3. PETROGRAPHY

3.1. Basal Gabbro Unit

This Unit predominantly comprises phaneritic, equigranular to inequigranular rocks but has an aphanitic chilled margin (PLATE 2) at the base. Plagioclase (50-60 vol%) clinopyroxene (5-15 vol%) and orthopyroxene (10-20 vol%) are the major cumulus phases, with chromite comprising less than 1 vol%. The intercumulus phases make up between 5 and 10% of the rock and consist of quartz, mica (biotite and phlogopite), K-feldspar, magnetite, apatite, ilmenite and sulphides. These phases increase in abundance from the base to the top of the Unit. The rock may be classified as a gabbronorite (Le Maitre, 1989) which is consistent with the results obtained by De Waal *et al.* (1995), Gauert *et al.* (1995), and Strauss (1995).

Plagioclase occurs as euhedral and subhedral lath-like cumulus grains up to 4 mm in length, and as anhedral interstitial grains. The relative proportion of intercumulus grains increases towards the top of the Unit. The grains show characteristic polysynthetic albite and Carlsbad twinning and most have undergone extensive saussuritization.

The pyroxenes are euhedral, subhedral and anhedral, and occur as cumulus and intercumulus grains, with the cumulus mode being dominant. Clinopyroxene commonly displays exsolution blebs and lamellae of orthopyroxene.

Quartz, biotite, K-feldspar and apatite occur as late stage phases filling the interstices between plagioclase laths and pyroxenes. The biotite grains are reddish-brown in colour, possibly due to high titanium contents (Deer *et al.*, 1992).

Magnetite is present in two main forms, as discrete anhedral grains and as spongiform or skeletal grains (see plate in section on Gabbronorite Unit). The latter grains generally increase in abundance with height. The abundance of the discrete grains tends to be directly proportional to the concentration of sulphide in the rock. The anhedral grains typically contain inclusions of ilmenite and globular pyrrhotite.

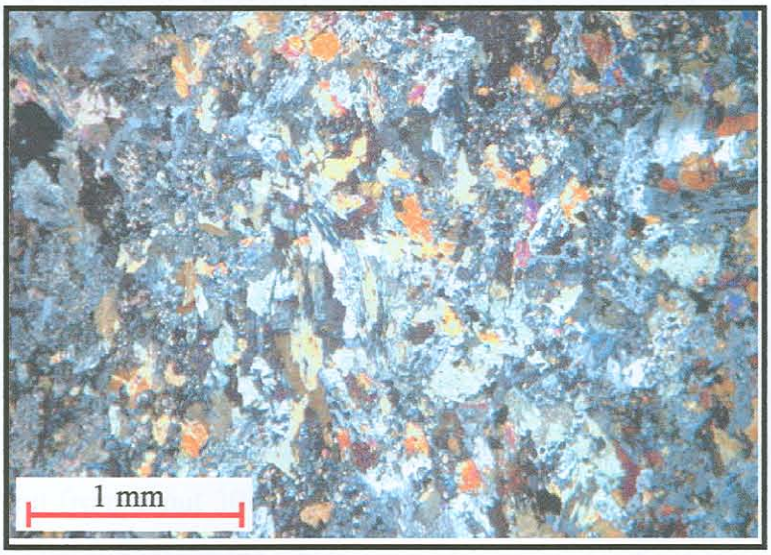

PLATE 2. Basal Gabbro chilled margin SH176 UP 60

Disseminated sulphides occur throughout the Unit, as discrete blebs and as fillings of interstices although Gauert (1998) reported that the basal part of the BGAB is essentially sulphide free. Chalcopyrite (about 50%) is the most abundant sulphide followed by pyrrhotite (about 40%) and then pentlandite (about 10%). Two types of pentlandite were identified. A flame-like exsolution variety and granular inclusions within pyrrhotite, particularly near fractures and grain boundaries between pyrrhotite and chalcopyrite. The former is more abundant than the latter.

Alteration

Secondary hydrothermal alteration of the Unit led to widespread reconstitution of the rocks, resulting in the formation of amphibole, chlorite, carbonate and epidote. Plagioclase is commonly partially altered to saussurite, a fine-grained aggregate of epidote group minerals, albite, sericite and other minerals (Deer *et al.*, 1992). Pyroxene alteration may be pervasive with complete pseudomorphic replacement of the pyroxenes by amphibole. Two types of amphibole were identified i.e. hornblende and acicular tremolite-actinolite. Phlogopite-biotite displays reaction rims of chlorite and calcite as well as occurring as rims attached to corroded grains of clinopyroxene.

3.2. Lower Harzburgite

The LHZBG is lithologically the most heterogeneous Unit of the Uitkomst Complex comprising a variety of ultramafic rock types. The main lithology is a poikilitic harzburgite with variable amounts of chromite and intercumulus plagioclase. Local varieties include feldspar-bearing lherzolite grading to sulphide-rich wehrlites and websterite.

The contact with the underlying BGAB is gradational, characterized by an increase in ferromagnesian minerals, including olivine. The latter phase comprises, on average, about 45 vol% of the LHZBG, but is rare in the BGAB. The major cumulus phases in the LHZBG are (i) olivine which generally increases in abundance from the base to the top of the Unit from about 30 to 45 vol%, (ii) orthopyroxene which varies from 10 to 30 vol% and (iii) clinopyroxene which ranges from zero to about 10 vol%, but broadly increases in abundance from the base to the top. Postcumulus phases are, in decreasing abundance, plagioclase, biotite and K-feldspar. Feldspar makes up about 20 vol% of the rock at the base decreasing to 10 vol% near the top. Biotite ranges from 5 to 10 vol% increasing gradually with height. Sulphides are concentrated within wehrlites (on average about 4 vol%), which occur predominantly in the central portion of the Unit. In general, the sulphide content increases from about 3 vol% at the base to about 4 vol% in the wehrlites and then decreases to about 2 vol% towards the top of the Unit. The chromite content increases marginally with height from less than 1 vol% to about 1 vol%.

The rocks are medium-grained throughout the Unit. Olivine is generally subhedral and equigranular ranging in size from 1 mm to 3 mm. Smaller olivine grains may occur as chadacrysts within clinopyroxene in which case they are relatively less altered than the larger cumulus grains. Towards the top of the Unit alteration is more pervasive, with "islands" of remnant olivine being surrounded by serpentine. Orthopyroxene occurs as euhedral to subhedral grains commonly showing clinopyroxene exsolution blebs and lamellae where the orthopyroxene grains are larger than 1 mm. The exsolution features are most prevalent in the feldspar-bearing lherzolite.

Clinopyroxene is present either as a cumulus phase, forming oikocrysts up to 4 mm in size, or as exsolution lamellae in orthopyroxene. Occasionally, smaller clinopyroxene grains may be strongly embayed and rimmed by hornblende.

Sulphides occur as discrete grains less than 1 mm in size or as net-textured aggregates. Some larger sulphide blebs of up to 1 mm in size may also be present. The main sulphides, in decreasing abundance, are pyrrhotite (approximately 60 vol%), chalcopyrite (approximately 30 vol%) and pentlandite (less than 10 vol%), with lesser pyrite and millerite (approximately 1 vol% in total). Generally, the sulphide grain boundaries are intergrown with acicular serpentine (PLATE 3 A). Pyrrhotite is commonly rimmed by secondary magnetite (PLATE 3 B). Chalcopyrite occurs as subhedral prismatic grains associated with pyrrhotite and as fracture fillings within orthopyroxene grains. It is relatively more enriched in the websterite than the wehrlite. Pentlandite occurs at the grain boundaries of pyrrhotite and as flame lamellae within pyrrhotite. Pyrite occurs as euhedral and subhedral grains within pyrrhotite (PLATE 3 B and C) and as discrete grains interstitial to silicates and chromite. It is most abundant in the sulphide-rich wehrlites. Millerite forms anhedral aggregates in pyrite exhibiting undulose extinction.

Disseminated chromite occurs as discrete euhedral and subhedral grains (less than 50 μm) or as partially annealed aggregates. The chromite is generally hosted by clinopyroxene, and more rarely by orthopyroxene. Fractures within chromite grains are commonly filled with magnetite.

PLATE 3

A. **LHZBG, SH176 UP56.** Intergrowth between pentlandite (PENT) and silicates.

B. **LHZBG, SH176 UP56.** Magnetite alteration rim around pyrrhotite (PO). Euhedral pyrite and subhedral chalcopyrite are enclosed in pyrrhotite. Note exsolution flame of pentlandite.

C. **LHZBG, SH176 UP56.** Subhedral pyrite grains enclosed in pyrrhotite (PO).

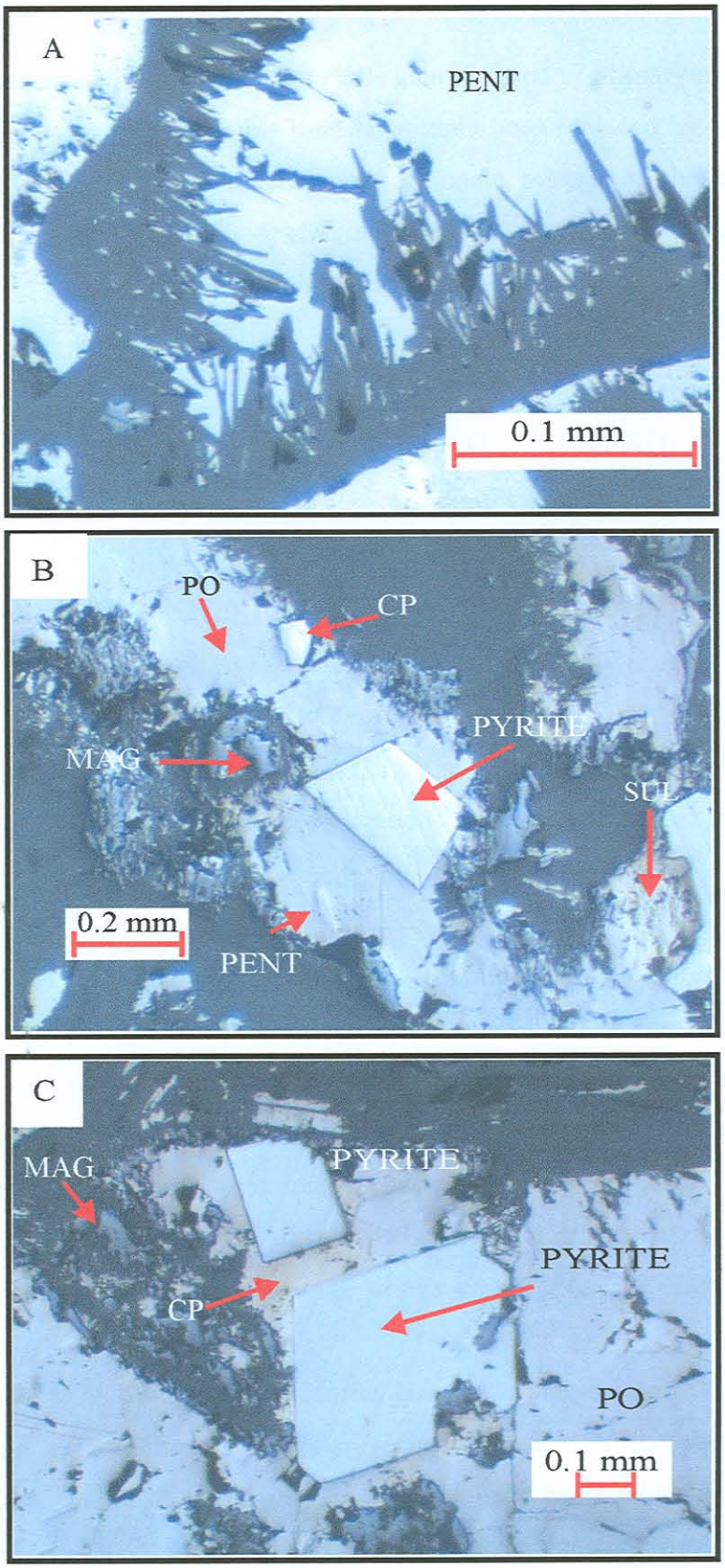
A
PENT
0.1 mm
B
PO
CP
PYRITE
MAG
SUL
0.2 mm
PENT
C
MAG
PYRITE
PYRITE
CP
PO
0.1 mm

PLATE 3

Alteration

Pervasive alteration throughout the Unit made identification of primary phases difficult in some sections. The olivine grains have commonly been replaced by chrysotile and lizardite with magnesite or magnetite and carbonate present at the center of the pseudomorphosed grain (PLATE 4). During alteration of olivine, serpentine, brucite and magnetite are produced along with talc and magnesite, according to the following equations (Deer *et al.*, 1992):

$$2Mg_2SiO_4 + 3H_2O \rightarrow Mg_3Si_2O_5(OH)_4 + Mg(OH)_2$$

Forsterite — Serpentine — Brucite

$$Mg_3Si_2O_5(OH)_4 + 3CO_2 \rightarrow Mg_3Si_4O_{10}(OH)_2 + 3MgCO_3 + H_2O$$

Talc — Magnesite

The olivine of the Uitkomst Complex contains some iron (Fe^{2+}) and this forms magnetite ($Fe^{2+}Fe_2^{3+}O_4$) during serpentinization, which is associated with the other alteration minerals of olivine.

Both orthopyroxene and clinopyroxene have been replaced by chlorite-tremolite and phlogopite, with phlogopite dominating in the core of the grains. Two juxtaposed varieties of chlorite could be distinguished, one being enriched in iron with distinct green-brown pleochroism and the other being reddish-brown in colour and displaying weak pleochroism. Chlorite is a common constituent of igneous rocks in which they have usually been formed by hydrothermal alteration of primary ferromagnesian minerals (Deer *et al.*, 1992). Phlogopite occurs as a result of continuous reactions

involving some or all of muscovite, chlorite, quartz and plagioclase. Amphibole occurs in association with biotite as irregular grains, occasionally forming rims around sulphide grains. Pentlandite is partially replaced by creamy-blueish violarite along fractures. Where the rock alteration assemblage is dominated by talc, worm-like aggregates of millerite within pyrite are observed characterized by strong anisotropism from yellow to light blue.

PLATE 4

LHZBG, SH176 UP56. Altered olivine grains embedded in massive sulphide. Grains have been pseudomorphically replaced by magnetite, lizardite and chrysotile. The top photomicrograph was taken in cross-polarized light, the bottom photomicrograph was taken in plane-polarized light.

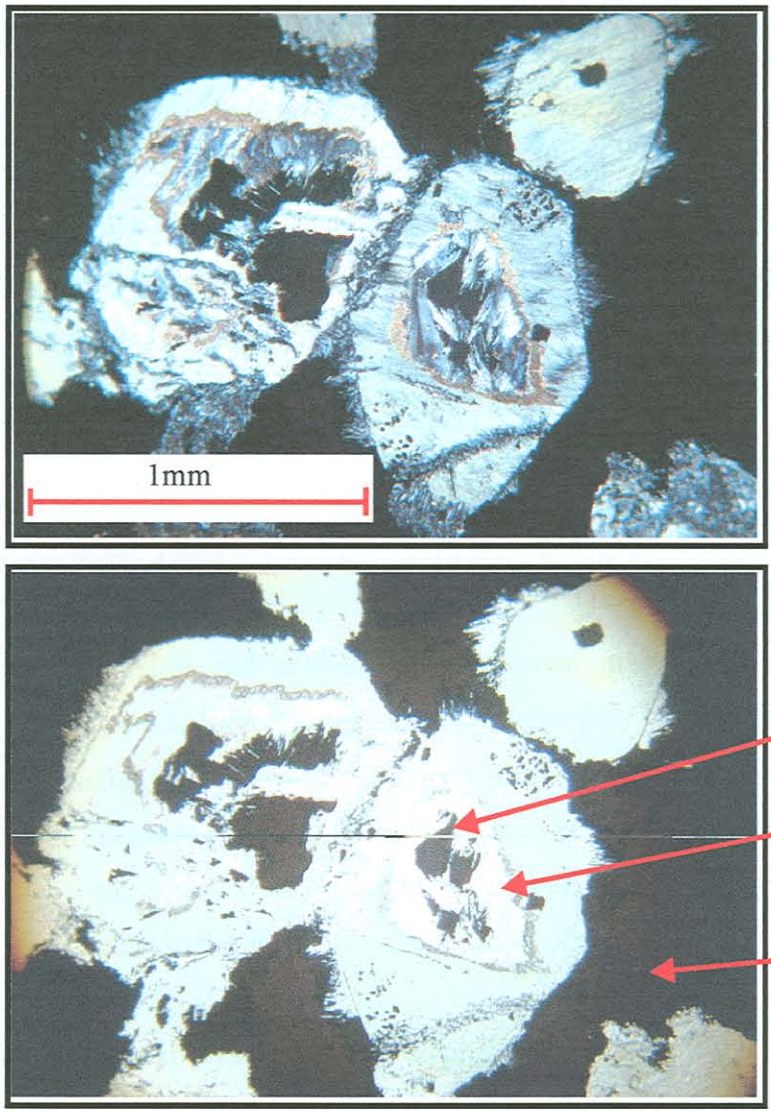

PLATE 4

3.3. Chromitiferous Harzburgite Unit

This Unit comprises equigranular and inequigranular rocks with olivine, chromite and orthopyroxene as major cumulus phases. There is a gradational basal contact with the LHZBG that is marked by an increasing olivine content from about 45 vol% to 60 vol%. Orthopyroxene averages 20 vol%, and the chromite content is greater than or equal to 10 vol%. Clinopyroxene averages about 2 vol% except for the base of the Unit where it may reach up to 20 vol% of the rock. Interstitial minerals, in decreasing abundance, are sulphides, plagioclase, muscovite, phlogopite and amphibole. Plagioclase, muscovite and phlogopite together make up less than 5 vol% of the rock with sulphides between 1 and 5 vol%, decreasing in abundance with height. The grain sizes vary between 3-4 mm for orthopyroxene, about 1 mm for the olivine and plagioclase, less than 1 mm for the remaining interstitial phases and between 50-500μm for chromite.

Olivine grains are subhedral equigranular with smaller grains near the base being enclosed by clinopyroxene. There is a gradual increase in olivine with height.

Chromite occurs as euhedral and subhedral disseminated grains that are largely interstitial to olivine and pyroxenes. Aggregates of chromite may be partially annealed or cemented by magnetite (see plates in section on MHZBG). A massive chromitite layer about 40 cm in thickness marks the boundary with the overlying MHZBG Unit. Within the layer, chromite grains are strongly brecciated along fractures that are dominantly oriented parallel to the sub-horizontal layering of the Complex.

Clinopyroxene occurs as oikocrysts enclosing olivine, as interstitial fillings as well as occasional exsolution lamellae in orthopyroxene. Cumulus clinopyroxene is rare. Orthopyroxene occurs as anhedral grains. Anhedral plagioclase fills interstices. Subhedral and anhedral biotite, phlogopite and amphibole also occur as interstitial phases.

Sulphide minerals are disseminated throughout the Unit. In decreasing abundance they consist of pyrrhotite, chalcopyrite, pentlandite, pyrite and millerite (similar relative proportions as in the LHZBG). Pyrrhotite occasionally displays exsolution of flame-like and granular pentlandite (PLATE 5 A). The finer grains are skeletal in morphology and tend to be intergrown with secondary silicate minerals. Chalcopyrite may be associated with pyrrhotite, occurring as anhedral grains juxtaposed with pyrrhotite (PLATE 5 B). Veinlets of chalcopyrite and millerite usually occur adjacent to or within chrysotile veins. Some magnesite veins contain remobilized sulphide grains indicating the secondary nature of part of the mineralization. The sulphide assemblage associated with chromitite layers usually consists of blebby aggregates of pentlandite, pyrrhotite and chalcopyrite. Net-textured and cusp shaped sulphides draped around cumulus chromite grains are also common textural features in the chromitite layers.

Alteration

Serpentine, amphibole, chlorite, calcite, phlogopite and muscovite occur as alteration products replacing olivine, orthopyroxene and clinopyroxene. Magnetite occurs as discrete grains occasionally surrounded by rims of lizardite and chrysotile and as veinlets within the serpentine in olivine grains. Serpentine occurs as fibrous masses that may show intergrowths with sulphides. The sulphides are commonly partially replaced by violarite and secondary magnetite. Secondary phlogopite plume aggregates may embay sulphide grain boundaries (see plates in section on LHZBG).

PLATE 5

A. **PCR, SH176 UP51.** Pyrrhotite (PO) showing flame exsolution lamellae of pentlandite (PENT). Note replacement of pyrrhotite by magnetite.

B. **PCR, SH176 UP51.** Chalcopyrite (CP) intergrown with pyrrhotite, also present are chromite and magnetite grains.

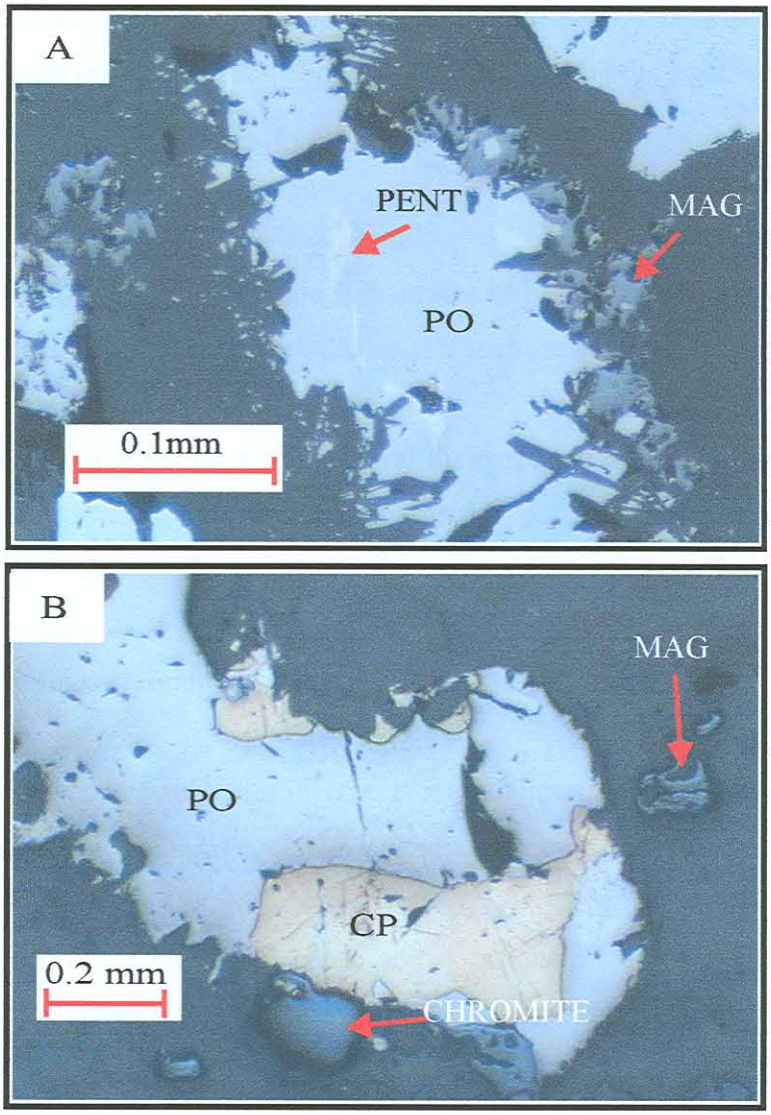

PLATE 5

3.4. Main Harzburgite Unit

This Unit is lithologically the most homogeneous of the Complex comprising essentially a poikilitic harzburgite (PLATE 6 A). Olivine and chromite are the main cumulus phases. Olivine averages between 65 and 70 vol% increasing towards the top. Chromite ranges between 1 and 5 vol% (PLATE 6 B). Oikocrystic orthopyroxene decreases from about 20 vol% near the base to about 15 vol% near the top. Minor intercumulus phases are plagioclase, clinopyroxene and amphibole making up between 5 and less than 10 vol% of the rock.

Olivine occurs mainly as 0.5 to about 2 mm sized chadacrysts enclosed in large oikocrysts of orthopyroxene. There does not appear to be a systematic change in size (between <1 and 2 mm) of olivine from the interior to the margin of oikocrysts.

Chromite is present as euhedral and subhedral disseminated grains hosted mainly by orthopyroxene. The grains are generally equigranular, partially annealed or cemented by magnetite (PLATE 7) and may also form vein aggregates. The chromite content marginally decreases with height through the Unit. A selvage of phlogopite occasionally surrounds chromite crystals.

Orthopyroxene may be up to 4 mm in size. It rarely shows clinopyroxene exsolution lamellae, but commonly contains accessory euhedral chromite.

Plagioclase occurs as an interstitial phase and occasionally as corroded or partially resorbed inclusions within orthopyroxene grains. These grains could be relicts of earlier cumulus plagioclase (Eales *et al.*, 1991).

Rare clinopyroxene is present as oikocrysts or as interstitial fillings as well as occasional exsolution lamellae in orthopyroxene. Cumulus clinopyroxene is rare. Some of the clinopyroxene may be rimmed by amphibole.

Sulphides are mainly pyrrhotite (70%) with lesser pentlandite (<30%) and minor chalcopyrite (about 1 to 2%). The sulphides occur as finely disseminated grains. The

grain size and concentration of the sulphides decreases with height. The sulphide grains are commonly very finely intergrown with serpentine and phlogopite grains.

Alteration

Alteration of this Unit increases with depth resulting in almost complete serpentinization of olivine near the base of the Unit. Magnetite and magnesite are common within the serpentinized zone along with lizardite, chrysotile and talc. Secondary amphibole (largely hornblende) is pervasive as a result of alteration of the pyroxenes.

PLATE 6

A. and B. **MHZBG, SH176 UP36**. Partially serpentinized olivine chadacrysts within orthopyroxene. Chromite and sulphide grains are disseminated in orthopyroxene.

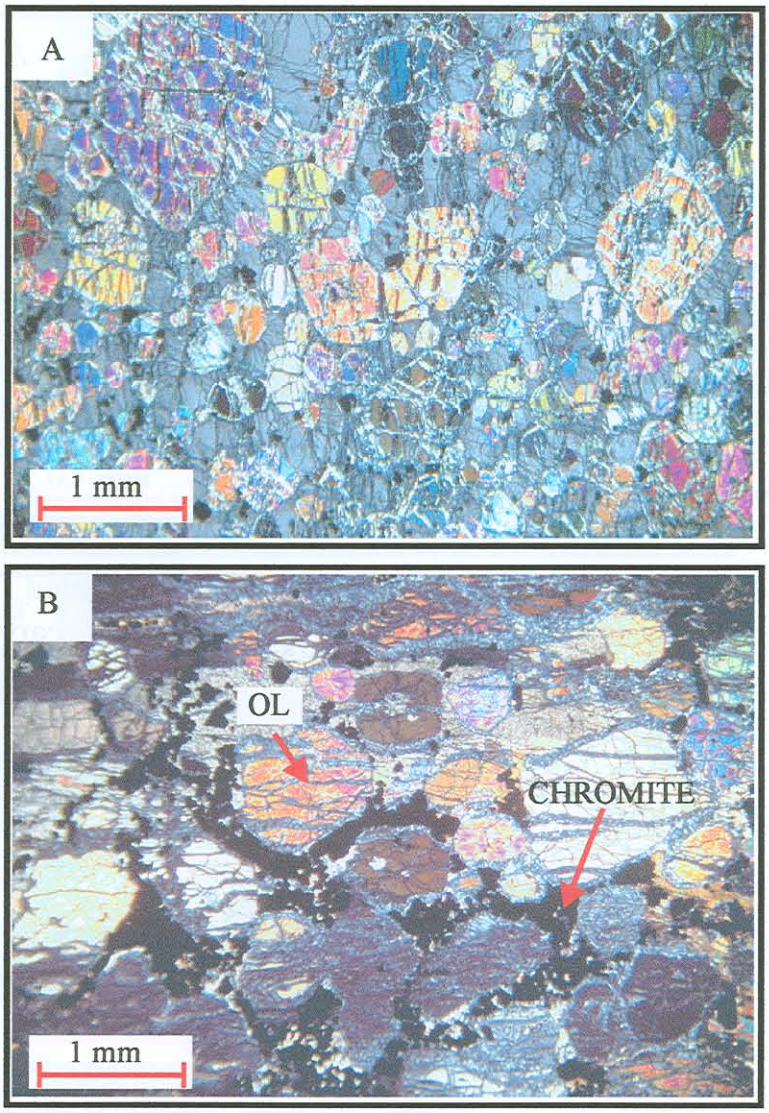

PLATE 6

PLATE 7

A. **MHZBG, SH176 UP51**. Partially annealed euhedral and subhedral chromite grains. C = Remnants of carbon coating for electron microprobe analyses.

B. **MHZBG, SH176 UP46**. Chromite grains annealed with magnetite.

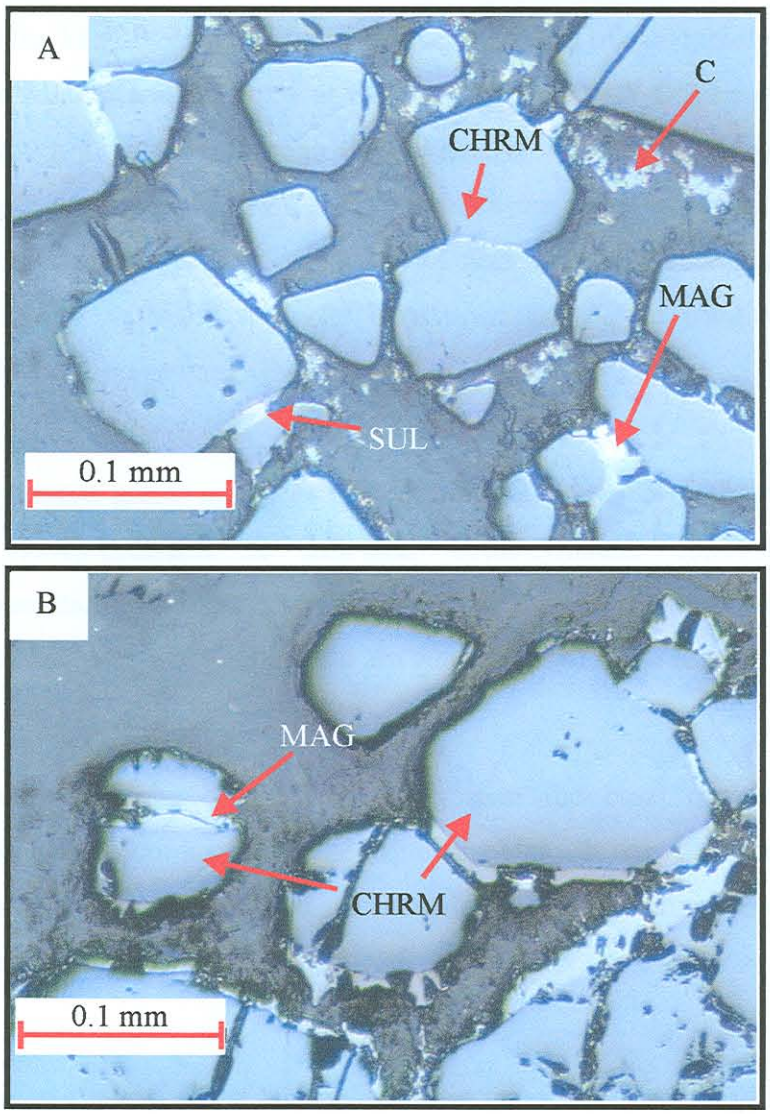

PLATE 7

3.5. Pyroxenite Unit

Orthopyroxene is the major cumulus mineral in the PXT, amounting to over 80 vol% of the rock (PLATE 8 A and B). Olivine, chromite and clinopyroxene (approximately 5 vol%) are locally present. Post-cumulus phases are, in order of decreasing abundance, plagioclase clinopyroxene, mica (phlogopite), amphibole and quartz. The basal contact of the PXT with the MHZBG is gradational over 1-2 m, with olivine rapidly decreasing from 65% in the MHZBG to 35 vol% at the base of the PXT. Olivine continues to decrease markedly in abundance through the remainder of the PXT and is essentially absent in the upper portion of the PXT. Plagioclase increases with height from about 10 vol% at the base to over 50 vol% at the top contact with the Gabbronorite Unit. It attains cumulus status within a relatively narrow noritic 1-2 m transition interval between the PXT and the overlying GN.

Cumulus orthopyroxene grains are generally subhedral equigranular with crystal habits varying from stubby-prismatic to lath-like. Orthopyroxene commonly shows clinopyroxene exsolution lamellae approximately parallel to (100). These lamellae tend to disappear towards the crystal margins and are generally rare at the base of the Unit.

Accessory euhedral chromite occurs particularly near the basal contact with the MHZBG and is much less common near the top of the Unit. It may be enclosed by any of the post cumulus phases as well as cumulus olivine. Orthopyroxene grains containing chromite are rare.

Within the norites at the top of the Unit, plagioclase generally forms oikocrysts with a maximum size of 5 mm enclosing orthopyroxene. In the orthopyroxenite, plagioclase occurs as small intercumulus grains. Some orthopyroxene grains in the norite contain ovoid plagioclase inclusions that are partially embayed.

Clinopyroxene is mainly present as oikocrysts, as interstitial fillings or as exsolution lamellae in orthopyroxene. Cumulus clinopyroxene is rare (but see Plate 8 B).

Amphibole (mainly hornblende) occurs interstitial to orthopyroxene in the pyroxenite. Mica is an abundant accessory or minor phase, associated with quartz in the orthocumulate pyroxenites. The interstitial quartz grains show no strained extinction. Other accessory minerals present are phlogopite, discrete anhedral magnetite grains surrounded by rims of phlogopite, and green actinolite. Magnetite occurs as anhedral grains with ilmenite and sulphide inclusions (PLATE 8 C).

Finely disseminated sulphides appear to be confined or concentrated towards the base of the Unit. Pyrrhotite is the most abundant sulphide followed by lesser pentlandite and minor chalcopyrite. Pyrrhotite is generally globular with flame-like exsolution zones of pentlandite. Overall, the sulphides fill the interstices together with biotite, plagioclase and quartz. In some instances, pentlandite occurs as finely disseminated grains within fractures of olivine and intergrown with serpentine.

Alteration

This is the least altered Unit of the Complex, but some of the orthopyroxene may be rimmed by an alteration halo of tremolite, phlogopite and fuchsite (a chromium muscovite). Some clinopyroxene grains display rims or patches of amphibole, evidence for interaction with late stage fluids.

PLATE 8

A. **Upper PXT Unit, SH176 UP26**. Norite.

B. **PXT central portion, SH176 UP30.** Pyroxenite.

C. **PXT, SH176 UP21.** Anhedral magnetite grain with (faint) exsolution lamellae of ilmenite and globule of sulphur.

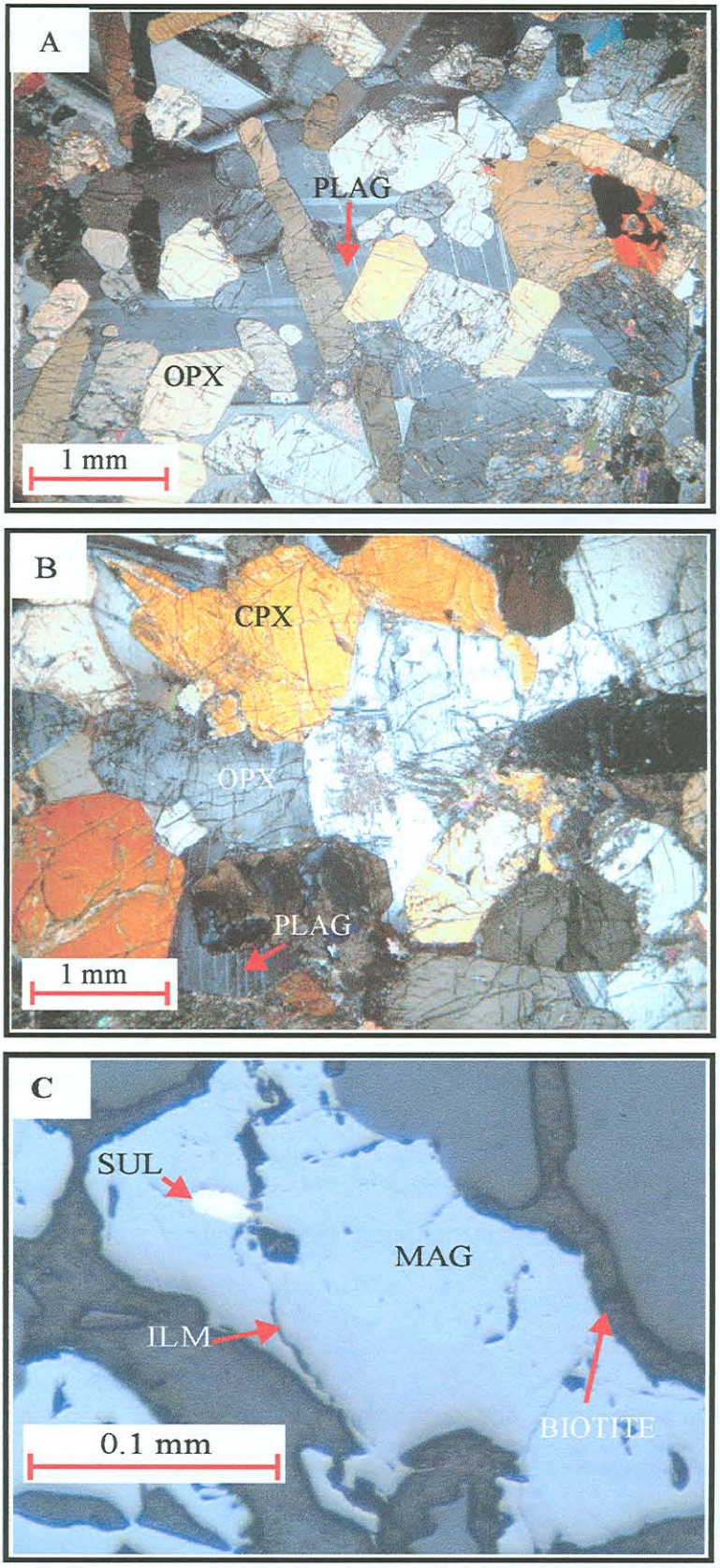

PLATE 8

3.6. Gabbronorite Unit

This Unit is essentially composed of fine to coarse-grained equigranular gabbronoritic to gabbroic rocks with minor norites and diorites. The contact with the PCR is gradational. The primary igneous lithology of the GN Unit is a plagioclase-pyroxene-hornblende rock with interstitial phlogopite, biotite, hornblende, quartz, apatite and opaque minerals. Plagioclase constitutes between 50 and 60 vol% of the rock. Generally, clinopyroxene increases with height whilst orthopyroxene decreases. Thus the base of the GN consists of a medium-grained norite with an intergranular texture (PLATE 9 A) becoming more gabbronoritic with height. At the top of the Unit, gabbro and diorite is developed. Biotite-phlogopite is ubiquitous throughout the Unit occurring in concentrations up to 10 vol% with hornblende, quartz, apatite and opaque minerals making up to 5 vol% in parts of the Unit.

Cumulus plagioclase grains average between 2 and 3 mm in length, reaching 5 mm in exceptional cases. Plagioclase additionally occurs within interstices and as subhedral to anhedral inclusions in clinopyroxene at the base of the Unit (PLATE 9 A). In some cases there is a sub-grain development of plagioclase grains, possibly in response to deformation of the grains (PLATE 9 B).

Clinopyroxene ranges from 1 to 2 mm in size and orthopyroxene grains are usually about 1 mm in size or less. Coarse-grained anhedral clinopyroxene occurs as oikocrysts hosting up to 1 mm sized plagioclase grains and as exsolution lamellae of orthopyroxene. Anhedral orthopyroxene grains may contain inclusions of clinopyroxene and, to a lesser degree, plagioclase.

Biotite-phlogopite grains are interstitial to pyroxene and plagioclase and are often associated with (titano-) magnetite, forming a rim around the magnetite grains. Primary hornblende occurs as stubby to long prismatic crystals in the GN. Towards the top of the Unit hornblende mainly occurs as an alteration mineral. The primary hornblende is normally zoned, being more blue-green and sodic around the outer rim. This could be an indication of a change in fluid composition during cooling of the magma and

crystallization of hornblende. Interstitial quartz grains increase in abundance with height to approximately 25 vol% in the diorite at the top of the Unit. Apatite occurs as elongate to prismatic grains increasing in abundance towards the top of the Unit.

Opaque minerals comprise magnetite, ilmenite and sulphides with a combined concentration of less than 1 vol%. There is a slight increase in the grain size of the sulphides with height. Magnetite tends to be enclosed by biotite or phlogopite throughout the Unit (PLATE 9 C). The least altered rocks have interstitial sulphides together with biotite, hornblende and quartz. The sulphides appear to have been vein remobilized in the more altered rocks, being associated with the secondary hornblende and with magnetite. The main sulphides present are pyrrhotite, pentlandite and chalcopyrite.

Alteration

Amphibolitization of the orthopyroxene and clinopyroxene is extensive with secondary hornblende making up to 10 vol% of the rock. Chlorite dominates the centers of the pseudomorphosed grains. There is an increase in abundance of hornblende with height, which indicates a strong overprint of hydrothermal alteration of the top portion of the Unit, with the base being least altered.

PLATE 9

A. **Base of GN, SH176 UP25**. Gabbronorite, plagioclase (PLAG) laths enclosed in clinopyroxene (CPX). Note corona of hornblende (HNBL) around orthopyroxene (OPX). The plagioclase is partially saussuritized.

B. **GN, SH176 UP22**. Gabbronorite showing a weak preferred orientation of the plagioclase laths. Quartz (QTZ) is also present. Note plagioclase subgrain development in the center of the photo.

C. **GN, SH176 UP18**. Magnetite grain (light grey in colour) showing skeletal texture. The matrix is mainly biotite.

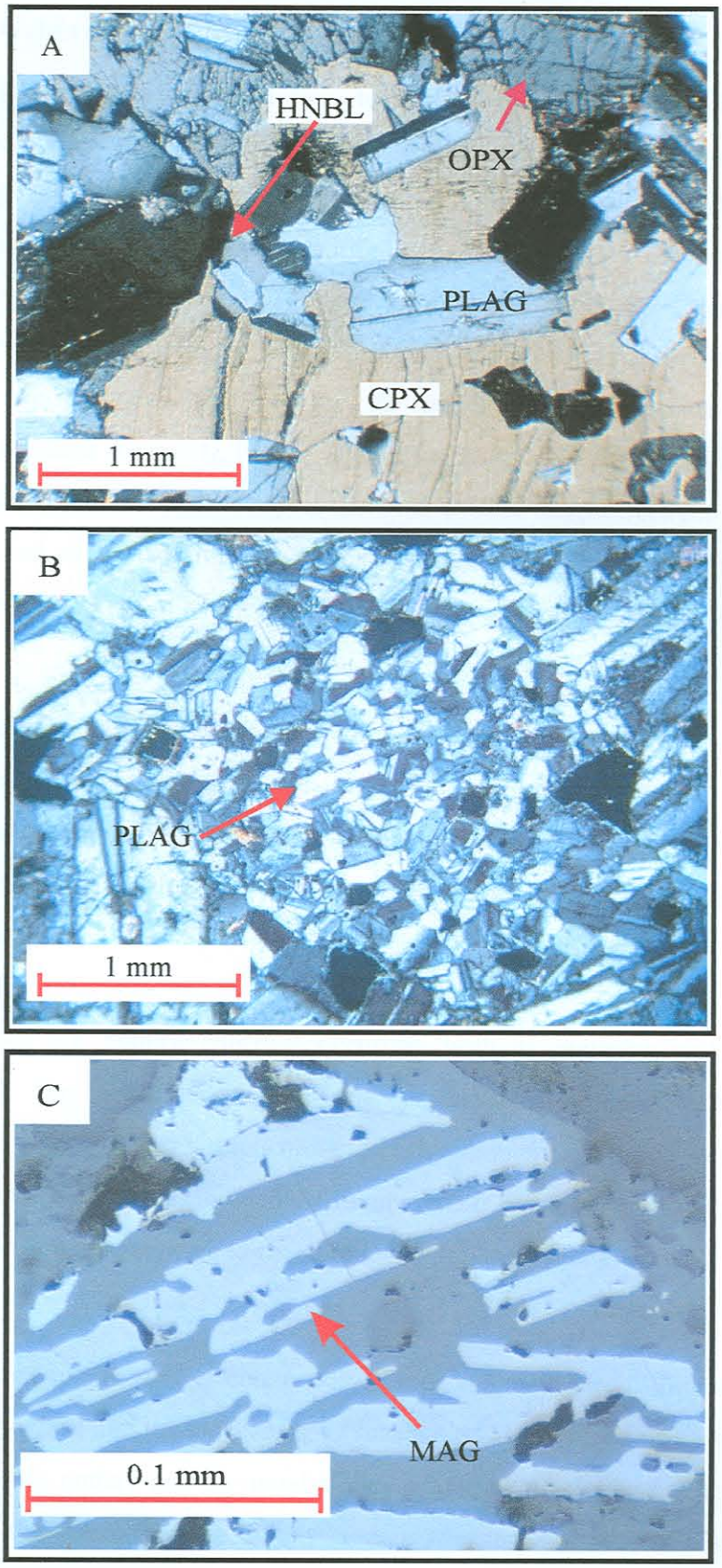

PLATE 9

3.7. Upper Gabbro

This Unit is composed mainly of fine- to medium-grained equigranular and seriate gabbroic rock. Closer to the roof contact the rocks become finer grained with long acicular plagioclase crystals (up to 5 mm) dominating the assemblage (PLATE 10 A). An up to 2 m thick aphanitic chilled margin containing composite inclusions of quartz (PLATE 10 B) that are possibly derived from the Klapperkop Quartzite Member characterizes the contact with the roof rocks. Plagioclase (40-60%), orthopyroxene (25-40%) and clinopyroxene (5-10%) are the major cumulus phases in the Unit. Intercumulus phases are quartz, biotite, apatite and zircon. Quartz ranges between 5 and 10 vol%, increasing towards the top of the Unit. Biotite ranges between 2 and 5 vol% with apatite and zircon making up between 1 and 2 vol%. Disseminated sulphides, less than 1 mm in size, occur in an irregular manner and make up less than 1 % of the rock.

Plagioclase occurs as lath-like cumulus- and anhedral interstitial grains. At times, the cumulus laths reach up to 3 mm in length with no preferred orientation. Occasionally, smaller radiate grain aggregates of alkali feldspar are observed, mainly towards the top of the Unit (PLATE 10 A). Many of the grains show Carlsbad twinning and partial saussuritization.

The pyroxenes are mainly anhedral occurring both as cumulus and intercumulus phases, with the cumulus mode being dominant. Orthopyroxene shows the characteristic pink to green pleochroism of hypersthene with no visible sign of exsolution lamellae of clinopyroxene. Clinopyroxene decreases gradually with height whereas orthopyroxene appears to remain broadly constant in abundance.

Quartz, biotite, apatite and zircon occur as late stage phases filling the interstices between plagioclase and the pyroxenes. Quartz grains are rounded or irregular in shape and may slightly embay and surround stubby grains of plagioclase. The quartz grain inclusions in the aphanitic zone usually contain intergrowths of apatite and inclusions of zircon (PLATE 10 B). Biotite displays light brown to dark brown pleochroism, and

increases in abundance with height. Apatite occurs as small colourless, subhedral (acicular), crystals within feldspar, quartz and other interstitial phases.

The sulphides are mainly pyrrhotite with minor chalcopyrite and pentlandite. Pyrrhotite occurs as finely disseminated grains, commonly less than 50 μm in size, but occasionally reaching up to 1 mm. Pyrrhotite occasionally shows globular and flame-like inclusions of pentlandite.

Alteration

Secondary hydrothermal alteration is pervasive throughout the Unit forming amphibole, alkali feldspar, chlorite and epidote. Plagioclase is altered to sericite, epidote and saussurite. Pyroxene is altered to amphibole. As in the alteration assemblage of the BGAB two types of amphibole are observed i.e. hornblende and actinolite tremolite.

PLATE 10

A. **UGAB, SH176 UP 2**. Elongated plagioclase laths and radial alkali feldspar. Matrix contains plagioclase, orthopyroxene, clinopyroxene, hornblende and biotite. Some of the plagioclase laths are saussuritized.

B. **UGAB, SH176 UP1**. Chilled margin, containing quartz grain aggregates. Note growth of needle-like grains of apatite along grain boundaries.

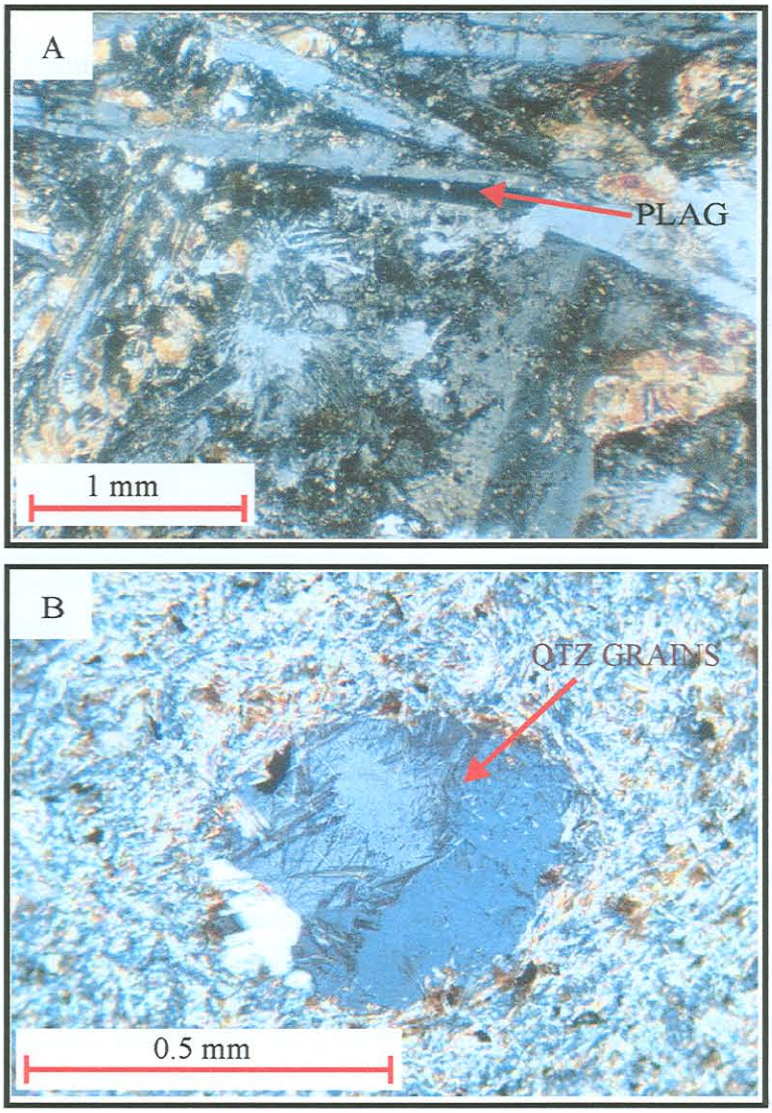

PLATE 10

3.8. Summary

The major-, intercumulus-, and alteration mineralization of the Uitkomst Complex is summarized in Table 2.

Table 2. Cumulus, intercumulus and alteration minerals in the different lithological units

Unit	Main Cumulus Minerals	Intercumulus and Alteration Minerals
UGAB	Plagioclase, orthopyroxene, clinopyroxene.	Quartz, biotite, apatite, zircon, pentlandite, chalcopyrite. Amphibole (hornblende and tremolite-actinolite, chlorite, carbonate, epidote, sericite, saussurite.
GN	Plagioclase, orthopyroxene, clinopyroxene, hornblende.	Phlogopite, biotite, hornblende, quartz, apatite, magnetite, chlorite, sulphides. Amphibole, chlorite.
PXT	Orthopyroxene, olivine, chromite.	Plagioclase, clinopyroxene, mica (phlogopite), amphibole, quartz, pyrrhotite, pentlandite, chalcopyrite. Tremolite, phlogopite, fuchsite, amphibole.
MHZBG	Olivine, orthopyroxene, chromite.	Plagioclase, clinopyroxene, amphibole, pyrrhotite, pentlandite, chalcopyrite. Serpentine, magnetite, lizardite, chrysotile, talc, hornblende.
PCR	Olivine, chromite, orthopyroxene, sulphides.	Sulphides, plagioclase, muscovite, phlogopite, amphibole. Serpentine, amphibole, chlorite, calcite, phlogopite, muscovite, violarite
LHZBG	Olivine, orthopyroxene, clinopyroxene, sulphides, chromite.	Biotite, K-feldspar. Chrysotile, lizardite, magnetite, magnesite, chlorite, tremolite-actinolite, phlogopite, millerite, amphibole, violarite.
BGAB	Plagioclase, clinopyroxene, orthopyroxene, chromite.	Quartz, mica, K-feldspar, magnetite, ilmenite, chalcopyrite, pyrrhotite, pentlandite. Amphibole (hornblende and tremolite-actinolite, chlorite, carbonate, epidote, saussurite, calcite.