APPENDIX A1

PETROGRAPHIC DESCRIPTIONS OF POLISHED SECTIONS AND POLISHED PUCKS FROM THE MARATHON DEPOSIT, NORTHERN ONTARIO

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11AV-M14 Granophyre **Marathon Basal Zone**

Description: coarse granophyre with fine to coarse tabular plagioclase, abundant quartz in coarse graphic intergrowth with ± perthitic alkali-feldspar, anhedral magnesio-hornblende, Ti-biotite, Ti-magnetite, fairly coarse apatite, and interstitial sulphides (chalcopyrite-pyrrhotite-pentlandite). Remnant clinopyroxene is replaced by amphibole, biotite by chlorite, primary hornblende by secondary actinolite-tremolite, which is also found intergrown with sulphides. Magnetite-ilmenite is rimmed by titanite; some grains are completely replaced by chlorite with oriented exsolution lamellae of hematite and/or rutile. Chalcopyrite is remobilized and squeezed in alteration assemblage.

Plagioclase (50%) medium to coarse subhedral tabular grains intergrown with quartz-alkali-feldspar

Quartz (20%) anhedral fine- to medium-grained in graphic intergrowth with alkalifeldspar

Alkalifeldspar (20%) medium-grained, slightly perthitic in graphic intergrowth with quartz

Diopside (tr.) anhedral to mottled remnants with tightly spaced exsolution lamellae replaced by amphibole (hornblende)

Hornblende (2%) coarse, anhedral, pale olive green intergrown with feldspar

Biotite (3%) medium to coarse, subhedral, orange to red-brown, intergrown with hornblende, partially replaced by chlorite + titanite

Actinolite (1%) fine-grained colourless acicular aggregates intergrown with sulphides and replacing primary hornblende and clinopyroxene

Chlorite (1%) fine-grained pale green (jean blue ifc.) micaceous aggregates replacing plagioclase and biotite, possibly also amphibole

Epidote (tr.) fine-grained colourless, medium relief, anhdral inclusions in chlorite-altered feldspar; one grain contains a brownish allanite core

Allanite (tr.) brown, medium relief, subhedral zoned grains grading into colourless epidote

Titanite (tr.) fine-grained pale brown, high-relief grains in chlorite alteration, coarse rims and discrete crystals associated with ilmenite

Apatite (tr.) medium- to coarse-grained euhedral grains intergrown with biotite and granophyre

Magnetite (tr.) medium- to coarse-grained, subhedral, altered grains with coarse ilmenite lamellae

Ilmenite (tr.) medium-grained, anhedral grains intergrained with biotite, titanite

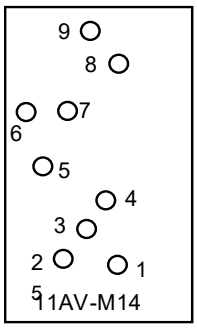
Chalcopyrite (2%) coarse, anhedral, yellow reflective grains enclosing pyrrhotite, fine-grained disseminated bits included in silicates

Pyrrhotite (1%) coarse blocky inclusions in chalcopyrite, with minute pentlandite flames; secondary porous pyrrhotite intergrown with alteration minerals

Pentlandite (tr.) fine-grained flames in pyrrhotite

Sphalerite (tr.) fine-grained dark grey reflective (red-brown translucent) inclusions in chalcopyrite and as minute star-shaped skeletal crystals in chalcopyrite

1) coarse titanite rimming ilmenite in chlorite replacint biotite with minor hornblende (photo 10)
2) two altered magnetite grains with thick ilmenite lamellae in actinolite alteration with myrmekitic magnetite (photo 1)



3) epidote-allanite in chlorite altered feldspar in granophyre (photo 2)
4) lath-like zircon adjacent to titanite rimmed ilmenite in altered biotite (photo 11)
5) two pseudomorphs after magnetite in granophyre w, extensive tremolite alteration patches (photo 8)
6) coarse primary biotite with chlorite layer intergrown with quartz and hornblende and sulphides (pyrrhotite-pentlandite-chalcopyrite), detail of photo 6
7) clinopyroxene remnants replaced by amphibole intergrown with apatite and plagioclase (photo 7)
8) secondary pyrrhotite in biotite- or clinopyroxene-alteration (photo 9)
9) sec. actinolite-tremolite intergrown with chalcopyrite-pyrrhotite-pentlandite and rimming hornblende, biotite (photo 4)

11AV-M15 Inequigranular Gabbro with Pyrrhotite **Marathon Basal Zone**

Description: the mineral assemblage is similar to M14 but the grain size varies strongly from coarse (≤7 mm) in the upper right corner to very fine-grained (≤70 μm) in the lower left. Sulphides (consisting predominantly of pyrrhotite with pentlandite flames, enclosing rounded magnetite grains and only minor chalcopyrite)) emulsion-textured intergrowth with the silicates — mostly plagioclase and clinopyroxene. Clinopyroxene is well preserved and much more abundant than in M14. Bioite is rare but pale green hornblende is intergrown with clinopyroxene in the coarser portion of the rock. The fine-grained portion is granular with plagioclase and clinopyroxene in granoblastic polygonal texture. The texture in the coarser grained areas is sub-ophitic with elongate euhedral plagioclase laths and interstitial anhedral clinopyroxene, hornblende and opaques. There is also more chalcopyrite in the coarse-grained upper portion of the section. Colourless to blue-green actinolite is replacing primary pale green amphibole, which in turn is replacing primary clinopyroxene.

Plagioclase (33%) fine to coarse, subhedral, stubby to elongate laths intergrown with clinopyroxene

Diopside (35%) very fine- to coarse-grained anhedral with prominent exsolution lamellae

Hornblende (5%) coarse, anhedral, pale olive green intergrown with feldspar

Biotite (tr.) rare, medium-grained subhedral orange, intergrown with hornblende

Actinolite (2%) fine-grained, colourless, acicular aggregates intergrown with sulphides; blue-green replacing primary hornblende

Clinozoisite (tr.) fine-grained colourless, medium-relief, anhedral inclusions in plagioclase

Apatite (tr.) medium-grained subhedral, rounded grains intergrown with clinopyroxene and plagioclase

Magnetite (tr.) medium-grained anhedral inclusion in pyrrhotite

Brookite ? (tr.) very fine grey reflecting grained euhedral aggregates altering magnetite

Pyrrhotite (23%) coarse anhedral with minute pentlandite flames enclosing rounded magnetite and chalcopyrite inclusions; emulsion- or net-textured to disseminated

Pentlandite (tr.) fine-grained flames in pyrrhotite

Chalcopyrite (2%) fine-grained inclusions in pyrrhotite increasing in size and abundance towards the top of the section.

10AV-35A Two Duck Lake pegmatitic gabbro (granophyric) Marathon Main zone

Description: coarse granophyre with coarse tabular plagioclase, anhedral clinopyroxene, coarse pyrrhotite-chalcopyrite and interstitial quartz - K-feldspar ± magnetite in graphic intergrowth. Magnetite is rimmed by red-brown biotite or titanite, clinopyroxene by actinolite-hornblende rims on clinopyroxene and chlorite-altered-brown biotite; also chlorite and apatite in graphic intergrowths; titanite rimming magnetite. Ore: coarse pyrrhotite, chalcopyrite, with skeletal sphalerite stars, lobed magnetite intergrown with ilmenite.

Plagioclase (35%) coarse subhedral tabular grains very clear albite lamellae, almost unaltered

Quartz+alkali feldspar (50%) in medium-grained graphic intergrowth, feldspar fairly altered

Diopside (2%) coarse anhedral pale brown with tightly spaced exsolution lamellae

Hornblende (tr.) olive green overgrowth on clinopyroxene

Biotite (tr.) orange-red-brown rims around magnetite in granophyre

Actinolite (tr.) fine-grained acicular aggregates intergrown with biotite and magnetite

Chlorite (tr.) fine-grained pale green micaceous aggregates, part of granophyre

Titanite (tr.) fine-grained pale brown, high-relief rims around magnetite in granophyre

Apatite (tr.) fine- to medium-grained euhedral grains intergrown with granophyre

Magnetite (1%) dark grey reflecting grains in graphic intergrowth with quartz and K-feldspar

Pyrrhotite (2%) coarse blocky grain rimmed by chalcopyrite

Chalcopyrite (tr.) anhedral yellow reflecting rimming pyrrhotite and as trace in granophyre

Pentlandite (tr.) rare cream-coloured inclusions in chalcopyrite

Pyrite (tr.) anhedral cream-coloured grain

Sphalerite (tr.) very fine-grained dark grey reflecting, star-shaped inclusions in chalcopyrite

10AV-35B2 (puck)

Description: mostly coarse plagioclase (~75%) intergrown with ~20% granophyre. Approximately 1-2% medium-grained lobed to graphic magnetite rimmed by micaceous minerals (biotite, actinolite) is part of the granophyre and surrounds anhedral very smooth grain of pyrite (~4 mm long) at edge of puck. Minor pyrrhotite is intergrown with trace fine-grained chalcopyrite and trace secondary magnetite.

10AV-35B Two Duck Lake pegmatitic gabbro (strongly granophyric) Marathon Main zone

Description: similar to A but granophyre portion is much more extensive with little mafic minerals. Secondary rutile forming in coarse ilmenite rimming sulphide patch (pyrrhotite), little chalcopyrite.

Plagioclase (10%) coarse subhedral tabular grains, very clear albite lamellae, almost unaltered

Quartz-K-feldspar-granophyre (82%) medium-grained graphic intergrowth, K-feldspar fairly altered

Diopside (1%) coarse anhedral pale brown with tightly spaced exsolution lamellae, inter- and overgrown by biotite

Cummingtonite (tr.) anhedral broken-out grains adjacent to clinopyroxene, remnants marginally altered

Hornblende (tr.) olive green to tan, intergrown with clinopyroxene

Biotite (tr.) fine- to medium-grained primary orange-red-brown surrounding clinopyroxene

Chlorite (tr.) fine-grained, pale green, micaceous, radiating and vermiform aggregates in granophyre

Chamosite (5%) olive to yellow-green, micaceous alteration of K-feldspar in granophyre

Sericite (tr.) fine-grained colourless micaceous aggregates in altered K-feldspar (high ifc.)

Allanite (tr.) fine-grained, subhedral to anhedral, zoned yellow-brown to orange with medium-high relief

Titanite (tr.) fine-grained, pale brown, high relief rims around magnetite in granophyre

Calcite (tr.) fine-grained anhedral alteration of feldspar

Apatite (tr.) medium-grained euhedral grains in granophyre (some show graphic textures)

Zircon (tr.) fine-grained, euhedral, rectangular, extremely high-relief grains with grey ifc.

Magnetite (tr.) dark grey reflectance, euhedral to lobed grains with or without ilmenite exsolution lamellae; secondary fine-grained magnetite cubes in ilmenite rimming pyrrhotite

Ilmenite (tr.) coarse subhedral grains and fine-grained exsolution lamellae in magnetite

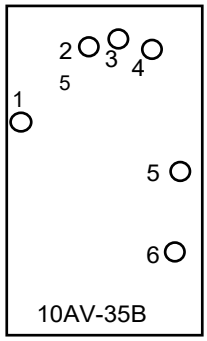
Brookite (?) (tr). fine-grained square euhedral grains ilmenite rim around coarse pyrrhotite (2)

Pyrrhotite (2%) dark cream-coloured (Ni-poor) coarse round grain rimmed by chalcopyrite, ilmenite and secondary magnetite; fine-grained elongate secondary pyrrhotite in altered olivine

Chalcopyrite (tr.) anhedral, rimming pyrrhotite and as trace in granophyre

Sphalerite (tr.) very fine-grained dark grey inclusions in chalcopyrite

Ag-pentlandite (tr.) very fine-grained at edge of chalcopyrite in (3)



1) coarse ilmenite with brookite inclusions rimmed by biotite (altered) and pyrrhotite (?) in granophyre with chlorite-altered K-feldspar

2) ilmenite with euhedral brookite inclusions rimming pyrrhotite (photo 2b), chamosite altered K-feldspar in granophyre (photo 4)

3) sphalerite and Ag-pentlandite (at rim) in chalcopyrite intergrown with coarse pyrrhotite; sericite aggregates in feldspar

4) carbonate, chamosite, and sericite altering K-feldspar

5) amph inclusion in clinopyroxene and biotite at rim (photo 6) with cummingtonite remnants in broken out bits, sec. pyrrhotite in altered ollivine; magnetite with ilm lamellae at rim

6) pyrrhotite rimmed by chlorite in feldspar with titanite/zircon (photo 5)

10AV-36A Two Duck Lake pegmatitic gabbro **Marathon**

Description: coarse, fresh tabular plagioclase with interstitial clinopyroxene, medium-grained euhedral apatite and coarse more or less altered magnetite with abundant exsolution lamellae and thick alteration zones around edges. Interstitial alteration patches (after magnetite and pyrrhotite) are zoned and contain orange phlogopite at rim, yellow brown chlorite, serpentine, tremolite, talc and fine-grained flames of pentlandite, some have solid pyrrhotite as cores. Plagioclase is overprinted by abundant secondary pyrite. Tremolite and ilmenite form intricate symplectitic intergrowths; chalcopyrite may be rimmed by epidote.

Plagioclase (50%) coarse subhedral to euhedral tabular grains, almost unaltered

Diopside (5%) medium to coarse anhedral pale brown with tightly spaced exsolution lamellae

Hornblende (tr.) rare, olive to blue-green, zoned overgrowth on augite in plagioclase

Biotite (tr.) orange-red-brown grains, mostly altered by actinolite; secondary phlogopite in altered rims

Tremolite-Actinolite (tr.) fine-grained acicular colourless to bluish green aggregates intergrown with chalcopyrite and as fine-grained masses in zones of some alteration patches, replacing bioitite

Talc (tr.) fine-grained colourless micaceous aggregates intergrown with serpentine

Serpentine (5%) very fine-grained pale olive green felted masses in alteration

(Oxy-)Chlorite (2%) fibrous yellow-brown zones in alteration

Epidote (tr.) rare fine-grained anhedral aggregates in altered plagioclase and rimming chalcopyrite

Titanite (tr.) very fine-grained brownish translucent medium relief aggregates in alteration patches

Zircon (tr.) fine-grained, pale brown, high-relief grains in plagioclase

Apatite (tr.) fine- to medium-grained euhedral grains intergrown with sulphides

Magnetite (10%) dark grey reflectance, more or less altered coarse anhedral grains with abundant exsolution lamellae

Ilmenite (tr.) thick exsolution lamellae and rims in and around altered magnetite; in symplectite with tremolite

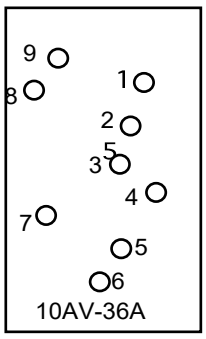
Pyrite (6%) cream-coloured euhedral cubes in aggregates overgrowing plagioclase

Pyrrhotite (1%) medium to coarse anhedral surrounded by extensive alteration, contains pentlandite flames

Chalcopyrite (tr.) anhedral, intergrown with tremolite, biotite and rimmed by epidote

Pentlandite (tr.) fine-grained cream-coloured flames and inclusions in pyrrhotite, rarely in chalcopyrite, flames in silicate alteration of pyrrhotite

Sphalerite (tr.) very fine-grained dark grey reflance, inclusions in chalcopyrite



1) pale brown to blue-green zoned amphibole intergrown with pyrrhotite and chalcopyrite rimmed by epidote in plagioclase *(circle chargig – low totals)*

2) talc and minor orange phlogopite in serpentine alteration with titanite inclusions

3) secondary phlogopite in rim of alteration (serpentine with blades of tremolite and titanite), magnetite myrmekite

4) secondary pyrite replacing euhedral plagioclase in augite

5) chlorite or actinolite aggregates intergrained with chalcopyrite ± pyrrhotite in plagioclase veined by serpentine; epidote coating chalcopyrite

6) remnants of biotite in actinolite with coarse apatite, magnetite and ilmenite lamella

7) zoned alteration patch with pyrrhotite in core and flames of pentlandite, intergrown with **apatite**

8) magnetite-tremolite myrmekite next to altred magnetite

9) pyrite repl plagioclase, chalcopyrite in core of alteration, also enclosing clinopyroxene and altered magnetite, with flames of pentlandite or pyrrhotite (optional)

10AV-36B (puck)

Description: very similar to 10AV-36A: ~50% coarse tabular plagioclase being replaced by secondary pyrite from the edges inwards along cracks. There is no pyrite outside plagioclase. A few medium- to coarse-grained pyrrhotite grains (≤3 mm) with very fine-grained pentlandite flames are surrounded by thick silicate alteration zones that also containing faint pentlandite flames (after pyrrhotite has been consumed by silicates). Minor anhedral chalcopyrite occurs in the outermost zones of the alteration (where there are no pentlandite flames) and in veins. Minor amounts of lobed anhedral magnetite with abundant fine and coarse exsolution lamellae is preferentially altered while ilmenite lamellae remain intact.

~10% pyrite and 2% pyrrhotite, trace pentlandite, chalcopyrite and magnetite.

10AV-37B (puck)

Description: ~40% tabular plagioclase, the remainder is coarse clinopyroxene and silicate alteration. ~1-2% sulphides, mostly chalcopyrite, which occurs as trails of fine-grained anhedral chalcopyrite ± trace pyrrhotite and pentlandite in clinopyroxene. The coarsest chalcopyrite patch (1.5 mm square grain) hosts remnants of pyrrhotite with pentlandite flames and rare pentlandite grains and sphalerite inclusions. The chalcopyrite is intergrown with anhedral remnants of magnetite from which only exsolution lamellae have survived alteration. Better preserved anhedral rounded medium-sized remnants of magnetite with ilmenite lamellae also occur in plagioclase. Chalcopyrite and pyrrhotite occurs as fine-grained ragged bits in silicates alteration. Secondary magnetite occurs intergrown with chalcopyrite and pyrite in amphibole. A small bright white, well polished, subhedral to euhedral grain occurs intergrown with pyrrhotite in silicate alteration patches (see circle).

10AV-38B (puck)

Description: The bulk of the puck (~70%) consists of a dark brown augite crystal (~2 cm across) intergrown with one coarse anhedral magnetite (6 mm), plagioclase and sulphides. The coarse magnetite contains fine ilmenite exsolution lamellae and a thick rim of ilmenite, and is pierced by medium- to coarse-grained euhedral apatite. Sulphides are predominantly chalcopyrite with blocky inclusions of coarse, fractured pentlandite and pyrrhotite (both surrounded by silicate alteration rims). Chalcopyrite also forms abundant smaller inclusions and inclusion trails in clinopyroxene. The grain boundaries between coarser chalcopyrite and clinopyroxene are strangely lobed (as shown in photo 1 of 38A) as if chalcopyrite had eroded clinopyroxene. Fine- to medium-grained inclusions of anhedral altered magnetite occur in clinopyroxene and plagioclase.

10AV-37A Two Duck Lake pegmatitic gabbro **Marathon**

Description: very coarse gabbro with coarse anhedral diopside, coarse apatite and tremolite(?)-altered plagioclase. Augite is clouded by abundant oriented maroon translucent rutile flakes and minor biotite inclusions. Vermiform chlorite intergrown with bladed epidote almost completely replaces primary biotite at the edge of the section. Only trace sulphides (chalcopyrite in augite) and minor altered anhedral magnetite ± ilmenite occur, but a white trapezoidal PGM occurs in epidote. Flakes of secondary pyrrhotite have formed in one altered magnetite grain. Secondary biotite and amphibole are rimming oxides and clinopyroxene against plagioclase.

Plagioclase (Albite) (60)% coarse subhedral tabular grains, altered by fine-grained prehnite and sericite

Diopside (30%) coarse anhedral pale brown with very fine-grained maroon exsolutions in cores

Hornblende (tr.) tan to olive anhedral remnants in plagioclase; and as thin rims on clinopyroxene, oxides

Biotite (tr.) tan anhedral as inclusion in clinopyroxene; red-brown secondary biotite rimming oxides; rusty brown highly altered remnants of primary biotite in chlorite-epidote patches

Epidote (3%) colourless anhedral acicular to bladed aggregates intergrown with chlorite

Chlorite (2%) fine-grained pale green radial and vermiform aggregates forming patches at edge of section (replacing biotite ?)

Prehnite (tr.) colourless (medium-high ifc.), anhedral alteration of plagioclase

Sericite (tr.) colourless (medium-high ifc.), fine-grained alteration of plagioclase

Siderite (tr.) red-brown coloured colloform, lining voids in vicinity of epidote-chlorite patch

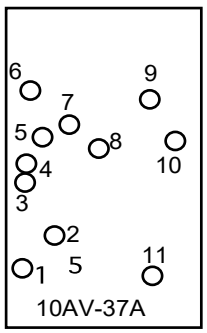
Apatite (2%) coarse-grained euhedral grain intergrown with plagioclase

Magnetite (tr.) anhedral rounded, altered grains with ilmenite exsolution lamellae

Talnakhite (tr.) anhedral yellow reflance, traces in clinopyroxene

Gersdorffite (tr.) fine-grained bright white reflance euhedral trapezoidal grains in epidote adjacent to clinopyroxene

Pyrrhotite (tr.) only as secondary flakes in one altered magnetite (contains Ti !)



1) three white trapezoidal gersdorffite grains in epidote between clinopyroxene and plagioclase, tiny pinprick inclusion in clinopyroxene

2) prehnite alteration in plagioclase

3) vermiform chlorite in secondary plagioclase, possibly some interstitial siderite

4) vermiform chlorite intergrown with bladed epidote aggregates and deep yellow-brown siderite lining void

5) remnants of primary biotite in epidote wtih minor chlorite what is other mineral intergrown with epidote (in center ?) - actinolite

6) epidote and chlorite rep; very altered biotite

7) secondary biotite and amphibole ± chlorite rimming magnetite-ilm and clinopyroxene against altered plagioclase

8) ditto without chlorite

9) tan to green amphibole (hornblende) with magnetite-ilm inclusions in alt. plagioclase

10) biotite in clinopyroxene

11) sec. pyrrhotite forming in altered magnetite rimmed by ? (chl, epidote ?) in alt. plagioclase

10AV-38A Two Duck Lake pegmatitic gabbro *(section too thick)* **Marathon**

Description: very coarse and comparatively fresh gabbro with coarse euhedral to subhedral plagioclase laths and interstitial greenish-brownish augite and one slightly altered olivine (at top of section). Diopside is intergrown with and veined by chalcopyrite. Fine-grained chalcopyrite forms finerprint-like inclusion trails in clinopyroxene. Coarse chalcopyrite contains medium-grained blocky pyrrhotite inclusions and minor pentlandite. The blocky pyrrhotite texturally resembles pyrite cubes and is surrounded by moats of felted actinolite (possibly indicating replacement of former pyrite by pyrrhotite and subsequent volume loss). Coarse magnetite with ilmenite exsolution lamellae is slightly altered. Both magnetite and sulphides are rimmed by deep red mica and green actinolite alteration.

Plagioclase (80%) very coarse (≤ 2 cm) subhedral to euhedral tabular, slightly altered

Diopside (15%) coarse anhedral pale brown to greenish brown, fractured grains with very fine-grained rutile exsolutions in cores, anhedral biotite and fingerprint-like chalcopyrite inclusions (trails)

Olivine (0.5%) one medium-grained rounded colourless fractured grain veined by dark red-brown alteration

Biotite (tr.) red-brown anhedral intergrown with chalcopyrite; fine-grained tan anhedral inclusions in augite

Act. Hornblende (tr.) dark to pale green, fine-grained euhedral in rims of opaques

Actinolite (tr.) extremely fine-grained pale green felted masses with I. order ifc. forming moats around pyrrhotite in chalcopyrite and rimming chalcopyrite (grading into actinolite hornblende)

Chlorite (tr.) fine-grained pale green, rimming opaques

Prehnite (tr.) colourless (medium-high ifc.), anhedral patchy alteration of plagioclase

Epidote (tr.) fine-grained radial aggregates filling pocket in plagioclase; also rimming chalcopyrite in plagioclase

Nb-Titanite (tr.) fine-grained euhedral pale brown high-relief grain intergrown with epidote in plagioclase

Hisingerite ? (tr.) dark red-brown alteration of olivine; low ifc. low reflectance

Apatite (tr.) fine-grained euhedral colourless grains in plagioclase and alteration rims around clinopyroxene/chalcopyrite

Magnetite (1%) coarse subhedral grains with ilm exsolution lamellae, slightly altered

Ilmenite (tr.) as exsolution lamellae in magnetite

Chalcopyrite (3%) very fine to coarse anhedral intergrained with pyrrhotite; remobilized into cracks in clinopyroxene (forming trails)

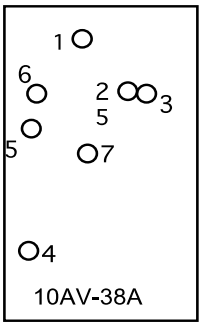
Pyrrhotite (1%) medium-grained blocky grains surrounded by partial serpentine filled moats in chalcopyrite; ex pyrite ?; secondary pyrrhotite forms fine-grained bladed aggregates in olivine alteration

Pentlandite (tr.) rare cream-coloured subhedral inclusions in pyrrhotite

Galena (tr.) very fine-grained light grey reflectance anhedral intergrown with chalcopyrite

Sphalerite (tr.) anhedral grey reflance anhedral inclusions in pyrrhotite in chalcopyrite

Ag-pentlandite (tr.) very fine-grained euhedral inclusions in chalcopyrite



1) red-brown alteration veining olivine and colloform alteration, both contain fine-grained bladed secondary pyrrhotite

2) chalcopyrite with pyrrhotite, pentlandite intergrown with clinopyroxene and rimmed by amphibole

3) fingerprint inclusions of chalcopyrite in clinopyroxene (tarnished at surface)

4) epidote and euhedral Nb-rich titanite in prehnite-altered plagioclase

5) biotite rimming magnetite-ilmenite and chalcopyrite (with pentlandite) all overgrown by green amphibole

6) similar to 5, amphibole and biotite rimming opaques (medium-grained pyrrhotite in coarse chalcopyrite)

7) chalcopyrite and galena in plagioclase

11AV-M09A Two Duck Lake pegmatitic gabbro **Upper Main Marathon**

Description: very coarse gabbro with fresh anhedral diopside and fresh to slightly altered anhedral plagioclase, intergrown with coarse magnetite and rare, almost completely serpentinized olivine. Minor brown and green zoned hornblende and deep red-brown biotite are intergrown with or rimming opaques (magnetite-ilmenite, chalcopyrite-pyrrhotite). Tan biotite also occurs as inclusions/alteration in diopside. Hornblende is overgrown and partially replaced by pale bluish green actinolite-tremolite ± calcite. An extremely fine-grained alteration mineral with high ifc. (talc ?) forms pseudomorphs containing fine-grained flames of pyrrhotite or pentlandite. Patches of pale green chlorite or serpentine (in radial aggregates), and radial spherical aggregates of epidote and prehnite are intergrown with sulphides in plagioclase. Apatite is fairly coarse and anhedral, some grains containing fingerprint textured emulsion-like inclusions of chalcopyrite. Sulphides occur as patches of predominantly chalcopyrite with pyrrhotite (containing flames and grains of pentlandite), trace sphalerite, galena and possibly cobaltite. Chalcopyrite and pyrrhotite are mobilized, chalcopyrite fills cracks in silicates and forms inclusion trails in clinopyroxene and fingerprint like features in apatite and clinopyroxene. Pyrrhotite occurs as flames in fine-grained pseudomorphs and forms euhedral pointy bladed aggregates in serpentine (after olivine). Euhedral pyrite cubes occur in carbonate inclusions in chalcopyrite. Oxides include coarse, rounded slightly altered Ti-magnetite with coarse ilmenite exsolution lamellae and ilmenite rims against sulphides (chalcopyrite-pyrrhotite-pentlandite ± py). The puck (**11AV-M09B**) contains more sulphides but no additional species. **11AV-M09C** contains more amphibole than A: coarse zoned hornblende overgrown by paler actinolitic hornblende. Here the sulphide textures look like they are replacing serpentine/chlorite alteration. **11AV-M09D** is mostly augite with very little sulphides.

Plagioclase (35%) coarse (≤10 mm long) subhedral tabular grains with slight alteration (by calcite, chlorite, serpentine ?)

Diopside (37%) very coarse (>15 mm) anhedral rounded fresh pale brown grains; some with very fine-grained oriented translucent maroon rutile exsolutions in cores and inclusions of biotite (alteration ?) in others; all with inclusion trails

Olivine (tr) rare, ≤3.5 mm anhedral grains mostly replaced by pale to dark olive green serpentine-tremolite mixture

Ti-Biotite (<1 %) deep red-brown subhedral to anhedral rimming and overgrowing opaques; grading into green amphibole or chlorite ± carbonate; also as allotriomorphic inclusions (alteration ?) of clinopyroxene.

Hornblende (tr.) zoned from tan to olive green, as medium to coarse euhedral grains intergrown with sulphides (in C) or as overgrowths on biotite (in A) and clinopyroxene; replaced by colourless to blue-green tremolite-actinolite

Tremolite-Actinolite (tr.) fine-grained acicular to felted masses replacing hornblende, clinopyroxene, extremely fine-grained in silicate pseudomorphs with sulphide flames (?) and rimming opaques

Chlorite 1 (1%) fine-grained green, pleochroic, forming interstitial masses and alteration patches consisting of fine-grained radial or vermiform aggregates; anomalous blue up to 1. order yellow ifc., coarser in contact with opaques

Chlorite 2 (tr.) coarser bluish green alteration of biotite/hornblende , deep violet to purple ifc.

Serpentine (tr.) fine-grained pale olive green, fibrous masses replacing olivine and altering plagioclase along cracks

Talc (1%) extremely fine-grained felted masses with sulphide flames filling pseudomorphs; could also be extremely fine-grained tremolite

Calcite (2%) fine-grained alteration of plagioclase to coarse together with chlorite 1 in interstices; overprinting olivine pseudomorphs ("listwanite") in C.

Epidote + Prehnite (tr.) medium- to coarse-grained medium-relief, colourless radiating aggregates with 2nd order ifc. nucleating around opaques in plagioclase. also as alteration in plagioclase.

Apatite (tr.) medium-grained anhedral to subhedral elongate grains with fingerprint-like inclusions of sulphides

Magnetite (5%) very coarse subhedral slightly altered, rounded grain with coarse ilmenite exsolution lamellae and ilmenite rims against sulphides.

Ilmenite (tr.) coarse exsolution lamellae in magnetite and thick rims around magnetite against sulphides, minor granular grains

Titanite (tr.) very fine-grained angular translucent colourless grains in chlorite 2

Chalcopyrite (1-2%) yellow reflance, anhedral patches (≤6.5 mm) in silicate matrix, intergrown with pyrrhotite, pentlandite; remobilized into cracks in silicates

Pyrrhotite (tr.) anhedral pinkish cream reflectance, patches in chalcopyrite, contains fine cream-coloured pentlandite flames; secondary fine-grained euhedral acicular to bladed aggregate in olivine alteration

Pentlandite (tr.) as fine-grained dark cream-coloured flames in pyrrhotite, and anhdral grains in pyrrhotite or chalcopyrite; as remnant flames in fine-grained fibrous silicate masses

Pyrite (tr) medium-grained creamy white cubes (~0.25 mm) in carbonate in chalcopyrite

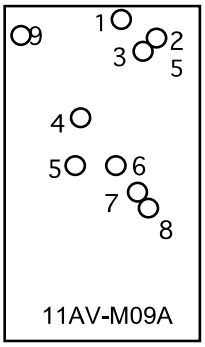
Sphalerite (tr.) as dark orange translucent anhedral or star-shaped skeletal inclusions in chalcopyrite

Marcasite (tr.) as rare white (strongly anisotropic) flames in pyrrhotite

Pyrite (tr.) rare fine-grained euhedral cream-coloured isotropic, zoned grains in pyrrhotite

Cubanite (tr.) fine-grained secondary, in olivine alteration

Galena (tr.) fine-grained anhedral light grey refl. soft inclusion in epidote associated with chalcopyrite, pyrrhotite



1) galena, pyrrhotite, chalcopyrite in epidote with chlorite 1 in epidote altered plagioclase

2) radial prehnite/epidote aggregate, chlorite and ? in altered plagioclase

3) pyrite in pyrrhotite adjacent to pentlandite in chalcopyrite bordering on prehnite

4) talc-pyrrhotite pseudomorph rimmed by chlorite 1 veining plagioclase

5) olivine remnant with alteration (2 phases) and bladed aggregates of secondary pyrrhotite and cubanite

6) chlorite 1, red biotite and minor green amphibole rimming sulphide (pyrrhotite, chalcopyrite) in plagioclase

7) coarse biotite, hornblende (brown and green), actinolite and chlorite 2 intergrown with plagioclase. chalcopyrite, and ilmenite

8) olivine-altered and crenulated magnetite-pyrrhotite-talc intergrowth

9) pyrite cubes in calcite in chalcopyrite with pyrrhotite, sphalerite and pentlandite, chlorite 1 at rim

11AV-M10A Apatite-olivine cumulate **Apatite-magnetite zone (nelsonite) above Main zone Marathon**

Description: the assemblage consists of abundant medium-grained euhedral apatite and coarse anhedral olivine with interstitial hornblende, deep red-brown biotite, sulphides (cubanite, chalcopyrite, pyrrhotite), felted masses of acicular tremolite and talc and abundant fine-grained magnetite ± ilmenite. The magnetite is only partly primary (smooth rounded grains) but mostly secondary showing porous and replacement textures (sheaves, bundles, infill). Secondary magnetite (and ilmenite) also rims sulphides (chalcopyrite, cubanite, pyrrhotite, pentlandite) against apatite and silicates.

Apatite (50%) medium-grained euhedral rounded colourless grains

Olivine (20%) coarse anhedral fractured grains interstitial to apatite with dark olive serpentine in fractures

Biotite (2%) dark red-brown, anh interstitial to apatite intergrained with sulphides; altering to intense dark blue-green biotite/phlogopite

Hornblende (tr.) coarse euhedral zoned tan to red-brown grains with colourless rims

Talc (5%) colourless fine- to medium-grained acicular crystals in talc, rims on hornblende

Tremolite (10%) colourless fine- to medium-grained acicular aggregates forming interstitial masses with very high ifc.

Serpentine (1-2%) dark olive green alteration of olivine

Phlogopite (2%) extreme blue-green alteration of biotite

Magnetite (4%) dark grey reflecting primary rounded grains with ilmenite exsolutions or intergrowth; secondary magnetite is slightly porous and mimics silicate textures; also as rims on sulphides

Ilmenite (tr.) anhedral intergrown with primary magnetite, as exsolution lamellae in primary magnetite

Cubanite (0.5%) anhedral interstitial to apatite, intergrained with chalcopyrite, rimmed by magnetite

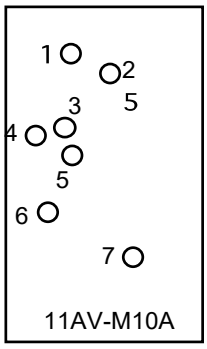
Chalcopyrite (tr.) anhedral intergrained with cubanite rimmed by magnetite

Pyrrhotite (tr.) rare in cubanite or chalcopyrite

Pentlandite-(Co) (tr.) euhedral cream-coloured remnants in cubanite

Mackinawite (tr.) dirty brownish alteration in cubanite

Sphalerite (tr.) dark grey reflectance, anhedral intergrown with cubanite



1) cubanite with remnants of pyrrhotite, inclusion of sphalterite and mackinawite interstitial to apatite with secondary magnetite intergrown with cubanite-chalcopyrite and talc [photo 2]

2) olive green serpentine intergrown with talc and sec. magnetite; coarse biotite at rim

3) talc with primary and secondary magnetite and minor chalcopyrite±cubanite interstitial to apatite

4) biotite-chlorite-talc and cubanite-chalcopyrite interstitial to apatite, largest cubanite contains mackinawite inclusion; secondary magnetite intergrained with sulphides

5) cubanite intergrained with chalcopyrite and biotite rimmed by secondary magnetite against apatite and interstitial biotite; cream-coloured inclusion in cubanite is pentlandite (Co)

6) zoned amphibole and acicular tremolite intergrained with secondary magnetite and to dark biotite, appetite and olivine at rim (see photo 7)

7) euhedral hornblende (twinned), blue-green altered biotite and acicular felted masses of blue-green tremolite with secondary magnetite inclusion (see photo 4).

11AV-M10B (puck) shows primary magnetite in biotite and abundant fine-grained secondary magnetite (some intergrown with sulphides) in alteration patches, sulphides consist of cubanite, chalcopyrite, pyrrhotite, UM1 and sphalerite interstitial to apatite and magnetite in coarse biotite. In rare cases sulphides are rimmed by magnetite against biotite. Rare euhedral pyrite occurs in chalcopyrite. Sphalerite shows filigree textures in chalcopyrite.

11AV-M10C Apatite cumulate

Description: very coarse pinkish brown anhedral augite intergrown with minor olivine, intense deep red biotite, medium-grained rounded euhedral apatite and abundant deep green amphibole (overgrown by paler tremolite) and anhedral magnetite. Alteration minerals are carbonate replacing plagioclase, dark olive to orange serpentine replacing olivine, acicular tremolite overgrowing primary hornblende, and a mixture of intense blue-green chlorite, red biotite and carbonate replacing augite. Anhedral lobed magnetite with ilmenite exsolution lamellae and sulphides occur interstitial to apatite and augite. Sulphides are chalcopyrite with filigree textured sphalerite, minor pyrrhotite, rare pentlandite and trace galena.

Apatite (18%) medium-grained euhedral rounded colourless grains in olivine and plagioclase

Augite (19%) coarse anhedral pale brown fractured grains with biotite and opaque inclusions

Olivine (1%) medium-grained rounded grains surrounded and veined by dark olive serpentine

Plagioclase (tr.) one coarse (12 mm) euhedral tabular grain now mostly replaced by carbonate

Carbonate (25%) anhedral replacing plagioclase, rimmed by amphibole

Biotite (<1%) dark red to orange pleochr., poikilitic intergrown with apatite and sulphides; overgrown by blue-green amphibole

Hornblende (15%) coarse euhedral zoned olive to blue-green pleochroic grains overgrown by paler green actinolite hornblende.

Tremolite (2%) colourless acicular aggregates with high ifc. overgrowing hornblende, intergrown with carbonate, serpentine and secondary magnetite

Serpentine ? (tr.) pale orange to brown fibrous alteration of and rims around olivine

Chlorite (5%) intense blue-green alteration of biotite and amphibole, intergrown with carbonate,

Magnetite (<1%) dark grey reflecting rounded grains with ilm exsolutions or intergrowth (primary); secondary magnetite is more fine-grained, slightly porous and mimics textures of silicate alteration minerals it is intergrown with;

Ilmenite (tr.) as thin exsolution lamellae in magnetite; as medium-grained rounded intergrained with magnetite

Chalcopyrite (tr.) anhedral intergrained with cubanite, predominantly in clinopyroxene and biotite; remobilized into cracks in clinopyroxene and apatite

Cubanite (tr.) fine beige reflecting lamellae in chalcopyrite

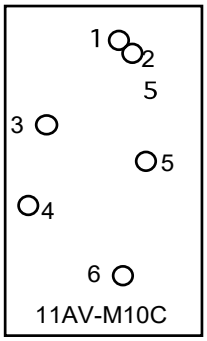
Pyrrhotite (tr.) anhedral pinkish cream inclusions in chalcopyrite

Pentlandite (tr.) rare cream-coloured inclusions in chalcopyrite

Sphalerite (tr.) dark grey reflecting filigree in chalcopyrite and as orange translucent rims on chalcopyrite

Se-Galena (tr.) very fine-grained bright greenish white grains at rim of chalcopyrite

Maucherite (tr.) cream-coloured isotropic anhedral sulphide attached to chalcopyrite-sph



1) filigree sph in chalcopyrite with tiny gn at rim; intergrown with calcite rimmed by chlorite

2) orange translucent sph with tiny gn inclusions rimming chalcopyrite in chlorite-biotite intergrowth

3) pentlandite and oblong maucherite in chalcopyrite in amphibole

4) lobed magnetite/ilmenite with tiny white inclusion in crack in augite

5) chalcopyrite with pentlandite remnant and sphalterite and cream-coloured maucherite at rim

6) rounded lobed ilmenite rimmed by sec magnetite and chalcopyrite in tremolite

11AV-M10D Two Duck Lake gabbro with abundant apatite **Marathon**

Description: coarse anhedral fractured augite and minor olivine intergrown with euh apatite deep red-brown biotite and tan hornblende in oikocrystic plagioclase. Alteration involves very fine-grained fuzzy alteration of plagioclase surrounding apatite and carbonate; dark olive serpentine altering olivine and intense blue-green alteration of biotite and red-brown amphibole. and more hornblende. Alteration (section too thick)

Apatite (15%) medium-grained euhedral rounded colourless grains in olivine and plagioclase

Augite (38%) coarse anhedral pale brown fractured grains with bio and opaque inclusions

Olivine (1-2%) medium-grained rounded grains surrounded and veined by dark olive serpentine

Plagioclase (30)% coarse anhedral oikocrystic hosting apatite and olivine

Biotite (1%) dark red-brown to pale orange pleochroic, anhedral interstitial to apatite intergrained with sulphides; altering to intense dark blue-green chlorite ?

Hornblende (tr.) coarse euhedral zoned tan grains overgrown by dark green to pale green amphibole

Tremolite ? (10%) extremely fine-grained colourless felted masses with I. order ifc. forming thick alteration rims in plagioclase around apatite and carbonate

Talc (tr.) fine-grained micaceous to bladed aggregates intergrown with carbonate, serpentine and secondary magnetite

Serpentine (tr.) dark olive green fibrous alteration of olivine; pale green veinlets in plagioclase

Chlorite ? (1-2%) intense blue-green alteration of biotite and amphibole

Magnetite (1-2%) dark grey reflecting rounded grains with ilmenite exsolutions or intergrowth (primary); secondary magnetite is more fine-grained, slightly porous and mimics textures of silicate alteration minerals it is intergrown with

Ilmenite (tr.) as thin exsolution lamellae in magnetite

Chalcopyrite (tr.) anhedral lemon yellow reflance, intergrained with cubanite, predominantly in clinopyroxene and biotite; remobilized into cracks in clinopyroxene and apatite

Cubanite (tr.) fine to coarse beige reflence, lamellae in chalcopyrite

Pyrrhotite (tr.) anhedral pinkish cream inclusions in chalcopyrite/cubanite

Pentlandite (tr.) rare cream-coloured inclusion in chalcopyrite

Sphalerite (tr.) dark grey reflance, anhedral intergrown with cubanite