APPENDICES

App. 1 Microphoto of Rock Samples

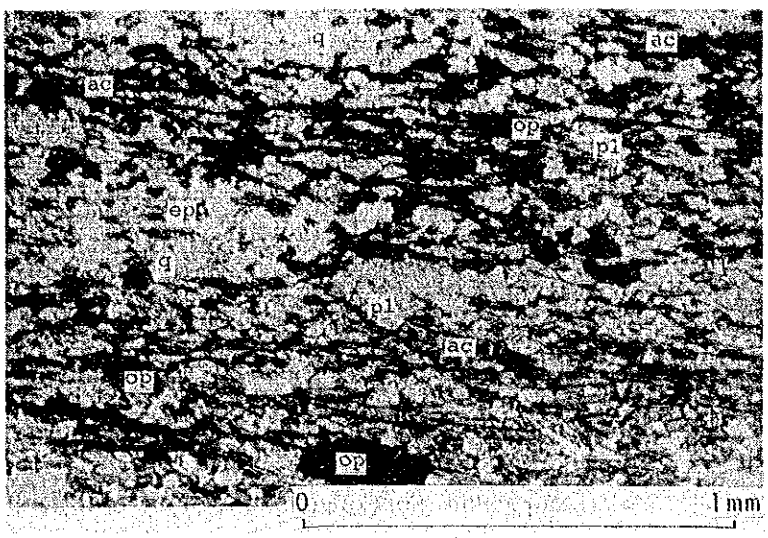


Plate – 1 Microscopic Photo of Epidote-Actinolite Schist of Dalupirip Schist (E–98)
q: quartz ac: actinolite ep: epidote pl: plagioclase op: opaque mineral

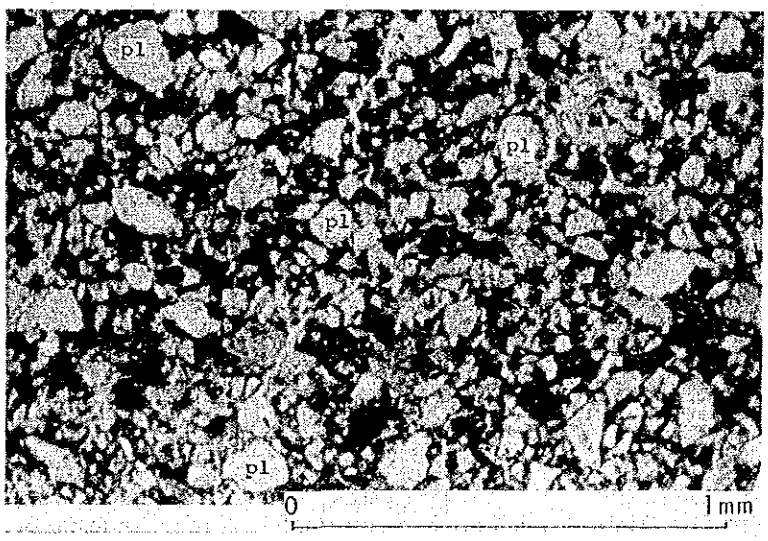


Plate – 2 Microscopic Photo of Sandstone of Miocene Sedimentary Rocks (F–224)
pl: plagioclase

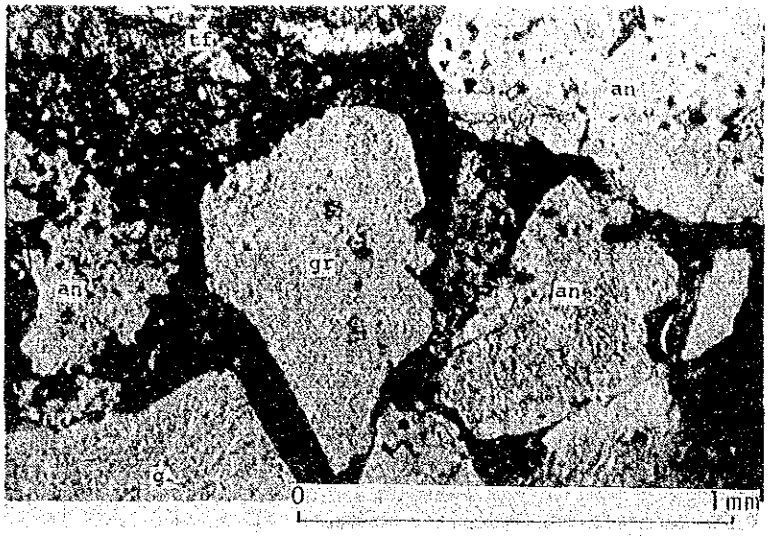


Plate – 3 Microscopic Photo of Conglomerate of Miocene Sedimentary Rocks (F–222)
tf: tuff an: andesitic rock gr: granitic rock

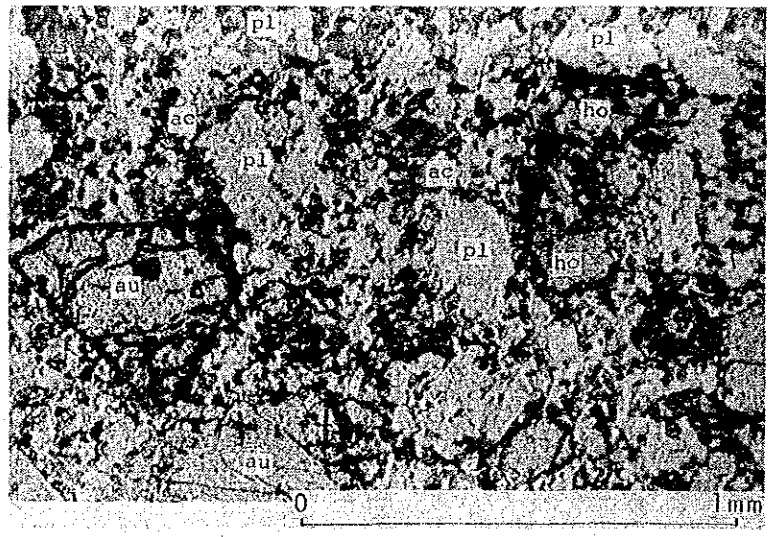


Plate – 4 Microscopic Photo of Hornblende-Augite Andesite of Miocene Sedimentary Rocks (F–291)
au: augite ac: actinolite pl: plagioclase ho: hornblende

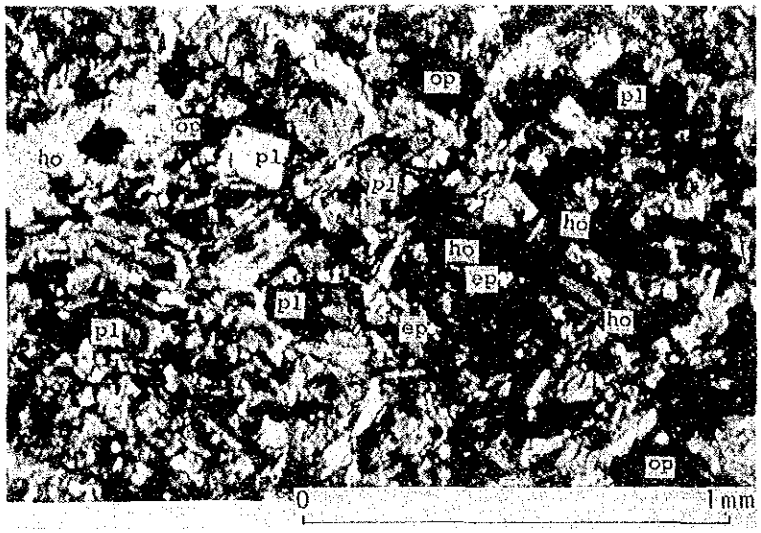


Plate – 5 Microscopic Photo of Hornblende Andesite Porphyry of Old Plug (F–133)
pl: plagioclase ho: hornblende ep: epidote op: opaque mineral

Plate – 6 Microscopic Photo of Dacitic Lapilli Tuff of Young Plug (G–31)
an: andesitic rock q: quartz pl: plagioclase bi: biotite

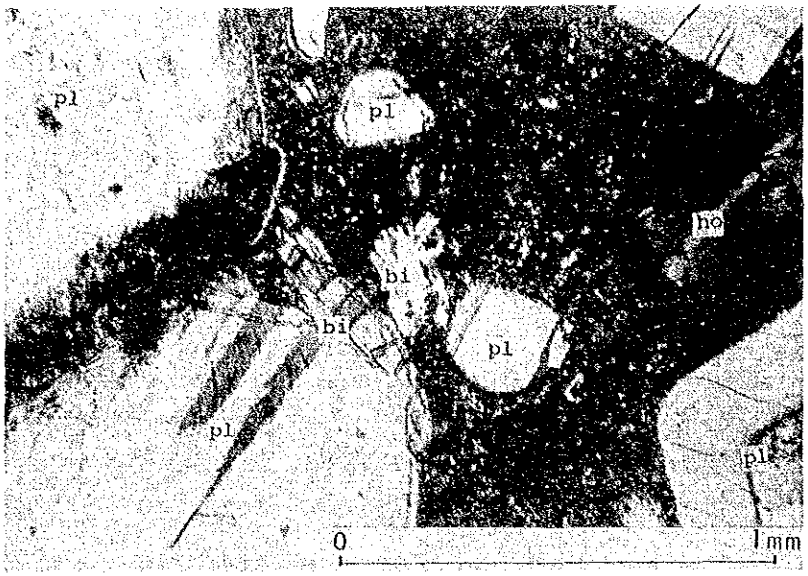


Plate – 7 Microscopic Photo of Biotite-Hornblende Dacite of Dacite Plug (J–1)
pl: plagioclase ho: hornblende bi: biotite

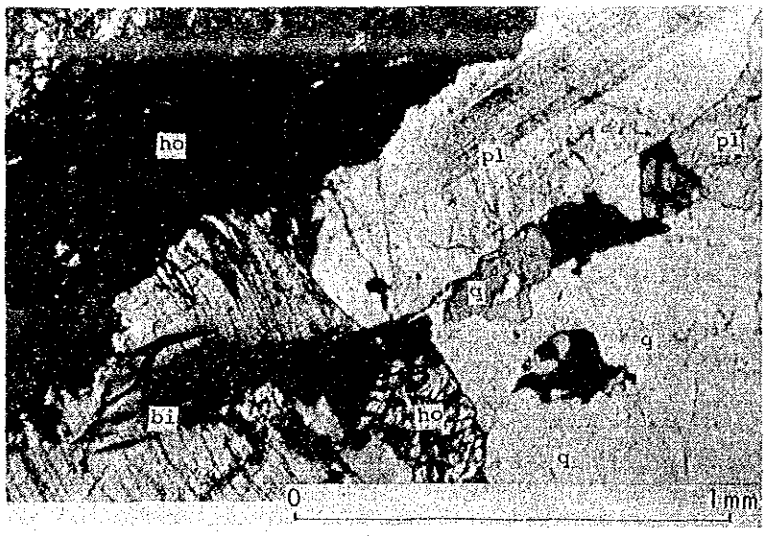


Plate – 8 Microscopic Photo of Biotite-Hornblende Quartz-Diorite of Itogon Quartz-Diorite Body (F–143)
q: quartz pl: plagioclase bi: biotite

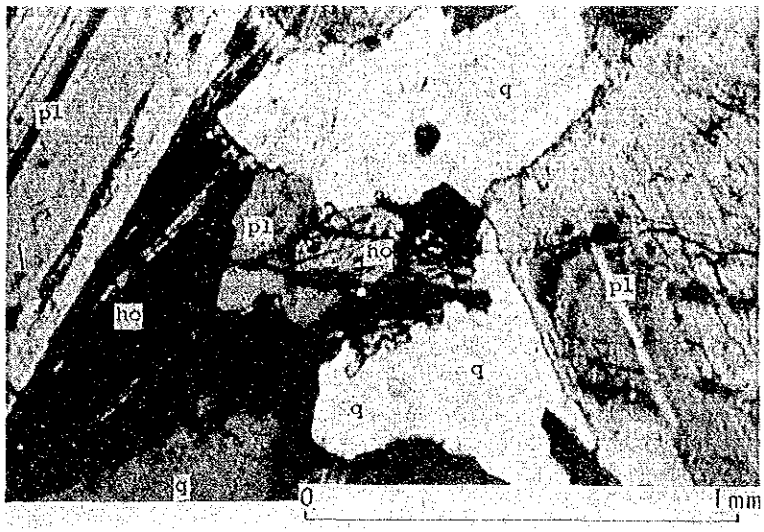


Plate – 9 Microscopic Photo of Hornblende-Biotite Tonalite of Itogon Tonalite Body (F–269)
pl: plagioclase ho: hornblende q: quartz

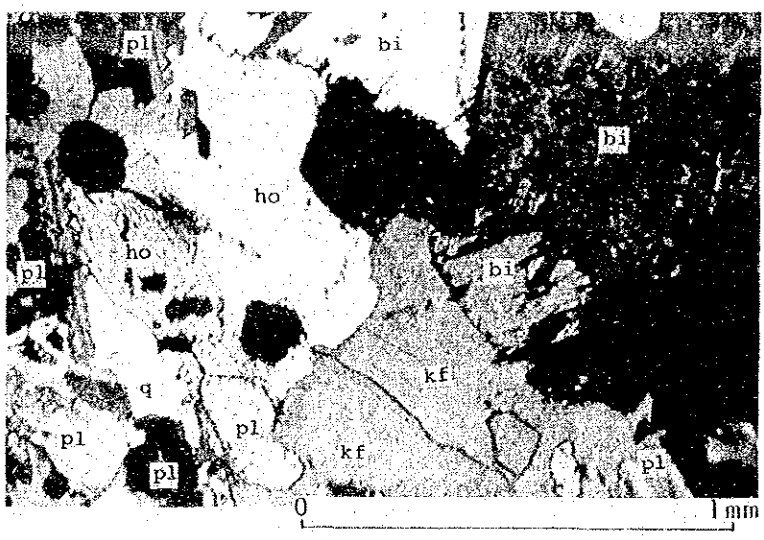


Plate – 10 Microscopic Photo of Biotite-Hornblende Granodiorite of Virac Granodiorite Body (F–24)
q: quartz pl: plagioclase ho: hornblende bi: biotite
kf: potash feldspar

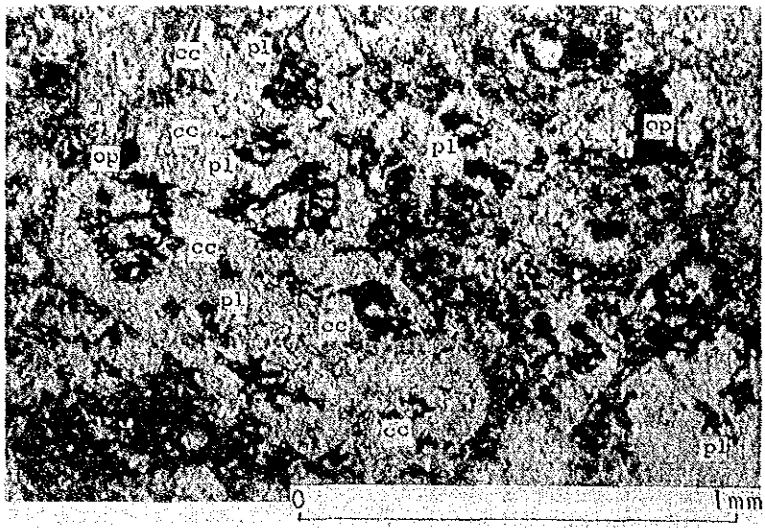
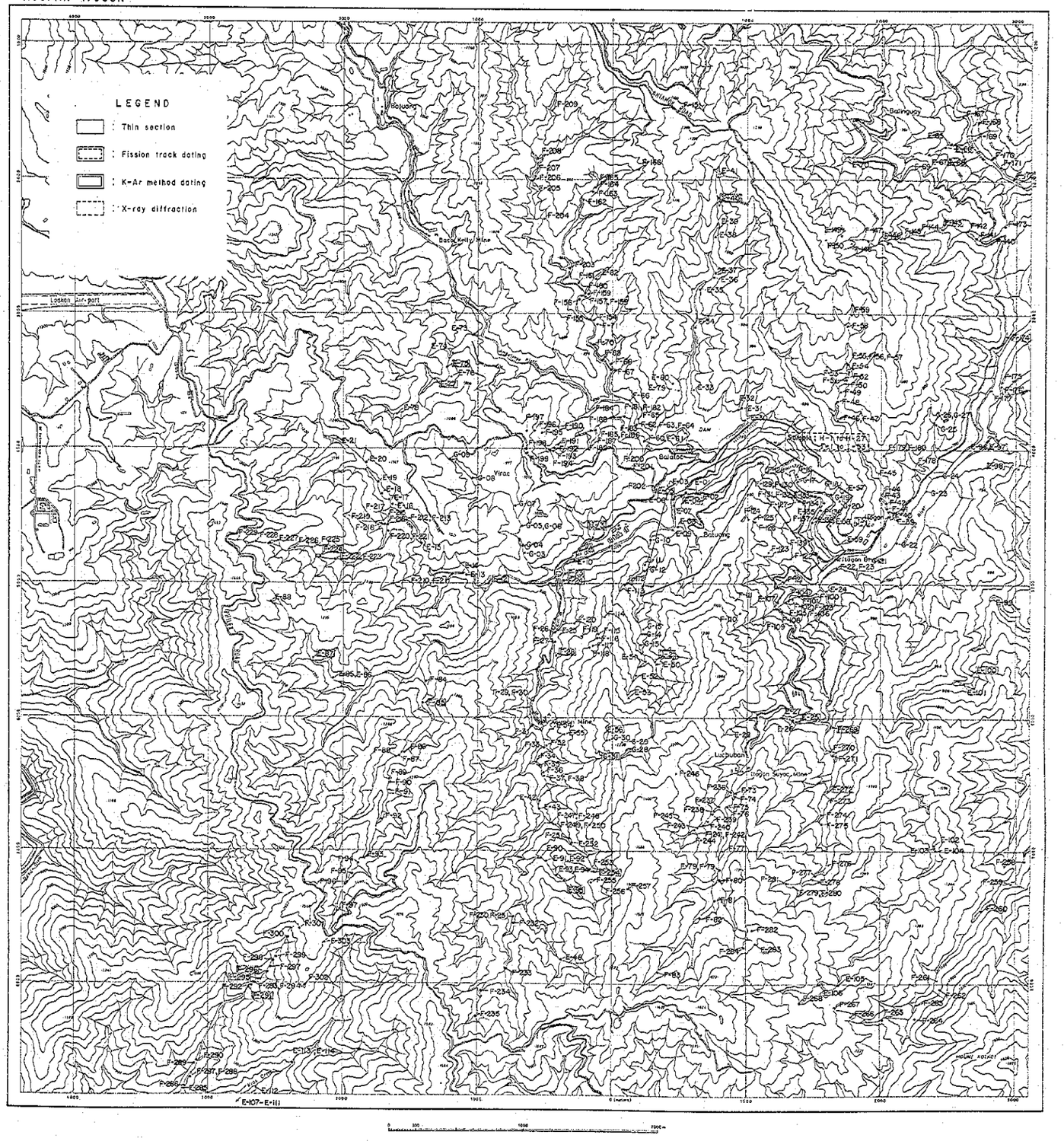


Plate – 11 Microscopic Photo of andesite of Andesite Complex (E–05)
pl: plagioclase cc: calcite op: opaque mineral



App. 2 Rock Sampling Point

10.6 Dacitic breccia

Rock is made up of broken crystals of plagioclases which are twinned and zoned, shards of quartz set in a quartzofeldspathic groundmass. The plagioclases are generally unaltered although some exhibit slight alteration to sphene, chlorite, anhydrite and clay. Vein mineralogy consists of anhydrite, calcite, and quartz (Ah>Ct>Q). Secondary quartz also occurs as islands.

21.6 Dacite breccia

The section is composed of lithic fragments of porphyritic dacite, and hypidiomorphic-granular diorite and individual crystals of plagioclases, quartz, and orthoclases, quartz, and orthoclase in a dacitic groundmass. Alteration in the diorite is characterized by minerals of calcite, chlorite, anhydrite, and clay. Veinlets filled with calcite + anhydrite ± quartz cut across the section.

27.2 Quartz diorite

The rock is holocrystalline and hypidiomorphic-granular in texture. Primary minerals consist of subhedral, twinned and zoned plagioclases, orthoclase, anhedral quartz and flaky biotite. The plagioclases are slightly altered to anhydrite ± quartz, calcite + clay. The orthoclases are starting to be altered to clay minerals. Incipient epidote is noted to alter the mafics. Other secondary minerals are found as interstitial like anhydrite ± quartz, sphene ± quartz + calcite. Main vein mineral is calcite.

This might be just a lithic fragment in the breccia of the preceding section.

30.7 Relatively unaltered fine-grained diorite

Rock is holocrystalline and hypidiomorphic-granular in texture. Primary minerals are subhedral to euhedral, twinned plagioclases, anhedral quartz, altered orthoclase and biotite flakes. Alteration mineral associations are chlorite + sphene + opaques, incipient epidote + chlorite + quartz + opaques, anhydrite + chlorite. Other secondary minerals are interstitial anhydrite. Calcite is the dominant vein-fill.

Probably also a clastics of the upper breccia section.

43.2 Completely altered rock

Relict texture not recognizable due to alteration. Alteration minerals are calcite + anhydrite + quartz (occuring in veins and veinlets with Ct>Ah + Q), weakly birefringent clay (which renders the section its dirty appearance) and disseminated opaques.

55.0 Andesite porphyry

Porphyritic texture of the rock is characterized by phenocrystal subhedral twinned and zoned plagioclases, completely altered ferromagnesians in a quartzofeldspathic matrix. Some ferromags exhibit ophitic texture. Plagioclases are slightly replaced by quartz + anhydrite and clay minerals. The mafics are completely replaced by a mosaic of chlorite + calcite + sphene. The groundmass is slightly altered to calcite + chlorite, calcite + sphene + chlorite.

58.9 Pyroxene-bearing hornblende andesite porphyry

Phenocrysts of fresh, subhedral to euhedral, twinned and zoned plagioclases, euhedral hornblende and subhedral orthopyroxenes in a quartzofeldspathic matrix with disseminated opaques. The rock exhibit weak alteration. Alteration minerals are interstitial anhydrite, incipient epidote-like minerals (slightly altering the hornblende), chlorite + epidote-like minerals + sphene-like minerals, chlorite + quartz + anhydrite + opaques.

68.6 Andesite porphyry

Subhedral to euhedral, twinned and zoned plagioclases, altered ferromagnesians set in a quartzofeldspathic groundmass. The mafics are replaced by calcite + sphene-like minerals + opaques while the plagioclases are slightly altered to anhydrite clay minerals. Other secondary mineral associations are anhydrite + chlorite, cholorite + opaques, incipient epidote + anhydrite + chlorite. Vein minerals are calcite and anhydrite with Ct Ah.

77.4 Dacitic breccia

Lithic clastics of porphyritic andesite and medium-grained dike rock are set in a dacitic groundmass. The porphyritic andesite is characterized by phenocrystal subhedral, twinned and zoned plagioclases in a matrix of plagioclase microlites with interstitial brown glass and specks of iron ore. The plagioclases are slightly altered to anhydrite + clay minerals while the groundmass is weakly altered to anhydrite.

The dike-like rock is made up of interlocking crystals of subhedral, twinned and zoned plagioclases, orthoclase with secondary minerals of anhydrite + chlorite + opaques in the interstices. The plagioclases are partially altered to clay minerals ± anhydrite ± chlorite.

The dacitic groundmass is porphyritic in texture with fragmental twinned and zoned plagioclases in a glassy matrix. The alteration minerals include clay minerals ± anhydrite ± sphene (altering the plagioclases) and sphene anhydrite + anhydrite + chlorite + opaques + calcite (altering the groundmass).

87.7 Dacite breccia

The rock is made up of chloritized as well as silicified lithic fragments in a dacitic groundmass. The chloritized clast is characterized by fragmental plagioclases in a chloritized matrix with other secondary minerals of anhydrite + quartz + opaques + other clays. The silicified fragments is composed of twinned plagioclases and orthoclase with interstitial secondary quartz + biotite + anhydrite + calcite. The plagioclases are slightly altered to chlorite + clay.

The dacitic groundmass is texturally porphyritic with twinned and zoned plagioclases and shards of quartz in a brown glass matrix. Alteration is marked by minerals of anhydrite + calcite + clay ± chlorite altering the plagioclases.

Vein-fill minerals include calcite + anhydrite + chlorite + opaques.

PETROGRAPHIC DESCRIPTIONS OF AGH-2 CORES
(Depths in meters from collar)

5.5 Biotite-hornblende granodiorite

A holocrystalline, hypidiomorphic-granular rock characterized by interlocking crystals of generally fresh, usually twinned, subhedral plagioclases, green hornblendes, brown biotite, anhedral quartz, orthoclase (enclosing plagioclases) and disseminated opaques. Some plagioclases are slightly altered to clay ± calcite; the biotites to chlorite and hornblendes to calcite.

21.2 Same as 5.5 m

Sample. Secondary minerals consist of chlorite ± sphene-like minerals ± opaques (altering biotite), quartz (in veinlets), clays (slightly altering plagioclases).

36.7 Granodiorite

Primary mineral composition similar to previous sections. Alteration products include clays, calcite, chlorite, quartz and epidote (?).

51.0 Granodiorite

62.75 Granodiorite

Calcite + chlorite alter hornblendes and plagioclases. These minerals also occur in stringers. The clays alter plagioclases.

75.8 Granodiorite

Secondary minerals made up of epidote + calcite + chlorite + opaques (replacing mafics) and calcite (replacing plagioclases).

85.5 Highly argillized granodiorite

Except for quartz, the primary minerals have been altered to a secondary suite of minerals. Occurring as replacement products are calcite (of biotite), clays (of feldspars and mafics) and quartz + chlorite + calcite. Vein-fill minerals are calcite + quartz and chlorite.

95.5 Biotite-hornblende granodiorite

Basically same primary mineral composition as previous sections. Alteration marked by minerals of clays (replacing plagioclases), chlorite (of hornblendes) and epidotes (altering biotite and plagioclases; also occurring in veinlets).

107.2 Highly argillized granodiorite

Secondary mineral assemblage consists of calcite, epidote + calcite + chlorite, quartz + chlorite + calcite and clays.

125.0 Altered breccia (andesitic ?)

The section is generally dirty in appearance (plane light) due to clay alteration. Some plagioclases are twinned and only slightly altered. The matrix has been altered to a mosaic of fine quartz, chlorite, calcite and clay. Noted is the sporadic occurrence of anhydrite, which is associated with calcite, altering the plagioclases. Calcite is the only vein-fill mineral observed.

134.55 Hornblende granodiorite.

This is basically the same granodiorite in previous sections except for an increase in ferromagnesian content. Alteration is characterized by the presence of calcite (partially replacing mafics and plagioclases; also in veinlets); minor clay (altering plagioclases) and sporadic anhydrite.

140.5 Altered breccia (andesitic ?)

Primary minerals recognizable are subhedral to euhedral, twinned plagioclases, minor apatite and disseminated opaques. The mafics have been completely altered to calcite + chlorite + clays + sphene-like minerals. Some plagioclases are altered to clays + calcite. Quartz occurs in patches and stringers.

144.05 Altered andesite porphyry

Alteration is characterized by the ubiquitous and pervasive occurrence of calcite. With chlorite + birefringent clay + sphene-like minerals, it replaces the mafics. It is also found associated with clays, altering the plagioclases. In veinlets, it occurs with minor quartz. The latter mineral is also present as islands in the groundmass.

154.15 Same as 144.05

Except for minor apatite, the primary minerals have been replaced by secondary minerals. Clays are the most pervasive alteration products. They are found associated with chlorite and opaques. Quartz is present in patches and in veinlets.

161.8 Altered andesite porphyry

Alteration mineral associations are chlorite + clays and epidote + calcite, clays ± chlorite. Quartz occurs in clusters.

169.05 Altered granodiorite

Except for quartz, the primary minerals have been altered to a secondary suite of minerals, consisting of well-crystallized epidote, calcite + clays and chlorite (in veinlets). In terms of abundance, clays > calcite > chlorite > epidote.

178.8 Hornblende granodiorite

The same mineralogy as 134.55 m. The feldspars are being altered to well-crystallized epidote and minor clays. Some mafics have been completely altered to chlorite + calcite + opaques while some are starting to be replaced by calcite. Found in clusters are fine-grained anhedral quartz. Calcite also occurs in stringers.

192.65 Hornblende granodiorite

Basically same mineralogy as previous sections except with increase in mafic content. The mafics are slightly altered to chlorite, calcite and well-crystallized epidote (also altered to calcite). Calcite + clays slightly replace plagioclases. Found in stringers are poorly crystalline epidote.

206.73 Argillized porphyritic rock

Pervasive alteration to clay renders the section its dirty appearance. Present as vein-fill minerals are calcite, quartz and calcite + quartz + chlorite + opaques.

209.43 Argillized porphyritic rock

As in previous section, clays are very pervasive. Other alteration minerals are calcite (large crystals in wide vein, associated with quartz) and minor chlorite + calcite (in mafics).

271.1 Altered granodiorite

Except for quartz, the other primary minerals are altered. Clays are still the most pervasive alteration product. Other secondary minerals are chlorite (in mafics and in stringers), calcite (replacing plagioclases and mafics and in veinlets) and disseminated opaques.

290.4 Hornblende andesite (dike ?)

This has an almost granular texture with observed primary minerals of subhedral, twineed and zoned plagioclases and hornblendes. The secondary mineralogy is composed of chlorite + calcite + clays, well-crystallized epidote, minor patchy anhydrite and quartz in clusters.

305.6 Hornblende granodiorite

Same mineralogy as granodiorites in the upper section. The plagioclases are slightly altered to calcite and clays. The mafics are altered to chlorite and well-crystallized epidote. Opaques are found as disseminated crystals.

311.85 Hornblende andesite porphyry

Subhedral to euhedral, twinned plagioclases and hornblendes are laid on a quartz-ofeldspathic matrix. Alteration is marked by well-crystallized epidote, chlorite and calcite, altering the hornblendes. Patchy anhydrite in minor amounts is also noted.

315.1 Hornblende granodiorite

The same primary minerals as granodiorites above. The feldspars are altered to flaky clay minerals (associated with calcite), patchy anhydrite and calcite + chlorite. Well-crystallized epidote occurs in clusters.

324.35 Hornblende granodiorite

Secondary minerals are calcite and clays (slightly altering the plagioclases); calcite and anhydrite (altering the mafics) and disseminated opaques. Veinlet minerals are calcite ± anhydrite.

333.65 Hornblende andesite porphyry (dike ?)

The plagioclases have been altered to clays, usually well-crystallized epidote (starting to alter to calcite) and chlorite + calcite. Occurring in stringers are epidote ± quartz. Patchy anhydrite and quartz are also noted.

335.5 Same as 333.65 m

Secondary mineralogy consists of calcite + clays (altering the plagioclases), calcite ± chlorite (altering the hornblendes), patchy anhyrite and quartz. Well-crystallized fan-shaped epidotes are also present and where found in clusters, are associated with calcite. Epidotes exhibit retrogadation to calcite.

340.05 Andesite dike (?)

Like section 290.4, the sample exhibits almost granular texture. Alteration is characterized by the mafics being altered to calcite + chlorite ± minor epidote ± opaques and chlorite ±

340.05 Sphene-like minerals;

The plagioclases to clays ± chlorite ± opaques and well-crystallized epidote. Patchy anhydrite in minor amounts observed.

349.75 Andesite porphyry (also a dike ?)

The secondary minerals are well-crystallized epidote, clays, calcite, chlorite (already altering to calcite) and quartz.

PETROGRAPHIC DESCRIPTIONS OF AGH-3 CORES
(Depths in meters from collar)

27.0 Feldspathic wacke

The section is made up of fine (0.25 – 0.125 mm), angular to sub-angular grains of quartz (10%), feldspars (40%), flaky clays (35%), disseminated opaque anhedras (5%) and hematite stains (10%), which sometimes outline the feldspars.

30.1 Conglomerate

The fragments range in size from 2 mm. to more than 5 mm. and are generally andesitic and dioritic in composition. These fragments appear to be set in a clayey matrix. Noted were stringers of secondary quartz.

37.8 Pyroxene-bearing porphyritic plagioclase andesite (lava flow)

Primary minerals of phenocrystal and microlithic plagioclases, clinopyroxenes, vesicular chlorite and disseminated opaques were observed. Alteration is weak as characterized by trace amounts of epidote (altering the plagioclases), clays (partially altering plagioclases) and disseminated sphene (?).

50.75 Conglomerate

Fragment composition similar to 30.1 sample. Alteration is almost absent except for occurrence of epidote in lithics and quartz + opaques in stringers.

62.5 Hematitic feldspathic wacke

Grain part composed of angular to sub-angular quartz and feldspars (55%), and minor pyroxenes. Hematite stains make up 45% of the section.

68.1 Medium-grained feldspathic wacke

The grains are angular to sub-angular with size range of 0.25 mm. to 0.5 mm. These are composed of feldspars, quartz and minor andesitic fragments. Also noted were flaky clays, chlorite, disseminated opaques and sphene (?) and hematite stains.

76.6 Conglomerate

Fragment part consists of pilotaxitic andesite porphyries and holocrystalline, allotromorphic-granular textured granodiorites. Alteration minerals in the andesites are epidotes + chlorite while in granodiorites, epidote, hematite stains and quartz (in stringers).

89.6 Hornblende andesite porphyry (dike ?)

Primary minerals are subhedral hornblendes and subhedral plagioclases (both as phenocrysts and microlites). Secondary mineralogy made up of calcite (replacing plagioclases and mafics; also in stringers); chlorite (in matrix), well-crystallized epidotes (altering to calcite); disseminated opaques and flaky clays (associated with calcite, altering the plagioclases).

92.3 Plagioclase andesite porphyry

This section has a pilotaxitic matrix, with the phenocrystal plagioclases usually pseudomorphed by secondary minerals. Alteration is weak with the plagioclases being altered to chlorite, flaky clays and epidotes. Occurring as disseminations are opaques and sphene-like minerals. The epidotes also occur in veinlets and exhibit retrogadation to chlorite.

96.65 Chloritic wacke (?)

The section is dirty in plane light (probably due to presence of clays). The fragments are generally medium-grained and made up of angular to sub-angular plagioclases with minor andesitic ones. These fragments are usually rimmed by leucoxene and cemented by chloritic clays. Clays + calcite pseudomorphs the plagioclases and mafics. Patchy microcrystalline quartz as well as chlorite is observed in the matrix. Epidotes are usually well-crystallized and altering to calcite. Calcite is present in stringers with anhyrite (?).

109.85 Intensely argillized andesite porphyry

The original minerals have been replaced by pervasive clays. Quartz occurs in patches and in stringers. Clays + opaques also found in veinlets.

115.5 Intensely altered andesite porphyry

Clays are the most pervasive alteration products. Basal pseudomorphs of hornblendes are altered to epidote + chlorite + clays + calcite. An epidote vein occurs adjacent to a quartz + opaques vein. Quartz also found in stringers. In terms of abundance, clays calcite epidote quartz.

124.35 Moderately altered andesite porphyry

As in previous section, clays are most abundant. The plagioclases are altered to epidote (some retrograding to calcite), clays and calcite. The mafics are altered to chlorite + epidote + calcite + opaques. Microcrystalline quartz occurs as islands.

133.2 Hematitic fine-grained wacke

Composed of sub-angular quartz grains (0.25 – 0.5 mm.), flaky clays, lithic fragments outlined by hematite (which makes up 40–45% of the section). Occurring in stringers are clays and opaques. Calcite is found in veinlets, lined with chlorite.

138.9 Fine-grained wacke

The fragment part consists of sub-angular quartz and feldspars, biotite flakes and disseminated opaques. Clays compose 50% of the section. Minerals of secondary nature are quartz ± minor calcite ± opaques (in veinlets/stringers).

145.5 Moderately altered andesite dike (?)

The plagioclases are subhedral to euhedral, exhibiting partial alteration to clays and well-crystallized epidotes. The latter are starting to alter to calcite. Microcrystalline quartz occurs in the matrix as patches. Calcite + quartz is found in veinlets.

147.4 Fine grained wacke.

Similar to 138.9 sample.

149.9 Hematitic fine-grained wacke

Similar to 133.3 m.

153.1 Altered porphyritic andesite (?)

The mafics are completely replaced by calcite + clays. Some of the plagioclases are not altered while others are altered to calcite, clays and opaques.

160.6 Same lithology as 153.1 except for more phenocrysts in this section. Chlorite + calcite + well-crystallized epidote alter the mafics and plagioclases. Some plagioclases are incompletely replaced by calcite + clays + opaques. Occurring in patches are quartz + opaques + epidote; in veinlets, calcite + quartz. The epidotes retrograde to calcite.

167.15 Fine-grained wacke

Alteration is weak with opaques found as stringers and disseminations and calcite + clays replacing some fragments.

178.5 Moderately altered hornblende andesite porphyry

Phenocrystal mafics and plagioclases show incomplete to complete alteration to calcite + chlorite, calcite ± clays ± epidotes. Found in veinlets are calcite + epidotes + clays.

188.35 Slightly altered hornblende andesite porphyry

Section is similar to previous sample. Alteration is characterized by calcite, chlorite and epidotes as replacement products and calcite + quartz in veinlets.

195.9 Slightly altered biotite-hornblende granodiorite

Primary mineralogy made up of subhedral to euhedral twinned and zoned plagioclases, anhedral orthoclase (mantling the plagioclases), interstitial anhedral quartz, green hornblendes, brown biotite and accessory apatite. The plagioclases are partially altered to epidote and calcite: the hornblendes to chlorite + calcite + epidotes; and the biotites to chlorite and epidotes. Calcite + quartz occur in veinlets.

204.0 Slightly altered biotite-hornblende granodiorite

The same primary mineralogy as previous sample. Alteration is weak with the mafics altered to calcite + epidote + opaques + chlorite, chlorite + epidotes + clays; and the plagioclases to calcite + clays. In stringers are calcite + opaques.

216.45 Same as 204.0 sample.

236.4 Still granodiorite. Alteration assemblage consisting of calcite ± clays ± opaques (in stringers; and slightly altering plagioclases); chlorite + epidote ± leucoxene (altering the mafics); clusters of epidote with associated quartz ± calcite; and disseminated opaques.

252.2 Still granodiorite. Secondary minerals are well-crystallized epidote (occurring in clusters) and calcite (slightly altering plagioclases; and in stringers).

266.45 Propylitized andesite porphyry

Subhedral to euhedral, sometimes twinned and zoned phenocrystal plagioclases and altered mafics are set in a pilotaxitic groundmass with feldspar microlites that appear to be welded due to albitization. The plagioclases are partially replaced by epidote, chlorite and calcite; the matrix by clays and chlorite.

275.75 Also propylitized andesite porphyry. Noted is the increase in clays, altering the plagioclases.

285.15 Also propylitized andesite porphyry.

293.4 Basaltic andesite porphyry (lava) in contact with hornblende granodiorite. The basaltic andesite has a hyalopilitic matrix with glass occupying interspaces between feldspar microlites. Its phenocrystal plagioclases are usually subhedral to euheldral, twinned and zoned and showing partial alteration to clays. The mafic minerals (hornblendes and orthopyroxenes) are altered to chlorite ± calcite + quartz and calcite, respectively.

The hornblende granodiorite part of the section is similar to the granodiorites in the upper section.

304.5 Biotite-hornblende granodiorite

Basically same primary mineralogy as previous granodiorites. Alteration is marked by minerals of clays, calcite and epidotes (partially replacing the plagioclases and mafics) and calcite + quartz (in veinlets/stringers).

315.5 Still granodiorite. Same primary and secondary mineralogy as 304.5 except for increase in abundance of epidotes.

322.45 Still same granodiorite as 315.5 sample.

PETROGRAPHIC DESCRIPTIONS OF AGH-4 CORES
(Depths in meters from collar)

27.5 Biotite-hornblende granodiorite

The rock is holocrystalline and hypidiomorphic-granular in texture. The primary minerals are subhedral, twinned plagioclases, orthoclases (mantling the plagioclases), interstitial quartz, brown biotite, green hornblendes and accessory sphene. Alteration is very feeble with relatively well-crystallized epidotes (deuteric ?) in stringers or as specks in feldspars. The plagioclases are starting to alter to minute clays; the biotites to chlorite and clay-like streaks.

35.4 Propylitized andesite porphyry

The phenocrystal part consists of green euhedral, occasionally twinned hornblendes and subhedral, twinned plagioclases. The groundmass is felty with feldspar microlites appearing to be welded due to albitization. The hornblendes are partially altered to calcite, sometimes associated with well-crystallized epidotes (which appear to be deuteric). Chlorite occurs (a) in minute cracks in the plagioclases; (b) in the matrix; and (c) occasionally completely replacing the mafics with associated epidotes.

43.1 Propylitized andesite porphyry

Phenocrystal plagioclases and euhedral hornblendes are set in a trachytic matrix with chlorite occupying the interspaces between feldspar microlites. Secondary mineralogy consists of clays, calcite, epidotes and quartz.

52.9 Biotite-hornblende granodiorite

This bears the same primary minerals as sample 27.5. Alteration is almost nil with minor amounts of flaky clays (along minute cracks in the plagioclases); chlorite (altering the biotites); and well-crystallized epidotes.

69.6 Moderately altered andesite porphyry

The phenocrystal plagioclases and mafics are usually completely replaced. The groundmass is felty with interstitial chlorite noted. Alteration is marked by clays, calcite, microcrystalline quartz and leucoxene disseminations.

75.75 Moderately altered biotite-hornblende granodiorite

Except for quartz, the feldspars and ferromagnesians have been corroded and altered to calcite + epidote + minor chlorite (which also outlines the cleavages of hornblendes). Pyrite occurs as disseminations. Vein-fill materials are calcite + minor epidote ± chlorite + quartz.

76.9 Moderately altered andesite porphyry

As in sample 69.6, the phenocrystal plagioclases and mafics are completely replaced by calcite ± quartz ± pyrite and clays. The matrix is trachytic with chlorite interstitial between sub-parallel feldspar microlites which have been altered to clays. Other secondary products are disseminated pyrite, calcite in stringers and quartz (in the matrix.).

85.92 Slightly altered andesite porphyry

Similar in phenocrystal composition as previous section. Groundmass is hyalopilitic. Alteration minerals present are calcite (in stringers and partially replacing plagioclases and mafics); clays (altering the microlites and phenocrystal plagioclases and mafics) and minor sphene.

86.6 Moderately altered hornblende-andesite porphyry

The phenocryst, consisting of subhedral and twinned plagioclases and hornblendes, are embedded in a felty groundmass. Most feldspars are usually partially altered to clays ± chlorite and exhibit albitization. Some are altered to clays + calcite ± epidote. The mafics are generally completely replaced by chlorite + calcite ± epidote. Noted in stringers are quartz ± calcite ± epidote.

102.5 Moderately altered andesite porphyry

This has a trachytic matrix with chlorite filling the interspaces between feldspar microlites. Replacing the feldspars and ferromagnesians are calcite, clays and chlorite. Fine disseminations of opaques are noted. Quartz (?) or albite (?) are also observed in matrix.

107.7 Slightly altered biotite granodiorite

The section contains more biotites than hornblendes in comparison with the granodiorite in previous sections. Alteration is marked by the occurrence of calcite ± clays ± chlorite (in the plagioclases); chlorite + calcite (in the biotite); and well-crystallized epidotes, occassionally associated with calcite + chlorite.

121.5 Weakly altered hornblende andesite porphyry with an intrusion of granodiorite

The andesite has an hyalopilitic matrix. Alteration here is characterized by calcite, clays and poorly-crystallized epidotes. The granodiorite is likewise weakly altered with minerals of well-crystallized epidotes (sometimes altering feldspars with minor calcite and clays), chlorite, microcrystalline quartz and flaky clays.

130.84 Moderately altered biotite granodiorite

This has a similar primary mineralogy as 107.7 sample. The minerals, however, exhibit crushing. Secondary products are chlorite ± calcite, altering the biotites; clays ± calcite, partially altering the plagioclases; and epidotes, associated with calcite + chlorite, in a veinlet.

138.74 Weakly altered hornblende-biotite granodiorite

The alteration minerals noted are chlorite, calcite, epidote and minute clay flakes. Occurring in stringers are fine microcrystalline quartz ± minor calcite, which are sometimes lined by chlorite.

148.9 Slightly altered biotite granodiorite

This bears primary minerals similar to sample 107.7. Secondary minerals consist of well-crystallized epidote (associated with calcite ± quartz); chlorite (altering the biotites); clays (associated with calcite and epidote, in clusters). Found in stringers are calcite (with quartz + epidote) and clays.

155.4 Moderately altered hornblende andesite porphyry

The phenocrystal part is made up of usually incompletely altered plagioclases and completely altered hornblendes. Alteration products are calcite + clays ± chlorite; usually finely disseminated opaques with occasional larger pyrite anhedras; quartz (?) or albite (?) in matrix.

158.7 Breccia

The section is highly brecciated with presence of numerous veins filled with quartz (occasionally associated with calcite). Occurring as replacement products of original minerals of granodiorite are calcite + clays + chlorite ± opaques. This may well be the contact between the andesite and granodiorite.

163.8 *Veined granodiorite*

Except for quartz, the primary minerals have been altered to clays, calcite, chlorite. (Note: clays > calcite > chlorite). Vein minerals comprise of quartz, calcite and opaques (quartz > calcite > opaques).

173.3 Moderately altered biotite granodiorite

The feldspars are altered to clays + calcite, while the biotites are partially altered to chlorite. Vein-fill minerals consist of calcite + minor quartz ± epidote, sometimes lined by chlorite.

174.1 Intensely altered granodiorite

Replacing the mafics are calcite + chlorite + epidote. The feldspars are altered to calcite + clays + epidote + quartz (?).

184.1 *Slightly altered biotite-hornblende granodiorite*

This basically the same as the previous granodiorites except for the presence of minor clinopyroxenes. Alteration products consist of minute clays, calcite, chlorite, epidote and disseminated opaques. Found also in stringers are calcite (with chlorite) and epidotes.

192.5 Propylitized andesite porphyry

The feldspars exhibit albitization. Calcite ± chlorite replace the feldspars and mafics; while epidote + calcite ± clays ± leucoxene replace feldspars.

201.35 Slightly altered biotite-hornblende granodiorite

Partially altering the feldspars and mafics are chlorite, clays ± calcite and calcite ± opaques. Calcite + epidote fill stringers.

211.2 Slightly altered biotite-hornblende granodiorite

Alterationwise, this is similar to sample 201.35 except for the absence of calcite.

238.3 Intensely altered (argillized) granodiorite

Except for quartz, the primary minerals are totally replaced by the assemblage-chlorite and clays. Vein-fill minerals include calcite + chlorite + quartz with minor opaques.

259.1 Slightly altered biotite-hornblende granodiorite

Replacement products are epidote + chlorite (of biotites) and clays (of feldspars).

271.3 Intensely altered granodiorite

Similar to sample 238.3.

279.9 Weakly altered biotite-hornblende granodiorite

Alteration minerals consist of chlorite, epidotes, calcite and clays.

295.25 Intensely altered granodiorite

Similar to sample 238.3.

313.75 Moderately altered granodiorite

The feldspars are altered into well-crystallized epidotes and clays ± calcite; while the biotites are incompletely replaced by chlorite. Occurring in stringers are microcrystalline quartz ± calcite ± epidote.

332.0 Moderately altered granodiorite

Similar to 313.75.

335.3 Moderately altered andesite porphyry

The phenocrystal feldspars and mafics are completely altered and embedded in a trachytic matrix (similar to that of 43.1 sample). Secondary mineralogy is made up of clays + calcite (clays > calcite), altering feldspars and mafics; disseminated opaques and sphene-like minerals; chlorite; and albite (?). Vein fill minerals include calcite > pyrite > quartz.

341.35 Slightly altered hornblende andesite porphyry

The phenocrystal part, which consists of subhedral, twinned plagioclases and subhedral hornblendes, is set in an intersertal groundmass with chlorite filling the interspaces between microlites and ferromagnesian granules. The feldspars are weakly altered to calcite, clays ± chlorite ± calcite; the mafics to chlorite + calcite + clays ± opaques and minor epidotes + calcite + chlorite + quartz. Calcite ± quartz occure in stringers.

345.5 Moderately altered granodiorite

Alteration is marked by minerals of clays, calcite, epidotes and chlorites (replacing the feldspars and mafics); calcite and clays (found in stringers).

355.0 Relatively fresh biotite-hornblende granodiorite

Basically the same primary minerals as the bt-hb granodiorite in 184.4. Alteration is feeble with minor amounts of clays and epidote (?).

366.6 Slightly altered biotite-hornblende granodiorite

The biotites are occasionally weakly altered to chlorite and epidotes. The feldspars are likewise weakly replaced by clays + calcite. Vein-fill minerals are calcite + quartz and epidote.

381.55 Moderately altered granodiorite with brecciated portion

Alteration in the granodiorite is characterized by chlorite (altering the biotites), calcite ± clays (in feldspars) and calcite + quartz (in veinlet). The brecciated part of this section is marked by intense alteration to clays + calcite with numerous veins of calcite, clays, quartz and chlorite

392.7 Slightly porpylitized andesite porphyry

The feldspars here are albitized and incompletely replaced by calcite + clays + minor epidote. Calcite is also present in stringers.

401.1 Slightly altered biotite-hornblende granodiorite

The feldspars are altered to calcite and clays; the hornblendes to calcite and chlorite, the biotites to epidote, occasionally associated with calcite and chlorite. Occurring in stringers are calcite + minor chlorite + quartz.

423.7 Breccia

Alteration ranges from moderate to intense with replacement products consisting of calcite, clays, chlorite and disseminated opaques. Vein minerals include calcite ± clays, quartz + calcite. This is most likely the contact between granodiorite and andesite.

503.9 Moderately altered hornblende andesite porphyry

The hornblendes are altered to calcite + chlorite and epidotes; the plagioclases to calcite + clays and chlorite. Also noted are opaque disseminations and calcite in stringers.

PETROGRAPHIC DESCRIPTIONS OF AGH-5 CORES
(Depths in meters from collar)

9.05 Andesitic breccia

Consists of broken crystals of twinned and zoned plagioclases, hornblende and clinopyroxenes with some highly pyritized fragments. The section is very weakly altered and secondary minerals present are quartz + biotite (?) and calcite in stringers.

20.0 Same rock type as above

Alteration mineralogy includes clays which partially alter some plagioclases and outline the hornblende crystals; chlorite + calcite, altering the groundmass; fine-grained quartz in stringers; and epidote (?) + opaques altering the pyroxenes.

29.2 Hornblende diorite

Holocrystalline, hypidiomorphic-granular in texture characterized by interlocking crystals of subhedral to euhedral twinned and zoned plagioclases, subhedral hornblendes and clinopyroxenes, anhedral orthoclase, interstitial quartz with partially alter hornblende and plagioclase. Quartz + minor calcite + chlorite + opaques, anhydrite are found in stringers.

29.85 Altered andesitic breccia

The section is almost completely replaced by a secondary mineral assemblage composed of calcite, quartz, anhydrite, chlorite, well-crystallized epidote, minor apatite and clays. Vein-fill minerals are quartz + calcite + anhydrite, calcite + quartz + minor epidote, calcite + clay + apatite.

50.15 Altered breccia

Made up of crystals of twinned, zoned plagioclases and pyroxenes, dioritic fragments and completely altered fragments. Some plagioclases are weakly altered to clay + anhydrite and calcite. Found replacing the matrix are quartz, chlorite and anhydrite. Alteration minerals in fragments include clay, anhydrite + calcite, quartz + calcite + opaques (veins) and anhydrite (in stringers).

60.0 Hornblende diorite

Hypidiomorphic-granular in texture with primary minerals of subhedral to euhedral twinned plagioclases, interstitial quartz, green hornblende and anhedral orthoclase (when in contact with plagioclases, this is bordered by myrmekite). Found as vein-fill are calcite + anhydrite + quartz (Ct Ah Q), and well crystallized apatite. Other secondary minerals are chlorite + anhydrite + quartz + calcite (in between crystals), sphene and minor epidote.

70.55 Hornblende andesite porphyry

Phenocrysts of unaltered to slightly altered subhedral to euhedral twinned and zoned plagioclases and mafics are laid in a groundmass of finer laths of plagioclases and quartz. Slight alteration in plagioclases marked by birefringent clay + quartz and calcite. Hornblendes are completely replaced by clay + quartz (?) while the pyroxenes by brown clay + opaques. Occurring in veins are calcite + opaques + quartz ± anhydrite.

79.8 Andesitic breccia

Crystals of subhedral twinned and zoned plagioclases, subhedral clinopyroxenes, brown euhedral hornblende, and dioritic fragments in a matrix of finer plagioclase laths and quartz. Some plagioclases are altered to birefringent clay ± anhydrite. Replacing the mafics are calcite + chlorite + opaques. Calcite occurs in stringers.

90.0 Hornblende microdiorite

Section is highly argillized. Plagioclases are partially altered to birefringent clay + calcite. Hornblende is partially replaced by chlorite + calcite while biotite is altered to chlorite. Calcite + opaques ± chlorite occur in veinlets.

99.85 Microdiorite

Consisting of a primary mineral assemblage of subhedral to euhedral, twinned and zoned plagioclases, euhedral pyroxenes, interstitial quartz and biotite. Calcite + birefringent clay + chlorite partially alters the plagioclases, calcite + minor chlorite + sphene-like minerals alter the pyroxenes and anhydrite + sphene - like mineral alter biotite. Occurring in veins are calcite ± opaques and anhydrite + chlorite + calcite + opaques.

101.0 Breccia

The groundmass is made up of altered phenocrystal plagioclases and ferromagnesians set in dark brown glass. Noted is a microdioritic dike (?) with primary minerals of subhedral twinned plagioclases, flaky biotite, anhedral quartz and orthoclase. Alteration in the matrix is characterized by calcite + opaques + minor anhydrite in veins and altering plagioclases; calcite + chlorite + sphene-like minerals replacing the mafics. Alteration products in the microdiorite are chlorite + calcite + anhydrite in veinlets and replacing the mafics; birefringent clay altering the plagioclases.

106.8 *Microdiorite (dike?)*

Hypidiomorphic-granualr texturally with primary mineralogy of subhedral to euhedral, twinned and zoned plagioclases, hornblende crystals and anhedral quartz and orthoclase (when in contact with plagioclases, some bordered by myrmekites). Secondary minerals include birefringent clay (partially replacing plagioclases), calcite ± chlorite (slightly altering hornblende), anhydrite + calcite ± chlorite (in stringers).

110.0 *Argillized microdiorite*

Texture is hypidiomorphic-granular. The primary plagioclases are replaced by birefringent clay and biotites are altered to calcite. Alteration mineral associations noted are chlorite + calcite, chlorite + anhydrite and calcite + anhydrite (in veins).

125.55 Breccia

Broken crystals of plagioclases, clinopyroxenes, brown hornblende and dioritic fragments in a quartz-rich matrix with specks of iron ore and ferromagnesians. Alteration is weak and characterized by clays (altering some of the plagioclases and mafics), calcite ± chlorite (slightly altering some pyroxenes), anhydrite (in the matrix). Calcite + quartz occur in stringers.

135.65 Microdiorite

Primary minerals include plagioclases, hornblendes, interstitial quartz and orthoclase with accessory apatite. Alteration products consist of clay + calcite + opaques + chlorite (altering hornblende), aggregates of anhydrite and calcite ± minor anhydrite (in veinlets).

144.7 Same rock type as 135.65

Birefringent clay + calcite ± quartz alter the plagioclases; secondary biotite (?) replaces hornblende; calcite alters the pyroxenes. Occurring in stringers is calcite.

153.0 Microdiorite

Plagioclases are altered to a mosaic of fine quartz + birefringent clay + calcite; mafics are replaced by chlorite + calcite. Noted are patchy chlorite + anhydrite. A vein of calcite + opaques occurs adjacent to a quartz + minor calcite + anhydrite vein. Quartz + calcite + chlorite also observed in veins.

162.2 Breccia

Made up of broken crystals of generally fresh plagioclases, orthopyroxenes, hornblende in a quartzofeldspathic matrix. Observed alteration minerals are quartz + anhydrite as fine crystals in stringers, jarosite (?) as tiny flakes in aggregates altering the matrix. Noted absence of calcite.

170.7 Altered microdiorite

Plagioclases are altered to birefringent clay + calcite + chlorite. Occurring in veins are calcite + chlorite + anhydrite + opaques + epidote and quartz + clay.

175.9 Microdiorite

The plagioclases exhibit alteration to calcite + birefringent clay ± anhydrite. Anhydrite + chlorite + calcite occurring in pathces. Found in stringers are opaques with associated anhydrite + chlorite; and calcite.

230.8 Breccia (?)

Primary minerals recognized are twinned plagioclases some of which are altered to birefringent clay and calcite. The mafics have been altered to secondary minerals of chlorite + calcite + anhydrite. The matrix is replaced by chlorite + sphene-like minerals, chlorite + calcite + anhydrite. In veins are calcite + anhydrite (Ct Ah) and chlorite + calcite + anhydrite.

240.3 Altered breccia

Primary minerals have been altered to secondary minerals consisting of chlorite, calcite, clay, sphene-like minerals and opaques. Matrix is highly chloritized. Noted in veins are calcite + anhydrite + quartz.

249.0 Quartz diorite

Texture is allotromorphic-granular. Primary minerals recognized consist of plagioclases, anhedral quartz and accessory apatite. Replacing plagioclases and orthoclases are calcite + clay. Found as vein-fill materials are anhydrite + quartz, calcite + anhydrite + quartz (?) ± chlorite.

262.0 Hornblende microdiorite

Section is made up of subhedral to euhedral twinned plagioclases, anhedral quartz and hornblende. Secondary minerals include anhydrite, chlorite, clay, biotite and opaques. Anhydrite occurs in veins.

273.55 Diorite

Primary minerals consisting of plagioclases, anhedral orthoclase and quartz and altered mafics. Alteration products observed are calcite + chlorite + minor sphene-like minerals (replacing mafics), anhydrite + calcite ± quartz (as aggregates)

286.6 Same rock as 273.55

Secondary mineral assemblage made up of chlorite + calcite (in veinlets), anhydrite, + quartz + chlorite + calcite (as aggregates) and clays (replacing plagioclases).

296.4 Same rock as above. Alteration products are calcite + opaques (of plagioclases and mafics), anhydrite + chlorite + calcite (in veins and as aggregates) and quartz ± anhydrite (in veins).

311.2 Dioritic breccia

The groundmass is made up of plagioclases altered to clay + calcite + anhydrite + opaques and ferromagnesians altered to calcite + chlorite. Occurring in veinlets are anhydrite + calcite + chlorite.

313.3 Dioritic breccia

Alteration is characterized by minerals of calcite + quartz (altering the plagioclases), anhydrite + quartz (as aggregates and in veins), anhydrite + chlorite (in veins).

322.65 Diorite

Alteration minerals noted are calcite + clay (slightly altering plagioclases), aggregates of quartz, chlorite + calcite + anhydrite + opaques (in veins).

332.2 Quartz diorite

Primary minerals noted are fresh twinned and zoned plagioclases, anhedral quartz, brown biotite, orthoclases and myrmekite. Alteration marked by occurrence of calcite + sphene-like minerals (in plagioclases), chlorite + sphene-like minerals (in biotite) and anhydrite + quartz (in veins).

339.5 Breccia

Phenocrystal subhedral twinned and zoned plagioclases, hornblende, clinopyroxenes in a quartzofeldspathic groundmass. Observed alteration products are chlorite + calcite + epidote + (replacing hornblendes), calcite + chlorite (altering pyroxenes). Calcite + quartz noted in veins while chlorite + anhydrite + epidote in vugs.

351.05 Same rock as 311.2

Alteration marked by occurrence of anhydrite in aggregates, sometimes associated with quartz and opaques and clay ± calcite + anhydrite (partially altering plagioclases). Vein-fill minerals are quartz + anhydrite + opaques.

360.7 Hornblende microdiorite

Hypidiomorphic-granular in texture with interlocking crystals of generally unaltered twinned, occassionaly zoned plagioclases, anhedral quartz and orthoclases, hornblende and accessory apatite. Alteration is marked by presence of calcite + anhydrite + quartz + opaques in veins/veinlets.

373.75 Chloritized andesite (?)

Remnants of original phenocrystal feldspars and ferromagnesians in a matrix of microlitic feldspars in a random orientation. Matrix is altered to vuggy chlorite + quartz. The plagioclases are replaced by clays + calcite while the mafics are replaced by calcite + quartz + epidote. Occurring as veinlets is calcite.

382.3 Diorite (?)

Allotromorphic-granular in texture with primary minerals slightly altered plagioclases, mafics and anhedral quartz. The plagioclases are altered to calcite, chlorite, + calcite + opaques, clays and well-crystallized epidote. Clays replace mafics. Noted occurrence of vuggy quartz.

391.9 Quartz diorite

Hypidiomorphic-granular texturally with primary minerals of subhedral twinned plagioclases, anhedral quartz and orthoclase and brown biotite. Plagioclases are altered to clay + well crystallized epidote while mafics are replaced by calcite + opaques. Noted occurring in aggregates is quartz. Vein-fill materials are epidote, chlorite + calcite + opaques + anhydrite with epidote vein older.

399.8 Intensity argillized diorite

Primary minerals, except for quartz are replaced by secondary products consisting of chlorite + calcite (altering mafics), calcite + clay (altering feldspars) and well-crystallized epidote. Vein-fill minerals are calcite + clay, quartz + calcite.

PETROGRAPHIC DESCRIPTIONS OF AGH-6 CORES
(All depths are in meters with respect to collar.)

15.15 Relatively fresh biotite-hornblende quartz diorite

A holocrystalline, hypidiomorphic-granular rock characterized by a primary mineralogy consisting of subhedral twinned and zoned plagioclases (65-70%), anhedral quartz (10–15%), usualsubhedral green hornblendes (5–8%), brown biotites (2–3%) and disseminated iron ore (5%). Alteration is very feeble with minerals of chlorite (slightly altering the ferromagnesians and occurring in cracks in feldspars) and minor amounts of clays in minute cracks in feldspars.

29.7 Weakly altered hornblende andesite porphyry

The matrix is glassy and has been devitrified into fine quartz. The primary minerals consist of subhedral, twinned plagioclases, incompletely altered hornblendes, disseminated iron ore and accessory apatite. Secondary minerals include calcite + chlorite + minor clays ± epidote (incompletely altering hornblende); microcrystalline quartz (occassionally in stringers); and calcite + clays + epidote (partially altering the feldspars).

60–60.2 Biotite hornblende quartz diorite

Same primary minerals as 15.15 m. Calcite and clays partially replace feldspars and mafics. Calcite also occurs in a veinlet.

103.13–103.45 Biotite-hornblende quartz diorite

Alteration minerals make up approximately 5% of the section and consist of chlorite and epidote, partially altering the biotites; calcite, partially altering the hornblende and occurring in stringers; and minor clays in cracks in feldspars.

124.2–124.37 Biotite-hornblende quartz-diorite

This bears the same primary and secondary minerals as 103.15 sample.

154.0–154.2 Weakly altered biotite-hornblende quartz diorite

Alteration is marked by minerals of calcite (slightly altering feldspars and hornblendes; also in stringers with minor chlorite); chlorite (slightly altering biotites) and flaky clays in feldspars and occasionally found in stringers associated with calcite.

189.7–189.85 Weakly altered biotite-hornblende quartz diorite

Chlorite and calcite slightly alters the mafics; clays occur in minute cracks in feldspars. In veinlets are calcite + quartz.

203.4 Biotite hornblende quartz diorite

Alteration products are the same as 189.7 sample.