CHAPTER IV

PETROGRAPHY

4.1 Classification

In this thesis, macroscopic and microscopic descriptions of rocks are explained in detail for the volcanic rocks present in the C-H pits of the Chatree gold mine. The general rock classification is based faintly upon that textures and subsequent classification is made using mineral components following the work done by McPhie et al.(1995) However, the subdivision of the volcanic units cannot be made and mapped in this study due to the unavailability of field data during the time of field investigation. So the volcanic rocks in this study can be divided petrographically into 2 types: coherent unit and non-coherent unit. The coherent unit is further subdivided into andesite and porphyritic andesite based on field observation. The non-coherent unit is divisible into fragment type and fiamme type. The breccia type shows variation in grain size from bottom (coarse fragment to top finer fragment).

4.2 Coherent facies

4.2.1 Andesite

Mesoscopic investigation reveals that andesite rock of the study area is commonly greenish grey to dark grey in color (Figure 4.1). The rocks has fine-grained and aphanitic textures. It has sparsely distributed microphenocrysts (<10%), which are mainly amphibole and 1-3 percent of calcite veinlets.

Microscopically, the andesine has inequigranular texture, groundmass of the andesite is composed of microlite and devitrified glass, the latter was altered into chlorite. Hornblende and its alteration product-chlorite are widely distributed in groundmass. Hornblende is the essential mafic mineral occured in both groundmass and as mafic phenocrysts which range from 5-10 volume percent. It occurs as relict subhedral microcrystals.

Table 4.1(A) Descriptive names used for subdivision of coherent lava (after McPhie et al. 1993)

COMPOSITION
a. estimate based on phenocryst assemblage: - rhyolite: K-feldspar ± quartz (± Ca-poor plagioclase ± ferromagnesian phase: biotite, amphibole, pyroxene,fayalite) - dacite: plagioclase ± ferromagnesian phase: biotite, amphibole, pyroxene ± quartz (± K- feldspar) - andesite: plagioclase + ferromanesian phase: biotite, amphibole, pyroxene(± olivine) - basalt: pyroxene + Ca-rich plagioclase ± olivine b. for aphanitic samples, estimate based on colour: - rhyolite(?), dacite(?) : pale grey, pink, cream, pale green - andesite(?), basalt(?) : dark grey, dark green, dark purple
LITHOUNIT
- massive or flow-foliated, flow-banded, flow-laminated - jointing: columnar, radial columnar, concentric, tortoise shell, blocky, prismatic, platy - pillows or pseudo-pillows
TEXTURE
- porphyritic: a. phenocrysts – type(quartz-phyric, pyroxene-phyric,etc) - abundance (poorly, moderate, highly) - size (fine $\leq$ 1 mm, medium 1-5 mm, coarse $\geq$ 5 mm) b. groundmass – glassy, cryptocrystalline, very fine grained - aphanitic: uniformly microcrystalline - aphyric: no phenocrysts present - glassy: composed of volcanic glass - non- vesicular or vesicular (or amygdaloidal): sparsely, moderate, highly, pumiceous, scoriaceous - spherulitic, microsperulitic, lithophysae-bearing
ALTERATION
- mineralogy: chlorite, sericite, silica, pyrite, carbonate, feldspar, hematite - distribution: disseminated, nodular, spotted, pervasive, patchy
GRAIN SIZE
mud/mudstone < 1/16 mm sand/sandstone 1/16 – 2mm gravel/conglomerate or breccia: granule 2-4 mm, pebble 4-64 mm, cobble 64-256mm, boulder >256 mm

Table 4.1(B) Descriptive names used for subdivision of volcanic clastic (after McPhie et al,1993)

COMPONENT
- crystals, crystal fragment: crystal-rich - lithic fragments: lithic-rich volcanic or non-volcanic, polymict or monomict - pumice or scoria: pumiceous , scoriaceous - shards: shard-rich - accretionary lapilli: accretionary lapilli-rich - vitriclasts: vitriclast-bearing - fiamme: fiamme bearing - cement: siliceous,carbonate,zeolite
LITHOUNIT
- massive (non-bedded) or stratified (bedded) - bedding: laminated < 1 cm very thinly bedded 1-3 cm thinly bedded 3-10 cm medium bedded 10-30 cm thickly bedded 30-100 cm very thickly bedded > 100 cm - equal or unequal thickness - laterally even or uneven thickness - laterally continuous or discontinuous - cross-bedded, cross-laminated - massive (non-graded) or graded normal ↑, reverse↓ normal-reverse , reverse-normal↕ - fabric: clast-supported or matrix-supported poorly sorted, moderately sorted, well sorted - jointing: blocky, prismatic, columnar, platy
ALTERATION
- mineralogy: chlorite, sericite, silica, pyrite, carbonate, feldspar, hematite - distribution: disseminated, nodular, spotted, pervasive, patchy

The hornblende always exhibits strong pleochroism (yellow green to green) Total and partial replacement of hornblende by chlorite and quartz are common (Figure 4.2). Plagioclase in groundmass cannot be determined optically owing to its rather small grain size. The ratio of phenocryst to groundmass is 1:5.

Andesite rocks exhibit strong alteration. Chlorite, quartz and opaque are the alteration products. Optically plagioclase and hornblende are altered to chlorite.

4.2.2 Porphyritic andesite

Porphyritic andesitic rock is commonly grey to dark grey in slab. Plagioclase is the most common among the phenocryts. It occurs as subhedral to euhedal long stubby prism which varies in size from 0.3 mm to 0.6 mm (Figure 4.3). Groundmass is aphanitic and shows some alteration.

Under microscope, groundmass of the porphyritic andesite is composed largely of inequigranular plagioclase and has microlite texture. Hornblende and chlorite are distributed widely in groundmass. Hornblende phenocrysts are as rhombohedral to subprismatic habits and has the size ranging from 0.3 to 0.5 mm (Figure 4.4). Plagioclase about 65-70% modal volume in the groundmass is tabular, but it is too small to be determined optically.

Hornblende occurs as the only essential mafic mineral which ranges from 5-10 volume percents. It occurs as relict euhedral crystals. The hornblende always exhibits strong plechroism (yellow green to green). Hornblende phenocrysts are partially replaced by chlorite.

Tabular plagioclase is abundant about 30-40 percent of its total volume. Plagioclase grains have invariably albite twining. Some of plagioclase is altered to chlorite.

4.3 Non coherent facies

4.3.1 Monomictic breccia or monomictic andesitic breccia

Monomictic andesite breccia rocks are composed only one kind of volcanic fragments (Figure 4.6). Volcanic fragments show jigsaw texture. Most of the volcanic fragments are hematitic andesite . Monomictic breccia rocks are greenish grey to dark grey and usually have calcite veins (Figure 4.5).The proportion of volcanic fragments to groundmass ranges from 5 to nearly 20 percent of modal volume in the total rock.

Microscopically andesite fragments are characterized by red colour and comprise hematite and plagioclase which are mainly small size. Chlorite is distributed in volcanic fragments. In some fragments, flow texture can be also recognized.

The groundmass consists chiefly of opaque and microcrystalline plagioclase, quartz and chlorite. Quartz vein is replaced by epidote (Figure 4.6). Microplagioclase shows tabular shape.

Under thin section, hornblende is found as microphenocryst with rhombic shape. Hornblende is also present as groundmass, and it ranges from 5 to 10 volume percent of the total groundmass. Relict hornblende is subhedral crystal and replaced by chlorite. (figure 4.7).

The characteristic of volcanic rock fragments indicates two episodes of volcanic eruption in the Chatree gold mine area. It is considered that the first eruption is more quiet condition due to the presence of debris flow fragments.

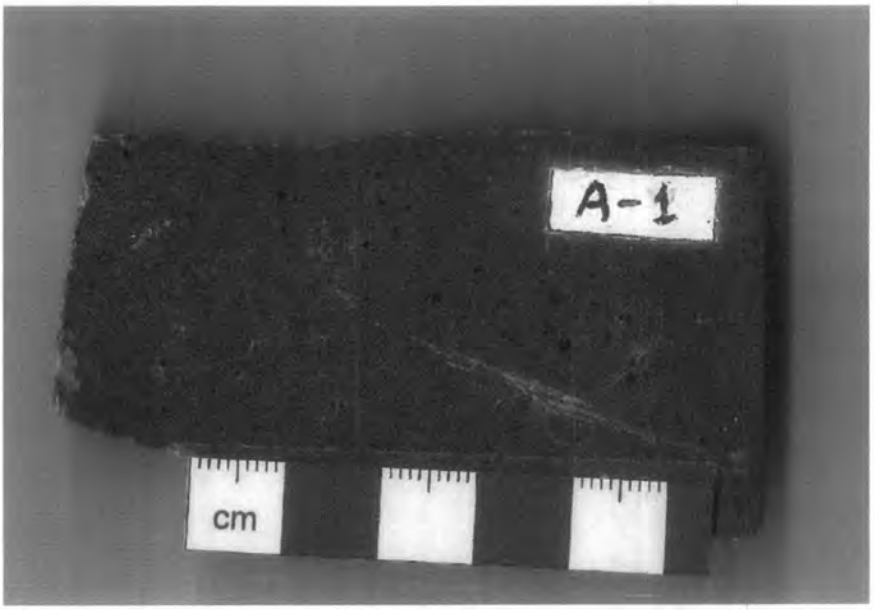


Figure 4.1. Slab of andesite (sample no. A-1) at the Chatree gold mine, Phichit.

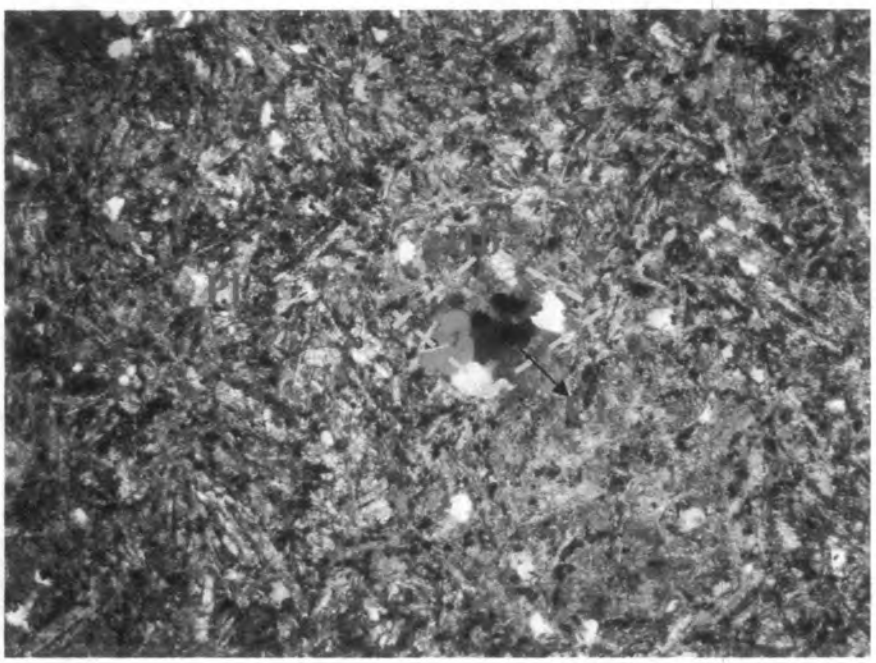


Figure 4.2. Photomicrograph of andesite (sample no. A-1) showing relict prismatic hornblende replaced by chlorite and quartz. Microlite and devitrified glass served as essential groundmass (XPL). The long axis of photo is about 3 mm.

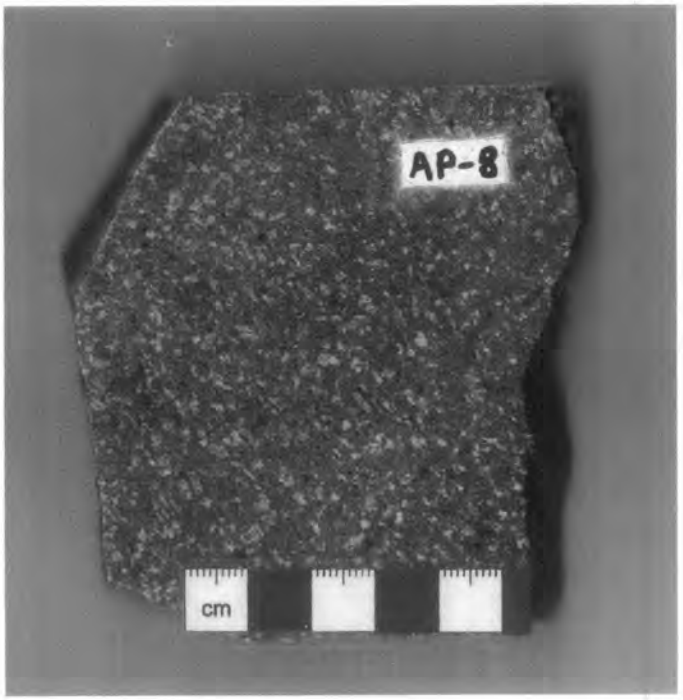


Figure 4.3. Slab of porphyritic andesine (sample no. AP-8) showing abundant stuby feldspar phenocrysts with faint foliation at the Chatree gold mine, Phichit.

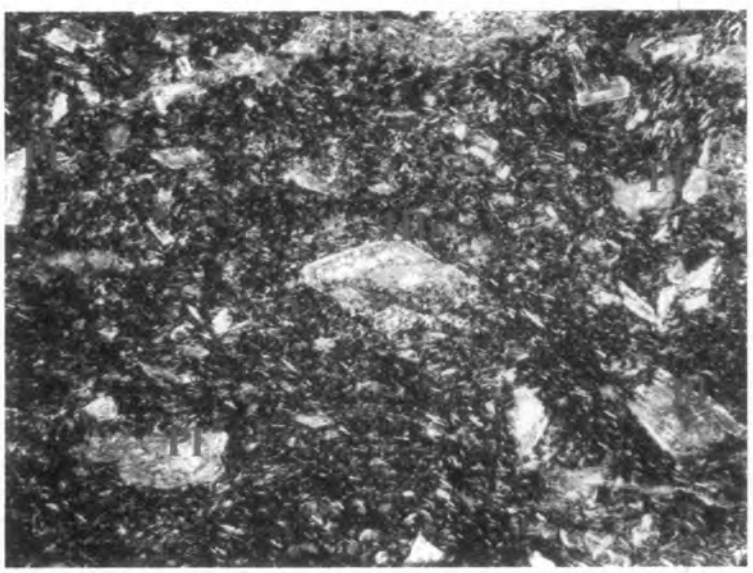


Figure 4.4. Photomicrograph of porphyritic andesite (sample no. AP-8) showing relict hornblende phenocryst partly replaced by chlorite and plagioclase phenocryst replaced by clay and micaceous minerals (XPL). The long axis of photo is about 3 mm.

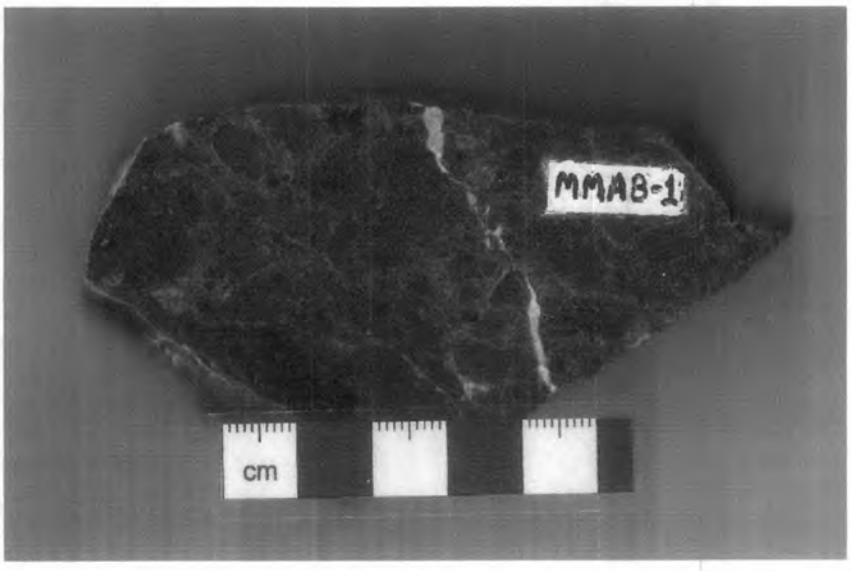


Figure 4.5. Slab of mononictic andesitic breccia (sample no.MMAB-1)showing only one type of dark-colored volcanic fragment at the Chatree gold min, Phichit. Note that the breccia rock was cross cut by calcite vein.

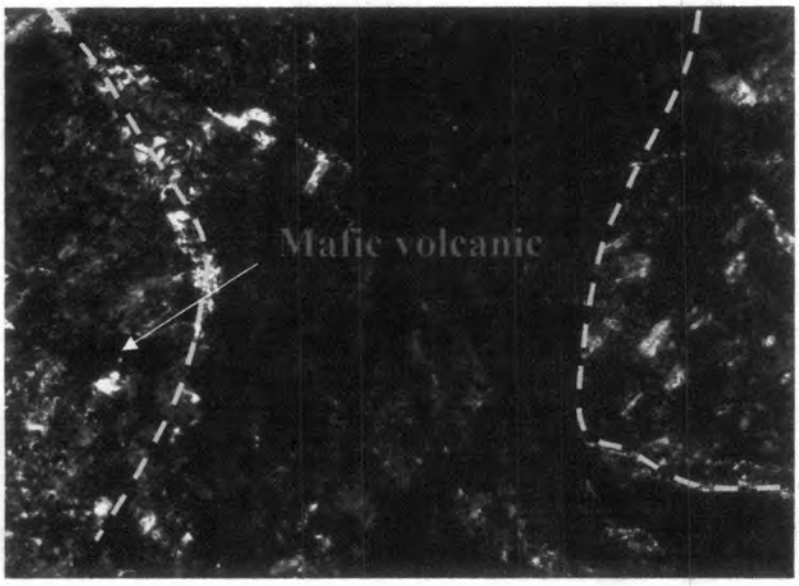


Figure 4.6. Photomicrograph of monomictic andesitic breccia (sample MMAB-1) showing similar type of mafic volcanic fragment (XPL). The long axis of photo is about 3 mm.

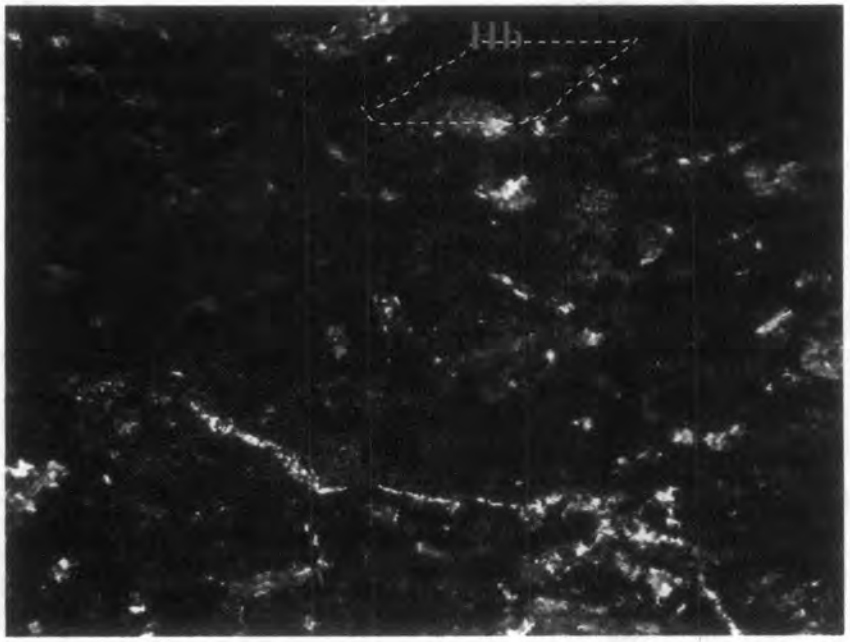


Figure 4.7. Photomicrograph of monomictic andesitic breccia (sample MMAB-1) showing hornblende phenocryst with relict texture (Hb). Note that chlorite almost entirely replace hornblende (XPL). The long axis of photo is about 3 mm.

4.3.2 Polymictic breccia

Petrographic investigation indicates two types of polymictic breccia based upon the compositions of fragments. One is the polymictic rhyolitic breccia and the other is polymictic andesitic breccia.

4.3.2.1 Polymictic Rhyolitic Breccia

Polymictic rhyolitic breccia rocks are composed more than two kinds of fragment. The volcanic fragments are rhyolitic largely, variable in colour and grain size. Generally, the polymictic rhyolitic breccia rocks are light green in colour (Figure 4.8).

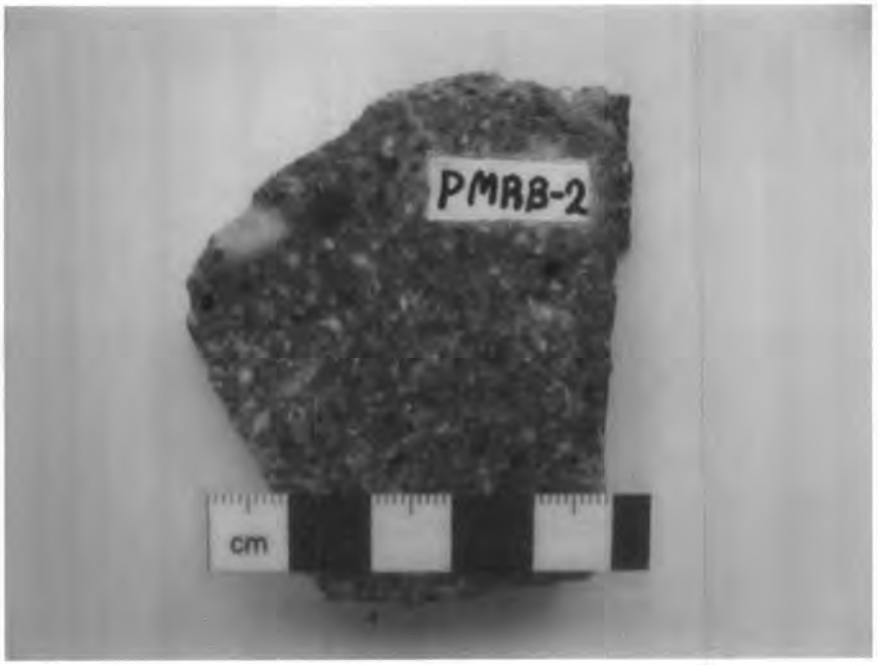


Figure 4.8. Slab of polymictic rhyolitic breccia (sample no PMRB-2) showing various sizes and kinds of volcanic fragments at the Chatree gold mine, Phichit.

Felsic volcanic fragments are composed of plagioclase, quartz and chlorite. This fragment is strongly altered and some are plagioclase fragments (Figure 4.9). Mafic volcanic fragments are also present in some specimens. The proportion of volcanic fragments to groundmass ranges from 25 to nearly 30 volume percent of the total rock.

The groundmass contain felsic constituents. Microphenocryst of plagioclase is found abundantly in groundmass. Its volume ranges from 30 to 40 percent of the total groundmass. Plagioclase is tabular in shape and always show albite twin. The An content as determined by extinction angle to be about oligoclase. Microphenocryst of quartz is also found and its volume ranges from 15 to 20 percent of the tolal groundmass. Chlorite is distributed in groundmass present, and it is always present as alteration product of the glass and devitrified groundmass (Figure 4.10).

This characteristic of volcanic rock fragments indicates that there were more than one episode of volcanic eruption in this area. It is also considered that the volcanic

eruption or violent explosion was involved in the generation of the fragment present in the rocks.

4.3.2.1 Polymictic Andesitic Breccia

Polymictic andesitic breccia is always pale grey in colour in the studied hand specimens. The volcanic fragments are andesite with variable colours and grain size is larger than 2 mm. The rock fragments are mainly red andesite and greenish grey andesite. Generally, they are very poor sorting, and contain subangular to angular fragments (Figure 4.11).

Felsic volcanic fragments are composed mainly of plagioclase, quartz, and epidote. The minerals are rather small in grain size. The felsic volcanic shows microcrystalline texture. Alteration is common in volcanic fragments as characterized by the present of epidote mineral (B in Figure 4.11). Volcanic fragments are mainly felsic.

Mafic volcanic fragments are also present and consist of plagioclase and opaque minerals. Similarly, the mafic volcanic fragments always show microcrystalline texture (A in Figure 4.11).

Both mesoscopic and microscopic investigations reveal that the proportion of volcanic fragments to groundmass ranges from 50 to nearly 60 volume percent of the total rock.

In general, groundmass is felsic with plagioclase and other very fine grained and colored minerals. Sometimes, the groundmass shows slightly porphyritic texture. Plagioclase phenocryst is found ranging from 20 to 30 volume percent of the total groundmass, Plagioclase is frequently tabular in shape and has albite twin, Its An content is about oligoclase to andesine (An content 0-10). Quartz veinlets are also present in groundmass. Alteration of groundmass is characteristically replaced by epidote (Figure 4.11).

This characteristic of breccias indicates that there were more than one episode of volcanic eruption in this area. It is here considered that the process involved the generation of this kind of breccia is the explosive volcanic eruption.

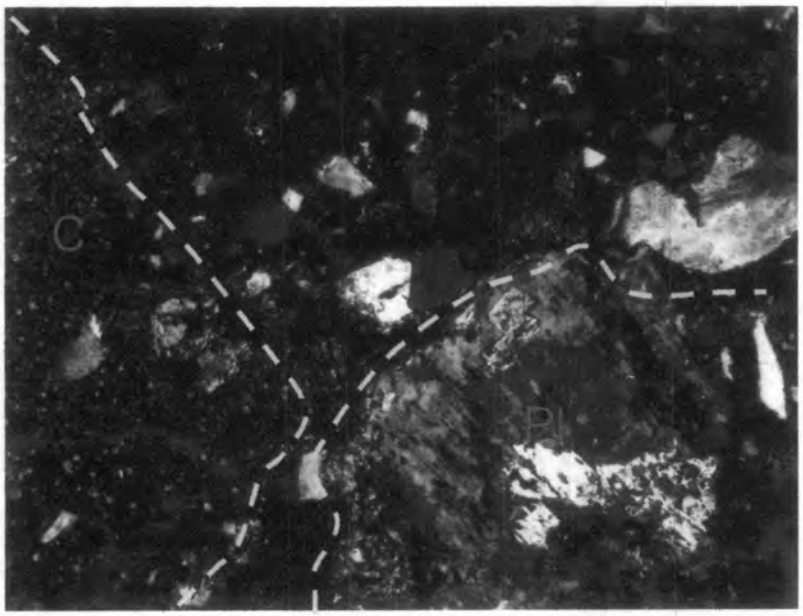
4.3.3 Fiamme breccia

Our petrographic analysis shows that two types of fiamme rocks are recognized based upon its color. They are green fiamme breccia and red fiamme breccia.

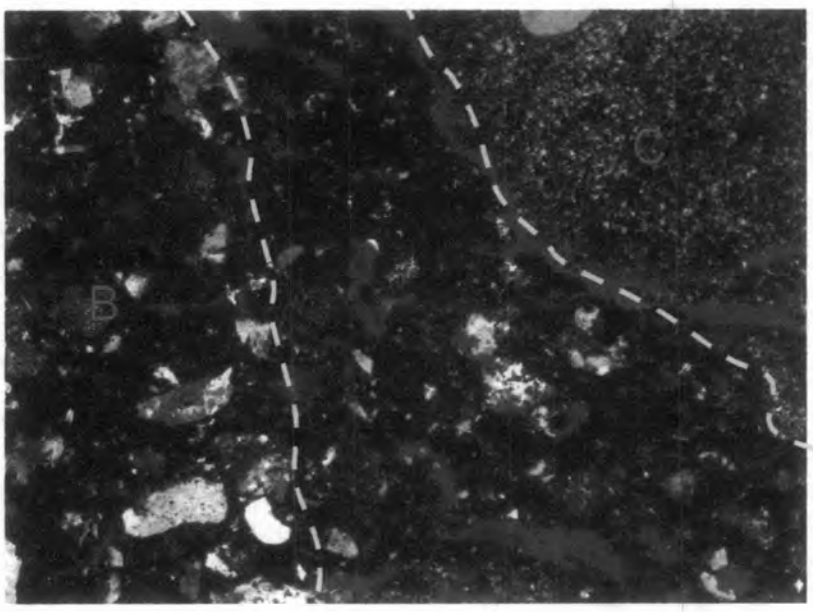
4.3.3.1 Green Fiamme breccia

Based upon mesoscopic investigation, it is recognized that green fiamme breccia rocks commonly show a wide range in size and variable amount of constituent materials. However, the dominant material is generally of lapilli (less than 5mm.) size but some are composed predominantly of volcanic fragments. Green colour is quit a characteristic of this rock type. This fiamme always contains lenticular phenocrysts, welded materials and phyric plagioclase fragments (Figure 4.12).

The other rock fragments are those containing plagioclase, quartz and chlorite aggregate felsic and mafic volcanic fragment are also present in some samples. Generally felsic fragments contain high volume of quartz. The proportion of volcanic to mineral fragments ranges from 40 to nearly 50 volume percent of the total rock. Stretched chlorite and plagioclase phenocrysts are characteristics of this rock. Plagioclase is present as phyric phenocryst. Quartz phenocrysts occur as subhedral to anhedral crystals (Figure 4.13).



(A)



(B)

Figure 4.9. Photomicrographs of polymictic volcanic breccia showing different kinds and sizes of volcanic fragments; **(A)** showing large subhedral laths of altered plagioclase (Pl) and rather felsic fragment (C); **(B)** showing similar felsic fragment (C) and the fragment with altered plagioclase (Pl) on the left (XPL).The long axis of photo is about 3 mm.

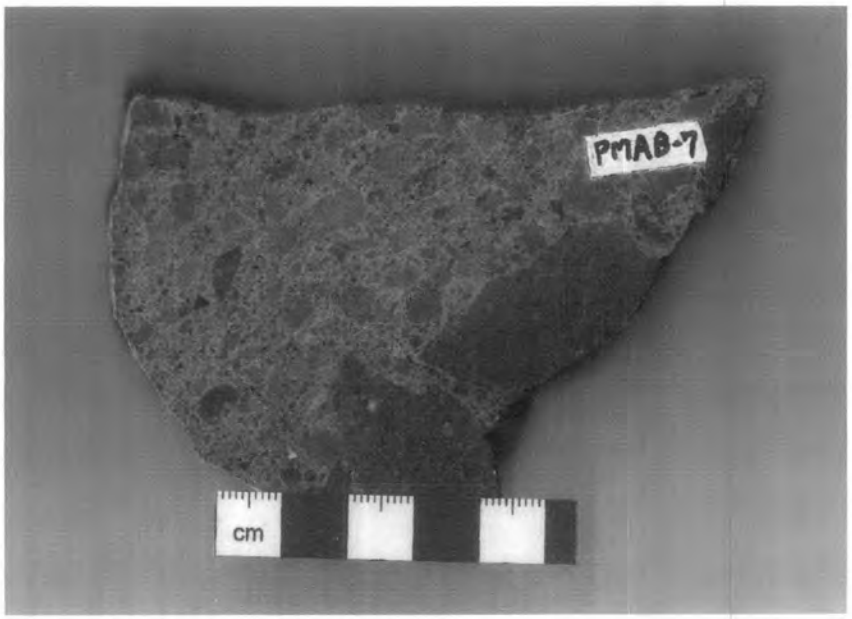


Figure 4.10. Slab of polymictic andesitic breccia (smple no PMAB-7) at the Chatree gold mine, showing various kinds and sizes of volcanic fragment set in the groundmass of more felsic composition.

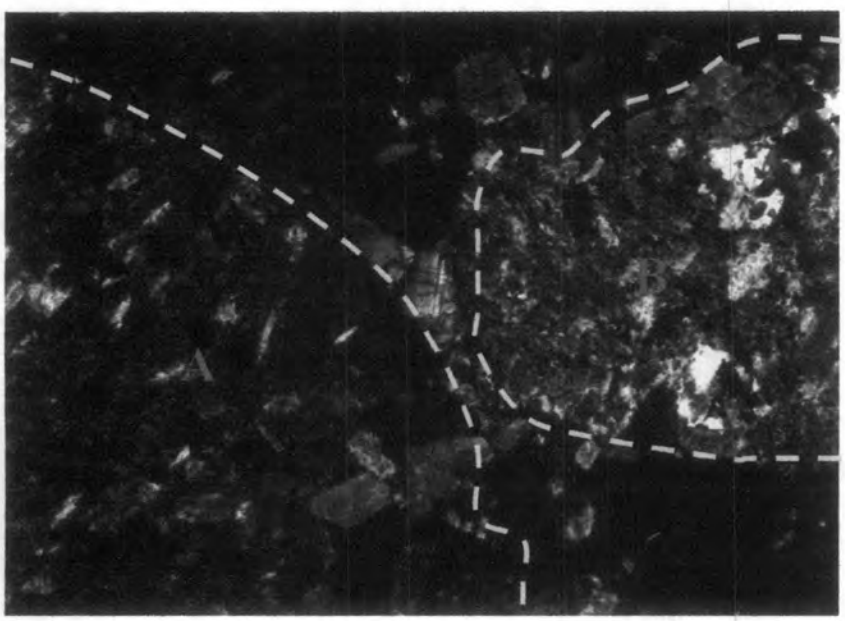


Figure 4.11. Photomicrograph of polymictic andesite breccia (sample no PMAB-7) showing different kinds of rock fragments, A= mafic fragment with slight foliation and B = felsic volcanic fragment (XPL).

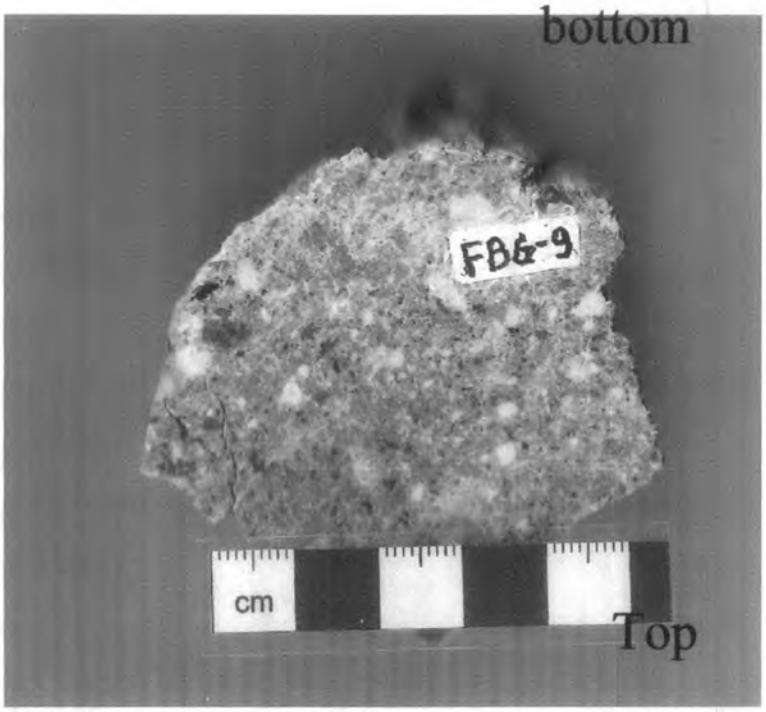


Figure 4.12. Slab of green fiamme breccia (sample no FBG-9.) at the Chatree gold mine, Phichit, showing graded bedding and some alteration texture (green-colored mineral)

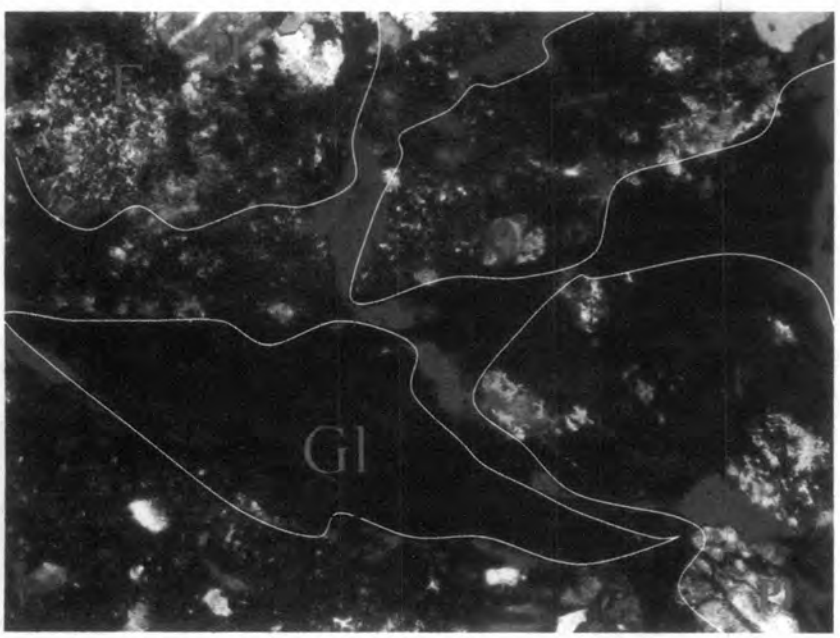


Figure 4.13. Photomicrograph of fiamme breccia (sample no FBG-9), showing felsic volcanic fragment (F) and stretched lenticular volcanic glass (gl), Chatree gold mine, Phichit (XPL). The long axis of photo is about 3 mm.

Microscopically, the groundmass consists of largely microcrystalline of plagioclase and quartz. Micro stretched chlorites are disseminated in groundmass. Frequently, plagioclase shows albite twin and tabular shape. The An content of plagioclase cannot be determined due to its strong alteration. Felsic groundmass of this rock consists of quartz and plagioclase, ranging in volume from 50 to nearly 60 volume percent of the total groundmass. Some of the plagioclase is altered directly to chlorite. The groundmass has inequigranular texture and contains mostly plagioclases and quartz.

This characteristic of the fiamme rock indicates that they were pressure, shear force and load structure involving in this study area.

4.3.3.1 Red Fiamme breccia

Similarly, as recognized in slab red fiamme breccia rocks commonly show a wide range in size and composition. The dominant material is generally lapilli, which rages in size from 1 to 64 mm. But some rocks are composed predominantly of andesite fragments. The fiamme rock has various red colours ranging from yellowish red to brownish red. The breccia is characteriszed by lenticular shape of welded chlorite and phyric plagioclase (Figure 4.14).

Fragments are essentially both felsic and mafic compositions. Felsic volcanic fragments consist mainly of quartz and plagioclase. Mafic volcanic fragments consists mosthly of hematite and unidentified opaque minerals. Both volcanic fragments are variable in size (Figure 4.15). Several fragments usually range from >2 mm to about 1 cm under thin section.

Some fragments of this rock contains plagioclase, quartz and chlorite. Plagiocase phenocrysts are anhedral to euhedral crystals showing mainly albite twins. Quartz phenocrysts occur as subhedral to anhedral crystals. Stretched chlorite and vari-colored crystals are characteristics of this rock. Chlorite is always fibrous to some platy

anhedral crystals. The proportion of volcanic to mineral fragments ranges from 40 to nearly 50 volume percent of the total studied rocks.

The groundmass consists essentially of inequigranular grains of plagioclase, quartz and chlorite. It is considered that the red colour of groundmass in this fiamme breccia is related more or less to the high persentages of Fe and Mn present in the rock. Some of the plagioclase were altered directly into chlorite. However, several chlorite is widely distributed in groundmass, suggesting the strong alteration in this type of breccia present alteration rock.

This characteristic of rock indicates that load pressure and shear force are the main mechanism responsible for the generation of this type of fiamme braccia.

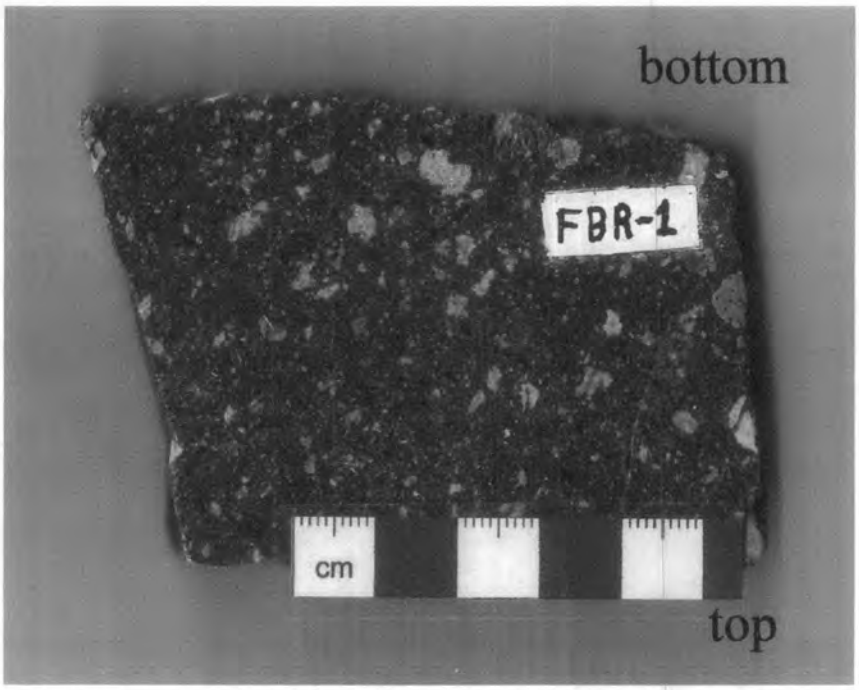


Figure 4.14. Slab of red fiamme breccia (sample no.FBR1) at the Chatree gold mine. Phichit, showing slight graded bedding. Note that the rock consists more mafic groundmass and more felsic volcanic fragments.

Figure 4.15. Photomicrograph of red fiamme breccia (sample no.FBR-1) showing stretched chlorite (Cl) conginally volcanic glasscous material, felsic volcanic fragment (F) and mafic volcanic fragment (M) hight Fe-Mg groundmass (XPL). The long axis of photo is about 3 mm.