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Ministry of Energy, Mines & Petroleum Resources
Mining & Minerals Division
BC Geological Survey

BC Geological Survey
Assessment Report
38499

Assessment Report
Title Page and Summary

TYPE OF REPORT [type of survey(s)]: Geochemical, Geological and Prospecting

TOTAL COST: $121,192.40

AUTHOR(S): Christopher O. Naas

SIGNATURE(S):

NOTICE OF WORK PERMIT NUMBER(S)/DATE(S): MX-13-240

YEAR OF WORK: 2019

STATEMENT OF WORK - CASH PAYMENTS EVENT NUMBER(S)/DATE(S): 5746761 (2019/JUL/04), 5752557 (2019/AUG/23)

PROPERTY NAME: Cathedral

CLAIM NAME(S) (on which the work was done): 684244, 688843, 689828, 689845, 837069, 1025888, 1045137, 1045138, 1055234, 1055266, 1055274, 1057886, 1057887, 1057889

COMMODITIES SOUGHT: Cu, Au, Ag

MINERAL INVENTORY MINFILE NUMBER(S), IF KNOWN: 094C-135, 094C-010, 094C-071, 094C-072, 094C-133, 094C-016, 094C-123

MINING DIVISION: Omineca

NTS/BCGS: 094C03, 094C04, 094C05, 094C06

LATITUDE: 56 ° 08 '28 " LONGITUDE: 125 ° 32 '18 " (at centre of work)

OWNER(S):
1) Thane Minerals Inc.
2)

MAILING ADDRESS:
PO Box 38099 Morgan Heights PO
Surrey, BC V3Z 6R3

OPERATOR(S) [who paid for the work]:
1) Thane Minerals Inc.
2)

MAILING ADDRESS:
PO Box 38099 Morgan Heights PO
Surrey, BC V3Z 6R3

PROPERTY GEOLOGY KEYWORDS (lithology, age, stratigraphy, structure, alteration, mineralization, size and attitude):
Property is mainly underlain by early Jurassic Hogem batholith comprised of quartz monzonites, diorites and syenites. The intrusives are in contact with the Upper Triassic Takla Group volcanics, comprised of volcanic flows, breccias and agglomerates. Copper mineralization is documented in many occurrences over much of the property, typically chalcopyrite along with malachite/azurite staining on rock surfaces. Alteration is mainly propylitic with potassic alteration associated with veining.

REFERENCES TO PREVIOUS ASSESSMENT WORK AND ASSESSMENT REPORT NUMBERS:
04599,14192,17742,17743,21419,21425,21426,26530A,29112,32106,33099,33294,33947,34793,35882,36337,37045,37736

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TYPE OF WORK IN THIS REPORT	EXTENT OF WORK (IN METRIC UNITS)	ON WHICH CLAIMS	PROJECT COSTS APPORTIONED (incl. support)
GEOLOGICAL (scale, area)			
Ground, mapping			
Photo interpretation			
GEOPHYSICAL (line-kilometres)			
Ground			
Magnetic			
Electromagnetic			
Induced Polarization			
Radiometric			
Seismic			
Other			
Airborne			
GEOCHEMICAL (number of samples analysed for...)			
Soil			
Silt			
Rock	48 samples (ICP-MS, Au geochem)	689828, 689845, 1055266	$2,783.37
Other	27 pulp samples (whole rock)	See page 1 under work done on claims	$940.44
DRILLING (total metres; number of holes, size)			
Core			
Non-core			
RELATED TECHNICAL			
Sampling/assaying			
Petrographic	27 samples	689828	$58,596.04
Mineralographic			
Metallurgic			
PROSPECTING (scale, area)	2.5 km2 (1:1,000)	689828, 689845, 1055266	$58,872.55
PREPARATORY / PHYSICAL			
Line/grid (kilometres)			
Topographic/Photogrammetric (scale, area)			
Legal surveys (scale, area)			
Road, local access (kilometres)/trail			
Trench (metres)			
Underground dev. (metres)			
Other			
		TOTAL COST:	$121,192.40

ASSESSMENT REPORT
GEOCHEMISTRY, GEOLOGY AND PROSPECTING
at the
Cathedral Area
of the
Cathedral Property
(684244, 688843, 689828, 689845, 837069, 1025888, 1045137,
1045138, 1055234, 1055266, 1055274, 1057886, 1057887, 1057889)
Omineca Mining Division, British Columbia, Canada

Owner: Thane Minerals Inc.
Operator: Thane Minerals Inc.

by
Christopher O. Naas, *P.Geo.*

October 6, 2019

NTS 094C
Latitude: 56°08'28"N
Longitude: 125°32'18"W

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1.0 INTRODUCTION

The Cathedral property (the "Property") is centred at latitude 56° 08' N and longitude 125° 32' W, approximately 65 kilometres northwest of Germansen Landing (Figure 1). The Property is located in the Omineca Mining Division of north-central British Columbia, Canada.

Field work consisted of two visits to the Property. The first visit was from August 23-25 2018, which collected samples for the petrographic study. The second was from July 17-26 2019, which undertook prospecting in the northern region of the Cathedral Area. These dates exclude project setup, shutdown, mobilization and demobilization.

The objective of the petrographic and whole rock study was to initiate the building of geological library for the Cathedral Property. The objective of the prospecting program was to investigate possible extensions of the Cathedral Showings to the northwest.

A list of definitions, abbreviations and conversion factors are presented in Appendix I. Structural orientations or Cartesian directions in this report are referenced with respect to true north.

1.1 ACCESS

Road access to the Property from Prince George is gained by taking Highway 97 north to Highway 39 (Mackenzie turnoff). At 16.2 kilometres along Highway 39, a 300 metre all-weather road exits to the west and connects to the Finlay FSR at the 8.2 km marker. At this junction, northbound travel heads to Mackenzie while southbound travel heads to Williston Lake via the Causeway and on to the Phillips Connection at the 18.6 km marker. At the Phillips Connection, the Mt. Milligan mine site and Fort St. James are accessed via the FSR that exits to the west, while access to the Cathedral property is north via the Finlay FSR. Continuing northward on the Finlay FSR, at the 173 km marker is the junction with the Finlay-Osilinka FSR. The Finlay FSR heads north to several small settlements such as Fort Ware, while the Finlay-Osilinka FSR heads west for 46.5 kilometres to the junction of the Osilinka FSR (46.5 km marker eastbound, 46 km marker westbound). At this junction, road signage designates the Finlay-Osilinka FSR as the Tenakihi Mainline. An abandoned logging camp is located to the northwest of the junction. The Tenakihi Mainline continues approximately 168 kilometres northwest from the junction to the closed Kemess South mine site.

From the Tenakihi Mainline/Osilinka FSR junction access is limited to the southern and eastern fringes of the Property. Access to the southern part of the Property is by the Thane Mountain FSR (62.6 km marker) and the Upper Osilinka Mainline (64 km marker), which is

modified from Hancock *et al*, Open File 2008-1

LEGEND

- Cathedral property
- Producing mine or under construction
- Proposed mine development
- Major exploration project
- Highway
- Secondary routes
- Railway
- River
- Waterbody

0 100km

THANE MINERALS INC.

LOCATION MAP
Cathedral Property

Cathedral Project
Omineca M.D., British Columbia, Canada

Project No:		By:	CN
Scale:	1:3,000,000	Drawn:	CN
Figure:	1	Date:	October 2019

gained via the Osilinka FSR. Access to the eastern part of the Property is by the Tenakihi FSR (14.5 km marker), which is gained via the Tenakihi Mainline. Access to the northern part of the Property is unknown, as an unnamed logging road exits to the west of the Tenakihi Mainline at the 23.8 km marker, but topographic maps show this road as being washed out. Alternatively, helicopter charters can be obtained from Smithers, Fort St. James and Mackenzie. An airstrip is located 3.2 kilometres north of the Tenakihi Mainline/Osilinka FSR junction along the Tenakihi Mainline (west side). The condition and capabilities of this airstrip for fixed wing aircraft is unknown.

1.2 PHYSIOGRAPHY

The property is located in Osilinka Ranges of the Omineca Mountains. The property is characterized by steep mountainous terrain. Elevations range from 960 metres in the Osilinka River valley along the southwestern boundary of the property to 2,360 metres above sea level at the mountain peaks. Numerous small tarns are found in the many cirques. Drainage is dendritic with a general flow to the southeast.

The Property is located on the eastern side of the Continental Divide and all drainage flows into Williston Lake, a man-made reservoir formed behind the W.A.C. Bennett dam and hydroelectric generating station. Drainage continues on to the Arctic Ocean.

1.3 PROPERTY

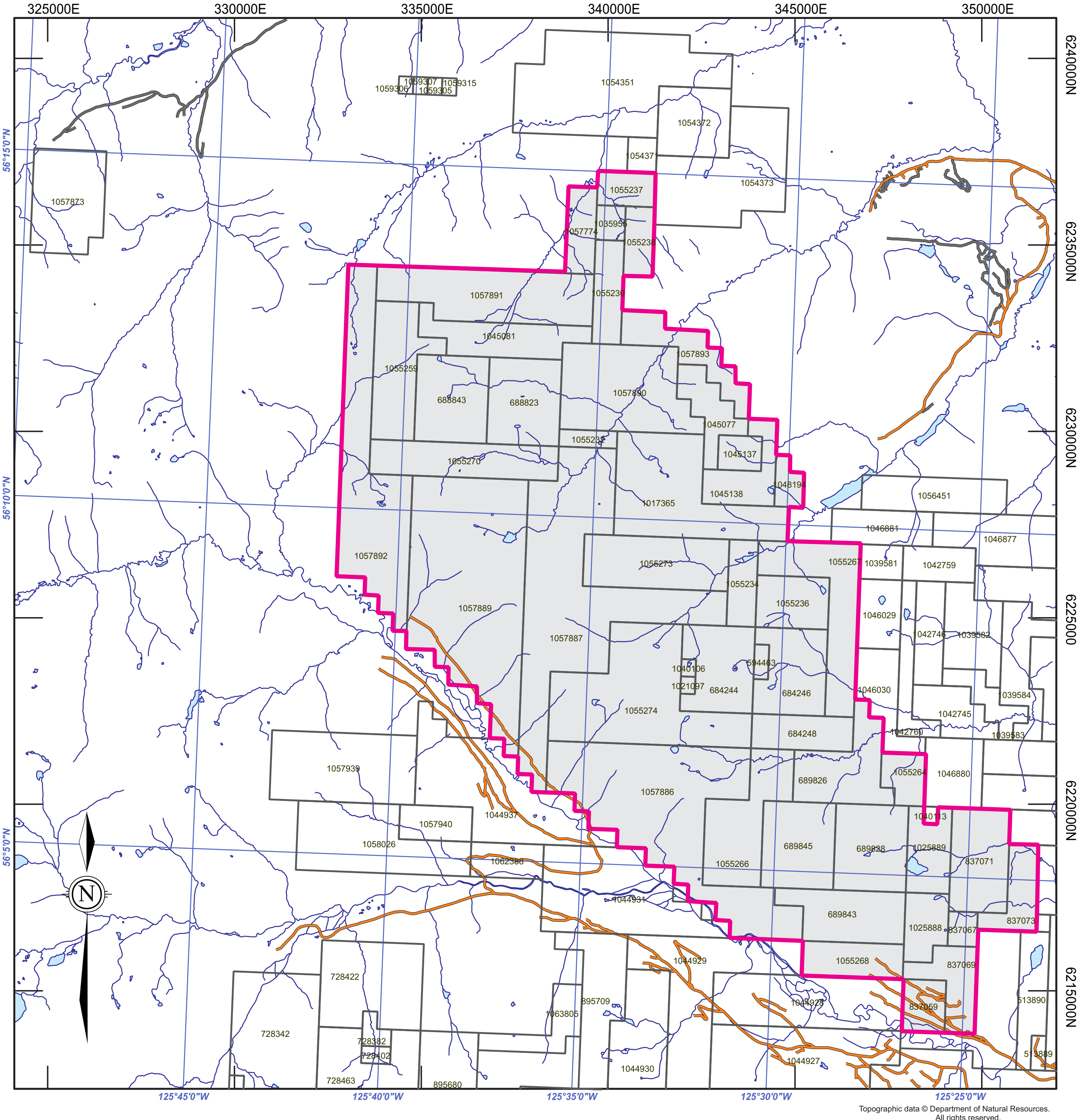
The 20,658.035 hectare Property consists of 48 MTO cell tenures, which are 100% owned by Thane Minerals Inc. A plan map of the mineral tenures is presented in Figure 2. Mineral tenure details are presented in Table 1.

Table 1: List of Mineral Tenures

Tenure Number	Area (ha)	Owner	Tenure Type	Good To Date
594463	36.0654	Thane Minerals Inc.	MTO Cell	2020/FEB/10
684244	414.7706	Thane Minerals Inc.	MTO Cell	2020/FEB/10
684246	414.7606	Thane Minerals Inc.	MTO Cell	2020/FEB/10
684248	252.555	Thane Minerals Inc.	MTO Cell	2020/FEB/10
688823	450.1158	Thane Minerals Inc.	MTO Cell	2020/FEB/10
688843	450.1199	Thane Minerals Inc.	MTO Cell	2020/FEB/10
689826	433.0388	Thane Minerals Inc.	MTO Cell	2020/FEB/10
689828	451.2893	Thane Minerals Inc.	MTO Cell	2020/FEB/10
689843	415.3282	Thane Minerals Inc.	MTO Cell	2020/FEB/10
689845	451.2932	Thane Minerals Inc.	MTO Cell	2020/FEB/10
837059	162.6033	Thane Minerals Inc.	MTO Cell	2020/FEB/10
837067	72.2301	Thane Minerals Inc.	MTO Cell	2020/FEB/10
837069	252.8936	Thane Minerals Inc.	MTO Cell	2020/FEB/10

Table 1: List of Mineral Tenures *(cont'd)*

Tenure Number	Area (ha)	Owner	Tenure Type	Good To Date
837071	433.2248	Thane Minerals Inc.	MTO Cell	2020/FEB/10
837073	216.6435	Thane Minerals Inc.	MTO Cell	2020/FEB/10
1017365	864.7239	Thane Minerals Inc.	MTO Cell	2020/FEB/10
1021097	18.0354	Thane Minerals Inc.	MTO Cell	2020/FEB/10
1025888	198.6395	Thane Minerals Inc.	MTO Cell	2020/FEB/10
1025889	252.7215	Thane Minerals Inc.	MTO Cell	2020/FEB/10
1035955	71.9387	Thane Minerals Inc.	MTO Cell	2020/FEB/10
1040106	18.0336	Thane Minerals Inc.	MTO Cell	2020/FEB/10
1045077	234.071	Thane Minerals Inc.	MTO Cell	2020/FEB/10
1045081	377.9497	Thane Minerals Inc.	MTO Cell	2020/FEB/10
1045137	108.0609	Thane Minerals Inc.	MTO Cell	2020/FEB/10
1045138	252.1758	Thane Minerals Inc.	MTO Cell	2020/FEB/10
1048194	90.0613	Thane Minerals Inc.	MTO Cell	2020/FEB/10
1055230	215.9103	Thane Minerals Inc.	MTO Cell	2020/FEB/10
1055232	72.0359	Thane Minerals Inc.	MTO Cell	2020/FEB/10
1055234	180.2442	Thane Minerals Inc.	MTO Cell	2020/FEB/10
1055236	270.3817	Thane Minerals Inc.	MTO Cell	2020/FEB/10
1055237	143.8463	Thane Minerals Inc.	MTO Cell	2020/FEB/10
1055238	143.8938	Thane Minerals Inc.	MTO Cell	2020/FEB/10
1055259	468.037	Thane Minerals Inc.	MTO Cell	2020/FEB/10
1055264	144.352	Thane Minerals Inc.	MTO Cell	2020/FEB/10
1055266	523.4329	Thane Minerals Inc.	MTO Cell	2020/FEB/10
1055267	540.7679	Thane Minerals Inc.	MTO Cell	2020/FEB/10
1055268	252.8778	Thane Minerals Inc.	MTO Cell	2020/FEB/10
1055270	468.2975	Thane Minerals Inc.	MTO Cell	2020/FEB/10
1055273	540.6773	Thane Minerals Inc.	MTO Cell	2020/FEB/10
1055274	1100.2454	Thane Minerals Inc.	MTO Cell	2020/FEB/10
1057774	179.8537	Thane Minerals Inc.	MTO Cell	2020/FEB/10
1057886	1588.3245	Thane Minerals Inc.	MTO Cell	2020/FEB/10
1057887	1748.4763	Thane Minerals Inc.	MTO Cell	2020/FEB/10
1057889	1784.4579	Thane Minerals Inc.	MTO Cell	2020/FEB/10
1057890	774.1504	Thane Minerals Inc.	MTO Cell	2020/FEB/10
1057891	737.7081	Thane Minerals Inc.	MTO Cell	2020/FEB/10
1057892	1080.7358	Thane Minerals Inc.	MTO Cell	2020/FEB/10
1057893	305.9846	Thane Minerals Inc.	MTO Cell	2020/FEB/10



LEGEND

Cathedral Property

728342 Other tenure boundaries (as of November 13, 2018)

Topography

Gravel road (not all roads and trails shown)

Watercourse

Waterbody

0 5km

NAD83 UTM Zone 10 North
NTC 094C03,04,05,06

THANE MINERALS INC.

MINERAL TENURE MAP
Cathedral Property

Cathedral Project
Omineca M.D., British Columbia, Canada

Project No:		By:	CN
Scale:	1:150,000	Drawn:	CN
Figure:	2	Date:	October 2019

2.0 WORK HISTORY

The Property has been subject to a number of preliminary regional exploration projects with only localized detailed exploration and sampling in specific areas.

Exploration of the Hogem batholith and surrounding area was initiated in the late 1800's with placer gold being discovered in the district in 1868. During the 1930's Consolidated Mining and Smelting Ltd. explored the margins of the Hogem batholith and conducted underground exploration on several properties for gold, silver, lead and mercury. Kennco Explorations Ltd. explored and staked portions of the Hogem batholith near Duckling Creek in the 1940's. In the early 1970's, mineralization on the Lorraine property discovered by Kennco and subsequently held by Granby Mining Company represented the only significant mineralization found to that date. At the time it was estimated that the Lorraine deposit contained a maximum of 10 million tons grading 0.70% copper.

In the late 1960's and early 1970's the Belgian company, Union Miniere Exploration and Mining Corp. Ltd (UMEX) of Montreal conducted extensive regional exploration in north-central British Columbia, over the Property and surrounding areas. Regional work, carried out by Dolmage Campbell & Associates Ltd., included aeromagnetic surveying and silt sampling (Kahlert, 2006). The aeromagnetic survey outlined three anomalies along the northeast flank of the Hogem batholith. The silt sampling revealed anomalous copper values at the headwaters of Matetlo Creek. Further investigation found low-grade copper mineralization in fractures and disseminated in both the volcanic and intrusive rocks. In 1970, a soil sample grid was established over what was known as the western half of the Mate 2 claim. An open-ended east-west trending copper anomaly (>l00 ppm) measuring 1500 by 750 meters was outlined. Anomalous copper values were found in silts in the headwaters of the south fork of Matetlo Creek.

Stevenson (1991) reports that during the summer of 1971, Amoco Canada conducted a reconnaissance stream sediment sampling-mapping program over the Hogem batholith in search of porphyry copper-molybdenum deposits. A total of 7,376 silts, water, rock and soil samples were collected from an area of approximately 2,400 square kilometers and analyzed for copper and molybdenum. Amoco did not assay for gold in any of these samples. Numerous areas with anomalous copper and/or molybdenum in stream sediments were detected. Four areas were staked and worked by Amoco during 1972 and 1974. These areas were known as the Tyger, Needle, Oy and Hawk properties. Property work consisted of reconnaissance and detailed soil sampling and geological mapping. The latter three properties were restaked by Cyprus in 1990 and named the Steele, Ten and Hawk properties, respectively. It is unclear how much overlap is between the Oy property and the subsequent Ten property. The former, based on limited information appears to have been located east of the Ten area, in and around the current OY occurrence (Minfile 094C 071). Geology and Exploration and Mining (1973) describes this as an area of monzodiorite and diorite, invaded by numerous dykes and apophyses of fine-grained quartz monzonite and monzonite which are in contact with Takla Group rocks Chalcopyrite occurs as fracture coatings, coarse grains in quartz veins, and minor disseminations over the whole property. Mineralization includes chalcopyrite and specular hematite. No reports of the results of work undertaken are known.

In 1971, Fortune Island Mines Ltd. located several copper occurrences proximal to the earlier UMEX showings. Chip samples from disseminated and fracture-controlled mineralization in propylitized intrusive assayed up to 0.23% and 0.38% copper over 50 and 30 feet respectively. A chip sample across the core of a six foot wide quartz-vein assayed 2.18% copper over 3.5 feet. A six inch chip sample from a four foot wide quartz-vein returned 3.52% copper and 0.02 oz/ton gold and represents the only gold assay reported. Four aeromagnetic positive anomalies were identified on and adjacent to the Mate property.

In 1972, Noranda Exploration Company, Limited staked the Gail Group claims encompassing a copper-molybdenum prospect located in a small north-facing cirque at the headwaters of Tenakihi Creek. Work on the Gail Group in 1973, included line cutting, soil sampling (40), rock geochemistry (30 talus chips representing a 200 foot section of the contour sampling traverse line), prospecting and mapping at a scale of 1”=400’. Soil and talus samples were analyzed for copper, molybdenum and zinc in Noranda’s company laboratory in Vancouver, British Columbia. It was noted that in soils, zinc values were erratic and didn’t correlate well with either copper or molybdenum, both of which were considered to be anomalous over the entire grid. The talus chips were noted as having values consistent with observed copper mineralization in the cirque walls to the south and southeast and its noted absence on the walls to the west.

Major General Resources Ltd. (now Commander Resources Ltd.) acquired the extensive UMEX database when UMEX closed its Canadian operations in the early 1980’s. With the discovery of the Mt. Milligan deposit and favorable metal prices, interest in copper-gold porphyry deposits resurged in the late 1980’s.

In 1990, Cyprus Gold (Canada) Ltd. investigated several properties in the Thane Creek area. These included the Ten claims encompassing the Gail Zone area and the ET claims encompassing the ET Zone, both on the current Property, as well as the OS, Hawk and Steele claim groups located south of the Property. All prospects were explored for potential gold mineralization.

Work done on the Ten and the ET claims included reconnaissance style geological mapping, soil sampling, rock sampling and proton magnetometer surveying. All soil and rock samples were analyzed for gold and copper.

On the Ten property there were no significant gold values returned from the analyses and as such, no further work was recommended for gold exploration. It was noted that the property did host several broad, moderate to strong copper anomalies associated with strongly potassic-altered syenites. Some of these anomalies were traced for greater than 1,400 metres along strike and up to 400 metres in width, with copper values ranging from 300 ppm to 600 ppm and a high noted at 1,200 ppm copper. From these significantly anomalous copper results, it was recommended that the property should be investigated further for its porphyry copper potential.

Soil and rock geochemistry results from the ET property yielded low gold values with a single high gold-in-soil value of 25 ppb and the highest gold value in rocks being 315 ppb. In terms of copper, several rock samples yielded results of >5000 ppm with the highest value being 1.9% copper found in float and 1.1% copper returned from an outcrop. Soil samples generally outline broad anomalous copper zones associated with the anomalous rock sample values. The largest anomalous zone measures 600 metres by 300 metres and has soil values ranging from 300 ppm to 500 ppm copper. Further exploration for gold on the ET property was dissuaded, however, as the property hosts several significant copper soil anomalies, further exploration of the property's porphyry copper potential was recommended.

The TK 1 and TK 2 mineral claims were staked by Electrum Resource Corporation in June of 1990 and subsequently worked on in the 1991 and 1992 field seasons. In 1992, preliminary mapping was done at a scale of 1:15,000 and 19 rock chip samples and 1 heavy mineral stream sediment sample were collected and analyzed. The highest copper value to come out of the 1992 work was 2,907 ppm copper from a piece of intensely calcified Takla volcanic float. The setting indicated that the float is locally derived and that further work was needed in order to define where the sample originated.

In 1991, Major General utilized the UMEX data to select specific porphyry targets within the Hogem batholith. Major General staked and subsequently explored number of properties, including the Mate property encompassed by the current Property.

Also in 1990 and1991 a program of prospecting and sampling was performed around the Link claims which included rock, silt and soil samples. Disseminated chalcopyrite, magnetite and pyrite were noted in rock samples. Soil samples returned anomalous copper up to 261 ppm copper and a rock sample returned 1,547 ppm copper (Ethier, 1991, BC Minfile 094C 123).

Regional mapping in 1991 by BC Geological Survey crews resulted in the defining of several new occurrences on and around the Mate property, which have been added to the provincial mineral occurrence database (MINFILE). These include 094C 113 (Yak), 114 (Koala), 115 (Intrepid), 116 (Bill), 117 (Yeti) and 118 (Dragon).

During the 1991 and 1992 field season, Major General's Mate property was explored under an option agreement with Swannell Minerals Corporation. Prospecting, silt sampling and geological mapping, followed by grid-controlled soil sampling over the previously identified soil anomaly, were carried out. Mapping noted that Takla volcanics on the property were intruded by a monzonite stock in the central portion of the then current Mate property and by the Hogem batholith in the south. Narrow granodioritic dykes cut Takla volcanics proximal to the monzonite stock. Mineralization occurred as disseminated magnetite and pyrite in monzonite and volcanics; fracture-controlled malachite, azurite with or without minor chalcopyrite, and, magnetite and pyrite in monzonite; magnetite veins up to 15 cm wide with rare chalcopyrite and quartz veins with azurite, malachite and rare bornite. While extensive propylitic or potassic alteration was not found, two areas of significant copper mineralization were identified. Of particular note was malachite-azurite in quartz monzonite traced in talus for 200 metres along the base of a slope.

Lithogeochemical response from the work on the Mate claims include 7 samples of greater than 1,000 ppm copper with a maximum 3.08% copper and 0.039 oz/ton gold. Gold response was generally <15 ppb with the exception of one other sample that ran 175 ppb gold and 2135 ppm copper and two with 107 and 500 ppb gold, both with copper <65 ppm. A total of 228 soil samples were collected. Copper ranged from 14 to 468 ppm. Gold ranged from 1 to 152 ppb. Material sampled was primarily talus fines and stream sediment. Additional work including detailed mapping and sampling was recommended on the Mate property. However, interest in porphyry targets waned and shortly thereafter a major decline occurred in the provincial mineral sector leading to the inability to raise exploration funds to pursue the targets and the property was allowed to lapse.

Swannell Minerals Corporation was also working on an area designated as the Aten group of claims, partially encompassed by the current northeastern portion of the Property, and enclosing three Minfile showings: Gail, Ten and Tenakihi Creek. In 1991, Swanell contracted Reliance Geological Services Inc. to explore the Aten group of claims for its alkalic porphyry copper-gold potential. During October 1991, a program of rock sampling (11 samples), stream sediment sampling (31 samples) and reconnaissance geological mapping at a scale of 1:10,000 was carried out. Two rock samples returned copper values of 2.82% and 2.83%. Based these values and on anomalous results from stream drainages, three target areas were identified. From there, further work was recommended consisting of grid establishment, detailed geological mapping, soil sampling, and talus fines sampling.

In 1993, Swanell Minerals Corporation worked on the Aten property encompassing the Tenakihi Creek Minfile occurrence. Fieldwork was designed to follow-up the anomalous rock and soil geochemistry identified in earlier exploration. Fieldwork consisted of a surveyed grid laid out over the north-central area of the property, geological mapping on the gridded area at a scale of 1:10,000, collection of 23 rock samples and 88 soil samples both analyzed for copper and gold. Lithogeochemistry results includes 9 samples of >1,000 ppm copper with a maximum of 3.20% copper. Gold response was lower and erratic, with 4 samples greater than 100 ppb gold and a maximum of 205 ppb gold and 3,599 ppm copper. Gold response from the 88 soil samples collected was noted as being below the 5 ppb detection limit, the only exceptions being two high values of 28 and 32 ppb gold. Further work was recommended targeting three specific areas on the property.

During 1994, a regional geochemical survey was carried out by the BCGS sampling drainages throughout the 1:250,000 scale NTS map area, 94C (Mesilinka River). A total of 1068 sites were visited. Anomalous samples collected from the Property area included 302 ppm copper from a creek draining the ET area, 246, 258 and 270 ppm copper from creeks draining the Mate/Mat areas, and 216 ppm, 220 ppm and 246 ppm copper draining areas in the Ten/Gail area. Several strong gold-in-silt anomalies were also noted particularly in the north of the property (154 ppb gold) from a creek draining into Matetlo Creek. In the Ten area a sample yielded 86 ppb gold and associated with copper values greater than 200 ppm.

Phelps Dodge Corporation staked claims in the area in late 1999 after completing a regional silt sampling and prospecting program consisting of collecting 16 rock samples and 8 silt samples.

The following year, Phelps Dodge Corporation conducted preliminary soil, bedrock and silt sampling and geological mapping in the Tenakihi Creek area, located near the eastern part of the property. A total of 83 bedrock and float samples, 15 chip samples and 25 silt samples were collected from the claim area and an additional 36 rock, 8 soil and 29 silt samples collected outside the claim area. Of the grab samples collected, 23 returned greater than 0.5% copper, and 8 samples returned greater than 2% copper (Kulla, 2001). This preliminary evaluation of the Tenakihi claims identified widespread disseminated chalcopyrite, chalcopyrite-bornite-malachite-magnetite veins and chalcopyrite-bearing quartz-carbonate veins. Numerous anomalous copper zones appear to be hosted in monzonitic intrusions of the Hogem batholith and are locally associated with prominent but discontinuous east-west trending faults and shear zones within the intrusions. Results from the work of Phelps Dodge were deemed favourable, warranting a follow-up program of detailed mapping, soil sampling and trenching as well as additional prospecting outside the claim boundaries.

In 2005, renewed interest in porphyry copper-molybdenum occurrences, inspired by increased metal prices, prompted Commander Resources to review their in-house data and former projects of the entire area. The Mate property, the Aten property, and four other prospective areas were acquired. In August 2005, a short prospecting program was completed on the Mate with 31 soil samples and 2 rock samples taken. From this cursory program further recommendations were made. These were that a detailed soil and induced polarization survey be completed, that all showings were to be re-sampled and assayed for gold and that drilling be done on any IP chargeability highs outlined in the follow-up.

On the Aten property, Commander Resources conducted a limited soil surveying and prospecting in August 2005. A total of 11 soil samples and 17 rock samples were collected while prospecting the property. This short program was successful in discovering a new high-grade copper prospect called the CJL Zone, located in the southern part of the property. The CJL Zone is hosted in highly altered, foliated syenite, not previously noted on the Aten property. Float samples were noted with values ranging as high as 12.4% copper. A program of detailed geological mapping, prospecting, gridding and magnetics surveying was recommended for follow-up, as well as diamond drilling on the CJL Zone should it warrant further work.

Also during 2005, Geoscience BC sponsored a program of increasing the ASTER imagery dataset for the BC Ministry of Mines, Energy and Petroleum Resources. Four alteration images for each scene were prepared using combinations of the standard ASTER bands. The images are designed to map the relative abundances of siliceous rocks, iron oxides, sericite and illite, and alunite and/or kaolinite (Kilby and Kilby, 2006). This work includes coverage over the current Property.

In 2006, Geoinformatics Exploration Canada Ltd (Geoinformatics) acquired a large tract of land totaling 126,664 hectares in the Mesilinka area of the Hogem batholith through staking and option agreements with Commander Resources and Norwest Enterprises. Commander conducted a regional exploration and data compilation on the ground, focusing on porphyry copper and copper-gold skarn potential within central to northern Quesnel Terrane. The fieldwork followed an extensive phase of digital data capture, integration and interpretation, and subsequent regional target generation. The data captured and compiled included 3,168 stream sediment samples, 4,491 rock samples (and rock chip samples), and 1,455 soil samples. Of the stream samples, 226 of the were collected over the southern portion of their project area during the 2006 field season due to insufficient data available in the public domain on that particular area. In addition to the stream sediment sample collection, a two hole diamond drill campaign totaling 751.5 metres on the previously drilled Kliyul copper-gold skarn located north of the Property, aimed to further evaluate the skarn potential.

From the work done on the Mesilinka project in the 2006 season, the regional stream sediment sample program identified a number of strongly anomalous catchments to focus the 2007 field program and validate copper-gold targets identified through the data compilation process. This both confirmed the significance of known copper-gold prospects and Minfile occurrences, and identified new target areas.

Follow-up work in 2007 by Geoinformatics involved geological mapping and diamond drilling on several prospects derived from the data gathered in the previous year's work. Within the greater area of their project, four main areas were investigated through detailed geological mapping and subsequent diamond drilling. These prospects were Norwest, Abe, Aten and Pal prospects with the Aten and Pal prospects closest to the current Property area. Two (2) diamond drill holes totaling 885.4 metres were drilled on Aten and three (3) diamond drill holes totaling 510.9 metres were drilled on Pal. Results at the Aten and Pal prospects were deemed insignificant and no further work was recommended.

Also during 2007, Geoscience BC commissioned airborne geophysical surveys including magnetics and gravity surveys as part of the QUEST Project. The surveys covered ground of the Quesnel Terrane from Williams Lake to Mackenzie, BC. The Property lies at the extreme northwestern edge of the survey coverage. Processed gravity data is available as images that cover the entire Property. Magnetic surveying did not completely cover the Property area so complete gridded coverage is not available.

During 2010, CME Consultants Inc. carried out a comprehensive compilation program of the Property and the surrounding area using data from assessment reports as well as public domain sources of geochemical, geophysical and geological data. This compilation led to identify four areas of interest. Three of the four areas of interest were visited over four days in August and September 2010. Exploration consisted of prospecting, rock sampling (69 samples) and stream sediment sampling (10 samples). In Area 1, rock sampling identified numerous anomalous samples (>0.1%) with copper and/or gold mineralization of up to 13.9% copper, and 23.6 g/t gold (also 27.6 g/t Ag). Other highlights included 1.23% copper and 0.65% copper. In Area 2, rock sampling also identified numerous samples of anomalous copper and/or gold mineralization including 2.85% copper and 265 ppb gold and 1.08% copper and 435 ppb gold. Significant results in Area 3 included 0.84% copper and 195 ppb gold and 0.54% copper and 45 ppb gold (Naas, 2011).

Follow-up exploration by CME during 2011 focused on the Cathedral Zone and the Link Zone in the southern portion of the Property. The Cathedral Zone has been previously referred to as Area 1 (Naas, 2011). The Link Zone is in the area of the BC Minfile showing 094C 123 (Link). Geochemical sampling consisted of rock, silt and soil sampling. Numerous high-grade rock samples of over 1% copper and 1 g/t gold were collected from a variety of locations in the explored area. Sampling at the Cathedral Zone in the vicinity of a high-grade copper-gold sample collected the previous year (13.9% copper, 23.6 g/t gold) returned another high-grade rock samples grading 3.29% copper and 20.1 g/t gold. Silt samples yielded strongly anomalous copper values of up to 419 ppm copper in the northwest portion of the Cathedral Zone, an area which remains relatively unexplored. Silt samples from a creek draining the eastern portion of the Cathedral Zone yielded anomalous gold values of up to 80 ppb gold. Soil sample analysis by a hand-held XRF unit returned anomalous copper values in the area of the Link Zone and suggest several parallel to sub-parallel zones of greater than 100 ppm copper striking in a north-north west direction with lengths of up to 500 metres and widths of up to 150 metres.

In 2012, Thane Minerals acquired the Property and undertook geological mapping, rock sampling, and soil sampling within the Cathedral, Gail, Cirque and Lake Areas. Detailed silt sampling was undertaken in the Lake Area. Results returned up to 13.9%Cu from the Cathedral Showing, up to 13.0 g/t Au from the Pinnacle Showing and 4.56% Cu from the Lake Area. Silt samples from the drainage of the Lake Area returned up to 627 ppm Cu (Naas 2013).

In 2013, Thane Minerals undertook a prospecting program at the Pinnacle Showing and at the Lake Area (Naas, 2014). A total of 54 rock samples were collected at the Pinnacle Showing, while 23 rock samples were collected at the Lake Area. Additionally, a 2.275 line-km survey grid was established at the Lake Area from which 96 soil samples were collected.

At the Pinnacle Showing, a 60 metre wide fault zone was mapped, which contained a minimum of seven faults striking 150° to 170° and dipping 50° to 60° W. Sampling from the two westernmost and two easternmost faults of the fault returned the most significant gold results (up to 3.60 g/t Au and 7.78 g/t Au respectively), though anomalous gold is also present within the central structures of the 60 wide fault zone. Significant gold samples were found to have anomalous arsenic values, although the converse did not necessarily hold.

Of the 54 rock samples collected from the Pinnacle Showing (and its strike extensions), 16 returned greater than 0.1 g/t Au and 7 returned greater than 1.0 g/t. Additionally 8 samples returned greater than 0.1% Cu with a maximum of 2.91% Cu.

In 2015, an airborne geophysical survey was undertaken on all mineral tenures of the Cathedral Property and four days of prospecting at the Mat and Pinnacle Showings and the ET and Lake Areas (Naas, 2016a). The work program consisted of:

- 974 line-km of helicopter-borne magnetic and radiometric surveying;
- 22 rock samples and 7 sediment samples for geochemical analysis.

The results from the propspecting program confirmed the presence of historically reported copper mineralization at the ET Showing and silver at the Mat Showing. Stream sediment sampling at the ET Showing failed to duplicate historical tin values.

Copper mineralization was discovered in a new area within the Lake Area, north of current known mineralization.

In 2016, prospecting was undertaken on select areas of the Property (Naas, 2016b). . A total of 56 rock samples and 79 soil samples were collected at the newly acquired CJL Showing. A total of 6 stream sediment samples, 49 soil samples and 24 rock samples were collected to test a historical sediment sample of anomalous gold values from the northern portion of the property, west of the Mat Showing (RS Creek). At the OY Showing, a total of 22 stream sediment samples and were collected.

At the CJL Showing, a total of 31 of the 56 samples returned greater than 0.10% Cu, with 10 samples returning greater than 1.0% Cu. The style of mineralization at the CJL Showing was observed to be a copper-rich magnetite/specular hematite breccia

At RS Creek, although the anomalous historical gold-in-silt sample was confirmed with a sample that returned 0.582 ppm Au, this sample was considered to be the result by glacial till contamination and not from bedrock sources.

At the OY Showing, the historical gold-in-silt sample was confirmed, but no other anomalous samples were returned from the creek.

In 2017, a structural and alteration study was undertaken at the Cathedral Area. Mineralization was considered to be the result of a structurally controlled alkalic porphyry system. Due to the moderate dip of the mineralization, the system was speculated to be tilted post-emplacement about a north-south to northwest-southeast axis of approximately 45 degrees, similar to Mount Milligan (Gordon *et al.*, 2018).

In 2018, a total of 959 soil samples were collected from 24.075 km of survey lines established in three areas within the south and southeastern portions of the Property. Four areas of anomalous soils were returned from the program (Naas, 2018).

3.0 GEOLOGY

3.1 REGIONAL GEOLOGY

The Property is situated within the Quesnel Terrane, on the eastern flank of the northern end of the Hogem batholith (Figure 3). The Quesnel Terrane is an accreted Mesozoic volcanic arc terrane that forms a north-south trending linear belt of rocks approximately 1,600 kilometre long along the eastern margin of the Canadian Cordillera. The terrane is dominantly Upper Triassic to Lower Jurassic volcano-sedimentary sequences that include the Takla, Nicola and

Stuhini groups. Coeval and post-accretionary Cretaceous intrusions are scattered throughout this terrane. The Cretaceous Hogem multi-phase batholith is the largest of these intrusions, forming the spine of this island arc allochthonous, intermontane superterrane. The northwest-

trending elongate Hogem batholith extends for approximately 120 kilometres from Chuchi Lake at the southernmost limits, to the Mesilinka River at the northern limit. It is bound on the west by the Pinchi Fault and on the east by the Upper Triassic to Lower Jurassic Takla volcanics. The Hogem batholith is composed of a peripheral zone of dioritic plutons, such as the Thane and Detni intrusives, surrounding a central granodioritic (Hogem granodiorite) and syenitic (Duckling Creek Complex) core. The Hogem batholith is intruded and crosscut by early to mid-Cretaceous granitic plutons, such as the Mesilinka Intrusive and the Osilinka Intrusive.

3.2 PROPERTY GEOLOGY

The Property is predominantly underlain by intrusive rocks of the Hogem Plutonic Suite (HPS). Intermediate volcanic rocks of the Takla Group are in contact with the HPS intrusives at the northeastern portion of the Property (Figure 4). Numerous dykes, sills and small stocks are noted in both the main geological units. These small intrusions are generally related to the Hogem intrusive. The areas of current exploration are located wholly within the HPS rocks. Descriptions of the various rock types over the whole property can be found in Naas (2013).

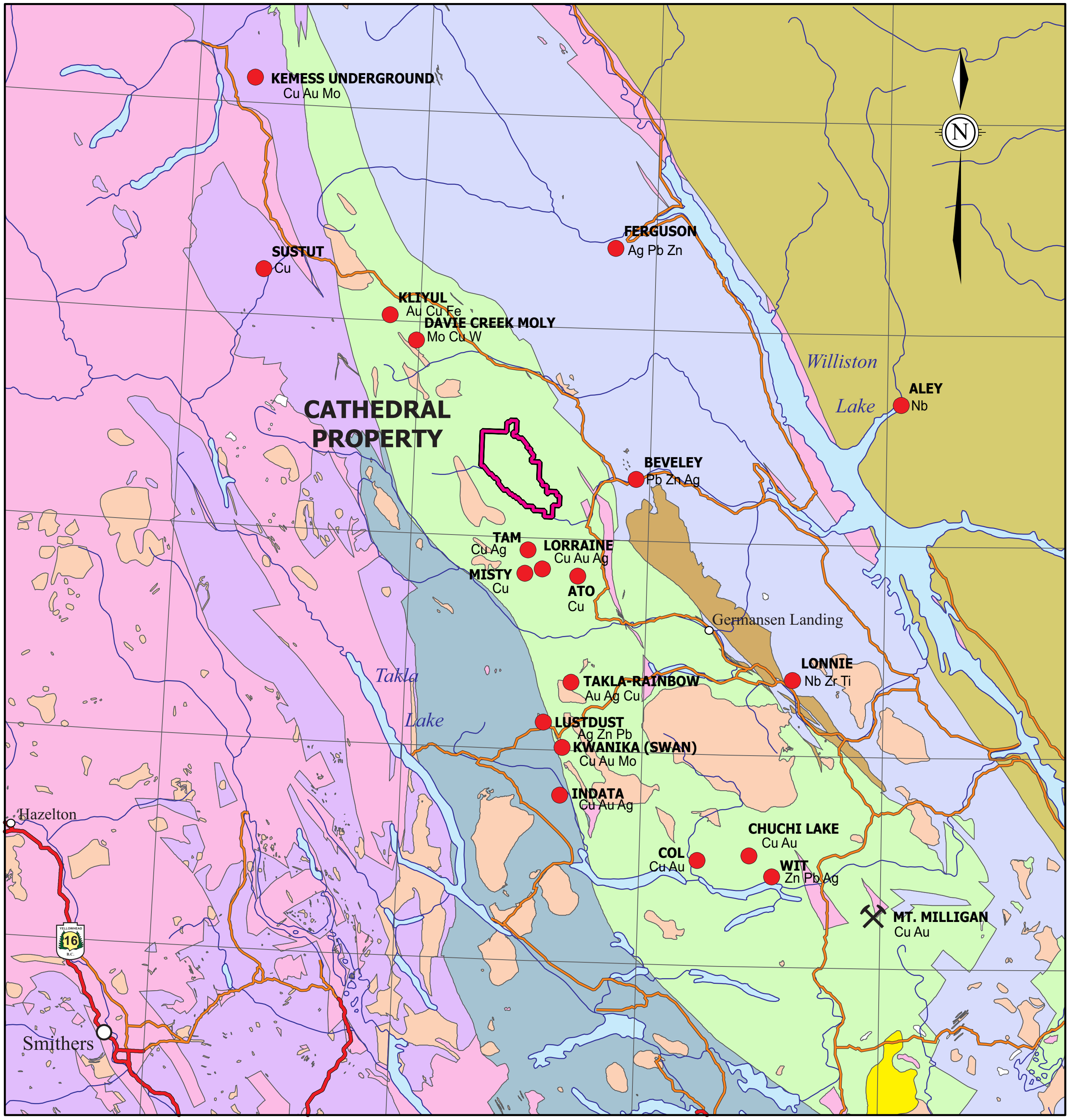
Hogem Plutonic Suite

From historical work done on and around the Property, there are numerous phases of the Hogem Plutonic Suite (HPS) including: granite; granodiorite; hornblende granodiorite; quartz diorite; microdiorite; diorite; monzodiorite; quartz monzonite; monzonite; and, syenite. The dominant intrusives types reported based on field mapping are monzonites, monzodiorites, diorites and syenites. Granites, granodiorites and other intrusives mapped tend to be smaller dyke-like units within the main intrusive types.

Quartz Monzonite

Quartz monzonite is identified in most areas of the Property, consistent with the regional BCGS mapping that identifies the Hogem Plutonic Suite as primarily quartz monzonitic. Quartz monzonite is the primary intrusive phase at the Cathedral Area, hosting the Pinnacle Showing, as well as noted in the Lake Area.

Quartz monzonite of the HPS can be a range of colours, from grey to salmon pink, or gossanous due to variable alteration. Typically, fresh surfaces show black, white and pink crystals. Texturally, the unit may range from fine to very coarse-grained and equigranular. Plagioclase and potassium feldspars make up 60 to 80% of the rock (50-75% plagioclase and 25-50% potassic feldspar). Quartz ranges from 5 to 15% and mafic minerals (amphiboles and biotite) comprise 10 to 25%. Magnetite is variable, with generally higher concentrations noted in the Link and Lake area occurrences (3-5%, locally up to 15%).



LEGEND

GEOLOGY

- Younger volcanics
- Post Accretionary
- Cache Creek Terrane
- Cariboo/Cassiar Terrane
- Quesnel Terrane
- Slide Mountain Terrane
- Stikine Terrane
- Overlap Assemblage
- North America

SYMBOLS

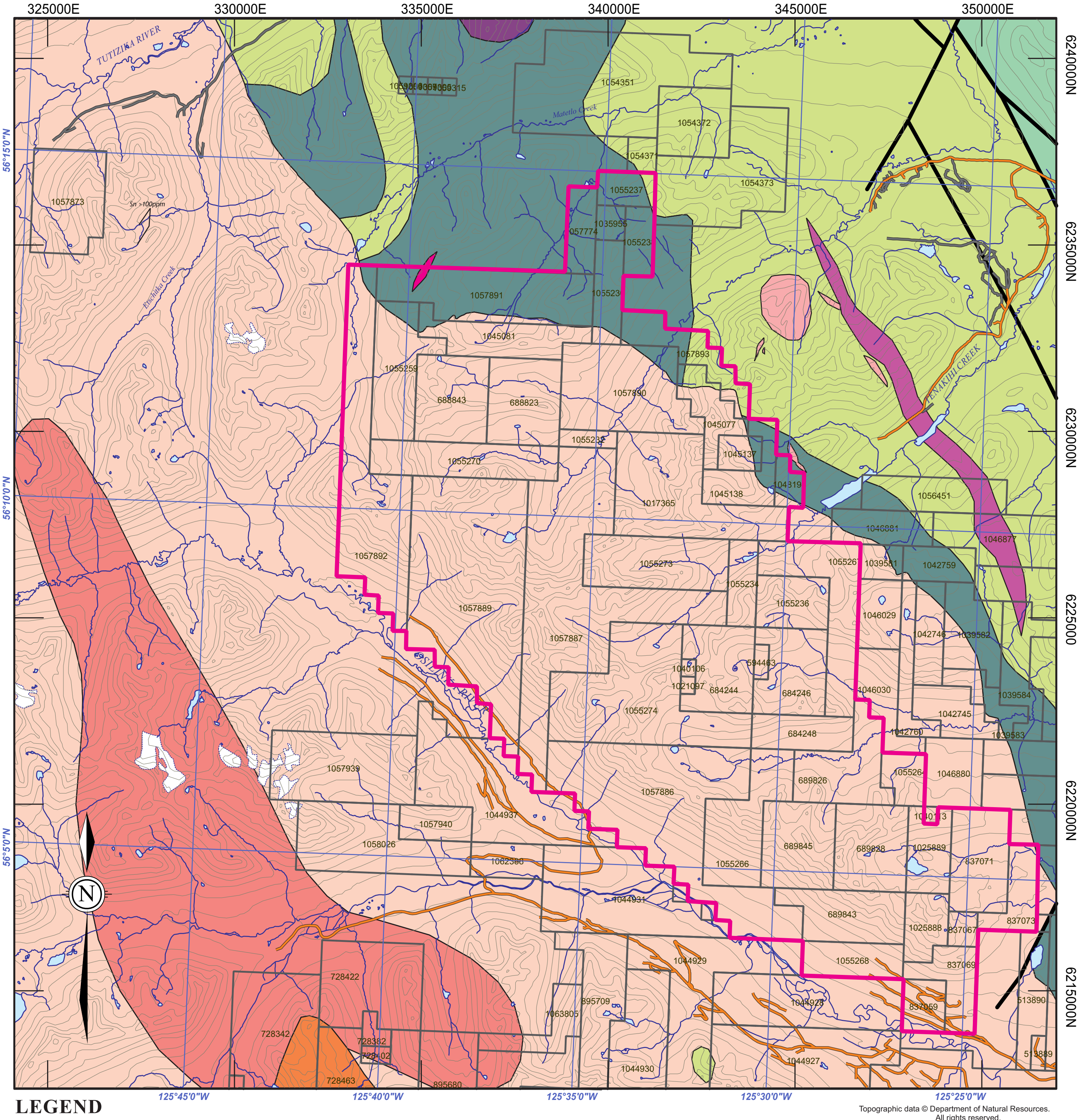
- Cathedral property
- Producing mine or under construction
- Selected developed prospect (BC Minfile)
- Highway
- Secondary routes
- Railway
- River
- Waterbody

0 50km

THANE MINERALS INC.

REGIONAL GEOLOGY AND ECONOMIC SETTING
Cathedral Property
Cathedral Project
Omineca M.D., British Columbia, Canada

Project No:		By:	CN
Scale:	1:1,500,000	Drawn:	CN
Figure:	3	Date:	October 2019



LEGEND

GEOLOGY

Takla Group - sediments; volcanics

Lay Range Assemblage - volcaniclastics

Hogem Plutonic suite

- Quartz monzonites
- Granite
- Duckling Creek syenite

Unnamed - quartz monzonitic intrusive rocks (associated with Cu-porphyry systems such as Mt. Milligan, BP-Chuchi, and Tas)

Tenakihi Intrusive Complex - diorite intrusive rocks

Aiken Lake Intrusive Complex - gabbro-diorite

SYMBOLS

Cathedral property boundary

689866 Tenure boundary and number

Gravel road (not all roads and trails shown)

Contour (100 metre interval)

Watercourse

Waterbody

0 5km

NAD83 UTM Zone 10 North
NTC 094C03,04,05,06

THANE MINERALS INC.

GEOLOGY PLAN MAP
Cathedral Property

Cathedral Project
Omineca M.D., British Columbia, Canada

Project No:		By:	CN
Scale:	1:150,000	Drawn:	CN
Figure:	4	Date:	October 2019

Potassic alteration is pervasive and the most common alteration observed in the Cathedral Area. Intensity ranges from subtle to strong, giving the quartz monzonite the characteristic salmon pink colour. Potassic alteration appears to be stronger in the northern half of the mapped area which weakly coincides with increased presence of copper mineralization.

Calcite is also consistently observed interstitially as well as along fracture surfaces and in veins. Chloritization is sporadic and may be present as veinlets or altering mafic minerals. Epidote is present as veins or selvage to quartz veinlets. In the western portion of the Cathedral Area, epidote veins (1mm, up to 10cm) are more common and are found as selvage to quartz veins. Quartz-calcite veinlets (<3mm wide) are observed throughout the Cathedral Area, comprised of quartz+/-calcite and may host sulphides. Malachite staining is prevalent throughout the area. Epidote alteration in the Link Area appears largely selective to selvages of calcite and/or quartz veinlets (<1-3mm wide) and veins (<1.5cm) but is also observed altering feldspar.

Sulphide mineralization is abundant in the quartz monzonite in the Cathedral Area. Chalcopyrite is the dominant copper-bearing mineral, commonly associated with malachite and azurite that may be present as large (1 by 1 metre) stains on the side of cliff faces. Chalcopyrite ranges from <1 to 1% in abundance and is most notably located in the western portion of the mapped area. Chalcopyrite was observed to occur as: fine grained disseminations; larger blebs; fracture-filling; within quartz-calcite veins; hairline stringers; and, massive lenses. Specularite was identified in the eastern area of the Cathedral Area, appearing as veins or massive lenses. Malachite, and less commonly azurite, was noted as stains on cliff faces but also at the smaller scale, interstitially within gossanous samples. Arsenopyrite was identified at the Pinnacle Showing. It was observed as blebs located along fracture surfaces (3-5%). Arsenopyrite also occurs as veinlets. Pyrite was observed as disseminated, fracture-fill, blebs, in veins, stringers, and massive. Comparable mineralization is noted in the units of the Gail and Lake Area. The Link Area quartz monzonite show much more limited chalcopyrite mineralization as evidenced by rock sampling results from the area (Naas, 2013).

Granodiorite

Granodiorite is noted in the Lake Area. These rocks can range from light grey to medium grey to almost beige, with a medium to very coarse-grained equigranular texture. Compositionally, these granodiorites consist of 20 to 40% quartz, 30 to 60% feldspar and 5 to 30% biotite with minor amphibole. Magnetite disseminations range from 1 to 5%. Alteration is subtle and with potassic and epidote locally observed. Exposed surfaces of granodiorite weather to a dark grey colour. Mineralization is present in the Lake Area granodiorites (pyrite, chalcopyrite, and malachite).

Diorite

In the Lake Area, the diorite is dark green to black in colour and medium to coarse grained. Typical composition is 60 to 70% mafics (biotite and amphibole), 30 to 40% feldspar (mostly plagioclase). No quartz is noted. Alteration in the diorite is relatively weak. Chlorite and magnetite alteration affect the mafics, and calcite is occasionally present in the matrix. Magnetite pervasive (5-7%) and is almost semi-massive (15-50%) in several samples.

Malachite and disseminated chalcopyrite mineralization is noted in almost all dioritic rocks in this area, usually ranging from trace amounts up to 1%. In sample 1830, chalcopyrite is 1-3%.

Alteration includes calcite and epidote. Calcite is generally weak and is observed within quartz veins as well as in the groundmass. Epidote alteration is moderate, locally altering the feldspars (Naas, 2013).

Monzonite

At the Lake Area, monzonitic rocks exhibit a slightly gossanous weathering whereas fresh exposure is pale grey to black to pink and has a medium- to coarse-grained texture. Compositionally, the mafics are highly variable, anywhere from 5% to 50%. Feldspar is strong where mafics are weak therefore also quite variable, from 20 to 90%. Quartz content is low, generally less than 5%. Alteration is dominated by potassic, epidote and chlorite. Potassic alteration varies greatly from subtle to intense. Epidote is less common, but when present is subtle to moderate and often seen in veinlets (<2mm). Chlorite alteration is infrequent and alters the mafic minerals. Magnetite is very inconsistent, ranging from trace to 15% (Naas, 2013).

Dykes

Feldspar porphyry

Feldspar porphyritic dykes have been noted in several areas of the Property underlain by the HPS. In the Cathedral Area these dykes are observed, but not in the area of the Pinnacle Showing. In the Lake Area, phenocrysts make up to 50% of the rock. Chlorite alteration of the groundmass is strong and calcite veinlets may be present.

Andesite

Andesite dykes have been noted in the Lake Area. These are described as feldspar-phyric with an aphanitic matrix. Feldspars are white to pale green, 1 to 2 mm in size, and comprise from 5 to 30% of the unit. The matrix ranges from greyish green to black in colour. Black crystals (amphibole?) are less than 1 mm in size. The dykes are typically 1 to 2 metres thick but can be as narrow as 10 cm. Magnetite is strong within the majority of samples from these dykes, ranging from 15 to 30%.

Alteration consists mainly of weak epidote and locally potassic altered feldspar. Calcite is noted within the matrix and as stringers.

3.3 PROPERTY MINERALIZATION

The principal areas of copper mineralization on the Property are the Cathedral (Cathedral, Cathedral South, Gully and Pinnacle Showings), Gail, Cirque, Mat, Lake and CJL.

Copper mineralization consists predominantly of chalcopyrite with rare occurrences of bornite. In the Cathedral Area, areas of massive mineralization have been identified including pyrite, chalcopyrite, specularite and magnetite. Throughout the Property malachite+/-azurite staining is common on exposed rock faces. Molybdenite, galena and sphalerite are seen as occasional accessory sulphides. Arsenopyrite is noted at the Pinnacle Showing of the Cathedral Area, and appears to be an indicator for significant gold mineralization.

At the CJL Showing, copper mineralization occurs within magnetic breccia hosted in quartz feldspar porphyritic dykes.

Field relations and preliminary petrographic work indicate that the sulphide mineralization is related to the lithologically complex Hogem batholith. A rare earth element (REE) geochemistry study done on several samples taken from the Property indicates that most of the intrusive phases have common parent magma (Naas, 2011).

Based on the sample suite collected, mineralization observed at the Property is similar to other well-studied alkalic porphyry copper systems in BC. Similarities include the variability and chemistry of the host intrusive complex and the style and grade of mineralization. Look-alike deposits include the deposits of the Iron Mask camp (Afton, Rainbow, DM), Galore Creek and Lorraine (Naas, 2011).

4.0 WORK PROGRAM

4.1 INTRODUCTION

The collection of rock samples for the petrographic study was carried out within the Cathedral Area between August 23 and 24, 2018. Samples collected for the whole rock study was undertaken in March, 2019 at Thane's sample storage facility in Vavenby, BC.

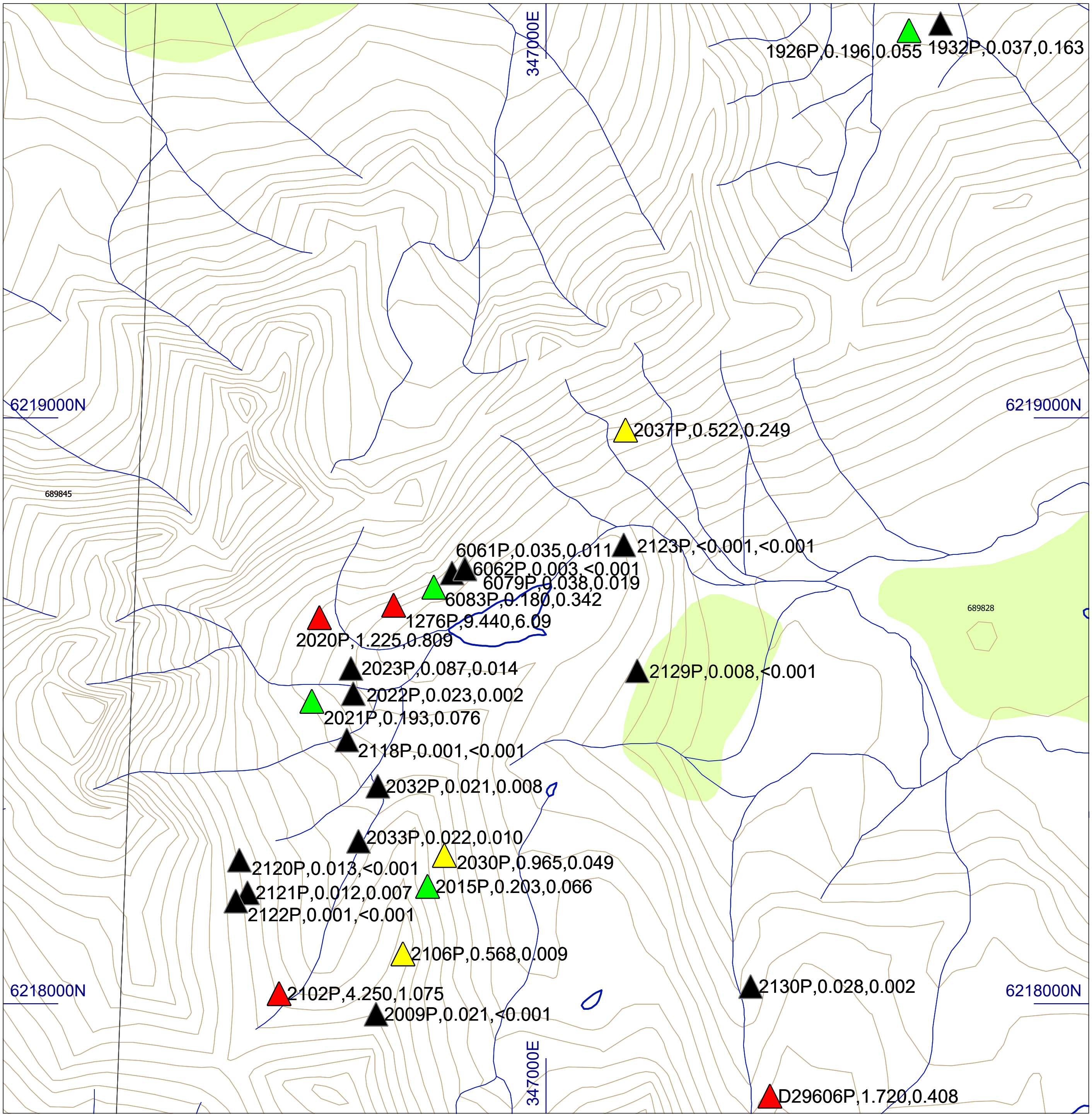
Prospecting in the northern region of the Cathedral Area was carried out between July 17 and 26, 2019, which excludes project preparation, mobilization and demobilization and shutdown.

Access to the property was gained by helicopter. The first visit utilized a Eurocopter AS355 twin-engine, while the second visit utilized a Bell 206 Longer Ranger. Both helicopters where from Canadian Helicopters of Smithers, BC.

The objective of the petrographic and whole rock study was to initiate the building of a geological library for the Cathedral Property. The objective of the prospecting program was to investigate possible extensions to known mineralization found at the Cathedral Showings.

4.2 PETROGRAPHIC STUDY

A total of 27 rock samples were collected from historical sample sites. Sample locations are presented in Figure 5. The historical sample number for each site was utilized for the sample name along with the suffix 'P" to distinguish the current sample from the historical. Samples were placed in thick polyethylene sample bags, labeled and sealed by flagging tape.



LEGEND

TOPOGRAPHY

- Gravel road
- Contour (20m interval)
- Watercourse
- Vegetation
- Property outline
- Mineral tenure (as of Nov 13, 2018)

GEOCHEMISTRY

Rock Samples - Cu

- < 0.1% Cu
- 0.1 - 0.5% Cu
- 0.5 - 1.0% Cu
- > 1.0% Cu

Sample Details

▲ Sample ID, Cu %, Au g/t

N

0 250m

NAD83, UTM Zone 10 North

THANE MINERALS INC.

SAMPLE LOCATION
PETROGRAPHIC STUDY

Cathedral Property
Omineca M.D., British Columbia, Canada

Project No.:		By:	CN
Scale:	1:10000	Drawn:	CN
Figure:	5	Date:	October 2019

All samples were cut by rock saw at Thane's field office in Vavenby, BC, with one half delivered to ALS Minerals (ALS) of Kamloops, BC for sample preparation and analysis and the other half delivered to Vancouver Petrographics of Langley, BC for petrographic study.

To compliment the petrographic work, ALS undertook multi-element ICP-MS and gold by fire assay. Certificates of analysis are presented in Appendix IIIa.

Results

Location coordinates for all samples, including selected analytical results, are presented in Table 2.

Table 2: Selected results, Petrographic samples

Sample	UTM		Study Area	Results			
	Northing	Easting		Ag (ppm)	As (ppm)	Cu (%)	Au (ppm)
2121P	6218189	346489	Cathedral	0.04	1.8	0.012	0.007
2118P	6218450	346659	Cathedral	0.02	3.1	0.001	<0.001
2120P	6218245	346475	Cathedral	0.08	1.2	0.013	<0.001
2123P	6218783	347133	Cathedral	0.01	1.9	<0.001	<0.001
2106P	6218085	346755	Cathedral	1.76	5.3	0.568	0.009
2020P	6218659	346612	Cathedral	5.94	11.6	1.225	0.809
2021P	6218516	346599	Cathedral	0.68	2.7	0.193	0.076
2022P	6218529	346670	Cathedral	0.10	18.1	0.023	0.002
2032P	6218371	346712	Cathedral	0.13	16.7	0.021	0.008
2023P	6218572	346666	Cathedral	0.70	897.0	0.087	0.014
2015P	6218200	346797	Cathedral	0.61	14.7	0.203	0.066
2009P	6217982	346709	Cathedral	0.04	2.8	0.021	<0.001
2122P	6218175	346469	Cathedral	0.02	3.3	0.001	<0.001
2102P	6218017	346543	Cathedral	9.35	3.8	4.250	1.075
2033P	6218277	346679	Cathedral	0.06	0.6	0.022	0.010
2030P	6218253	346826	Cathedral	2.12	8.7	0.965	0.049
2037P	6218979	347136	Cathedral	2.54	6.6	0.522	0.249
D29606P	6217842	347383	Gully	4.77	20.1	1.720	0.408
2130P	6218029	347350	Gully	0.13	1.8	0.028	0.002
2129P	6218568	347156	Cathedral	0.03	1.5	0.008	<0.001
1276P	6218680	346739	Cathedral	34.00	191.5	9.440	6.09
6079P	6218735	346839	Cathedral	0.11	3.9	0.038	0.019
6061P	6218743	346861	Cathedral	0.16	2.5	0.035	0.011
6062P	6218742	346861	Cathedral	0.02	1.8	0.003	<0.001
6083P	6218711	346808	Cathedral	1.97	10.9	0.180	0.342
1926P	6219661	347621	Pinnacle	0.88	44.4	0.196	0.055
1932P	6219673	347675	Pinnacle	0.37	5860.0	0.037	0.163

The full report by Leitch (2019) is presented in Appendix IV with the summary provided below.

Samples were classified into a four groups:

- Hornblende (after pyroxene?) diorite;
- Biotite-hornblende (pyroxene?) (quartz) monzonite;
- Biotite?-hornblende (quartz) syenite; and
- Vein.

Hornblende (pyroxene?) diorite (2009P, 2015P, *2020P, 2021P, 2022P, 2023P, 2030P, 2032P, 2037P?, *2106P, 2122P, 6083P, D29606P; *=strongly altered): mainly plagioclase-relict amphibole or rarely clinopyroxene, accessory sphene ± rutile, anatase? (after ilmeno-magnetite?) and apatite.

Biotite-hornblende (pyroxene?) (quartz) monzonite (2033P,2118P, 2121P, 2123P, 2129P): albite-Kspar (microperthitic orthoclase/microcline, partly late magmatic?) ±quartz, chloritized amphibole (partly after pyroxene?) and biotite, accessory magnetite-rutile-apatite; locally porphyritic or Kspar megacrystic (M), or in one case cut by aplitic dikelets.

Biotite-hornblende (quartz) syenite (2120P, 2130P, 6061P, 6062P, 6079P?): mainly Kspar (generally microperthitic orthoclase/microcline, partly late magmatic?) ±quartz, with chloritized amphibole and biotite, accessory magnetite, ilmenite or ilmeno-magnetite, rutile and apatite.

Veins (1276P, 1926P, 1932P, 2102P): variable quartz-carbonate-chlorite-sericite/muscovite (partly after secondary biotite?)-sulfides (pyrite, chalcopyrite, local arsenopyrite, trace molybdenite)-secondary magnetite (partly oxidized to hematite)-rutile/sphene-apatite.

Alteration is weak to significant in many of these samples, ranging from incipient or weak transitional propylitic/potassic (albite ±Kspar, actinolite-chlorite-epidote-local quartz-carbonate-sphene-apatite) that affects many samples in the South Cathedral area, to moderate to strong potassic (Kspar-relict albite-chlorite (after secondary biotite?)-secondary quartz-magnetite-epidote-apatite), especially in the Gully and Cathedral Zones. Many samples are locally variably overprinted by weak argillic to moderate phyllic (with addition of clay?/sericite/muscovite to the assemblage). The potassic alteration may take the form of K-flooding (spanning the late-magmatic to hydrothermal interval?), or more significantly, is commonly closely related to significant stockwork veining by minerals similar to those in the relevant alteration assemblage (albite, quartz, magnetite, actinolite, epidote, chlorite, carbonate, sericite, rare tourmaline). Sulfides mainly comprise pyrite and lesser chalcopyrite (most samples, from all zones) most typically closely associated with quartz, epidote, actinolite or chlorite; molybdenite is seen in only one high-grade vein sample (1276P) closely associated with chalcopyrite and quartz, arsenopyrite in another vein sample (1932P) associated with quartz and carbonate, and in one sample (2023P) relict pyrrhotite is suggested by lamellar textured pyrite/marcasite closely associated with relict mafic sites although some occurs with the irregular veinlet network with chlorite-quartz-albite.

4.3 WHOLE ROCK

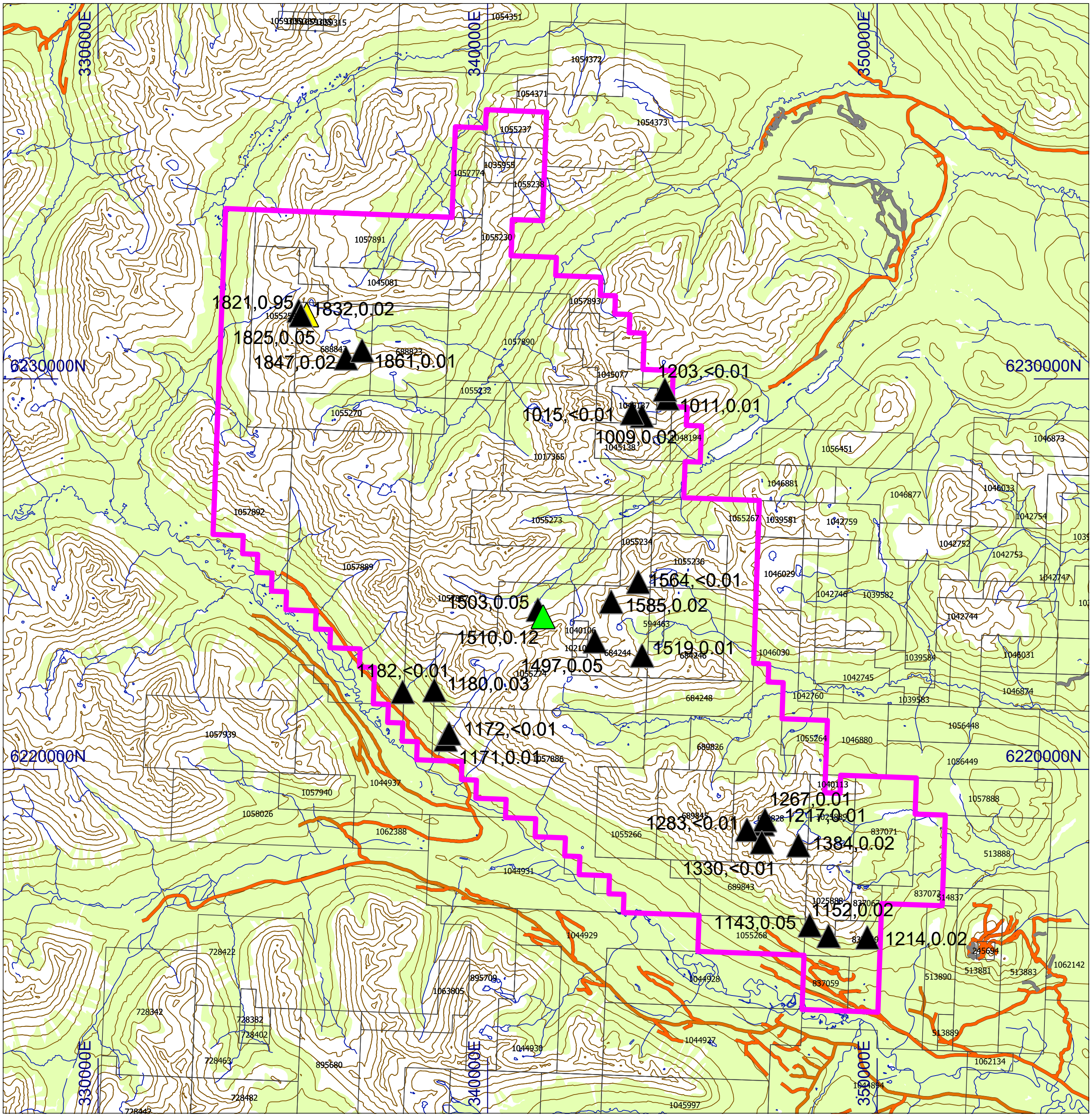
To complement the geological library, a total of 27 samples retrieved from previous years' work were selected and submitted for whole rock analysis. Pulp material from the original sample, which was stored at Thane's field office in Vavenby, BC, was retrieved. Samples were selected from rock sampling undertaken in 2012. The selected samples were not originally submitted for multi-element analysis. These samples were submitted to ALS Minerals of Kamloops, BC for sample preparation, from which the pulps were analysed for copper by portable XRF.

The selection process attempted to cover the full range of rock types found on the Property.

Rock descriptions of the selected samples are provided in Appendix IIa with certificate of analysis provided in Appendix IIIb. Sample details are provided in Table 3 with locations presented in Figure 6.

Table 3: Sample details, Whole Rock samples

Sample	UTM		Study Area	Rock Type	Cu (%)
	Northing	Easting			
1009	6232517	349430	CJL	Granite	0.02
1011	6232618	348804	CJL	Takla volcanic (basalt)	0.01
1015	6230413	346620	CJL	Quartz diorite	<0.01
1143	6216003	348270	Link	Andesite dyke	0.05
1152	6215732	348752	Link	Monzonite/Quartz Monzonite	0.02
1171	6220760	338921	Osilinka	Granite/ Granodiorite	0.01
1172	6220918	339009	Osilinka	Granite	<0.01
1180	6222025	338632	Osilinka	Diorite	0.03
1182	6221982	337818	Osilinka	Granodiorite/ granite	<0.01
1203	6231631	347356	Tenakihi	Takla sediment?	<0.01
1214	6215692	349745	Link	Quartz Monzonite	0.02
1217	6218593	347060	Cathedral	Monzonite	0.01
1267	6218702	347120	Cathedral	Monzonite	0.01
1283	6218451	346657	Cathedral	Porphyritic rhyolite	<0.01
1330	6218129	347038	Cathedral	Possible volcanic dyke	<0.01
1384	6218052	347976	Cathedral	Syenite	0.02
1497	6223278	342751	Gail	Tonalite/Quartz diorite?	0.05
1503	6224087	341291	Gail	Aplite	0.05
1510	6223906	341424	Gail	Tonalite/Quartz diorite?	0.12
1519	6222912	343963	Gail	Dyke (rhyolite or dacite?)	0.01
1564	6224796	343866	Gail	Monzonite	<0.01
1585	6224290	343171	Gail	Aplite dyke	0.02
1821	6231633	335353	Lake	Diorite	0.95
1825	6231625	335203	Lake	Diorite	0.05
1832	6231741	335151	Lake	Quartz diorite/ Possible tonalite??	0.02
1847	6230524	336364	Lake	Quartz monzonite	0.02
1861	6230724	336775	Lake	Feldspar porphyritic dyke	0.01



LEGEND

TOPOGRAPHY

- Gravel road
- Contour (100m interval)
- Watercourse
- Vegetation
- Property outline
- Mineral tenure (as of Nov 13, 2018)

GEOCHEMISTRY

Rock Samples - Cu

- < 0.1% Cu
- 0.1 - 0.5% Cu
- 0.5 - 1.0% Cu
- > 1.0% Cu

Sample Details

- ▲ Sample ID, Cu %

N

0 2500m

NAD83, UTM Zone 10 North

THANE MINERALS INC.

SAMPLE LOCATION
WHOLE ROCK STUDY

Cathedral Property
Omineca M.D., British Columbia, Canada

Project No.:		By:	CN
Scale:	1:150000	Drawn:	CN
Figure:	6	Date:	October 2019

At the time of this report, multi-element analysis by ICP-MS is pending. Once received, the samples will be cataloged utilizing their geochemical signatures.

4.4 PROSPECTING

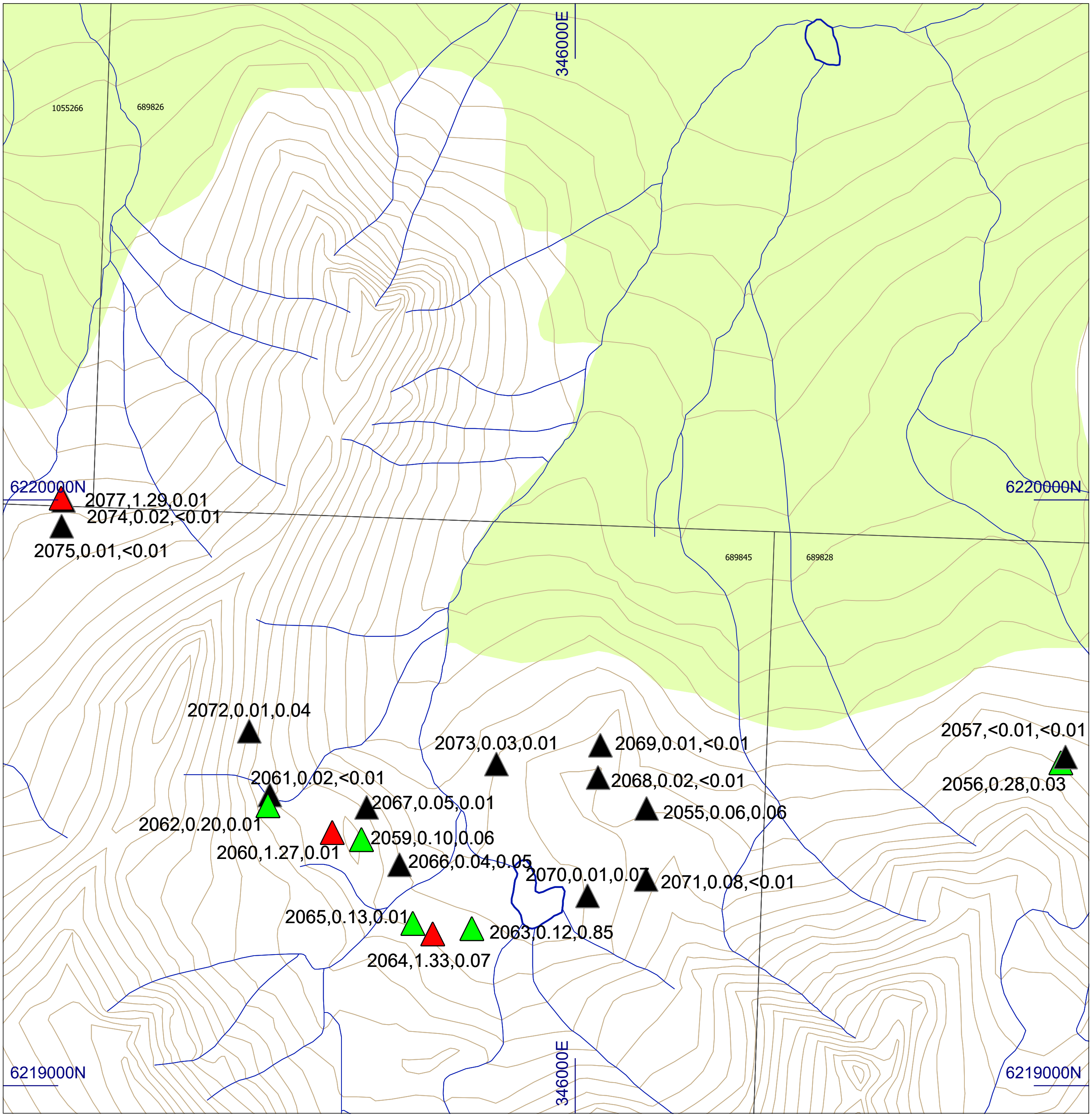
A total of 21 rock samples were collected from the northern region of the Cathedral Area. This area is located 1 km northwest of the Cathedral and Cathedral South Showings, which have returned significant copper and gold results of up to 13.9% Cu and 6.85 g/t (Naas, 2013).

All samples were grab collected from outcrop sources. Samples were placed in thick polyethylene sample bags, labeled and sealed by flagging tape. All samples were cut by rock saw at Thane's field office in Vavenby, BC, with one half delivered to ALS Minerals (ALS) of Kamloops, BC for sample preparation and analysis. Analysis consisted of multi-element ICP-MS and gold by fire assay with assays performed on over limits.

Rock descriptions are provided in Appendix IIb with certificate of analysis provided in Appendix IIIc. Sample details are provided in Table 4 with locations and selected results presented in Figure 7.

Table 4: Selected results, Northern Region, Cathedral Area

Sample	UTM		Sample Type	Results			
	Northing	Easting		Ag (ppm)	As (ppm)	Cu (%)	Au (ppm)
2055	6219473	346122	Grab	0.20	18.6	0.06	0.06
2056	6219551	346831	Grab	1.87	4.6	0.28	0.03
2057	6219561	346839	Grab	0.05	1.2	<0.01	<0.01
2059	6219420	345634	Grab	1.34	77.4	0.10	0.06
2060	6219432	345584	Grab	14.35	85.1	1.27	0.01
2061	6219496	345477	Grab	0.10	1.3	0.02	<0.01
2062	6219478	345474	Grab	1.63	38.4	0.20	0.01
2063	6219268	345823	Grab	0.52	7.9	0.12	0.85
2064	6219259	345756	Grab	10.05	143.5	1.33	0.07
2065	6219277	345722	Grab	4.01	37.7	0.13	0.01
2066	6219377	345699	Grab	0.50	6.6	0.04	0.05
2067	6219475	345643	Grab	0.26	1.6	0.05	0.01
2068	6219526	346039	Grab	0.15	5.8	0.02	<0.01
2069	6219581	346043	Grab	0.14	4.2	0.01	<0.01
2070	6219324	346021	Grab	0.06	2.2	0.01	0.07
2071	6219352	346121	Grab	0.37	1.5	0.08	<0.01
2072	6219605	345442	Grab	0.05	0.8	0.01	0.04
2073	6219549	345865	Grab	0.11	0.6	0.03	0.01
2074	6219999	345124	Grab	0.12	3.7	0.02	<0.01
2075	6219955	345121	Grab	0.06	0.5	0.01	<0.01
2077	6220003	345120	Grab	3.54	36.0	1.29	0.01



LEGEND

TOPOGRAPHY

- Gravel road
- Contour (20m interval)
- Watercourse
- Vegetation
- Property outline
- Mineral tenure (as of Nov 13, 2018)

GEOCHEMISTRY

Rock Samples - Cu

- < 0.1% Cu
- 0.1 - 0.5% Cu
- 0.5 - 1.0% Cu
- > 1.0% Cu

Sample Details

▲ Sample ID, Cu %, Au g/t

N

0 250m

NAD83, UTM Zone 10 North

THANE MINERALS INC.

GEOCHEMISTRY PLAN MAP
NORTHERN REGION
CATHEDRAL AREA

Cathedral Property
Omineca M.D., British Columbia, Canada

Project No.:		By:	CN
Scale:	1:10000	Drawn:	CN
Figure:	7	Date:	October 2019

Results

The entire study area is underlain by intrusive rocks of the Hogem Batholith. The most dominant rock unit is fine-grained quartz monzonite, with lesser amounts of fine-grained monzonite. In one location, a quartz syenite was observed intruding quartz monzonite.

Although not observed in outcrop, float evidence supports the presence of andesite dykes.

The area is dominated by chlorite and epidote alteration. Potassic alteration is confined to areas of structural complexity, ranging from hairline fractures to large fault zones with widths of up to 3 metres.

Magnetite is wide spread and occurs in all samples that have not been affecting by faulting. Fault zones are devoid of magnetite.

Sulphide mineralization consists of pyrite and lesser chalcopyrite. Malachite staining was observed in on sample (2064). The strongest copper values were returned from structurally complex areas. Sample 2064 of a 2 cm quartz vein, contained within a north-south fracture system hosted in quartz monzonite, returned the highest copper grade of 1.33 % Cu.

Samples 2059 and 2060, located within different areas of a 30 cm wide north-south trending fault that can be traced in outcrop for 10's of metres, returned 0.10% Cu and 1.27% Cu respectively.

Other samples that returned anomalous copper values were located within north-south trending hairline fractures. They include sample 2056 (0.28% Cu) and 2063 (0.12 % Cu). Sample 2063 returned the highest gold grade of 0.85 g/t Au.

5.0 CONCLUSIONS

The petrographic study confirms the field mapping of syenite rock at the Cathedral Showings. This is significant, as syenite rocks of the Duckling Creek Complex host the Lorraine copper alkalic porphyry deposit just south of the Cathedral Property (Giroux 2016). This further supports the interpretation from 2017 that mineralization at the Cathedral Area is related to an alkalic porphyry system (Gordon et al, 2018).

The dominate rock type in the northern region of the Cathedral Area is quartz monzonite, which has been subject to chlorite and epidote alteration. Magnetite is common throughout the area, but was found not to occur within areas of intense faulting. The dominant structural trend of the area is north south. Structural features that follow this trend range from hairline fractures to 3 metre wide fault zones.

Copper values are strongest when associated with these fault systems. Although potassic alteration is associated with almost all anomalous copper values, sample 2063 (0.12 % Cu) contained hairline fractures with no potassic alteration.

A significant difference between the northern region and southern regions of the Cathedral Area is lower gold grades in the north. The northern region is not completely devoid of gold, as sample 2063 returned 0.85 g/t Au.

The lower gold signature of the northern region may support the theory presented in Gordon (2017) that that area has undergone thrust movement. The northern region may be a distal portion of the alkalic deposit.

Respectfully Submitted,

Christopher O. Naas, *P.Geo.*

6.0 REFERENCES

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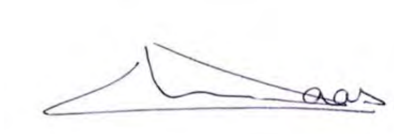
7.0 CERTIFICATE

I, Christopher O. Naas, *P.Geo*., do hereby certify that:

1. I am a graduate in geology of Dalhousie University (*B.Sc*., 1984); and have practiced in my profession continuously since 1987;
2. Since 1987, I have been involved in mineral exploration for precious and/or base metals in Canada, United States of America, Chile, Venezuela, Ghana, Mali, Nigeria, and Democratic Republic of the Congo (Zaire); for diamonds in Venezuela; and for rare metals in Nigeria. I have also been involved in the determination of base metal and gold resources for properties in Canada and Ghana, respectively, and the valuation of properties in Canada and Equatorial Guinea.
3. I am a member in good standing of the Association of Professional Engineers and Geoscientists of British Columbia (Registration Number 20082);
4. I am presently a Consulting Geologist and have been so since November 1987;

Dated at Surrey, British Columbia, this 6th day of October, 2019.



Christopher O. Naas, *P.Geo.*

8.0 STATEMENT OF COSTS

Project Preparation & Shutdown

	Unit	Rate			
Personnel					
C. Naas	5	1,000.00	5,000.00		
(Jul 12-14, 2019; Jul 29-30, 2019)					
S. Naas	2	400.00	800.00		
(Jul 29-30, 2019)				5,800.00	
Equipment					
Truck	5	175.00	875.00		
				875.00	
Room & Board					
Board	7	175.00	1,225.00		
				1,225.00	
Subtotal					7,900.00

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Field

	Unit	Rate		
Personnel				
C. Naas	25	1,000.00	25,000.00	
(Aug 20-26, 2018, Mar 11-14, 2019; Jul 15-28, 2019)				
E. Dube	14	400.00	5,600.00	
(Jul 15-28, 2019)				
S. Naas	14	400.00	5,600.00	
(Jul 15-28, 2019)				
				36,200.00
Equipment				
Truck 1	25	175.00	4,375.00	
Truck 2	14	175.00	2,450.00	
Comptuer (incl software)	14	50.00	700.00	
Chainsaw	2	45.00	90.00	
				7,615.00
Room & Board	Unit	Rate		
Room & Board	53.00	175.00	9,275..00	
				9,275.00
Disbursements				

Petrographic Study			9,341.57		
Helicopter			40,217.00		
Travel			957.76		
Fuel (truck)			1,269.57		
Analysis			3,723.81		
Communications			564.35		
Field Supplies			190.84		
				56,264.90	
Subtotal					109,354.90

Office *(Report Preparation)*

Personnel	*Unit*	*Rate*			
C. Naas	3.75	1,000.00	3,750.00		
				3,750.00	
Equipment					
Comptuer (incl software)	3.75	50.00	187.50		
				187.50	
Subtotal					3,937.50
			Total		**$121,192.40**

APPENDIX I
ABBREVIATIONS AND CONVERSION FACTORS

ABBREVIATIONS

Elements		**Abbreviations**	
Ag	Silver	Az	azimuth
As	Arsenic	CDN$	Canadian dollars
Au	Gold	ppm	parts per million
Ba	Barium	ppb	parts per billion
Cd	Cadmium	g/t	grams per metric tonne
Cu	Copper	oz/T	troy ounces per ton
Mo	Molybdenum	tpd	metric tonnes per day
Pb	Lead	Eq. Au	Gold equivalent
Sb	Antimony	UTM	Universal Transverse Mercator
Ti	Titanium	NAD83	North American Datum 1983
Zn	Zinc	°/ ‘ / “	degree/minute/second of arc

CONVERSION FACTORS

Length			
1 millimetre (mm)	0.03937 inches (in)	1 inch (in)	25.40 millimetre (mm)
1 centimetre (cm)	0.394 inches(in)	1 inch (in)	2.540 centimetres (cm)
1 metre (m)	3.281 feet (ft)	1 foot (ft)	0.3048 metres (m)
1 kilometre (km)	0.6214 mile (mi)	1 mile (mi)	1.609 kilometres (km)
Area			
1 sq. centimeter (cm^2)	0.1550 sq. inches (in^2)	1 sq inch (in^2)	6.452 sq. centimetres (cm^2)
1 sq. metre (m^2)	10.76 feet (ft^2)	1 foot (ft)	0.0929 sq. metres (m^2)
1 hectare (ha) (10,000 m^2)	2.471 acres	1 acre	0.4047 hectare (ha)
1 hectare (ha)	0.003861 sq. miles (m^2)	1 sq. mile (m^2)	640 acres
1 hectare (ha)	0.01 sq. kilometre (km^2)	1 sq. mile (m^2)	259.0 hectare (ha)
1 sq. kilometre (km^2)	0.3861 sq. miles (mi^2)	1 sq. mile (m^2)	2.590 sq. kilometres (km^2)
Volume			
1 cu. centimetre (cc)	0.06102 cu. inches (in^3)	1 cu. inch (in^3)	16.39 cu. centimetres (cm^3)
1 cu. metre (m^3)	1.308 cu. yards (yd^3)	1 cu. yard (yd^3)	0.7646 cu. metres (m^3)
1 cu. metre (m^3)	35.310 cu. feet (ft^3)	1 cu. foot (ft^3)	0.02832 cu. metres (m^3)
1 litre (l)	0.2642 gallons (U.S.)	1 gallon (U.S.)	3.785 litres (l)
1 litre (l)	0.2200 gallons (U.K.)	1 gallon (U.K.)	4.546 litres (l)
Weights			
1 gram (g)	0.03215 troy ounce (20dwt)	1 troy ounce (oz)	31.1034 grams (g)
1 gram (g)	0.6430 pennyweight (dwt)	1 pennyweight (dwt)	1.555 grams (g)
1 gram (g)	0.03527 oz avoirdupois	1 oz avoirdupois	28.35 grams (g)
1 kilogram (g)	2.205 lb avoirdupois	1 lb avoirdupois	0.4535 kilograms (kg)
1 tonne (t) (metric)	1.102 tons (T) (short ton)	1 ton (T) (short ton) (2000 lb)	0.9072 tonnes (t)
1 tonne (t)	0.9842 long ton	1 long ton (2240 lb)	1.016 tonnes (t)
Miscellaneous			
1 cm/second	0.01968 ft/min	1 ft/min	50.81 cm/second
1 cu. m/second	22.82 million gal/day	1 million gal/day	0.04382 m^3/second
1 cu. m/minute	264.2 gal/min	1 gal/min	0.003785 m^3/minute
1 g/cu. m	62.43 lb/ cu. ft	1 lb/cu. ft^3	0.01602 g/m^3
1 g/cu. m	0.02458 oz/cu. yd	1 oz/cu. yd	40.6817 g/m^3
1 Pascal (Pa)	0.000145 psi	1 psi	6985 Pascal
1 gram/tonne (g/t)	0.029216 troy ounce/ short ton (oz/T)	1 troy ounce/short ton (oz/T)	34.2857 grams/tonne (g/t)
1 g/t	0.583 dwt/short ton	1 dwt/short ton	1.714 g/t
1 g/t	0.653 dwt/long ton	1 dwt/long ton	1.531 g/t
1 g/t	0.0001 %		
1 g/t	1 part per million (ppm)		
1 %	10,000 part per million (ppm)		
1 part per million (ppm)	1,000 part per billion (ppb)		
1 part per billion (ppb)	0.001 part per million (ppm)		

APPENDIX II
SAMPLE DESCRIPTIONS

APPENDIX II
SAMPLE DESCRIPTIONS

a. Whole Rock Study Samples

Sample No.	Area	Location (UTM Zone 10N NAD 83)		Description						Results
		Easting	Northing	Sample Type	Lithology	Alteration	Sulphides (%)	Mineralization Style	Field Sample Descriptions	Cu (%)
1009	CJL	349430	6232517	Float	Granite	none	Mag 7-15	N/A	At 349430E, 6232517N, found a large cluster of subrounded to subangular **boulders** of igneous rock that look similar to samples 1001 and 1002. It is very quartz and magnetite-rich, and contains plagioclase and potassium feldspar as well as hornblende and biotite. Coarse-grained, equigranular rock with 40% quartz, 15% magnetite, 5-10% biotite, 5-10% hornblende, the remainder plagioclase and potassium feldspar.	0.02
1011	CJL	348804	6232618	Outcrop	Takla volcanic (basalt)	Chl 3, CaCb 1	Py <1	Py D	Huge **outcrop** on top of the mountain, above the 1600m elevation contour. Took a GPS point where we sampled at 348804E, 6232618N, but the outcrop goes all the way up the mountain as far as we can see. Definitely a volcanic rock and looks like a basalt. There is no quartz in it and it seems to be chlorite altered due to the green colour. There is less than 1% olivine phenocrysts (in small crystals as seen in the other volcanics) and less than 1% of the sample consists of specks of disseminated pyrite. No other visible sulphides. Fizzes locally with acid, likely in the matrix (a tiny bit of calcite).	0.01
1015	CJL	346620	6230413	Subcrop	Quartz diorite	Chl 1	none	N/A	Angular boulders on the mountain side in **subcrop** at 346620E, 6230413N. Medium to dark grey igneous rocks. Contain 40-50% mafic minerals, 20-30% plagioclase, 20-30% quartz. Weakly chloritized. This is float and looks like a rockfall area. Boulders are ~1-3ft in size. Walked up to see where rocks fell from but hit snow about 5ft deep so came down to go along contour.	<0.01
1143	Link	348270	6216003	Outcrop	Andesite dyke	Epi 1	Py <=1%, Mag 15-30%, Mal <1	Py blebs	Conitinuing along the ridge contour. Outcrop appears to be continuous from the previous on noted (348298E, 6216019N) as it extends along the whole ridgetop. It is at least 45m up and 20m across. Here there is a contact between a volcanic rock and the quartz monzonite. The sample is grey with a bluish hue, aphanitic with small black blebby phenocrysts and pale grey (plag?) epidote altered phenocrysts. It is strongly magnetic (15-30% magnetite). Sulphides appear as blebs or clumps <= 0.5mm wide. Malachite is also noted but chalcopyrite is not visible. This may be a andesite dyke cross-cutting the quartz monzonite. Average thickness of volcanic dyke is ~10cm. It does not look similar to the Takla volcanics observed in the Tenakihi Zone.	0.05
1152	Link	348752	6215732	Outcrop	Monzonite/Quartz Monzonite	Pot 3, Epi 3	Mag 5-7, Py tr	Py D	Outcrop with quartz monzonite 5m wide by 50m down the hill. The rock less potassic and epidote altered than sample 1151. The rock is a light grey to pale pinkish green colour and coarse grained. Compositionally is 20% mafics, 75% feldspar and 5% quartz. Alteration includes moderate potassic and epidote altered feldspars. Magnetite comprises 5-7%. Sulphides include trace amounts of pyrite, disseminated.	0.02
1171	Osilinka	338921	6220760	Outcrop	Granite/ Granodiorite	None	Mag 1-3	N/A	Walking up the river in the M05 zone. Outcrop along the river 2m high by 4m wide. Also outcrop on the other side of the river. Very coarse grained, light grey. 30-40% quartz, 5-10% biotite, 40-50% feldspar, and minor amphibole. Magnetite is approximately 1-3%. No alteration noted. Biotite phenocrysts are quite large (<=5mm) and are the largest we've seen mapping this project. Biotite dominates mafics. No sulphides noted.	0.01
1172	Osilinka	339009	6220918	Outcrop	Granite	Pot 2, Epi 2	Mag 1	N/A	Outcrop on both sides of the river. 15m tall by 20m along. Fine to coarse grained, light grey with a peachy pink and light green hues locally. Very similar compositionally to 1171 but lack the large biotite phenocrysts (biotite still present but small phenocrysts). Also magnetite percent is slightly decreased. Potassic and epidote alteration is also present and leads me to believe this is a granite with approximately equal amounts of kspar and plagioclase. This may be true for sample 1171 as well but the lack of alteration makes identifying feldspars difficult. No sulphides noted.	<0.01
1180	Osilinka	338632	6222025	Outcrop	Diorite	Chl 2	Py <1, Mag 5-7	Py D	1m by 3m long. There appears to be two rock types here. Possible contact? This sample is medium green and fine grained. Sample taken only appears to be from an area that is 1m wide with samples similar to 1177-1179 in compostion on either side. Is possibly a fine grained diorite as 50-60% is made up of chloritized and non-chloritized mafic minerals and 40-50% is made up of plagioclase. Magnetite is 5-7%. Very fine grained disseminated pyrite is also present.	0.03
1182	Osilinka	337818	6221982	Outcrop	Granodiorite/ granite	None	Mag 1-3	N/A	6m along the river by 1.5m tall. Outcrop across the river also, 10m long and 1.5m high. Sample is medium grey and coarse grained. Composition consists of 20-30% mafics, 30-40% quartz, and 30-50% feldspar. Very similar to sample 1172 from yesterday. Magnetite is 1-3%. No alteration or sulphides are noted.	<0.01
1203	CJL	347356	6231631	Outcrop	Takla sediment?	CaCb 4	Py Tr	Py D	Outcrop at the top of the ridge. 5m by 5m on the top. Sample is brownish to bluish in colour. Mud to silt sized grains. Dark grey to creamy yellow coloured quartz veinlets up to 2mm in size, possibly along fractures. Rock was very hard to hit, but scratches fairly easily in some areas, but in others is very hard. Strongly effervescent, not certain whether it is the matrix, calcite blebs or fracture surfaces that are reacting. Trace pyrite present. No magnetism. Appears to be a Takla sediment, but not sure whether it could be a chert or limestone. Due to softness and effervescence, could be a limestone. However, due to local hardness, fracture patterns and resistance to being broken off the outcrop it could also be a chert.	<0.01
1214	Link	349745	6215692	Outcrop	Quartz Monzonite	none	Mag 3-5	N/A	Outcrop along the same ridge ~150m east of sample 1213. Outcrop is ~8m long by 2m high. As described compositionally in 1212 but with less magnetite (3-5%) and finer grained (fine to medium grained). Also no potassic alteration.	0.02
1217	Cathedral	347060	6218593	Outcrop	Monzonite	Pot 4	Mag 3-5	N/A	Salmon pink in colour and coarse grained. Composition consists of 70-80% feldspar, 5% quartz, 5-10% mafics (biotite and amphibole), 3-5% magnetite. Alteration includes strong potassic. No sulphides are observed. This sample is taken from a potassic altered fracture zone approximately 20cm wide. Overall the rock appears to be similar in composition to sample 1262. Fracture surface is 291/44.	0.01
1267	Cathedral	347120	6218702	Outcrop	Monzonite	Pot 2	Mag 1-3, no sulphides noted	N/A	Outcrop ~5m long by 1m tall. Rock does not appear to have any gossanous fracture planes. The weathered surface is grey to pink and the fresh surface is light grey to pink. The rock is medium-grained and contains 5-10% quartz, 10-15% mafics, 75-85% feldspar (K-spar>plag). Joints run at ~209, 306 and 190 degrees.	0.01
1283	Cathedral	346657	6218451	Outcrop	Porphyritic rhyolite	none	Mag 5-7	N/A	Dark brown grey weathered surface. Pale purplish grey fresh surface. Porphyritic in texture. Fine grained black mafics (3-5%), pale pink feldspar (1%), white feldspar (3-5%) set within a pale purplish grey groundmass. Locally an epidote green is present but not sure if epidote or not. Magnetite 5-7%. No sulphides noted. Likely a dyke in host monzonite/quartz monzonite.	<0.01
1330	Cathedral	347038	6218129	Outcrop	Possible volcanic dyke	Chl 4, FeOxid 2, CaCb 3	Py 1, Cpy Tr	Py & Cpy in veinlets	Took a sample of a possibly volcanic (?) dyke with gossanous weathering within the host quartz monzonite. The weathered surface is orange-brown and the fresh surface is grey-green. The dyke appears to be about 10m wide but is not consistent. It appears to be an interfingering contact (not sharp with the quartz monzonite). The potassic alteration is mostly on the north side of the dyke in the host rock and is about 1m wide on this side. Took a measurement of 272/62. Pyrite is present along calcite veinlets in about 1% of the rock, and there is trace chalcopyrite as well.	<0.01
1384	Cathedral	347976	6218052	Outcrop	Syenite	None	Py tr	Py - diss	Brown weathered surface and salmon pink to orange fresh surface. Fine grained. Composed of >80% potassium feldspar (plagioclase not noted), 5-10% mafics, and 10% quartz. This rock may be potassic altered but the deeper orange and pink colours differ from potassically altered monzonites as this sample is very homogenous in nature. No alteration is noted. Possible trace sulphides, very fine grained pyrite. <1% magnetite present.	0.02
1497	Gail	342751	6223278	Outcrop	Tonalite/Quartz diorite?	Pot 1, FeOxid 2, CaCb 1	Cpy 1, Py <1, Mal tr	Cpy - diss, fracture surface blebs, Py - diss, fracture surface blebs	Lithology sample: Grey to black throughout. Coarse grained and composed of 40-50% mafics (biotite and amphibole), 10-20% quartz, and 30-50 feldspar (predominatley plagioclase). Magnetite comprises 3-5%. Alteration includes subtle potassic and weak iron oxidation. Sulphides include disseminated and blebs along fracture surface (1% chalcopyrite, and <1% pyrite). Trace specks of malachite are noted as well. This sample is much more mafic than previous ones observed. It may be a dyke or a new intrusive body. 10m down ridge and 20m along contour in both directions.	0.05
1503	Gail	341291	6224087	Float	Aplite	FeOxid 2	Cpy <1, Py <1, Mag 1	Cpy - diss, Py - diss	Orangish brown weathered surface and light grey fresh surface. Another example of a fine grained/sugary rock observed in the area. Other than iron oxidation generally fresh overall. Very fine grained disseminated sulphides that appear to include both chalcopyrite and pyrite but grain size makes identification difficult. Magnetite is 1%.	0.05
1510	Gail	341424	6223906	Outcrop	Tonalite/Quartz diorite?	Epi 1, Pot 1, FeOxid 2	Cpy tr, Mag 5-7	Cpy - diss	Litholgoy sample: Mainly grey to black with patches of iron oxidation throughout. Compositionally it looks similar to samples 1497 and 1500 (intrusive part). Mafic rich with a strong amount of quartz and mainly plagioclase. Alteration includes epidote and potassic locally. Chalcopyrite is very fine grained and disseminated but in trace amounts. Magnetite is 5-7%.	0.12
1519	Gail	343963	6222912	Outcrop	Dyke (rhyolite or dacite?)	Pot 1	Mag 1-3	N/A	A dyke cross-cutting ~1-2 metres wide with a strike and dip of 342/82. Light brown weathered surface and medium grey fresh surface. Composed of <1mm plagioclase, amphibole, biotite, possible potassium feldspar, and quartz set within a grey groundmass. Alteration includes potassic with magnetite 1-3%. No sulphides noted. This could be a felsic dyke therefore in the rhyolite or dacite vacinity.	0.01

1564	Gail	343866	6224796	Outcrop	Monzonite	None	None	N/A	Lithology sample: Taken along the ridge and suggests a possible change in intrusive with this sample much less quartz rich than granodiorites described to the south. It is coarse grained with mafics composing 10% of primarily amphibole, feldspar compose >85% and only minor quartz. The feldspar grains appear to be about equal in potassic feldspar and plagioclase based on the light and white colourations but potassic alteration could be playing a role as well. No magnetite or sulphides noted.	<0.01
1585	Gail	343171	6224290	Outcrop	Aplite dyke	Pot 2, CaCb 2	Cpy and/or Py combined <1	Cpy or Py - diss	3m wide and oriented 170/72. Aplitic texture and pale pink in colour. Quartz rich. Very fine grained disseminated sulphides. Malachite locally.	0.02
1821	Lake	335353	6231633	Float	Diorite	Chl 2, CaCb 3	Cpy <1, Mal 1, Mag 5-7	Cpy D	Float with malachite. Biotite and amphibole rich. Dark green to black and medium to coarse grained. Composed of 60-70% mafics (bio and amph) and 30% plagioclase. Magnetite appears as blebs and disseminations 5-7%. Chlorite is weakly altering mafic minerals. Chalcopyrite appears as blebs and stringers as does malachite.	0.95
1825	Lake	335203	6231625	Outcrop	Diorite	Chl 1, Pot 1, Epi 1	Cpy <1, Mag 5-7	Cpy D	Dark green to black with pale grey to white interstitial grains. Coarse grained. Appears to have a weak linear fabric with feldspar phenocrysts elongated parallel to one another. 30-40% feldspar phenocrysts with 60-70% mafic minerals including biotite and amphibole. similar to samples 1821 and 1823. Subtle chlorite, potassic and epidote noted. Disseminated and blebby magnetite 5-7% localized to mafic grains. Sulphide mineralization includes <1% disseminated chalcopyrite.	0.05
1832	Lake	335151	6231741	Outcrop	Quartz diorite/ Possible tonalite??	N/A	Mag 5-7	N/A	LITHO- Outcrop litho sample on the top on the ridge. A lot of the boulders below look to be almost schistose, but this rock from outcrop does not. Medium to dark grey, coarse grained. Composed of 20-30% quartz, 20-30% feldspar, and 40-50% mafic minerals. Magnetite is 5-7%, disseminated. Generally unaltered. No sulphides noted.	0.02
1847	Lake	336364	6230524	Outcrop	Quartz monzonite	Pot 2	Mag 3-5	N/A	LITHO - Weathered to grey/brown. Fresh surface is black and pinkish white. Coarse grained. Mafics are 20-30%, quartz is 5-10% and feldspar is 60-75%. Magnetite is 3-5%. Potassic alteration is weak. No sulphides noted.	0.02
1861	Lake	336775	6230724	Float	Feldspar porphyritic dyke	CaCb 3, Chl 3, Pot 3, Epi 1	Py tr	Py D	Dark green aphanitic matrix with greysih pink porphyritic feldspar. Feldspar range up to 6mm in length. Calcite within matrix and as <1mm veinlets. Chlorite altered groundmass. No magnetite. Very fine grained, disseminated pyrite (trace).	0.01

APPENDIX II
SAMPLE DESCRIPTIONS

b. Prospecting Samples

Sample No.	Area	Location (UTM Zone 10N NAD 83)		Description						Results
		Easting	Northing	Sample Type	Lithology	Alteration	Sulphides (%)	Mineralization Style	Field Sample Descriptions	Cu (%)
2055	Cathedral Area	346122	6219473	Grab	Quartz Monzonite	FeOxide, CaCarb, Chl	Py 2-3, Cpy tr	Diss, FactureFill	Bleached appearance. Strongest alteration is associated with fractures. Sample is of 0.5m wide area that has a concentration of fractures that trends north-south. Original rock textures absent.	0.06
2056	Cathedral Area	346831	6219551	Grab	Quartz Monzonite	FeOxide	Mag 3-5	Veinlets	Several areas within quartz monzonite contain hairline fractures trending 006/50W. Occasionally, pockets with the fractures contain semi-massive pyrite bands Fractures that contain mineralization are strongly epidote and chlorite altered. Py is contained with epidote/chlorite veinlets of up to several mm's wide but collectively can be up to several cm's with width. Pyrite is strongly associated with epidote veinlets.	0.28
2057	Cathedral Area	346839	6219561	Grab	Monzonite	Mag, Pot	Mag 3-5	Veinlets	Fine grained monzonite with hairline fractures which trend 346/62W. Magnetite banding of several mms is common. In some areas magnetite banding can be stacked up to 1 cm in width. Weak potassic alteration, with alteration associated with hairline fractures.	<0.01
2059	Cathedral Area	345634	6219420	Grab	Quartz Monzonite	Chl, Pot	Py 3-5, Cpy tr-1	Blebs	Medium grained quartz monzonite from within a 30cm wide fault zone that trends 360/70E and is traceable for several 10's of metres in outcrop. Sample is highly fractured with sulphides along hairline fractures as well as disseminated. Minor occurrences of Py in blebs up to 1 cm in size.	0.10
2060	Cathedral Area	345584	6219432	Grab	Quartz Monzonite	Chl, FeOxide	Py 5-7	Blebs	Similar to sample 2059 but sample collected from different location along fault zone. More Py present in this sample than in sample 2059 and Py blebs are larger as they can get to 2cm in size. Sample weathers dark brown. Py can occur as blebs and veinlets. Fault zone is 360/70E	1.27
2061	Cathedral Area	345477	6219496	Grab	Monzonite	Epi, Pot	Mag 1-3	Diss	Fine grained with sporadic epidote alteration along hairline fractures. Outcrop has strong potassic alteration associated with hairline factures and extends outward for several cm's. No visible sulphides	0.02
2062	Cathedral Area	345474	6219478	Grab	Monzonite	Chl	Cpy tr	Diss	Sample collected from within fault zone that pinches and swells between 1 and 10cm in width. Dark green in colour. Fault zone trends 176/33W.	0.20
2063	Cathedral Area	345823	6219268	Grab	Quartz Monzonite	Chl, FeOxide	Py tr-1, Cpy tr-1	Diss, FactureFill	Greenish medium grained quartz monzonite containing hairline fractures. Strong potossic alteration is not associated with the hairline factures as is seen in other samples. Py and Cpy are associated with the hairline fractures but also can be disseminated. Appearance doesn't weather gossanous or have malachite staining, but fresh surface exposes Cpy mineralization. Similar to sample 2071.	0.12
2064	Cathedral Area	345756	6219259	Grab	Quartz Vein	FeOxide	Cpy 5-7	Blebs	A 2 cm wide quartz vein occurs within fractures trending 160/42W cutting quartz monzonite. Minor malachite staining is visible. Massive Cpy on edge of quartz vein.	1.33
2065	Cathedral Area	345722	6219277	Grab	Qtz Vein & Qtz Monzonite	Chl, Epi	Py 3-5, Cpy 1-3	Blebs, FactureFill	Sample collected of 2-5cm wide quatz vein contained with a 45cm wide fault. Host rock is fine grained quartz monzonite. Fault trends 146/34S. Sulphides within quartz vein are disseminated and fracture filled.	0.13
2066	Cathedral Area	345699	6219377	Grab	Quartz Syenite	Pot, FeOxide, CaCarb	Py tr-1, Cpy tr	Diss, FactureFill	1 metre wide quartz syenite dyke cutting epidote altered quartz monzonite. Sample collected from quartz syenite dyke. Dyke trends 180/70W. Dyke weathers light brown. Contact between dyke and host rock defines a cliff face	0.04
2067	Cathedral Area	345643	6219475	Grab	Quartz Monzonite	Pot, Epi	Mag 1-3, Cpy tr	Diss	Medium grained quartz monzonite containing hairline fractures. Strong potassic alteration associated with hairline fractures that extends outward several cm's.	0.05
2068	Cathedral Area	346039	6219526	Grab	Quartz Monzonite	Chl, FeOxide	Py 1-3, Mag tr	Diss	Dark green in colour. Sample is of hanging wall of 1-2 metre wide fault zone which trends 324/30W. Sample is highly fractured with disseminated Py with minor fracture fill. Same fault that hosts sample 2069.	0.02
2069	Cathedral Area	346043	6219581	Grab	Quartz Monzonite	Chl, FeOxide	Py 1-3	Diss	Medium green colour. Sample collected within 1-2 metre fault zone that trends 324/30W. Py occurs along fractures oblique to the trend of the fault. Sample is highly fractured> No breccia/gauge zone within the fault.	0.01
2070	Cathedral Area	346021	6219324	Grab	Quartz Monzonite	Chl, Epi	Mag 3-5, Py 1-3	Diss, FactureFill	Fine grained with minor hairline fractures. Magnetite associated with mafic minerals with Py associated with hairline fractures. Possible Cpy along fracture planes. Fractures trend 202/64W.	0.01
2071	Cathedral Area	346121	6219352	Grab	Monzonite	Chl	Py tr, Cpy tr, Mag tr-1	Diss	Fine grained equigranular Quartz Monzonite. Darke green in colour. No fractures as seen in other samples that are related to potassic alteration. Minor chlorite and weak iron carbonate alteration with minor sulphides, which include trace Cpy. Similar to sample 2063	0.08
2072	Cathedral Area	345442	6219605	Grab	Quartz Monzonite	Pot	Py tr	Diss	Fine grained pink in colour quartz monzonite. Outcrop contains numerous hairline fractures with associated potassic alteration. Strongest alteration is at fracture and extends outward fro several cm's	0.01
2073	Cathedral Area	345865	6219549	Grab	Quartz Monzonite	Pot	Py tr	Diss	Fine grained quartz monzonite with minor hairline fractures. Potassic alteration associated with these hairline fractures and extends outward for several cm's. Trace disseminated Cpy associated with potassic alteration.	0.03
2074	Cathedral Area	345124	6219999	Grab	Epidote Vein & Monzonite	Pot, Epi	Py tr-1	Veinlets	Massive eqidote vein within the fault zone containing sample 2077 and historical sample 6312. Medium grained monzonite. Epidote veinlets are several cm's in width. Feldspars are altered both potassic and epidote. Minor Py occurs along fracture planes.	0.02
2075	Cathedral Area	345121	6219955	Grab	Monzonite	Chl, Epi	Py tr	Diss	Sample taken from 1 metre wide fault zone that is traceable for 10's of metres in outcrop. This fault hosts historical sample 6312. Fault trends 238/72N. Epidote alteration is intense with epidote veins up to several cm's in width. Potasic alteration is strong. Sample 6312 was of 2-3 cm wide sulphide quartz vein. Sample 2075 was collected from epidote alteration areas within the fault.	0.01
2077	Cathedral Area	345120	6220003	Grab	Quartz Vein	FeOxide, CaCarb	Py 1-3, Cpy 3-5, Mag 3-5	Diss, Veinlets	Sample collected within fault zone that hosts both sample 2074 and historical sample 6312. Quartz vein is 3-4 cm wide with magnetite occurring along footwall in veinlets Py occurs more in hanging wall. Cpy occurs throughout quartz vein in veinlets.	1.29

APPENDIX III
CERTIFICATES OF ANALYSIS

APPENDIX III
CERTIFICATES OF ANALYSIS

a. Petrographic Study Samples

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To: THANE MINERALS INC.
PO BOX 38099 MORGAN HEIGHTS PO
SURREY BC V3Z 6R3

Finalized Date: 20-JUN-2019
Account: RESTHA

CERTIFICATE KL19140620

Project: Cathedral

This report is for 27 Rock samples submitted to our lab in Kamloops, BC, Canada on 8-JUN-2019.

The following have access to data associated with this certificate:

CHRIS NAAS		

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LOG-21	Sample logging - ClientBarCode
CRU-QC	Crushing QC Test
PUL-QC	Pulverizing QC Test
CRU-31	Fine crushing - 70% <2mm
SPL-21	Split sample - riffle splitter
PUL-31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	INSTRUMENT
ME-OG46	Ore Grade Elements - AquaRegia	ICP-AES
Cu-OG46	Ore Grade Cu - Aqua Regia	
Au-ICP21	Au 30g FA ICP-AES Finish	ICP-AES
ME-MS41	Ultra Trace Aqua Regia ICP-MS	

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

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CERTIFICATE OF ANALYSIS KL19140620

Sample Description	Method	WEI-21	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Recvd Wt.	Ag	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs
	Units	kg	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
	LOD	0.02	0.01	0.01	0.1	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05
2121P		0.19	0.04	1.16	1.8	<0.02	<10	130	0.31	0.01	1.89	0.03	19.95	10.1	4	0.86
2118P		0.06	0.02	0.73	3.1	<0.02	<10	100	0.22	0.02	0.80	0.04	16.25	4.3	3	0.33
2120P		0.18	0.08	0.60	1.2	<0.02	<10	60	0.22	0.02	0.48	0.03	15.30	6.1	2	0.38
2123P		0.15	0.01	0.79	1.9	<0.02	<10	50	0.79	<0.01	2.83	0.06	33.0	7.5	4	1.55
2106P		0.05	1.76	0.54	5.3	<0.02	<10	260	0.38	0.21	0.97	0.10	11.95	3.8	2	0.17
2020P		0.09	5.94	0.88	11.6	0.43	<10	10	0.14	0.42	2.00	0.82	17.30	7.7	2	0.05
2021P		0.28	0.68	0.92	2.7	0.05	<10	40	0.24	0.04	1.65	0.21	17.10	4.4	3	0.38
2022P		0.37	0.10	0.79	18.1	<0.02	<10	10	0.16	0.10	1.46	0.08	16.00	16.6	2	0.18
2032P		0.03	0.13	1.89	16.7	<0.02	<10	40	0.74	0.11	1.59	0.05	57.0	48.2	3	0.25
2023P		0.18	0.70	1.69	897	<0.02	<10	20	0.36	0.83	0.32	0.12	11.85	89.4	2	0.13
2015P		0.12	0.61	2.33	14.7	0.03	<10	150	0.34	0.17	2.33	0.06	31.9	45.6	2	0.70
2009P		0.12	0.04	1.64	2.8	<0.02	<10	120	0.17	0.02	1.34	0.01	6.09	4.2	2	0.57
2122P		0.35	0.02	1.02	3.3	<0.02	<10	20	0.55	0.02	1.70	0.05	18.25	1.8	2	0.12
2102P		0.25	9.35	2.35	3.8	1.71	<10	30	0.57	3.96	1.14	0.53	40.8	26.2	1	0.18
2033P		0.11	0.06	1.15	0.6	<0.02	<10	340	0.44	0.04	0.89	0.03	32.9	7.9	2	1.27
2030P		0.13	2.12	2.68	8.7	0.04	<10	100	0.24	0.34	3.74	0.49	22.1	106.5	3	0.50
D29606P		0.13	4.77	1.43	20.1	0.24	<10	50	0.36	0.51	0.27	0.05	8.45	88.4	4	0.84
2130P		0.15	0.13	0.45	1.8	<0.02	<10	90	0.56	0.04	0.34	0.02	48.8	4.1	2	0.17
2129P		0.11	0.03	0.67	1.5	<0.02	<10	50	0.49	0.01	0.36	0.03	23.3	6.2	2	0.33
1276P		0.21	34.0	3.03	191.5	7.23	<10	10	0.15	1.08	0.18	0.55	2.31	217	2	0.53
6079P		0.37	0.11	1.07	3.9	<0.02	<10	50	0.11	0.01	0.58	0.04	8.95	16.2	4	0.10
6061P		0.12	0.16	0.57	2.5	<0.02	<10	80	0.17	0.03	0.56	0.04	26.1	7.0	2	0.35
6062P		0.45	0.02	0.90	1.8	<0.02	<10	140	0.36	0.01	1.14	0.03	20.0	3.5	3	0.59
6083P		0.17	1.97	0.58	10.9	0.37	<10	40	0.17	0.09	0.70	0.03	23.2	2.0	2	0.41
2037P		0.10	2.54	1.52	6.6	0.25	<10	70	0.81	0.12	0.20	0.09	21.2	40.8	2	0.16
1926P		0.03	0.88	2.48	44.4	0.05	20	80	0.34	0.27	3.17	0.07	14.10	14.3	3	0.63
1932P		0.35	0.37	2.14	5860	0.10	<10	50	0.18	0.55	3.51	0.74	14.05	45.9	5	0.98

***** See Appendix Page for comments regarding this certificate *****

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CERTIFICATE OF ANALYSIS KL19140620

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Cu	Fe	Ga	Ge	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb
	Units	ppm	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm
	LOD	0.2	0.01	0.05	0.05	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05
2121P		121.0	4.28	5.27	0.06	0.12	0.01	0.020	0.13	9.7	11.5	0.88	404	1.65	0.07	0.13
2118P		8.8	3.36	3.91	0.07	0.28	0.01	0.006	0.13	8.3	4.5	0.37	215	0.36	0.10	0.38
2120P		126.0	2.46	3.64	0.07	0.09	<0.01	0.011	0.14	7.4	3.9	0.34	271	1.05	0.05	0.31
2123P		3.6	2.73	3.26	0.05	0.25	0.01	0.018	0.24	20.1	13.6	0.39	819	0.09	0.03	<0.05
2106P		5680	10.95	3.16	0.10	0.09	<0.01	0.083	0.04	5.0	3.4	0.11	120	2.33	0.13	<0.05
2020P		>10000	3.35	6.33	0.08	0.13	0.01	0.209	0.01	9.2	13.5	0.42	317	0.40	0.09	0.19
2021P		1930	4.67	4.84	0.06	0.17	<0.01	0.029	0.05	8.1	12.3	0.54	323	0.67	0.06	0.21
2022P		229	2.61	4.94	0.05	0.11	<0.01	0.010	0.03	7.0	13.2	0.38	239	0.30	0.06	0.28
2032P		214	5.71	7.67	0.15	0.18	0.01	0.027	0.05	39.9	22.9	1.45	488	0.22	0.12	0.24
2023P		868	8.24	10.55	0.06	0.10	0.38	0.041	0.02	4.3	18.0	0.59	208	57.1	0.06	<0.05
2015P		2030	7.30	9.30	0.07	0.05	0.01	0.026	0.14	21.3	30.6	1.32	604	11.25	0.05	<0.05
2009P		210	5.53	6.04	0.05	0.06	<0.01	0.006	0.13	2.9	15.9	0.99	936	0.34	0.05	<0.05
2122P		9.5	0.96	4.17	0.08	0.12	<0.01	0.010	0.03	9.2	7.3	0.39	161	0.14	0.05	0.39
2102P		>10000	44.3	14.05	0.65	0.04	0.01	0.537	0.03	40.8	15.1	1.09	1580	238	0.01	<0.05
2033P		219	3.06	5.43	0.06	0.05	<0.01	0.018	0.19	18.0	11.5	0.61	531	2.28	0.04	<0.05
2030P		9650	7.72	10.35	0.11	0.20	0.01	0.145	0.03	12.3	31.7	1.78	1120	8.99	0.04	0.05
D29606P		>10000	8.71	11.15	0.07	0.13	0.04	1.005	0.17	2.9	9.3	1.07	271	8.40	0.02	<0.05
2130P		278	2.81	3.33	0.08	0.10	<0.01	0.044	0.10	22.5	4.5	0.16	469	3.58	0.03	0.07
2129P		84.7	2.92	4.26	0.08	0.28	<0.01	0.014	0.15	10.9	5.3	0.33	424	1.62	0.04	0.76
1276P		>10000	26.3	7.60	0.19	0.04	0.16	3.22	0.11	1.3	22.6	0.89	302	16.20	<0.01	<0.05
6079P		380	2.46	5.25	0.08	0.18	0.01	0.015	0.07	4.7	13.0	0.75	245	0.81	0.02	0.07
6061P		345	1.80	3.05	0.07	0.18	<0.01	0.022	0.14	12.4	5.6	0.24	198	1.03	0.04	0.45
6062P		30.3	3.34	4.78	0.08	0.12	<0.01	0.006	0.10	9.9	8.6	0.42	157	1.09	0.04	0.28
6083P		1795	1.94	3.31	0.07	0.15	0.01	0.163	0.10	13.7	3.4	0.16	92	1.08	0.06	0.53
2037P		5220	13.80	10.15	0.16	0.15	<0.01	0.051	0.11	11.3	12.3	0.54	458	3.45	0.03	<0.05
1926P		1960	10.25	7.59	0.06	0.10	0.01	0.078	0.17	6.4	62.5	0.77	1920	2.19	0.01	<0.05
1932P		373	8.57	5.99	0.06	0.08	0.01	0.052	0.12	5.9	19.5	1.21	2010	3.06	<0.01	<0.05

***** See Appendix Page for comments regarding this certificate *****

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To: THANE MINERALS INC.
PO BOX 38099 MORGAN HEIGHTS PO
SURREY BC V3Z 6R3

Finalized Date: 20-JUN-2019
Account: RESTHA

Project: Cathedral

CERTIFICATE OF ANALYSIS KL19140620

Sample Description	Ni	P	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti
Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Units	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%
LOD	0.2	10	0.2	0.1	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005
2121P	4.4	1610	2.0	6.0	<0.001	0.04	0.12	6.6	0.2	0.4	54.0	<0.01	0.02	4.4	0.089
2118P	2.1	1360	2.0	4.5	<0.001	0.01	0.25	1.7	<0.2	0.3	46.4	<0.01	0.02	2.4	0.143
2120P	1.2	800	4.4	4.5	<0.001	0.01	0.14	2.9	<0.2	0.4	29.5	<0.01	0.01	3.0	0.103
2123P	3.1	1000	2.0	12.6	<0.001	0.01	0.09	2.9	<0.2	0.4	108.5	<0.01	0.01	2.2	0.010
2106P	1.4	4400	1.4	1.7	0.001	0.45	0.24	0.7	0.5	0.5	22.4	<0.01	0.06	1.2	<0.005
2020P	5.5	1300	13.0	0.4	<0.001	0.89	0.11	4.2	0.7	1.0	53.0	<0.01	0.42	3.2	0.043
2021P	2.6	1690	1.6	2.6	<0.001	0.11	0.16	2.7	0.2	1.1	45.2	<0.01	0.05	2.8	0.109
2022P	12.2	1750	1.9	1.3	<0.001	0.74	0.22	3.2	0.5	0.9	20.5	<0.01	0.04	1.2	0.096
2032P	13.6	1950	6.3	1.9	<0.001	1.74	0.57	7.3	2.1	2.0	129.5	<0.01	0.11	4.1	0.178
2023P	2.2	1320	3.5	1.1	<0.001	3.97	5.69	3.8	0.6	0.8	7.1	<0.01	0.24	0.6	<0.005
2015P	10.6	1260	1.7	7.5	0.002	1.53	0.13	8.8	0.4	0.2	54.7	<0.01	0.15	2.6	<0.005
2009P	3.0	1260	0.8	5.2	<0.001	0.03	0.07	2.2	<0.2	0.2	23.8	<0.01	0.01	2.6	0.006
2122P	1.0	1670	2.2	1.4	<0.001	0.01	0.15	1.7	<0.2	1.2	39.5	<0.01	0.01	3.8	0.106
2102P	10.0	1030	7.1	1.1	0.001	2.48	0.21	2.3	0.8	0.4	52.6	<0.01	1.94	2.2	0.008
2033P	1.1	1430	3.6	8.3	<0.001	0.05	0.09	4.5	<0.2	0.3	25.5	<0.01	0.01	4.7	0.023
2030P	9.1	1780	8.6	1.3	0.004	1.24	0.08	15.7	0.5	0.6	268	<0.01	0.17	3.8	0.042
D29606P	6.6	1250	0.9	11.0	<0.001	3.86	0.18	6.2	0.3	0.9	13.4	<0.01	0.52	2.4	0.016
2130P	0.7	570	2.6	4.7	<0.001	0.03	0.13	3.9	<0.2	0.6	8.2	<0.01	<0.01	12.4	0.007
2129P	1.0	830	4.3	8.5	<0.001	0.02	0.15	4.0	<0.2	0.8	11.4	<0.01	<0.01	12.6	0.130
1276P	15.4	920	12.1	5.7	0.007	>10.0	1.09	5.6	4.2	1.4	3.0	<0.01	3.42	0.2	<0.005
6079P	4.2	730	0.6	2.0	<0.001	0.08	0.08	3.4	<0.2	0.3	15.3	<0.01	0.01	4.7	0.024
6061P	0.9	1570	5.0	4.4	<0.001	0.05	0.18	2.3	<0.2	0.8	18.0	<0.01	0.01	4.3	0.137
6062P	2.1	1530	3.3	4.3	<0.001	0.01	0.12	1.8	<0.2	0.5	47.3	<0.01	0.01	4.6	0.123
6083P	1.7	1690	2.3	5.2	<0.001	0.32	0.24	1.9	0.2	1.4	29.8	<0.01	0.20	2.7	0.126
2037P	2.1	780	3.0	3.1	<0.001	0.75	0.16	3.9	<0.2	0.5	9.7	<0.01	0.09	3.8	0.008
1926P	3.8	1060	2.2	9.0	<0.001	0.51	0.08	7.7	<0.2	0.2	36.8	<0.01	0.02	2.1	<0.005
1932P	4.6	730	16.8	6.3	0.001	1.59	0.58	4.9	<0.2	<0.2	58.8	<0.01	0.02	1.3	<0.005

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To: THANE MINERALS INC.
PO BOX 38099 MORGAN HEIGHTS PO
SURREY BC V3Z 6R3

Finalized Date: 20-JUN-2019
Account: RESTHA

Project: Cathedral

CERTIFICATE OF ANALYSIS KL19140620

Sample Description	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05	ME-MS41 V ppm 1	ME-MS41 W ppm 0.05	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5	Cu-OG46 Cu % 0.001	Au-ICP21 Au ppm 0.001
2121P	<0.02	1.45	149	0.37	12.10	26	2.1		0.007
2118P	<0.02	0.73	99	0.87	8.88	20	6.2		<0.001
2120P	<0.02	0.85	45	0.30	7.97	28	1.3		<0.001
2123P	0.02	0.60	74	<0.05	11.80	46	10.0		<0.001
2106P	<0.02	1.20	115	0.08	17.25	7	2.0		0.009
2020P	<0.02	1.50	28	0.29	14.90	20	2.2	1.225	0.809
2021P	<0.02	1.00	85	0.37	10.35	41	3.1		0.076
2022P	<0.02	0.76	28	0.29	10.70	20	1.8		0.002
2032P	<0.02	1.55	84	0.66	12.95	32	2.8		0.008
2023P	0.58	0.65	37	0.09	15.75	16	2.5		0.014
2015P	0.02	0.38	71	0.07	11.85	65	1.6		0.066
2009P	0.02	0.30	45	0.06	7.97	79	1.5		<0.001
2122P	<0.02	0.72	44	0.16	9.00	15	2.2		<0.001
2102P	<0.02	11.65	324	0.08	3.18	112	1.3	4.25	1.075
2033P	0.02	1.39	38	0.09	15.55	33	1.0		0.010
2030P	<0.02	1.07	111	0.22	16.10	98	4.4		0.049
D29606P	0.04	1.15	96	2.00	8.73	41	2.9	1.720	0.408
2130P	<0.02	3.97	10	0.18	19.25	30	1.9		0.002
2129P	<0.02	2.66	38	0.62	14.30	25	4.6		<0.001
1276P	0.03	0.46	83	<0.05	1.86	128	0.8	9.44	6.09
6079P	<0.02	0.95	62	0.20	5.63	19	3.7		0.019
6061P	<0.02	1.68	32	0.72	12.65	22	3.3		0.011
6062P	<0.02	1.22	139	0.41	9.91	14	2.6		<0.001
6083P	<0.02	1.30	38	0.62	9.80	12	3.0		0.342
2037P	<0.02	3.69	94	0.22	12.30	37	3.0		0.249
1926P	0.02	0.79	79	0.20	15.00	64	3.3		0.055
1932P	0.02	0.75	41	0.08	26.5	84	1.8		0.163

***** See Appendix Page for comments regarding this certificate *****

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To: THANE MINERALS INC.
PO BOX 38099 MORGAN HEIGHTS PO
SURREY BC V3Z 6R3

Finalized Date: 20-JUN-2019
Account: RESTHA

Project: Cathedral

CERTIFICATE OF ANALYSIS KL19140620

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Kamloops located at 2953 Shuswap Drive, Kamloops, BC, Canada.

Applies to Method:	CRU-31	CRU-QC	LOG-21	PUL-31
	PUL-QC	SPL-21	WEI-21	

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:	Au-ICP21	Cu-OG46	ME-MS41	ME-OG46

APPENDIX III
CERTIFICATES OF ANALYSIS

b. Whole Rock Study Samples

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To: THANE MINERALS INC.
PO BOX 38099 MORGAN HEIGHTS PO
SURREY BC V3Z 6R3

Finalized Date: 9-JUL-2019
Account: RESTHA

CERTIFICATE KL19144701

This report is for 28 Pulp samples submitted to our lab in Kamloops, BC, Canada on 13-JUN-2019.

The following have access to data associated with this certificate:

CHRIS NAAS		

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
CRU-QC	Crushing QC Test
PUL-QC	Pulverizing QC Test
LOG-23	Pulp Login - Rcvd with Barcode
LOG-22	Sample login - Rcd w/o BarCode
CRU-31	Fine crushing - 70% <2mm
SPL-21	Split sample - riffle splitter
PUL-31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	INSTRUMENT
ME-ICP06	Whole Rock Package - ICP-AES	ICP-AES
OA-GRA05	Loss on Ignition at 1000C	WST-SEQ
TOT-ICP06	Total Calculation for ICP06	

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:

Colin Ramshaw, Vancouver Laboratory Manager

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To: THANE MINERALS INC.
PO BOX 38099 MORGAN HEIGHTS PO
SURREY BC V3Z 6R3

Finalized Date: 9-JUL-2019
Account: RESTHA

CERTIFICATE OF ANALYSIS KL19144701

Sample Description / Method / Analyte / Units / LOD	WEI-21 Recvd Wt. kg 0.02	ME-ICP06 SiO2 % 0.01	ME-ICP06 Al2O3 % 0.01	ME-ICP06 Fe2O3 % 0.01	ME-ICP06 CaO % 0.01	ME-ICP06 MgO % 0.01	ME-ICP06 Na2O % 0.01	ME-ICP06 K2O % 0.01	ME-ICP06 Cr2O3 % 0.002	ME-ICP06 TiO2 % 0.01	ME-ICP06 MnO % 0.01	ME-ICP06 P2O5 % 0.01	ME-ICP06 SrO % 0.01	ME-ICP06 BaO % 0.01	OA-GRA05 LOI % 0.01
1009	0.07	54.1	17.45	8.73	6.22	3.01	3.48	3.40	0.002	0.77	0.19	0.43	0.07	0.18	1.51
1011	0.09	46.4	14.25	11.15	11.65	8.58	1.48	0.23	0.046	0.71	0.20	0.05	0.01	0.02	5.04
1015	0.13	55.6	17.25	7.30	6.98	3.16	3.78	2.83	0.003	0.59	0.17	0.34	0.11	0.21	1.00
1143	0.11	49.3	16.70	16.65	4.33	3.42	4.00	3.27	<0.002	0.67	0.09	0.34	0.07	0.18	1.68
1152	0.13	56.1	17.15	9.34	3.61	2.97	3.55	4.95	<0.002	0.70	0.13	0.40	0.07	0.26	2.45
1171	0.16	60.2	17.75	6.64	6.18	2.45	4.05	2.25	0.002	0.58	0.15	0.29	0.08	0.17	0.71
1172	0.16	62.9	16.95	5.78	4.52	2.10	3.85	2.98	0.003	0.55	0.13	0.25	0.07	0.19	1.67
1180	0.12	47.6	19.05	11.05	9.10	4.41	2.99	1.65	<0.002	0.97	0.22	0.56	0.10	0.20	2.17
1182	0.14	59.5	17.35	6.55	5.43	2.38	3.93	2.09	<0.002	0.59	0.14	0.31	0.08	0.13	1.46
1203	0.02	51.8	15.80	6.79	12.30	2.93	4.29	0.89	0.007	0.65	0.18	0.11	0.03	0.06	4.31
1214	0.13	56.8	17.85	7.75	5.94	2.75	3.68	3.90	<0.002	0.70	0.15	0.40	0.08	0.19	0.78
1217	0.07	65.2	16.45	5.43	0.86	0.88	3.97	6.54	<0.002	0.69	0.08	0.28	0.03	0.15	1.02
1267	0.07	63.0	16.50	5.98	1.75	0.74	3.67	7.14	<0.002	0.67	0.12	0.26	0.02	0.11	0.52
1283	0.08	56.3	16.70	10.15	3.46	2.48	7.26	1.10	<0.002	0.59	0.07	0.33	0.04	0.10	2.34
1330	0.12	44.1	18.45	14.80	3.26	6.35	3.79	1.13	<0.002	0.94	0.17	0.52	0.02	0.02	6.57
1384	0.11	74.2	13.30	2.89	0.42	0.23	3.06	6.06	<0.002	0.22	0.04	0.05	0.01	0.08	0.87
1497	0.11	50.6	12.10	15.35	8.07	6.77	2.42	1.48	0.003	1.26	0.33	0.78	0.05	0.08	1.49
1503	0.09	62.6	16.85	6.69	4.80	0.45	4.94	0.87	<0.002	0.14	0.04	0.07	0.13	0.06	3.14
1510	0.11	46.0	18.15	12.15	9.90	5.25	3.03	1.44	<0.002	1.10	0.23	0.73	0.12	0.14	1.98
1519	0.07	59.7	16.30	6.65	4.62	2.47	3.91	3.34	<0.002	0.60	0.14	0.33	0.08	0.20	1.41
1564	0.11	57.4	19.60	4.30	6.33	1.74	6.53	0.60	<0.002	0.55	0.08	0.42	0.08	0.06	2.88
1585	0.11	73.1	14.00	1.92	1.01	0.34	4.08	5.29	<0.002	0.12	0.03	0.05	0.03	0.15	0.80
1821	0.09	43.4	7.81	19.15	9.64	10.95	1.12	1.10	0.053	1.77	0.36	0.57	0.03	0.02	2.12
1825	0.09	45.7	16.70	11.05	9.09	7.33	2.51	2.48	0.035	1.04	0.21	0.81	0.09	0.26	2.37
1832	0.07	53.3	17.40	7.91	7.23	4.59	3.41	3.04	0.019	0.75	0.15	0.50	0.08	0.21	0.91
1847	0.10	53.5	17.70	9.61	7.08	3.75	3.65	2.74	0.002	0.82	0.20	0.48	0.08	0.13	1.92
1861	0.12	47.3	15.85	8.05	9.14	2.72	3.50	2.52	0.002	0.65	0.18	0.35	0.07	0.10	8.73
2039	0.21	66.2	15.40	4.63	1.03	0.53	3.57	6.74	<0.002	0.47	0.05	0.14	0.01	0.08	1.18

***** See Appendix Page for comments regarding this certificate *****

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PO BOX 38099 MORGAN HEIGHTS PO
SURREY BC V3Z 6R3

Finalized Date: 9-JUL-2019
Account: RESTHA

CERTIFICATE OF ANALYSIS KL19144701

Sample Description	Method Analyte Units LOD	TOT-ICP06 Total % 0.01
1009		99.54
1011		99.82
1015		99.32
1143		100.70
1152		101.68
1171		101.50
1172		101.94
1180		100.07
1182		99.94
1203		100.15
1214		100.97
1217		101.58
1267		100.48
1283		100.92
1330		100.12
1384		101.43
1497		100.78
1503		100.78
1510		100.22
1519		99.75
1564		100.57
1585		100.92
1821		98.09
1825		99.68
1832		99.50
1847		101.66
1861		99.16
2039		100.03

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.
2103 Dollarton Hwy
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www.alsglobal.com/geochemistry

To: THANE MINERALS INC.
PO BOX 38099 MORGAN HEIGHTS PO
SURREY BC V3Z 6R3

Finalized Date: 9-JUL-2019
Account: RESTHA

CERTIFICATE OF ANALYSIS KL19144701

CERTIFICATE COMMENTS

LABORATORY ADDRESSES

Processed at ALS Kamloops located at 2953 Shuswap Drive, Kamloops, BC, Canada.

Applies to Method:	CRU-31	CRU-QC	LOG-22	LOG-23
	PUL-31	PUL-QC	SPL-21	WEI-21

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:	ME-ICP06	OA-GRA05	TOT-ICP06

APPENDIX III
CERTIFICATES OF ANALYSIS

c. Prospecting Samples

ALS Canada Ltd.
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To: THANE MINERALS INC.
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SURREY BC V3Z 6R3

Finalized Date: 16-SEP-2019
Account: RESTHA

CERTIFICATE KL19219630

Project: Cathedral

This report is for 21 Rock samples submitted to our lab in Kamloops, BC, Canada on 2-SEP-2019.

The following have access to data associated with this certificate:

CHRIS NAAS		

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LOG-21	Sample logging - ClientBarCode
CRU-QC	Crushing QC Test
PUL-QC	Pulverizing QC Test
CRU-31	Fine crushing - 70% <2mm
SPL-21	Split sample - riffle splitter
PUL-31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	INSTRUMENT
ME-OG46	Ore Grade Elements - AquaRegia	ICP-AES
Cu-OG46	Ore Grade Cu - Aqua Regia	
Au-ICP21	Au 30g FA ICP-AES Finish	ICP-AES
ME-MS41	Ultra Trace Aqua Regia ICP-MS	

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

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To: THANE MINERALS INC.
PO BOX 38099 MORGAN HEIGHTS PO
SURREY BC V3Z 6R3

Finalized Date: 16-SEP-2019
Account: RESTHA

Project: Cathedral

CERTIFICATE OF ANALYSIS KL19219630

Sample Description	Method / Analyte / Units / LOD	WEI-21 Recvd Wt. kg 0.02	ME-MS41 Ag ppm 0.01	ME-MS41 Al % 0.01	ME-MS41 As ppm 0.1	ME-MS41 Au ppm 0.02	ME-MS41 B ppm 10	ME-MS41 Ba ppm 10	ME-MS41 Be ppm 0.05	ME-MS41 Bi ppm 0.01	ME-MS41 Ca % 0.01	ME-MS41 Cd ppm 0.01	ME-MS41 Ce ppm 0.02	ME-MS41 Co ppm 0.1	ME-MS41 Cr ppm 1	ME-MS41 Cs ppm 0.05
2055		1.12	0.20	2.06	18.6	0.04	<10	80	0.55	0.31	1.74	0.04	38.2	10.8	3	0.84
2056		0.39	1.87	1.06	4.6	0.04	<10	10	0.36	0.25	0.71	0.08	14.95	145.0	4	0.42
2057		0.47	0.05	0.32	1.2	<0.02	<10	20	0.21	0.01	0.33	0.03	27.0	4.4	2	0.20
2059		0.73	1.34	2.47	77.4	0.03	<10	20	0.18	0.71	0.37	0.07	12.30	56.1	2	0.66
2060		0.68	14.35	3.76	85.1	<0.02	<10	40	0.09	9.62	0.13	2.63	5.63	53.1	2	0.57
2061		0.62	0.10	1.17	1.3	<0.02	<10	40	0.39	0.03	1.04	0.03	26.8	6.0	3	0.19
2062		0.80	1.63	3.81	38.4	<0.02	<10	20	0.21	0.41	2.70	0.42	13.40	31.1	2	0.87
2063		0.47	0.52	0.74	7.9	0.62	<10	60	0.19	0.11	0.54	0.11	23.9	11.9	3	0.84
2064		0.40	10.05	0.50	143.5	0.07	<10	50	0.05	0.60	0.05	0.31	2.47	4.4	6	0.11
2065		0.64	4.01	0.91	37.7	0.02	<10	50	0.13	0.17	0.23	0.73	8.93	15.4	7	0.51
2066		0.60	0.50	0.26	6.6	0.03	<10	20	0.07	0.04	0.05	0.03	6.20	1.3	5	0.22
2067		0.57	0.26	1.19	1.6	0.02	<10	40	0.35	0.07	1.10	0.05	23.4	9.3	3	0.65
2068		0.58	0.15	1.56	5.8	<0.02	<10	70	0.41	0.05	1.41	0.05	14.15	9.6	2	3.27
2069		0.75	0.14	1.00	4.2	<0.02	<10	60	0.26	0.07	1.04	0.06	17.75	9.0	3	0.79
2070		0.39	0.06	1.23	2.2	0.06	<10	150	0.22	0.05	0.91	0.03	16.60	7.3	3	0.90
2071		0.70	0.37	1.46	1.5	<0.02	<10	60	0.21	0.02	1.17	0.07	25.7	10.8	2	0.89
2072		0.33	0.05	1.10	0.8	<0.02	<10	90	0.34	0.01	0.68	0.08	21.2	7.6	3	0.95
2073		0.50	0.11	0.70	0.6	<0.02	<10	90	0.15	0.01	0.56	0.02	10.90	4.5	4	0.95
2074		1.22	0.12	1.03	3.7	<0.02	<10	30	0.13	0.01	1.03	0.07	9.22	6.1	4	0.08
2075		0.58	0.06	1.88	0.5	<0.02	<10	30	0.27	0.01	1.13	0.10	20.7	12.7	6	0.05
2077		0.77	3.54	0.50	36.0	<0.02	<10	10	0.15	0.05	0.06	0.22	0.67	52.7	11	0.06

***** See Appendix Page for comments regarding this certificate *****

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www.alsglobal.com/geochemistry

To: THANE MINERALS INC.
PO BOX 38099 MORGAN HEIGHTS PO
SURREY BC V3Z 6R3

Finalized Date: 16-SEP-2019
Account: RESTHA

Project: Cathedral

CERTIFICATE OF ANALYSIS KL19219630

Sample Description	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Method / Analyte	Cu	Fe	Ga	Ge	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb
Units	ppm	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm
LOD	0.2	0.01	0.05	0.05	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05
2055	556	4.62	9.24	0.23	0.17	<0.01	0.099	0.18	22.5	13.8	0.16	181	0.31	0.05	0.40
2056	2810	18.30	6.37	0.19	0.12	0.03	0.014	0.10	8.4	8.4	0.37	364	4.51	0.05	0.73
2057	38.3	3.92	4.52	0.09	0.32	<0.01	0.007	0.07	13.4	2.5	0.09	210	2.81	0.06	1.68
2059	1045	13.90	15.75	0.16	0.13	0.01	0.091	0.09	6.1	17.9	0.86	556	0.83	0.06	0.12
2060	>10000	15.40	11.50	0.07	0.05	0.24	0.581	0.17	2.7	41.3	1.24	1340	1.77	0.01	<0.05
2061	180.0	2.69	6.24	0.12	0.21	<0.01	0.014	0.10	12.5	12.6	0.70	391	1.15	0.05	0.54
2062	1985	9.27	15.15	0.08	0.06	0.01	0.054	0.07	7.1	73.6	2.38	1560	2.08	0.02	<0.05
2063	1210	3.24	4.20	0.08	0.14	<0.01	0.062	0.18	11.6	6.1	0.31	181	2.67	0.04	0.49
2064	>10000	5.34	3.81	<0.05	0.02	0.14	0.630	0.04	1.1	6.8	0.27	100	0.65	0.01	0.05
2065	1315	4.77	5.33	<0.05	0.07	0.16	0.063	0.07	4.3	8.4	0.43	257	5.43	0.03	0.09
2066	447	0.87	1.37	<0.05	0.19	<0.01	0.045	0.10	3.1	2.0	0.07	75	7.70	0.04	0.23
2067	483	3.15	5.83	0.10	0.09	<0.01	0.010	0.12	11.9	12.4	0.68	391	1.06	0.06	0.28
2068	166.5	5.83	7.17	0.10	0.13	<0.01	0.018	0.11	7.4	20.3	0.89	429	2.12	0.07	0.13
2069	83.7	2.56	4.71	0.08	0.12	<0.01	0.010	0.10	7.7	6.5	0.58	275	0.28	0.05	0.28
2070	144.5	2.98	6.00	0.07	0.06	<0.01	0.008	0.24	7.3	10.7	0.41	345	0.57	0.07	0.34
2071	790	3.24	6.96	0.07	0.13	<0.01	0.026	0.12	13.9	23.2	0.88	733	79.4	0.05	0.23
2072	116.5	2.97	5.46	0.09	0.09	<0.01	0.008	0.19	11.2	8.6	0.54	439	0.61	0.05	0.34
2073	293	1.83	3.08	<0.05	0.07	<0.01	0.008	0.19	5.4	5.7	0.23	213	0.63	0.07	0.36
2074	157.0	1.86	4.04	0.16	0.07	<0.01	0.006	0.06	4.3	4.0	0.26	206	0.74	0.02	0.37
2075	119.0	3.14	6.47	0.12	0.15	<0.01	0.010	0.04	10.4	23.1	1.19	773	0.99	0.02	0.14
2077	>10000	7.41	2.56	0.08	0.02	0.01	0.115	0.01	0.3	3.2	0.21	117	44.2	<0.01	0.07

***** See Appendix Page for comments regarding this certificate *****

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To: THANE MINERALS INC.
PO BOX 38099 MORGAN HEIGHTS PO
SURREY BC V3Z 6R3

Finalized Date: 16-SEP-2019
Account: RESTHA

Project: Cathedral

CERTIFICATE OF ANALYSIS KL19219630

Sample Description	Method / Analyte / Units / LOD	ME-MS41 Ni ppm 0.2	ME-MS41 P ppm 10	ME-MS41 Pb ppm 0.2	ME-MS41 Rb ppm 0.1	ME-MS41 Re ppm 0.001	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005
2055		1.8	1980	2.6	10.3	<0.001	1.65	0.30	6.1	<0.2	1.7	152.5	0.01	0.42	4.5	0.111
2056		9.1	1030	2.9	7.3	0.038	7.85	0.44	3.1	3.9	0.7	158.0	<0.01	0.05	2.3	0.110
2057		0.9	690	1.6	2.5	0.001	0.03	0.08	1.6	<0.2	0.8	18.5	<0.01	<0.01	6.4	0.118
2059		7.8	1220	5.9	4.5	<0.001	4.09	0.49	5.5	1.5	3.5	11.4	<0.01	1.12	3.6	0.106
2060		5.7	980	7.1	6.3	<0.001	5.92	0.94	7.9	2.4	0.2	3.5	<0.01	13.75	2.3	0.008
2061		1.9	1140	1.8	4.2	<0.001	0.05	0.09	2.6	<0.2	0.6	67.1	<0.01	0.03	4.5	0.145
2062		5.9	1570	10.6	3.2	0.002	0.67	0.06	9.7	0.3	0.3	91.9	<0.01	0.19	3.3	0.011
2063		1.6	1550	5.0	9.8	<0.001	1.16	0.14	2.3	0.3	0.6	26.6	<0.01	0.41	6.0	0.147
2064		1.3	320	7.0	1.4	<0.001	2.07	1.12	2.5	1.5	1.2	3.6	<0.01	2.00	1.6	0.008
2065		2.3	660	12.5	4.7	0.001	1.17	0.44	3.7	0.8	0.2	12.7	<0.01	0.59	1.6	0.030
2066		0.4	110	3.5	3.1	0.001	0.07	0.15	0.7	<0.2	<0.2	10.3	<0.01	0.09	6.8	0.005
2067		3.2	1760	3.0	6.5	<0.001	0.04	0.09	2.5	0.2	0.4	70.4	<0.01	<0.01	3.0	0.156
2068		3.6	1810	1.5	9.2	<0.001	0.38	0.18	7.5	<0.2	0.5	41.7	<0.01	0.03	2.2	0.124
2069		2.3	1560	3.5	4.8	<0.001	0.27	0.19	2.9	<0.2	0.8	22.8	<0.01	0.07	2.0	0.160
2070		2.9	1250	1.9	13.7	<0.001	0.12	0.08	1.2	<0.2	0.3	54.9	<0.01	0.07	1.4	0.168
2071		1.8	1600	1.7	7.2	0.040	0.06	0.13	3.6	0.3	0.4	43.8	<0.01	0.02	4.0	0.141
2072		2.4	980	2.4	10.9	<0.001	0.02	0.09	2.3	<0.2	0.4	35.7	<0.01	0.01	5.6	0.165
2073		1.8	620	2.9	10.2	<0.001	0.01	0.10	1.1	0.3	0.3	41.6	<0.01	0.01	4.6	0.104
2074		2.0	910	1.4	1.5	<0.001	0.08	0.22	1.5	0.3	0.2	235	<0.01	0.04	1.4	0.090
2075		5.9	1540	1.7	1.0	<0.001	0.01	0.18	4.2	<0.2	0.3	181.5	<0.01	0.01	3.3	0.104
2077		4.1	90	2.0	0.2	0.004	1.43	0.08	1.3	4.0	<0.2	13.0	<0.01	0.36	0.2	0.018

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To: THANE MINERALS INC.
PO BOX 38099 MORGAN HEIGHTS PO
SURREY BC V3Z 6R3

Finalized Date: 16-SEP-2019
Account: RESTHA

Project: Cathedral

CERTIFICATE OF ANALYSIS KL19219630

Sample Description	Method / Analyte / Units / LOD	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05	ME-MS41 V ppm 1	ME-MS41 W ppm 0.05	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5	Cu-OG46 Cu % 0.001	Au-ICP21 Au ppm 0.001
2055		0.07	16.45	115	0.82	13.10	10	3.7		0.062
2056		0.02	0.98	112	1.51	7.78	52	2.2		0.032
2057		<0.02	1.84	21	2.81	15.60	18	5.8		0.001
2059		0.04	0.65	125	0.35	5.55	49	2.4		0.064
2060		0.03	0.44	94	0.29	3.29	658	1.1	1.270	0.011
2061		<0.02	1.59	53	0.40	15.20	34	2.8		0.004
2062		<0.02	0.76	195	0.10	8.66	174	1.0		0.007
2063		0.06	2.11	66	0.44	13.55	26	2.4		0.848
2064		<0.02	0.27	48	0.12	0.92	70	0.6	1.330	0.065
2065		0.03	0.78	63	0.08	4.31	202	1.2		0.011
2066		<0.02	2.65	4	2.75	4.99	10	3.5		0.045
2067		<0.02	1.05	110	0.63	12.00	48	1.7		0.010
2068		0.03	0.73	123	0.49	9.75	33	2.2		0.001
2069		0.02	0.95	85	0.44	8.34	24	2.1		0.001
2070		0.04	0.44	91	0.19	7.62	32	1.1		0.071
2071		<0.02	2.66	72	0.19	11.15	62	1.7		0.004
2072		0.02	1.58	62	0.15	8.14	46	1.7		0.035
2073		0.03	1.50	58	0.21	4.94	19	1.1		0.013
2074		<0.02	0.39	35	0.53	4.15	14	1.4		0.001
2075		<0.02	1.06	60	0.19	10.20	93	2.4		0.001
2077		<0.02	0.40	37	20.4	0.54	19	<0.5	1.290	0.011

***** See Appendix Page for comments regarding this certificate *****

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To: THANE MINERALS INC.
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SURREY BC V3Z 6R3

Finalized Date: 16-SEP-2019
Account: RESTHA

Project: Cathedral

CERTIFICATE OF ANALYSIS KL19219630

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Kamloops located at 2953 Shuswap Drive, Kamloops, BC, Canada.

Applies to Method:	CRU-31	CRU-QC	LOG-21	PUL-31
	PUL-QC	SPL-21	WEI-21	

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:	Au-ICP21	Cu-OG46	ME-MS41	ME-OG46

APPENDIX IV
PETROGRPAHIC STUDY REPORT

PETROGRAPHIC REPORT ON 27 SAMPLES FROM CATHEDRAL PROJECT

Report for: Chris Naas
CSN Enterprises Ltd.
16188 Morgan Creek Crescent
Surrey, B.C. V3Z 05Z (604) 542-5760

Invoice 190153

April 30, 2019.

SUMMARY:
The 27 samples may be roughly classified into a suite of possibly consanguineous felsic intrusive rocks, 1) hornblende (after pyroxene?) diorite (13 samples, mostly from South Cathedral, less so the Cathedral and Gully Zones), 2) biotite-hornblende (pyroxene?) (quartz) monzonite (5 samples, including one porphyritic and one Kspar megacrystic, also mostly from South Cathedral, less Gully Zones), 3) biotite?-hornblende (quartz) syenite (5 samples, mostly from Cathedral, less South Cathedral or Gully Zones), and 4) vein (4 samples, 2 from Pinnacle Zone) summarized as follows:

Hornblende (pyroxene?) diorite (2009P, 2015P, *2020P, 2021P, 2022P, 2023P, 2030P, 2032P, 2037P?, *2106P, 2122P, 6083P, D29606P; *=strongly altered): mainly plagioclase-relict amphibole or rarely clinopyroxene, accessory sphene ± rutile, anatase? (after ilmeno-magnetite?) and apatite.

Biotite-hornblende (pyroxene?) (quartz) monzonite (2033P,2118P, 2121P, 2123P, 2129P): albite-Kspar (microperthitic orthoclase/microcline, partly late magmatic?) ±quartz, chloritized amphibole (partly after pyroxene?) and biotite, accessory magnetite-rutile-apatite; locally porphyritic or Kspar megacrystic (M), or in one case cut by aplitic dikelets.

Biotite-hornblende (quartz) syenite (2120P, 2130P, 6061P, 6062P, 6079P?): mainly Kspar (generally microperthitic orthoclase/microcline, partly late magmatic?) ±quartz, with chloritized amphibole and biotite, accessory magnetite, ilmenite or ilmeno-magnetite, rutile and apatite.

Veins (1276P, 1926P, 1932P, 2102P): variable quartz-carbonate-chlorite-sericite/muscovite (partly after secondary biotite?)-sulfides (pyrite, chalcopyrite, local arsenopyrite, trace molybdenite)-secondary magnetite (partly oxidized to hematite)-rutile/sphene-apatite.

Alteration is weak to significant in many of these samples, ranging from incipient or weak transitional propylitic/potassic (albite ±Kspar, actinolite-chlorite-epidote-local quartz-carbonate-sphene-apatite) that affects many samples in the South Cathedral area, to moderate to strong potassic (Kspar-relict albite-chlorite (after secondary biotite?)-secondary quartz-magnetite-epidote-apatite), especially in the Gully and Cathedral Zones. Many samples are locally variably overprinted by weak argillic to moderate phyllic (with addition of clay?/sericite/muscovite to the assemblage). The potassic alteration may take the form of K-flooding (spanning the late-magmatic to hydrothermal interval?), or more significantly, is commonly closely related to significant stockwork veining by minerals similar to those in the relevant alteration assemblage (albite, quartz, magnetite, actinolite, epidote, chlorite, carbonate, sericite, rare tourmaline). Sulfides mainly comprise pyrite and lesser chalcopyrite (most samples, from all zones) most typically closely associated with quartz, epidote, actinolite or chlorite; molybdenite is seen in only one high-grade vein sample (1276P) closely associated with chalcopyrite and quartz, arsenopyrite in another vein sample (1932P) associated with quartz and carbonate, and in one sample (2023P) relict pyrrhotite is suggested by lamellar textured pyrite/marcasite closely associated with relict mafic sites although some occurs with the irregular veinlet network with chlorite-quartz-albite.

Capsule descriptions are as follows:

2121P: biotite?-amphibole (after pyroxene?) quartz monzonite with accessory magnetite?-apatite, altered to chlorite-sericite-carbonate-minor Kspar partly along hairline veinlets.

2118P: biotite-amphibole (quartz?) monzonite porphyry (plagioclase-amphibole ±biotite, rare quartz, ilmeno-magnetite? and apatite phyric; groundmass rich in barely phaneritic Kspar) slightly altered to clay?/sericite-chlorite-epidote. It seems likely to be related to or consanguineous with sample 2121.

2120P: porphyritic biotite-amphibole (quartz) syenite with accessory ilmeno-magnetite?-apatite, slightly altered to Kspar-epidote-clay?/sericite mostly along/near thin epidote-Kspar veinlets.

2123P: appears to represent Kspar megacrystic, plagioclase-biotite?-amphibole-apatite phyric monzonite (?) porphyry with accessory opaques, strongly altered to sericite/muscovite-carbonate-chlorite-probable hematite-rutile (?).

2106P: confirmed as strong to intense albite (trace sericite, chlorite) altered, albite-magnetite-minor chalcopyrite-chlorite-apatite-rutile or later quartz-chlorite veined rock of uncertain derivation, likely indicative of transitional propylitic-potassic alteration.

2020P: confirmed as strong to intense albite-carbonate-chalcopyrite-chlorite-epidote-minor quartz-rutile-apatite altered, later carbonate-epidote veined rock of uncertain derivation, likely indicative of transitional propylitic-potassic alteration.

2021P: amphibole diorite altered to albite-oligoclase?-actinolite-sericite-carbonate-epidote-chlorite-sphene-chalcopyrite-pyrite-apatite, with veinlets of epidote-chlorite-trace quartz.

2022P: amphibole diorite altered to albite-actinolite-carbonate-sericite-epidote-chlorite-sphene-pyrite (trace chalcopyrite)-apatite, with veinlets of epidote-chlorite-carbonate.

2032P: amphibole diorite altered to albite-actinolite-carbonate-sericite-epidote-chlorite-sphene-apatite-trace chalcopyrite, with veinlets of pyrite-actinolite-epidote-chlorite-carbonate-late “hydrobiotite”.

2023P: amphibole diorite? altered to albite-chlorite/”hydrobiotite”-sulfides-rutile-apatite-sericite, with veinlets of albite-chlorite-quartz-pyrite-relict pyrrhotite-chalcopyrite, oxidized to limonite-late “hydrobiotite”.

2015P: strong/intense albite-chlorite-carbonate-quartz-sericite-magnetite-pyrite-chalcopyrite-rutile/anatase?/sphene-apatite altered and stockwork veined felsic plutonic rock possibly originally about amphibole diorite; note the addition of fracture-controlled sericite to the assemblage, implying phyllic overprint on transitional propylitic/potassic alteration.

2009P: strong/intense albite-chlorite-carbonate-sericite-quartz ±magnetite-trace chalcopyrite-rutile/sphene-apatite altered and stockwork veined felsic plutonic rock originally about amphibole diorite? (note the fracture-controlled sericite, implying phyllic overprint on transitional propylitic/potassic alteration).

2122P: strongly albite-actinolite-chlorite-sericite-epidote-minor calcite-sphene-apatite altered, probably originally clinopyroxene diorite with accessory ilmeno-magnetite?-apatite, but no sulfides.

2102P: confirmed as magnetite-chalcopyrite-chlorite-minor calcite-quartz-trace sericite-apatite-rutile/anatase altered rock/vein, partly oxidized to hematite and limonite, local malachite.

2033P: biotite quartz monzonite/aplitic quartz monzonite composed of albite-Kspar (partly microcline, partly myrmekitic; could be late magmatic)-quartz-chloritized biotite-accessory magnetite-rutile-apatite, weakly altered to chlorite-sericite-calcite-hematite.

2030P: strongly transitional propylitic/potassic (phyllic overprinted?) amphibole or pyroxene diorite, altered to albite-chlorite-calcite-sericite-minor quartz-rutile/sphene-chalcopyrite ±pyrite, apatite, epidote associated with veinlet network of most of the same minerals.

D29606P: confirmed as strongly potassic (Kspar-relict chloritized biotite-quartz-magnetite-apatite) altered (minor sericite overprint) probable former amphibole/pyroxene diorite, associated with major vein of quartz-pyrite-magnetite-chalcopyrite-chloritized secondary biotite.

2130P: biotite quartz syenite (accessory primary apatite, magnetite?), propylitic/argillic altered to chlorite-clay?/sericite-hematite-trace carbonate-rutile-chalcopyrite, partly oxidized to limonite.

2129P: could represent biotite-hornblende quartz monzonite (accessory magnetite, apatite), incipiently potassic altered by K-flooding, minor chlorite-clay?/sericite-epidote-quartz-hematite-trace chalcopyrite, partly oxidized to limonite.

1276P: confirmed as pyrite-chalcopyrite-quartz-chlorite/sericite (after former secondary biotite?)-trace rutile/sphene-apatite-molybdenite vein, slightly oxidized to traces of limonite.

6079P: strongly potassic (Kspar-quartz-albite-chlorite (after secondary biotite?)-minor epidote-apatite-rutile/anatase?) altered dyke/plutonic rock, cut by veins of quartz-chlorite-epidote-carbonate-pyrite ±chalcopyrite.

6061P: biotite-amphibole syenite (accessory magnetite, ilmenite, apatite), transitional potassic/propylitic ±argillic altered to Kspar-actinolite ±biotite?-chlorite-clay?/sericite-sphene-hematite-trace pyrite-chalcopyrite, partly oxidized to limonite.

6062P: biotite-amphibole (quartz) syenite (accessory ilmeno-magnetite, apatite), transitional potassic/propylitic ±argillic altered to Kspar?-quartz-actinolite ±biotite?-chlorite-clay?-sericite-epidote-sphene-hematite-trace pyrite, chalcopyrite partly oxidized to limonite. Veins are actinolite-magnetite-calcite local Kspar?-quartz-trace chalcopyrite.

6083P: hornblende diorite (accessory apatite, ilmeno-magnetite?) altered to transitional potassic/propylitic assemblage of hematite-stained albite-minor Kspar-quartz-epidote-actinolite-sericite-sphene/rutile-pyrite-chalcopyrite mainly along thin sub-parallel veinlets.

2037P: strongly potassic (Kspar-quartz-chlorite-magnetite-albite-rutile-apatite) altered, possible hornblende diorite (?) in association with significant sub-parallel veining by quartz-magnetite-chlorite-pyrite-chalcopyrite, partly/largely oxidized to limonite-local malachite.

1926P: replacement vein of quartz-sericite/muscovite-chlorite-Fe carbonate-accessory rutile-apatite-pyrite-chalcopyrite (after plutonic intrusive) flanked by selvages of partly sheared quartz-calcite-minor pyrite-chalcopyrite (partly oxidized to limonite).

1932P: confirmed as banded, multistage quartz-carbonate-chlorite-sericite-minor arsenopyrite-pyrite-chalcopyrite-rutile-limonite-apatite vein, partly of replacement and partly of open-space fill origin (the latter with local comb texture)

Detailed petrographic descriptions and photomicrographs are appended (on CD/by email attachment). If you have any questions regarding the petrography, please do not hesitate to contact me.

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2121P: BIOTITE?-AMPHIBOLE (AFTER PYROXENE?) QUARTZ MONZONITE WITH ACCESSORY MAGNETITE?-APATITE, ALTERED TO CHLORITE-SERICITE-CARBONATE-MINOR KSPAR PARTLY ALONG HAIRLINE VEINLETS

Described as from AT35, quartz monzonite from South Cathedral area; hand specimen shows relatively coarse-grained, mottled grey-pink and dark green-green, intermediate/felsic plutonic rock cut by sub-parallel hairline dark green (chlorite?) and white (calcite?) fractures. The rock is distinctly magnetic, shows local rapid reaction to cold dilute HCl, and significant yellow stain for K-feldspar (partly controlled along fractures, so partly secondary?) and white etch for plagioclase in the etched offcut. Modal mineralogy (regular thin section only) is approximately:

Plagioclase (sericite, carbonate altered oligoclase?)	35%
K-feldspar (microperthitic orthoclase, partly secondary?)	30%
Amphibole (secondary, actinolitic, after pyroxene)	15%
Quartz (mainly primary?)	5%
Chlorite (likely mainly after biotite?)	3-5%
Sericite (after plagioclase)	3-5%
Carbonate (after amphibole, plagioclase, mainly calcite?)	3-5%
Opaque (mainly magnetite?)	2-3%
Apatite	<1%

This sample consists of roughly equal proportions of Kspar and sericite-carbonate altered plagioclase, lesser amphibole (altered to actinolite-carbonate; minor chlorite likely after biotite, associated with accessory opaques and apatite), minor interstitial quartz; hairline fractures <0.3 mm thick are mostly filled with chlorite and calcite, but along some there appears to be some secondary Kspar.

Plagioclase forms sub- to euhedral laths up to about 4 mm long (glomeratic to ~7 mm) with only local relict twinning preserved (small extinction angle, and relief close to that of quartz, suggests original composition around oligoclase?) due to widespread pervasive alteration to very fine-grained sericite (randomly oriented subhedral flakes mainly <30 μm) and carbonate (ragged sub/anhedral mainly <45 μm, likely mainly calcite?) plus local traces of chlorite similar in size to sericite.

K-feldspar occurs in irregular to subhedral crystals up to 3 mm across that although somewhat interstitial to the coarser plagioclase, commonly poikilitically enclose smaller plagioclase crystals. Kspar is microperthitic, locally clouded by reddish hematite particles, but distinctly less altered to sericite and carbonate than plagioclase.

Minor quartz forms ragged, irregular an- to subhedra <2 mm mainly interstitial to feldspar and quartz, with relatively weak undulose extinction, sub-grain development, and suturing of grain boundaries indicative of weak strain. The quartz is likely primary.

Mafic minerals are mostly amphibole (but likely after original pyroxene, since traces of relict Schiller structure commonly remain); minor chlorite relics are probably after former biotite. The amphibole occurs as felted, fibrous subhedra mainly <0.3 mm long, oriented along the length of the former pyroxene crystal which displays sub/euhedral outlines to ~3 mm, with pale to bright green pleochroism and small extinction angle <15º suggestive of (secondary) actinolite. The amphibole is locally heavily altered to fine-grained, variable mixtures of carbonate (interlocking anhedra <0.1 mm, calcite and/or dolomite?) plus lesser chlorite (subhedral flakes mainly <50 μm) Chlorite altered biotite relicts are foliated, with ragged outlines to ~1 mm; chlorite optical properties (bright green to yellow pleochroism, length-slow weakly anomalous purplish birefringence) indicate a relatively ferroan composition with Fe:Fe+Mg, or F:M, ratio perhaps 0.5-0.6?).

Accessory opaques closely associated with mafics form sub- to euhedra mostly <0.8 mm, likely mainly magnetite or ilmeno-magnetite, but locally in aggregates up to ~2 mm long; they are associated with minor apatite as stubby euhedral prisms <0.4 mm long.

In summary, this is biotite?-amphibole (after pyroxene?) quartz monzonite with accessory magnetite?-apatite, altered to chlorite-sericite-carbonate-minor Kspar partly along hairline veinlets.

2118P: BIOTITE-AMPHIBOLE (QUARTZ?) MONZONITE PORPHYRY (PLAGIOCLASE-AMPHIBOLE ±BIOTITE, QUARTZ, ILMENO-MAGNETITE? AND APATITE PHYRIC; GROUNDMASS RICH IN BARELY PHANERITIC KSPAR) SLIGHTLY ALTERED TO CLAY?/SERICITE-CHLORITE-EPIDOTE

Described as from AT7, diorite porphyry from South Cathedral area; hand specimen shows fine-grained, greenish-grey, intermediate/felsic hypabyssal rock lacking visible fractures or alteration. The rock is distinctly magnetic, shows no reaction to cold dilute HCl, and significant yellow stain for K-feldspar (groundmass only, so mainly primary?) and white etch for plagioclase (seriate-textured phenocrysts) in the etched offcut. Modal mineralogy (regular thin section only) is approximately:

Plagioclase (clay?/sericite altered, calcic oligoclase?)	40%
K-feldspar (groundmass only, mainly primary?)	35%
Amphibole (secondary actinolitic, actinolitic hornblende?)	15%
Quartz (groundmass only, mainly primary?)	3-5%
Opaque (partly altered to sphene, ilmeno-magnetite?)	2-3%
Chlorite (mainly after biotite, traces of which remain)	1-2%
Clay?/sericite (after plagioclase)	1-2%
Apatite	<1%
Epidote (Fe-rich after amphibole, zoisite after plagioclase)	<1%

This sample consists of about 25-30% relict (clay?/sericite altered) plagioclase and 10% amphibole ±biotite (altered to actinolite-chlorite respectively),very rare quartz phenocrysts in a fine-grained, barely phaneritic groundmass of Kspar, seriate-textured plagioclase and amphibole crystals, minor quartz (?), and accessory opaques and apatite.

Plagioclase phenocrysts range from slender tabular/lath-shaped euhedral phenocrysts up to ~4 mm long, with random orientations, through progressively smaller (seriate) crystals mostly <1 mm, to microlites <50 µm in the groundmass. Most show rather vague relict twinning with extinction Y^010 up to ~12º, suggestive of calcic oligoclase around An_{25-30} (?), and are slightly (<5-15%) replaced by very fine-grained clay?/sericite as randomly oriented subhedral flakes mainly <20 µm, locally with minor epidote-group mineral (zoisite?) as rounded sub/anhedra <20 µm.

Amphibole phenocrysts have mainly rounded-off, sub- to euhedral outlines up to about 2.2 mm long (locally glomeratic to 3 mm) with random orientations. They are either single crystals (actinolitic hornblende?) or show replacement by fine-grained fibrous secondary actinolitic amphibole similar to that described for 2121, or rarely traces of epidote (subhedra <0.1 mm with strong yellow pleochroism indicative of high Fe content). They are locally associated with a little relict biotite (brownish cores mostly replaced by chlorite with similar optical characteristics as described above for 2121; F:M 0.5-0.6?) and are closely associated with most of the accessory opaques and apatite. Opaques form rounded subhedra to 0.5 mm, locally microphenocrysts (as is biotite and accessory apatite). The opaque typically shows partial replacement at rims by sphene, suggesting it is likely ilmeno-magnetite (?); apatite forms stubby sub/euhedra to 0.3 mm long.

Rare relict quartz phenocrysts have corroded, anhedral outlines to ~1 mm, rimmed by fibrous secondary amphibole; the quartz is essentially unstrained.

In the groundmass, microlitic subhedral crystals of plagioclase and amphibole mostly <0.2 mm, altered as for phenocrysts, are set in a matrix of K-feldspar (randomly oriented, feathery subhedra mainly <50, but locally to ~100 µm), possible quartz (subhedra <30 µm, difficult to identify with confidence) plus accessory opaques and apatite both mostly <35 µm.

In summary, this is biotite-amphibole (quartz?) monzonite porphyry (plagioclase-amphibole ±biotite, quartz, ilmeno-magnetite? and apatite phyric; groundmass rich in barely phaneritic Kspar) slightly altered to clay?/sericite-chlorite-epidote. It seems likely to be related to or consanguineous with sample 2121.

2120P: PORPHYRITIC BIOTITE-AMPHIBOLE (QUARTZ) SYENITE WITH ACCESSORY ILMENO-MAGNETITE?-APATITE, SLIGHTLY ALTERED TO KSPAR-EPIDOTE-CLAY?/SERICITE MOSTLY ALONG/NEAR THIN EPIDOTE-KSPAR VEINLETS

Described as 0.5 m dike from AT34, syenite porphyry from South Cathedral area; hand specimen shows fine-grained, greenish-grey, felsic hypabyssal rock cut by prominent pink fractures. The rock is distinctly magnetic, shows no reaction to cold dilute HCl, and major yellow stain for K-feldspar (groundmass and fractures, primary/secondary?), minor white etch for plagioclase (small phenocrysts) in the etched offcut. Modal mineralogy (regular thin section only) is approximately:

K-feldspar (groundmass, primary; local veinlet, secondary?)	65%
Plagioclase (clay?/sericite altered, oligoclase-andesine?)	17%
Amphibole (secondary, actinolitic, after hornblende?)	5-7%
Quartz (interstitial, mainly primary?)	3-5%
Chlorite (mainly after biotite, some of which remain)	2-3%
Opaque (ilmeno-magnetite?)	2-3%
Clay?/sericite (after plagioclase)	1-2%
Epidote (Fe-rich after biotite and in veinlets)	1%
Apatite	<1%

This sample consists of perhaps 30% Kspar, 15% small plagioclase and <10% mafic (relict amphibole, biotite) phenocrysts in a groundmass of only slightly smaller Kspar, minor interstitial quartz, accessory opaques and apatite. Apparent secondary Kspar is controlled along thin epidote veinlets.

Kspar phenocrysts (difficult to separate from groundmass except by size) form rounded subhedra up to about 3.5 mm long, with random orientations. They typically contain only traces of albite inclusions (subhedral, <0.15 mm) and are only slightly clouded by incipient clay?/hematite inclusions <2 µm in size. Kspar of the groundmass differs only by smaller grain size (randomly oriented subhedra mainly <1mm).

Plagioclase occurs as randomly oriented, tabular sub- or locally euhedra mostly <1.5 mm long that are characterized by stronger clay?/sericite alteration (randomly oriented, subhedral flakes mostly <15 µm) than in K-feldspar. The alteration mostly obscures twinning, but rarely seen extinction Y^010 up to 17° suggests composition near An_{30-35} (oligoclase-andesine?).

Mafic crystals are mainly amphibole (sub- to rarely euhedra, up to ~1 mm (glomeratic to 2 mm, with local biotite as ragged sub/anhedra to ~1.5 mm with dark green-brown pleochroism. Both but especially biotite are partly altered in places to variable combinations of chlorite and epidote <0.35 and <0.15 mm respectively, with Fe-rich composition suggested by optical properties as described above for 2121 and 2118. Elsewhere, the amphibole is partly altered to fibrous secondary (actinolitic?) amphibole, and both are closely associated with accessory opaques (rounded to irregular subhedra mostly <0.3 mm, likely magnetite or ilmeno-magnetite?) and apatite (prismatic euhedra to 0.6 mm long, or stubby interstitial subhedra to 0.5 mm diameter associated with quartz).

Quartz occurs as small (<1 mm) interstitial, somewhat skeletal crystals whose shape is determined by the enclosing crystals of feldspar; the crystals are essentially unstrained.

Veinlets mostly <0.5 mm thick are characterized by central thin zones of epidote (bright yellow, Fe-rich subhedra <0.25 mm long) or Kspar (relatively clear subhedra <0.2 mm) with flanking zones up to ~5 mm wide of strongly cloudy brown (clay?/hematite-stained) Kspar.

In summary, this is porphyritic biotite-amphibole (quartz) syenite with accessory ilmeno-magnetite?-apatite, slightly altered to Kspar-epidote-clay?/sericite mostly along/near thin epidote-Kspar veinlets.

2123P: KSPAR MEGACRYSTIC, PLAGIOCLASE-BIOTITE?-AMPHIBOLE-APATITE PHYRIC MONZONITE (?) PORPHYRY WITH ACCESSORY OPAQUES, STRONGLY ALTERED TO SERICITE/MUSCOVITE-CARBONATE-CHLORITE-PROBABLE HEMATITE-RUTILE?

Described as from AT522, megacrystic syenite; hand specimen shows coarse pink Kspar phenocrysts to at least 4 cm long in fine-grained, pinkish-grey groundmass of felsic hypabyssal rock lacking visible fractures. The rock is distinctly magnetic, shows abundant vigorous reaction to cold dilute HCl, and major yellow stain for K-feldspar (phenocrysts, weaker in groundmass, primary), minor white etch for plagioclase (smaller seriate crystals) in the etched offcut. Modal mineralogy (regular thin section only) is approximately:

K-feldspar (megacrysts, groundmass; primary)	40%
Carbonate (after feldspars, mainly calcite?)	20%
Sericite (after feldspars), muscovite (after mafic sites)	17%
Plagioclase (relict, clay?/sericite-carbonate altered)	15%
Chlorite (intimately mixed with carbonate, after mafic sites)	5%
Opaque (ilmeno-magnetite, partly altered to hematite, rutile?)	2-3%
Apatite (phenocrysts/microphenocrysts)	<1%
Quartz (rare, possibly partly secondary with calcite)	<1%

This sample consists of perhaps 10% megacrystic Kspar, 20% small relict (sericite-carbonate altered) plagioclase, and 10% relict (carbonate-muscovite-opaque altered) mafic, local apatite phenocrysts in a groundmass of Kspar, carbonate, chlorite, sericite and accessory opaques plus trace quartz.

Kspar megacrysts cut in the section are euhedral to subhedral (the latter corroded?), up to 1 cm long, with random orientations. The cores tend to be clear but rims are clouded by dark brown alteration to minute particles of clay?/hematite (?); rims also tend to contain poikilitic inclusions of plagioclase (sub/euhedra <1 mm, strongly replaced by fine sericite-calcite as described below).

Plagioclase phenocrysts show random orientation and seriate texture, ranging from a maximum of about 4 mm down to <0.2 mm in the groundmass; originally, this sample probably contained too much plagioclase to be classified as syenite. Most plagioclase is now strongly to locally severely replaced by variable combinations of sericite (matted, randomly oriented subhedral flakes mainly <25 µm) and carbonate (ragged, interlocking anhedra mainly <0.1 mm, likely calcite?); the intervening remnant plagioclase is not determinable, but could be albitized judging by alteration.

Relict mafic sites with mainly euhedral outlines up to 5 mm long, with random orientations, appear likely to represent both amphibole and biotite, variably pseudo-morphed by variable combinations of relatively finer-grained, intimately mixed carbonate and minor chlorite, or coarser-grained, somewhat foliated, muscovite-minor chlorite-carbonate respectively. The carbonate forms interlocking, ragged anhedra <0.25 mm that could be calcite and dolomite (?); chlorite forms subhedral flakes mainly <0.1 mm with pale green colour/pleochroism and near-zero birefringence, suggestive of F:M 0.5 (?). Muscovite forms subhedral flakes to ~0.5 mm (but optically continuous for several mm, due to alignment parallel to relict outline). Both are typically rimmed by fine-grained opaques <0.2 mm that likely include hematite and rutile after former ilmeno-magnetite (?), and are associated with apatite as euhedral prisms <0.25 mm long. Distinctive apatite phenocrysts have stubby euhedral outlines to 1.1 mm long; opaque microphenocrysts are rounded subhedra <0.5 mm.

In the groundmass, highly sericite altered plagioclase and carbonate-chlorite altered mafic microlites mainly <0.2 mm are set in a matrix of Kspar (feathery subhedra mainly <0.1 mm) with abundant sericite, carbonate-minor chlorite-accessory opaques and apatite. Rare quartz forming sub- to anhedra <0.1 mm (aggregates to 0.25 mm, with carbonate of similar size) may be partly secondary.

In summary, this appears to represent Kspar megacrystic, plagioclase-biotite?-amphibole-apatite phyric monzonite (?) porphyry with accessory opaques, strongly altered to sericite/muscovite-carbonate-chlorite-probable hematite-rutile (?).

2106P: STRONG TO INTENSE ALBITE (TRACE SERICITE, CHLORITE) ALTERED, ALBITE-MAGNETITE-MINOR CHALCOPYRITE-CHLORITE-APATITE-RUTILE OR LATER QUARTZ-CHLORITE VEINED ROCK OF UNCERTAIN DERIVATION, LIKELY INDICATIVE OF TRANSITIONAL PROPYLITIC-POTASSIC ALTERATION

Described as from AT18, albite-actinolite-carbonate-chalcopyrite alteration on ridge; hand specimen shows whitish-grey, highly altered and fractured rock of uncertain derivation cut by thin sub-parallel dark (magnetite) veinlets and local fractures coated by limonite ±malachite. The rock is strongly magnetic, shows no reaction to cold dilute HCl, and no stain for K-feldspar (but abundant white etch for plagioclase) in the etched offcut. Modal mineralogy in polished thin section is approximately:

Plagioclase (largely secondary, albite)	85%
Magnetite (largely secondary, along veinlets)	7-8%
Chlorite (mainly hairline veinlets)	2-3%
Apatite (partly secondary?)	1-2%
Rutile (after ilmenite or ilmeno-magnetite?)	1%
Quartz (veinlet, secondary only)	~1%
Chalcopyrite (veinlets only)	<1%
Sericite (after plagioclase)	<1%

This sample consists mainly of albite, in various forms (albitized large crystals, cut by veinlets of finer albite, generally associated with veinlets of magnetite-minor chlorite-apatite-rutile or locally quartz). Traces of sericite accompany albitization of large plagioclase crystals.

Coarse albitized plagioclase crystals have random orientations, with sub- to euhedral tabular outlines up to as much as 8 mm long although somewhat fractured and offset along magnetite veinlets. Well-defined twinning with extinction Y^010=15º and poorly defined negative relief compared to quartz in rare veinlets, plus flecking by minute randomly oriented flakes of sericite (mostly euhedral, <30 µm) all indicate it has been albitized (An_5?). Locally, traces of chlorite of similar size accompany the sericite. Along the veinlets, fine-grained albite (interlocking sub/anhedra mainly <0.15, but up to 0.3 mm, relatively clear by comparison to the coarser wallrock albite) may be An_0 (?), indicative of strong transitional propylitic/potassic alteration, especially in association with secondary magnetite, minor chlorite, apatite, rutile and quartz. Rutile occurs in aggregates with subhedral outlines up to ~1.5 mm across, suggestive of former ilmenite (?).

The bulk of the veinlets, making up roughly 10-15% of the sample, form a variable network, are sub-planar and mostly <1 mm thick except at junctions where they may spread to ~3 mm. They consist mainly of magnetite (interlocking irregular sub/anhedra mainly <0.1 mm, only trace alteration to hematite as minute euhedral flakes <20 µm), local chlorite (subhedral flakes mainly <0.2 mm with distinct pale to bright green pleochroism, length-slow, anomalous bluish-grey birefringence suggestive of F:M 0.5-0.6?), distinctly abundant apatite (stubby sub/euhedra as coarse as 1 mm long) and rutile (golden or yellow-brown subhedra to 0.15 mm, clearly partly remobilized, suggesting alteration intense enough to redistribute TiO_2). Locally, minor chalcopyrite forming irregular masses up to 2 mm long of interlocking anhedra (trace oxidation at margins to limonite) accompanies the vein magnetite as coarser sub/euhedra to 0.35 mm. Malachite was not seen in the section.

Relatively rare, thin (<1 mm) planar quartz veinlets consist of interlocking sub- to rarely euhedral crystals of quartz <0.2 mm, with central or marginal bands of chlorite as described above but no magnetite, apatite or rutile; they clearly cut the earlier magnetite-rich veinlet network.

In summary, this is confirmed as strong to intense albite (trace sericite, chlorite) altered, albite-magnetite-minor chalcopyrite-chlorite-apatite-rutile or later quartz-chlorite veined rock of uncertain derivation, likely indicative of transitional propylitic-potassic alteration.

2020P: STRONG TO INTENSE ALBITE-CARBONATE-CHALCOPYRITE-CHLORITE-EPIDOTE-MINOR QUARTZ-RUTILE-APATITE ALTERED, LATER CARBONATE-EPIDOTE VEINED ROCK OF UNCERTAIN DERIVATION, LIKELY INDICATIVE OF TRANSITIONAL PROPYLITIC-POTASSIC ALTERATION

Described as from AT501, albite-actinolite-magnetite-chalcopyrite alteration near snow patch; hand specimen shows pale grey, strongly altered rock of uncertain derivation with significant disseminated chalcopyrite, cut by thin irregular cryptic (calcite) veinlets and local fractures coated by limonite ±malachite. The rock is not magnetic, shows local rapid reaction to cold dilute HCl, and no stain for K-feldspar (but abundant white etch for plagioclase) in the etched offcut. Modal mineralogy in polished thin section is approximately:

Plagioclase ("chessboard"/irregular secondary albite)	75%
Carbonate (largely along veinlets/less in "spots", calcite?)	8%
Chalcopyrite (disseminated; rarely in carbonate veins with trace pyrite)	5%
Chlorite (mainly in "spots")	5%
Epidote (closely associated with chalcopyrite)	3%
Quartz (spots/secondary only)	2%
Rutile, trace sphene (after ilmenite?)	2%
Apatite (partly secondary?)	<1%

This sample is similar to 2106, composed mainly of albite, in various forms (albitized large crystals, cut by poorly defined, very irregular microveinlets of finer albite, generally associated with spotty disseminations of chalcopyrite-chlorite-epidote-apatite-rutile-local carbonate-quartz. Late carbonate-epidote veins contain only traces of chalcopyrite, local pyrite.

Coarse albitized plagioclase crystals are randomly oriented, with subhedral, ragged/corroded semi-tabular outlines up to ~6 mm long although somewhat fractured and offset by microveinlets. Well-defined twinning with extinction Y^010=15º and well-defined negative relief compared to quartz in rare veinlets, plus classic "chessboard" or irregular albite textures) all indicate it has been even more strongly albitized (An_{0-5}?) than in 2106. Near the "spots" of sulfide-epidote-chlorite, and along microveinlets, finer-grained albite (interlocking sub/anhedra mainly <0.25, but up to 0.5 mm, relatively clear by comparison to the coarser wallrock albite) may be An_0 (?), indicative of strong transitional propylitic/potassic alteration, especially considering the association with chalcopyrite, chlorite, epidote, quartz, rutile and minor apatite. Rutile occurs in aggregates with subhedral outlines up to ~1 mm across intergrown in skeletal fashion with carbonate, suggestive of former ilmenite (?).

The bulk of the chalcopyrite, making up ~5% of the sample, occurs as disseminated "spots" or along a poorly defined network of microveinlets mostly <0.5 mm thick except at junctions where they may spread to ~1 mm. The clots/veinlets consist mainly of chalcopyrite (sub/anhedra mainly <1 mm, only trace pyrite as subhedra <0.25 mm, both partly oxidized to limonite at rims or as subhedra to 0.4 mm), typically surrounded by epidote (randomly oriented sub/euhedra mainly <0.25 mm with strong yellow pleochroism indicative of high Fe content), chlorite (semi-radiating, subhedral flakes mainly <0.45 mm with distinct pale to bright green pleochroism, length-slow, anomalous blue-grey birefringence suggestive of F:M 0.6-0.7?), local quartz (interlocking sub- to rarely euhedral crystals <0.6 mm, carbonate (irregular sub/anhedra to ~0.7 mm, likely mainly calcite), rutile (golden or yellow-brown euhedra to 0.4 mm), trace apatite (stubby sub/euhedra <0.4 mm long). The presence of rutile in these clots suggests alteration intense enough to redistribute TiO_2. Malachite was not seen.

Later, more planar veins to 2 mm thick consist mainly of carbonate (interlocking sub/anhedra up to 2.5 mm long, mainly calcite?), with central or marginal bands of epidote (ragged skeletal subhedra <0.75 mm, also Fe-rich) but only trace chalcopyrite-rare pyrite partly oxidized to limonite, flanked by envelopes of albite-epidote-minor chlorite as described above with local apatite or rutile.

In summary, this is confirmed as strong to intense albite-carbonate-chalcopyrite-chlorite-epidote-minor quartz-rutile-apatite altered, later carbonate-epidote veined rock of uncertain derivation, likely indicative of transitional propylitic-potassic alteration.

2021P: AMPHIBOLE DIORITE ALTERED TO ALBITE-OLIGOCLASE?-ACTINOLITE-SERICITE-CARBONATE-EPIDOTE-CHLORITE-SPHENE-CHALCOPYRITE-PYRITE-APATITE, WITH VEINLETS OF EPIDOTE-CHLORITE-TRACE QUARTZ

Described as from AT540, stockwork actinolite in albite zone with chalcopyrite-pyrite; hand specimen shows green-grey/pale orange-pinkish, altered coarse-grained felsic plutonic rock with local dark (chlorite?) hairline veinlets partly controlling chalcopyrite, which also occurs weakly disseminated; fractures are coated by limonite ±malachite. The rock is weakly magnetic, shows local trace rapid reaction to cold dilute HCl, and no stain for K-feldspar (but abundant white etch for plagioclase) in the etched offcut. Modal mineralogy in polished thin section is approximately:

Plagioclase (sericite ± carbonate, epidote altered, albite-oligoclase?)	60%
Amphibole (mainly secondary, actinolitic)	15%
Sericite (after plagioclase)	10%
Carbonate (mainly after amphibole, calcite?)	5%
Epidote (closely associated with chalcopyrite, also in veinlets)	2%
Chlorite (mainly along hairline veinlets, with epidote)	2%
Magnetite (partly martitized/oxidized to hematite)	2%
Sphene, minor rutile (after ilmenite or ilmeno-magnetite?)	2%
Chalcopyrite (disseminated; in veinlets; partly oxidized to limonite)	1%
Pyrite (associated with chalcopyrite; partly oxidized to limonite)	<1%
Apatite (partly secondary?)	<1%

This sample shows relict plutonic texture: hypidiomorphic-granular textured plagioclase (albitized, altered to sericite± carbonate, epidote), amphibole (altered to actinolite-carbonate ±chlorite-epidote) associated with magnetite (partly oxidized to martite, hematite)-sphene/rutile (after ilmenite?)-sulfides-apatite; hairline veinlets of calcite-epidote-chlorite are only loosely associated with sulfides.

Coarse plagioclase crystals forming the bulk of the slide are randomly oriented, tabular or barely subhedral up to ~5 mm long. They only locally retain vague relict twinning with extinction Y^010 up to ~10º, suggestive of a composition near An_{10} (albite-oligoclase boundary), due to the generally severe and pervasive (30-50%) alteration to sericite (randomly oriented, sub/euhedral flakes mainly <20 µm), local carbonate (ragged anhedra <50 µm, likely calcite) and epidote-group mineral (aggregates to 0.2 mm of colourless, presumably low Fe, zoisite/clinozoisite sub/anhedra <30 µm). Thus albitization appears to be much less strong in this sample, except for small areas around rims of the large crystals or interstices between them, where much clearer, better twinned secondary albite forms fine sub/euhedra mainly <0.5 mm.

Relict mafic crystals have rounded sub- to euhedral outlines up to about 2.5 mm long, but commonly occur in crude aggregates or glomeratic masses up to ~6 mm. They are mainly amphibole, either as single relict crystals <1.5 mm or recrystallized to fibrous, fine-grained masses (both with similar pale to medium green pleochroism and small extinction angle ~17ºsuggestive of actinolite), but may have replaced original pyroxene (?). Most are partly (10-30%) replaced by variable carbonate (minute sub- to anhedra <0.1 mm, likely mostly calcite?). Near veinlets, some are replaced by better crystallized, deep green actinolite as slender acicular subhedra to 0.6 mm long.

Accessory magnetite (heavily fractured subhedra to about 1 mm, partly martitized or oxidized to fine-grained hematite as sub/euhedral flakes to 0.1 mm, or rimmed by sphene as subhedra to 0.5 mm, locally with cores of rutile <0.2 mm) and apatite (stubby sub/euhedral prisms to ~1 mm long) are closely associated with the mafic relics, as are sulfides (chalcopyrite as ragged sub/anhedra <1 mm, lesser pyrite as sub/euhedral cubes to 0.8 mm, both partly oxidized at rims and along fractures to limonite, and commonly closely associated/rimmed by epidote (ragged sub/anhedra to 0.7 mm with pale yellow colour implying moderate Fe content) and chlorite (bright yellow/green pleochroic, birefringence as for 2020, F:M 0.6-0.7?). Hairline veinlets <0.25 mm thick consist of epidote and chlorite, local trace quartz, all mainly <0.15 mm, but are not associated with sulfides.

In summary, this is amphibole diorite altered to albite-oligoclase?-actinolite-sericite-carbonate –epidote-chlorite-sphene-chalcopyrite-pyrite-apatite, with veinlets of epidote-chlorite-trace quartz.

2022P: AMPHIBOLE DIORITE ALTERED TO ALBITE-ACTINOLITE-CARBONATE-SERICITE-EPIDOTE-CHLORITE-SPHENE-PYRITE (TRACE CHALCOPYRITE)-APATITE, WITH VEINLETS OF EPIDOTE-CHLORITE-CARBONATE

Described as from A543, albite alteration; hand specimen shows pale greenish-grey/pale orange-pinkish, altered coarse-grained felsic plutonic rock with local dark (chlorite?) hairline veinlets not obviously controlling sulfide, which mostly occurs disseminated in relict mafic sites. The rock is not magnetic, shows local rapid reaction to cold dilute HCl, and no stain for K-feldspar (but abundant white etch for plagioclase) in the etched offcut. Modal mineralogy in polished thin section is approximately:

Plagioclase (albitized, sericite ± carbonate, chlorite altered)	70%
Amphibole (mainly secondary, actinolitic)	13%
Carbonate (mainly after amphibole, calcite?)	5-7%
Sericite (after plagioclase)	3%
Epidote (mainly in veinlets)	2%
Chlorite (mainly along hairline veinlets, with epidote)	2%
Sphene (after ilmeno-magnetite?)	1-2%
Pyrite, trace chalcopyrite	~1%
Apatite (accessory/secondary?)	~1%

This is similar to 2020, relict plutonic texture of hypidiomorphic-granular textured plagioclase (strongly albitized, minor sericite± carbonate), amphibole (strongly altered to actinolite-carbonate) associated with sphene (after ilmeno-magnetite?)-sulfides-apatite; hairline veinlets of calcite-epidote-chlorite are not closely associated with sulfides.

Coarse plagioclase crystals forming the bulk of the rock are randomly oriented, tabular sub- to euhedral, up to ~6 mm long. They typically show sharp to vague twinning with extinction Y^010 = 14º, suggestive of composition near An_{0-5} (albite), likely secondary especially in view of the minor (5-10%) replacement by sericite (randomly oriented, sub/euhedral flakes mainly <25 µm), local carbonate (ragged anhedra <30 µm, likely calcite) and chlorite (aggregates to 0.2 mm of bright green subhedral flakes <30 µm). Thus albitization appears to be considerably stronger in this sample than in 2020, especially for small areas around rims of the large crystals or interstices between them, where distinct clear, well twinned/local "chessboard" secondary albite forms fine sub/euhedra mainly <1.5 mm.

Relict mafic crystals have ragged sub- to anhedral outlines, commonly in crude glomeratic aggregates to ~4 mm. They are mainly amphibole, either as single relict crystals <2.25 mm or recrystallized to fibrous, fine-grained sub-domains <0.5 mm long (both with similar pale to medium green pleochroism and small extinction angle ~14º suggestive of actinolite). Most are partly (10-25%) further replaced by variable carbonate (minute sub- to anhedra <0.1 mm, mostly calcite?). As in 2020, near some veinlets, some amphibole is replaced by better crystallized, deep green actinolite as slender acicular subhedra to 0.6 mm long.

Accessory ilmeno-magnetite (?) sites are replaced by sphene (pale brownish sub- to euhedra to 0.35 mm) associated with apatite (stubby sub/euhedral prisms to ~1 mm long), closely associated with the mafic relics, and local sulfides (pyrite as sub/euhedral cubes to 0.8 mm, trace chalcopyrite as ragged sub/anhedra <0.1 mm. both partly oxidized at rims and along fractures to limonite, in part closely associated/rimmed by epidote as ragged sub/anhedra <0.2 mm with pale yellow colour implying moderate Fe content) and chlorite (bright yellow/green pleochroic, birefringence as described above, F:M 0.6-0.7?). Hairline veinlets <0.35 mm thick consist of epidote and chlorite, both mainly <0.5 mm, in places with carbonate as subhedra up to ~1 mm long, but are not associated clearly with sulfides.

In summary, this is amphibole diorite altered to albite-actinolite-carbonate-sericite-epidote-chlorite-sphene-pyrite (trace chalcopyrite)-apatite, with veinlets of epidote-chlorite-carbonate.

2032P: AMPHIBOLE DIORITE ALTERED TO ALBITE-ACTINOLITE-CARBONATE-SERICITE-EPIDOTE-CHLORITE-SPHENE-APATITE-TRACE CHALCOPYRITE, WITH VEINLETS OF PYRITE-ACTINOLITE-EPIDOTE-CHLORITE-CARBONATE-LATE "HYDROBIOTITE"

Described as from AT504, type actinolite stockwork (albite-magnetite-pyrite-chalcopyrite); hand specimen shows mottled, pinkish-grey and dark greenish-black, medium-grained strongly altered felsic plutonic rock cut by a swarm of sub-parallel black veinlets with sulfides (mainly pyrite). The rock is only locally slightly magnetic, shows local vigorous reaction to cold dilute HCl, and no stain for K-feldspar in the etched offcut (but extensive white etch for plagioclase). Modal mineralogy in polished thin section is approximately:

Plagioclase (albitized, sericite ± carbonate altered)	70%
Amphibole (mainly secondary, actinolitic)	8%
Carbonate (mainly after amphibole, calcite?)	7%
Sericite (after plagioclase)	5%
Epidote (mainly in veinlets)	3%
Chlorite (mainly in veinlets, with epidote); late "hydrobiotite"	3%
Pyrite, trace chalcopyrite	2%
Sphene (after ilmeno-magnetite?)	1%
Quartz (secondary only, in veinlets)	~1%
Apatite (accessory/secondary?)	<1%

This is similar to 2022: relict plutonic texture of hypidiomorphic-granular textured plagioclase (strongly albitized, minor sericite± carbonate), amphibole (strongly altered to actinolite-carbonate-local epidote ± chlorite) associated with sphene ±hematite (after ilmeno-magnetite?) ±apatite, chalcopyrite. Most pyrite is found in thin veinlets of actinolite-epidote-chlorite-calcite-local quartz.

Coarse plagioclase crystals forming the bulk of the rock are randomly oriented, tabular sub- to euhedra up to ~3 mm long. They typically show sharp to vague twinning with extinction Y^010 = 14º, suggestive of composition near An_{0-5} (albite), likely secondary especially in view of the minor (5-10%) replacement by sericite (randomly oriented, sub/euhedral flakes mainly <25 µm), local carbonate (ragged anhedra <30 µm, likely calcite) and chlorite or epidote (bright green subhedral flakes, colourless subhedra <20 µm). Thus albitization appears to be similar to 2022, considerably stronger than in 2020, especially for small areas in thin veinlets cutting across or interstices between the coarse crystals, where distinct clear, well twinned/local "chessboard" secondary albite forms fine sub/euhedra mainly <0.75 mm.

Relict mafic crystals have ragged sub- to anhedral outlines, commonly in crude glomeratic aggregates to ~4 mm. They are mainly amphibole, either as rare single relict crystals <2 mm, or strongly recrystallized to fibrous, fine-grained sub-domains <0.35 mm long (both with similar pale to medium green pleochroism and small extinction angle ~15º suggestive of actinolite). Most are partly (10-25%) further replaced by variable carbonate (sub- to anhedra <0.25 mm, mostly calcite?)or, especially near some veinlets, by better crystallized, deeper green actinolite as slender acicular subhedra to 0.5 mm long in places accompanied by epidote and chlorite (matted subhedra <0.1 mm).

Probable former accessory ilmeno-magnetite (?) sites are replaced by sphene (pale brownish sub- to euhedra to 0.3 mm) associated with apatite (stubby sub/euhedral prisms to 0.6 mm long), and trace chalcopyrite as ragged sub/anhedra <0.2 mm closely associated with the mafic relics. However, most pyrite (fractured sub/euhedral cubes to ~1mm, partly oxidized at rims and along fractures to limonite, in part closely associated/rimmed by epidote as sub/anhedra <0.4 mm with pale yellow colour implying moderate Fe content) and chlorite (bright yellow/green pleochroic, blue-grey length-slow birefringence, F:M 0.6-0.7?) occurs in veinlets <2 mm thick of epidote and chlorite, in places with carbonate as subhedra up to ~1 mm long, cut by later yellowish-brown "hydrobiotite" (Fe-rich chlorite) veinlets. No actual magnetite is found.

In summary, this is amphibole diorite altered to albite-actinolite-carbonate-sericite-epidote-chlorite-sphene-apatite-trace chalcopyrite, with veinlets of pyrite-actinolite-epidote-chlorite-carbonate-late “hydrobiotite”.

2023P: AMPHIBOLE DIORITE? ALTERED TO ALBITE-CHLORITE/"HYDROBIOTITE"-SULFIDES-RUTILE-APATITE-SERICITE, WITH VEINLETS OF ALBITE-CHLORITE-QUARTZ-PYRITE-RELICT PYRRHOTITE-CHALCOPYRITE, OXIDIZED TO LIMONITE-LATE "HYDROBIOTITE"

Described as from AT544, actinolite-albite-magnetite veins, high pyrite/chalcopyrite, distal; hand specimen shows mottled, orange-white and dark grey-green, coarse-grained strongly altered felsic plutonic rock cut by a swarm of sub-parallel black hairline veinlets with sulfides (mainly pyrite). The rock is only locally slightly magnetic, shows no reaction to cold dilute HCl, and no stain for K-feldspar in the etched offcut (but extensive white etch for plagioclase). Modal mineralogy in polished thin section is approximately:

Plagioclase (albite/albitized, ±sericite altered)	70%
Chlorite (in veinlets, mafic sites); part altered to late "hydrobiotite"	10%
"Hydrobiotite" (mafic sites, partly after chlorite, plagioclase)	10%
Relict pyrrhotite (altered to lamellar pyrite/marcasite)	2%
Pyrite, trace chalcopyrite	2%
Rutile (after ilmeno-magnetite?)	1-2%
Quartz (secondary only, in veinlets/relict mafic sites)	1-2%
Apatite (accessory/secondary?)	~1%
Limonite (supergene stains)	~1%
Sericite (after plagioclase)	~1%

This is strongly altered: relict plutonic texture of hypidiomorphic-granular textured plagioclase (strongly albitized, trace sericite), relict mafics (strongly altered to chlorite-"hydrobiotite"-local quartz, associated with rutile likely after ilmeno-magnetite, apatite, and sulfides. More sulfide occurs along thin irregular veinlets of chlorite-local quartz stained by supergene limonite-"hydrobiotite".

Coarse plagioclase crystals forming the bulk of the rock are randomly oriented, tabular sub- to euhedra up to 3.5 mm long but commonly fractured/cut by clear albite microveinlets. They typically show sharp to vague twinning with extinction Y^010 = 15ºand negative relief compared to quartz, (albite An_{0-5}), likely secondary (local "chessboard" texture, trace (<5%) replacement by sericite (randomly oriented, sub/euhedral flakes mainly <30 µm), or near relict mafic sites, "hydrobiotite" (brownish subhedral flakes <50 µm spreading out from the mafic sites). Albitization is stronger along thin veinlets cutting across, or interstices between, the coarse crystals, where distinct clear, well twinned/local "chessboard"/unsericitized secondary albite forms finer sub/euhedra mainly <0.35 mm. These veinlets are irregular, <1 mm thick, and also contain variable chlorite-quartz-sulfide (see below)

Relict mafic sites have ragged irregular outlines, commonly in crude glomeratic aggregates to ~5 mm. They are now of unrecognizable origin, being strongly recrystallized to aggregates of "hydrobiotite" (actually Fe-rich chlorite, partly supergene as shown by association with pyrrhotite oxidized to pyrite/marcasite and limonite) forming aggregates to 1.5 mm of randomly oriented, matted subhedral flakes <0.1 mm with greenish-brown to brown colour but no pleochroism, 1st/2nd order birefringence, in part after chlorite (subhedral flakes to 0.5 mm with pale green pleochroism and near-zero to weakly length-slow, anomalous bluish grey birefringence suggestive of F:M 0.5?) in places accompanied by secondary quartz as subhedra to ~1 mm, and associated with rutile/sulfides.

Probable former accessory ilmeno-magnetite (?) sites (subhedral outlines to 0.5 mm) replaced by rutile (opaque sub/euhedra <40 µm), apatite (stubby sub/euhedral prisms to 0.8 mm), and sulfides are closely associated with the mafic relics although some occurs with the irregular veinlet network with chlorite-quartz-albite. Sulfides include relict pyrrhotite (ragged sub/anhedra <1 mm, oxidized to pyrite/marcasite (lamellar aggregates of minute subhedra <20 µm), pyrite (fractured sub/euhedral cubes <0.5 mm) and minor chalcopyrite (sub/anhedra <0.2 mm), all partly oxidized at rims and along fractures to limonite which spreads out to stain adjacent rock. No actual magnetite is found.

In summary, this is amphibole diorite? altered to albite-chlorite/"hydrobiotite"-sulfides-rutile-apatite-sericite, with veinlets of albite-chlorite-quartz-pyrite-relict pyrrhotite-chalcopyrite, oxidized to limonite-late "hydrobiotite".

2015P: Strong/Intense Albite-Chlorite-Carbonate-Quartz-Sericite-Magnetite-Pyrite-Chalcopyrite-Rutile/Anatase?/Sphene-Apatite Altered And Stockwork Veined Felsic Plutonic Rock Possibly Originally About Amphibole Diorite; Note Addition of Fracture-Controlled Sericite to the Assemblage, Implying Phyllic Overprint On Transitional Propylitic/Potassic Alteration

Described as from AT519, albite-carbonate-chalcopyrite new showing; hand specimen shows dark grey-green, fine-grained intensely altered felsic plutonic rock cut by a network/swarm of sub-parallel black veinlets with magnetite and sulfides (mainly pyrite). The rock is locally strongly magnetic, shows rapid reaction to cold dilute HCl, and no stain for K-feldspar in the etched offcut but extensive white etch for plagioclase. Modal mineralogy in polished thin section is approximately:

Plagioclase (albite/albitized, sericite ± carbonate altered)	65%
Chlorite (in veinlets, mafic sites)	10%
Carbonate (mainly veinlets, minor pervasive, calcite?)	7%
Quartz (secondary only, in veinlets/relict mafic sites)	7%
Sericite (mainly after albite, partly along veinlets)	3%
Pyrite (mainly in veins)	3%
Magnetite (mainly in veins)	2%
Chalcopyrite (veinlets, relict mafic sites)	1%
Rutile/anatase?/sphene	~1%
Apatite (partly secondary?)	<1%

This is a strongly altered rock composed mainly of secondary albite (partly altered to sericite ±calcite) with diffuse relict mafic sites almost completely obscured by a network of veinlets/microveinlets of chlorite, carbonate, quartz, local sericite, sulfides, magnetite, and rutile ±apatite.

Coarse plagioclase crystals forming the bulk of the rock are randomly oriented, tabular sub- to anhedra mostly <1.5 mm due to fracturing/shattering or disruption by clear albite microveinlets or the larger quartz-calcite-chlorite-sulfide veinlets. Albite typically shows vague to rarely sharp twinning with extinction Y^010 = 16ºand negative relief compared to quartz, (near An_0), likely all secondary (local "chessboard" texture, minor (<15%) replacement by sericite (randomly oriented, sub/euhedral flakes mainly <40 µm), or local carbonate (ragged sub/anhedra <50 µm, calcite?). Albitization is strongest along thin veinlets cutting across, or interstices between, the coarser crystals, where distinct clear, untwinned/unsericitized secondary albite forms finer sub/euhedra mainly <0.25 mm. These veinlets are irregular, <1 mm thick, and also contain variable chlorite-quartz-sulfide (see below).

Relict mafic sites are virtually unrecognizable due to the intensity of alteration and disruption by veining, but may be guessed at by irregular aggregates to ~5 mm of increased chlorite, quartz, sericite, sulfides, magnetite, TiO_2 minerals, and local apatite, all commonly re-distributed along veinlets. Chlorite forms matted sub/euhedral flakes mostly <0.2 mm with pale green pleochroism and length-slow, weakly anomalous bluish-grey birefringence (F:M 0.6?), quartz forms interlocking ragged or skeletal subhedra to 0.8 mm with minor strain indicated by weak undulose extinction, sub-grain development, and suturing of grain boundaries, and sericite forms matted subhedral flakes as in adjacent albite. Sulfides are mainly chalcopyrite (irregular anhedra to ~1 mm, but generally much finer) closely associated with quartz; magnetite occurs as fine subhedra <0.1 mm associated with chlorite and variable aggregates of rutile (opaque/dark brown subhedra <35 µm) or anatase (golden brown/yellow subhedra to 0.1 mm), local sphene (clear or brownish subhedra <0.1 mm), local apatite as rounded/stubby subhedra to ~1 mm. The distinction between these aggregates and veins is subtle.

Veinlets are mostly sub-planar, <2 mm thick where mainly chlorite-quartz-sericite (as above)-carbonate (subhedra <1 mm, calcite), local chalcopyrite (anhedra to ~2 mm), but up to 6 mm where with significant magnetite (fractured subhedra <0.2 mm) and pyrite (subhedra up to 4 mm long).

In summary, this is strong/intense albite-chlorite-carbonate-quartz-sericite-magnetite-pyrite-chalcopyrite-rutile/anatase?/sphene-apatite altered and stockwork veined felsic plutonic rock possibly originally about amphibole diorite; note the addition of fracture-controlled sericite to the assemblage, implying phyllic overprint on transitional propylitic/potassic alteration.

2009P: STRONG/INTENSE ALBITE-CHLORITE-CARBONATE-SERICITE-QUARTZ ±MAGNETITE-TRACE CHALCOPYRITE-RUTILE/SPHENE-APATITE ALTERED AND STOCKWORK VEINED FELSIC PLUTONIC ROCK ORIGINALLY ABOUT AMPHIBOLE DIORITE? (TRANSITIONAL PROPYLITIC/POTASSIC OVERPRINTED BY PHYLLIC)

Described as from AT513, albite-actinolite-chalcopyrite stockwork on ridge; hand specimen shows pale grey-green/white, fine-grained strongly altered felsic plutonic rock cut by network/swarm of sub-parallel black veinlets with magnetite, overprinted by pale green sericite. The rock is locally magnetic, shows rapid reaction to cold dilute HCl, and no stain for K-feldspar in the etched offcut but extensive white etch for plagioclase. Modal mineralogy in polished thin section is approximately:

Plagioclase (albite/albitized, sericite ± carbonate, chlorite altered)	70%
Chlorite (in veinlets, mafic sites)	10%
Carbonate (in veinlets/pervasive, mainly calcite?)	7%
Sericite (mainly after albite, pervasive/ along veinlets)	5%
Quartz (secondary only, in veinlets)	3%
Magnetite (largely secondary, part altered to hematite/rutile)	1-2%
Rutile, minor sphene (after ilmeno-magnetite?)	~1%
Apatite (partly secondary?)	~1%
Chalcopyrite (chlorite veinlets, partly oxidized to limonite)	<1%
Tourmaline (rare, schorlitic, veinlets only)	<1%

This is a strongly altered rock composed mainly of secondary albite (partly altered to sericite ±calcite -chlorite) with diffuse relict mafic sites mostly obscured by a network of veinlets/microveinlets of chlorite, carbonate, quartz, sericite, local magnetite, sulfides, rutile and apatite, trace tourmaline.

Coarse plagioclase crystals forming most of the rock are randomly oriented, tabular subhedra up to 4 mm except where fractured/shattered/disrupted by clear albite microveinlets or the larger chlorite-quartz-calcite-magnetite ±sulfide veinlets. Albite typically shows vague to rarely sharp twinning with extinction Y^010 = 16ºand negative relief compared to quartz, (near An_0), likely all secondary (local "chessboard" texture, variable (<5-35%) replacement by sericite (randomly oriented, subhedral flakes to ~65 μm), local carbonate (ragged sub/anhedra <0.2 mm, calcite?), chlorite (flakes as for sericite). Albitization is strongest along thin veinlets traversing, or forming interstices between, the coarser crystals, where distinctly clearer, i.e. less sericitized , only locally twinned secondary albite forms finer sub/euhedra mainly <0.5 mm. These veinlets are sub-planar to irregular, <1 mm thick, and also commonly contain variable chlorite, local quartz, trace sulfide (see below).

Relict mafic sites are difficult to recognize due to the intensity of alteration and disruption by veining, but are likely represented by irregular aggregates to ~5 mm of increased chlorite, quartz, sericite, sulfides, magnetite, TiO_2 minerals, and local apatite, all commonly re-distributed along veinlets. Chlorite forms matted sub/euhedral flakes mostly <0.2 mm with pale green pleochroism and length-slow, weakly anomalous bluish-grey birefringence (F:M 0.6?), quartz forms interlocking subhedra <1.2 mm with minor strain indicated by weak undulose extinction, sub-grain development, and suturing of grain boundaries, and sericite forms matted subhedral flakes as in adjacent albite. Magnetite occurs as coarse, relict primary (?) subhedra to 2 mm slightly altered to hematite/rutile , or fine subhedra <0.1 mm (likely secondary) associated with chlorite and variable aggregates of rutile (opaque/dark brown subhedra <35 μm) or local sphene (clear subhedra <0.1 mm), local apatite as rounded/stubby subhedra to ~1 mm. Distinction between relict mafic relics and veins is difficult.

Veinlets are mostly sub-planar/anastamose, <2 mm thick, mainly filled with chlorite-quartz-sericite (all as above)-local carbonate (subhedra <0.7 mm, calcite), rare chalcopyrite (irregular anhedra <0.3mm, partly oxidized to limonite, associated with quartz or chlorite), only local trace magnetite (fractured subhedra <0.2 mm), tourmaline (euhedra <0.7 mm, schorl with F:M 0.8?).

In summary, this is strong/intense albite-chlorite-carbonate-sericite-quartz ±magnetite-trace chalcopyrite-rutile/sphene-apatite altered and stockwork veined felsic plutonic rock originally about amphibole diorite? (note the fracture-controlled sericite, implying phyllic overprint on transitional propylitic/potassic alteration).

2122P: STRONGLY ALBITE-ACTINOLITE-CHLORITE-SERICITE-EPIDOTE-MINOR CALCITE-SPHENE-APATITE ALTERED, PROBABLY ORIGINALLY CLINOPYROXENE DIORITE WITH ACCESSORY ILMENO-MAGNETITE?-APATITE, BUT NO SULFIDES

Described as from AT36, barren albite roots; hand specimen shows mottled grey-green and pinkish-buff, fine-grained strongly altered felsic plutonic rock cut by sub-parallel pale or dark green veinlets. The rock is not magnetic, shows local rapid reaction to cold dilute HCl mainly in veinlets, and no stain for K-feldspar in the etched offcut but extensive white etch for plagioclase. Modal mineralogy in polished thin section is approximately:

Plagioclase (albite/albitized, sericite ± carbonate, chlorite altered)	65%
Clinopyroxene (relict mafics and secondary in vein)	13%
Amphibole (actinolite, after pyroxene)	5%
Chlorite (in veinlets, after amphibole, pyroxene, plagioclase)	5%
Sericite (after plagioclase)	5%
Epidote (veinlets, after amphibole, pyroxene)	3%
Carbonate (in veinlets/pervasive, mainly calcite?)	1-2%
Sphene, trace rutile inclusions	1-2%
Apatite	1%
Pyrite (largely oxidized to limonite)	<<1%

This sample consists of medium- to coarse-grained albitized, sericite ±carbonate, chlorite altered plagioclase, clinopyroxene altered to amphibole, chlorite, and epidote associated with accessory sphene-trace rutile and apatite, cut by veins of clinopyroxene-carbonate-epidote-actinolite-chlorite.

Albitized plagioclase forms randomly oriented, rounded tabular sub- to locally anhedral crystals mainly <5 mm long, typically so strongly clouded by minute flakes of sericite (randomly oriented, <25 µm), lesser chlorite (similar sized but in small aggregates to 0.1 mm) and scattered carbonate (sub/anhedra <50 µm) as to be distinctly brownish in thin section. The crystals are typically only very vaguely twinned ("irregular albite"), suggestive of composition near An_0 although this is difficult to prove given the lack of suitably twinned and oriented crystals (interference figures are very fuzzy). The intense, veinlet-controlled fine-grained, clear albite seen in many of the previous samples from the South Cathedral area appear to be absent in this sample.

Relict clinopyroxene crystals have sub- to locally euhedral outlines up to about 3 mm, but are commonly glomeratic to ~6 mm. The crystals show large (~45º) extinction angle and distinct pale green colour but essentially no pleochroism, so may be augite or diopside-hedenbergite, but not aegirine augite. They are typically extensively altered, beginning along margins and along fractures or cleavage, to dark green fibrous amphibole (actinolite?) as subhedra <0.7 mm long, chlorite as subhedral flakes <0.25 mm with pale bright green pleochroism, length-slow, weakly anomalous blue-grey birefringence (F:M 0.5-0.6?), and epidote as rounded sub/anhedra <0.35 with variable yellow colour (moderate to rarely high Fe content?). The mafic sites are also typically closely associated with apatite as stubby subhedral prisms up to ~1 mm long, and variable TiO_2 minerals (sphene as sub/euhedra to 0.3 mm, locally with traces of semi-opaque rutile <25 µm included at the core). Sulfides are extremely rare (only traces of pyrite <25 µm, largely oxidized to limonite).

Veins are sub-planar, up to 2.5 mm thick, and consist of clinopyroxene (similar to that in the host rock, sub/euhedra up to ~3 mm, coarsest where the vein crosses pre-existing wallrock pyroxene) that are extensively altered to epidote (randomly oriented matted subhedra mainly <0.25 mm or rarely larger pseudomorphs to 1.5 mm, both with pale to rarely yellow colour suggestive of low to moderate Fe content), local carbonate (ragged sub/anhedra <0.75 mm, calcite?) or lesser actinolite as described above, or chlorite as subhedral flakes to 0.4 mm with F:M possibly to 0.7 (?). In some veins only actinolite and chlorite, or only epidote and minor chlorite, occur.

In summary, this is strongly albite-actinolite-chlorite-sericite-epidote-minor calcite-sphene-apatite altered, probably originally clinopyroxene diorite with accessory ilmeno-magnetite?-apatite, but no sulfides.

2102P: MAGNETITE-CHALCOPYRITE-CHLORITE-MINOR CALCITE-QUARTZ-TRACE SERICITE-APATITE-RUTILE/ANATASE ALTERED ROCK/VEIN, PARTLY OXIDIZED TO HEMATITE AND LIMONITE, LOCAL MALACHITE

Described as high-grade chalcopyrite-magnetite mineralization from AT14; hand specimen shows presumed vein sample composed of semi-massive magnetite, lesser chalcopyrite, and gangues of chlorite (dark green, readily scratchable), local white calcite, partly oxidized to limonite and malachite. The rock is intensely magnetic, shows local rapid reaction to cold dilute HCl, and no stain for K-feldspar (or white etch for plagioclase) in the etched offcut. Modal mineralogy in polished thin section is approximately:

Magnetite (secondary, partly oxidized to hematite at rims)	40%
Chalcopyrite (partly oxidized to limonite	25%
Chlorite (interstitial to magnetite, or in patches), "hydrobiotite"	25%
Carbonate (mainly calcite?)	3-5%
Quartz (secondary, skeletal)	2%
Voids (mainly due to plucking)	2%
Limonite, local malachite (mainly after chalcopyrite)	1-2%
Sericite (with quartz areas)	<1%
Apatite	<15
Rutile or anatase (?)	<1%

This sample consists of semi-massive magnetite (partly oxidized to hematite) and chalcopyrite (partly oxidized to limonite and minor malachite), with a gangue matrix of chlorite-local calcite-quartz, accessory rutile or anatase? apatite and sericite; the sample is partly plucked out by section preparation to leave small void spaces mainly <1 mm across.

Magnetite occurs in masses up to several centimeters across, composed of granular/sucrosic textured, interlocking sub- to euhedral crystals mainly <0.25 mm (rarely over 0.5 mm) in diameter, typically set in a matrix of interstitial chlorite or rarely carbonate. The magnetite crystals are typically lightly (<5-15%) replaced at margins and along fractures or partings by hematite as sub- to euhedral crystals mainly <45 μm in size, but not by limonite which appears to be restricted to replacement of chalcopyrite.

Chalcopyrite occurs as irregular masses that are semi-continuous for up to about 1 cm in size, composed of interlocking subhedra probably mainly in the 1-2 mm size range, locally containing inclusions of magnetite as euhedra to ~1 mm. The chalcopyrite is locally attacked at rims and along fractures by bright red-brown limonite (±local malachite) due to oxidation of the sample.

Chlorite typically occurs as matted, scaly masses to semi-radiating clusters of sub- to euhedral flakes mainly <0.25 mm in diameter, in patches up to ~1 cm across, or as described, interstitial to magnetite. Chlorite shows optical properties (pale bright green pleochroism, near-zero to greyish blue, length-slow birefringence indicative of F:M perhaps 0.5-0.6 (?) but it is commonly altered to brownish (limonite-stained?) "hydrobiotite" in similar-sized flakes with significantly higher (1st order orange) birefringence in areas where limonite is abundant. In places, the chlorite appears to be after possible former secondary biotite (?) as semi-radiating sub/euhedral flakes to 0.5 mm with brownish-green pleochroism and 1st order birefringence similar to that of the "hydrobiotite".

Carbonate locally occurs as irregular aggregates to vein-like masses up to 3 m across by 1 cm long, composed of interlocking subhedra to 2 mm (mainly calcite), complexly intergrown with chlorite and containing poikilitic inclusions of magnetite.

Quartz occurs in irregular-shaped areas up to 7 mm across composed of randomly oriented, sub/euhedral, locally skeletal crystals to 2.5 mm that are locally associated with minor sericite (matted subhedral flakes <0.1 mm), apatite as fractured, corroded rounded subhedra to 0.4 mm, rare rutile or anatase as golden yellow-brown sub/euhedra <0.2 mm.

In summary, this is confirmed as magnetite-chalcopyrite-chlorite-minor calcite-quartz-trace sericite-apatite-rutile/anatase altered rock/vein, partly oxidized to hematite and limonite, local malachite.

2033P: BIOTITE QUARTZ MONZONITE/APLITIC QUARTZ MONZONITE COMPOSED OF ALBITE-KSPAR (PARTLY MICROCLINE, PARTLY MYRMEKITIC; COULD BE LATE MAGMATIC)-QUARTZ-CHLORITIZED BIOTITE-ACCESSORY MAGNETITE-RUTILE-APATITE, WEAKLY ALTERED TO CHLORITE-SERICITE-CALCITE-HEMATITE

Described as early stage K-feldspar alteration from AT554; hand specimen shows mottled, salmon-pink or buff-white/ greenish-grey, medium/coarse-grained felsic plutonic rock, somewhat crumbly and fractured. The rock is weakly magnetic, shows local rapid reaction to cold dilute HCl, and common yellow stain for K-feldspar and white etch for plagioclase in the etched offcut. Modal mineralogy in polished thin section is approximately:

Plagioclase (partly hematite-stained albite)	30%
K-feldspar (mainly primary or late-magmatic?)	30%
Quartz (mainly primary?)	25%
Biotite (partly secondary, after amphibole?), now largely chloritized	5%
Chlorite (after biotite)	5%
Sericite (replacing feldspars)	2-3%
Carbonate (mainly calcite, after mafics/along fractures)	1%
Magnetite (accessory, partly oxidized to hematite)	<1%
Apatite (accessory)	<1%
Rutile (accessory, with relict mafic sites)	<1%
Pyrite (partly oxidized to limonite, which stains adjacent rock)	<1%

This sample is divisible into two parts across a poorly defined contact: coarse-grained plagioclase (altered to local sericite, probable hematite-stained albite near the contact)-lesser Kspar-minor quartz, plus interstitial relict mafics altered to biotite-chlorite-calcite associated with accessory magnetite-apatite-rutile-trace pyrite, and finer-grained Kspar-quartz-minor plagioclase-mafics with aplitic appearance. Fractures are partly filled with chlorite, carbonate (calcite), sericite and limonite.

In the coarse-grained plutonic rock, plagioclase forms interlocking, tabular or lath-shaped sub- to euhedral crystals up to ~4 mm long, with random orientations. Twinning ranges from vague to locally sharp, with extinction Y^010 = 15º and relief distinctly negative compared to quartz indicating composition near albite (An_{0-5}); secondary origin is suggested by vague twinning in conjunction with flecking or local replacement by fine sericite (randomly oriented subhedral flakes mainly <25, but locally up to 50 µm) plus the hematite-stained character in places. Apatite is common as slender acicular euhedra up to 0.5 mm long included within the plagioclase. Kspar forms sub- to anhedral, more interstitial crystals to 3.5 mm that are characterized by brownish hematite staining, local microperthitic texture due to albite inclusions, and (near the contact) graphic-textured inclusions of quartz mostly <0.5 mm long. Quartz is mostly interstitial to feldspars, forming sub/anhedra to 2mm but locally glomeratic to 3.5 mm; the crystals show mild to moderate strain (undulose extinction, sub-grain development, and suturing of grain boundaries). Relict mafics are mostly biotite as ragged, subhedral flakes to 2 mm with remnant dark brown pleochroism except where replaced by chlorite of similar or smaller size with dark green pleochroism but near-zero birefringence, suggestive of F:M near 0.5-0.6 (?) and carbonate as ragged sub/anhedra <0.2 mm (mainly calcite?); the biotite locally has an appearance suggestive of secondary origin, after amphibole (possibly suggestive of early potassic alteration?). Accessory magnetite (subhedra to ~1 mm, not obviously secondary, partly oxidized to hematite at margins), apatite (stubby sub or euhedra to 0.6 mm) and rutile (aggregates to 0.3 mm of dark brown/opaque subhedra <50 µm) are all closely associated with mafic sites, as are trace pyrite as cubes <0.2 mm oxidized to limonite.

In the fine-grained, aplitic rock, Kspar and quartz are more abundant, forming interlocking, somewhat graphic-textured subhedral crystals both mostly <2 mm (rarely to 3 mm) with lesser plagioclase as tabular subhedra <1.5 mm, only rare chloritized biotite as ragged subhedral flakes <1 mm containing traces of rutile, associated with accessory magnetite/hematite, plus very rare traces of pyrite oxidized to limonite, all as described above. Kspar shows local "grid" twinning indicative of microcline, grading further from the contact to fine myrmekitic intergrowths with quartz, plagioclase shows extinction Y^010 to 14º, suggestive of albite around An_5, slightly flecked or locally partly replaced by sericite as above. Quartz is moderately to locally strongly strained (shows distinct undulose extinction, sub-grain development, and suturing of grain boundaries, as does quartz in the coarser-grained portion).

In summary, this is biotite quartz monzonite/aplitic quartz monzonite composed of albite-Kspar (partly microcline, partly myrmekitic; could be late magmatic)-quartz-chloritized biotite-accessory magnetite-rutile-apatite, weakly altered to chlorite-sericite-calcite-hematite/limonite.

2030P: STRONGLY TRANSITIONAL PROPYLITIC/POTASSIC (PHYLLIC OVERPRINTED?) AMPHIBOLE OR PYROXENE DIORITE, ALTERED TO ALBITE-CHLORITE-CALCITE-SERICITE-MINOR QUARTZ-RUTILE/SPHENE-CHALCOPYRITE ±PYRITE, APATITE, EPIDOTE ASSOCIATED WITH VEINLET NETWORK OF MOST OF THE SAME MINERALS

Described as from AT551, albite-actinolite-pyrite stockwork; hand specimen shows mottled, grey-green/white, medium-grained strongly altered felsic plutonic rock cut by network of fine black veinlets, overprinted by dark green chlorite/local pale green sericite. The rock is locally slightly magnetic, shows rapid reaction to cold dilute HCl, and no stain for K-feldspar in the etched offcut but extensive white etch for plagioclase. Modal mineralogy in polished thin section is approximately:

Plagioclase (albite/albitized, sericite ± carbonate, chlorite altered)	60%
Chlorite (in veinlets, mafic sites; after secondary biotite?)	15%
Carbonate (in veinlets/pervasive, mainly calcite?)	10%
Sericite (mainly after albite, pervasive/ along veinlets)	7%
Quartz (secondary only, in veinlets)	3%
Rutile, minor sphene (after ilmeno-magnetite?)	2%
Chalcopyrite (chlorite veinlets, partly oxidized to limonite)	1-2%
Apatite (partly secondary?)	~1%
Epidote	<1%
Pyrite	<1%

This sample consists of plagioclase (albitized, sericite ± carbonate, chlorite altered) and relict mafic sites (pseudomorphed by chlorite, carbonate, quartz, sericite associated with accessory rutile ±sphene, chalcopyrite ±pyrite, apatite, epidote) cut by poorly defined carbonate-chlorite-quartz-sulfide veins.

Plagioclase forming the framework of the rock occurs as randomly oriented, sub- to euhedral lath/tabular crystals up to ~4 mm long that are variably albitized, sericitized, or altered to carbonate ±chlorite. The larger crystals show vague to locally sharp twinning with extinction Y^010 up to 14º and negative relief compared to local quartz, flecked by sericite/rare chlorite as randomly oriented sub/euhedral flakes mostly <35 µm indicative of albite An_5, but in places clearer, partly twinned, interstitial finer grains (sub/anhedra <0.35 mm) suggest approach to An_0 (true secondary albite). In places, especially near veinlets, albite is further extensively altered to sericite forming radiating rosettes (almost like pyrophyllite?) to 0.2 mm, of ~0.1 mm subhedral flakes, partly intergrown with or poikilitically enclosed in carbonate (calcite) as ragged skeletal sub/anhedral crystals to ~2 mm.

Relict mafic sites have irregular to subhedral glomeratic outlines to ~3 mm, composed of randomly oriented subhedra <2 mm long (suggestive of former amphibole or pyroxene?) replaced by variable combinations of chlorite (matted, randomly oriented subhedral flakes mainly <0.1 mm with pale green pleochroism and near-zero to slightly grey-blue anomalous, length-slow birefringence indicative of F:M 0.5?), carbonate (sub/anhedra <0.5 mm, also calcite?), secondary quartz (subhedra mainly <0.3 mm, only weak strain) and sericite (matted subhedral flakes mostly <0.1 mm) plus accessory rutile (aggregates to 0.4 mm of acicular sub/euhedra <45 µm) or sphene (euhedra to 0.25 mm), sulfides (mainly chalcopyrite, forming ragged sub/anhedra <0.35 mm but in loose aggregates to ~1 mm; rare pyrite as sub/euhedra to 0.7 mm, both closely associated with traces of epidote as subhedra <0.15 mm, and both partly oxidized to limonite in places), and apatite as stubby euhedral prisms mostly <0.6 mm. Sulfides in relict mafic sites grade to sulfides in veinlets.

Veinlets are generally poorly defined, irregular/anastamose in character, up to ~3 mm thick, filled mainly with carbonate (calcite as described above), variable chlorite as described above, local minor quartz indistinguishable from that replacing mafics except in aggregates up to 2 mm long, and chalcopyrite as described above. It is not clear whether some coarser sericite as described above, and mixed with the calcite, is part of the veinlet system; similarly, there are also local traces of epidote.

In summary, this is strongly transitional propylitic/potassic (phyllic overprinted?) amphibole or pyroxene diorite, altered to albite-chlorite-calcite-sericite-minor quartz-rutile/sphene-chalcopyrite ±pyrite, apatite, epidote associated with veinlet network of most of the same minerals.

D29606P: STRONGLY POTASSIC (KSPAR-RELICT CHLORITIZED BIOTITE-QUARTZ-MAGNETITE-APATITE) ALTERED (MINOR SERICITE OVERPRINT) PROBABLE FORMER AMPHIBOLE/PYROXENE DIORITE, ASSOCIATED WITH MAJOR VEIN OF QUARTZ-PYRITE-MAGNETITE-CHALCOPYRITE-CHLORITIZED SECONDARY BIOTITE

Described as high-grade quartz-chalcopyrite vein from Gully Zone, AT523; hand specimen shows coarse clotty chalcopyrite-lesser pyrite-local black magnetite in salmon-pink K-feldspar matrix partly stained by limonite (unfortunately the area sectioned does not correspond with the chalcopyrite rich area of the sample, but with a pyrite-rich area instead). The rock is locally strongly magnetic, shows no reaction to cold dilute HCl, and major yellow stain for K-feldspar in the etched offcut. Modal mineralogy in polished thin section is approximately:

K-feldspar (largely secondary?), partly sericite altered	45%
Quartz (secondary, vein)	20%
Chlorite (after secondary biotite, some of which remains)	15%
Pyrite	10%
Magnetite (secondary, vein; part altered to hematite)	2-3%
Sericite (after Kspar)	2-3%
Chalcopyrite (partly oxidized to limonite)	1-2%
Limonite (after sulfides)	1-2%
Apatite (accessory/partly secondary?)	~1%
Rutile (mixed with limonite, difficult to confirm?)	<1%

This sample consists of quartz-sulfide-magnetite vein with intensely potassic (Kspar-chloritized secondary biotite-minor secondary quartz-sericite-sulfide-apatite-rutile) altered wallrock, partly oxidized to limonite along hairline fractures.

In the wallrock, K-feldspar making up the bulk of the section forms randomly oriented, lath-shaped to tabular sub/euhedra to ~5 mm long that are strongly reminiscent of albite crystals in other samples of this suite (and even appear to retain traces of former polysynthetic twinning and former albite rims/interstitial replacements, as commonly described for samples above), suggesting the Kspar has replaced albitized rock. Most crystals show minor variable (<5-15%) replacement by sericite (randomly oriented subhedral flakes mostly <65 µm, locally in aggregates to 0.15 mm with minor chlorite similar in size to the sericite). Relict mafic sites have vague, poorly defined irregular to ovoid outlines up to ~1 cm across, likely glomeratic in nature, pseudomorphed by chlorite (randomly oriented, matted or locally semi-radiating sub/euhedral flakes up to 0.35 mm in diameter, with distinct pale green pleochroism and weakly anomalous blue, length-slow birefringence suggestive of F:M 0.5-0.6?) commonly interleaved by/intergrown with either relict pale/medium brown biotite (probably secondary) and/or sericite as subhedral flakes mainly <0.3 mm. Minor secondary quartz (subhedra <0.25 mm) and magnetite (subhedra mainly <0.1 mm, on hairline veinlets or disseminated) occurs, and there is accessory apatite (stubby sub/euhedral prisms to 0.7 mm, partly secondary?) and possible traces of rutile (minute subhedra <25 µm, difficult to distinguish from common limonite after sulfides except where it occurs along hairline fractures). Much of the chalcopyrite in the section occurs as an irregular bleb ~0.5 cm long oriented sub-perpendicular to the main vein.

In the vein, which is exposed for <1 cm thickness, quartz forms interlocking sub/anhedra mainly <2 mm, although commonly recrystallized or fractured to sub-domains of smaller size (displaying moderate strain, evidenced by undulose extinction, sub-grain development, and suturing of grain boundaries). Pyrite dominates vein sulfides, forming rounded sub/anhedra mainly <2 mm but in masses up to ~1 cm, intergrown with magnetite as subhedra to ~2 mm with exsolved or supergene hematite lamellae to 1.5 mm, minor chalcopyrite as ragged subhedra <1mm. Minor chlorite with relict secondary biotite occurs as radiating aggregates to 0.5 mm, partly plucked out or associated with small voids of similar size around magnetite.

In summary, this is confirmed as strongly potassic (Kspar-relict chloritized biotite-quartz-magnetite-apatite) altered (minor sericite overprint) probable former amphibole/pyroxene diorite, associated with major vein of quartz-pyrite-magnetite-chalcopyrite-chloritized secondary biotite.

2130P: BIOTITE QUARTZ SYENITE (ACCESSORY PRIMARY APATITE, MAGNETITE?), PROPYLITIC/ARGILLIC ALTERED TO CHLORITE-CLAY?/SERICITE-HEMATITE-TRACE CARBONATE-RUTILE-CHALCOPYRITE, PARTLY OXIDIZED TO LIMONITE

Described as Fe carbonate-calcite-quartz-argillic alteration in syenite from AT524; hand specimen shows massive/fractured, brick-red coloured medium/fine-grained syenite (?) with only minor black mafic relics. The rock is locally slightly magnetic, shows trace reaction to cold dilute HCl along hairline fractures only, and comprehensive yellow stain for K-feldspar/minor white etch for plagioclase in the etched offcut. Modal mineralogy in polished thin section is approximately:

K-feldspar (orthoclase microperthite, mainly primary?)	65%
Quartz (mainly interstitial primary?)	13%
Plagioclase (oligoclase-albite, sericitized)	12%
Chlorite, "hydrobiotite" (mostly after biotite; some remains)	3%
Clay?/sericite (mostly after plagioclase; minor after Kspar)	2-3%
Hematite (after magnetite?)	2%
Carbonate (along hairline fractures, mainly calcite?)	1%
Rutile (mixed with limonite?)	1%
Limonite	1%
Apatite (accessory)	<1%
Chalcopyrite (partly oxidized to limonite)	<<1%

This sample consists of interlocking, finely hypidiomorphic-granular textured Kspar, much lesser relict (sericite altered) plagioclase, quartz, and minor relict mafic sites altered to chlorite/hydrobiotite (after biotite)-hematite (likely after magnetite)-rutile/limonite-trace apatite-chalcopyrite.

K-feldspar forming the bulk of the sample occurs as randomly oriented, interlocking sub- to rarely euhedral crystals mainly <2 mm in diameter, with large negative 2V and containing common wispy micro-sized albite inclusions, suggesting it is likely mainly orthoclase microperthite. It is relatively unaltered to sericite compared to adjacent plagioclase, but is commonly stained brownish-red by minute inclusions of clay?/hematite. There is no evidence to support a secondary origin for the K-feldspar. Minor acicular apatite <0.2 mm long commonly occurs in Kspar or plagioclase.

Plagioclase forms tabular to lath-shaped sub/euhedra mostly <1.75 mm long commonly poikilitically enclosed in Kspar; the crystals are commonly more or less vaguely, rarely sharply twinned, with extinction on 010 mainly <10º and relief slightly negative compared to adjacent quartz, suggestive of composition near the albite-oligoclase boundary (An_{10}?), which could be primary or secondary, as suggested by the common minor replacement (<5 to rarely 15%) by sericite as randomly oriented, subhedral flakes mostly <25 µm in size.

Quartz forms subhedral crystals mostly <2 mm in diameter, interstitial to feldspars and locally associated with interstitial mafic relic sites. The quartz shows only mild strain (weak undulose extinction, essentially no sub-grain development or suturing of grain boundaries).

Relict mafic sites have subhedral glomeratic outlines up to ~2 mm, composed of relict biotite as ragged subhedral flakes/booklets <1 mm, with medium/dark brown pleochroism at cores but mostly replaced by chlorite (subhedral flakes <0.5 mm with pale green pleochroism, weakly anomalous grey length-slow birefringence suggestive of F:M 0.5-0.6?) or brownish "hydrobiotite" (Fe-rich chlorite) of finer size, associated with subhedral hematite <0.25 mm likely after former primary magnetite, aggregates of very fine-grained red-brown limonite and possible rutile (?), rare apatite (as described above) and traces of chalcopyrite (anhedra <35 µm, partly oxidized to limonite). It is possible that some biotite is secondary, and has replaced former amphibole (?).

Traces of carbonate, likely mainly calcite, occur along hairline fracture veinlets as subhedra mostly <0.2 mm in diameter.

In summary, this appears to be biotite quartz syenite (accessory primary apatite, magnetite?), propylitic/argillic altered to chlorite-clay?/sericite-hematite-trace carbonate-rutile-chalcopyrite, partly oxidized to limonite.

2129P: COULD REPRESENT BIOTITE-HORNBLENDE QUARTZ MONZONITE (ACCESSORY MAGNETITE, APATITE), INCIPIENTLY POTASSIC ALTERED BY K-FLOODING, MINOR CHLORITE-CLAY?/SERICITE-EPIDOTE-QUARTZ-HEMATITE-TRACE CHALCOPYRITE, PARTLY OXIDIZED TO LIMONITE

Described as K-feldspar flooding in medium-grained monzonite from AT44 (Gully Zone); hand specimen shows massive/locally fractured, salmon-pink medium-grained syenite (?) similar to 2130 with minor black mafics. The rock is weakly magnetic, shows no reaction to cold dilute HCl, and comprehensive yellow stain for K-feldspar/minor white etch for plagioclase in the etched offcut. Modal mineralogy in polished thin section is approximately:

K-feldspar (orthoclase microperthite/microcline, mainly primary?)	65%
Plagioclase (sericitized, oligoclase-albite?)	12%
Quartz (mainly interstitial primary; trace secondary)	10%
Amphibole (partly altered to biotite, chlorite, epidote)	5%
Biotite (partly chloritized)	3%
Magnetite, ilmenite (slightly altered to hematite)	2%
Clay?/sericite (mostly after plagioclase; minor after Kspar)	2%
Epidote (Fe-rich, after mafics)	<1%
Apatite (accessory)	<1%
Chalcopyrite (partly oxidized to limonite)	<<1%

This sample consists of interlocking, finely hypidiomorphic-granular textured Kspar, much lesser relict (sericite altered) plagioclase, quartz, and amphibole or biotite both partly altered to chlorite ±epidote, magnetite or ilmenite (partly altered to hematite)-apatite-trace chalcopyrite.

K-feldspar forming the bulk of the sample occurs as randomly oriented, interlocking sub- to rarely euhedral crystals mainly <3 mm in diameter, containing common wispy micro-sized albite inclusions or showing "grid" twinning, suggesting it is orthoclase/microcline microperthite. It is relatively unaltered to sericite compared to adjacent plagioclase, but is commonly stained brownish-red by minute inclusions of clay?/hematite. The orthoclase appears to replace plagioclase at rims, suggesting it may be secondary and that this may have originally been quartz monzonite (?). Minor acicular apatite to ~1 mm long commonly occurs in Kspar or plagioclase.

Plagioclase forms tabular to lath-shaped sub/euhedra to ~3 mm long or smaller crystals poikilitically enclosed in or partly replaced by Kspar; the crystals are commonly more or less vaguely, rarely sharply twinned, with extinction on 010 mainly <10º and relief slightly negative compared to adjacent quartz, suggestive of composition near the albite-oligoclase boundary (An_{10}?), which could be primary or secondary, as suggested by the common minor replacement (<5 to rarely 45%) by sericite as randomly oriented, subhedral flakes mostly <25 µm in size.

Quartz forms subhedral crystals mostly <1 mm although glomeratic to 1.7 mm, interstitial to feldspars and locally associated with interstitial biotite. The quartz shows only mild strain (weak undulose extinction, essentially no sub-grain development or suturing of grain boundaries).

Mafics as glomeratic aggregates up to ~4 mm consist of amphibole as subhedra to 1.5 mm with dark brownish green pleochroism (hornblende?), lesser biotite as ragged subhedral booklets to 2 mm, with pale yellowish/dark greenish-brown pleochroism at cores but partly replaced by chlorite (subhedral flakes <0.5 mm with deep green pleochroism, weakly anomalous greenish length-slow birefringence suggestive of F:M 0.6-0.7?) and minor epidote (subhedra <0.2 mm with intense yellow pleochroism indicative of high Fe content); both chlorite and epidote, plus local secondary quartz <0.5 mm also locally affect amphibole. The mafics are closely associated with subhedral magnetite and ilmenite <0.65 mm both slightly to partly oxidized to hematite as very fine-grained subhedra <30 µm, rare apatite (as described above) and traces of chalcopyrite (anhedra <35 µm, partly oxidized to limonite). Locally minor biotite appears to have replaced amphibole and therefore be secondary (?).

In summary, this could represent biotite-hornblende quartz monzonite (accessory magnetite, apatite), incipiently potassic altered by K-flooding, minor chlorite-clay?/sericite-epidote-quartz-hematite-trace chalcopyrite, partly oxidized to limonite.

1276P: PYRITE-CHALCOPYRITE-QUARTZ-CHLORITE/SERICITE (AFTER FORMER SECONDARY BIOTITE?)-TRACE RUTILE/SPHENE-APATITE-MOLYBDENITE VEIN, SLIGHTLY OXIDIZED TO TRACES OF LIMONITE

Described as high-grade chalcopyrite-quartz vein from AT538 (Cathedral Zone); hand specimen shows dark grey-green, quartz-chalcopyrite-pyrite-chlorite vein~4cm thick. The rock is locally slightly magnetic, shows no reaction to cold dilute HCl, and no yellow stain for K-feldspar or white etch for plagioclase in the etched offcut. Modal mineralogy in polished thin section is approximately:

Pyrite (central to chalcopyrite, with quartz)	20%
Chalcopyrite (closely associated with quartz)	20%
Quartz (secondary, vein)	20%
Chlorite (with sericite, after secondary biotite?)	20%
Sericite (intimately mixed with chlorite)	8-10%
Rutile, trace sphene	<1%
Apatite (possibly secondary?)	<1%
Molybdenite (in local bands of the vein)	<1%
Limonite (after sulfides)	<1%

This sample consists essentially of sulfides (pyrite, chalcopyrite slightly oxidized locally to limonite) closely associated with quartz, in a matrix of chlorite-lesser sericite that appears likely to be after former secondary biotite (?), plus local traces of apatite, rutile and sphene, molybdenite.

Pyrite forms a more or less central band up to about 1 cm thick, composed of interlocking sub- to euhedral crystals up to about 4 mm in diameter, commonly with small ragged or irregular bleb-like inclusions of chalcopyrite <50 µm (but up to 0.2 mm), grading to interstitial aggregates up to 0.5 mm between the pyrite crystals.

Most chalcopyrite, however, occurs separately from pyrite, in the surrounding gangue matrix as ragged, irregular aggregates mainly <0.5 cm long composed of interlocking sub/anhedra <1.5 mm, where it (as for pyrite) is closely associated/intergrown with the secondary quartz. Pyrite is essentially absent from the chalcopyrite aggregates. In certain bands of the vein, minor molybdenite occurs closely associated with (locally included in) chalcopyrite, or around the margins of quartz where it is in contact with chlorite-sericite.

Quartz occurs as randomly oriented, sub- to locally euhedral crystals mostly <1.5 mm long. The quartz shows essentially no strain (no undulose extinction, sub-grain development, and suturing of grain boundaries) but commonly contains abundant inclusions of the adjacent chlorite/sericite, especially at its margins.

Patches of chlorite ±sericite have irregular, lensy outlines up to ~1 cm thick by several cm long (oriented sub-parallel to the vein walls). They are composed of intimately intermixed chlorite and sericite both forming subhedral flakes mostly <0.5, but locally up to ~1.5, mm in diameter. The chlorite shows very pale green colour/weak pleochroism, weakly anomalous blue-grey length-slow birefringence suggestive of F:M ~0.5-0.6 (?), and the sericite locally shows traces of remnant very pale brown pleochroism, suggesting chlorite/sericite has replaced former secondary biotite (?).

Accessory minor rutile, trace sphene locally associated with chalcopyrite form aggregates to 0.25 mm of stubby euhedra <0.1 mm (golden brown and transparent respectively). Possible apatite forms stubby sub/euhedral prisms up to 0.6 mm long, but are heavily fractured and thus difficult to identify with confidence.

Very minor dark red-brown (goethitic?) limonite occurs along narrow, through-going fractures <0.1 mm thick.

In summary, this is confirmed as pyrite-chalcopyrite-quartz-chlorite/sericite (after former secondary biotite?)-trace rutile/sphene-apatite-molybdenite vein, slightly oxidized to traces of limonite.

6079P: STRONGLY POTASSIC (KSPAR-QUARTZ-ALBITE-CHLORITE (AFTER SECONDARY BIOTITE?)-MINOR EPIDOTE-APATITE-RUTILE/ANATASE?) ALTERED DYKE/PLUTONIC ROCK, VEINS OF QUARTZ-CHLORITE-EPIDOTE-CARBONATE-PYRITE ±CHALCOPYRITE

Described as syenite swarm with disseminated chalcopyrite with actinolite, from Cathedral Zone (AT535); hand specimen shows what appear to be narrow dikelets of fine-grained, salmon-pink (syenitic?) rock cutting slightly less pink, coarser-grained, possibly originally amphibole/pyroxene bearing, Kspar altered plutonic rock (like the diorite of the South Cathedral area?), cut by local network of dark fractures. The rock is not magnetic and shows only trace reaction to cold dilute HCl (along fractures), but there is extensive yellow stain for K-feldspar, only minor white etch for plagioclase in the etched offcut. Modal mineralogy in polished thin section is approximately:

K-feldspar (partly secondary, replacing plagioclase)	70%
Plagioclase (albite, likely secondary?) partly replaced by Kspar, quartz	10%
Quartz (partly secondary, replacing plagioclase)	10%
Chlorite (after mafics, along veinlets; partly after secondary biotite)	5%
Carbonate (fracture veinlets only)	~1%
Epidote (mainly fracture veinlets)	~1%
Apatite (part of alteration assemblage?)	~1%
Rutile, anatase?	~1%
Pyrite, trace chalcopyrite (both partly oxidized to limonite)	~1%
Clay (with minute hematite, staining feldspars)	<1%

This sample composed mainly of K-feldspar (partly after plagioclase. which remains as remnants poikilitically enclosed in Kspar), quartz (also partly to largely secondary, in part replacing plagioclase) with only minor relict mafics (chlorite, partly after secondary biotite) and accessory apatite, rutile, and sulfide, cut by veinlets of quartz-chlorite-epidote-carbonate associated with minor sulfides.

Alteration is so strong that it is difficult to distinguish between syenite dikelet and host rock. In general, Kspar forms sub- to euhedral, tabular to lath-shaped crystals up to ~3 mm long, with random orientations, in places clearly having replaced plagioclase with similar habit (euhedral laths up to ~4 mm long). The Kspar is distinguished by abundant clouding due to minute particles of clay?/hematite, and thus can be seen in all stages replacing plagioclase as ragged, irregular sub-domains from <0.1 mm to several mm. Remaining plagioclase is relatively clear (i.e. unaffected by clay?/sericite, indicating secondary origin) with distinctive negative relief compared to quartz and locally sharp twinning that gives Y^010=16º (albite, An_0). Quartz forms sub- to locally euhedral, somewhat skeletal crystals to ~1.3 mm, typically either clearly replacing plagioclase or along poorly defined to sub-planar veins, so probably mainly secondary; it shows only mild strain. Relict mafics with poorly defined, irregular outlines to ~4 mm are heavily replaced by chlorite (subhedral flakes to 0.6 mm with distinct pale yellowish-green pleochroism, weakly anomalous blue-grey, length-slow birefringence suggestive of F:M 0.5-0.6?), significant secondary quartz (interlocking subhedra mostly <0.4 mm). The chlorite can in rare instances be seen to be after secondary biotite (subhedral flakes <0.12 mm with distinct brown pleochroism; the original mafic may have been amphibole?). Closely associated with the mafic sites are accessory rutile (aggregates to 0.4 mm of dark brown/semi-opaque subhedra mainly <35 µm) or local anatase (transparent, golden yellow, subhedra to 0.15 mm), apatite (stubby sub/euhedra to 0.8 mm long, possibly part of the alteration assemblage?) and rare epidote bright yellow, Fe-rich subhedra <0.15 mm, rarely with chalcopyrite <0.1 mm).

The network veinlets are mostly sub-planar to irregular/anastamose, <2 mm thick, composed of variable proportions of quartz (subhedra to 2.5 mm, partly skeletal as for wallrock replacements), chlorite (subhedra <0.5 mm, as above), epidote (sub/euhedra to 1.7 mm, pale yellow, moderate Fe), local carbonate (sub/anhedra to 0.9 mm, calcite?) plus local pyrite (sub/euhedra to 1.6 mm, rarely with trace chalcopyrite as subhedra <0.2 mm, both partly oxidized to limonite).

In summary, this is strongly potassic (Kspar-quartz-albite-chlorite (after secondary biotite?)-minor epidote-apatite-rutile/anatase?) altered dyke/plutonic rock, cut by veins of quartz-chlorite-epidote-carbonate-pyrite ±chalcopyrite.

6061P: BIOTITE-AMPHIBOLE SYENITE (ACCESSORY MAGNETITE, ILMENITE, APATITE), TRANSITIONAL POTASSIC/PROPYLITIC ±ARGILLIC ALTERED TO KSPAR-ACTINOLITE ±BIOTITE?-CHLORITE-CLAY?/SERICITE-SPHENE-HEMATITE-TRACE PYRITE-CHALCOPYRITE, PARTLY OXIDIZED TO LIMONITE

Described as syenite swarm with disseminated pyrite from AT534A (Cathedral Zone); hand specimen shows fine-grained, salmon-pink, Kspar rich (syenitic?) rock essentially lacking fractures. The rock is weakly magnetic, and shows no reaction to cold dilute HCl, but there is extensive yellow stain for K-feldspar, only minor white etch for plagioclase in the etched offcut. Modal mineralogy in polished thin section is approximately:

K-feldspar (microcline, secondary orthoclase replacing plagioclase?)	70%
Plagioclase (albitized, sericitized)	13%
Amphibole (partly altered to actinolite, then to secondary biotite)	5%
Quartz (mainly primary, interstitial; trace secondary after mafics?)	3%
Clay?/sericite (mainly after plagioclase)	3%
Biotite (partly secondary, after amphibole)	2%
Magnetite, local ilmenite (partly altered to sphene, hematite)	2%
Chlorite (after biotite)	<1%
Pyrite, trace chalcopyrite (partly oxidized to limonite)	<1%
Apatite (mainly primary accessory, in feldspars)	<1%

This sample consists of interlocking, finely hypidiomorphic-granular textured Kspar, much lesser relict (sericite altered) plagioclase, interstitial quartz, and minor amphibole altered to chlorite (after biotite), accessory magnetite/ilmenite (part altered to sphene)-trace pyrite ±chalcopyrite, apatite.

K-feldspar forming the bulk of the sample occurs as randomly oriented, interlocking sub- to rarely euhedral crystals mainly <2 mm in diameter, either with "grid" twinning (microcline, primary?) or containing common wispy micro-sized albite inclusions, suggestive of orthoclase microperthite that appear to replace margins of corroded included plagioclase crystals, secondary?). Kspar is unaltered to sericite compared to adjacent plagioclase, but is commonly stained brownish-red by minute inclusions of clay?/hematite. Thus there may be significant secondary (or late-magmatic?) K-feldspar flooding. Minor acicular apatite <0.3 mm long commonly occurs in Kspar or plagioclase.

Plagioclase forms tabular to lath-shaped sub/euhedra up to 5 mm long typically poikilitically enclosed in Kspar; the crystals are commonly more or less vaguely, rarely sharply twinned, with extinction on 010 mainly <10º and relief slightly negative compared to adjacent quartz, suggestive of composition near the albite-oligoclase boundary (An_{10}?), which could be primary or secondary, as suggested by the common minor replacement (10 to 25%) by sericite as randomly oriented, subhedral flakes mostly <25 µm in size.

Quartz forms subhedral crystals mostly <1 mm in diameter, interstitial to feldspars and locally associated with interstitial mafic relic sites (partly replacing them). The quartz shows only mild strain (weak undulose extinction, essentially no sub-grain development or suturing of grain boundaries).

Relict mafic sites have subhedral glomeratic outlines up to ~2 mm, composed mainly of relict amphibole (hornblende?) as subhedra <1 mm, altered at rims to deeper sea-green, fibrous actinolite <0.5 mm, or locally biotite (subhedral flakes <0.15 mm) although biotite also occurs as ragged subhedral booklets <1 mm, with medium/dark brown pleochroism except where replaced by chlorite (subhedral flakes <0.5 mm with deep green pleochroism, weakly anomalous blue-grey length-slow birefringence suggestive of F:M 0.6-0.7?). Accessory opaques associated with the mafic sites are subhedral magnetite or rarely ilmenite <0.25 mm partly altered to sphene as brown subhedra <0.15 mm or traces of hematite, relatively rare pyrite (subhedra to 0.5 mm, aggregates to ~1 mm) or trace chalcopyrite (<0.1 mm) both partly oxidized to red-brown limonite, rare apatite (subhedra <0.1 mm).

In summary, this appears to be biotite-amphibole syenite (accessory magnetite, ilmenite, apatite), transitional potassic/propylitic ±argillic altered to Kspar-actinolite ±biotite?-chlorite-clay?/sericite-sphene-hematite-trace pyrite-chalcopyrite, partly oxidized to limonite.

6062P: BIOTITE-AMPHIBOLE (QUARTZ) SYENITE (ACCESSORY ILMENO-MAGNETITE, APATITE), TRANSITIONAL POTASSIC/PROPYLITIC ±ARGILLIC ALTERED TO KSPAR?-QUARTZ-ACTINOLITE ±BIOTITE?-CHLORITE-CLAY?-SERICITE-EPIDOTE-SPHENE-HEMATITE-TRACE PYRITE, CHALCOPYRITE PARTLY OXIDIZED TO LIMONITE, VEINS ARE ACTINOLITE-MAGNETITE-CALCITE-± KSPAR-QUARTZ-TRACE CHALCOPYRITE

Described as quartz monzonite near syenite with actinolite-pyrite veins, AT534B (Cathedral Zone); hand specimen shows medium-grained, salmon-pink/mottled dark grey-green felsic plutonic rock cut by dark green veins/veinlets. The rock is magnetic, shows local rapid reaction to cold dilute HCl, and extensive yellow stain for K-feldspar/minor white etch for plagioclase (small, included crystals) in the etched offcut. Modal mineralogy in polished thin section is approximately:

K-feldspar (orthoclase microperthite, minor microcline?)	70%
Plagioclase (sericite/epidote altered, albite-oligoclase?)	15%
Quartz (mainly primary, partly secondary)	5%
Magnetite (partly secondary, partly oxidized to hematite, sphene)	3%
Amphibole (relict; biotite, actinolite ±quartz altered)	3%
Biotite (relict, chlorite-epidote altered)	1%
Sericite, clay?/sericite	1%
Carbonate (mainly calcite?)	<1%
Sphene (mostly after ilmeno-magnetite)	<1%
Apatite (primary accessory)	<1%
Epidote-group (after plagioclase, biotite)	<1%
Pyrite (partly oxidized to limonite)	<<1%

This sample consists mainly of hypidiomorphic-granular textured, K-feldspar-lesser plagioclase (partly altered to clay?/sericite-epidote)-minor quartz and mafics (relict amphibole, biotite altered to actinolite ±biotite, quartz, carbonate, chlorite-epidote respectively) associated with magnetite (partly secondary, altered to hematite-sphene) and accessory apatite, trace pyrite (oxidized to limonite).

K-feldspar forming the bulk of the sample occurs as randomly oriented, interlocking sub- to rarely euhedral crystals up to 6 mm, either containing wispy micro-sized albite inclusions, suggestive of orthoclase microperthite, or locally with “grid” twinning (microcline?) both of which appear to replace margins of corroded included plagioclase crystals?). Kspar is less altered to clay? or sericite, local carbonate compared to adjacent plagioclase, but is variably brownish-red stained by minute inclusions of clay?/hematite. There may be minor secondary (or late-magmatic?) K-feldspar flooding.

Plagioclase forms tabular to lath-shaped sub/euhedra up to 3 mm long typically poikilitically enclosed in Kspar; the crystals are commonly more or less vaguely twinned, with extinction on 010 mainly <10^{o} and relief slightly negative compared to adjacent quartz, suggestive of composition near the albite-oligoclase boundary (An_{10}?), which could be primary or secondary, as suggested by the common minor replacement (10 to 25%) by sericite as randomly oriented, subhedral flakes mostly <25 µm in size, local patchy colourless epidote (zoisite?) as sub/anhedra of similar size..

Quartz forms subhedra mostly <3 mm (loose aggregates to 5 mm), interstitial to feldspars and locally associated with interstitial mafic relic sites (partly replacing them), with moderate strain (distinct undulose extinction, minor sub-grain development and suturing of grain boundaries).

Relict mafic sites have irregular glomeratic outlines up to ~4 mm, composed mainly of relict amphibole (hornblende?) as subhedra <2 mm, altered at rims to deeper sea-green, fibrous actinolite <0.5 mm, local quartz (subhedra <0.5 mm), secondary biotite (subhedral flakes <0.25 mm) and lesser biotite as ragged subhedral booklets <1 mm, with medium brown pleochroism except where replaced by chlorite (subhedral flakes <0.5 mm with weak green pleochroism, weak anomalous length-slow birefringence, F:M 0.5?), minor epidote (subhedra <0.2 mm). Accessory opaques associated with the mafic sites are subhedral ilmeno-magnetite <2 mm (aggregates to ~4 mm) partly altered to sphene as brown subhedra <0.5 mm or traces of hematite, very rare pyrite (subhedra <0.4 mm, partly oxidized to red-brown limonite, associated with common apatite (rounded subhedra <0.6 mm).

Veinlets are confirmed as actinolite (randomly oriented, sub/anhedra mainly <0.8 mm and magnetite (mainly minute subhedra <0.1 mm, clearly secondary) and local patchy carbonate (subhedra to ~1 mm, likely calcite, intergrown with the secondary magnetite) but only trace chalcopyrite (subhedra <0.2 mm), not pyrite; locally fine-grained, recrystallized Kspar (sub-domains <0.1 mm) is likely secondary, in places with minor quartz <0.35 mm (also possibly secondary). This assemblage, therefore, is clearly potassic.

In summary, this is biotite-amphibole (quartz) syenite (accessory ilmeno-magnetite, apatite), transitional potassic/propylitic ±argillic altered to Kspar?-quartz-actinolite ±biotite?-chlorite-clay?-sericite-epidote-sphene-hematite-trace pyrite, partly oxidized to limonite. Veins are actinolite-magnetite-calcite-local Kspar?-quartz-trace chalcopyrite.

6083P: HORNBLENDE DIORITE (ACCESSORY APATITE, ILMENO-MAGNETITE?) ALTERED TO TRANSITIONAL POTASSIC/PROPYLITIC ASSEMBLAGE OF HEMATITE-STAINED ALBITE-MINOR KSPAR-QUARTZ-EPIDOTE-ACTINOLITE-SERICITE-SPHENE/RUTILE-PYRITE-CHALCOPYRITE MAINLY ALONG THIN SUB-PARALLEL VEINLETS

Described as quartz monzonite disseminated mineralization from AT537 (Cathedral Zone); hand specimen shows salmon-pink/mottled dark greenish-grey felsic plutonic rock cut by thin veinlets/microveinlets of sulfides. The rock is not magnetic, shows no reaction to cold dilute HCl, and major white etch for plagioclase but only minor (fracture-controlled, secondary) yellow stain for K-feldspar in the etched offcut. Modal mineralogy in polished thin section is approximately:

Plagioclase (sericite, minor epidote altered; hematite-stained albite)	70%
Amphibole (relict cores, secondary actinolite, partly in veinlets)	15%
K-feldspar (secondary, veinlets/microveinlets only)	5%
Quartz (secondary, veinlets only)	2-3%
Epidote (mainly with sulfides, in veinlets; trace after plagioclase)	1-2%
Sericite (after plagioclase)	1-2%
Pyrite (partly oxidized to limonite)	1%
Chalcopyrite (partly oxidized to limonite)	1%
Sphene, trace rutile (after ilmeno-magnetite?)	1%
Apatite (primary accessory and partly secondary?)	1%

This sample consists essentially of hypidiomorphic-granular textured plagioclase (altered to sericite-minor epidote) and amphibole (altered to actinolite-minor quartz-epidote-sulfides where near veinlets of the same minerals and Kspar) associated with accessory sphene (after ilmeno-magnetite?)-apatite.

Plagioclase crystals are randomly oriented, mostly subhedral to locally euhedral tabular to lath-shaped crystals up to ~4 mm long, but commonly clumped together to form aggregates to almost 1 cm across that alternate with the mafic aggregates; there is virtually no primary quartz or Kspar evident. Plagioclase crystals are typically altered to sericite as minute, randomly oriented sub- to euhedral flakes mainly <25 μm in size (15-25% replaced?) and locally by epidote as subhedra mostly <30 μm with very low birefringence, suggestive of zoisite (?). Weak negative relief against quartz and very poorly defined (blurry, vague) small (<10º) extinction on 010 suggests remnant plagioclase is likely in the albite-oligoclase range, and likely secondary given the hematite-stained, altered nature.

Relict mafics are mainly amphibole, as subhedra to ~6 mm long (or aggregates of similar size) showing cores of pale brownish-green possible relict hornblende or actinolitic hornblende?, typically variably replaced at margins or irregularly by finer-grained, fibrous, darker/bright sea-green actinolite mostly <0.75 mm long plus a little local secondary quartz, epidote and sulfides as described for the veinlets. Accessory relict ilmeno-magnetite (?) sites mostly <1 mm across are now represented by irregular aggregates of sphene (subhedra to 0.65 mm, locally with traces of rutile as subhedra <65 μm at the cores), and significant apatite as stubby sub/euhedra to ~1 mm long (some may be secondary?).

Most of the sulfides in this sample are distinctly controlled along sub-parallel veinlets up to ~1.5 mm thick (widest at intersections where two oblique veinlets cross) composed of quartz, epidote, minor actinolite, and microveinlets (mainly of K-feldspar) mostly <0.2 mm thick. Quartz forms sub- to anhedra mainly <1 mm that mostly lack evidence of strain; epidote forms somewhat skeletal subhedra up to 1.2 mm long with locally bright yellow colour indicative of high Fe content; and actinolite forms subhedra <0.65 mm as described above. Pyrite dominates in some veinlets as elongate sub/euhedra to 1.5 mm, locally with trace ragged/anhedral inclusions of chalcopyrite <0.1 mm, and chalcopyrite dominates in others as similar-sized anhedra (aggregates to several mm of both, partly oxidized to limonite that also spreads out as stains into adjacent rock). K-spar crystals are skeletal to subhedral, rarely up to 0.6 mm long, and clearly secondary.

In summary, this is hornblende diorite (accessory apatite, ilmeno-magnetite?) altered to transitional potassic/propylitic assemblage of hematite-stained albite-minor Kspar-quartz-epidote-actinolite-sericite-sphene/rutile-pyrite-chalcopyrite mainly along thin sub-parallel veinlets.

2037P: STRONGLY POTASSIC (KSPAR-QUARTZ-CHLORITE-MAGNETITE-ALBITE-RUTILE-APATITE) ALTERED, POSSIBLE HORNBLENDE DIORITE (?) IN ASSOCIATION WITH SIGNIFICANT SUB-PARALLEL VEINING BY QUARTZ-MAGNETITE-CHLORITE-PYRITE-CHALCOPYRITE, PARTLY/LARGELY OXIDIZED TO LIMONITE-LOCAL MALACHITE

Described as magnetite-chalcopyrite-quartz veins in K-feldspar altered monzonite, AT559 (Cathedral Zone); hand specimen shows medium-grained, pale salmon-pink potassic altered rock cut by sub-parallel network of grey quartz-magnetite-sulfide veins. The rock is strongly magnetic, shows no reaction to cold dilute HCl, and major pervasive yellow stain for K-feldspar/only rare white etch for relict plagioclase in the etched offcut. Modal mineralogy in polished thin section is approximately:

K-feldspar (largely secondary?)	70%
Quartz (mainly secondary, vein; minor primary?)	10%
Chlorite (after relict mafic sites, in veins; after secondary biotite)	10%
Magnetite (largely secondary, vein; minor relict primary?)	5%
Plagioclase (relict, albitized; slightly sericite-epidote altered)	2%
Pyrite (partly oxidized to limonite)	2%
Chalcopyrite (largely oxidized to limonite, malachite)	<1%
Rutile (after ilmeno-magnetite?)	<1%
Apatite (relict primary/minor secondary?)	<1%

This is strongly potassic altered rock now composed essentially of (mainly secondary?) Kspar with chloritized mafic relics, only minor relict (albitized) plagioclase, interstitial quartz and accessory rutile and apatite, cut by sub-parallel veins of quartz-magnetite-chlorite-sulfides partly oxidized to limonite and malachite.

In the body of the rock, Kspar making up the bulk of the section forms interlocking, randomly oriented subhedral crystals to about 2 mm diameter, commonly with ragged boundaries suggestive of secondary origin (only rarely are corroded relics of plagioclase visible, as poikilitic remnants contained within the Kspar). Moderate negative 2V and lack of “grid” twinning suggests the Kspar may be orthoclase. Remaining plagioclase forming lath-like sub/euhedral crystals up to 3 mm long shows sharp twinning with extinction Y^010=15º and negative relief compared to quartz, indicative of composition near An_{0-5}. The crystals are further slightly altered to the usual minor sericite (random subhedral flakes <25 µm) and rare epidote (rounded subhedra <20 µm with very low birefringence, probably zoisite). Minor quartz occurring as relatively small (<1 mm) subhedra interstitial to feldspars is possibly mainly primary, or partly recrystallized/secondary. Relict mafic sites have subhedral, <3 mm long outlines that are locally highly stretched out by the veining; they are pseudomorphed by variable combinations of chlorite (subhedral flakes mainly <0.35 mm with distinct pale bright green pleochroism, anomalous blue-grey, length-slow birefringence suggestive of F:M 0.6 (?), magnetite as small subhedra mainly <0.2 mm (but locally associated with ragged, likely recrystallized relict primary crystals to ~1 mm), local rutile as aggregates to 1 mm of semi-opaque or red-brown subhedra to 0.4 mm, and apatite as mainly slender euhedral prisms <0.3 mm long.

The well-developed vein system making up about 15-20% of the section consists of sub-planar, sub-parallel veins up to 3 mm thick composed mainly of quartz (interlocking sub- to euhedral, locally bladed crystals mostly <1.5m, but up to 3 mm long that show only mild strain indicated by weakly developed undulose extinction, sub-grain development, and suturing of grain boundaries and local chlorite (as described above; partly remobilized from mafic sites?). Variable magnetite occurs as fractured subhedra up to 1.5 mm or semi-massive, banded aggregates of sub/anhedra mainly <0.15 mm, commonly closely associated with (enclosing) the sulfides, which form elongated aggregates mostly <1 mm thick by <1 cm long down the middle of the veins, mostly pyrite (subhedra <1 mm) and lesser chalcopyrite (anhedra <1 mm) both partly to largely oxidized to limonite and in some places, malachite as subhedra <0.35 mm with bright green pleochroism.

In summary, this is strongly potassic (Kspar-quartz-chlorite-magnetite-albite-rutile-apatite) altered, possible hornblende diorite (?) in association with significant sub-parallel veining by quartz-magnetite-chlorite-pyrite-chalcopyrite, partly/largely oxidized to limonite-local malachite.

1926P: REPLACEMENT VEIN OF QUARTZ-SERICITE/MUSCOVITE-CHLORITE-FE CARBONATE-ACCESSORY RUTILE-APATITE-PYRITE-CHALCOPYRITE (AFTER PLUTONIC INTRUSIVE) FLANKED BY SELVAGES OF PARTLY SHEARED QUARTZ-CALCITE-MINOR PYRITE-CHALCOPYRITE (PARTLY OXIDIZED TO LIMONITE)

Described as high grade sheeted quartz vein with chalcopyrite-rich mineralogy from AT560, Pinnacle Zone; hand specimen shows dark greenish-grey, fine-grained vein core with minor sulfides, flanked by thin white (mainly quartz, calcite?) selvages. The rock is not magnetic, shows local rapid reaction to cold dilute HCl mainly along the selvages, and no stain for K-feldspar or white etch for plagioclase in the etched offcut. Modal mineralogy in polished thin section is approximately:

Quartz (secondary, vein)	35%
Sericite, muscovite (after feldspars?)	30%
Chlorite (with carbonate, after relict mafic sites?)	20%
Carbonate (calcite, Fe-calcite?)	12%
Pyrite	2%
Rutile (after ilmeno-magnetite?)	<1%
Apatite (relict primary?)	<1%
Chalcopyrite	<1%

This vein sample consists of a central zone of secondary quartz, sericite/muscovite, chlorite, Fe-carbonate, minor sulfides and accessory rutile suggestive of replacement origin (after plutonic intrusive similar to those described for this suite above), flanked by selvages of coarser-grained or sheared, recrystallized quartz, calcite and minor chlorite and sulfides.

In the central (replacement?) section of the vein, quartz typically occurs as irregular aggregates up to 8 mm across of randomly oriented, locally somewhat skeletal sub- to rarely euhedral crystals up to 4 mm in diameter, mainly showing only mild strain (weak undulose extinction, sub-grain development, and suturing of grain boundaries). The distribution and occurrence somewhat interstitial to patches of sericite/muscovite is suggestive of former partly primary quartz intergrown with original feldspars, and with mafic relic sites now altered to chlorite-carbonate ±rutile-sulfides. The possible relict feldspar sites have locally well defined, subhedral to rarely tabular euhedral outlines to ~3.5 mm, pseudomorphed by sericite (matted, randomly oriented subhedral flakes mainly <0.1 mm) and lesser coarser muscovite (somewhat aligned, subhedral flakes to 0.5 mm that may be associated with minor chlorite <0.1 mm and traces of rutile of similar or smaller size. The mafic relic sites have rounded to irregular or rarely subhedral outlines mostly <2 mm (but in loose aggregates up to 4 mm) and are pseudomorphed by chlorite (sub- to euhedral flakes to ~0.7 mm with pale but distinct green pleochroism, length-slow weakly anomalous grey/blue birefringence suggestive of F:M 0.5-0.6?) with variable Fe-carbonate (interlocking ragged sub/anhedra to ~1.5 mm variably stained by limonite) and accessory rutile (aggregates to ~1 mm of dark brown/opaque subhedra mainly <0.3 mm), apatite (rounded stubby prisms to 0.5 mm) and sulfides (mainly pyrite as rounded subhedra to cubic euhedra to ~1 mm locally aggregating to ~2 mm, rare chalcopyrite as anhedra <0.6 mm long, mainly found along quartz microveinlets).

In the flanking selvages, quartz and relatively clear, non-limonite stained carbonate (calcite) are either relatively coarse (interlocking sub- to euhedral crystals up to ~2 mm diameter) or relatively fine (granulated, recrystallized, possibly sheared to locally almost mylonitic sub/anhedra mainly <0.2 mm for quartz, although calcite may occur as deformed, stretched anhedra up to 1.5 mm long elongated parallel to the vein margin). Pyrite in these areas of the vein forms rounded sub/euhedra that are strongly fractured or crushed, and the latter very fine-grained pyrite may be partly oxidized to limonite; minor chalcopyrite forms ragged sub/anhedra to 0.5 mm that is also fractured and partly to largely oxidized to limonite.

In summary, this appears to represent replacement vein of quartz-sericite/muscovite-chlorite-Fe carbonate-accessory rutile-apatite-pyrite-chalcopyrite (after plutonic intrusive) flanked by selvages of partly sheared quartz-calcite-minor pyrite-chalcopyrite (partly oxidized to limonite).

1932P: BANDED, MULTISTAGE QUARTZ-CARBONATE-CHLORITE-SERICITE-MINOR ARSENOPYRITE-PYRITE-CHALCOPYRITE-RUTILE-LIMONITE-APATITE VEIN, PARTLY OF REPLACEMENT AND PARTLY OF OPEN-SPACE FILL ORIGIN (THE LATTER WITH LOCAL COMB TEXTURE)

Described as thick arsenopyrite quartz veins with anomalous gold values from AT564 (Pinnacle Zone); hand specimen shows, dark grey fine-grained and white coarser-grained, complex banded vein with local sulfides (pyrite, arsenopyrite, minor chalcopyrite). The rock is not magnetic, shows local reaction to cold dilute HCl (mainly in the white portion), and no stain for K-feldspar/etch for plagioclase in the etched offcut. Modal mineralogy in polished thin section is approximately:

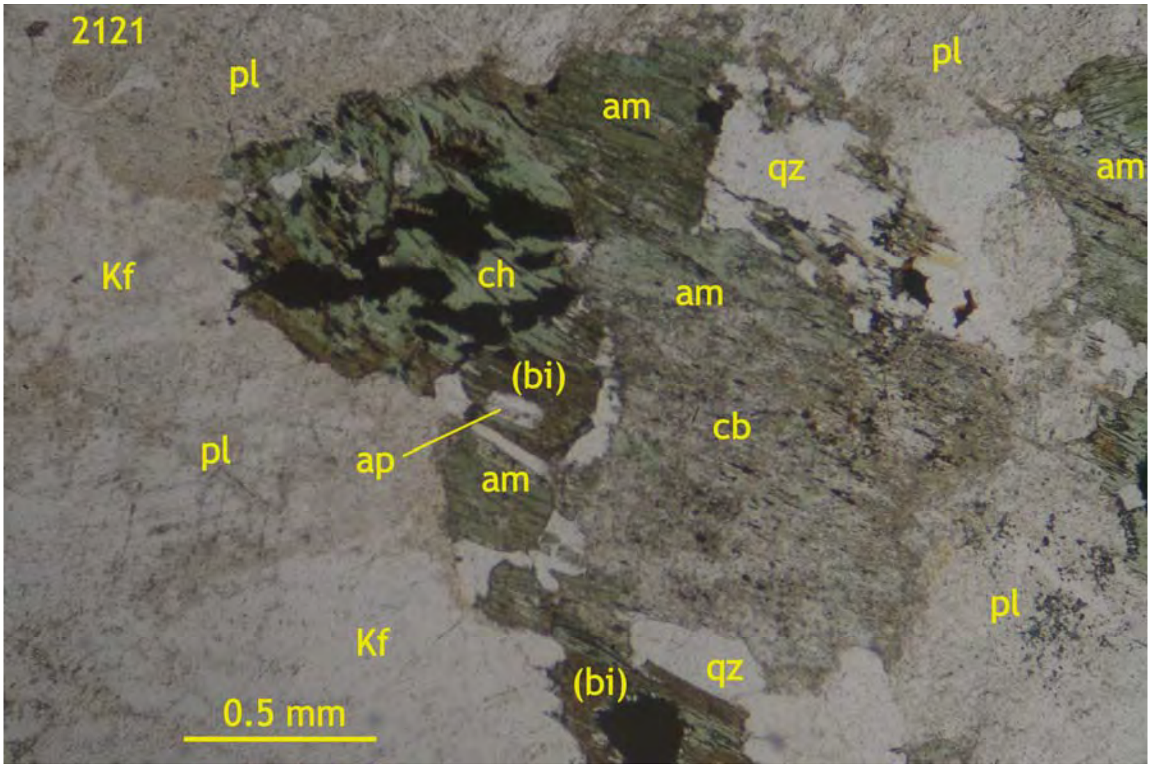
Quartz (secondary, replacement/vein, multiple generations)	55%
Carbonate (mainly calcite?)	20%
Chlorite	15%
Sericite	10%
Arsenopyrite	2%
Pyrite	2%
Chalcopyrite	1%
Rutile	<1%
Limonite	<1%
Apatite (relict primary?)	<1%
Galena (trace inclusions in arsenopyrite only)	trace

This sample comprises a vein made up of multiple bands or stages, ranging from replacement (with clear relict textures of former plutonic intrusive rock; mafic sites replaced by chlorite, rutile and local sulfides, possible feldspar sites replaced by quartz and lesser sericite) to open-space filling (with local comb-textured, coarse quartz, carbonate and sulfides).

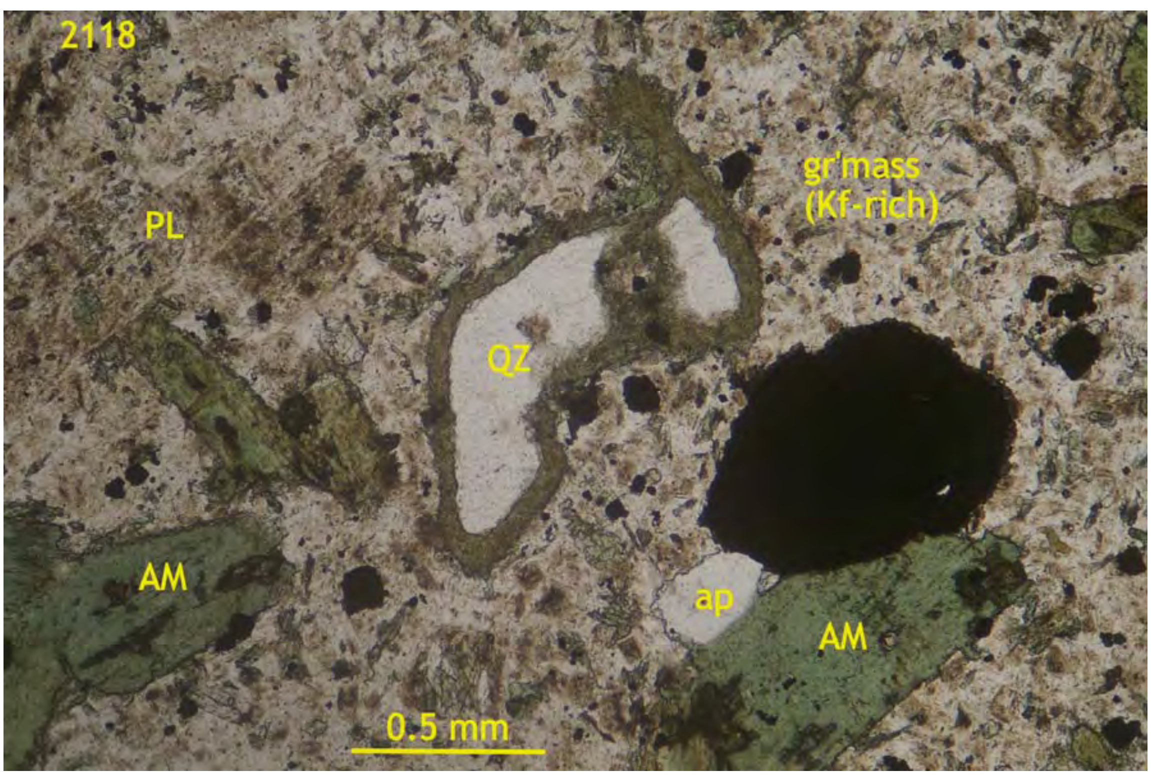
In the former, replacement vein portions, relict mafic sites with irregular to locally euhedral outlines up to about 3 mm are characterized by concentrations of chlorite (subhedral flakes to 0.4 mm with distinct green pleochroism, anomalous blue length-slow birefringence suggestive of F:M 0.6-0.7?) with lesser sericite (randomly oriented, subhedral flakes mainly <0.1 mm) and carbonate (subhedra to 0.65 mm, possibly mainly calcite?) all variably overprinted by secondary quartz as interlocking sub- to locally euhedral crystals mainly <0.25 mm with little strain indicated by absence of undulose extinction, sub-grain development, and suturing of grain boundaries. Accessory rutile occurring in ragged, commonly skeletal aggregates to 1.2 mm, composed of dark brown/opaque subhedra <0.2 mm, likely mark the sites of former ilmeno-magnetite, and there are local cubic crystals of pyrite to 0.5 mm, or apatite as euhedral prisms to 0.3 mm long. Possible former feldspar sites are characterized by more abundant sericite/muscovite (matted, randomly oriented subhedral flake up to 0.2 mm) with lesser chlorite, variable quartz. Quartz also occurs in anastamosing, irregular veinlets mainly <2 mm thick that are commonly disrupted or sheared by ongoing tectonic activity; these are transitional to the more major, throughgoing banded vein portions of the sample.

In the latter, banded veins up to about 1 cm thick are sub-parallel to the overall vein walls, and consist of quartz (sub- to commonly euhedral, locally bladed crystals up to ~3 mm long, in places with comb texture, carbonate as interlocking subhedra to ~3 mm (likely mainly calcite), local ribbons of chlorite <0.5 mm thick (properties as described above) and variable sulfides (euhedral arsenopyrite and pyrite up to ~2 mm, local chalcopyrite as ragged, subhedral aggregates mainly <1.5 mm; traces of chalcopyrite and rare galena <45 µm occur in arsenopyrite, but no gold was observed). The quartz varies from virtually unstrained (in the euhedral, bladed, comb-textured crystals) to moderate/strong strain in areas where disruption and shearing has occurred. Areas with irregular outlines up to ~2 mm long stained by very fine-grained limonite (<5 µm) are of uncertain origin (not obviously after former sulfides).

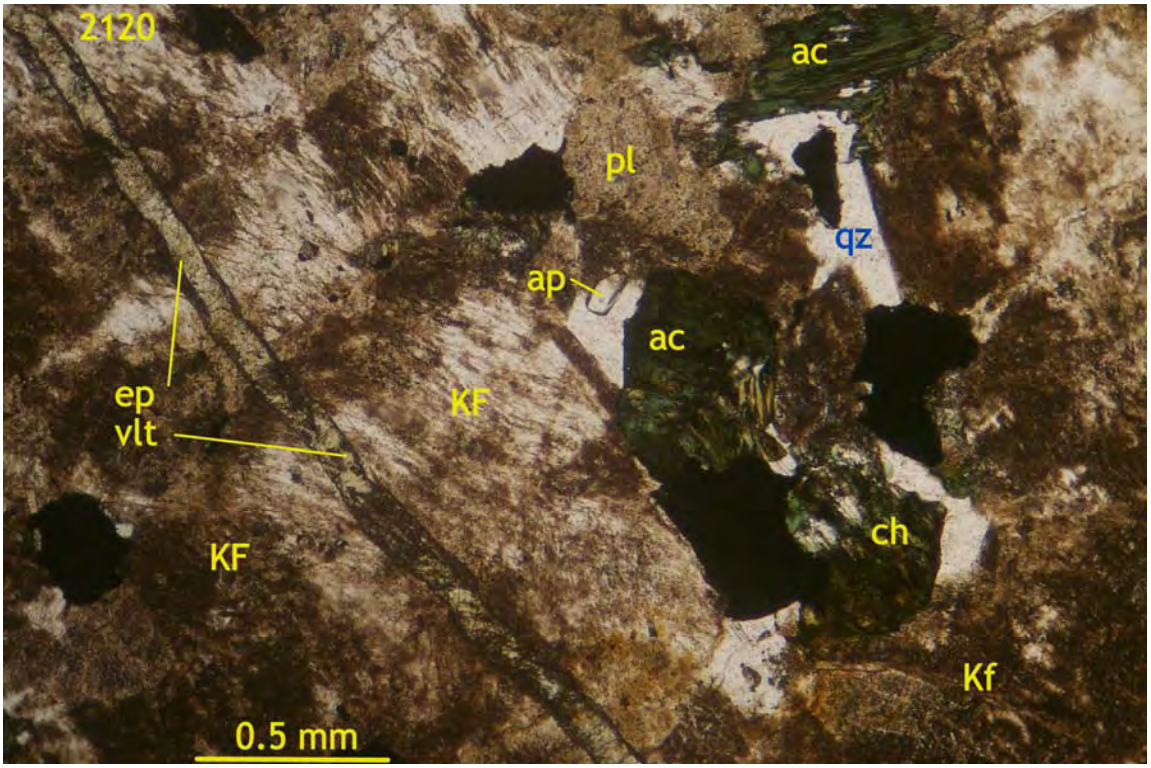
In summary, this is confirmed as banded, multistage quartz-carbonate-chlorite-sericite-minor arsenopyrite-pyrite-chalcopyrite-rutile-limonite-apatite vein, partly of replacement and partly of open-space fill origin (the latter with local comb texture).



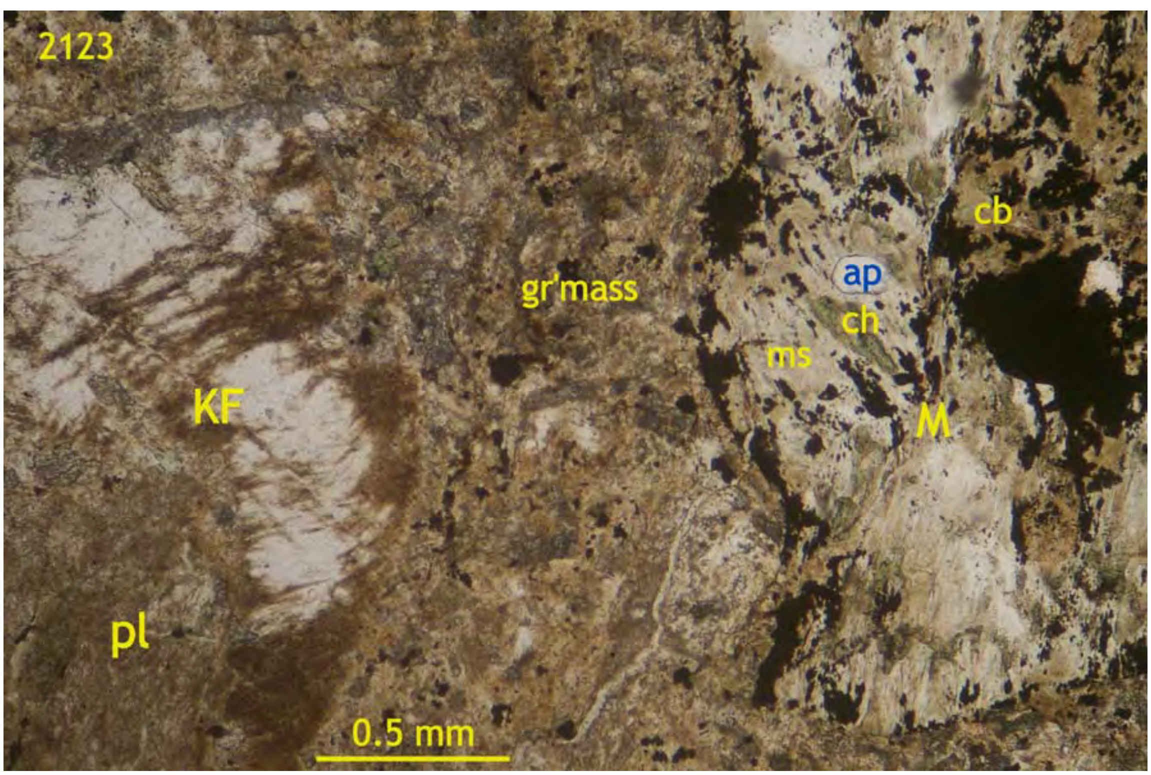
2121P: biotite?-amphibole quartz monzonite composed of plagioclase (pl, sericitized), Kspar (Kf, clear by comparison to plagioclase), relict amphibole (am, actinolitic, altered to carbonate, cb), chlorite (ch after probable biotite, bi), associated with opaques, trace apatite (ap), and minor interstitial quartz (qz). Transmitted plane light, field of view ~3 mm wide.



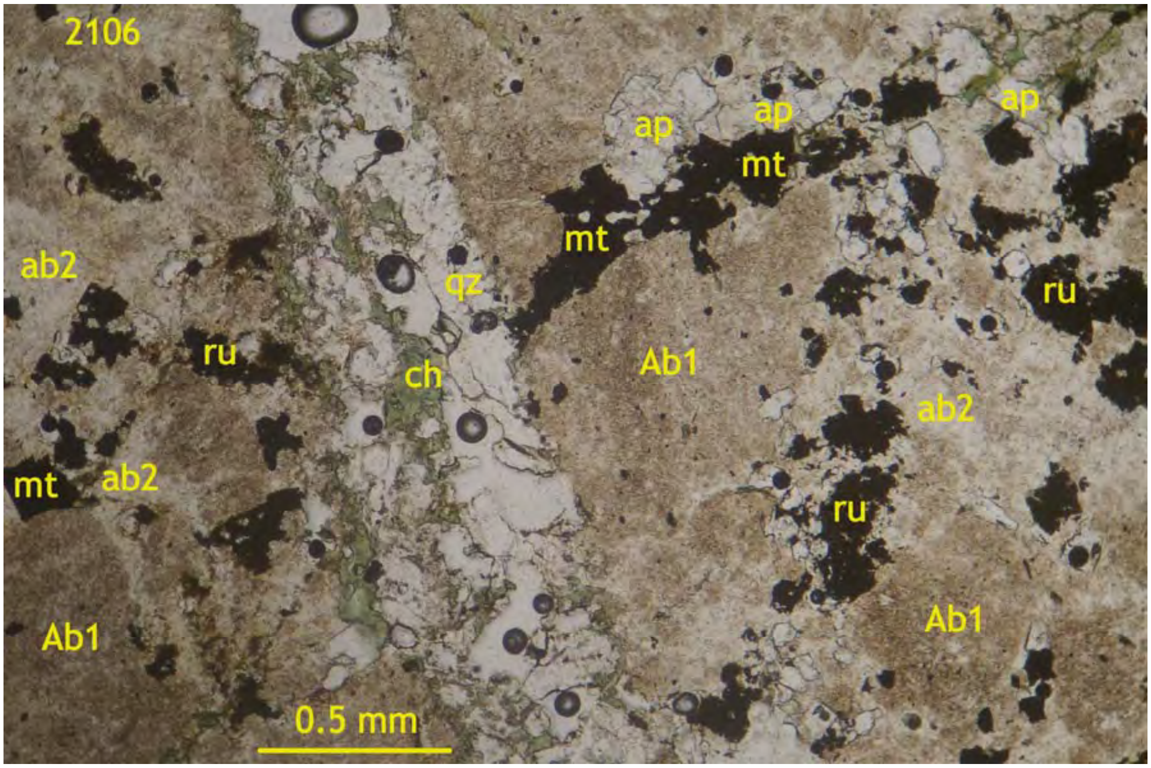
2118P: phenocrysts of plagioclase (PL, altered to clay?/sericite-trace epidote), amphibole (AM) associated with accessory opaque and apatite (ap) microphenocrysts, rare quartz (QZ) partly rimmed by fibrous secondary amphibole, in groundmass of Kspar, plagioclase and amphibole microlites, opaques. Transmitted plane light, field of view ~3 mm wide.



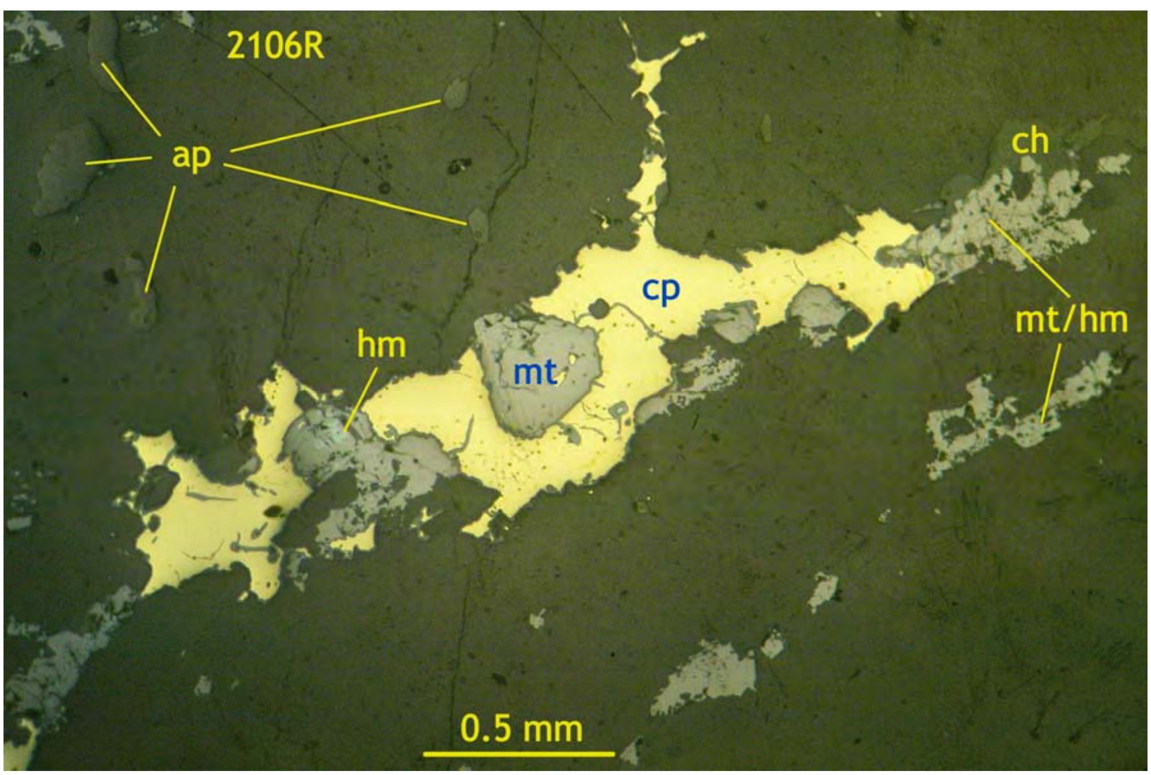
2120P: porphyritic syenite composed of Kspar (KF), smaller plagioclase (pl, clay?/sericite altered), actinolitic amphibole (ac), chlorite (ch, after biotite?), opaque and accessory apatite (ap) in finer-grained Kspar, quartz (qz), cut by thin epidote (ep) veinlet associated with cloudy clay?/hematite alteration of Kspar. Transmitted plane light, field of view ~3 mm wide.



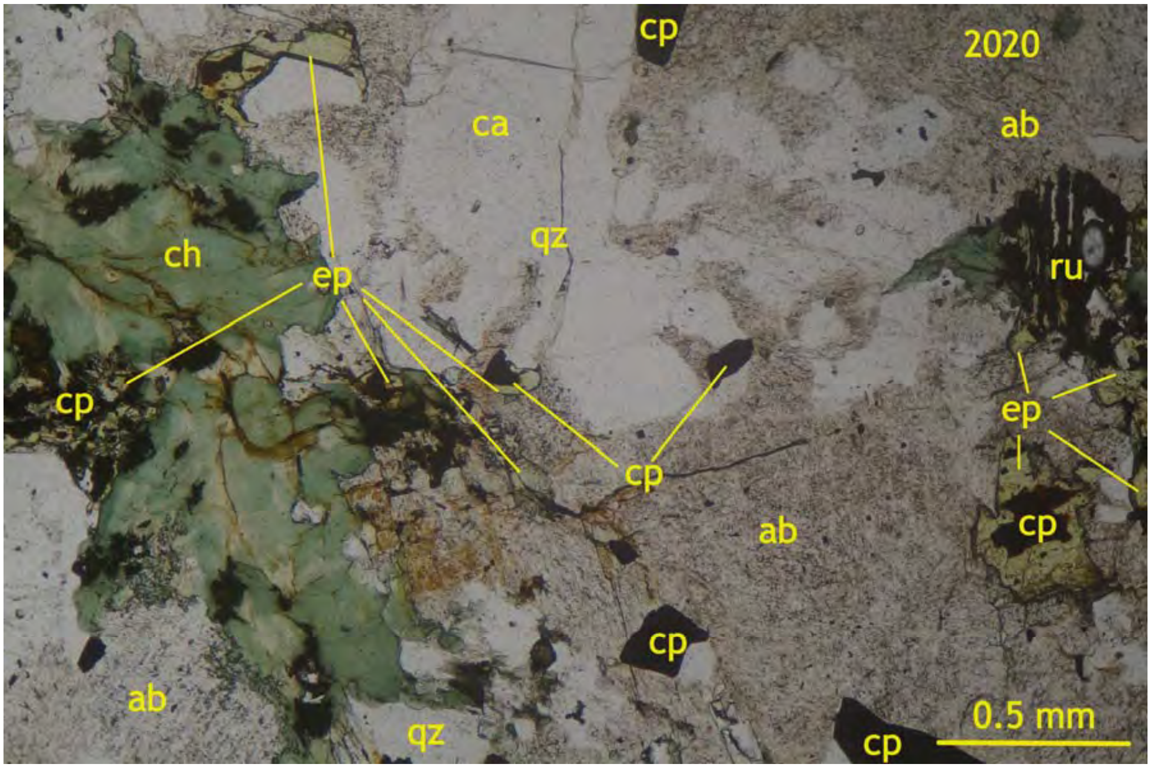
2123P: Kspar megacryst (KF) altered to brownish clay?/hematite at margin, with included plagioclase (pl, strongly altered to sericite-calcite) and relict mafic (M, originally biotite?) now pseudomorphed by muscovite-carbonate-chlorite-opaques-trace apatite, in groundmass of Kspar-sericitized plagioclase-carbonate/chlorite altered mafics microlites, accessory opaques. Transmitted plane light, field of view ~3 mm wide.



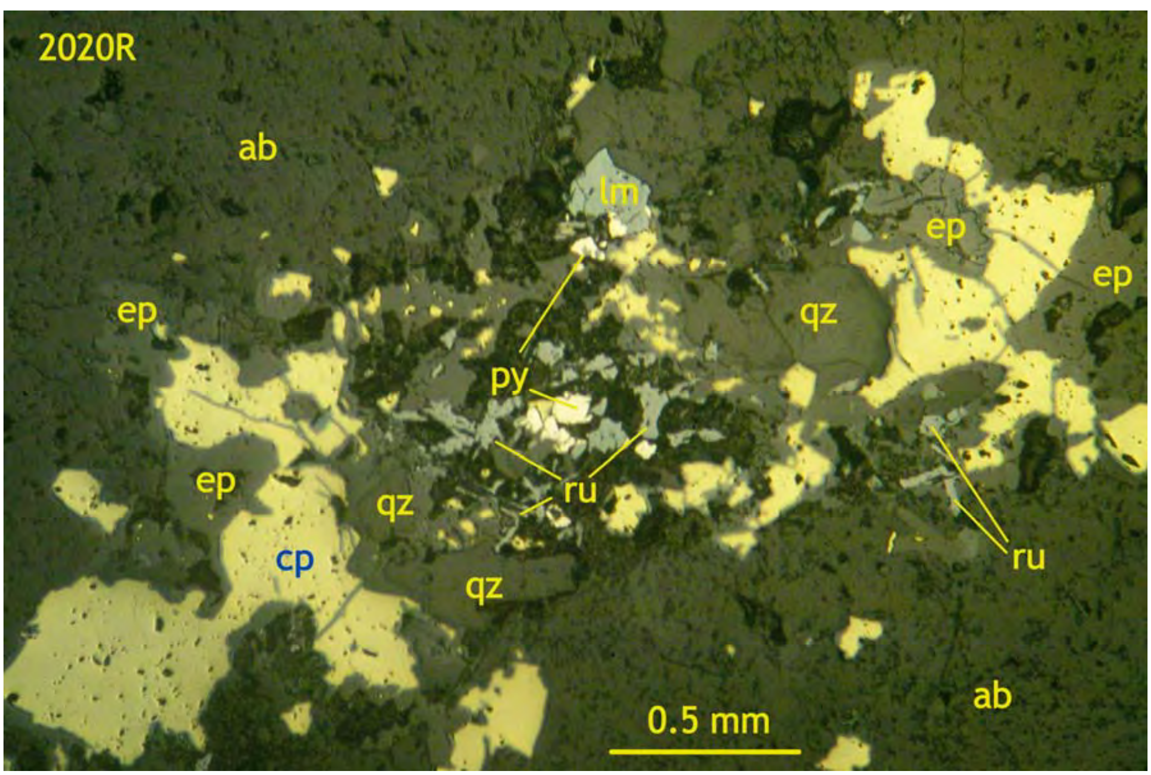
2106P: strongly albitized (coarse, cloudy brownish Ab1) rock cut by late, planar quartz (qz)-chlorite (ch) veinlet cutting earlier irregular network of magnetite (opaque, mt)-rutile (ru)-fine-grained albite (relatively clear, ab2)-apatite (ap)-local chlorite veinlets. Transmitted plane light, field of view ~3 mm wide.



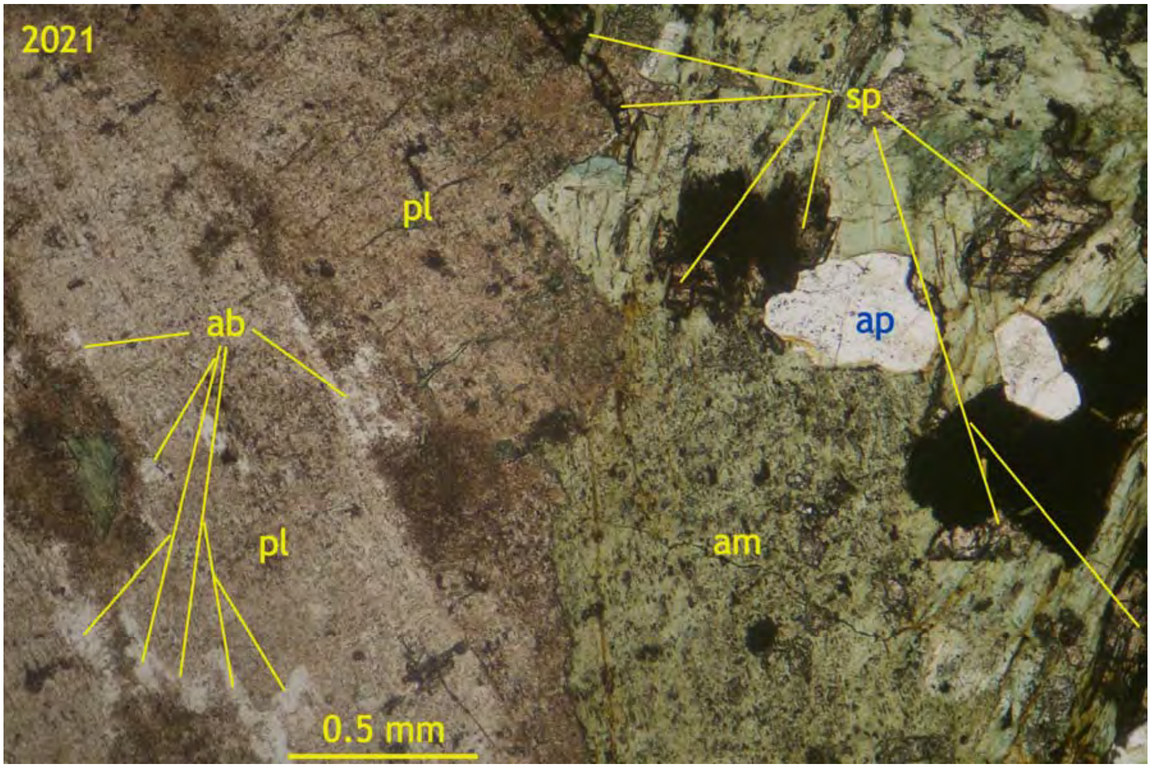
2106PR: chalcopyrite (cp) intergrown with magnetite (mt; trace alteration to paler grey hematite, hm) along irregular veinlets (note local chlorite, ch, and apatite, ap, in and along some veinlets), cutting strongly albitized rock. Reflected light, uncrossed polars, field of view ~3 mm wide.



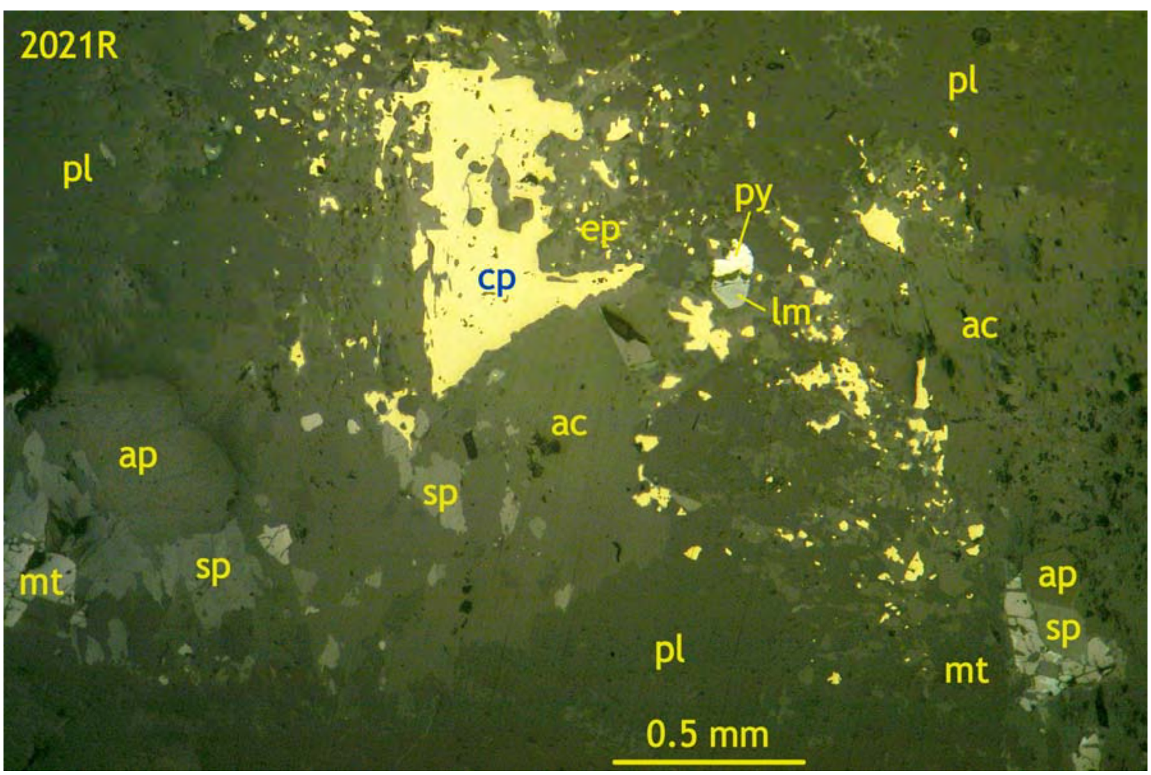
2020P: irregular “spots” or clots of chlorite (ch)-epidote (ep)-chalcopyrite (opaque, cp, partly oxidized to limonite at rims)-rutile (ru), local coarser quartz (qz), trace carbonate (ca) all in thoroughly albitized (ab) matrix. Transmitted plane light, field of view ~3 mm wide.



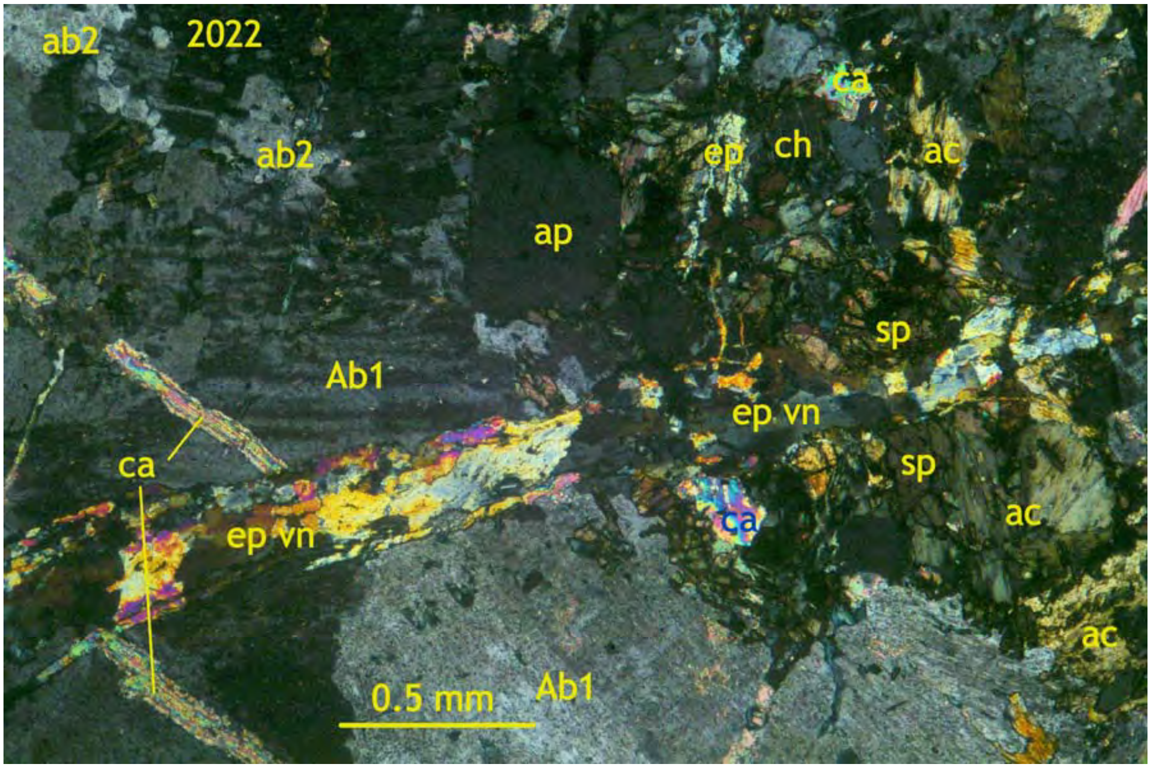
2020PR: irregular clot of chalcopyrite (cp)-rare pyrite (py), partly oxidized to limonite, lm) closely associated with epidote (ep), secondary quartz (qz), rutile (ru), minor chlorite and carbonate, in strongly albitized host matrix. Reflected light, uncrossed polars, field of view ~3 mm wide.



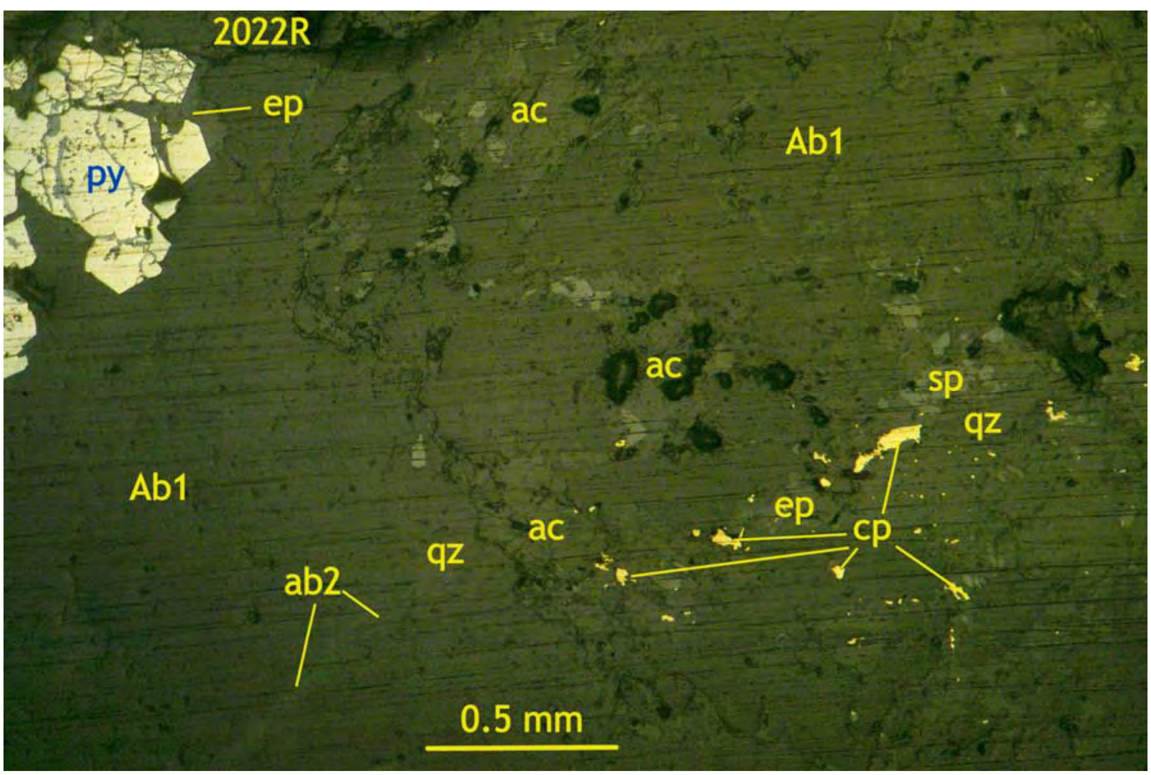
2021P: amphibole diorite (?) composed of plagioclase (albite-oligoclase, altered at rims to minor clear albite, ab, and at cores to very fine sericite ±calcite, epidote) and pale green amphibole (altered to actinolite, carbonate) associated with magnetite (opaque, partly altered to sphene, sp) and apatite (ap). Transmitted plane light, field of view ~3 mm wide.



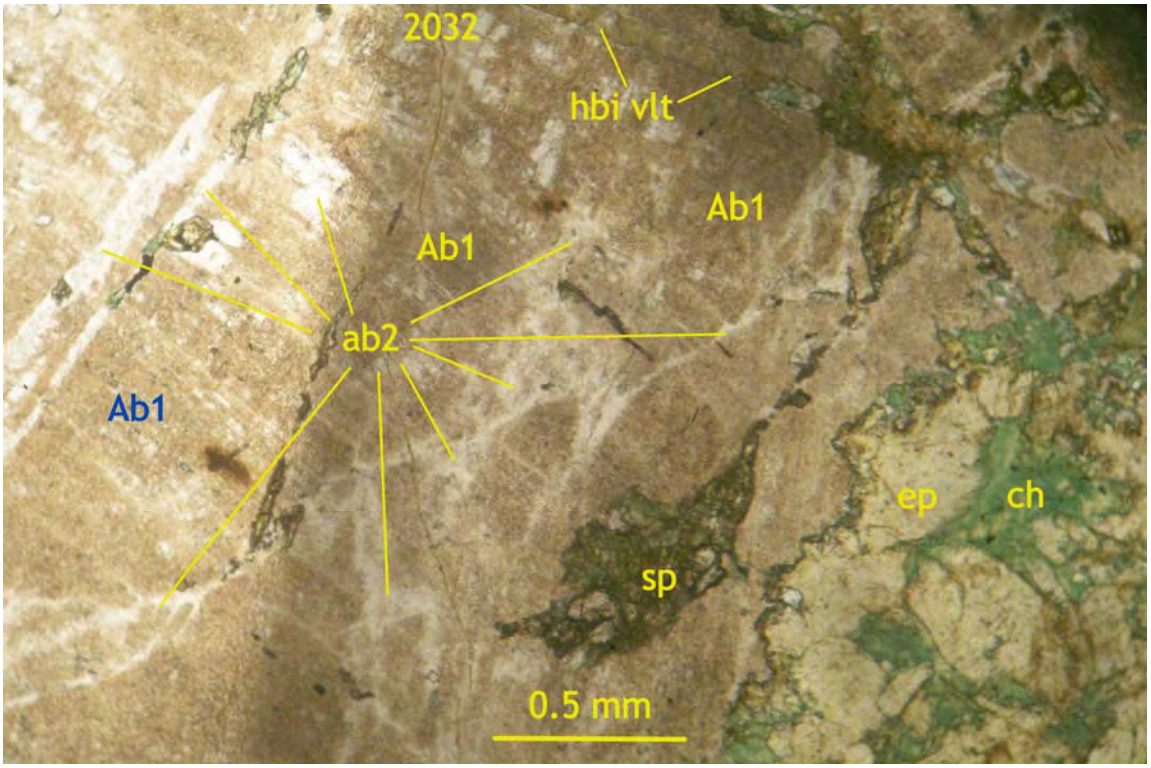
2021PR: chalcopyrite (cp) and minor pyrite (py, partly altered to limonite, lm) associated with/replacing relict mafic site (amphibole altered to actinolite, ac, and epidote, ep; magnetite altered to sphene, accessory apatite, ap). Reflected light, uncrossed polars, field of view ~3 mm wide.



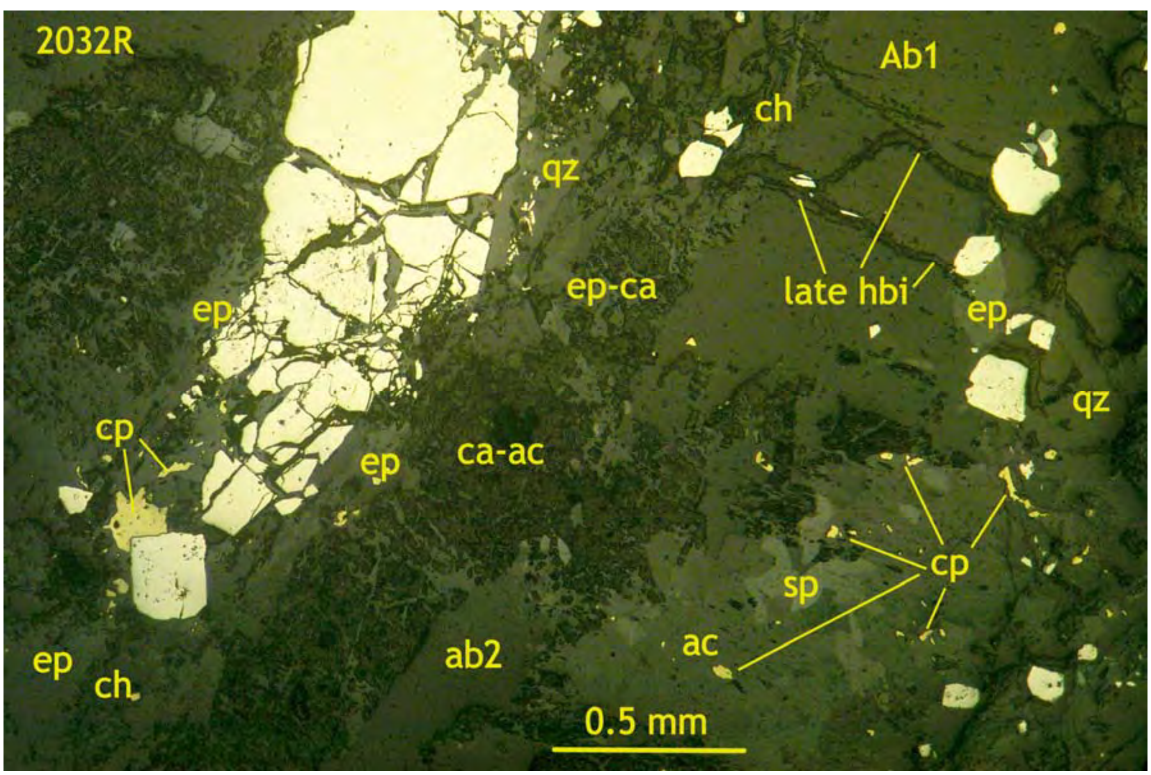
2022P: vaguely twinned secondary albite (Ab1) and relict mafic site (altered to actinolite-chlorite-calcite-epidote, associated with sphene and apatite), cut by veinlets of finer-grained albite (ab2), and vein of epidote that offsets earlier veinlet of calcite (ca). Transmitted light, crossed polars, field of view ~3 mm wide.



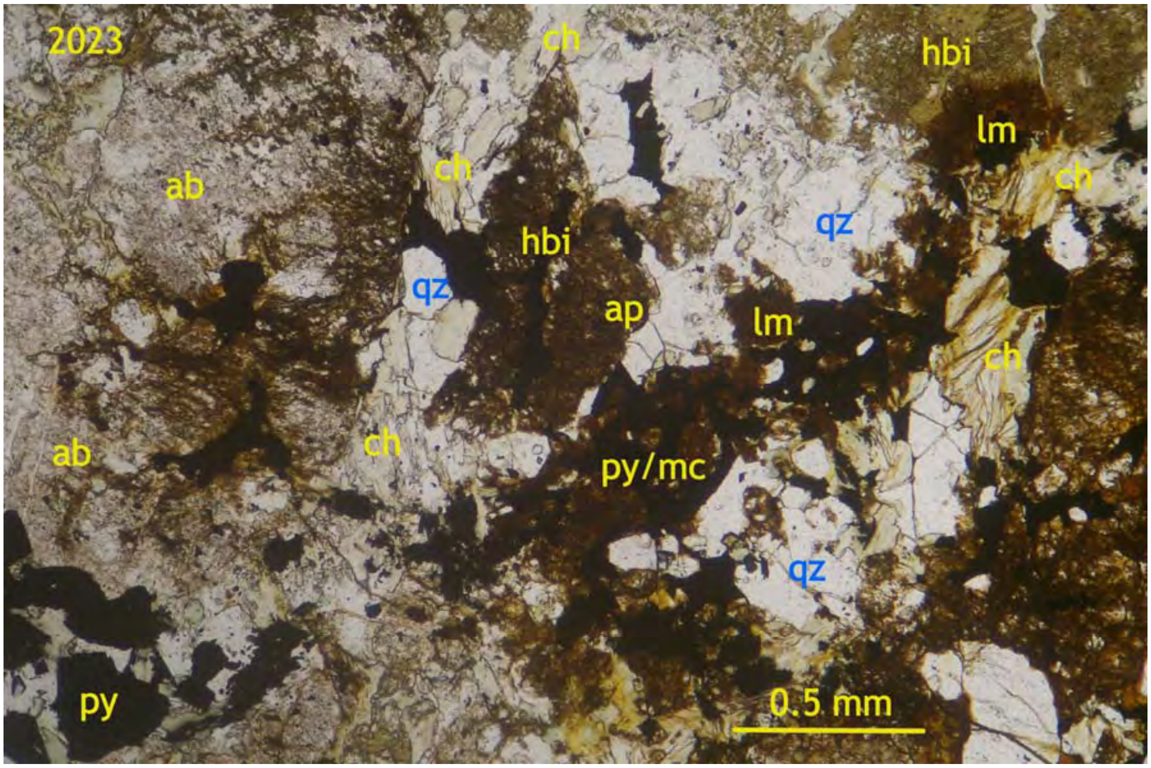
2022PR: relict mafic sites replaced by either pyrite (py) and epidote (ep), or traces of chalcopyrite (cp) associated with hairline veinlet of clear secondary albite (ab2) and quartz (qz), epidote, ragged anhedra of actinolite (ac) and accessory sphene (sp), in matrix of albitized plagioclase (Ab1) Reflected light, uncrossed polars, field of view ~3 mm wide.



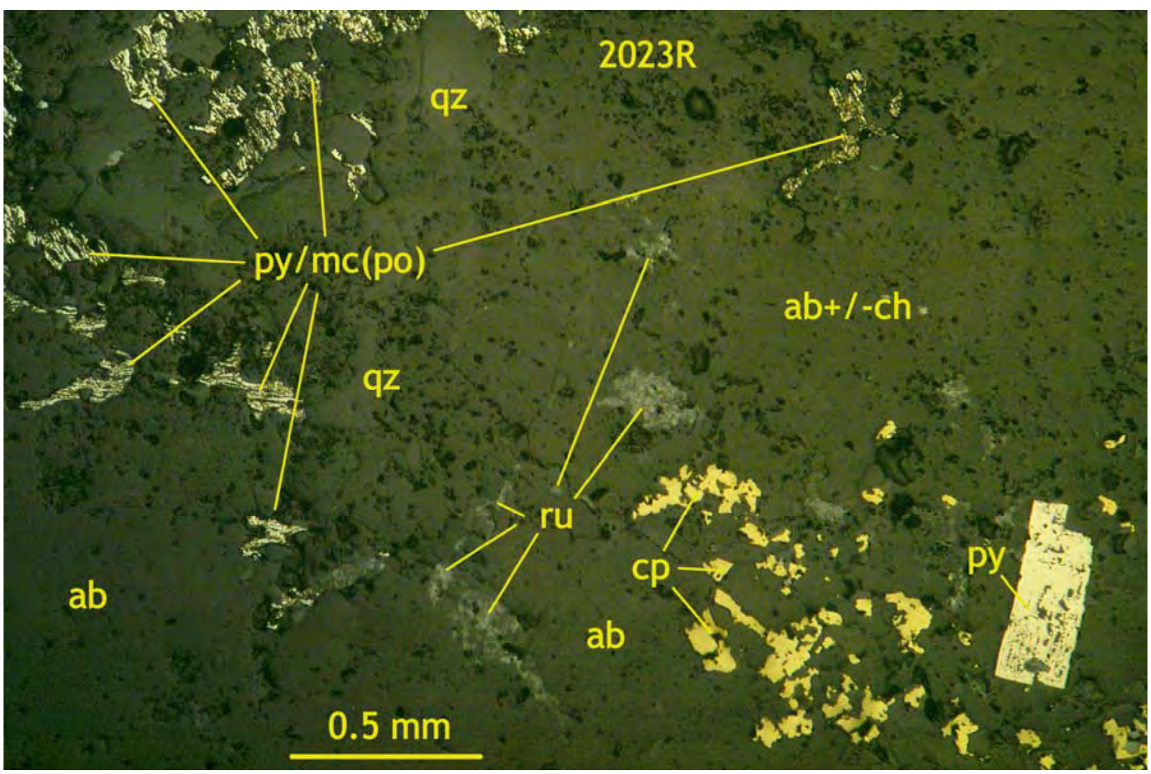
2032P: strongly albitized rock (coarse albite, Ab1, cloudy where partly sericitized, clear where along microveinlets, ab2), cut by thicker veinlets of epidote (ep) and pale green chlorite (ch), local sphene (sp) possibly after ilmeno-magnetite (?); late yellowish veinlets are "hydrobiotite" (hbi). Transmitted plane light, field of view 3 mm wide.



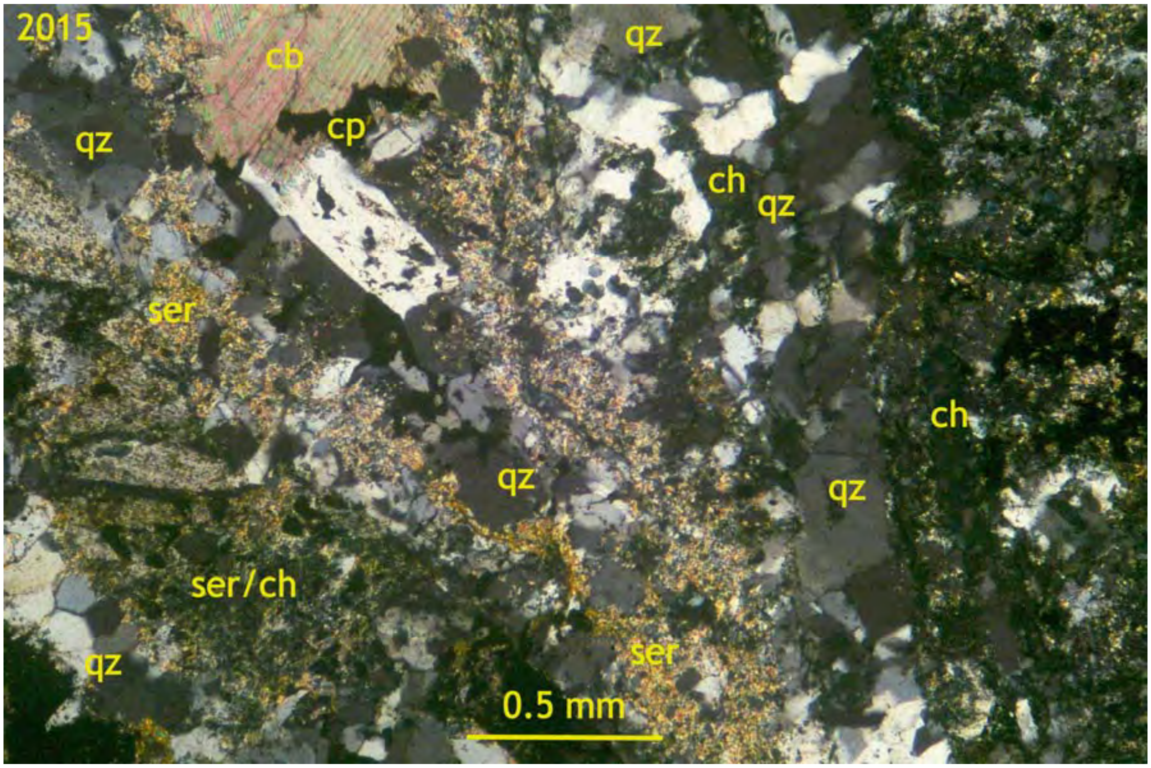
2032PR: strongly fractured pyrite (py) and trace chalcopyrite (cp) in and along veinlets of actinolite-epidote-chlorite-calcite-local quartz (cut by late "hydrobiotite"). Reflected light, uncrossed polars, field of view ~3 mm wide.



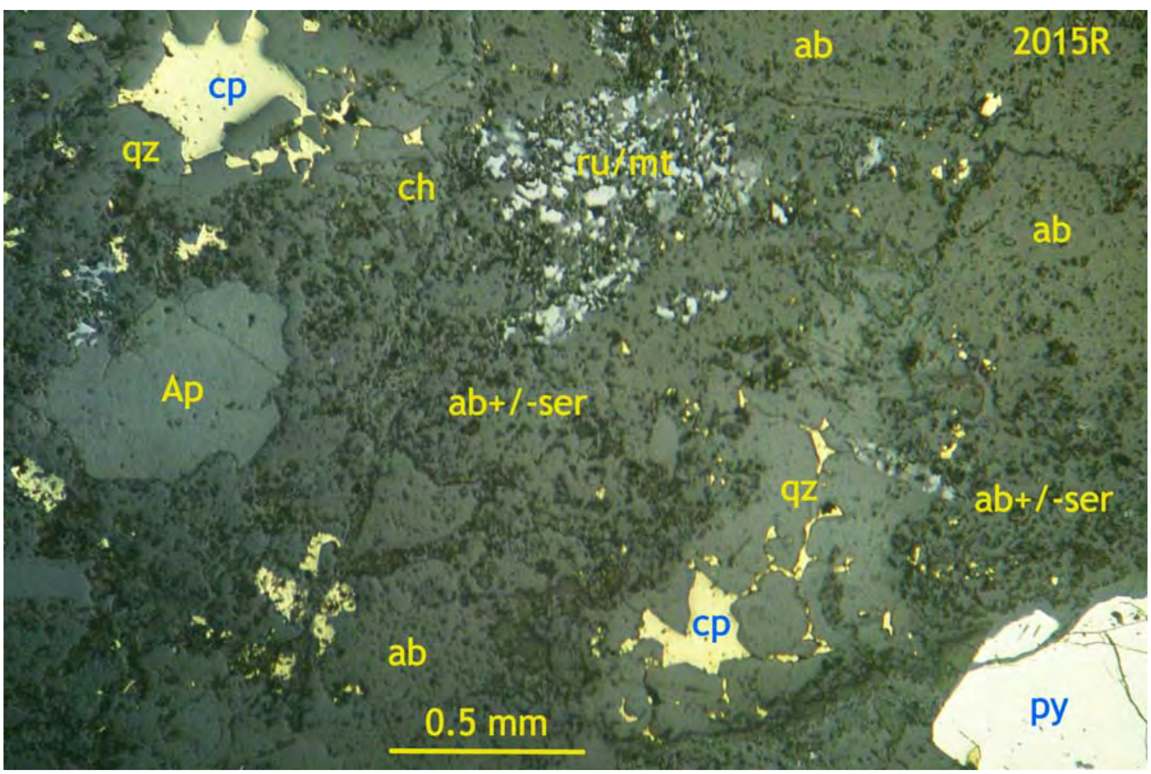
2023P: irregular relict mafic site replaced by pale greenish chlorite (ch) or later (partly supergene?) brownish "hydrobiotite", quartz (qz), opaque sulfides (pyrite/marcasite after pyrrhotite) ±limonite, rutile, local apatite (ap), in matrix of albite/albitized plagioclase (ab) partly stained by spreading limonite, "hydrobiotite". Transmitted plane light, field of view ~3 mm wide.



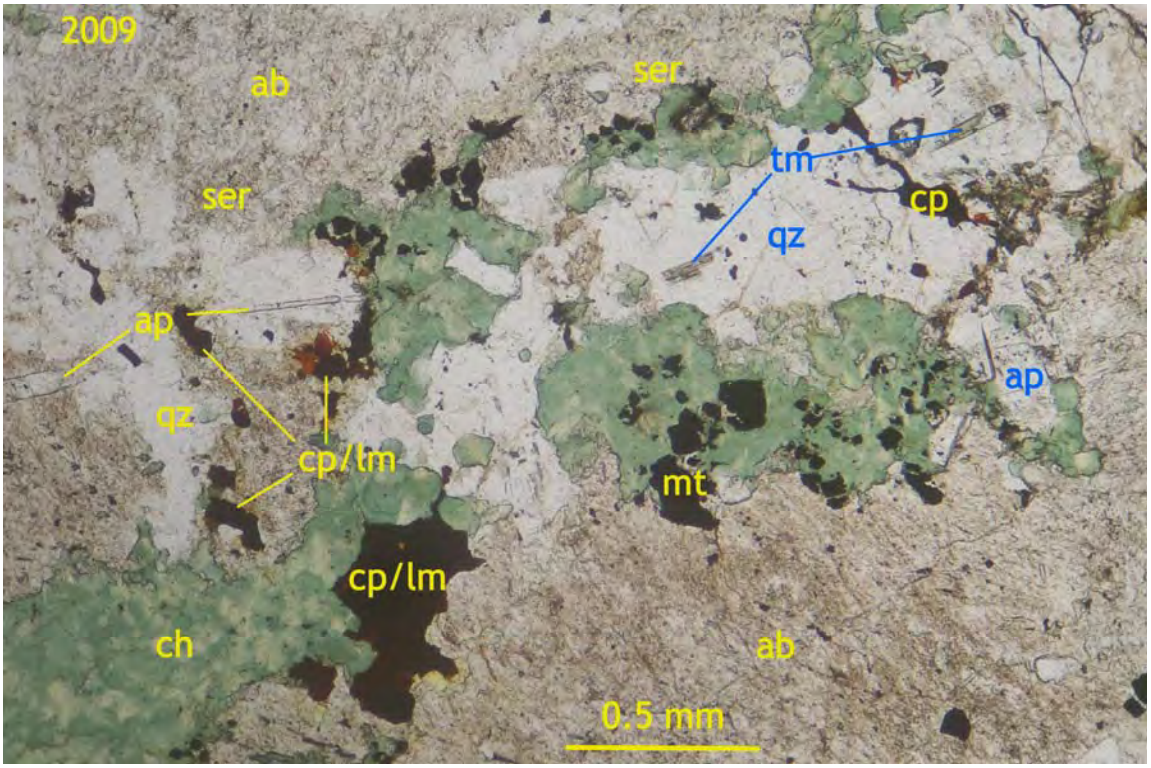
2023PR: relict mafic site/irregular veinlet showing association of relict pyrrhotite (replaced by lamellar-textured pyrite/marcasite, py/mc), aggregates of rutile (ru, after ilmeno-magnetite?), chalcopyrite (cp) and cubic pyrite (py) associated with albite-chlorite difficult to distinguish at this scale, local quartz (qz). Reflected light, uncrossed polars, field of view ~3 mm wide.



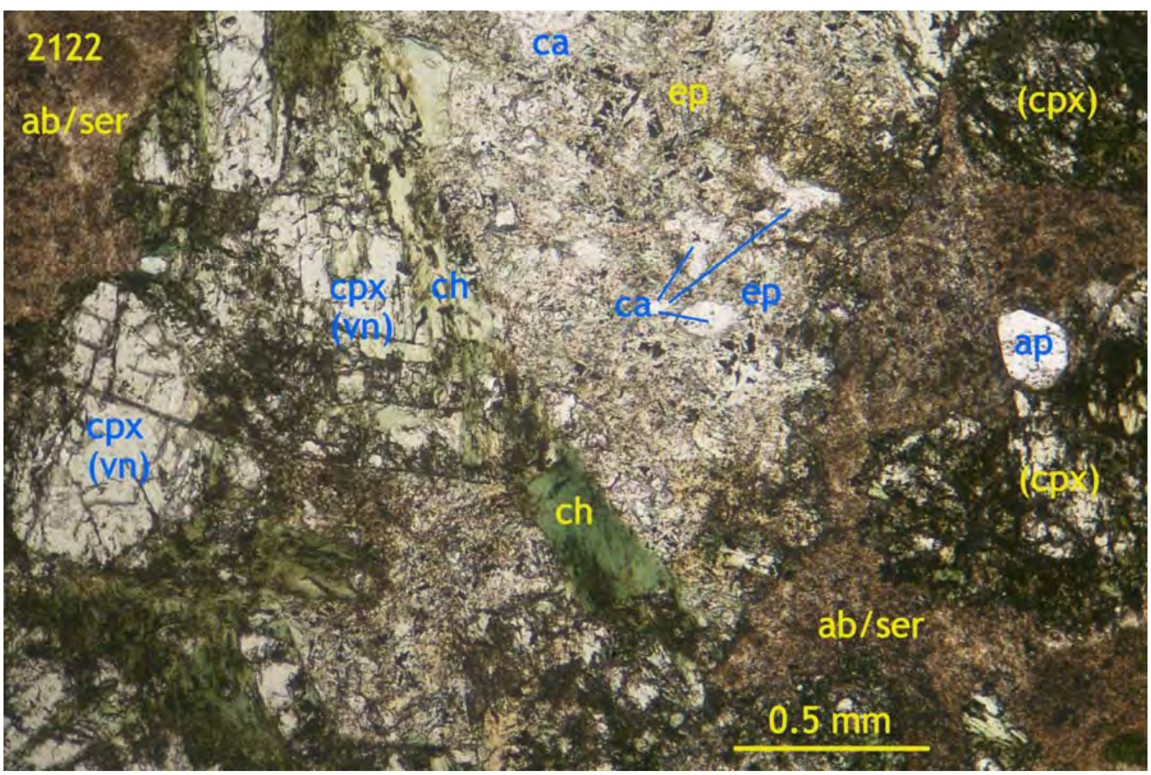
2015P: well-developed stockwork veining of quartz (qz), chlorite (ch), local carbonate (cb) and chalcopyrite (opaque, probably mostly derived from replacement of relict mafic site); note common matted fine sericite (ser) along veinlets, suggesting incipient phyllic overprint on propylitic/potassic. Transmitted light, crossed polars, field of view ~3 mm wide.



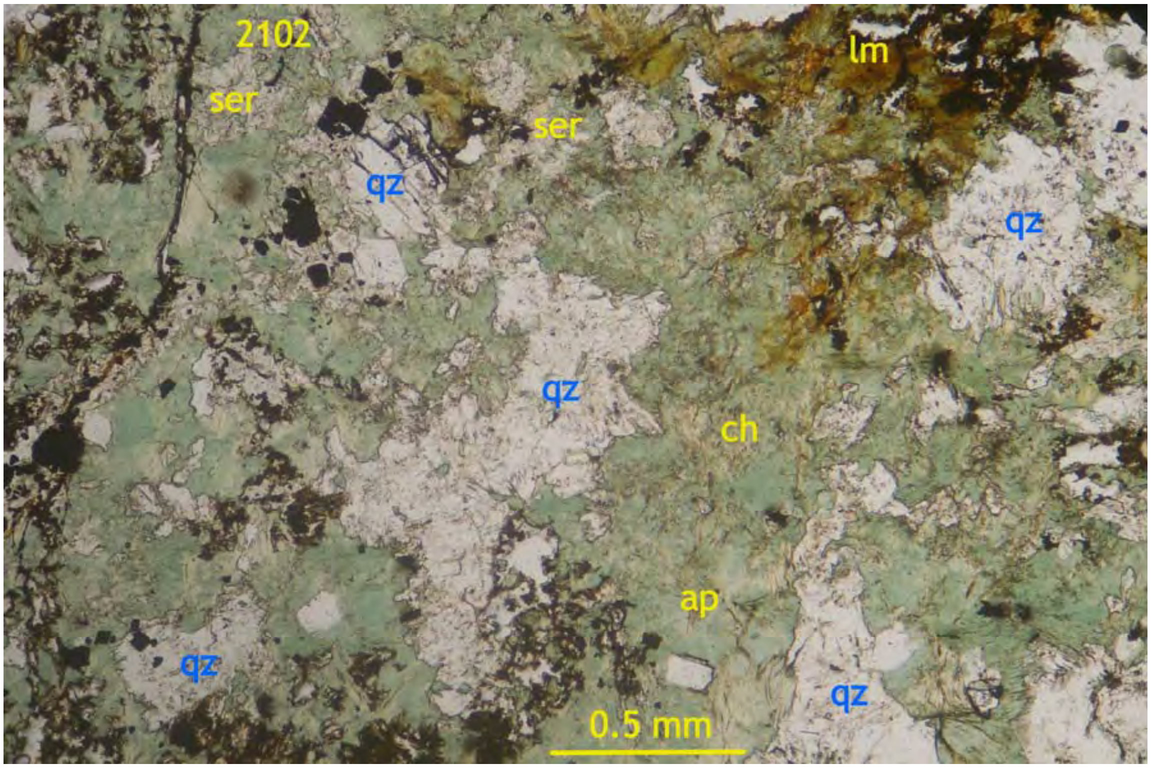
2015PR: irregular relict mafic sites/veinlets replaced by chalcopyrite (cp) or pyrite (py) closely associated with secondary quartz (qz), chlorite (ch), coarse apatite (Ap) and aggregates of rutile/secondary magnetite (ru/mt) after former ilmeno-magnetite (?), cutting strongly albitized rock partly flecked by sericite (ser). Reflected light, uncrossed polars, field of view ~3 mm wide.



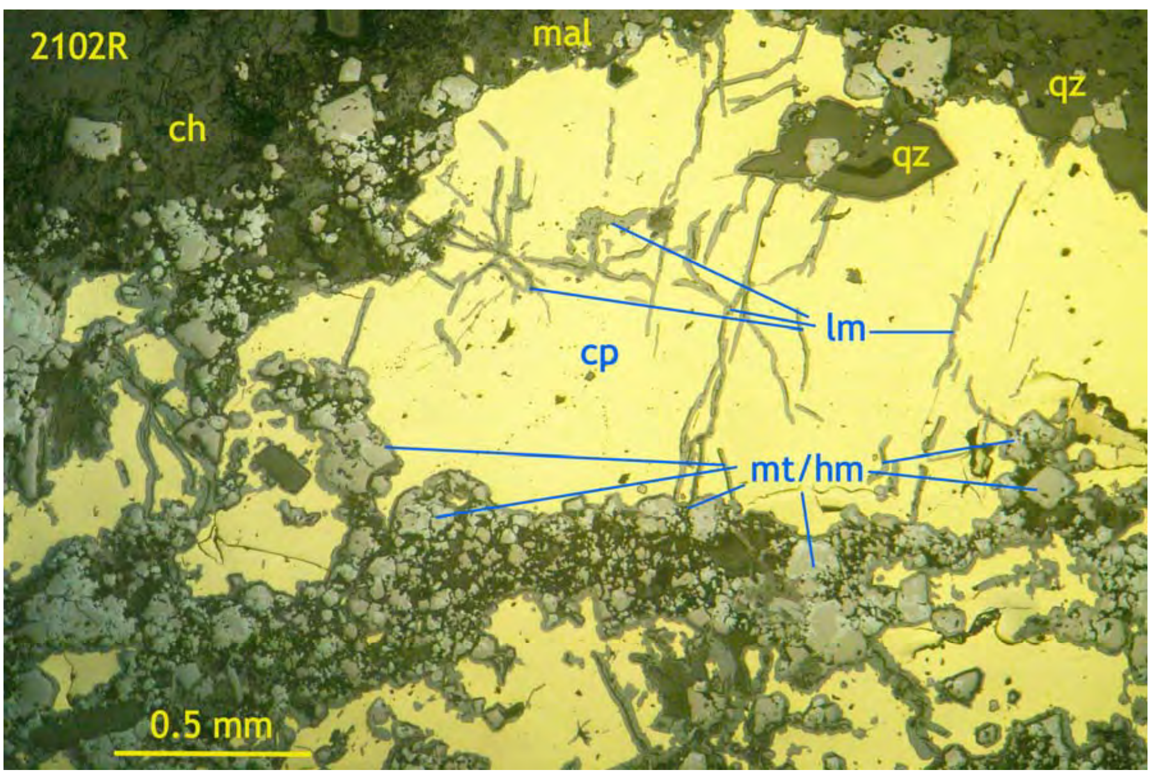
2009P: irregular veinlet of chlorite (ch), quartz (qz), local opaque magnetite (mt) and chalcopyrite (cp, partly oxidized to limonite), trace tourmaline (tm), apatite (ap), flanked by sericite (ser, difficult to distinguish in this view) cutting strongly albitized rock. Transmitted plane light, field of view ~3 mm wide.



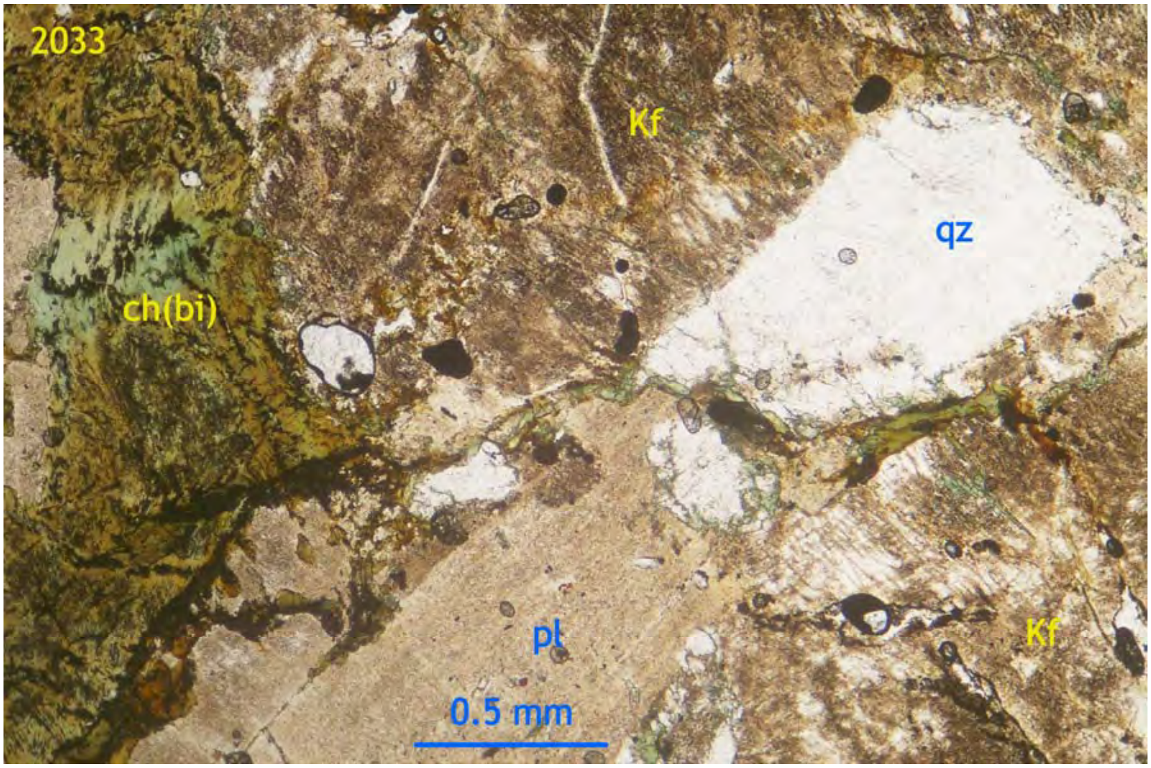
2122P: vein of clinopyroxene (cpx)-epidote (ep)-calcite (ca)-local actinolite (ac)-chlorite (ch) cutting probable pyroxene diorite composed of albitized plagioclase so clouded by minute sericite-calcite-chlorite as to be semi-opaque, and relict pyroxene similarly altered, with accessory apatite (ap) and sphene (sp). Transmitted plane light, field of view ~3 mm wide.



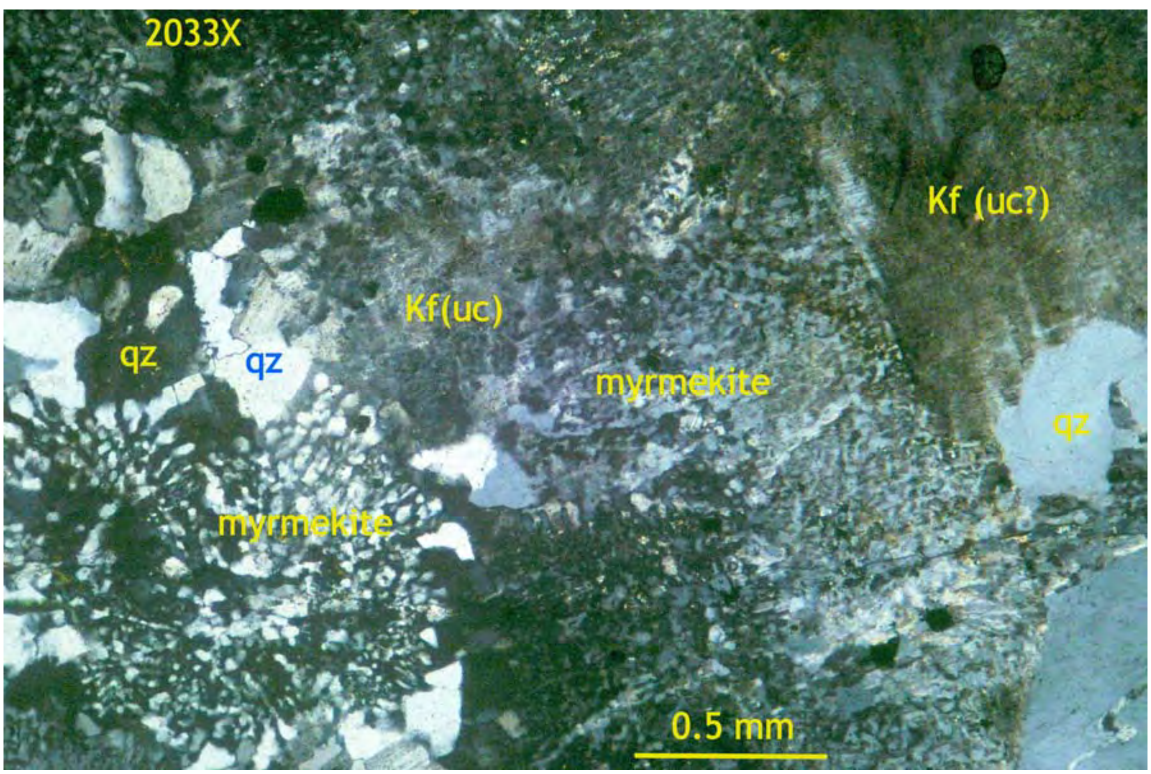
2102P: gangue matrix to semi-massive magnetite-chalcopyrite composed of fine-grained, semi-radiating pale green chlorite partly stained by limonite in places spreading from adjacent oxidized chalcopyrite, quartz (qz) and minor sericite (ser), local apatite (ap); included secondary magnetite crystals are opaque. Transmitted plane light, field of view ~3 mm wide.



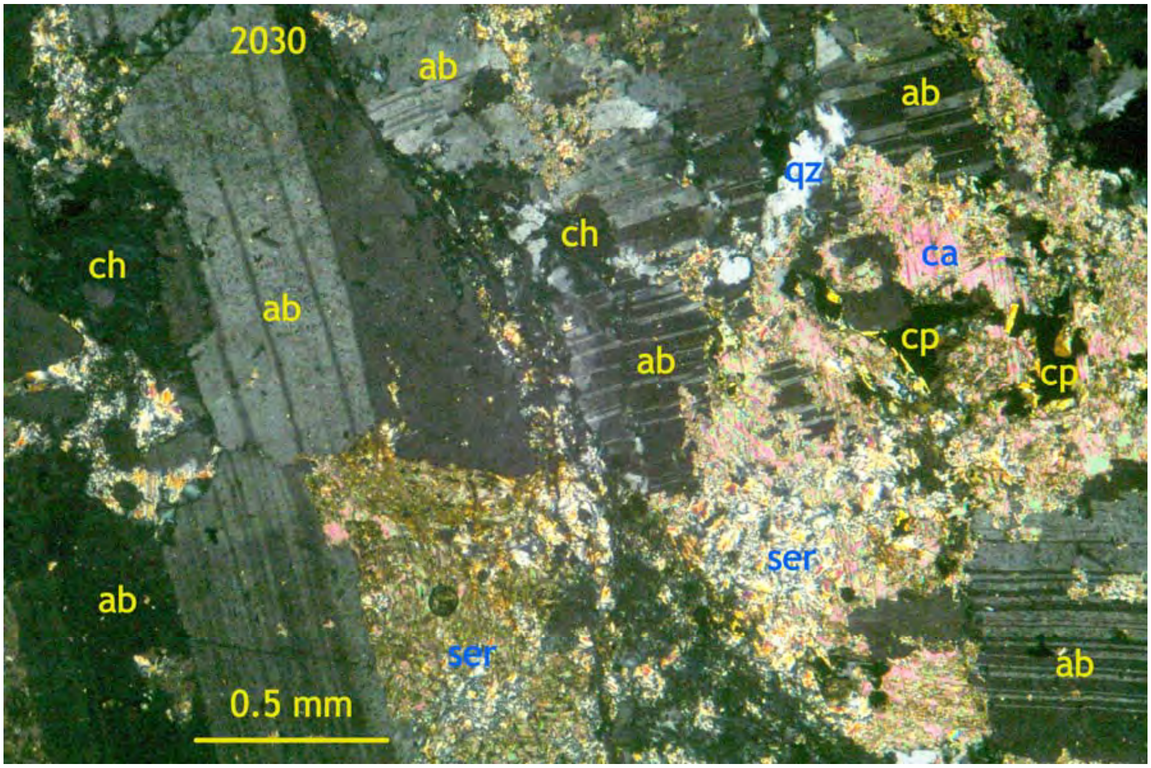
2102PR: intergrown, crudely banded fine-grained magnetite part oxidized to hematite (mt/hm) and coarser chalcopyrite (cp) partly oxidized to limonite along fractures (and at margin to local malachite, mal), adjacent to area of quartz and chlorite (note minor euhedral quartz, qz, included within chalcopyrite). Reflected light, uncrossed polars, field of view ~3 mm.



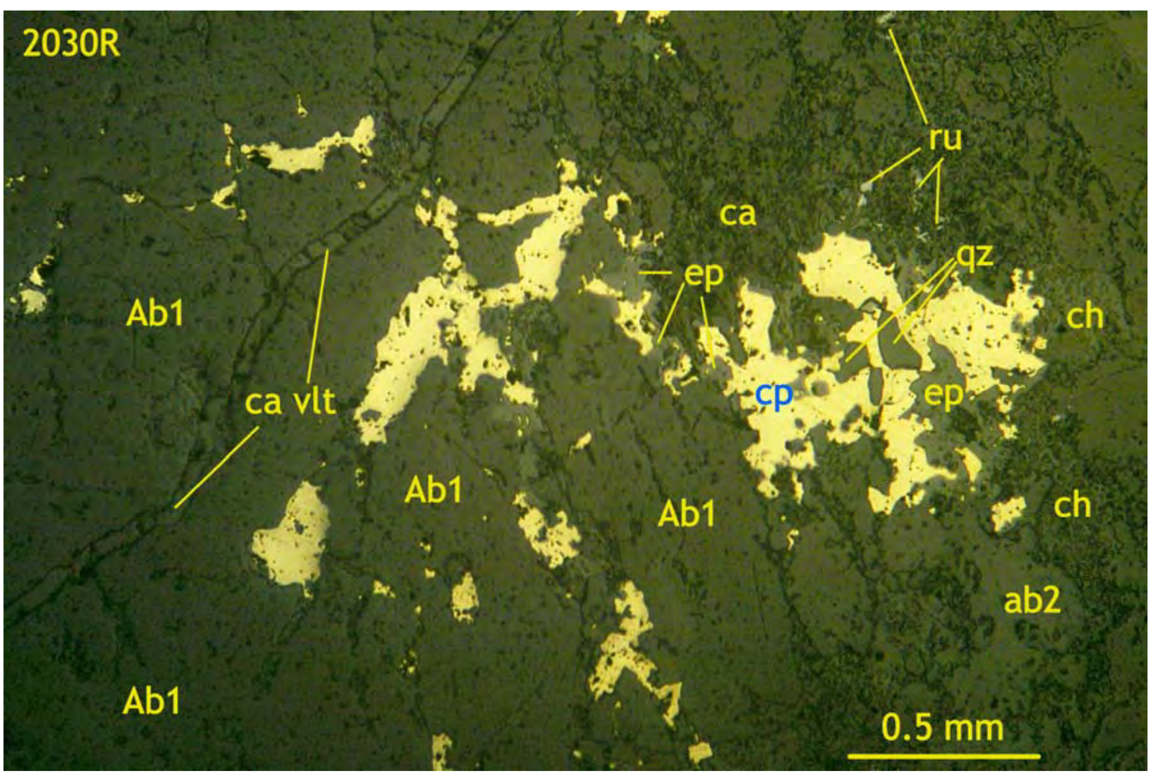
2033P: quartz monzonite portion composed of plagioclase (vaguely twinned, slightly sericitized, albitized), Kspar (stained brownish by minute clay?/hematite particles, micrographic intergrowths with albite and quartz at margin), quartz (clear) and chloritized biotite. Transmitted plane light, field of view ~3 mm wide.



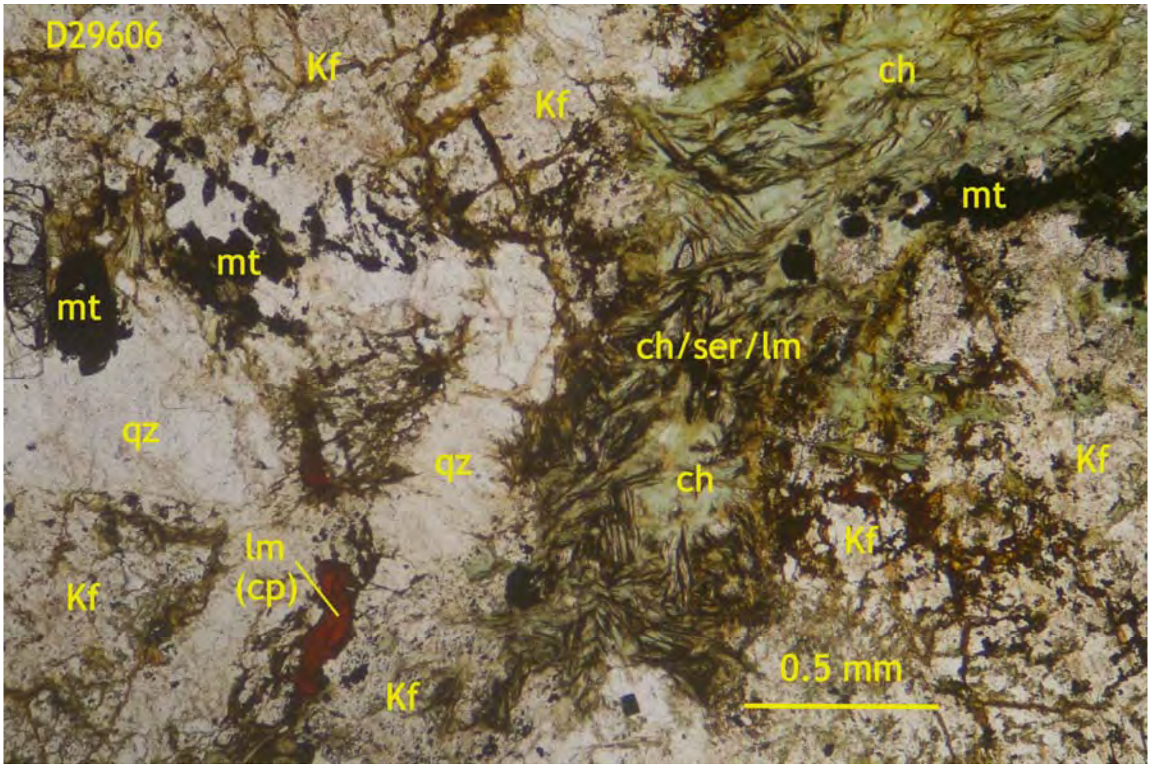
2033PX: aplitic portion of sample showing Kspar (Kf, partly microcline, uc), quartz (qz) and myrmekitic intergrowths of the two, possibly representing late-magmatic "early stage K-feldspar alteration"; there are also local traces of very fine sericite alteration. Transmitted light, crossed polars, field of view ~3 mm wide.



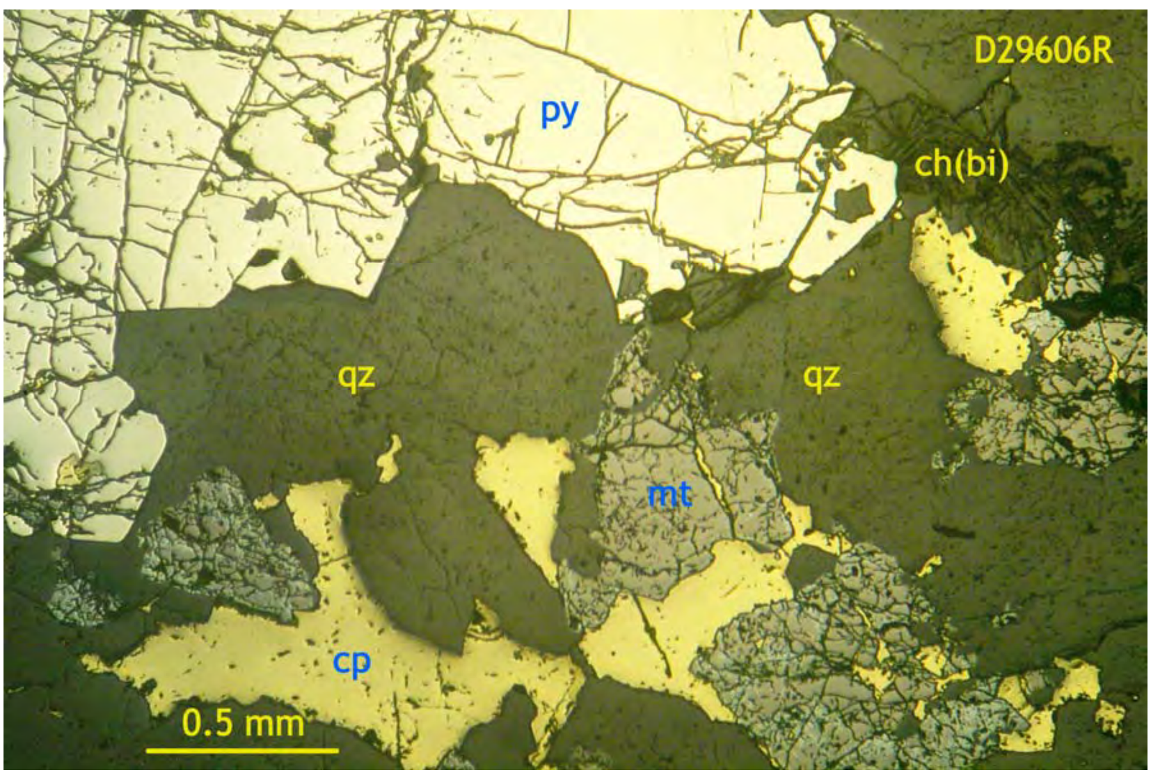
2030P: irregular veinlet system/relict mafic sites composed of calcite (ca)-chlorite (dark, ch)-sericite (ser)-minor secondary quartz (qz) and sulfides (mainly chalcopyrite, cp) or rutile (both opaque), cutting and disrupting variably albitized plagioclase/secondary albite (ab). Transmitted light, crossed polars, field of view ~3 mm wide.



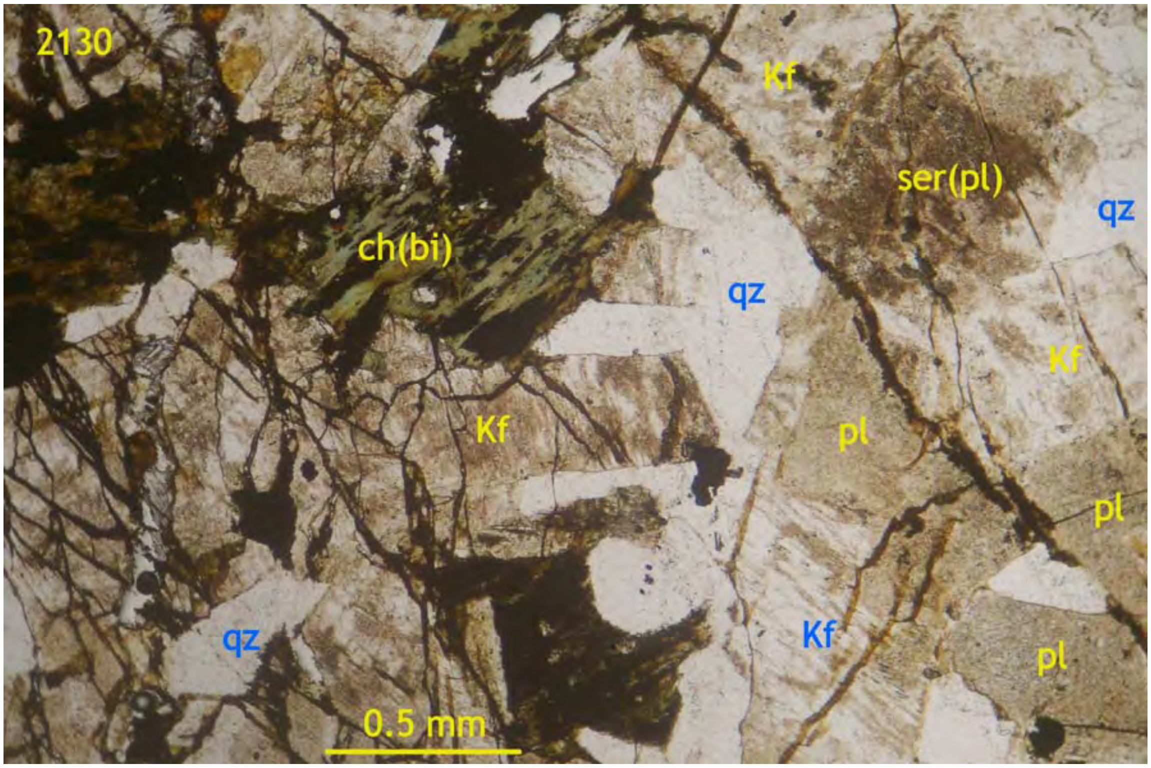
2030PR: veinlet/relict mafic site controlled chalcopyrite (cp) associated with chlorite (ch), calcite (ca), local quartz (qz), trace epidote (ep), accessory rutile (ru) cutting variably albitized (Ab1, ab2) rock; note late thin calcite veinlet. Reflected light, uncrossed polars, field of view ~3 mm wide.



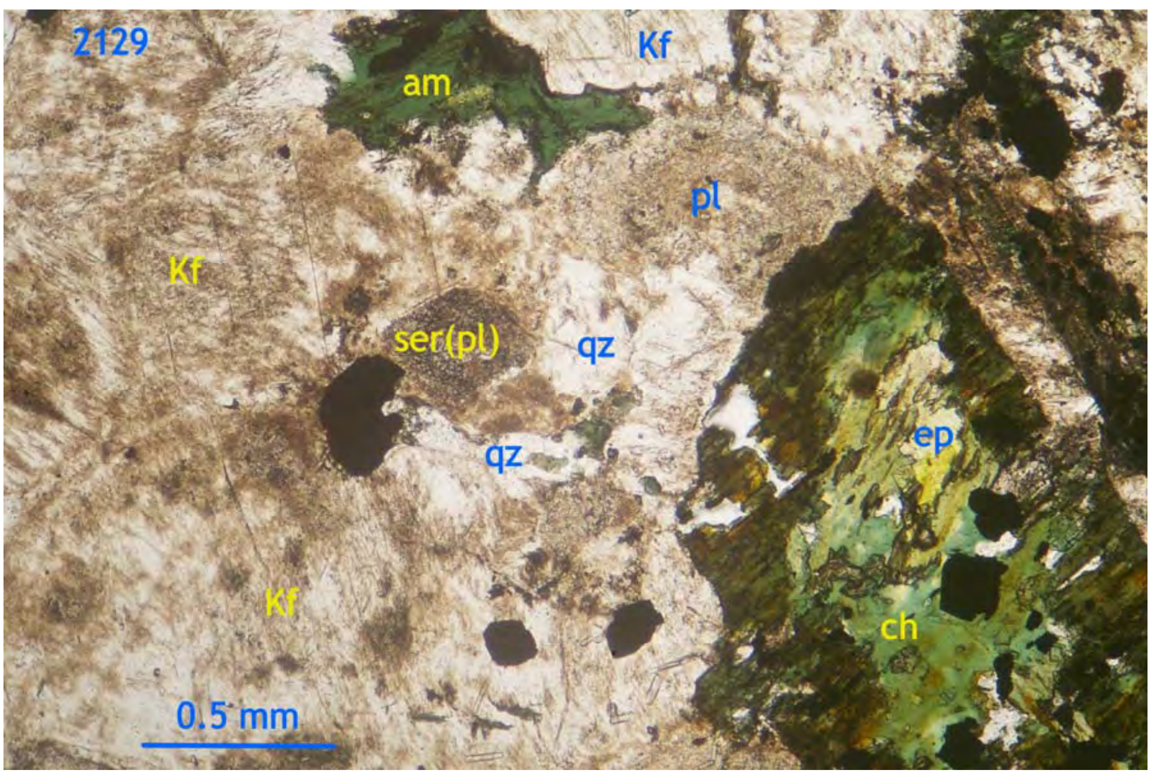
D29606P: strongly potassic altered wallrock composed of secondary Kspar (Kf, likely after former albite?), chlorite likely after former secondary biotite and partly interleaved by sericite/stained by limonite, local secondary quartz (qz) and minor magnetite (opaque, along poorly defined microveinlet). Transmitted plane light, field of view ~3 mm wide.



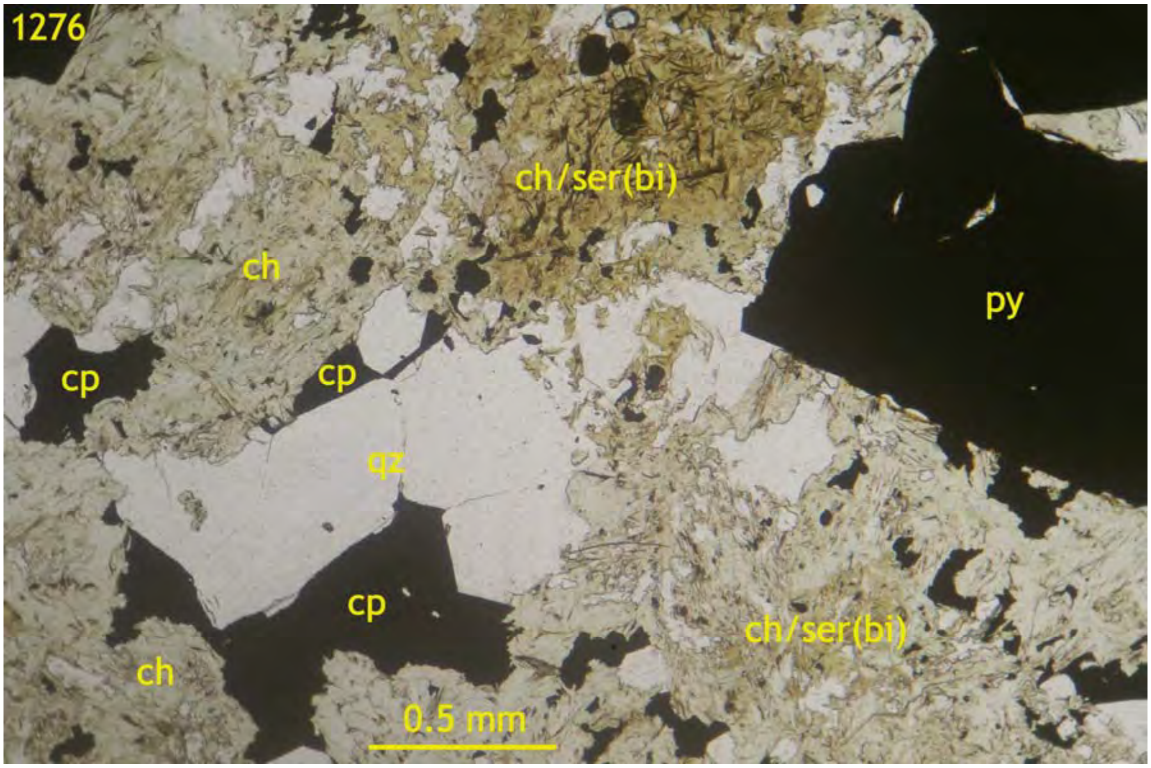
D29606PR: vein, composed of coarse-grained pyrite (py) intergrown with magnetite (mt) slightly oxidized to hematite, and lesser chalcopyrite (cp), local chlorite (ch) likely after secondary biotite, in matrix of coarse secondary quartz (qz). Reflected light, uncrossed polars, field of view ~3 mm wide.



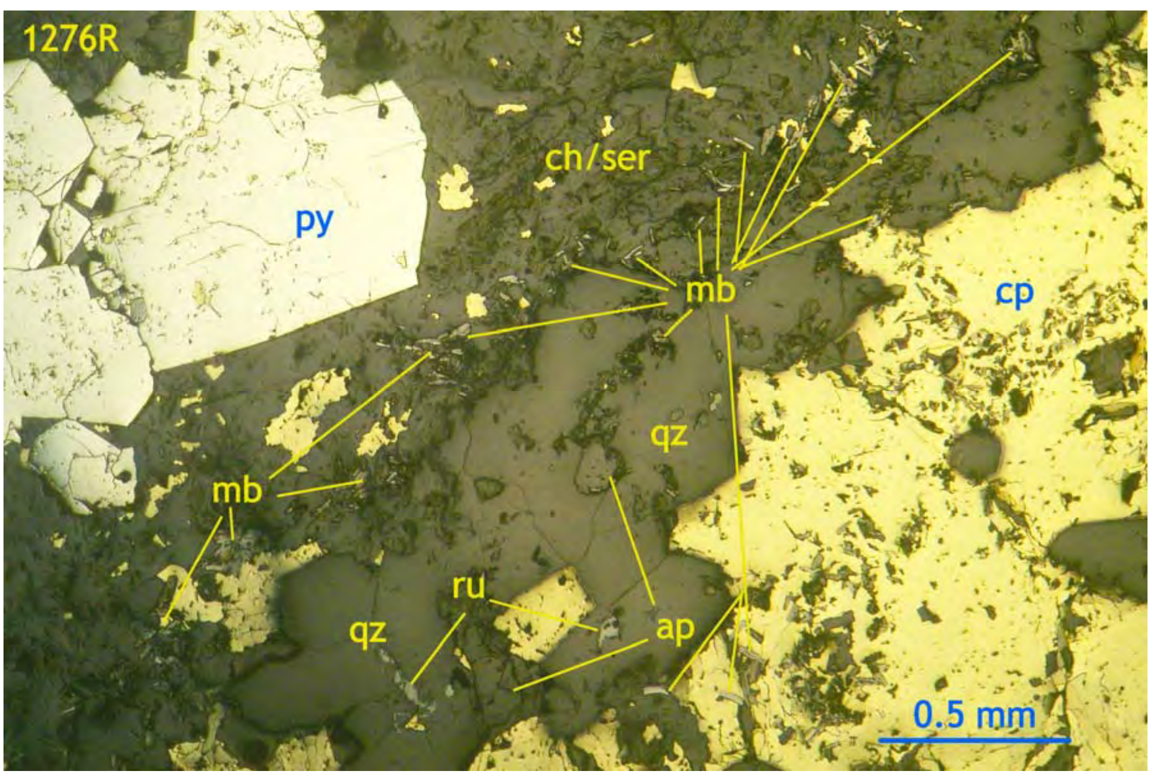
2130P: fine-grained biotite quartz syenite composed of interlocking Kspar (Kf), lesser quartz (qz) and partly sericitized plagioclase (pl), with interstitial relict biotite sites altered to chlorite associated with opaques (mainly hematite, minor limonite and rutile?), cut by limonite fractures. Transmitted plane light, field of view ~3 mm wide.



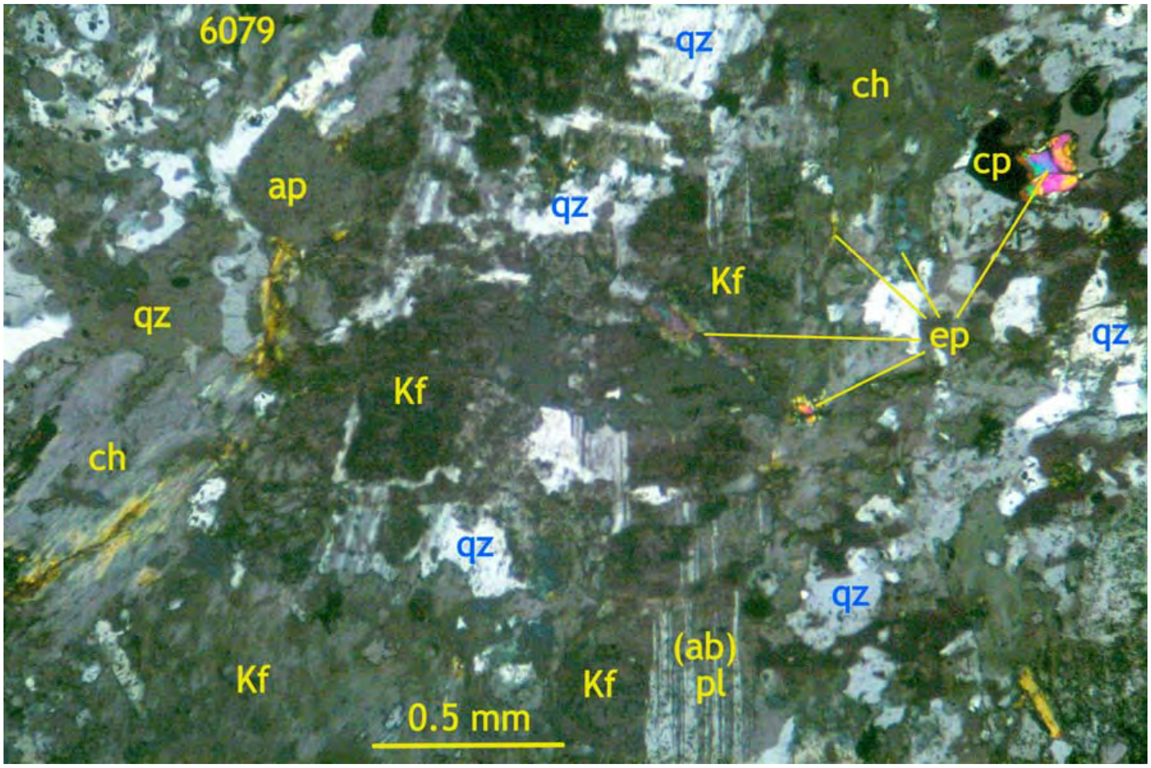
2129P: K-feldspar (Kf), possibly both microcline and orthoclase, the latter possibly replacing plagioclase (pl, sericitized relics remaining as inclusions in Kspar), and amphibole (am) or biotite both replaced by chlorite (ch) and minor epidote, trace secondary quartz, associated with opaques (mostly magnetite). Transmitted plane light, field of view ~3 mm wide.



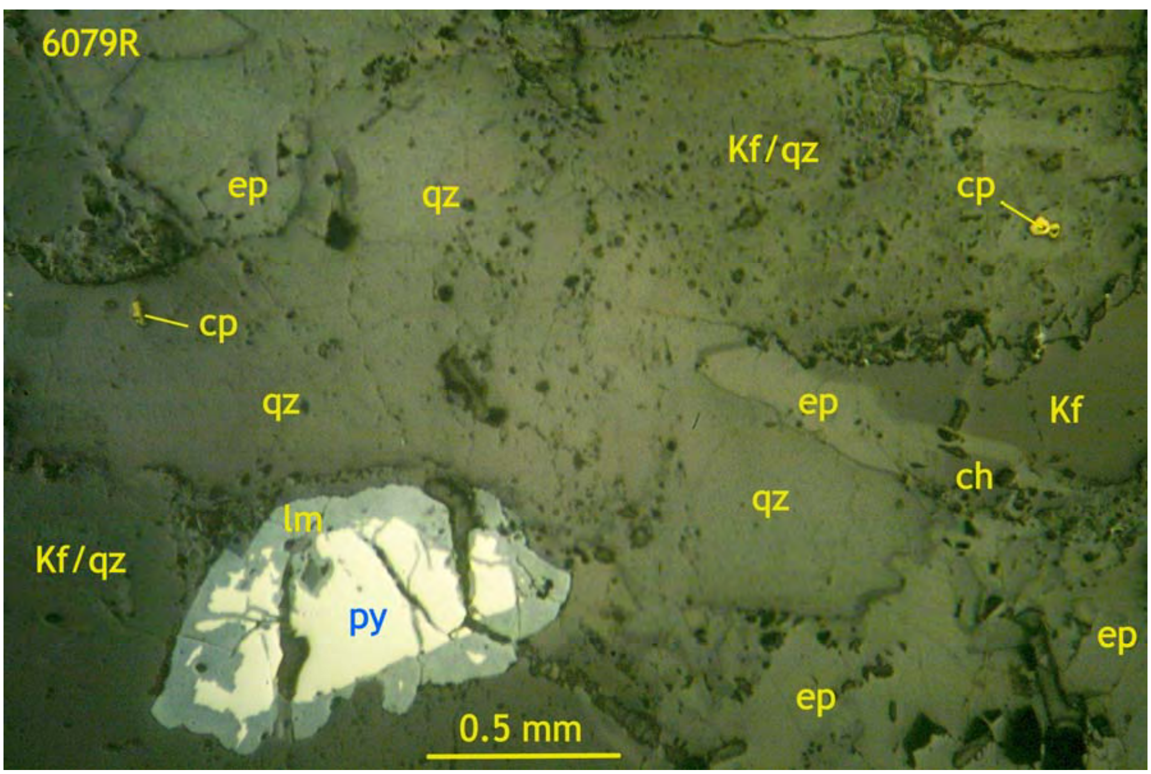
1276P: pale greenish to brownish chlorite and sericite (ch, ser) likely after former secondary biotite (?), sulfides including euhedral pyrite (py) and irregular anhedral chalcopyrite (cp) closely associated with sub- to euhedral secondary quartz (qz). Transmitted plane light, field of view ~3 mm wide.



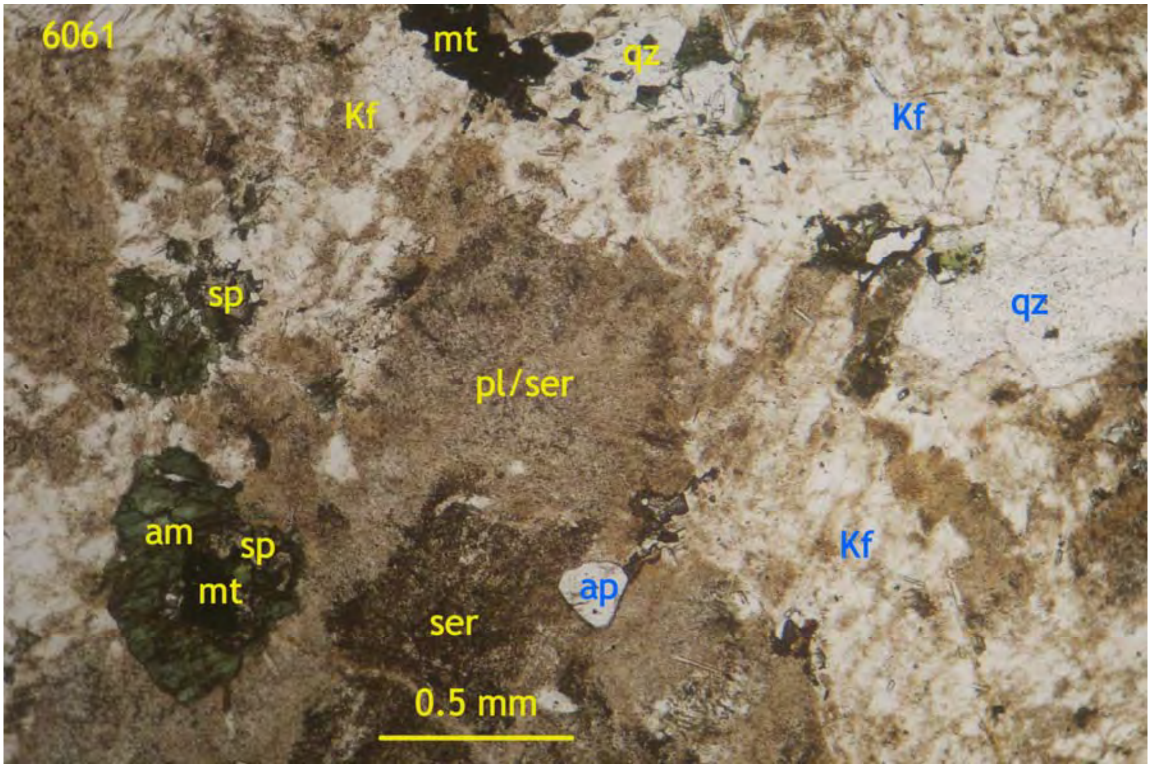
1276PR: segregation of bands of pyrite (py) and chalcopyrite (cp) separated by bands rich in quartz (qz) or chlorite-sericite (ch/ser), with minor molybdenite (mb) and trace rutile (ru) associated with the contact, or with chalcopyrite. Reflected light, uncrossed polars, field of view ~3 mm wide.



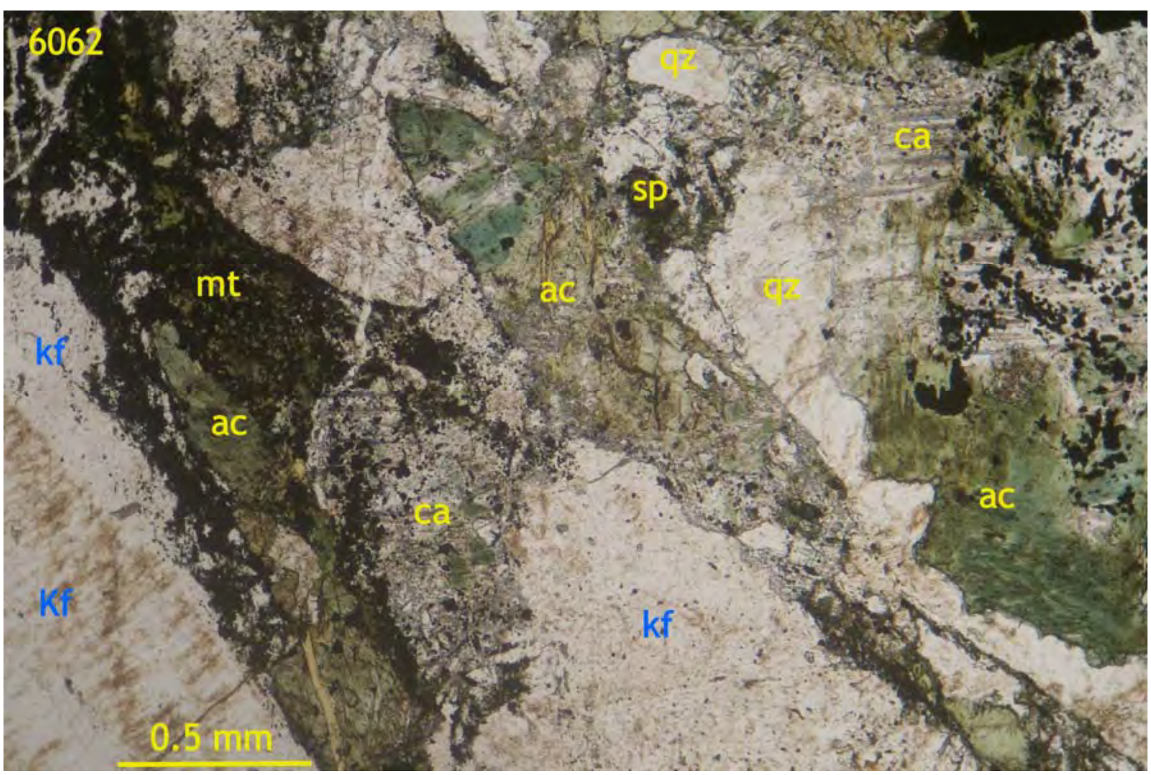
6079P: strongly potassic altered rock in which Kspar (Kf, dark, cloudy) and secondary quartz (qz) replace relict albite (ab, twinned) accompanied by chlorite (ch, dark) and apatite (ap) after relict mafic sites, trace epidote (ep) associated with chalcopyrite (opaque, cp, oxidized at rim to limonite). Transmitted light, partly crossed polars, field of view ~3 mm wide.



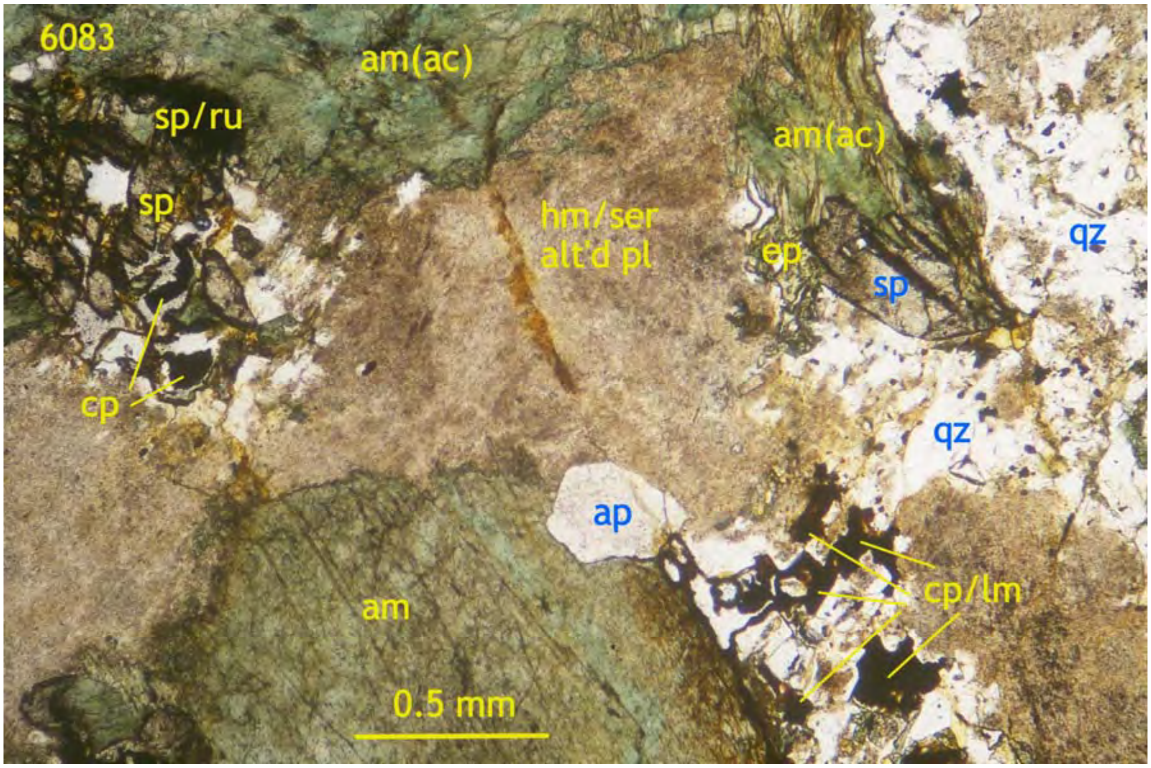
6079PR: coarse subhedral pyrite (py, partly oxidized to limonite at rim) and trace chalcopyrite (cp) in veinlet network of quartz (qz), epidote (ep)-minor chlorite (ch) cutting wallrock thoroughly altered to secondary quartz-Kspar. Reflected light, uncrossed polars, field of view ~3 mm wide.



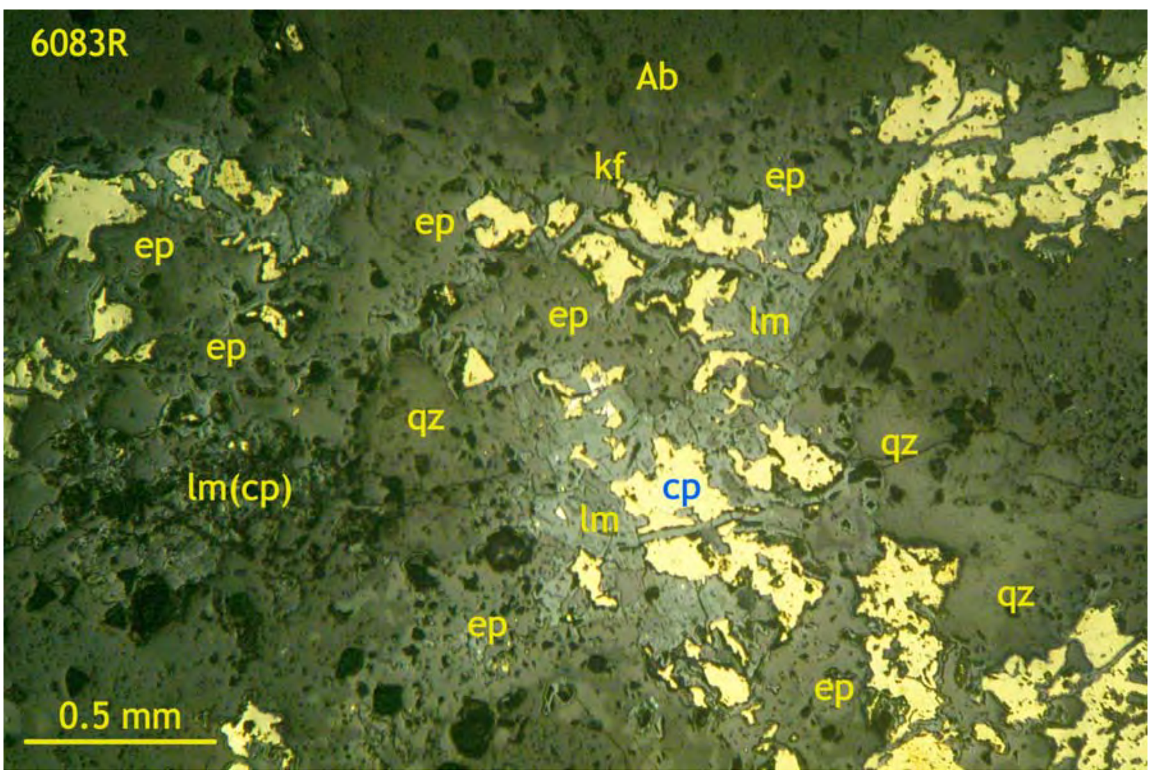
6061P: sericitized, corroded relict plagioclase (pl/ser) attacked at margins by surrounding K-feldspar (Kf); note minor interstitial quartz (qz) also found partly replacing relict amphibole (am) sites which are associated with opaque magnetite ±ilmenite altered to sphene (sp), hematite, with trace apatite (ap). Transmitted plane light, field of view ~3 mm wide.



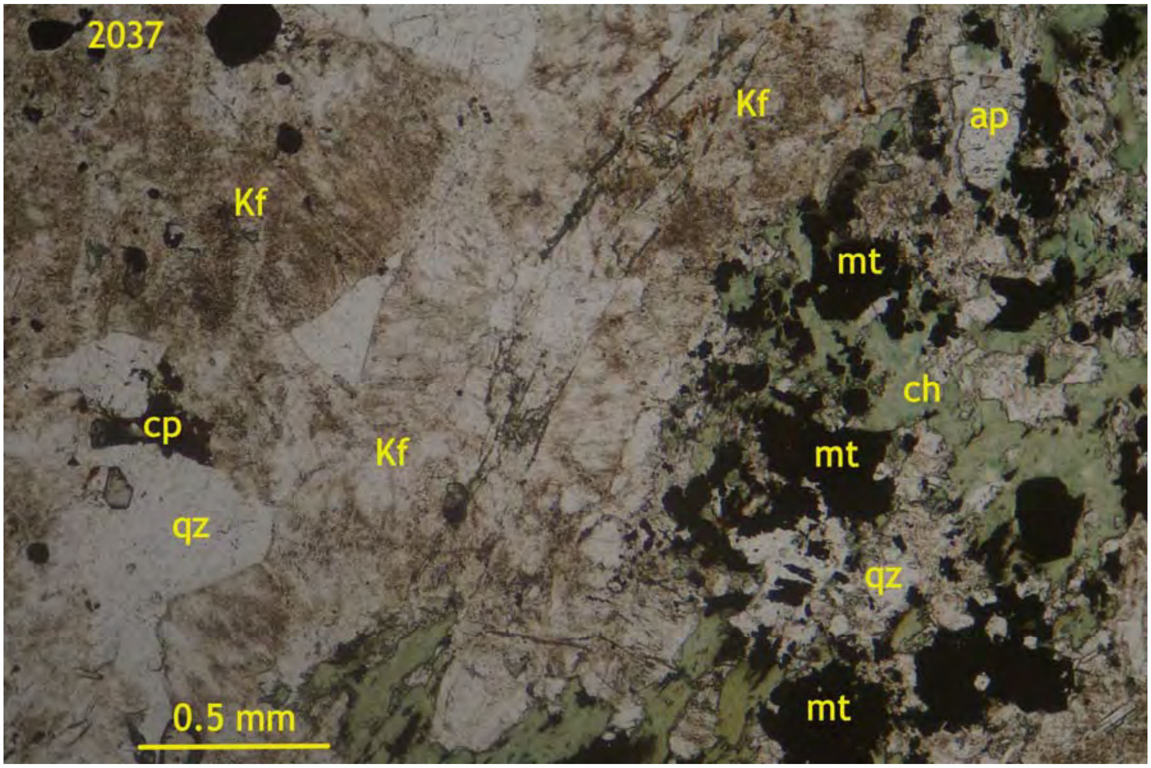
6062P: vein zone of actinolitic amphibole (am), magnetite (opaque, locally intimately intergrown with carbonate, likely mainly calcite, ca), minor quartz (qz) and sphene (sp) plus local fine-grained, recrystallized, possibly secondary Kspar (kf) compared to host coarse Kspar (Kf). Transmitted plane light, field of view ~3 mm wide.



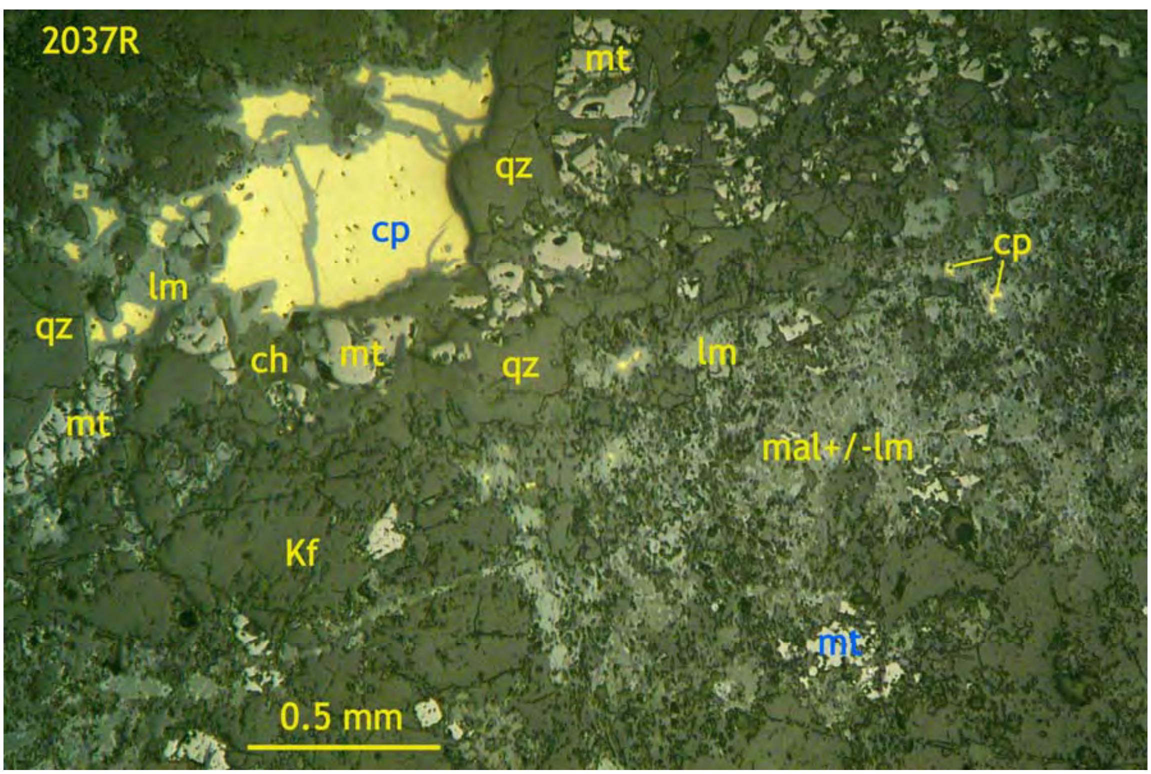
6083P: hornblende diorite (actinolite altered amphibole and hematite-stained, sericitized plagioclase) in which sulfides (mainly chalcopyrite, opaque) are associated with irregular veinlet of quartz (qz)-epidote (ep) on right, or less commonly with mafic, ±sphene (sp) after ilmeno-magnetite, apatite ±chalcopyrite (cp). Transmitted plane light, field of view ~3 mm.



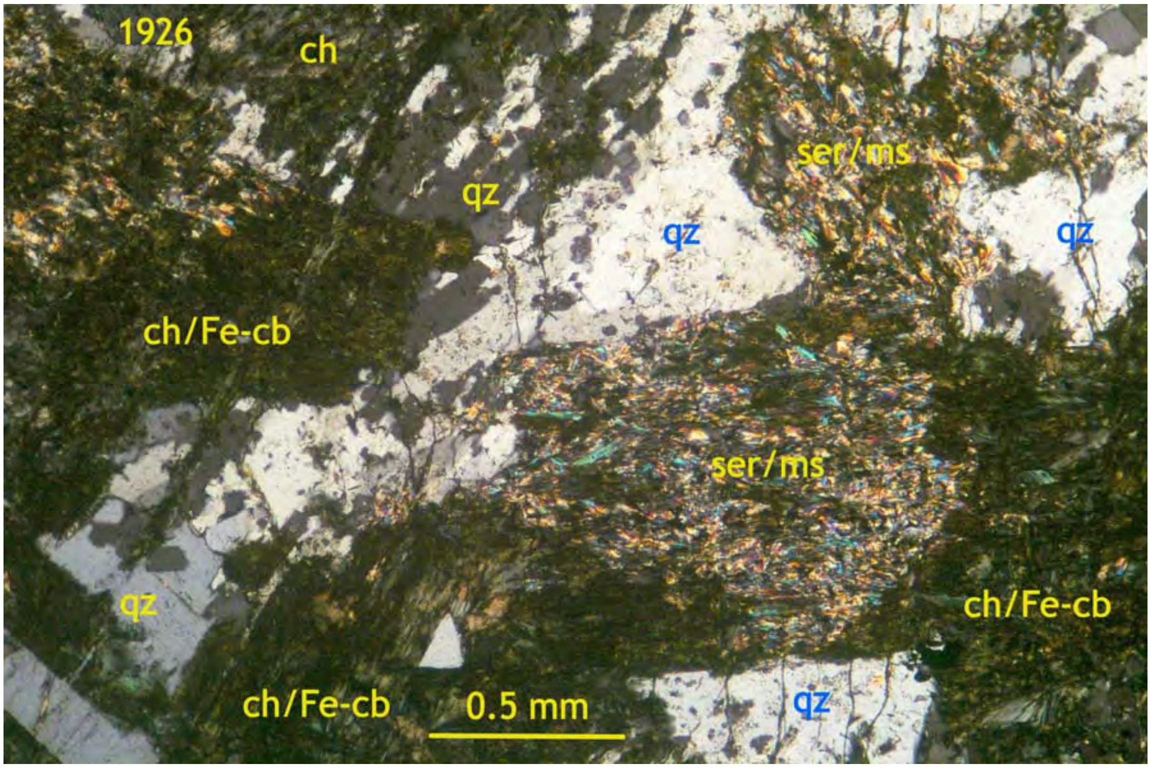
6083PR: chalcopyrite as irregular masses extensively oxidized to limonite (lm) closely associated with epidote (ep) and quartz (qz) at intersection of veinlets; adjacent hematite-stained albite is locally altered to fine-grained Kspar along veinlet selvages. Reflected light, uncrossed polars, field of view ~3 mm wide.



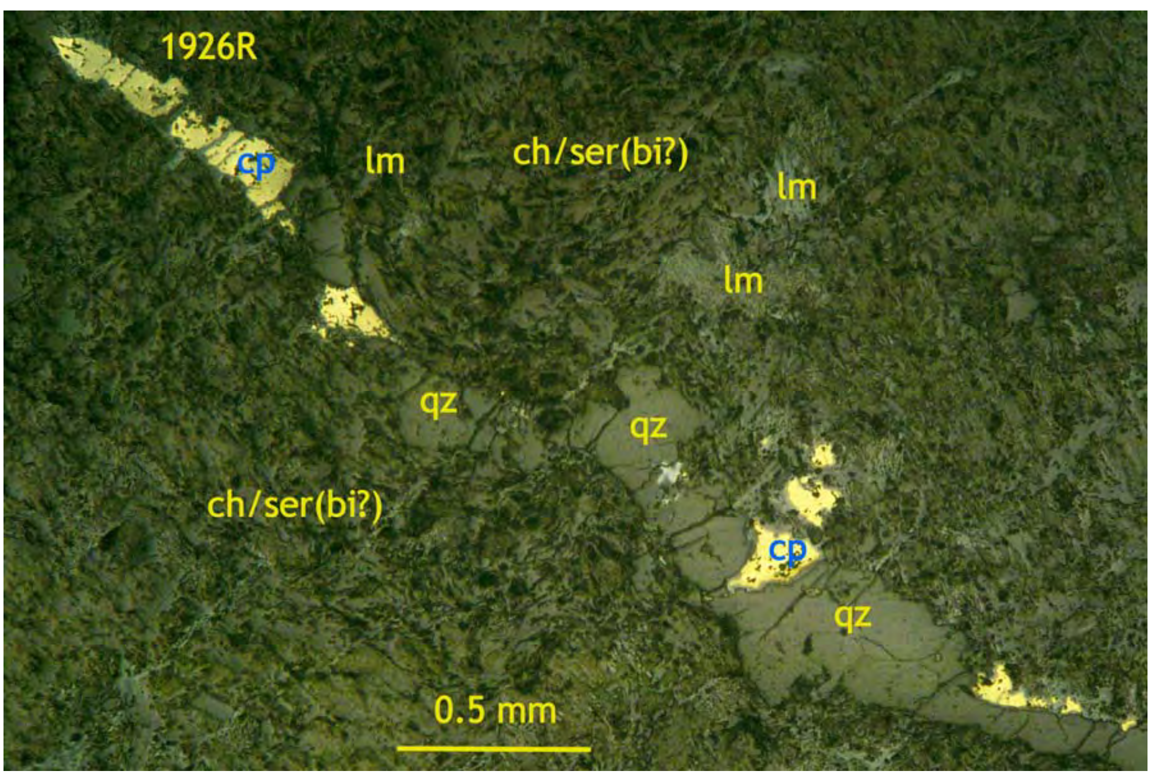
2037P: relict mafic (former amphibole?) site now pseudomorphed by chlorite, secondary quartz and magnetite (mt, opaque, local apatite (ap), set in matrix of Kspar (Kf, mostly secondary?), minor quartz (qz, interstitial, relict primary/partly secondary?) associated with minor chalcopyrite (opaque, cp). Transmitted plane light, field of view ~3 mm wide.



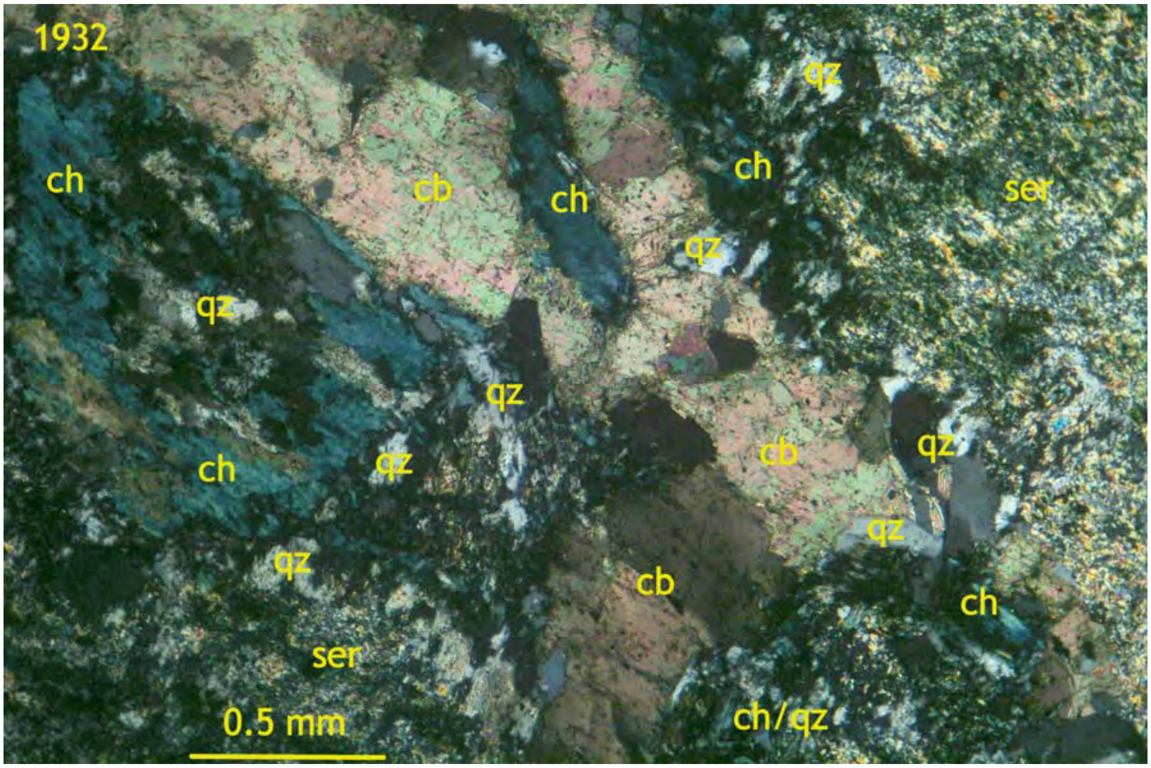
2037PR: vein of quartz (qz)-magnetite (mt)-chalcopyrite (cp, largely oxidized in places to limonite (lm) and malachite (mal) and surrounded by chlorite (ch). Reflected light, uncrossed polars, field of view ~3 mm wide.



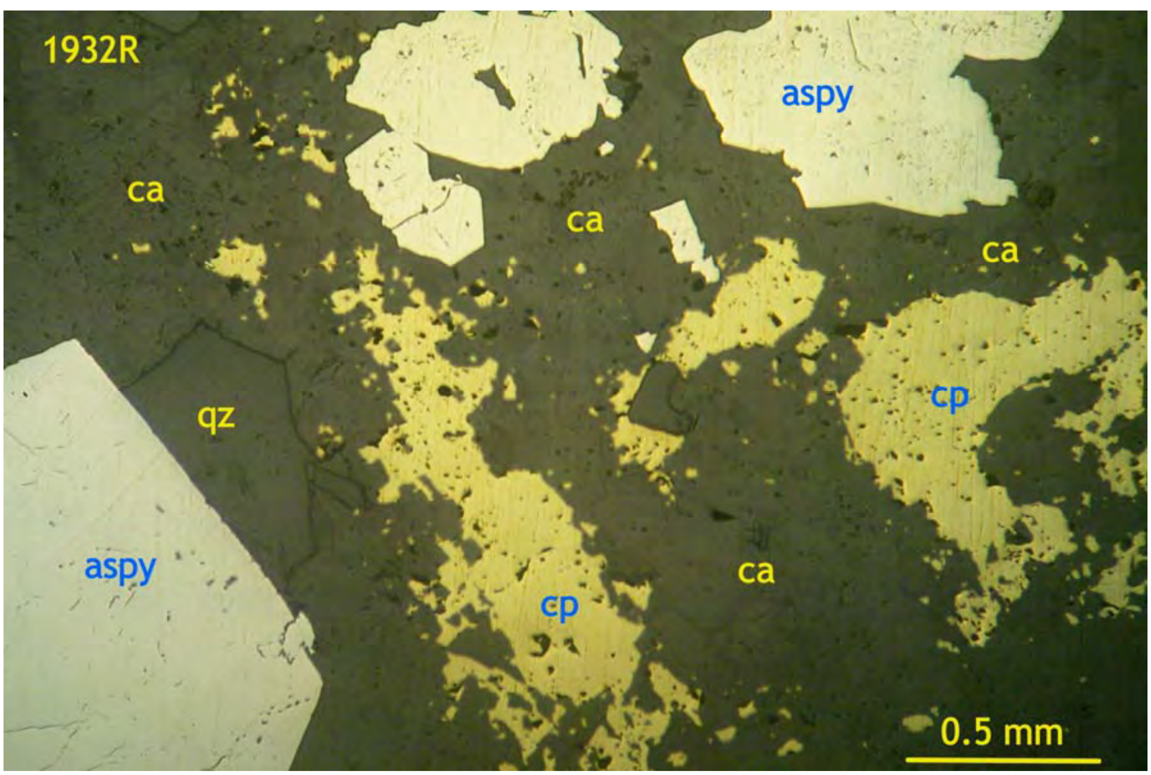
1926P: central portion of vein showing relict plutonic intrusive texture of subhedral former plagioclase sites (now sericite/muscovite, ser/ms) and mafic sites (now chlorite, ch and Fe-carbonate, Fe-cb) attacked and replaced by skeletal secondary quartz (qz). Transmitted light, crossed polars, field of view ~3 mm wide.



1926PR: chalcopyrite (cp) partly to largely oxidized to limonite (lm) closely associated with minor quartz (qz) veinlet trending off quartz-calcite vein selvage to cut across central portion. Reflected light, uncrossed polars, field of view ~3 mm wide.

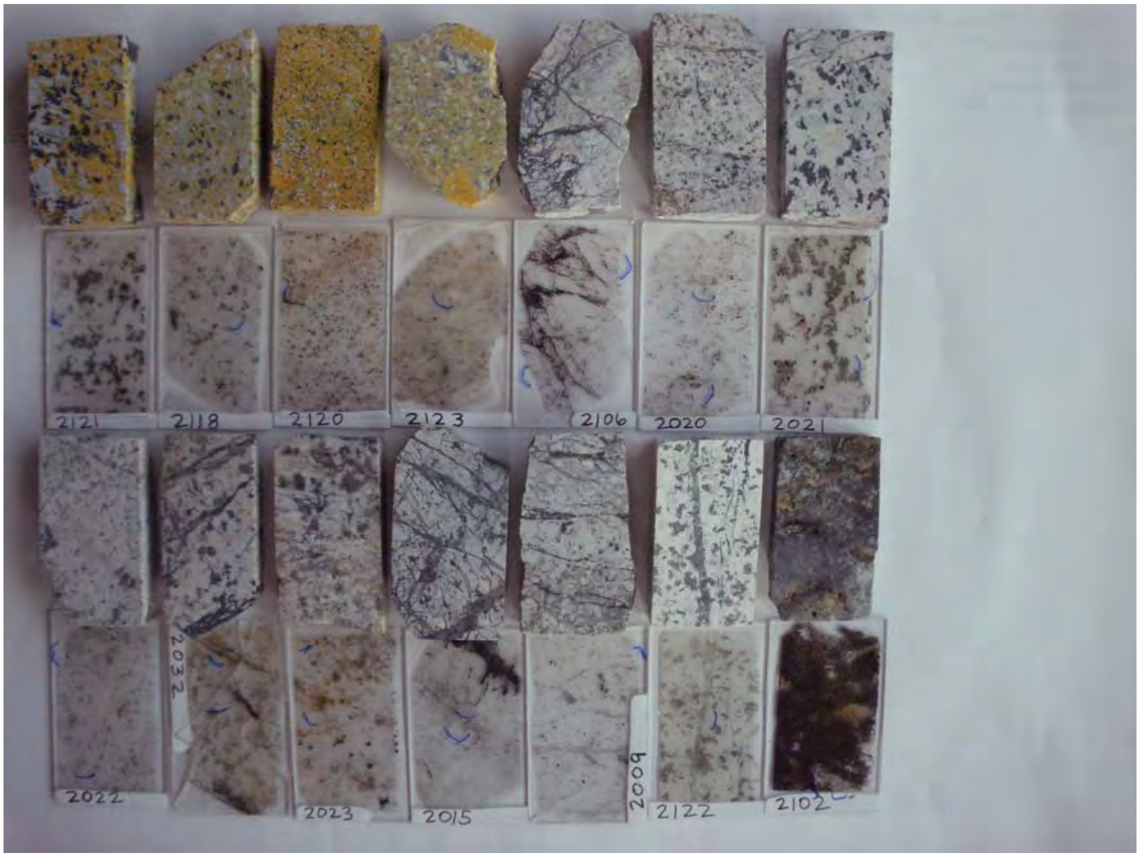


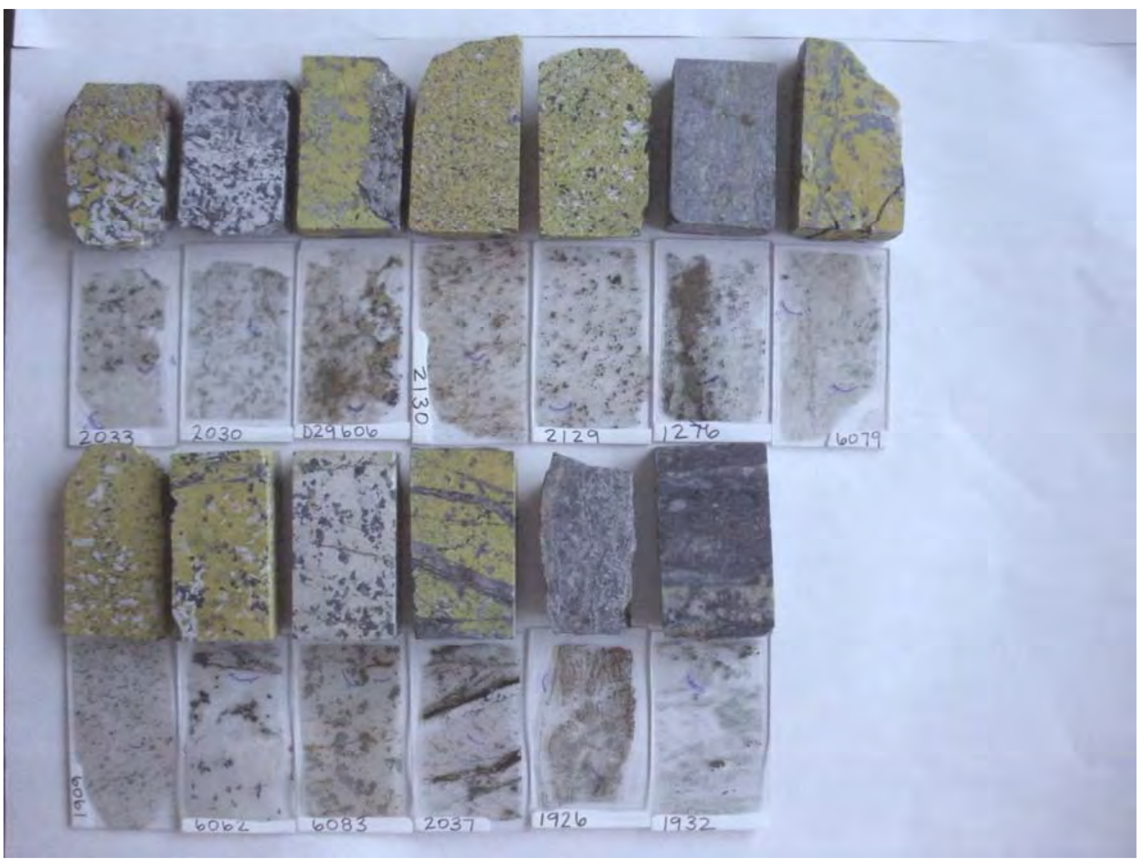
1932P: replacement portion of vein characterized by relict mafic sites (subhedral outlines, altered to chlorite, ch, or carbonate, ca) or possible relict feldspar sites (altered to sericite, ser), both overprinted by fine-grained secondary quartz, (qz). Transmitted light, crossed polars, field of view ~3 mm wide.



1932PR: euhedral arsenopyrite (aspy) associated with lesser chalcopyrite (cp) as ragged aggregates, in gangue matrix of carbonate (mainly calcite, ca) and quartz (qz). Reflected light, uncrossed polars, field of view ~3 mm wide.

Overviews of thin sections and offcuts (blue semi-circles mark photomicrograph locations).





9.0 LIST OF SOFTWARE USED

In the preparation of this report the following software was used:

Microsoft	Word 2010
	Excel 2010
Corel	CorelDraw 2018
Adobe	Acrobat version 10
Micromine	Micromine version 13