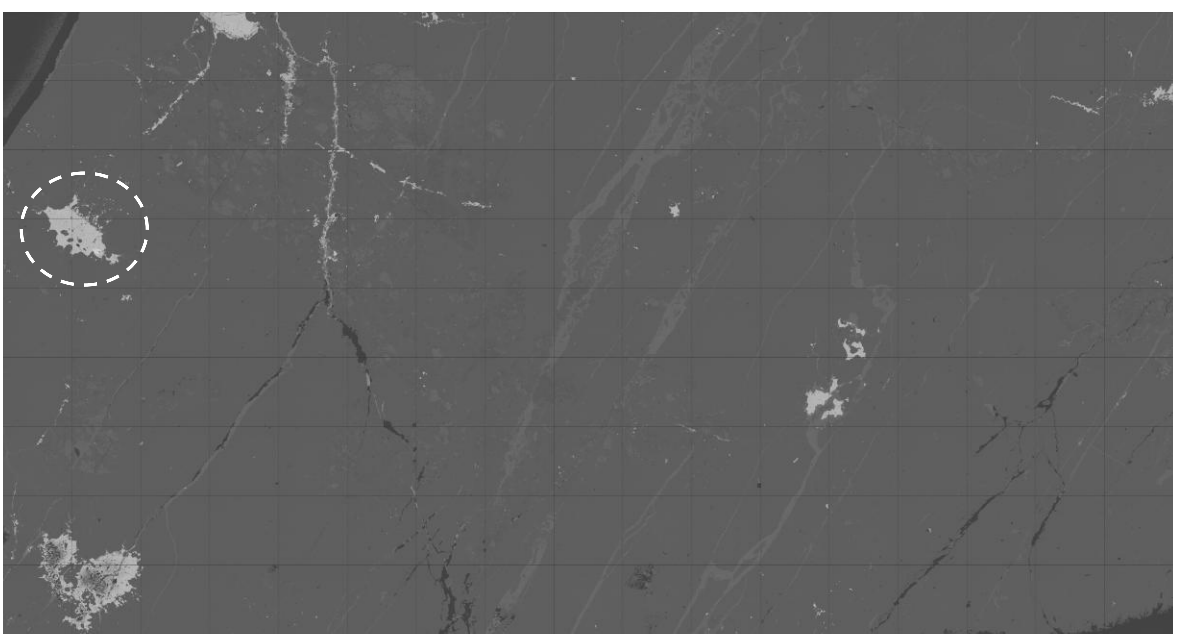
This rock is a **weakly mineralized, amphibole-feldspar-phyric, crystal breccia porphyry**.

Sample 18/ C011653 – N Delta Grid



Pyrite-barren, massive-quartz-rich lithology with anastomosing ankerite/dolomite veining and Cu-sulphide clots associated with carbonate. Bright veinlets are malachite-rich. Clots vary from bornite-rich to chalcocite rich, with variable proportions and minor Ag minerals (see pages 24 to 26 for details of sulphides). Malachite formation clearly postdates sulphide and carbonate mineralization/veining. Petrographic examination reveals that the quartz ranges from cherty bands to plumose, recrystallized bands, probably representing the difference between matrix quartz and stoped and brecciated quartz enveloped and cross-cut by carbonate.

Below: Same view as above, but with lower contrast to show chalcocite rimming bornite (circled). The rock is probably a **quartz vein with Cu-mineralization and carbonate veining**.

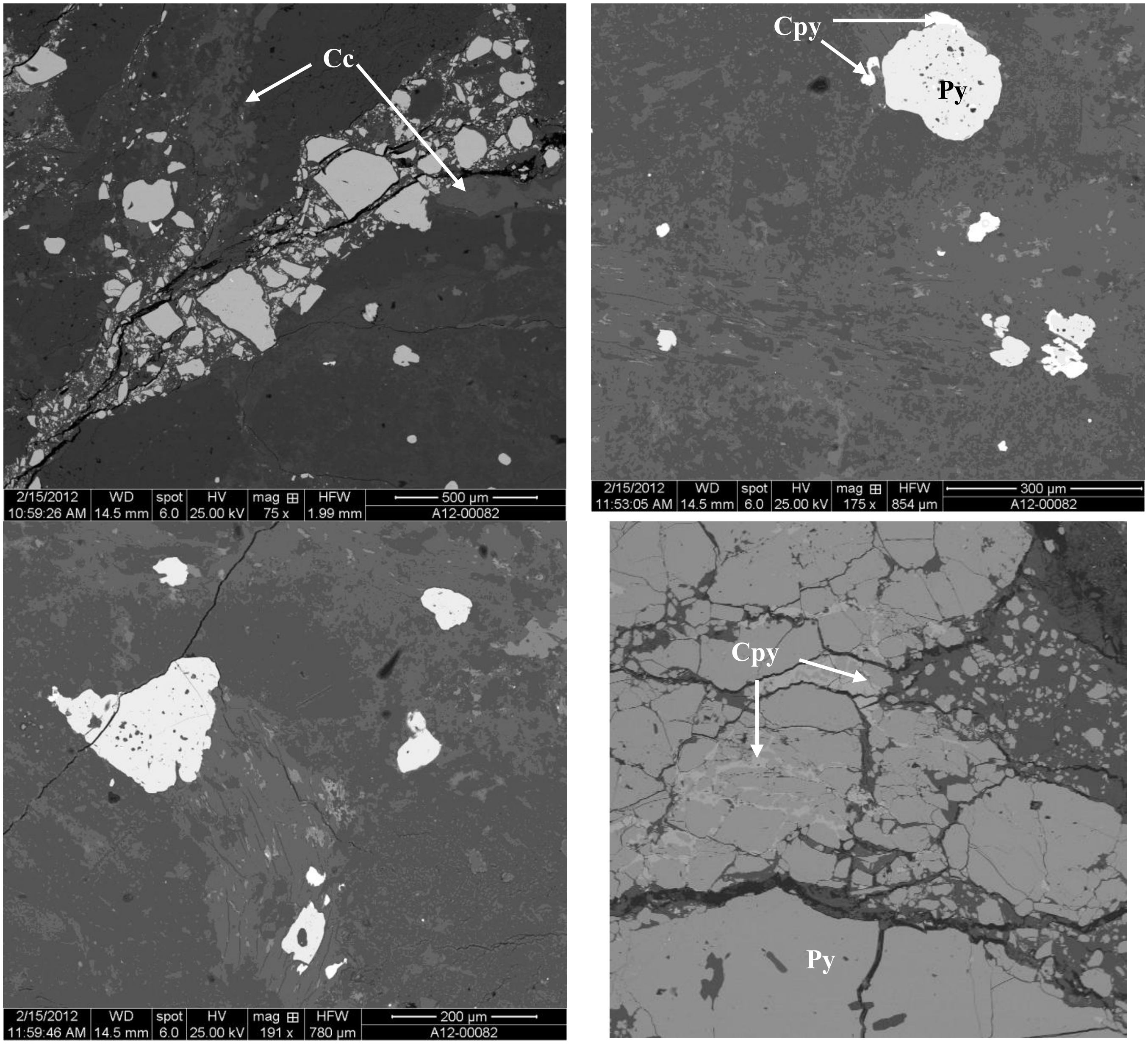


APPENDIX 5-B.

Detail of Sulphide Mineralogy for selected samples

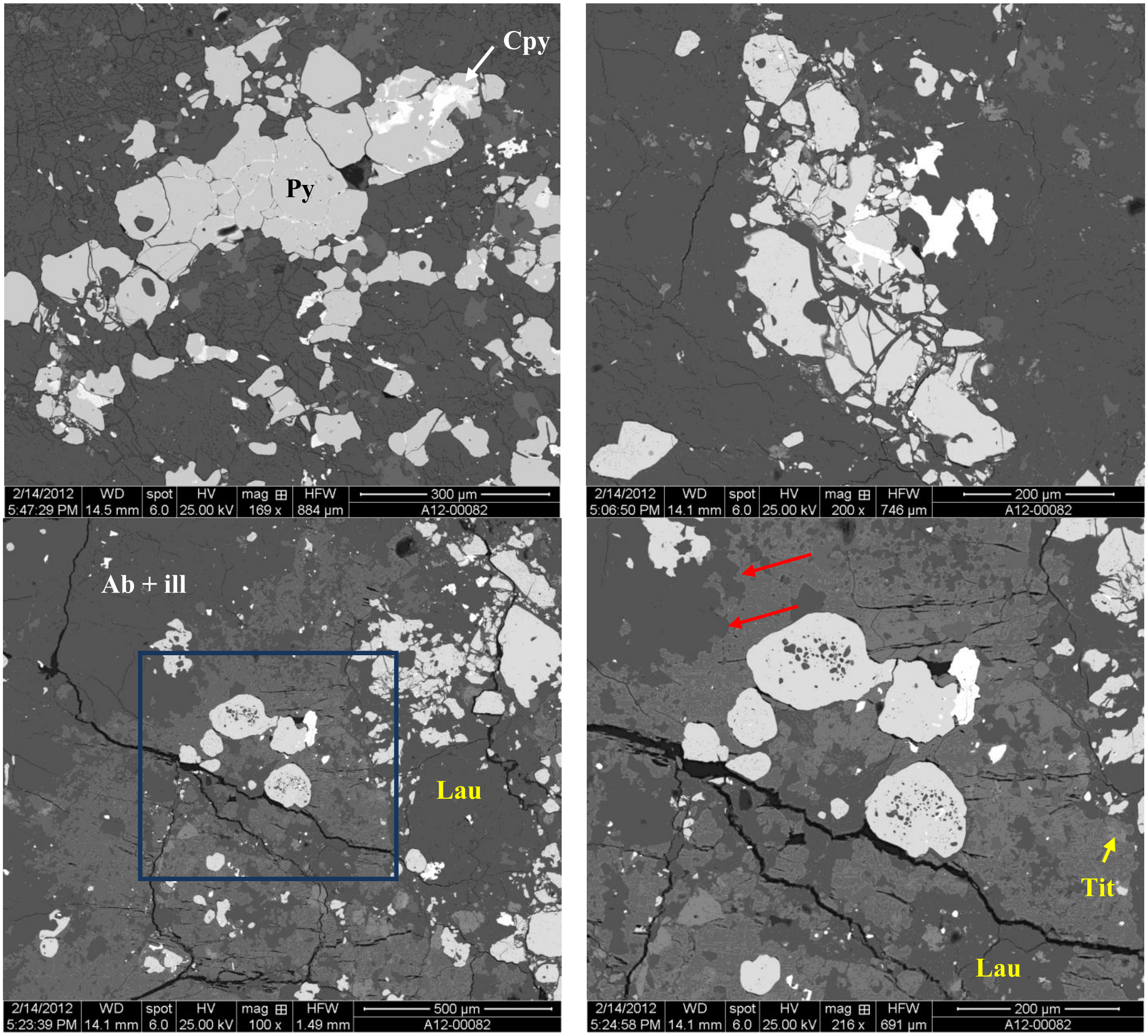
For all groups of photomicrographs, the sequence is as schematized below:

A	**B**
C	**D**



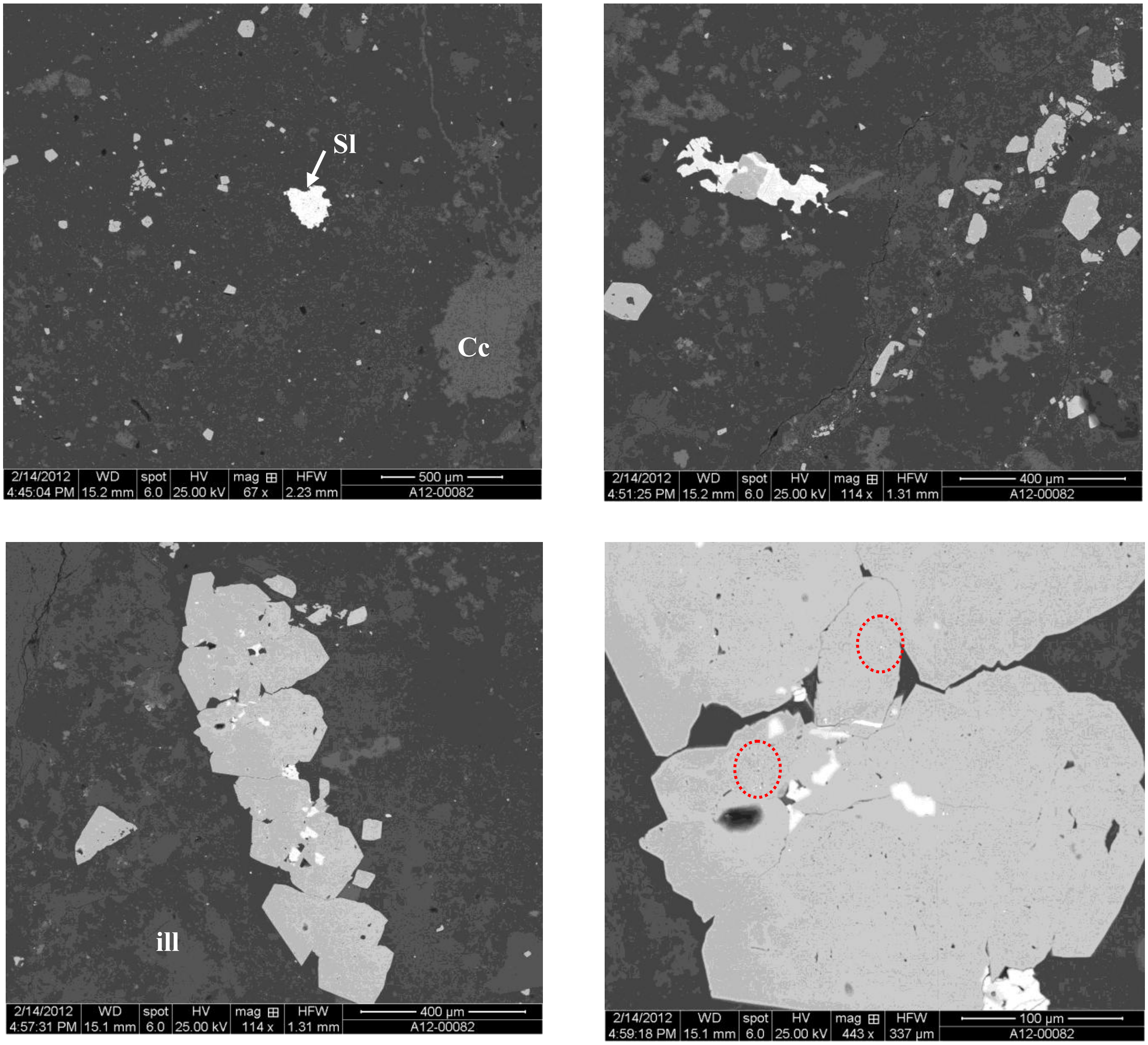
Sample 7 and 8

A, B and C. BSE images of sample C011637. A. Brecciated pyrite along a fracture in a matrix of quartz, feldspar, illite and calcite. Also note the silicification and quartz recrystallization bordering the calcite/pyrite vein. **B.** Pyrite associated with chalcopyrite in a matrix of altered biotite with disseminated titanite and feldspars. **C.** Pyrite and chalcopyrite in a matrix containing biotite with titanite, albite, quartz and laumontite. **D**. BSE image of sample **C011638, s**howing fractured pyrite associated with chalcopyrite. Illite fills micro-fractures and cements pyrite fragments.



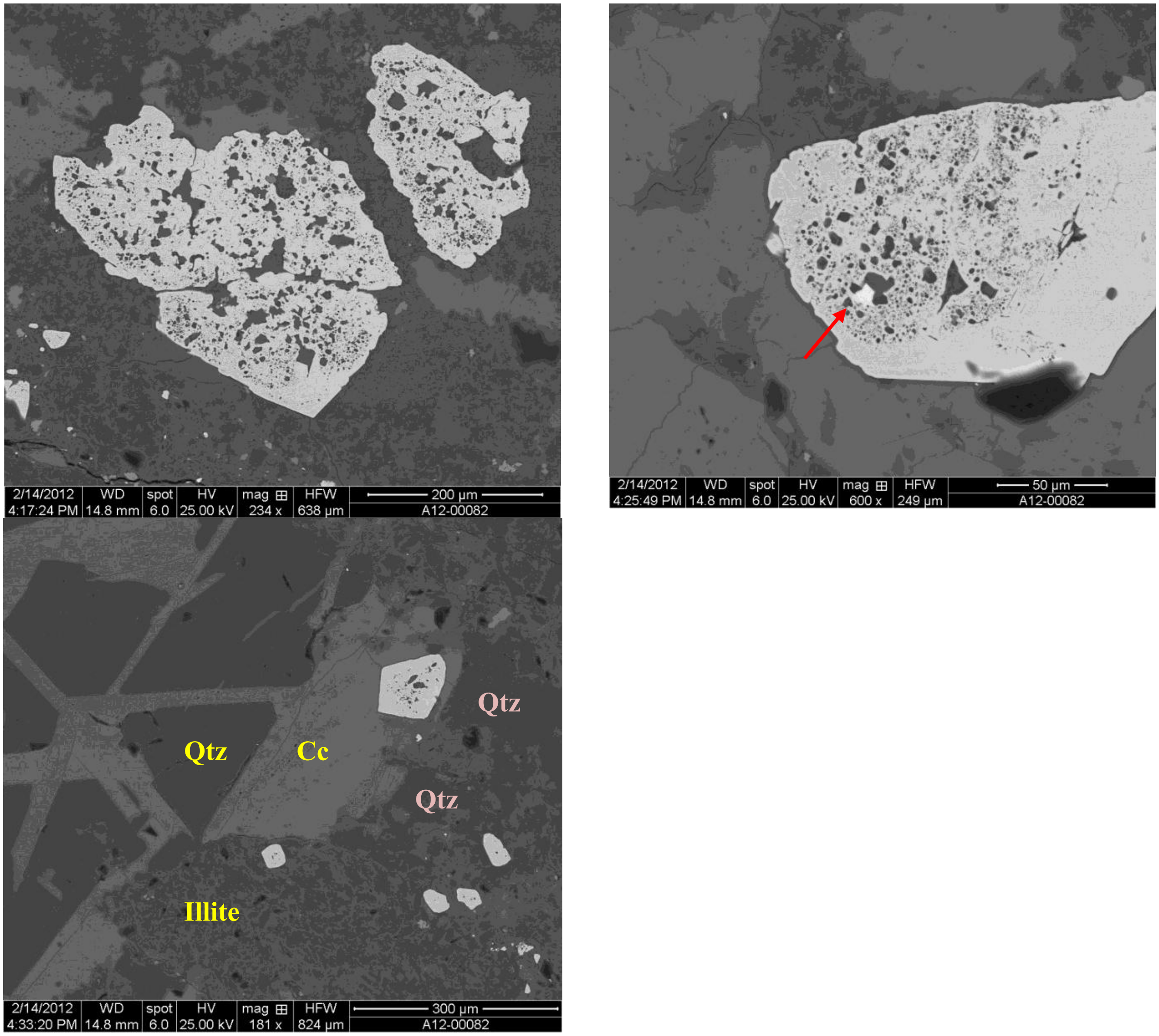
Sample 10 and Sample 12

BSE images of sample C011640. A. Subhedral and crackle-fractured pyrite associated with chalcopyrite and galena in a matrix of albite, laumontite and quartz. **B, C and D. BSE images of sample C011642. B.** Brecciated pyrite associated with chalcopyrite. C. Pyrite and chalcopyrite in a matrix of vein-epidote/laumontite, albite and illite. Micro-fractures through the matrix. **D.** Enlarged region in C, showing detail of epidote-hosted pyrite and irregular replacement of feldspar (red arrow) as well as minor Ti-minerals (e.g. titanite, abbreviated Tit). Albitization of the plagioclase accompanied epidote formation.



Sample 13

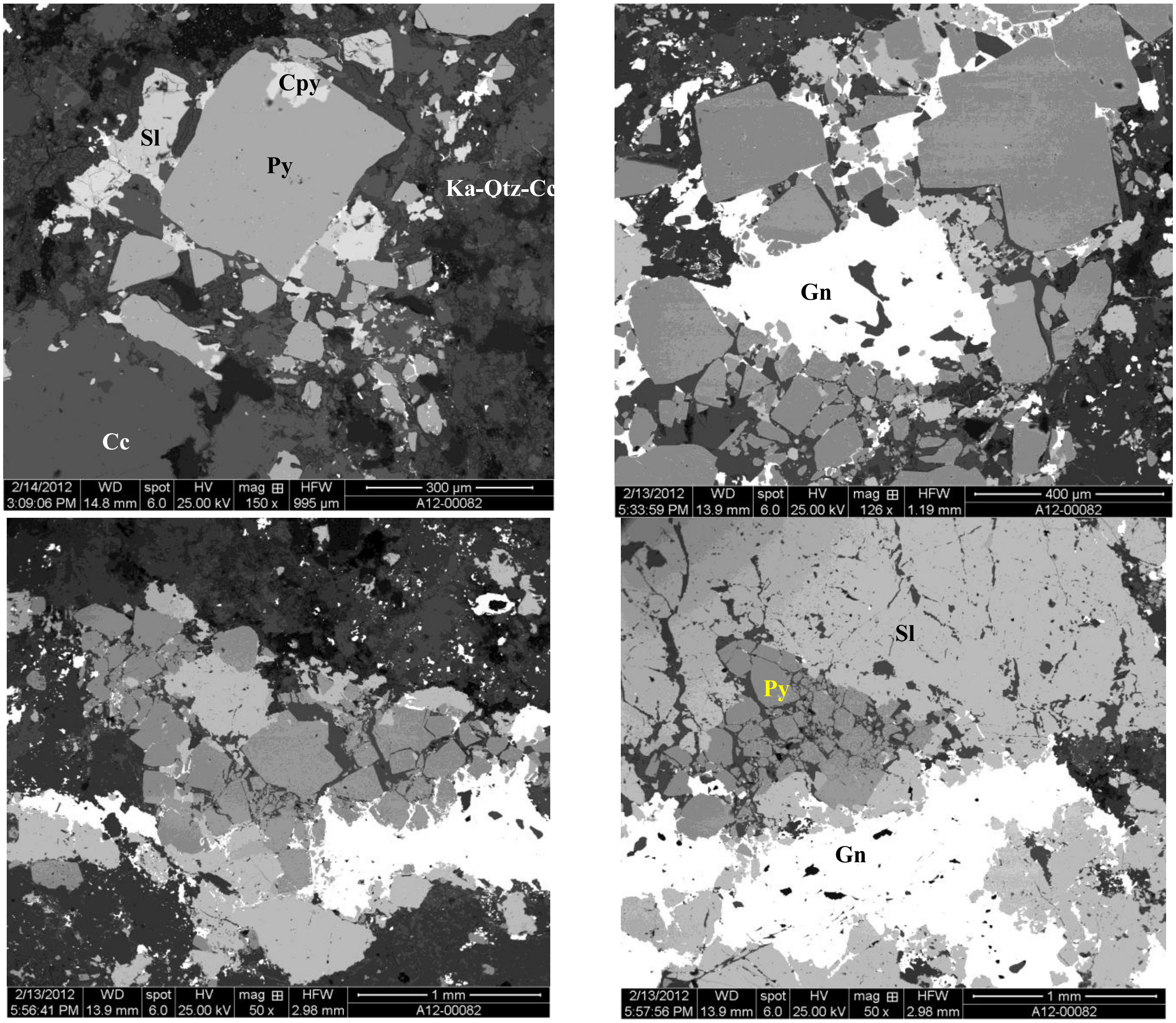
BSE images of sample C011644. **A.** Disseminated pyrite and sphalerite in a silicified rock matrix with illite and calcite. **B**. Sphalerite (white) associated with pyrite. Pyrite is as disseminated subhedral crystals and in a veinlet with rutile. **C.** Pyrite enclosing sphalerite. **D**. Detail of C showing sphalerite and very fine galena (red circles) in pyrite.



Sample 14

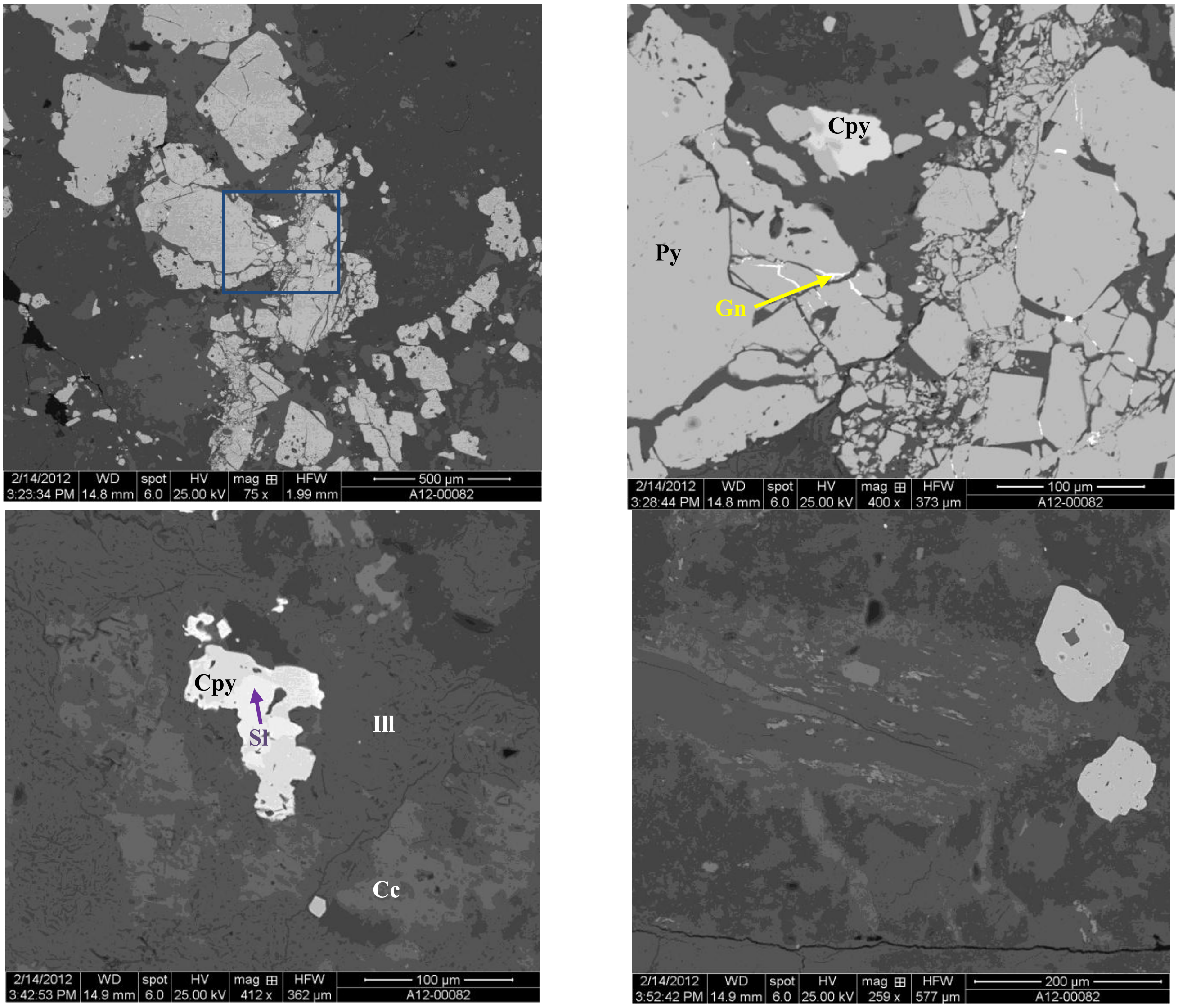
BSE images of sample C011646. A. Pyrite with abundant inclusions of illite and quartz in a matrix of illite, quartz and calcite. **B.** Pyrite with an inclusion rich core region, as well as a grain of chalcopyrite (red arrow). The core region represents a first generation pyrite (possibly marcasitic), which was later overgrown by more massive, euhedral pyrite. **C.** Subhedral pyrites: The coarsest pyrite is within calcite and shows strong central porosity, whereas pyrite within the argillic matrix is finer grained. Clear evidence of recrystallization of quartz in calcite is provided by the hexagonal quartz crystal morphology.

There is also evidence of re-crystallized quartz within the illitized rock (pink annotation).



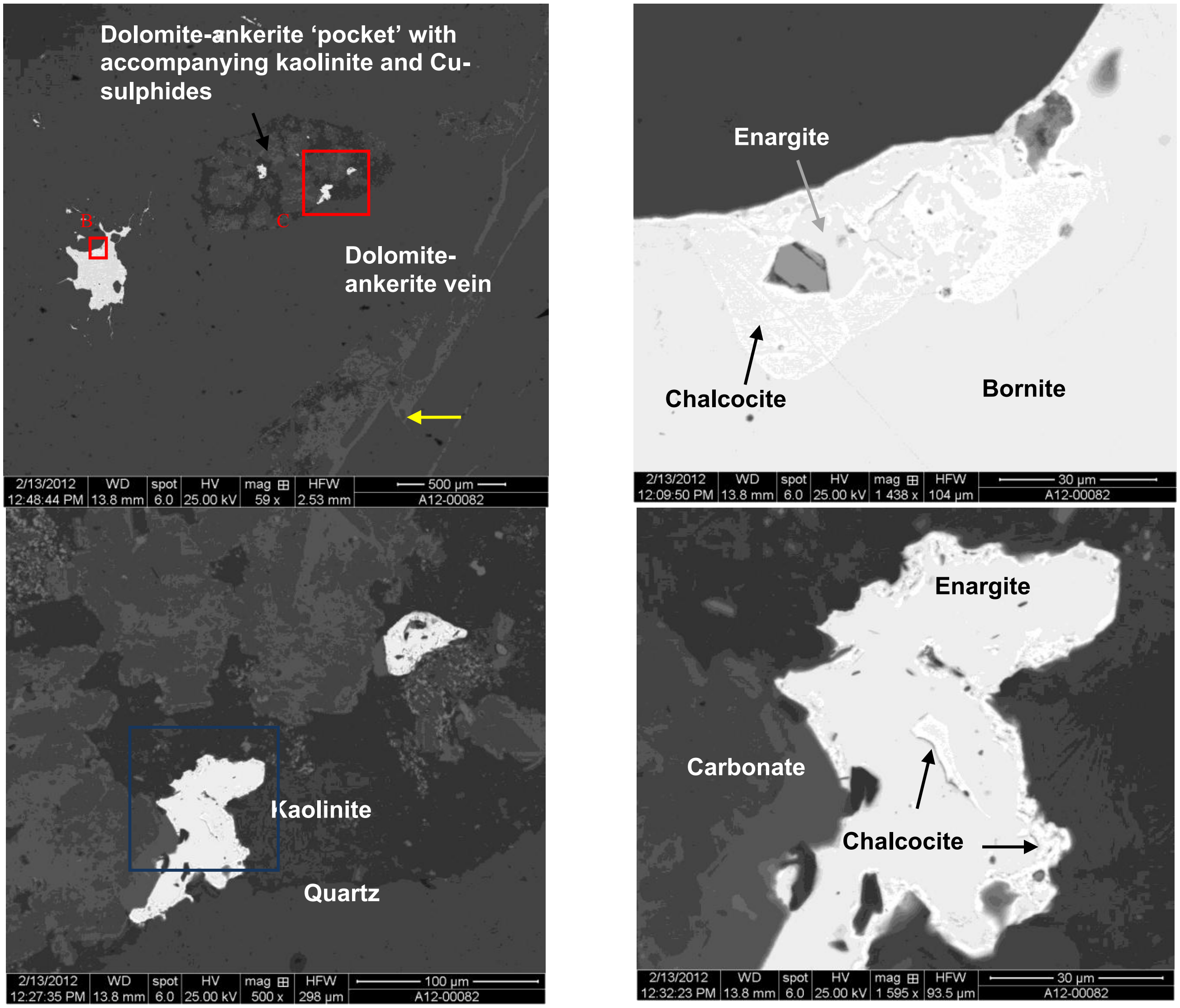
Sample 15

BSE images of sample C011648. A. Variably sized, sub-hedral pyrite associated with chalcopyrite, sphalerite and minor galena. The matrix is composed of calcite, quartz and kaolinite. **B** and **C**. Galena replacing matrix between fragmented pyrite and cracks in sphalerite. **D**. Fragmented pyrite enclosed in massive sphalerite and galena.



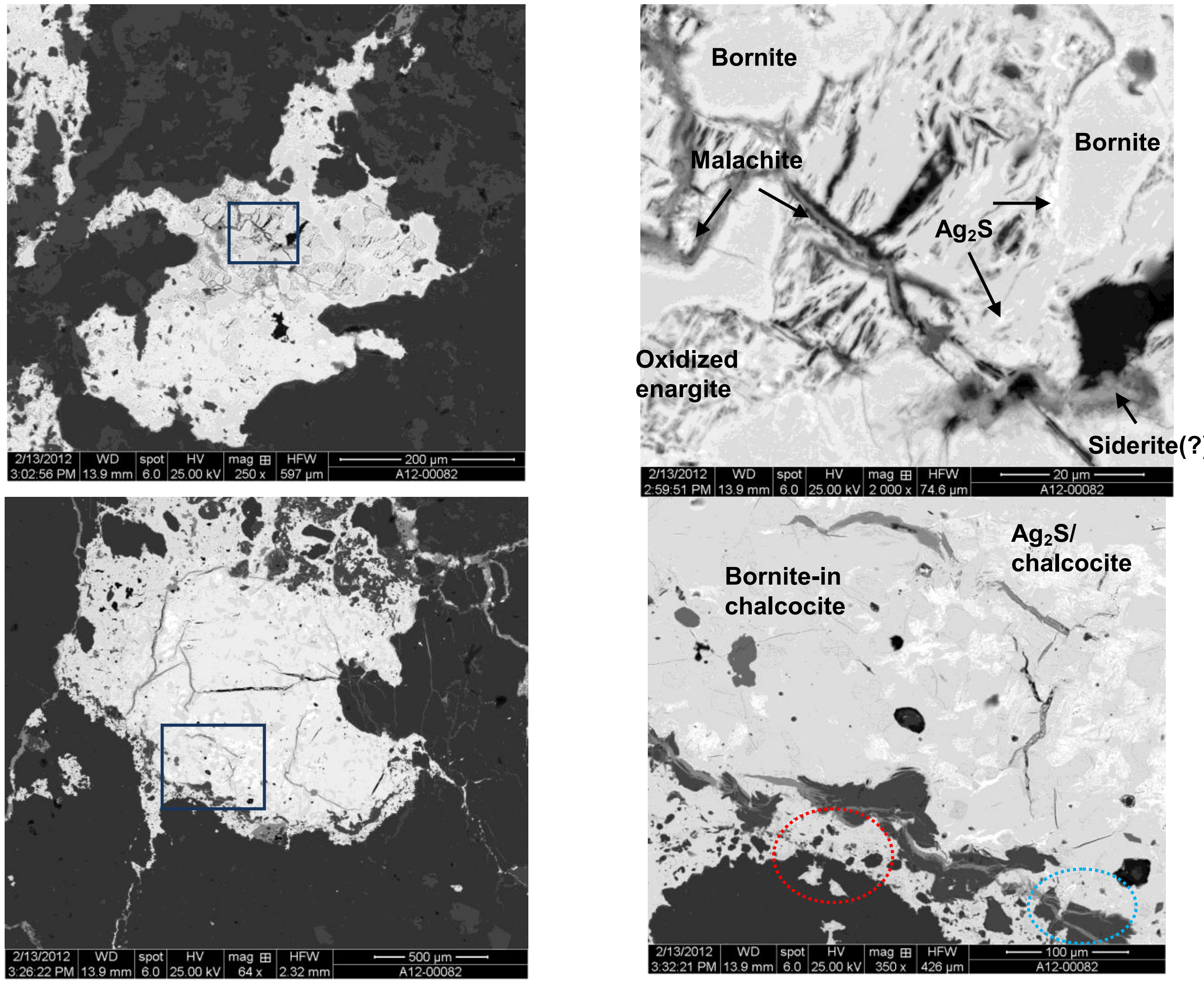
Sample 16

BSE images of sample C011649. A. Brecciated pyrite in a matrix of calcite, quartz and illite. **B.** Detail of A showing calcite cementing pyrite and chalcopyrite fragments and galena replacing calcite in veinlets in pyrite. **C**. Chalcopyrite associated with sphalerite (inclusions and rims of sphalerite) in a matrix of illite (ill) and calcite (Cc). **D.** Subhedral pyrite adjacent to chlorite replaced by calcite and illite. The chlorite also contains disseminated titanite and rutile. The mafic precursor phenocryst was probably a biotite or amphibole.



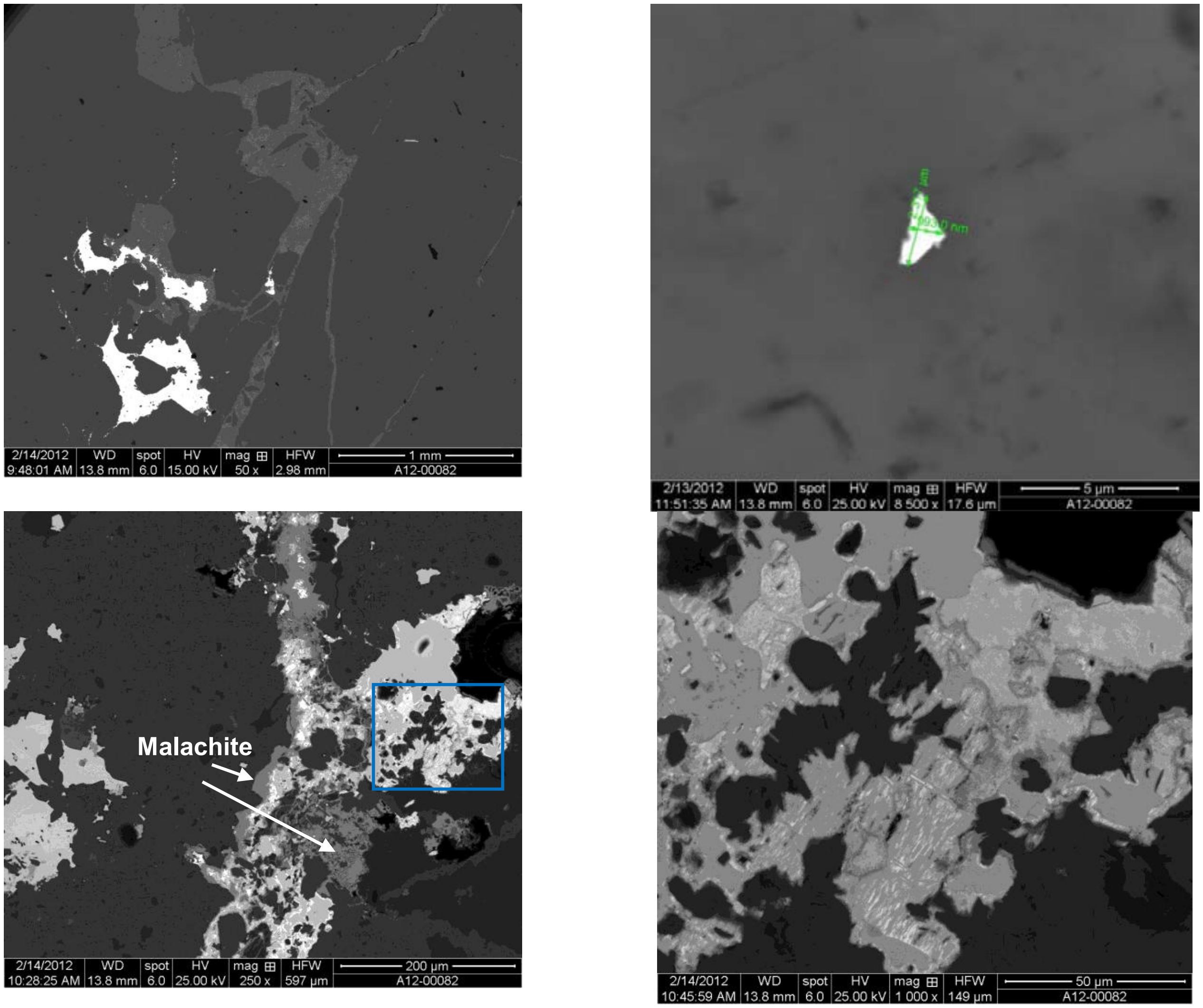
Sample 18

BSE images of sample C011653. A. A general view of the sample showing Cu sulphides (bright) in quartz groundmass and in a patch of kaolinite replaced by ankerite and dolomite. Sulphide mineralization clearly accompanies carbonate veining. Veinlets of ankerite and dolomite cross cutting the quartz groundmass, with clear brecciation of the quartz (yellow arrow). **B.** Detail of box in A showing chalcocite replacing enargite at the edge of bornite. **C.** Enargite and chalcocite in the kaolinite-ankerite-dolomite patch in figure A. **D.** Detail of C, showing chalcocite replacing enargite peripherally and as infill (elongate body in centre).



Sample 18

BSE images of sample C011653. A. Cu sulphide body composed of bornite and enargite, with clear infill texture to quartz demonstrated by irregular and embayed margins and rafted bodies of quartz within the sulphide. **B.** Detail of outlined area in A showing enargite-bornite intergrowths and enargite replaced by chalcocite. Cross-cutting malachite and possible siderite veins are also evident. Acanthite, the very bright phase, occurs both intergrown with chalcocite and enargite, as well as rimming bornite. **C.** Another chalcocite/bornite sulhide bleb with peripheral and vein-malachite. **D.** Detail of area in C, showing illite/malachite (encircled with blue stippled line) at the grain boundary of the sulphide, giving way to an intensely replaced sulphide border with finely rafted quartz adjacent to peripheral quartz in the lower left of the field of view (encircled with red stippled line). The sulphide bleb clearly shows vein malachite, bleb-like bornite in chalcocite, as well as intergrowths of interstitial acanthite/chalcocite (brightest BSE phase).



Sample 18

BSE images of sample C011653. **A.** Clear evidence of sulphide accompanying carbonate veining and brecciation of quartz. **B.** Platinum grain measuring 2.3 by 0.9 microns within ankerite. **C.** Coarse-grained malachite adjacent to sulphide veining, with the sulphide dominated by bornite. **D.** Detail of area outlined in C, at enhanced brightness/contrast to illustrate the relationships between bornite, chalcocite and Ag-Cu-phase intergrowth (brightest material). This intergrowth is distinctly myrmekitic in places, suggesting possible decomposition from a former Cu-Ag-S precursor phase.

APPENDIX 6.

Petrographic Report by GeoConsult.

PETROGRAPHIC STUDY OF DRILL CORES FROM THE STEWART PROJECT IN NORTHWESTERN BRITISH COLUMBIA

Prepared For:
ACTIVATION LABORATORIES LTD.

March 25, 2012

Prepared by:
Eva S. Schandl Ph.D.

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GeoConsult

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Table of Contents

INRODUCTION AND OBJECTIVES

The present petrographic study is based on a suite of eighteen samples from the Stewart Porphyry-VMS Project in Northwestern British Columbia.

The objectives of the study were;

1. To identify the rock types
2. To describe the primary and secondary minerals and the texture in individual samples, with special emphasis on alteration types,
3. To determine the presence of the following minerals: actinolite, epidote, illite, albite, garnet, magnetite, quartz-carbonate veins, K-feldspars and base metals, and
4. To determine which part of the porphyry system is represented by the suite of rocks.

Analytical Techniques

The suite of polished and covered thin sections were examined under a Nikon petrographic microscope, using reflected and transmitted lights in order to identify the silicates, carbonates, sulfides and oxides. The composition of plagioclase was visually estimated where possible, using the Michele-Levy method, which is based on the extinction angles of the twin lamellae.

Two to four photomicrographs were obtained from each thin section, using a Leica cooled digital camera attached to the microscope.

DISCUSSION AND CONCLUSIONS

The mineralogy and texture of individual samples are described in detail in the Petrography section, the rock types are summarized in Table 1. and the visually estimated percent minerals in individual samples in Table 2.

Rock Types

Based on mineralogy and texture (on the scale of the thin sections), the following lithologies were identified: 1. feldspar porphyry 2. felsic intrusive, 3. tuff / fragmental, 4. porphyritic diorite (?) and 5 quartz-carbonate vein+chalcedony. Because the thin sections represent only a few cm of the rock, they may not be true representation of the lithological units. For example, the “feldspar porphyries” could also be tuffs, derived partly from coarse-grained porphyritic rocks during explosive volcanism. There is textural evidence of extensive brecciation in the rocks.

Table 1 is a summary of rock types.

Table 1. Summary of rock types

Sample #	Rock Type
DRILL HOLE 03	
CO11630	Feldspar Porphyry
CO11632	Feldspar Porphyry
CO11633	Feldspar Porphyry
CO11634	Feldspar Porphyry
CO11635	Felsic Intrusive
CO11636	Feldspar Porphyry
CO11637	Feldspar Porphyry
CO11638	Feldspar Porphyry
CO11639	Felsic Intrusive
CO11640	?
CO11641	Fragmental?
CO11642	Feldspar Porphyry
DRILL HOLE 04	
Sample #	Rock Type
CO11644	?
CO11646	?
CO11648	?
CO11649	Tuff
CO11651	Porphyritic Diorite?
CO11653	Mineralized Quartz Vein and Chalcedony / Chert

Alteration Types

As shown in Table 2, the major alteration types in the rocks are: sericite or illite (microprobe analysis is needed for positive distinction between the two), quartz carbonate and pyrite. The suite of rocks appear to represent the **quartz + sericite + carbonate + pyrite** zone of the porphyry system.

However, as there are significant differences in mineralogy between host rocks in drill holes 03 & 04 (Table 2), there is also a notable difference in their alteration mineralogy.

Tentative separation of the two yields the following alteration assemblages:

Hole 03: sericite + carbonate + pyrite

Hole 04: quartz + sericite + carbonate + biotite +/- chlorite, sphalerite, galena

I found no evidence for replacement by albite or K-feldspar in the rocks. The relatively high Na_2O concentration in the rocks is the function of the high sodium content of feldspars in the porphyries (oligoclase).

Actinolite, secondary albite, epidote, garnet, and magnetite are virtually absent.

Base Metals

Chalcopyrite, sphalerite, galena and chalcocite are base metal sulfides identified in selective samples. Sample CO11648 is particularly rich in metals The host rock to these sulfides consists of quartz, carbonate, sericite / illite

The following relationships were observed between the sulfides:

galena is intergrown with and included in sphalerite
sphalerite is rimmed by, or intergrown with, chalcopyrite
accessory chalcopyrite accompanies pyrite

Table 2. Visually estimated % minerals in samples from the Stewart Project

Sample number **Rock type**	**CO11630** **feldspar porphyry**	**CO11632** **feldspar porphyry**	**CO11633** **feldspar porphyry**	**CO11634** **feldspar porphyry**	**CO11635** **felsic intrusive**	**CO11636** **feldspar porphyry**	**CO11637** **feldspar porphyry**
Plagioclase	55	50	60	40	40	58	38
K-feldspar		15	18	6	20	18	12
Quartz	12	8	5	10	x	x	8
Muscovite/sericite/illite	18	7	5	10	12	10	7
Biotite							
Chlorite	x		x		x	x	
Epidote				x			
Carbonate	5	8	x	15	8	2	5
Apatite	x	x	x	x	x	x	x
Zircon		x					x
Rutile					x	x	x
Titanite					x	x	
Pyrite	10	12	12	6	20	12	10
Chalcopyrite		x		x			x
Chalcocite							
Galena							
Sphalerite							
Irresolvable matrix				13.			.
x - trace amount							

Table 2. Visually estimated % minerals in samples from the Stewart Project

Sample number Rock type	CO11638 feldspar .porphyry	CO11639 felsic intrusive	CO11640 ?	CO11641 fragmental?	CO11642 feldspar porphyry	CO11644 ?	CO11646 ?
Plagioclase	37	46	30	46	43	35	
K-feldspar	5?	12	15	6	25	28	
Quartz	8	7	28	12	7		28
Muscovite/sericite/illite	23	25	15	18	18	5	25
Biotite				3		20	5
Chlorite		x		x	x	x	
Epidote	x						
Carbonate	3	5	7	8	6		35
Apatite	x	x	x	x	x	x	
Zircon			x				
Rutile					x	x	
Titanite							
Pyrite	24	5	5	7	1	12	7
Chalcopyrite	x	x	x				
Chalcocite	x						
Galena							
Sphalerite					x	x	

Table 2. Continued

Sample number Rock type	CO11648 ?	CO11649 Tuff?	CO11651 porphyritic diorite?
Plagioclase			33
K-feldspar			12
Quartz		20	10
Muscovite/ sericite/illite		40	7
Biotite		x	8
Chlorite		8	7
Epidote			
Carbonate		20	20
Apatite		x	x
Zircon			
Rutile		x	x
Titanite			
Pyrite	7	12	3
Chalcopyrite	x		
Chalcocite	x		
Galena	0.5-1		
Sphalerite	3-4		

PETROGRAPHY

(with photomicrographs)

Ppl = Plane polarized light
XN = crossed nicols
Refl. light = Reflected light

Sample Number: CO11630 **Rock Type: Feldspar porphyry**

Petrographic Description:

A relatively coarse-grained rock that consists of broken fragments of feldspars, both plagioclase and K-feldspar, euhedral plagioclase phenocrysts and fragments of feldspar porphyry. Most twin lamellae were destroyed during alteration; therefore, visual estimation of their composition is not possible. Relict granophyre is interstitial to some feldspars. It appears that the rock was derived from a feldspar porphyry possibly by explosive volcanism / magmatism.

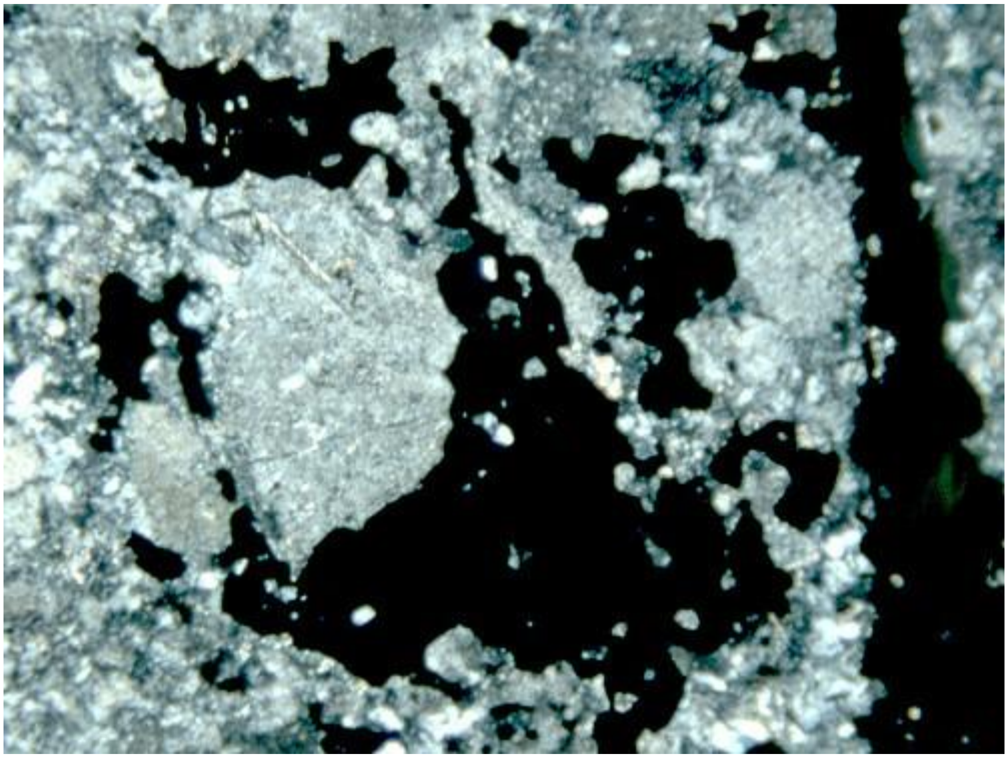
The rock is mottled, partly sericitized, weakly carbonatized and silicified. Sericite (or illite) occurs as replacement after the feldspars but also as small stringers that cross-cut the rock fabric.

Pyrite is the dominant sulfide. It occurs as small, brecciated veins that locally form a network, as single grains and as anhedral poikiloblasts that over-grow some of the feldspar phenocrysts and broken clasts.

Detailed mineralogy

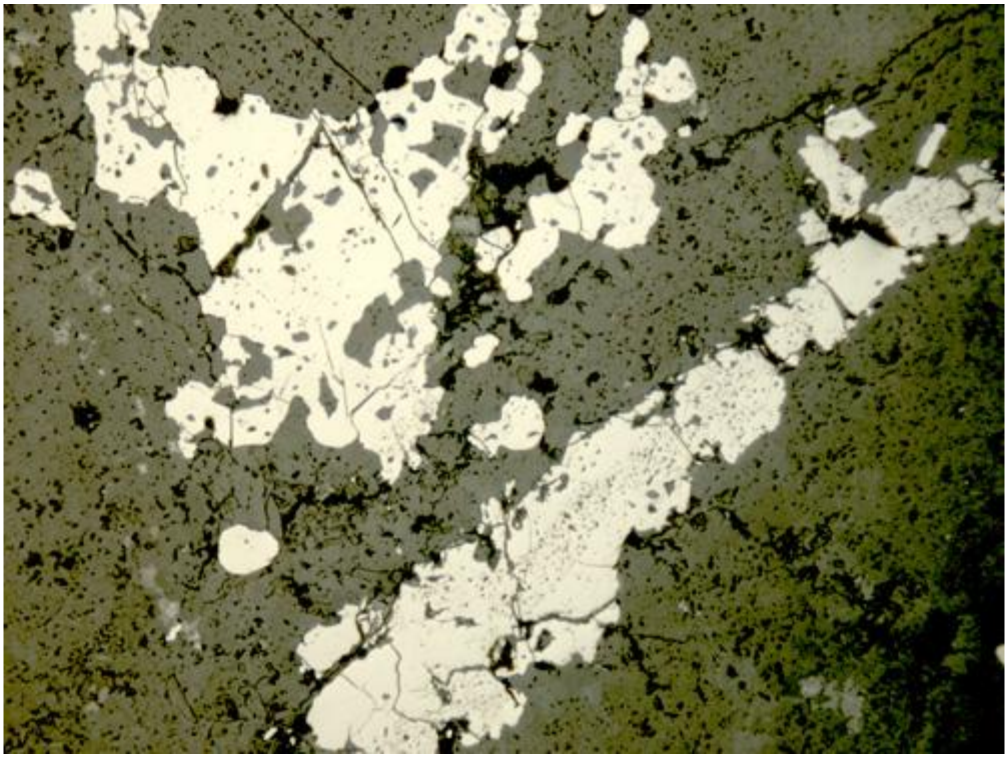
Mineral	%	Grain size(mm)	Comments
Plagioclase	55	minute-2.8	Weakly twinned plagioclase clasts and euhedral phenocrysts make up a significant part of the rock. The euhedral grains mostly occur in fragments of feldspar porphyry.
Sericite/illite	18		Microcrystalline micas partly replaced some of the plagioclase, they form a rim on the broken phenocrysts and occur as minute, discontinuous veinlets that form a network.
Quartz	12	.0<0.5-1.5	The matrix of the feldspar porphyry fragments consists predominantly of microcrystalline quartz. Broken fragments of quartz and fragments of relict granophyres.
Carbonate	5	variable up to	Anhedral carbonate is a replacement after the feldspars. Most form aggregates within the feldspar clasts and phenocrysts and some occur in aggregates within the chaotic matrix.
Pyrite	10	minute-1.0	Pyrite veins form an intricate network within sericitized rock.

Accessory minerals: apatite, chlorite



Pyrite (black) rims plagioclase. X-axis of photo: 1.6mm. Ppl.

Feldspar porphyry. X-axis of photo: 1.6mm. Ppl.



Pyrite vein and poikiloblast. X-axis of photo: 1.6mm. Refl. Light.

Sample Number: CO11632 **Rock Type: Feldspar porphyry**

Petrographic Description:

The mineralogy and texture of the rock is comparable to the previous sample. Coarse to fine-grained plagioclase and orthoclase occur in rock flour-like matrix. The plagioclase phenocrysts and clasts are euhedral to anhedral, whereas the K-feldspars are anhedral, broken fragments with Carlsbad twinning. The plagioclase composition ranges between albite and oligoclase. The grain size of euhedral plagioclase varies between 0.5 and 2.8mm. Most are mottled and weakly sericitized and/or partly replaced by carbonate. Carbonate occurs as disseminated aggregates within the matrix and the individual grains.

The major sulfide in the thin section is pyrite. It occurs as veins that cross-cut some of the feldspars and as large poikiloblasts that over-grow the existing texture. A few grains of fine-grained chalcopyrite occur as single grains or aggregates interstitial to the rock matrix.

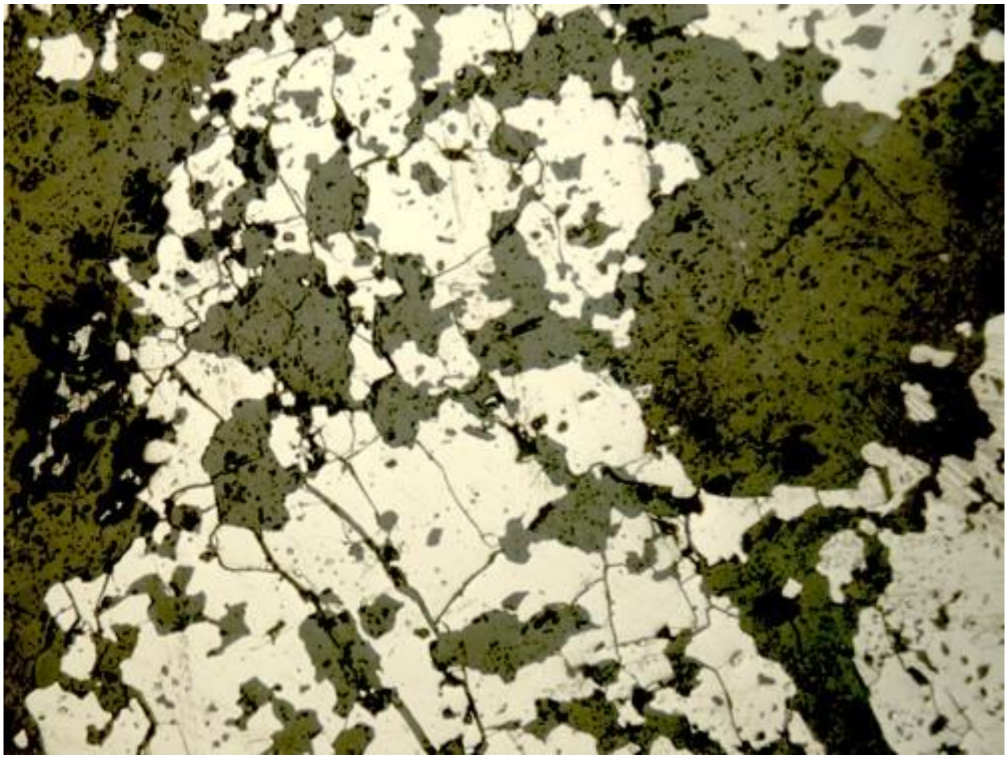
Detailed mineralogy

Mineral	**%**	**Grain size(mm)**	**Comments**
Plagioclase	50	0.1-3.0	Anhedral to euhedral plagioclase occurs as large clasts and as part of the rock-flour-like matrix. Their composition is albite-oligoclase. Most of the large grains are mottled, variably sericitized and partly replaced by sericite and carbonate.
K-feldspar	15	variable up to 4.0	K-feldspars are anhedral fragments of variable grain size. The broken angular grains are mottled and weakly sericitized . The mineral is also part of the rock flour-like matrix.
Quartz	8	variable up to 0.5	Anhedral, fine-grained quartz is part of the matrix. Some are angular clasts and some form interlocking aggregates as if part of the original matrix of a feldspar porphyry.
Sericite / illite	7		Sericite partly replace some of the feldspars and form narrow stringers that cross-cut the feldspars.
Carbonate	8	<0.05-0.6	Aggregates of fine-grained carbonate replace the feldspars. They also occur within the matrix, some of which are intergrown with pyrite.
Pyrite	12	variable up to 2.0	Pyrite is relatively abundant in the rock. It

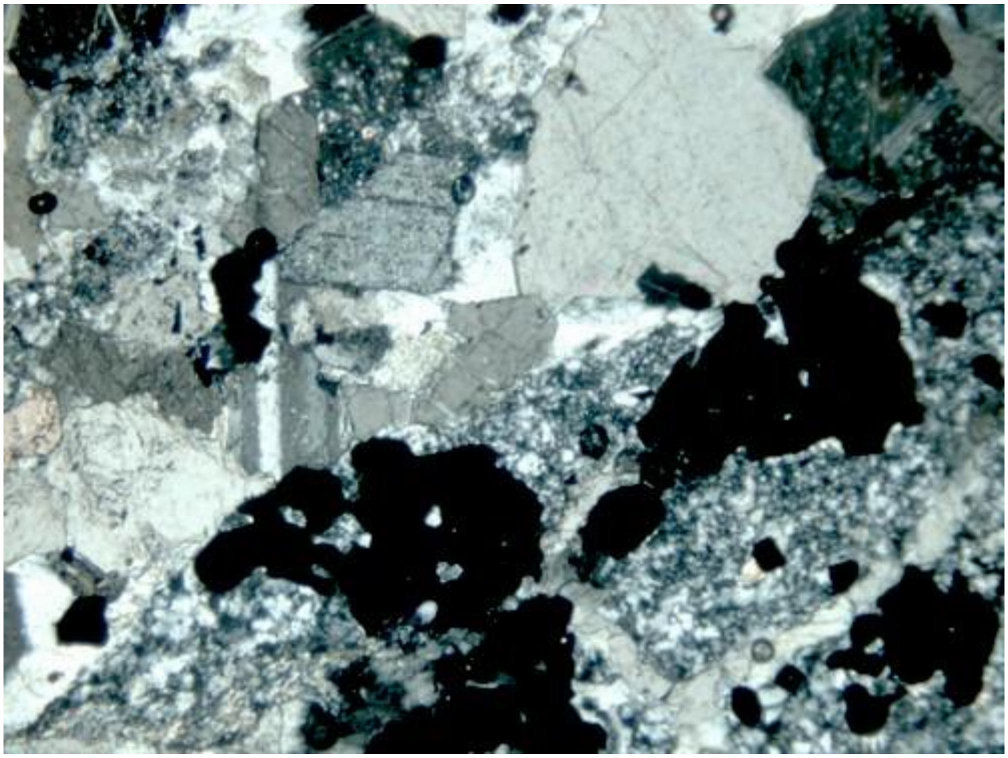
occurs as late veins, as single grains and as poikiloblasts that over-grow the feldspars. Most represent late sulfidation.

Accessory minerals: chalcopyrite, apatite, zircon

Broken (brecciated) plagioclase phenocryst. X-axis of photo: 1.6mm. XN.



Brecciated pyrite. X-axis of photo: 1.6mm. Refl. Light.



Pyrite (black) in carbonate. X-axis of photo: 1.6mm. XN.

Sample Number: CO11633 **Rock Type: Feldspar porphyry**

Petrographic Description:

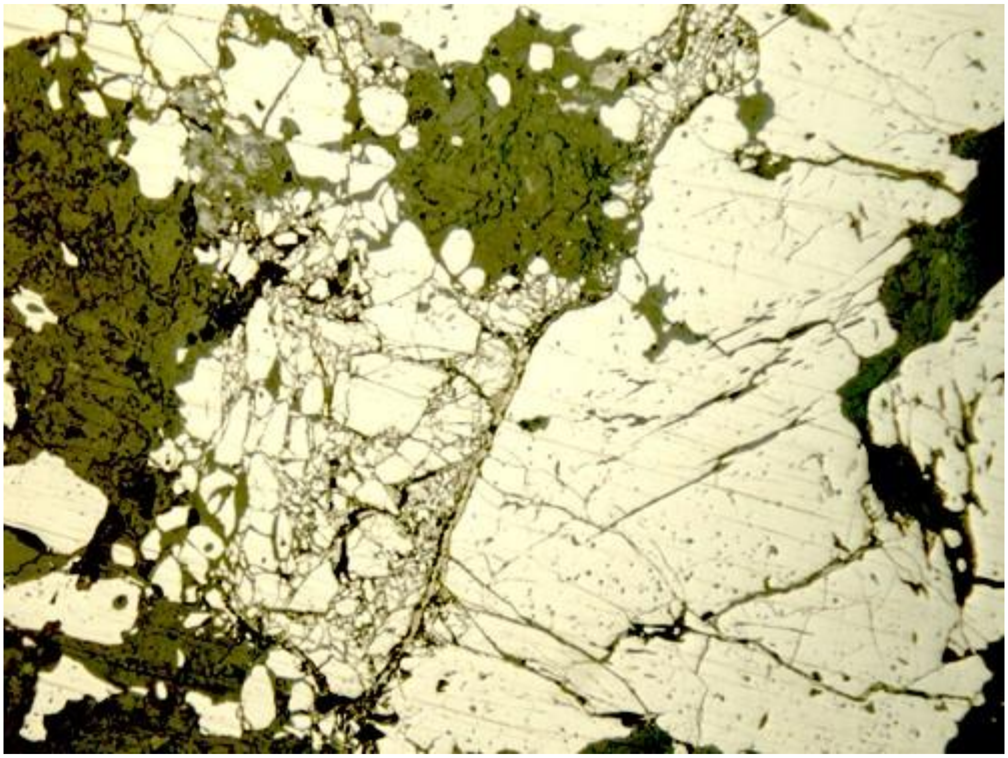
The mineralogy and texture of the rock is almost identical to the two previous samples. The only difference is that the present sample contains somewhat less euhedral phenocrysts of plagioclase. As the previous samples, plagioclase is the dominant mineral, with lesser K-feldspar. The proportion of matrix to clasts is slightly higher and contains a few relict fragments of muscovite phenocrysts. Replacement minerals are also comparable; muscovite / sericite and carbonate is relatively rare.

Pyrite is the dominant sulfide. It occurs as late, cross-cutting veins, as anhedral poikiloblasts and as small, single grains interstitial to the matrix.

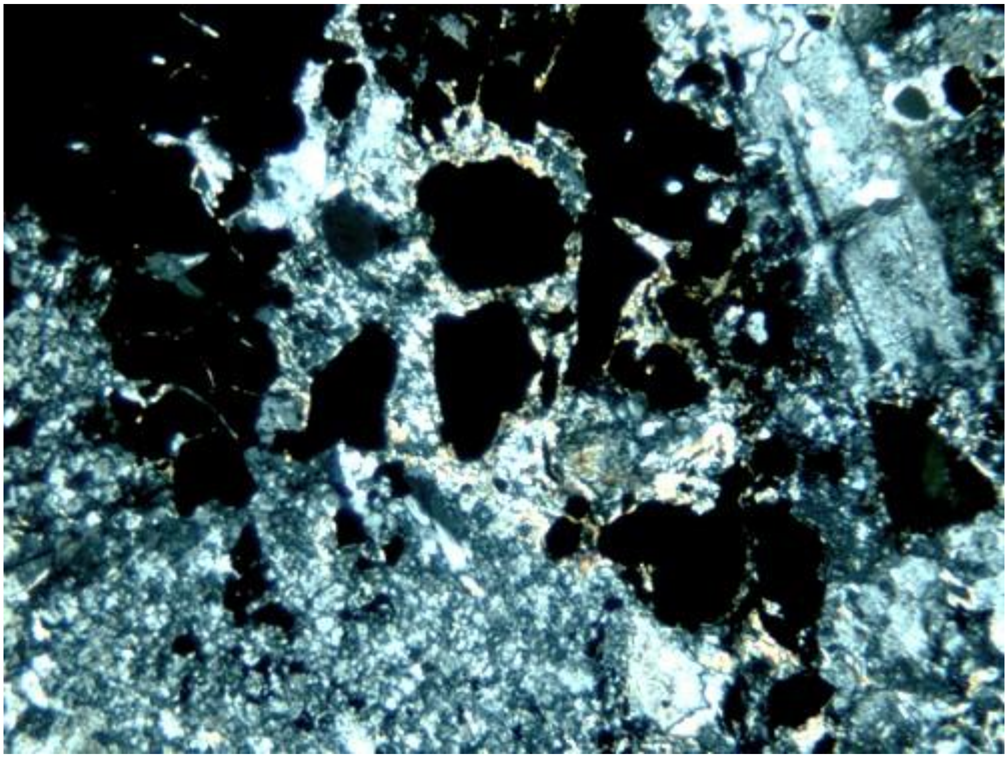
Detailed mineralogy

Mineral	%	Grain size(mm)	Comments
Plagioclase	60	<0.5-5.0	Anhedral to euhedral plagioclase makes up a significant part of the rock. Large phenocrystic grains are set in a chaotic matrix of granulated feldspar and quartz,
K-feldspar	18	0.2-2.5	Anhedral, broken grains of coarse-grained orthoclase are weakly sericitized and are also part of the fine-grained matrix. The mottled, anhedral grains are up to 2.5mm.
Quartz	5	av. 0.3	Fine-grained quartz is part of the granulated, inequigranular matrix.
Muscovite /sericite	5	up to 1.5	Relict muscovite phenocrysts are interstitial to the plagioclase. The corroded grains are partly recrystallized to fine-grained aggregates.
Pyrite	12	variable up to 2.0	Pyrite veins and poikiloblasts represent late-stage sulfidation, Most veins cross-cut the feldspars, but some are rimmed by sericite.

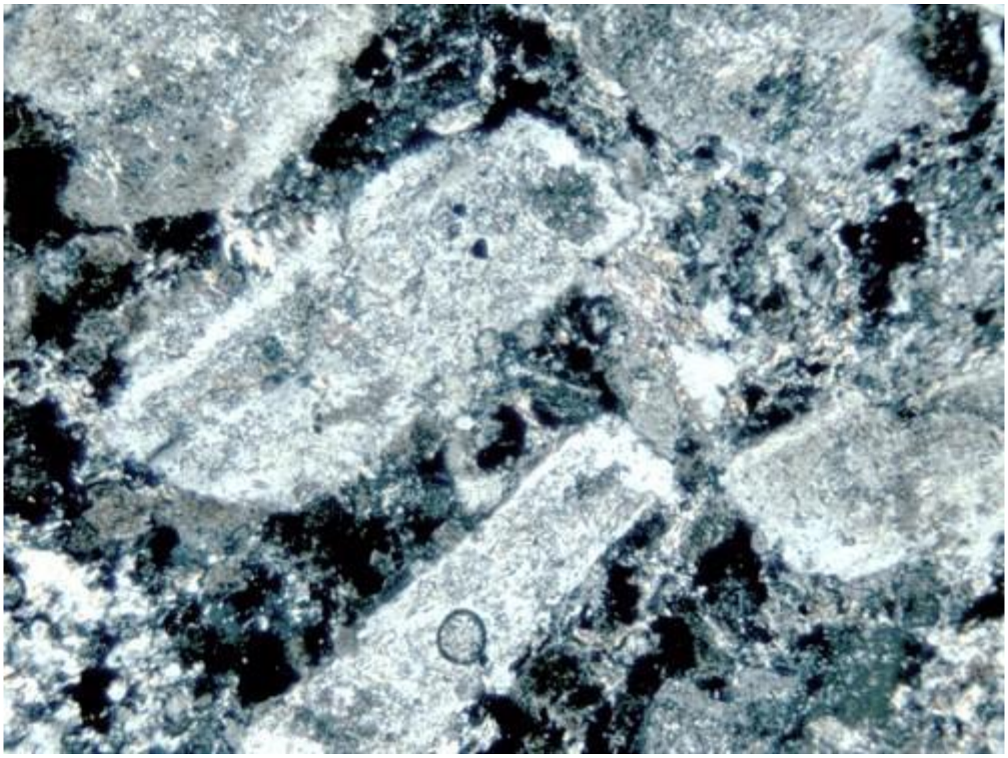
Accessory minerals: carbonate, chlorite, apatite



Brecciated pyrite. X-axis of photo: 1.6mm. Refl. Light.



Brecciated pyrite in sericite. X-axis of photo: 1.6mm. XN.


Plagioclase phenocrysts in feldspar porphyry. X-axis of photo: 1.6mm.XN.

Sample Number: CO11634 **Rock Type: Feldspar porphyry**

Petrographic Description:

The rock is a highly granulated and brecciated variation of the previous samples. The matrix is rock flour-like and it consists of domains of microcrystalline quartz, granulated feldspars of various grain size, and carbonate. The clasts or "phenocrysts" of plagioclase are anhedral / subhedral and several of the grains are partly replaced by aggregates of carbonate. K-feldspars are also granulated and the anhedral clasts are partly sericitized. Sericite and carbonate alteration are pervasive in comparison to the previous samples and the fine-grained micas partly replaced some of the muscovite. Carbonate occurs as replacement after the feldspars, as well as late veins. Some carbonate are partly replaced by epidote aggregates.

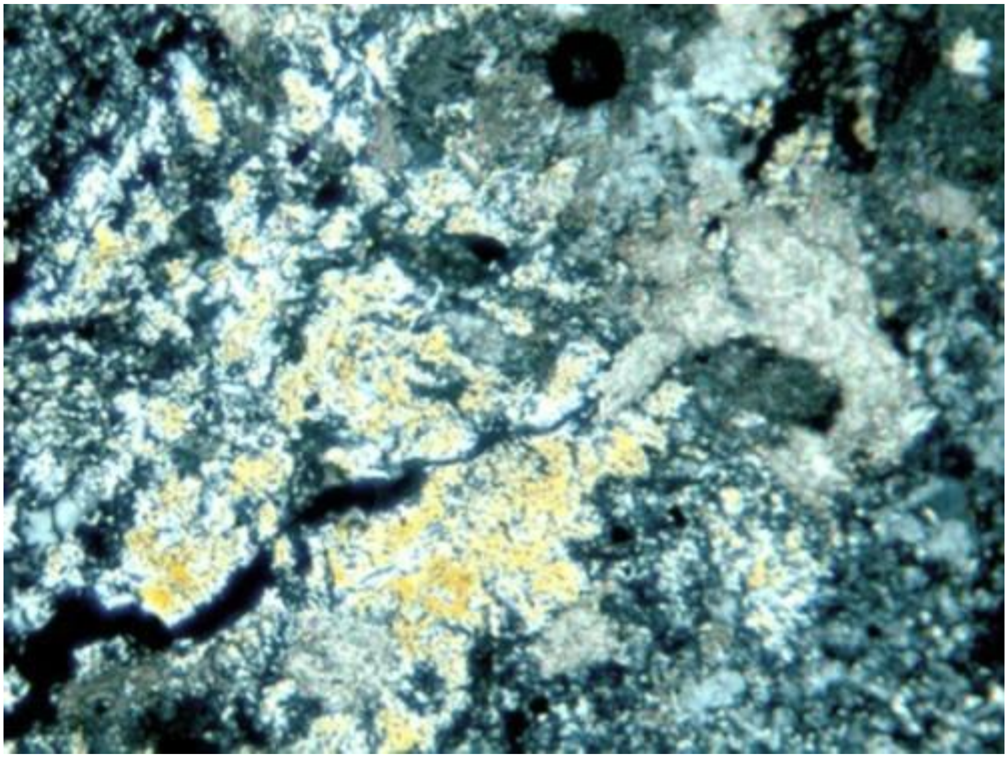
Pyrite occurs mostly as anhedral single grains – poikiloblasts and some are rimmed by late carbonate or muscovite. A few grains contain inclusions of small chalcopyrite.

Detailed mineralogy

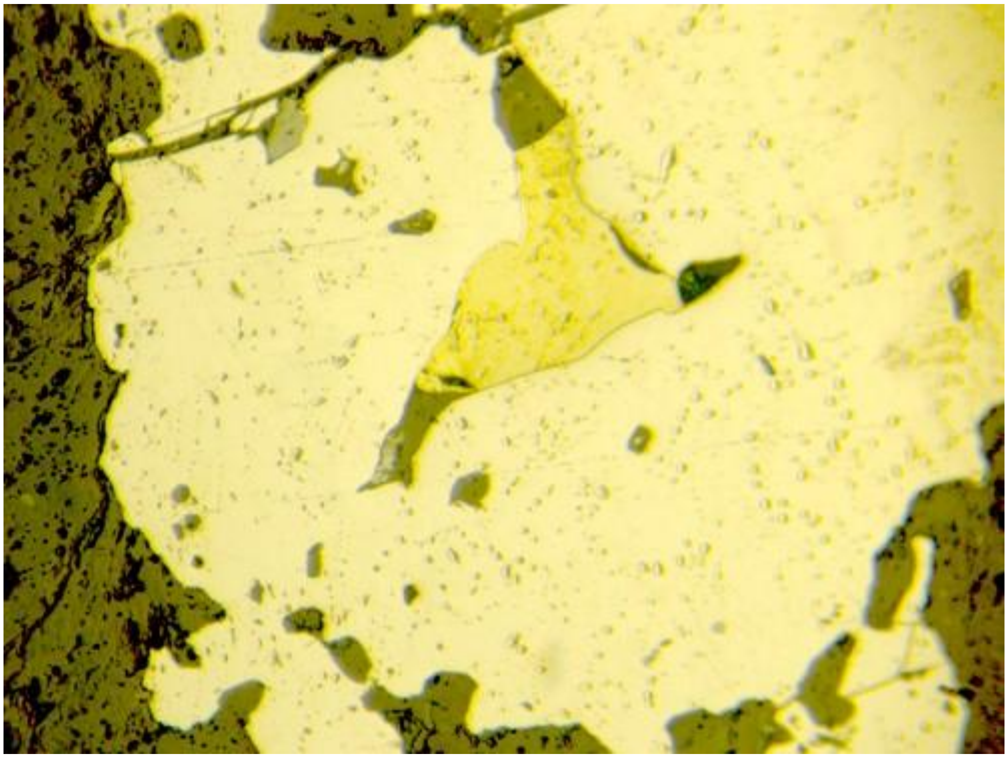
Mineral	%	Grain size(mm)	Comments
Plagioclase	40	0.3-2.5	Mottled and altered plagioclases are relict grains. They are partly fragmented and partly replaced by carbonate and sericite. Their composition is in the range of oligoclase.
K-feldspar	6	variable up to 1.5	Fragments of anhedral K-feldspars are mottled, poorly defined grains. They are partly granulated and partly replaced by sericite.
Quartz	10	variable up to 0.3	Microcrystalline quartz makes up the matrix of some domains. Quartz also occurs as secondary aggregates and discontinuous veins intergrown with fine-grained carbonate.
Carbonate	15	variable up to 1.0	Two carbonate generations were identified. The earlier carbonates are replacement after the plagioclase phenocrysts and late carbonates occur as small, discontinuous veins. Some of the earlier carbonates are partly replaced by epidote.
Muscovite / sericite	10	up to 1.0	Muscovite phenocrysts are all recrystallized to fine-grained aggregates, only the shape of the aggregates indicates their original precursor.
Pyrite	6	0.1-1.5	Anhedral, slightly subrounded pyrite are disseminated through the thin section. They are poikiloblasts and porphyroblasts and most

		have embayed grain boundaries, A few grains contain small chalcopyrite inclusions.
Irresolvable matrix	13	The mottled “matrix” consists of small fragments of quartz, feldspars, sericite, carbonate and chlorite.

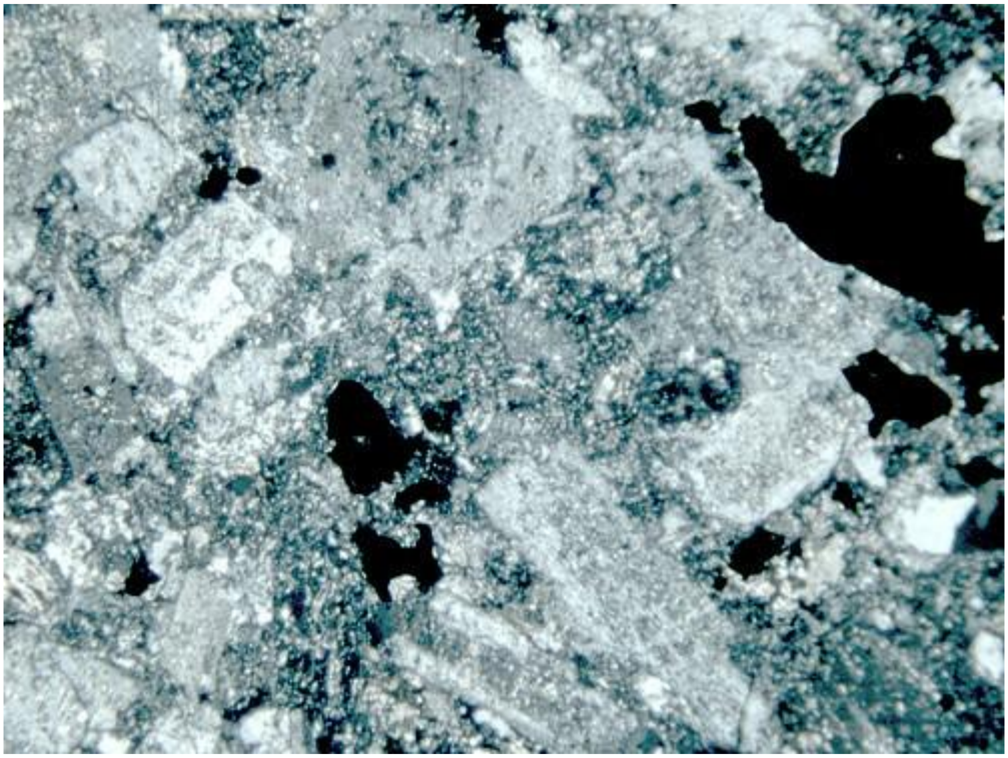
Accessory minerals: epidote, apatite, chalcopyrite



Carbonate ((tan color) is replaced by epidote (yellow). X-axis of photo: 1.6mm. XN.



Chalcopyrite inclusion in center of pyrite. X-axis of photo 0.64 mm.


Mottled plagioclase phenocrysts. X-axis of photo: 1.6mm. XN.

Sample Number: CO11635 **Rock Type: Felsic intrusive**

Petrographic Description:

Coarse-grained intrusive rock that consists predominantly of mottled and sericitized plagioclase and K-feldspar phenocrysts and minor recrystallized muscovite phenocrysts. The plagioclase composition could only be estimated on a few of the least altered plagioclase, and their composition is within the range of oligoclase. Minor granophyric quartz are interstitial to the feldspars and some quartz also occurs as fine-grained secondary aggregates

Most feldspars are sericitized and some are partly replaced by carbonate. Carbonate veins cross-cut the rock fabric, including some of the fractured feldspars. Fine-grained, anhedral carbonate aggregates are intercalated with some of the pyrite and form a rim on selected pyrite grains.

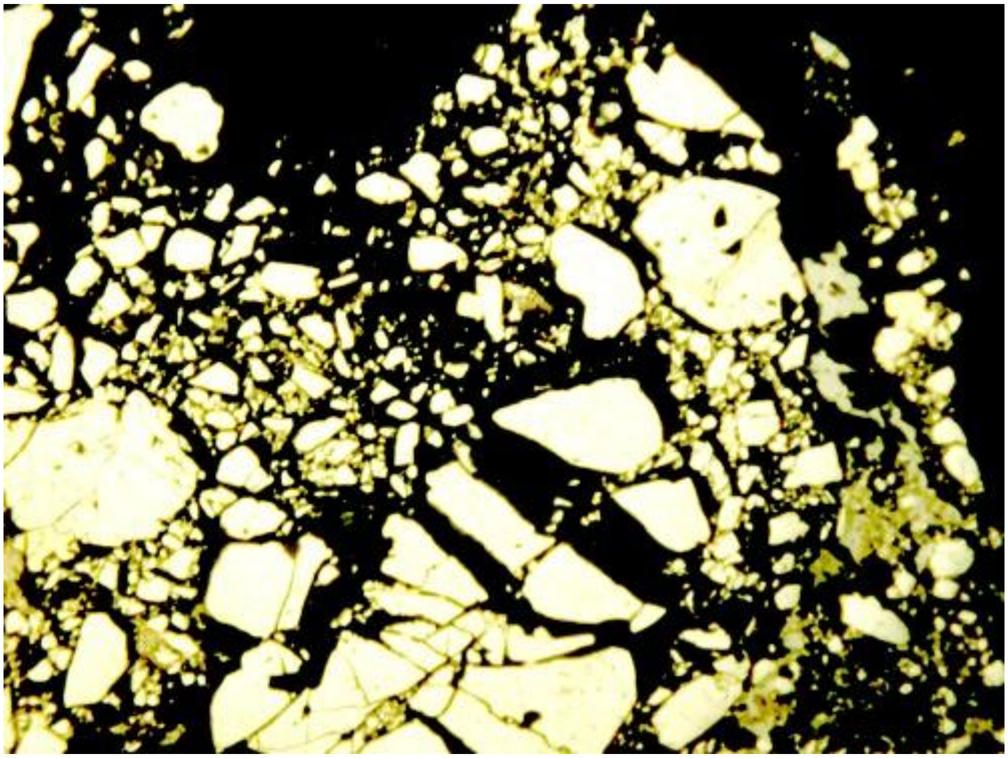
The only sulfide identified in the thin section is pyrite. The anhedral porphyroblasts and poikiloblasts over-grow the feldspars and some form a rim on the feldspars. Relict massive pyrite in the rock are brecciated and the fractures are filled by Fe-stained, fibrous muscovite.

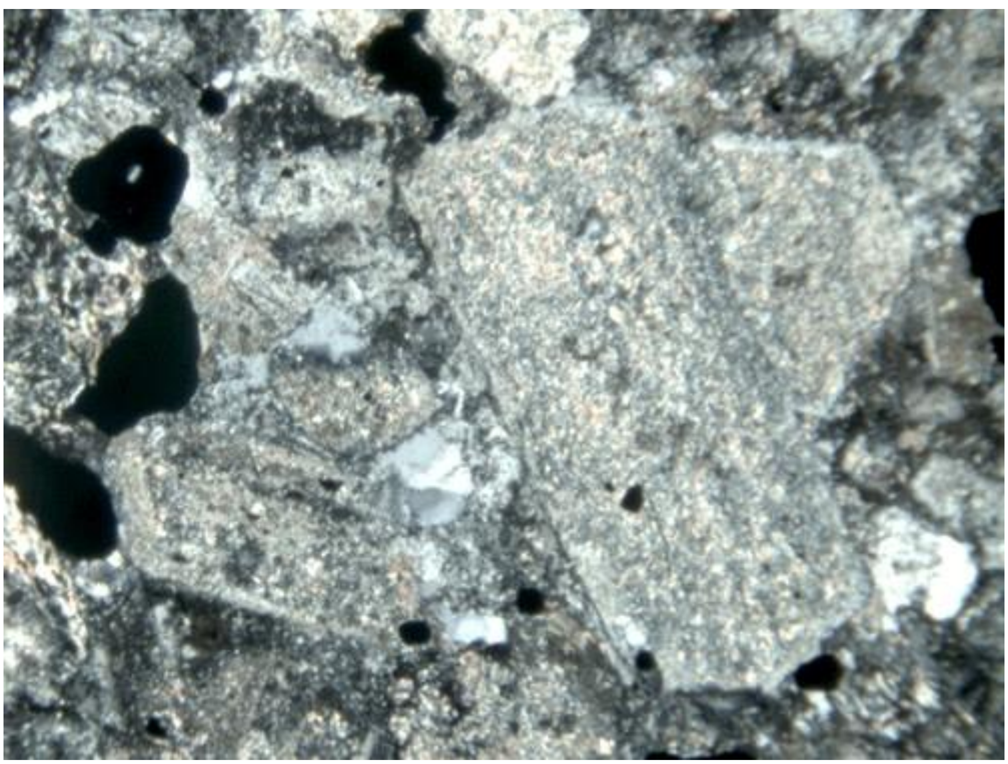
Detailed mineralogy

Mineral	**%**	**Grain size(mm)**	**Comments**
Plagioclase	50	0.5-3.5	Mottled plagioclase occurs as subhedral phenocrysts and as broken clasts. They are partly sericitized and some contain aggregates of fine-grained carbonate. Most twin lamellae were partly destroyed and estimation of composition is base only on a few grains. They are in the oligoclase range (An_{12-28}).
K-feldspars	25	0.3-2.0	Anhedral, subhedral orthoclase phenocrysts are untwinned or have single twinning. They are sericitized and some are intergrown with the plagioclase. A few are fractured and fragmented and cross-cut by late carbonate veins.
Carbonate	8	variable up to 1.8	Carbonate occurs in aggregates, as replacement after the plagioclase and as cross-cutting veins. Fine-grained carbonate is also intercalated with sericite.
Muscovite / sericite	12	up to 1.5	The original rock contained a few muscovite phenocrysts. They phenocrysts recrystallized and were replaced by aggregates of fine-grained muscovite. Sericite alteration is pervasive throughout the thin section and both feldspars are variably sericitized.

Pyrite	20	0.2-2.8	Two pyrite generations were identified; massive, coarse-grained pyrite and small, anhedral porphyroblasts and poikiloblasts. The coarse-grained pyrite is brecciated and fractures are filled by fine breccia that consists of small, angular fragments. Some of the fractures are also filled by slightly fibrous, radiating fine-grained muscovite.

Accessory minerals: quartz, chlorite, titanite, rutile, apatite


Brecciated pyrite. X-axis of photo: 1.6mm. Refl. Light.


Subhedral / euhedral phenocrysts of plagioclase in felsic intrusive.
X-axis of photo: 1.6mm. XN.

Sample Number: CO11636 **Rock Type: Feldspar porphyry**

Petrographic Description:

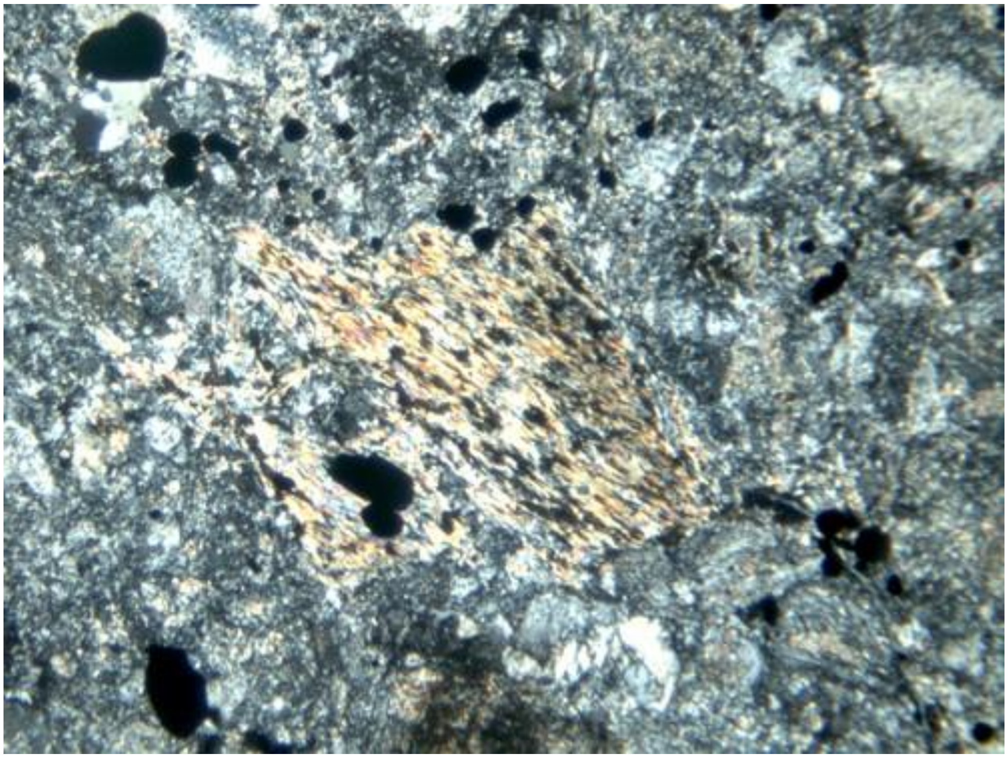
The rock consists of phenocrysts of plagioclase, K-feldspars, sericite, minor carbonate and an abundance of pyrite. The rock is more or less equivalent to the previous sample, but has a porphyritic texture. The plagioclase composition is in the range of oligoclase, the K-feldspars are single twinned or untwinned orthoclase. Both feldspars are moderately to extensively altered and partly replaced by sericite and minor carbonate.The matrix of the rock consists of fine-grained to microcrystalline quartz and feldspars.

Two pyrite generations were identified; relict massive (anhedral/subhedral) grains that are fractured and fragmented and the fractures are filled by fine-grained, angular pyrite breccia. The later pyrite includes fine-grained, anhedral porphyroblasts and poikiloblasts.

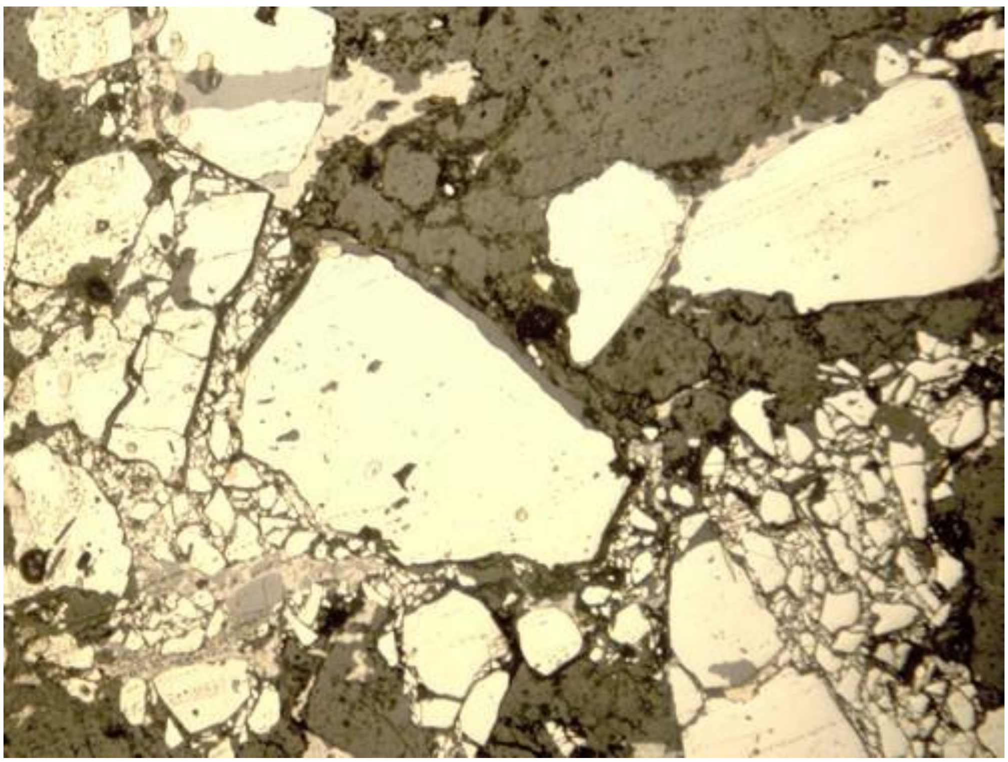
Detailed mineralogy

Mineral	**%**	**Grain size(mm)**	**Comments**
Plagioclase	58	0.3-3.0	Partly sericitized subhedral phenocrysts of plagioclase have oligoclase composition where twinning is preserved. Other phenocrysts are slightly zoned and the rims appear to be more sodic than the core. They are pervasively sericitized in the center.
K-feldspar	18	0.4-2.5	Anhedral, subhedral orthoclase crystals have single twining or they are untwinned. All phenocrysts are pervasively sericitized.
Muscovite / sericite	10	up to 1.5	The original muscovite phenocrysts are recrystallized to fine-grained muscovite. Sericite alteration is pervasive throughout the thin section. Fe-stained fine-grained muscovite forms a rim on fractured pyrite.
Carbonate	2	variable	Aggregates of fine-grained, anhedral carbonate partly replace some of the plagioclase and some occur in the matrix. A few small, discontinuous carbonate veins also occur within the fine-grained matrix.
Pyrite	12	0.1-1.8	Two pyrite generations were identified; massive pyrite, rimmed by fine pyrite breccia and Fe-stained muscovite, and small grains of anhedral pyrite porphyroblasts and poikiloblasts. The latter post-dated the brecciated pyrite.

Accessory minerals: quartz, chlorite, titanite, rutile, apatite



Recrystallized muscovite phenocryst (yellow). X-axis of photo: 0.64mm. XN.



Brecciated pyrite. X-axis of photo: 1.6mm. Refl. Light.

Sample Number: CO11637 **Rock Type: Feldspar porphyry**

Petrographic Description:

The rock consists of fragments of feldspar porphyry, separated by siliceous bands and domains. The rock is pervasively silicified, sericite and carbonate altered. Typical porphyritic texture, the subhedral /euhedral plagioclase are set in a fine-grained matrix that consists of microcrystalline quartz, fine-grained feldspars and sericite. Subhedral / euhedral plagioclase occur as partly altered phenocrysts having a sericite-rich core. Their composition is in the oligoclase range, which would be consistent with a felsic intrusion. Quartz veins and a siliceous band separate the porphyry fragments. Recrystallized muscovite phenocrysts are relatively common and occur within the feldspar porphyry.

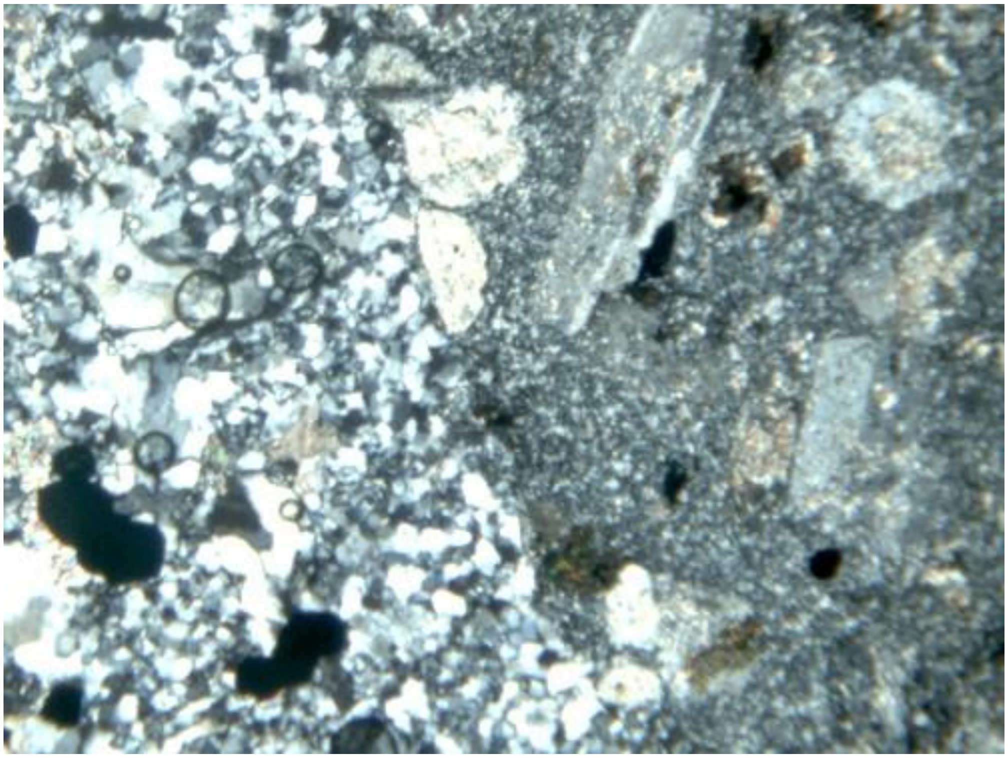
A pyrite-rich rock that contains an abundance of anhedral aggregates of pyrite porphyroblasts and poikiloblasts. Minor, small grains of chalcopyrite occur within the matrix and are associated with pyrite. Two pyrite generations were identified; the early pyrite are rimmed by fine-grained pyrite breccia, whereas the later pyrite (and chalcopyrite) post-dated the brecciate pyrite.

Detailed mineralogy

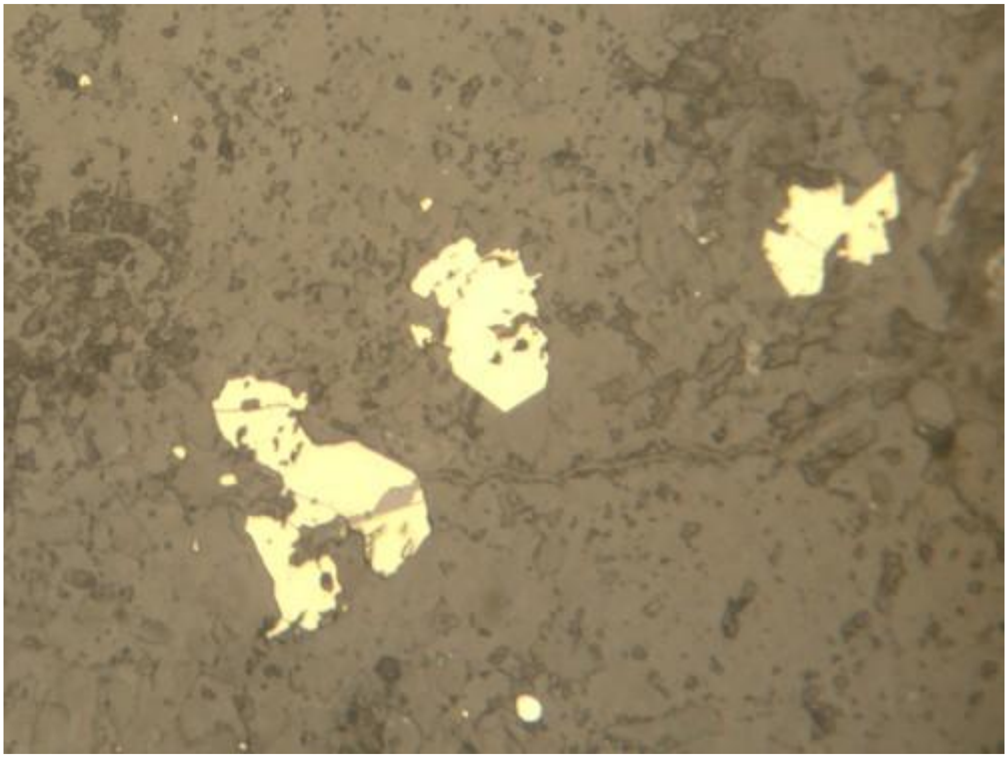
Mineral	%	Grain size(mm)	Comments
Plagioclase	40	0.5-2.8	Subhedral / euhedral plagioclase phenocrysts occur within the matrix. They are strongly silicified, criticized and the centers of some phenocrysts are almost completely replaced by sericite ± carbonate.
K-feldspar	12	variable up to 2.0	Orthoclase phenocrysts are mostly broken fragments within the fine-grained matrix. The anhedral grains are sericitized and some have sutured grain boundaries, suggesting disequilibrium.
Quartz	8	av. 0.3	Fine-grained quartz occurs in small veins and in narrow bands that separate the fragmented host rock. Quartz also occurs in small domains within the feldspar porphyry. Some have semi-granolithic texture.
Muscovite / sericite	7	up to 1.8	Muscovite phenocrysts recrystallized to fine-grained aggregates. Sericite alteration of the feldspars and the matrix is pervasive.
Carbonate	5	minute to 2.5	Fine-grained, mottled carbonates occur in aggregates within the fine-grained matrix. They also forms aggregates within some plagioclase phenocrysts, partly replacing the

			feldspars.
Pyrite	10	0.5-1.5	Relict pyrites are rimmed by fine pyrite breccia, suggesting early brecciation in the rock. Second generation pyrite are anhedral porphyroblasts or poikiloblasts disseminated through the thin section. They were probably contemporaneous with chalcopyrite.
Irresolvable matrix	20	Fine-grained to microcrystalline	The matrix consists of microcrystalline quartz, variable proportion of fine-grained feldspars, sericite and minor carbonate.

Accessory minerals: chalcopyrite, rutile, apatite, zircon



Silicified (left) feldspar porphyry. X-axis of photo: 1.6mm. XN.



Small grains of chalcopyrite. X-axis of photo: 0.64mm. Refl. Light.

Sample Number: CO11638 **Rock Brecciated, granulated porphyry**

Petrographic Description:

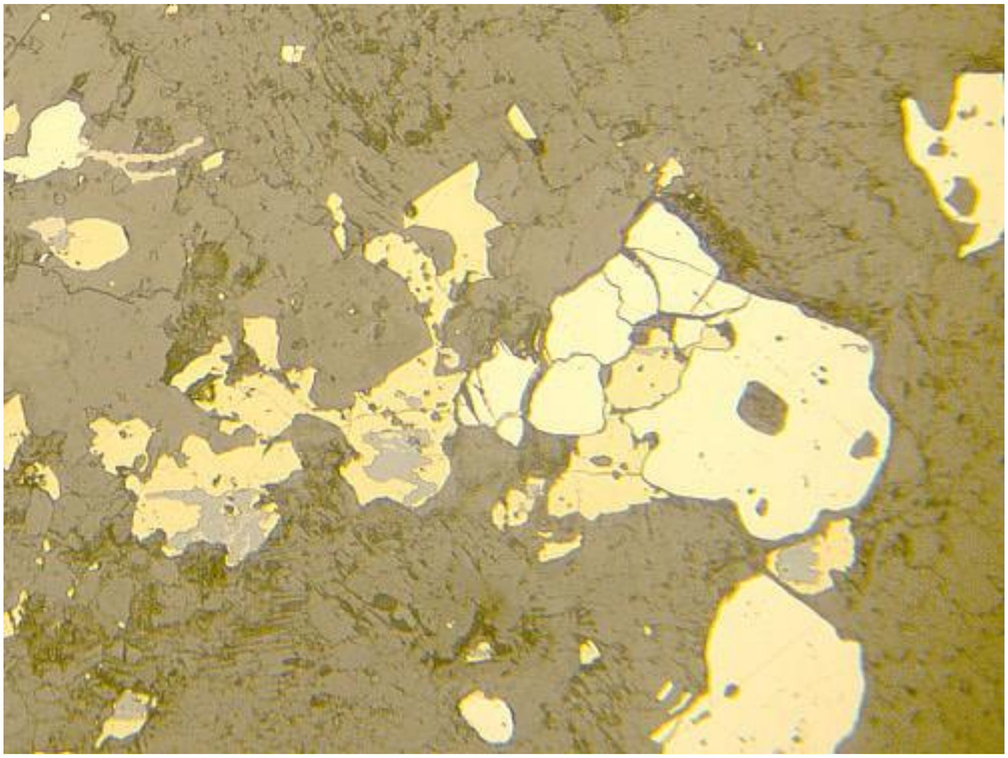
An extensively granulated, fragmented and recrystallized rock. The protolith was a coarse-grained feldspar porphyry. The rock is extensively altered, including silicification major sericite and minor carbonate alteration. Some of the carbonates are partly replaced by aggregates of granular epidote. Granulation, brecciation destroyed much of the original texture.

Massive pyrite veins and aggregates are interfingered with chalcopyrite. In brecciated pyrite the fractures are filled by chalcopyrite veinlets.

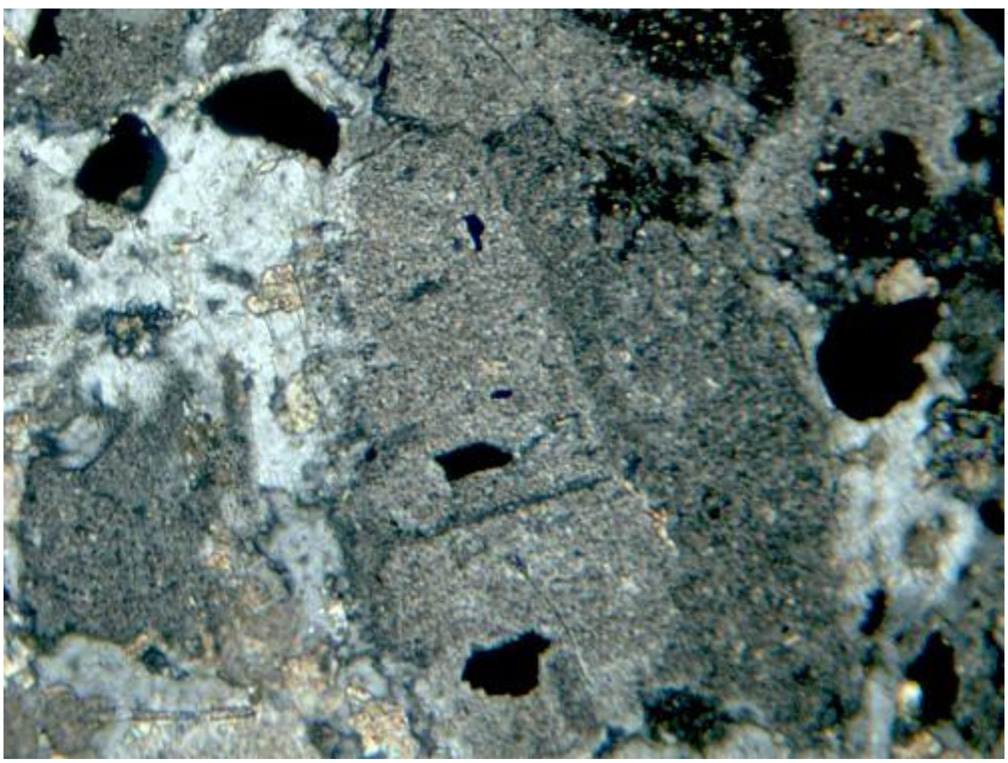
Detailed mineralogy

Mineral	**%**	**Grain size(mm)**	**Comments**
Plagioclase	37	<0.5-	Some plagioclase phenocrysts are well preserved, whereas others are fragmented and brecciated. Fragmented grains are rimmed by secondary K-feldspar and quartz. Most phenocrysts are sericitized.
K-feldspar	5?	variable (fragments)	Phenocrysts of mottled relict orthoclase are single-twinned and some are rimmed by quartz and some by clear, secondary K-feldspar. Several phenocrysts are fragmented and partly sericitized.
Quartz	8	0.2-1.0	The rock is weakly silicified. It contains fine-grained aggregates of secondary quartz, whereas some form a rim on feldspar phenocrysts.
Muscovite / sericite/illite	23	minute-2.0	Sericite alteration is pervasive. The brecciated sulfides are rimmed by Fe-stained sericite or fine-grained muscovite. Some are intercalated with aggregates of carbonate.
Carbonate	3	up to 1.5	Anhedral carbonate occurs in aggregates, replacing some of the feldspars and forming a rim on some of the sulfides.
Pyrite	24	0.1- 3,0	A pyrite-rich rock that also contains chalcopyrite. The pyrites are strongly brecciated, fractured, and the fractures are filled by chalcopyrite veins.

Accessory minerals: chalcopyrite, chalcocite, epidote, apatite



Pyrite (large grain) is rimmed by chalcopyrite, and chalcopyrite shows carbon coating adhering to surfaces. X-axis of photo: 0.64mm. Refl. Light.



Relict orthoclase (dk. grey) is rimmed by second generation K-feldspars (white). X-axis of photo: 1.6mm. XN.

Sample Number: CO11639 **Rock Type: Felsic intrusive**

Petrographic Description:

A pervasively sericitized rock that consists of subhedral / anhedral broken phenocrysts of plagioclase, fragments of orthoclase, sericite, carbonate and clay minerals. The rock is brecciated and the fragments are extensively altered, they are partly sericitized and partly replaced by aggregates of fine-grained carbonate. The plagioclase composition cannot be estimated as the twin lamellae of most plagioclase were destroyed during alteration. A few secondary feldspars are chessboard albite. The matrix of the rock is a chaotic mixture of fine-grained (broken) plagioclase, orthoclase, carbonate, sericite and anhedral pyrite.

The only sulfide identified in the thin section (apart from a few minute grains of chalcopyrite, pyrite. Fine to medium-grained pyrite is disseminated through the rock. The anhedral grains are poikiloblasts and porphyroblasts, suggesting that their crystallization post-dated brecciation and fragmentation of the feldspars. Some sulfides are rimmed by Fe-stained sericite, which superficially resembles biotite.

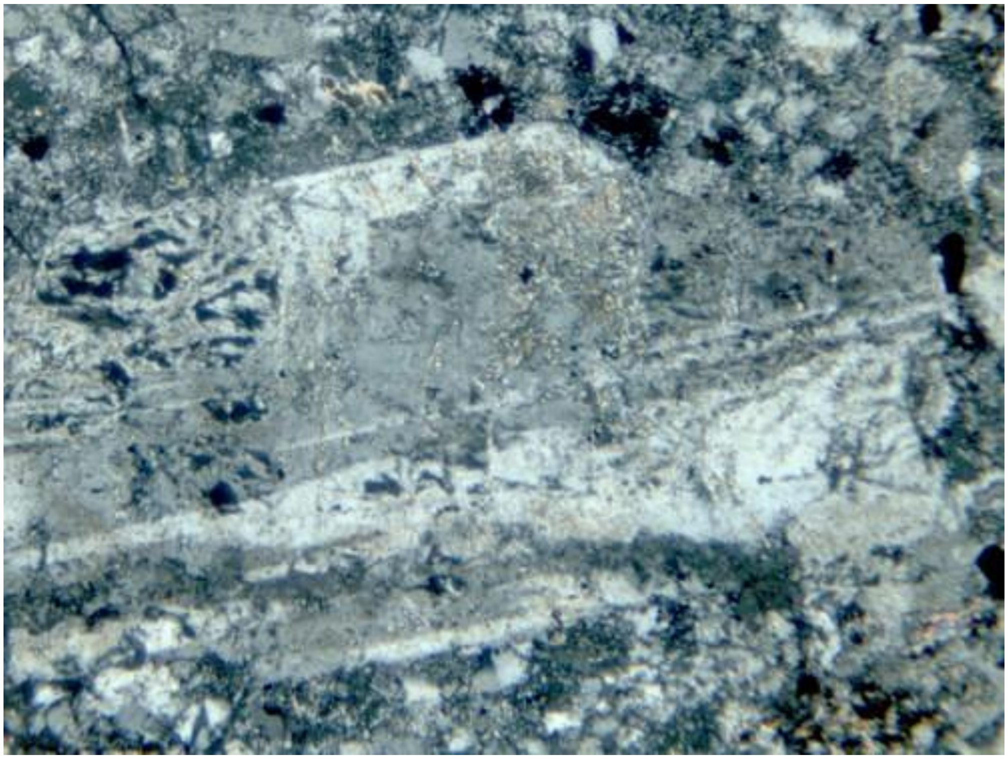
Detailed mineralogy

Mineral	**%**	**Grain size(mm)**	**Comments**
Plagioclase	46	variable up to 2.6	Plagioclase phenocrysts are fragmented and partly replaced by sericite. The twin lamellae of most phenocrysts are obscured by alteration. Their composition was estimated only from two of the least altered phenocryst, as oligoclase (An_{25}). The matrix consists predominantly of broken plagioclase fragments.
K-feldspar	12	up to 2.0	Mottled orthoclases have single twinning and the phenocrysts are pervasively sericitized. Just as the plagioclase, they are fragmented and the small fragments are part of the matrix.
Muscovite / sericite	25	up to 1.2	A few relict muscovite phenocrysts are interstitial to the feldspars. They are recrystallized to fine-grained aggregates, but retained their original shape.
Quartz	7	variable	Fine-grained, anhedral / granular quartz are part of the matrix. Some form part of the matrix and some are secondary.
Carbonate	5	<0.1-1.0	Anhedral carbonate occurs in aggregates in the matrix ad also as discontinuous veinlets that cross-cut some of the feldspar phenocrysts. They are intercalated with

			sericite and probably post-dated sericite alteration.
Pyrite	5	0.05-0.3	Fine-grained anhedral pyrites occur as porphyroblasts and poikiloblasts. Some are rimmed by Fe-stained sericite. And some occur as small, discontinuous veinlets.

Accessory minerals: chlorite, apatite, chalcopyrite

Carbonate veins cross-cut fragmented feldspars. X-axis of photo: 1.6mm. XN.



Partly granulated large plagioclase phenocryst. X-axis of photo: 1.6mm. XN.

Sample Number: CO11640 **Rock Type: ?**

Petrographic Description:

A pervasively altered and recrystallized felsic intrusive rock (?) or it was derived from a felsic intrusive. The mineralogy and texture are comparable to the previous thin section, with the exception that the present rock is also silicified and contains small domains of quartz aggregates and veins. It consists of pervasively sericitized and weakly carbonadoed broken phenocrysts of plagioclase, orthoclase, aggregates of quartz, sericite, carbonate and pyrite.

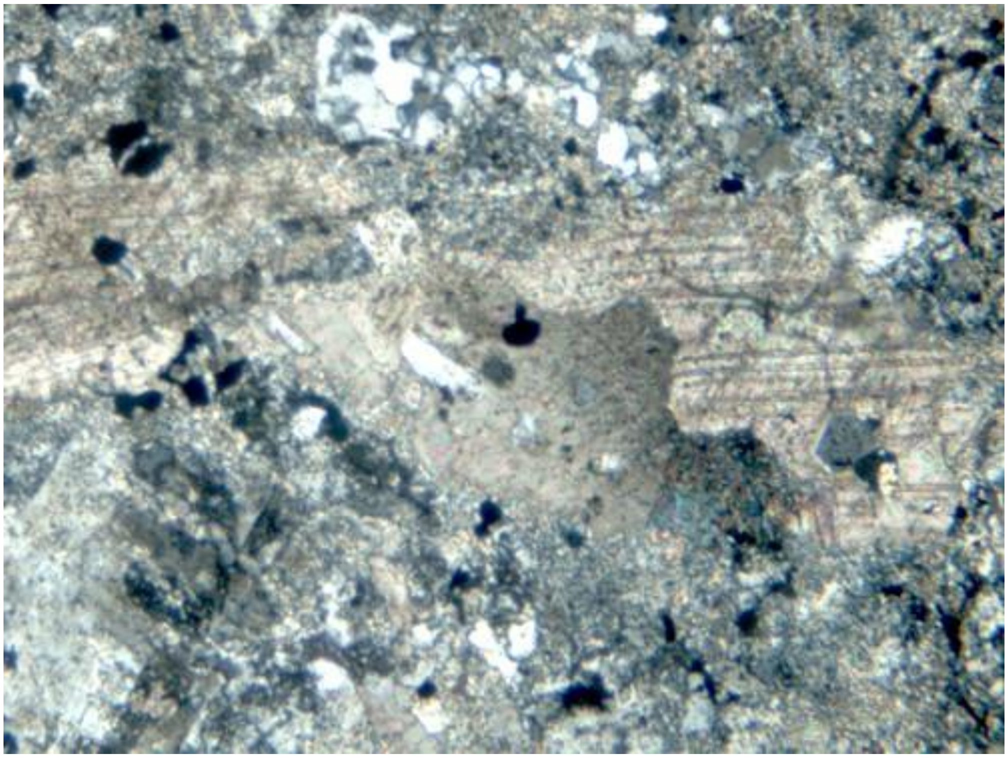
Pyrite is the only sulfide identified. The small poikiloblasts and porphyroblasts occur in aggregates, some of which form a rim on secondary quartz. and also as occur as small, discontinuous veins.

Detailed mineralogy

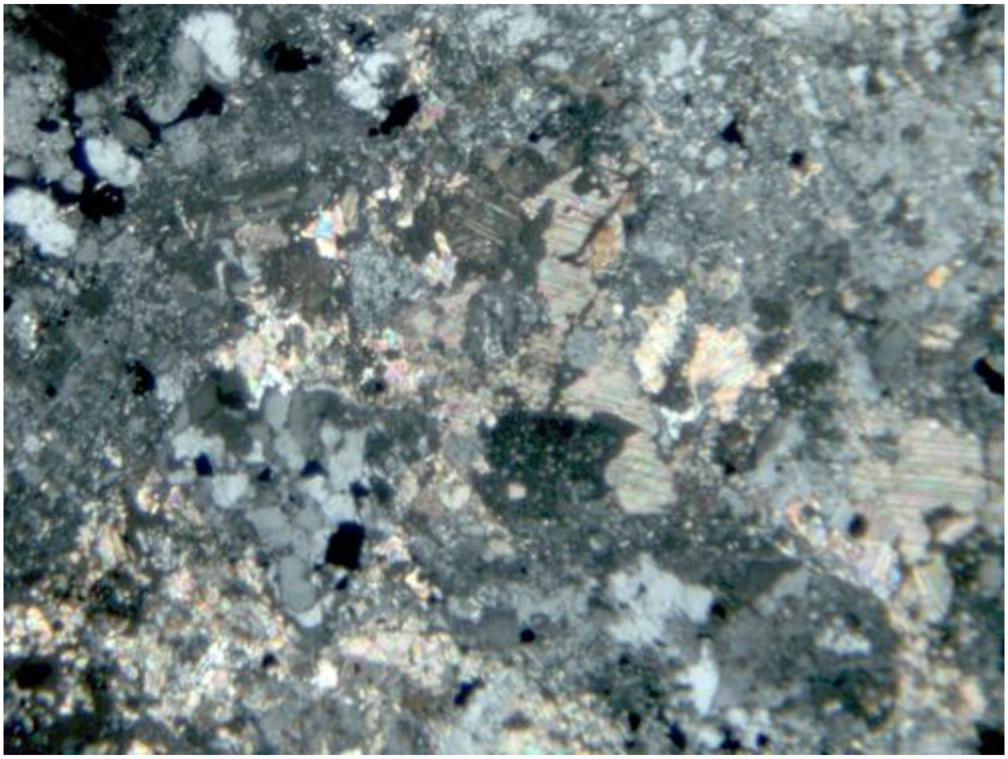
Mineral	**%**	**Grain size(mm)**	**Comments**
Plagioclase	30	0.5-2.5	Most plagioclases are fragmented and relict phenocrysts are less common. They are pervasively sericitized and some are weakly carbonatized. The phenocrysts are granulated and only a few relict grains retained their original lath shape.
Orthoclase	15	0.3-1.8	Fragmented orthoclase are untwinned, extensively sericitized grains, some of which are intergrown with the plagioclase. The fragmented grains have sutured grain boundaries, suggesting disequilibrium.
Quartz	28	variable up to 1.0	Some of the matrix quartz may be primary, but aggregates of quartz in small domains and in veins are secondary. They were added to the rock after fragmentation of the feldspar phenocrysts. Some of the quartz aggregates have sutured grain boundaries.
Sericite	15		Sericite is abundant and it partly replaced the feldspars. It also occurs as small, discontinuous veinlets that wrap-around some of the feldspar clasts.
Carbonate	7	variable up to 0.8	Fine-grained, mottled carbonate is intercalated with sericite. It partly replaced some of the plagioclase. The carbonates also occur in aggregates, forming small domains. Some form discontinuous veins that cross-cuts the sericitized feldspars.

Pyrite	5	0.08-0.7	Fine-grained anhedral pyrites are disseminated through the matrix. It forms discontinuous veins and occur as porphyroblasts and poikiloblasts.

Accessory minerals: chalcopyrite, apatite, zircon



Carbonate vein cross-cuts altered plagioclase. X-axis of photo: 1.6mm. XN.



Carbonate aggregates (pinkish color) partly replaces mottled grey plagioclase. X-axis of photo: 1.6mm. XB.

Sample Number: CO11641 **Rock Type: Fragmental?**

Petrographic Description:

Although the mineralogy of the rock is comparable to the previous samples (plagioclase, K-feldspar, sericite, carbonate and pyrite), the texture suggests that it consists of different rock fragments. The fragments include feldspar porphyry, more fine-grained and more or less equigranular fragments of sericitized feldspars, and aggregates of fine-grained quartz. As alteration is pervasive and the original mineralogy of the rock was replaced by sericite and carbonate, the protolith cannot be identified with certainty. In the porphyry fragments, it is possible to distinguish between plagioclase and orthoclase, but in other fragments, most feldspars have lost their characteristic optical properties and distinction is not possible.

The rock is overall sericitized, carbonatized and weakly silicified.

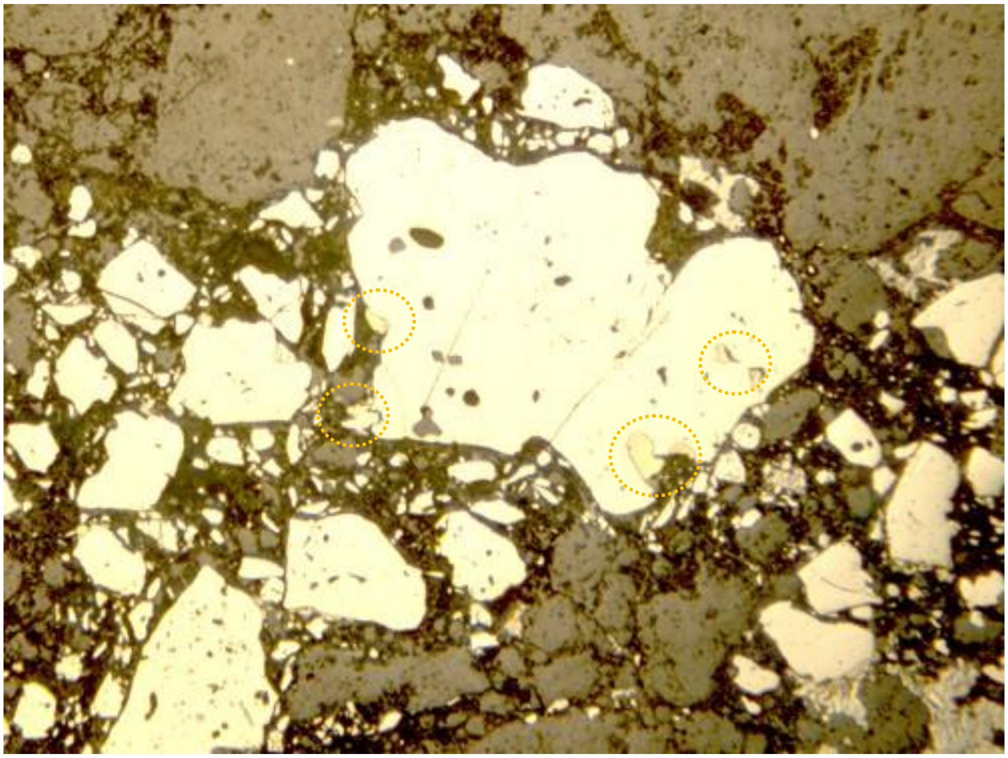
Fine to medium-grained pyrite are disseminated through the thin section. Some pyrite is brecciated and the second generation pyrite occurs as anhedral poikiloblasts or porphyroblasts and small veinlets.

Detailed mineralogy

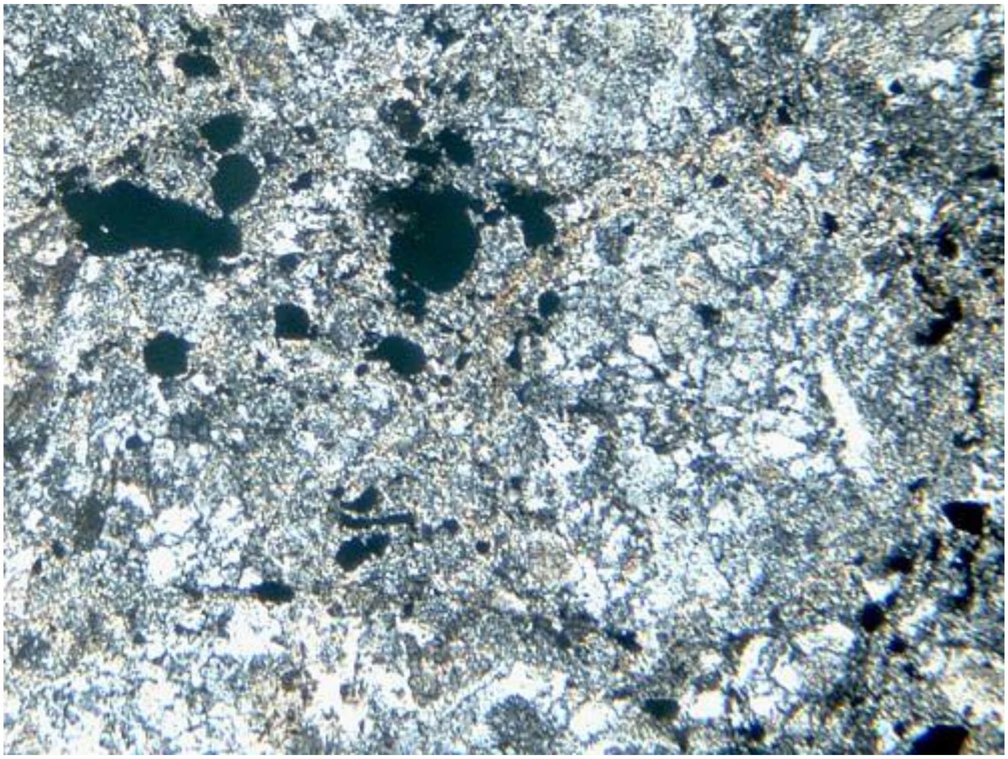
Mineral	%	Grain size(mm)	Comments
Plagioclase	46	av. 0.5-2.5	Plagioclase phenocrysts occur in fragments of the feldspar porphyry,- and as part of the more or less equigranular rock fragments. They are pervasively sericitized, variably carbonatized and their composition is in the oligoclase range. Some plagioclases are fragmented and weakly granulated.
K-feldspar	6	up to 2.0	Orthoclase phenocrysts were identified only in the feldspar porphyry. They are sericitized and some are fractured / fragmented.
Quartz	12	minute-0.6	Aggregates of quartz occur in small domains and some form a rim on the feldspars, partly replacing them. Small quartz veins cross-cuts the rock fabric and represent weak silicification.
Sericite	18		Sericite alteration is pervasive. All feldspars are partly replaced by sericite – some of which occur in carbonate-rich domains.
Biotite	3		Fe-stained sericite or biotite forms a rim on pyrite. Optical distinction between the two is difficult.

Carbonate	8	variable up to 1.5	Anhedral aggregates of carbonate form small domains within the various rock fragments. Some are intercalated with sericite and partly replaced the feldspars.
Pyrite	7	0.1-1.5	Brecciated pyrite represents a first generation sulfide, whereas poikiloblasts and porphyroblasts of pyrite formed at a later episode.

Accessory minerals: chlorite, apatite



Brecciated pyrite with fine chalcopyrite (circled). X-axis of photo: 1.6mm. Refl. Light.



Silicified rock. X-axis of photo: 1.6mm. XN.

Sample Number: CO11642 **Rock Type: Feldspar porphyry**

Petrographic Description:

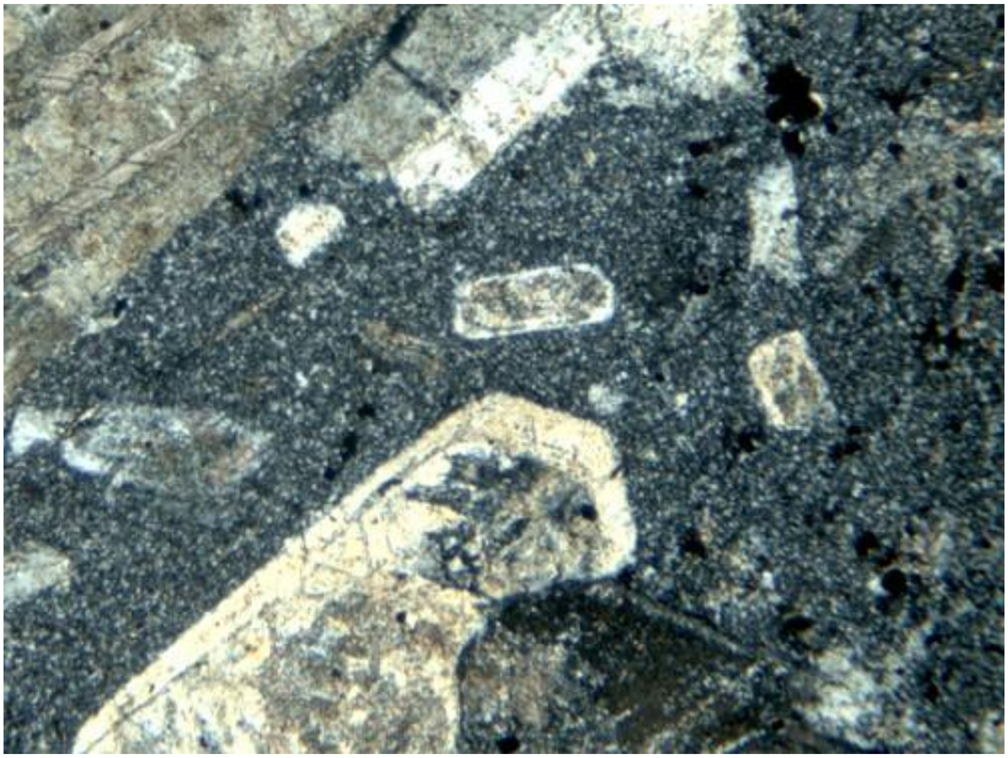
The rock is a pervasively altered feldspar porphyry but it also contains an equigranular fragment similar to sample CO11641. The porphyry consists of subhedral / euhedral phenocrysts of plagioclase, orthoclase, sericite, carbonate, quartz and pyrite. The mineralogy and texture of the rock is comparable to the other feldspar porphyries as described in the previous pages. The plagioclases are subhedral, euhedral phenocrysts and their composition is in the range of oligoclase. The orthoclase have single twinning, some are untwinned and their optic axis is biaxial –ve. As the plagioclase, they are pervasively sericitized, although carbonate alteration of the K-feldspars is rare. Fine-grained quartz occurs in small domains, also as veins, suggesting minor silicification. Sericite is the most abundant secondary mineral. It replaced the core of some feldspars, it forms a rim on the feldspar phenocrysts and a network in the matrix. Carbonate is secondary in abundance to sericite.

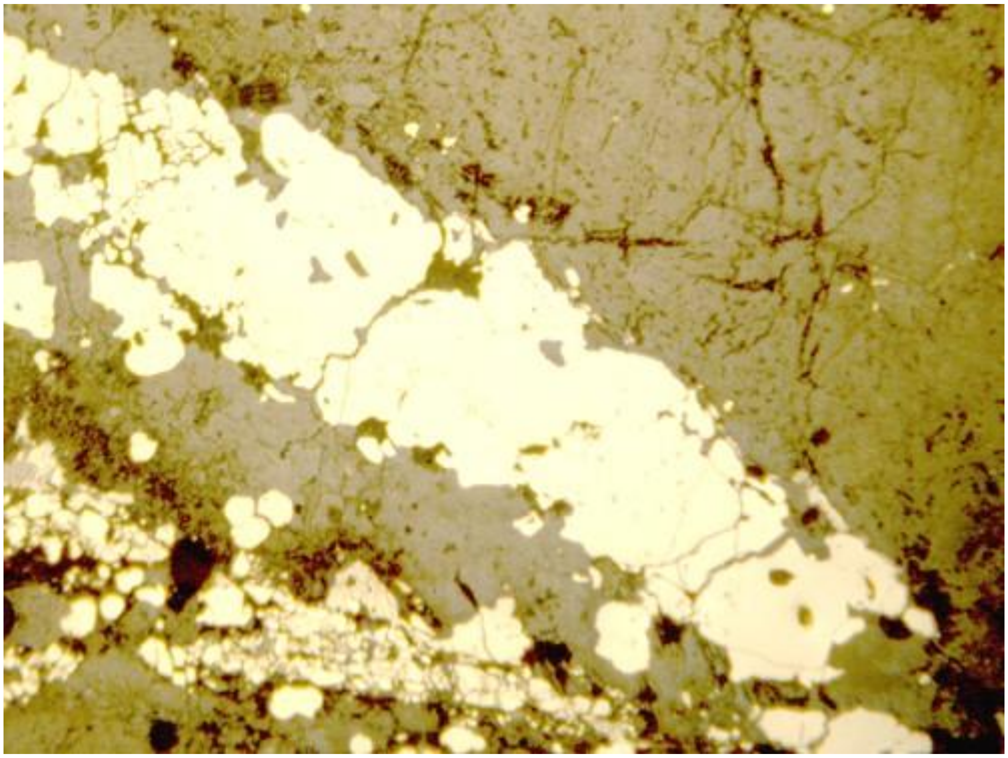
The rock is sulfide-rich and contains an abundance of pyrite. Two pyrite generations were identified: the more massive, first generation, which was subsequently brecciated and a later, more fine-grained pyrite which over-grows the existing fabric of the rock. Volumetrically, the brecciated pyrite is the more important of the two.

Detailed mineralogy

Mineral	**%**	**Grain size(mm)**	**Comments**
Plagioclase	43	0.5-4.0	Subhedral / euhedral plagioclase phenocrysts make up a significant part of the rock, Their composition is sodic - in the oligoclase range. Most plagioclase ate partly sericitized.
Orthoclase	25	0.6-2.0	Subhedral / euhedral orthoclase phenocrysts are relatively abundant. The single twinning, the shape and –ve optical sign are characteristic. The large single phenocrysts are moderately sericitized and some are fragmented.
Quartz	7	variable up to 1.0	Fine-grained quartz is part of the matrix. Small quartz-rich domains contain aggregates of semi-granoblastic quartz.
Sericite	18		Although the porphyry is sericitized, sericite alteration is more pervasive in the equigranular fragment included in the rock Sericite form a network in the rock fragment.
Carbonate	6	variable up to 1.2	Aggregates of carbonate are disseminated through the rock. The carbonates occur in distinct domains and also partly replace some

			of the feldspars.
Pyrite	1	minute-2.5	Coarse-grained, brecciated pyrite is abundant in the porphyry. They are fragmented at the rim and aggregates of sharp, angular slivers form a rim on the massive pyrite. The more fine-grained late pyrite poikiloblasts have embayed grain boundaries.


Feldspar porphyry. X-axis of photo: 1.6mm. XN.


Brecciated pyrite. X-axis of photo: 1.6mm. Refl. Light.

Sample Number: CO11644 **Rock Type: ?**

Petrographic Description:

A chaotic rock of unrecognizable protolith. It consists predominantly of coarse-grained quartz, carbonate, fine-grained biotite and sulfide. The "rock" was probably part of a mineralized quartz-carbonate vein that also contains fine-grained fragments of uncertain origin. The fine-grained fragments may have been derived from volcanic (or volcaniclastic) rocks. It consists of fine-grained matrix of quartz, carbonate and sericite and biotite-altered small phenocrysts.

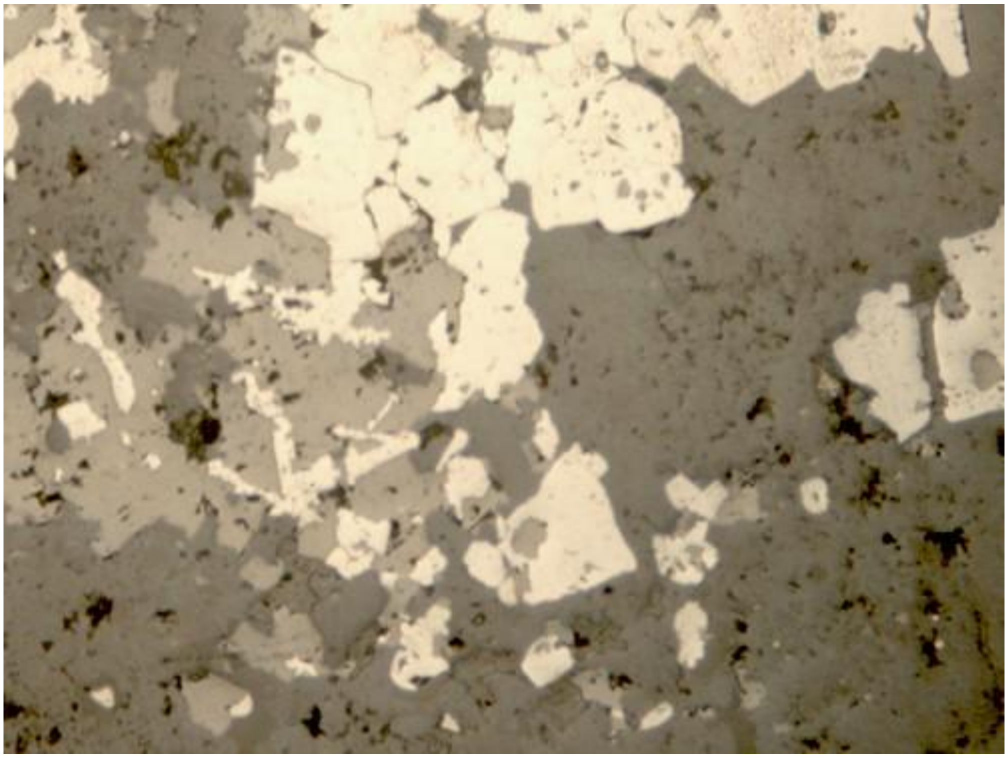
The most abundant minerals in the thin section are quartz, carbonate and fine-grained biotite. The texture and mineralogy of the rock suggest that the biotite represents pervasive K-metasomatism.

Pyrite is abundant, it is disseminated throughout the thin section. Some pyrite are intergrown with sphalerite, although sphalerite is not a major sulfide.

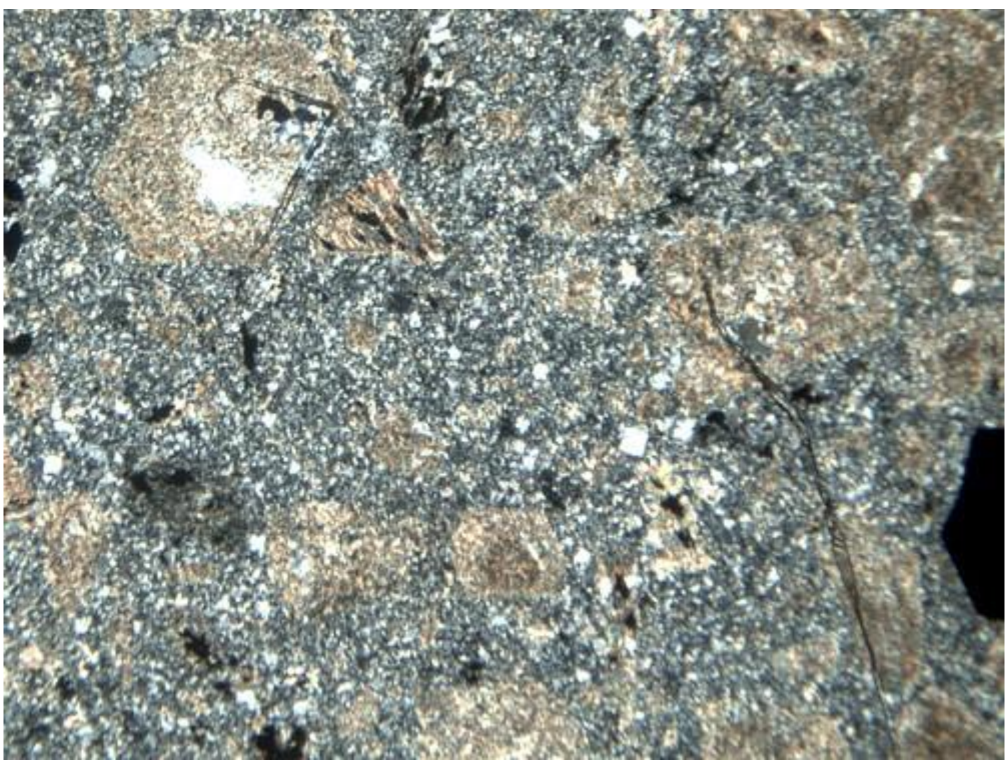
Detailed mineralogy

Mineral	**%**	**Grain size(mm)**	**Comments**
Quartz	35	up to 5.0	Coarse-grained quartz is intergrown with carbonates and the two represent fragments of a vein. Small lath-shaped quartz also occurs as part of the matrix in the fine-grained rock fragment. They are associated with biotite-altered phenocrysts.
Carbonate	28	up to 4.0	Anhedral / subhedral carbonate is an important replacement mineral in the rock. The large and medium-size grains occur as aggregates, as well as late veins that contain pyrite.
Biotite	20	minute	Fine-grained biotite is a replacement after the small phenocrysts in the volcanic (?) fragment and suggests pervasive K-metasomatism.
Pyrite	12	minute-2.5	Brecciated relict pyrite and late pyrite are disseminated through the rock. Sphalerite is intergrown with the late pyrite and occurs in the fractured pyrite.
Sericite	5		Sericite is disseminated through the rock. It pre-dated biotite

Accessory minerals: apatite, rutile, chlorite, sphalerite



Pyrite (yellow) is intergrown with medium grey sphalerite. X-axis of photo:



Ghosts of biotite-altered (brown) feldspar phenocrysts. X-axis of photo: 1.6mm. XN.

Sample Number: CO11646 **Rock Type: ?**

Petrographic Description:

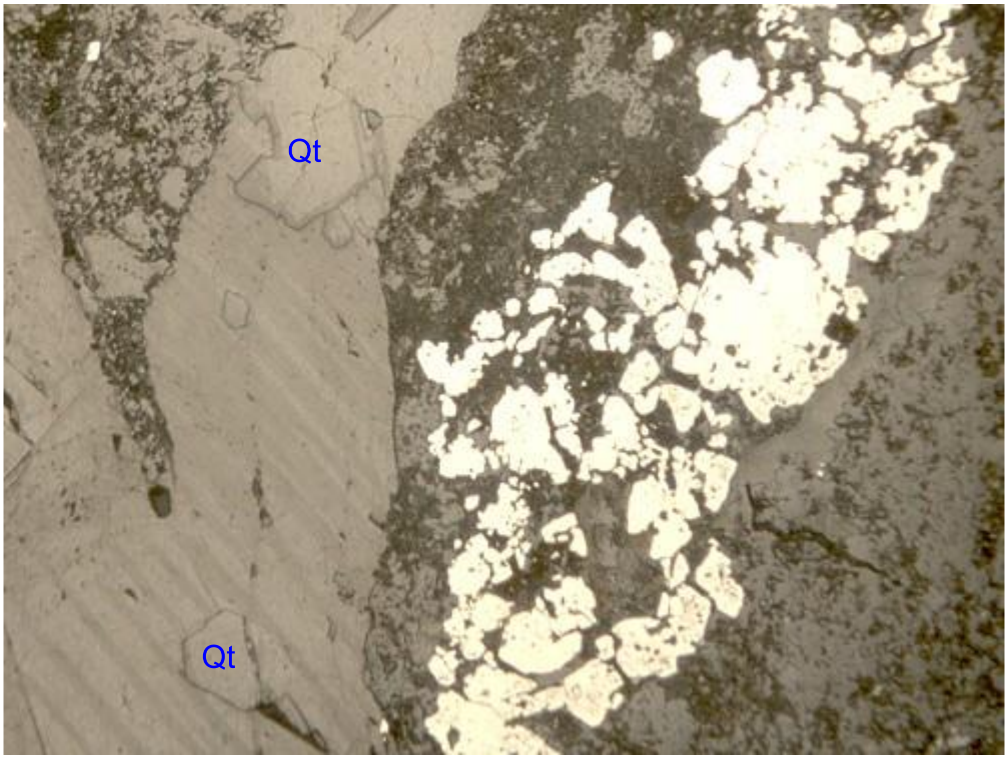
A highly sericitized and carbonate-altered rock. The protolith is not possible to identify due to the high degree of alteration. The rock is a chaotic mixture of sericite, carbonate and quartz. The original texture of the protolith was completely destroyed during the various stages of alteration and the present mineralogy suggests pervasive sericite and carbonate alteration.

Two carbonate generations were identified; the first generation partly replaced the matrix and clasts, and the second generation forms veins and is intergrown with late quartz

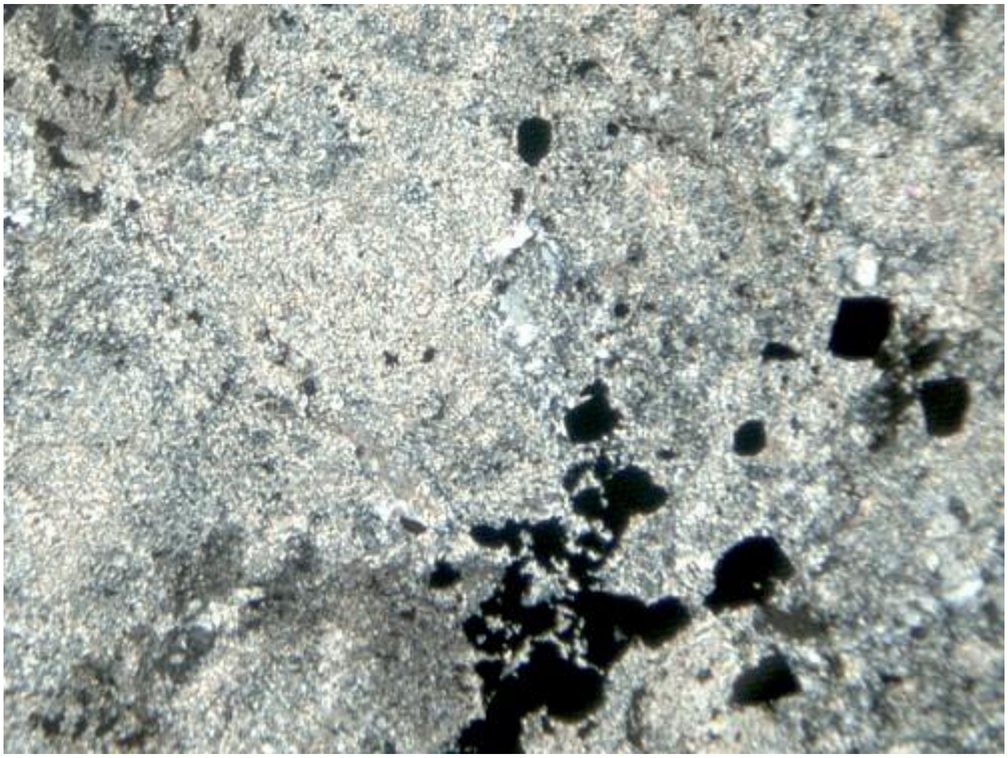
The early carbonates probably preceded the sericite, as some of the sericite veins wrap around aggregates of carbonate.

Fine-grained pyrite is disseminated through the thin section. They do not show evidence of brecciation.

Minerals	%
Carbonate	35
Quartz	28
Biotite	5
Sericite	25
Pyrite	7



Pyrite (yellow) is interstitial to large carbonate veins with quartz. X-axis of photo: 1.6mm.Refl. light.



Pervasive sericite alteration. X-axis of photo: 1.6mm. XN.

Sample Number: CO11648 **Rock Type: ?**

Petrographic Description:

A highly mineralized sample. The brecciated pyrite-rich rock contains sphalerite, galena and chalcopyrite.

Paragenetic sequence and the relationship of sulfides:

1. Sphalerite forms rims on pyrite and it is intergrown with pyrite.
2, Galena is included in sphalerite and it is intergrown with sphalerite.
3. Chalcopyrite forms a rim on sphalerite and it intrudes fractured pyrite.

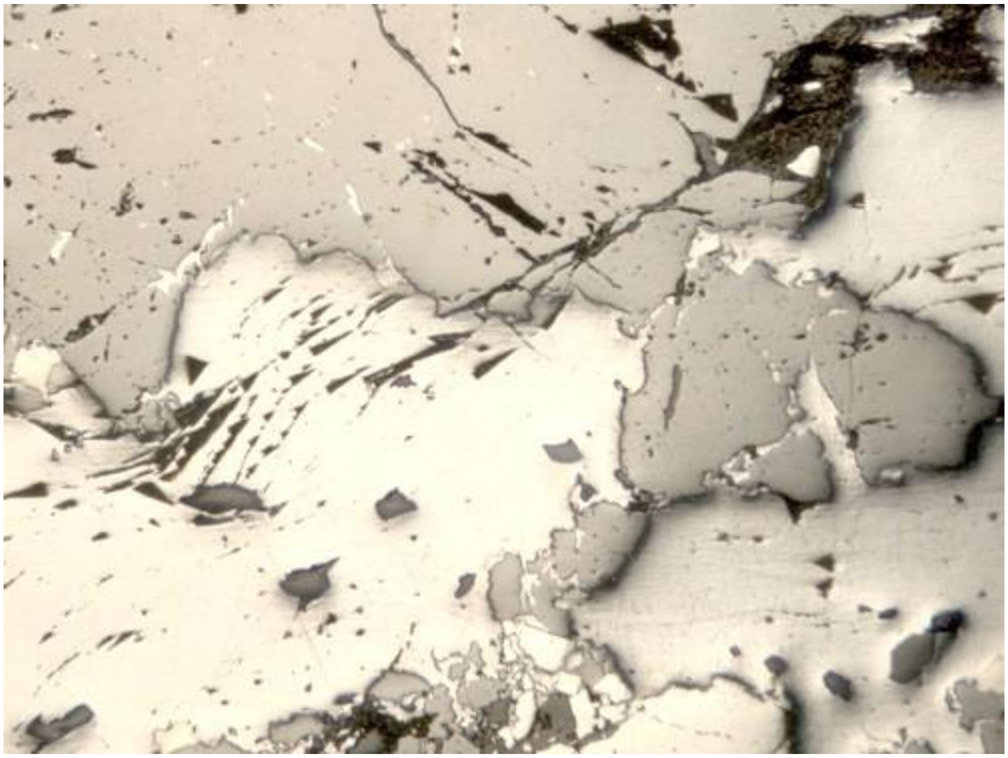
An approximate estimation of sulfides in the thin section:

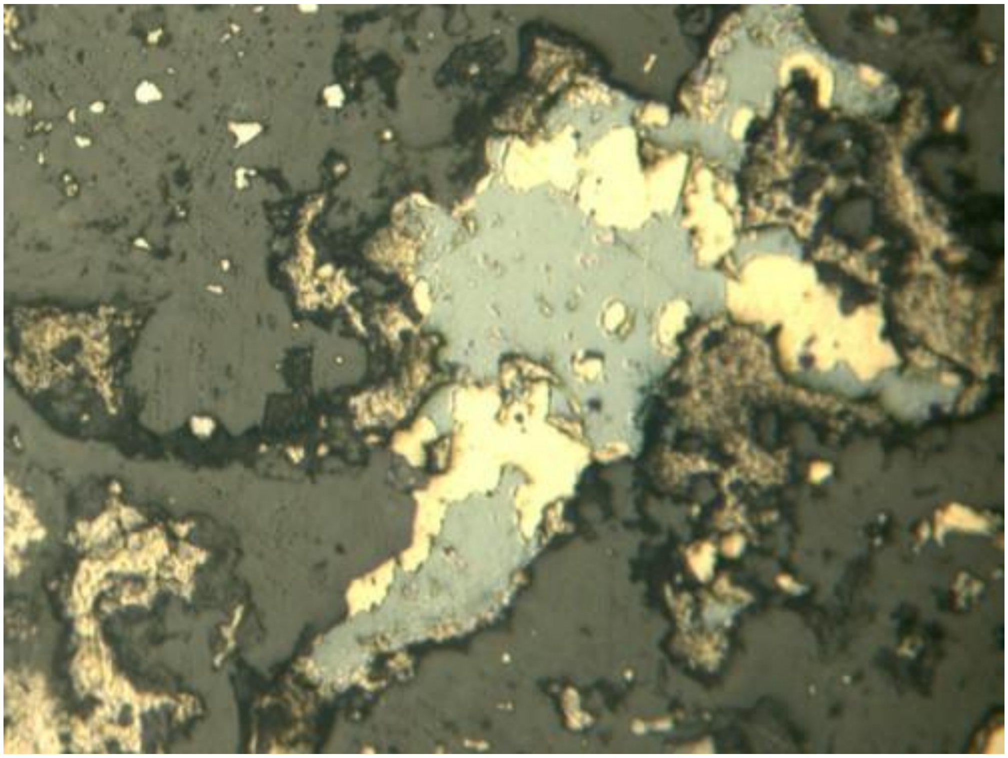
Mineral	%
Pyrite	7
Sphalerite	3-4
Galena	0.5-1.0
Chalcopyrite	trace

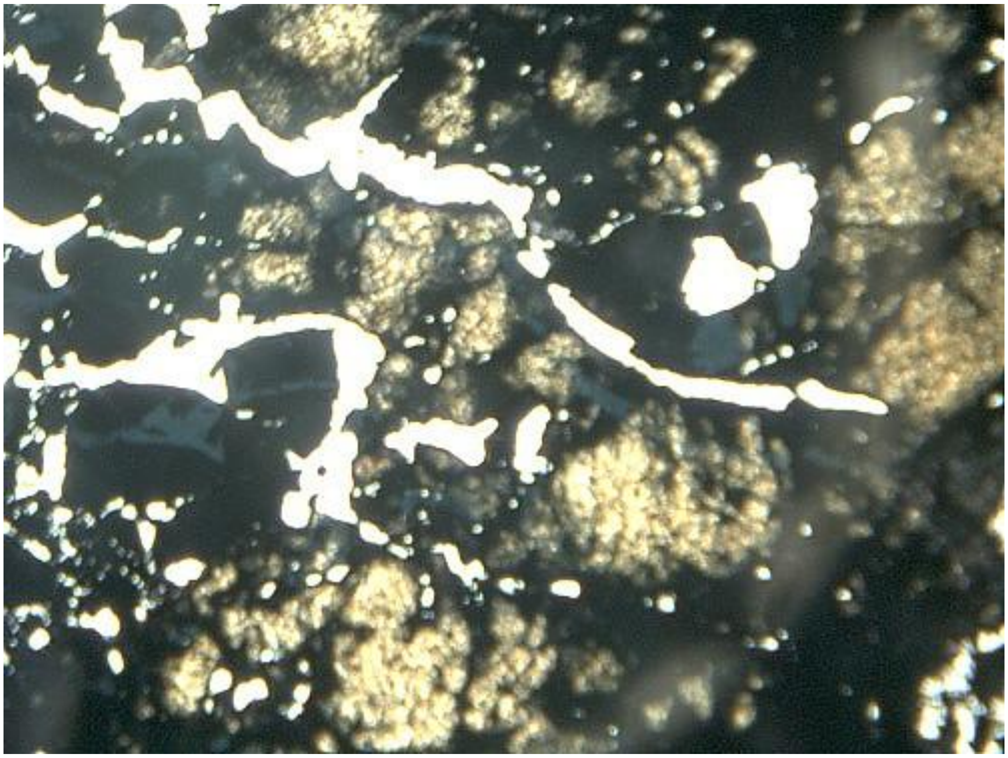
There is an increase in temperature during sulfide crystallization, where chalcopyrite formed at the highest temperature.

The gangue minerals in the rock include: quartz, carbonate, sericite, biotite – and possibly willemite. Willemite is the high birefringent fibrous mineral that forms a rim on sphalerite and is interstitial to sphalerite and galena.

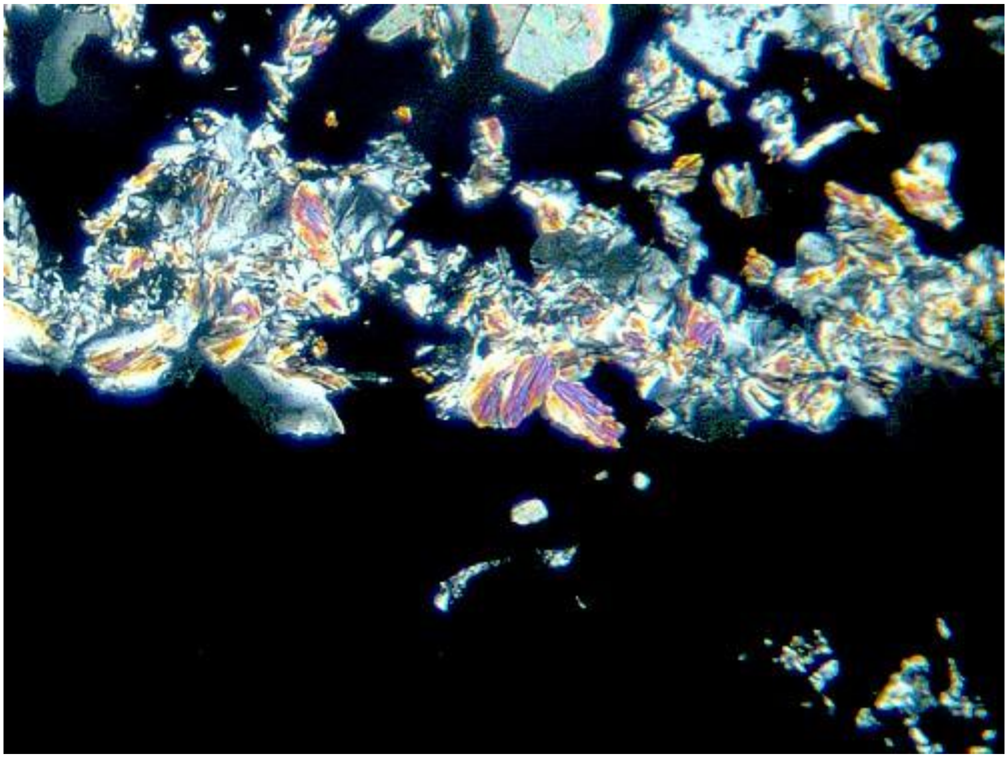
There is no textural evidence to suggest which alteration was preferentially involved with mineralization.


Grey sphalerite is intergrown with – and replaced by - light galena. X-axis of photo: 0.64mm. Refl. Light.


Chalcopyrite (yellow) with fine pyrite and un-removed carbon coating (blue-grey). X-axis of photo: 0.64mm. Refl. Light.



Brecciated sphalerite (semi anisotropic yellow) is cross-cut by carbonate veinlets.
X-axis of photo: 1.6mm. Ppl.



Multi-colored, fibrous muscovite (or willemite) forms a rim on sphalerite (black).
X-axis of photo: 0.64mm. XN.

Sample Number: CO11649 **Rock Type: Tuff?**

Petrographic Description:

The medium-grained rock is sericitized, carbonatized, weakly silicified and contains a relative abundance of sulfides. Some of the original plagioclase phenocrysts were replaced by sericite as suggested by the large lath-shaped ghosts of some feldspars. Anhedral, fine to medium-grained quartz is interstitial to the sericitized matrix and the sericite forms a network between the quartz grains. The texture of the rock appears to be intermediate between intrusive and extrusive, although the grain size is too coarse for an extrusive rock. In order to reconcile the discrepancy of the grain sizes between different domains, it is suggested that the origin of the unaltered protolith would probably be consistent with a tuff or fragmental.

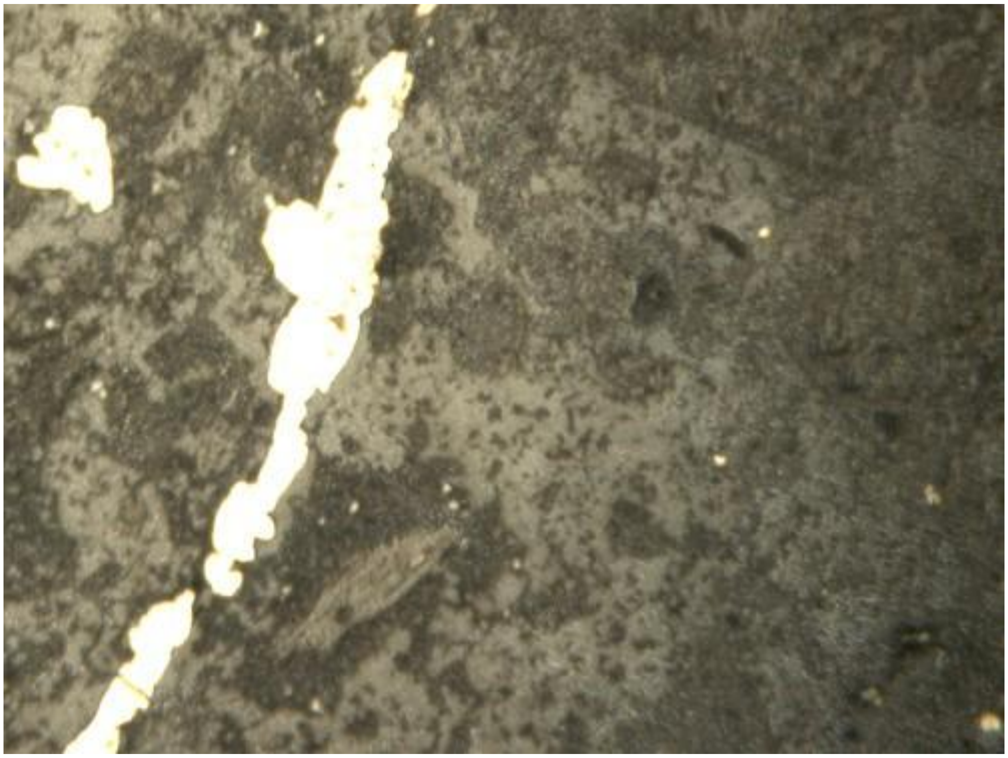
Sericite and carbonate alteration in the rock is interchangeable and there is no textural evidence to distinguish between the paragenetic sequence of the two minerals. Carbonate is interstitial to the sericite-altered domains and carbonate occurs also as veins, some of which are intergrown with late quartz. Minor chlorite is interstitial to the carbonates, quartz and sericite.

Pyrite is the only sulfide present in the rock. Some occur as discontinuous veins, and some pyrite are fragmented and brecciated.

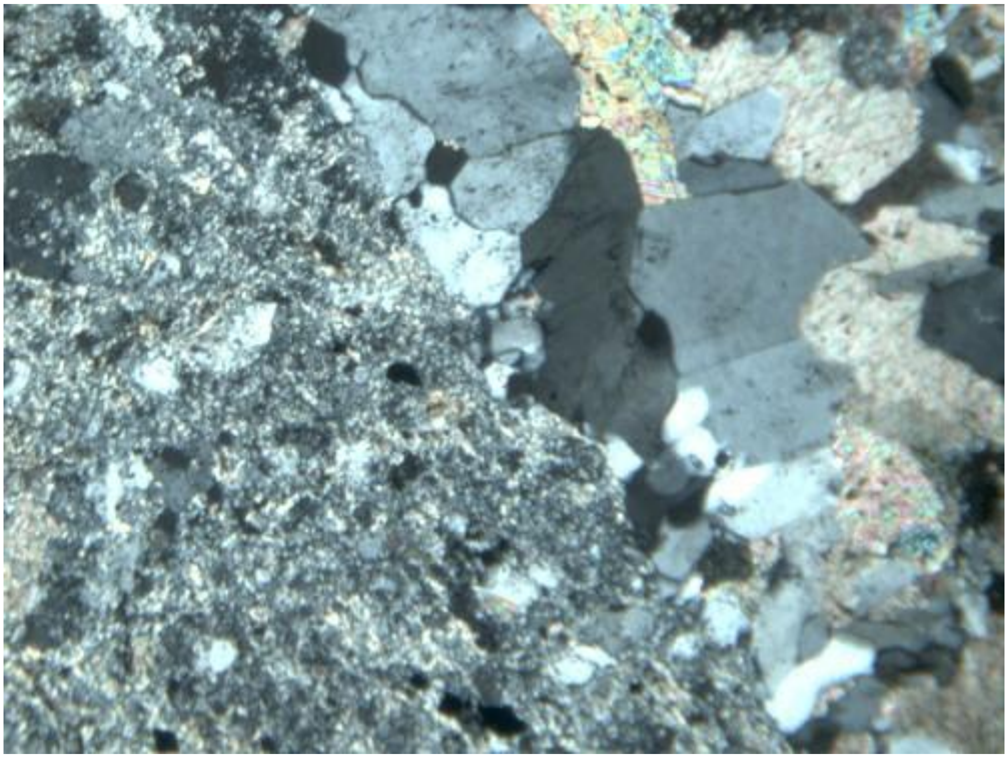
Detailed mineralogy

Mineral	**%**	**Grain size(mm)**	**Comments**
Quartz	20	0.3-1.5	Quartz and sericite make up part of the rock. The anhedral quartz is interstitial to the sericite and to the carbonate.
Sericite	40		Sericite forms a network and partly or completely replace some of the feldspar phenocrysts.
Carbonate	20	av. 0.6 up to 2.5	Carbonate occurs mostly in aggregates and some in veins The vein carbonates are intergrown with minor secondary quartz.
Pyrite	12	variable up to 1.5	Fine to coarse-grained pyrite are disseminated through the thin section. Some pyrite form veins and some are brecciated in-situ.
Chlorite	8		Fine-grained chlorite is interstitial to the matrix quartz.

Accessory minerals: apatite, rutile, biotite



Pyrite vein. X-axis of photo: 1.6mm. Refl. Light.



Fine-grained, sericitized rock is cross-cut by quartz+carbonate vein. X-axis of photo: 1.6mm.XN.

Sample Number: CO11651 **Rock Type: Porphyritic diorite?**

Petrographic Description:

A porphyritic rock that consists of plagioclase phenocrysts, K-feldspar phenocrysts, biotite-altered and chlorite-altered mafic phenocrysts. The fine-grained matrix consists of quartz, feldspars, chlorite, sericite, biotite and minor fine-grained pyrite. The composition of plagioclase is intermediate between oligoclase and andesine. Although the mineralogy of the rock would be consistent with an intermediate composition, the relative abundance of K-feldspar phenocrysts is puzzling (hybrid rock?). Carbonate alteration is pervasive as coarse-grained carbonate is abundant and carbonate veins of various width cross-cut the matrix.

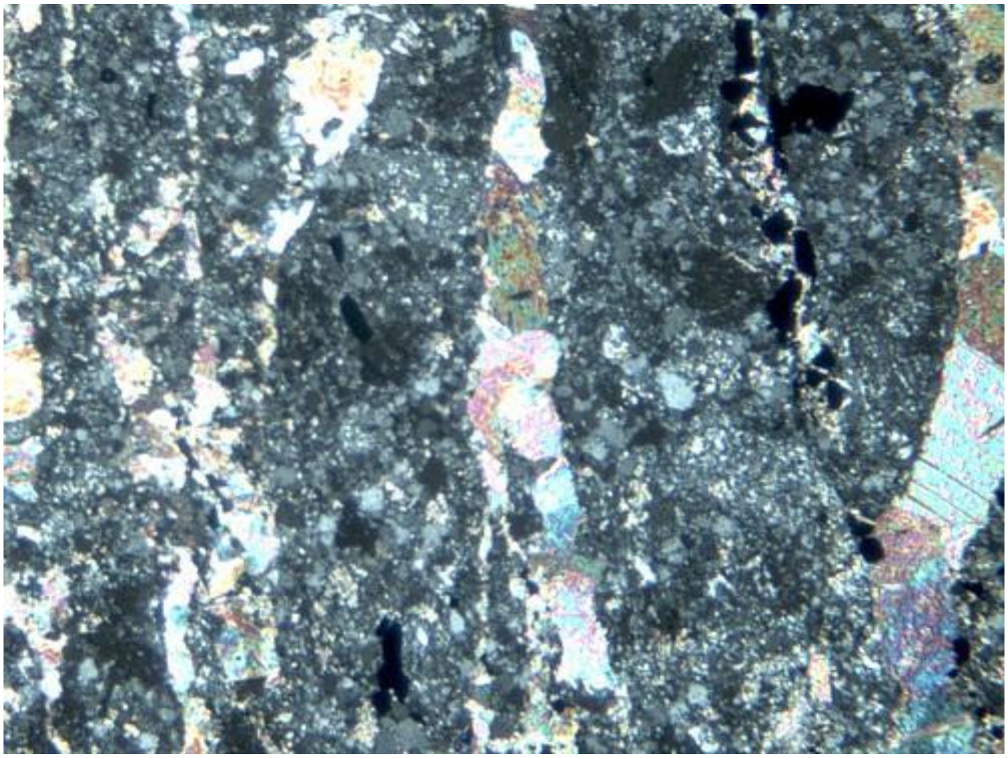
Fine-grained pyrite is the only sulfide present. The anhedral grains are disseminated through the matrix.

Detailed mineralogy

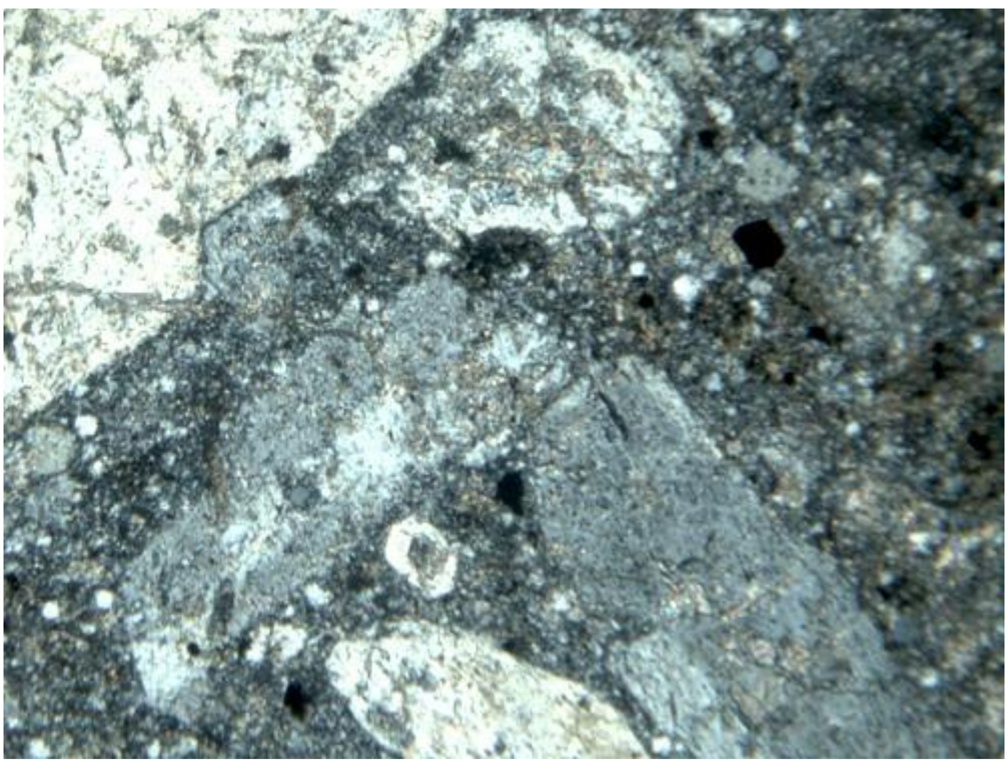
Mineral	**%**	**Grain size(mm)**	**Comments**
Plagioclase	33	0.2-3.0	Anhedral / subhedral plagioclase occurs as phenocryst and as small grains that are part of the matrix. Their composition ranges between oligoclase and andesine (more commonly oligoclase). Some are unaltered and some of the phenocrysts are sericitized.
K-feldspar	12	0.1-2.5	Subhedral orthoclases occur as phenocrysts and fine-grained anhedral orthoclase is part of the matrix. It is intercalated with matrix quartz and plagioclase.
Quartz	10	0.100.8	Fine-grained quartz is part of the matrix and a few anhedral grains are intergrown with carbonates in the carbonate veins.
Biotite	8	fibrous, minute	Fine-grained fibrous biotite is a replacement after biotite phenocrysts and also after what may have been originally amphibole phenocrysts (as suggested by the amphibole shape of some replaced grains).
Muscovite / sericite	7	minute-1.5	The rock originally contained a few muscovite phenocrysts, as suggested from the replacement of the phenocrysts by aggregates of fine-grained muscovite.
Chlorite	7		Fine-grained chlorite is interstitial to the matrix and it also occurs as replacement after some mafic phenocrysts (possibly amphibole?).

Carbonate	20	0.2-2.5	Carbonate veins having various widths are relatively abundant. They are fine to coarse-grained and the small grains are intergrown with the matrix quartz and feldspars.
Pyrite	3	0.05-0.6	Fine-grained pyrites are disseminated through the thin section. They range in size between 0.05 and 0.6mm.

Accessory minerals: apatite, rutile



Parallel carbonate veinlets in matrix of porphyritic diorite. X-axis of photo: 1.6mm. XN.



Porphyritic diorite (?) with large plagioclase phenocrysts.
X-axis of photo: 1.6mm. XN.

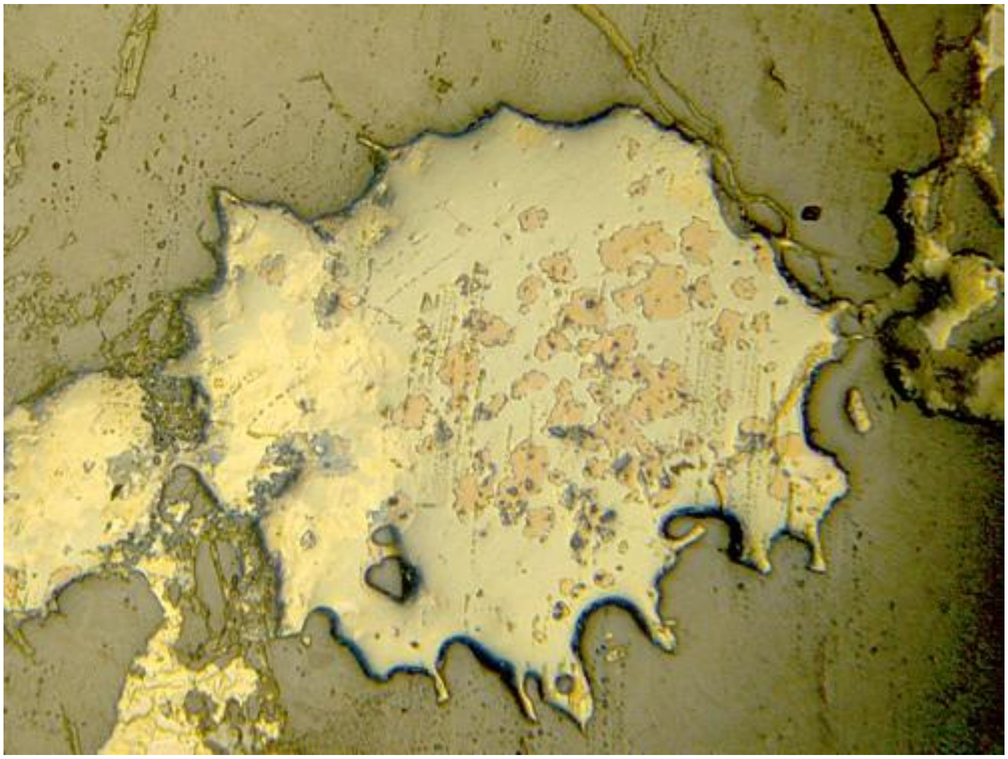
Sample Number: CO11653 **Rock Type: Mineralized quartz vein**

Petrographic Description:

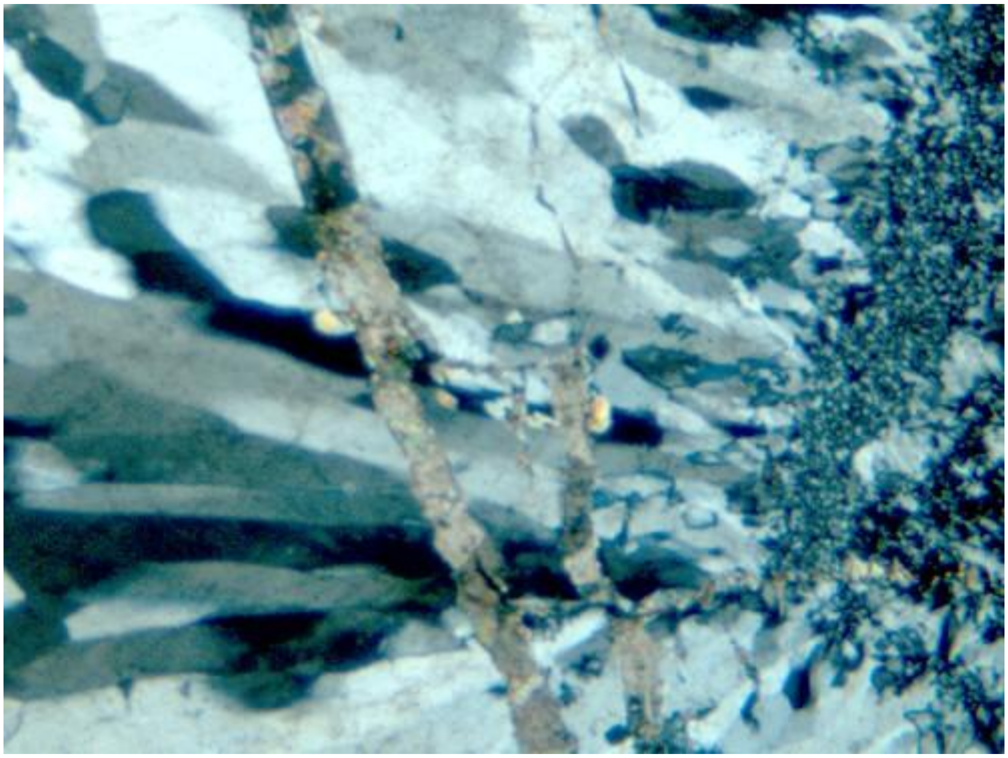
The thin section consists predominantly of quartz, minor carbonate and a small amount of sulfide. Coarse-grained, radiating plumose quartz and coarse-grained oriented quartz nucleates on microcrystalline chert. The quartz “veins” are cross-cut by narrow carbonate veins.

Only one type of sulfide is present in the quartz. Amoeboid shape and blue / orange color are characteristic of Cu-sulfides. The mineral is tentatively identified as chalcocite.

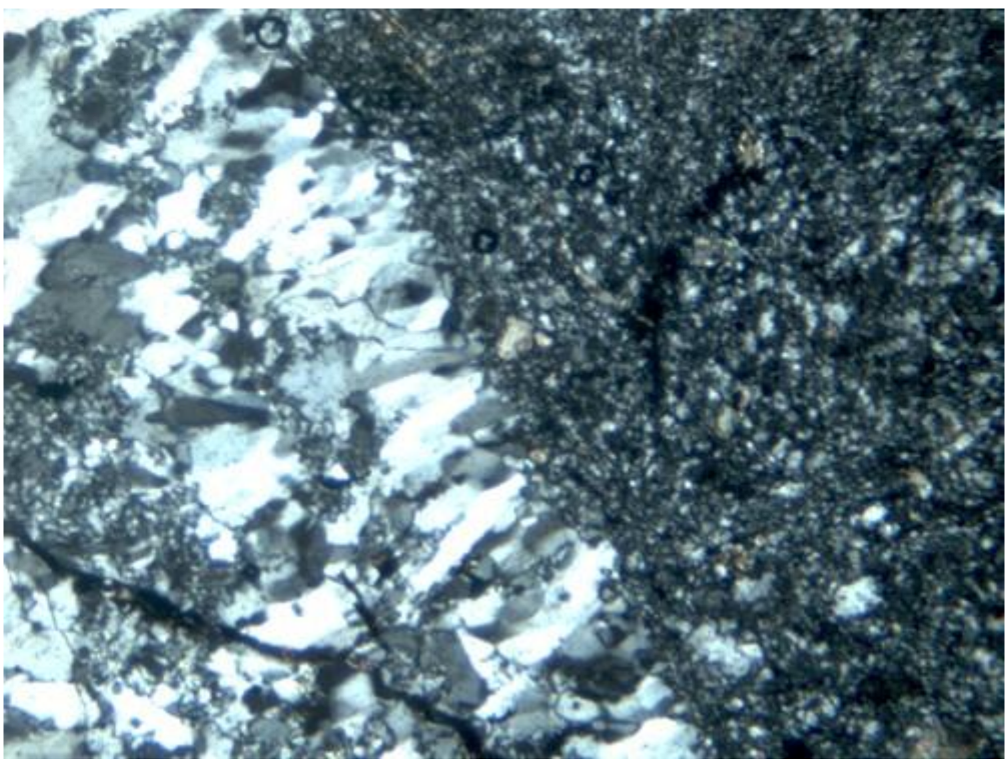
Note: the ‘swollen’ texture of chalcocite is the result of over-grinding the thin section during preparation. Quartz-rich rocks with soft minerals are notoriously difficult to prepare. The mineral should be analyzed for positive identification.



Amoeboid chalcocite in quartz vein. X-axis of photo: 0.64mm. Refl. Light.



Plumose quartz nucleates from microcrystalline siliceous matrix and is cross-cut by carbonate veinlets. X-axis of photo: 1.6mm. XN.



Similar to above. Cherty rock to right, vein to left.