CHAPTER 3

PETROGRAPHY

3.1 Diorite

In the study area, rocks of dioritic composition are found to be distributed subordinately, at Khao Chedi and Khao Luk Chang, south of Changwat Nakhon Sawan, at Khao Phanom Rok, north of Amphoe Tha Tako, and at Ban Khok Samakkhi, southern part of Khao Chang Amphoe Phai Sali. In some places the diorite appears to grade into quartz diorite. Field and petrographic evidences reveal that diorite and quartz diorite at Amphoe Tha Tako and Amphoe Muang are strongly affected by shear stress. Cataclastic features are strained quartz, broken and granulated grains of quartz and plagioclase, and microsheared zone.

Generally the dioritic rock is commonly green, medium-grained, and hypidiomorphic granular. The average grain size ranges from 1 to 2 millimeters (Figure 3.1). The dioritic rock is composed by all means, of two essential minerals, plagioclase and hornblende. One or more of several other subordinate minerals namely, augite, biotite, quartz, K-feldspar, and opaque may be included up to a certain amount in the dioritic rock. For instant, quartz diorite is assigned for the rock that the modal volume of quartz exceeds 10 percent volume. Sphene and apatite are common accessory minerals, whilst chlorite, epidote, sericite, calcite and streak of sphene are secondary ones.

Tabular plagioclase is the most abundant constituent of the rock, making up 60-70 modal percent of its total volume. The great majority of plagioclase grains are charactisized by albite and Carlsbad-albite twinning and normal zoning. Normally, composition of plagioclase is rather difficult to be determined optically. This is due to the fact that amount of plagioclase grains are clouded by products of post magmatic alteration, namely sericitization and saussuritization. Only few grains of zoned plagioclase from the Phai Sali diorite can be determined their An content with a certain confidence. In the pyroxene bearing diorite the An content of plagioclase is 16 at the rim and 52 at the core (Figure 3.2). The An-content of plagioclase decreases progressively in the diorite that contains increasingly amount of quartz and is free of pyroxene. Plagioclase composition of quartz diorite in the Amphoe Tha Tako and Amphoe Muang areas is albite. The anomalous low An content of plagioclase for the quartz diorite in these areas is believed to be occurred by the effect of retrograde thermal reaction and alteration. Evidences are shown by very intensive sericitization and saussuritization of plagioclase and chloritization of biotite and hornblende (Figure 3.3).

Hornblende is the essential mafic mineral which range from 15 to 20 volume percent. It occurs as subhedral crystal. The hornblende always exhibits strong pleochroism (yellow green to green). Partial replacement of hornblende by biotite and chlorite is widespread.

Colorless or pale-green diopsidic-augite is the characteristic pyroxene in diorite distributed in the Phai Sali area. It may be partially included by plagioclase. Commonly pyroxene is rimmed and

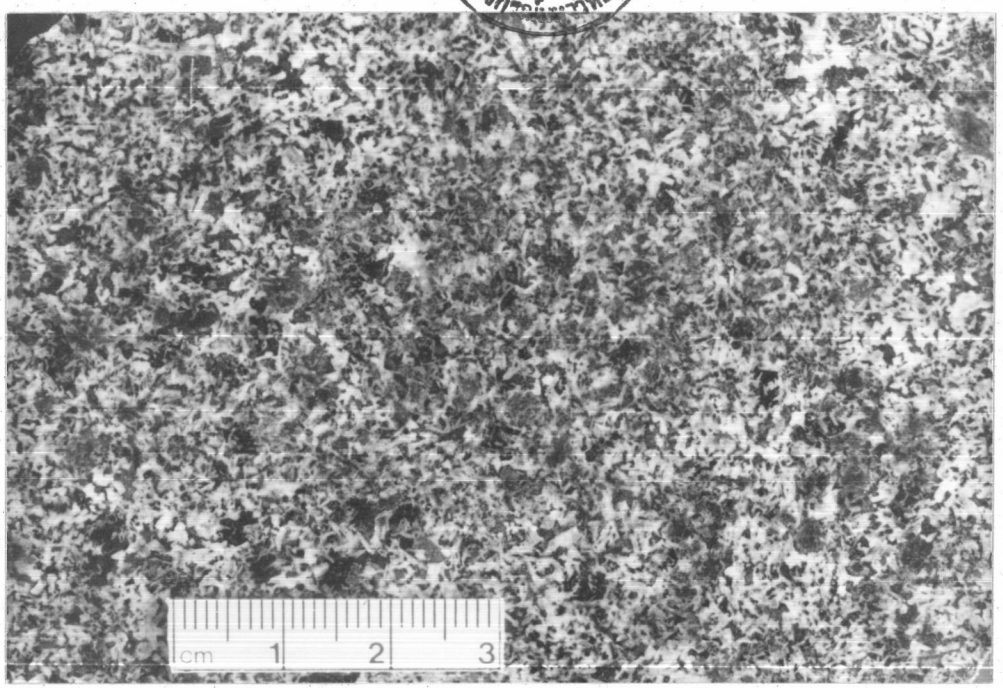


Fig. 3.1 General texture of diorite.

Fig. 3.2 Photomicrograph of diorite showing normal zoned plagioclase (Pl) associated with hornblende (Hb). Some of plagioclace grains are altered to sericite. The secondary amphibole is actinolite (Ac) (X-nicol, 45x).

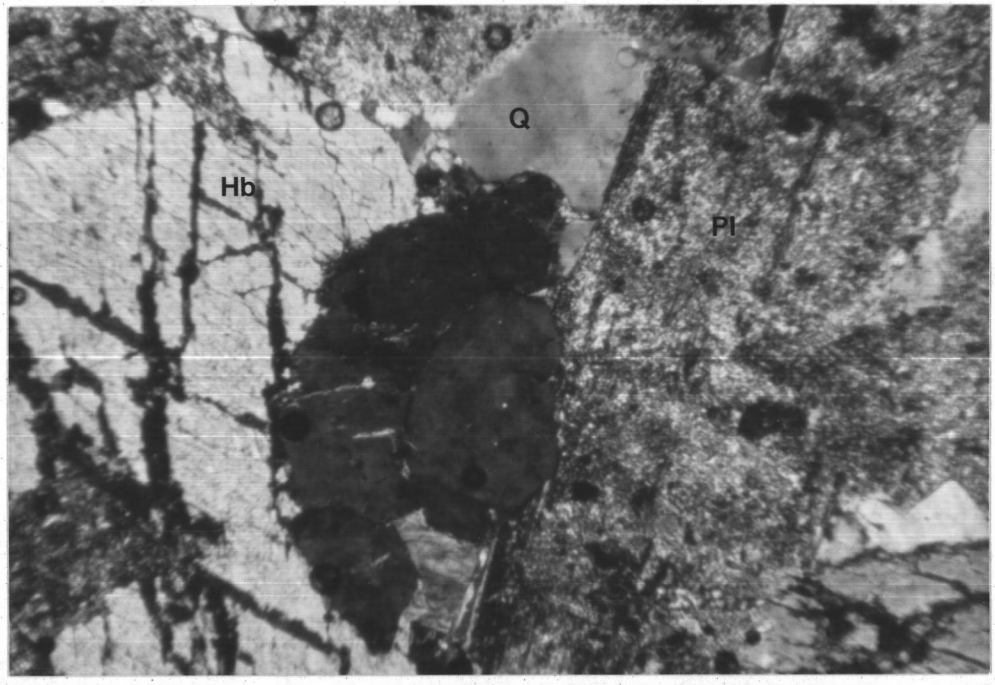


Fig. 3.3 Photomicrograph of diorite in Phai Sali area showing sericitization and saussuritization of plagioclase (Pl) (X-nicols, 45 x).

internally replaced by green hornblende.

The biotite is usually characterized by brown to reddish brown pleochroism. It occurs as small flakes and in close association with pyroxene, hornblende, and opagues. Many of the biotite are partly or entirely altered to chlorite especially in rocks from the Tha Tako and Muang areas.

Quartz, if present, is invariably late interstitial crystallization. Occasionally quartz content exceeds 10 percent in modal volume.

K-feldspar is orthoclase in diorite and microcline in quartz diorite. It occurs in rather small amount and by no means in every specimen. K-feldspar has crystallized in rather late stage as discrete tabular crystals and interstitial anhedral grains.

Opaque minerals are subhedral to anhedral, intergrowth with hornblende and biotite. These opaques are skeleton ilmenite and iron oxides. The assessory minerals are apatite and sphene.

3.2 Granodiorite

The rock typically has greenish white in colour, medium-grained (0.8-3.0 m.m.), and granular texture. It has been found to be distributed on the west flank of Khao Luang, Khao Yong-Khao Rusi, Khao Kaew, and Khao Khok Mai Den, Amphoe Muang Nakhon Sawan and at Ban Khok Samakkhi, Amphoe Phai Sali.

The mineral composition of granodiorite in these area is constituted of 40-50 percent plagioclase, 10-15 percent pyroxene,

5-8 percent hornblende, 8-12 percent K-feldspar, 10-12 percent quartz, 3-5 percent sphene, and 5 percent opaques. Apatite, chlorite, and zircon are accessory minerals (Figure 3.4).

Plagioclase is the most abundance with euhedral to subhedral crystal, of which the average size varies in length from 1.8 to 3.0 millimeters. Some of plagioclase grains are partly enclosed by orthoclase. The plagioclase shows fine-albite twin and ranges in composition between An_5 and An_{10} of albite. Most of plagioclase grains are clouded with sericite and epidote (Figure 3.5).

Pyroxene is apparently the first major ferromagnesian that has been crystallized from melt. Its average size varies from 0.5-1.8 millimeters. The pyroxene is augite and occurs as euhedral to subhedral crystals. Pyroxene grains are partly replaced by hornblende in the process of uralitization.

Hornblende is green to yellowish green in color. Generally, its modal volume is slightly less than the pyroxene. The remnant of the small grain of pyroxene in hornblende core probably suggests that the hornblende has also replaced pyroxene while it has been crystallizing from the melt.

Quartz and K-feldspar are late minerals that have been crystallized from melt. Quartz is always present in noticeable amount. It is commonly anhedral. K-feldspar, orthoclase is varying in amount from few modal percent at Ban Khok Samakkhi to about 10 percent or more at Khao Khok, Amphoe Phai Sali. Fine myrmekitic texture is generally found when orthoclase and plagioclase are in contact.

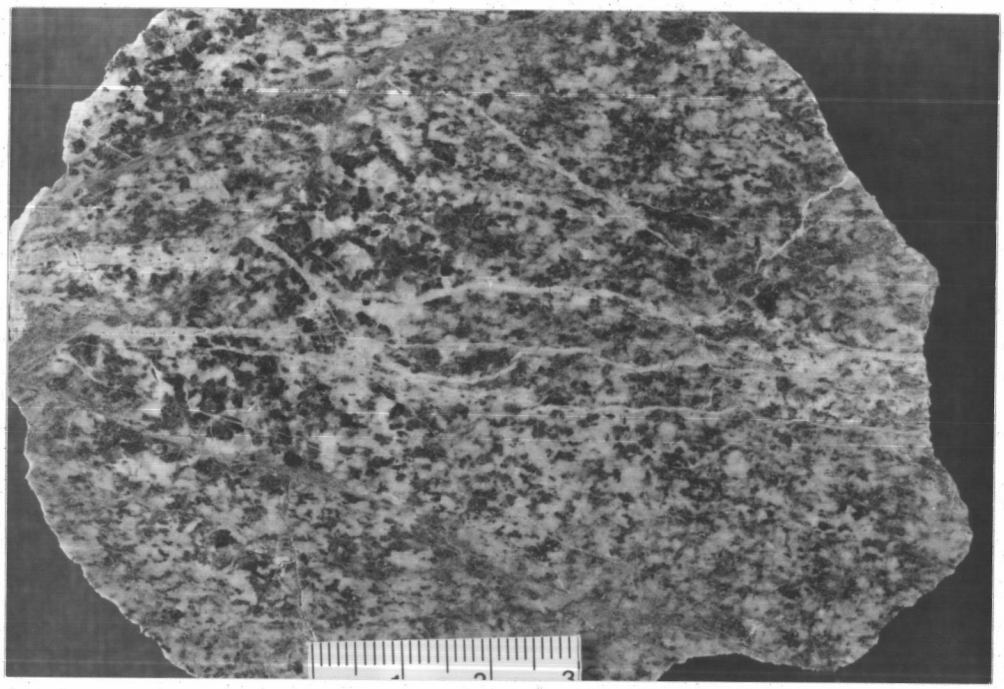


Fig. 3.4 General texture of granodiorite in Nakhon Sawan area.

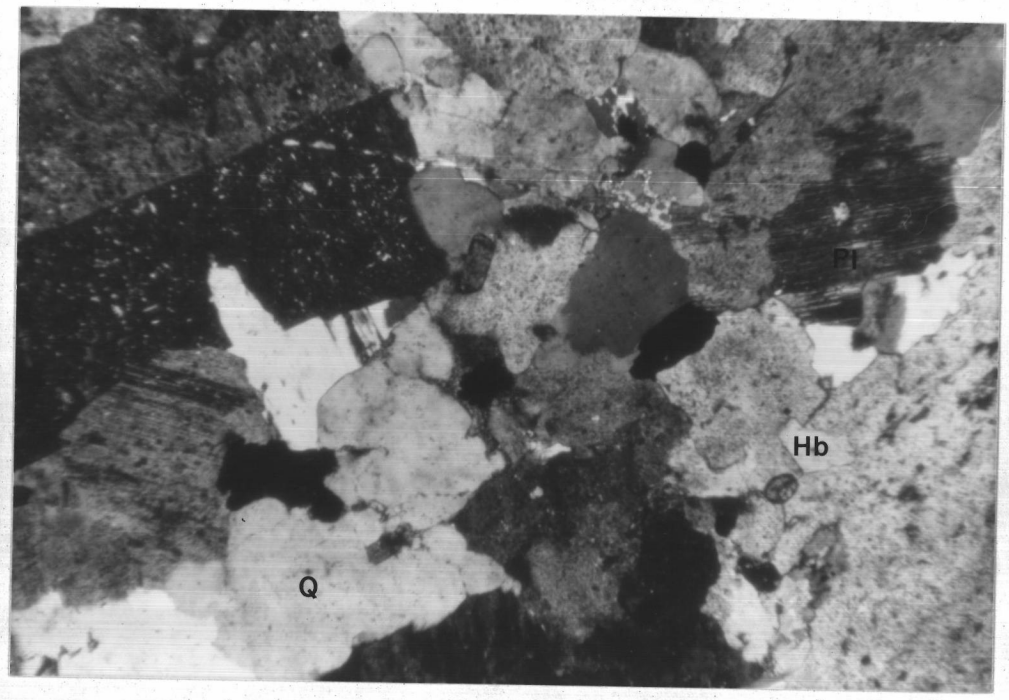


Fig. 3.5 Photomicrograph of granodiorite in Phai Sali area showing fine albite twin of plagioclase (Pl) associated with anhedral quartz (Q). Hornblende (Hb) is enclosed by plagioclase (X-nicols, 45x).

Opaque, sphene, and apatite are common accessory minerals. Chlorite, epidote and sericite are secondary minerals. Especially in rocks from Khao Khok area, there are ubiquitous amount of epidote and chlorite suggesting that the rocks might have been affected from low grade thermal metamorphism.

3.3 Granite

Granite is generally pink in color, medium-grained, and hypidiomorphic equigranular. It has been found to be distributed at Khao Khok, south of Khao Chan, Khao Krok Pradu and Phu Khao Phra Phuthabat just east of Amphoe Phai Sali. At Phu Khao Phra Phuthabat, however, specimens collected show variety of fine grained inequigranular granite (Figure 3.6).

The granite is composed almost totally of plagioclase, K-feldspar and Quartz. Other minerals, such as biotite, chlorite, sphene, epidote, and opaque are constituted to be less than 5 modal percent.

Plagioclase is the first mineral to have been crystallized from the melt. It is subhedral tabular, characterized by fine albite twinning and weak normal zoning. The composition of plagioclase falls within the range of An_3-An_5. Commonly plagioclase is subjected to moderate alteration by processes of sericitization and saussuritization. Many plagioclase grains are mantled by subsequently crystallized microcline.

Microcline and quartz are apparently could have been crystallized from melt almost at the same time. However, some microcline grains appear

to have been crystallized into subhedral tabular form and mantle grains of plagioclase. Therfore the microcline might have been crystallized from melt just slightly before quartz. The content of microcline ranges from 35 to 40 percent by volume. Microcline is present predominantly as anhedral crystal varying in size from 1 to 3 millimeters. It commonly shows perthitic texture and contains micrographic quartz. Quartz is present as interstitial anhedral grains, and crystal aggregates of various size. Their average grain size is approximately i millimeter. Quartz content varies in amount from 25 to 30 percents by volume and is normally less than those of feldspar minerals. Cuneiform intergrowth of quartz and microcline is very common (Figure 3.7).

Biotite is the only essential mafic mineral found in granite. It generally amount to less than 5 percent of the total modal mineral constituent. Biotite has been crystallized from melt as small individual flakes. Post-magmatic replacement by chlorite, either totally or partially, and streak of sphene is very common. The accesory minerals are apatite, zircon, sphene, and opaques.

Some of the granite specimens from Phu Khao Phra Phutthabat are petrographically different. They show finer in grain size and sometimes granophyric texture (Figure 3.8). Subhedral to euhedral plagioclase is rimmed by radiate spherulite and micrographic to micropegmatitic intergrowth of quartz and alkali feldspar (Figure 3.9). Groundmass is fine-grained hypidiomorphic granular of quartz and alkali feldspar. This texture has led to believe that the granite is probably a shallow intrusive. During stage of consolidation

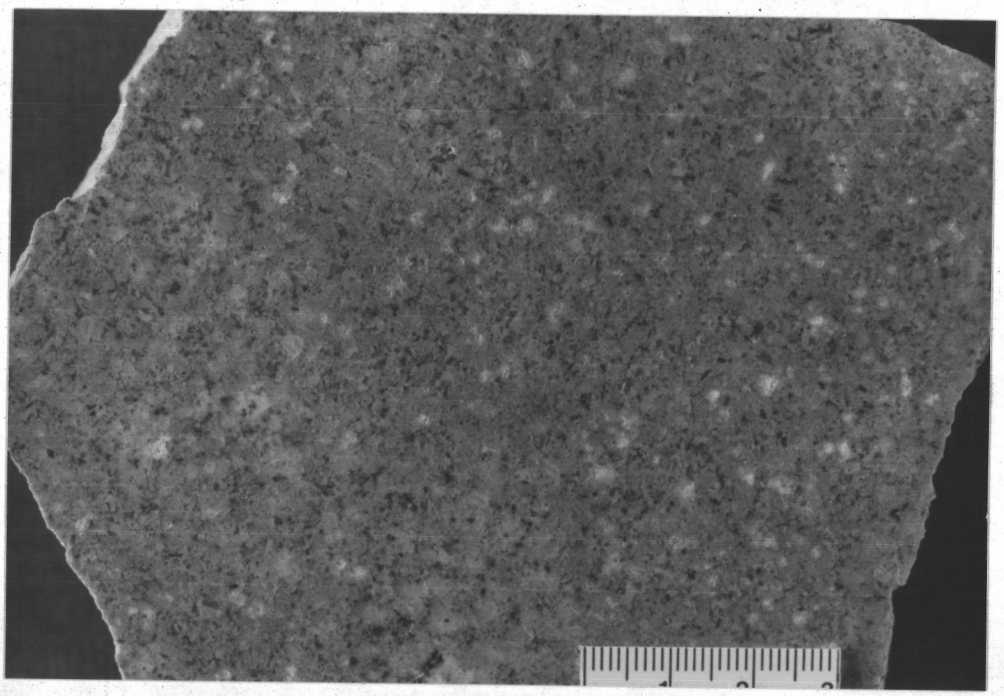


Fig. 3.6 General texture of fine-grained pink granite in Phai Sali area.

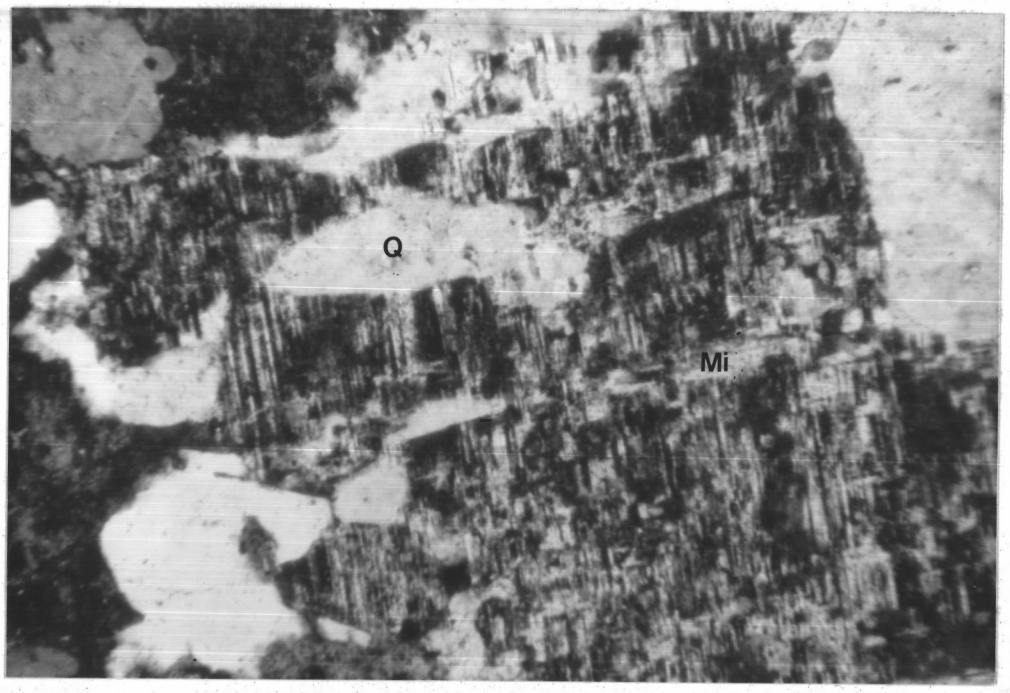


Fig. 3.7 Photomicrograph of granite in Phai Sali area showing perthitic microcline (Mi) which containing micrographic quartz (Q) (X-nicols, 45x).

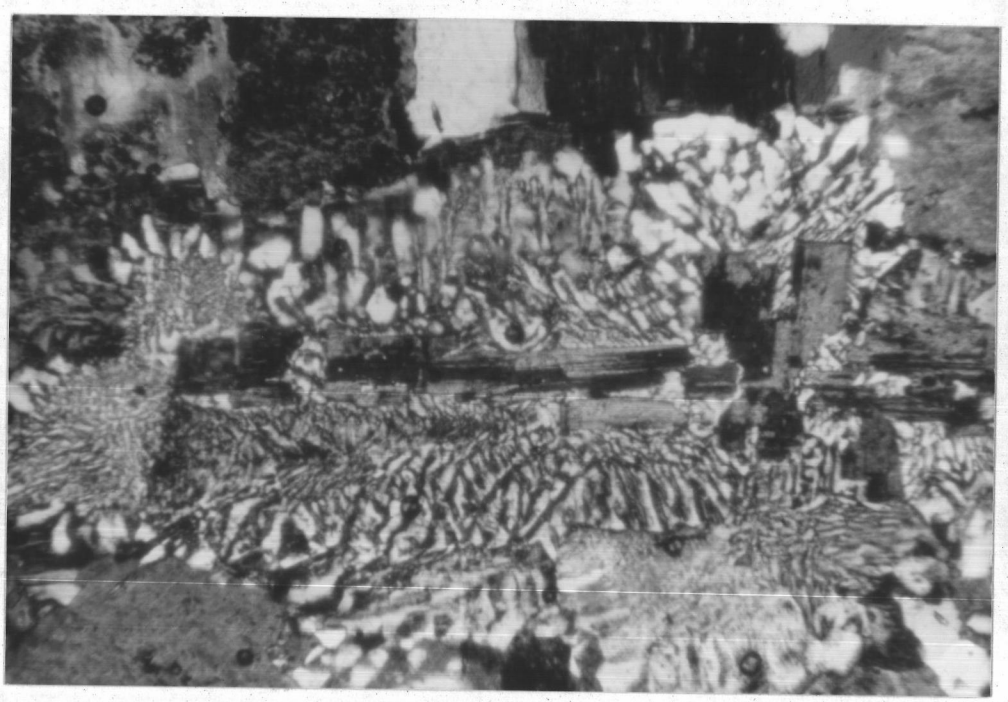


Fig. 3.8 Photomicrograph of granite in Phai Sali area showing micropegmatitic intergrowth of quartz and K-feldspar (X-nicols, 45x).

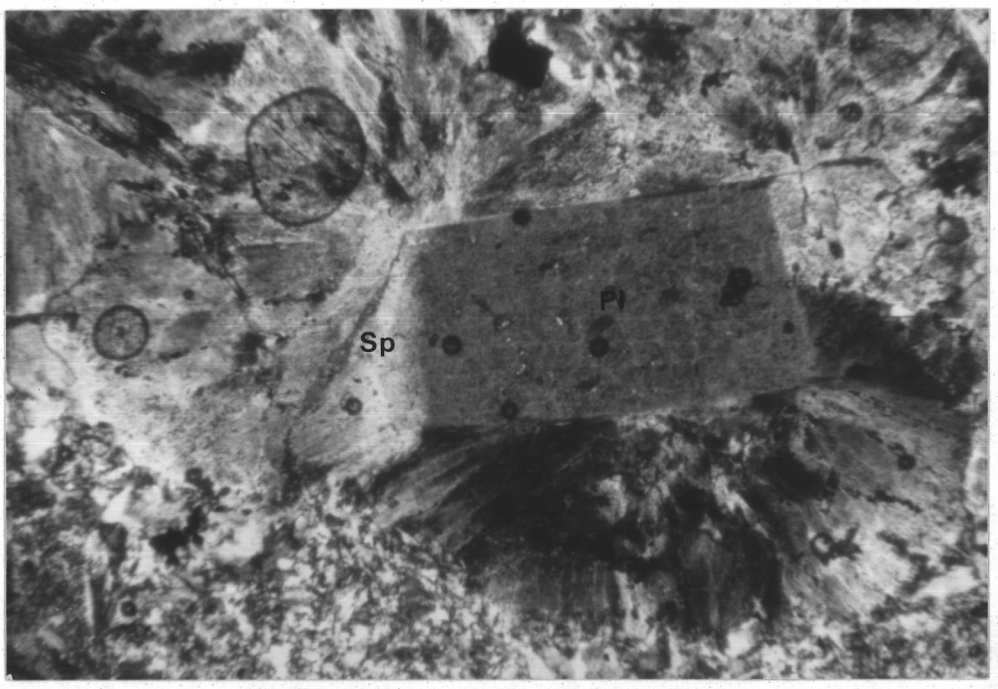


Fig. 3.9 Photomicrograph of granitic rocks showing euhedral plagioclase (Pl) rimmed by radiate spherulite (Sp) that represent the transitional zone between shallow intrusive and extrusive rocks (X-nicols, 45x).

parts of melt phase with crystallized plagioclase might eject up very close to surface.

3.4 Andesite

Andesitic volcanic rocks are found to occur locally as lava flow at Khao Khot Yang, Amphoe Thap Than, Changwat Uthai Thani and Khao Luk Chang, Amphoe Muang, Changwat Nakhon Sawan and as dykes crosscutting the shallow intrusive granite, granodiorite, and diorite.

The small volume of andesitic rock at Khao Khot Yang, Amphoe Thap Than, Changwat Uthai Thani is generally green to dark green in color (Figure 3.10). It is hypocrystalline, fine-grained, and porphyritic texture. This andesitic rock contains large amount and varying size of phenocryst. Plagioclase is the most common amoung the phenocrysts found. It may occur as discrete, cluster, and penetrating of subhedral grains which varies in size from 0.5 millimeters to 8.0 millimeters. Clinopyroxene phenocryst is found in rather small amount and smaller in size as compared with that of plagioclase.

Usually, groundmass of the andesite is composed of interwoven plagioclase microlite and interstitially filled chloritized glass. Fine spherulitic quartz and poorly crystalline chlorite may be found to fill irregular vesicles in the groundmass. Dust clots of sphene and/or epidote are widespread in the groundmass of some specimens (Figure 3.11).

Composition of plagioclase phenocryst when determined optically, is labradorite (An_{55-65}). However, composition of plagioclase in the

groundmass can not be determined optically owing to its rather small grain size.

Andesitic rocks in this area are affected by shear stress. Brecciation of andesite is clearly shown in area of Khao Khot Yang. Optically plagioclase phenocrysts are bent or broken into fragments (Figure 3.12). Along cracks of broken plagioclase are filled by secondary calcite and/or green chlorite. Commonly, grains of plagioclase phenocryst are also affected by process of sericitization and saussuritization. In groundmass, fine grains of epidote mineral are distributed throughout.

3.5 Dacite-rhyolite

Silicic volcanic rocks found in the study area ranging from dacite to rhyolite are rather difficult to be distinguished in hand specimen and undermicroscope. They are closely related and believed to have a common origin. Though the silicic volcanic rocks are mostly porphyritic, only phenocrysts are readily identified. Groundmass of these rocks is either glassy or too fine to be determined mineralogically. Therefore, rock classification based on modal volume of mineral constituents is virtually impractical. In this study, classification on the silicic rocks will depend much on the chemical composition. The dacitic-rhyolitic rocks are distributed both in form of lava flow and explosive tuff. The more silicic in composition of the rock the higher the ratio of tuff to flow in distribution. In other words it is possible to say that dacitic rocks are mostly eruption as lava flow rather than ejecta while it is reverse for the rhyolitic rocks. Stratigraphic position of these two rock types,

Fig. 3.10 General texture of Andesite in Uthai Thani area.

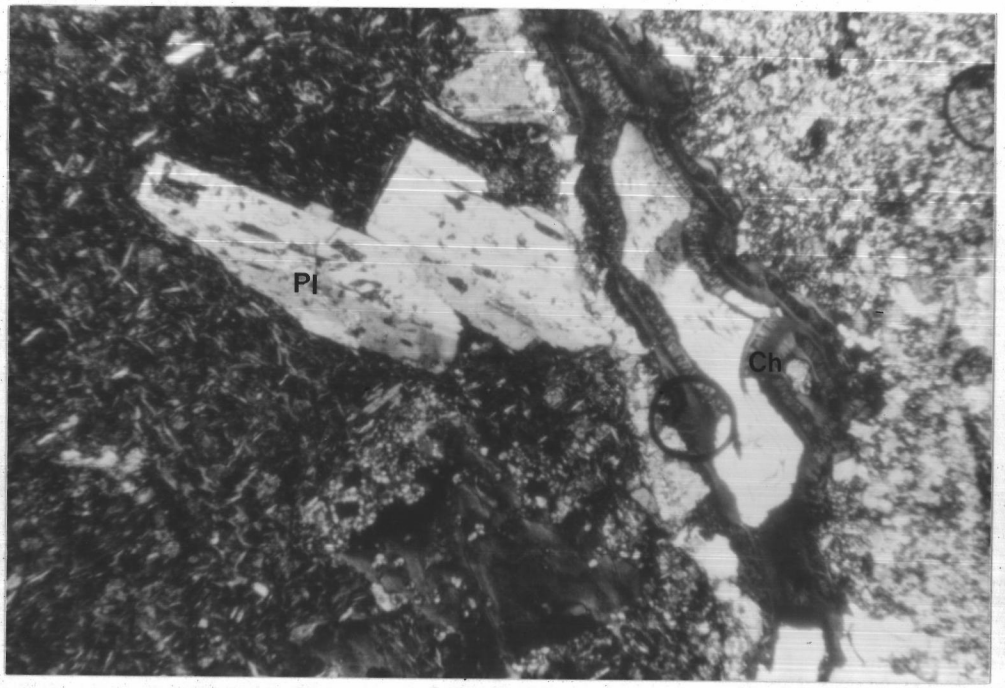


Fig. 3.11 Photomicrograph of Andesite in Uthai Thani area showing plagioclase phenocryst (Pl) in the groundmass of interwoven plagioclase microlite and interstitially filled chloritized glass. Chlorite (Ch) replace in the irregular vesicles. (X-nicols, 45x).

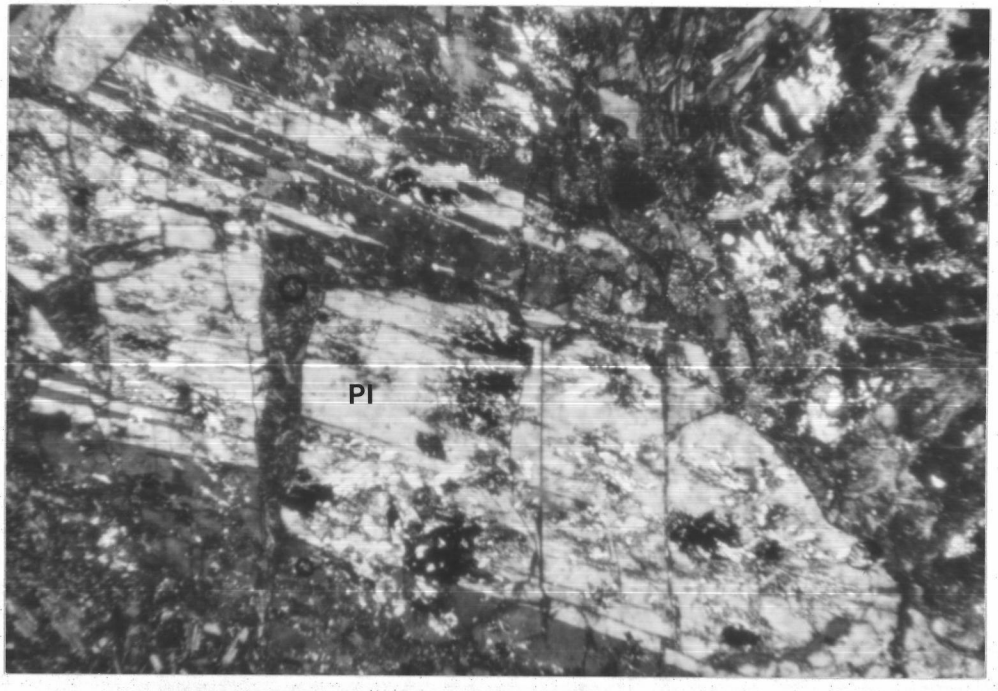


Fig. 3.12 Photomicrograph of Andesite in Uthai Thani area showing grain of plagioclase (Pl) phenocryst broken into fragments (X-nicol, 45x).

which implies their relative time of eruption, is suggested by dacitic rock fragments enclosed in the rhyolitic tuffaceous rocks. Dacitic rocks are therefore in the lower stratigraphic position.

It is important to note here that the composition of plagioclase phenocryst in these rocks as determined optically is invariably albite. Therefore keratophyre and quartz keratophyre may as well be used for the dacite and rhyolite, respectively.

Dacitic-rhyolitic rocks in the study area are by all means porphyritic. They can be roughly separated into two types i.e., one with plagioclase phenocryst and the other with plagioclase and quartz phenocrysts.

Plagioclase dacite-rhyolite is distributed at Khao Noi, Khao Wong, Khao Khang Khao, Khao Sa Wang Kaeo, Khao Khok, Khao Laem and Khao Tabaeng of Amphoe Tha Tako. Rocks of this type are reddish purple and grayish green to dark green in colour (Figure 3.13). The plagioclase phenocryst is embayed in the groundmass of fine-grained quartz and feldspar. It is solely albitic plagioclase. The composition determined ranges from An_4 to An_8. Plagioclase phenocrysts distribute throughout the rock as discrete or cluster of subhedral grains. Their grain size vary from 0.5 to 2.5 millimeters. Some of plagioclase phenocrysts show weak normal zoning. Commonly the plagioclase phenocryst is partially replaced by calcite.

It is apparent in this plagioclase dacite-rhyolite that there is relict form of another phenocryst which believe to be a formerly amphibole mineral. The presence of the formerly amphibole phenocryst

is prismatic shape and pseudohexagonal cross-section encrusted by red brown opaques. Internally the original mineral is totally replaced by combination of chlorite, sericite, calcite, and fine sphene or opaques. Occasionally this formerly amphibole phenocryst is partly enclosed by plagioclase phenocryst.

Groundmass of the plagioclase dacite-rhyolite is almost totally consisted of micro to crypto-crystalline felsic mineral. The groundmass of plagioclase dacite-rhyolite at Khao Noi, Khao Khang Khao, and Khao Wong appears to have heterogeneous groundmass consisting of coalescence of patches of microlite and patches of felsite (Figure 3.14). Laths of fine plagioclase show pilotaxitic texture. Cryptofelsite and green chlorite fill along the interstices of plagioclase laths. In felsitic patches, quartz and presumably some alkali feldspars aggregate in forms of microcrystalline to cryptocrystalline.

The groundmass of plagioclase dacite-rhyolite of Khao Khok, Khao Laem, and Khao Sa Wang Kaeo, on the other hand, is rather uniform in textural appearance as shown in Figure 3.15. It is microcrystalline felsite with abundant quartz. Radiate spherulite is normally found in the groundmass.

Irregular cavities filled with secondary green chloritic mineral are often found in the plagioclase dacite-rhyolite. Calcite, chlorite, epidote, sphene, and specks of opaques are common secondary mineral in the groundmass. Apatite is an accessory mineral.

Plagioclase-quartz dacitic-rhyolitic rock at Khao Tabaeng, Khao Noi, Khao Pun, Khao Khwang, and Khao Donkha is different in many

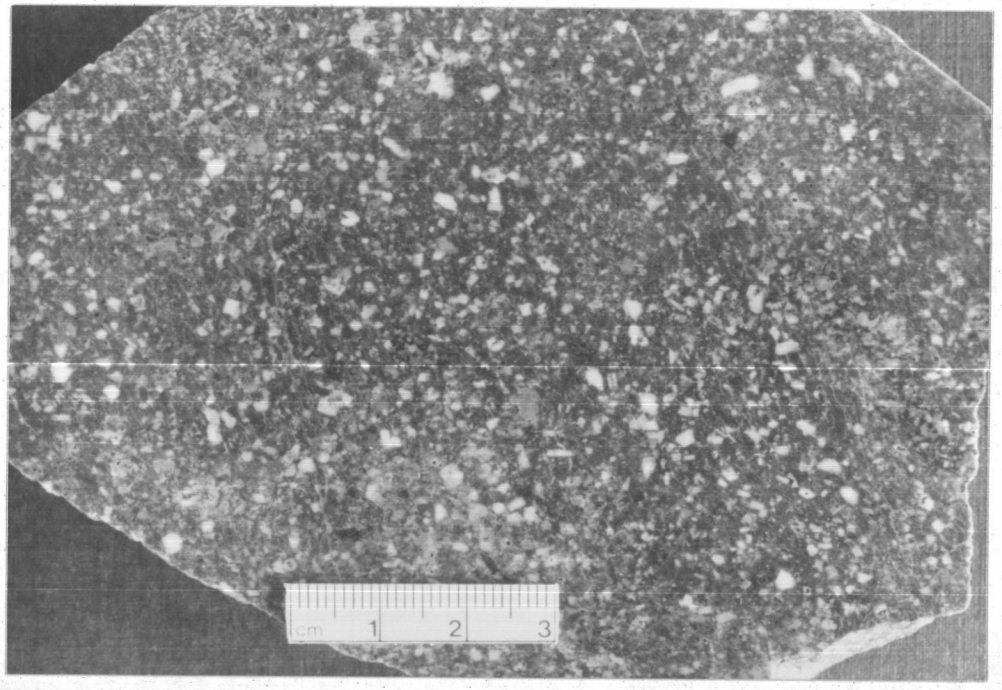


Fig. 3.13 General texture of dacite-rhyolite in Tha Tako area.

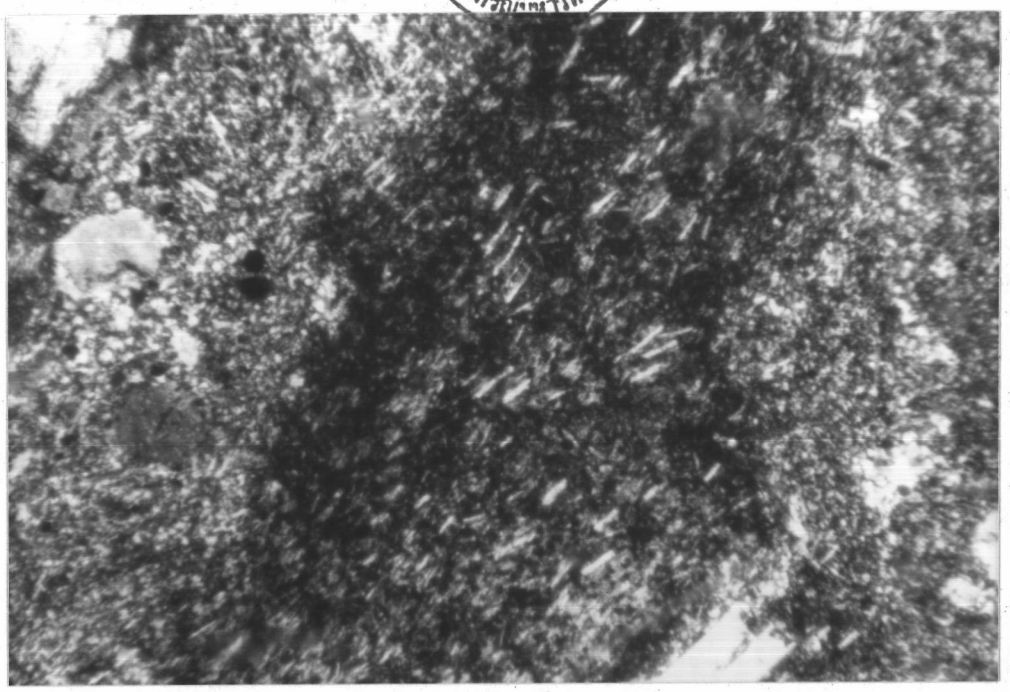


Fig. 3.14 Photomicrograph of plagioclase dacite-rhyolite in Tha Tako area showing heterogeneous groundmass consisting of coalescence of patches of feldspar microlite and patches of felsite (X-nicols, 45x).

Fig. 3.15 Photomicrograph of plagioclase dacite-rhyolite in Tha Tako area showing plagioclase phenocryst in felsitic groundmass (X-nicols, 45x).

aspects from the aforementioned plagioclase dacite-rhyolite. In hand specimen this rock is grayish green to dark green in colour and porphyritic texture. The rock consists of plagioclase and quartz phenocrysts as well as rock fragments which show alignment indicating of deformation (Figure 3.16).

Under microscope, this rock is fine-grained and porphyritic. Plagioclase and quartz, present in variable amount, are constantly phenocrysts (Figure 3.17). They vary considerably in size and shape due to post-consolidated cataclastic effect (Figure 3.18). Composition of plagioclase phenocryst ranges from An_4 to An_7. Lithic fragments of previously formed volcanic rocks, presumably plagioclase dacite-rhyolite are commonly included in these rocks.

Groundmass of the plagioclase-quartz dacite-rhyolite is composed of microcrystalline felsite and biotite flakes. Chlorite and fine granule of sphene are common alteration product of the biotite. Secondary green amphibole develops in the groundmass as radiate, sheaf-like, and spiny worm-like shape as shown in Figure 3.19. Epidote is another common secondary mineral. Opaque and apatite are accessory.

Rocks subjected to cataclastic effect especially along Khao Donkha are expressed by strong fluxion texture of the groundmass. Phenocrysts are strained, crushed, and granulated into finer fragments (Figure 3.20).

3.6 Rhyolitic tuff

Rhyolitic tuff is predominantly found in Changwat Uthai Thani along the western volcanic chain of the study area i.e., Khao Kwang

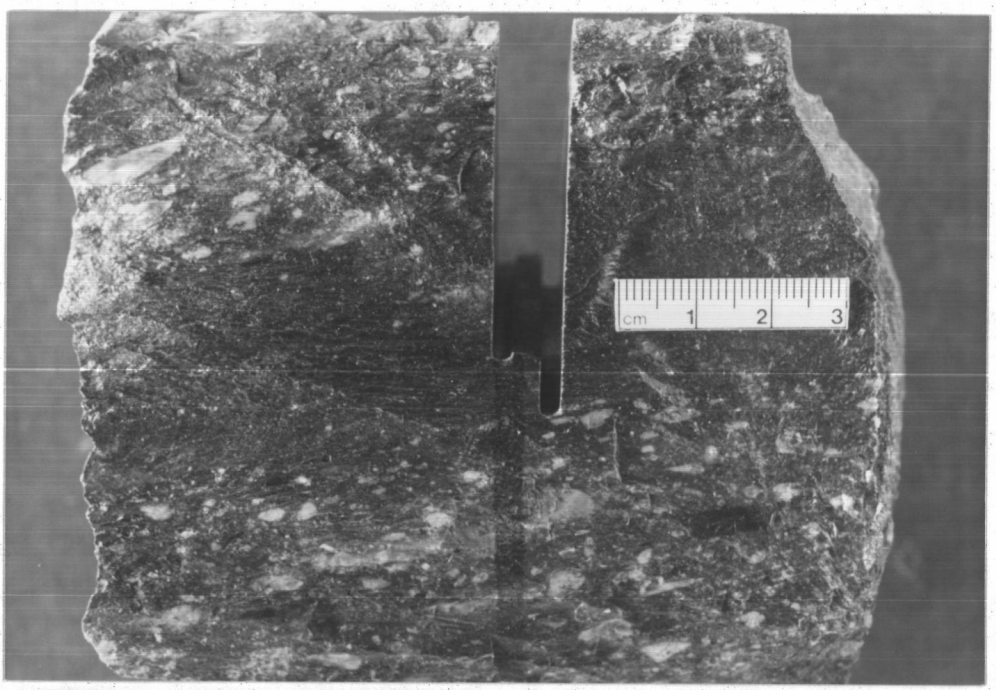


Fig. 3.16 General texture of plagioclase-quartz dacite-rhyolite

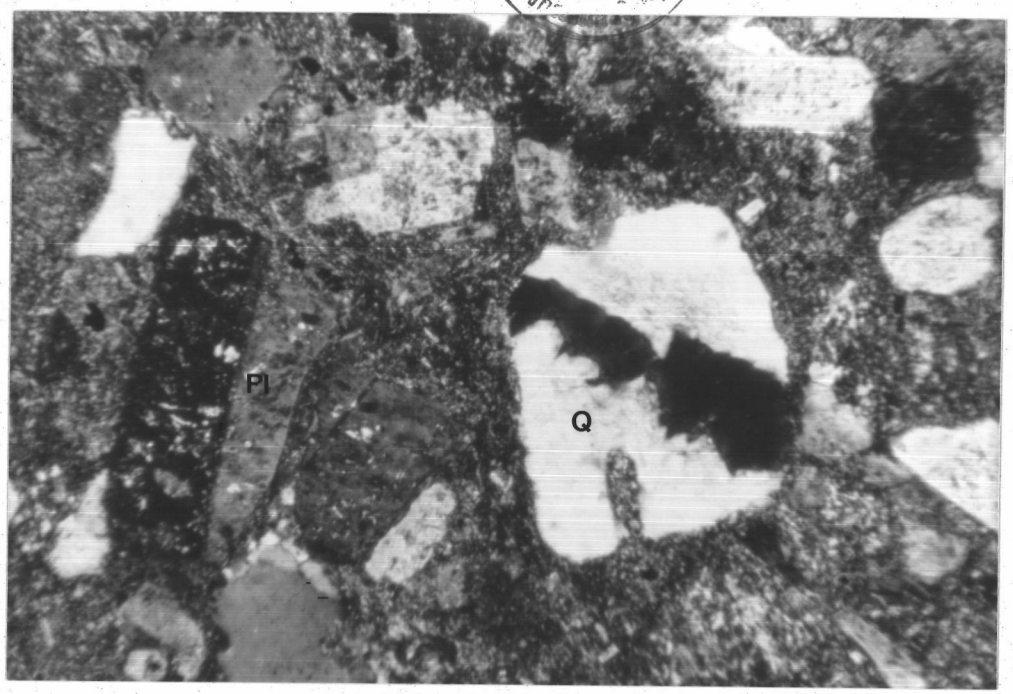


Fig. 3.17 Photomicrograph of plagioclase-quartz dacite-rhyolite in Tha Tako area showing plagioclase and resorbed quartz phenocryst in felsitic groundmass (X-nicols, 2.5x5x).

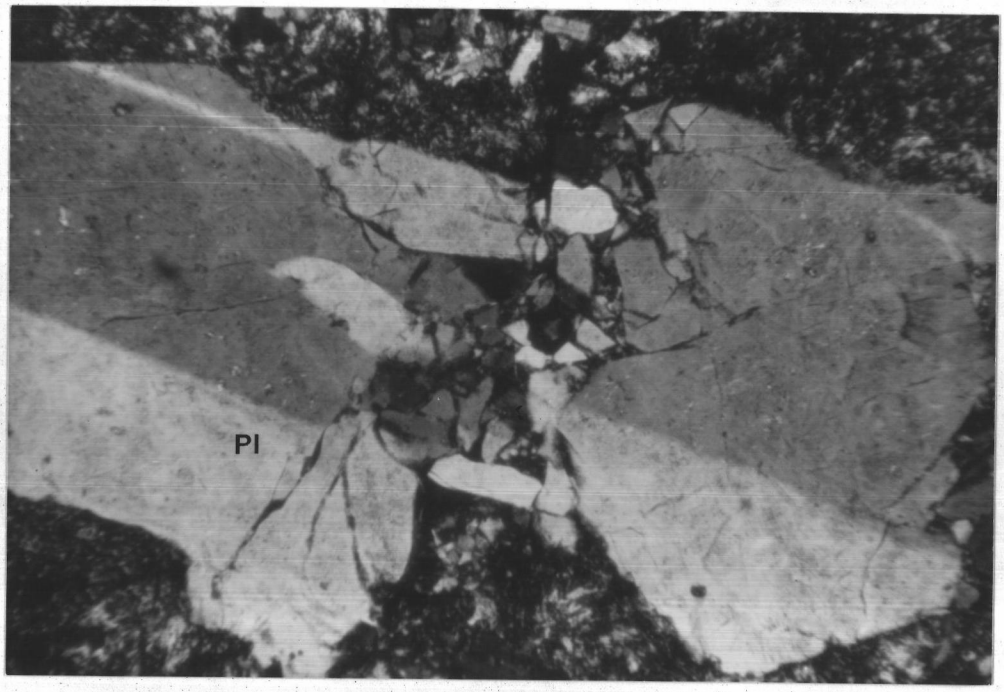
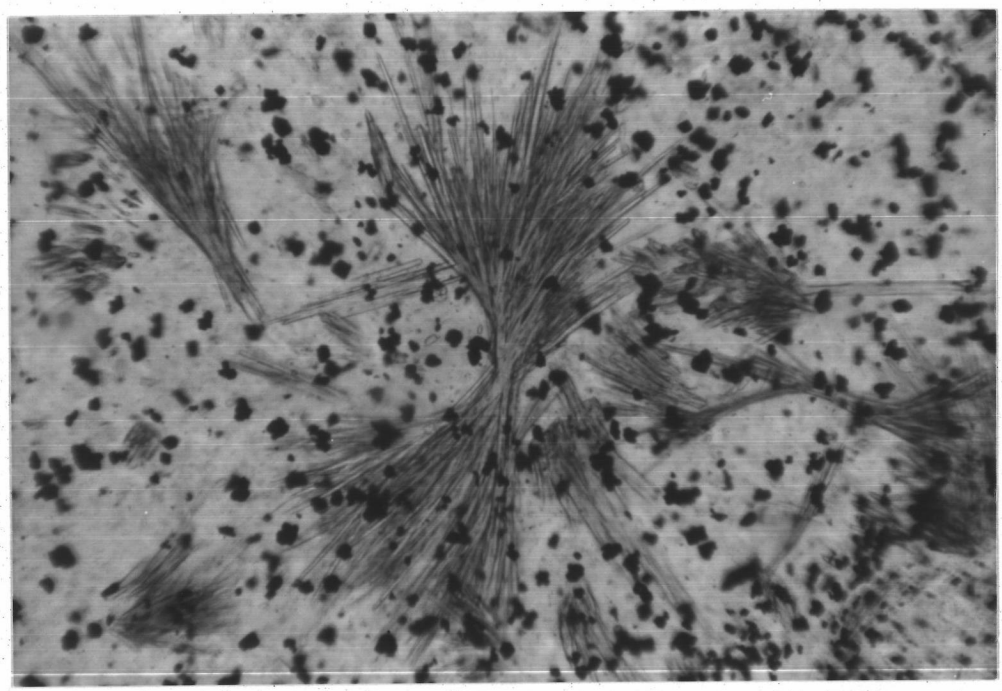


Fig. 3.18 Photomicrograph of plagioclase-quartz dacite-rhyolite in Tha Tako area showing post consolidated cataclastic effect. Plagioclase phenocryst broken into fragments (X-nicols, 45x).

a)



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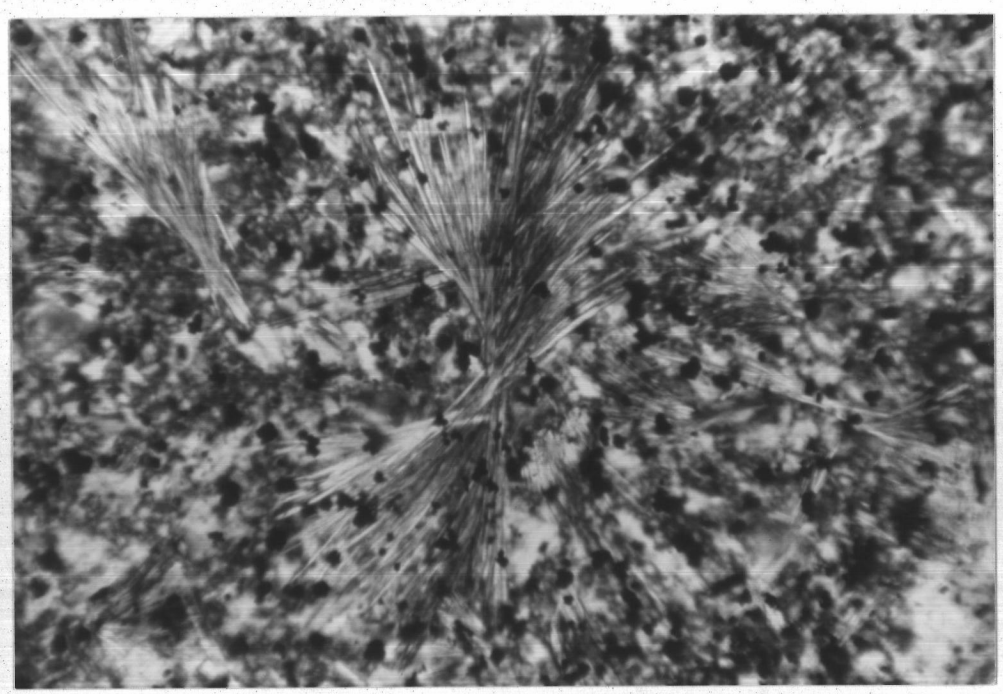
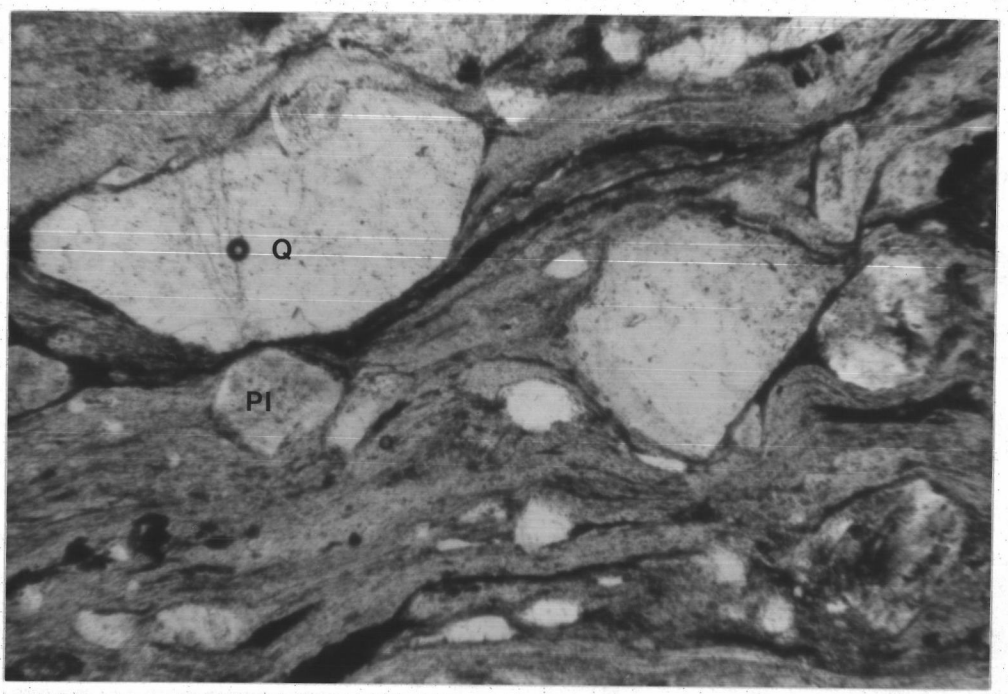


Fig. 3.19 Photomicrograph of dacite-rhyolite of Tha Tako area showing secondary green amphibole developing in the groundmass as radiate and sheaf-like shape (90x, a) plane polarized light, b) X-nicols).

a)



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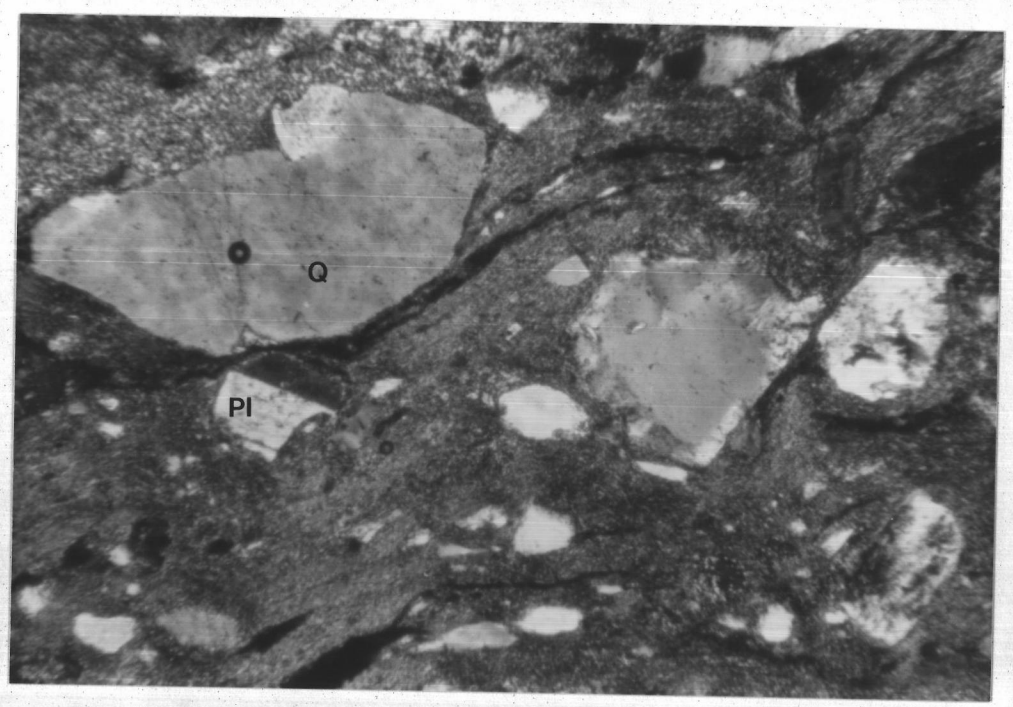


Fig. 3.20 Photomicrograph of dacite-rhyolite in Tha Tako area showing strong fluxion texture of groundmass (90x, a) plane polarized light, b) X-nicols).

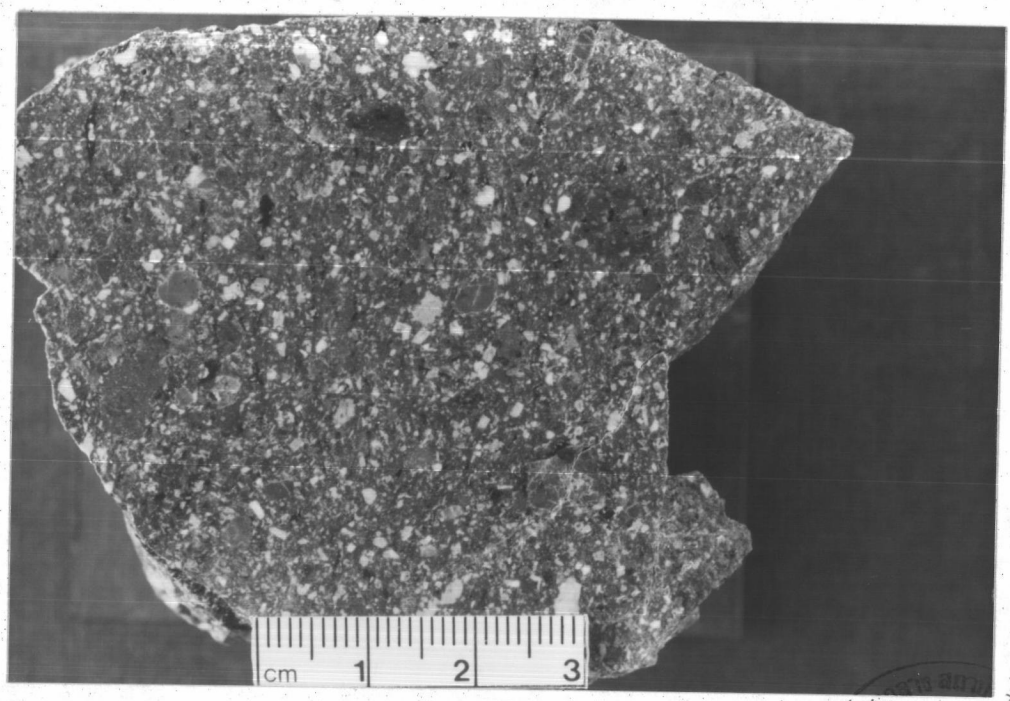
Thong, Khao Pha Lat, Khao Hin Thoen, and Khao Khot Yang. Smaller amount of this tuff is also found in Tha Tako area. Here, the tuff is exposed at Khao Tamyae, southern tip of Khao Wong, and at Khao Don Kha.

In general the rhyolitic tuff, though the most common unit of the ejecta, often associates with lapillae tuff, graywacke, and tuffaceous sandstone. The rhyolitic tuff commonly shows a wide range in size and variable amounts of constituent materials (Figure 3.21).

The dominant material is generally ash or fine ash size but some are composed predominantly of pumice fragments and blocks of different size. The phenocrysts of this rock are crystal of quartz, plagioclase, and potassium feldspar, and there are several kinds of rock fragment. The proportion of observed rock and mineral fragments ranges from 5 to nearly 30 volume percent of the total rock.

Thegroundmass consists of fine-grained glassy and interstitial dust. In some specimens the groundmass consists of microcrystalline intergrowth of quartz and feldspar. Glass usually shows characteristic shard-like forms which are welded. In this rock, there are several variations of the glass shard forms, such as arrowheads, plate-like curved forms, and other slender. The structure of these shards is characterized by fine-grained glassy material that represents fragment of bubble wall which has been explosively disrupted and produced curved plates (Figure 3.22). These different forms indicate that the original plastic glass contains bubbles of different size, sphene, and thickness of wall (C.S.Ross and R.L.Smith, 1961). In some specimens there are marked molding of shards against feldspar and quartz phenocrysts that

a)



b)

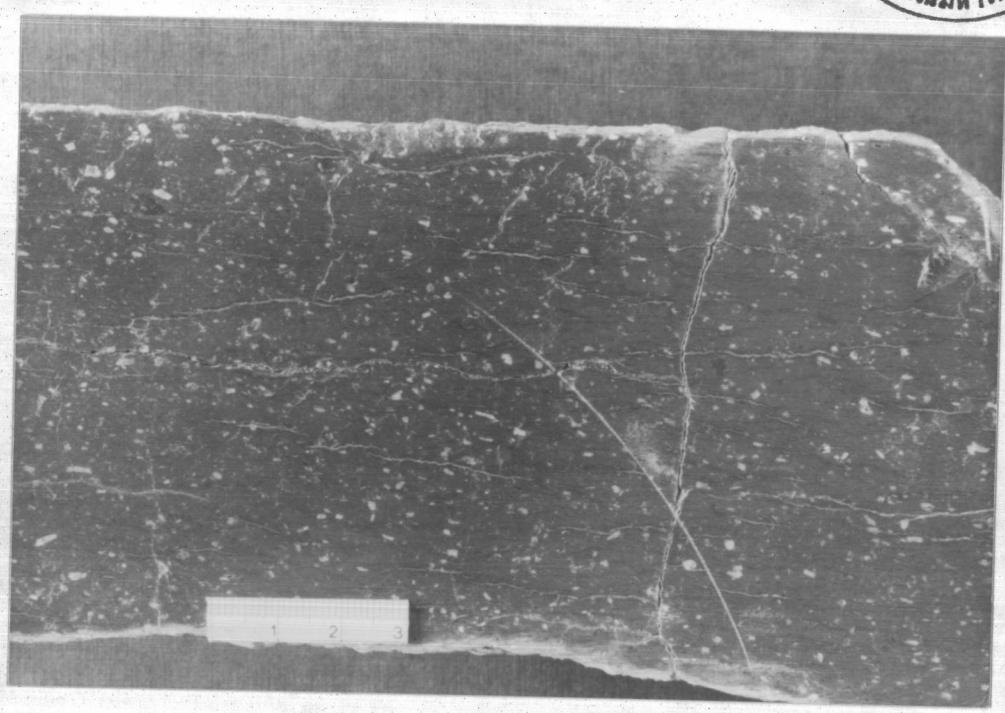
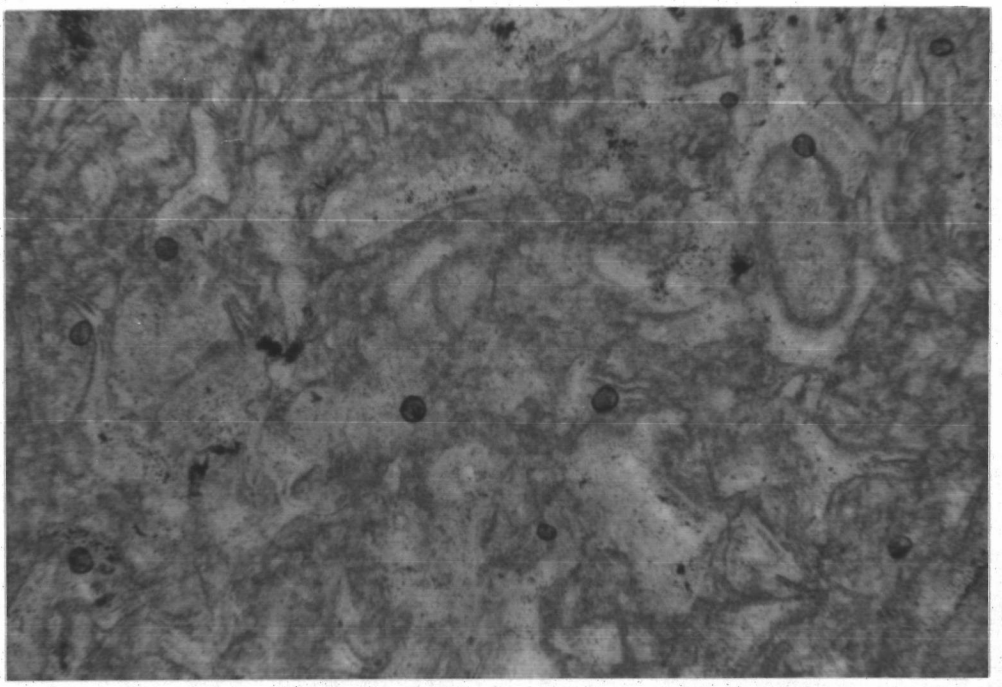


Fig. 3.21 General texture of rhyolitic tuff in Uthai Thani area

a) Show a wide range in size and variable amounts of constituent materials.

b) Show flow structure.

a)



b)

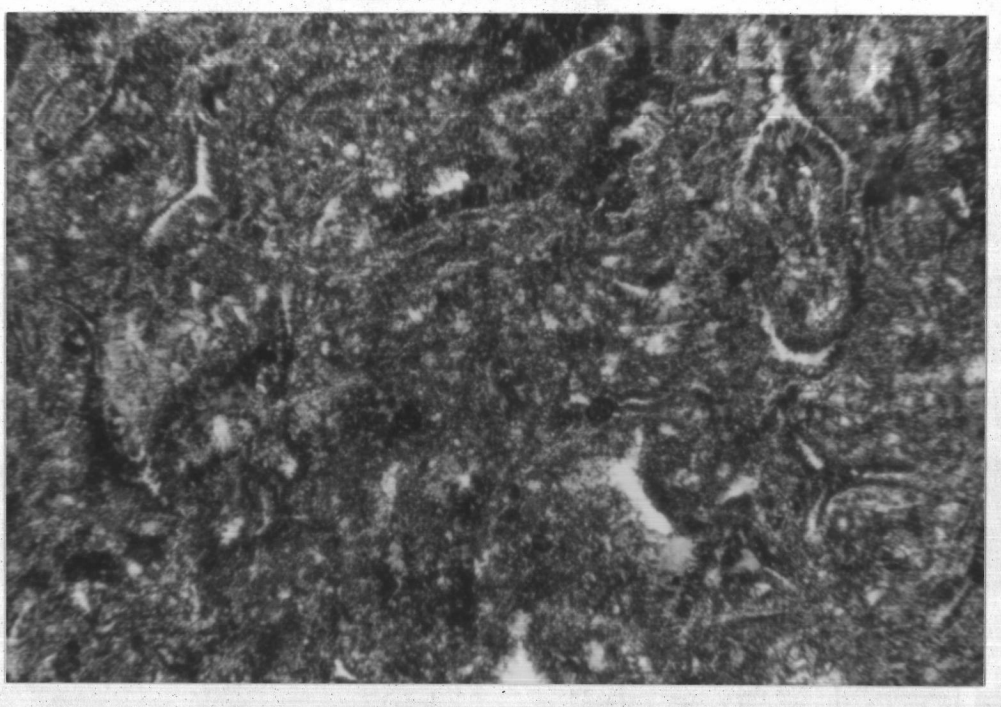
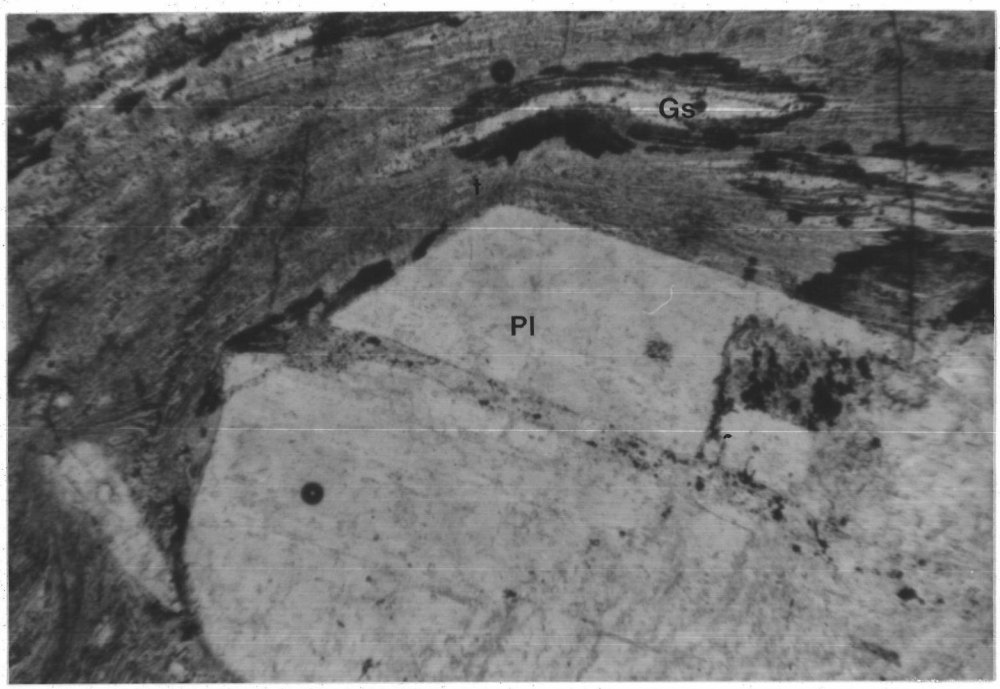


Fig. 3.22 Photomicrograph of rhyolitic tuff in Uthai Thani area showing a wide range in size and different forms of glass shards in the groundmass of interstitial dust (45x, a) plane polarized light, b) X-nicols).

is the evidence of distortion (Figure 3.23). Devitrification tends to be more prevalent in tuff of this area. The most characteristic and widespread type of devitrification product is where the growth of replacing feldspar and cristobalite has begun at the grain boundary (Ross and Smith, 1961) (Figure 3.24). The alteration of groundmass has also been occured. The altered-glass recrystallizes to microcrystalline silica and feldspar. Some of the glass may alter directly to clay.

Feldspar phenocryst of rhyolitic tuff is mainly plagioclase. Plagioclase contitutes larger in amount than potassium feldspar and quartz. They varying in size from 0.5 up to 2.5 millimeters. All together there are about 5-25 percents feldspar phenocrysts in this tuff. The feldspar grains are commonly subhedral. Plagioclase phenocryst is rather common and often shows both albite and Carlsbad twinnings. An-content of plagioclase, when it is possible to be determined optically, appears to be around An_5. This indicates plagioclase composition in the range of sodic albite. Most of the plagioclase grains are replaced by calcite and some are rimmed by potassium feldspar. Potassium feldspar is frequently sanidine occasionally orthoclase. Anorthoclase is also present in small amount. Sanidine constitutes larger in amount than orthoclase and it is rimmed by anorthoclase (Figure 3.25). Optical characteristic of sanidine is relatively low birefringence and possesses extremely small optical angle. Orthoclase, though being present in small amount, it is subhedral and ofter shows Carlsbad twins. Orthoclase is distinguished from sanidine by its large optical angle. Anorthoclase ofter shows fine

a)



b)

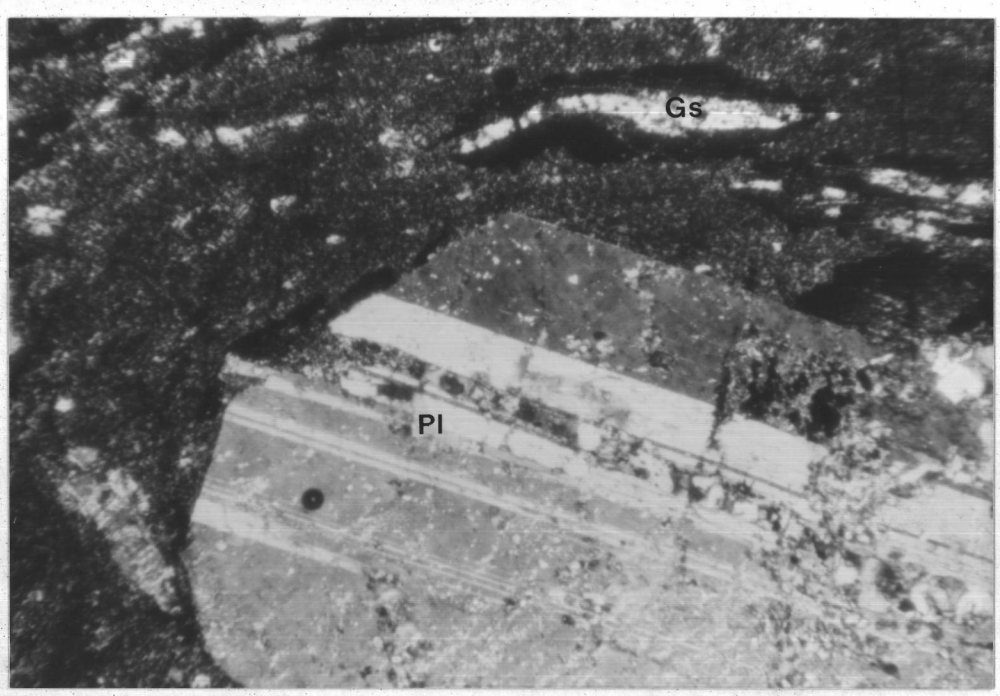


Fig. 3.23 Photomicrography of rhyolitic tuff in Uthai Thani area showing compression and distortion of the glass shard (Gs). They are molded against plagioclase phenocryst (Pl) until there is a marked simulation of flow structure (45x, a) plane polarized light, b) X-nicols).

Fig. 3.24 Photomicrograph of rhyolitic tuff in Uthai Thani area showing the devitrification of glass shard (Gs) (X-nicols, 90x).

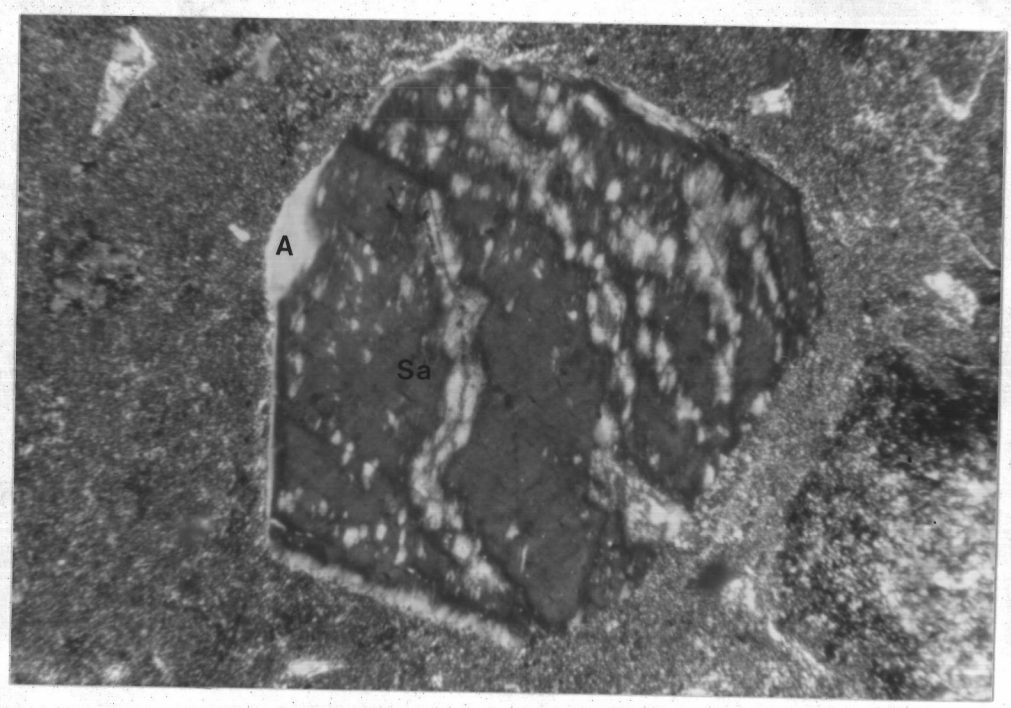


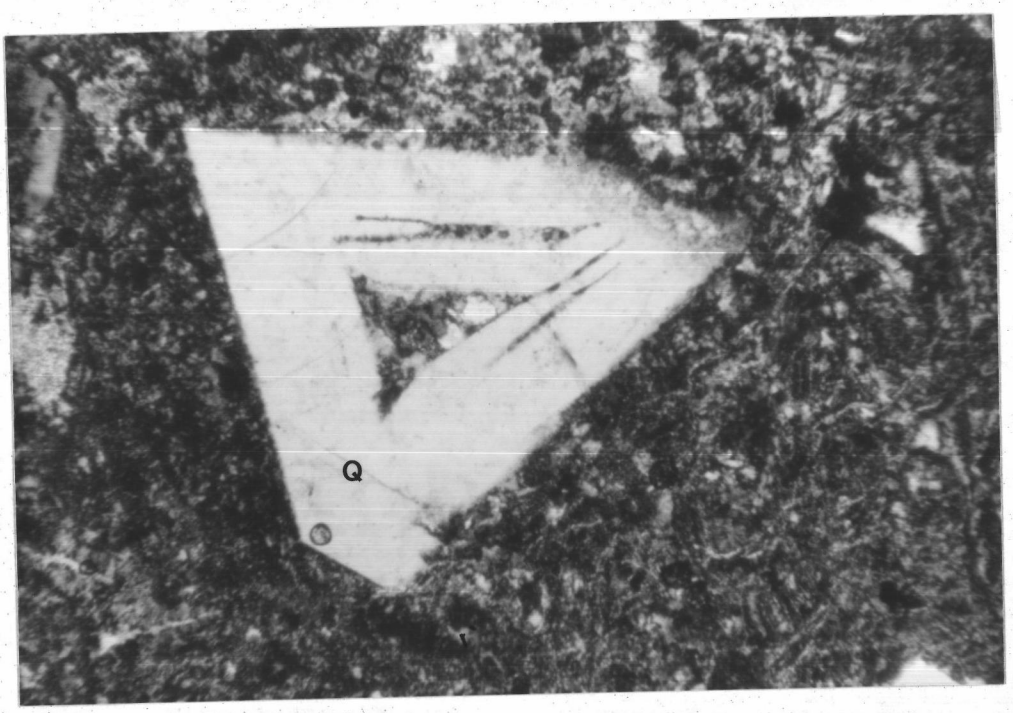
Fig. 3.25 Photomicrograph of rhyolitic tuff in Uthai Thani area showing sanidine (Sa) is rimmed by anorthoclase (A) (X-nicols, 45x).

grid twin. It can be distinguished from microcline by the small extinction angle on (001) and the optical angle of about 50^{o}.

Quartz is the second must abundant phenocryst found in this rock. Quartz grain is about 0.5-1.2 millimeters in diameter and is euhedral or subhedral in shape with corroded rims (Figure 3.26).

The rock fragments of this rock are rhyolitic tuff, andesite and pumice. Amoung these, rock fragments of rhyolitic tuff and andesite are rather common. The rhyolitic tuff fragment are reddish purple in colour. The groundmass is composed of quartz and plagioclase. In some rock fragments, groundmass is microcrystalline aggregate of quartz, feldspar and spherulite that are usually obscured by iron oxides. Phenocrysts in this rhyolitic tuff fragments are plagioclase and quartz. Plagioclase phenocryst is present in smaller amount than quartz. It is mostly albite in composition (An_5). Quartz phenocryst occurs as subhedral to anhedral crystals. Texturally and mineralogically, rhyolitic tuff fragments are similar to its mother rock. This indicates that there were at least more than one volcanic eruption in this area. Andesite fragments are always characterized by feldspar microlite, and commonly shows flow structure. Mafic minerals occur small amount. Secondary calcite is occasionally found. Pumice fragment occurs in small amount. It is made up of greatly elongated tabular pore spaces in glassy groundmass. Pumice fragments in this rocks are subjected to the same devitrification effects as glass and the resulting minerals are feldspar and cristobalite (Ross and Smith, 1961) (Figure 3.27).

a)



b)

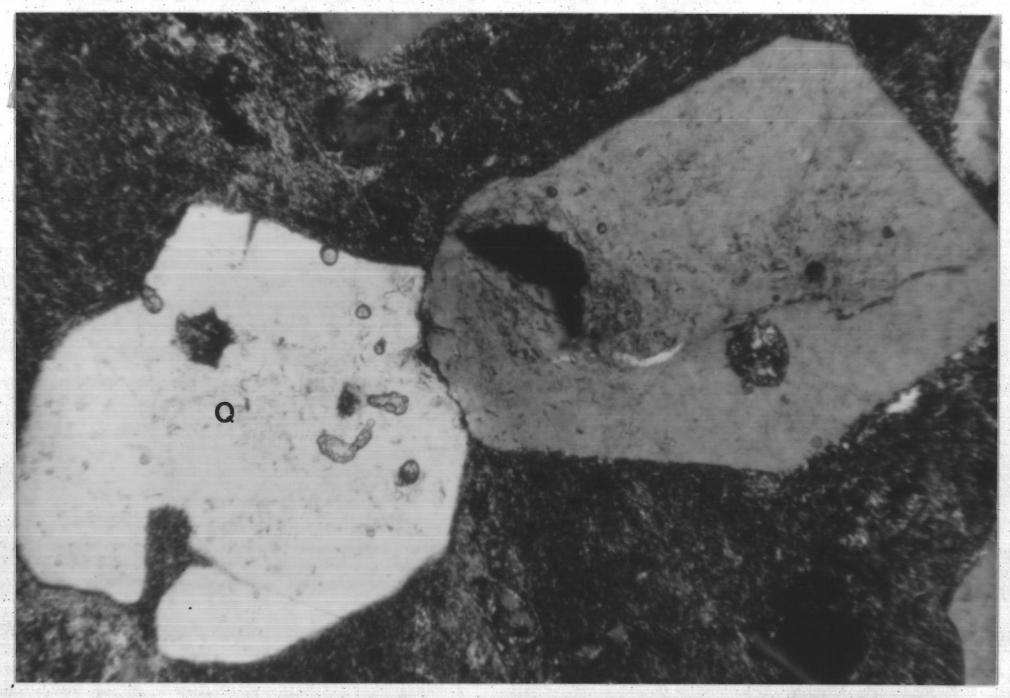


Fig. 3.26 Photomicrograph of rhyolitic tuff in Uthai Thani area showing a) euhedral and b) subhedral shapes with corroded rims of quartz phenocryst (Q) (X-nicols, 45x).

a)

b)

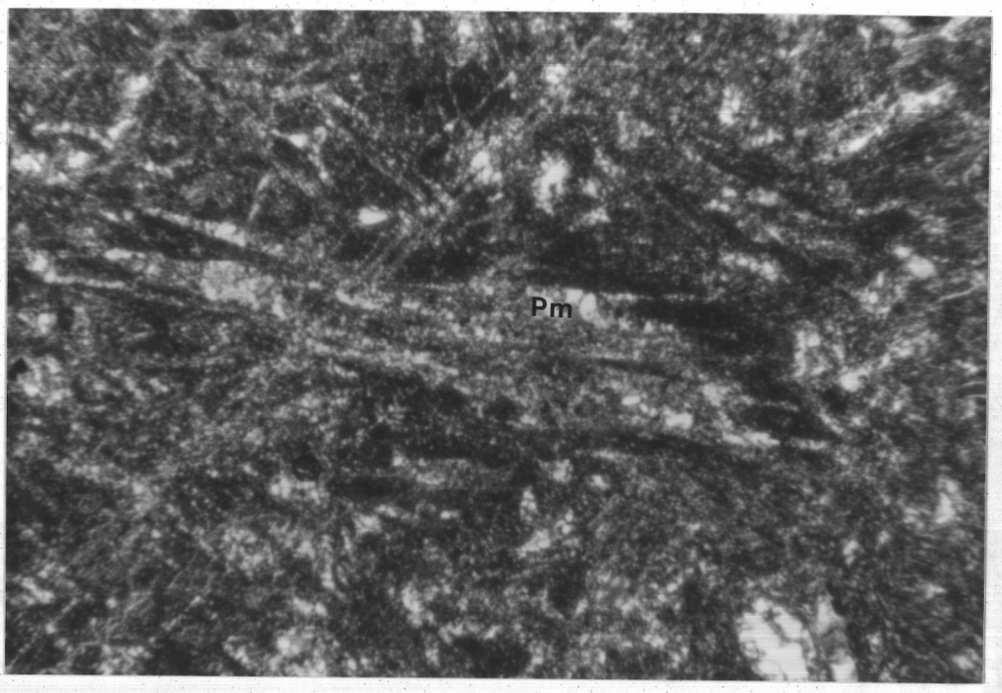


Fig. 3.27 Photomicrograph of rhyolitic tuff in Uthai Thani area showing glassy pumice fragments (Pm) (45x, a) plane polarized light, b) X-nicols).