

**SILICATE AND SULPHIDE ALTERATION
MINERALOGY AND TEXTURES IN A FELSIC DYKE
ASSOCIATED WITH STIBNITE MINERALIZATION
IN A FELSIC DYKE
BERNICE CANYON AREA, CHURCHILL DISTRICT
NEVADA**

for

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January 21, 2025

Frontispiece

Composite photomicrograph, reflected light, shows the three textural locations of stibnite in the argillic altered and quartz veined (Q vn) felsic dyke: quartz vein hosted stibnite (vn Sb), clotted stibnite (cSb) in the altered dyke and disseminated stibnite (dSb) in the altered.

Field Of View – as shown.

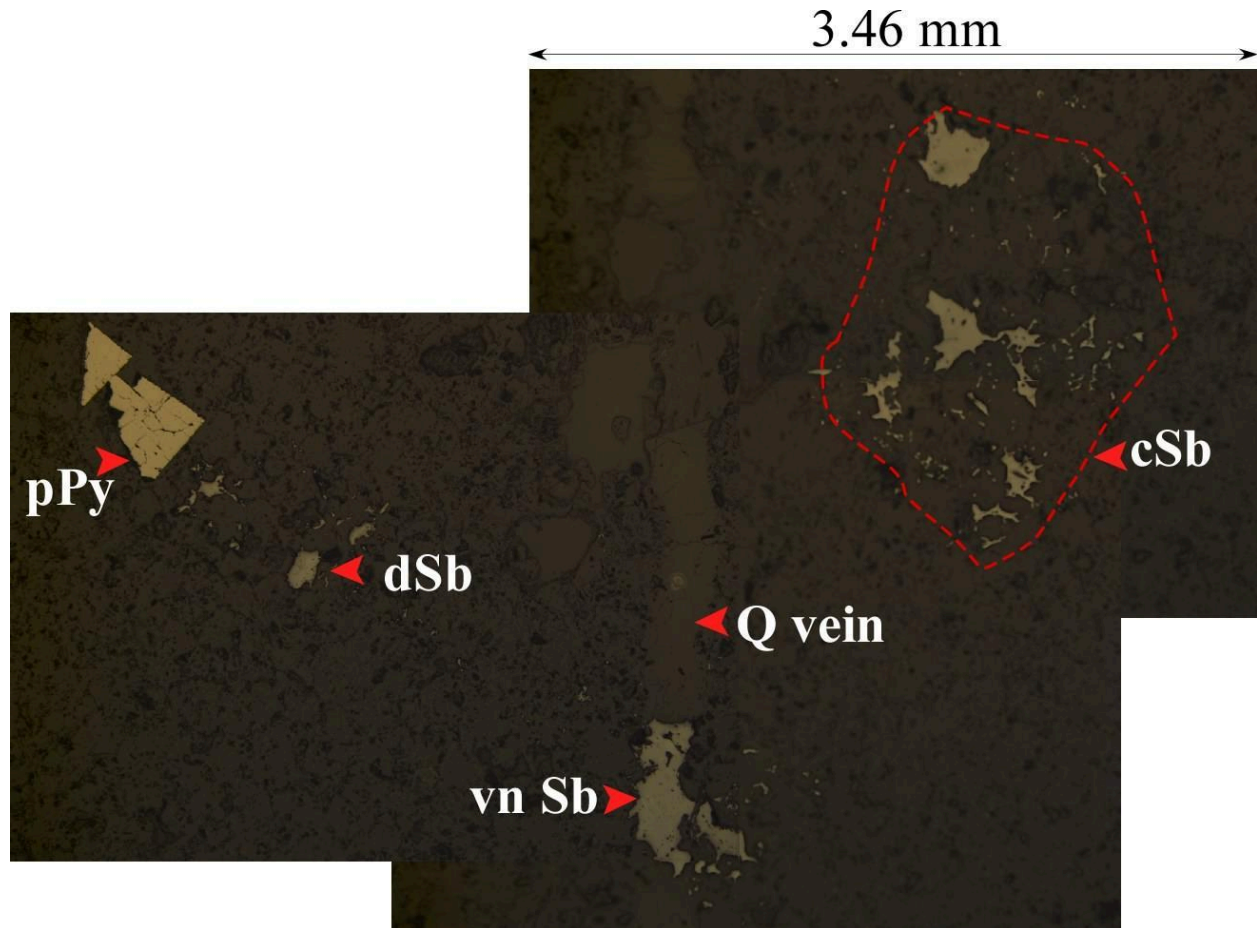


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Disclaimer

The writer has not conducted geological mapping or examined mineralized stibnite outcrops in the Bernice Canyon area, Churchill County Nevada. Three samples were collected by the J. Johansing and sent to the writer for the making of polished thin sections. The following report is a descriptive document with interpretations that encompasses a petrographic review of the three polished thin sections using multiple photomicrographs/photomicrographs and mineralogical analyses using a scanning electron microscope that provided energy dispersive spectrum and semi-quantitative mineral analyses in order to present a first-order interpretation of the mineral species being analyzed. Definitive mineral identification is best obtained by electron microprobe mineral analyses and/or X-ray diffraction.

Due to the ultra fine grain size of the groundmass and the intensity of alteration, the writer chose not to do the standard petrographic documentation but chose to review each polished thin section noting significant silicate-sulphide mineral associations, textures and structures. With that list of salient attributes for each section, the writer documented those attributes through multiple photomicrographs. Based on the petrographic review of the very fine-grained alteration assemblage and poly phased sulphide assemblage, the sections were reviewed again with a petrographic microscopy with the intent to select multiple areas having silicate-sulphide relationships. Those areas would be investigated with a scanning electron microscope to obtain mineral chemistry and species so that the alteration- mineralization sequencing would be better understood.

Introduction

This document is comprised of three parts: **Part I**: the synoptic review of the data presented in Parts II and III; **Part II**: the photomicroscopy archival data set with interpretations and **Part III**: the scanning electron microscopy archival data set with investigation. The synoptic Part I will reference images and data in Parts II and III in order that the reader can search efficiently between parts.

Project Objectives

- identify the primary mineralogy and textures with the intent to establish the protolith
- identify the silicate alteration assemblage and document the alteration textures.
- identify the sulphide minerals and textural associations;
- present a paragenesis/sequential ordering between the silicate and sulphide replacement assemblages based on the three chosen samples,

PART 1: Synoptic review with interpretations

- Based on the provided three samples, the felsic dyke has sustained intense poly phased metasomatism. However there has been preservation of some primary textures and rarely primary minerals.
- The dyke groundmass is comprised of an ultra fine-grained, average grain size <0.1mm, equigranular quartz-feldspar mosaic (Plates 1, 3). This texture of the mosaic-textured quartzofeldspathic groundmass is considered primary and is a function of the high level of intrusion and rapid cooling of the narrow dyke. The only primary minerals in that intensely altered groundmass are quartz along with rare relict phenocrystic plagioclase.
- That altered quartzofeldspathic groundmass hosts two types of phenocrysts: 1) the most abundant phenocryst type is plagioclase which is present as individual euhedral grains to 0.8 mm and glomeroporphyritic aggregates to 1.5 mm (Plates 1, 3, 5, 7, 13, 16-18). These phenocrysts occur as prominent white crystals in the cut slabs; albite twinning is present in relict plagioclase phenocrysts; these are exceedingly rare; no An component was attempted based on the intensity of metasomatism; 2) rare minute, 0.1- 0.2 mm, anhedral/rounded quartz micro-phenocrysts in altered quartzofeldspathic groundmass (Plates 20, 21).
- There are sericite pseudomorphs after platy grains that are inferred to have been biotite (Plates 2, 14, 23). The presence of minute rutile grains in these pseudomorphs has been used as the criteria for the biotite micro-phenocryst inference.
- Based on the abundance of plagioclase>>>>quartz phenocryst, a quartzofeldspathic groundmass and biotite micro-phenocrysts, it is proposed that the protolith was within the compositionally range of dacite.
 - Because alteration in the selected rocks is too intense, these rocks are not suitable for geochemistry should it be desired to obtain geochemical data to determine the protolith. Least altered segments of the dyke should be identified and sampled should a protolith want to be identified utilizing major element oxides and trace element geochemistry.
- The dyke has sustained an intense poly phased staged metasomatism that include K, S, As, Sb with minor silica and CO₂.
- Stage 1 metasomatism is represented by K+S+As+CO₂.
 - The felsic dyke does not display a penetrative foliation due to deformation but does display ultra narrow, discontinuous, unoriented, sericite-filled fractures/cracks (Plates 1, 5, 6-8, 10). This is attributed to a hydraulic fracturing event that flushed the dyke with K-bearing hydrothermal fluid. The grain contacts in the fine-grained groundmass would also be micro-fluid pathways. The result was sericitization of plagioclase phenocrysts, plagioclase component in the groundmass, sericite sheaths in the groundmass, and sericite replacement of assumed biotite micro-phenocrysts. The absence of chlorite after biotite is a testimony to the intensity of K-metasomatism.

- o Plagioclase in the sericitized groundmass is albite, pure end member and is an expected product formed during intense sericitization of an igneous plagioclase.
- o Calcite and Fe-dolomite in trace amounts was detected in the sericitized groundmass. Manganese in trace amounts of Mn is present in the carbonates – a fingerprint for a hydrothermal origin.
 - Calcite would form due to the destruction of the igneous plagioclase having a higher anorthite component. Since carbonate alteration is minimal, the CO₂ in the hydrothermal fluid must have been low to capture minimal Ca during the destruction of primary Ca-bearing plagioclase. Consequently there must have been significant Ca-loss during stage 1 K-metasomatism.
- o The K-bearing metasomatic hydrothermal fluid was accompanied by sulphidation. Sulphidation is recorded by sparsely distributed iron sulphide grains (Plates 1, 6, 9, 10, 14, 18, 19) through the sericitized groundmass and by elongated clusters that are aligned along the micro fractures/cracks described above (Plates 4, 33).
- o The iron sulphide is characteristically euhedral (Plates 1, 4, 10B, 18, 33, 34) and poikiloblastic (Plates 1, 9C, 25, 31, 32, 32A, 33, 38) with inclusion-rich cores and inclusion-free to poor margins.
- o In addition to the textural zoning i.e. poikiloblastic, the iron sulphide is compositionally zoned – variable arsenic. Arsenic contents in stage 1 iron sulphide are >1 wt% As, an arsenic threshold that defines this iron sulphide as arsenian pyrite (Plates 25, 31, 32, 32S, 38)
- o Minute arsenopyrite grains are present in trace amounts in both compositional zones of the arsenian pyrite (Plate 31) and as rare grains sparsely distributed through the altered groundmass (Plate 25).
- o Trace amounts of a crandallite group mineral, inferred to be goyazite (Plate 26, 27), (SrAl₃(PO₄)₂(OH)₅·H₂O), in the altered groundmass implies acidic alteration during intense sericitization and fluorapatite (Plate 27) possibly implying an F-component during alteration.
- o Trace amounts of gypsum/anhydrite? with kaolinite are present with sericite in the altered groundmass. It is uncertain if this assemblage belongs to stage 1 or stage 2 hydrothermal alteration.
- Stage 2 metasomatism is represented by Sb+S+K+Si.
 - o This mineralizing episode is characterized by macro (Plates 10, 12, 14) and micro quartz veins (Plate 13) with the veins hosting sericite, subordinate kaolinite and stibnite.
 - o Sericite in the altered groundmass contain variable minor and trace abundances of Fe and Mg based on grey scales in electron backscattered images and semi-quantitative analyses (semi-quantitative analyses under Plates 22, 24, 26, 28,

30, 34, 35, 39, 40, 42-45, 47). These variable compositions may be related to the two stages of K-metasomatism.

- o Stibnite is unequivocally associated with stage 2 metasomatism.
 - Stibnite displays three textural associations: 1) in quartz veins (Plates 14-15), 2) as sub equant domains, termed clotted stibnite (Plates 14-21), where the stibnite is ultra fine-grained and intergranular to quartz-altered feldspar/sericite in the groundmass and 3) disseminated ultra fine-grained aggregates in the altered groundmass (Plates 15-16, 21).
 - Stibnite is intergrown with and hosts inclusions of sericite and kaolinite
 - Examination of the sample with the clotted stibnite, it is proposed that this texture is formed by intense migration of Sb-S into wall rock adjacent to stibnite-filled fractures or stibnite-bearing quartz veins (Nevada 3 image of cut slab).
- o Semi-quantitative analyses of stibnite indicated that stibnite is stoichiometric Sb_2S_3 containing no other elemental substitution (energy dispersive spectrum under Plates 36, 37, 41, 44, 48, 49, 51) based on the detection level of the scanning electron microscope. Sb^{3+} can be substituted by Cu^+ , Pb^{2+} and As^{3+} but none of these elements were present in electron dispersive spectrum during the scanning electron microscope investigation.
 - The lack of arsenic in stibnite sets the stage 2 stibnite mineralizing event apart from the earlier arsenian pyritization-arsenopyrite stage 1 event.
- A trace amount of antimony oxide, Sb_2O_3 - valentinite, was identified in the clotted stibnite textural type (energy dispersive spectrum under Plate 46, 48, 49). The clotted stibnite sample does not appear to be oxidized. The presence of valentinite in the stibnite-dominated assemblage remains unexplained.
- Recommendation: Can domains in the dyke be identified where there is a greater intensity/density of micro fractures/cracks and/or quartz networks. The trace of the dyke shown In Figure 2 of Johansing 2024 displays subtle bends/changes in strike. On that map, a waste dump is located at or near an inflection point in the dyke. Could inflection points control stage 2 mineralization?

Part II: Photomicroscopy – Petrography, mineralogy, textures with interpretations

Polished Thin Section: Nevada 1

Cut slab and area selected for sectioning

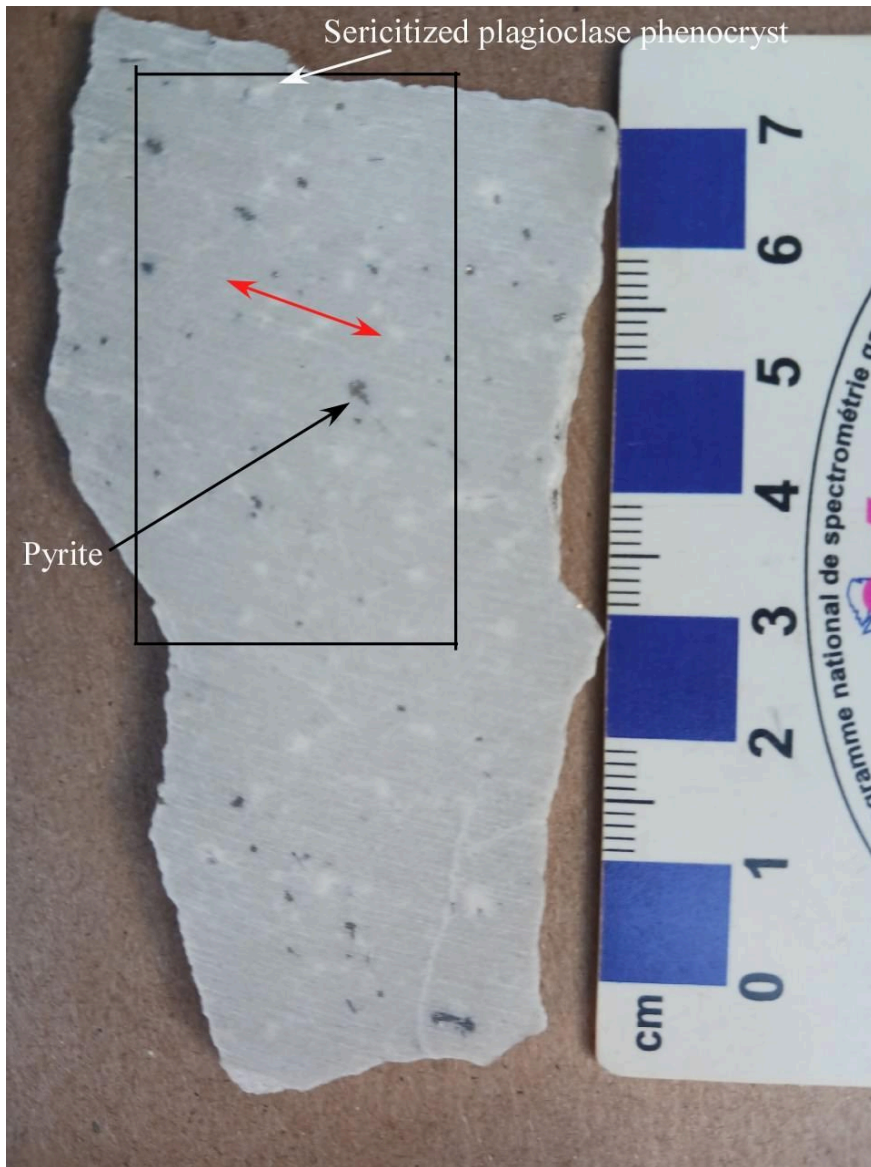


Plate 1. Photomicrographs, **A**-plane light, **B**-crossed nicols, show the ultra fine-grained altered groundmass (agm) with sparsely distributed sericitized plagioclase phenocrysts (Se/Pc) and euhedral pyrite (Py). Note the discontinuous sericite-filled micro fracture (yellow arrow).

A, B: (Field Of View) FOV = 6.92 mm.

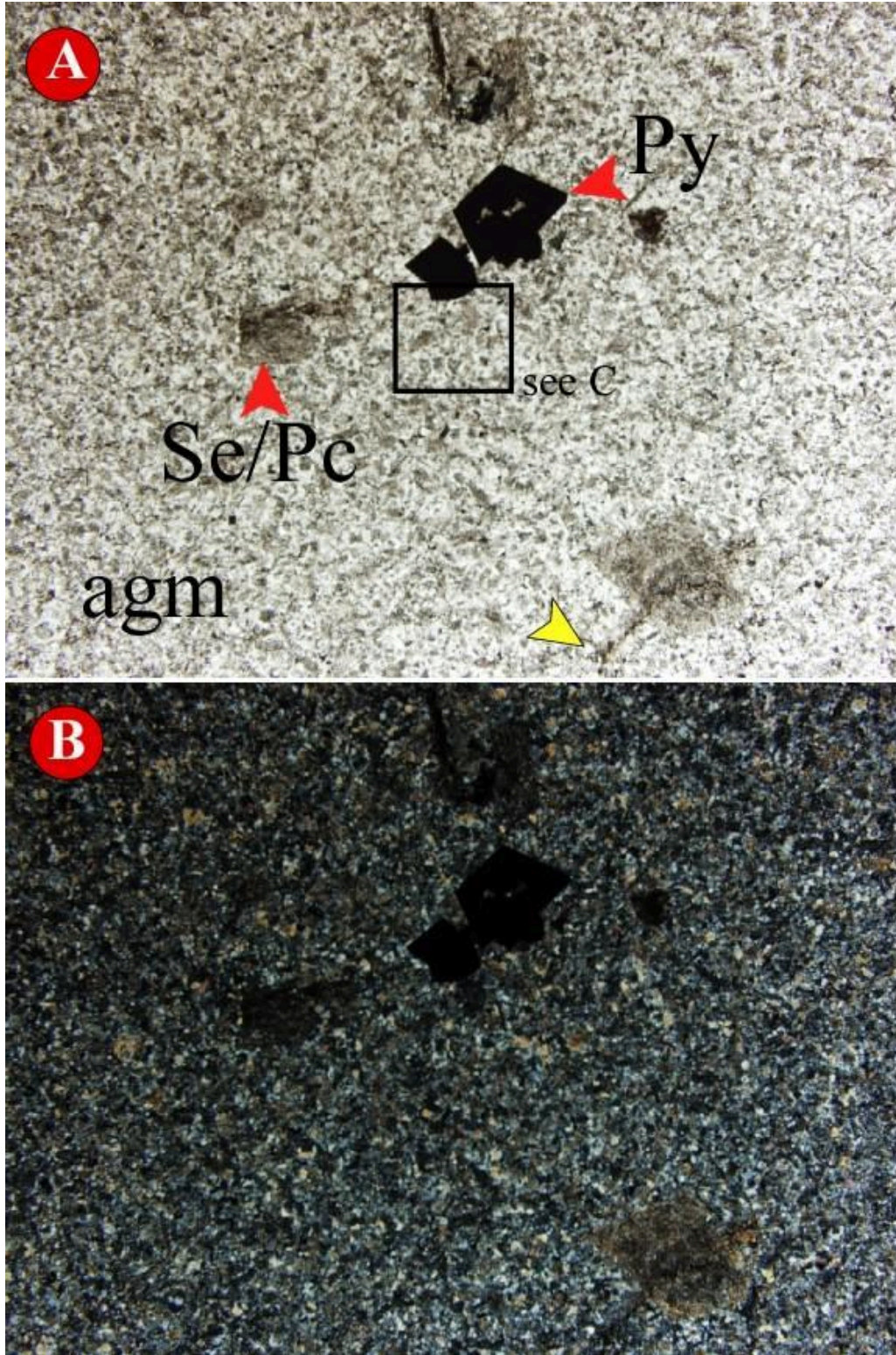


Plate 1C, D. Photomicrographs, C-plane light, D-crossed nicols, show the ultra fine-grained altered groundmass (agm) which is comprised of equigranular quartz, feldspar (albite Ab as

determined during the scanning electron microscope investigation, minute sericite (Se) splays and ultra fine-grained aggregates with pyrite (Py). C, D: FOV = 1.72 mm.

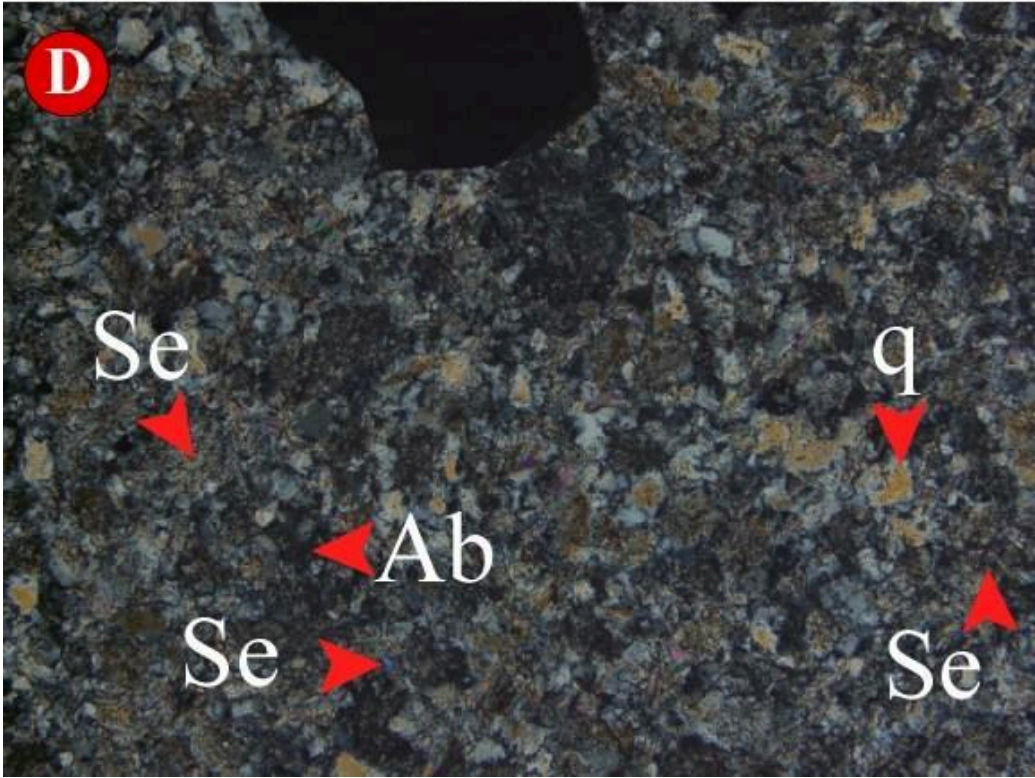
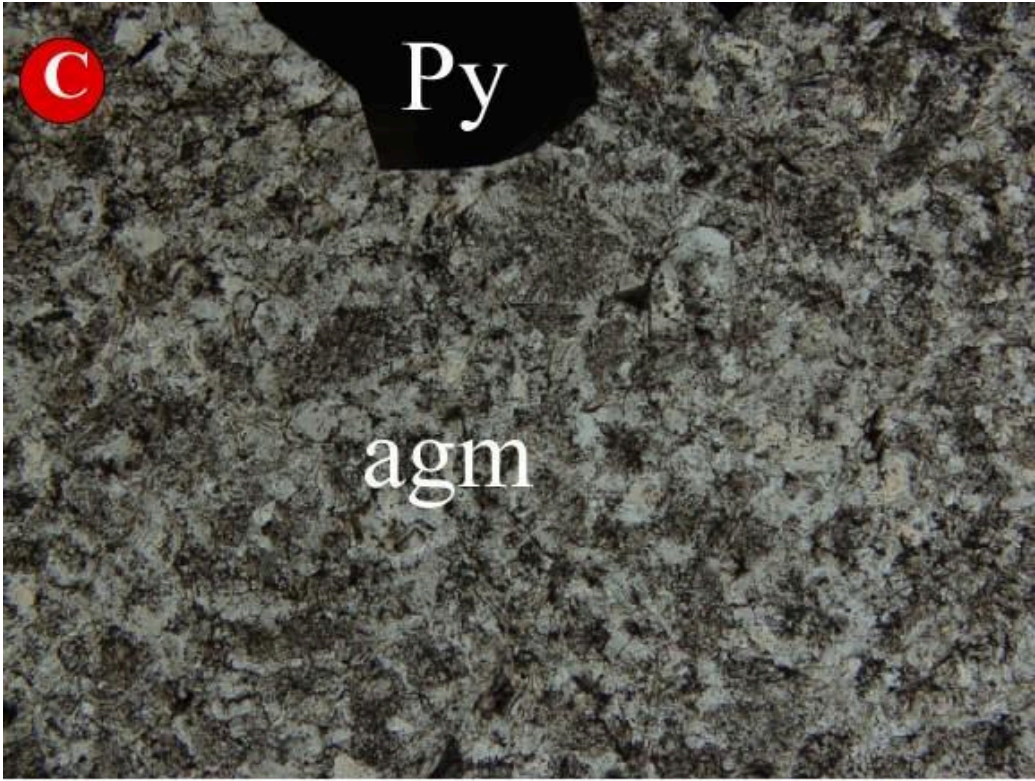


Plate 2. Photomicrographs, **A**-plane light, **B**-crossed nicols, show the very fine-grained altered groundmass (agm) of the dyke. The groundmass is comprised of very fine-grained equigranular quartz+feldspar (q+fs) with sericite splays and sericite after groundmass plagioclase (Se/gmPc). Sericite also replaced plagioclase phenocrysts (Se/Pc) and replaced biotite (?) (aBi).

A, B: FOV = 3.46 mm.

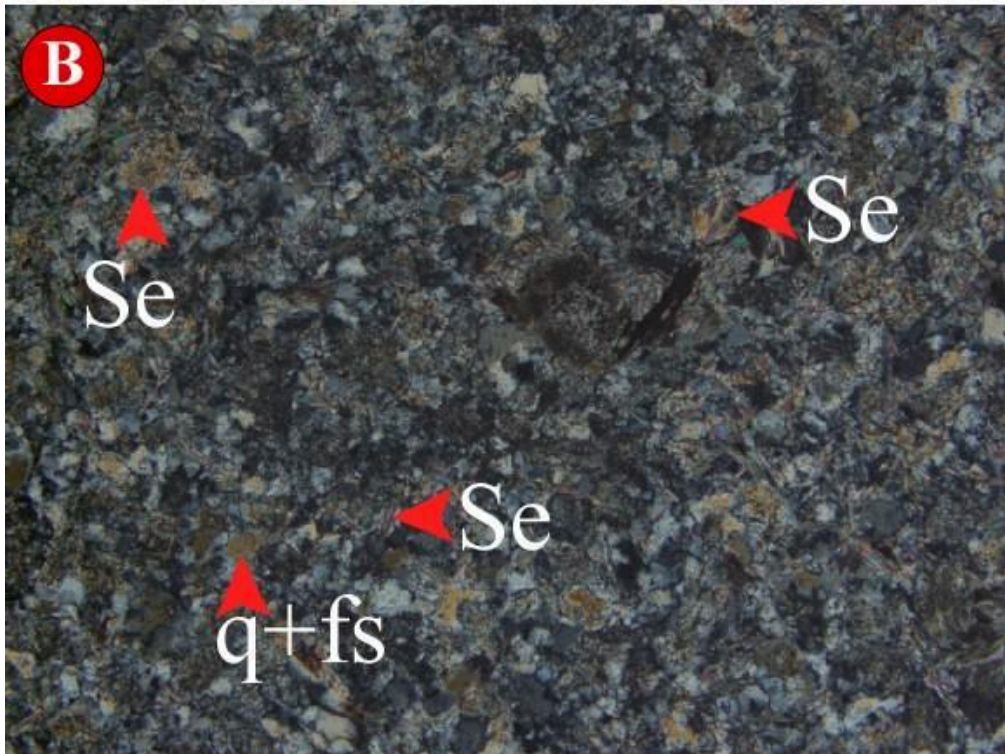
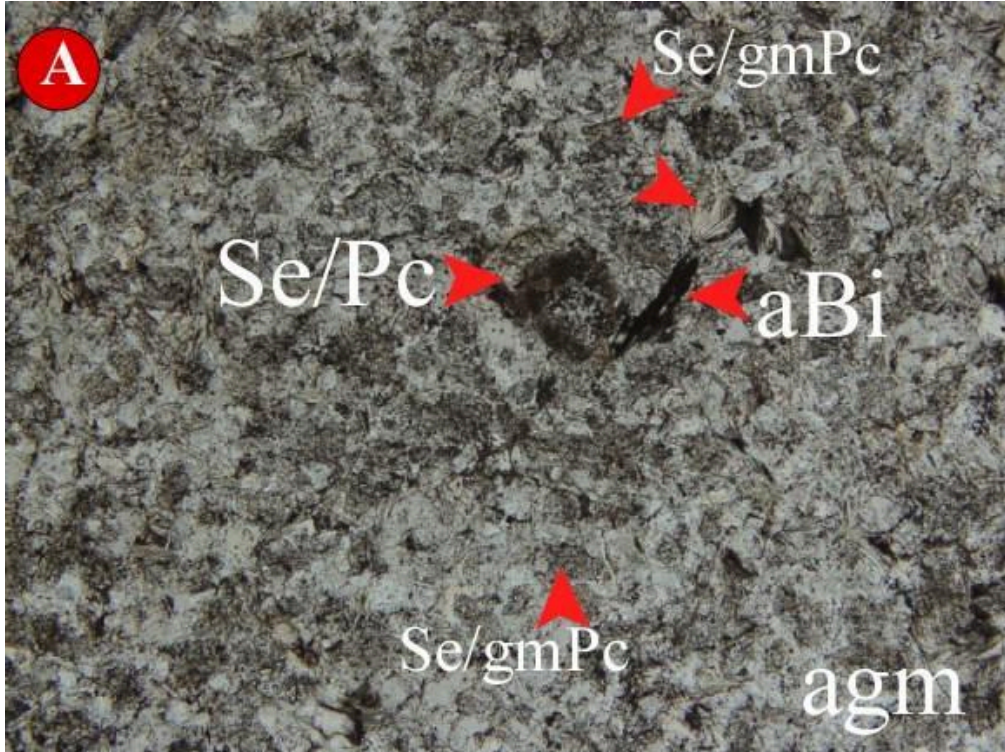


Plate 3. Photomicrographs, **A**-plane light, **B**-crossed nicols, show a sericite altered plagioclase (Se/Pc) phenocrysts hosted in the altered groundmass (agm). **A**, **B** FOV = 1.73 mm.

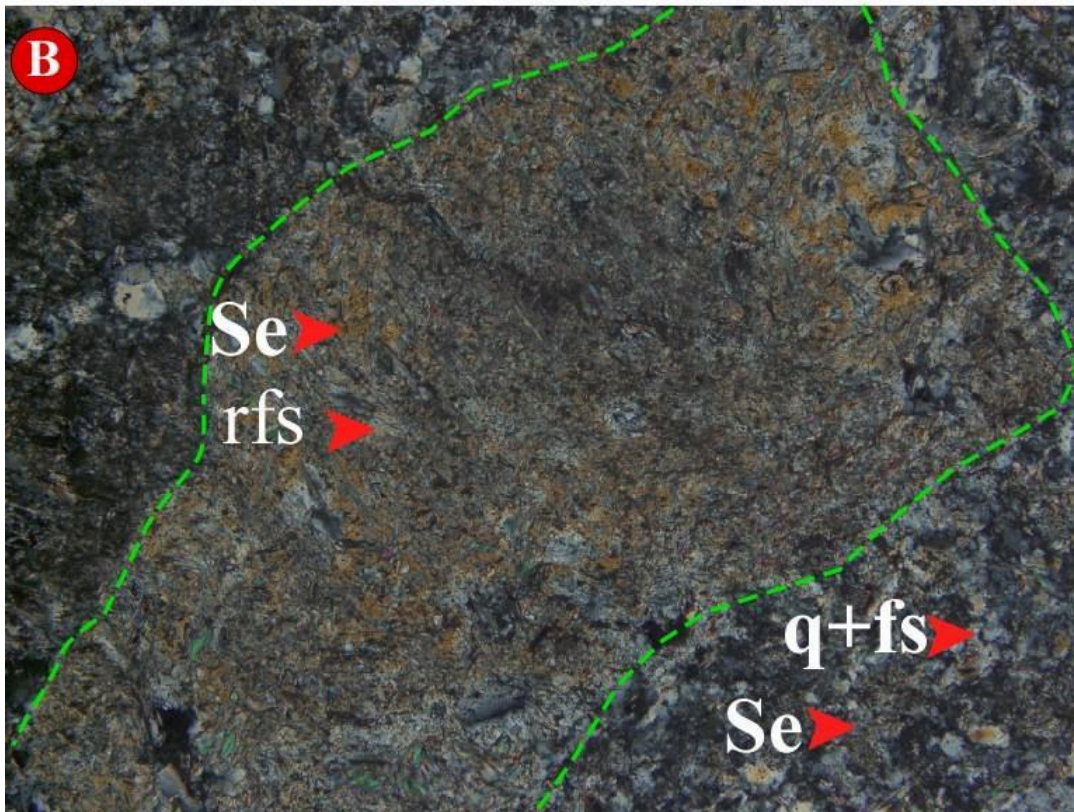
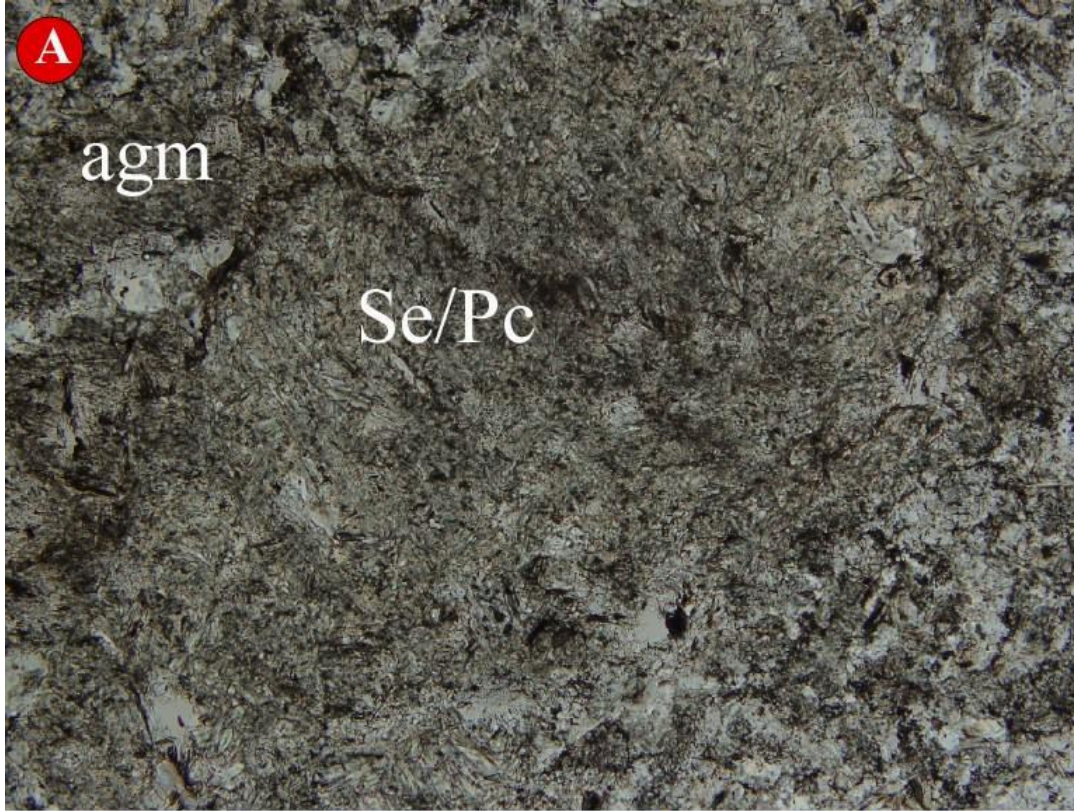


Plate 4. Photomicrographs, **A**-plane light, **B**-crossed nicols, show plagioclase phenocrysts replaced by sericite (Se/Pc) and individual grains of pyrite (Py) and clustered pyrite (cl Py) in the very fine-grained equigranular altered groundmass. **A, B**: FOV = 6.92 mm.

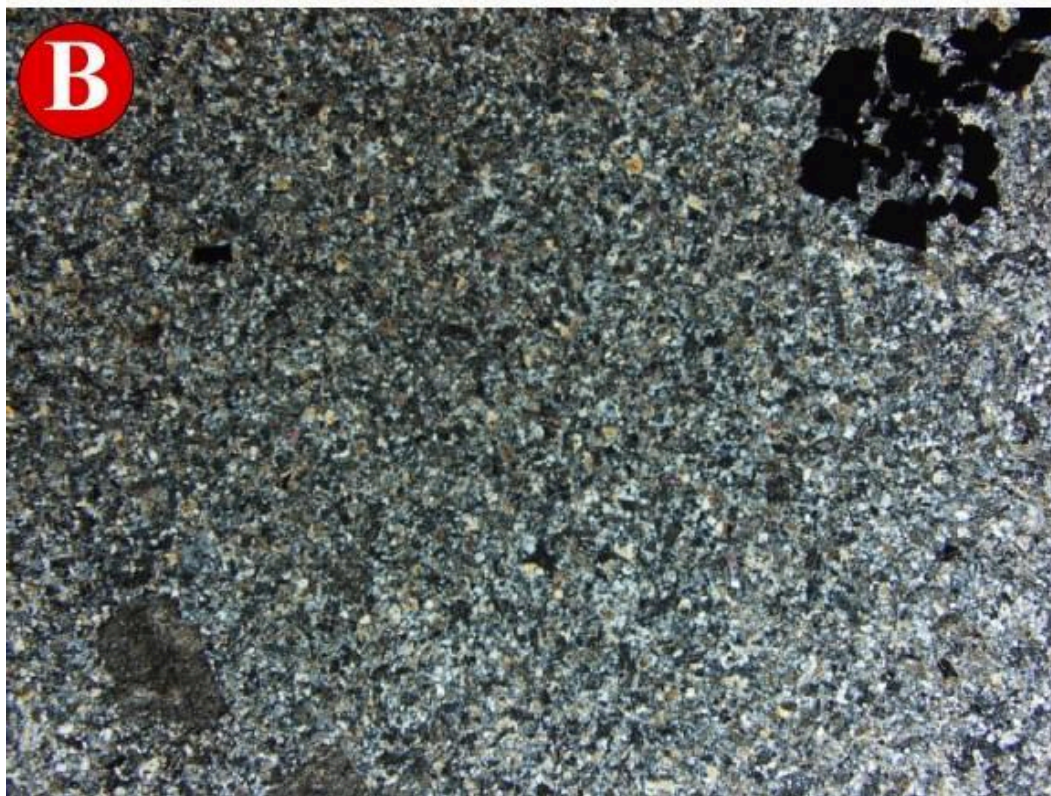
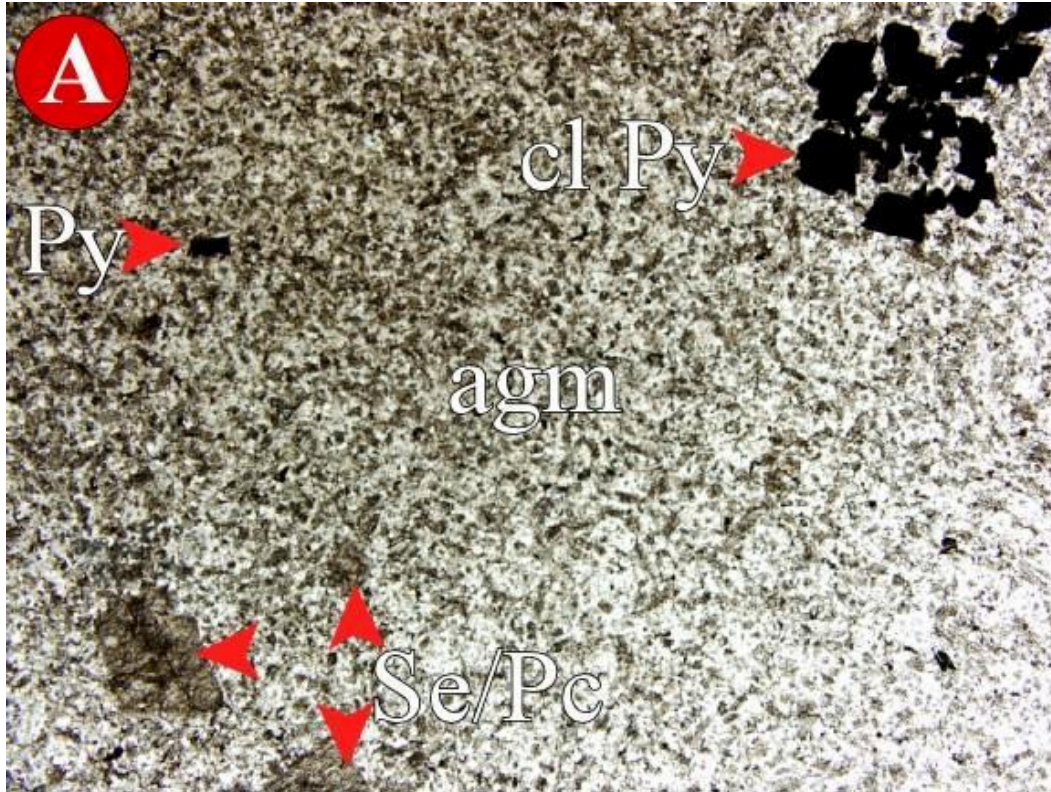


Plate 5. Photomicrographs, **A**-plane light, **B**-crossed nicols, show the altered groundmass (agm) with completely sericite altered plagioclase phenocrysts (se/Pc). Note the discontinuous

unoriented seams (yellow arrows) filled with sericite (Se). It is proposed that the dyke was hydraulically micro-fractured and these micro-fractures were the pathways for alteration (sericitization) and sulphidation. **A**, **B**: FOV = 3.46 mm.



Plate 6. Photomicrographs, **A**-plane light, **B**-crossed nicols, show the sericite-filled discontinuous micro fractures (yellow arrows) filled with sericite in the altered groundmass (agm) comprised of

quartz+feldspar (q+fs) and sericite and completely sericite replacement of plagioclase phenocrysts (Se/Pc). Note the euhedral pyrite (Py) and sericite having replaced the plagioclase phenocrysts – early sulphidation accompanied sericitization. **A, B:** FOV = 3.46 mm.

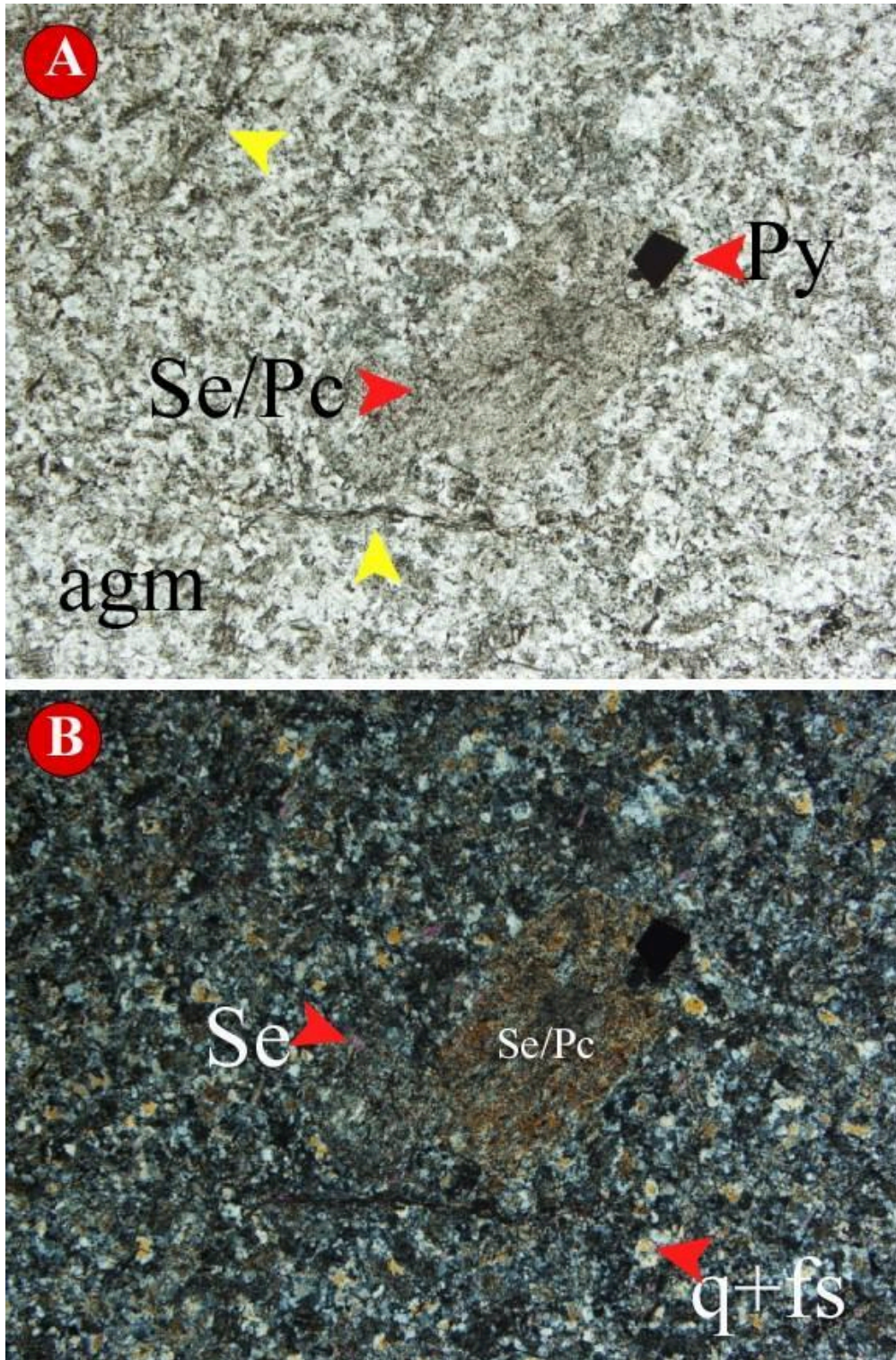


Plate 7. Photomicrographs, **A**, **B**-reflected light, show in **A**, clustered pyrite (cl Py) elongated in the trend of a micro-fracture (yellow arrow) and in **B**, the long dimension of the clustered pyrite is a continuation of the micro-fracture in the altered groundmass. Pyrite is poikiloblastic (pPy) (inclusion-bearing). It is inferred/proposed that sulphidation/pyritization was coeval with early K-metasomatism. **A**: FOV = 6.92 mm. **B**: FOV = 3.46 mm.

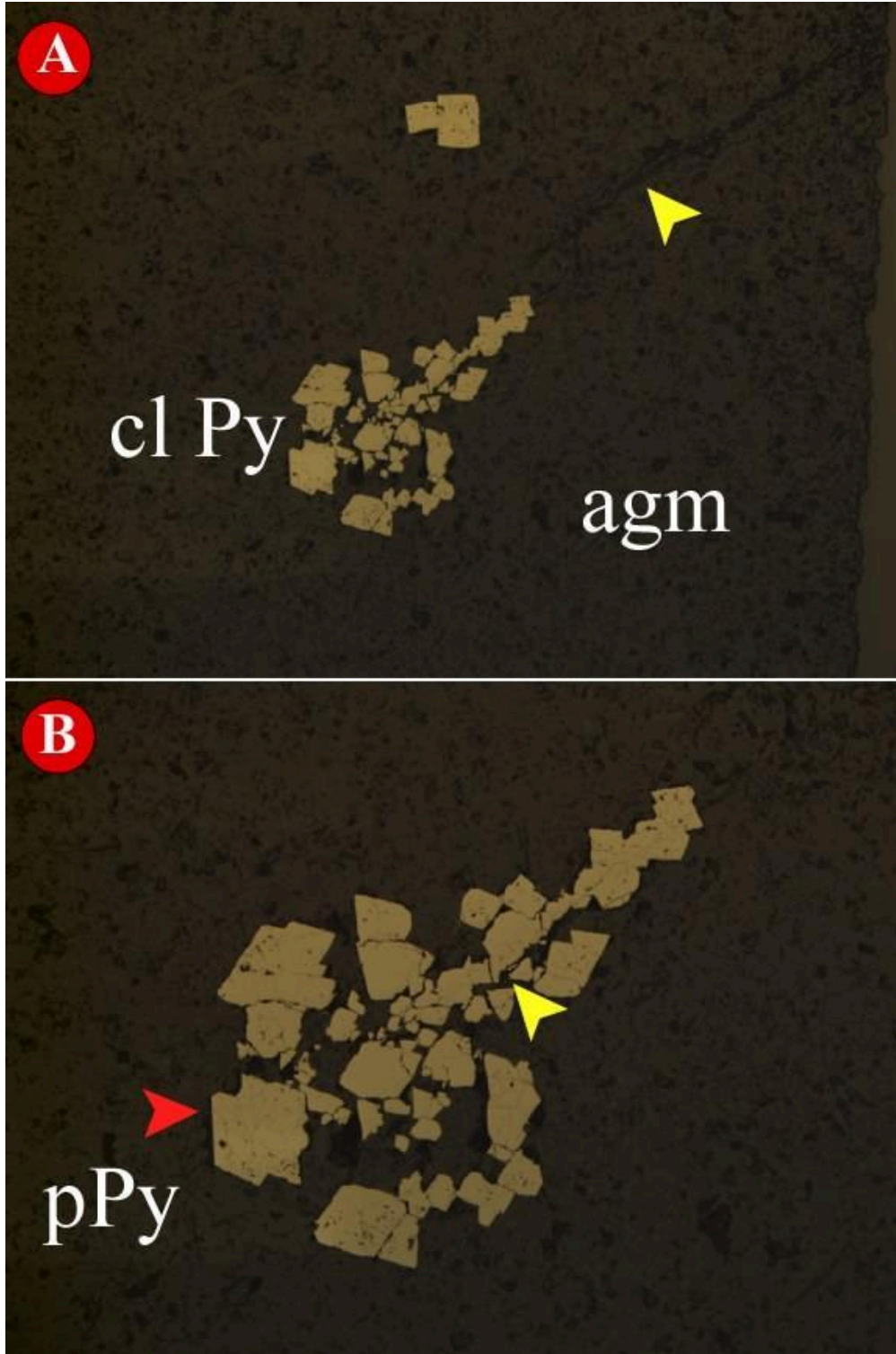
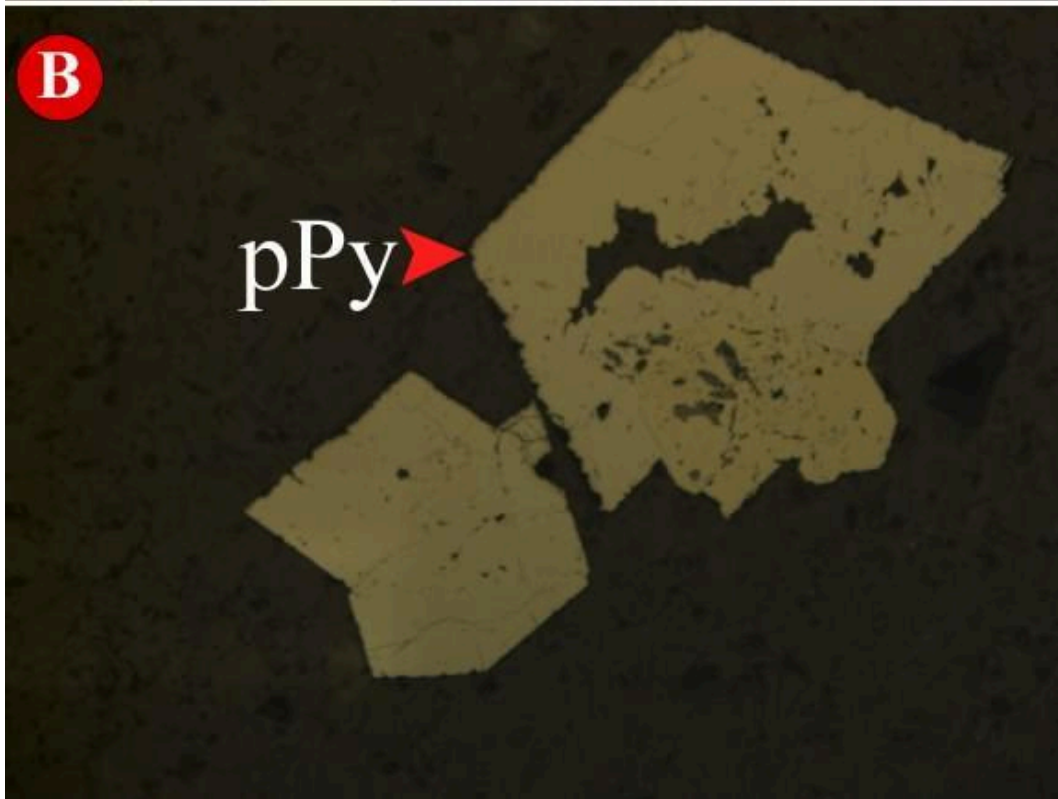
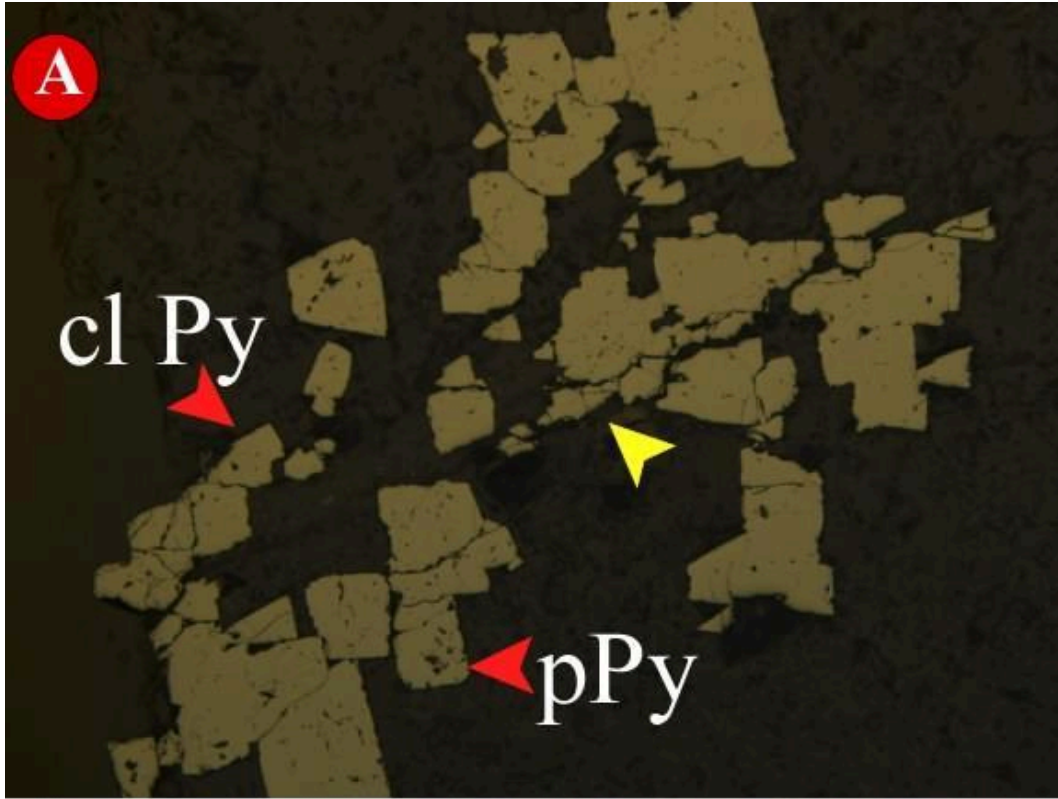


Plate 8. Photomicrographs, **A**, **B**-reflected light, show the poikiloblastic texture in pyrite (pPy) and the alignment of the clustered pyrite (cl Py) along a micro-fracture (yellow arrow).

A, **B**: FOV = 1.73 mm.



Polished Thin Section: Nevada 2
Cut slab and area selected for sectioning

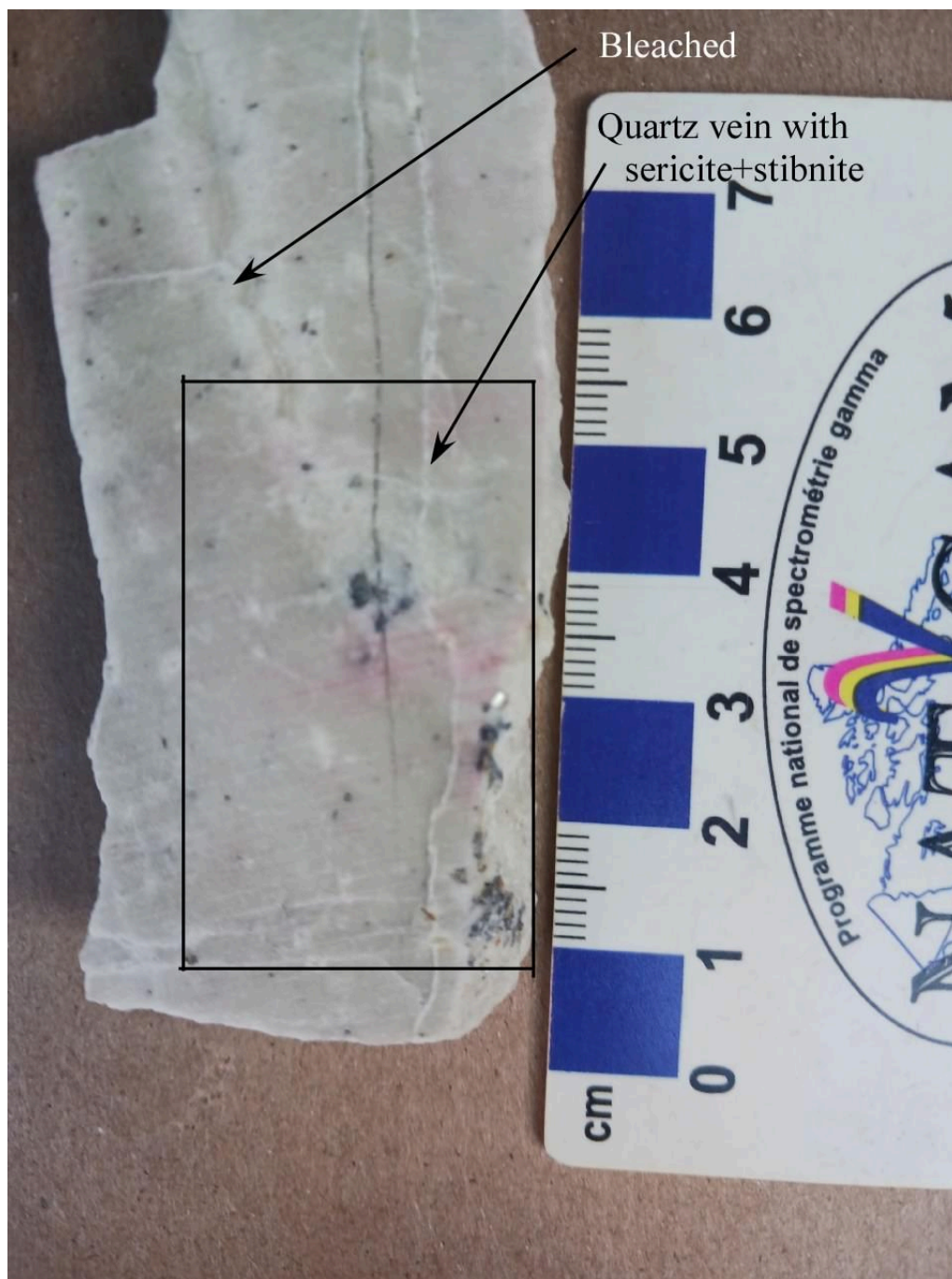


Plate 9. Photomicrographs, **A**-plane light, **B**-crossed nicols, show the uniformly ultra fine-grained altered groundmass (agm) with sericitized plagioclase phenocrysts (Se/Pc) and euhedral pyrite (Py). **A, B**: FOV = 6.92 mm.

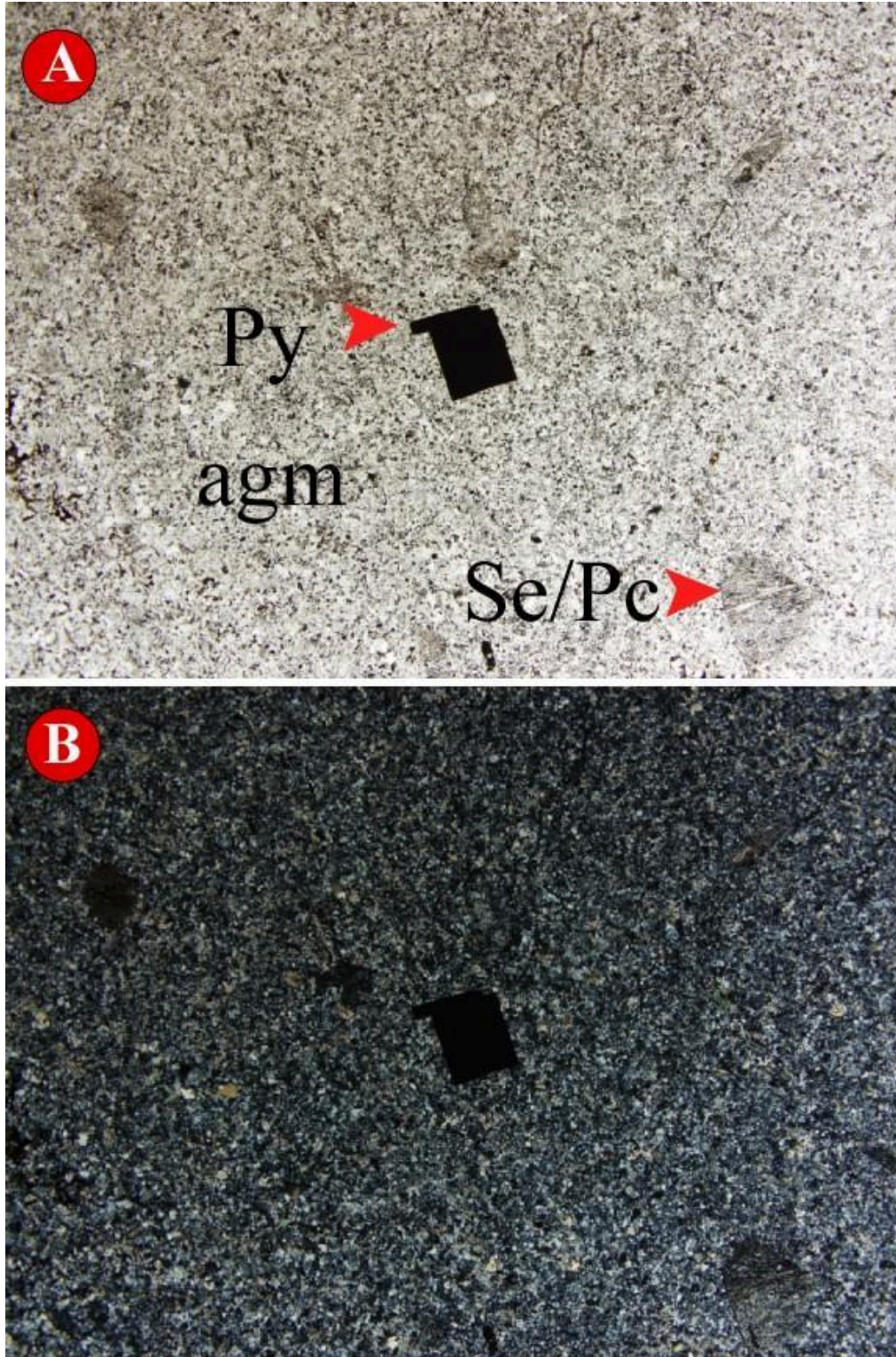


Plate 9C. Photomicrograph, C-reflected light, shows the texture of the metasomatic early poikiloblastic pyrite (pPy), inclusion bearing core and inclusion-free margin. Pyritization is associated with sericitization (K-metasomatism). C: FOV = 1.73 mm.

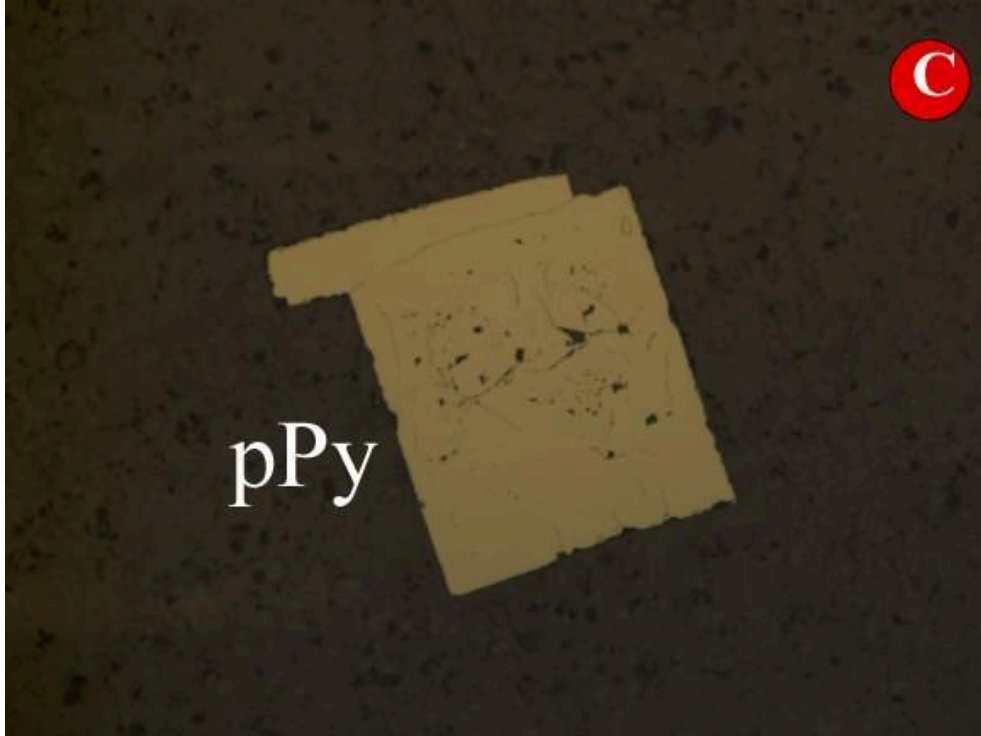


Plate 10. Composite photomicrograph, A-plane light, shows parallel quartz veins (q vn) crossing the ultra fine-grained altered groundmass (agm) with sericitized plagioclase phenocrysts (Se/Pc). Note: 1) the pyrite (Py) grain is predominantly still hosted in the groundmass, implying that quartz veining is post early sericitization and sulphidation, 2) the sericite-filled micro crack (yellow arrow). A: FOV = as shown.

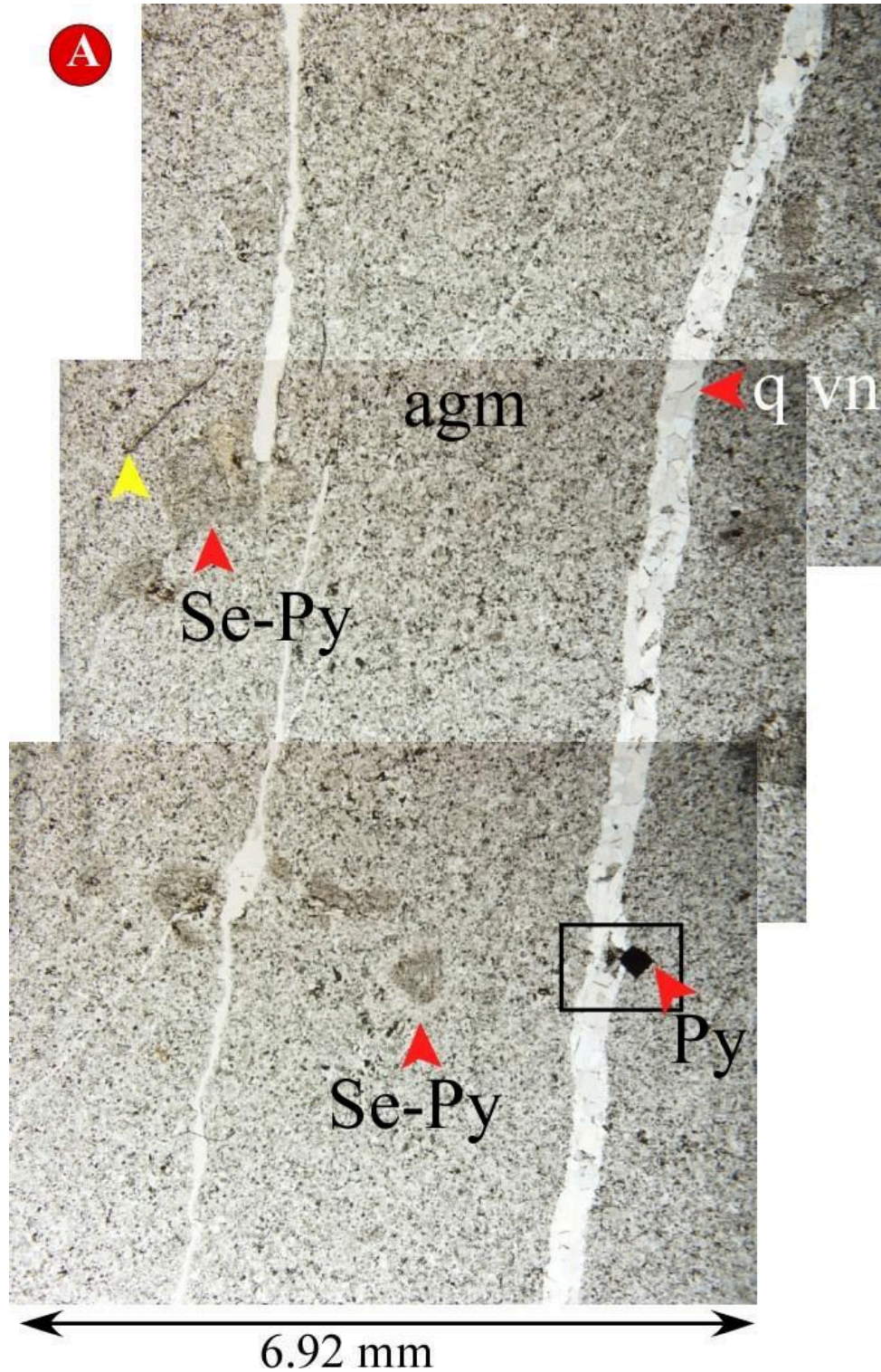


Plate 10B, C. Photomicrographs, **B**-plane light, **C**-crossed nicols, show the quartz vein cutting the altered groundmass (agm) comprised of sericite (Se) and quartz+felspar (q+fs). Note that the pyrite (Py) grain is attached to a fragment of wall rock (WR) the latter is incorporated into the vein. Consequently sericitization with pyritization was followed by quartz vein networks.

B, C: FOV = 1.73 mm.

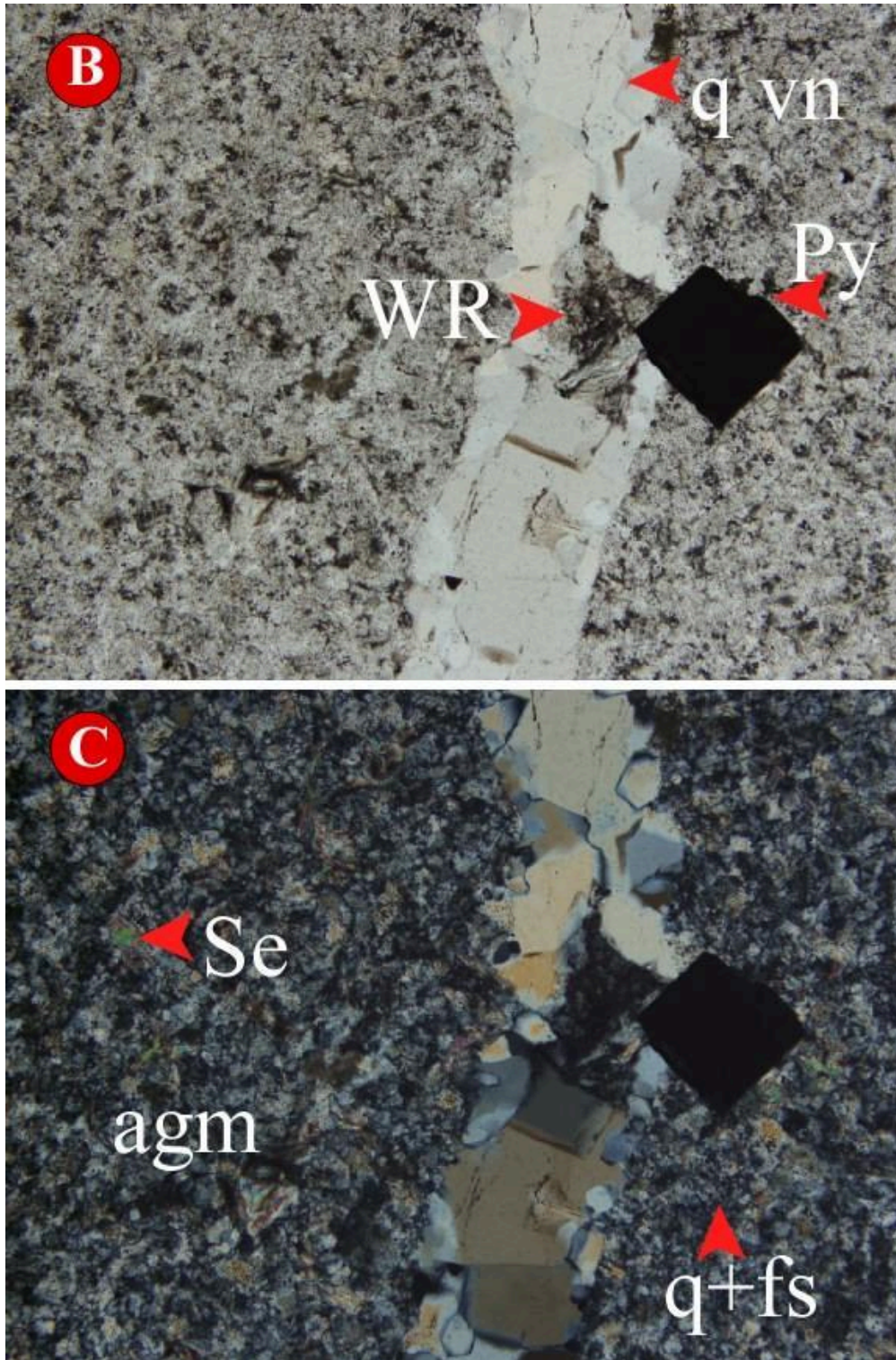


Plate 10D. Photomicrograph, **D**-reflected light, shows the poikiloblastic texture of the pyrite (pPy), a texture typical of early sulphidation. **D**: FOV = 1.73 mm.



Plate 12. Photomicrographs, **A**-plane light, **B**-crossed nicols, show a clot of sericite/muscovite (se/Mu) in the quartz vein (q vn) that cuts across the altered groundmass (agm). The presence of sericite/muscovite in the quartz vein implies a second generation of K-metasomatism.

A, B: FOV = 1.73 mm.

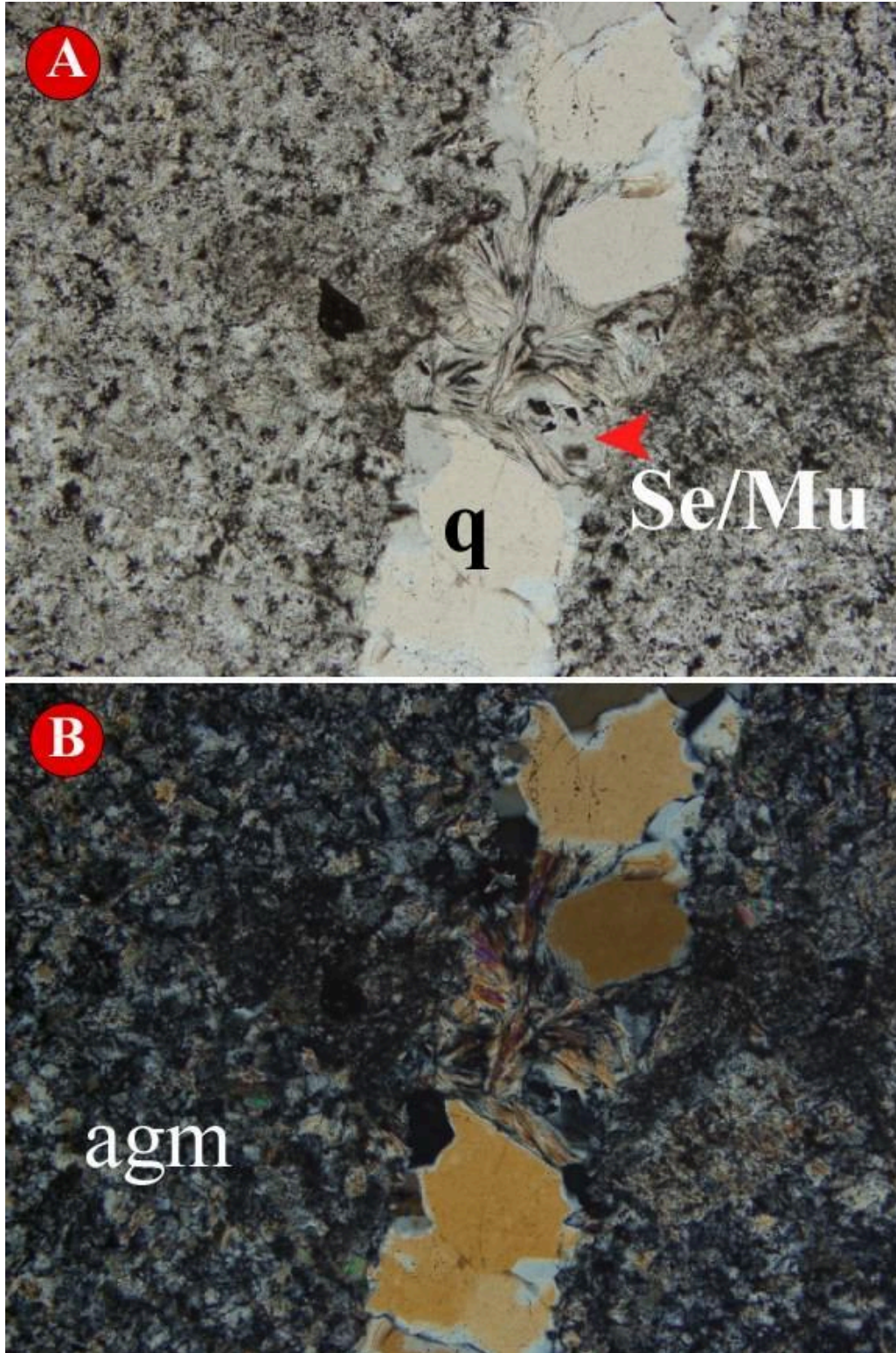


Plate 13. Photomicrographs, **A**-plane light, **B**-crossed nicols, show ultra narrow quartz veinlets (orange arrows) cutting the altered groundmass that hosts sericitized plagioclase phenocrysts (Se/Pc). Quartz veining is present at various scales. **A**, **B**: FOV = 6.92 mm.

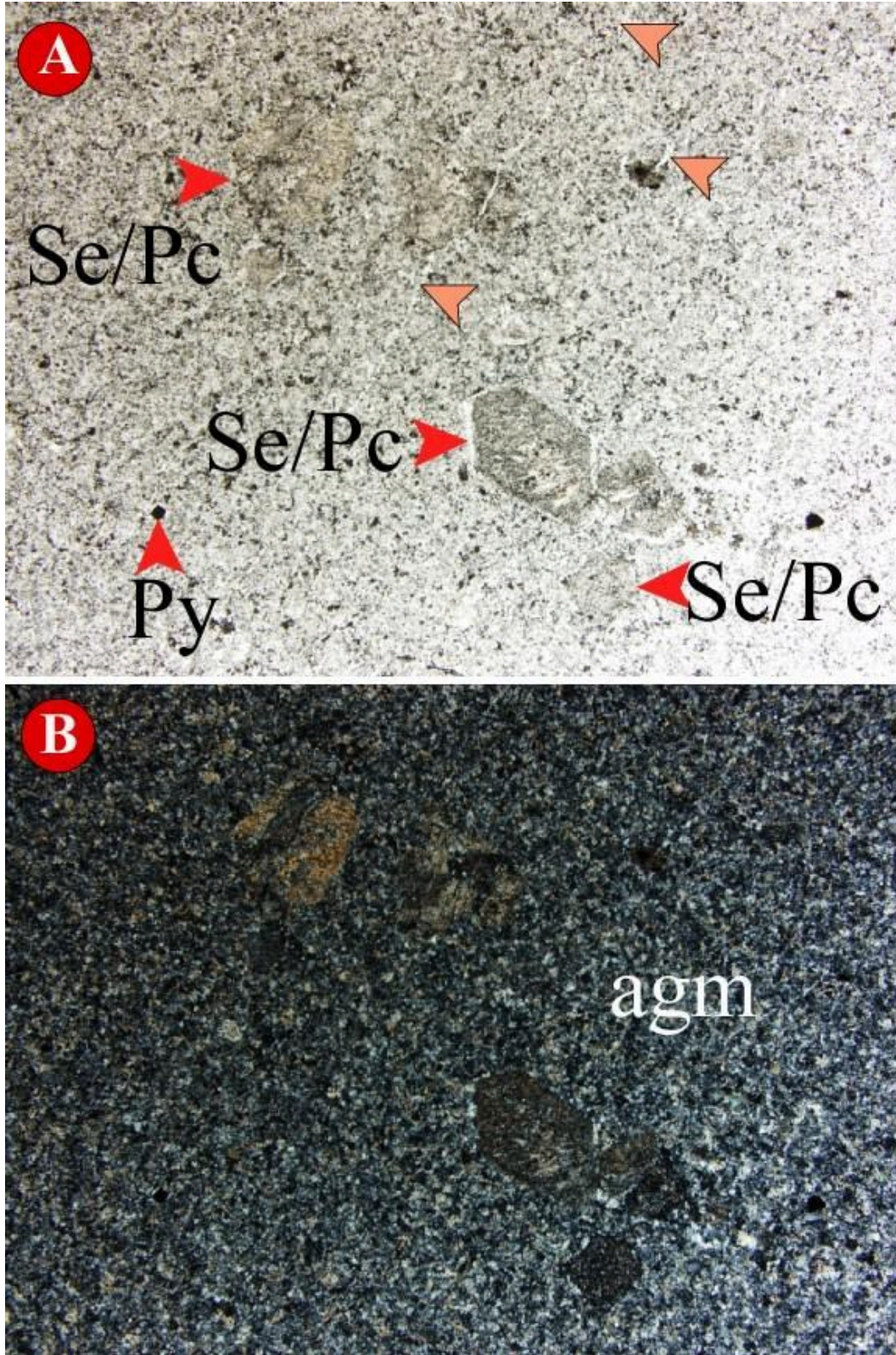
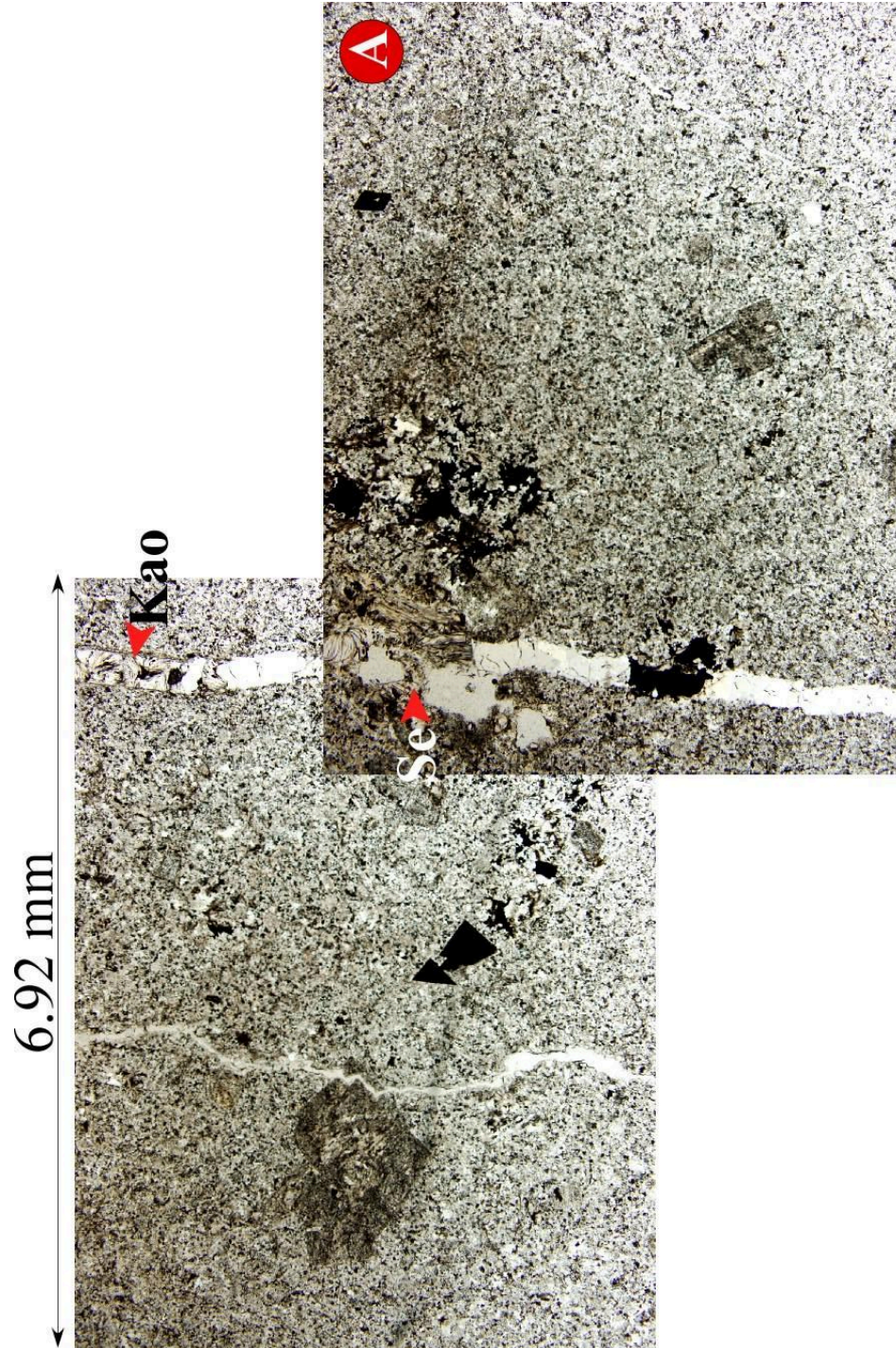


Plate 14. Composite photomicrographs, **A**-plane light, **B**-crossed nicols, show the altered groundmass with sericitized plagioclase phenocrysts (Se/Pc) and euhedral pyrite (Py).

Importantly, the quartz vein (q vn) hosts sericite/muscovite (Se/Mu) and kaolinite (Kao) and stibnite (vn Sb), stibnite textural type #1. A second textural type #2 of stibnite, clotted stibnite (cSb) is present immediate to the vein. The clotted stibnite textural type is inferred to be related to Sb+S metasomatism through the previously altered groundmass. The relatively coarse-grained sericite pseudomorph may have been biotite (Se/aBi?). **A, B**: FOV = as shown.



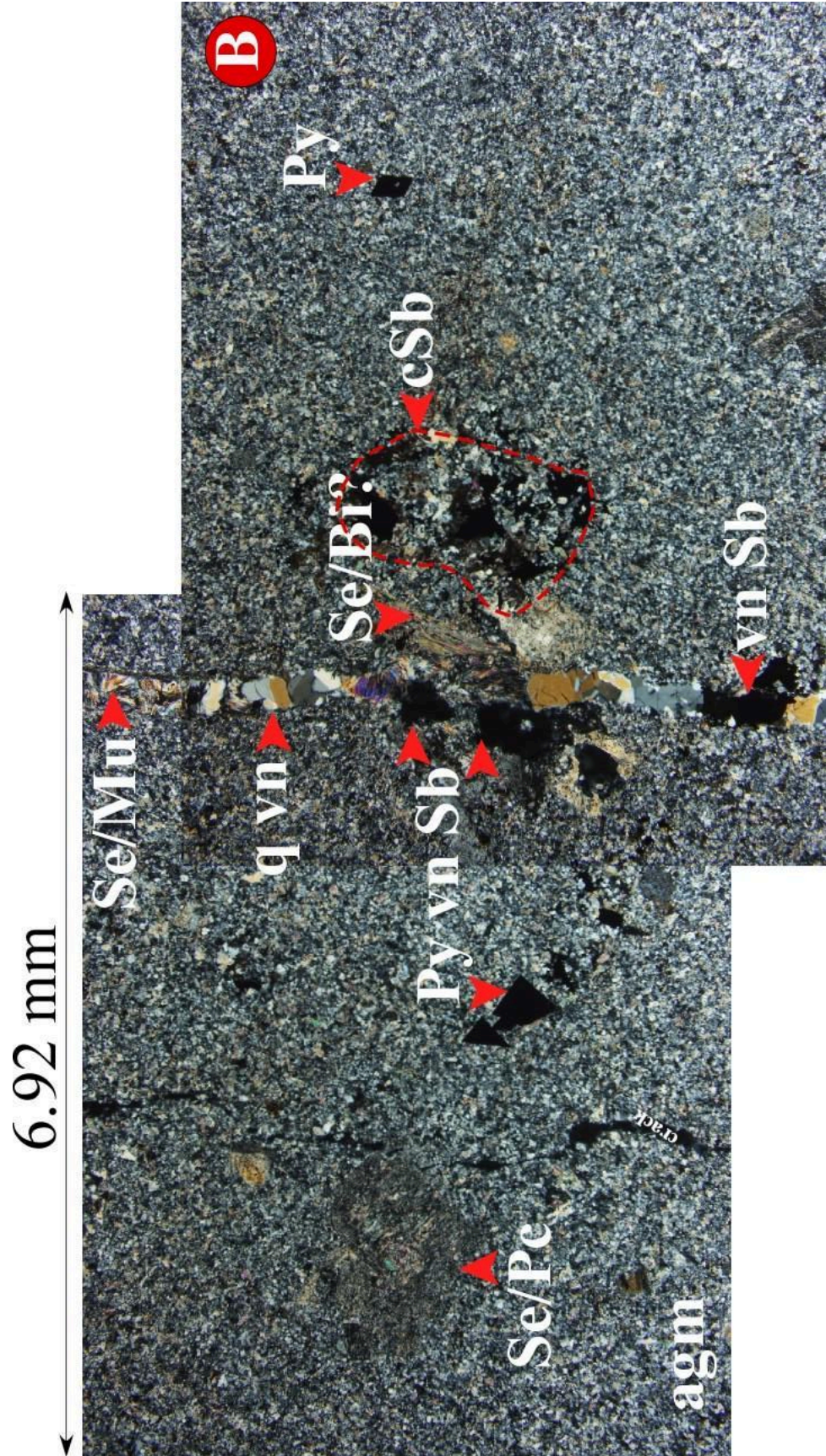
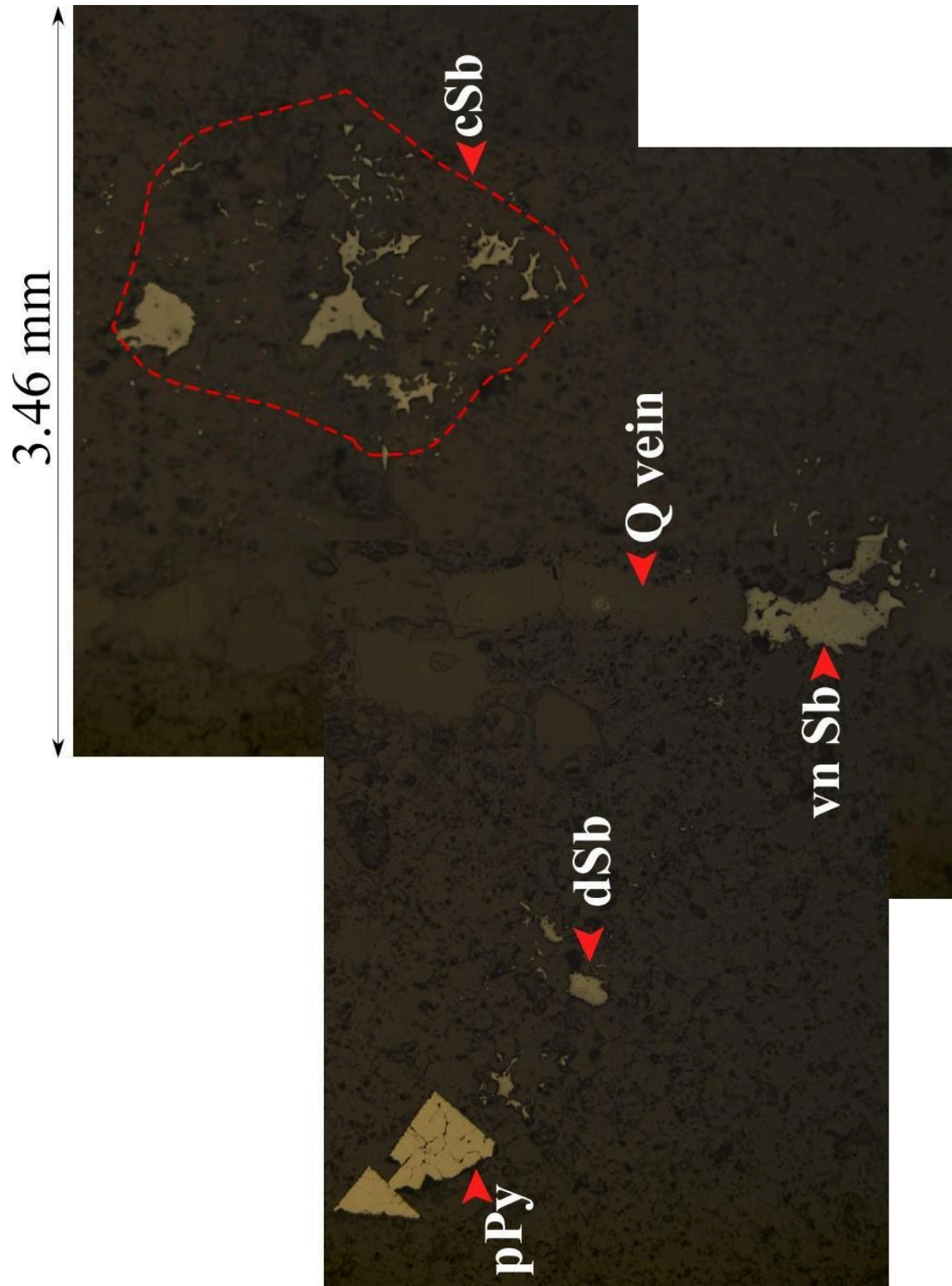


Plate 15. Composite photomicrograph, reflected light, **B**-crossed nicols, shows three textural varieties of stibnite: vein stibnite (vn Sb), clotted stibnite (cSb) and impregnated or disseminated stibnite (dSb). Poikiloblastic pyrite is earlier and associated with stage 1 K+S metasomatism of the dyke. FOV = as shown.



Polished Thin Section: Nevada 3
Cut slab and area selected for sectioning

Sb+S-metasomatism
inward from veins

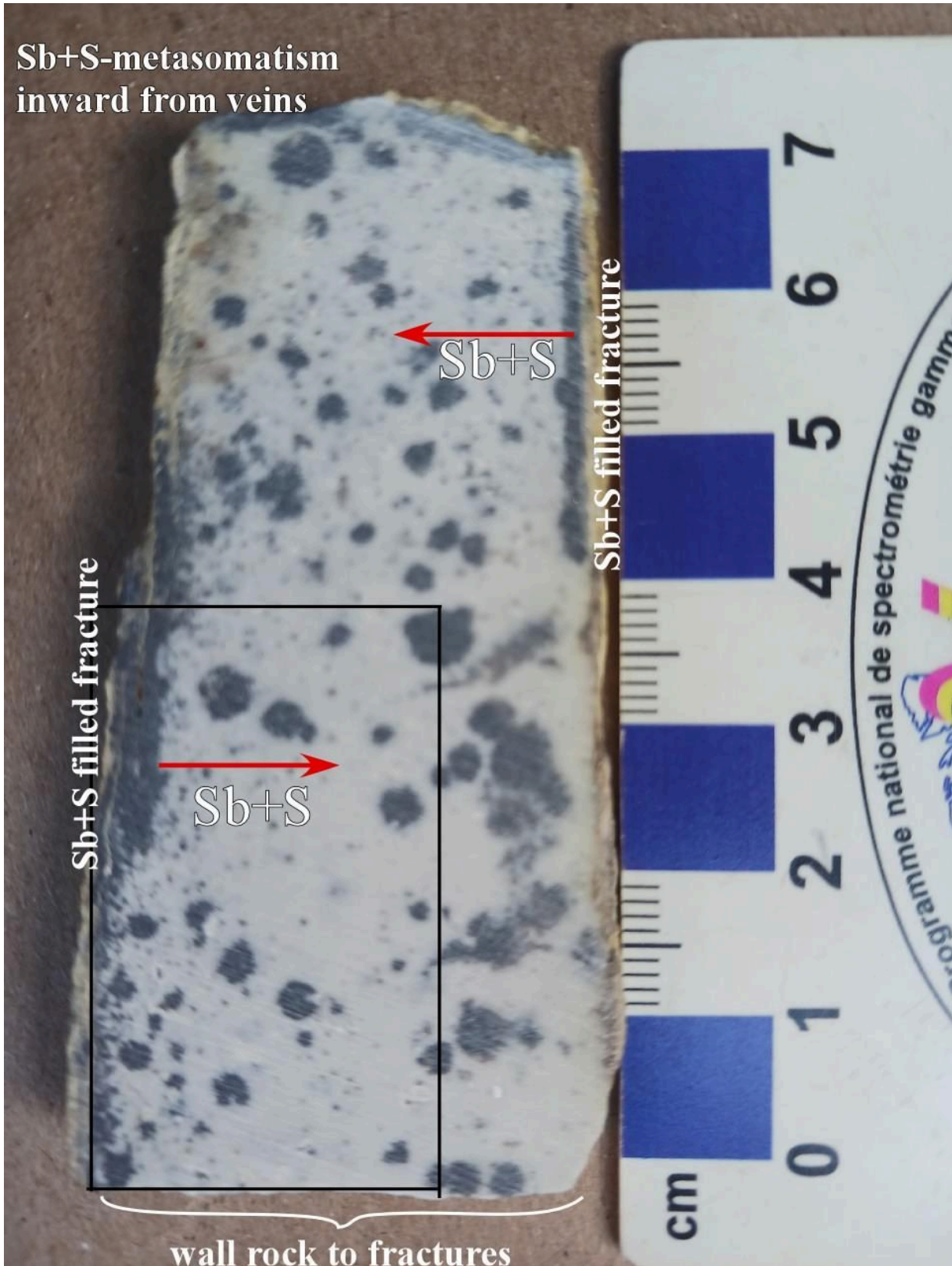


Plate 16. Photomicrograph, plane light, show sub equant/circular clotted stibnite (cSb) and disseminated stibnite (dSb) in the altered groundmass that hosts sericitized plagioclase phenocrysts (Se/Pc). FOV = 6.92 mm.

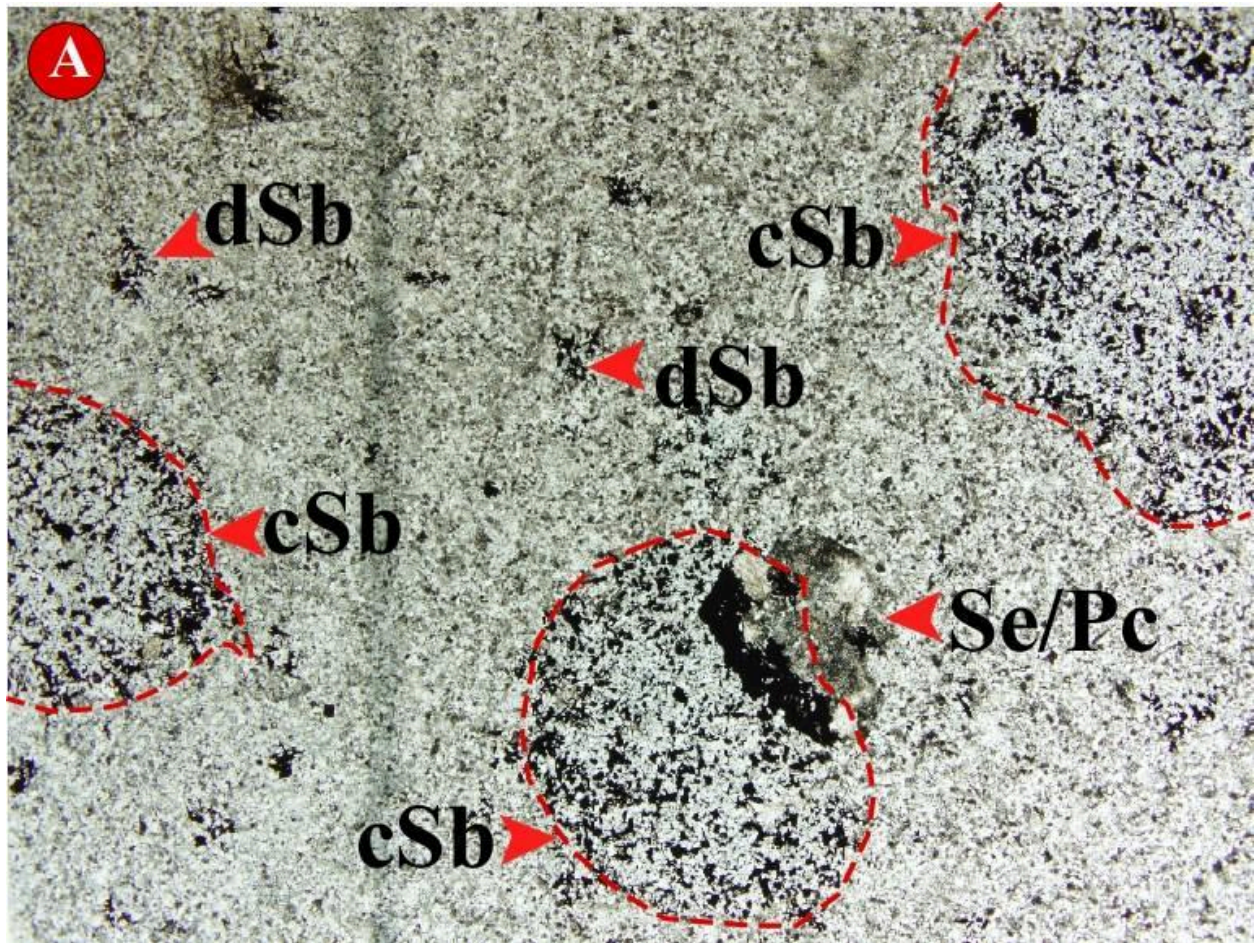


Plate 16B, C. Photomicrographs, **B**-plane light, **C**-crossed nicols, show the very fine grain size of stibnite that collectively form the sub equant clotted stibnite (cSb) domain in the altered groundmass (agm). There is minor stibnite outside the domain suggesting that these stibnite domains incrementally increase in area/volume during stage 2 Sb+K metasomatism.

A, B: FOV = 3.46 mm.

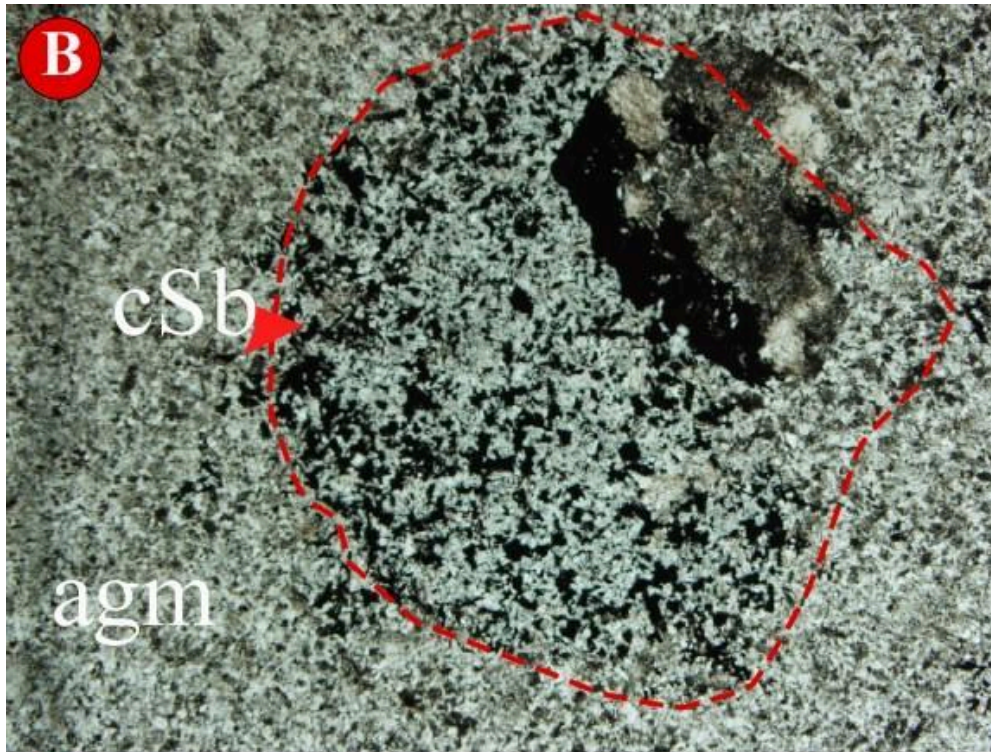


Plate 16D, E. Photomicrographs, **D**, **E**-reflected light, show in A, the ultra fine grain size of stibnite in the clotted stibnite domain; in B, the replacement of early sericitized plagioclase by stibnite, unequivocally placing this textural type, clotted stibnite, late in the ore-forming process –i.e. intense Sb+S metasomatism. **D**: FOV = 3.46 mm, **E**: FOV = 1.73 mm.

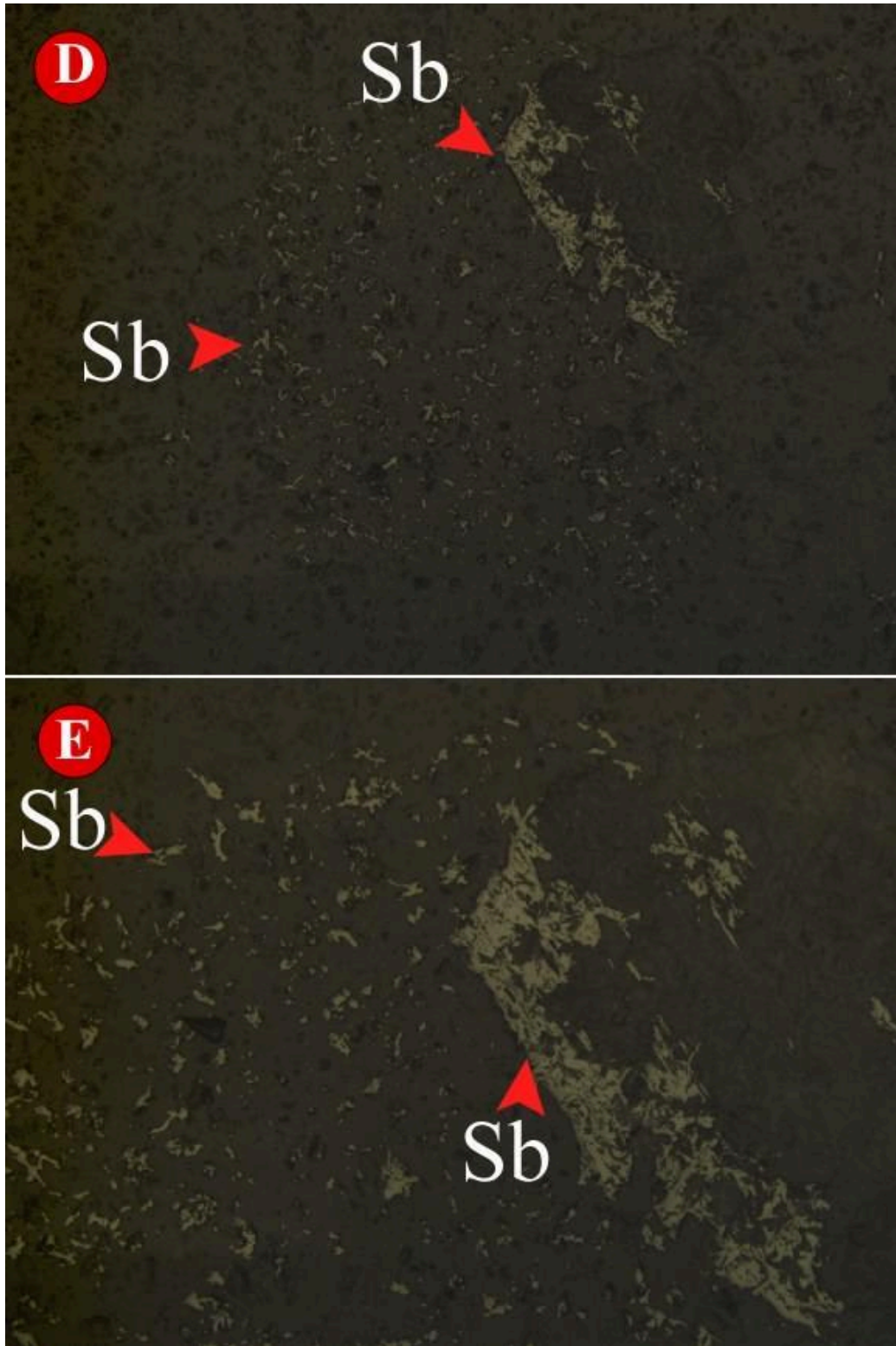


Plate 17. Composite photomicrographs, **A**-plane light, **B**-crossed nicols, show clotted stibnite domains (cSb) that have almost coalesced and partial stibnite replacement of sericitized plagioclase phenocrysts (Se/Pc) in the altered groundmass (agm). **A**, **B**: FOV = 6.92 mm.

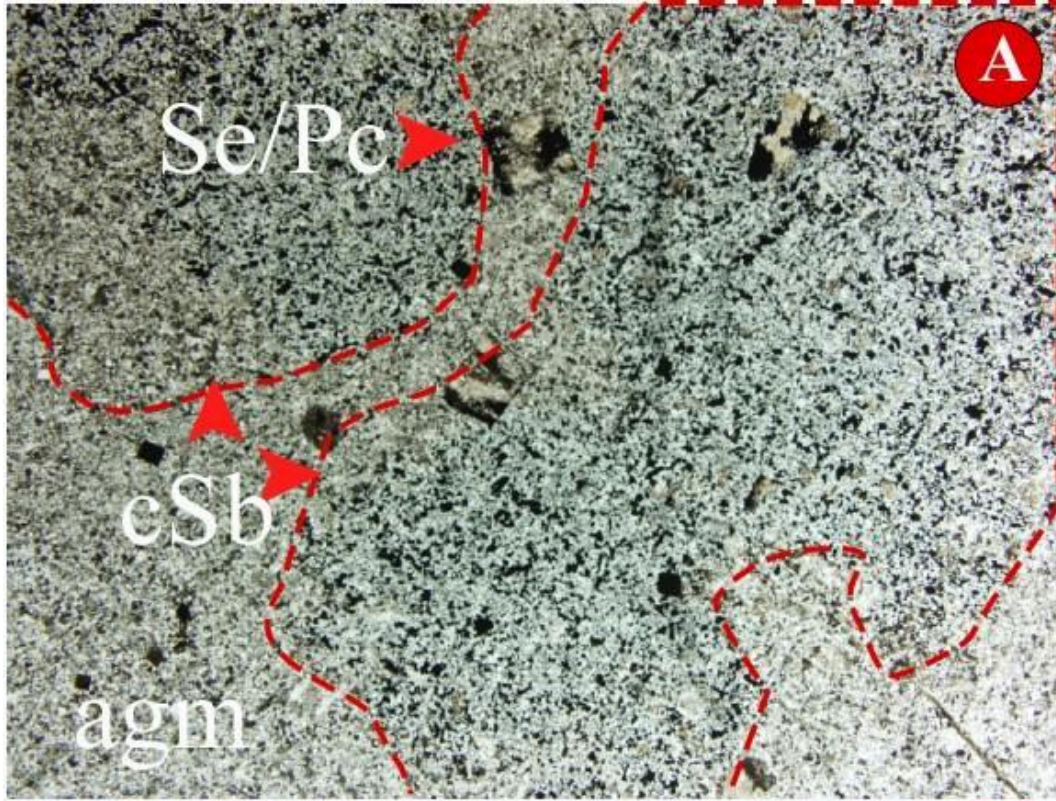


Plate 17C, D. Photomicrographs, **C**, **D**-reflected light, show early stage euhedral poikiloblastic pyrite (pPy) in and near clotted stibnite domains and importantly the euhedral early pyrite is not corroded/replaced during clotted stibnite formation i.e. stable with stibnite.

C: FOV = 6.92 mm, **D**: FOV = 1.73 mm.

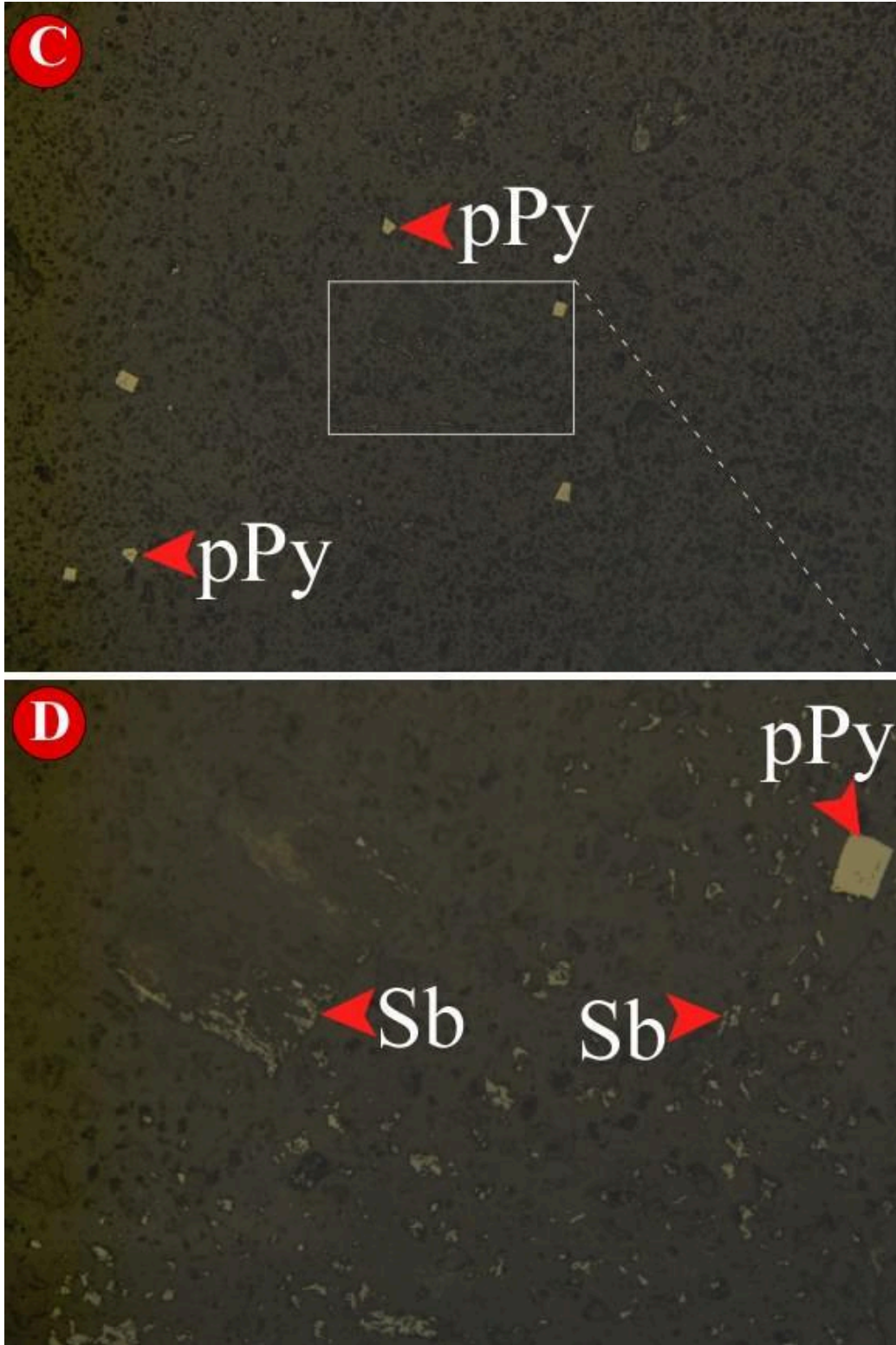


Plate 17E. Photomicrograph, **E**-reflected light, shows very fine-grained stibnite (Sb) in the clotted stibnite domain and matted stibnite partially replacing sericitized plagioclase phenocryst (mSb in Se/Pc). **E**: FOV = 0.87 mm.

E

agm

mSb in Se/Pc

Sb

Plate 18. Photomicrographs, **A**-plane light, **B**-crossed nicols, show closely spaced clotted stibnite domains (cSb) in the altered groundmass (agm) that has sericitized plagioclase phenocrysts (Se/Pc) and pyrite (Py). **A, B**: FOV = 6.92 mm.

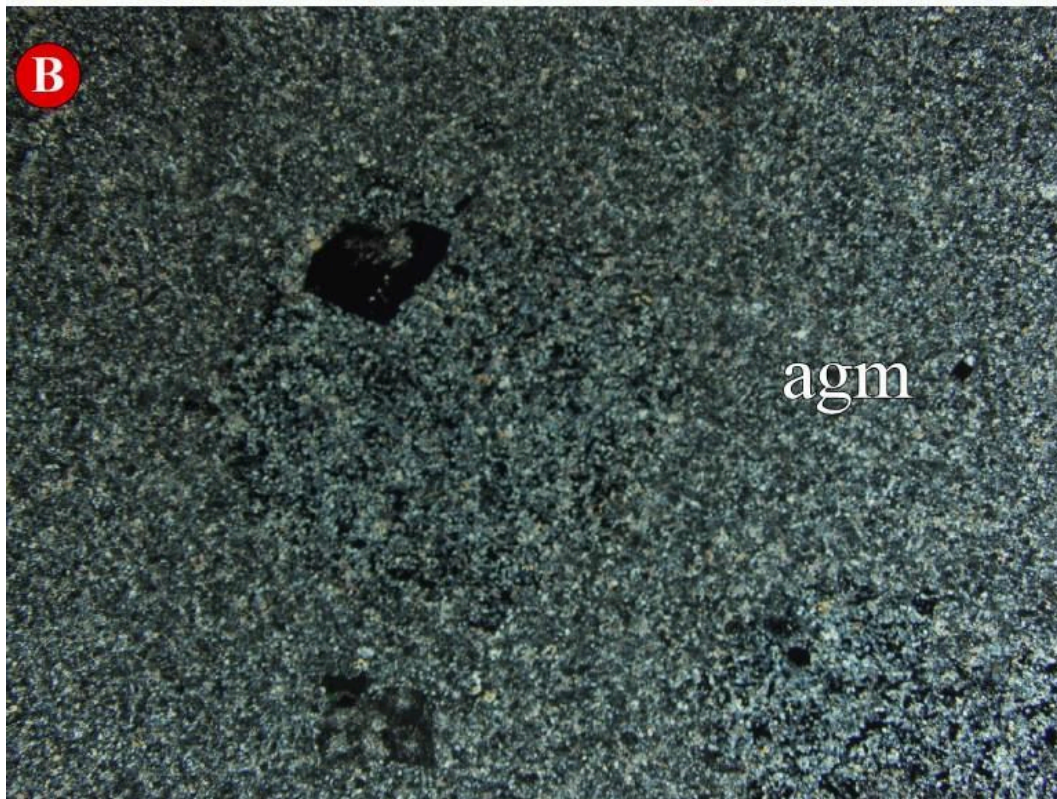
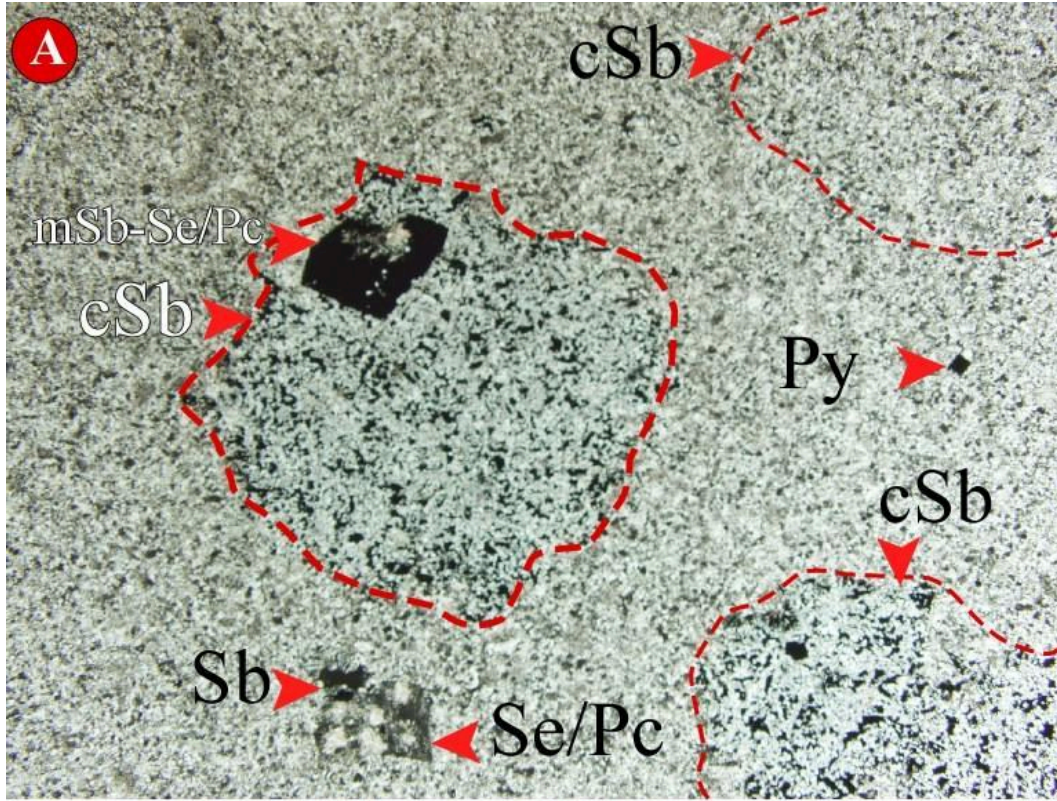


Plate 18C, D. Photomicrographs, **C**, **D**-reflected light, show the very fine grain size of stibnite (Sb) in the clotted domain, the delicate replacement of sericitized plagioclase phenocryst by matted stibnite (mSb) and the presence of euhedral early pyrite in a clotted domain.

C: FOV = 6.92 mm, **D**: FOV = 3.46 mm.

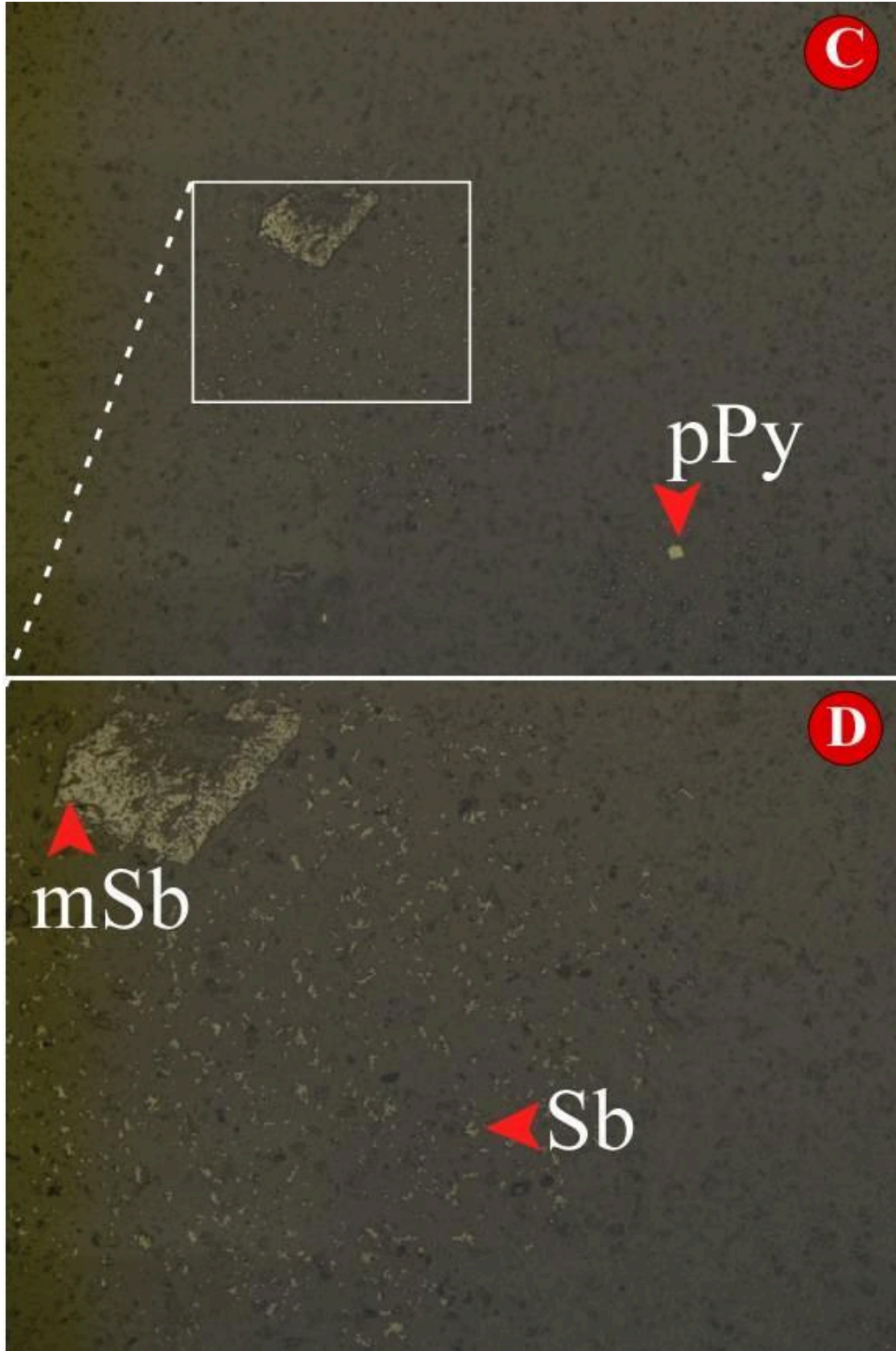


Plate 18E. Composite photomicrograph, **E**-reflected light, shows the fineness of metasomatic stibnite (Sb and mSb) that form the clotted domains. **E**: FOV = as shown.

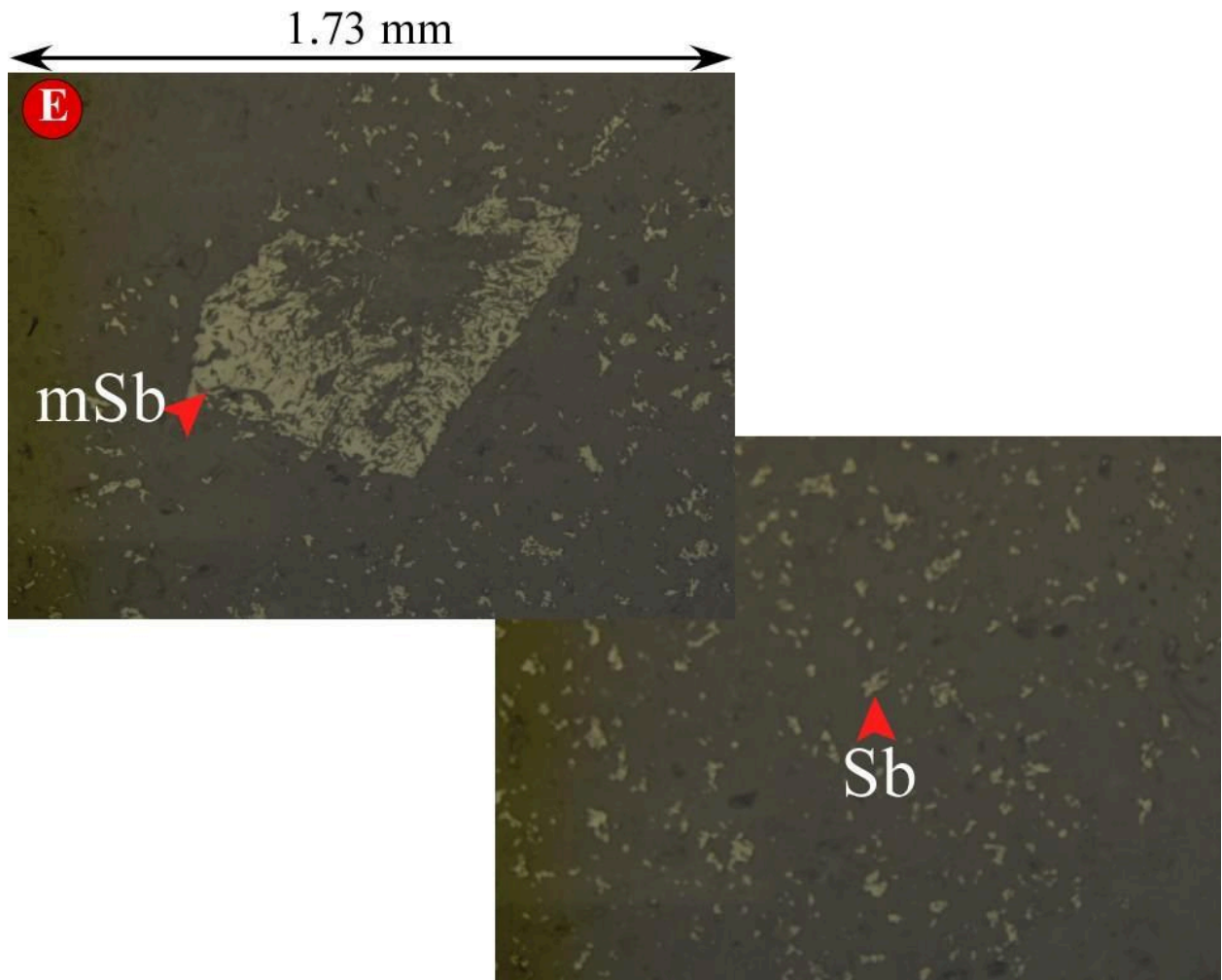


Plate 19. Photomicrographs, **A**-plane light, **B**-crossed nicols, show two coalesced clotted stibnite domains (cSb) within the altered groundmass (agm) that contains euhedral early pyrite (Py).
A, B: FOV = 6.92 mm.

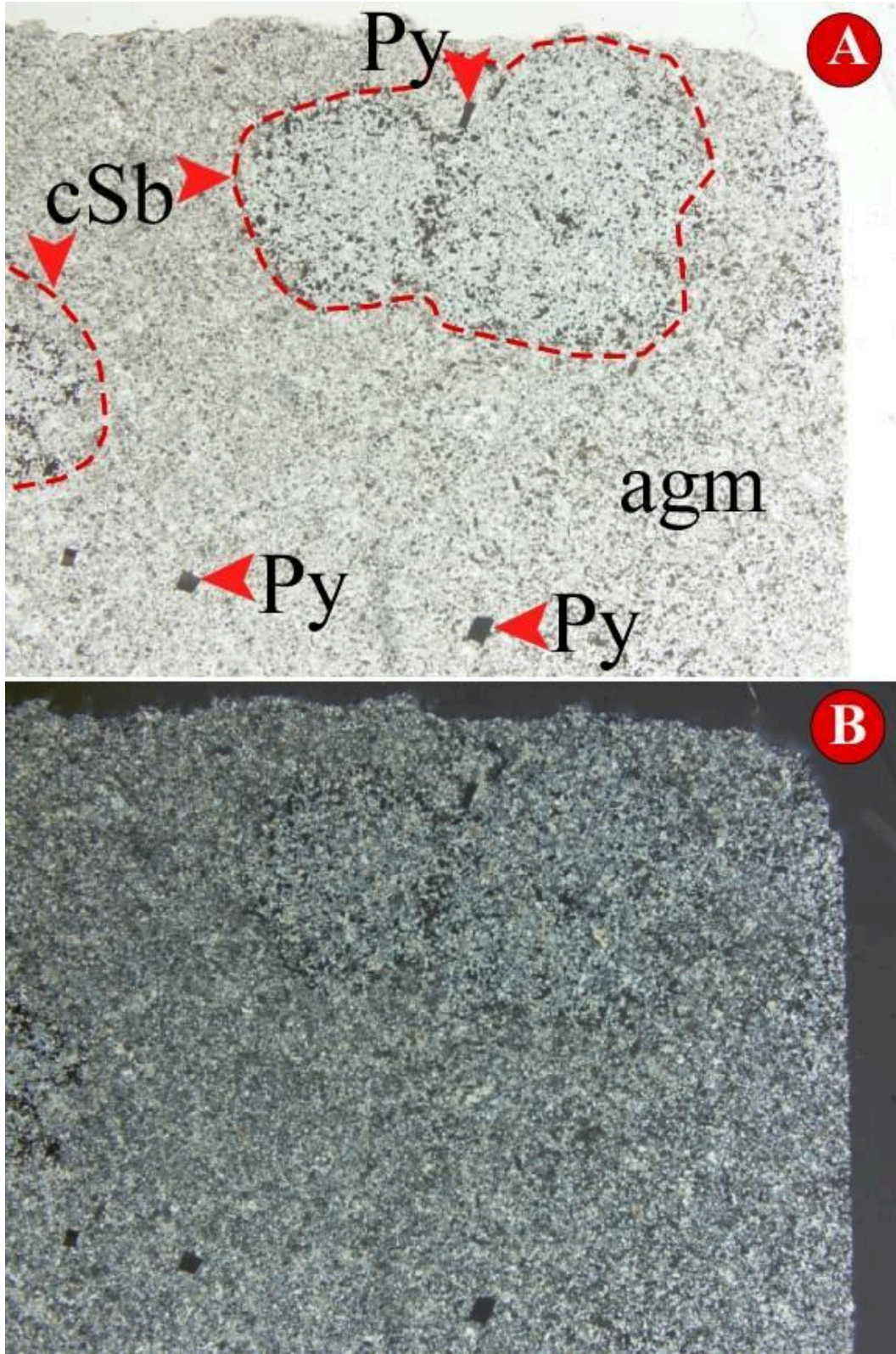


Plate 19C, D. Photomicrographs, C, D-reflected light, show in C, the texture of early poikiloblastic pyrite (pPy) in the altered groundmass and in D, a stable unaltered euhedral early

pyrite (Py) grain incorporated into a clotted stibnite domain which has very fin-grained stibnite (Sb). **C**: FOV = 6.92 mm, **D**: FOV = 3.46 mm.

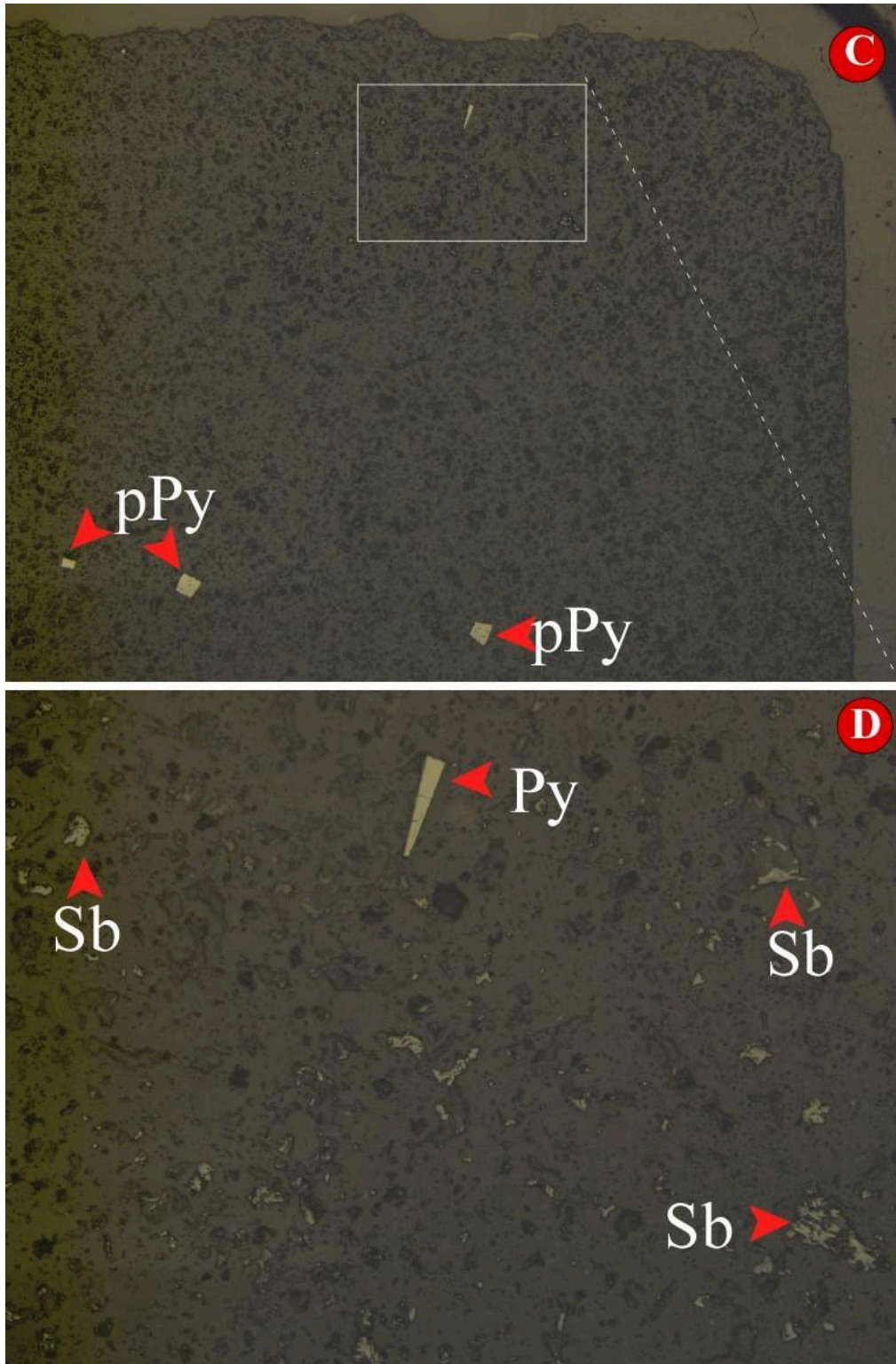


Plate 20. Photomicrographs, **A**-plane light, **B**-crossed nicols, show altered groundmass (agm) with two types of phenocrysts: sericitized glomeroporphyritic plagioclase (Se/gPc) and equant quartz micro-phenocryst (Q). In detail, the edge of the quartz phenocryst is scalloped indicating resorption in the magma chamber. A clotted stibnite domain (cSb) encompassed the altered plagioclase and quartz phenocrysts. **A, B**: FOV = 6.92 mm.

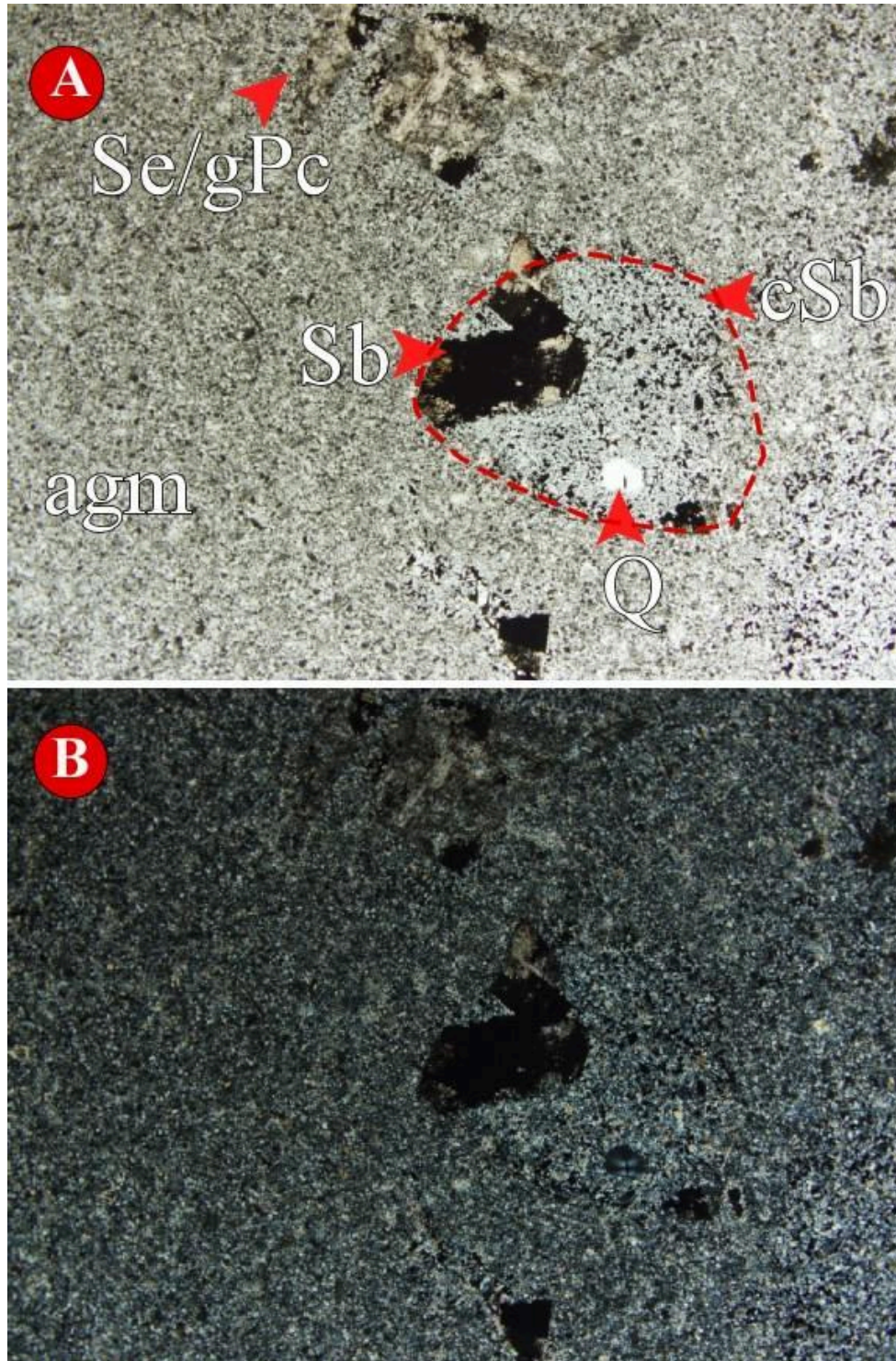


Plate 20C. Photomicrograph, C-reflected light, shows early poikiloblastic pyrite (pPy) in the altered groundmass and sericitized plagioclase phenocryst. C: FOV = 6.92 mm.

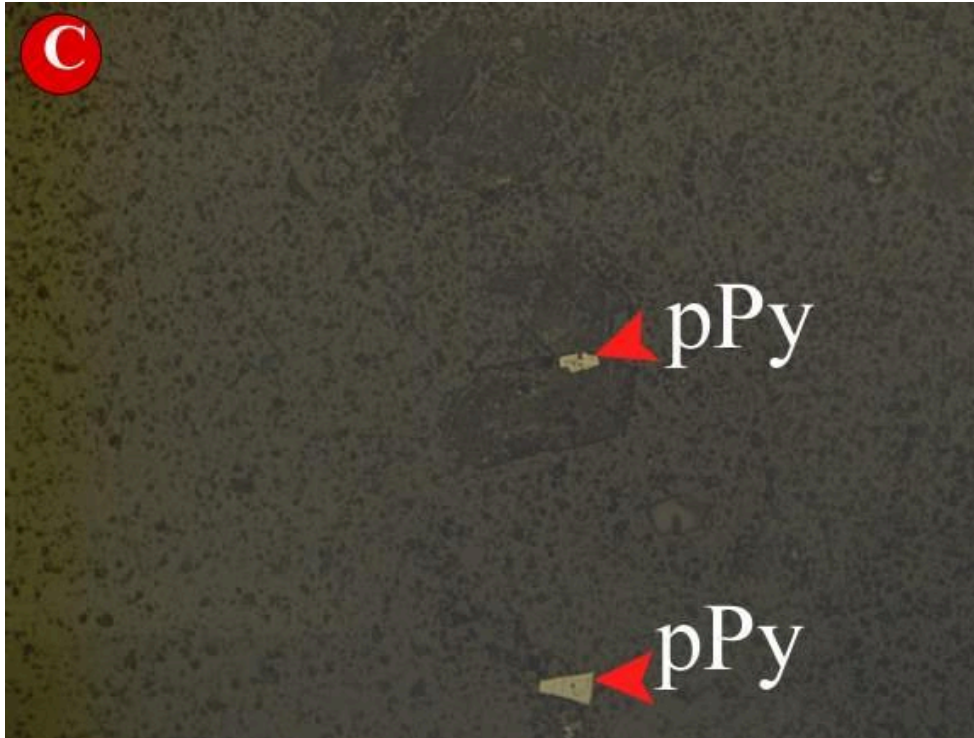
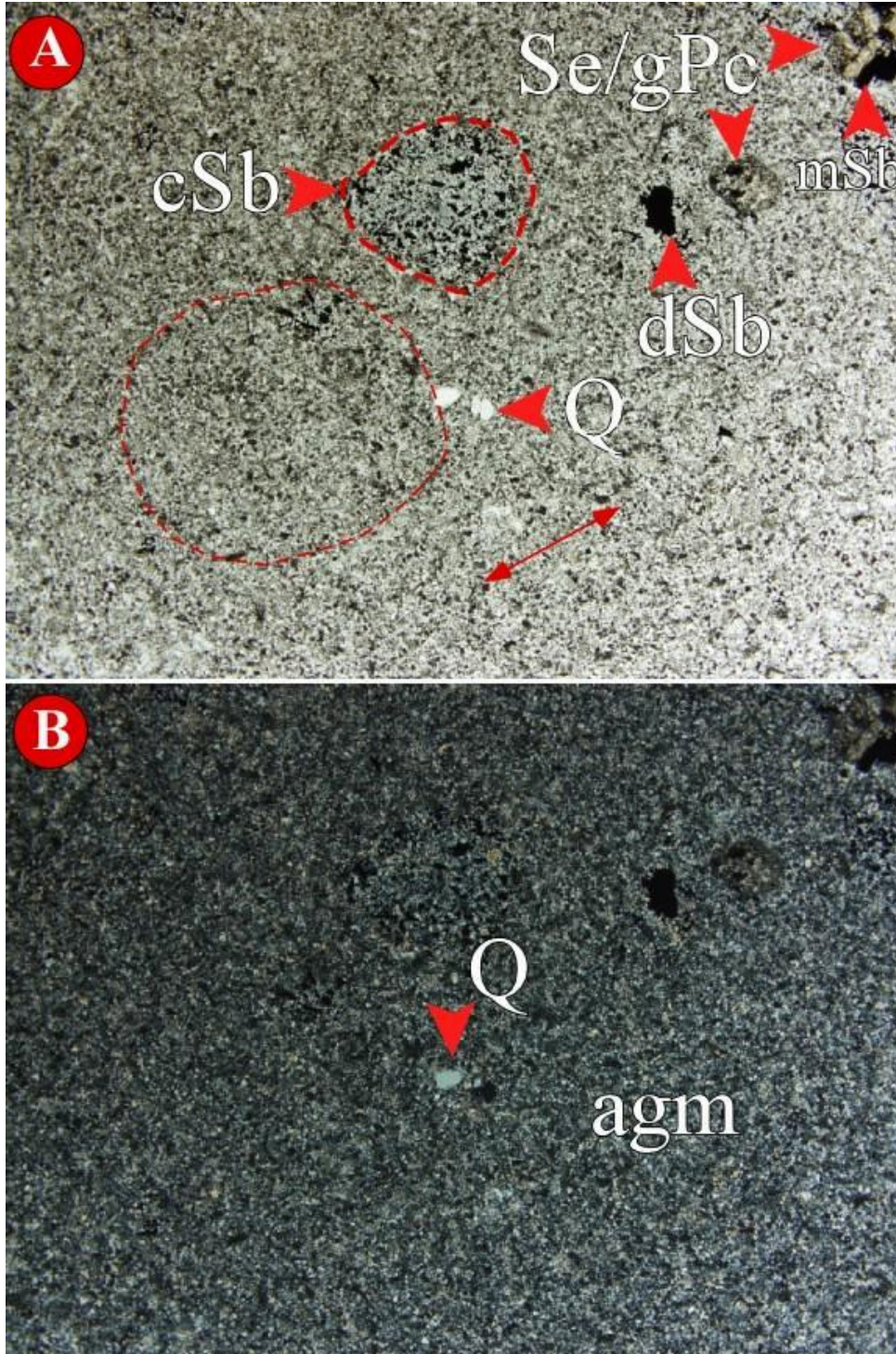


Plate 21. Photomicrographs, **A**-plane light, **B**-crossed nicols, show the altered groundmass (agm) hosting sericitized glomeroporphyritic plagioclase (Se/gPc) embayed quartz phenocrysts (Q) with domains of clotted stibnite (cSb), disseminated stibnite (dSb) and matted stibnite (mSb) after sericitized plagioclase. There is a subtle foliation, double headed red arrow, which is interpreted as flow banding since there is no indication of a tectonic overprint.

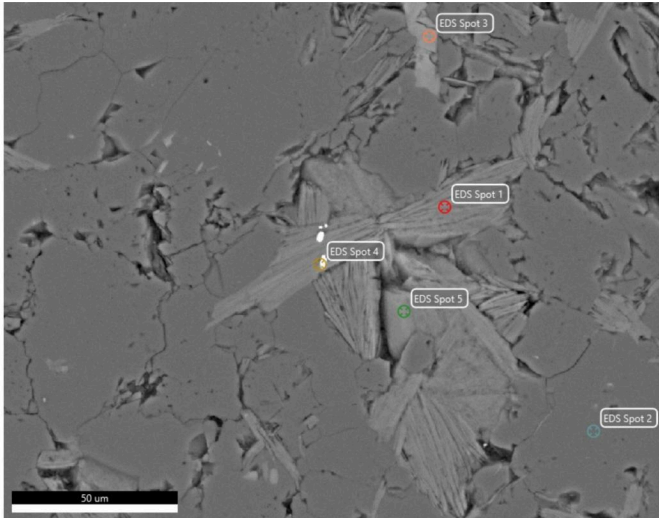
A, B: FOV = 6.92 mm.



Part III: Scanning Electron Microscope – Mineralogy and micro-textures
Polished Thin Section: Nevada 1

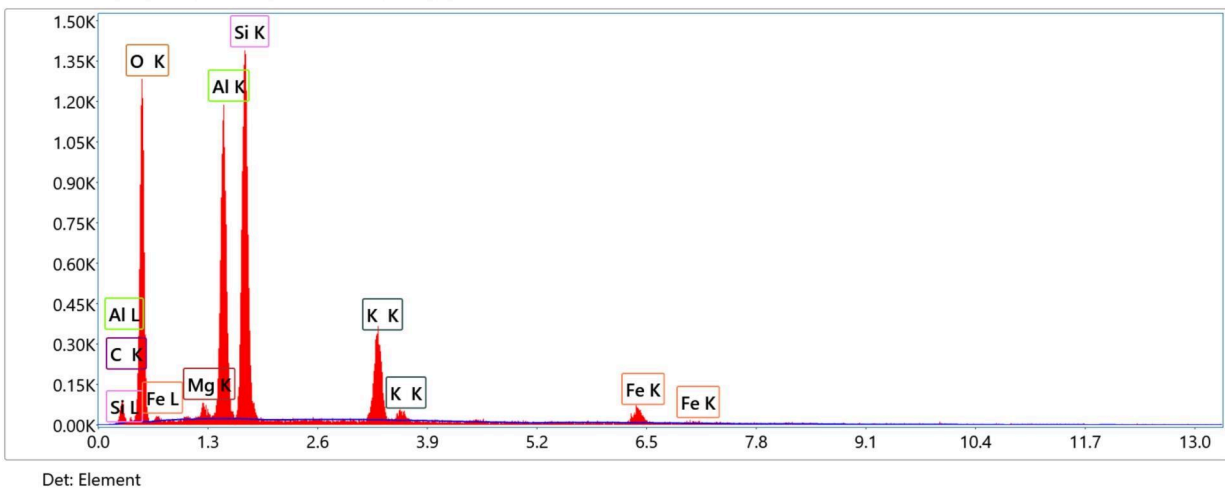
Area 1

Plate 22. Electron backscattered image of sericite in the altered groundmass



Spot 1

Energy Dispersive Spectrum



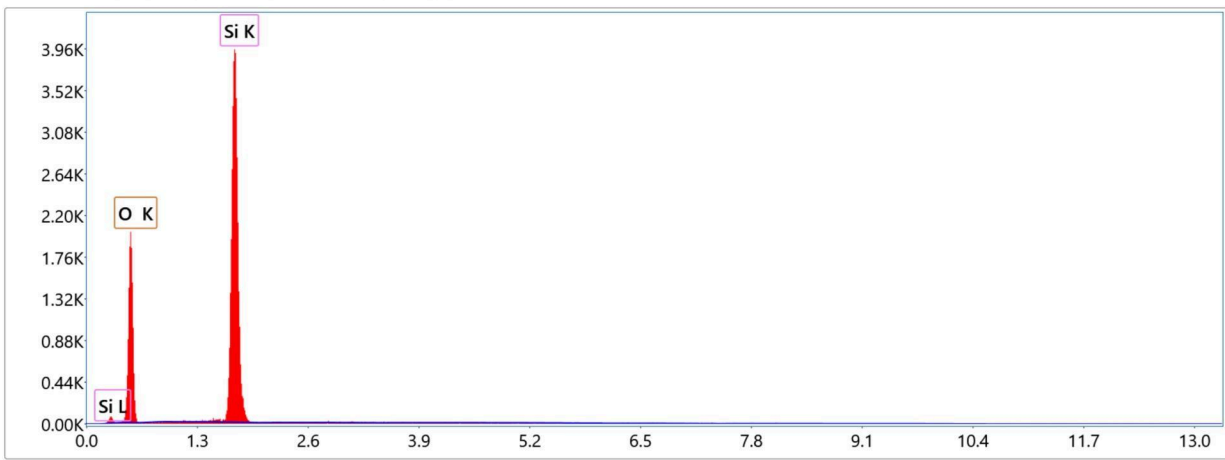
Semi-quantitative analyses

Element	Weight %	Atomic %
C K	16.7	25.0
O K	48.2	54.1
Mg K	0.8	0.6
Al K	11.5	7.7
Si K	14.4	9.2
K K	6.0	2.8
Fe K	2.5	0.8

Interpretation: sericite with minor Fe and minor Mg; note the minute differences in grey scales within a sericite plate, indicative of compositional variations.

Spot 2

Energy Dispersive Spectrum



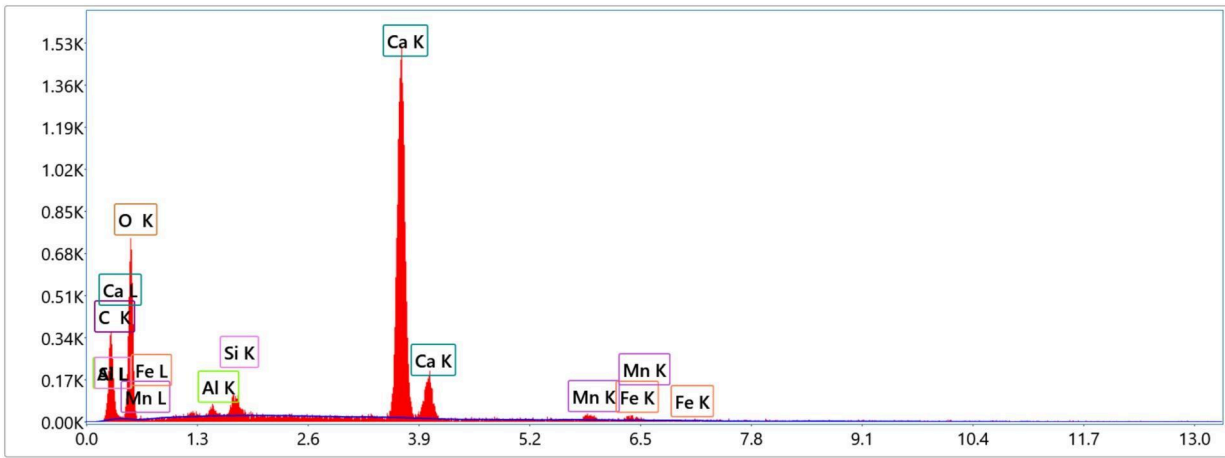
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	58.0	70.8
Si K	42.0	29.2

Interpretation: quartz

Spot 3

Energy Dispersive Spectrum



Det: Element

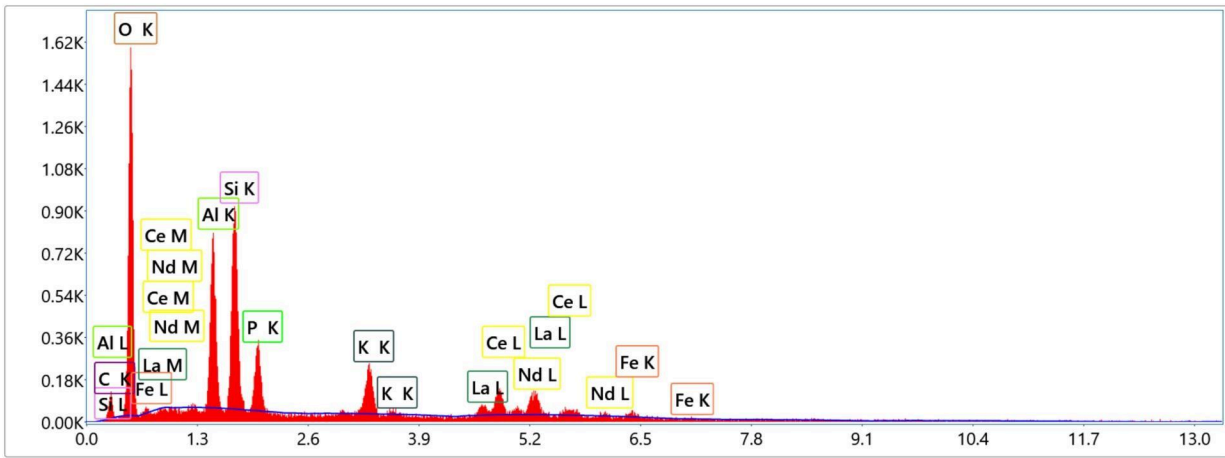
Semi-quantitative analyses

Element	Weight %	Atomic %
C K	23.1	34.6
O K	45.4	51.1
Al K	0.5	0.3
Si K	0.9	0.6
Ca K	28.3	12.7
Mn K	1.0	0.3
Fe K	0.8	0.3

Interpretation: calcite

Spot 4

Energy Dispersive Spectrum



Det: Element

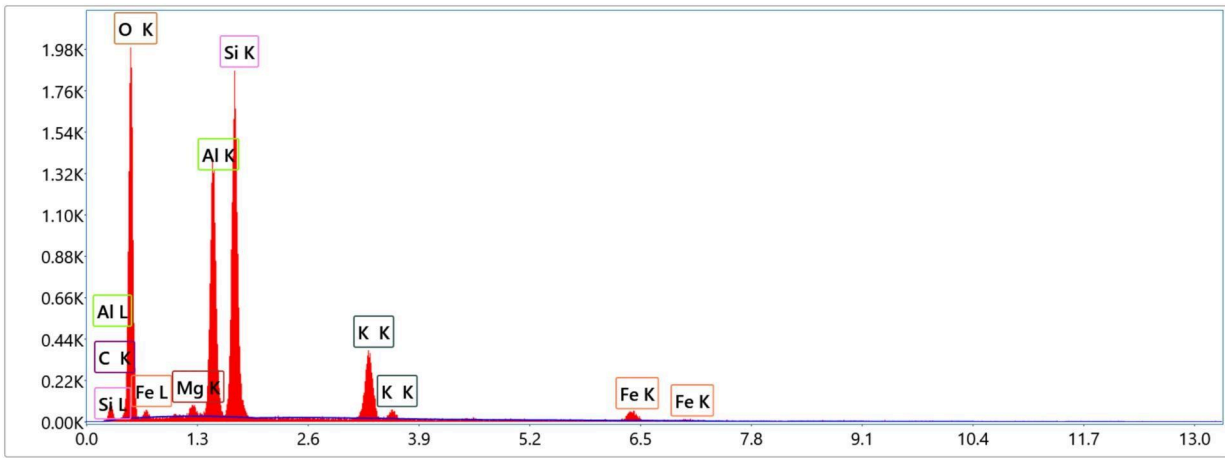
Semi-quantitative analyses

Element	Weight %	Atomic %
C K	16.3	26.2
O K	46.8	56.4
Al K	7.6	5.4
Si K	8.9	6.1
P K	3.5	2.1
K K	3.4	1.7
Fe K	0.7	0.2
La L	2.6	0.4
Ce L	7.0	1.0
Nd L	3.2	0.4

Interpretation: monazite

Spot 5

Energy Dispersive Spectrum



Det: Element

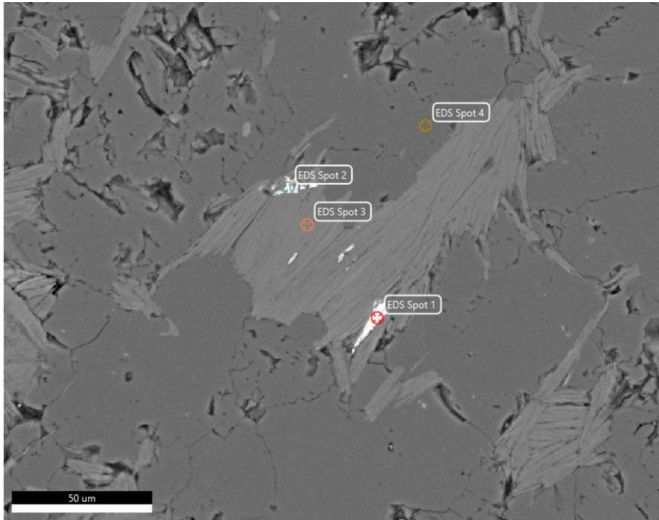
Semi-quantitative analyses

Element	Weight %	Atomic %
C K	14.9	22.1
O K	52.7	58.6
Mg K	0.7	0.5
Al K	10.9	7.2
Si K	13.8	8.8
K K	5.0	2.3
Fe K	1.9	0.6

Interpretation: sericite with minor Fe and minor Mg

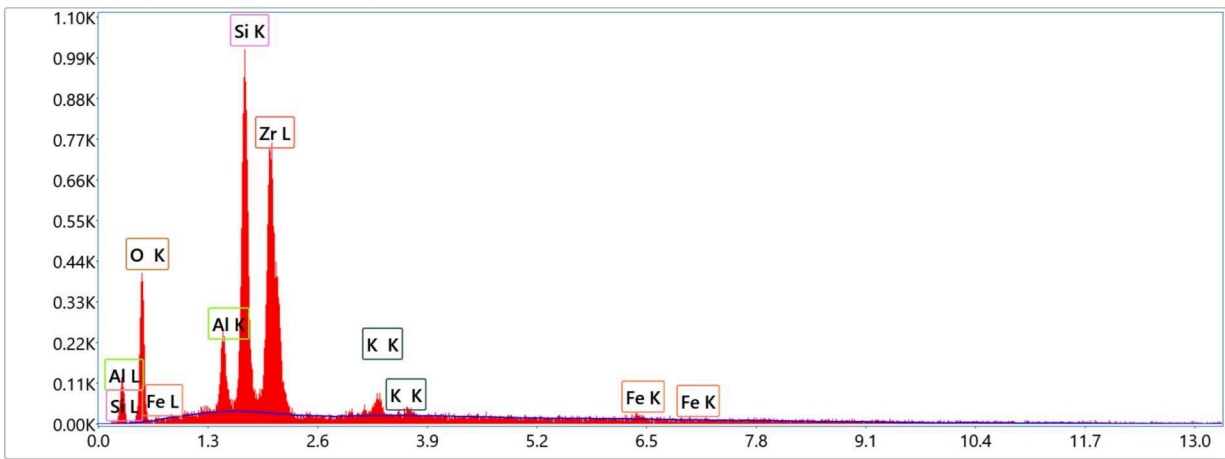
Area 2

Plate 23. Electron backscattered image of an altered primary mica, possibly biotite?



Spot 1

Energy Dispersive Spectrum



Det: Element

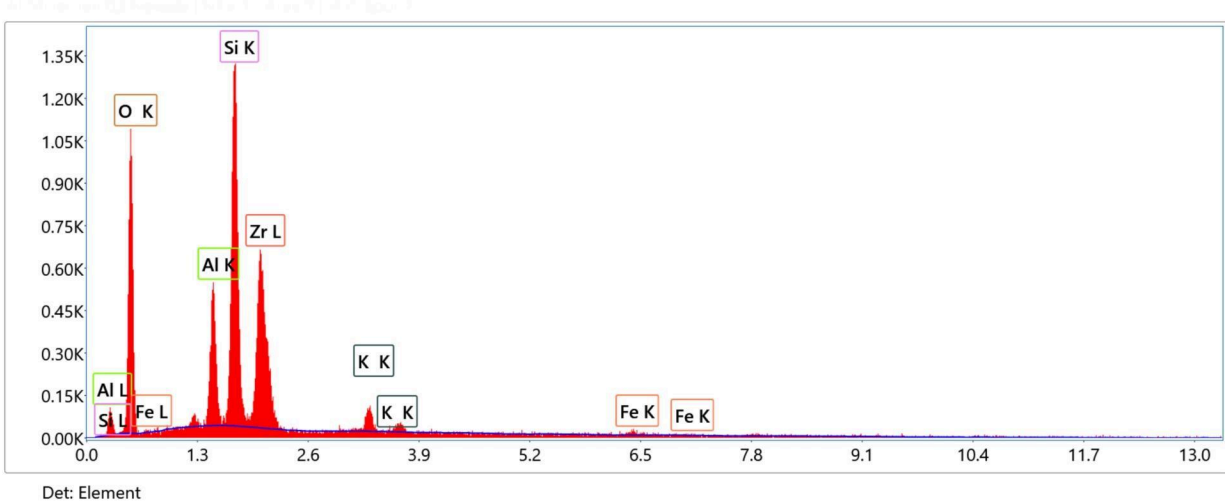
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	36.7	65.0
Al K	3.9	4.1
Si K	16.2	16.4
K K	2.5	1.8
Fe K	0.0	0.0
Zr L	40.7	12.7

Interpretation: zircon

Spot 2

Energy Dispersive Spectrum



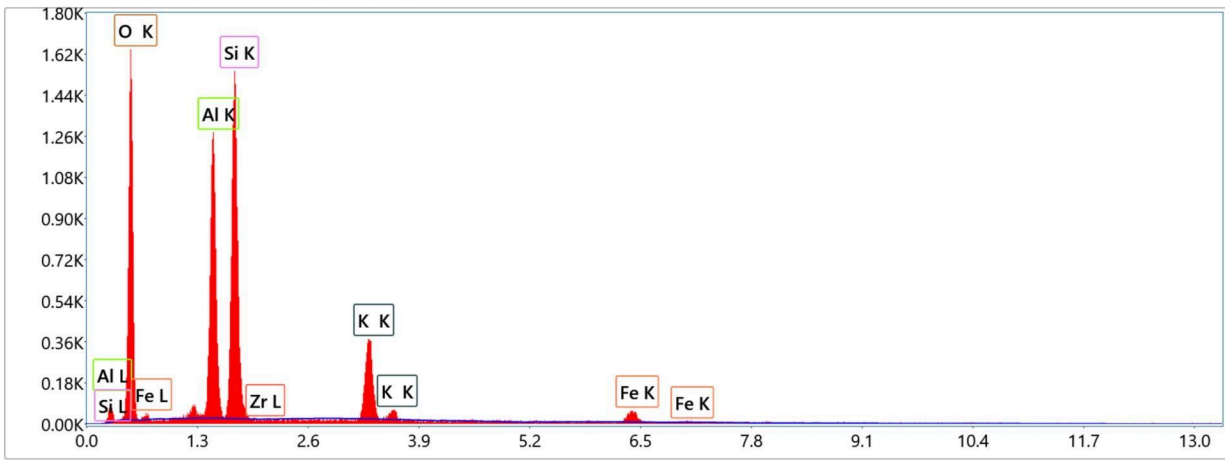
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	50.1	73.5
Al K	6.1	5.3
Si K	15.6	13.0
K K	2.0	1.2
Fe K	1.3	0.5
Zr L	24.8	6.4

Interpretation: mixture – zircon and sericite. sericite after a mica/biotite?

Spot 3

Energy Dispersive Spectrum



Det: Element

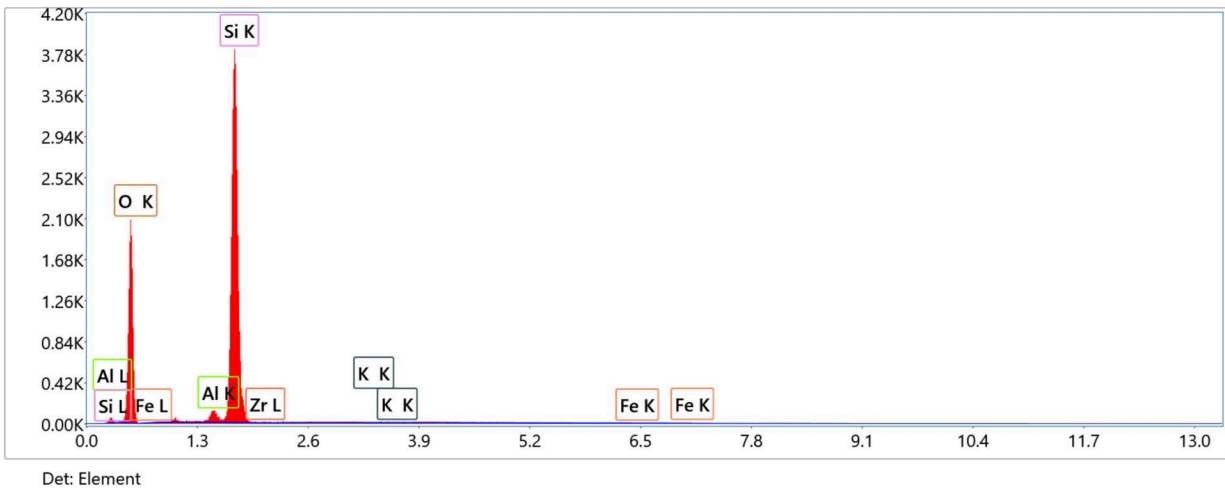
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	54.8	69.5
Al K	15.2	11.4
Si K	19.5	14.1
K K	7.7	4.0
Fe K	2.9	1.0
Zr L	0.0	0.0

Interpretation: sericite with Fe

Spot 4

Energy Dispersive Spectrum



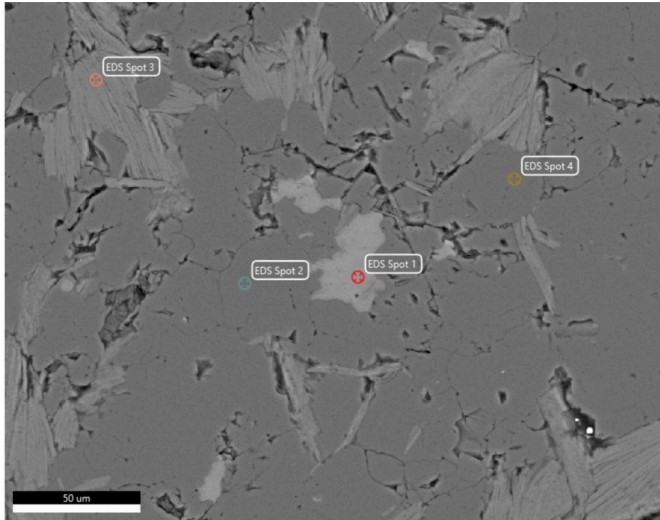
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	57.9	70.8
Al K	1.8	1.3
Si K	39.8	27.7
K K	0.1	0.1
Fe K	0.3	0.1
Zr L	0.1	0.0

Interpretation: quartz with minor sericite

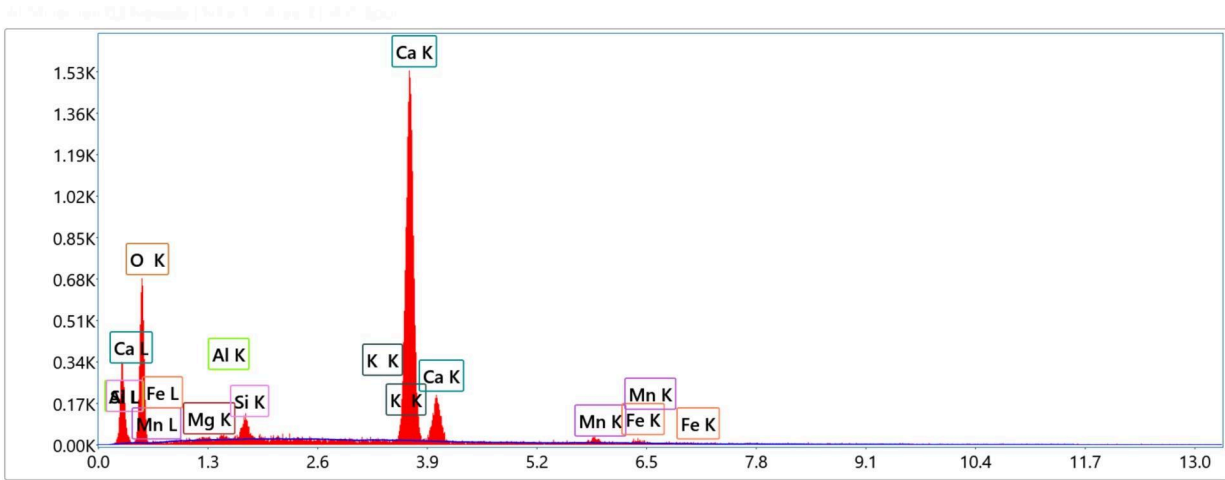
Area 3

Plate 24. Electron backscattered image sericite splays in the altered groundmass



Spot 1

Energy Dispersive Spectrum



Det: Element

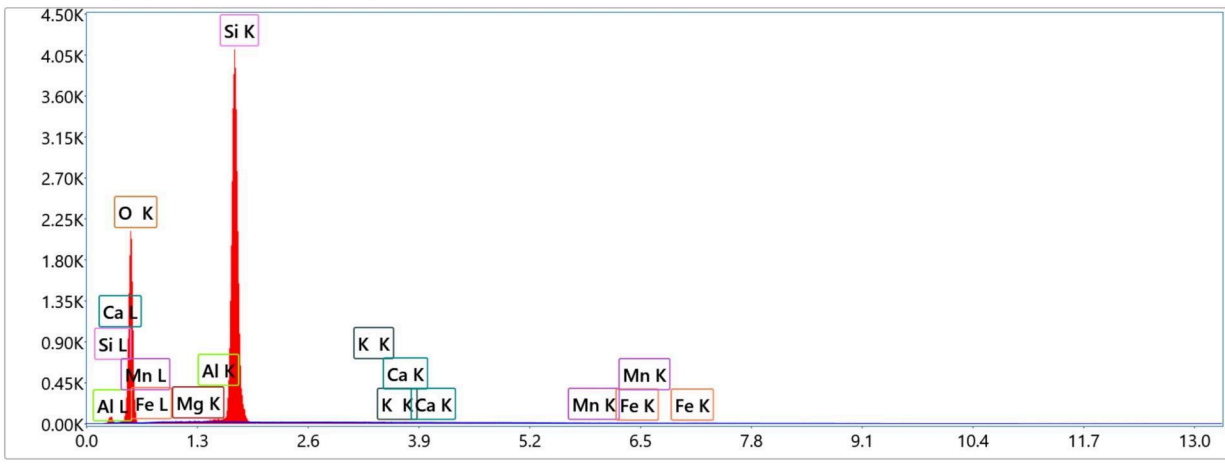
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	56.0	76.0
Mg K	0.4	0.4
Al K	0.4	0.3
Si K	1.4	1.0
K K	0.2	0.1
Ca K	39.5	21.4
Mn K	1.3	0.5
Fe K	0.8	0.3

Interpretation: calcite with minor Mn and trace Mg and Fe

Spot 2

Energy Dispersive Spectrum



Det: Element

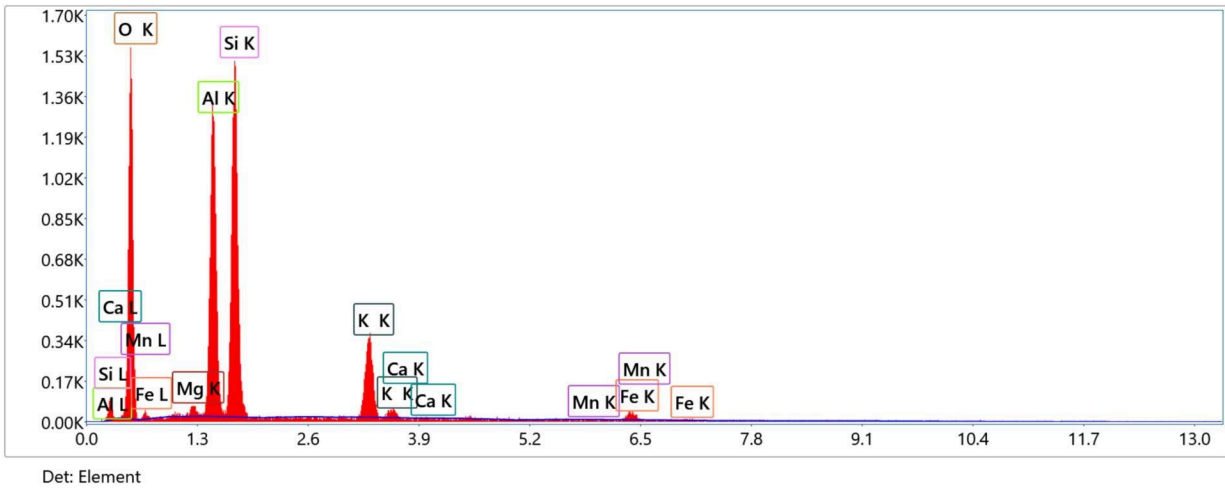
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	57.5	70.5
Mg K	0.4	0.3
Al K	0.6	0.5
Si K	40.8	28.5
K K	0.1	0.0
Ca K	0.1	0.0
Mn K	0.3	0.1
Fe K	0.2	0.1

Interpretation: quartz

Spot 3

Energy Dispersive Spectrum



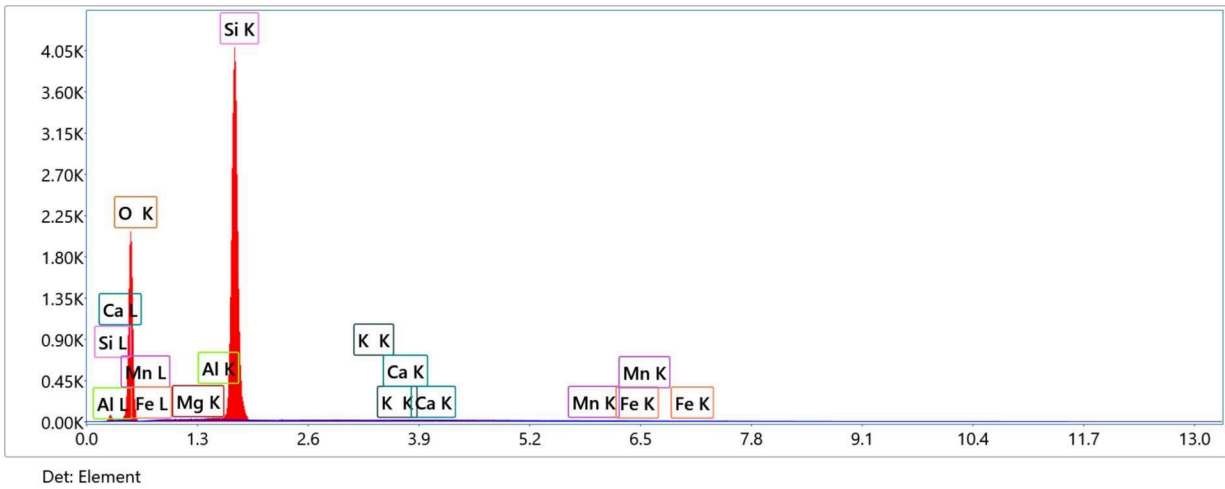
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	54.2	68.5
Mg K	0.8	0.7
Al K	16.2	12.1
Si K	19.7	14.2
K K	7.5	3.9
Ca K	0.0	0.0
Mn K	0.0	0.0
Fe K	1.6	0.6

Interpretation: sericite with minor Fe and trace Mg

Spot 4

Energy Dispersive Spectrum



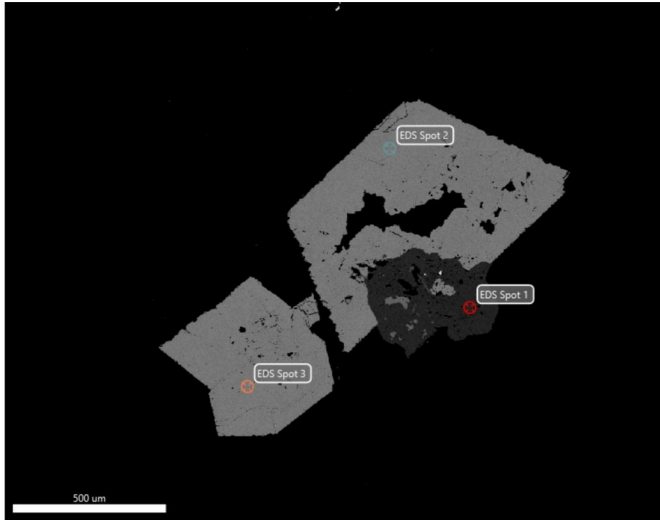
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	57.8	70.7
Mg K	0.4	0.3
Al K	0.6	0.4
Si K	41.0	28.5
K K	0.1	0.0
Ca K	0.1	0.0
Mn K	0.1	0.0
Fe K	0.1	0.0

Interpretation: quartz

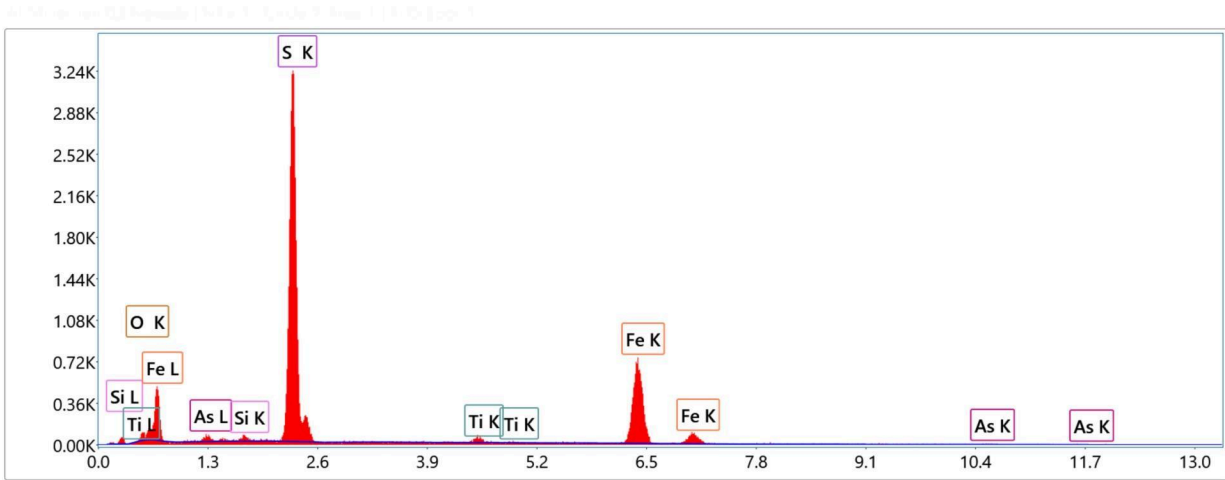
Circle 2 Area 1

Plate 25. Electron backscattered image of poikiloblastic arsenopyrite and pyrite



Spot 1

Energy Dispersive Spectrum



Det: Element

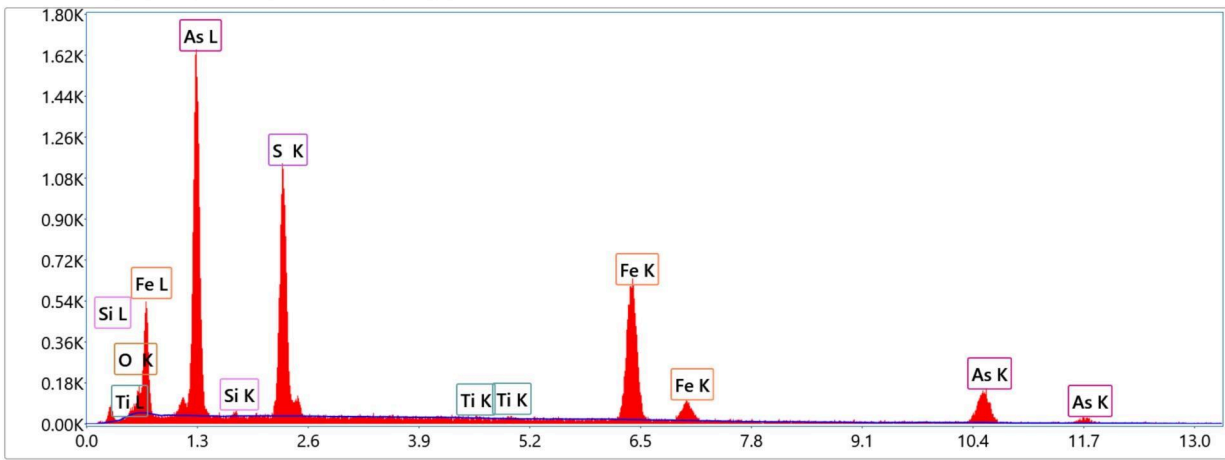
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	3.8	9.1
Si K	0.8	1.1
S K	48.6	57.7
Ti K	1.6	1.3
Fe K	45.1	30.8
As K	0.0	0.0

Interpretation: pyrite

Spot 1

Energy Dispersive Spectrum



Det: Element

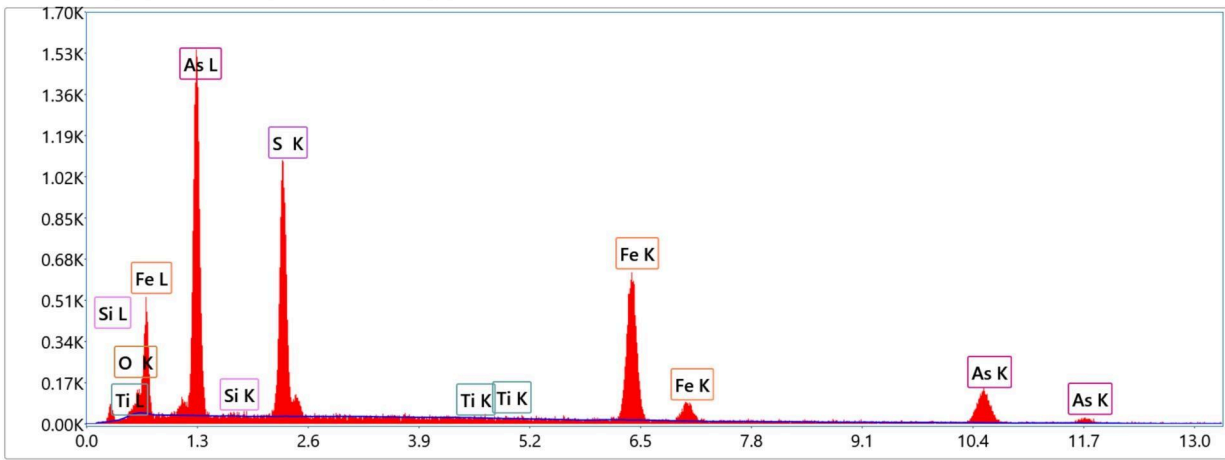
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	1.2	3.8
Si K	0.3	0.5
S K	19.3	31.9
Ti K	0.3	0.3
Fe K	32.1	30.4
As K	46.8	33.1

Interpretation: arsenopyrite

Spot 3

Energy Dispersive Spectrum



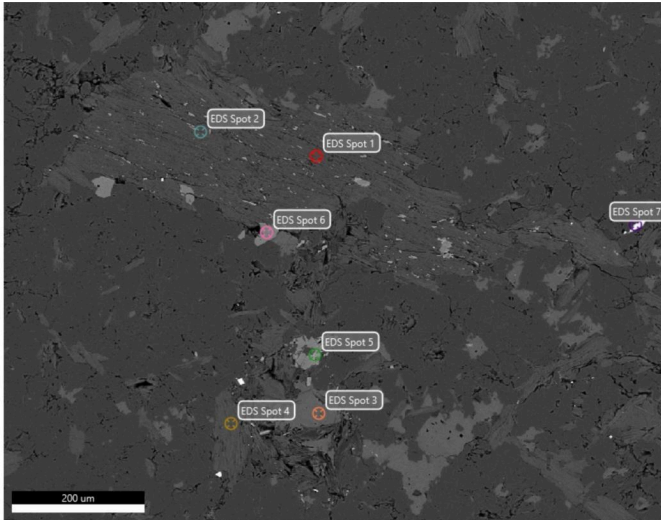
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	1.3	4.4
Si K	0.4	0.7
S K	18.8	31.0
Ti K	0.2	0.2
Fe K	31.2	29.6
As K	48.1	34.1

Interpretation: arsenopyrite

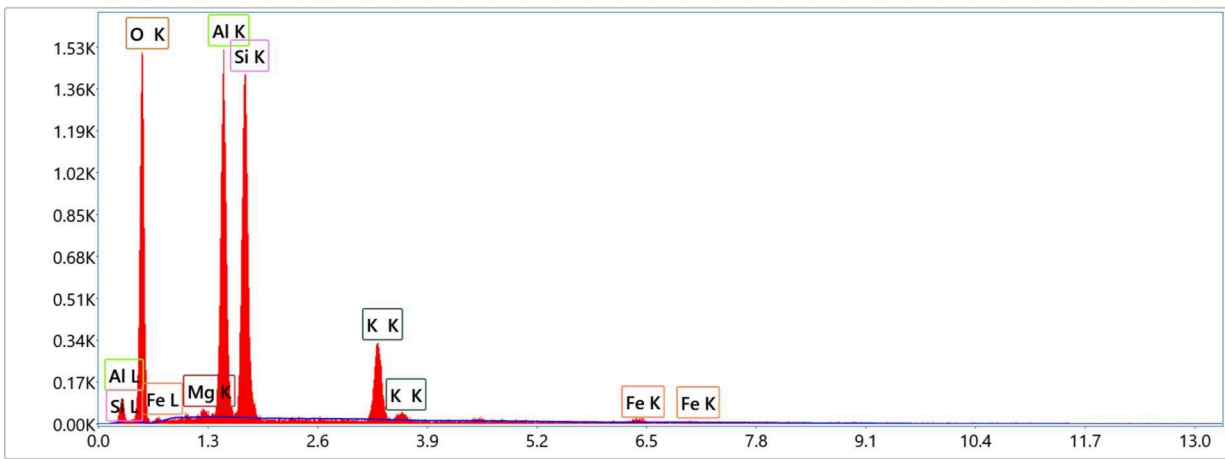
Circle 2 Area 2

Plate 26. Electron backscattered image of the altered groundmass



Spot 1

Energy Dispersive Spectrum



Det: Element

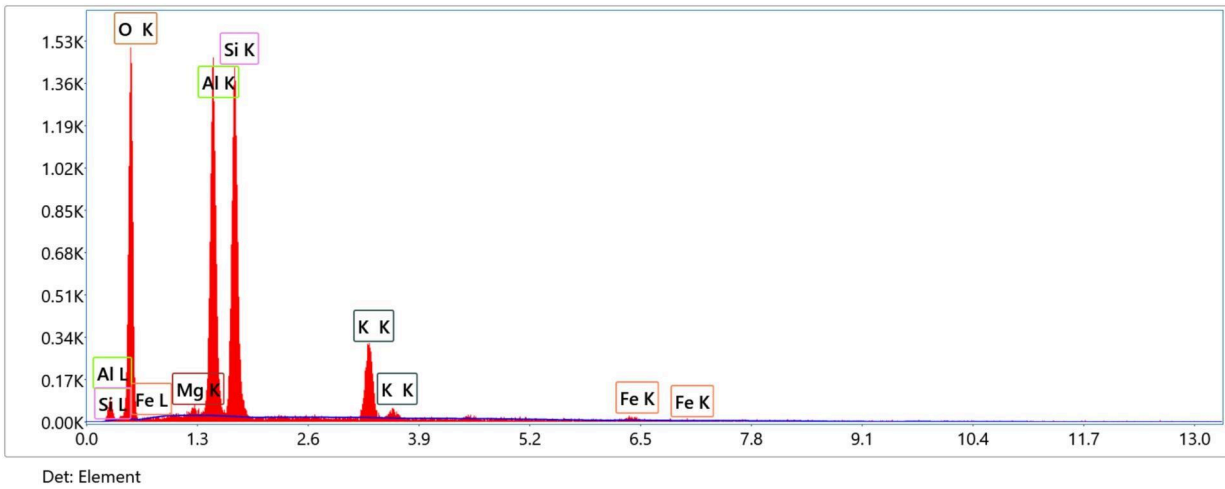
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	54.9	68.9
Mg K	0.5	0.4
Al K	17.2	12.8
Si K	19.4	13.9
K K	7.0	3.6
Fe K	1.0	0.3

Interpretation: sericite with minor Fe and trace Mg

Spot 2

Energy Dispersive Spectrum



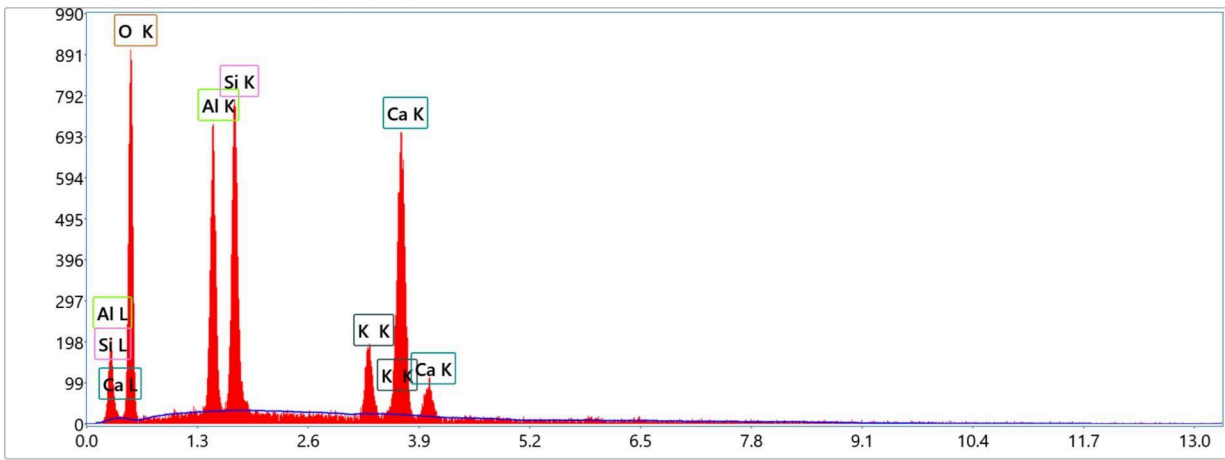
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	54.6	68.6
Mg K	0.7	0.5
Al K	17.6	13.1
Si K	19.3	13.8
K K	6.9	3.5
Fe K	1.0	0.4

Interpretation: sericite with minor Fe and trace Mg

Spot 3

Energy Dispersive Spectrum



Det: Element

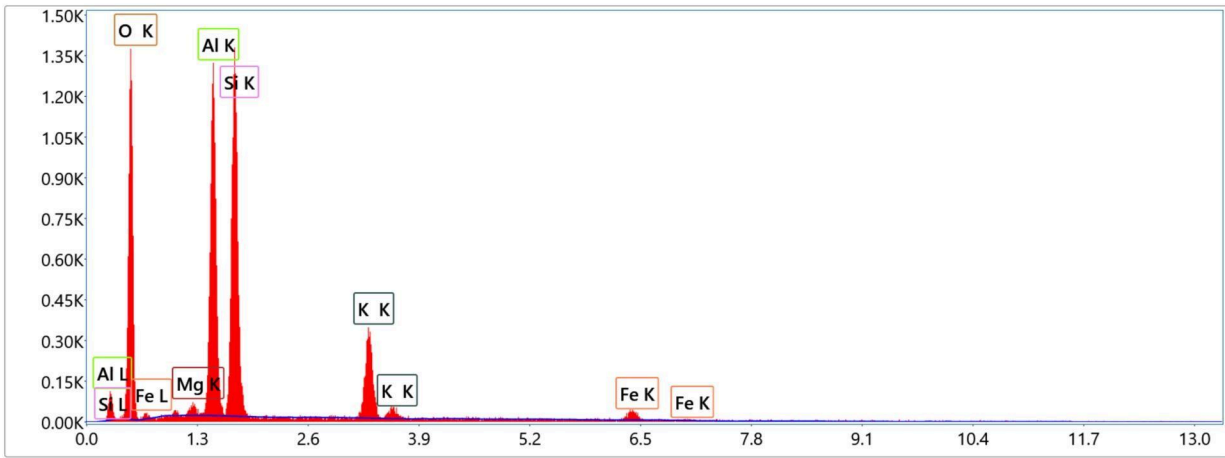
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	56.6	72.9
Al K	9.5	7.2
Si K	10.6	7.8
K K	3.5	1.9
Ca K	19.8	10.2

Interpretation: sericite + calcite

Spot 4

Energy Dispersive Spectrum



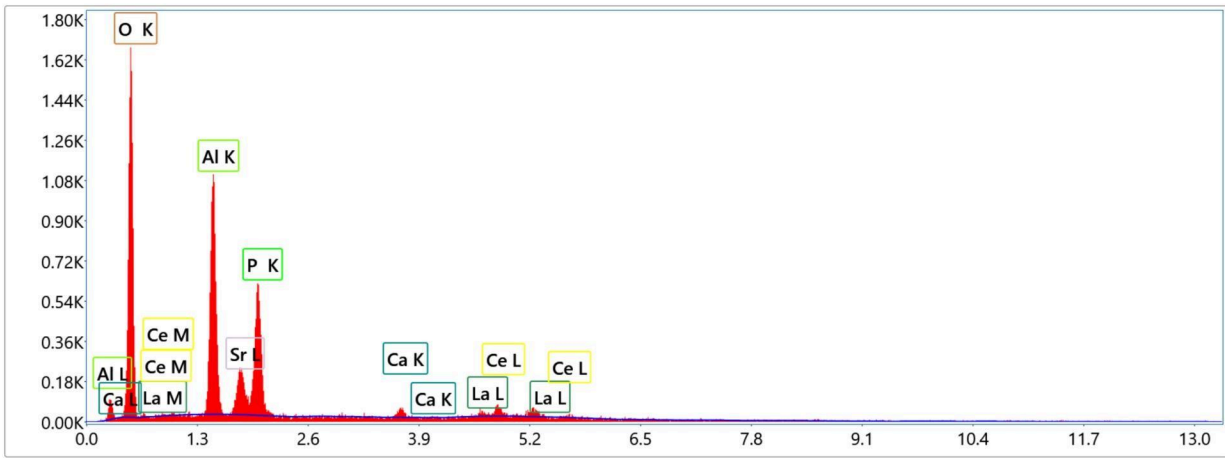
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	52.8	67.5
Mg K	0.8	0.7
Al K	16.7	12.7
Si K	19.5	14.2
K K	7.8	4.1
Fe K	2.3	0.8

Interpretation: Interpretation: sericite with minor Fe and trace Mg

Spot 5

Energy Dispersive Spectrum



Det: Element

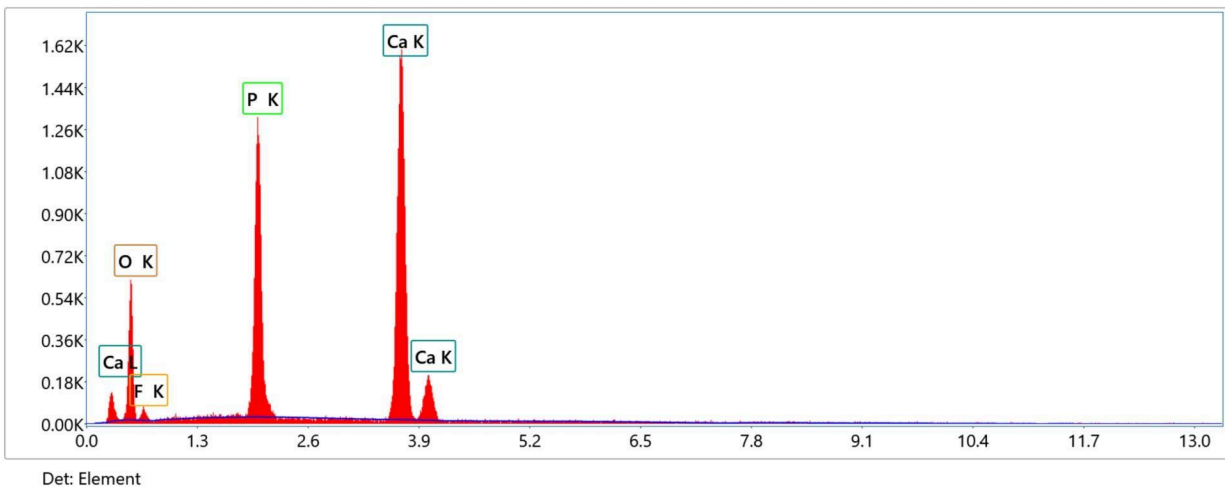
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	57.5	76.4
Al K	15.8	12.4
P K	11.3	7.7
Ca K	1.2	0.6
Sr L	7.9	1.9
La L	2.0	0.3
Ce L	4.3	0.7

Interpretation: crandallite group, possibly goyazite $(\text{SrAl}_3(\text{PO}_4)_2(\text{OH})_5 \cdot \text{H}_2\text{O})$

Spot 6

Energy Dispersive Spectrum



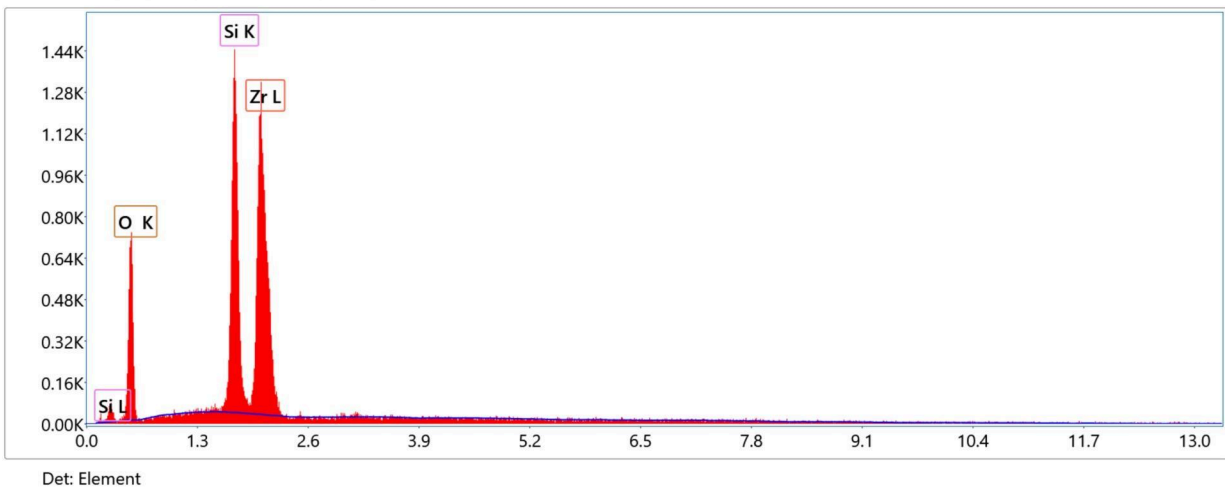
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	43.4	62.5
F K	3.7	4.5
P K	15.6	11.6
Ca K	37.3	21.5

Interpretation: fluorapatite

Spot 7

Energy Dispersive Spectrum



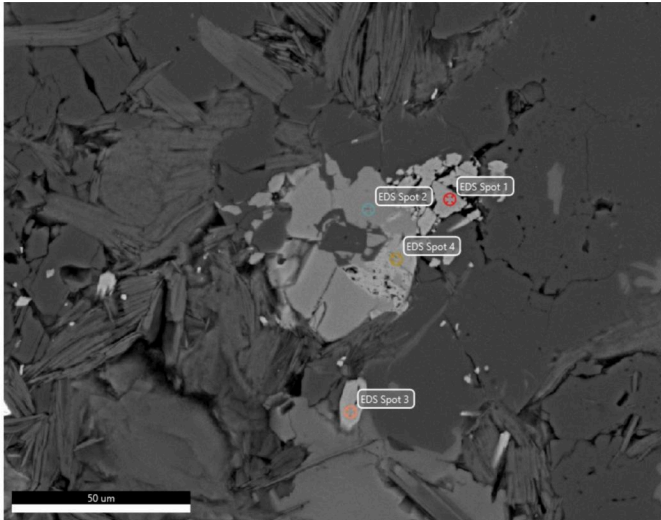
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	42.5	72.7
Si K	14.9	14.6
Zr L	42.6	12.8
O K	42.5	72.7

Interpretation: zircon

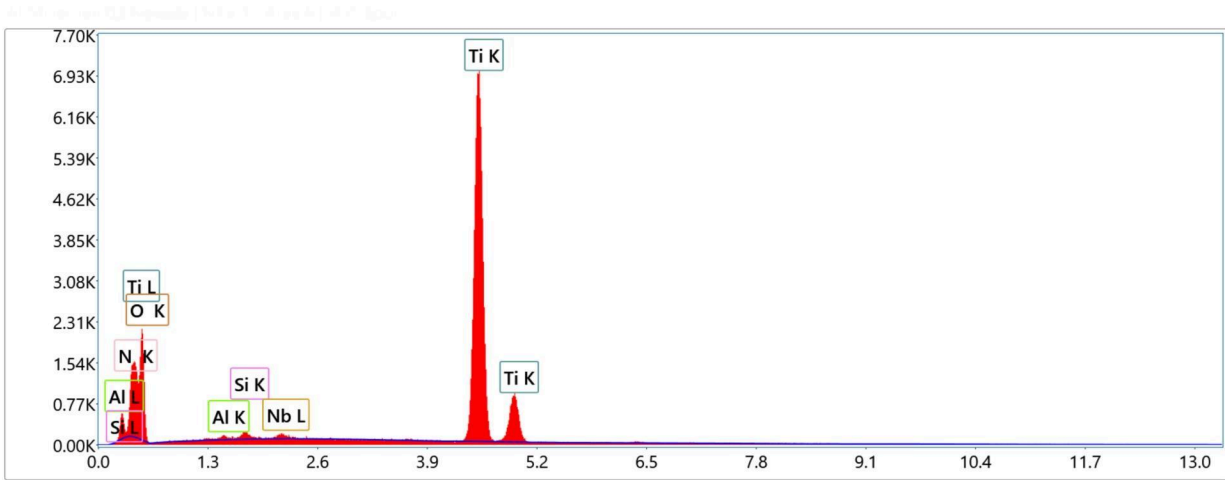
Circle 2 Area 3

Plate 27. Electron backscattered image shows rare minerals in the altered groundmass



Spot 1

Energy Dispersive Spectrum



Det: Element

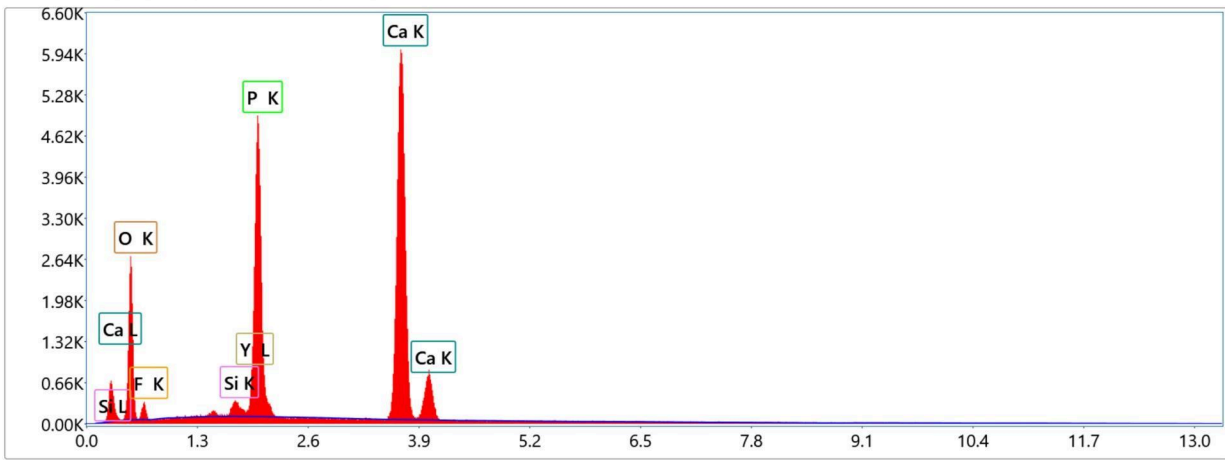
Semi-quantitative analyses

Element	Weight %	Atomic %
N K	4.3	7.5
O K	43.7	66.1
Al K	0.5	0.4
Si K	0.5	0.5
Ti K	50.1	25.3
Nb L	0.8	0.2

Interpretation: niobium-bearing rutile

Spot 2

Energy Dispersive Spectrum



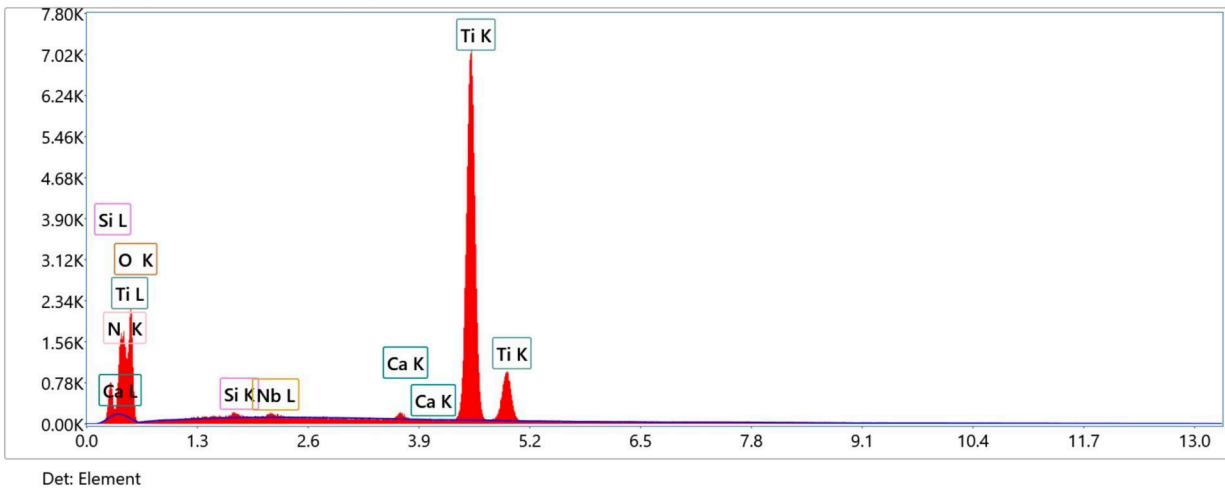
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	44.7	63.9
F K	4.0	4.9
Si K	0.8	0.6
P K	13.6	10.1
Ca K	35.2	20.1
Y L	1.6	0.4

Interpretation: fluorapatite

Spot 3

Energy Dispersive Spectrum



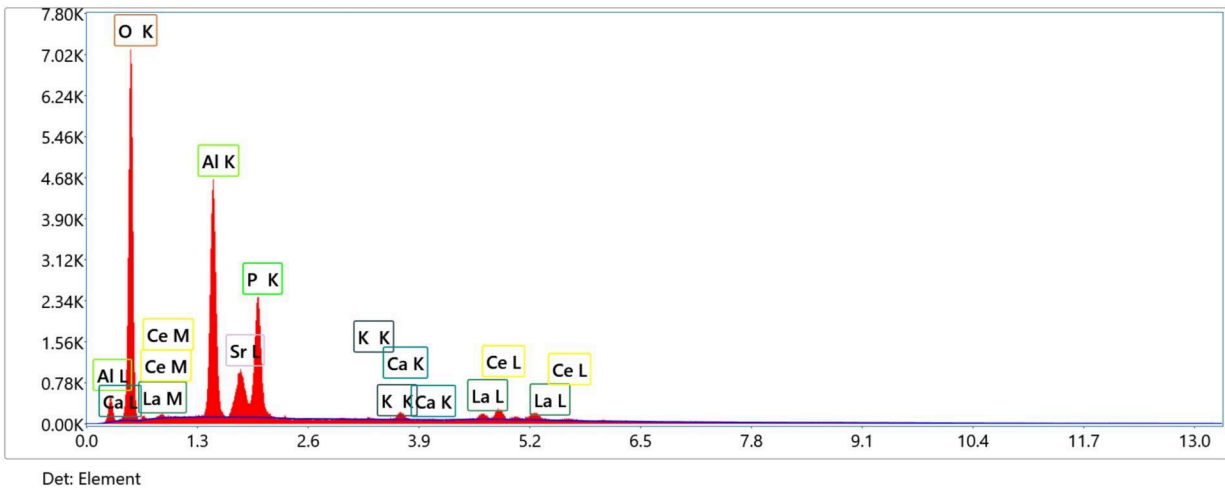
Semi-quantitative analyses

Element	Weight %	Atomic %
N K	0.2	0.3
O K	44.7	70.5
Si K	0.5	0.4
Ca K	0.5	0.3
Ti K	53.5	28.2
Nb L	0.7	0.2

Interpretation: niobium-bearing rutile

Spot 4

Energy Dispersive Spectrum



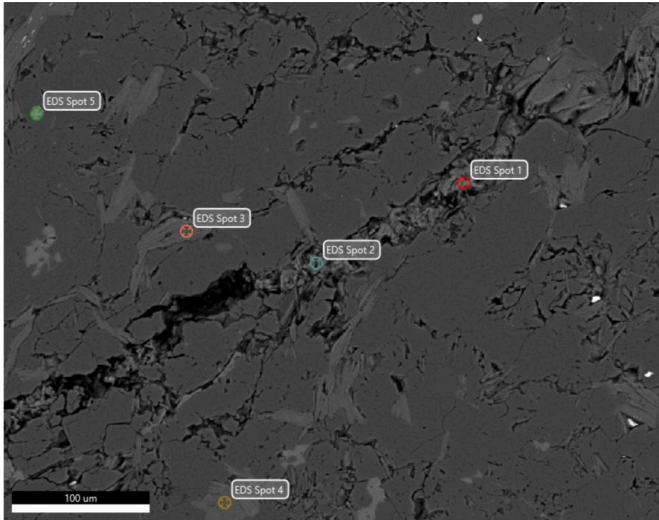
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	57.5	76.8
Al K	15.6	12.3
P K	10.2	7.1
K K	0.2	0.1
Ca K	0.9	0.5
Sr L	9.0	2.2
La L	2.3	0.4
Ce L	4.3	0.7

Interpretation: crandallite group, possibly goyazite $(\text{SrAl}_3(\text{PO}_4)_2(\text{OH})_5 \cdot \text{H}_2\text{O})$

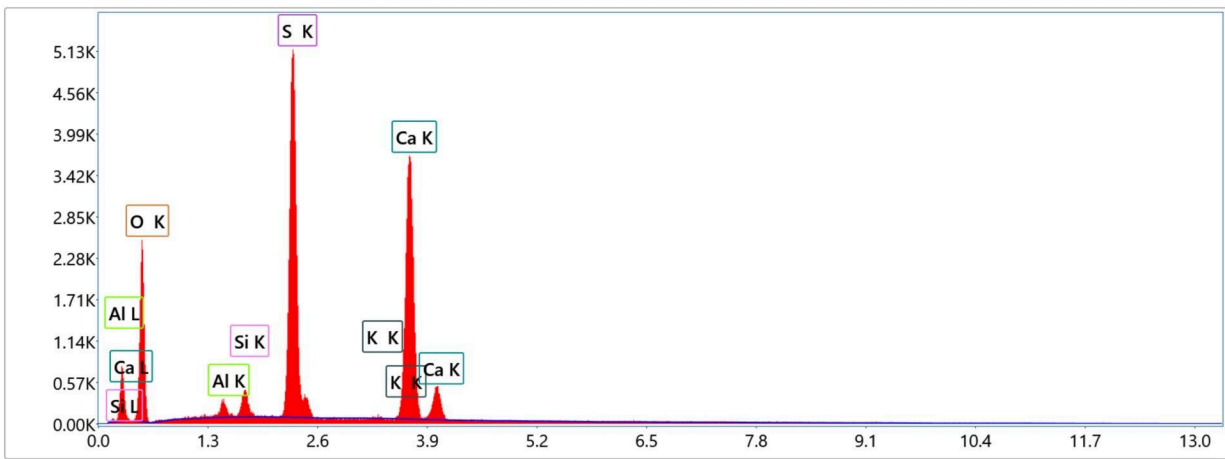
Circle 4 Area 1

Plate 28: Electron backscattered image shows the texture of the altered groundmass



Spot 1

Energy Dispersive Spectrum



Det: Element

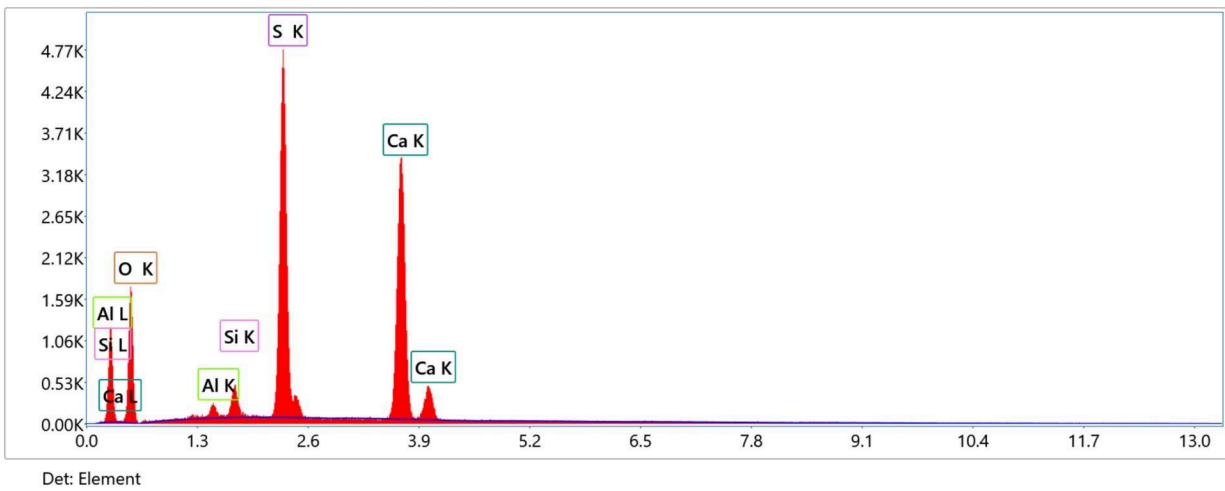
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	50.8	69.7
Al K	1.1	0.9
Si K	1.3	1.0
S K	19.3	13.3
K K	0.1	0.1
Ca K	27.4	15.0

Interpretation: gypsum or anhydrite with trace clay (kaolinite); is this primary or secondary?

Spot 2

Energy Dispersive Spectrum



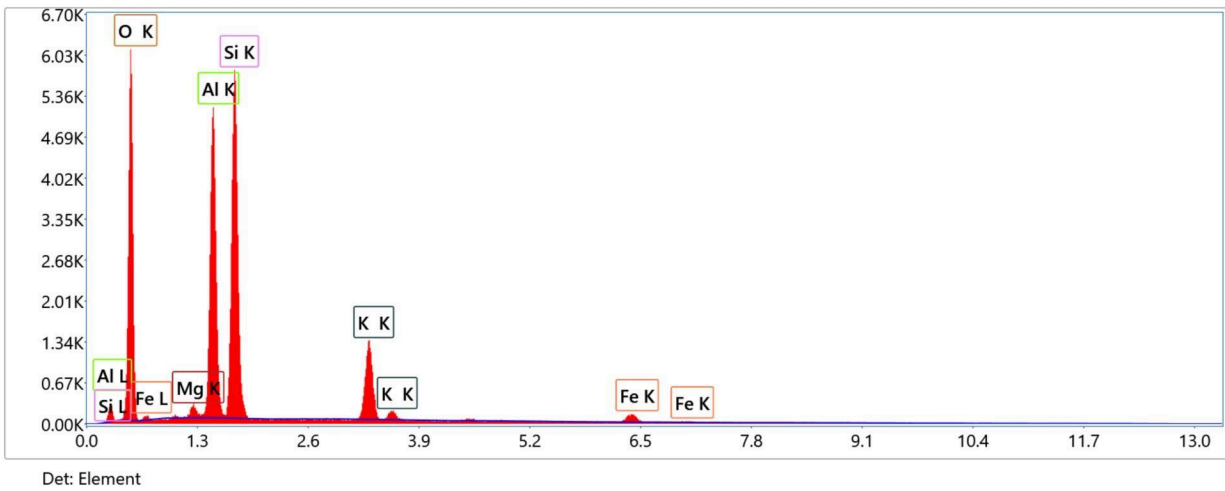
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	46.4	65.9
Al K	1.0	0.8
Si K	1.7	1.4
S K	20.8	14.7
Ca K	30.2	17.1

Interpretation: gypsum or anhydrite with trace clay (kaolinite)

Spot 3

Energy Dispersive Spectrum



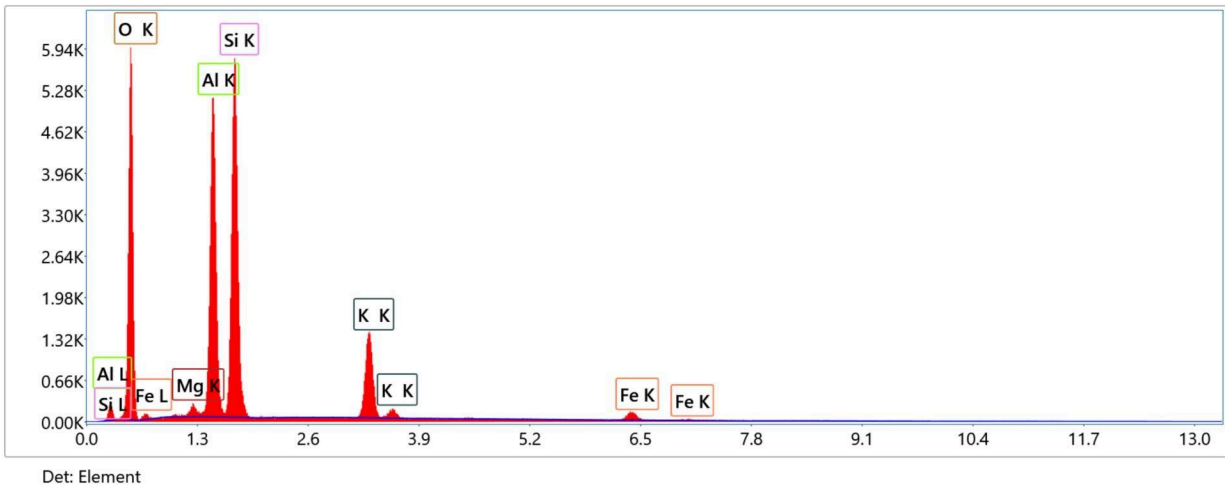
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	54.3	68.7
Mg K	0.9	0.8
Al K	16.1	12.0
Si K	19.6	14.1
K K	7.1	3.7
Fe K	2.0	0.7

Interpretation: sericite with trace Fe and Mg in altered groundmass of dyke

Spot 4

Energy Dispersive Spectrum



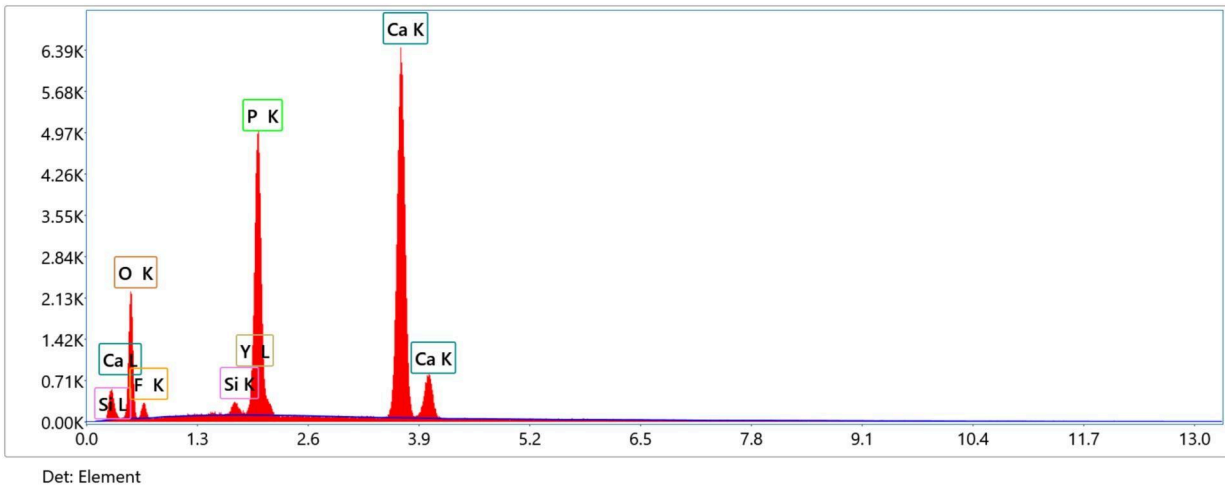
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	53.8	68.3
Mg K	1.0	0.8
Al K	16.1	12.1
Si K	19.4	14.1
K K	7.7	4.0
Fe K	2.0	0.7

Interpretation: sericite with trace Fe and Mg in altered groundmass of dyke

Spot 5

Energy Dispersive Spectrum



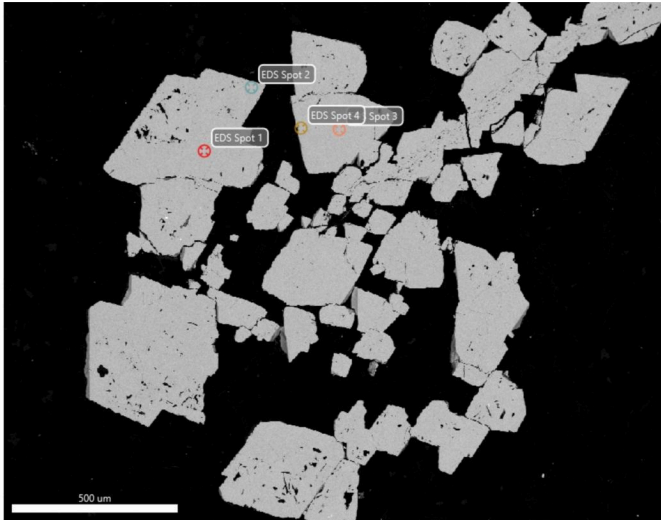
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	41.8	61.0
F K	4.3	5.3
Si K	0.7	0.5
P K	14.8	11.2
Ca K	37.2	21.7
Y L	1.3	0.3

Interpretation: fluorapatite

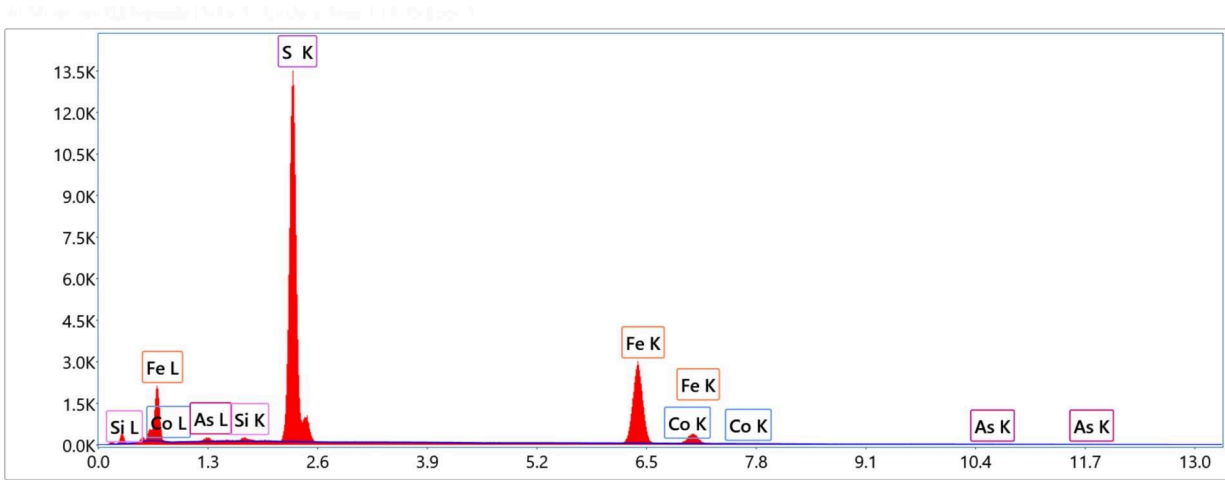
Circle 5 Area 1

Plate 29. Electron backscattered image of an elongated cluster of poikiloblastic euhedral pyrite



Spot 1

Energy Dispersive Spectrum



Det: Element

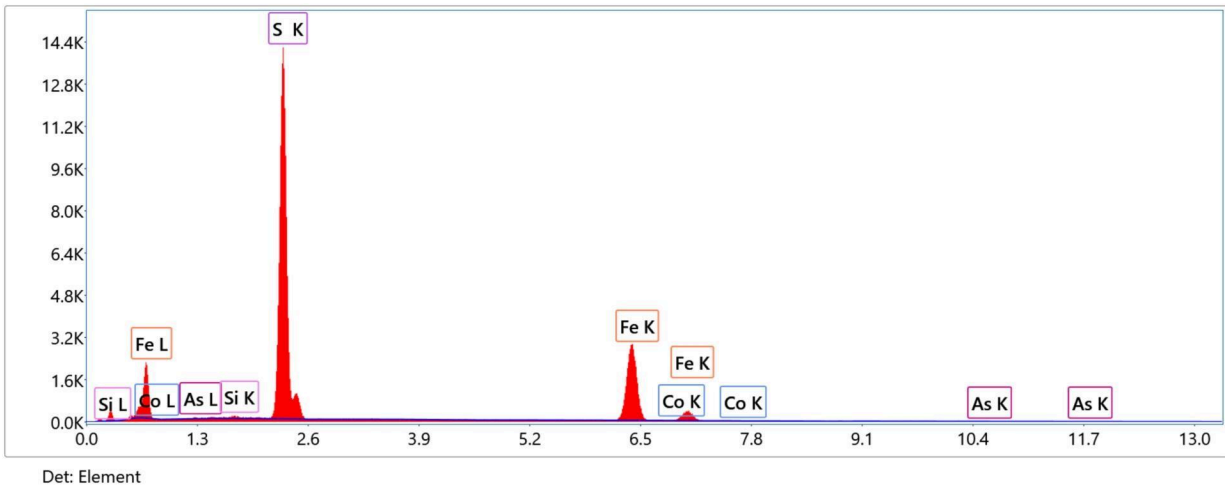
Semi-quantitative analyses

Element	Weight %	Atomic %
Si K	0.7	1.0
S K	51.6	64.8
Fe K	45.5	32.9
Co K	0.4	0.3
As K	1.8	1.0

Interpretation: arsenian pyrite

Spot 2

Energy Dispersive Spectrum



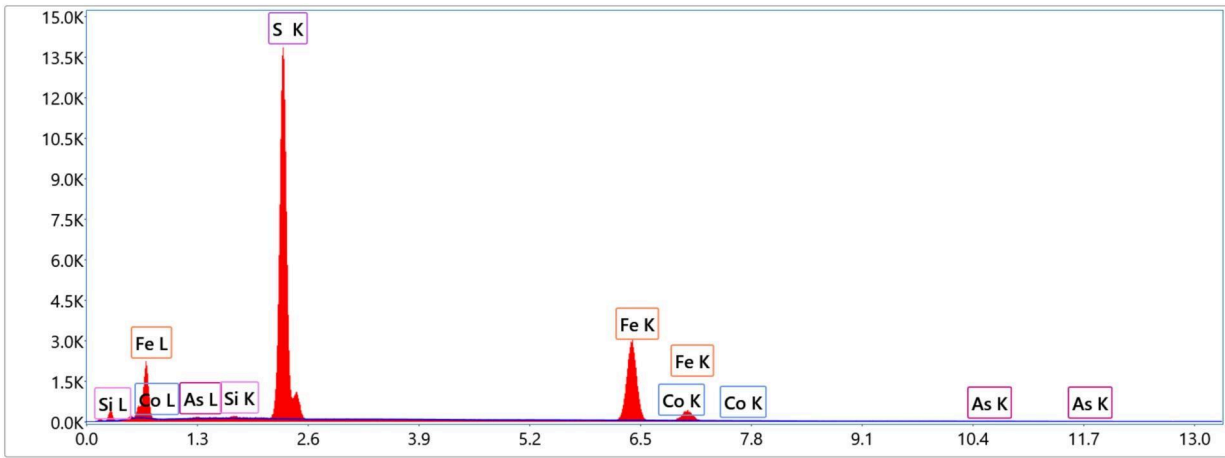
Semi-quantitative analyses

Element	Weight %	Atomic %
Si K	0.6	0.9
S K	52.2	65.4
Fe K	45.6	32.8
Co K	0.4	0.3
As K	1.1	0.6

Interpretation: arsenian pyrite

Spot 3

Energy Dispersive Spectrum



Det: Element

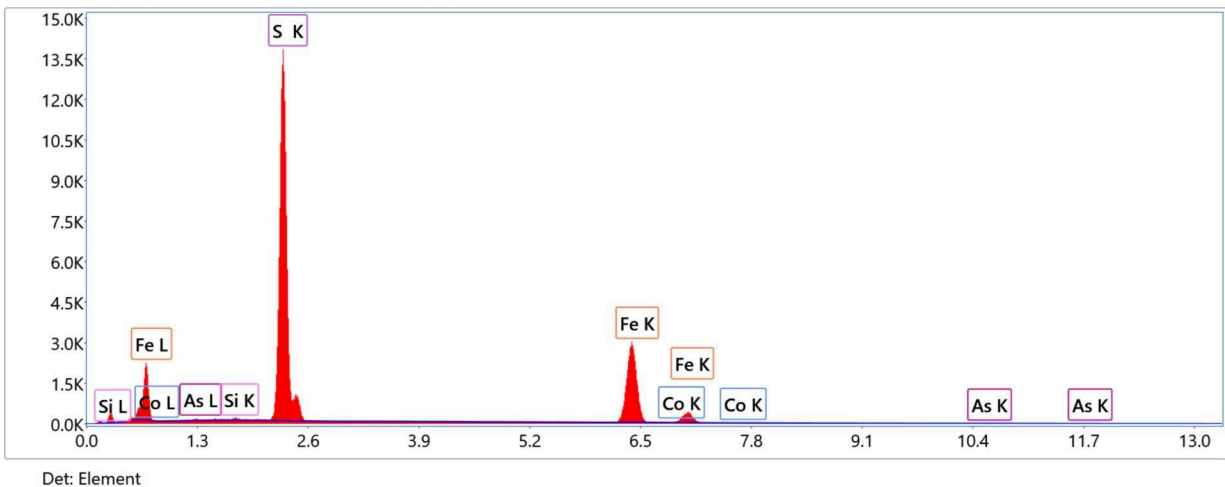
Semi-quantitative analyses

Element	Weight %	Atomic %
Si K	0.5	0.8
S K	52.1	65.4
Fe K	45.4	32.7
Co K	0.5	0.3
As K	1.4	0.8

Interpretation: arsenian pyrite

Spot 4

Energy Dispersive Spectrum



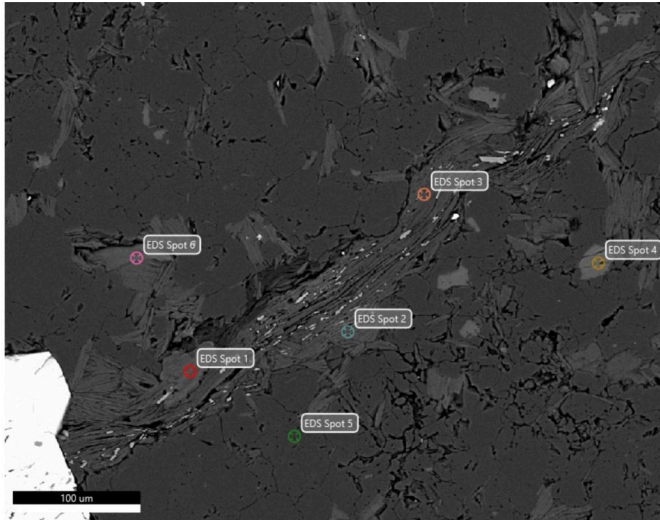
Semi-quantitative analyses

Element	Weight %	Atomic %
Si K	0.5	0.7
S K	51.7	65.0
Fe K	45.9	33.2
Co K	0.4	0.3
As K	1.5	0.8

Interpretation: arsenian pyrite

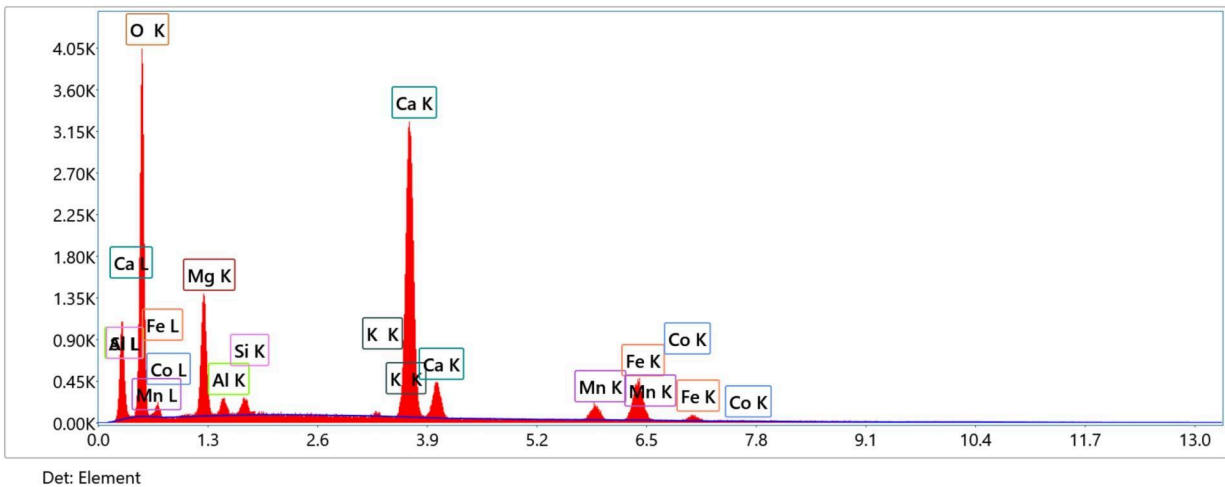
Circle 5 Area 2

Plate 30. Electron backscattered image of a fracture filled with multiple minerals. The pyrite grain shown in the lower left hand corner is part of the cluster of pyrite shown in the preceding electron backscattered image.



Spot 1

Energy Dispersive Spectrum



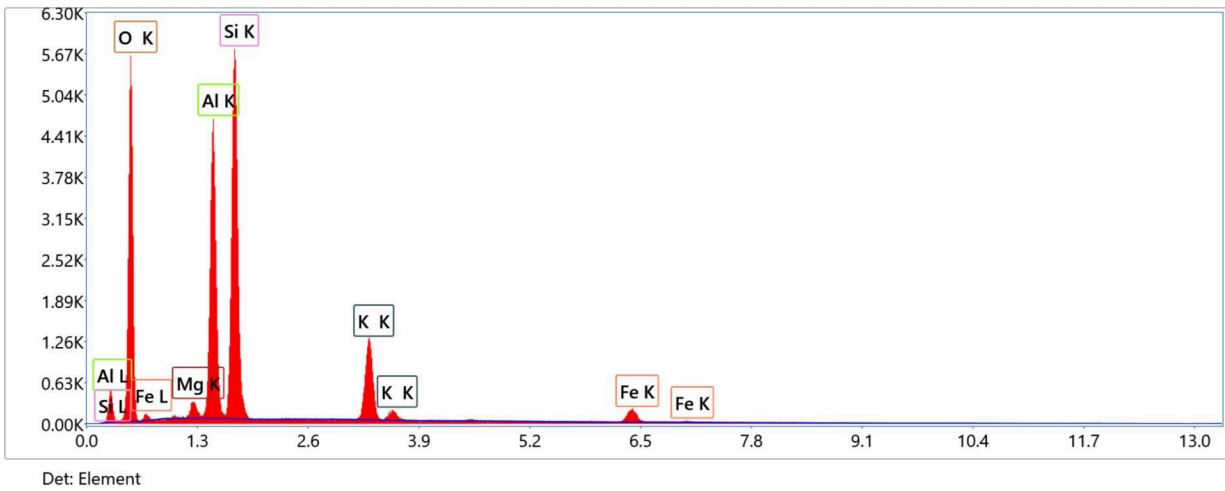
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	57.2	75.9
Mg K	7.2	6.3
Al K	1.0	0.8
Si K	0.8	0.6
K K	0.2	0.1
Ca K	23.4	12.4
Mn K	2.6	1.0
Fe K	7.3	2.8
Co K	0.2	0.1

Interpretation: mixture of anhydrite/gypsum and carbonate

Spot 2

Energy Dispersive Spectrum



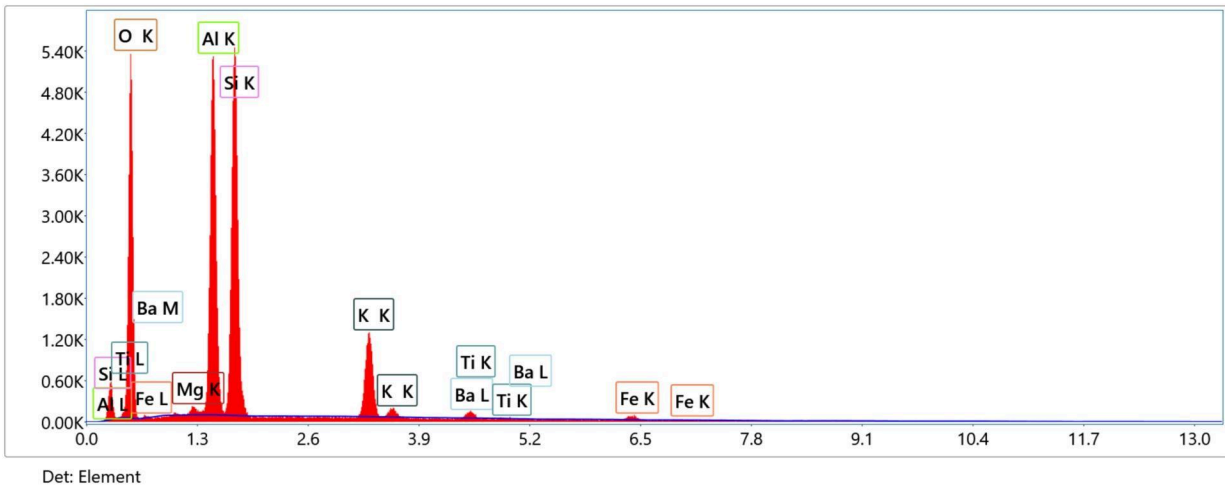
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	52.9	67.7
Mg K	1.3	1.1
Al K	15.1	11.5
Si K	20.1	14.7
K K	7.4	3.9
Fe K	3.2	1.2

Interpretation: sericite with Fe and Mg in the altered groundmass

Spot 3

Energy Dispersive Spectrum



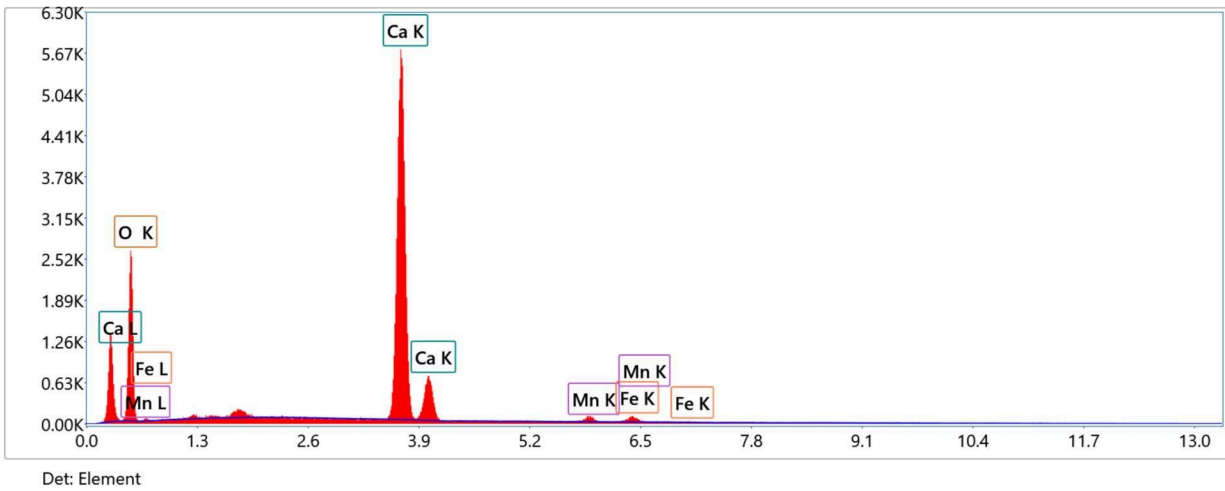
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	52.8	67.3
Mg K	0.6	0.5
Al K	17.4	13.1
Si K	20.0	14.5
K K	7.4	3.9
Ti K	0.7	0.3
Fe K	0.9	0.3
Ba L	0.1	0.0

Interpretation: mixture - sericite with Fe and Mg with rutile, possibly after biotite

Spot 4

Energy Dispersive Spectrum



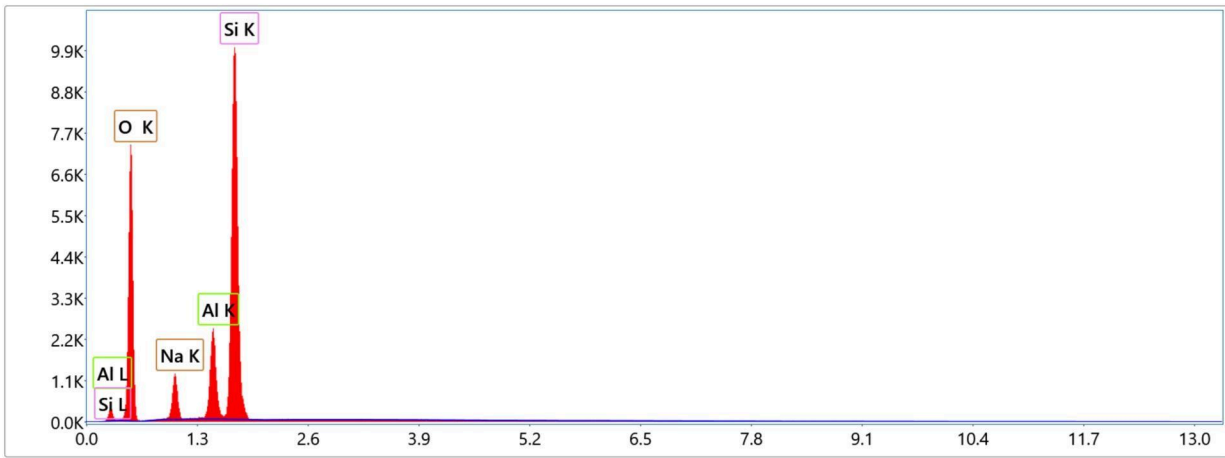
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	56.8	77.1
Ca K	40.4	21.9
Mn K	1.3	0.5
Fe K	1.4	0.6

Interpretation: calcite with minor Mn and trace Mg and Sr (two unmarked peaks)

Spot 5

Energy Dispersive Spectrum



Det: Element

Semi-quantitative analyses

Element	Weight %	Atomic %
O K	53.6	66.1
Na K	6.9	6.0
Al K	7.9	5.8
Si K	31.5	22.1

Interpretation: albite in groundmass

Spot 6

Energy Dispersive Spectrum



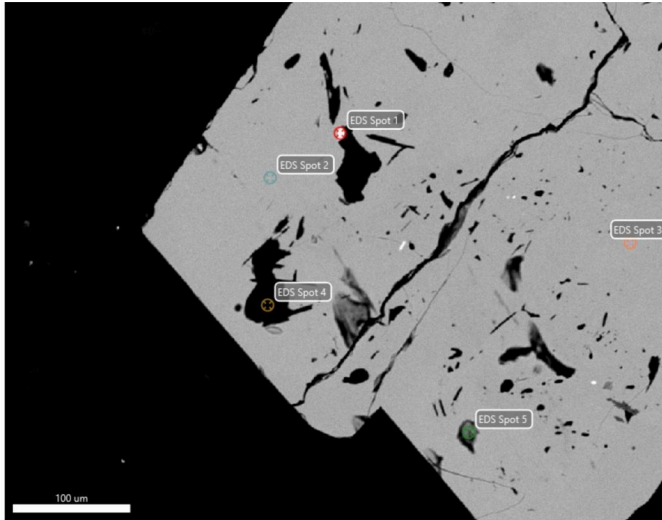
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	55.4	69.9
Mg K	1.3	1.0
Al K	14.1	10.5
Si K	18.8	13.6
K K	7.3	3.8
Fe K	3.2	1.1

Interpretation: sericite with Fe and Mg in the altered groundmass

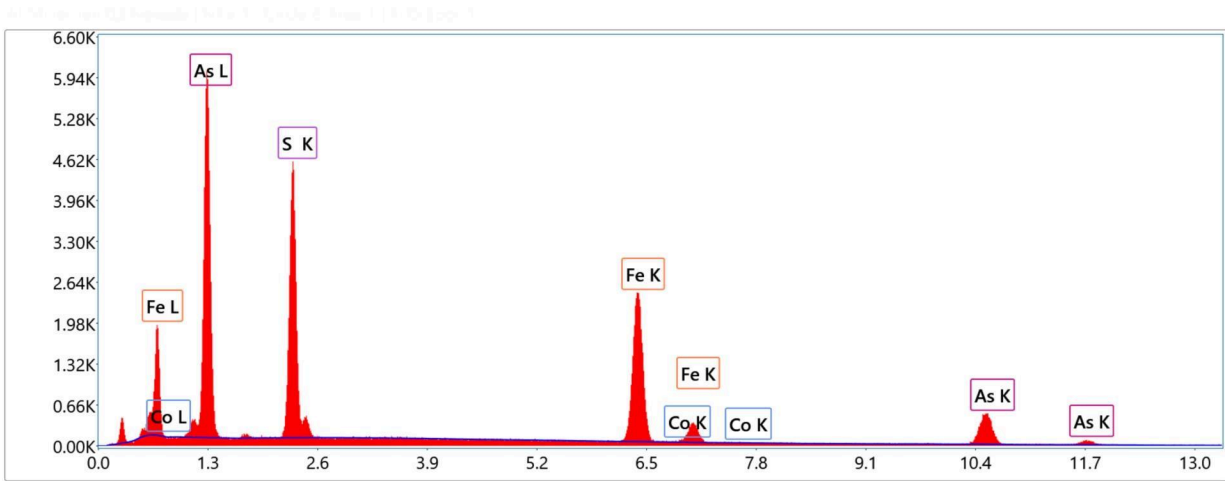
Circle 8 Area 1

Plate 31. Electron backscattered image of poikiloblastic pyrite. Note: 1) the poikiloblastic core and inclusion-free margin and 2) minute bright grains in the poikiloblastic core.



Spot 1

Energy Dispersive Spectrum



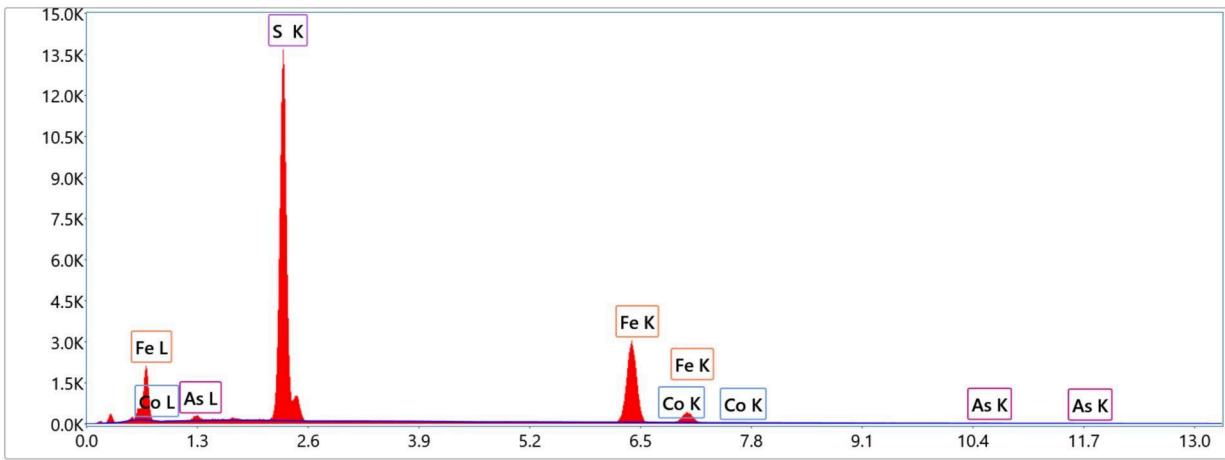
Semi-quantitative analyses

Element	Weight %	Atomic %
S K	20.3	34.1
Fe K	33.6	32.5
Co K	0.6	0.6
As K	45.5	32.8

Interpretation: arsenopyrite as minute grains in the poikiloblastic core of pyrite.

Spot 2

Energy Dispersive Spectrum



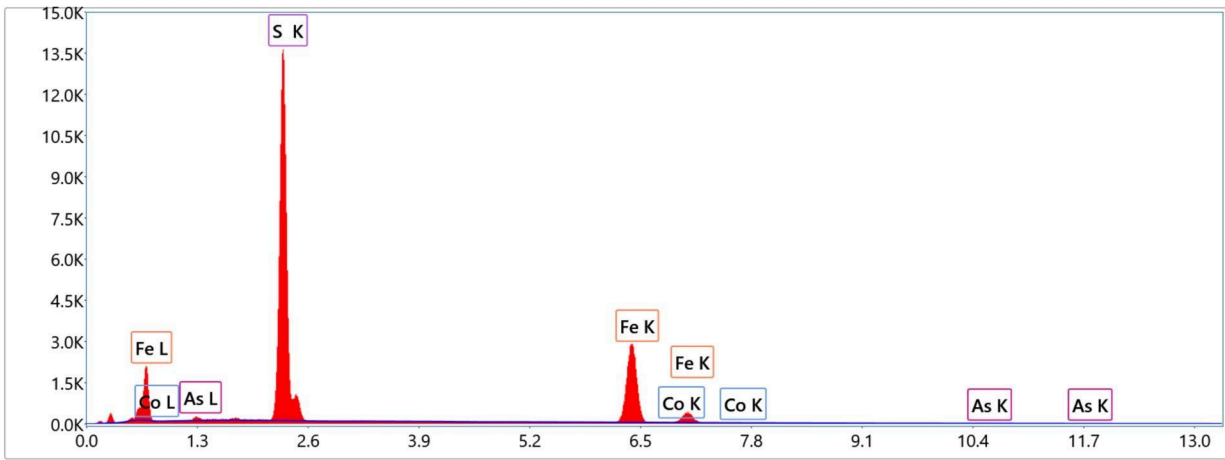
Semi-quantitative analyses

Element	Weight %	Atomic %
S K	51.3	64.9
Fe K	46.2	33.6
Co K	0.4	0.3
As K	2.1	1.1

Interpretation: arsenian pyrite – inclusion-free margin

Spot 3

Energy Dispersive Spectrum



Det: Element

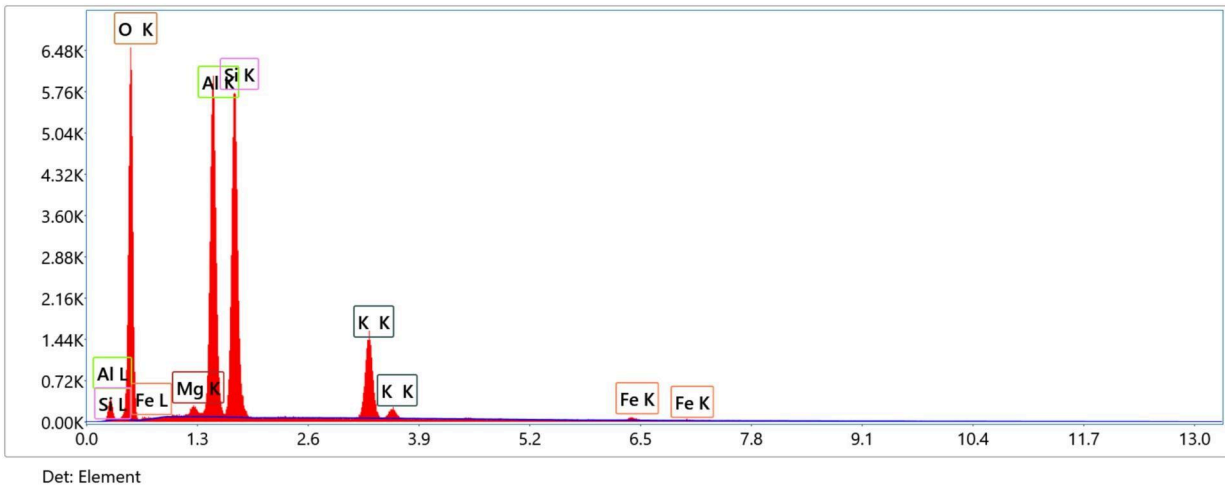
Semi-quantitative analyses

Element	Weight %	Atomic %
S K	51.6	65.2
Fe K	46.0	33.4
Co K	0.5	0.3
As K	2.0	1.1

Interpretation: arsenian pyrite – poikiloblastic core

Spot 4

Energy Dispersive Spectrum



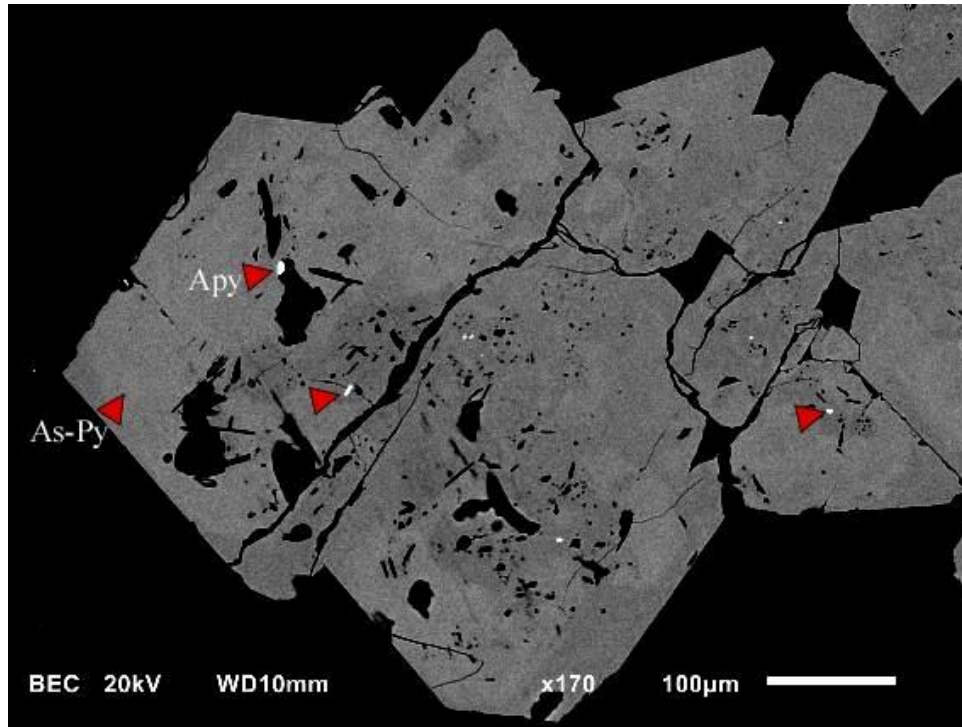
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	55.0	69.0
Mg K	0.9	0.7
Al K	17.3	12.9
Si K	18.5	13.2
K K	7.7	3.9
Fe K	0.7	0.2

Interpretation: sericite with trace Fe and Mg. This mica has the same composition as mica in the altered groundmass. Consequently there is an early sericitization that was accompanied by arsenian pyrite with arsenopyrite

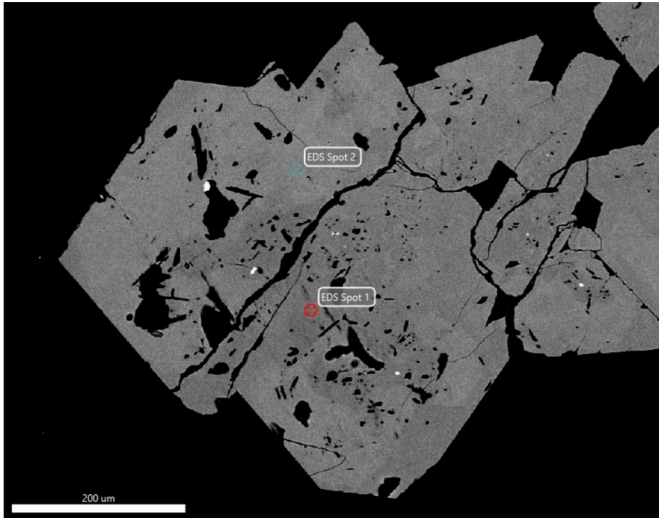
Spot 5 hole no mineral, Fe-S from adjacent pyrite

Plate 32. Electron backscattered image shows the delicate zoning formed by variable abundances of arsenic in arsenian pyrite, see following energy dispersive spectrum and semi-quantitative analyses. Note that the minute arenopyrite (Apy) grains are hosted in both domains.



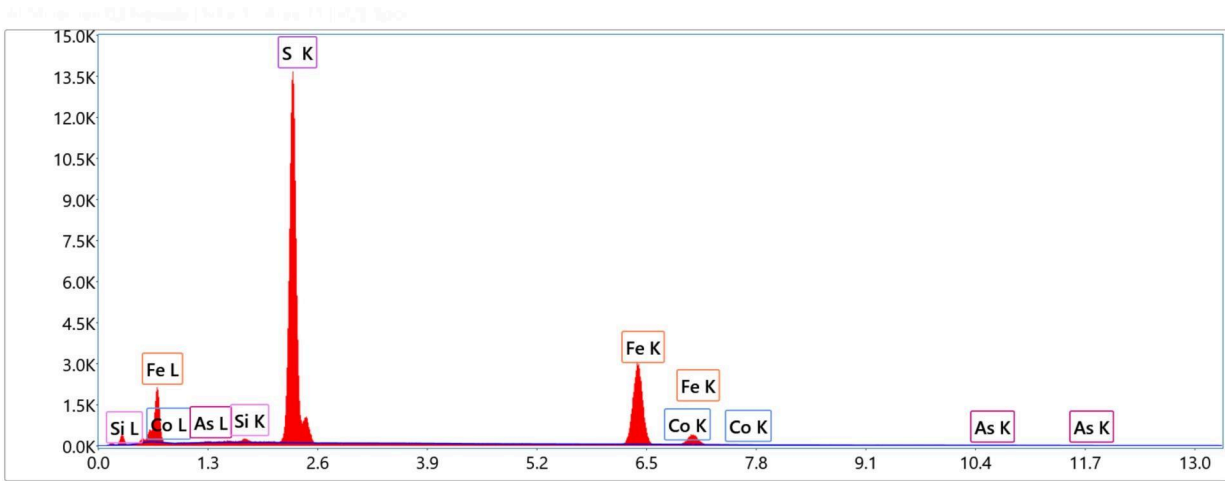
Circle 8 Area 2

Plate 32A. Electron backscattered image poikiloblastic arsenian pyrite with arsenopyrite inclusions



Spot 1

Energy Dispersive Spectrum



Det: Element

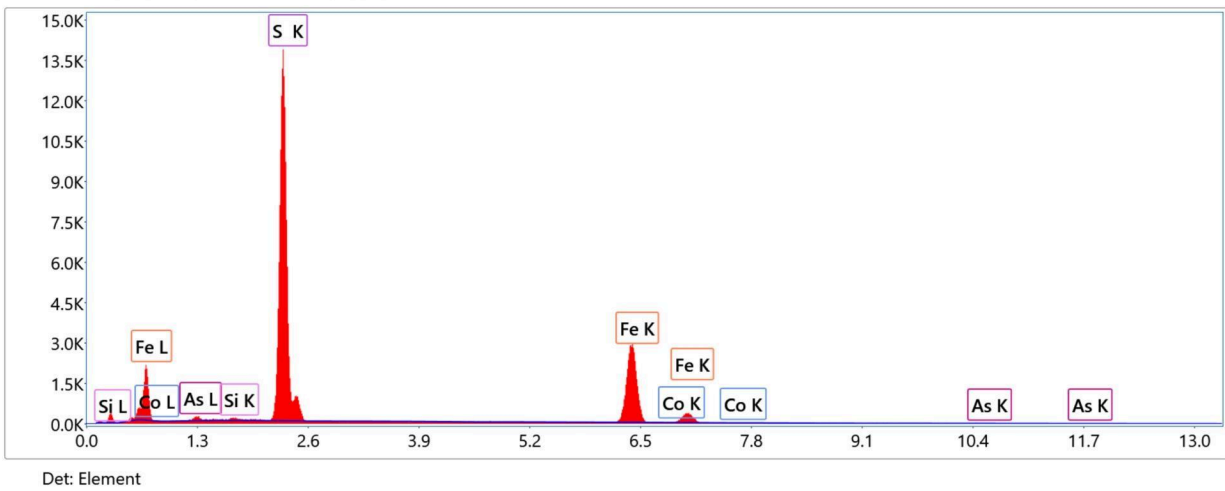
Semi-quantitative analyses

Element	Weight %	Atomic %
Si K	0.7	1.1
S K	51.3	64.6
Fe K	45.7	33.0
Co K	0.6	0.4
As K	1.7	0.9

Interpretation: darker domain in the arsenian pyrite has 1.7 wt% As

Spot 2

Energy Dispersive Spectrum



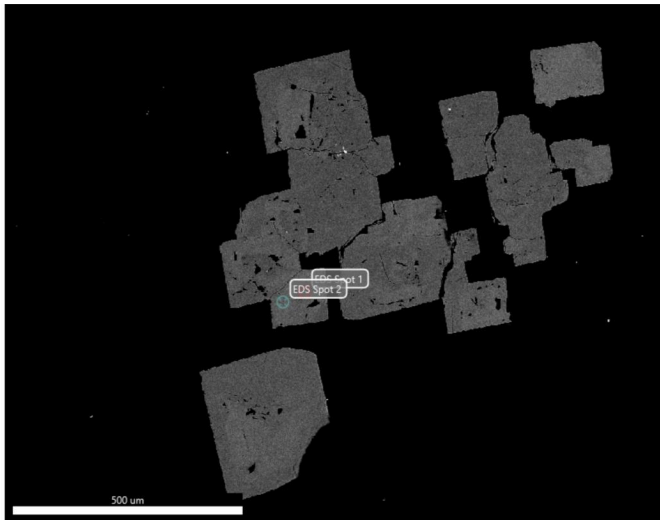
Semi-quantitative analyses

Element	Weight %	Atomic %
Si K	0.6	0.9
S K	51.0	64.4
Fe K	45.9	33.3
Co K	0.5	0.3
As K	2.0	1.1

Interpretation: lighter domain in the arsenian pyrite has slightly higher As, 2.0 wt%

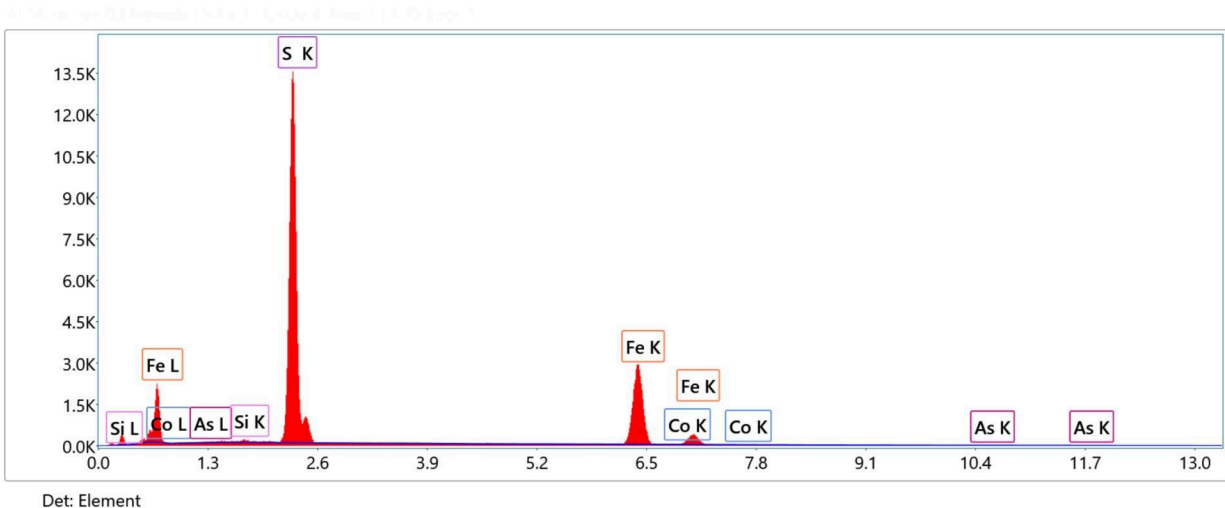
Circle 9 Area 1

Plate 33. Electron backscattered image of an arsenian pyrite cluster. Grains are complexly concentrically zoned, dark and lighter domains



Spot 1

Energy Dispersive Spectrum



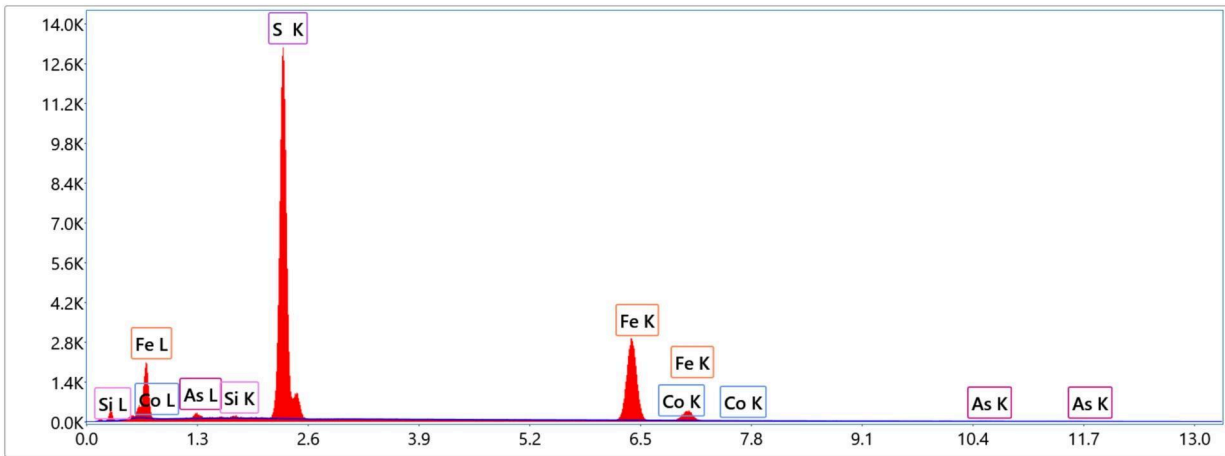
Semi-quantitative analyses

Element	Weight %	Atomic %
Si K	0.6	0.9
S K	51.9	65.1
Fe K	46.0	33.1
Co K	0.4	0.3
As K	1.1	0.6

Interpretation: dark domain with 1.1 wt% arsenic in pyrite – arsenian pyrite

Spot 2

Energy Dispersive Spectrum



Semi-quantitative analyses

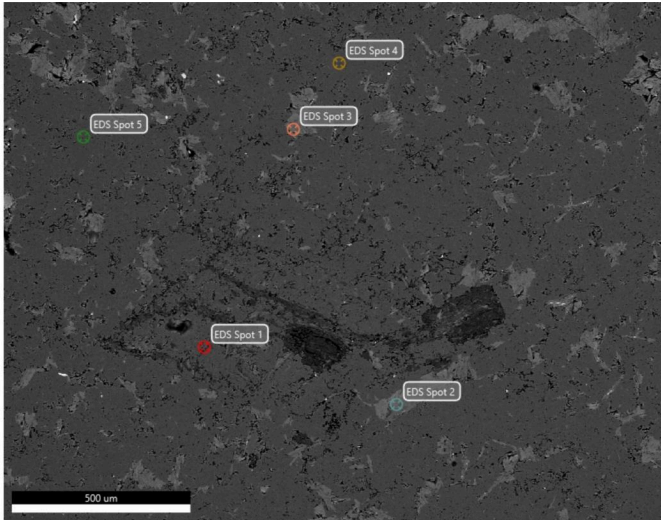
Element	Weight %	Atomic %
Si K	0.5	0.8
S K	50.9	64.4
Fe K	45.8	33.3
Co K	0.5	0.3
As K	2.3	1.2

Interpretation: lighter domain with 2.3 wt% arsenic – arsenian pyrite

Polished Thin Section: Nevada 2

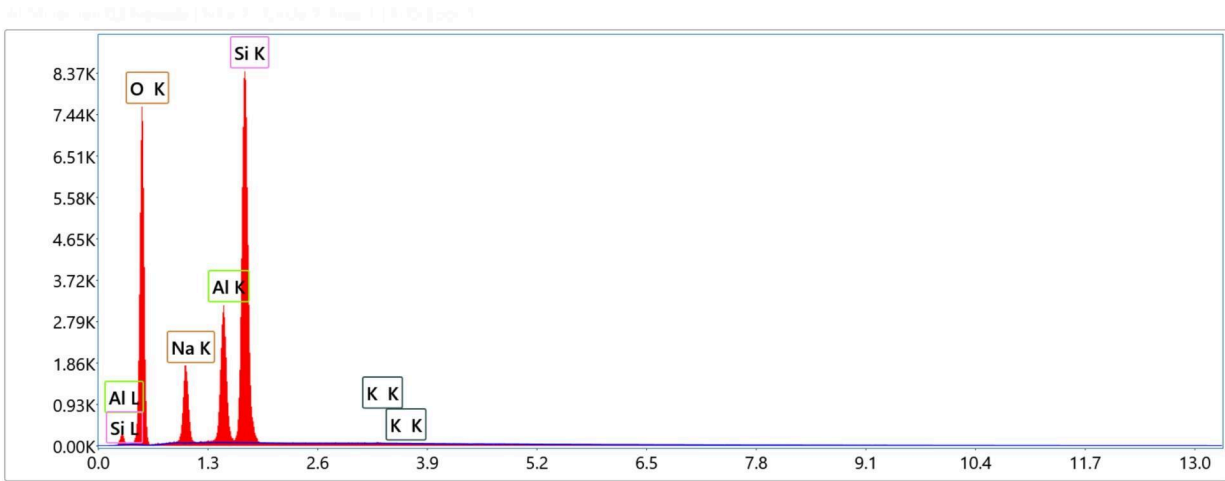
Circle 2 Area 1

Plate 34. Electron backscattered image of the very fine-grained altered groundmass



Spot 1

Energy Dispersive Spectrum



Det: Element

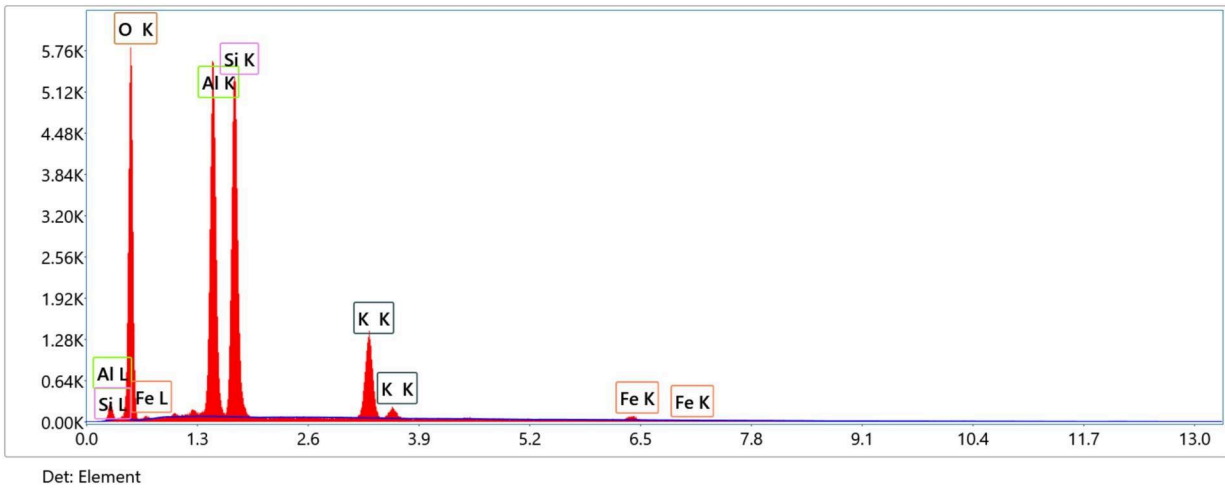
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	52.6	64.9
Na K	9.8	8.4
Al K	10.0	7.3
Si K	27.4	19.2
K K	0.1	0.1

Interpretation: albite

Spot 2

Energy Dispersive Spectrum



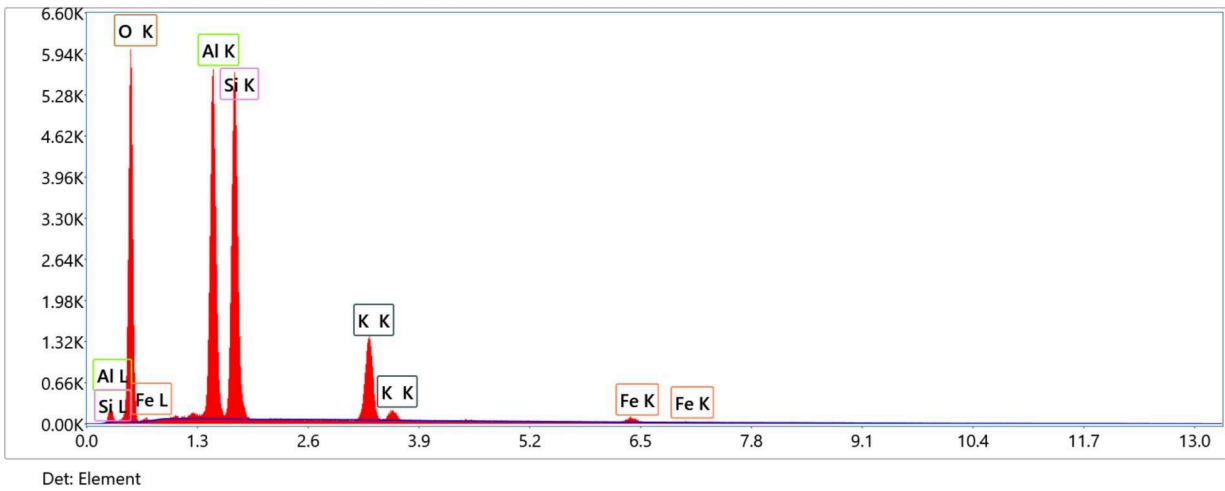
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	54.8	69.0
Al K	17.6	13.1
Si K	19.1	13.7
K K	7.7	3.9
Fe K	0.8	0.3

Interpretation: sericite with trace Fe, no Mg

Spot 3

Energy Dispersive Spectrum



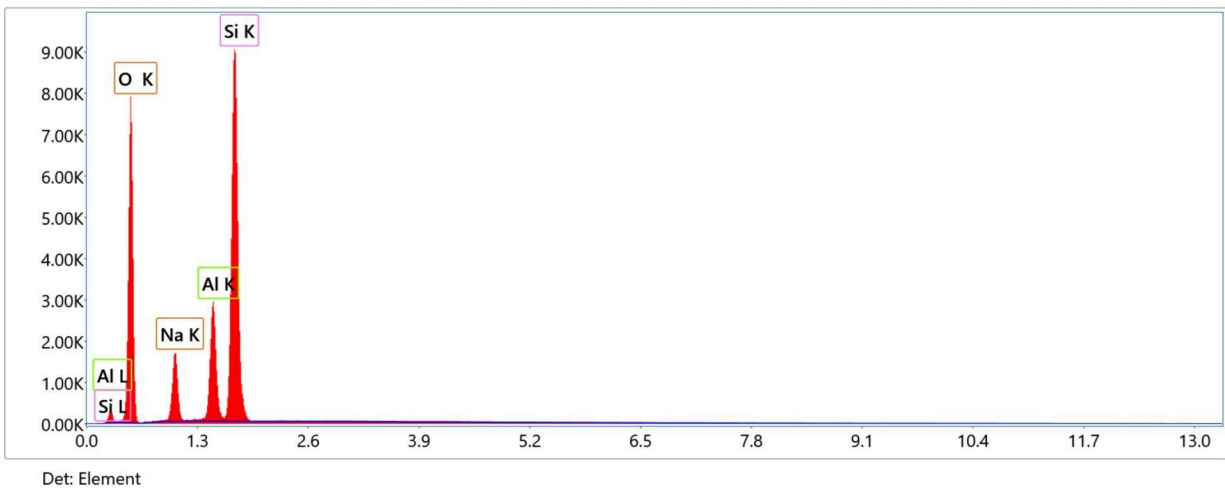
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	54.4	68.7
Al K	17.4	13.1
Si K	19.1	13.8
K K	7.8	4.0
Fe K	1.3	0.5

Interpretation: sericite minor Fe, no Mg

Spot 4

Energy Dispersive Spectrum



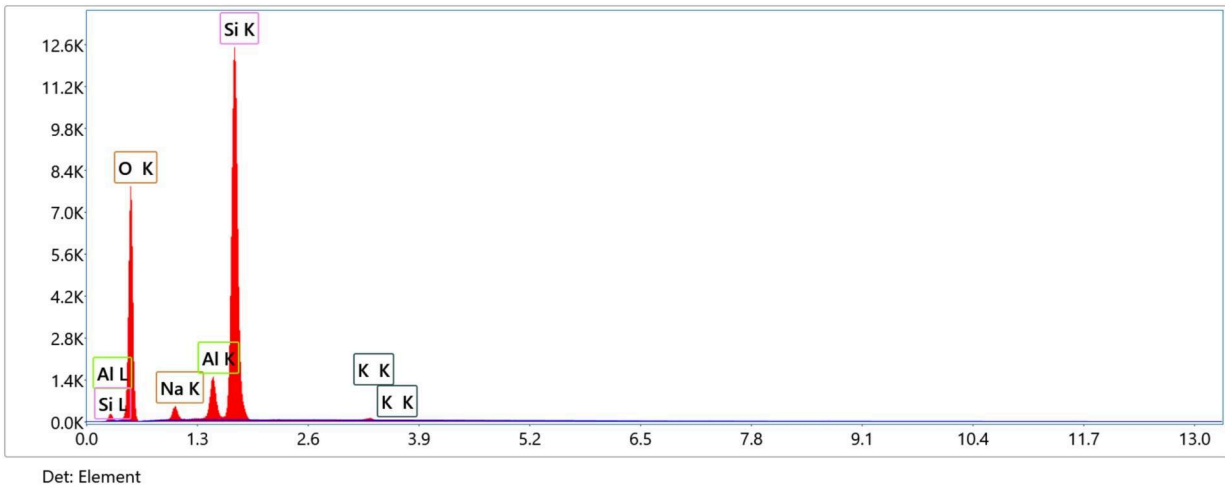
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	52.9	65.2
Na K	9.3	8.0
Al K	9.2	6.7
Si K	28.6	20.1

Interpretation: albite

Spot 5

Energy Dispersive Spectrum



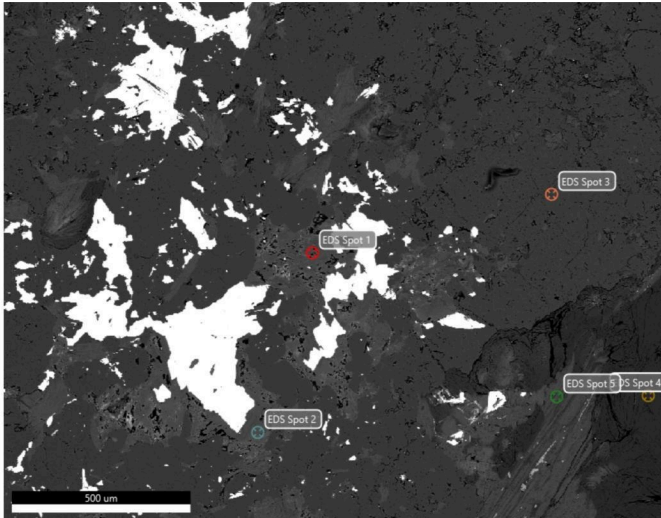
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	56.3	69.0
Na K	3.0	2.5
Al K	4.6	3.4
Si K	35.7	24.9
K K	0.5	0.2

Interpretation: mixture of albite and quartz based on high Si

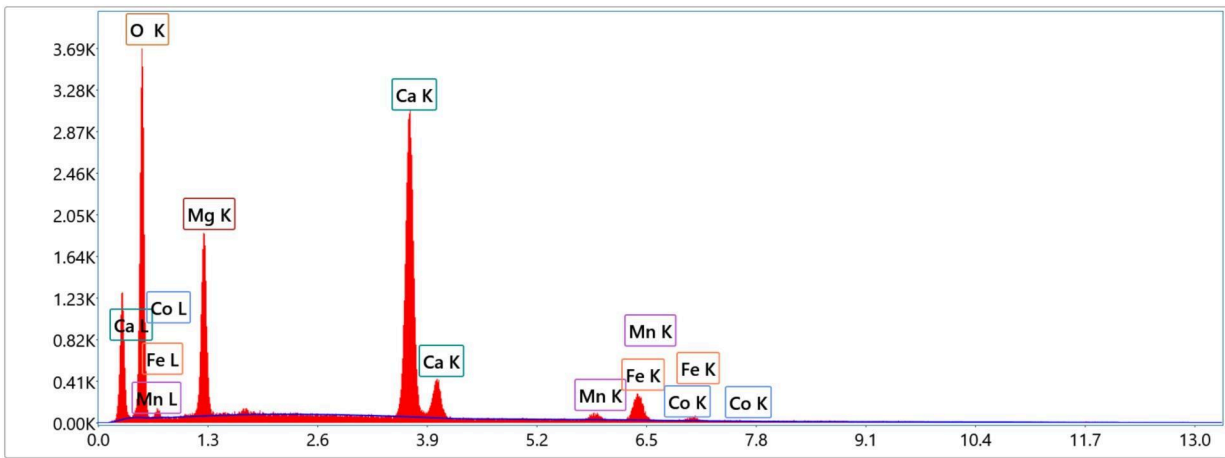
Circle 3 Area 1

Plate 35. Electron backscattered image of clotted stibnite adjacent to quartz vein (vein not shown)



Spot 1

Energy Dispersive Spectrum



Det: Element

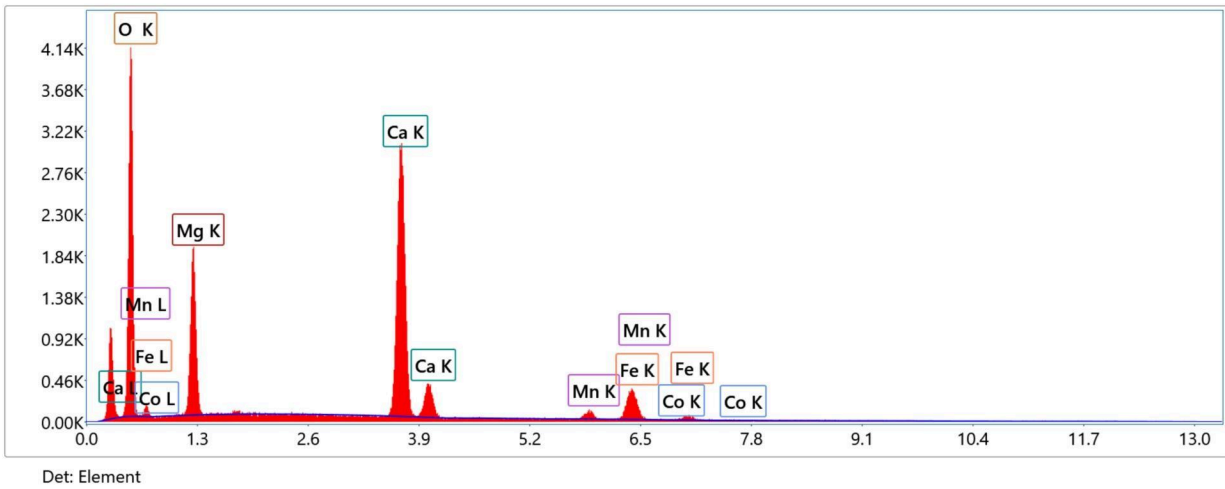
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	58.8	76.2
Mg K	10.2	8.7
Ca K	24.9	12.9
Mn K	1.1	0.4
Fe K	4.8	1.8
Co K	0.2	0.1

Interpretation: Fe-dolomite

Spot 2

Energy Dispersive Spectrum



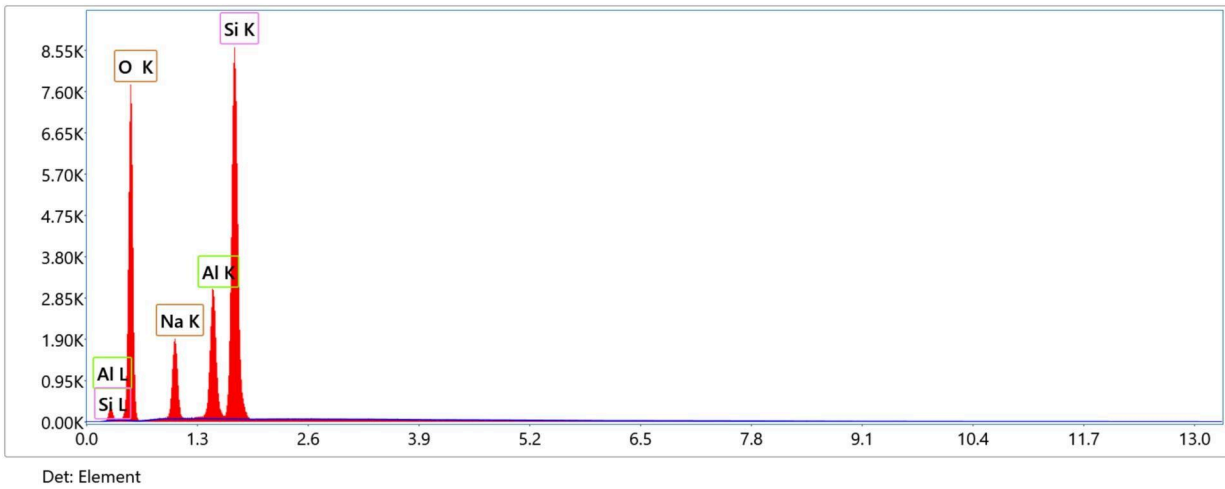
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	59.3	76.8
Mg K	9.8	8.3
Ca K	23.1	11.9
Mn K	1.4	0.5
Fe K	6.2	2.3
Co K	0.2	0.1

Interpretation: Fe-dolomite

Spot 3

Energy Dispersive Spectrum



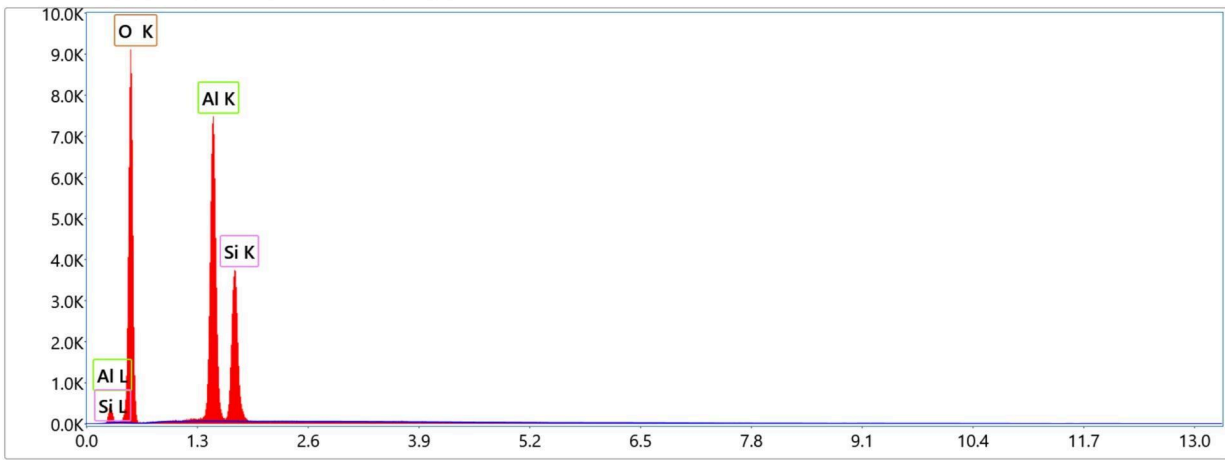
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	52.5	64.8
Na K	10.2	8.7
Al K	9.9	7.2
Si K	27.4	19.3

Interpretation: albite

Spot 4

Energy Dispersive Spectrum



Det: Element

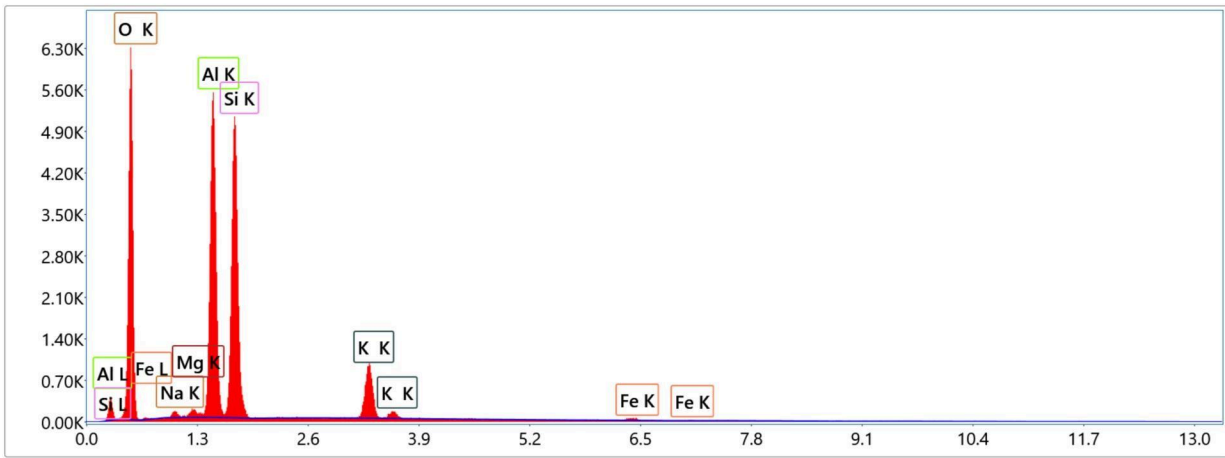
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	61.4	73.1
Al K	23.9	16.9
Si K	14.7	10.0

Interpretation: clay – kaolinite

Spot 5

Energy Dispersive Spectrum



Det: Element

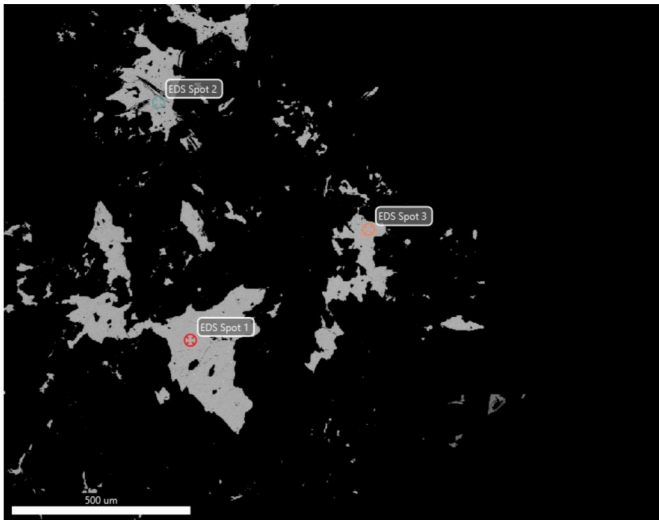
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	55.1	68.7
Na K	0.8	0.7
Mg K	0.8	0.7
Al K	18.2	13.4
Si K	18.8	13.4
K K	5.5	2.8
Fe K	0.8	0.3

Interpretation: groundmass alteration sericite with trace Fe and Mg

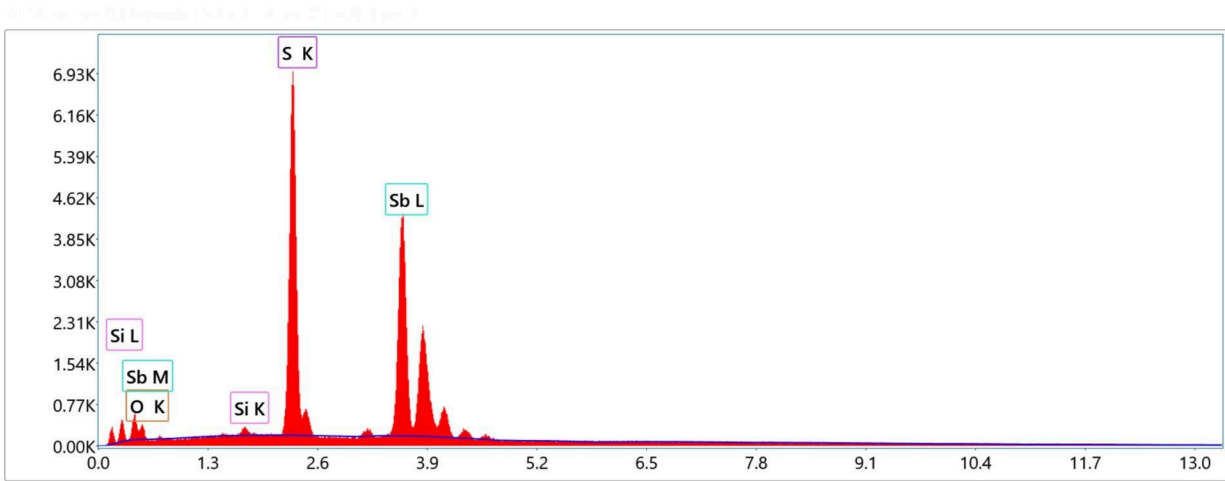
Circle 3 Area 2

Plate 36. Electron backscattered image showing ragged very fine-grained stibnite intergrown with sericite+quartz+albite to form a sub equant stibnite clot



Spot 1

Energy Dispersive Spectrum



Det: Element

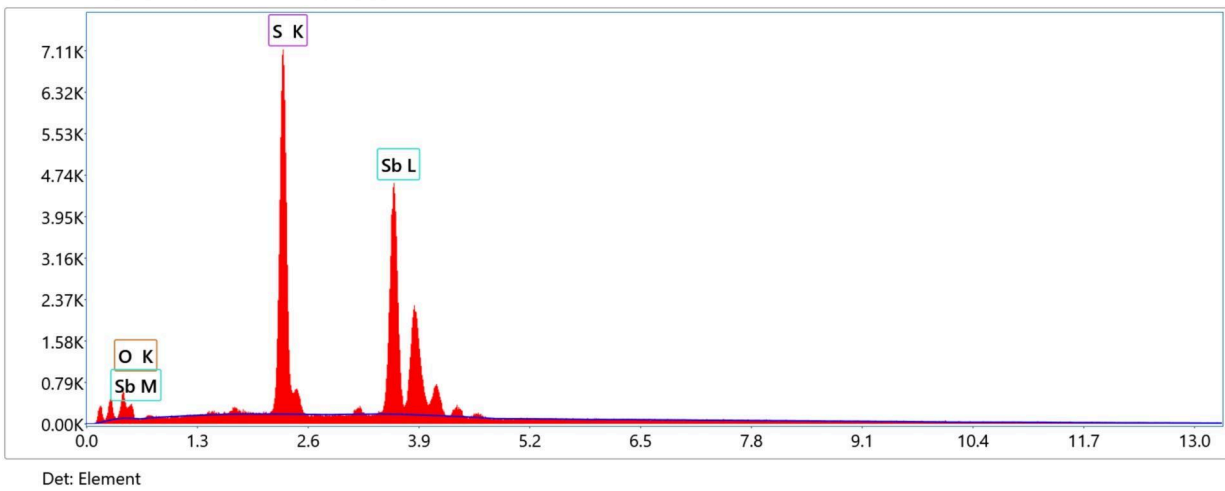
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	1.2	4.9
Si K	0.7	1.6
S K	27.2	55.5
Sb L	70.9	38.0

Interpretation: stibnite with no other elements substituting in the Sb site, possible ultra fine quartz or micron-sized quartz inclusions?

Spot 2

Energy Dispersive Spectrum



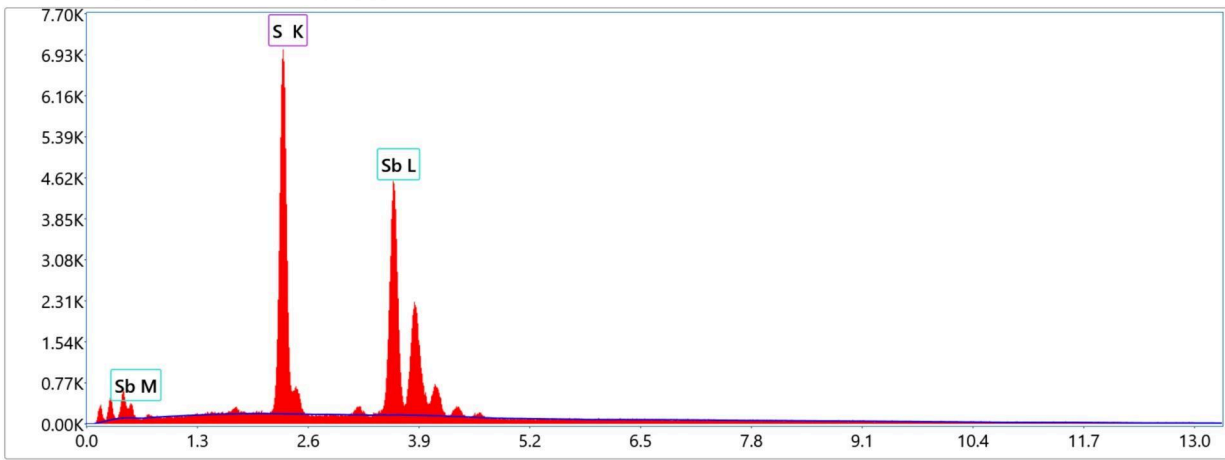
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	1.0	4.3
S K	27.3	56.6
Sb L	71.6	39.1

Interpretation: stibnite with no other elements substituting in the Sb site

Spot 3

Energy Dispersive Spectrum



Det: Element

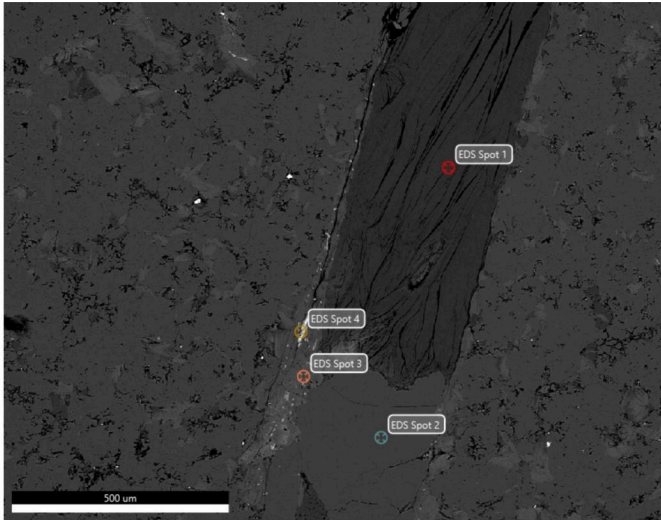
Semi-quantitative analyses

Element	Weight %	Atomic %
S K	27.4	58.8
Sb L	72.6	41.2

Interpretation: stibnite with no other elements substituting in the Sb site

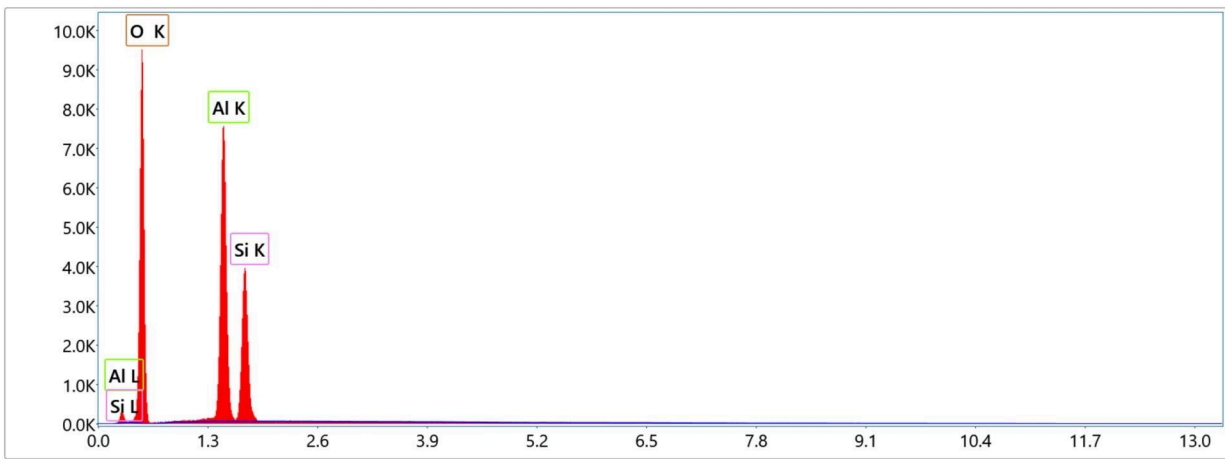
Circle 3 Area 3

Plate 37. Electron backscattered image of vein beside the stibnite clot



Spot 1

Energy Dispersive Spectrum



Det: Element

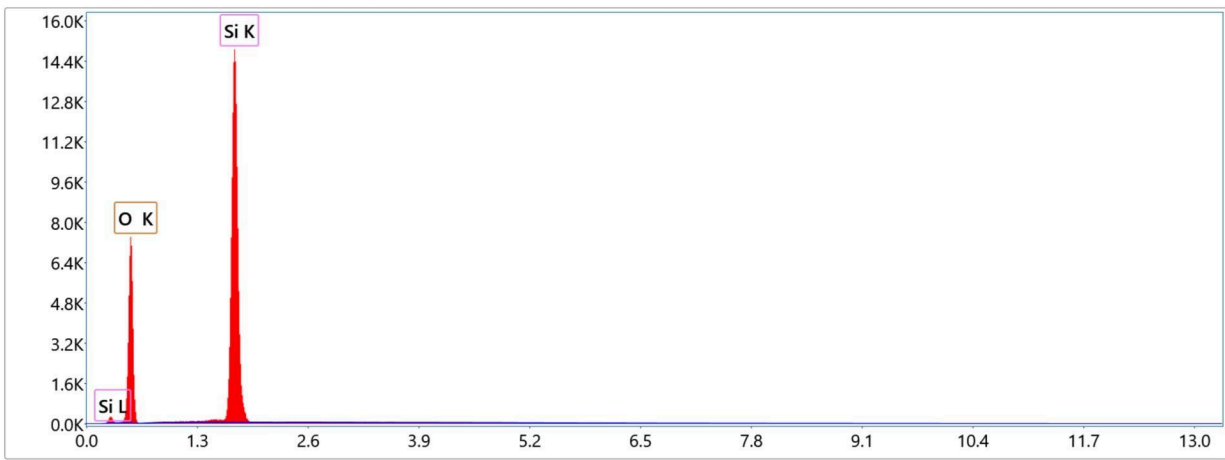
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	61.8	73.5
Al K	23.6	16.6
Si K	14.6	9.9

Interpretation: kaolinite

Spot 2

Energy Dispersive Spectrum



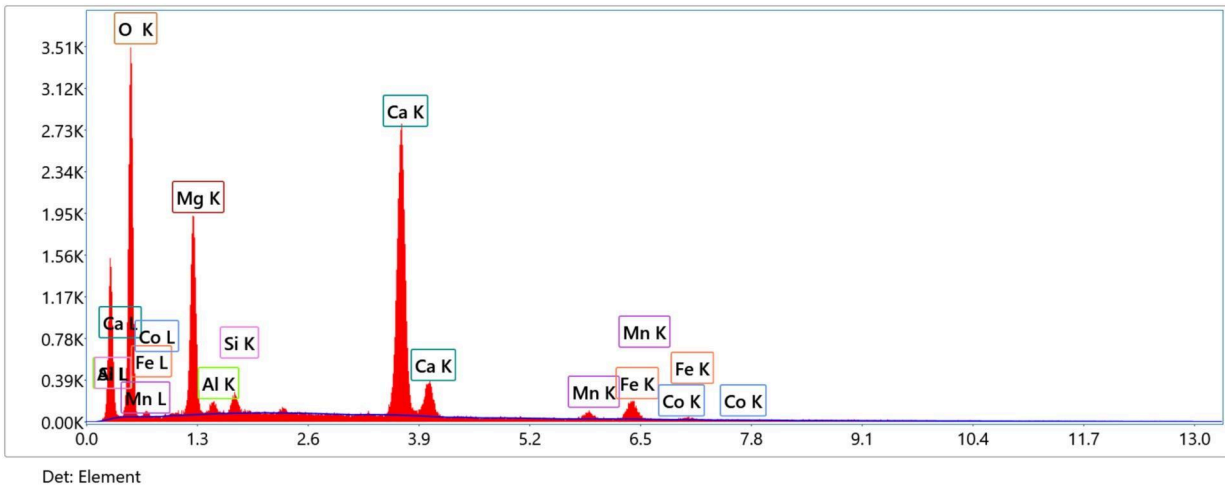
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	58.0	70.8
Si K	42.0	29.2

Interpretation: quartz

Spot 3

Energy Dispersive Spectrum



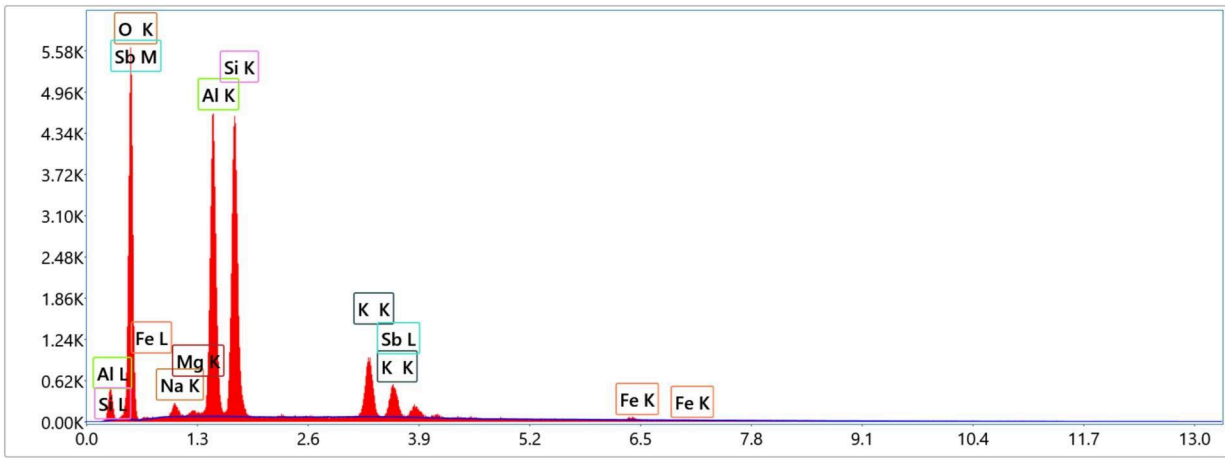
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	59.0	75.7
Mg K	10.9	9.2
Al K	0.7	0.6
Si K	0.9	0.6
Ca K	23.8	12.2
Mn K	1.3	0.5
Fe K	3.4	1.3
Co K	0.1	0.0

Interpretation: mixture – mainly Fe-carbonate with trace Mn and kaolinite

Spot 4

Energy Dispersive Spectrum



Det: Element

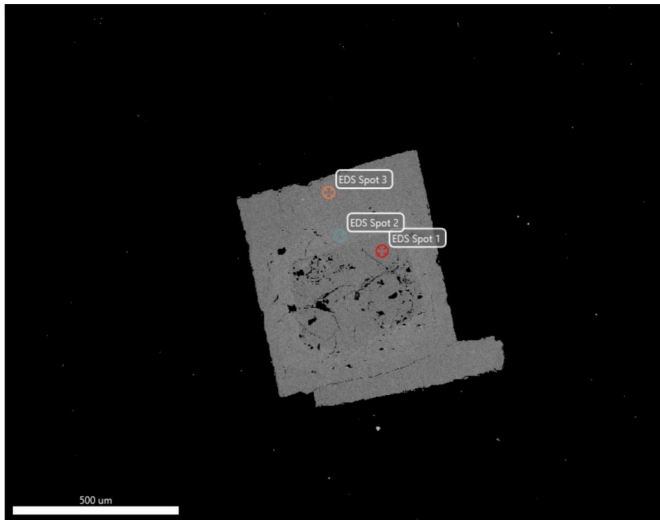
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	49.6	66.5
Na K	1.7	1.6
Mg K	0.6	0.6
Al K	16.7	13.3
Si K	17.8	13.6
K K	5.5	3.0
Fe K	0.6	0.2
Sb L	7.4	1.3

Interpretation: stibnite with sericite and possible albite from wall rock

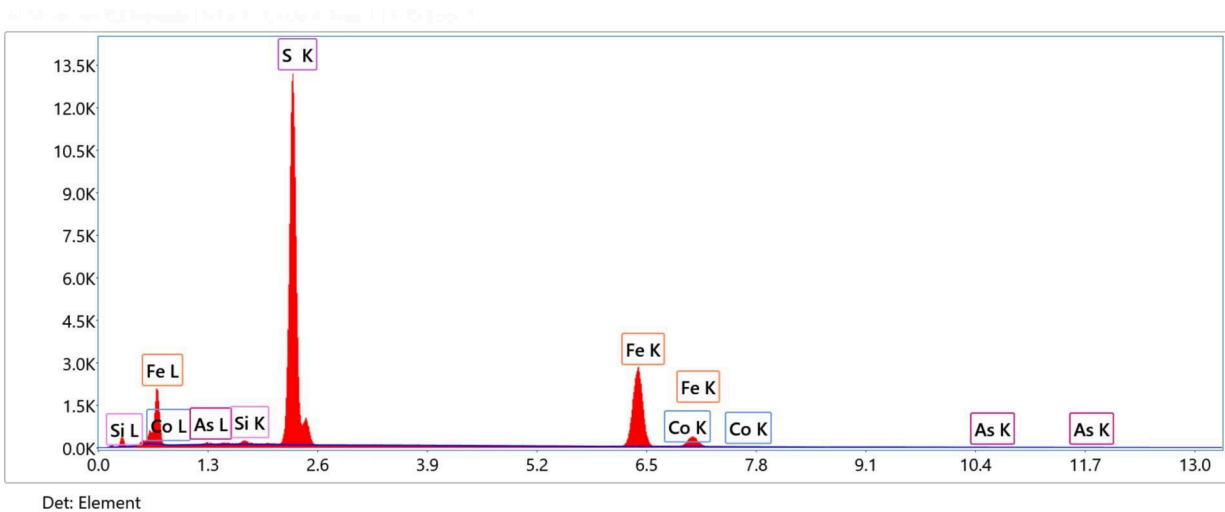
Circle 4 Area 1

Plate 38. Electron backscattered image showing arsenic zoning in a poikiloblastic arsenian pyrite in the altered groundmass of dyke.



Spot 1

Energy Dispersive Spectrum



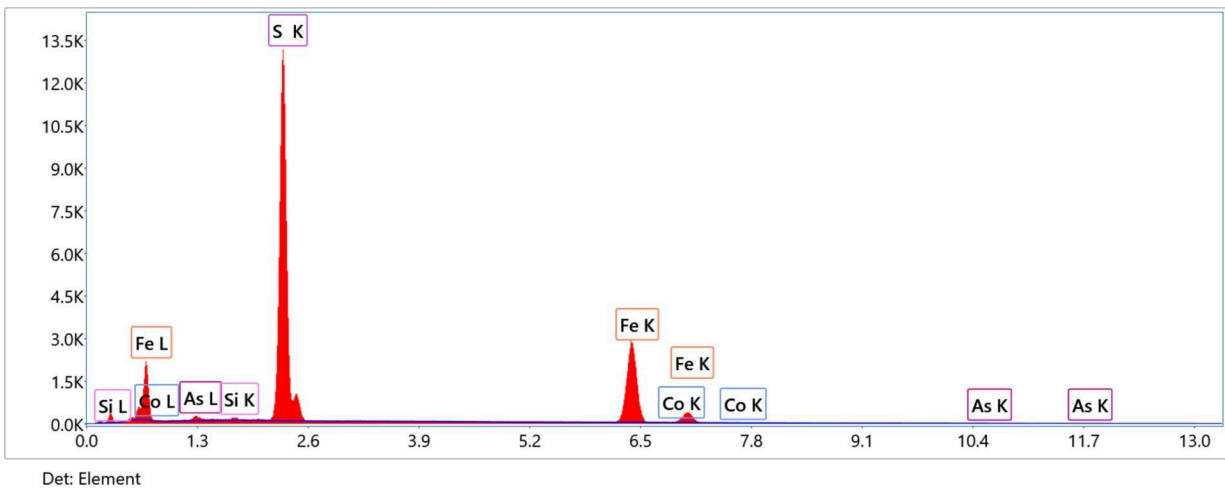
Semi-quantitative analyses

Element	Weight %	Atomic %
Si K	0.7	1.0
S K	51.5	64.8
Fe K	45.8	33.1
Co K	0.6	0.4
As K	1.5	0.8

Interpretation: arsenian pyrite, trace quartz micro-inclusions?

Spot 2

Energy Dispersive Spectrum



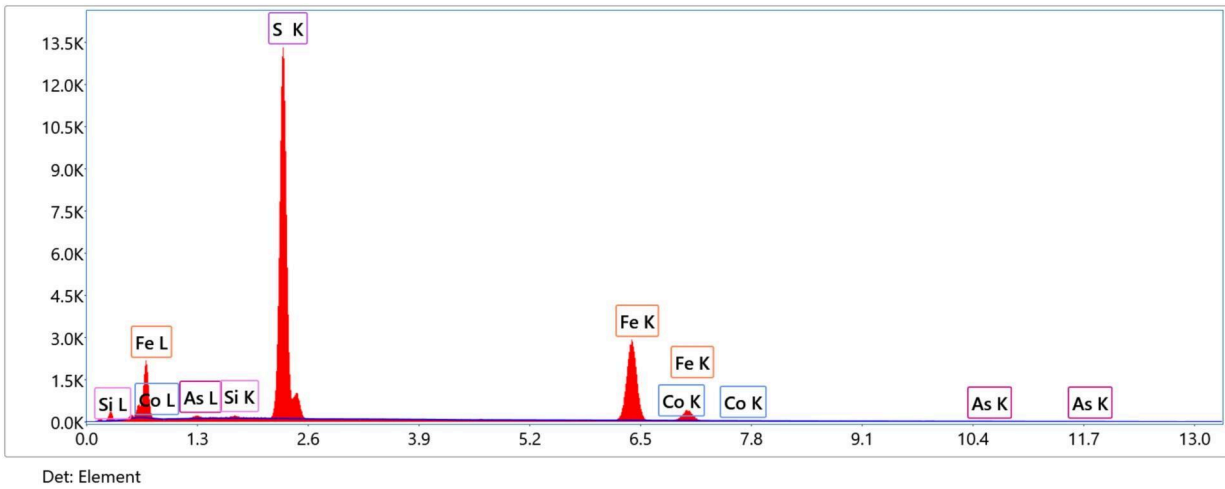
Semi-quantitative analyses

Element	Weight %	Atomic %
Si K	0.6	0.9
S K	51.0	64.4
Fe K	45.6	33.1
Co K	0.5	0.4
As K	2.3	1.2

Interpretation: arsenian pyrite, trace quartz micro-inclusions? Pyrite with arsenic above 1 wt% is termed arsenian pyrite.

Spot 3

Energy Dispersive Spectrum



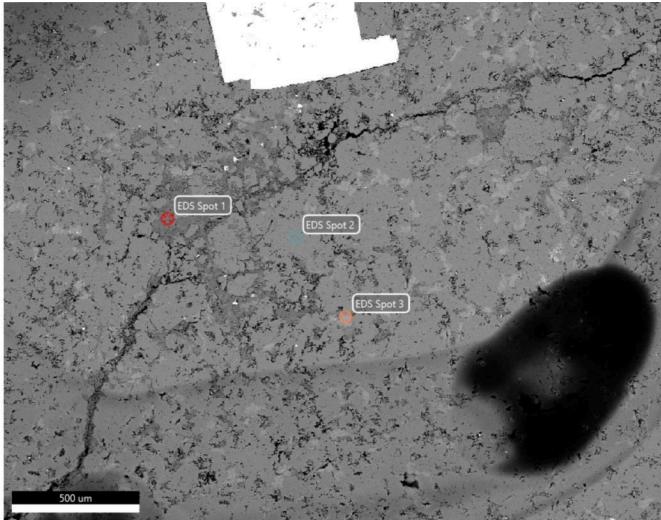
Semi-quantitative analyses

Element	Weight %	Atomic %
Si K	0.6	0.8
S K	51.6	64.9
Fe K	45.8	33.1
Co K	0.5	0.3
As K	1.6	0.9

Interpretation: arsenian pyrite, trace quartz micro-inclusions?

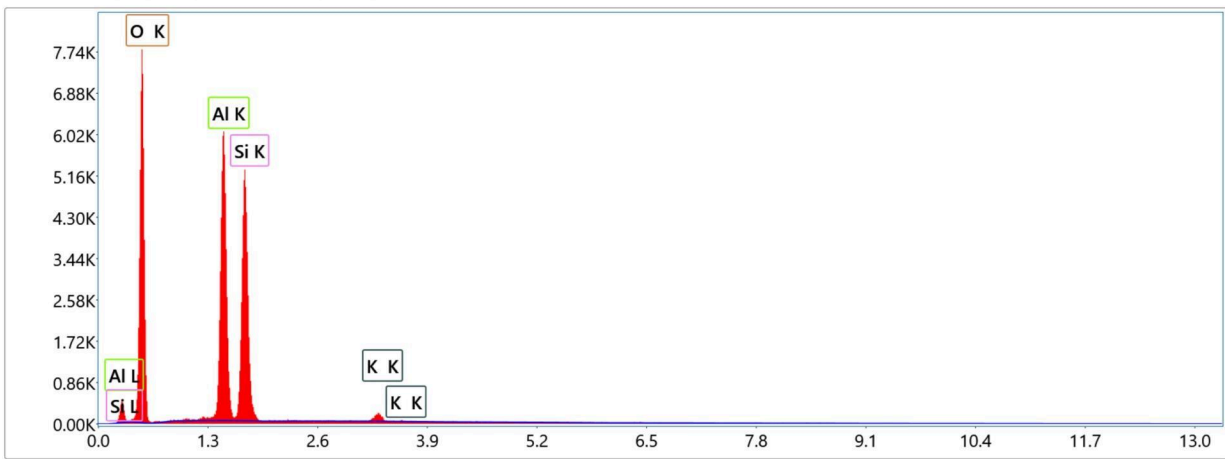
Circle 4 Area 2

Plate 39. Electron backscattered image of altered groundmass that hosts the arsenian pyrite



Spot 1

Energy Dispersive Spectrum



Det: Element

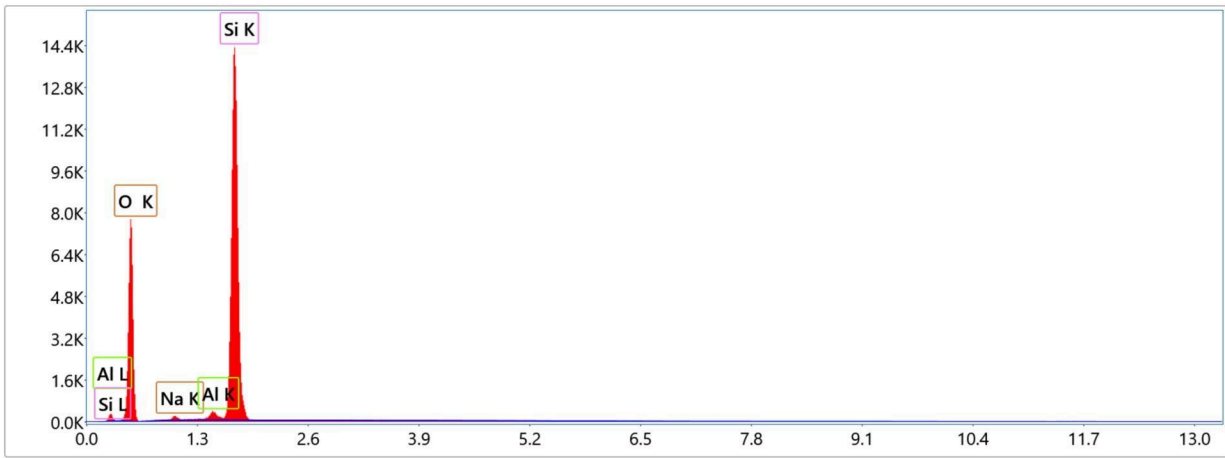
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	59.3	71.6
Al K	19.9	14.3
Si K	19.7	13.6
K K	1.1	0.5

Interpretation: K-bearing clay-kaolinite

Spot 2

Energy Dispersive Spectrum



Det: Element

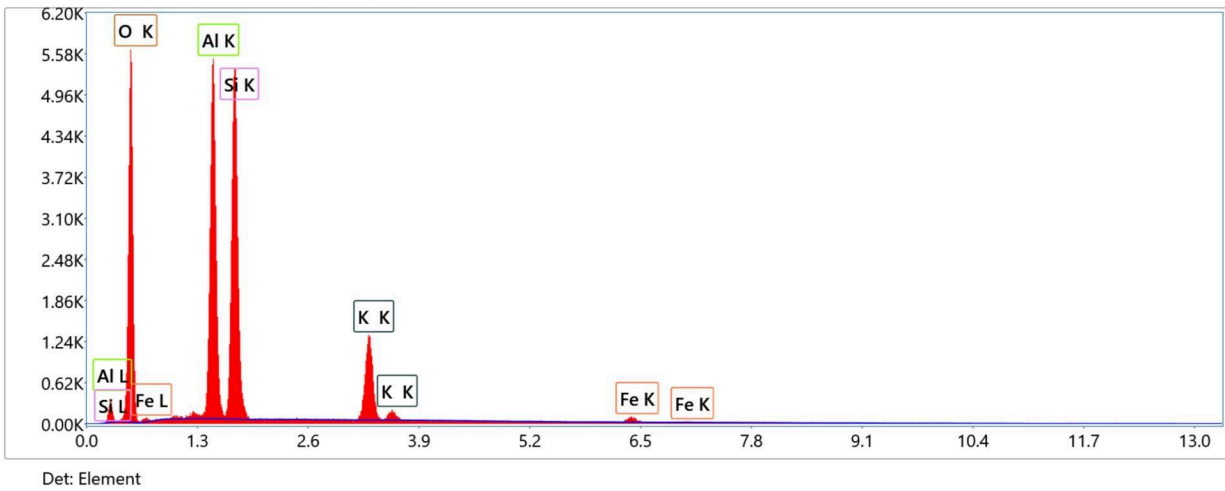
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	57.5	70.2
Na K	1.3	1.1
Al K	1.4	1.0
Si K	39.8	27.7

Interpretation: mixture – quartz and albite

Spot 3

Energy Dispersive Spectrum



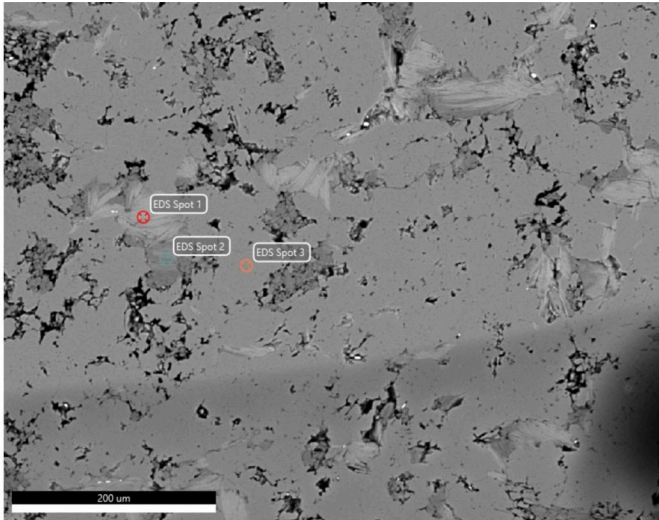
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	54.3	68.6
Al K	17.5	13.1
Si K	19.3	13.9
K K	7.7	4.0
Fe K	1.2	0.4

Interpretation: sericite with minor Fe

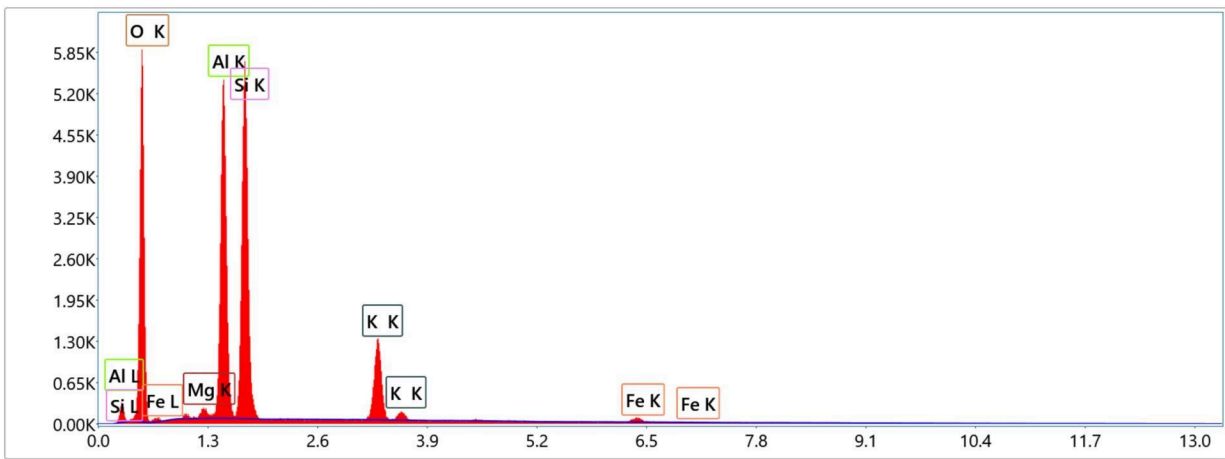
Circle 4 Area 3

Plate 40. Electron backscattered image of the altered very fine-grained groundmass



Spot 1

Energy Dispersive Spectrum



Det: Element

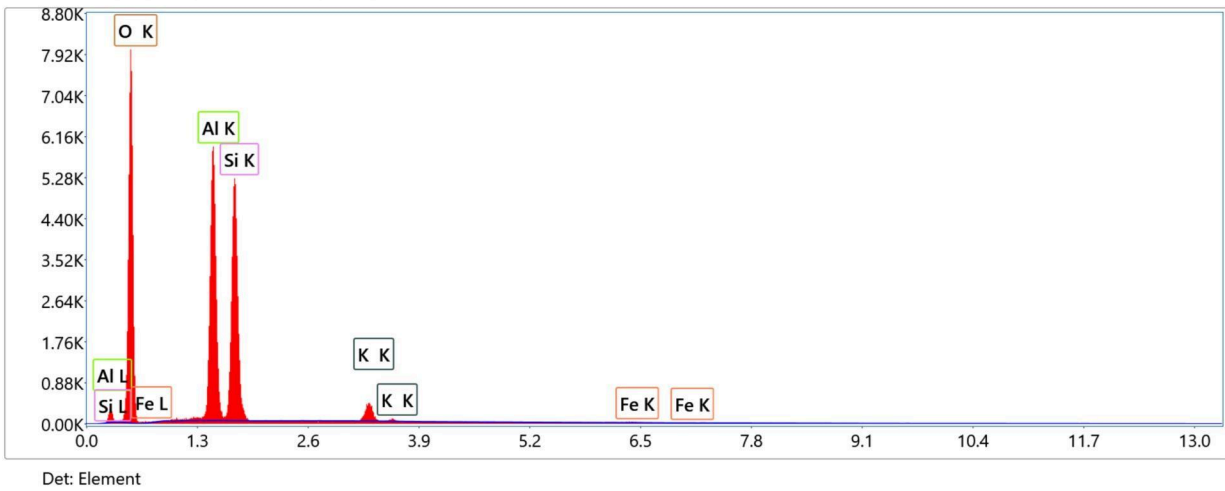
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	54.3	68.4
Mg K	0.9	0.7
Al K	17.0	12.7
Si K	19.6	14.0
K K	7.3	3.7
Fe K	1.1	0.4

Interpretation: sericite with trace/minor Fe and Mg

Spot 2

Energy Dispersive Spectrum



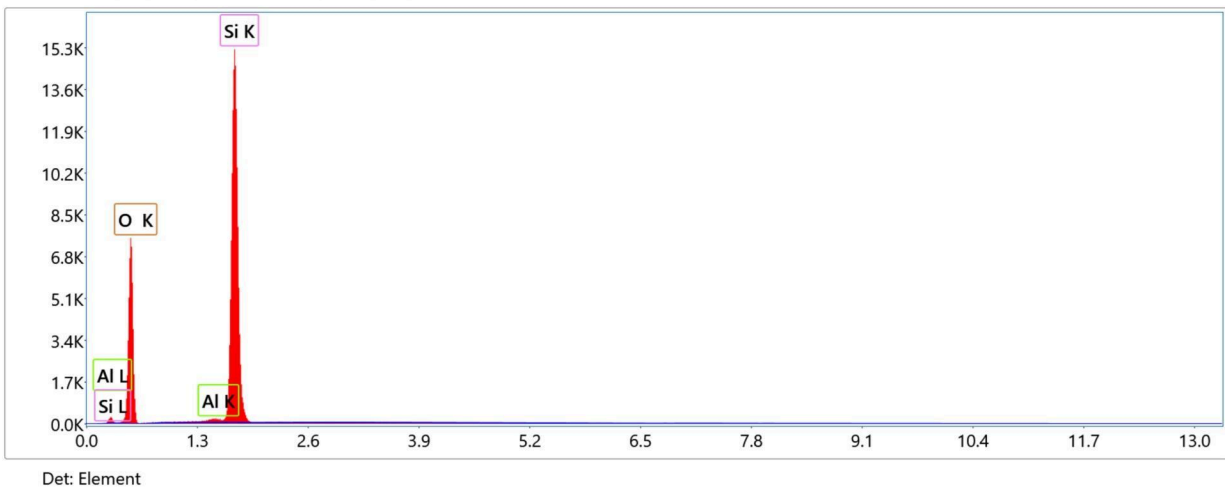
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	59.6	72.2
Al K	18.8	13.5
Si K	18.9	13.0
K K	2.3	1.1
Fe K	0.4	0.1

Interpretation: sericite with trace Fe

Spot 3

Energy Dispersive Spectrum



Semi-quantitative analyses

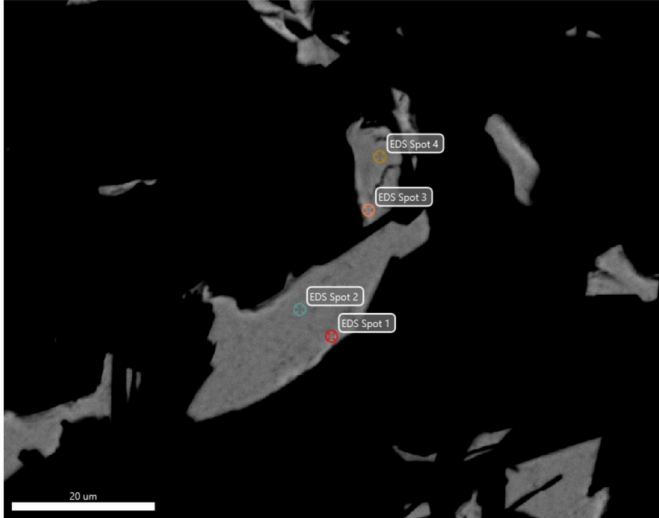
Element	Weight %	Atomic %
O K	57.4	70.3
Al K	1.0	0.7
Si K	41.6	29.0

Interpretation: quartz

Polished Thin Section: Nevada 3

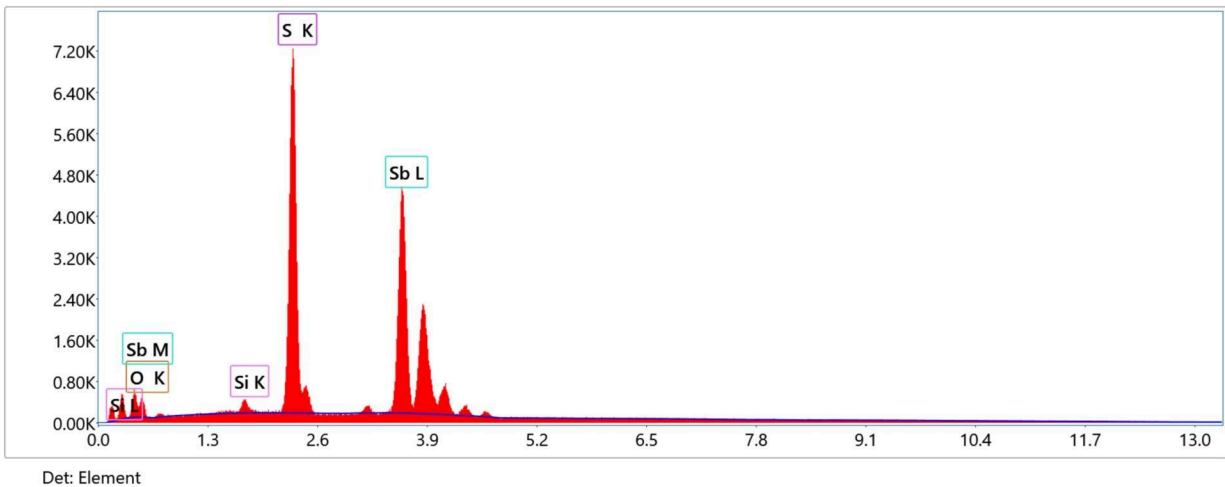
Circle 1 Area 1

Plate 41. Electron backscattered image of irregular stibnite grains in a portion of a sub equant stibnite clot.



Spot 1

Energy Dispersive Spectrum



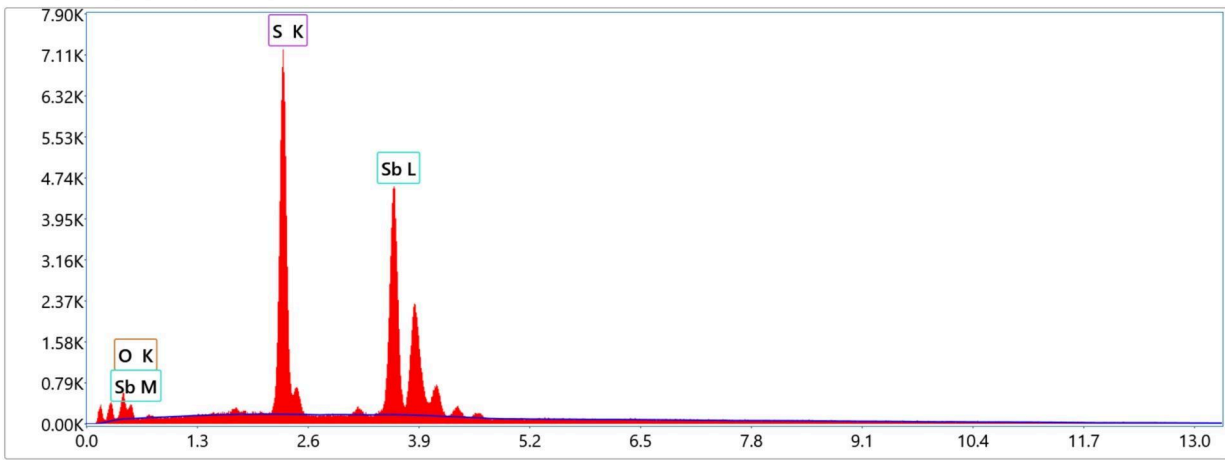
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	2.0	8.0
Si K	1.2	2.6
S K	27.3	53.5
Sb L	69.5	35.9

Interpretation: stibnite with no elements substituting for Sb; possibly sub micro-sized quartz inclusions?

Spot 2

Energy Dispersive Spectrum



Det: Element

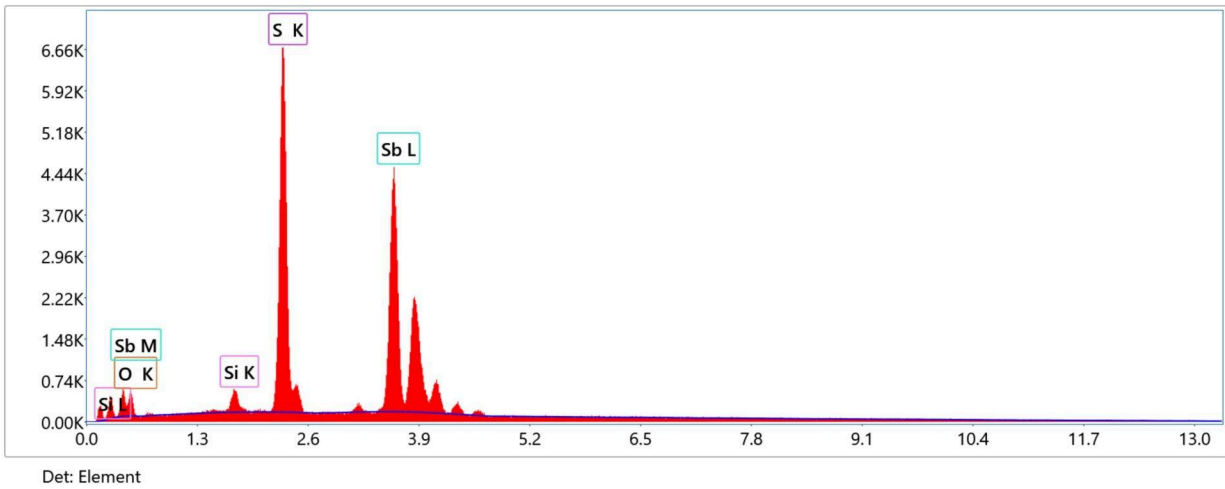
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	0.9	3.8
S K	27.1	56.6
Sb L	72.0	39.6

Interpretation: stibnite

Spot 3

Energy Dispersive Spectrum



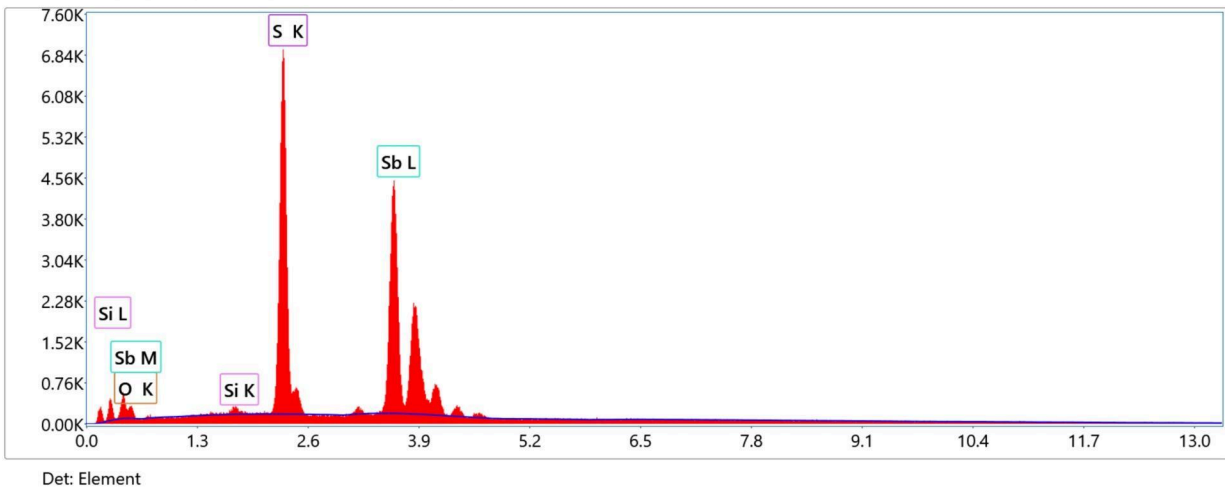
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	2.4	9.5
Si K	1.9	4.1
S K	25.9	50.5
Sb L	69.8	35.9

Interpretation: stibnite, no additional elements substituting for Sb or S; possibly ultra fine-grained, sub-micron-sized quartz inclusions

Spot 4

Energy Dispersive Spectrum



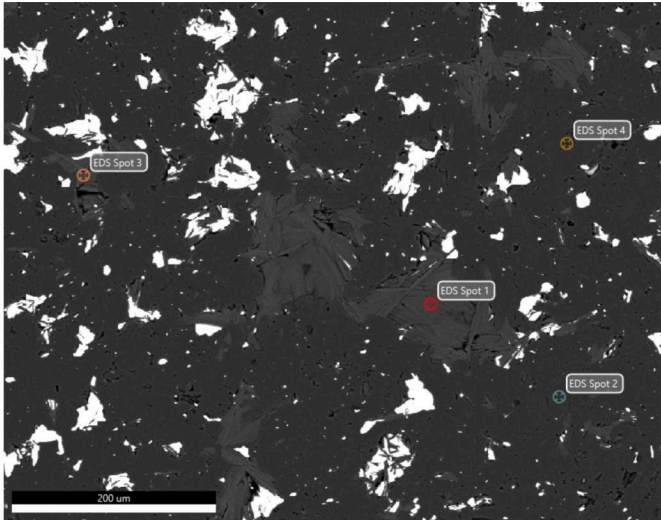
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	1.0	4.1
Si K	0.8	1.8
S K	26.9	55.3
Sb L	71.3	38.7

Interpretation: stibnite, no additional elements substituting for Sb or S; possibly ultra fine-grained, sub-micron sized quartz inclusions

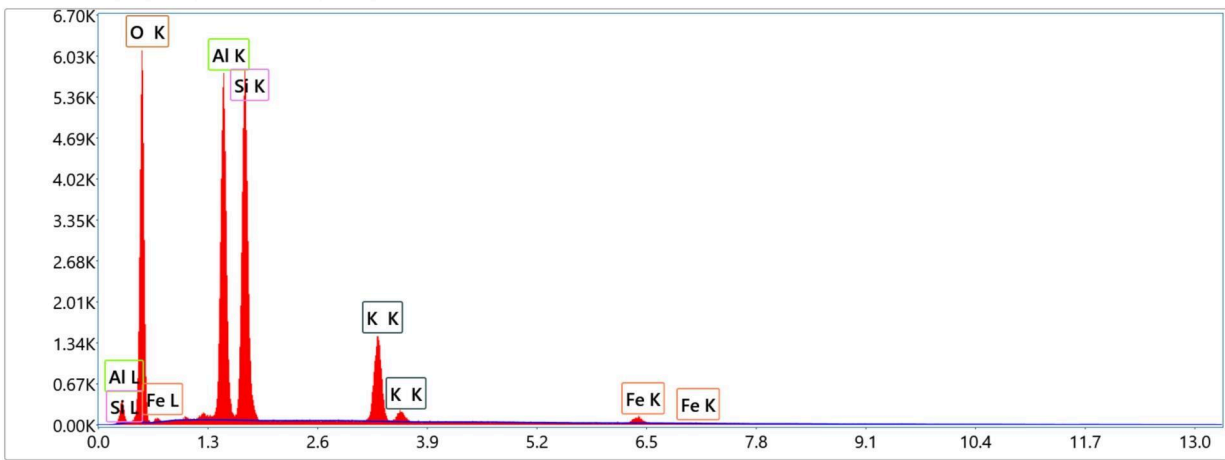
Circle 1 Area 2

Plate 42. Electron backscattered image shows a portion of a clotted stibnite showing the irregular-shaped disseminated stibnite grains in the altered groundmass



Spot 1

Energy Dispersive Spectrum



Det: Element

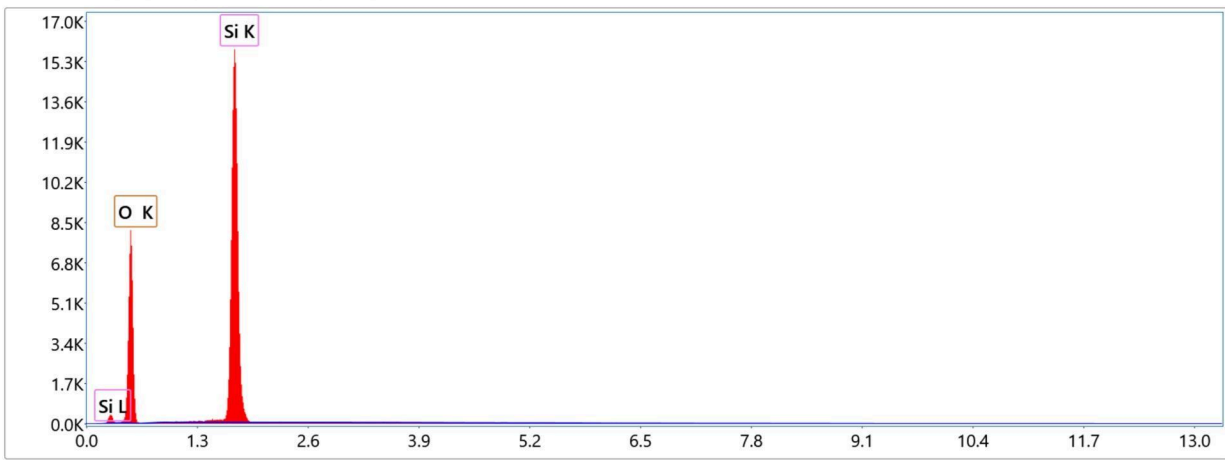
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	54.5	68.9
Al K	17.0	12.7
Si K	19.2	13.8
K K	7.9	4.1
Fe K	1.5	0.5

Interpretation: sericite with minor Fe

Spot 2

Energy Dispersive Spectrum



Det: Element

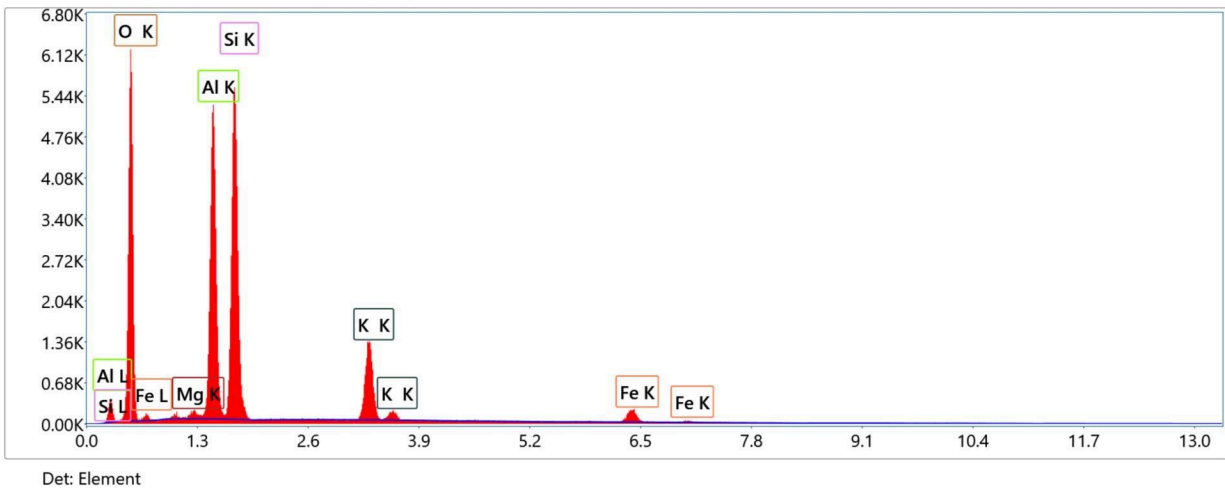
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	58.2	71.0
Si K	41.8	29.0

Interpretation: quartz

Spot 3

Energy Dispersive Spectrum



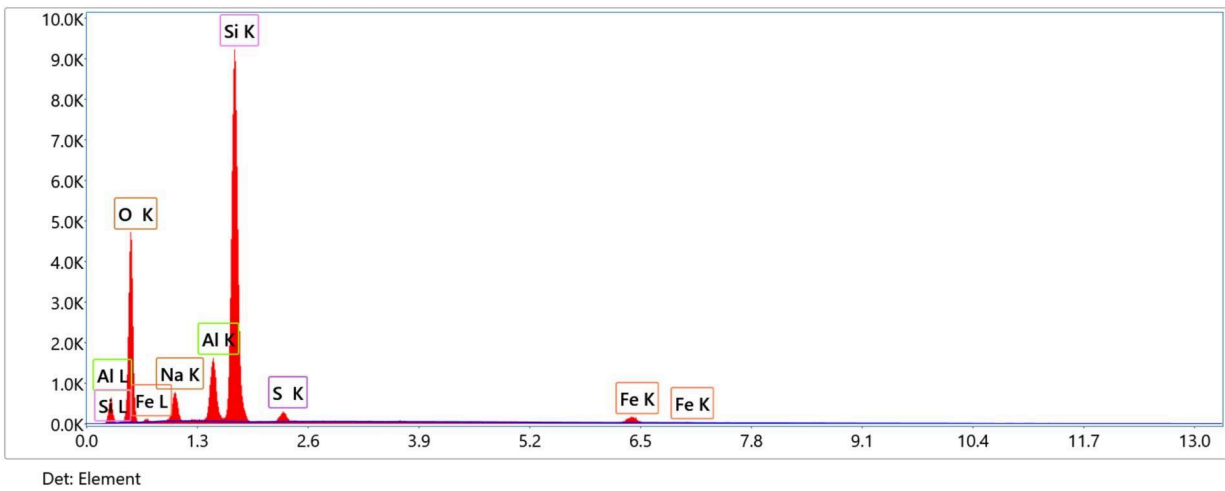
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	53.8	68.6
Mg K	0.8	0.6
Al K	16.1	12.2
Si K	18.8	13.6
K K	7.4	3.9
Fe K	3.0	1.1

Interpretation: sericite with minor Fe and trace Mg

Spot 4

Energy Dispersive Spectrum



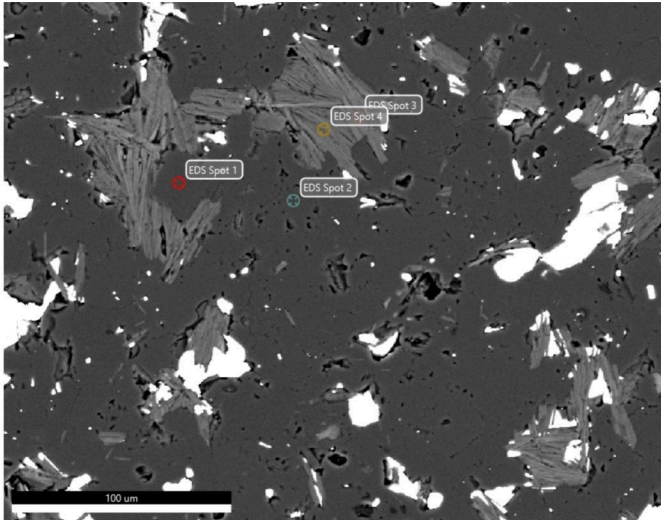
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	47.6	61.5
Na K	5.6	5.0
Al K	6.6	5.1
Si K	36.0	26.5
S K	1.4	0.9
Fe K	2.9	1.1

Interpretation: mixture – albite with pyrite

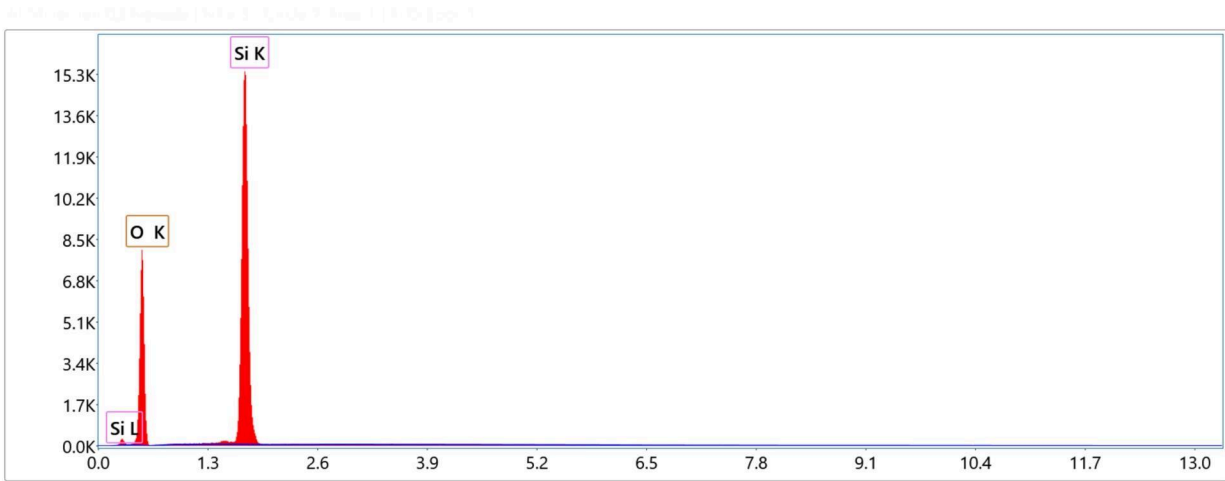
Circle 2 Area 1

Plate 43. Electron backscattered image shows disseminated stibnite distributed amongst silicates. Note the different grey scale in the muscovite – due to variable Fe content



Spot 1

Energy Dispersive Spectrum



Det: Element

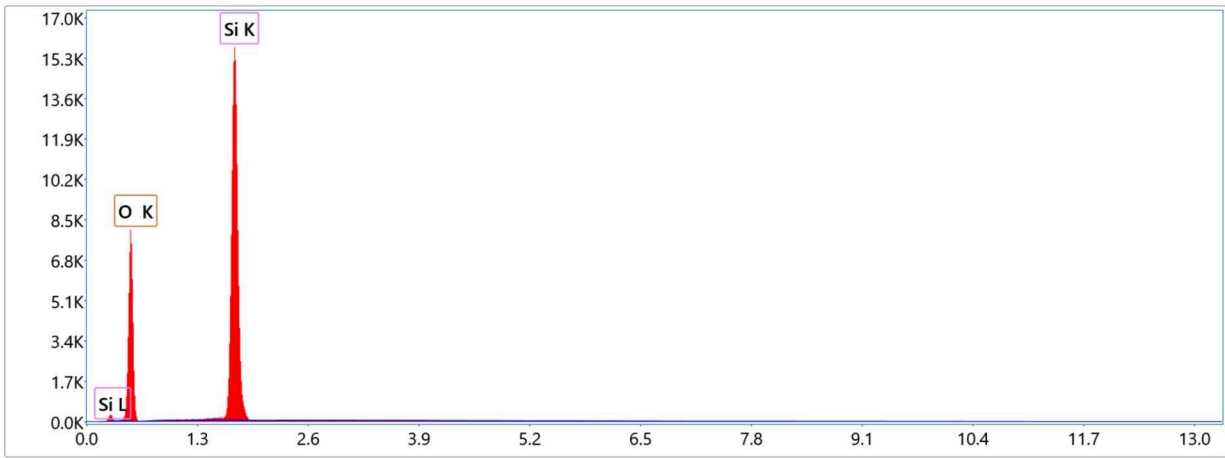
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	58.5	O K
Si K	41.5	Si K

Interpretation: quartz

Spot 2

Energy Dispersive Spectrum



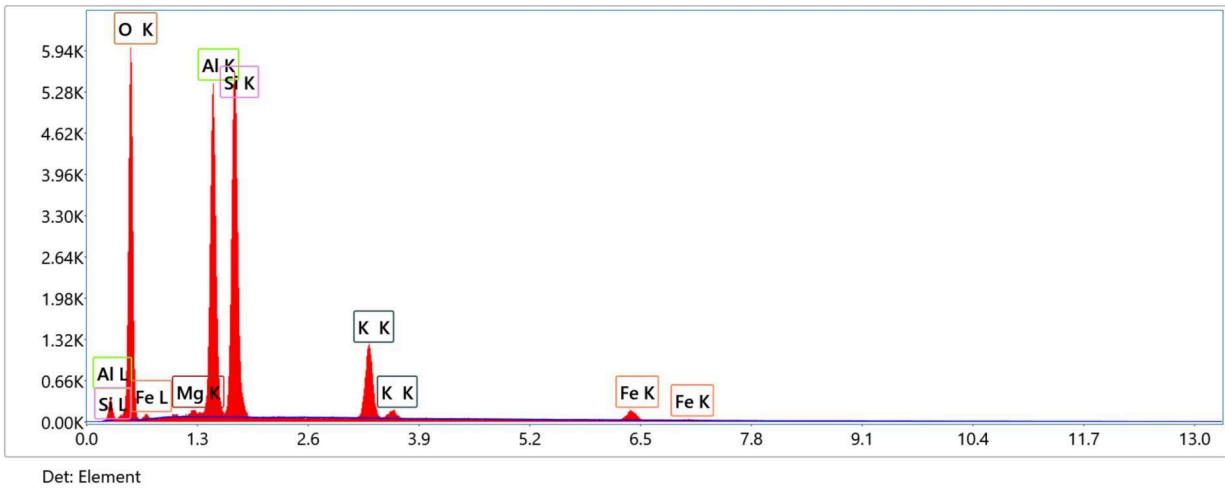
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	58.2	71.0
Si K	41.8	29.0

Interpretation: quartz

Spot 3

Energy Dispersive Spectrum



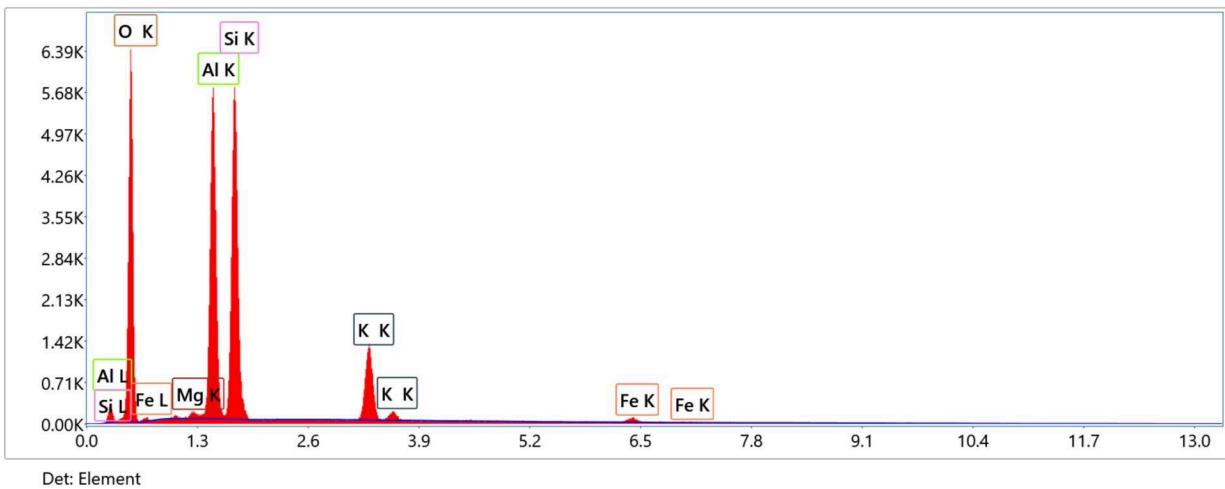
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	54.0	68.4
Mg K	0.7	0.6
Al K	16.7	12.5
Si K	19.6	14.1
K K	6.9	3.6
Fe K	2.3	0.8

Interpretation: sericite with minor Fe and trace Mg

Spot 4

Energy Dispersive Spectrum



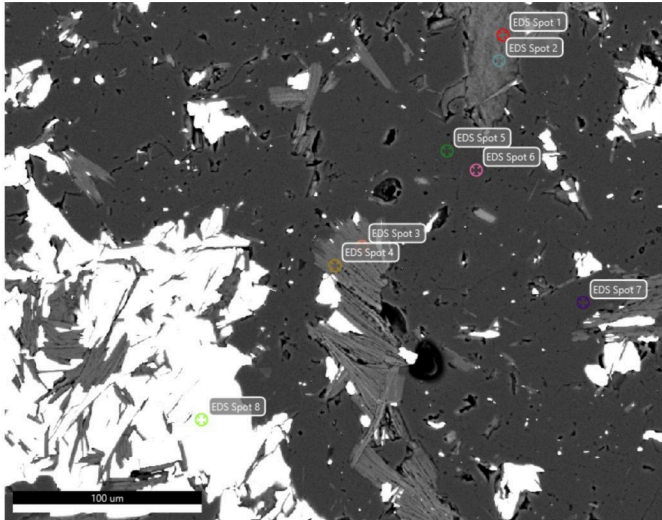
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	54.9	68.9
Mg K	0.6	0.5
Al K	17.2	12.8
Si K	19.1	13.7
K K	7.1	3.6
Fe K	1.2	0.4

Interpretation: sericite with lower Fe and Mg than the previous analysis. Consequently the different grey-scale in muscovite is due to variable Fe and Mg. In particular higher Fe in muscovite is represented by the brighter grey scale.

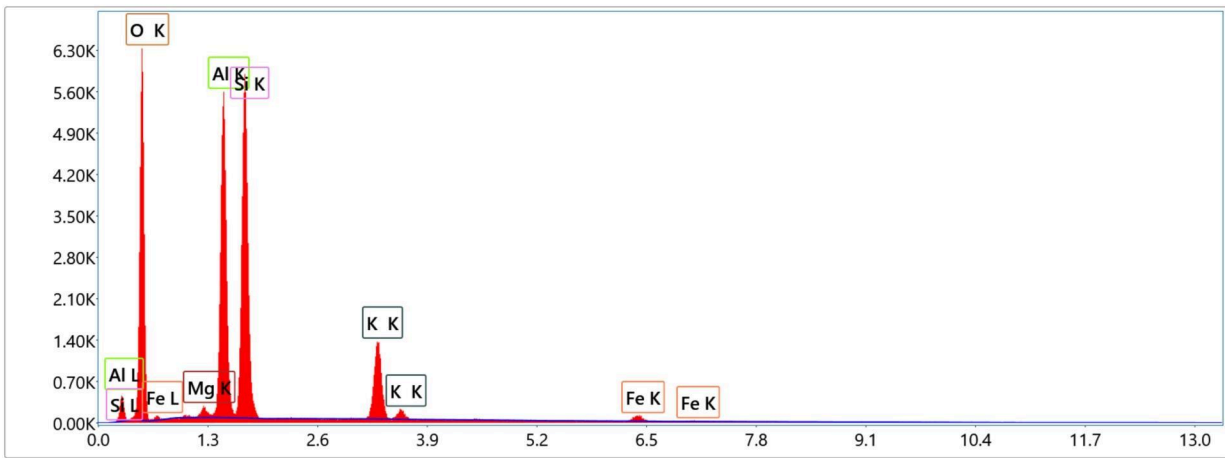
Circle 2 Area 2

Plate 44. Electron backscattered image shows stibnite intergrown with mica and minute stibnite distributed through a groundmass of silicates



Spot 1

Energy Dispersive Spectrum



Det: Element

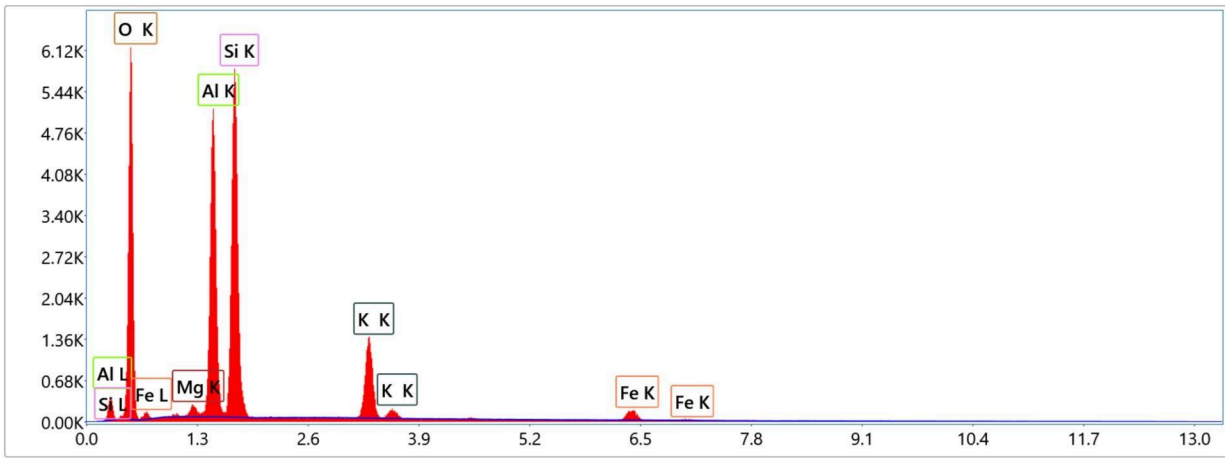
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	54.7	68.9
Mg K	0.8	0.7
Al K	16.5	12.3
Si K	19.3	13.8
K K	7.4	3.8
Fe K	1.4	0.5

Interpretation: sericite with minor Fe and trace Mg

Spot 2

Energy Dispersive Spectrum



Det: Element

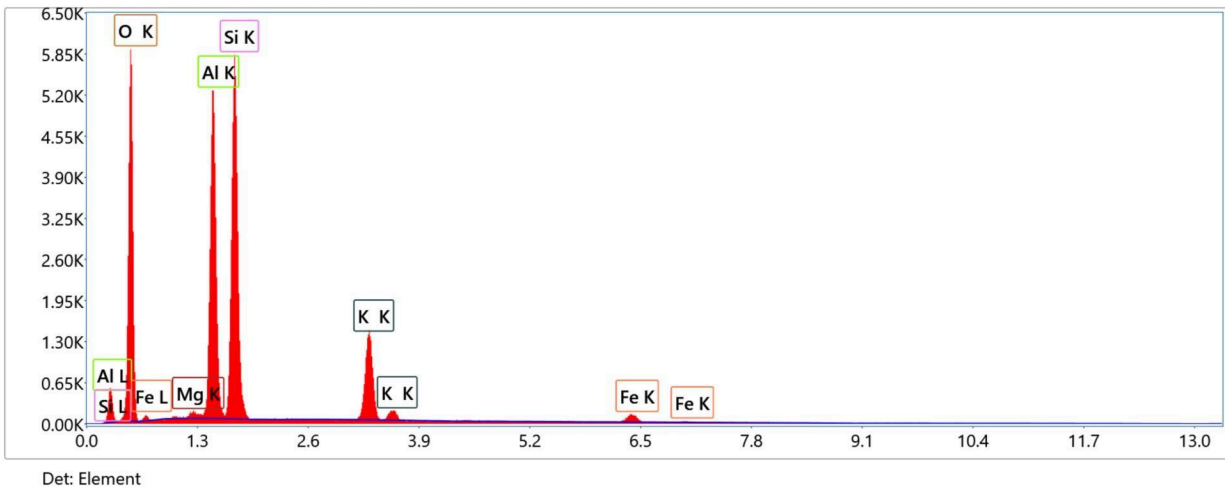
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	54.0	68.6
Mg K	1.0	0.8
Al K	15.7	11.8
Si K	19.4	14.0
K K	7.4	3.8
Fe K	2.5	0.9

Interpretation: sericite with minor Fe and Mg

Spot 3

Energy Dispersive Spectrum



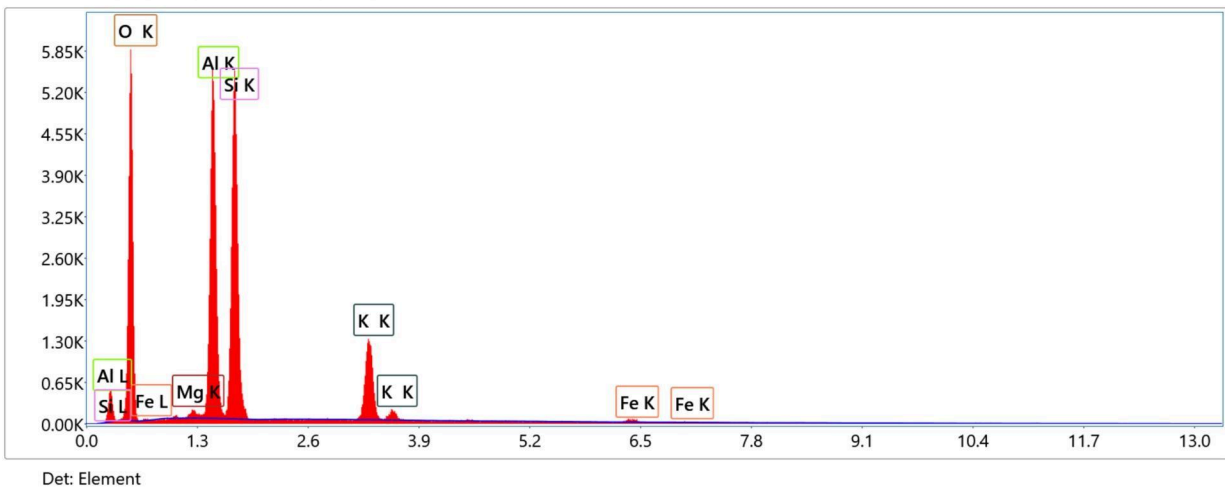
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	54.1	68.6
Mg K	0.7	0.6
Al K	16.2	12.2
Si K	19.3	13.9
K K	7.9	4.1
Fe K	1.9	0.7

Interpretation: sericite with minor Fe and trace Mg

Spot 4

Energy Dispersive Spectrum



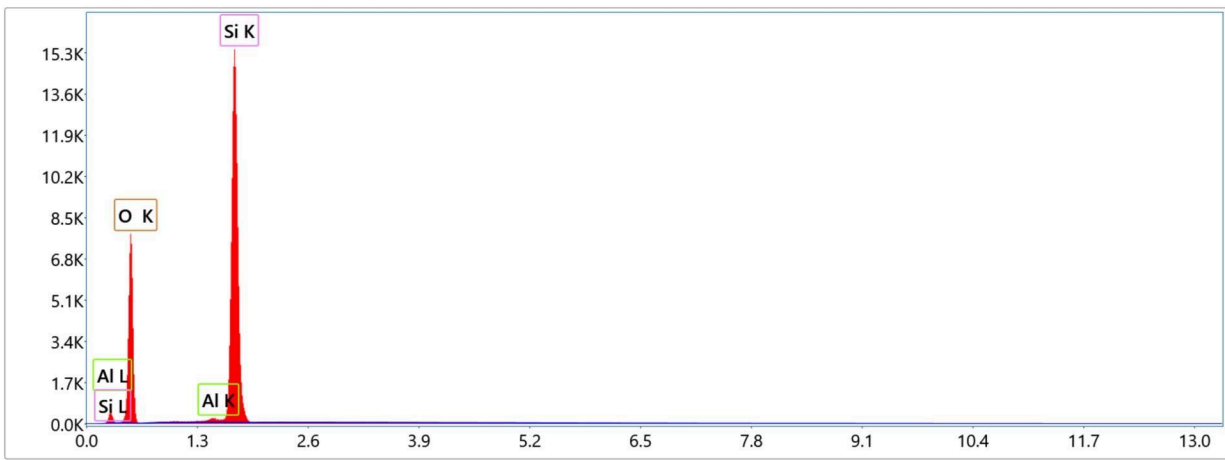
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	54.2	68.4
Mg K	0.7	0.6
Al K	17.5	13.1
Si K	19.1	13.7
K K	7.7	4.0
Fe K	0.8	0.3

Interpretation: sericite with minor Fe and Mg

Spot 5

Energy Dispersive Spectrum



Det: Element

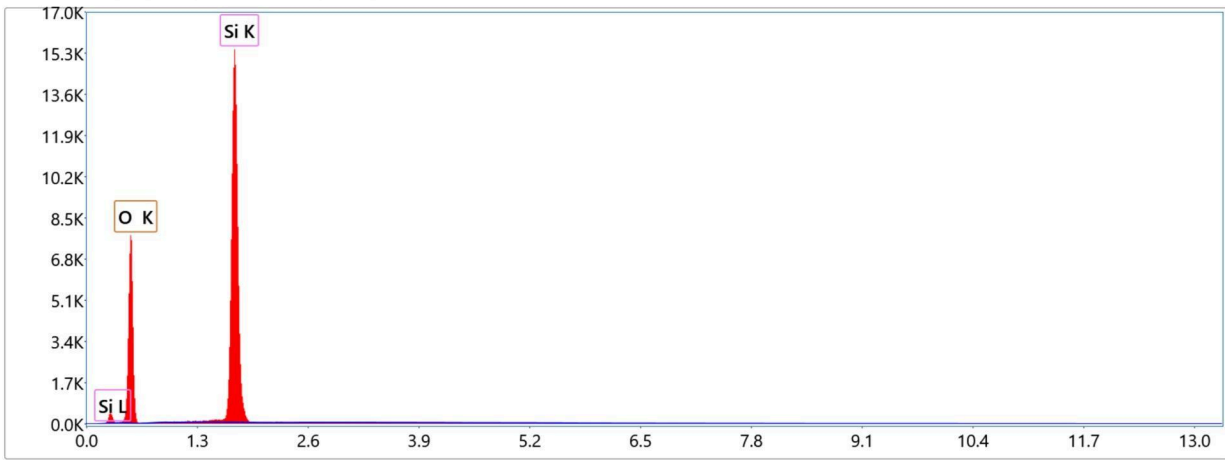
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	57.7	70.5
Al K	1.0	0.7
Si K	41.3	28.8

Interpretation: quartz

Spot 6

Energy Dispersive Spectrum



Det: Element

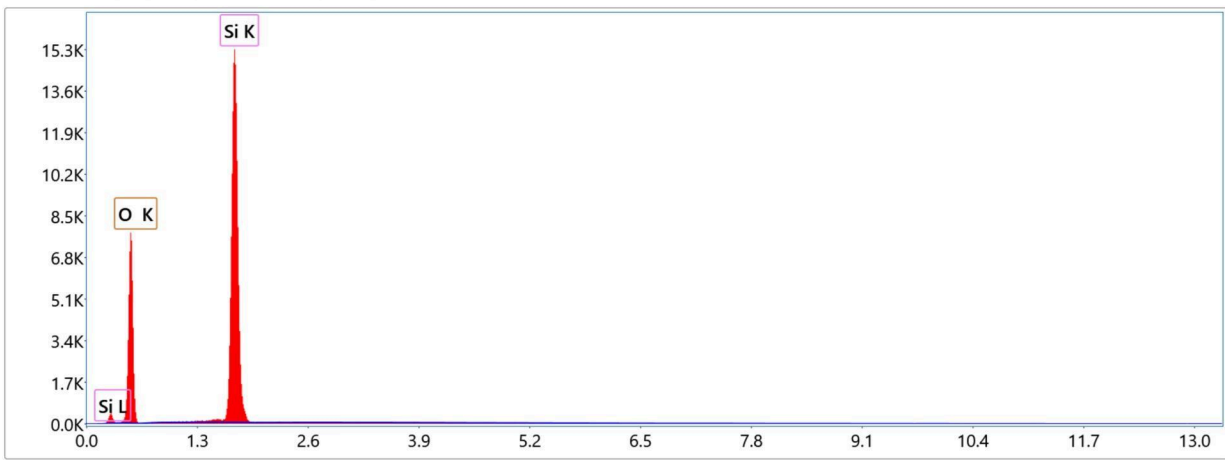
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	58.2	71.0
Si K	41.8	29.0

Interpretation: quartz

Spot 7

Energy Dispersive Spectrum



Det: Element

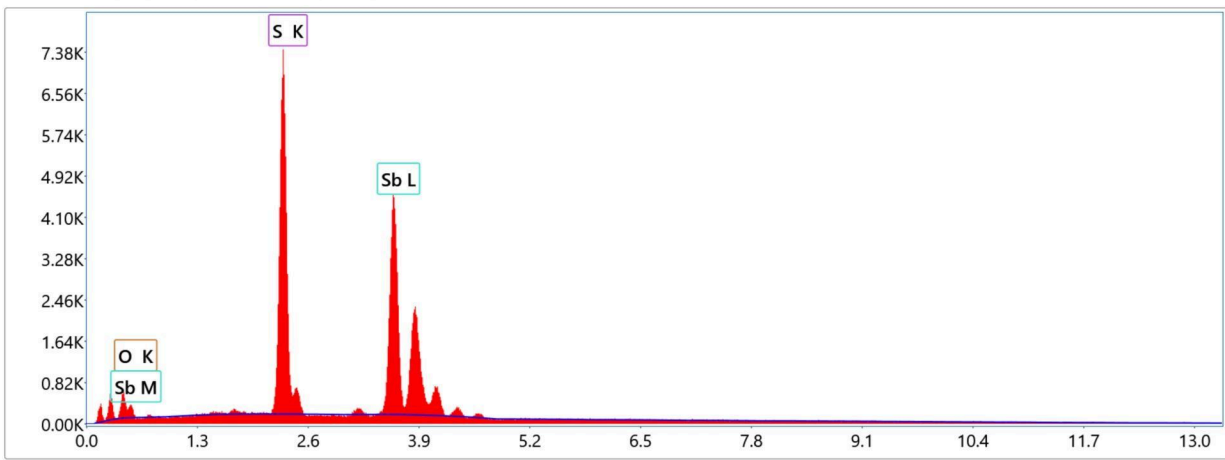
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	58.2	70.9
Si K	41.8	29.1

Interpretation: quartz

Spot 8

Energy Dispersive Spectrum



Det: Element

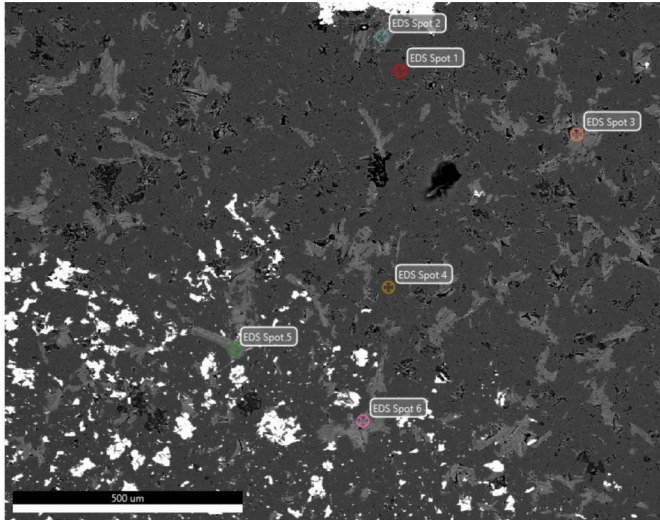
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	1.0	4.1
S K	27.6	57.1
Sb L	71.4	38.9

Interpretation: stibnite

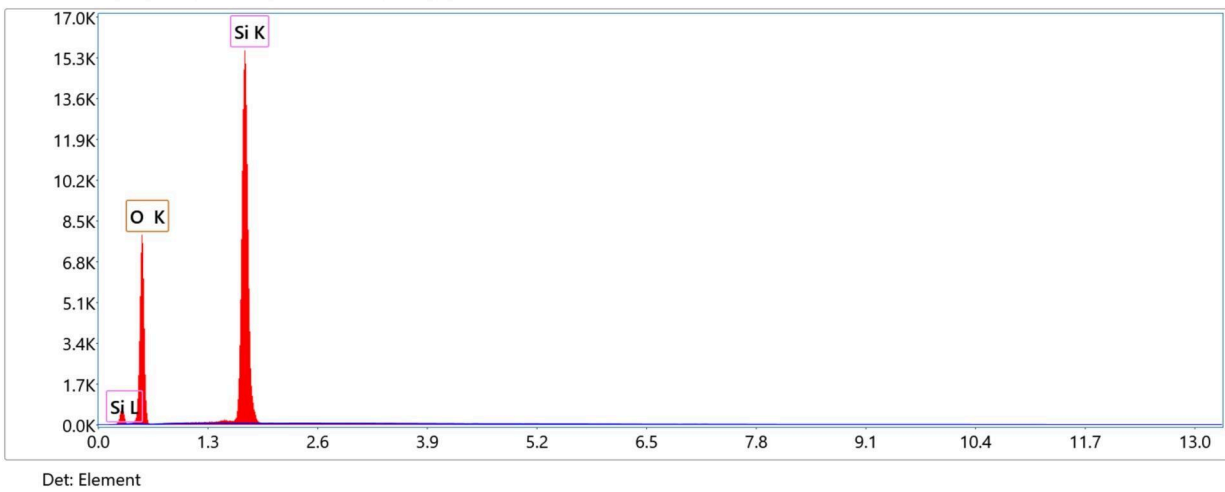
Circle 3 Area 1

Plate 45. Electron backscattered image shows the sharp margin between the sub equant stibnite clot and the non-stibnite bearing altered groundmass of the dyke. The non-stibnite bearing altered groundmass may be relatively coarser grained than within the stibnite clot.



Spot 1

Energy Dispersive Spectrum



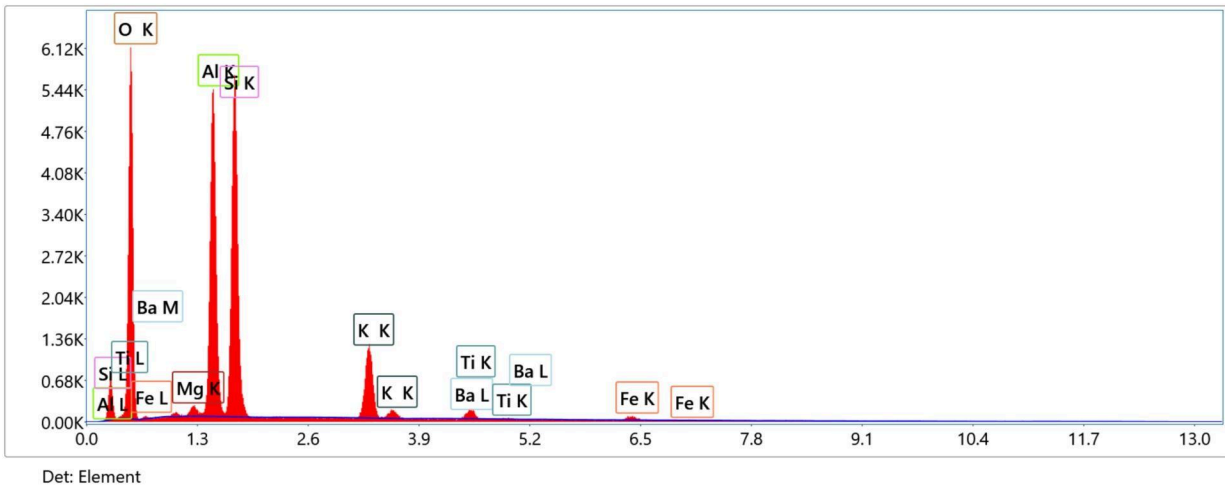
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	58.2	71.0
Si K	41.8	29.0

Interpretation: quartz

Spot 2

Energy Dispersive Spectrum



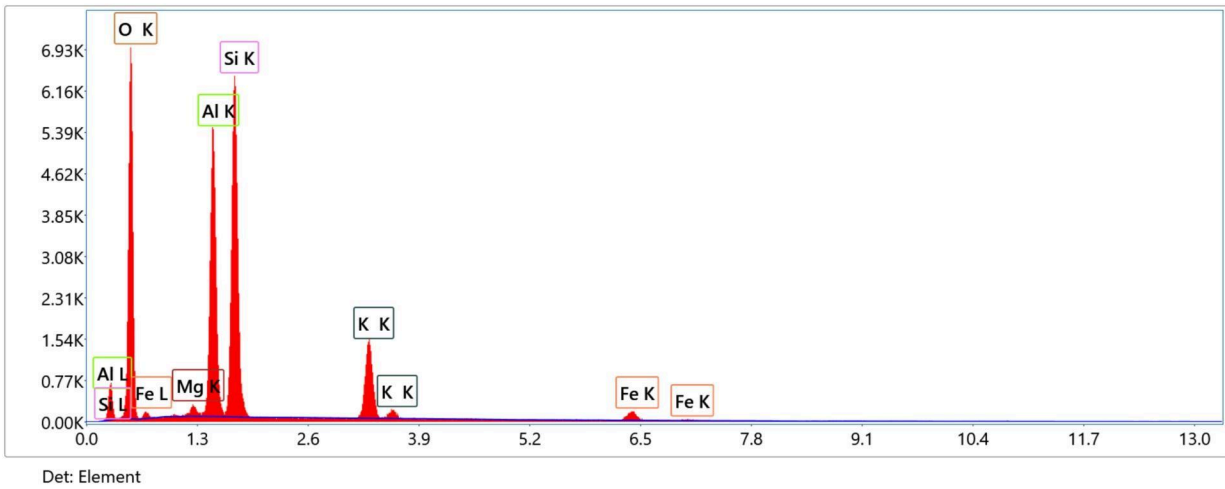
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	54.5	68.8
Mg K	0.9	0.7
Al K	16.7	12.5
Si K	18.9	13.6
K K	6.7	3.5
Ti K	1.1	0.5
Fe K	0.9	0.3
Ba L	0.3	0.1

Interpretation: mixture – sericite with rutile inclusions, possibly altered biotite

Spot 3

Energy Dispersive Spectrum



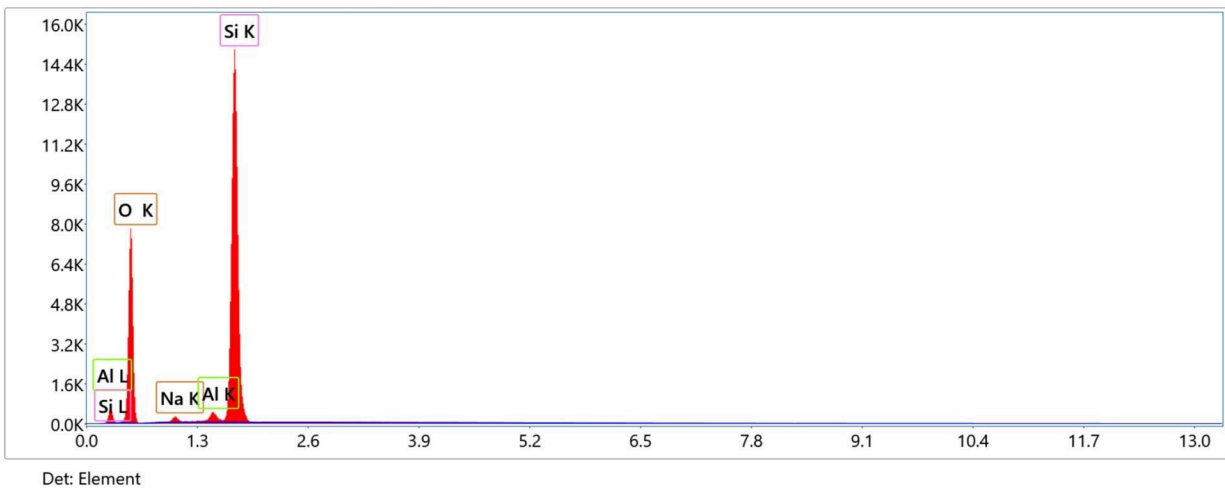
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	55.0	69.4
Mg K	0.9	0.8
Al K	15.2	11.4
Si K	19.2	13.8
K K	7.3	3.8
Fe K	2.3	0.8

Interpretation: sericite with minor Fe and trace Mg

Spot 4

Energy Dispersive Spectrum



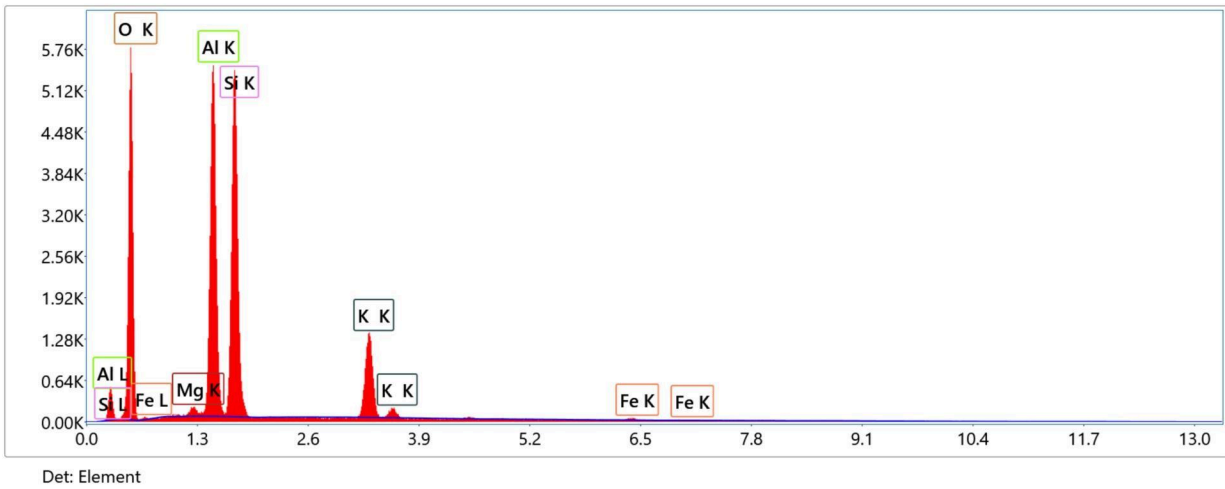
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	56.6	69.4
Na K	1.7	1.5
Al K	1.6	1.2
Si K	40.1	28.0

Interpretation: mixture - quartz with albite

Spot 5

Energy Dispersive Spectrum



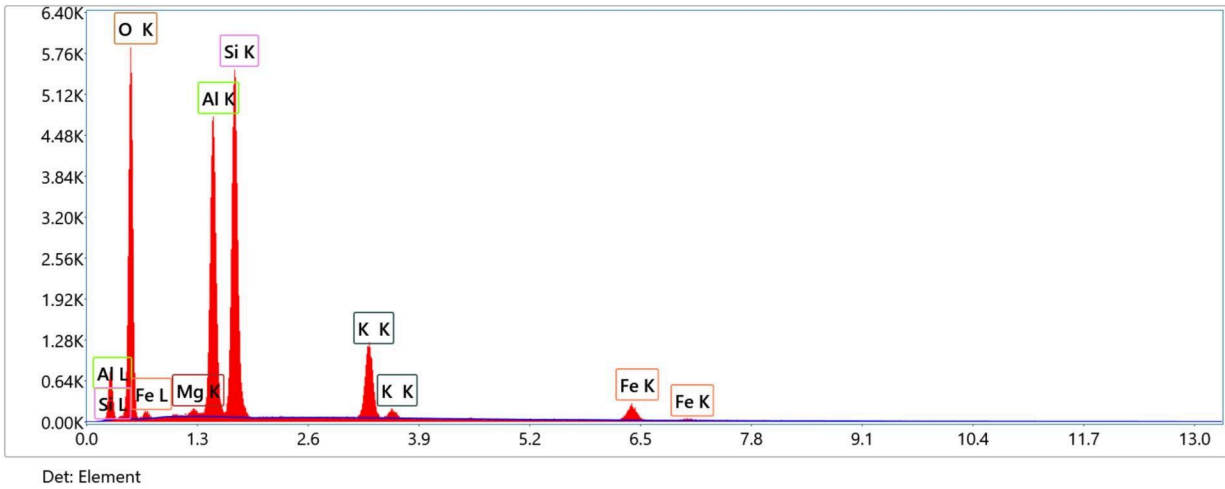
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	54.4	68.4
Mg K	0.8	0.6
Al K	17.6	13.1
Si K	19.1	13.7
K K	7.7	4.0
Fe K	0.4	0.2

Interpretation: sericite with trace Fe and Mg

Spot 6

Energy Dispersive Spectrum



Semi-quantitative analyses

Element	Weight %	Atomic %
O K	53.3	68.2
Mg K	0.7	0.6
Al K	15.8	12.0
Si K	19.3	14.1
K K	7.1	3.7
Fe K	3.7	1.4

Interpretation: sericite with minor Fe and trace Mg

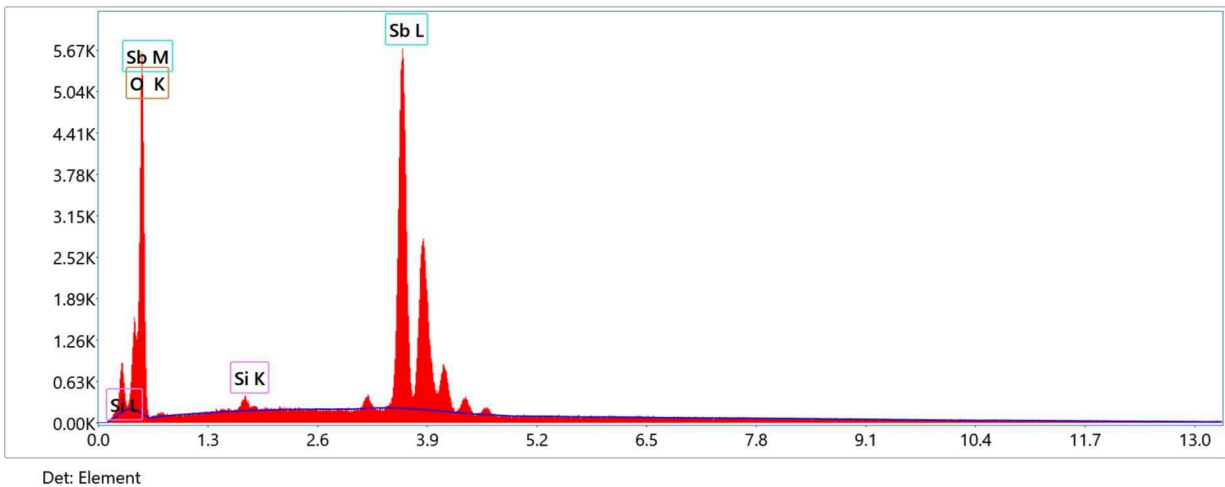
Circle 3 Area 2

Plate 46. Electron backscattered image of antimony oxide, valentinite. This mineral is present in a sub equant stibnite clots, Could the irregular-shaped grains with interstitial material indicate formation by secondary processes – post mineral?



Spot 1

Energy Dispersive Spectrum



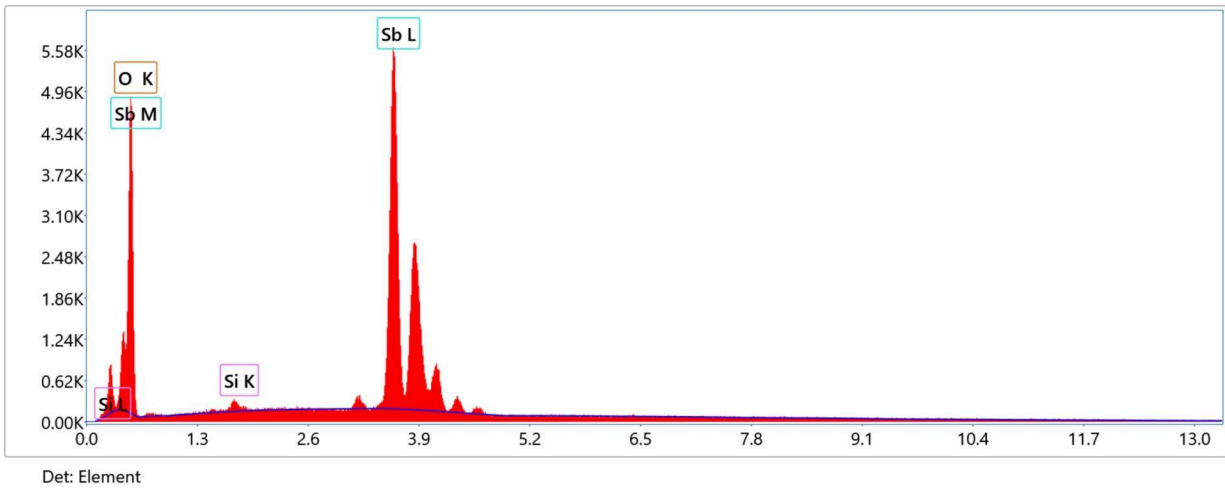
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	21.3	O K
Si K	1.0	Si K
Sb L	77.7	Sb L

Interpretation: valentinite with trace quartz

Spot 2

Energy Dispersive Spectrum



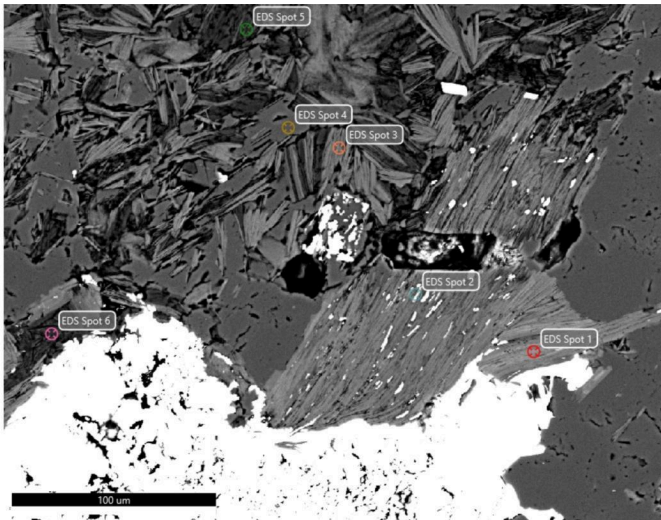
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	19.5	64.0
Si K	1.0	1.8
Sb L	79.5	34.2
O K	19.5	64.0

Interpretation: valentinite with trace quartz

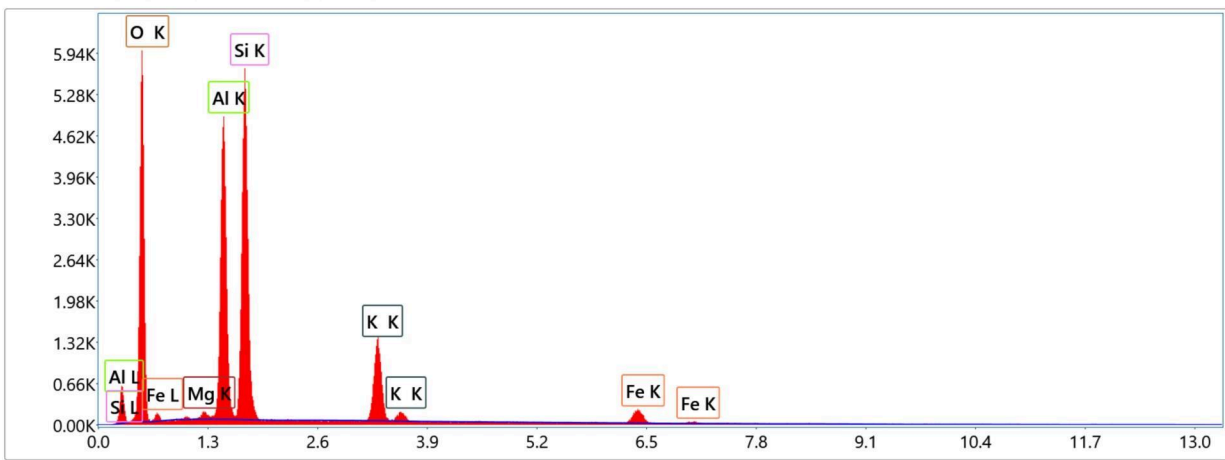
Circle 3 Area 3

Plate 47. Electron backscattered image of micas adjacent to inclusion-bearing stibnite (bright at bottom of image)



Spot 1

Energy Dispersive Spectrum



Det: Element

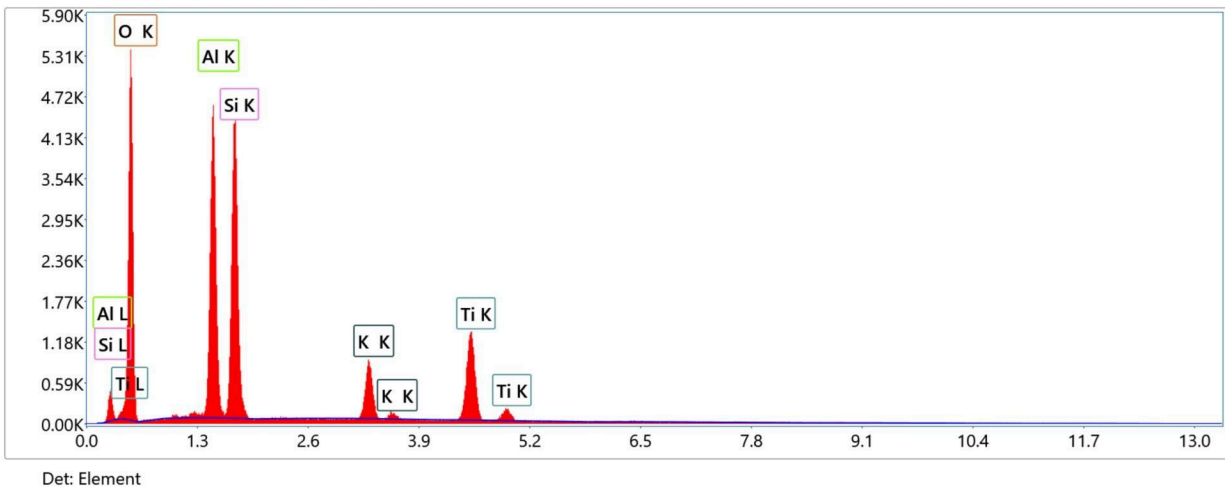
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	53.9	O K
Mg K	0.6	Mg K
Al K	15.6	Al K
Si K	19.0	Si K
K K	7.5	K K
Fe K	3.5	Fe K

Interpretation: sericite with minor Fe and trace Mg

Spot 2

Energy Dispersive Spectrum



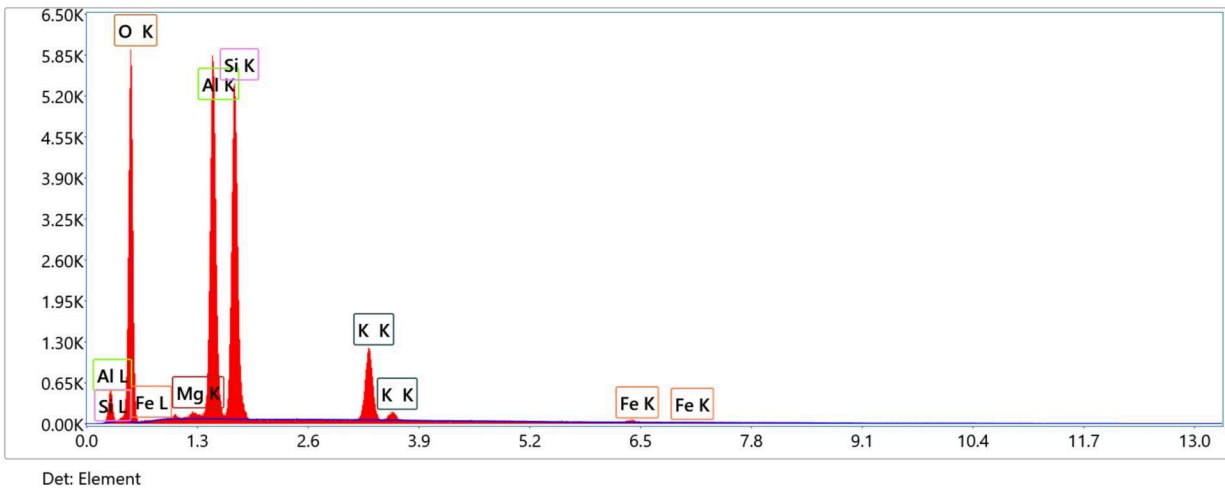
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	56.5	72.0
Al K	14.2	10.7
Si K	14.6	10.6
K K	4.2	2.2
Ti K	10.5	4.5

Interpretation: mixture - sericite with rutile. This grain could have been biotite but has been completely replaced by muscovite. Titanium is immobile and is present as minute grains of rutile

Spot 3

Energy Dispersive Spectrum



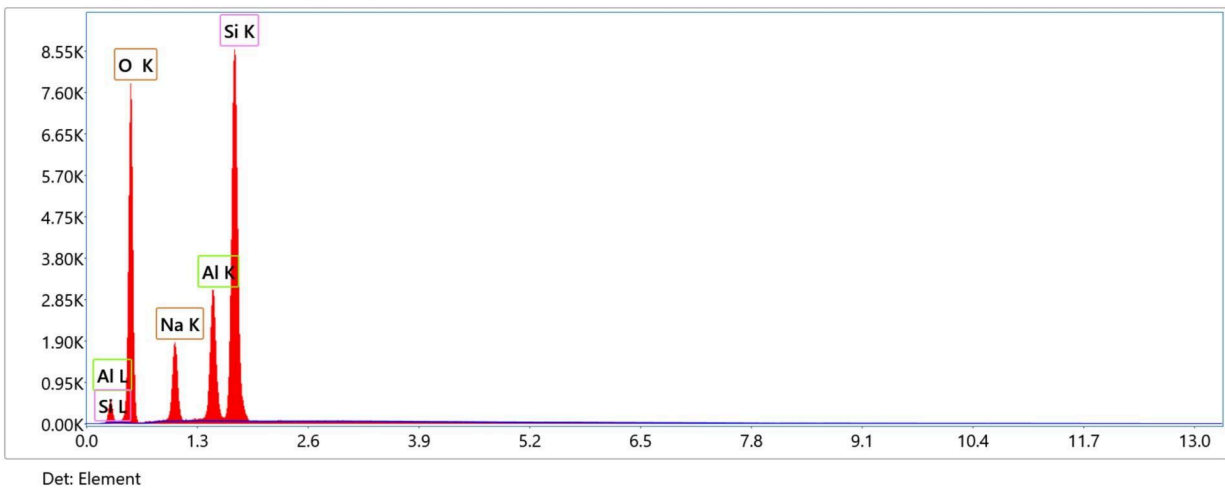
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	54.4	68.3
Mg K	0.7	0.6
Al K	18.4	13.7
Si K	19.3	13.8
K K	6.7	3.4
Fe K	0.6	0.2

Interpretation: sericite with minor Fe and Mg

Spot 4

Energy Dispersive Spectrum



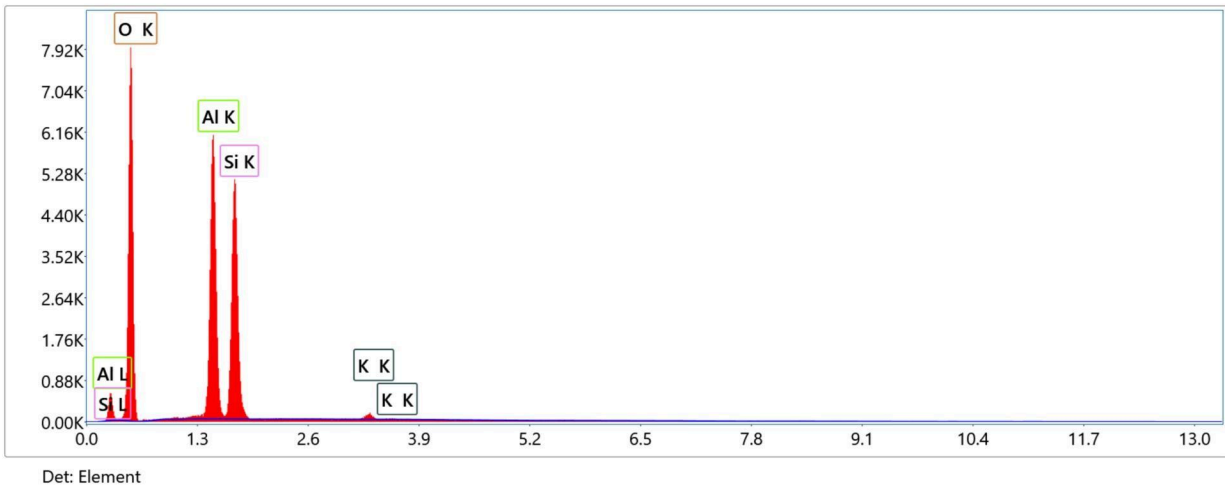
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	52.7	64.9
Na K	10.2	8.7
Al K	9.8	7.2
Si K	27.3	19.2

Interpretation: albite

Spot 5

Energy Dispersive Spectrum



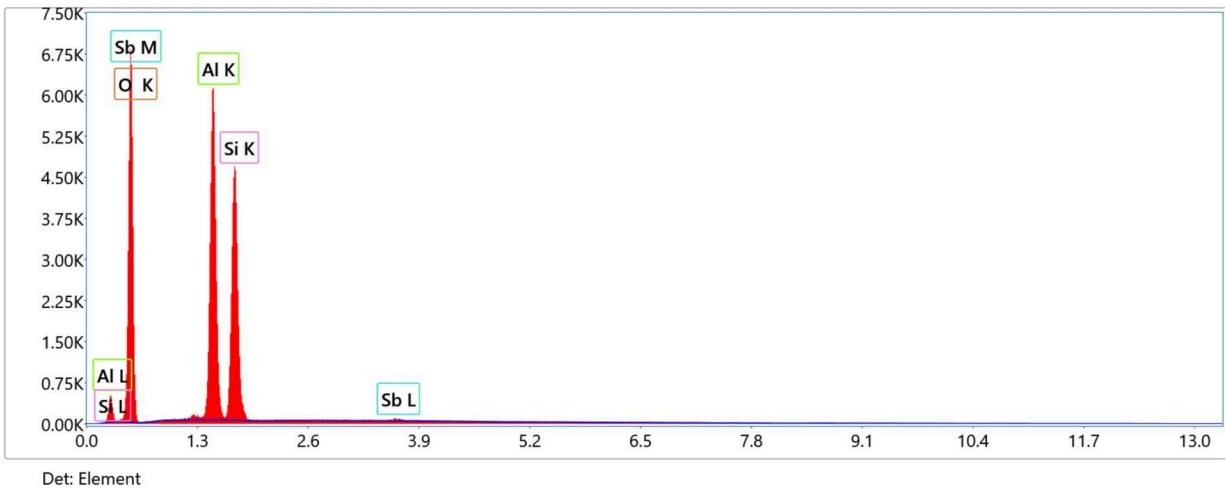
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	59.7	71.9
Al K	20.0	14.3
Si K	19.5	13.4
K K	0.7	0.4

Interpretation: kaolinite

Spot 6

Energy Dispersive Spectrum



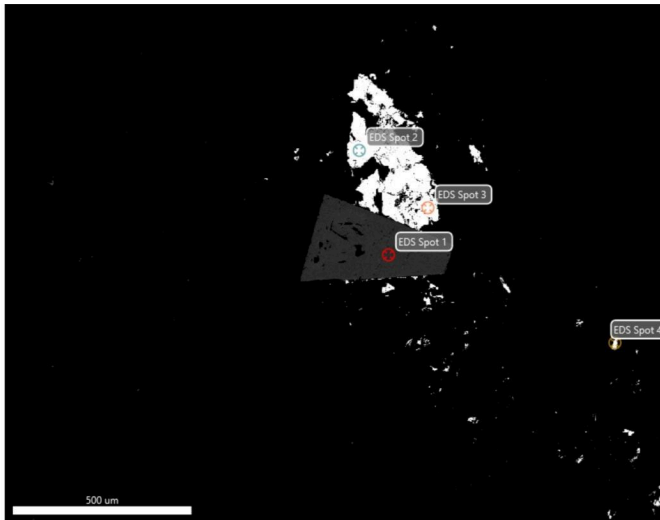
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	57.1	69.9
Al K	21.9	15.9
Si K	20.2	14.1
Sb L	0.9	0.1

Interpretation: kaolinite with stibnite or valentinite?

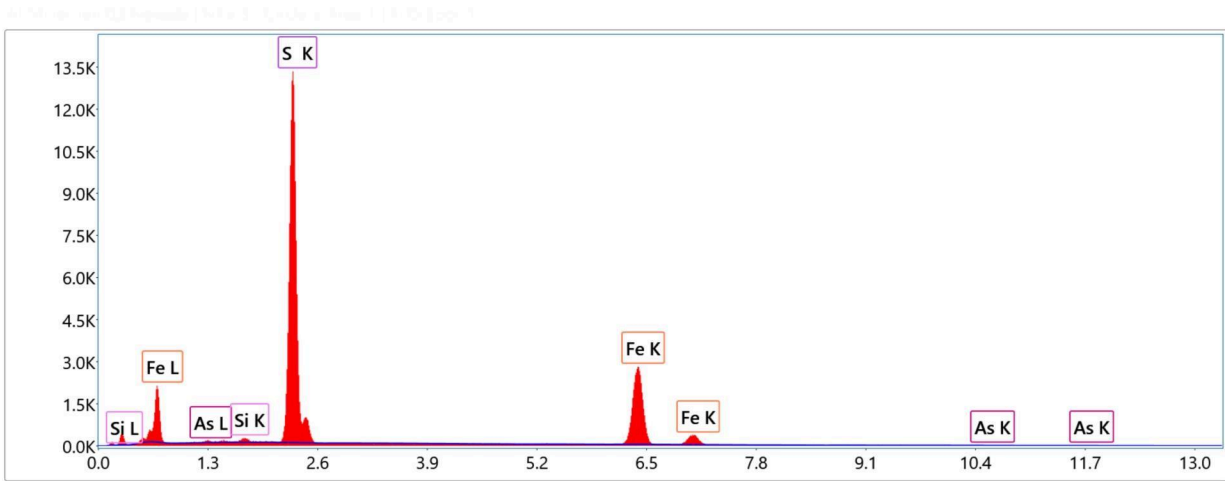
Circle 5 Area 1

Plate 48. Electron backscattered image of textural relationship, i.e. stable, between arsenian pyrite-stibnite-valentinite



Spot 1

Energy Dispersive Spectrum



Det: Element

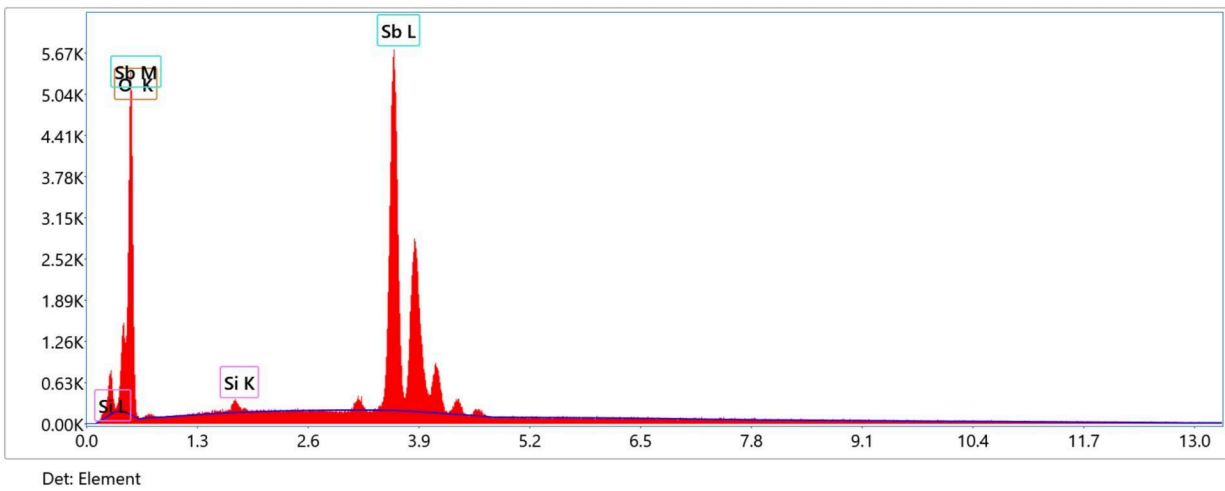
Semi-quantitative analyses

Element	Weight %	Atomic %
Si K	0.8	1.1
S K	51.6	64.9
Fe K	45.7	33.0
As K	1.9	1.0

Interpretation: arsenian pyrite with quartz

Spot 2

Energy Dispersive Spectrum



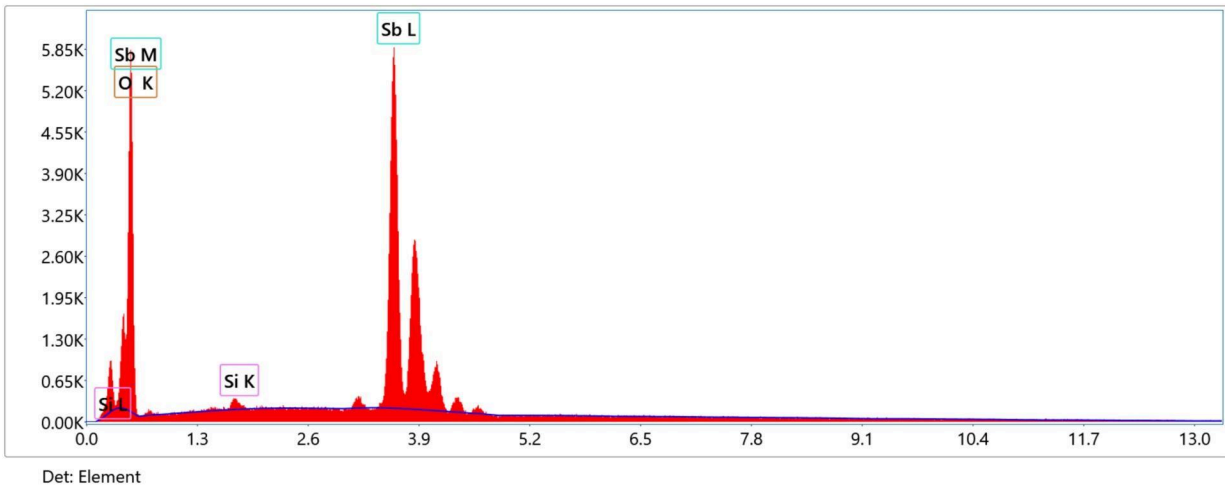
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	20.3	65.1
Si K	1.0	1.8
Sb L	78.7	33.1

Interpretation: valentinite with trace quartz

Spot 3

Energy Dispersive Spectrum



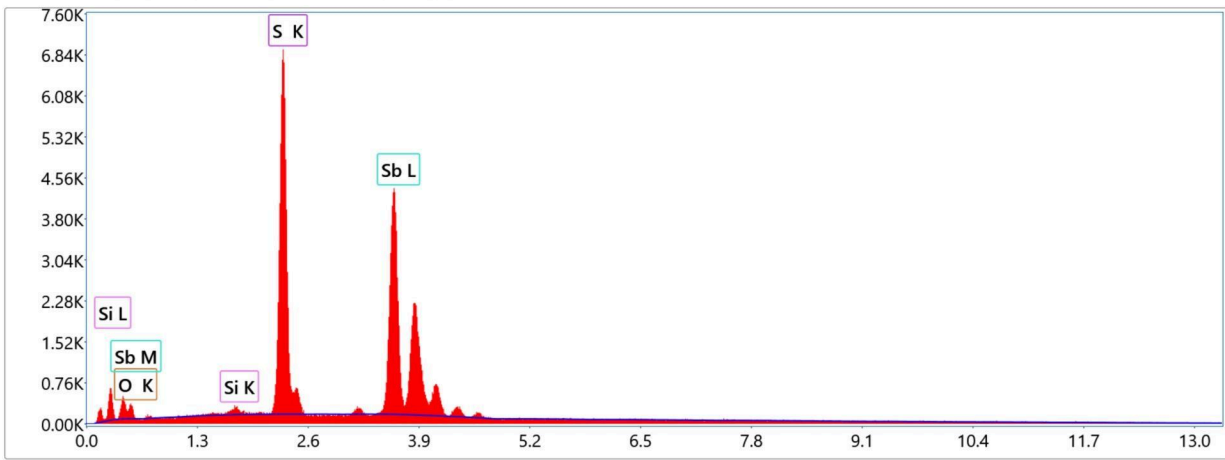
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	21.5	66.7
Si K	0.9	1.6
Sb L	77.6	31.7

Interpretation: valentinite with trace quartz

Spot 4

Energy Dispersive Spectrum



Det: Element

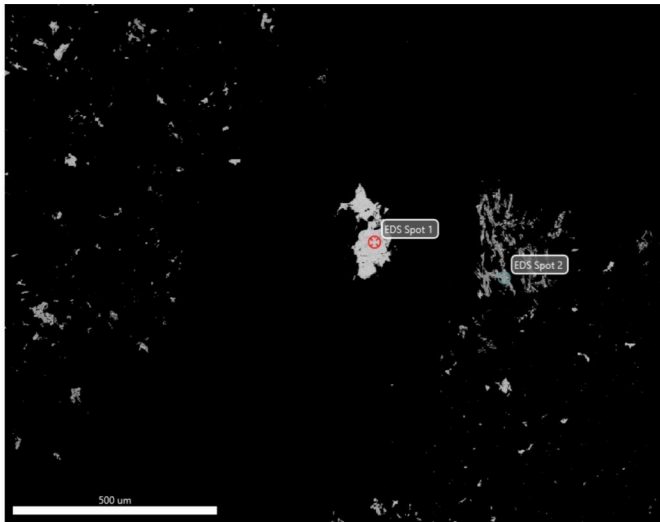
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	1.2	4.9
Si K	0.9	2.0
S K	27.0	55.0
Sb L	70.9	38.1

Interpretation: stibnite with trace quartz

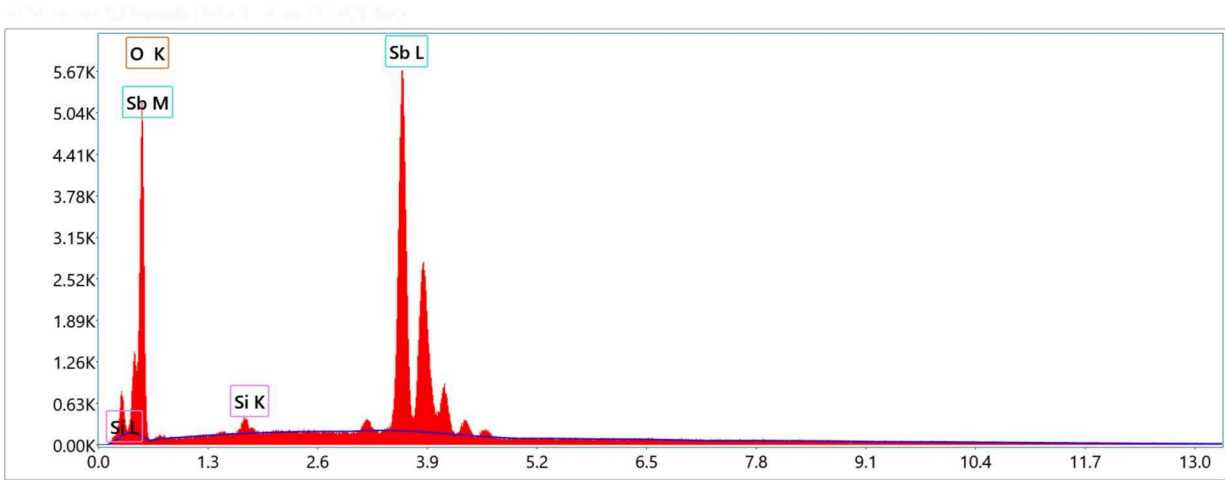
Circle 5 Area 2

Plate 49. Electron backscattered image valentinite and stibnite in altered groundmass



Spot 1

Energy Dispersive Spectrum



Det: Element

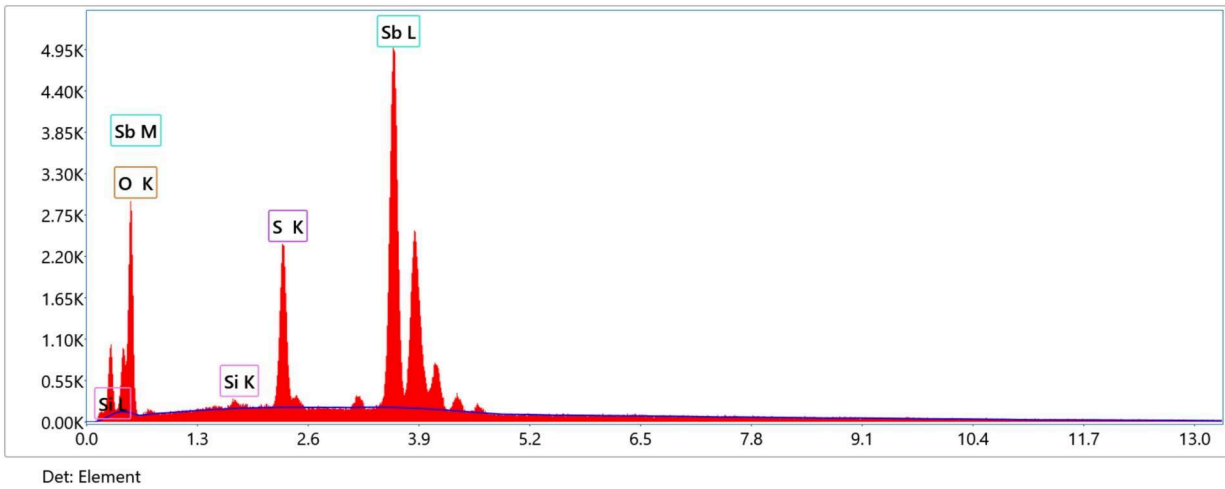
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	20.2	64.8
Si K	1.2	2.1
Sb L	78.6	33.1

Interpretation: valentinite with trace quartz

Spot 2

Energy Dispersive Spectrum



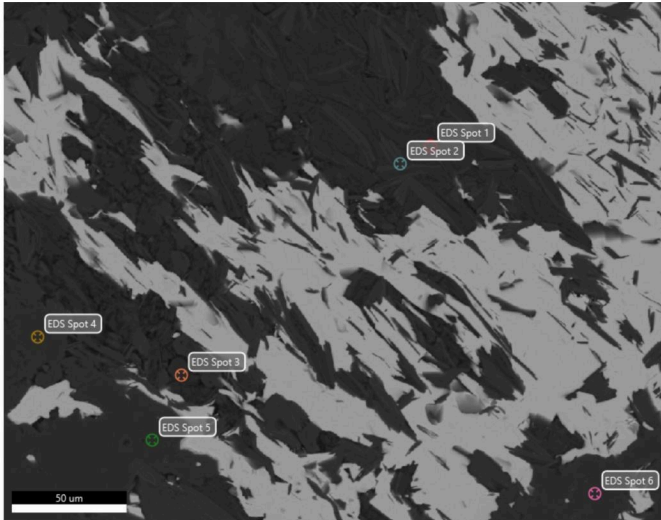
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	14.7	49.9
Si K	0.6	1.2
S K	8.7	14.9
Sb L	76.0	34.0

Interpretation: stibnite with quartz

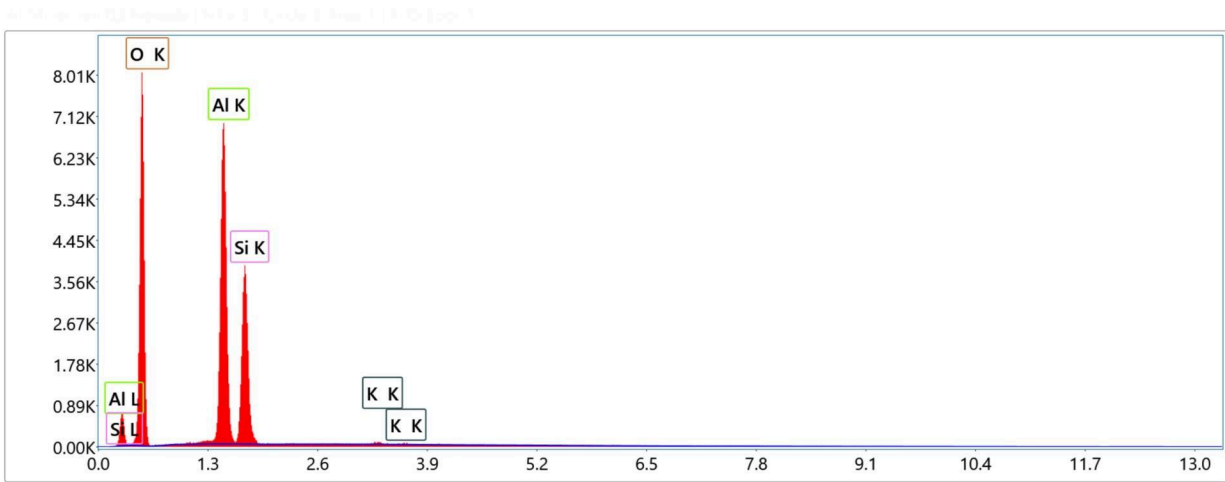
Circle 6 Area x

Plate 50. Electron backscattered image of stibnite intergrown with clay-mica mixture.



Spot 1

Energy Dispersive Spectrum



Det: Element

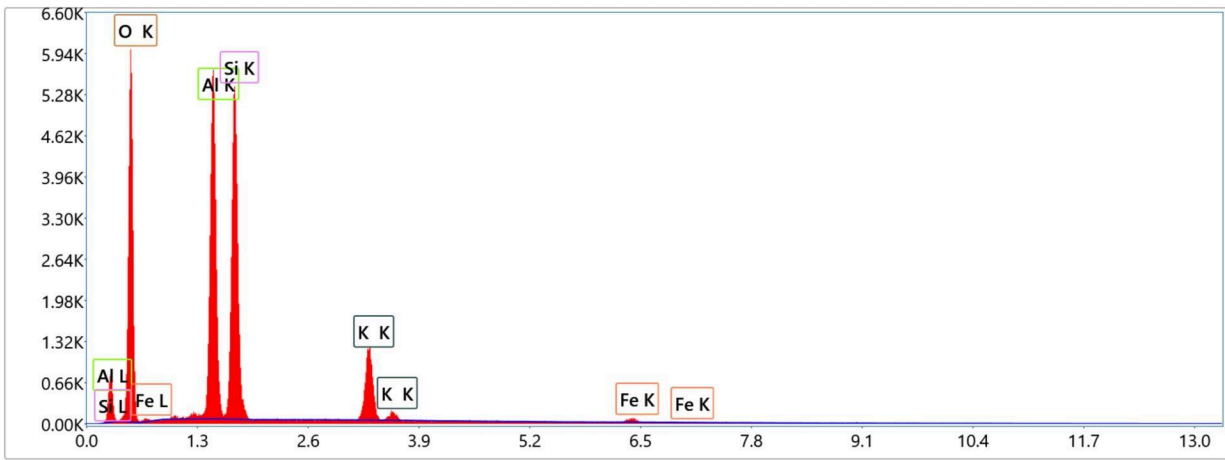
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	60.0	72.0
Al K	23.8	16.9
Si K	15.9	10.9
K K	0.4	0.2

Interpretation: Kaolinite

Spot 2

Energy Dispersive Spectrum



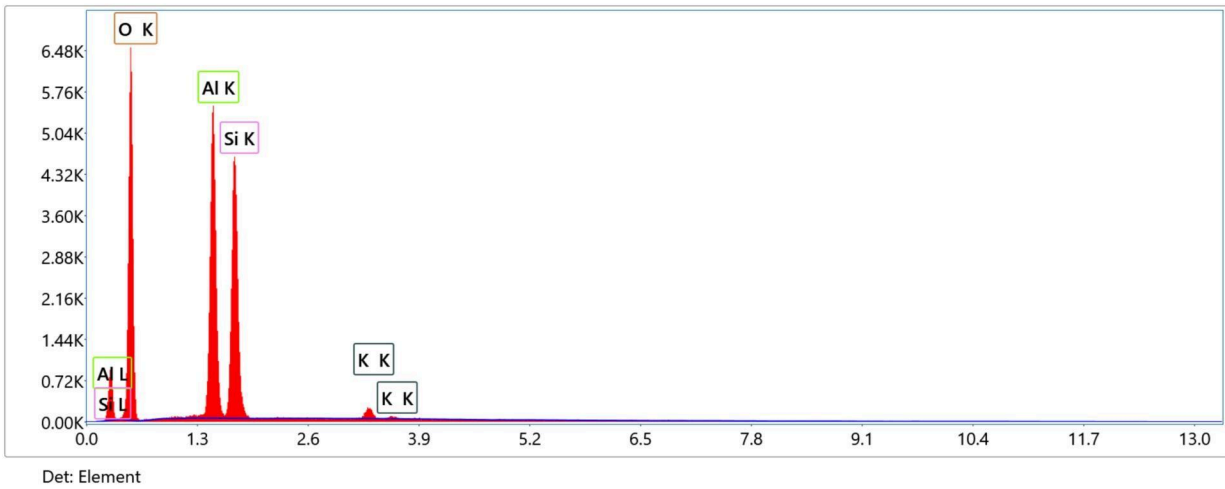
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	55.1	69.2
Al K	17.9	13.3
Si K	19.1	13.6
K K	6.9	3.6
Fe K	1.0	0.4

Interpretation: sericite with minor Fe

Spot 3

Energy Dispersive Spectrum



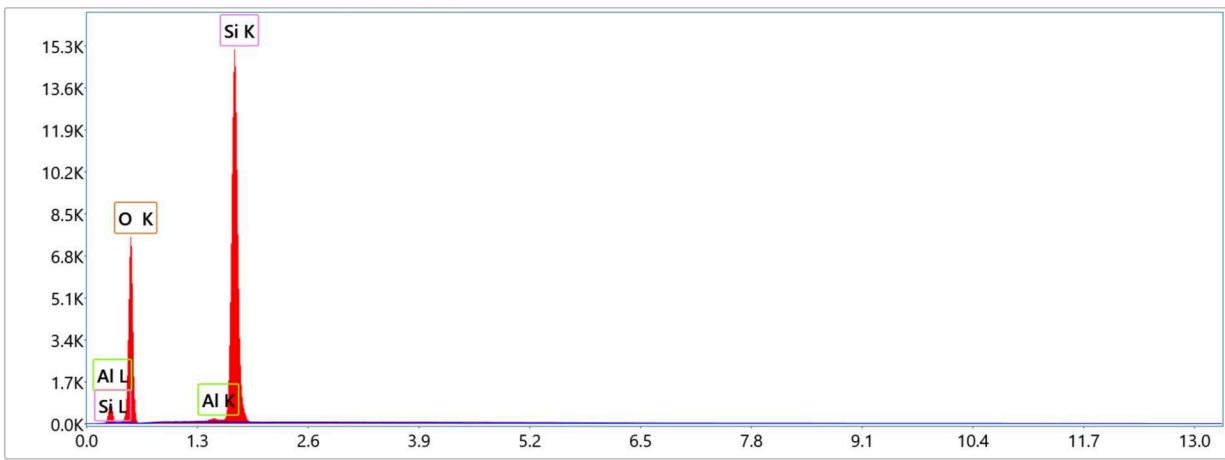
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	57.8	O K
Al K	20.4	Al K
Si K	20.4	Si K
K K	1.3	K K

Interpretation: kaolinite

Spot 4

Energy Dispersive Spectrum



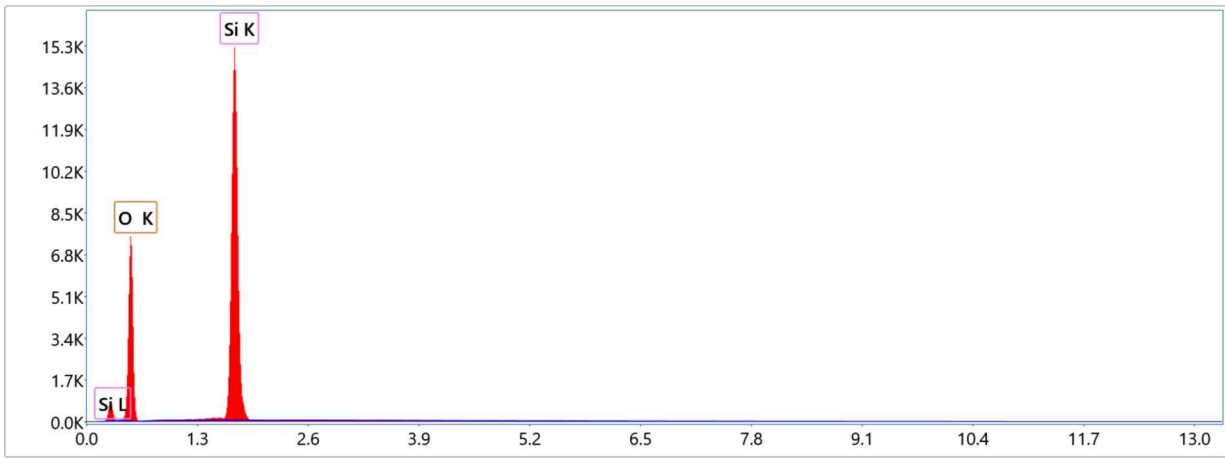
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	57.6	70.4
Al K	0.8	0.6
Si K	41.6	29.0

Interpretation: quartz

Spot 5

Energy Dispersive Spectrum



Det: Element

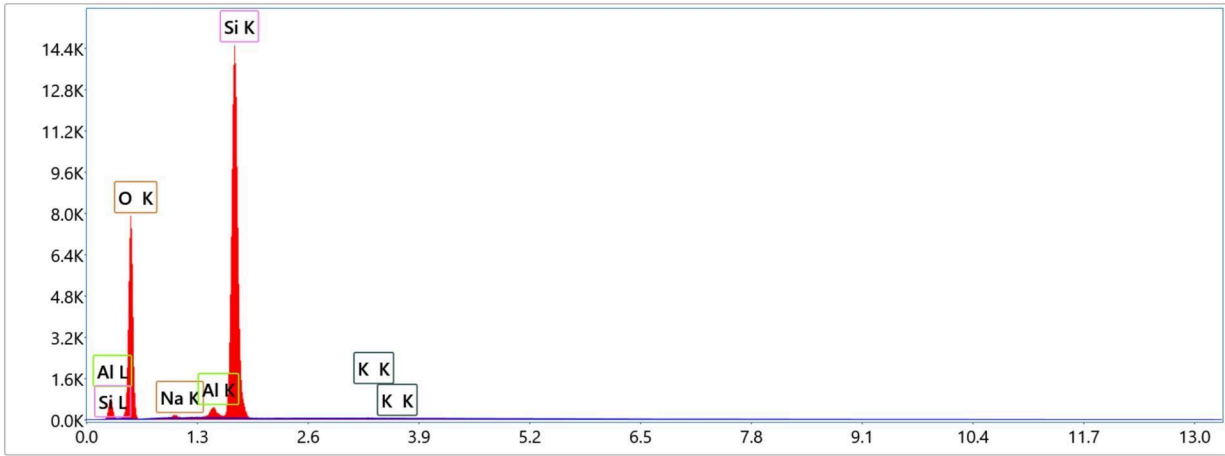
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	58.2	71.0
Si K	41.8	29.0

Interpretation: quartz

Spot 6

Energy Dispersive Spectrum



Det: Element

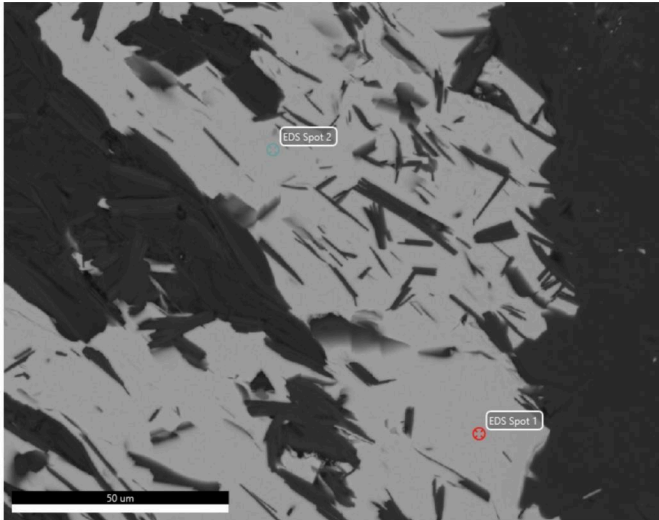
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	57.5	70.3
Na K	1.0	0.9
Al K	1.7	1.2
Si K	39.6	27.5
K K	0.2	0.1

Interpretation: mixture – quartz with trace albite

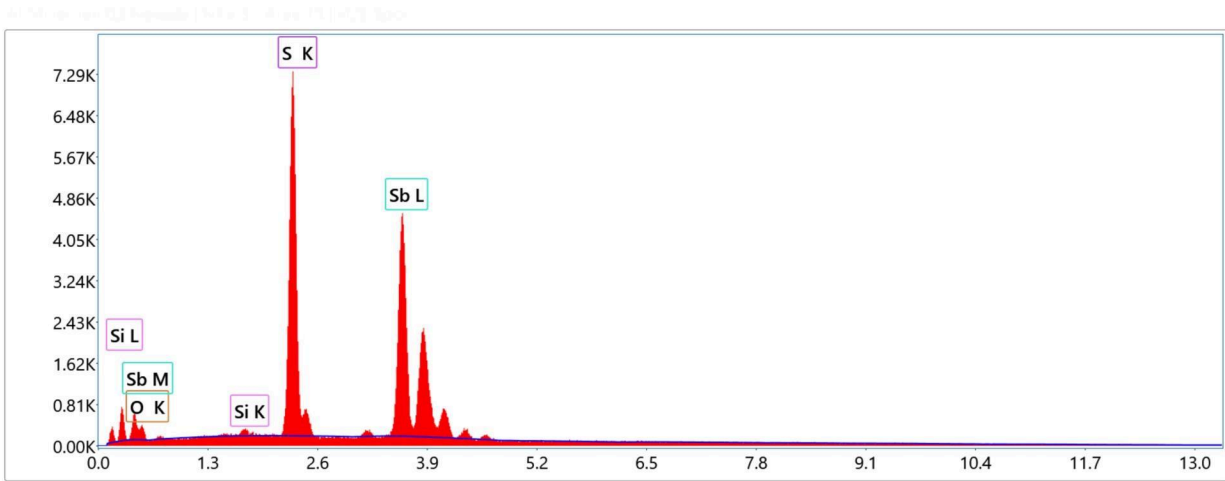
Circle 6 Area 2

Platte 51. Electron backscattered image of stibnite intergrown with and host inclusions of silicates.



Spot 1

Energy Dispersive Spectrum



Det: Element

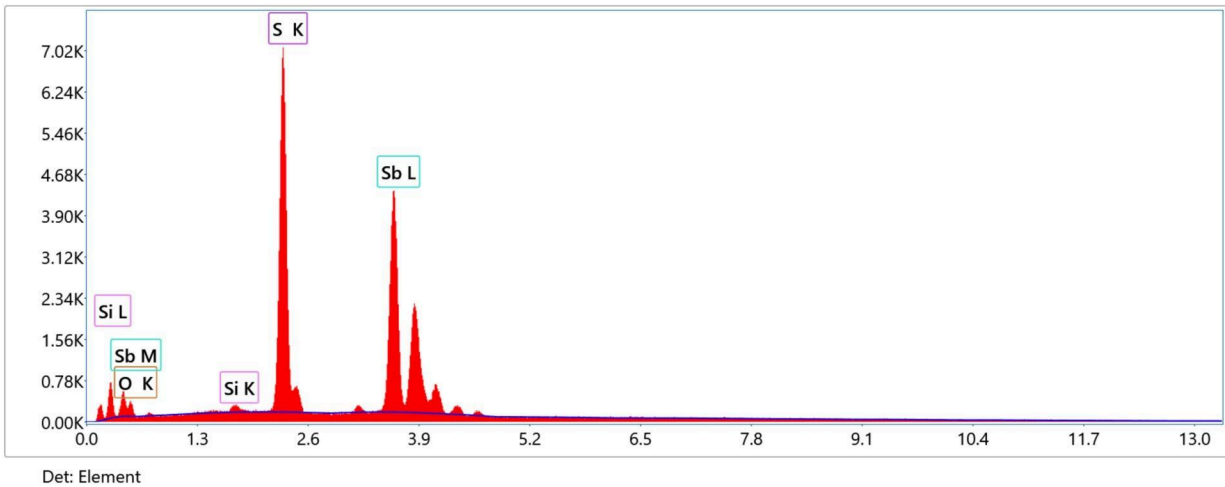
Semi-quantitative analyses

Element	Weight %	Atomic %
O K	1.1	4.5
Si K	0.7	1.7
S K	27.5	55.9
Sb L	70.7	37.9

Interpretation: stibnite with quartz

Spot 2

Energy Dispersive Spectrum



Semi-quantitative analyses

Element	Weight %	Atomic %
O K	1.1	4.4
Si K	0.8	1.8
S K	27.6	56.1
Sb L	70.6	37.8

Interpretation: stibnite with quartz

Reference

Johansing, R. 2024. Preliminary Report: Geologic Description of Antimony (Stibnite) Deposits in the Bernice Canyon Area, Churchill County, Nevada and Recommendations for Ongoing Exploration. Confidential report, 25p.