



भारत सरकार
GOVERNMENT OF INDIA
खान मंत्रालय
MINISTRY OF MINES

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भारतीय भूवैज्ञानिक सर्वेक्षण / Geological Survey of India
दक्षिण क्षेत्र / Southern Region
बैंडलागुडा / Bandlaguda
हैदराबाद / Hyderabad-500068

No. 1405/TCS/GSI/Pet/EPMA/SR/2026

Date: 14/05/2026

Petrographic report

Sender details

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Critical mineralTrackers,
Hyderabad

T. R. No. 3702

Letter no. 897/Charges/Receipt/2025-26 dated 31.12.2025

Sir/Madam,

Please find the attached petrographic report on submitted samples (30 nos.) for your perusal.

Thanking you,

Yours sincere

K. Basak

(Dr. KRISHNAPRIYA BASAK)

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PETROGRAPHIC REPORT

1. Sample code: TNS-MN-03

Microscopic observations: Microscopic study reveals that the rock exhibits a coarse-grained, inequigranular texture. The modal mineral assemblage is characterized by quartz (Qz), microcline (Mc), sericite (Ser), epidote (Ep), biotite (Bt), titanite (Ttn), and zircon (Zrn) (**Fig. 3A-3F**).

The microcline exhibiting characteristic cross-hatched tartan twinning. The microcline appears fractured and partially altered, with quartz occupying interstitial spaces and fractures, suggesting late-stage silica influx. Quartz grains are anhedral to subhedral and display undulose extinction, indicating deformation (**Fig. 3A**).

Sericite is abundantly developed as fine-grained aggregates replacing feldspar, indicating pervasive hydrothermal alteration. The presence of biotite alongside sericite suggests re-equilibration under metamorphic conditions, with partial chloritization possibly occurring but not prominently visible (**Fig. 3B**).

Epidote, observed as bright, high-relief grains with strong interference colors, and is typically associated with hydrothermal or low-grade metamorphic conditions. Its occurrence suggests alteration of plagioclase or mafic minerals under oxidizing conditions (**Fig. 3C**).

Titanite appears as elongated, high-relief grains with characteristic wedge-shaped morphology and high birefringence. Its presence supports metamorphic recrystallization under fluid-rich conditions (**Fig. 3E**).

Zircon occurs as small, euhedral to subhedral accessory grains, typically enclosed within quartz or biotite. These grains are indicative of magmatic origin and are resistant to alteration, preserving primary geochemical signatures (**Fig. 3F**).

The rock records an initial magmatic assemblage (microcline, quartz, zircon) overprinted by deformation and hydrothermal alteration, leading to sericitization, epidote formation, and titanite growth. The textures and mineral relationships suggest a transition from magmatic crystallization to deformation-assisted fluid alteration under metamorphic conditions.

Rock/Mineral Name: Based on the mineral and textural characteristics, it is **deformed granite**.

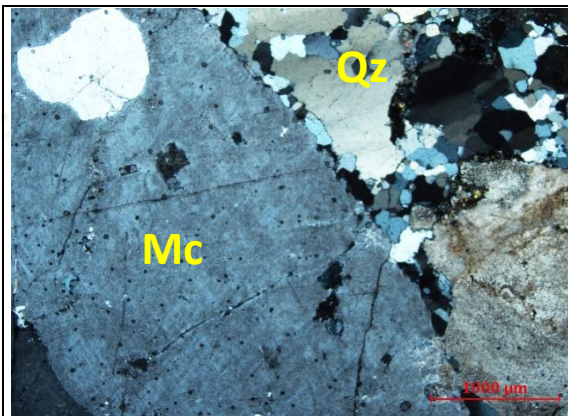


Fig. 3A. Photomicrograph showing presence of microcline (Mc), and quartz (Qz) under transmitted light XPL (2X).

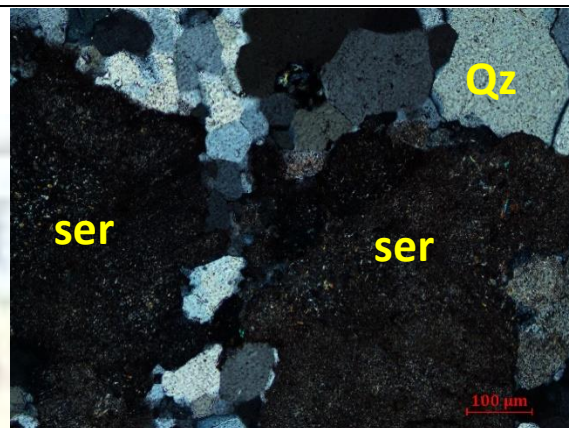


Fig. 3B. Photomicrograph showing presence of sericite (Ser), and quartz (Qz) under transmitted light XPL (10X).

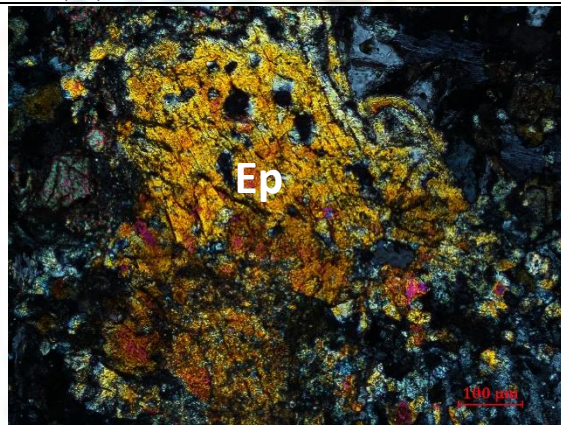


Fig. 3C. Photomicrograph showing presence of epidote (Ep) under transmitted light XPL (10X).

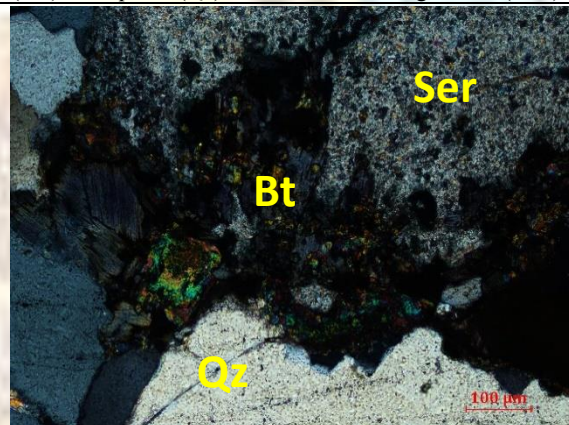


Fig. 3D. Photomicrograph showing presence of sericite (Ser), biotite (Bt) and quartz (Qz) under transmitted light XPL (10X).

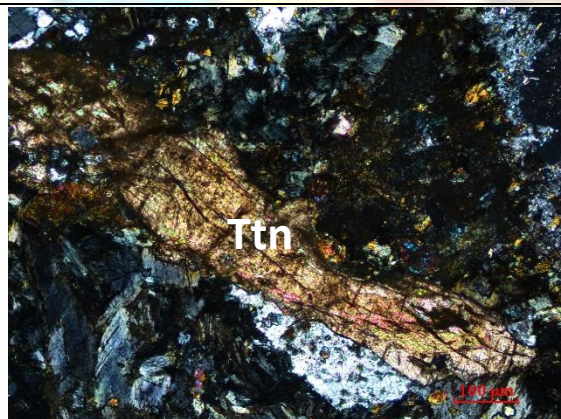


Fig. 3E. Photomicrograph showing presence of titanite (Ttn) under transmitted light XPL (10X).

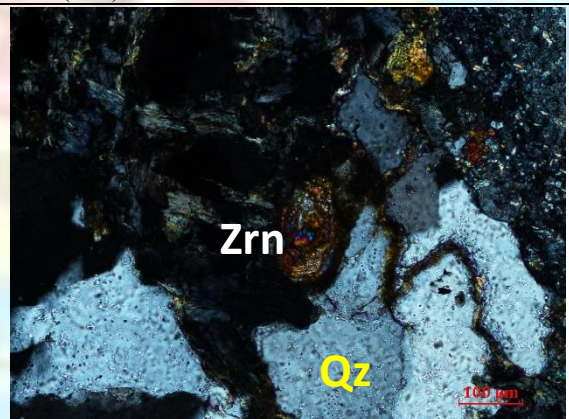


Fig. 3F. Photomicrograph showing presence of zircon (Zrn) and quartz (Qz) under transmitted light XPL (10X).

2. Sample code: TNS-MN-04

Microscopic observations: Microscopic study reveals that the rock exhibits a coarse-grained, inequigranular texture. The modal mineral assemblage is dominated by perthitic K-feldspar, quartz, and accessory phases (**Fig. 4A-4F**).

The most prominent feature is the development of perthite (Perth), observed as coarse K-feldspar hosting exsolved albite lamellae. These lamellae occur as fine, oriented intergrowths, indicating subsolidus exsolution during slow cooling of a granitic magma. In several places, perthitic feldspar shows deformation features such as microfractures and undulose extinction, suggesting post-crystallization deformation (**Fig. 4A-4B**).

Quartz (Qz) occurs as anhedral interstitial grains forming a mosaic texture. It commonly displays undulose extinction and recrystallized grain boundaries, indicating dynamic recrystallization under metamorphic conditions. The grain boundaries are sutured in places, reflecting strain-induced modification. Myrmekitic intergrowths are well developed at feldspar-quartz interfaces (**Fig. 4A & 4C**).

Sericite (Ser) occurs as fine-grained aggregates replacing feldspar, representing pervasive hydrothermal alteration (sericitization). This alteration is particularly intense along fractures and grain margins, suggesting fluid infiltration pathways. Biotite (Bt) appears as pleochroic, flaky grains, locally altered, and associated with epidote (Ep), which shows high birefringence and granular texture (**Fig. 4C-4D**).

Accessory minerals include titanite (Ttn), occurring as high-relief, wedge-shaped grains with characteristic brownish interference colors, and zircon (Zrn), present as small, euhedral inclusions within quartz and feldspar. These minerals are resistant phases and record primary magmatic crystallization (**Fig. 4E-4F**).

The rock represents a granitic protolith that underwent subsolidus re-equilibration (perthite formation), deformation-induced recrystallization (quartz), and fluid-mediated alteration (sericite, myrmekite, epidote), reflecting a transition from magmatic to hydrothermal-metamorphic conditions.

Rock/Mineral Name: Based on the mineral and textural characteristics, it is a **granite**.

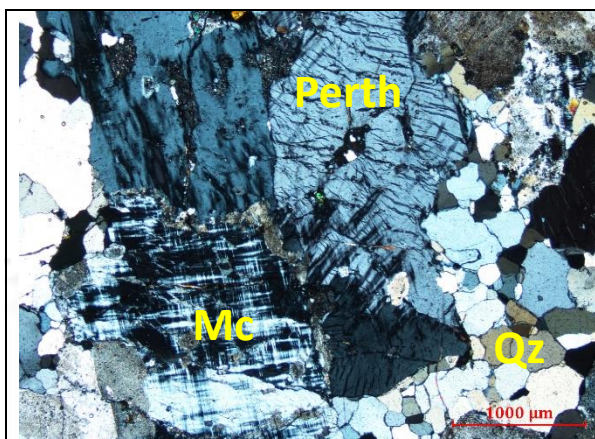


Fig. 4A. Photomicrograph showing presence of microcline (Mc), perthite (Perth) and quartz (Qz) under transmitted light XPL (2X).

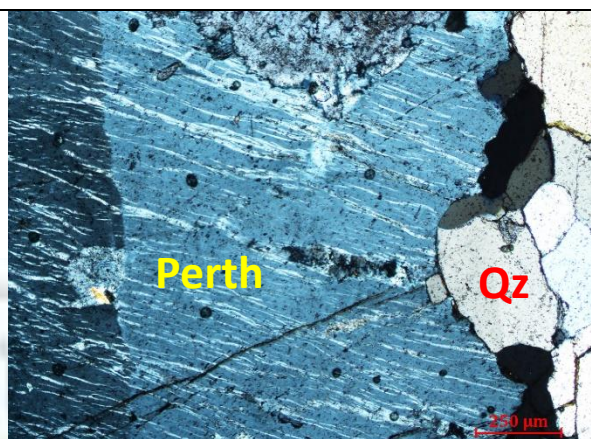


Fig. 4B. Photomicrograph showing presence of microcline (Mc) and quartz (Qz) under transmitted light XPL (5X).



Fig. 4C. Photomicrograph showing presence of mymerkite (Mymer) and sericite (Ser) under transmitted light XPL (10X).

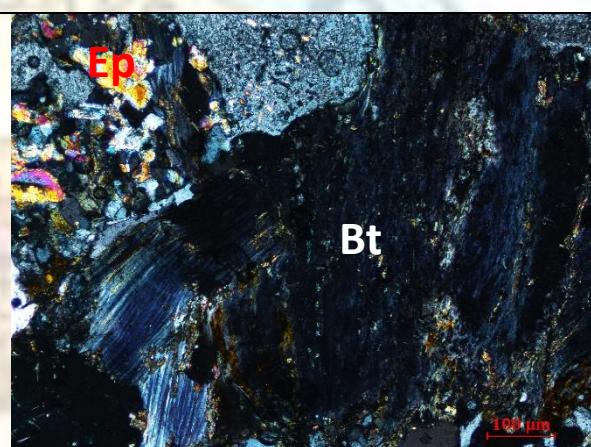


Fig. 4D. Photomicrograph showing presence of epidote (Ep) and biotite (Bt) under transmitted light XPL (10X).

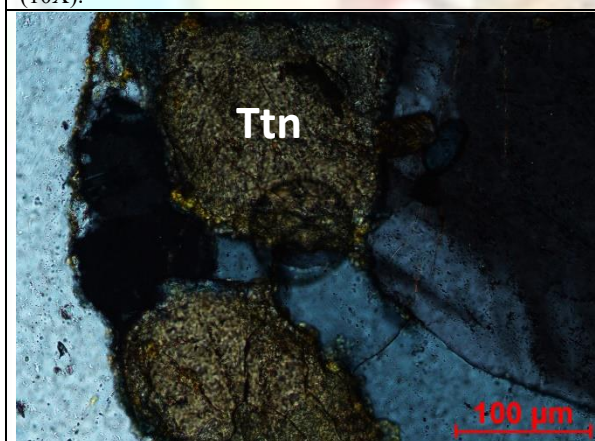


Fig. 4E. Photomicrograph showing presence of tianite (Ttn) under transmitted light XPL (20X).

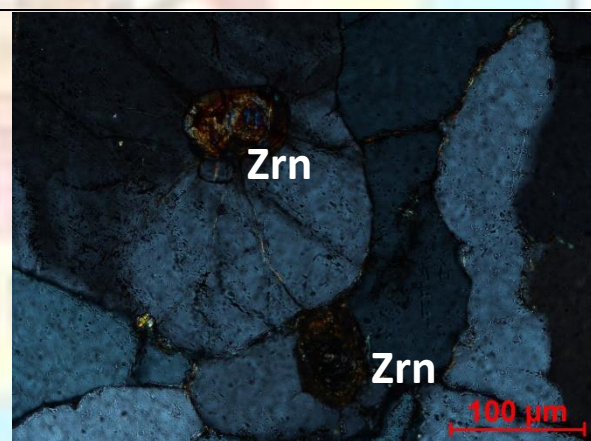


Fig. 4F. Photomicrograph showing presence of zircon (Zrn) under transmitted light XPL (20X).

3. Sample code: TNS-MN-06

Microscopic observations: Microscopic study reveals that the rock exhibits a coarse-grained, inequigranular texture. The modal mineral assemblage is dominated by alkali feldspar, plagioclase, quartz, and ferromagnesian minerals (**Fig. 6A-6F**).

Perthitic texture (Perth) is the most diagnostic feature. The lamellae are well-developed, oriented, and locally patchy, indicating slow cooling and subsolidus exsolution of a homogeneous alkali feldspar. In several places, the perthite shows deformation features such as microfracturing and strain-induced undulose extinction, suggesting that the rock experienced post-magmatic deformation. Microcline (Mc) occurs adjacent to perthite. K-feldspar (Kfs) also appears as discrete grains apart from perthite, indicating multiple generations or incomplete exsolution (**Fig. 6A-6B**).

Plagioclase (Plg) is present as subhedral grains with well-developed polysynthetic twinning. Some plagioclase crystals appear partially altered along cleavage planes and grain margins, indicating incipient sericitization or saussuritization. Quartz (Qz) occurs as interstitial, anhedral grains forming a mosaic texture, locally showing undulose extinction and recrystallization, reflecting deformation under metamorphic conditions (**Fig. 6C**).

Epidote (Ep) is widespread as granular aggregates with high relief and bright interference colors, typically associated with altered plagioclase. Biotite (Bt) occurs as pleochroic, flaky grains with strong birefringence, commonly associated with epidote and partially altered along margins, suggesting fluid-mediated re-equilibration (**Fig. 6C-6D**).

The mineral assemblage and textures indicate transition from magmatic crystallization to subsolidus re-equilibration and alteration, marked by epidote growth, biotite modification, and feldspar alteration.

Rock/Mineral Name: Based on the mineral and textural characteristics, it is a **quartz-syenite**.

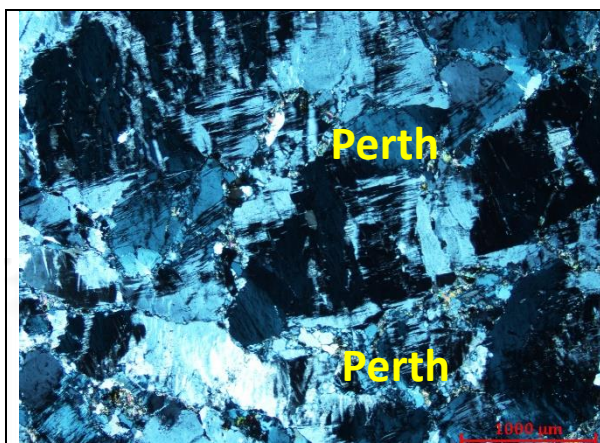


Fig. 6A. Photomicrograph showing presence of perthite (Perth) under transmitted light XPL (2X).

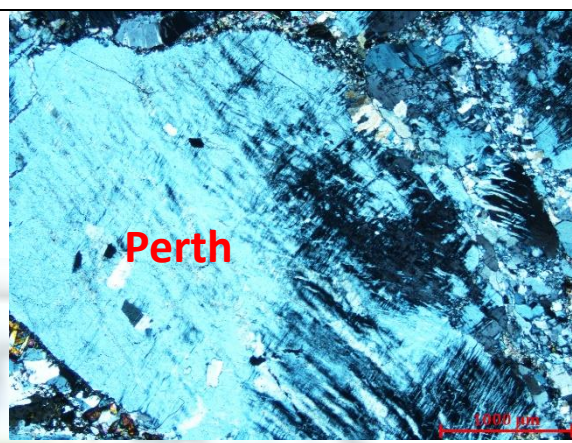


Fig. 6B. Photomicrograph showing presence of perthite (Perth) under transmitted light XPL (2X).

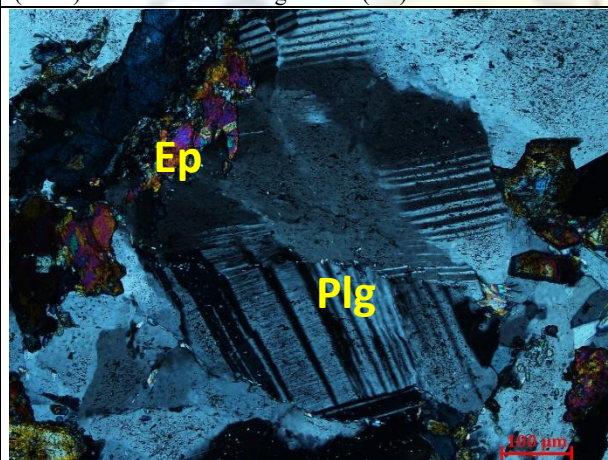


Fig. 6C. Photomicrograph showing presence of epidote (Ep) and plagioclase (Plg) under transmitted light XPL (10X).

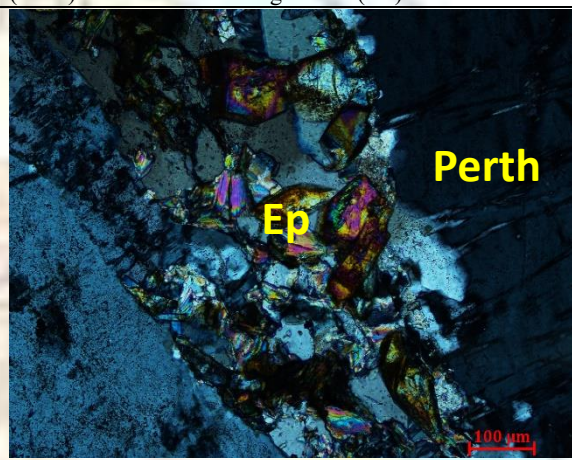


Fig. 6D. Photomicrograph showing presence of epidote (Ep) and perthite (Perth) under transmitted light XPL (10X).

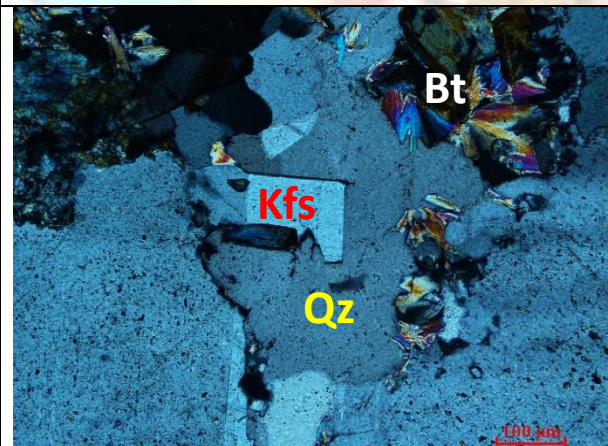


Fig. 6E. Photomicrograph showing presence of orthoclase (Kfs), quartz (Qz) and biotite (Bt) under transmitted light XPL (10X).

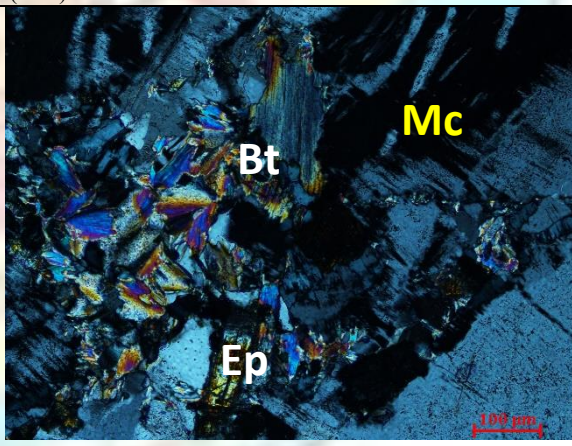


Fig. 6F. Photomicrograph showing presence of epidote (Ep), microcline (Mc) and biotite (Bt) under transmitted light XPL (10X).

4. Sample code: TNS-MN-15

Microscopic observations: Microscopic study reveals that the rock exhibits a coarse-grained, inequigranular texture. The modal mineral assemblage is dominated by K-feldspar (microcline and perthite), plagioclase, quartz, and accessory phases apatite, allanite and zircon (**Fig. 15A-15F**).

Microcline (Mc) occurs as coarse, subhedral to anhedral grains exhibiting well-developed tartan twinning. These grains are locally fractured and intergrown with quartz (Qz), which appears as anhedral. Quartz commonly shows undulose extinction and minor recrystallization, indicating deformation under metamorphic conditions. K-feldspar (Kfs) also occurs as discrete grains, suggesting multiple generations or incomplete exsolution (**Fig. 15A**).

Perthitic texture (Perth) is prominently developed, characterized by exsolution lamellae of albite within K-feldspar. Some perthitic grains exhibit microfractures and strain effects (**Fig. 15B**).

Plagioclase (Plg) is present as subhedral grains with polysynthetic twinning, locally altered along cleavage and grain margins. The presence of epidote (Ep) as high-relief, brightly birefringent grains associated with plagioclase indicates saussuritization under hydrothermal conditions. Sericite (Ser) occurs as fine-grained aggregates replacing feldspar, especially along fractures and grain boundaries, reflecting pervasive fluid-mediated alteration (**Fig. 15C-15D**).

Biotite (Bt) appears as pleochroic, flaky grains with moderate to high interference colors, often hosting accessory phases. Allanite (Aln), identified by its high relief and strong interference colors, occurs in association with biotite. Apatite (Ap) is present as small prismatic inclusions, commonly enclosed within biotite or feldspar (**Fig. 15E**).

Zircon (Zrn) occurs as euhedral to subhedral accessory grains with high relief and bright interference colors, typically included within biotite or quartz, indicating a primary magmatic origin (**Fig. 15F**).

The assemblage of epidote, sericite, and altered feldspars suggests fluid-assisted metasomatism, overprinting the original magmatic textures.

Rock/Mineral Name: Based on the mineral and textural characteristics, it is a **granite**.

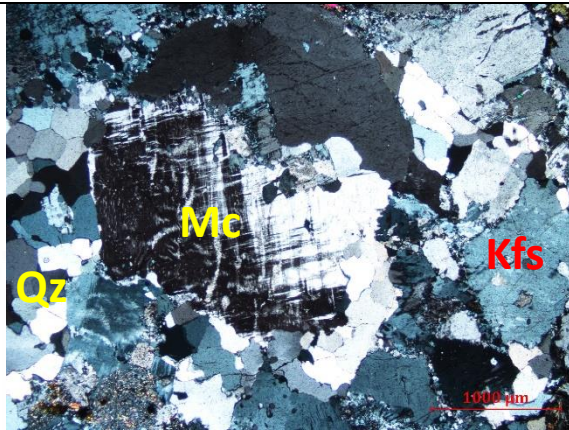


Fig. 15A. Photomicrograph showing presence of orthoclase (Kfs), quartz (Qz) and microcline (Mc) under transmitted light XPL (2X).

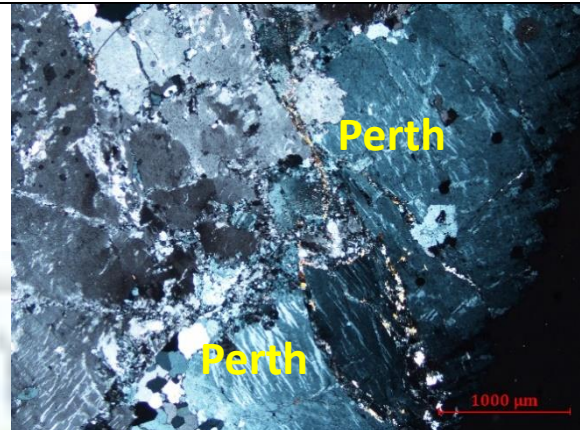


Fig. 15B. Photomicrograph showing presence of perthite (Perth) under transmitted light XPL (2X).

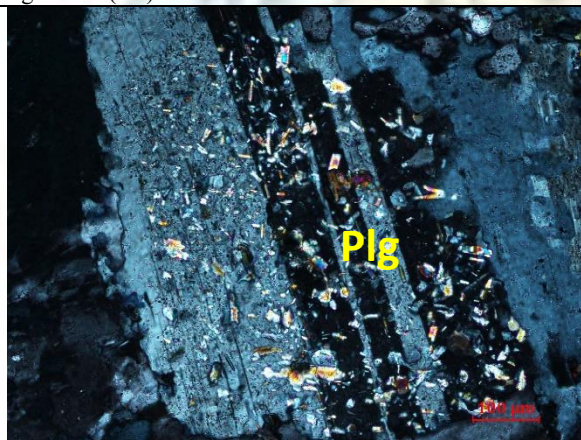


Fig. 15C. Photomicrograph showing presence of plagioclase (Plg) under transmitted light XPL (10X).

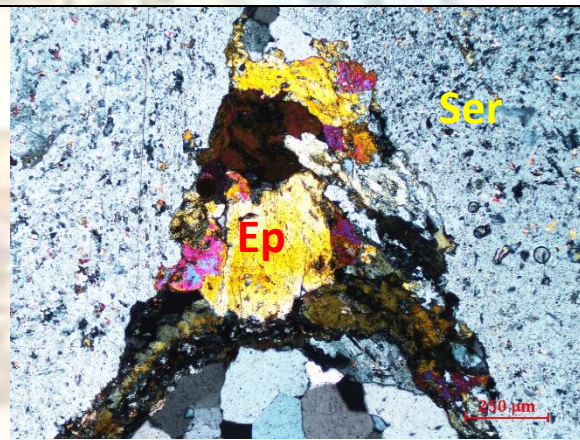


Fig. 15D. Photomicrograph showing presence of epidote (Ep) under transmitted light XPL (5X).

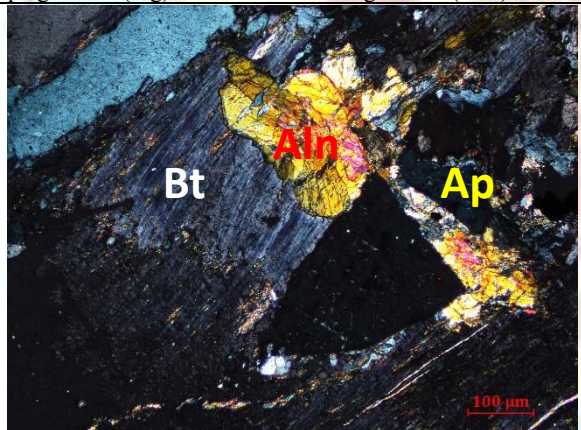


Fig. 15E. Photomicrograph showing presence of apatite (Ap), allanite (Aln) and biotite (Bt) under transmitted light XPL (10X).

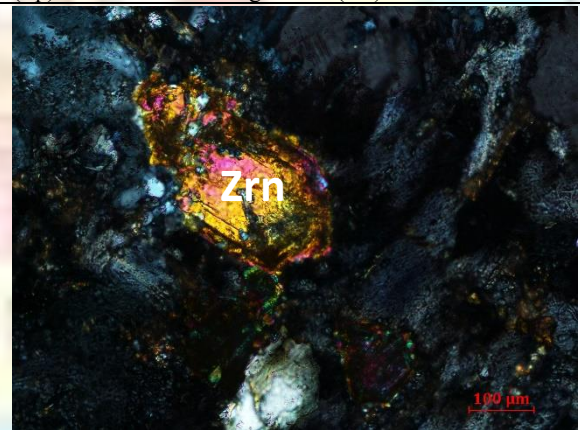


Fig. 15F. Photomicrograph showing presence of zircon (Zrn) under transmitted light XPL (10X).

5. Sample code: TNS-MN-29

Microscopic observations: Microscopic study reveals that the rock exhibits a coarse-grained, inequigranular texture. The modal mineral assemblage includes quartz (Qz), plagioclase (Plg), microcline (Mc), perthitic K-feldspar (Perth), and biotite (Bt), along with secondary phases such as sericite (Ser) and myrmekite (**Fig. 29A-29F**).

Quartz occurs as anhedral to subhedral grains forming an interlocking mosaic. Many grains display undulose extinction and locally sutured grain boundaries, indicating deformation and dynamic recrystallization under low- to moderate-grade metamorphic conditions. Feldspars are abundant and show diverse textural features. Microcline (Mc) exhibits characteristic tartan twinning, while perthitic texture (Perth) is well developed, with albite lamellae exsolved within K-feldspar (**Fig. 29A**).

Plagioclase (Plg) is present as subhedral grains with polysynthetic twinning, commonly showing signs of alteration along cleavage planes and grain margins. The development of myrmekite suggests metasomatic replacement processes involving Na–Ca exchange during fluid activity (**Fig. 29B-29D**).

Sericite (Ser) is widely developed as fine-grained aggregates replacing feldspar, particularly along fractures and grain boundaries, indicating pervasive hydrothermal alteration (sericitization). Biotite (Bt) occurs as pleochroic, flaky grains with moderate to high birefringence, locally showing deformation and minor alteration. The association of biotite with altered feldspar suggests re-equilibration under hydrous conditions (**Fig. 29D-29E**).

Accessory zircon (Zrn) occurs as small, euhedral inclusions within biotite and quartz, representing a resistant magmatic phase that preserves primary crystallization signatures (**Fig. 29F**).

The presence of myrmekite, sericitization, and strained quartz indicates a transition from primary magmatic textures to subsolidus and hydrothermal overprinting.

Rock/Mineral Name: Based on the mineral and textural characteristics, it is a granite.

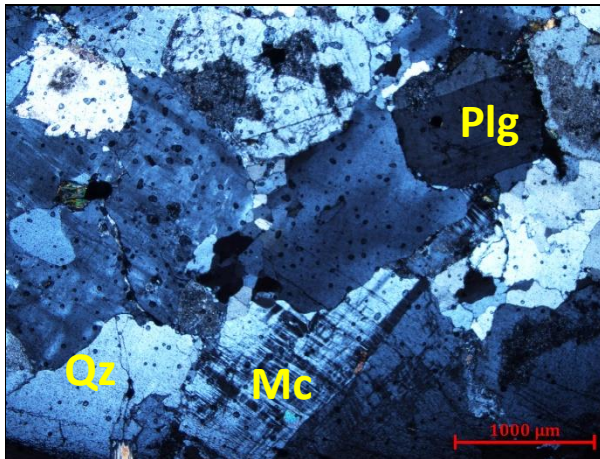


Fig. 29A. Photomicrograph showing presence of plagioclase (Plg), quartz (Qz) and microcline (Mc) under transmitted light XPL (2X).



Fig. 29B. Photomicrograph showing presence of perthite (Perth), Sericite (Ser) and biotite (Bt) under transmitted light XPL (5X).

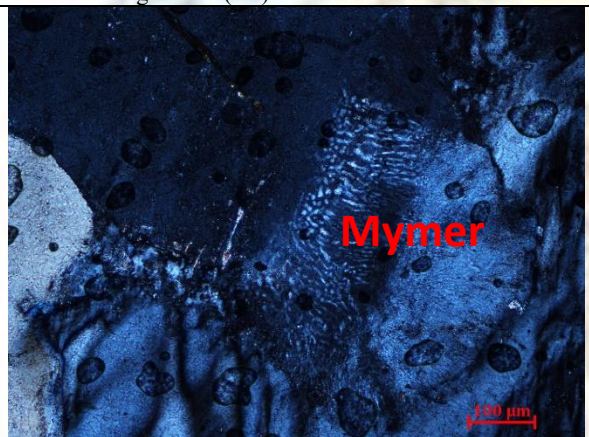


Fig. 29C. Photomicrograph showing presence of mymerkite under transmitted light XPL (10X).

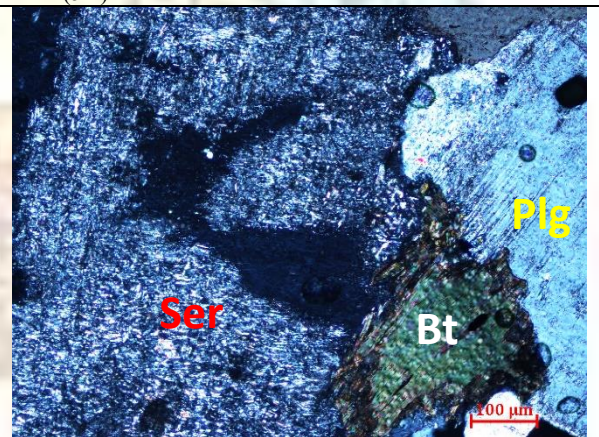


Fig. 29D. Photomicrograph showing presence of plagioclase (Plg), Sericite (Ser) and biotite (Bt) under transmitted light XPL (10X).

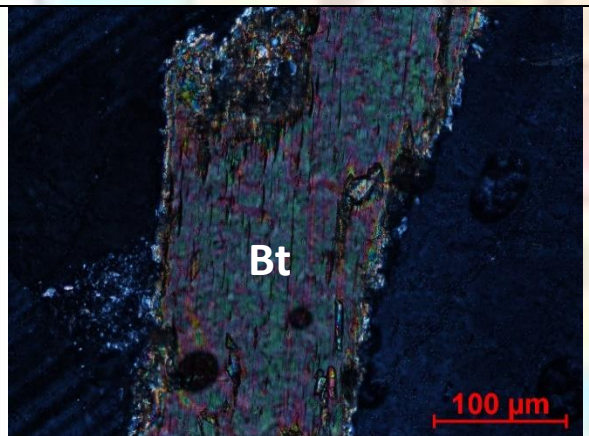


Fig. 29E. Photomicrograph showing presence of biotite (Bt) under transmitted light XPL (20X).

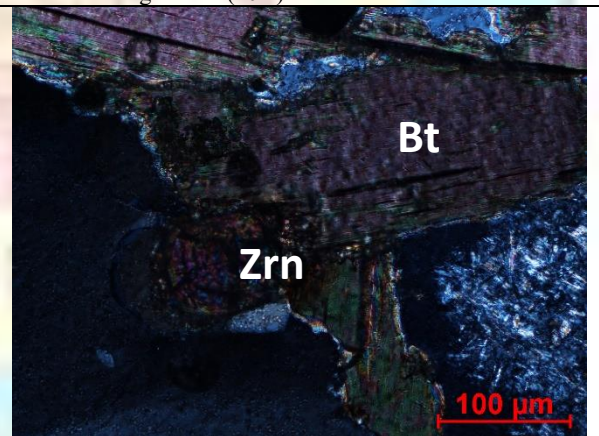


Fig. 29F. Photomicrograph showing presence of biotite (Bt) and zircon (Zrn) under transmitted light XPL (20X).

6. Sample code: TNS-MN-47

Microscopic observations: Microscopic study reveals that the rock exhibits a coarse-grained, inequigranular texture. The modal mineral assemblage dominated by perthitic alkali feldspar, plagioclase, quartz, biotite, and accessory phases such as titanite and allanite (**Fig. 47A-47F**).

Perthitic alkali feldspar (Perth) is the most prominent phase, displaying well-developed perthitic intergrowths formed by exsolution of albite lamellae within a K-feldspar host. These lamellae appear as flame-like and stringy textures, suggesting subsolidus re-equilibration during cooling. Plagioclase (Plg) occurs as subhedral to anhedral grains and commonly shows polysynthetic twinning. In several places, plagioclase is partially altered to sericite (Ser), indicating hydrothermal alteration. This sericitization is pervasive along cleavage planes and fractures, reflecting post-magmatic fluid interaction (**Fig. 47A-47D**).

Quartz (Qz) is present as anhedral interstitial grains occupying spaces between feldspar crystals, suggesting late-stage crystallization. It exhibits undulose extinction in some places, implying minor deformation effects after crystallization. Biotite (Bt) occurs as subhedral flakes with strong pleochroism from brown to dark brown and shows well-developed cleavage. In altered places, biotite displays partial chloritization and oxidation along margins (**Fig. 47D-47E**).

Accessory minerals include titanite (Ttn), recognized by its high relief and wedge-shaped morphology, and allanite (Aln), which appears as brownish, high-relief grains often associated with alteration halos (**Fig. 47F**).

The rock exhibits evidence of both magmatic and post-magmatic processes, including exsolution, hydrothermal alteration, and minor deformation. The petrographic features suggest crystallization from an evolved, silica-rich magma followed by subsolidus re-equilibration and fluid-mediated alteration.

Rock/Mineral Name: Based on the mineral and textural characteristics, it is a granite.

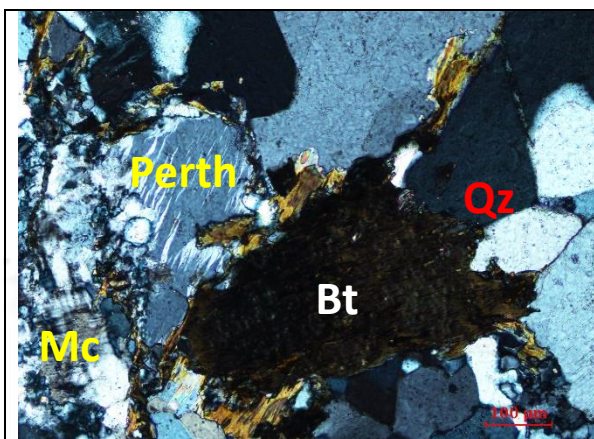


Fig. 47A. Photomicrograph showing presence of perthite (Perth), biotite (Bt), quartz (Qz) and microcline (Mc) under transmitted light XPL (10X).

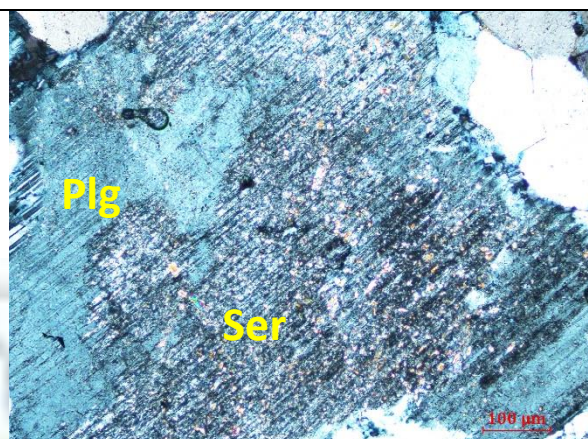


Fig. 47B. Photomicrograph showing presence of plagioclase (Plg) and sericite (Ser) under transmitted light XPL (10X).

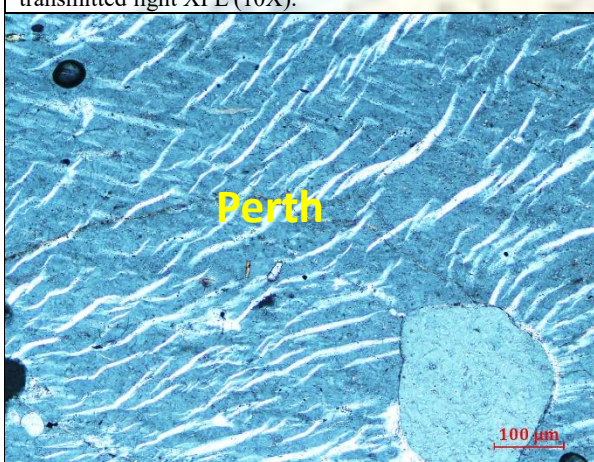


Fig. 47C. Photomicrograph showing presence of perthite (Perth) under transmitted light XPL (10X).

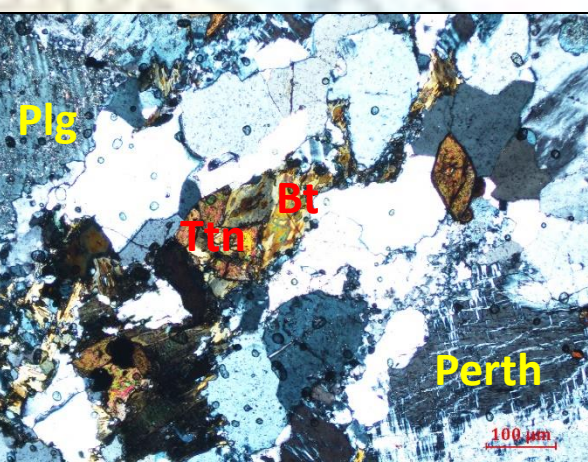


Fig. 47D. Photomicrograph showing presence of perthite (Perth), biotite (Bt), plagioclase (Plg) and titanite (Ttn) under transmitted light XPL (10X).

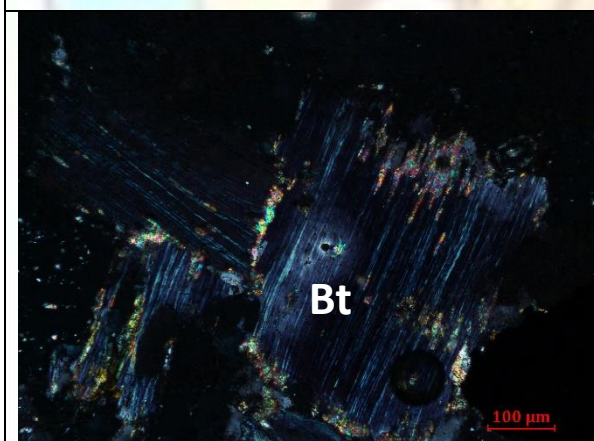


Fig. 47E. Photomicrograph showing presence of chloritized biotite (Bt) under transmitted light XPL (10X).

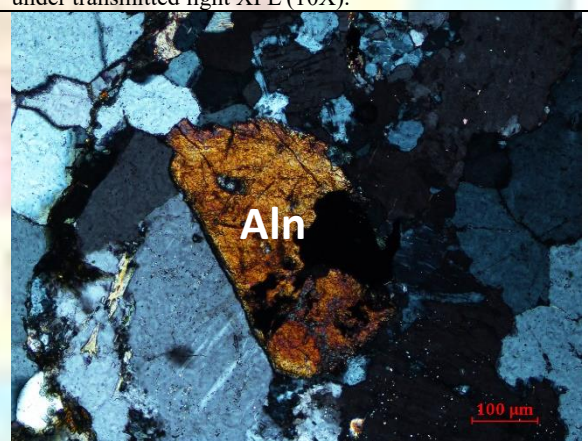


Fig. 47F. Photomicrograph showing presence of allanite (Aln) under transmitted light XPL (10X).

7. Sample code: TNS-MN-55

Microscopic observations: Microscopic study reveals that the rock exhibits a coarse-grained, inequigranular texture. The modal mineral assemblage comprising quartz (Qz), plagioclase (Plg), perthitic alkali feldspar (Perth), and biotite (Bt), along with secondary and accessory phases such as sericite (Ser), calcite (Cal), epidote (Ep), and titanite (Ttn) (**Fig. 55A-55F**).

Quartz occurs as anhedral to subhedral grains occupying interstitial spaces between feldspars, suggesting late-stage crystallization. It commonly shows undulose extinction, indicating minor post-crystallization deformation. Plagioclase is subhedral and exhibits well-developed polysynthetic twinning; however, it is extensively altered to sericite, forming fine-grained aggregates that obscure primary textures (**Fig. 55A**).

Perthitic alkali feldspar is abundant and displays characteristic exsolution lamellae, forming flame-like and patchy perthitic textures. These features indicate subsolidus re-equilibration during cooling of the magma. Biotite occurs as subhedral to anhedral flakes with strong pleochroism. In several places, biotite shows marginal alteration to chlorite and is commonly associated with secondary minerals (**Fig. 55B-55D**).

The presence of calcite and epidote indicates secondary hydrothermal processes. Calcite occurs as irregular patches or vein-like fillings, while epidote appears as small, high-relief grains associated with altered place of plagioclase and biotite (**Fig. 55E**).

Titanite is present as euhedral to subhedral wedge-shaped grains with very high interference colors. It commonly occurs in association with biotite and opaque phases (**Fig. 55F**).

The petrographic features indicate a granitic rock that has undergone significant subsolidus modification, including feldspar exsolution and hydrothermal alteration. The mineral assemblage and textures suggest crystallization from an evolved magma followed by fluid-assisted alteration under relatively low-temperature conditions.

Rock/Mineral Name: Based on the mineral and textural characteristics, it is an **alkali feldspar granite**.

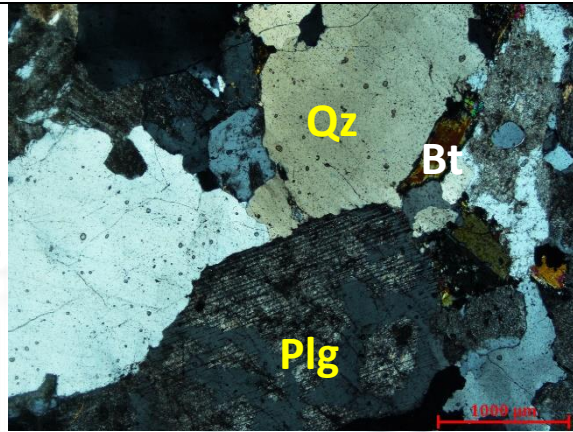


Fig. 55A. Photomicrograph showing presence of biotite (Bt), quartz (Qz) and plagioclase (Plg) under transmitted light XPL (2X).

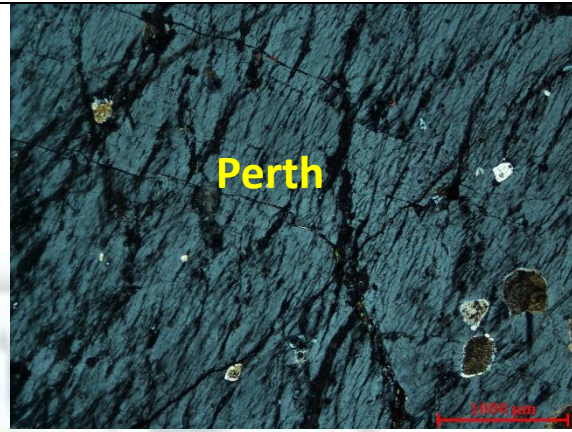


Fig. 55B. Photomicrograph showing presence of perthite (Perth) under transmitted light XPL (2X).



Fig. 55C. Photomicrograph showing presence of sericite (Ser) under transmitted light XPL (10X).



Fig. 55D. Photomicrograph showing presence of biotite (Bt), under transmitted light XPL (10X).

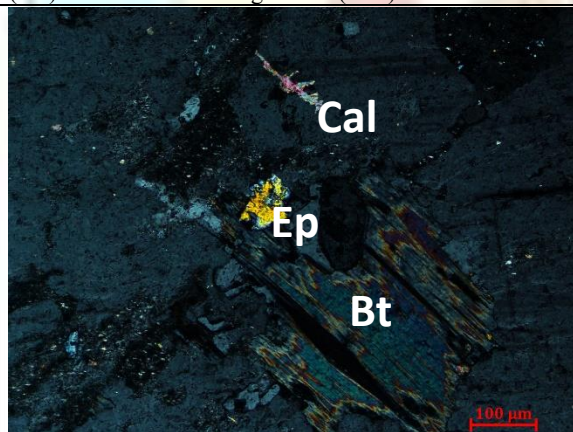


Fig. 55E. Photomicrograph showing presence of biotite (Bt), epidote (Ep) and calcite (Cal) under transmitted light XPL (10X).

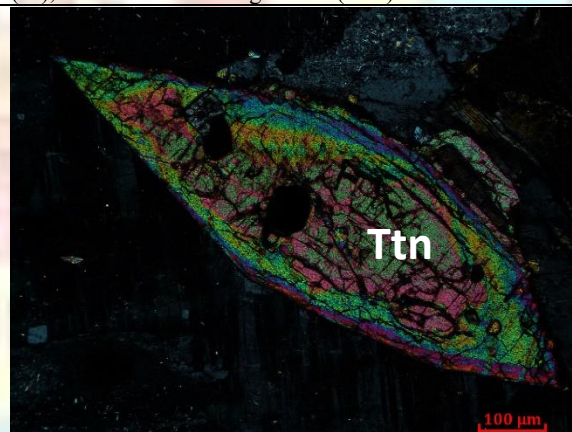


Fig. 55F. Photomicrograph showing presence of titanite (Ttn), under transmitted light XPL (10X).

8. Sample code: TNS-MN-63

Microscopic observations: Microscopic study reveals that the rock exhibits a coarse-grained, inequigranular texture. The modal mineral assemblage dominated by quartz (Qz), perthitic alkali feldspar (Perth), plagioclase (Plg), and biotite (Bt), along with secondary phases such as sericite (Ser), epidote (Ep), and myrmekite (**Fig. 63A-63F**).

Quartz occurs as anhedral interstitial grains, occupying spaces between feldspar crystals. It is generally clear but locally exhibits undulose extinction, pointing to minor post-magmatic deformation. Alkali feldspar is prominently represented by perthite, characterized by well-developed exsolution lamellae of albite within K-feldspar, forming stringy to patchy perthitic textures. These features indicate subsolidus re-equilibration during slow cooling of the magma (**Fig. 63A**).

Plagioclase occurs as subhedral grains displaying polysynthetic twinning; however, it is extensively altered to sericite, forming fine-grained aggregates that partially obliterate primary textures. The presence of myrmekitic intergrowths along the margins of K-feldspar, consisting of vermicular quartz within plagioclase, suggests late-stage metasomatic interaction between feldspars (**Fig. 63B-63C**).

Biotite is present as subhedral flakes showing strong pleochroism. It is commonly associated with alteration products such as epidote and sericite, indicating secondary replacement. In some places, biotite appears partially replaced by epidote (**Fig. 63E**).

Epidote occurs as high-relief, pistachio-green grains often associated with altered plagioclase and biotite. The coexistence of sericite, epidote, and myrmekite indicates significant post-magmatic fluid interaction and subsolidus recrystallization (**Fig. 63F**).

The petrographic characteristics suggest crystallization from an evolved, silica-rich magma followed by extensive deuteric alteration and fluid-assisted metasomatism.

Rock/Mineral Name: Based on the mineral and textural characteristics, it is a **granite**.



Fig. 63A. Photomicrograph showing presence of perthite (Perth), quartz (Qz) and microcline (Mc) under transmitted light XPL (2X).

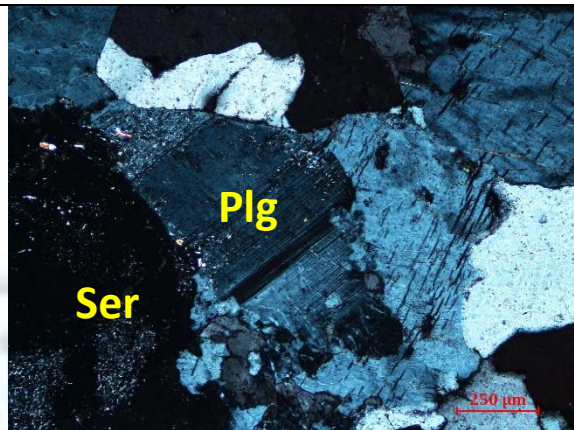


Fig. 63B. Photomicrograph showing presence of plagioclase (Plg) and sericite (Ser) under transmitted light XPL (5X).

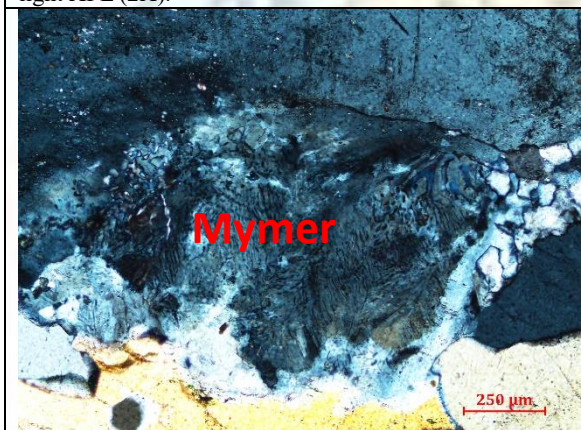


Fig. 63C. Photomicrograph showing presence of mymerkite (Mymer) under transmitted light XPL (5X).

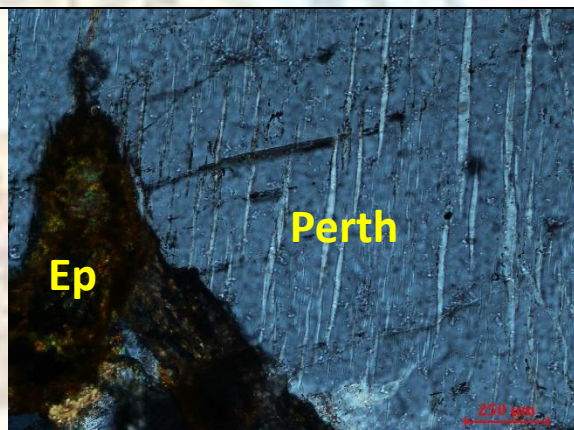


Fig. 63D. Photomicrograph showing presence of perthite (Perth), and epidote (Ep) under transmitted light XPL (5X).

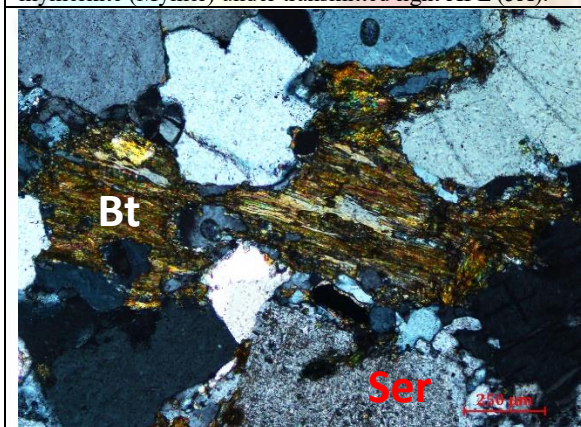


Fig. 63E. Photomicrograph showing presence of biotite (Bt) and sericite (Ser) under transmitted light XPL (5X).

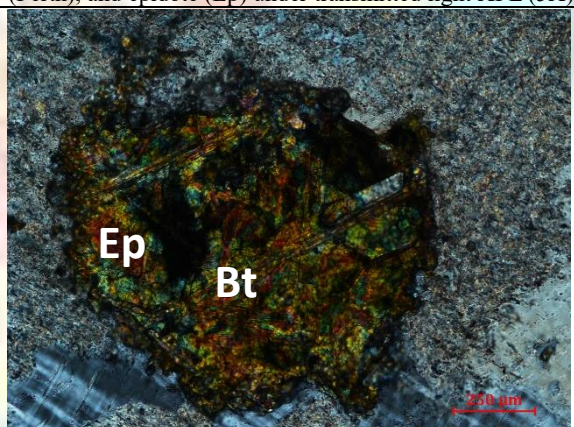


Fig. 63F. Photomicrograph showing presence of biotite (Bt), and epidote (Ep) under transmitted light XPL (5X).

9. Sample code: TNS-MN-74

Microscopic observations: Microscopic study reveals that the rock exhibits a medium to coarse-grained, inequigranular texture. The modal mineral assemblage dominated by perthitic alkali feldspar (Perth), microcline (Mc), plagioclase (Plg), quartz (Qz), and biotite (Bt), along with accessory and secondary phases such as epidote (Ep), titanite (Ttn), and zircon (Zrn) (**Fig. 74A-74F**).

Alkali feldspar is abundant and occurs as perthite and microcline. Perthitic textures are well developed. Microcline is recognized by characteristic cross-hatched (tartan) twinning. Plagioclase appears as subhedral grains with polysynthetic twinning, although in several places, it shows incipient alteration (**Fig. 74A-74B**).

Quartz occurs as anhedral interstitial grains filling spaces between feldspar crystals, suggesting late-stage crystallization. The grains are generally clear but may locally exhibit undulose extinction, indicating mild deformation. Biotite is present as subhedral flakes with moderate to high interference colors. It commonly hosts inclusions of zircon and is locally associated with alteration products (**Fig. 74A-74B**).

Epidote occurs as high-relief, pistachio-green grains often replacing or associated with plagioclase and biotite, indicating hydrothermal alteration. Titanite is present as euhedral to subhedral wedge-shaped grains with high birefringence and is typically associated with mafic phases. Zircon appears as small, high-relief inclusions within biotite, representing an early crystallizing accessory phase (**Fig. 74C-74F**).

Based on the petrographic features indicate a granitic rock that has undergone significant subsolidus modifications, including feldspar exsolution and hydrothermal alteration. The presence of epidote, titanite, and zircon suggests an evolved magma with enrichment in high field strength elements, followed by fluid-mediated alteration during the late stages of crystallization.

Rock/Mineral Name: Based on the mineral and textural characteristics, it is an alkali feldspar granite.

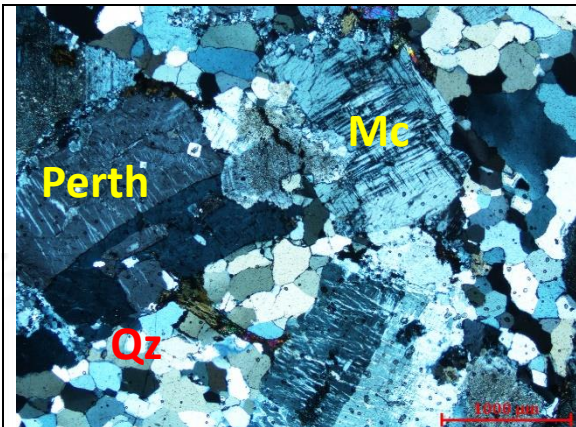


Fig. 74A. Photomicrograph showing presence of perthite (Perth), quartz (Qz) and microcline (Mc) under transmitted light XPL (2X).

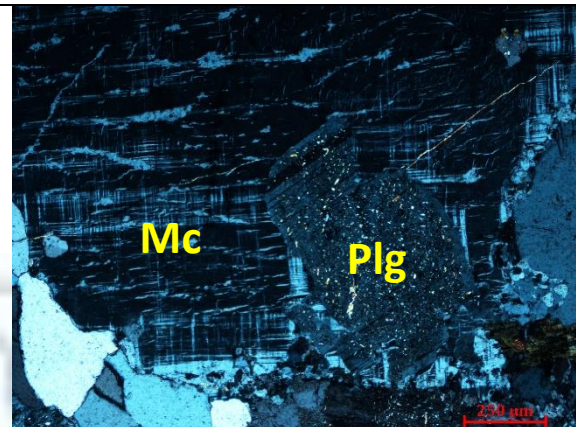


Fig. 74B. Photomicrograph showing presence of plagioclase (Plg) and microcline (Mc) under transmitted light XPL (5X).

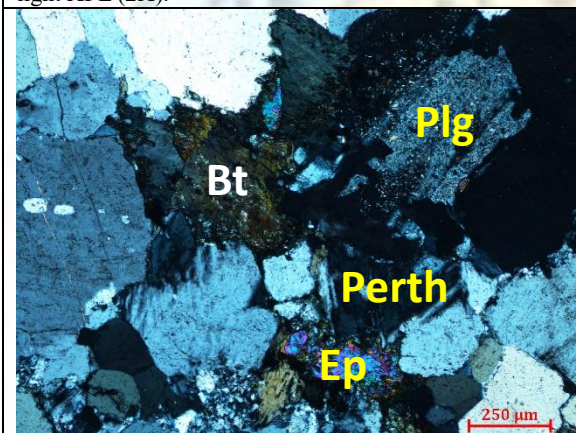


Fig. 74C. Photomicrograph showing presence of perthite (Perth), plagioclase (Plg) and epidote (Ep) under transmitted light XPL (5X).

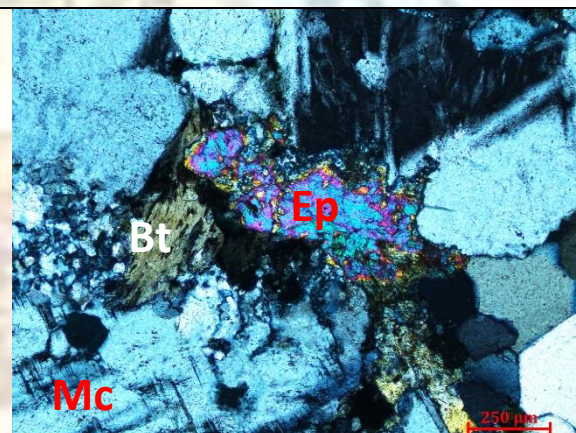


Fig. 74D. Photomicrograph showing presence of biotite (Bt), microcline (Mc) and epidote (Ep) under transmitted light XPL (5X).

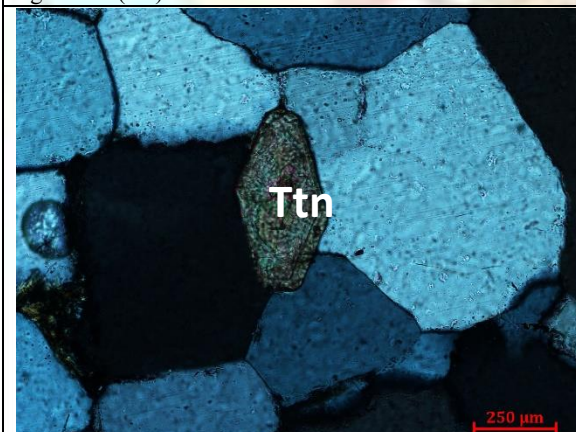


Fig. 74E. Photomicrograph showing presence of titanite (Ttn) under transmitted light XPL (5X).

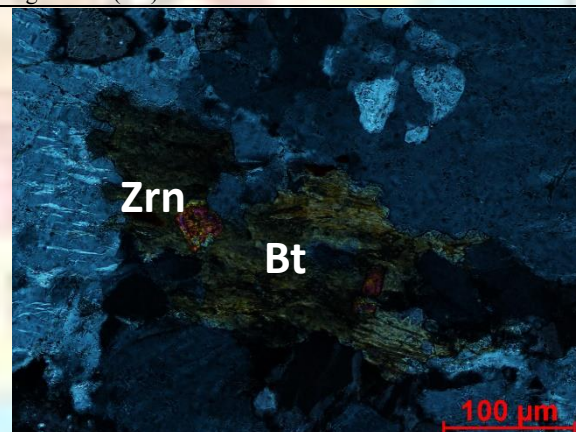


Fig. 74F. Photomicrograph showing presence of zircon (Zrn) in biotite (Bt) under transmitted light XPL (20X).

10. Sample code: TNS-MN-77

Microscopic observations: Microscopic study reveals that the rock exhibits a medium to coarse-grained, inequigranular texture. The modal mineral assemblage of plagioclase (Plg), quartz (Qz), perthitic alkali feldspar (Perth), and microcline (Mc), with abundant secondary and accessory phases including epidote (Ep), calcite (Cal), and allanite (Aln) (**Fig. 77A-77F**).

Plagioclase occurs as subhedral to anhedral grains exhibiting well-developed polysynthetic twinning. Many plagioclase crystals show partial to extensive alteration to epidote and sericite, particularly along cleavage planes and grain margins. Quartz is present as anhedral interstitial grains occupying spaces between feldspars, indicating late-stage crystallization. Some quartz grains display slight undulose extinction, reflecting minor post-crystallization deformation (**Fig. 77A**).

Alkali feldspar is represented by perthite and microcline. Perthitic textures are prominent, with exsolution lamellae of albite within K-feldspar forming stringy to patchy intergrowths, indicative of subsolidus re-equilibration. Microcline is identified by characteristic tartan twinning (**Fig. 77B**).

Epidote occurs as high-relief, pistachio-green grains associated with altered plagioclase and along fractures, indicating hydrothermal alteration. Calcite is present as irregular patches and vein-like fillings, representing late-stage carbonate precipitation from fluid phases. Allanite appears as euhedral to subhedral, brownish-yellow grains with high relief and strong interference colors, commonly associated with epidote (**Fig. 77C-77F**).

The spatial association of epidote, calcite, and allanite with feldspar alteration zones indicates significant fluid-mediated metasomatism during the late to post-magmatic stages. Based on the petrographic features suggest crystallization from an evolved, silica-rich magma followed by extensive subsolidus re-equilibration and hydrothermal alteration.

Rock/Mineral Name: Based on the mineral and textural characteristics, it is a **granite**.

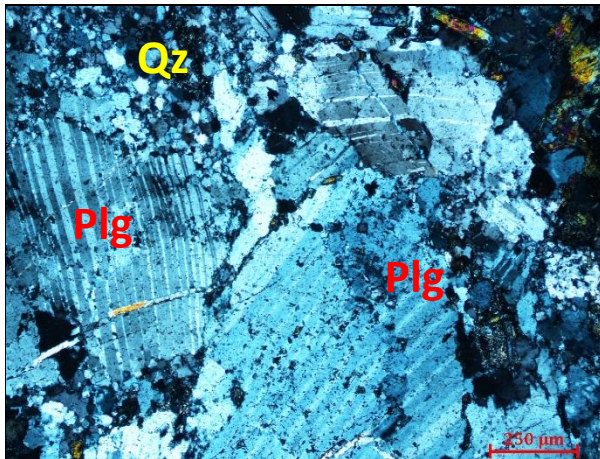


Fig. 77A. Photomicrograph showing presence of plagioclase (Plg) and quartz (Qz) under transmitted light XPL (5X).

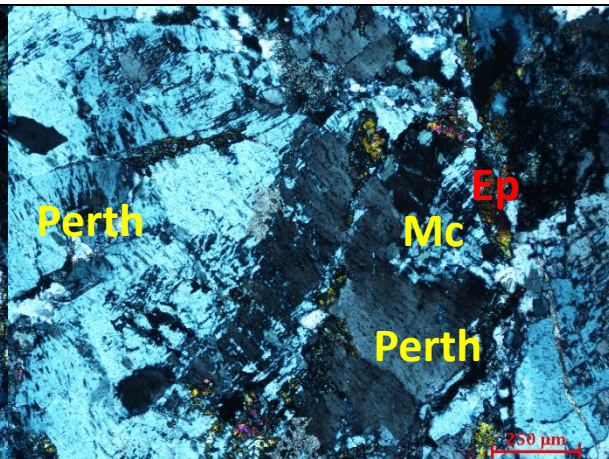


Fig. 77B. Photomicrograph showing presence of perthite (Perth), microcline (Mc) and epidote (Ep) under transmitted light XPL (5X).

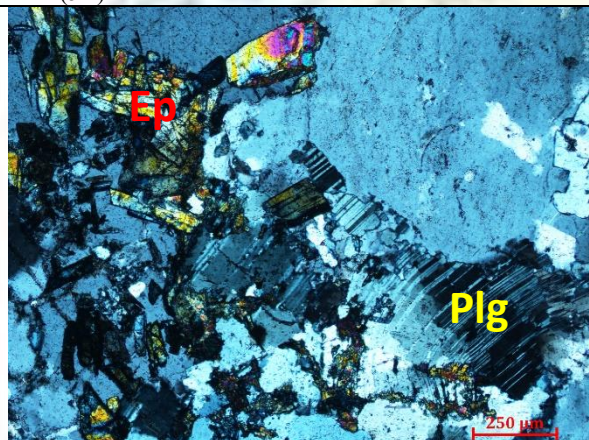


Fig. 77C. Photomicrograph showing presence of plagioclase (Plg) and epidote (Ep) under transmitted light XPL (5X).

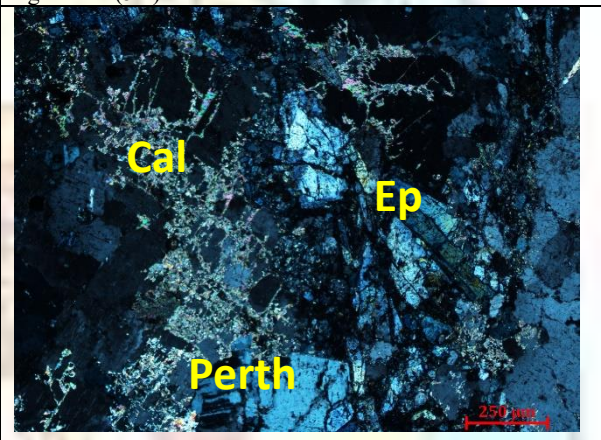


Fig. 77D. Photomicrograph showing presence of perthite (Perth), calcite (Cal) and epidote (Ep) under transmitted light XPL (5X).

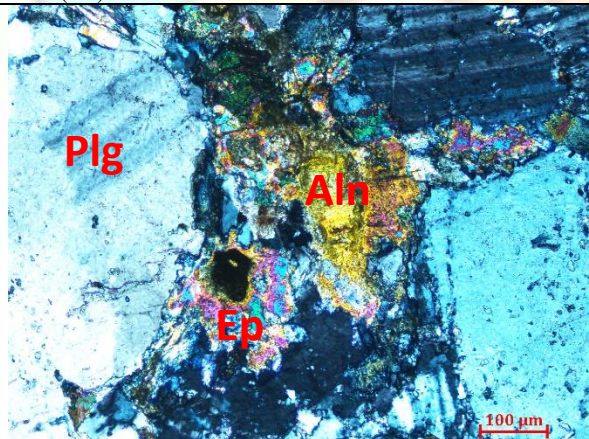


Fig. 77E. Photomicrograph showing presence of plagioclase (Plg), allanite (Aln) and epidote (Ep) under transmitted light XPL (10X).

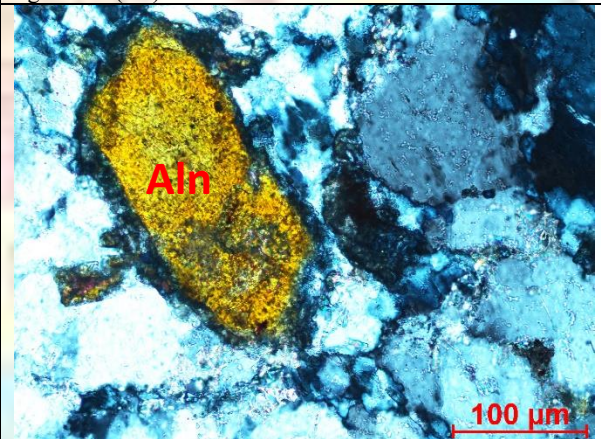


Fig. 77F. Photomicrograph showing presence of allanite (Aln) under transmitted light XPL (20X).

11. Sample code: TNS-MN-97

Microscopic observations: Microscopic study reveals that the rock exhibits a medium to coarse-grained, inequigranular texture. The modal mineral assemblage dominated by quartz (Qz), perthitic alkali feldspar (Perth), biotite (Bt), and abundant secondary epidote (Ep), along with accessory titanite (Ttn) (**Fig. 97A-97F**).

Quartz occurs as anhedral to subhedral grains forming a mosaic of interlocking crystals. In several places, quartz shows undulose extinction and local recrystallization, suggesting mild post-magmatic deformation. Alkali feldspar is present as perthite, exhibiting well-developed exsolution lamellae of albite within K-feldspar. The perthitic grains are commonly fractured and partially replaced along grain boundaries (**Fig. 97A-97B**).

Epidote is a dominant secondary phase, occurring as high-relief, pistachio-green grains and granular aggregates. It is widely distributed along fractures, grain boundaries, and as replacement products of feldspar and biotite. The abundance and distribution of epidote indicate extensive hydrothermal alteration or late-stage deuteric alteration. In some places, epidote forms dense clusters and vein-like networks, suggesting fluid pathways and localized metasomatism (**Fig. 97A-97D**).

Biotite occurs as subhedral flakes with moderate interference colors and is commonly associated with epidote. It shows partial alteration along cleavage planes, indicating instability during fluid interaction. Titanite is present as euhedral to subhedral wedge-shaped grains with high relief and characteristic high-order interference colors. It is typically associated with altered places and may represent both primary magmatic and secondary hydrothermal origins (**Fig. 97E-97F**).

Based on the petrographic features indicate that the rock initially crystallized from an evolved felsic magma, followed by intense fluid-mediated alteration. The pervasive development of epidote and the presence of titanite suggest significant post-magmatic hydrothermal activity, leading to mineralogical re-equilibration and partial recrystallization of the original igneous assemblage.

Rock/Mineral Name: Based on the mineral and textural characteristics, it is a **granite**.

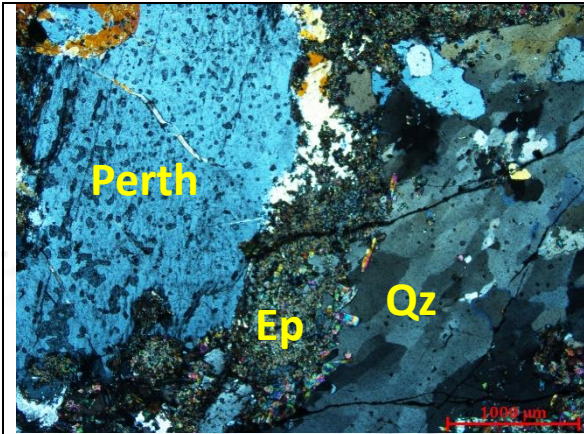


Fig. 97A. Photomicrograph showing presence of perthite (Perth), quartz (Qz) and epidote (Ep) under transmitted light XPL (2X).

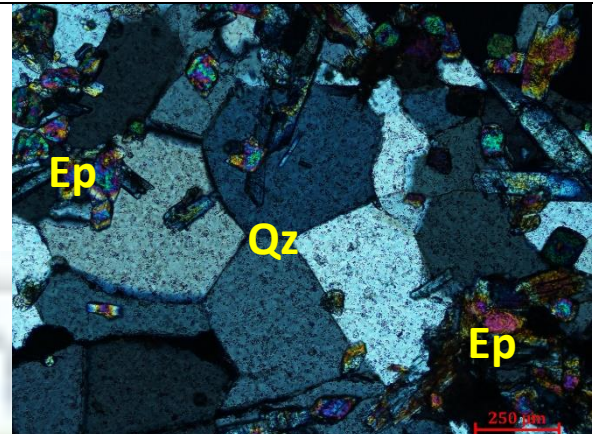


Fig. 97B. Photomicrograph showing presence of quartz (Qz) and epidote (Ep) under transmitted light XPL (5X).



Fig. 97C. Photomicrograph showing presence of biotite (Bt) and epidote (Ep) under transmitted light XPL (10X).

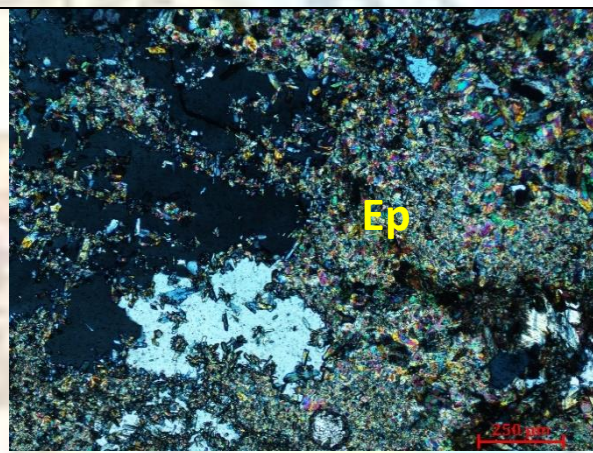


Fig. 97D. Photomicrograph showing presence of epidote (Ep) cluster under transmitted light XPL (5X).

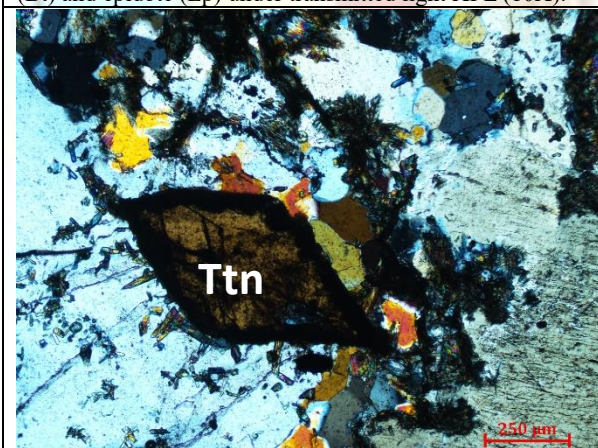


Fig. 97E. Photomicrograph showing presence titanite (Ttn) under transmitted light XPL (5X).

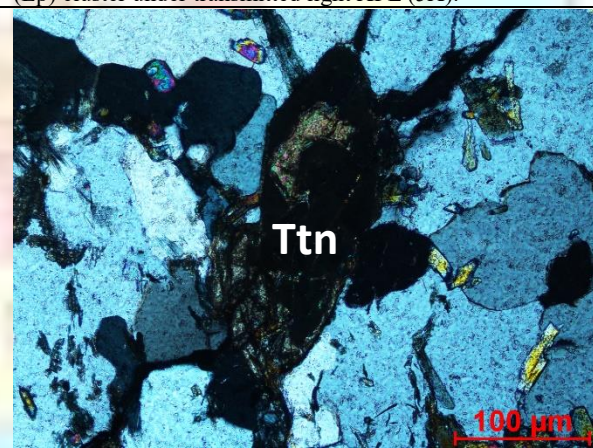


Fig. 97F. Photomicrograph showing presence titanite (Ttn) under transmitted light XPL (20X).

12. Sample code: TNS-MN-13

Microscopic observations: Microscopic study reveals that the rock exhibits a medium to coarse-grained, inequigranular texture. The modal mineral assemblage dominated by quartz (Qz), perthitic alkali feldspar (Perth), microcline (Mc), plagioclase (Plg), and biotite (Bt), along with accessory phases such as titanite (Ttn), zircon (Zrn), and apatite (Ap) (**Fig. 13A-13F**).

Quartz occurs as anhedral to subhedral grains occupying interstitial spaces between feldspars, suggesting late-stage crystallization. Some grains display undulose extinction, indicating mild post-magmatic deformation. Alkali feldspar is present as perthite and microcline. Microcline is identified by characteristic tartan twinning (**Fig. 13A-13C**).

Plagioclase occurs as subhedral crystals with well-developed polysynthetic twinning, although some grains show incipient alteration. Biotite appears as subhedral flakes with strong pleochroism. It is commonly associated with accessory minerals and may show minor alteration along cleavage planes (**Fig. 13D**).

Accessory minerals are well represented. Titanite occurs as wedge-shaped, high-relief grains with bright interference colors, indicating high birefringence. Zircon is observed as small, euhedral inclusions within biotite, suggesting early crystallization from the magma. Apatite appears as prismatic to rounded grains, often enclosed within biotite or feldspars, further supporting a magmatic origin (**Fig. 13E-13F**).

Based on the petrographic characteristics indicate a granitic rock formed from an evolved, silica-rich magma. The presence of perthitic textures, microcline twinning, and accessory mineral assemblages reflects significant subsolidus re-equilibration and magmatic differentiation, with only minor post-magmatic alteration affecting the primary mineralogy.

Rock/Mineral Name: Based on the mineral and textural characteristics, it is a **granite**.

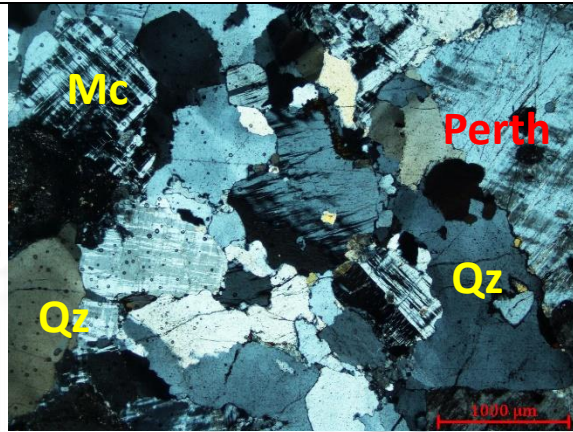


Fig. 13A. Photomicrograph showing presence of perthite (Perth), quartz (Qz) and microcline (Mc) under transmitted light XPL (2X).

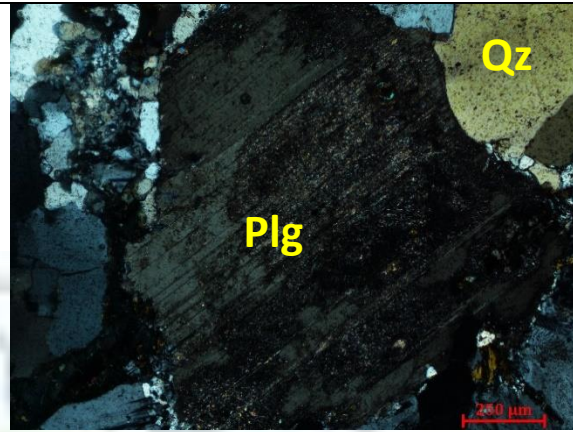


Fig. 13B. Photomicrograph showing presence of quartz (Qz) and plagioclase (Plg) under transmitted light XPL (5X).

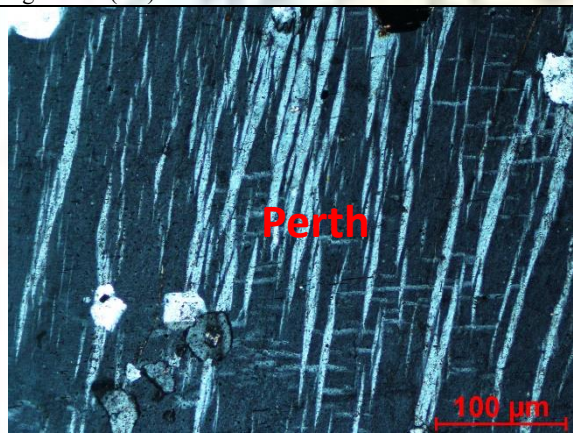


Fig. 13C. Photomicrograph showing presence of perthite (Perth) under transmitted light XPL (20X).

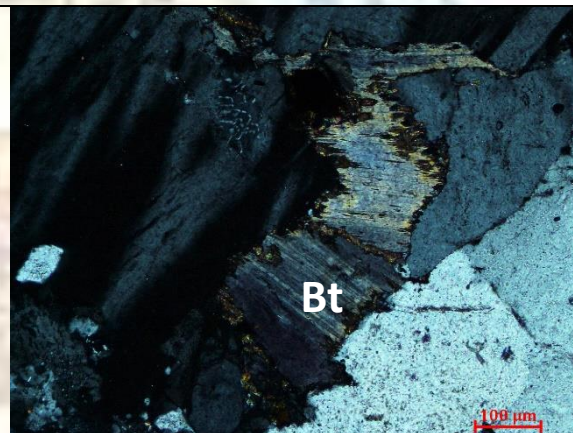


Fig. 13D. Photomicrograph showing presence of biotite (Bt) under transmitted light XPL (10X).



Fig. 13E. Photomicrograph showing presence of titanite (Ttn) under transmitted light XPL (10X).

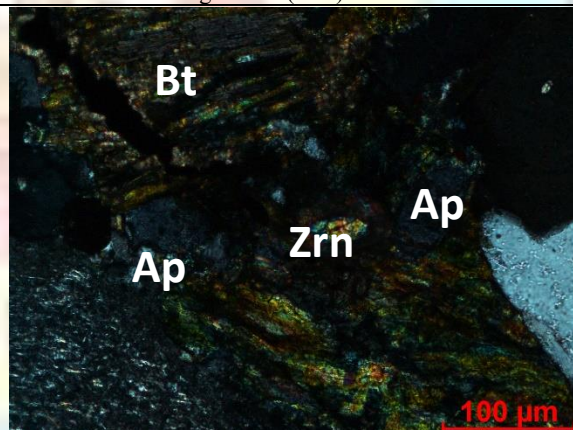


Fig. 13F. Photomicrograph showing presence of biotite (Bt), zircon (Zrn) and apatite (Ap) under transmitted light XPL (20X).

13. Sample code: TNS-MN-18

Microscopic observations: Microscopic study reveals that the rock exhibits a medium to coarse-grained, inequigranular texture. The modal mineral assemblage composed predominantly of plagioclase (Plg), quartz (Qz), perthitic alkali feldspar (Perth), and microcline (Mc), with abundant secondary epidote (Ep) and accessory titanite (Ttn) (**Fig. 18A-18F**).

Plagioclase occurs as subhedral crystals showing well-developed polysynthetic twinning. Several grains are partly replaced along margins and fractures by epidote, indicating alteration of primary feldspar during late-stage fluid interaction. Quartz is present as anhedral interstitial grains occupying spaces between feldspar crystals, suggesting crystallization during the later stages of magma solidification. In some grains, weak undulose extinction indicates minor post-magmatic strain (**Fig. 18A-18B**).

Alkali feldspar is represented by perthite and microcline. Perthitic feldspar displays conspicuous exsolution lamellae. Microcline exhibits characteristic tartan twinning. These textures collectively indicate prolonged cooling and subsolidus re-equilibration (**Fig. 18B-18C**).

Epidote is a major secondary phase and occurs as high-relief, strongly birefringent granular aggregates dispersed along grain boundaries, fractures, and alteration zones within plagioclase and alkali feldspar. Its widespread occurrence suggests pervasive hydrothermal alteration. In several places, epidote forms dense clusters and replacement patches, implying focused fluid pathways and localized metasomatic overprint (**Fig. 18D-18F**).

Titanite occurs as brown to honey-colored, subhedral to anhedral grains with high relief and very bright interference colors. It is commonly associated with epidote-rich domains, suggesting either late-magmatic crystallization or hydrothermal growth during alteration (**Fig. 18F**).

Based on the petrographic characteristics indicate crystallization from an evolved felsic magma followed by substantial subsolidus re-equilibration and hydrothermal alteration. The pervasive epidotization and local titanite development record a significant late- to post-magmatic fluid overprint superimposed on the primary granitic assemblage.

Rock/Mineral Name: Based on the mineral and textural characteristics, it is a **granite**.

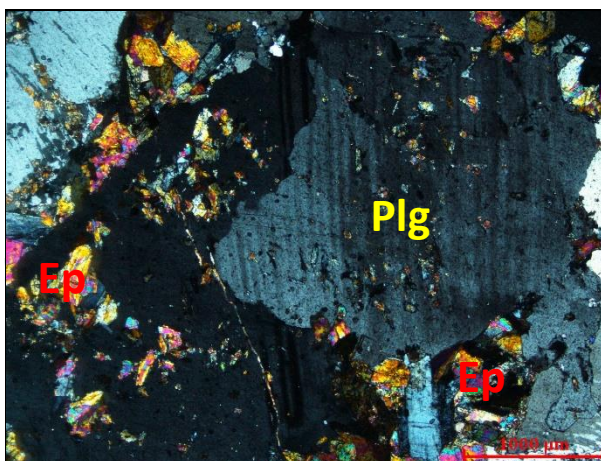


Fig. 18A. Photomicrograph showing presence of epidote (Ep) and plagioclase (Plg) under transmitted light XPL (2X).

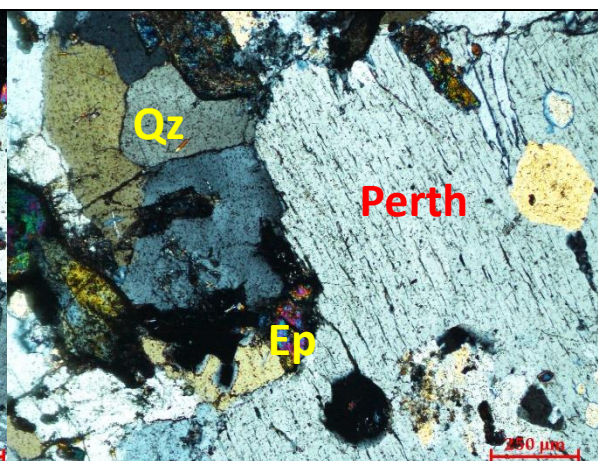


Fig. 18B. Photomicrograph showing presence of epidote (Ep), quartz (Qz) and perthite (Perth) under transmitted light XPL (5X).



Fig. 18C. Photomicrograph showing presence of perthite (Perth) under transmitted light XPL (5X).

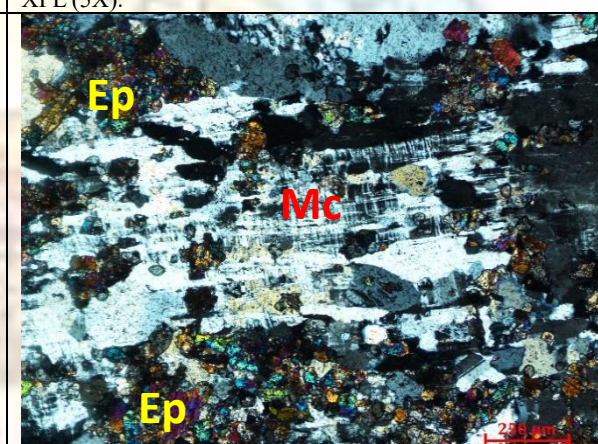


Fig. 18D. Photomicrograph showing presence of epidote (Ep) and microcline (Mc) under transmitted light XPL (5X).

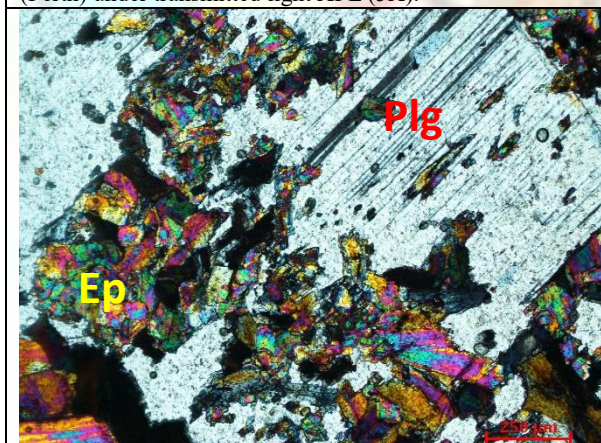


Fig. 18E. Photomicrograph showing presence of epidote (Ep) and plagioclase (Plg) under transmitted light XPL (5X).

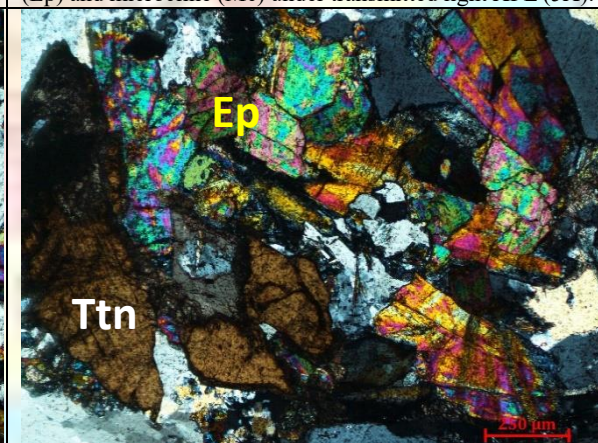


Fig. 18F. Photomicrograph showing presence of epidote (Ep) and titanite (Ttn) under transmitted light XPL (5X).

14. Sample code: TNS-MN-56

Microscopic observations: Microscopic study reveals that the rock exhibits a medium to coarse-grained, inequigranular texture. The modal mineral assemblage composed of quartz (Qz), plagioclase (Plg), perthitic alkali feldspar (Perth), microcline (Mc), and biotite (Bt), along with secondary phases such as sericite (Ser) and epidote (Ep), and accessory minerals including titanite (Ttn) and zircon (Zrn) (**Fig. 56A-56F**).

Quartz occurs as anhedral interstitial grains forming a mosaic between feldspar crystals. Some grains show weak undulose extinction, indicative of minor post-magmatic deformation. Plagioclase is present as subhedral crystals with well-developed polysynthetic twinning; however, many grains exhibit partial alteration to sericite, especially along cleavage planes and fractures (**Fig. 56A-56B**).

Alkali feldspar occurs as perthite and microcline. Perthitic feldspar displays well-developed exsolution lamellae. Microcline is identified by characteristic tartan twinning. These feldspar textures collectively point to prolonged cooling and chemical re-adjustment in the subsolidus stage (**Fig. 56A-56D**).

Biotite occurs as subhedral flakes with moderate to high interference colors and shows partial alteration along cleavage planes. It is commonly associated with epidote, which occurs as high-relief, strongly birefringent grains replacing plagioclase and biotite (**Fig. 56E**).

Accessory minerals are well developed. Titanite occurs as anhedral to subhedral, high-relief grains with bright interference colors, often associated with altered places. Zircon appears as small, euhedral inclusions within biotite, indicating early magmatic crystallization (**Fig. 56E-56F**).

Based on the petrographic features suggest crystallization from an evolved granitic magma followed by significant subsolidus re-equilibration and hydrothermal alteration, as evidenced by feldspar exsolution, sericitization, and epidotization processes.

Rock/Mineral Name: Based on the mineral and textural characteristics, it is an **alkali feldspar granite**.

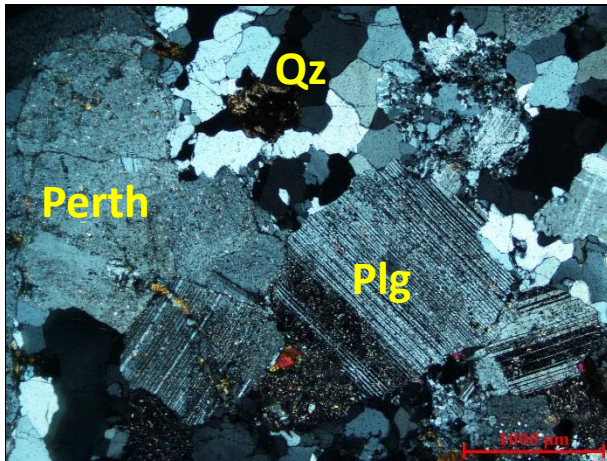


Fig. 56A. Photomicrograph showing presence of plagioclase (Plg), quartz (Qz) and perthite (Perth) under transmitted light XPL (2X).

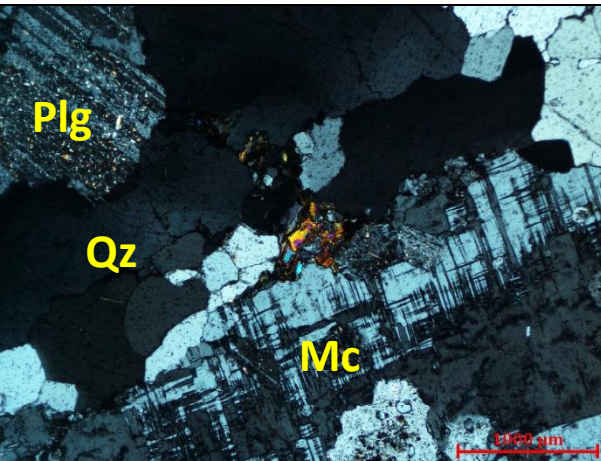


Fig. 56B. Photomicrograph showing presence of plagioclase (Plg), quartz (Qz) and microcline (Mc) under transmitted light XPL (2X).



Fig. 56C. Photomicrograph showing presence of sericite (Ser) in microcline (Mc) under transmitted light XPL (10X).

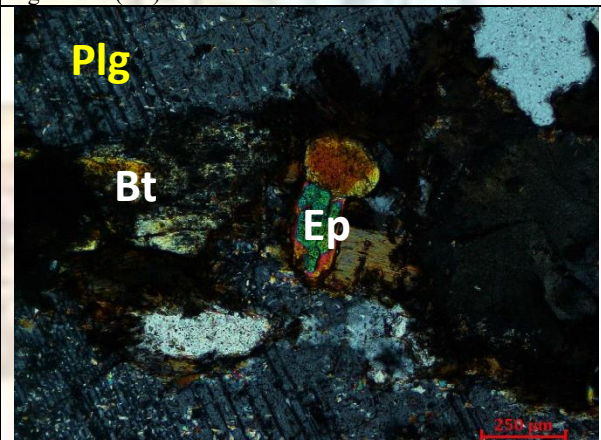


Fig. 56D. Photomicrograph showing presence of plagioclase (Plg), quartz (Qz) and biotite (Bt) under transmitted light XPL (5X).

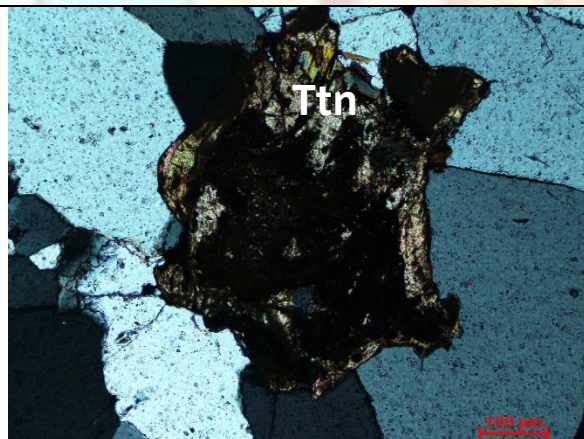


Fig. 56E. Photomicrograph showing presence of titanite (Ttn) under transmitted light XPL (10X).

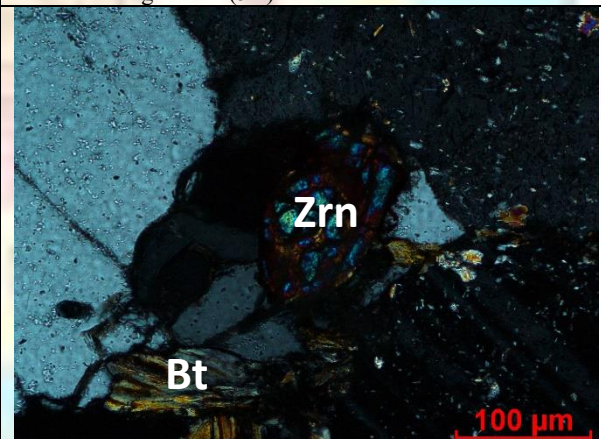


Fig. 56F. Photomicrograph showing presence of zircon (Zrn) in biotite (Bt) under transmitted light XPL (20X).

15. Sample code: TNS-MN-61

Microscopic observations: Microscopic study reveals that the rock exhibits a medium to coarse-grained, inequigranular texture. The modal mineral assemblage dominated by perthitic alkali feldspar (Perth), plagioclase (Plg), quartz (Qz), and biotite (Bt), along with secondary and accessory phases including sericite (Ser), apatite (Ap), allanite (Aln), and zircon (Zrn) (**Fig. 61A-61F**).

Alkali feldspar occurs predominantly as perthite, showing well-developed exsolution lamellae. These lamellae appear as fine, linear to patchy intergrowths. Plagioclase is present as subhedral grains, commonly exhibiting polysynthetic twinning, although in many places, it is significantly altered to sericite. The sericitization is pervasive, forming fine-grained aggregates that obscure primary feldspar textures, indicating low- to moderate-temperature hydrothermal alteration (**Fig. 61A-61B**).

Quartz occurs as anhedral interstitial grains filling spaces between feldspar crystals, suggesting late-stage crystallization. The quartz grains are generally clear but locally may show slight undulose extinction, indicating minor deformation after crystallization. Biotite appears as subhedral flakes with moderate to strong pleochroism and is commonly associated with accessory minerals. (**Fig. 61B-61C**).

Accessory phases are well represented. Apatite occurs as small prismatic inclusions within biotite and feldspar, indicating early magmatic crystallization. Allanite is observed as high-relief, brownish grains, often associated with altered places. Zircon occurs as small, euhedral grains with high relief and bright interference colors, typically enclosed within biotite, indicating early crystallization from the magma. (**Fig. 61D-61F**).

Based on the petrographic features suggest that the rock crystallized from an evolved, silica-rich magma and subsequently underwent significant subsolidus modification, including feldspar exsolution and pervasive sericitization. The presence of accessory minerals such as allanite and zircon reflects enrichment in incompatible elements, while the alteration textures point to fluid-mediated processes during the late to post-magmatic stages.

Rock/Mineral Name: Based on the mineral and textural characteristics, it is a granite.

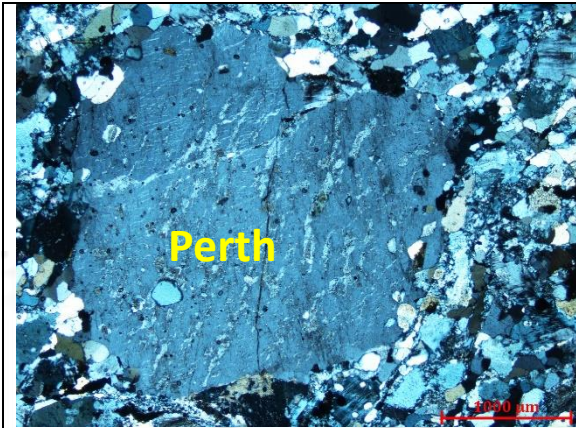


Fig. 61A. Photomicrograph showing presence of perthite (Perth) under transmitted light XPL (2X).

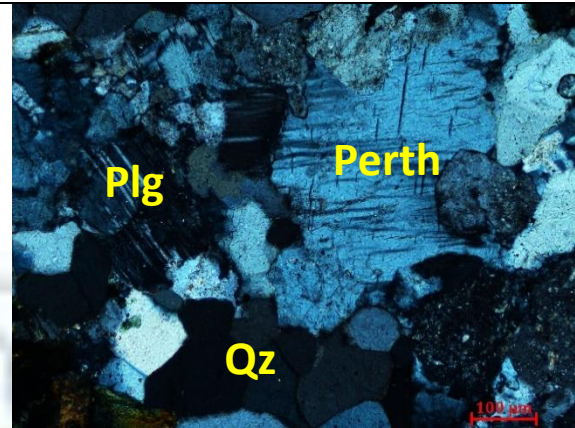


Fig. 61B. Photomicrograph showing presence of plagioclase (Plg), quartz (Qz) and perthite (Perth) under transmitted light XPL (10X).

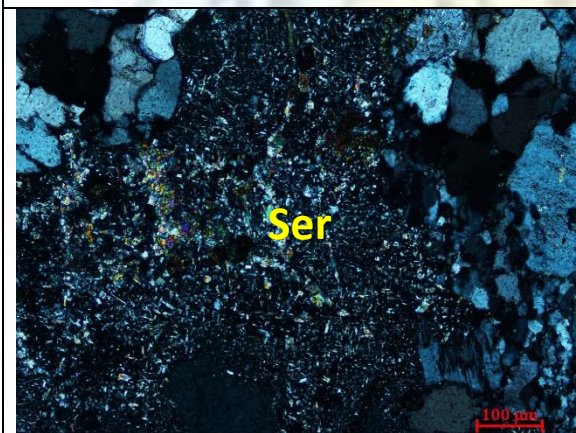


Fig. 61C. Photomicrograph showing presence of sericite (Ser) under transmitted light XPL (10X).

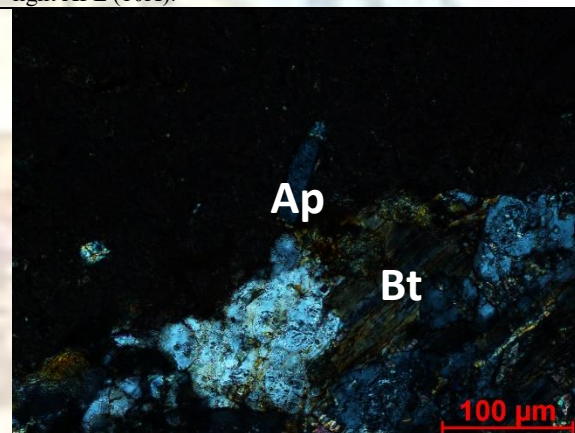


Fig. 61D. Photomicrograph showing presence of apatite (Ap) and biotite (Bt) under transmitted light XPL (20X).



Fig. 61E. Photomicrograph showing presence of allanite (Aln) and biotite (Bt) under transmitted light XPL (10X).



Fig. 61F. Photomicrograph showing presence of zircon (Zrn) under transmitted light XPL (20X).

16. Sample no: TNS_MN_40

Mineral assemblages: Alkali feldspar + Plagioclase + Quartz + Amphibole + Biotite + Apatite + Titanite + Magnetite + Pyrite

Secondary mineral assemblage: Epidote + Chlorite + Allanite + Sericite

Texture: It is a coarse grained, inequigranular rock consisting mostly of alkali feldspar and plagioclase feldspar. Alkali feldspar grains show cross-hatched twinning and flame perthite. Along the boundaries between two feldspar, there is extensive growth of myrmekite i.e. intergrowth of albite with worm-like quartz. The convexity of myrmekite is towards plagioclase indicating replacement of latter. Most of the alkali feldspar grains are extensively altered to very fine grained sericite.

Plagioclase feldspar grains are present much less in modal and are characterized by lamellar twinning. Tiny epidote and sericite grain have replaced the plagioclase.

Quartz grains are relatively smaller in size and modally present much less than the feldspar. All the grains are deformed showing undulose extinction, deformation bands and recrystallized granoblastic texture with smooth lobate to serrated grain boundaries.

Amphiboles are pleochroic from pale yellow to dark greenish brown containing apatite as inclusions. Along the margin, amphibole grains are replaced by epidote, chlorite and allanite. Biotites are associated with amphiboles forming a mafic streak within the rock.

Magnetite with minor pyrites are the opaque minerals present in this rock. Allanite has replaced magnetite along the fractures.

Epidotes are high refractive index mineral with high birefringence. It is a secondary minerals forming over other minerals such as plagioclase and amphiboles. Allanites are also secondary minerals having dark brown colour and high RI and birefringence. Sphenes are having perfect rhomb shape, dark brown in colour. All these three minerals are REE enriched.

Alkali feldspar, plagioclase, amphibole and quartz represent the primary mineral assemblages of this granitic rock. Presence of sericite replacing alkali feldspar represent late hydrothermal alteration of the granitic rock. During this late hydrothermal alteration, epidote, allanite, chlorite and sericite. The rock has also suffered ductile deformation resulted into formation of

deformation bands, flame perthite, myrmekite followed by strain recovery features such as recrystallization of quartz. Flame perthite also represent replacement of K-Feldspar by Na – feldspar formed during deformation assisted metasomatism.

Name of the rock: Alkali Feldspar Granite

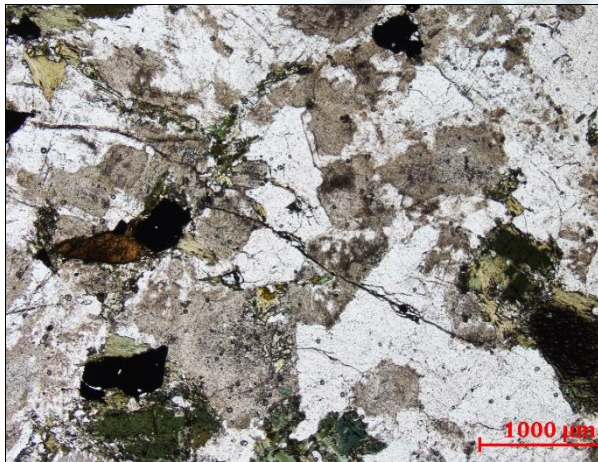


Fig.40.1 Altered alkali feldspar, plagioclase, quartz, amphibole, titanite and magnetite represent the primary mineral assemblage; under 2X magnification and plane polarized light

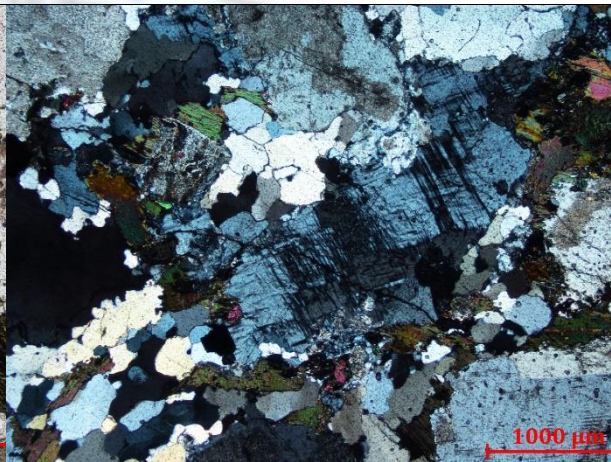


Fig 40.2 Large alkali and plagioclase feldspar within smaller grained recrystallised matrix of quartz; note the lobate, smooth grain boundaries between recrystallized quartz; under cross polarized light

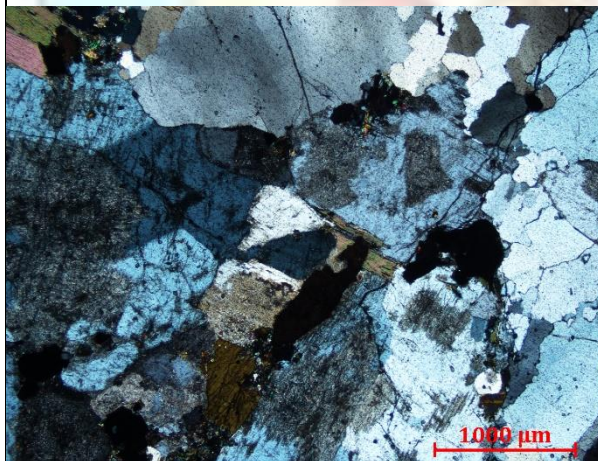


Fig 40.3 Undulose extinction in quartz and dusty appearance of alkali feldspar due to sericitization; under cross polarized light

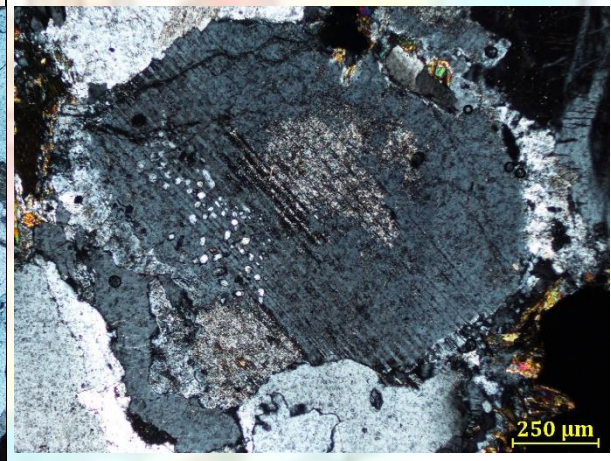


Fig.40.4 Sericitization at the core of plagioclase feldspar; note the quartz inclusions and myrmekite formation along grain boundaries with convexity towards plagioclase showing replacement texture. Under 5X magnification

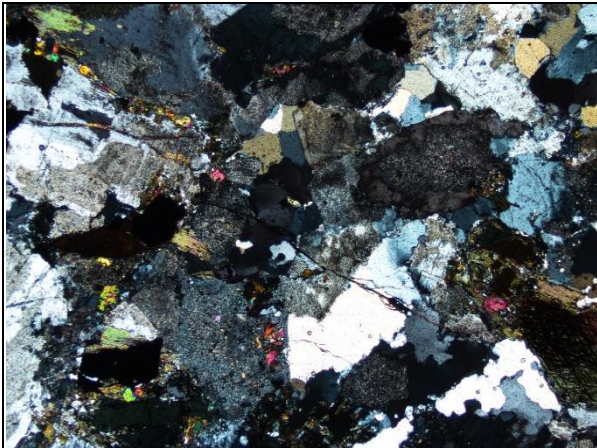


Fig. 40.5 Partially altered and Sericitized alkali feldspar

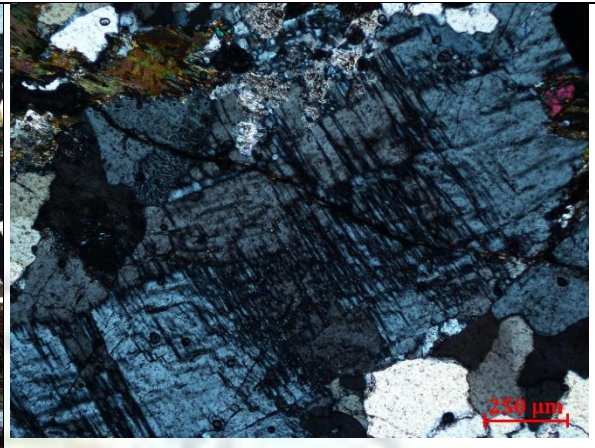


Fig. 40.6 Characteristic tapered cross hatched twinning in alkali feldspar

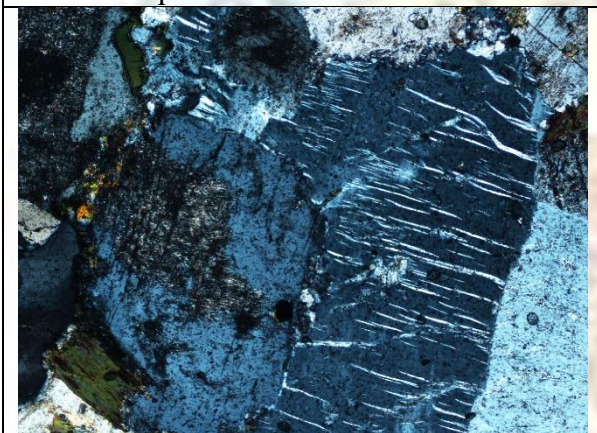


Fig. 40.7 Flame perthite within alkali feldspar

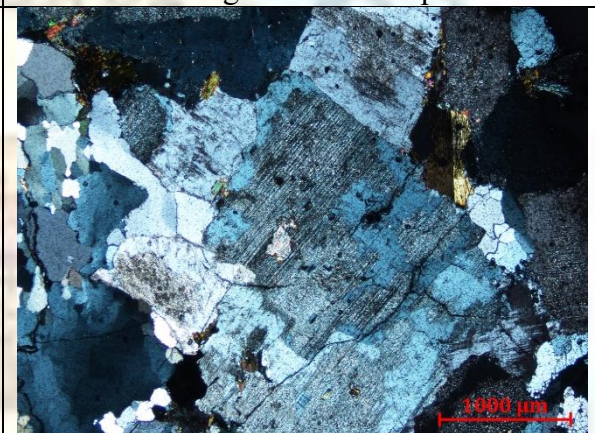


Fig. 40.8 Partially altered alkali feldspar; note the small quartz grains at the grain boundaries representing coarsening of myrmekites.

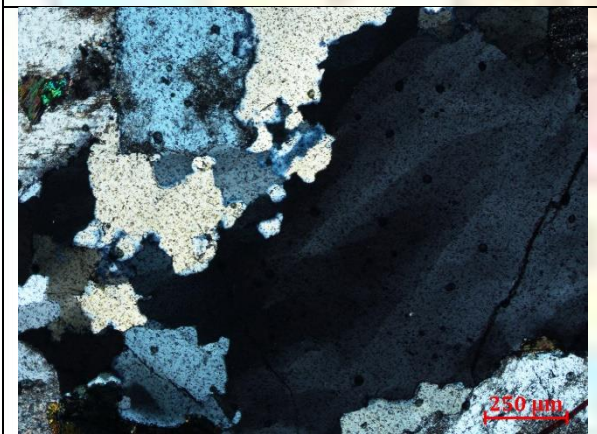


Fig. 40.9 Deformation band in quartz grains represent crystal scale deformation of quartz.

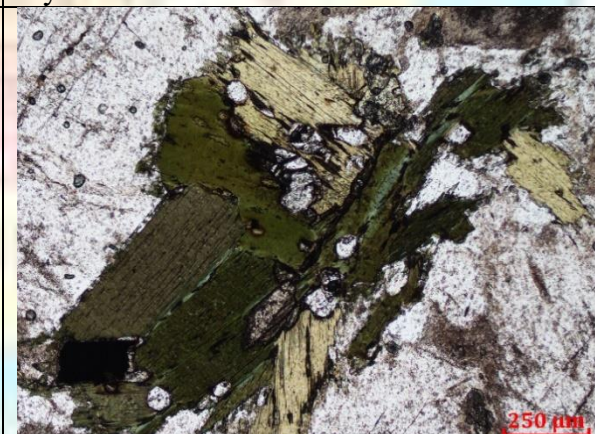


Fig. 40.10 Cluster of biotite and amphibole along with epidote, apatite and chlorite.

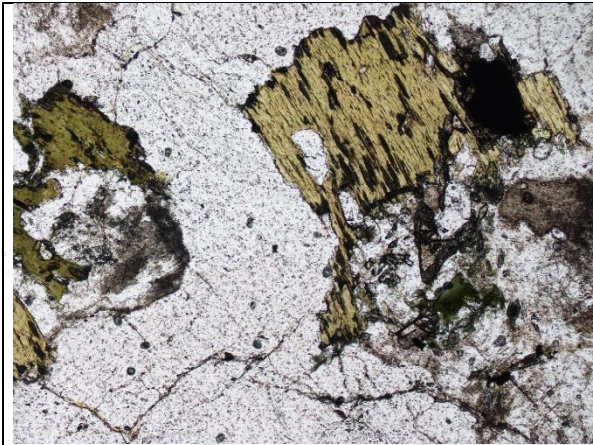


Fig.40.11 Irregular grain boundaries of biotite flakes indicating replacement; tiny epidote and sphene along the margin of biotite;



Fig. 40.12 Amphibole- sphene assemblage; note the fine high RI epidote replacing amphibole along its margin

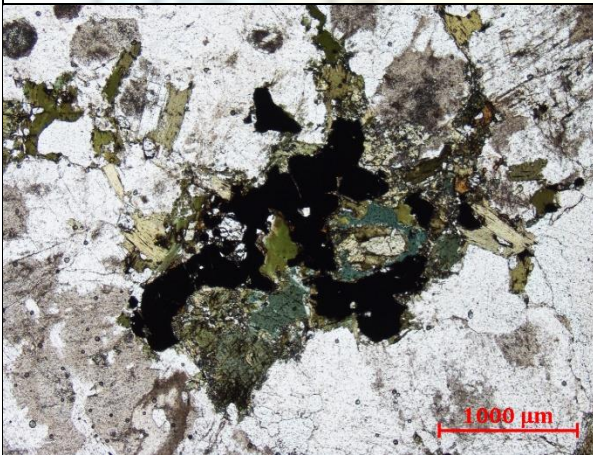


Fig. 40.13 Amphibole-chloritised biotite-magnetite forming the mafic assemblages of the rock;

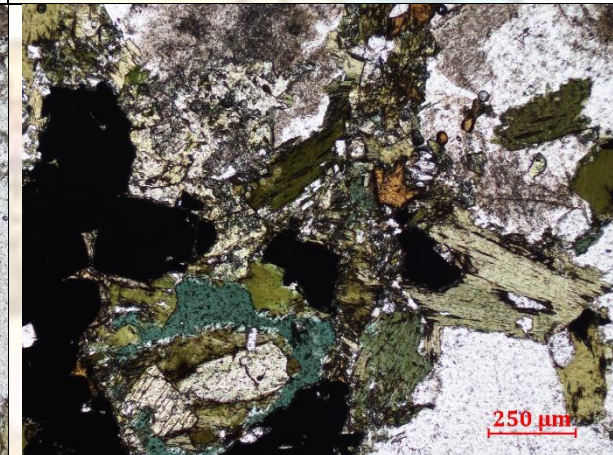


Fig. 40.14. Similar with Fig. 40.13; late chlorite-epidote – allanite replacing the primary mafics.

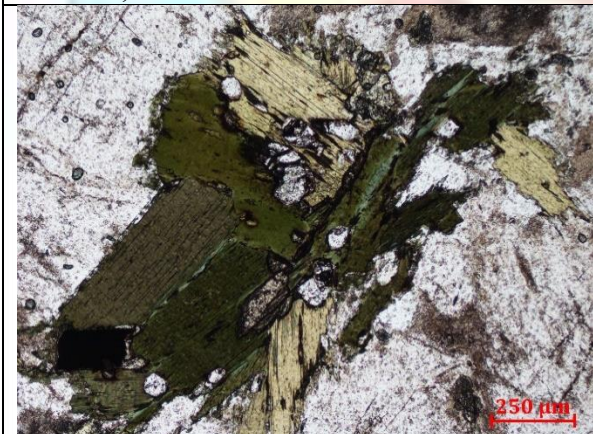


Fig. 40.15 Biotite and amphibole cluster with apatite inclusions; chloritised biotite and bleached amphibole represent alteration

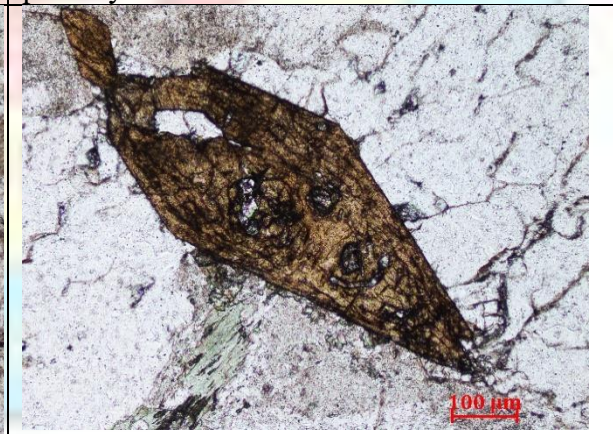
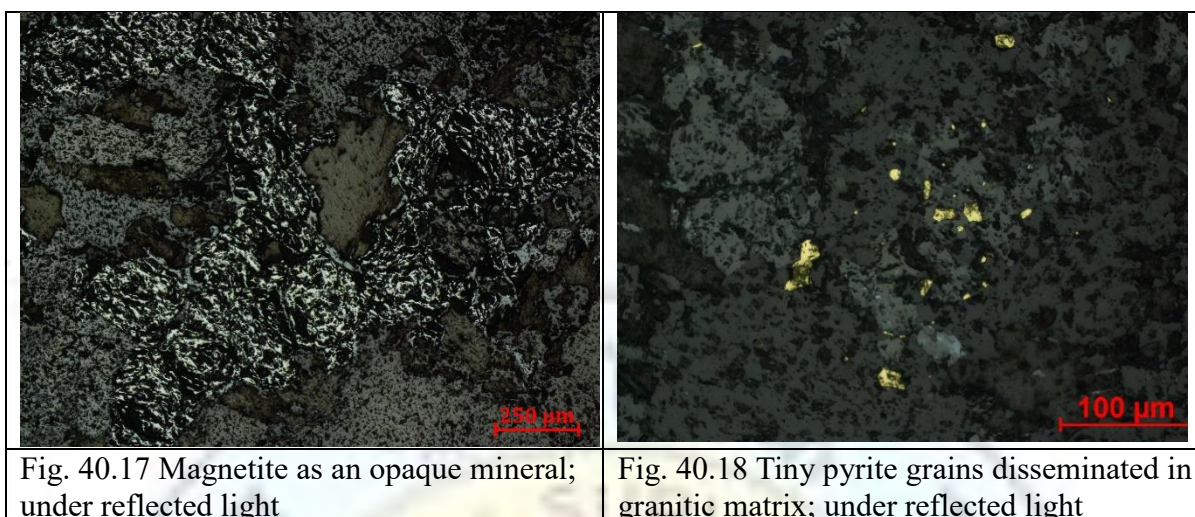


Fig. 40.16 Large zoned titanite; also note the green chlorite



17. Sample no: TNS_MN_07

Mineral assemblages: Quartz + Alkali Feldspar + Biotite + Amphibole + Plagioclase + Allanite + Zircon + Apatite + Magnetite

Secondary Mineral assemblage: Epidote + Sericite + Chlorite

Texture: It is a coarse grained, porphyritic rock consisting of large alkali feldspar phenocrysts within quartz –biotite rich matrix. Alkali feldspar grains are characterized by tapered cross-hatched twinning and flame perthite. Myrmekite intergrowth of albite-quartz along the feldspars boundaries is also conspicuous. Often coarsening of myrmekite form tiny grains along the boundaries. Alteration of alkali feldspar to sericite at places give the dusty appearance of feldspar. Quartz grains are relatively smaller in size, showing recrystallized granoblastic aggregate.

Biotite grains are mostly anhedral and often interstitial. It is pleochroic from pale straw yellow to dark brown. Biotite grains also show bending of cleavages due to deformation. Pale green chlorite and epidote replace biotite. Tiny magnetite, zircon and apatite also present within the biotite clusters.

Epidote, occurring as secondary minerals, replace feldspar along its boundaries. Plagioclase grains are replaced by tiny epidotes. Large allanite grains are present within the matrix. It is brown coloured and rhomb shaped.

The primary mineral assemblage represents coarse grained, porphyritic, recrystallized granoblastic aggregate of granitic rock which later affected by hydrothermal alteration such as sericitization, chloritization and sausseritization.

Name of the rock: Alkali feldspar granite

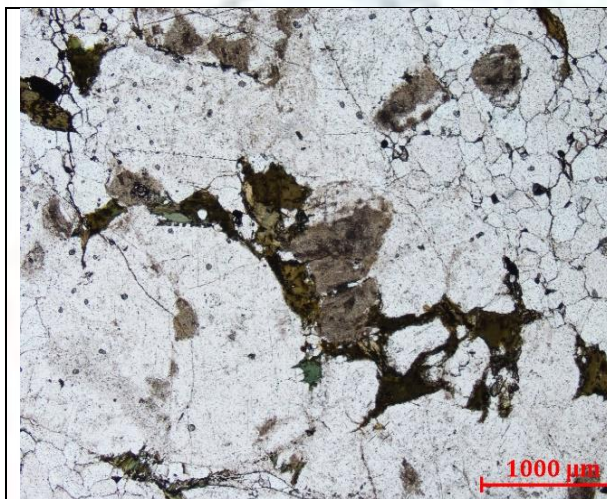


Fig 07.1 Alkali feldspar, quartz, altered dusty feldspar define the recrystallized aggregate; biotite occur as interstitial mineral. Under 2X magnification

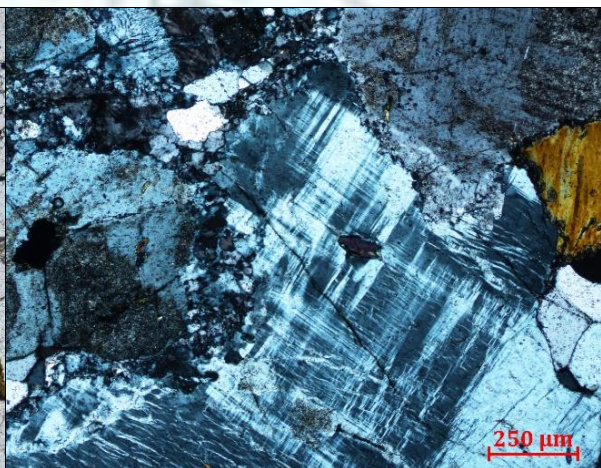


Fig. 07.2 Cross hatched twinning and flame perthite in large alkali feldspar grain; convex boundary of myrmekite intergrowth replace the feldspar

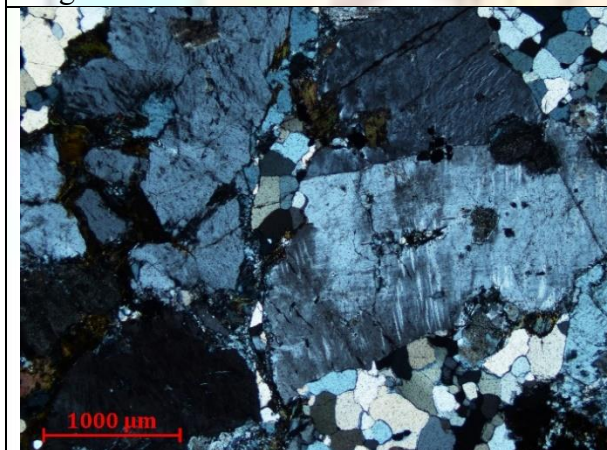


Fig.07.3 Large alkali feldspar grains within smaller recrystallized quartz grains.

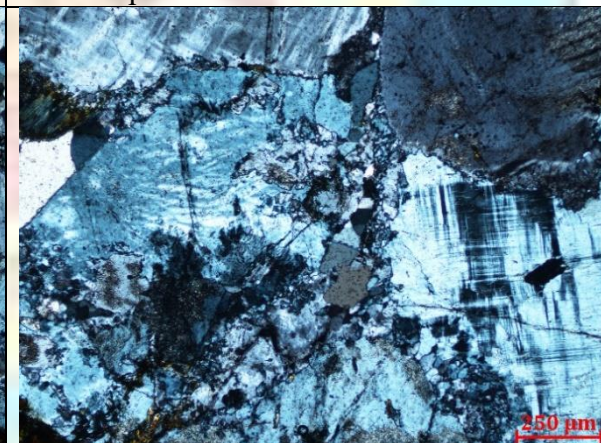


Fig.07.4 Coarsening of myrmekitic intergrowth along the feldspar grain boundaries;

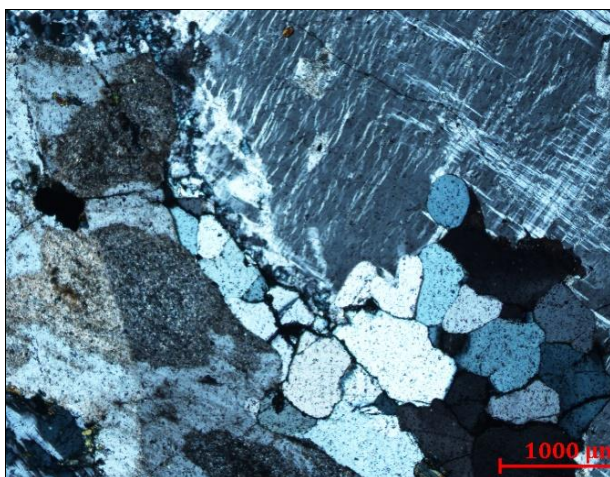


Fig.07.5 Recrystallized granoblastic aggregate of quartz with smooth grain boundaries.

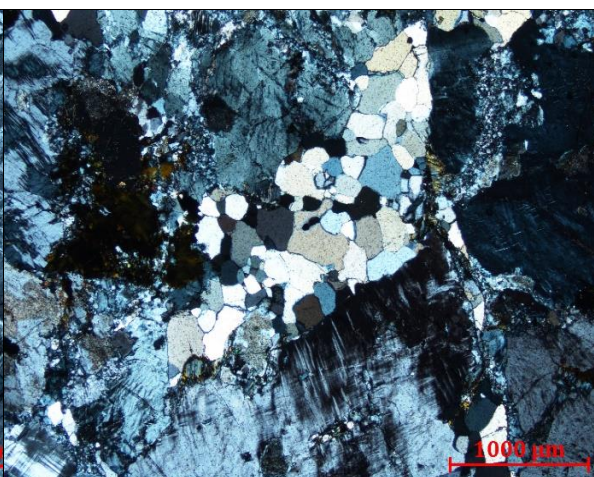


Fig.07.6 Recrystallized granoblastic aggregate of quartz with smooth grain boundaries.

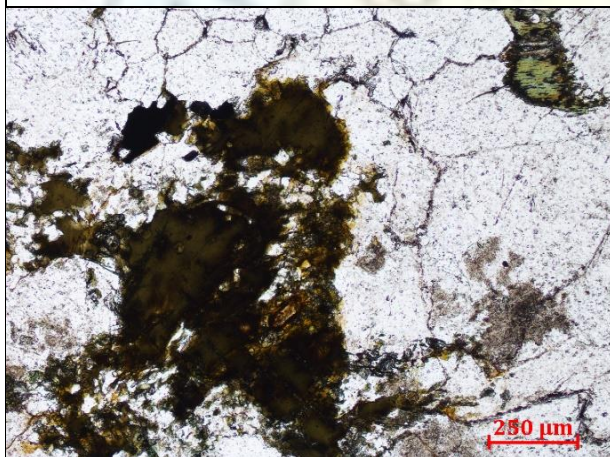


Fig. 07.7 Dark brown coloured altered biotite having irregular shape

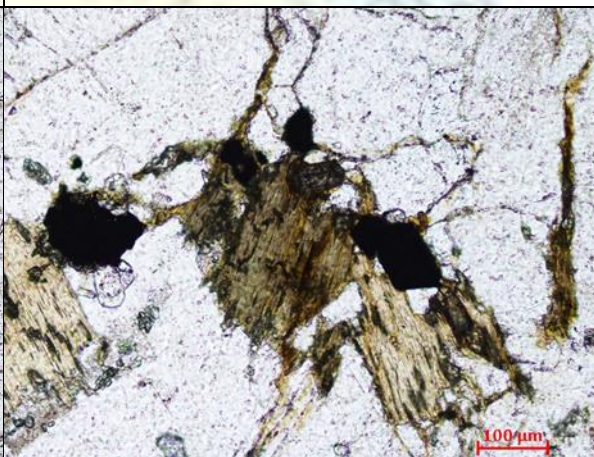


Fig. 07.8 Pale yellow to dark brown pleochroic and anhedral biotite with magnetite

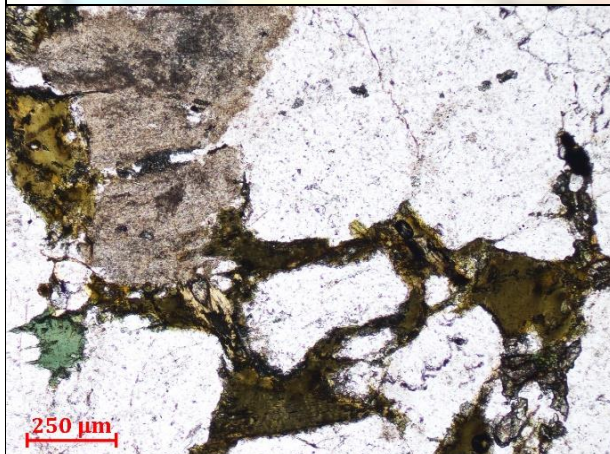


Fig.07.9 Irregular biotite along the interstitial spaces; note the altered alkali feldspar

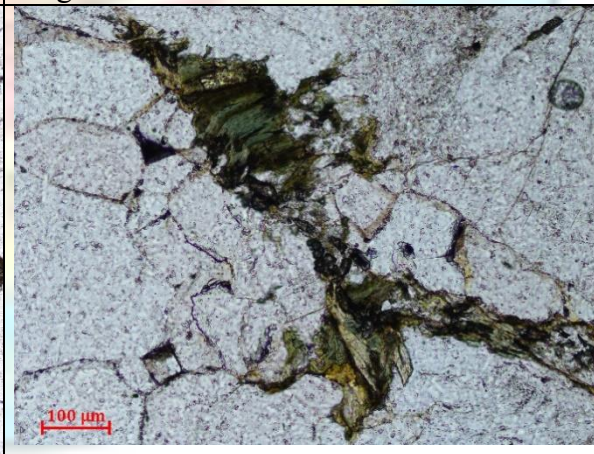


Fig.07.10 Pale green coloured chlorite replacing biotite

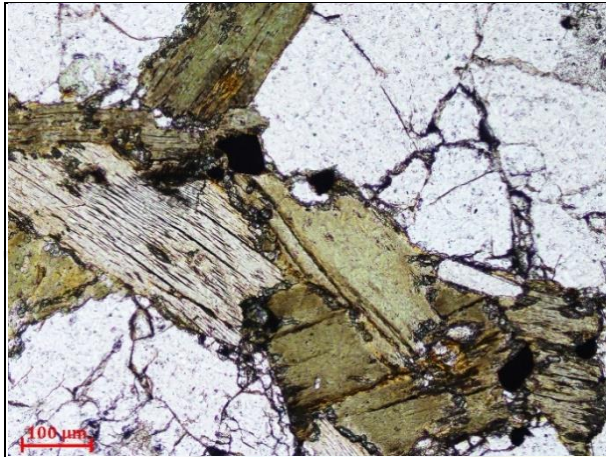


Fig. 07.11 Cluster of biotite flakes, magnetite and apatite

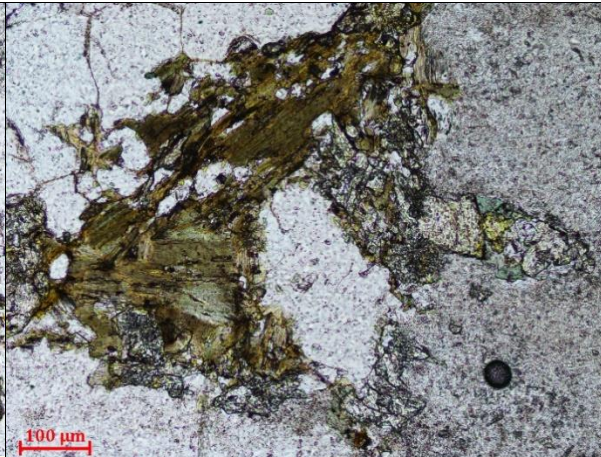


Fig. 07.12 Replacement of biotite and feldspar by epidote; note the high refractive index of epidote occurring along the boundaries of biotites.

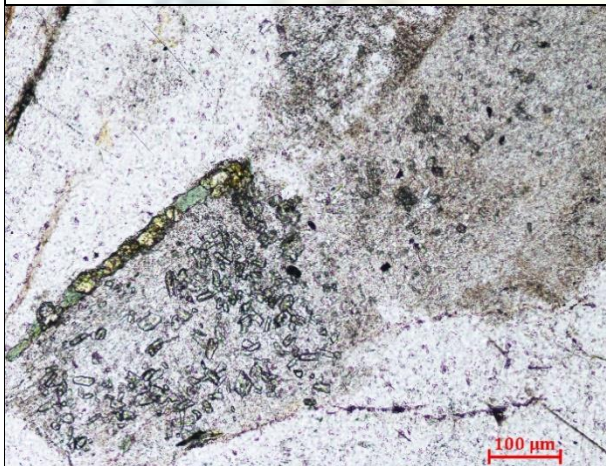


Fig.07.13 Tiny epidote grains replacing feldspar representing alteration

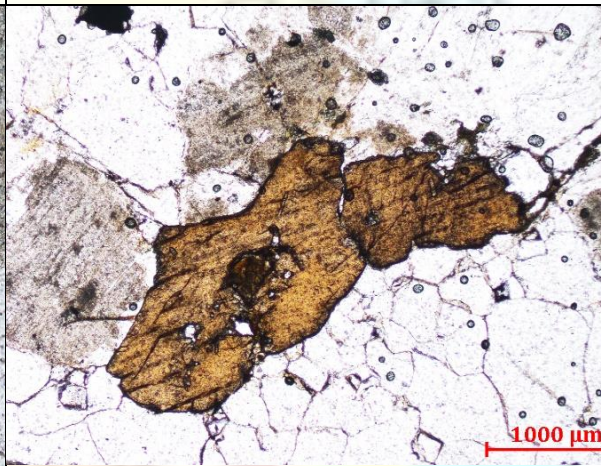


Fig. 07.14 Large allanite grain within feldspathic matrix.

18. Sample no.: TNS_MN_12

Mineral Assemblages: Alkali feldspar + Quartz + Biotite + Plagioclase + allanite + ilmenite + Magnetite

Secondary minerals: Epidote + Chlorite + Sericite

Texture: It is a medium to coarse grained rock consisting of Alkali feldspar , quartz, biotite, ilmenite and magnetite as primary mineral assemblage. Epidote, sericite and chlorite are the secondary mineral assemblages formed during late hydrothermal alteration of the granitic rock.

Alkali feldspar grains i.e. microcline are anhedral, coarse in size having flame type perthite and cross hatched tartan twinning. Extensive myrmekitic intergrowth formed along the grain boundaries of alkali feldspar. Alteration of orthoclase feldspar to sericite give a dusty appearance to it. Plagioclase content of the rock is much less and are identified by lamellar twinning. Quartz grains are relatively smaller in size due to strain recovery features such as recrystallized sutured grain boundaries. Deformation bands are present in larger quartz grains. Epidote and sericite both replace feldspar marking hydrothermal alteration. Biotite grains are mostly anhedral, interstitial and pleochroic from pale yellow to dark brown. At most of the places biotite is replaced by pale green chlorite. Chlorite has also replaced epidote. Allanite-epidote –chlorite assemblage replaced biotite. Allanite and epidote minerals may control the REE budget of the rock as both of them may contain REE.

The petrographic characteristics suggest crystallization from an evolved, silica-rich magma followed by extensive deuteric alteration and fluid-assisted metasomatism. Formation of flame perthite, myrmekite replacing microcline, sericitization of orthoclase, chloritization of biotite and sausseritization (epidote forming event) of plagioclase are the major alteration feature of late deformation assisted metasomatism

Name of the rock: Alkali feldspar granite

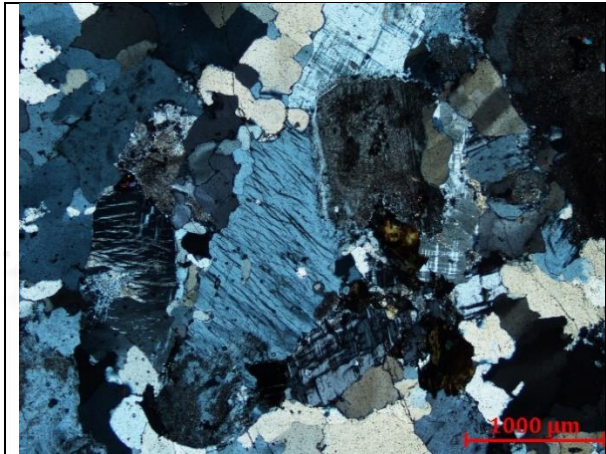


Fig.12.1 Flame perthite and cross hatched twinning bearing alkali feldspar, recrystallized quartz and biotite are the major minerals; note the deformation features of quartz showing undulose extinction, deformation band and sutured recrystallized grain boundaries.

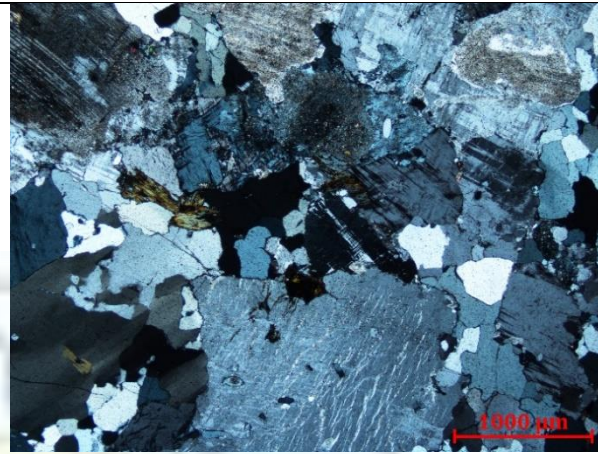


Fig. 12.2 Alkali feldspar rich rock showing altered feldspar, flame perthite in alkali feldspar and lamellar twinning in plagioclase; note the deformation bands in large quartz grains.

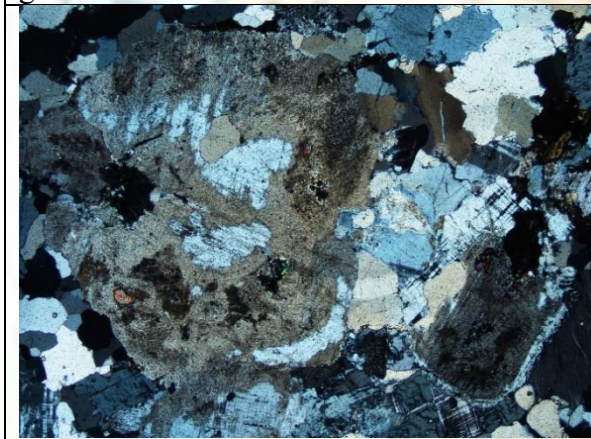


Fig. 12.3 Alteration / sericitization of alkali feldspar

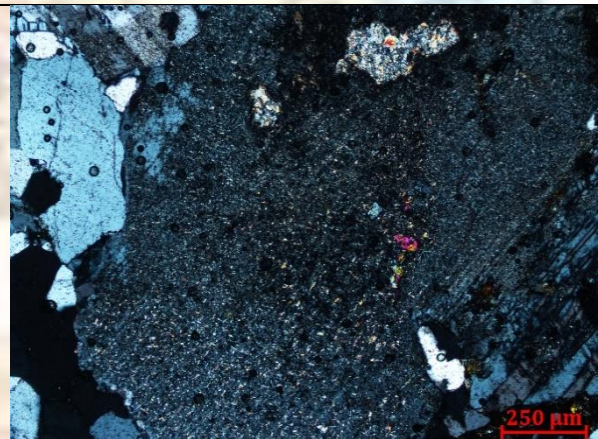


Fig. 12.4 Sericitization and epidote formation in plagioclase due to hydrothermal alteration

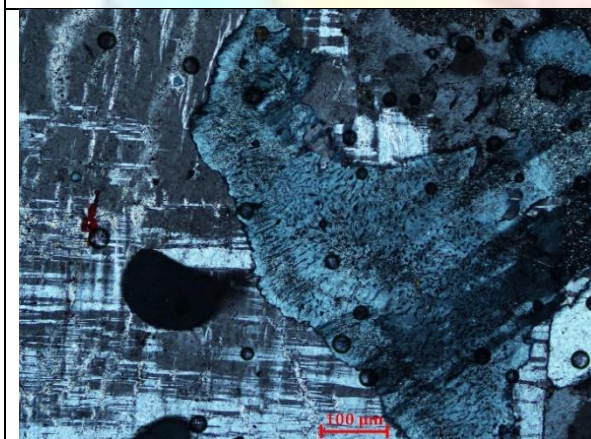


Fig.12.5 Myrmekite formation along the grain boundaries of two feldspar; convexity showed the direction of replacement front.



Fig. 12.6 Sericitization and epidote formation in plagioclase due to hydrothermal alteration; formation of pale green chlorite replacing epidote.

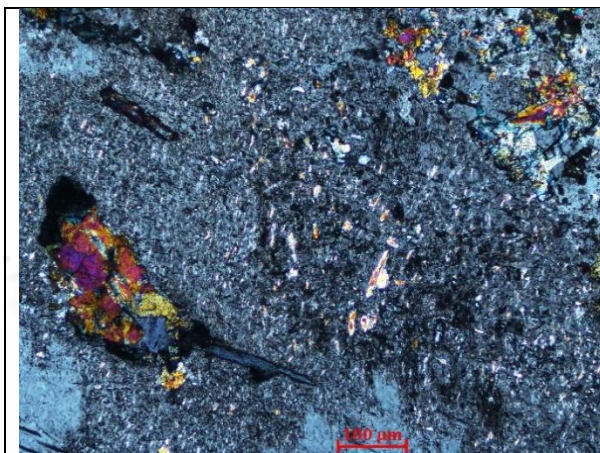


Fig. 12.7 Sericitization and epidote formation in plagioclase due to hydrothermal alteration; under cross polarized light

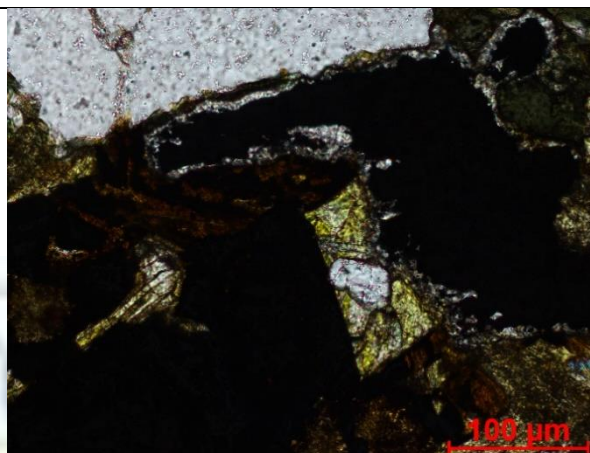


Fig. 12.8 Thin rim of epidote forming over magnetite; epidote grains also formed with allanite

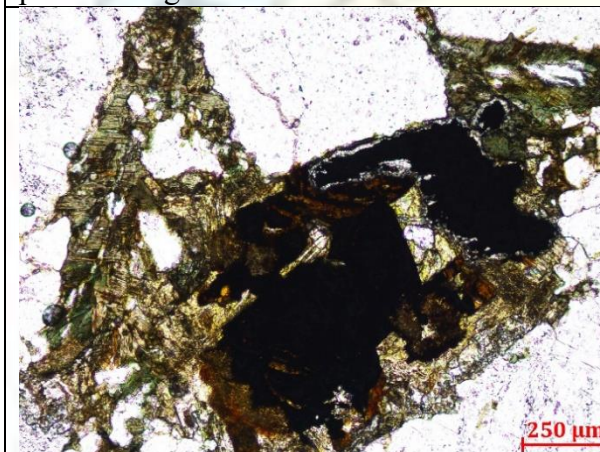


Fig. 12.9 Allanite-epidote-chlorite forming over primary biotite

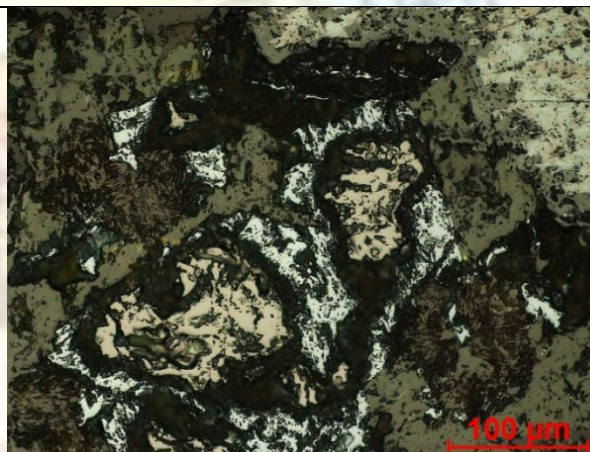


Fig. 12.10 Small Magnetite-hematite and ilmenite grains within feldspathic matrix.

19. Sample no: TNS_MS_67

Mineral Assemblage: Alkali feldspar + Plagioclase + Quartz + Biotite + Allanite

Secondary minerals: Epidote + Chlorite

Texture: It is a medium grained, inequigranular rock showing recrystallized granoblastic aggregate of quartz, alkali feldspar. Alkali feldspar grains are large anhedral occur as interstitial mineral. Due to its large anhedral structure, numerous quartz grains become engulfed by feldspar. Flame perthite and cross hatched twinning are characteristic features of alkali feldspar. Extensive myrmekitization along the boundaries of alkali feldspars are noted which represent replacement of feldspar. Due to coarsening of myrmekite, intergrowth of albite and quartz form small tiny grains which surround the feldspars grains. Convexity of myrmekite front indicate replacement of feldspar by the intergrowth. Due to alteration of feldspar into sericite, brownish tinge marks the alkali feldspar. Sericite and epidote both replaces feldspars. Plagioclase grains are present in less amount than alkali feldspar.

Quartz grains are relatively smaller in size and shows recrystallized granoblastic aggregate with lobate to straight grain boundaries indication strain recovery features at high temperature.

Dark brown coloured, anhedral allanite(?) are present with an epidote rim. Biotite flakes are present as small mafic clusters. It is pleochroic from pale yellow to brown. At most of the places, biotite has been replaced by pale green coloured chlorite.

The mineral assemblage of the rock represents an alkali feldspar rich granite which was later affected by hydrothermal alteration forming epidote-chlorite and sericite.

Name of the rock: Alkali feldspar granite

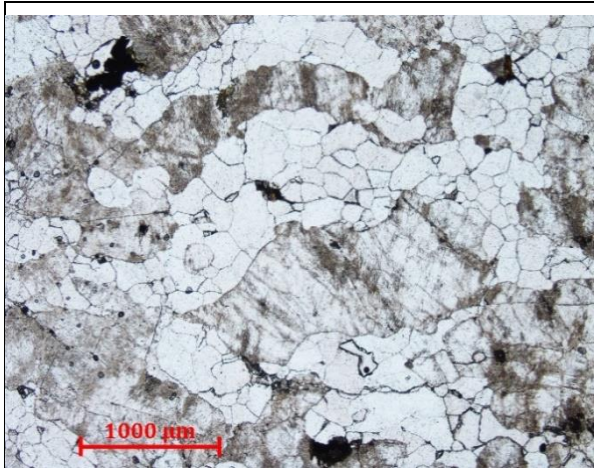


Fig.67.1 Sericitized alkali feldspar and recrystallized aggregate forming the major mineral assemblage

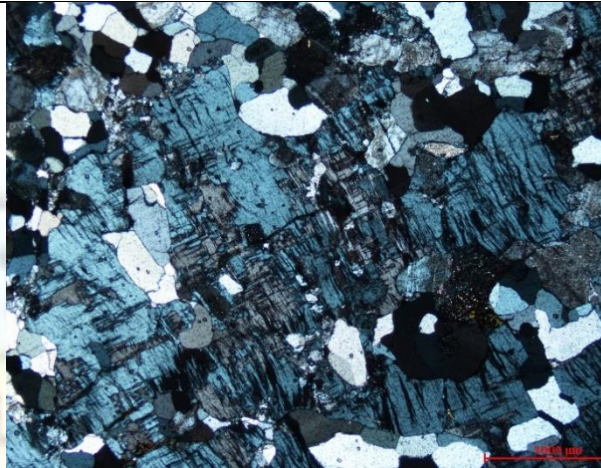


Fig. 67.2 Large anhedral alkali feldspar with cross hatched twinning occupying the interstitial spaces.

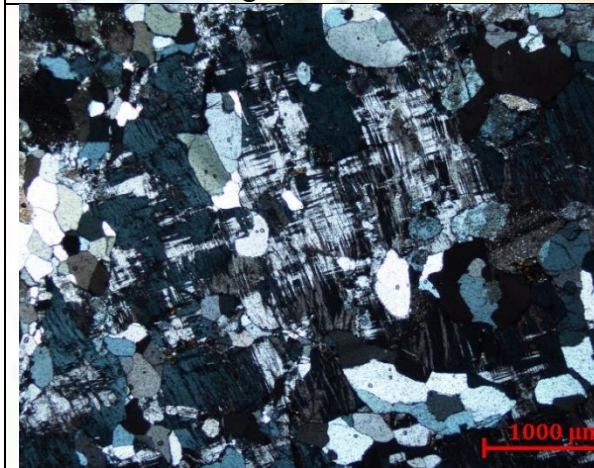


Fig. 67.3 Large anhedral alkali feldspar with cross hatched twinning occupying the interstitial spaces.

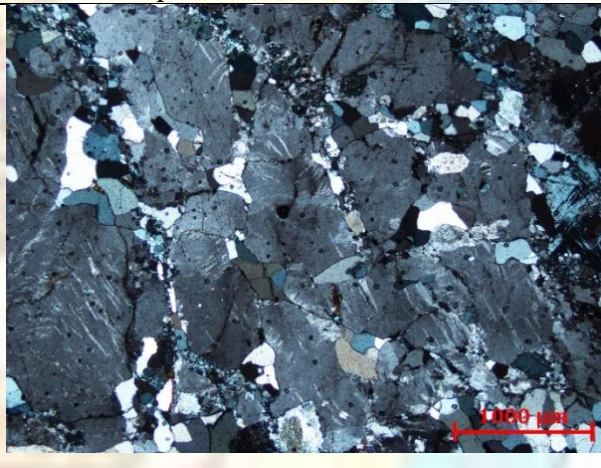


Fig. 67.4 Flame perthite in alkali feldspar; note the high modal content of alkali feldspar and smaller quartz grains at the boundaries.

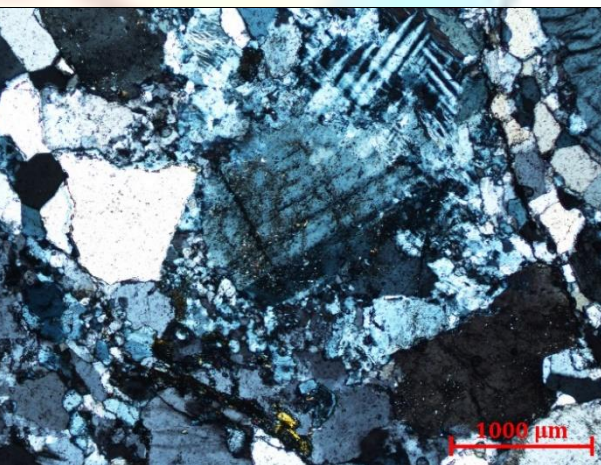
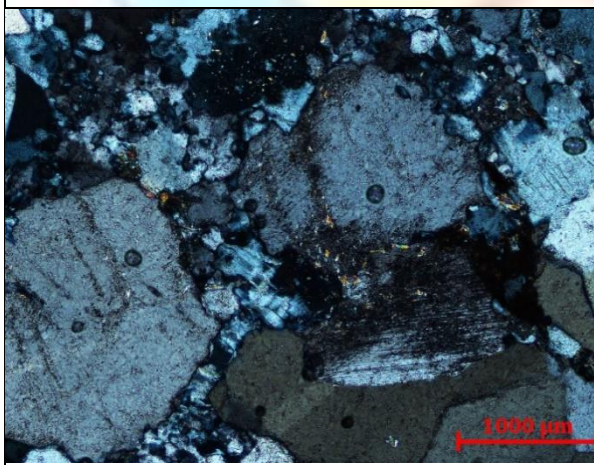


Fig. 67.5 Myrmekite intergrowth along the grain boundaries of feldspar; note the undulose extinction in quartz

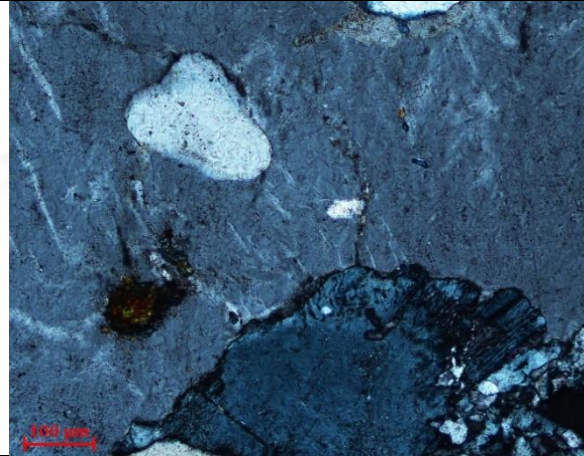


Fig. 67.6 Coarsening of myrmekite from tiny grains of quartz and albite at the grain margins.

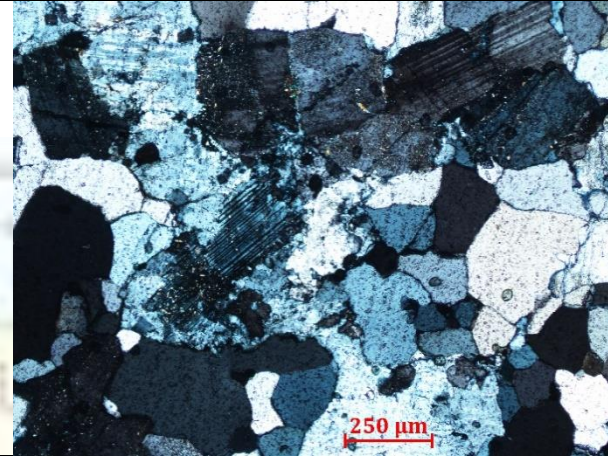


Fig 67.7 Convexity of myrmekite front towards alkali feldspar; note small allanite-epidote cluster as inclusion within feldspar

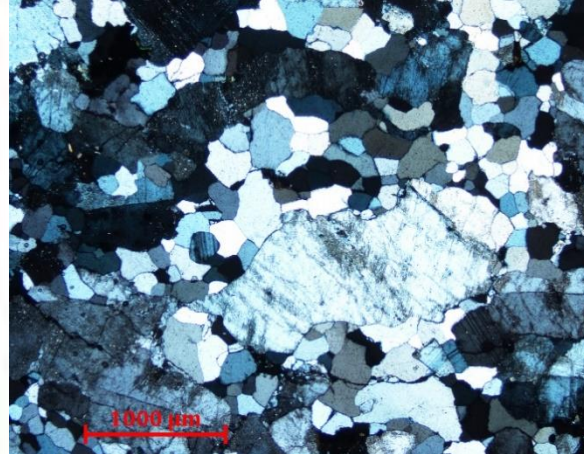


Fig. 67.8 Plagioclase grains with lamellar twinning

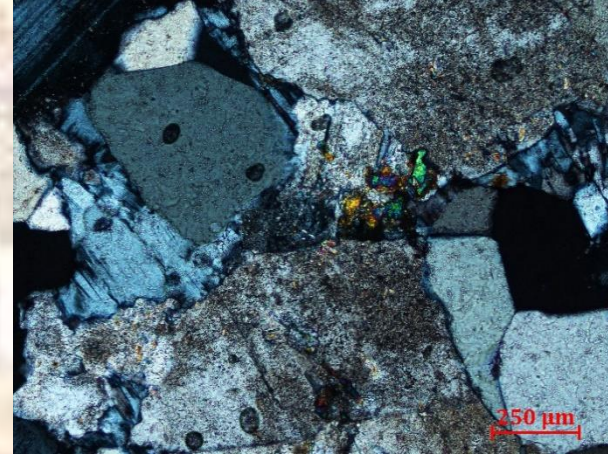


Fig. 67.9 Recrystallized granoblastic aggregate of quartz with lobate to straight grain boundaries

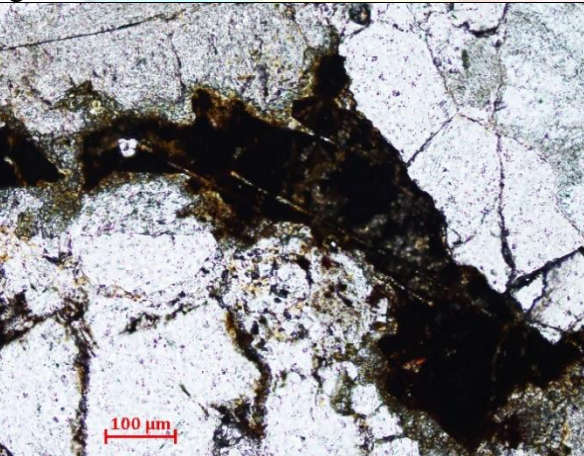


Fig. 67.10 Sericitization of feldspar and epidote formation in plagioclase

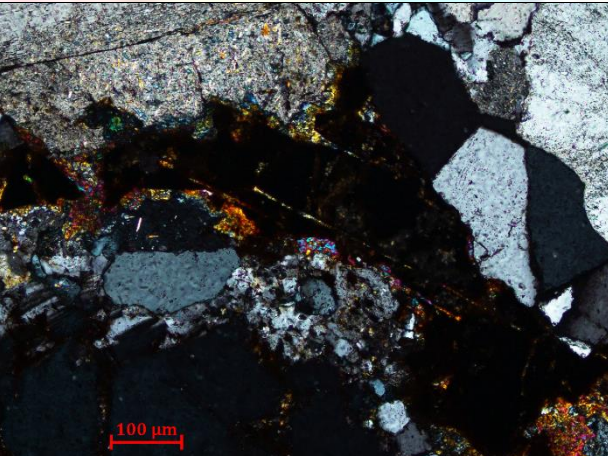
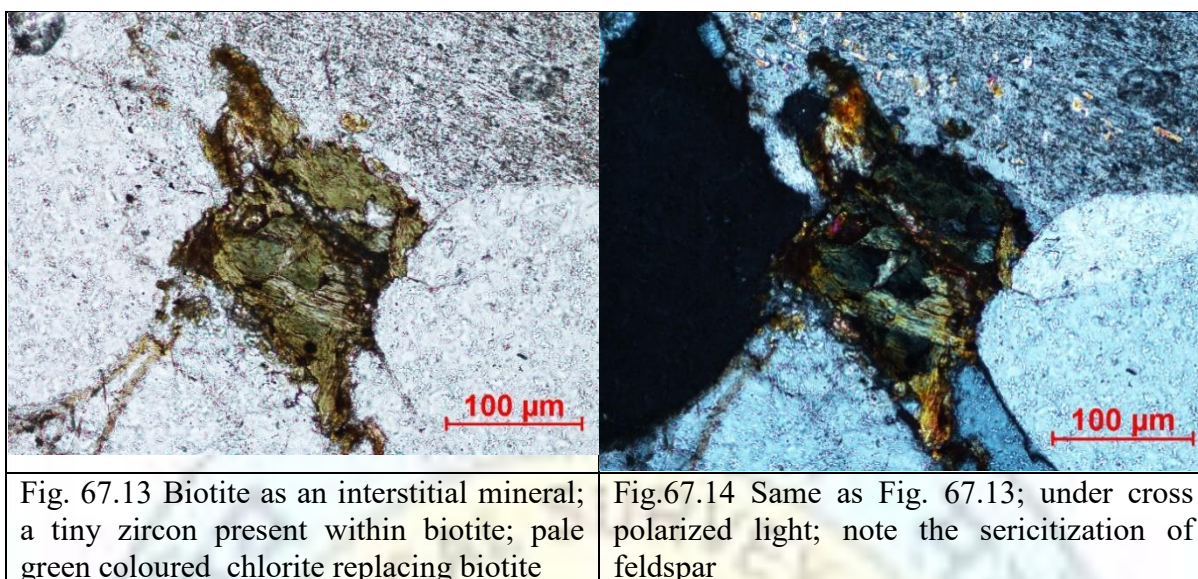


Fig. 67.11 Dark brown allanite with epidote rim; both contain REE; under plane polarized light

Fig 67.12 Same as Fig. 67.11; under cross polarized light, epidote with high birefringence colour is prominent



20. TNS_MN_10

Mineral Assemblage: Alkali feldspar (Microcline and orthoclase)+ Plagioclase + Quartz + Biotite + magnetite

Secondary minerals: Epidote + Chlorite + Sericite

Texture: The rock is coarse grained alkali feldspar granite consisting of microcline, orthoclase, plagioclase feldspar and biotite. Quartz grains are relatively smaller in size showing recrystallized granoblastic aggregate with smooth to sutured grain boundaries. The major mineral of the rock is orthoclase which are anhedral to subhedral, large and completely replaced by sericite. Microclines are large anhedral alkali feldspar showing cross-hatched as well as simple twinning. Flame perthites are also present in feldspars. The large anhedral microcline grains have inclusions of early crystallized plagioclase feldspar and quartz showing its late formation after crystallization of other phases. Biotite grains are mostly occurring as interstitial mineral and at most of the places become chloritized. Biotite are pleochroic from pale straw yellow to brown. Epidote grains are secondary minerals formed by replacing plagioclase and have high refractive index.

Another secondary mineral is sericite which occur as tiny specs and have completely replaced existing primary orthoclase. Microclines are less altered by sericite. Extensive myrmekitic intergrowths are observed along plagioclase-alkali feldspar boundaries with convexity towards

plagioclase. Plagioclase grains are deformed showing bent twin lamellae and concentric zoning. Very few magnetites are present in this rock as interstitial

Based on the petrographic observation, it is inferred that the rock is an alkali feldspar granite which is later affected by deformation and secondary alteration.

Rock name: Alkali feldspar granite

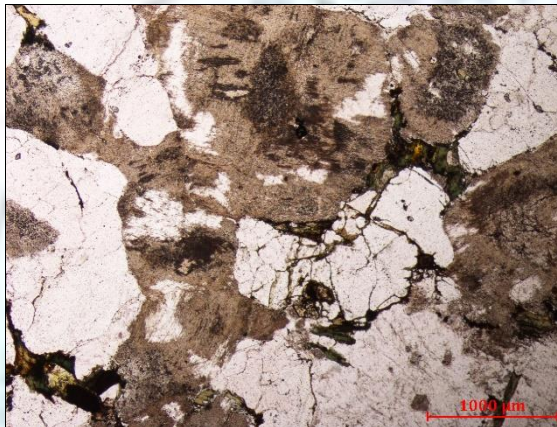


Fig. 10.1 Coarse grained granitic rock with altered feldspar and quartz; under plane polarized light at 2X magnification



Fig. 10.2 Interstitial chloritized biotite within quartzo-feldspathic matrix.

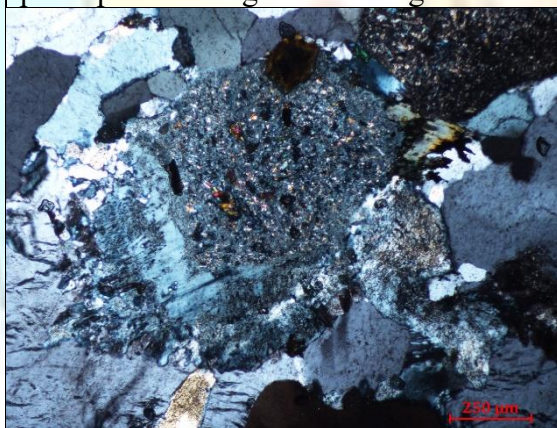


Fig. 10.3 Alteration of plagioclase to epidote; note the myrmekitic intergrowth along the boundary of two feldspars.

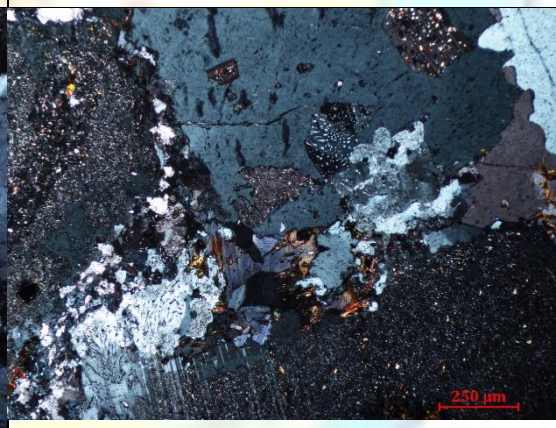


Fig. 10.4 Coarsening of myrmekite along the grain boundaries; note alteration of feldspars to sericite and inclusions of altered orthoclase in microcline

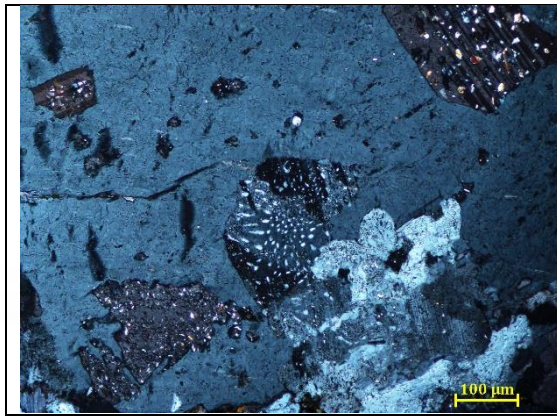


Fig. 10.5 Inclusions of altered plagioclase and sericitised orthoclase in late perthitic feldspars; convexity of myrmekite shows the replacement front



Fig. 10.6 Replacement of feldspars by Sericite and epidote grains

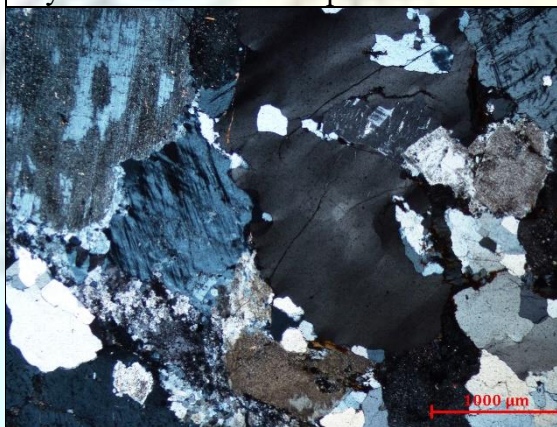


Fig. 10.7 Undulose extinction in large quartz grains indicating deformation of rock; coarsening of myrmekite and alteration of feldspars represent deformed and altered granitic rocks.

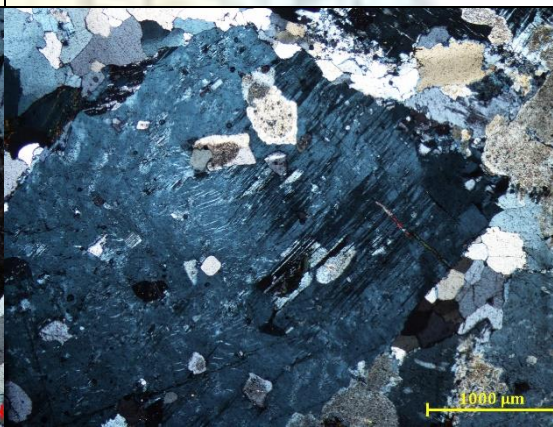


Fig. 10.8 Inclusions of quartz, plagioclase and orthoclase within large perthitic feldspar.

21. TNS_MN_41

Mineral Assemblage: Alkali feldspar + Plagioclase + Quartz + Biotite
+ magnetite

Secondary minerals: Epidote + Chlorite + Sericite

Texture: This is a very coarse grained rock consisting of alkali feldspar, quartz, plagioclase and few biotites. Alkali feldspar consists of both microcline and orthoclase. Orthoclase are anhedral to subhedral in shape and are mostly altered to sericite.

Microcline grains are large, subhedral and crystallized after orthoclase and plagioclase as both of these minerals are present as inclusions within microcline. Simple and cross hatched twinning are the characteristic features of microcline. Myrmekitic intergrowths are observed along the two feldspars contact.

Biotites are mostly occur as interstitial and are pleochroic from yellow to green. Most of the biotite are altered to chlorite. Very few tiny magnetites are present as dissemination in this rock.

Secondary alterations have changed orthoclase to sericite and plagioclase to epidote.

The rock is deformed and altered. Deformation features and recovery features such as deformation bands and recrystallization of quartz respectively are commonly noted. Bend in twin lamellae are present due to deformation.

Rock name: **Alkali feldspar Granite.**

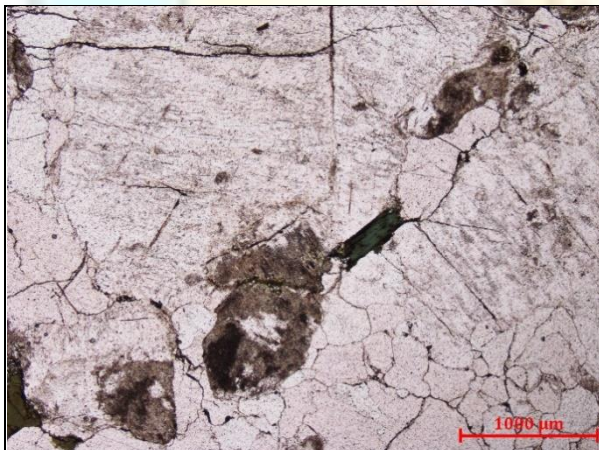


Fig. 41.1 Coarse grained granitic rock with altered orthoclase, quartz and plagioclase.

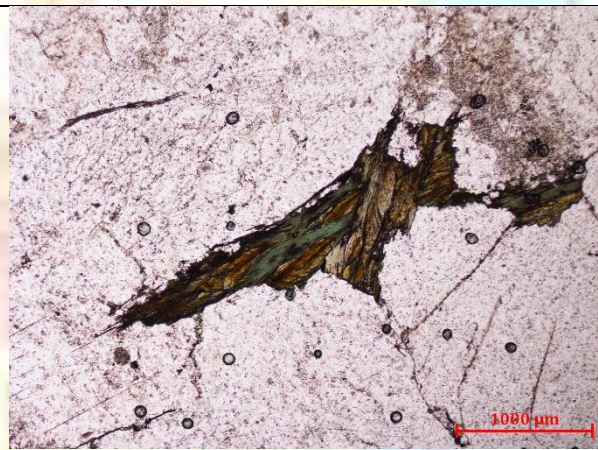


Fig. 41.2 Cluster of biotite; few of them are chloritised showing greenish colour .

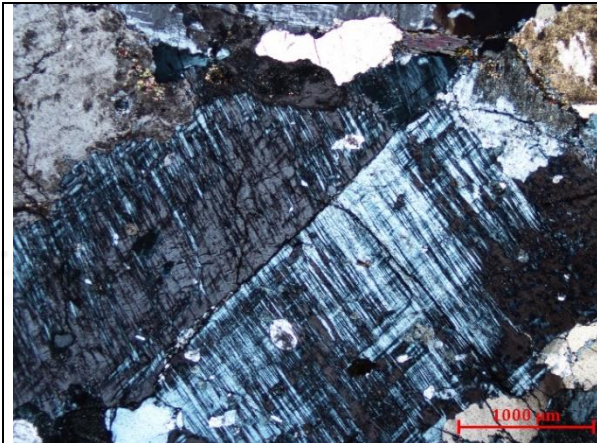


Fig. 41.3 Simple twinning and cross-hatched twinning of large microcline grain

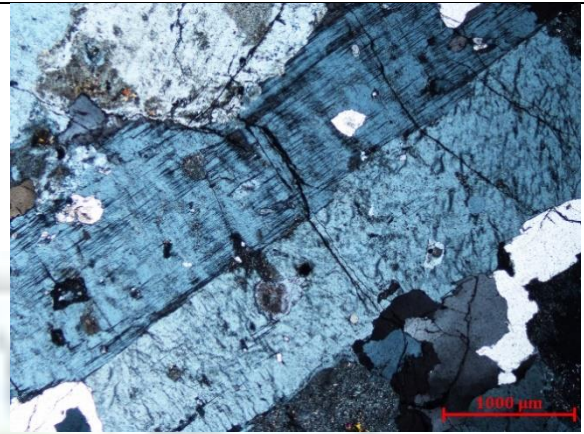


Fig. 41.4 Simple twinning of microcline; also note the quartz and plagioclase inclusions within large microcline.

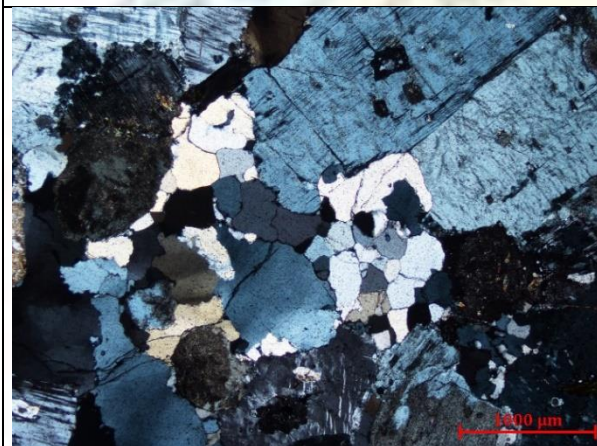


Fig. 41.5 Recrystallized granoblastic aggregate of quartz with sutured to smooth grain boundaries; also note replacement of microcline by myrmekite; perthite and simple twinned microcline in medium grained quartz-orthoclase rich matrix.

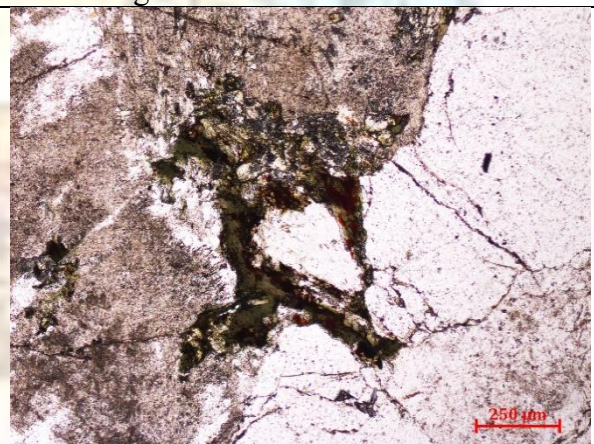


Fig. 41.6 Interstitial biotite with anhedral shape; few epidotes also present; note the alteration of orthoclase.

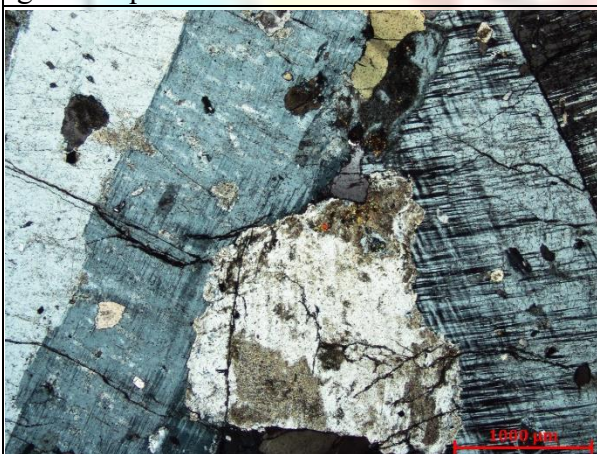


Fig. 41.7 Large microcline grains with simple twinning; note altered orthoclase in between these microclines.

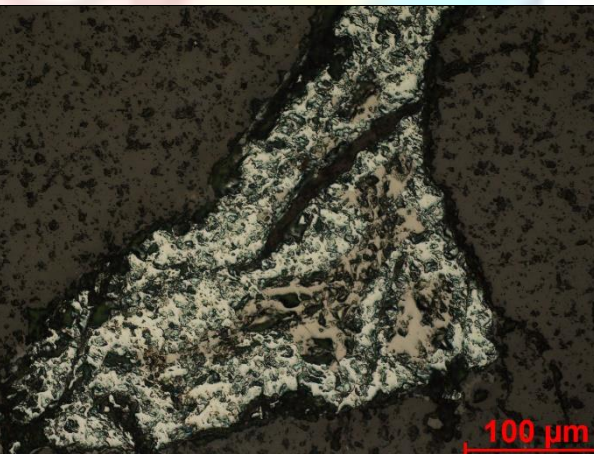


Fig. 41.8 Magnetite occurring as interstitial phase

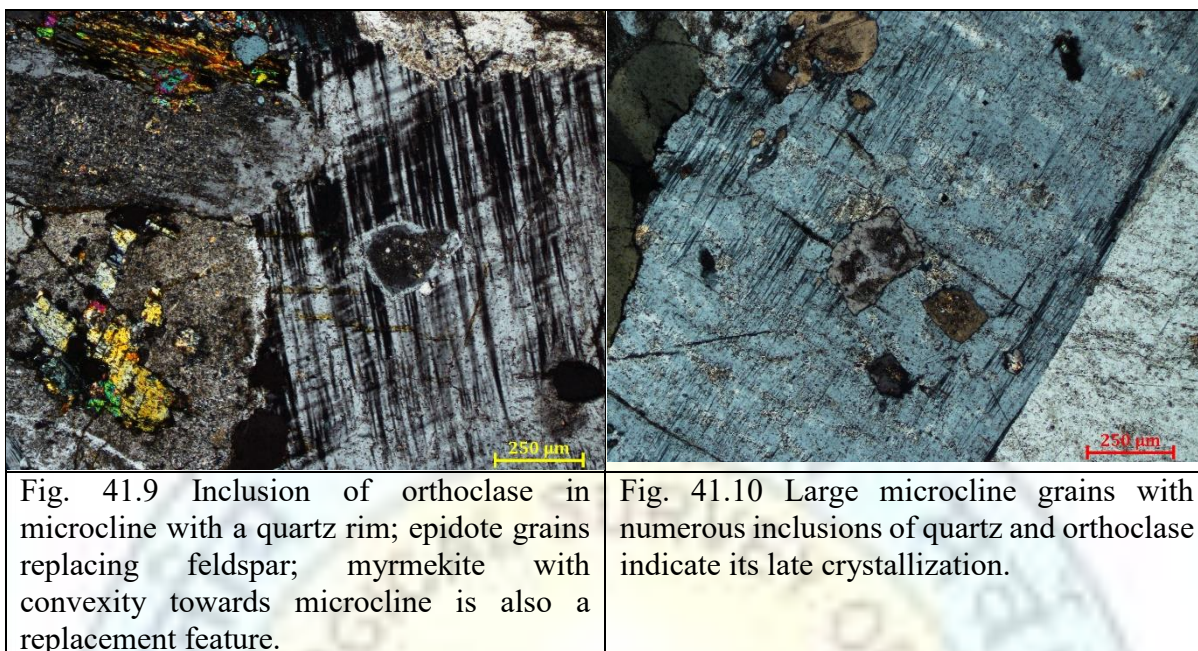


Fig. 41.9 Inclusion of orthoclase in microcline with a quartz rim; epidote grains replacing feldspar; myrmekite with convexity towards microcline is also a replacement feature.

Fig. 41.10 Large microcline grains with numerous inclusions of quartz and orthoclase indicate its late crystallization.

22. TNS_MN_60

Mineral Assemblage: Alkali feldspar + Plagioclase + Quartz + Biotite + Allanite

Secondary minerals: Epidote + Chlorite + Sericite + Sphene/Titanite

Texture: This rock is a coarse grained granitic rock consisting of alkali feldspar, quartz, plagioclase and secondary minerals like epidote, sericite, allanite, chlorite and titanite.

Microcline grains are much coarser than the other feldspar having inclusions of orthoclase, quartz and plagioclase. Quartz grains are relatively smaller probably due to recrystallization and show granoblastic texture with sutured grain boundaries. It is a deformation recovery feature. Plagioclase and microcline grains often occur as clusters. Microcline grains are characterized by flame perthite, cross hatched twinning and simple twinning. Myrmekitic intergrowth of quartz and albite was formed along the boundaries of feldspar. Coarsening of these intergrowths formed tiny grains along the feldspar margins. Epidote and sericite, the secondary minerals have replaced plagioclase and orthoclase respectively indicating late metasomatic activities.

Another major secondary mineral is chlorite which is green in colour, and anhedral shape, occurring at interstitial spaces along with sphene, allanite and epidote.

Epidote also occurs as veins passing through a brecciated zone. This zone consists of broken feldspar grains and interstices are filled up by epidote.

High temperature ductile deformation of the rocks is manifested by bent twin lamellae of plagioclase, faulted and shifted lamellae, flame perthite in microcline and recrystallization of quartz.

Rock name: Alkali feldspar granite

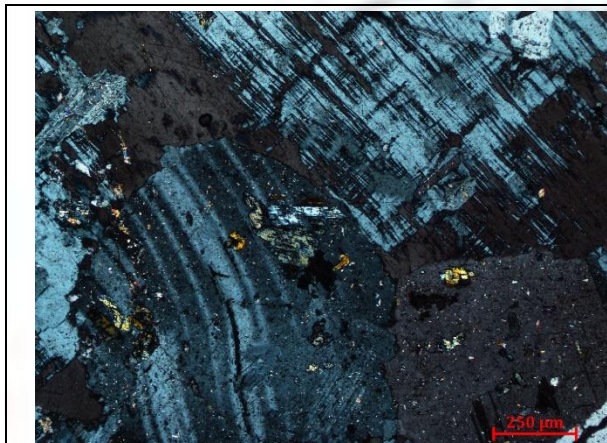


Fig. 60.1 Plagioclase , microcline and orthoclase bearing granitic assemblage; note the deformed and bent lamellar twinning of plagioclase indicating ductile deformation

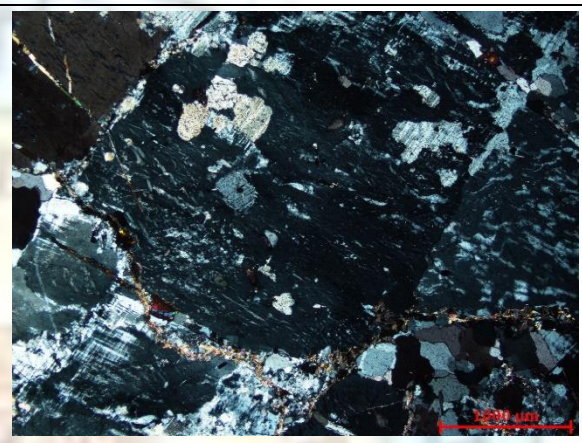


Fig. 60.2 Large microcline grains with inclusions of plagioclase ; also note the perthite and simple twinning of microcline; thin carbonate vein cutting across microcline

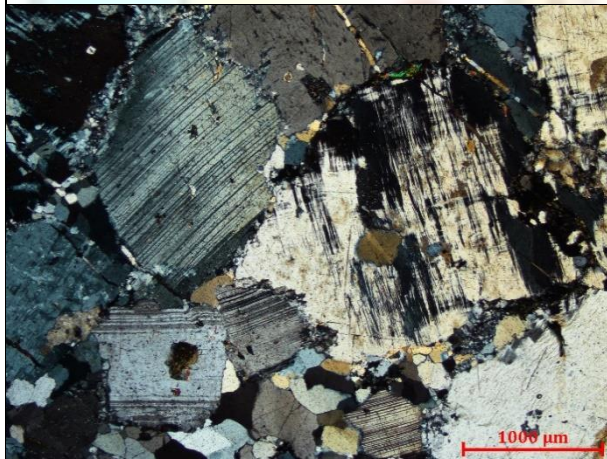


Fig. 60.3 Recrystallized aggregate of plagioclase and microcline; quartz grains are much smaller forming granoblastic aggregate.

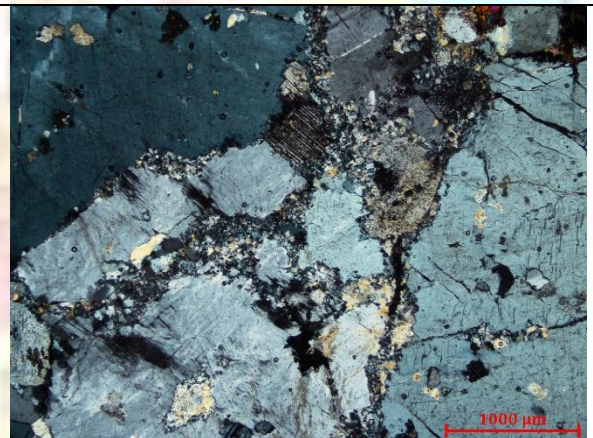


Fig. 60.4 Zones of small quartz grains and albite cutting across large microcline grain.

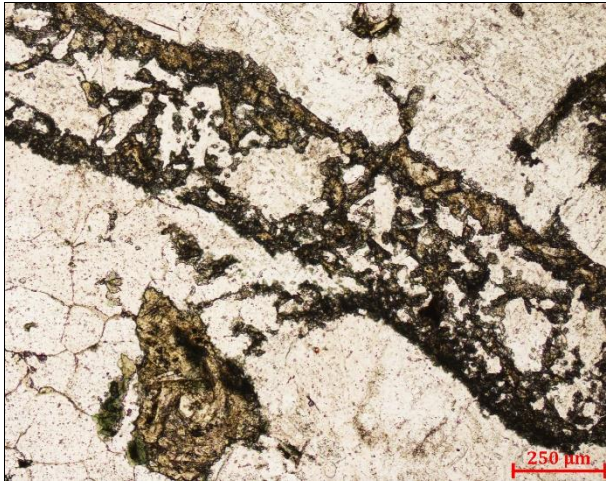


Fig. 60.5 Thin zone of brecciation with epidotization; plagioclase and quartz grains became brecciated; note the high RI epidote in matrix also

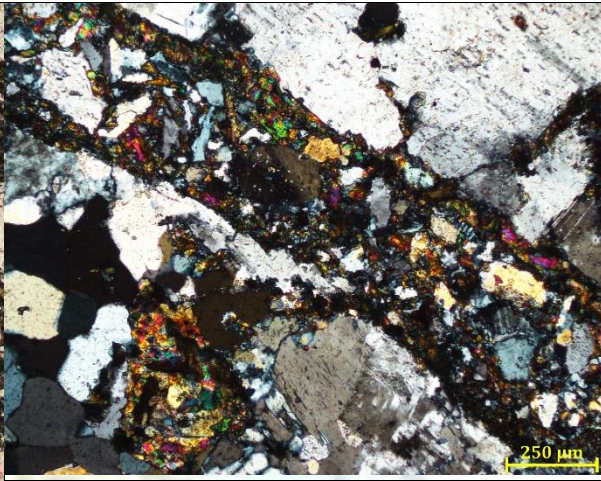


Fig. 60.6 Same as Fig. 60.5; under cross polarized light.

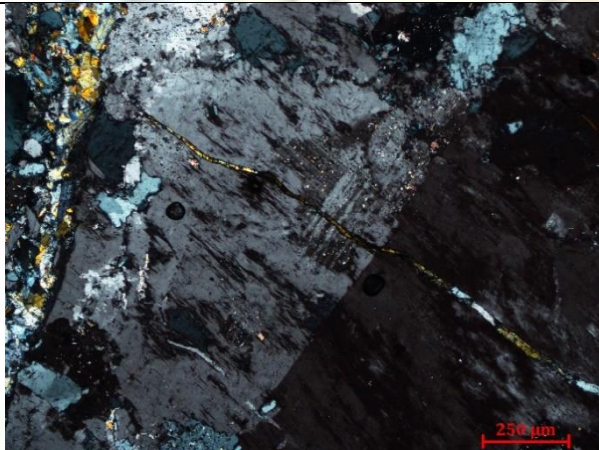


Fig. 60.7 Large microcline grains with simple twinning; thin vein of epidote cutting across the feldspar grain

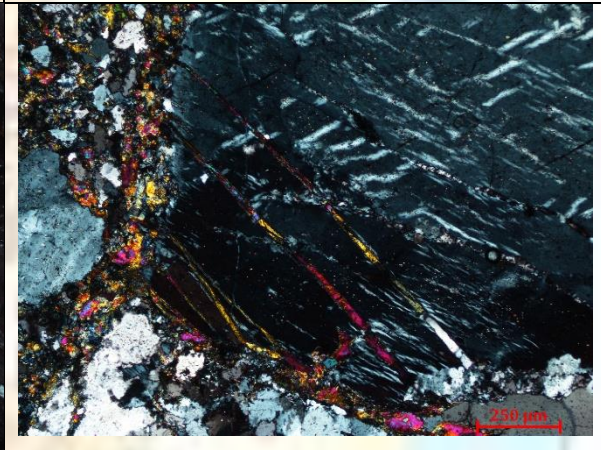


Fig. 60.8 Thick epidote vein with branches of epidote veins cutting across perthitic feldspar

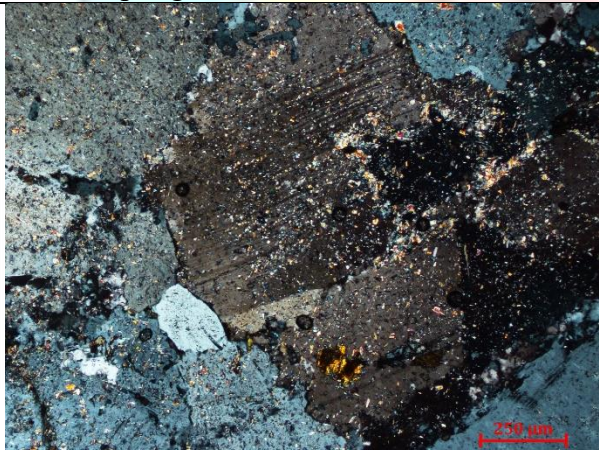


Fig. 60.9 Alteration of plagioclase feldspar; formation of sericite and epidote during alteration

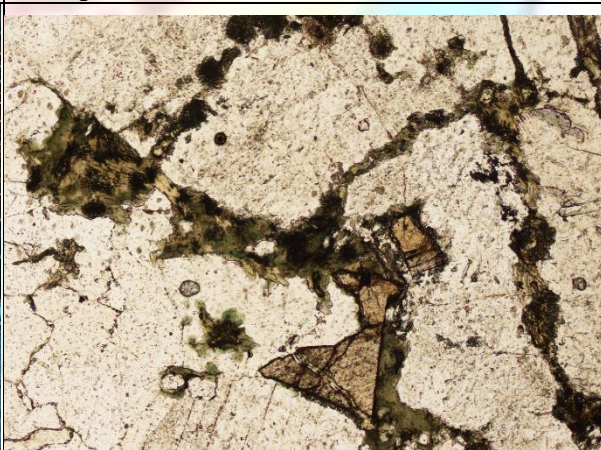
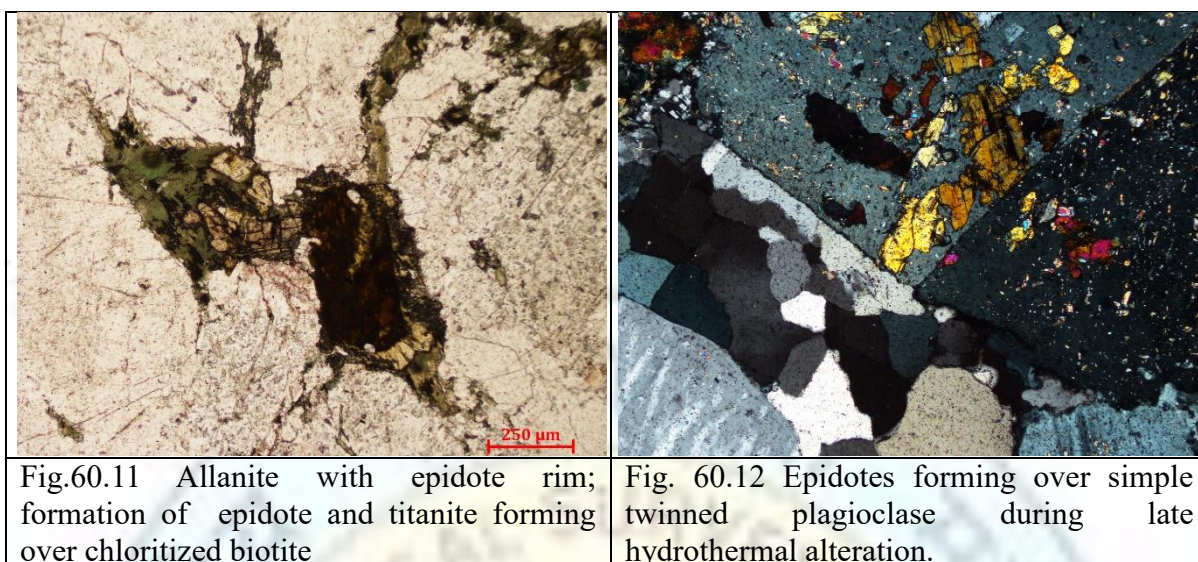


Fig. 60.10 Chloritized biotite, sphene and epidote defining the mafic part



23. TNS_MN_25

Mineral Assemblages: Alkali feldspar + Plagioclase Feldspar + Quartz + Biotite + Zircon

Secondary Minerals: Chlorite + Epidote+ Allanite ; Epidote vein

Texture: It is a coarse grained granitic rock with alkali feldspar viz. microcline and orthoclase as major minerals. Microcline grains are large and are characterized by flame perthite, simple twinning and cross hatched twinning. Orthoclase is mostly altered to sericite indicated by its dusty appearance. Microcline grains have formed later as it has numerous inclusion of quartz and plagioclase. Myrmekitic intergrowth of quartz and albite forming along the grain boundaries of feldspar. Allanite are dark brown in color and are associated with chlorite and epidote.

Biotites are pleochroic in shades of yellow to brown and most of the places are replace by chlorite along cleavages. Biotite and chlorites are mostly occur as interstitial grains. Plagioclase grains are identified by its lamellar winning and tiny epidote grains were formed over it. A late thin epidote vein cut across the rock.

This granitic rock had suffered deformation as well as late hydrothermal alteration.

Name of the rock: Granite

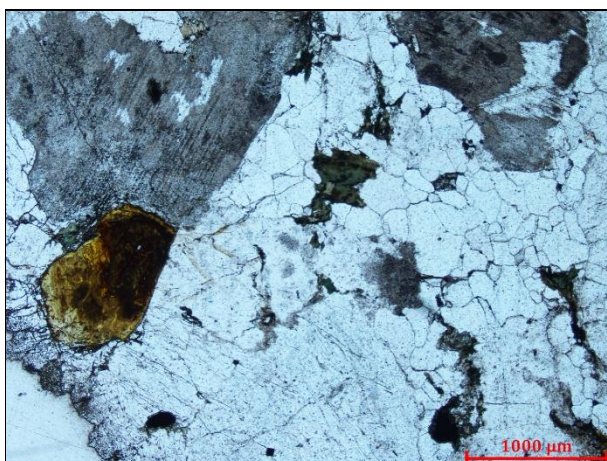


Fig. 25.1 Recrystallized granoblastic aggregate of quartz, feldspar; large grain of allanite in granitic rock

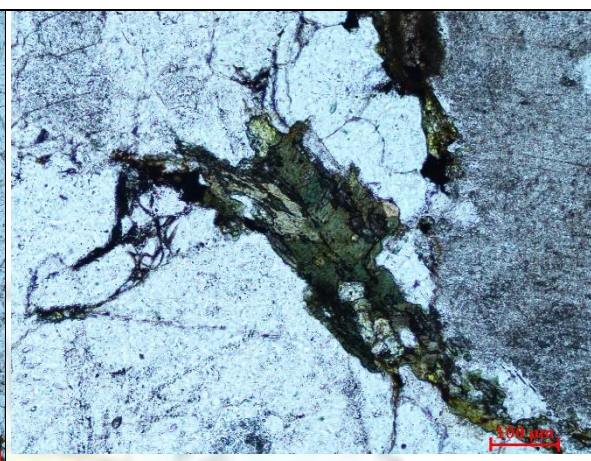


Fig. 25.2 Interstitial chloritized biotite

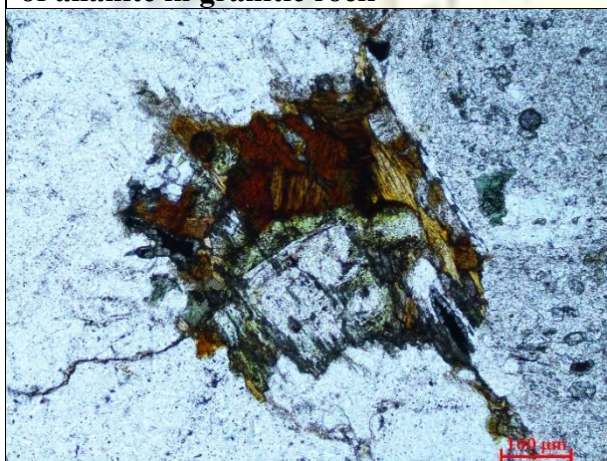


Fig 25.3 Allanite, biotite and epidote in granite; note the altered sericitised feldspar

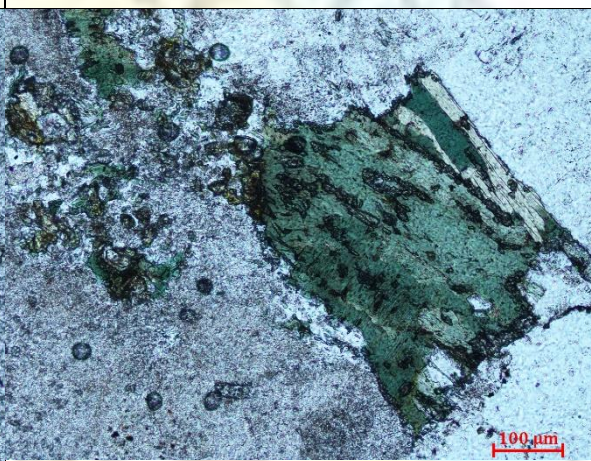


Fig. 25.4 Large Chlorite grain beside altered sericitized feldspar; few epidote and chlorite also form within feldspar during late hydrothermal event

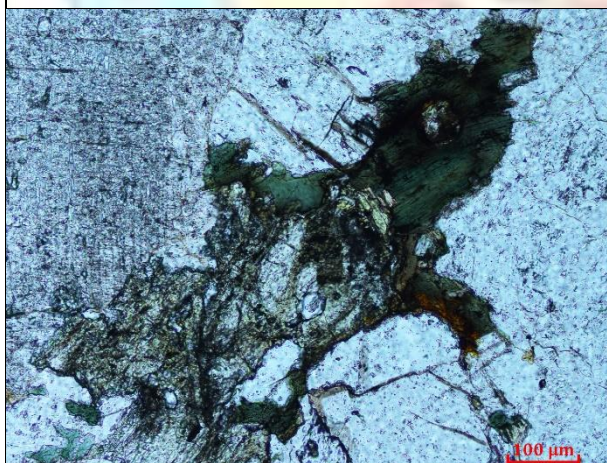
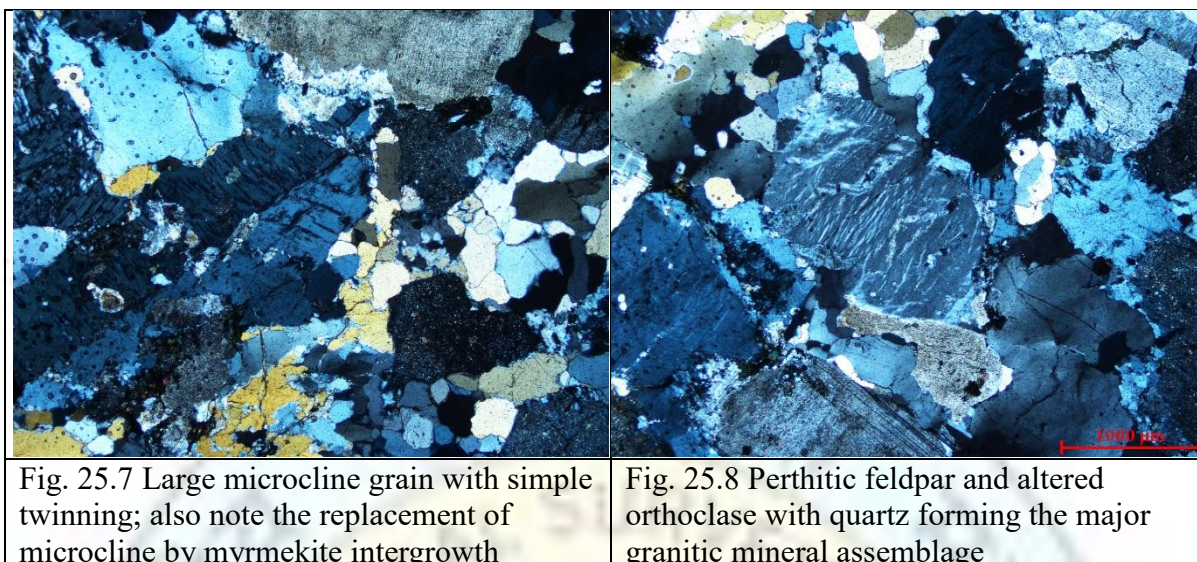


Fig. 25.5 Chloritised biotite and large epidote in altered granite



Fig. 25.6 Thin epidote vein cutting across the sericitized orthoclase



24. TNS_MN_78

Mineral assemblage: Quartz + Orthoclase + Plagioclase + Biotite + Epidote + Magnetite

Texture: It is an equigranular medium grained granitic rocks consisting of quartz, orthoclase and plagioclase. Recrystallized granoblastic aggregate of these minerals is the major texture. Orthoclase have minor alteration giving a dusty appearance whereas plagioclase is relative unaltered. Flame perthite is present in few microcline. Lamellar twinning of plagioclase is the distinguishable feature. Myrmekitic intergrowth along the feldspar boundaries are present. At places coarsening of intergrowth gave rise to tiny grains of quartz and albite. Biotite-epidote occur as interstitial grains. Epidote grains replace plagioclases. Few disseminated magnetites are only opaque present in the rock.

Based on the petrographic observation, it is inferred that this rock is relatively unaltered in comparison to other rock types submitted.

Name of the rock: **Granite.**

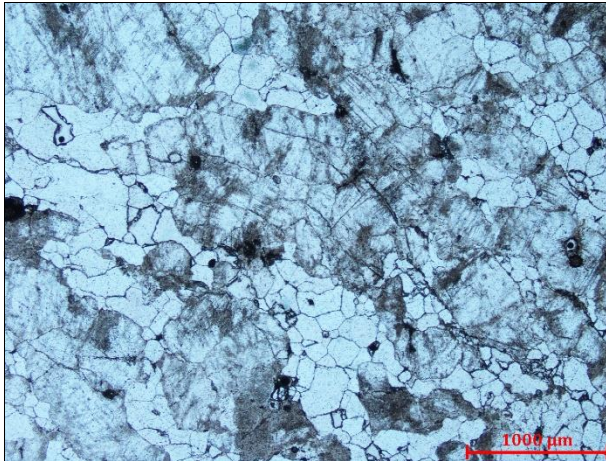


Fig. 78.1 Medium grained and equigranular granitic rock with very less mafic content.

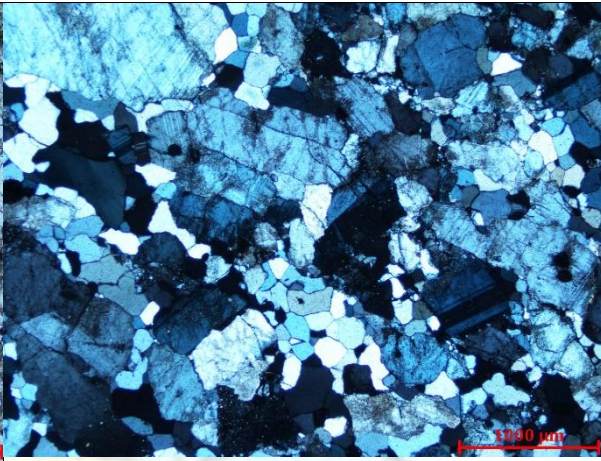


Fig. 78.2 Plagioclase and orthoclase in a recrystallized granoblastic aggregate of quartz; under cross polarized light



Fig. 78.3 Microcline with cross hatched twinning and plagioclase with lamellar twinning surrounded by myrmekites and small quartz grains

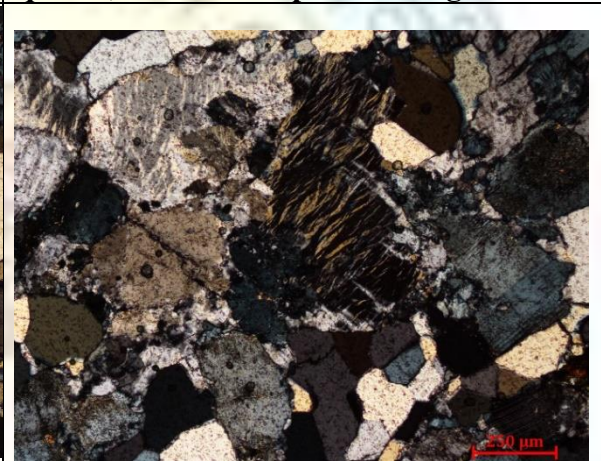


Fig. 78.4 Flame perthite in microcline

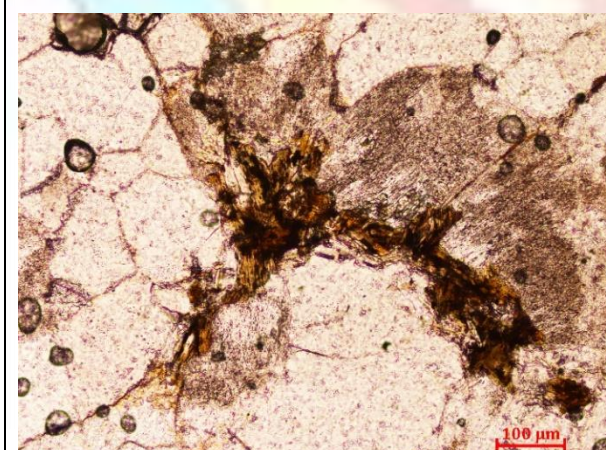


Fig. 78.5 Interstitial phases of biotite and epidote, allanite occurring along the grain boundaries of altered feldspar.



Fig. 78.6 Anhedral magnetite as dissemination in granite

25. TNS_MN_35

Mineral assemblages: Quartz + Alkali Feldspar + Biotite + magnetite

Secondary Minerals: Epidote + Chlorite + Allanite + Titanite

Texture: It is a coarse grained inequigranular rock consisting of quartz-feldspathic matrix with thin mafic streaks consisting of biotite-epidote-magnetite and titanite.

Quartz and plagioclase define the recrystallized granoblastic aggregate.

Microcline grains are large with cross hatched twinning, simple twinning and perthite. Orthoclase grains are devoid of any twinning but are altered. Biotite flakes are pleochroic from yellow to light brown and mostly altered to green chlorite.

Chlorite grains are anhedral patchy in shape with light green colour and along the margin, tiny epidote grains developed indicating formation of epidote after chlorite. Titanite often form clusters. Magnetite is mostly associated with chlorite and titanite.

Epidote and titanite were developed over biotite and chlorite matrix.

Based on the petrographic observation, it is inferred that the rock is granite which is later affected by deformation and secondary alteration during late hydrothermal event.

Name of the rock: **Granite.**

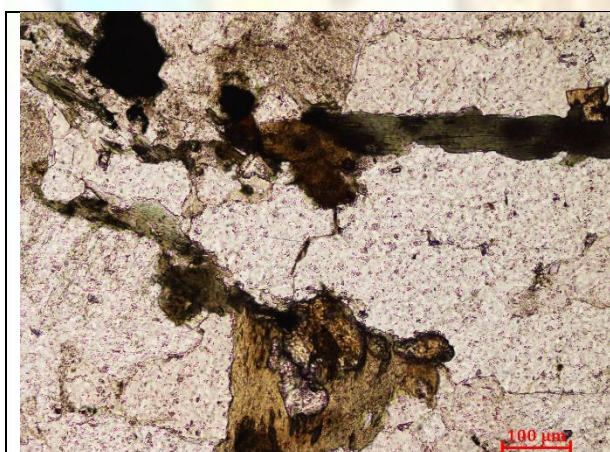


Fig. 35.1 Biotite and chloritised biotite as thin mafic streaks within quartz-orthoclase bearing granitic rock

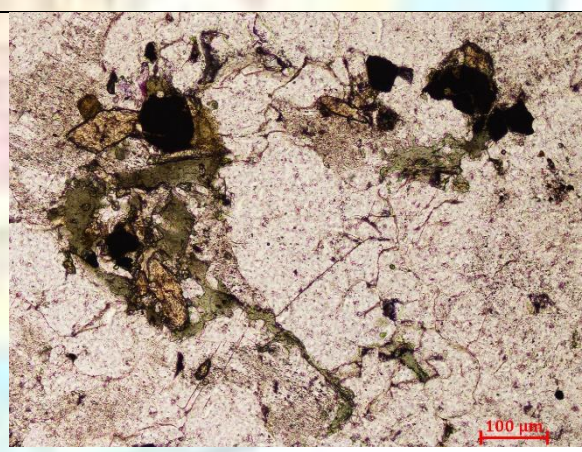


Fig. 35.2 Chloritised biotite with epidote, titanite and opaque form the mafic parts of granitic rock; all these formed during late hydrothermal event

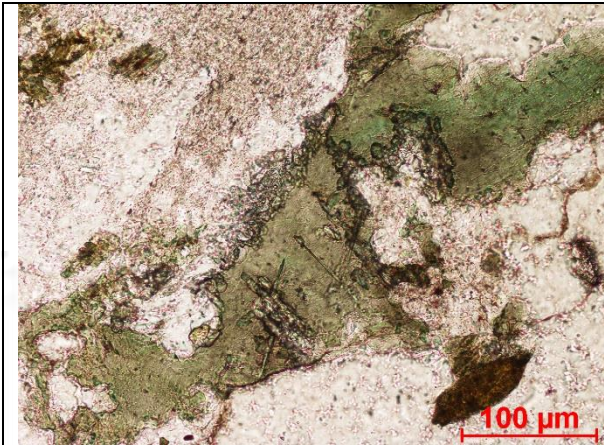


Fig. 35.3 Anhedronal patches of chlorite with thin rim of epidote forming over chlorite

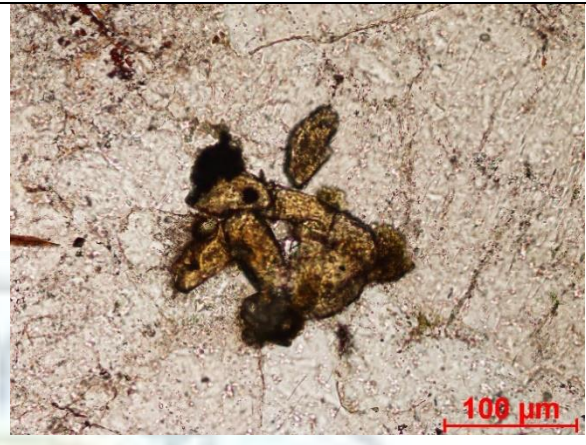


Fig. 35.4 Cluster of titanite and epidote in granite

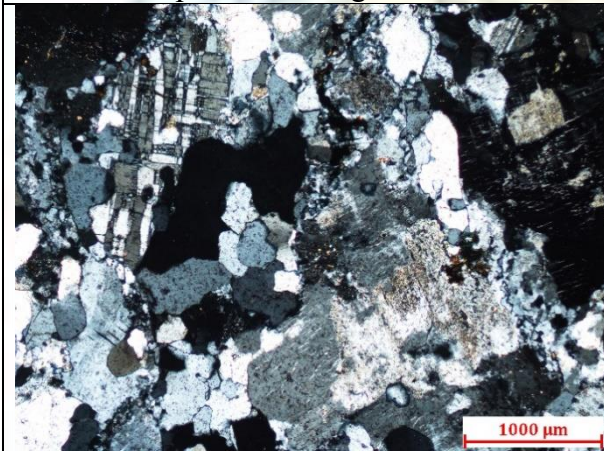


Fig. 35.5 Microcline and altered orthoclase within finer grained quartz orthoclase rich matrix.

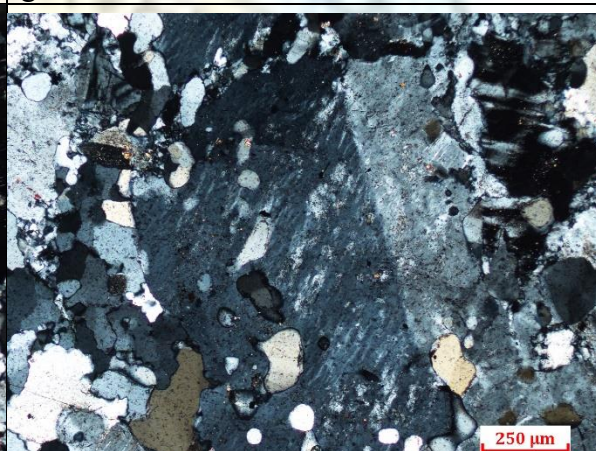


Fig. 35.6 Large perthitic feldspar with simple twin; also contain numerous quartz inclusions indicating its late crystallization.

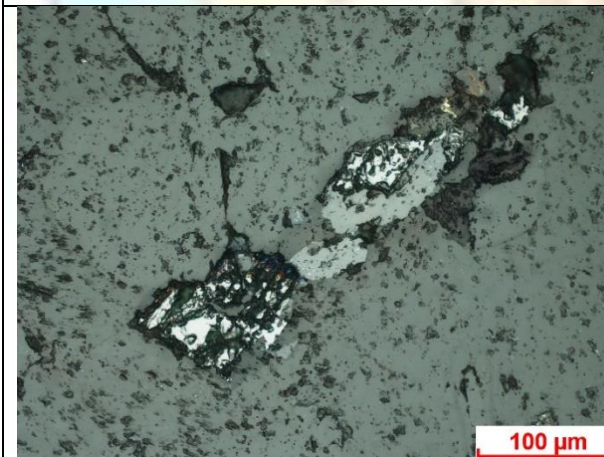


Fig. 35.7 Anhedronal, interstitial magnetite grains; under reflected light

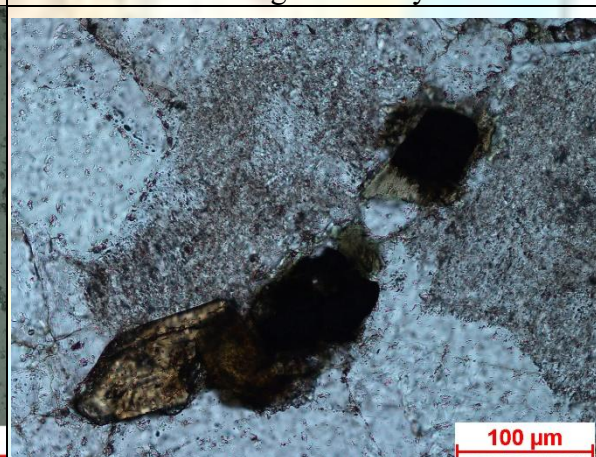


Fig. 35.8 Same as in Fig 35.7; under plane polarized light; sphene, allanite and magnetite association.

26. TNS_MN_57

Mineral assemblage: Quartz + Alkali feldspar + Plagioclase feldspar

Secondary Minerals: Chlorite + Epidote + Sphene + Muscovite

Texture: It is a very coarse grained rock having large microcline grains and other feldspars as major minerals. The large subhedral to anhedral microcline grains engulfed the other mineral phases and inclusions of plagioclase grains are present within it indicating its late low temperature crystallization. Flame perthite and simple twinning along with cross-hatched twinning are characteristics of microcline. Flame perthite formed during late deformation assisted hydrothermal alteration event replacing Orthoclase is completely altered to sericite giving a dusty appearance.

Quartz grains represent strain recovery features such as recrystallization with smooth grain boundaries. Biotite is also altered to chlorite during late hydrothermal alteration. Muscovite is present as secondary minerals. Epidote, sphene and chloritized biotite often form clusters.

Epidotes are colourless to yellowish in colour with high refractive indices whereas sphenes are light brown in colour. Biotites are mostly flaky, interstitial in nature and altered to green chlorite.

Based on the petrographic observation it has been inferred that the granitic rocks has undergone high temperature deformation as well as affected by late hydrothermal alteration.

Name of the rock: **Alkali Feldspar Granite.**

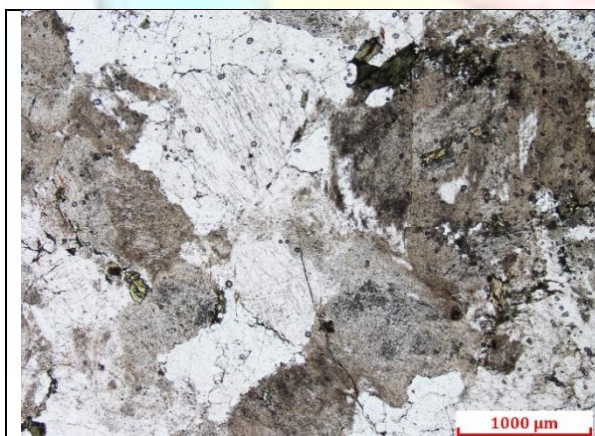


Fig. 57.1 Coarse grained granite consisting of altered orthoclase (brownish colour), plagioclase and quartz



Fig. 57.2 The mafic part of granite consisting of chloritized biotite, biotite, epidote

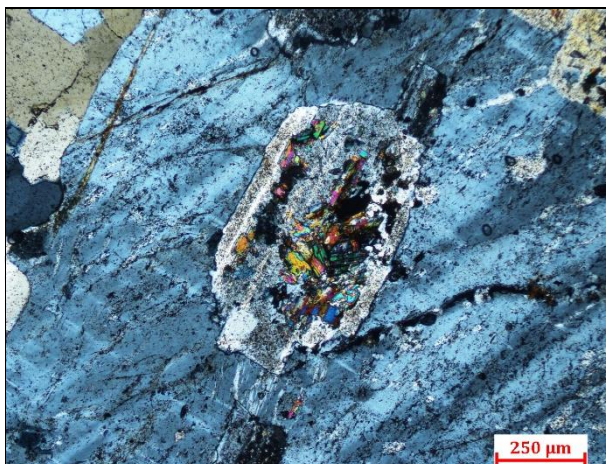


Fig. 57.3 Large alkali feldspar grain with inclusion of plagioclase; note the epidote replacing the plagioclase inclusion



Fig. 57.4 Large microcline with simple and cross-hatched twinning, plagioclase and altered orthoclase assemblage of granite; note the recrystallization of quartz.

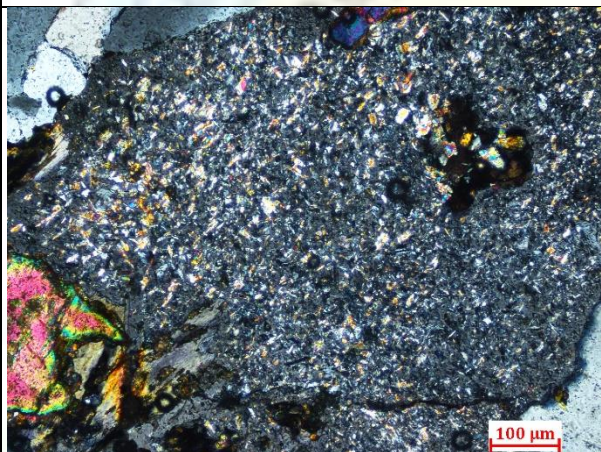


Fig. 57.5 Numerous sericite specks replacing orthoclase during late alteration event

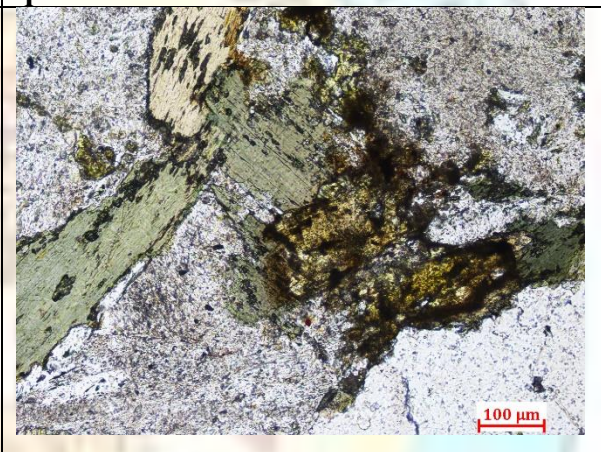


Fig. 57.6 Biotite, chloritized biotite, epidote with altered orthoclase represent secondary alteration



Fig. 57.7 Large euhedral sphene with orthoclase

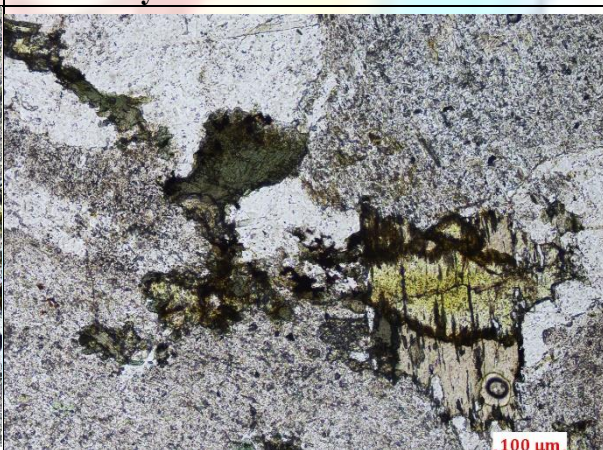


Fig. 57.8 Large Epidote forming over biotite, plagioclase and orthoclase.

Mineral Assemblage: Alkali Feldspar + Plagioclase + Quartz

Secondary Minerals: Sericite + epidote

Texture: It is a very coarse grained rock consisting of large subhedral microcline, orthoclase, plagioclase and relatively smaller quartz grains. Large feldspar grains are characterized by twinning and extensive perthite formation. Large alkali feldspar grains have inclusions of altered plagioclase feldspars. This feature represents the late low-temperature crystallization of microcline. Extensive flame perthite representing replacement of K by late Na rich fluid during hydrothermal alteration.

Quartz grains represent recrystallized granoblastic aggregate with straight grain boundaries indicating strain recovery features. Undulose extinction and deformation bands are present in the relatively large quartz grains indication deformation features. Very fine grained quartz rich part probably represent coarsening of myrmekite intergrowth of quartz and albite. This feature also indicates replacement of alkali feldspar by myrmekitic growth, flame perthite formation during Na- metasomatism at high temperature. This albite veins cut across the large alkali feldspar also formed during metasomatism.

Tiny epidote grains formed over plagioclase. Sericite replaced orthoclase indicating late alteration.

The granitic rock has suffered deformation and hydrothermal alteration. Intrusion of thin albitic and quartz veins cutting across feldspar grains mark late hydrothermal activities.

Name of the rock: Alkali feldspar granite.

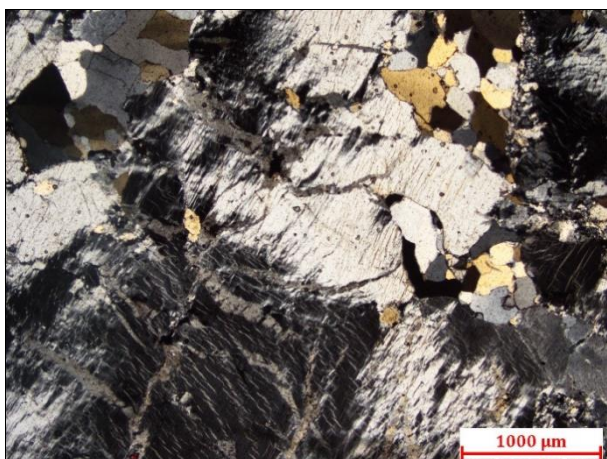


Fig. 16.1 Inequigranular granite with large alkali feldspar and smaller recrystallized quartz grains.

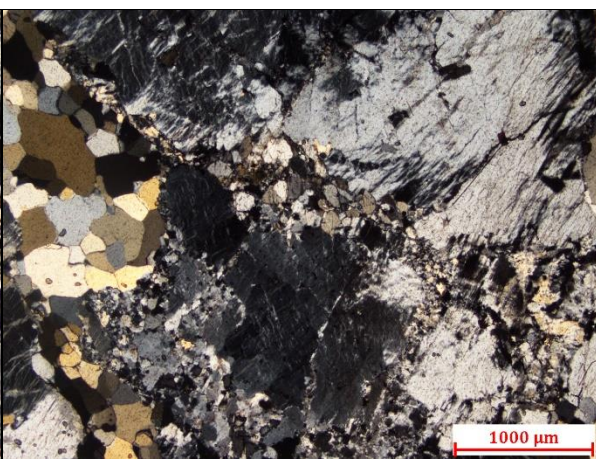


Fig. 16.2 Recrystallized granoblastic aggregate of quartz with smooth grain boundaries; Large alkali feldspar grains are also deformed and replaced by very fine grained myrmekites (quartz-albite intergrowth).

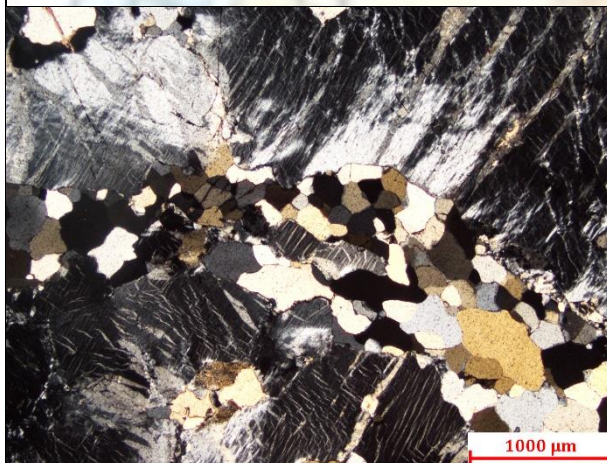


Fig. 16.3 Large alkali feldspar grain with inclusions of altered orthoclase and show replacement feature such as flame perthite.



Fig. 16.4 Large alkali feldspar with inclusions of plagioclase indicating its late crystallization.

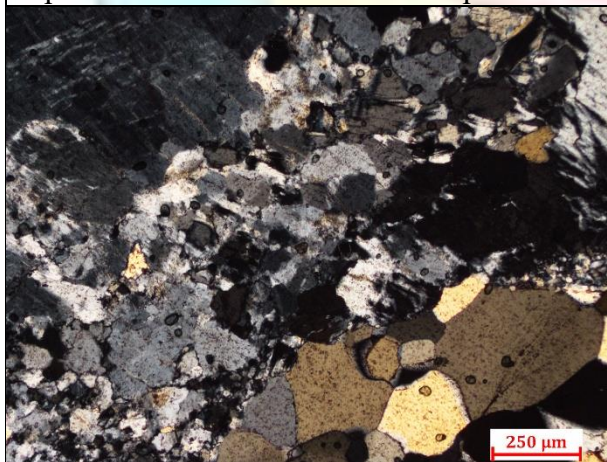


Fig. 16.5 Coarsening of myrmekite intergrowth from tiny quartz-albite along feldspar boundary indicating prevailing of high temperature

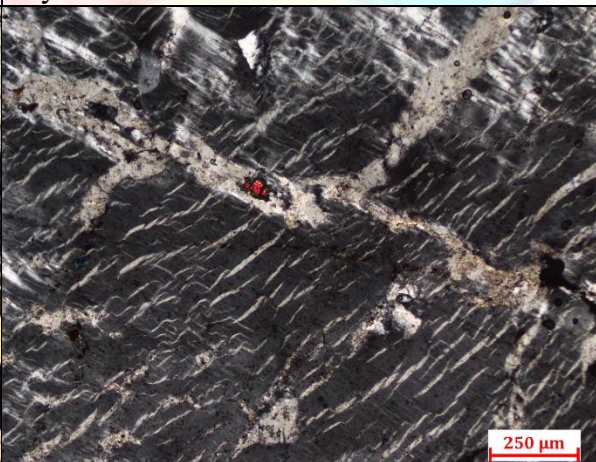
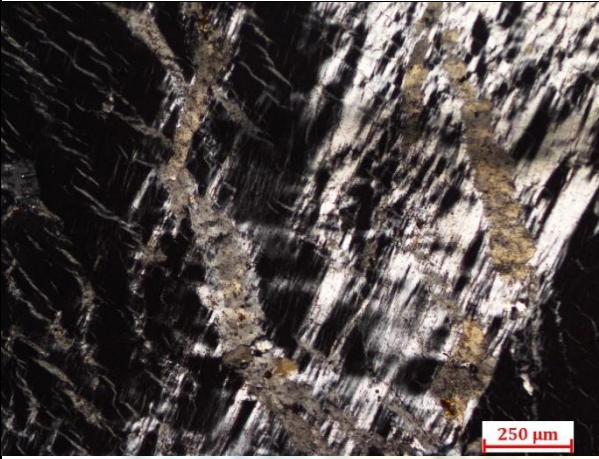
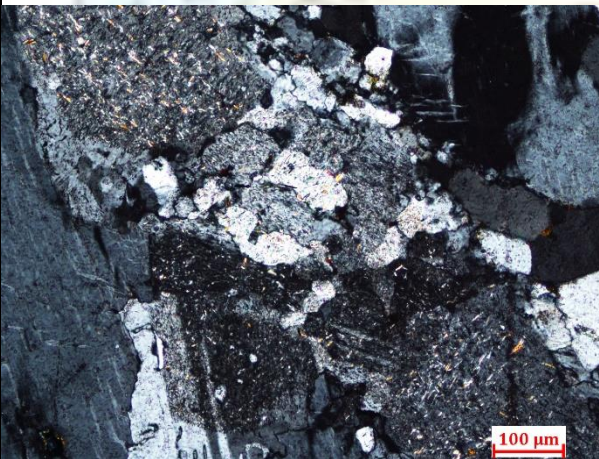
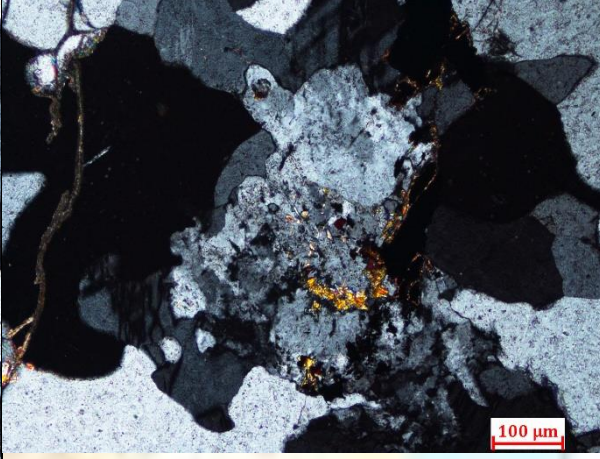


Fig. 16.6 Replacement of alkali feldspar by Na feldspar as flame perthite; intrusion of albitic veins due to late Na-metasomatism

	and formation of tiny epidote within that vein.
	
Fig. 16.7 Replacement features such as flame perthite and albite veins in alkali feldspar	Fig. 16.8 Sericitization of orthoclase and flame perthite in microcline
	
Fig. 16.9 Tiny sericite specks replacing orthoclase i.e. sericitization during late hydrothermal event	Fig. 16.10 Tiny epidotes replacing plagioclase

28. TNS_MN_17

Mineral assemblage: Alkali feldspar + Plagioclase + Quartz + Biotite + Allanite + Magnetite

Secondary minerals: Chlorite + Sericite + Epidote

Texture: The rock is characterized by granoblastic aggregate of quartz, alkali feldspar, plagioclase with thin mafic sinuous streaks defining foliation. Quartz grains are relatively smaller forming recrystallized aggregate along the grain boundaries of feldspar. Plagioclase and orthoclase both are altered with the formation of sericite and epidote. Microcline grains are large with inclusions of other minerals indicating its low-temperature and late

crystallization. Simple twins and cross hatched twins both are present within Microcline. Flame perthite is a very conspicuous features of microclines indicating replacement of K-feldspar by Na feldspar during deformation or/and hydrothermal alteration. Biotites are mostly altered to chlorites. Tiny epidote grains were formed over plagioclase and opaques. REE bearing Allanite grains are associated with the secondary epidote grains. Small magnetite grains are present with epidote chlorite clusters.

Based on the petrographic observation it can be inferred that the granitic rocks is deformed and have suffered late hydrothermal alteration.

Name of the rock: Alkali Feldspar Granite

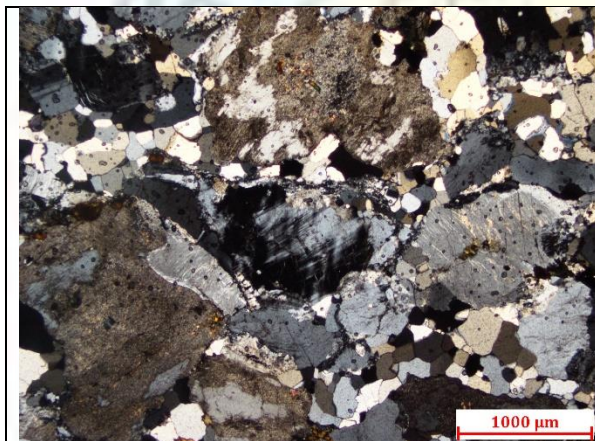


Fig. 17.1 Large orthoclase and microcline and smaller recrystallized quartz grains

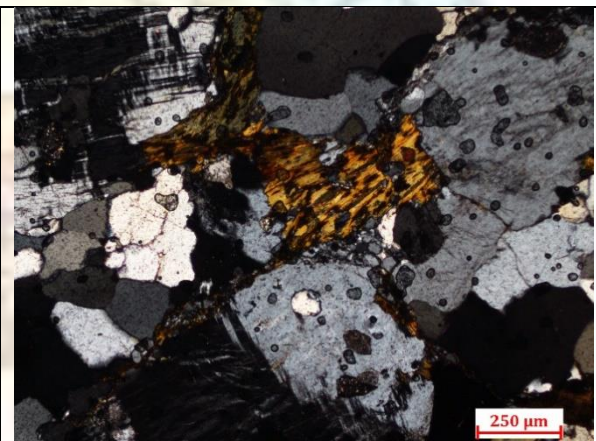


Fig. 17.2 Chloritized biotite occurring interstitial spaces within microcline and orthoclase.

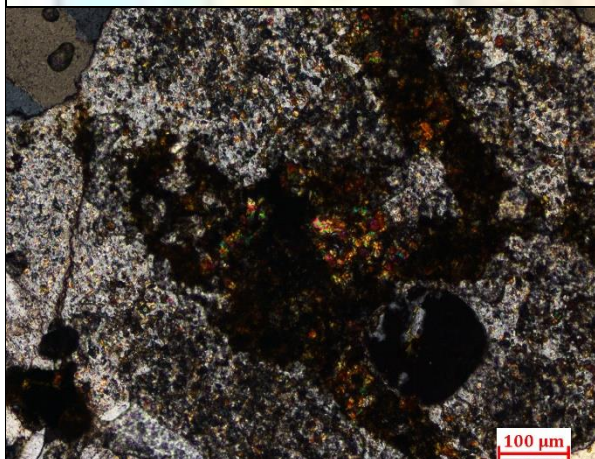


Fig. 17.3 Epidote and sericite flakes replacing feldspar during late alteration event

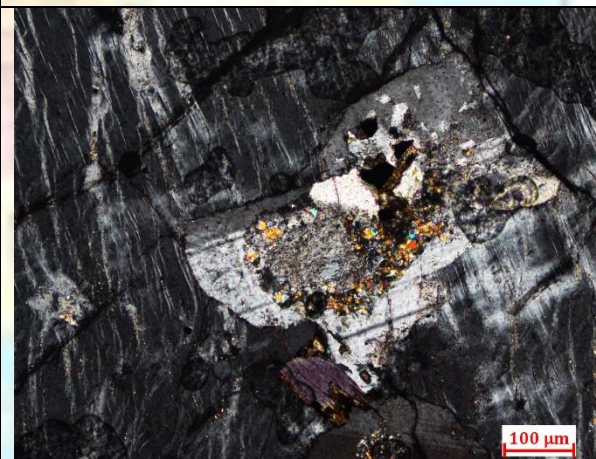


Fig. 17.4 Large alkali feldspar with inclusion of altered plagioclase ; epidotes formed replacing plagioclase; note the flame perthite of the host feldspar

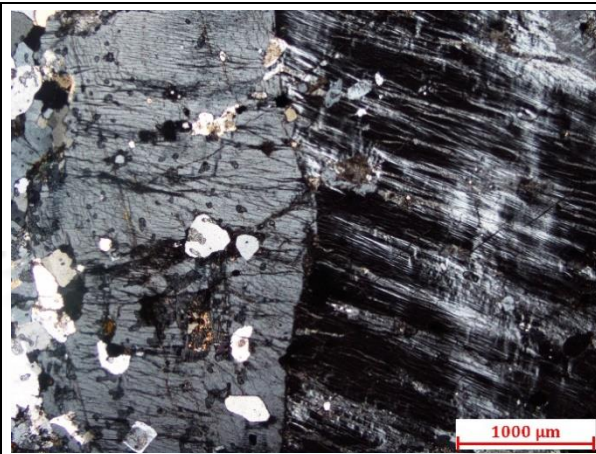


Fig. 17.5 Simple twinning in large and perthitic alkali feldspar; numerous quartz inclusions in feldspar indicate its late crystallization

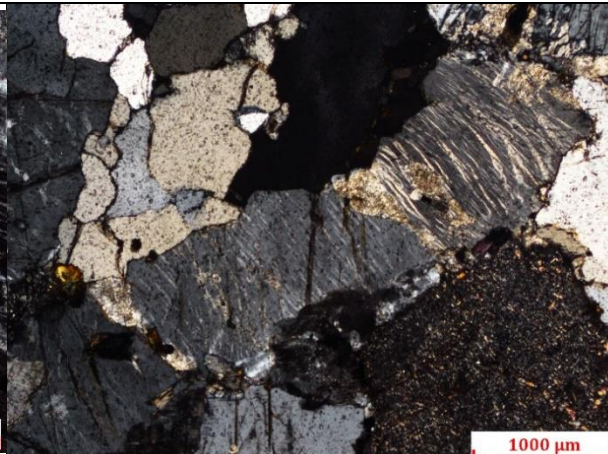


Fig. 17.6 Flame perthite in alkali feldspar representing flame shaped albite lamellae replacing host K-Feldspar indicating hydrothermal-metasomatic replacement in deformed granite.

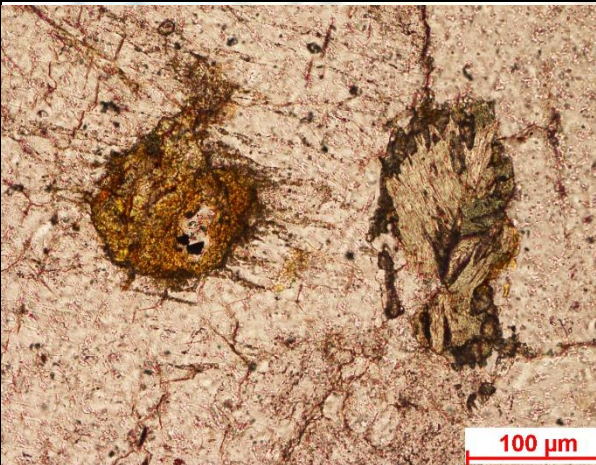


Fig. 17.7 Biotite with chloritization and epidotization at the margin and allanite with epidote represent secondary minerals forming due to late hydrothermal activity

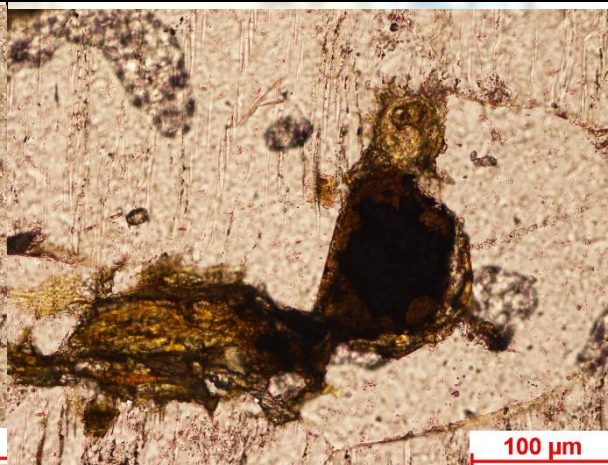


Fig. 17.8 Magnetite with allanite association in granite; under plane polarized light

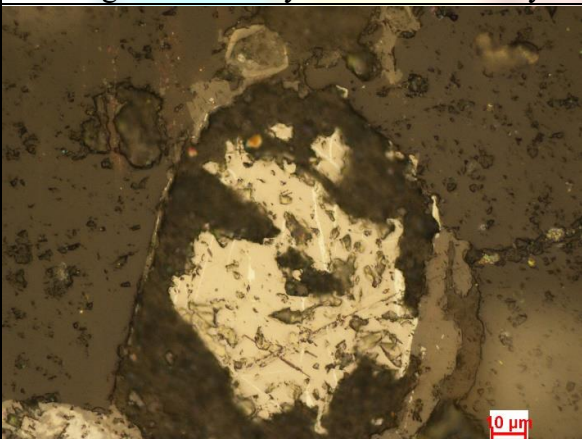


Fig. 17.9 Same as Fig 17.8; under reflected light, magnetite is identified

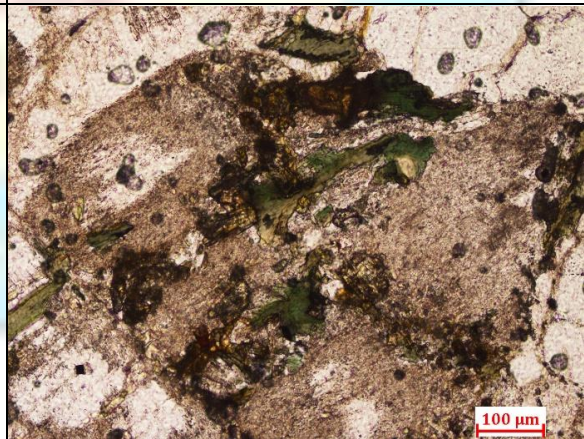


Fig. 17.10 Alkali feldspar being replaced by secondary minerals like sericite, chlorite, epidote and allanite

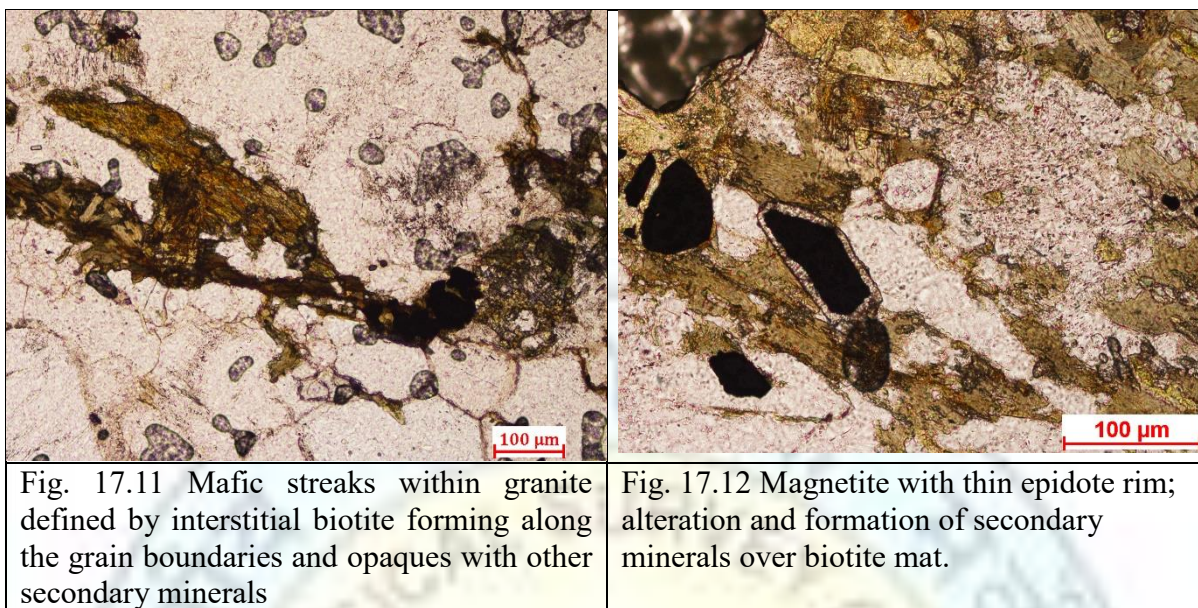


Fig. 17.11 Mafic streaks within granite defined by interstitial biotite forming along the grain boundaries and opaques with other secondary minerals

Fig. 17.12 Magnetite with thin epidote rim; alteration and formation of secondary minerals over biotite mat.

29. TNS_MN_80

Mineral Assemblage: Clinopyroxene + Amphibole + Plagioclase + Titanite + Alkali Feldspar

Secondary Minerals: Sericite + Epidote

Texture: It is a coarse grained mafic rock consisting of clinopyroxene, amphibole, plagioclase and sphene showing a granoblastic aggregate. Amphiboles are green to dark green in pleochroism and associated closely with clinopyroxene. Clinopyroxene mostly occurs as subhedral grains as well as inclusions in amphiboles. Clinopyroxenes are characterized by pale green colour, one set of cleavage, higher order interference colour and inclined extinction. This mafic rock, namely meta gabbro, was intruded by late granitic melt as evidenced from the formation of large alkali feldspar which engulfed clinopyroxene, amphibole and plagioclase.

Secondary minerals such as sericite and epidote were formed by replacing plagioclase. Epidote grains are subhedral and mostly form over plagioclase and often near amphiboles. Titanite, a dark yellowish brown coloured mineral, formed interstitially. Inclusions of other minerals are also present within this late brown coloured minerals.

Name of the rock: Meta gabbro.



Fig. 80.1 Coarse grained Clinopyroxene, amphibole, plagioclase and orthoclase mineral assemblage of the rock

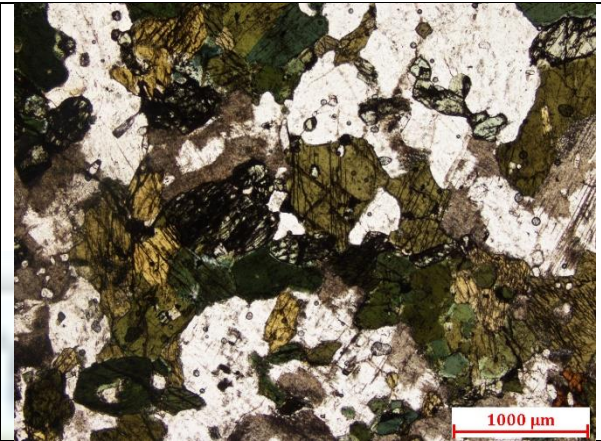


Fig 80.2 Altered orthoclase have dusty appearance

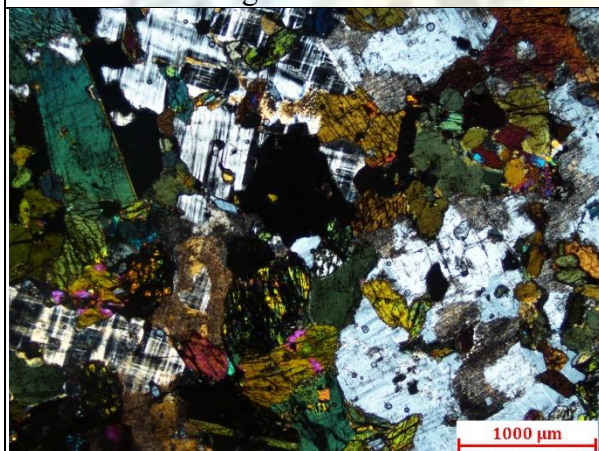


Fig. 80.3 Recrystallized aggregate of amphibole, plagioclase, clinopyroxene and altered orthoclase.

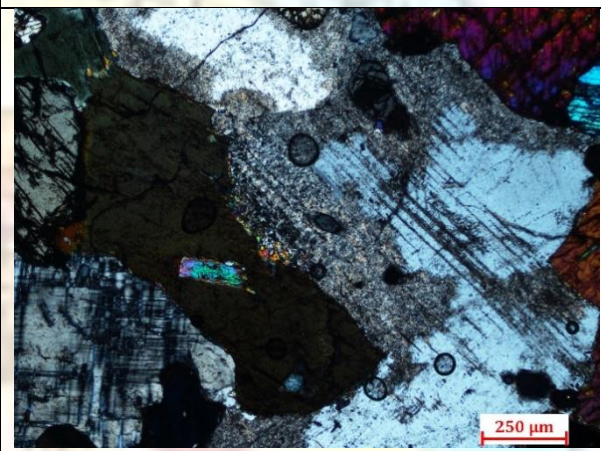


Fig. 80.4 Microcline and plagioclase both present in the gabbroic rock; microcline have formed during later event



Fig. 80.5 Amphibole, clinopyroxene, titanite on altered feldspar grains.

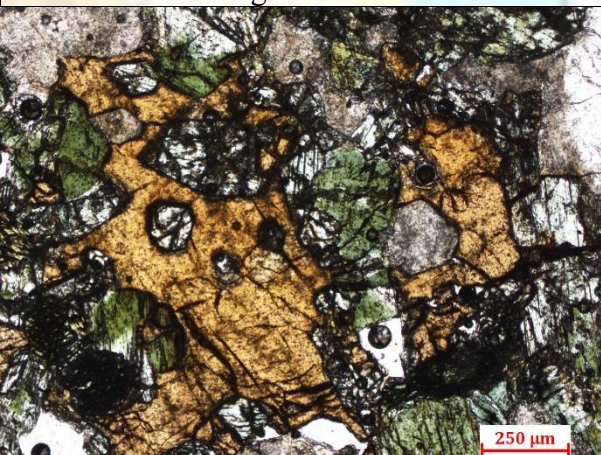


Fig. 80.6 Interstitial titanite with inclusions of clinopyroxene

30. TNS_MN_85

Mineral Assemblage: Amphibole + Plagioclase + Quartz + Alkali Feldspar + Titanite

Secondary minerals: Epidote + Sericite

Texture: The rock represents a sheared amphibolite with features of mylonitisation and ductile deformation. It is a coarse grained rock cutting across by zones of very fine grained rock representing ductile deformation, grain size reduction and shearing. Augen shaped feldspar and amphiboles occur as clasts within very fine grained mylonitic quartzofeldspathic matrix. Amphiboles are green to dark green in pleochroism and show alteration in patches. This alteration must be associated with mylonitisation. S-C fabric, amphibolite fish within mylonitic zone represent sinistral movement. Mylonitization i.e. grain size reduction is confined along narrow zones in which very fine grained quartz associated with clasts of plagioclase and amphibole fishes. Feldspar often forms rounded to augen shaped clasts with thin pressure shadow tails. At most of the places sericite and epidote replace the feldspar. Epidote also formed along the mylonite zones probably due to fluid movement. Titanite grains are completely skeletal in shape and formed over other grains indicating its late stage development. Alteration of amphibolite-rich and feldspar-quartz rich bands define banding parallel to mylonitic foliation. The foliation outside the mylonitic zone is abut against and dragged along the mylonitic foliation. Often zone of epidotization cut across the amphibolites and are parallel to the mylonitization.

Based on the petrographic study, it is inferred that the original amphibolite rocks was affected by high temperature ductile deformation and shearing resulted into thin mylonite zone where grain size drastically reduced and S-C fabric was formed. The shearing was accompanied by intrusion of epidote veins. This rock represent a zone of high shear strain.

Name of the rock: **Sheared amphibolite.**

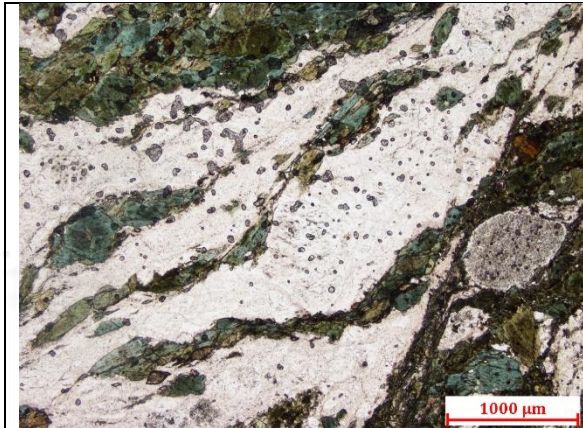


Fig. 85.1 Mylonitic foliation and augen shaped feldspar in sheared amphibolite; note the pressure shadow tail against the rounded feldspar clasts. under plane polarized light and 2X magnification.

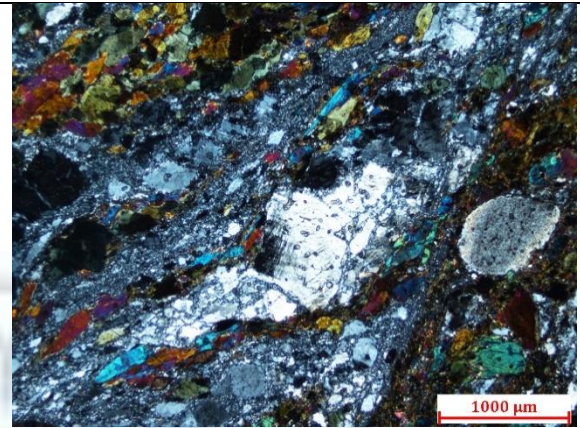


Fig. 85.2 Same as fig 85.1; under cross polarized light

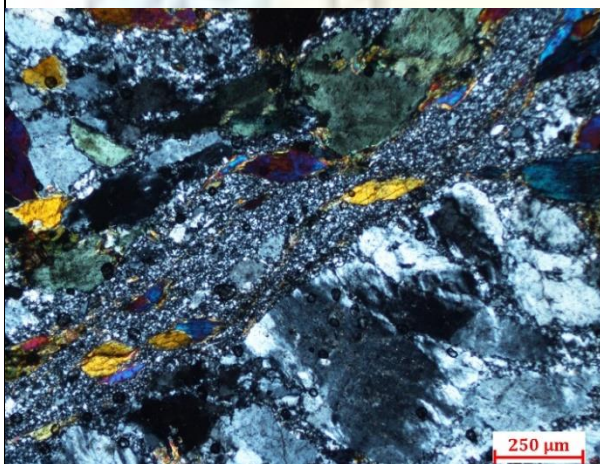


Fig. 85.3 Zone of mylonitisation cutting across the coarse grained rock; note amphibolite fishes showing sinistral sense of movement within very fine grained mylonitic zone;

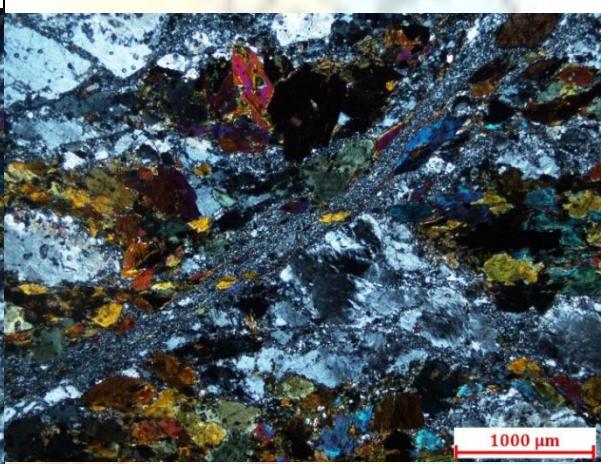


Fig. 85.4 Zone of mylonitisation cutting across the coarse grained rock; the foliation outside the mylonitic zone is abut against and dragged along the mylonitic foliation.



Fig. 85.5 Large feldspar replaced by sercite and epidotes; feldspar is surrounded by

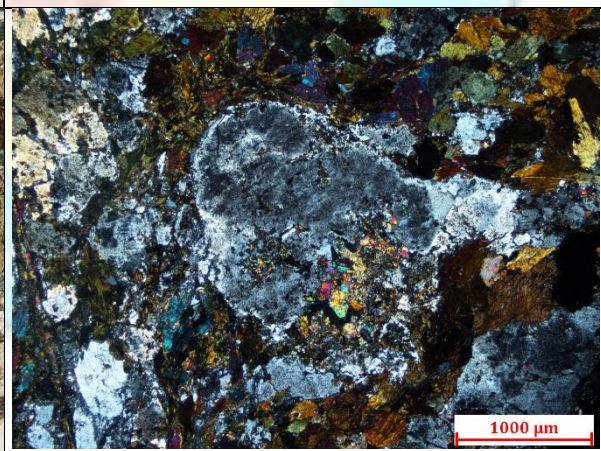


Fig.85.6 Same as Fig 85.5; under cross polarized light

amphibolites; under plane polarized light and 2X magnification.

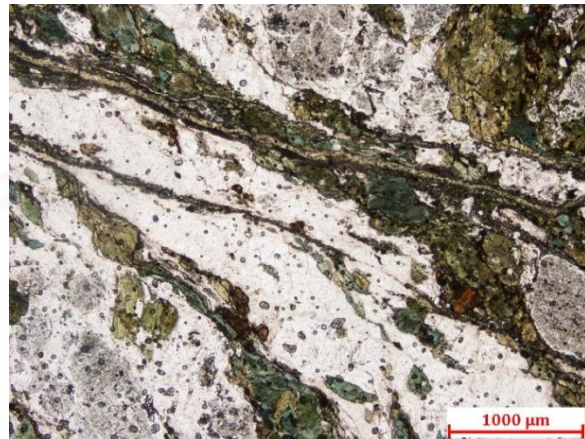


Fig. 85.7 Zone of mylonitisation cutting across the coarse grained rock

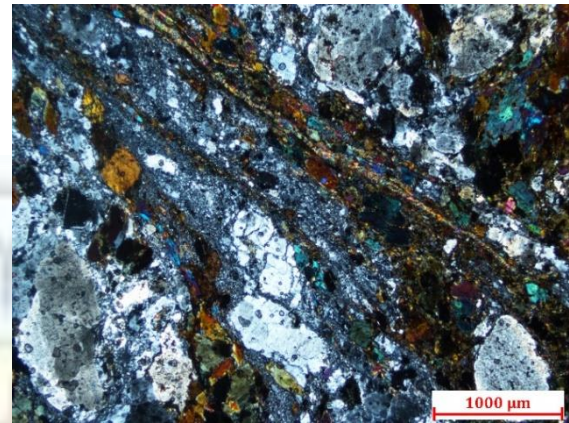


Fig. 85.8 Feldspar occur as clasts within mylonites

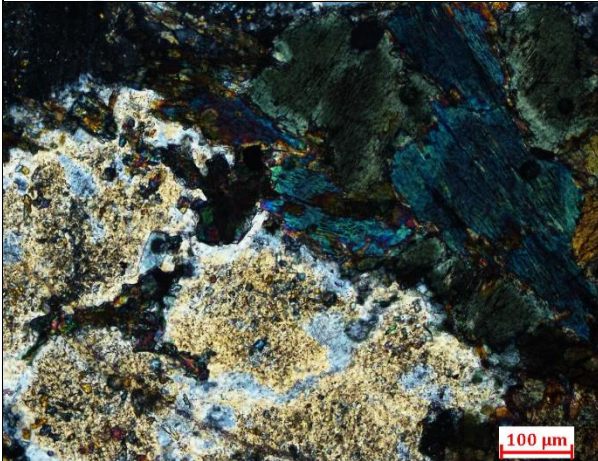


Fig. 85.9 Alteration of feldspar and amphibole; note the concentric bleached patches of amphibole grains; feldspar is also completely altered to sericite clusters.

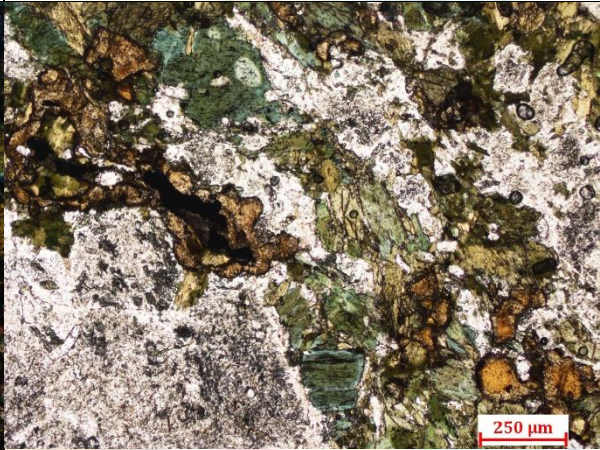


Fig. 85.10 Titanite having anhedral shape forming over opaques and chritised amphibolite matrix.



Fig. 85.11 Anhedral titanite in amphibolite

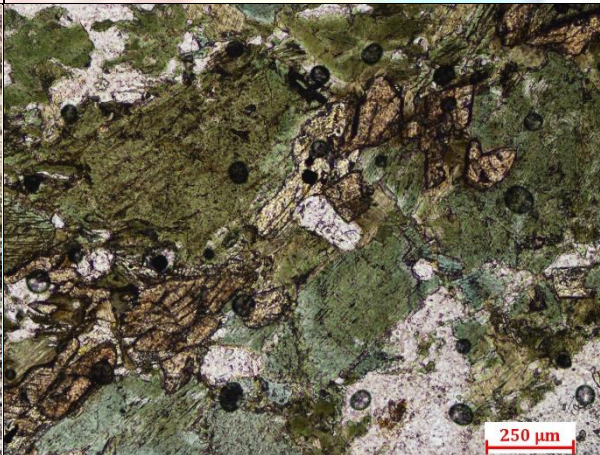


Fig. 85.12 Anhedral titanite in amphibolite

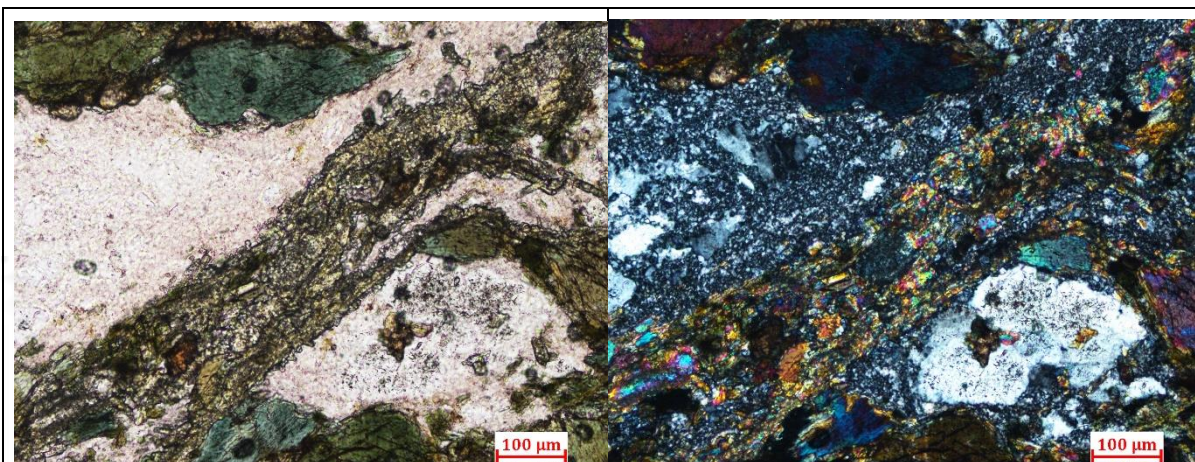


Fig. 85.13 Zone of epidotization cutting across the coarse grained amphibolite; under plane polarized light.

Fig. 85.14 Zone of epidotization cutting across the coarse grained amphibolite; under cross polarized light.

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