CHAPTER III

VOLCANIC STRATIGRAPHY OF C-H PITS

3.1 Subdivision and Criteria

Volcanic stratigraphy was documented in the field by using a GPS with a precision altimeter to locate points and provide a detailed record of the lilhologic observation. The criteria and subdivision of the volcanic rocks used in this study follow that of McPhie et al. (1993) (see Figures 3.1 and 3.2) The volcanic rocks of the C-H pits can be divided into 2 facies-coherent and non-coherent facies. The former is defined as a vocanic rocks with lava flow textures and the latter is described as a volcanic rock with pyroclastic fragments or debris. Tables 4.1 (A) and (B) display descriptive names for coherent lavas and volcaniclastic rocks. Figures 3.5 show schematic volcanic stratigraphy of the C-H pits , the stratigraphic correlation of the studied C-H pits, based on field mapping (see Figures 1.4)

A representative suite of 44 samples was collected from 2 short-period field surveys. Thin section was made of 44 samples to document differences in matrix size, clast size and clast compositions within the volcanic clastics, and textural and mineralogical differences within various volcanic clans and their alteration products.

3.1.1 Coherent facies

The coherent facies consists largely of volcanic rocks with the groundmass of aphanitic texture. They are mainly pale green to dark brown in color. In some locations, the rocks are slightly to moderately porphyritic. This volcanic unit are formed in both C-H pits (Figure 3.3). Coherent volcanic textures form from cooling and solidification of molten lava or magma. The most ubiquitous hallmark is porphyritic texture, especially the presence of evenly distributed, euhedral crystals that have narrow size ranges. No-phenocryst-aphyric, aphanitic and totally glassy textures are also regarded as the coherent. Vesicles, flow foliations, spherulites and lithophysae are common in this unit , though not independently diagnostic, and also occur in volcaniclastic deposits. Coherent textures occur principally in lava flows and in intrusions (McPhie et al., 1993).

Subdivision of coherent unit can be made petrographically using the presence or absence of some index minerals. For instance rhyolite if it contains quartz phenocryst,, or andesite if phenocrysts are plagioclase and hornblende. Figures 3.1 A and B show typical coherent unit as described by McPhie et al.(1993).

3.1.2 Non-coherent facies

The non-coherent facies is defined as a volcanic rock with pyroclastic facies and debris in both pits is characterizes by rock fragments of inequant sizes. Various kinds of rock fragments are recognized, inclusions and xenoliths (or xenocrysts), glass and volcanic materials. There are two major kinds of non-coherent unit – volcanic breccias and fiamme breccia. Figures 3.3 A and B show typical non-coherent unit as described by McPhie et al. (1993).

The vocanic breccia can be subdivided into monomictic and polymictic breccia. The monomictic breccia contains only one kind of volcanic fragments in the matrix (or groundmass) and the other contains at least two kinds of volcanic fragments. The monomictic breccias presents only in the H pit.

Polymictic and monomictic breccia unit

Theoretically during explosive eruptions of porphyritic magma, whole crystals and crystal fragments are liberated. A small proportion of crystal fragments in pyroclastic rocks may be derived from disintegration of igneous and metamorphic wall rocks. In the polymictic and monomictic breccia unit, angular fragments of euhedral crystals are typically more abundant than complete euhedral crystals, and show a relatively wider grain size range. The upper limit of which is determined by the maximum phenocryst size in the porphyritic source magma. The crystal fragments, especially euhedral, have thin partial selvedge of glassy pumice or scoria. Some crystals in pumice or scoria clasts are fractured in situ, and the fragments show jigsaw-fit texture.

Quench fragmentation of porphyritic magma is another means of generating free crystals and crystal fragments, and these can be significant in the coarse sand- and granule-size components of especially resedimented hyaloclastite. In situ quench fragmentation of porphyritic lavas commonly affects phenocrysts, producing jigsaw-fit or near jigsaw-fit monominerallic crystal fragment clusters. Subsequent alteration and deformation from quench-fragmented phenocrysts and glassy groundmass may result in and apparent pyroclastic texture.

Crystals in volcanogenic sedimentary deposits are derived by reworking and resedimentation of non-welded, crystal-bearing pyroclastic or autoclastic deposits, and by surface weathering and erosion of crystal-bearing volcanic rocks, such as porphyritic lava or crystal-rich welded ignimbrite. Crystal fragments of either origin become increasingly rounded by surface processes, and evidence of the original clast-forming mechanisms may be destroyed. Note that some primary phenocrysts are rounded prior to eruptin , due to magmatic resorption.

Crystal fragments are typically confined to, and dominate the sand or coarse ash grain size of volcaniclastic deposits (McPhie et al.,1993).

Fiamme breccia unit

The term *fiamme* has been applied to glassy lenses with flame-like shapes in welded pyroclastic deposits. Alignment of long dimensions of glassy lenses defines a bedding-parallel foliation attributed to welding compaction of presumed formerly vesicular juvenile clasts. The term is now widely used for both glassy and devitrified lenticular juvenile fragments, regardless of the fragments having been originally vesicular or non-vesicular. Furthermore, foliated lenticular juvenile fragments are not restricted to welded pyroclastic deposits but also occur in diagenetically compacted, non-welded, primary pyroclastic diagenetically compacted, non-welded, primary pyroclastic deposits and pumice-or scoria-rich, resedimented and reworked volcaniclastic deposits. Here, fiamme refers to lenticular to disc-shaped juvenile volcanic fragments that define a pre-tectonic foliation. The fragments usually have wispy, flame-like ends. The preferred shape and orientation of the fragments is most commonly due to welding or diagenetic compaction. Ancient examples of diagenetically compacted pumice-rich deposits (Allen 1990, Allen and Cas 1991) show that many fiamme are compacted single pumice clasts, whereas some comprise compacted aggregates of a few pumice clasts.

In this research, it is emphasized restriction of fiamme to confirm juvenile fragments that define a confirmed pre-tectonic foliation. Foliated lenticular apparent clasts are common in altered and deformed volcanic sequences . In cases where lenticular apparent clasts are the result of alteration and deformation, or in cases where the origin is uncertain, the terms *pseudofiamme* or fiamme-like lens can be used (McPhie et al., 1993). However, based upon this research investigation only the fiamme breccia rocks were observed. The fiamme-like lens can be found only in the drill core samples.

3.2 Detailed stratigrapical units

Generally, stratigraphic units are groups of sedimentary and / or volcanic unit that occur at specific levels in the stratigraphy. In this research, C-H pits of Chatree gold mine have been selected for studying volcanic stratigraphy. This is because both pits are the current and largest active pits of the mine and there are several kinds of rocks present.

3.2.1 C Pit

The C Pit is located in the north of the mapped area (Figure 2.2) the volcanic rocks at the C pit can be grouped into certain stratigraphic units based on compositions, textures and positions in the stratigraphy. In the C Pit, 3 stratigraphic units are recognized. The lowest stratigraphic unit is the coherent facies. The succesive younger units are grouped as non-coherent facies,which is dominated by volcanic breccias. This unit consists of 2 units, from older to younger, as polymictic and fiamme breccia units. Below are the detailed stratigraphy of individual units.

Coherent facies

Coherent facies occurs widely in the C pit and occupies about 40 % of the total mapped area The coherent facies recognized in the field can be divided into 2 types, namely porphyritic andesite and andesite. The former is much more abundant than the latter and occurs about 90 % of the specimens collected. The porphyritic andesite consists mainly of subhedral to enhedral phenocrysts. The phenocrysts are chiefly felsic and mostly rectangular to stubby prism in shape. Their sizes vary from 1/16 to 2 mm. Phenocryst colors vary widely from white, green gray, pinkish white to reddish brown. They are indentified as altered plagioclase and unidentified felsic minerals. Groundmass is generally dark gray to greenish and reddish gray. The ratios of phenocrysts to groundmass is about 1 : 2.5 to 1:3. Some mafic phenocrysts (with the common size of 0.5 – 1 mm) are present in much smaller amount (less than 20 % of the total phenocrysts). The mafic phenocrysts are identified as hornblende in the field. The other type of the coherent facies is andesite which has massive and dense textures, sometimes they show slight flow texture. Colors of andesite are largely grey and greenish grey. In some places, it graded to basaltic andesite due to their darker colors. However, in general the rocks are aphanitic and require petrographic analysis under microscopic investigation. The coherent facies has no floor generally is thicker than 80 m (Figure 3.6) The volcanics of this unit show strong to moderate alteration as displayed by quartz, +- calcite veins and veinlets. The coherent unit was later cut by dike rocks.

Polymictic Breccia Unit

Polymictic breccia unit occurs in the medium zone of the C pit and covers about 30% of the pit. This unit consists of more than two kinds of fragments. In general, the rocks contain poorly sorted fragments which vary in size from 1 to 4 mm. They are dominated by subangular to angular shapes and have various colors, as grey, red, pale green, and dark grey. The matrix or groundmass also has various colors of green to grey shades. Ratios of fragments to matrix vary from 1:3 to 1:2.5. The rocks show grading structure with lithic fragments at base and pumice and crystals in the upper part. The unit has invariable thickness from 25 to 30 m and the average thickness is about 28 m (see Figure 3.7) The unit was subsequently cut by the dike rocks.

Fiamme Breccia Unit

Fiamme breccia unit representing the youngest unit of the C pit occurs in the north and the south of the mapped C pit. Exposures of this unit occupies about 20 % of the overall mapped area. The fiamme breccia rocks are composed of lenticular (or collapse) volcanic glasseous fragments with sizes ranging from 0.3 to 2.5 mm. Colors of fragments vary considerably from grey, red, green to yellowish brown. This breccia unit has similar thickness (20-30 m)(Figure3.8) for the northern and southern exposure. This unit always show intense alteration by the presense of veins and veinlets. The unit was also cut by some dike rocks.

3.2.2 H Pit

H pit is located in the southern part of the mapped C – H pits of the Chatree gold mine. Two unit including coherent and non-coherent facies were found similarly in the H pit. The coherent facies was observed to be older than the non-coherent facies and consists of 2 major rock types similar to those of the C pit. The non-coherent facies includes 3 succesive breccia units – viz. polymictic, monomictic and fiamme units. The latter is the highest and youngest volcanic unit (Figure 3.9). Overlying the monomictic unit is the epiclastic unit. This unit is composed mainly of fine-grained clastic unit and was not recognized in the C pits.

Coherent facies

Coherent unit was observed in both eastern and western part of the mapped area. It occupies about 30 % of the area. The coherent rocks in the H pit are mainly porphyritic andesite and minor andesite. Porphyritic andesite rocks contain subhedal to euhedal felsic phenocrysts with the common size of 1/16 to 2 mm. Majority of phenocrysts is pinkish white feldspar. Sometime mafic phenocrysts are also recognized. Ratio of phenocryats to groundmass is approximately 1:3. Porphyritic andesite rocks are generally greenish to dark grey. Andesite has apanitic texture under hand specimens and their colors vary from dark brown to dark grey. Similar to C pit, the coherent unit has no floor and is as thick as 70 m (see Figure 3.5). In some places, the coherent unit shows chill margins (Figure 3.15), flow texture (Figure 3.16) and cross-cut by dike rocks (Figure 3.14).

Monomictic Breccia Unit

Monomictic breccia unit has been found only in the southern part of the H pit. The unit occupies approximately 20% of the mapped H pit. The rocks have moderate sorting. The fragments of this breccia unit vary in size from 3 to 64 mm and are subangular to angular. The fragments are pale red, yellowish red, and reddish brown in color. In general, matrix (or groundmass) of monomictic breccias has colors varying from pale grey, grayish green to dark grey. The monomictic breccia rocks have the thickness ranging from 10 to 20 m, and the average thickness is about 18 m (Figure 3.10). This unit was later cut by andesite dike.

Polymictic Breccia Unit

Polymictic breccia unit has been found widely in the north-south trend. The unit covers about 35% of the H pit. Polymictic breccia rocks are composed of various kinds of fragments , with bad sorting. The fragments vary in size from 4 to 64 mm, and are dominanted by subangular to angular fragments. Their colors are greenish grey, reddish brown and dark grey. Colors of groundmass vary from deep grey to pale green. This breccia unit has the thickness ranging from 20 to 30 m and the average thickness is 30 m (Figure 3.11). Similar to that of the C pit, the polymictic unit was cut later by dikes.

Epiclastic Unit

Epiclasic unit is the sedimentary unit found in the H pit and composed largely of siltstone and very fine sandstone. It is located in the northernmost part of the H pit and occupies about 10% of the mapped H pit. This rock unit is well sorted and yellowish brown to reddish brown in colos. Fine grain sandstone, tuffaceous sandstone, siltstone, and tuffaceous mudstone were found in this pit. However, no limestone was observed during the course of field work. This is probably due to the removal of sediment overburden during intensive mining. Thickness of this unit varies from 10 to 15 m with average thickness of about 10 m (Figure 3.12). The unit is partly sheared, but shows no alteration.

Fiamme Breccia Unit

Fiamme breccia unit occurs in the east of the H pit. The unit covers an area of about 15% of the H pit. The Fiamme breccia rocks are composed of lenticular glass of about 0.4-1 cm in size. Fiamme breccia unit has greenish grey and grey fragments. The groundmass of the unit are green and light green in colors. Quartz fragments are also present. The fiamme breccia unit is about 20 to 30 m thick (see Figure 3.13).

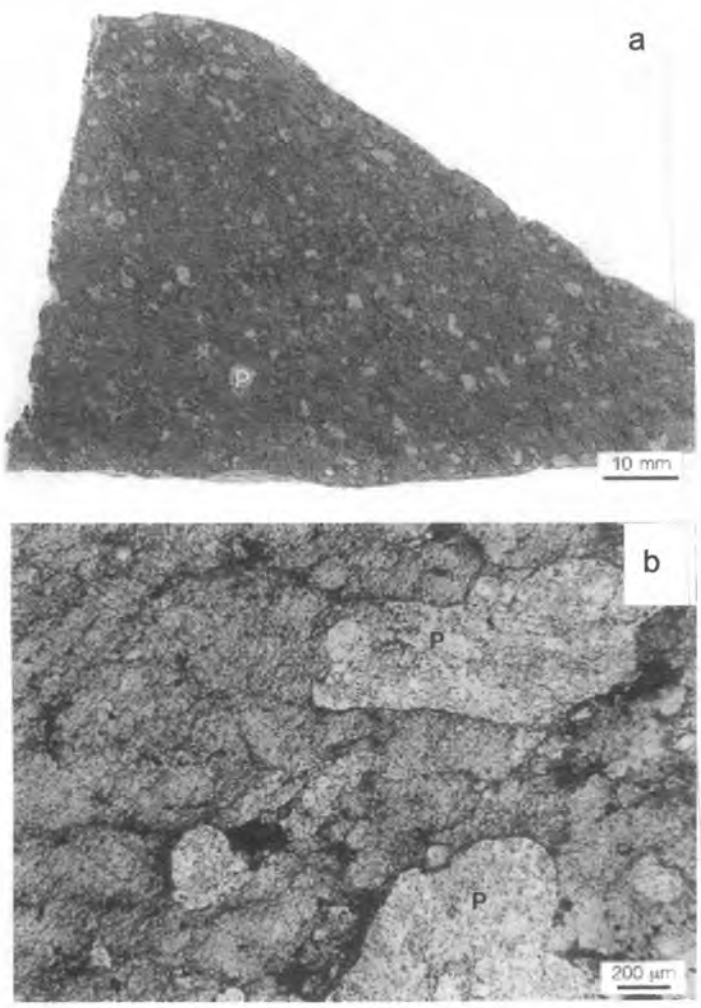

Figure 3.1(A) Rock slab (a) photomicrograph (b) of porphyritic dacite that represent coherent facies from McPhie et al. (1993).

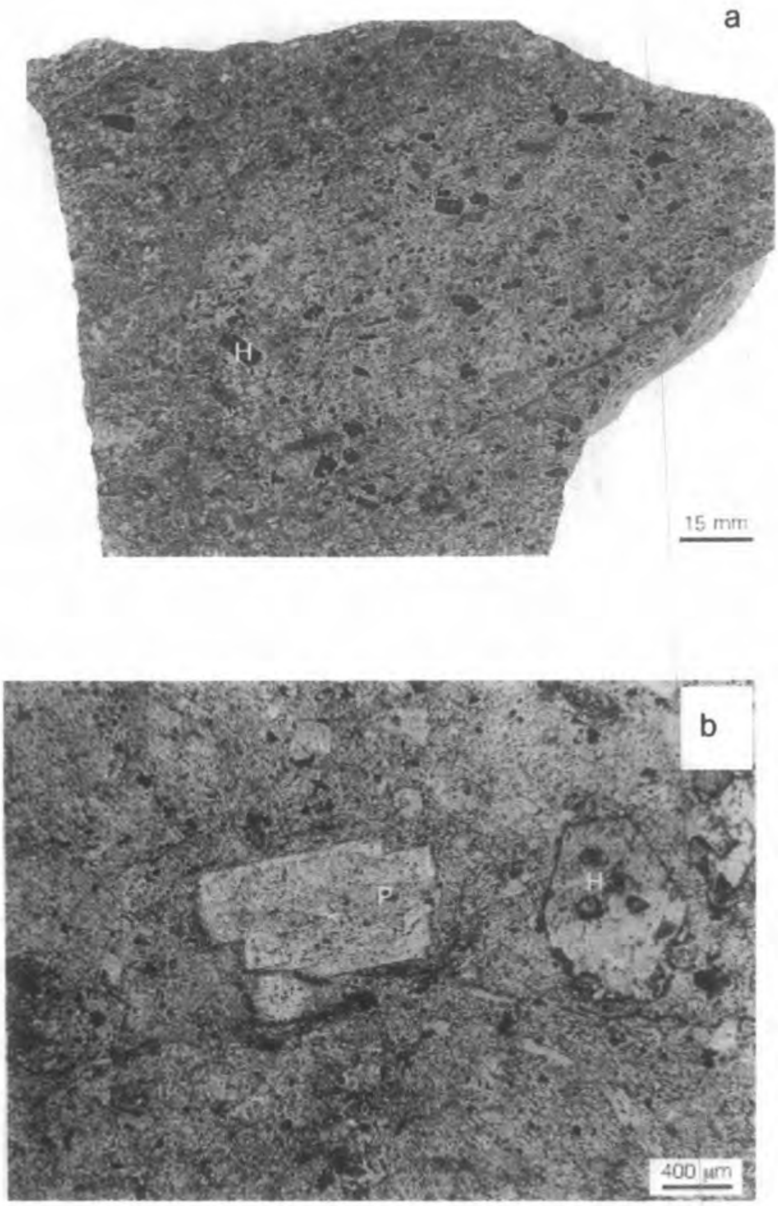

Figure 3.1(B) Rock slab (a) photomicrograph (b) of porphyritic andesite showing hornblende (H) and plagioclase (P) phenocryst are euhedral and unbroken that represent coherent facies from McPhie et al. (1993).

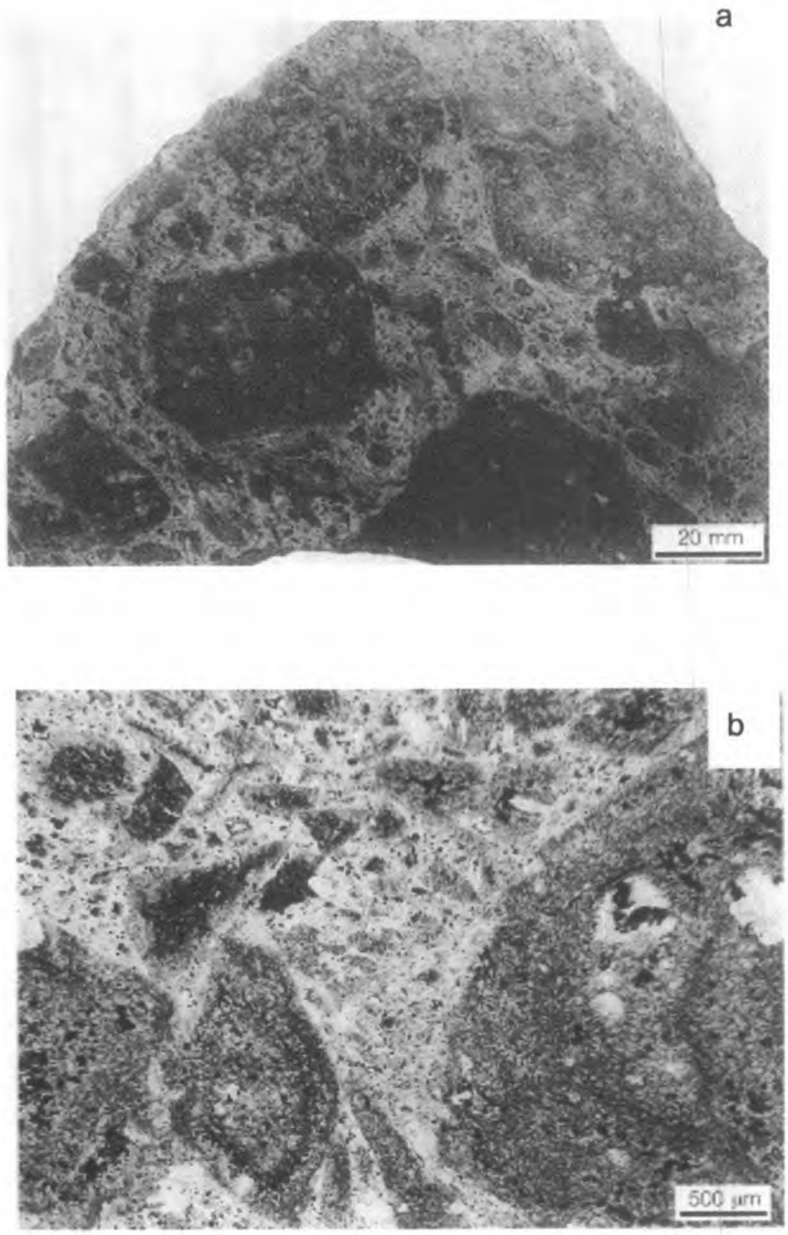

Figure 3.2(A) Rock slab (a) photomicrograph (b) of non-coherent facies that represent polymictic and monomictic breccia unit from McPhie et al. (1993).

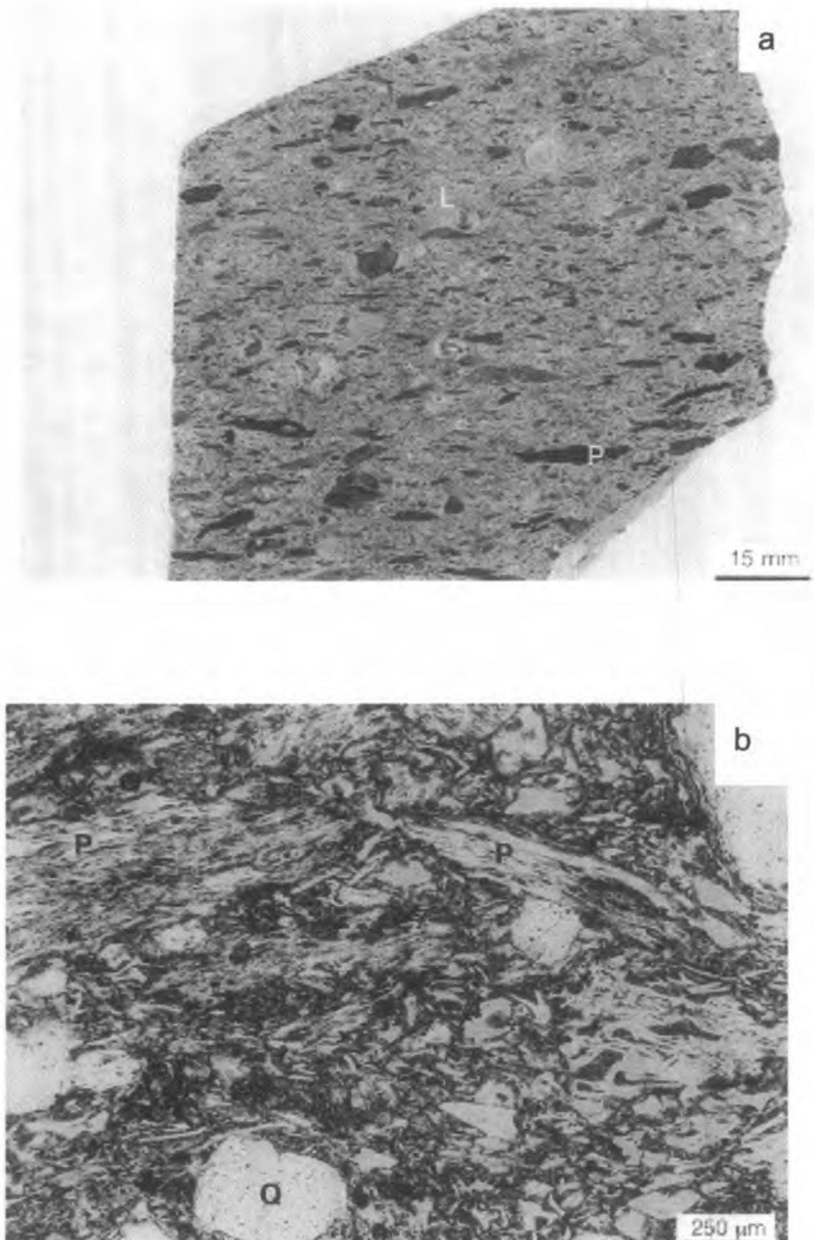

Figure 3.2(B) Smooth rock slab (a) photomicrograph (b) of non-coherent facies that represent fiamme breccia unit. The lenticules are glassy wisps (P) and quartz (Q) from McPhie et al. (1993).

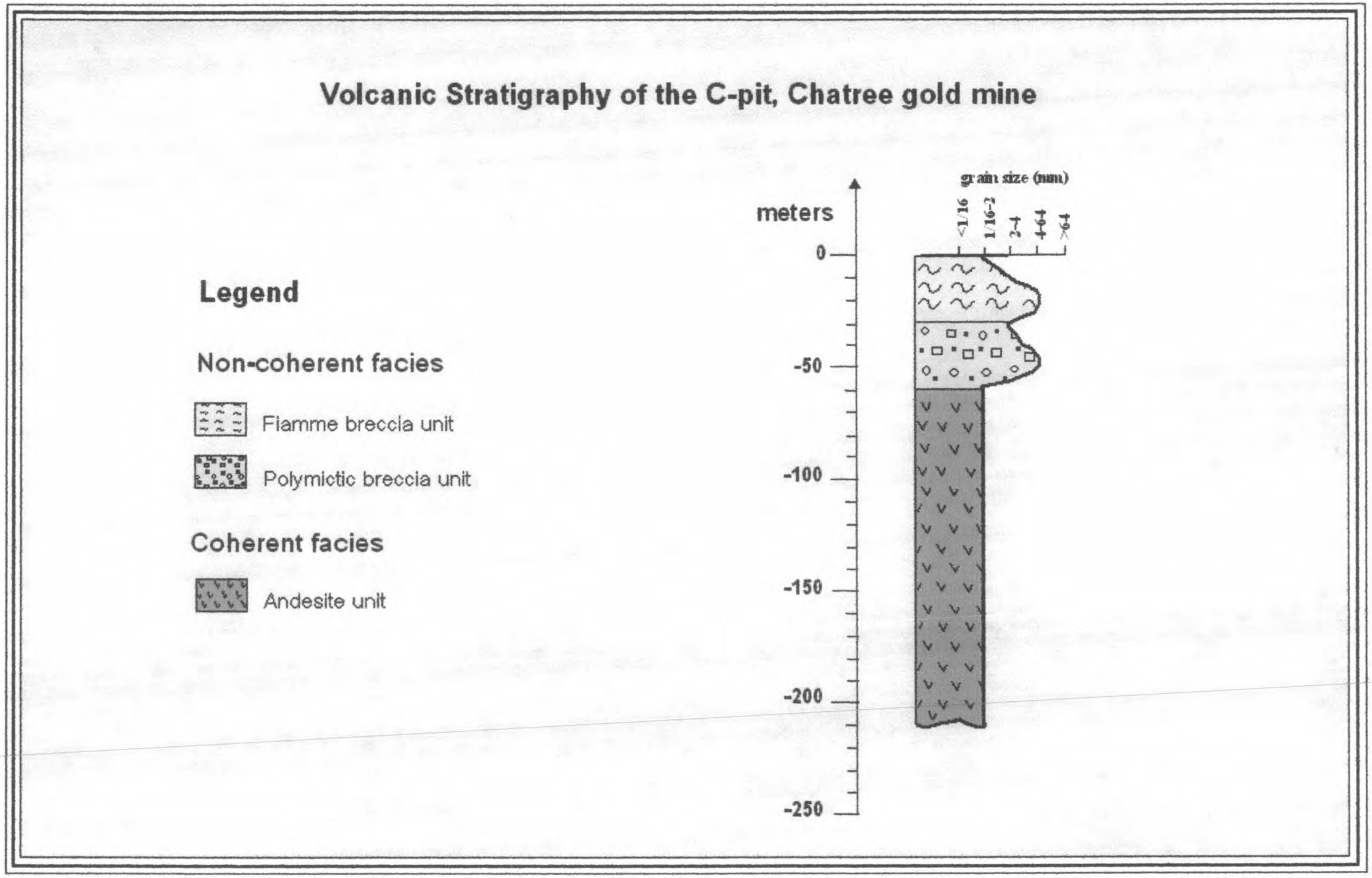

Figure 3.3. Stratigraphy of the C-Pit, Chatree gold mine, Phichit, central Thailand, from geological survey and drill hole data.

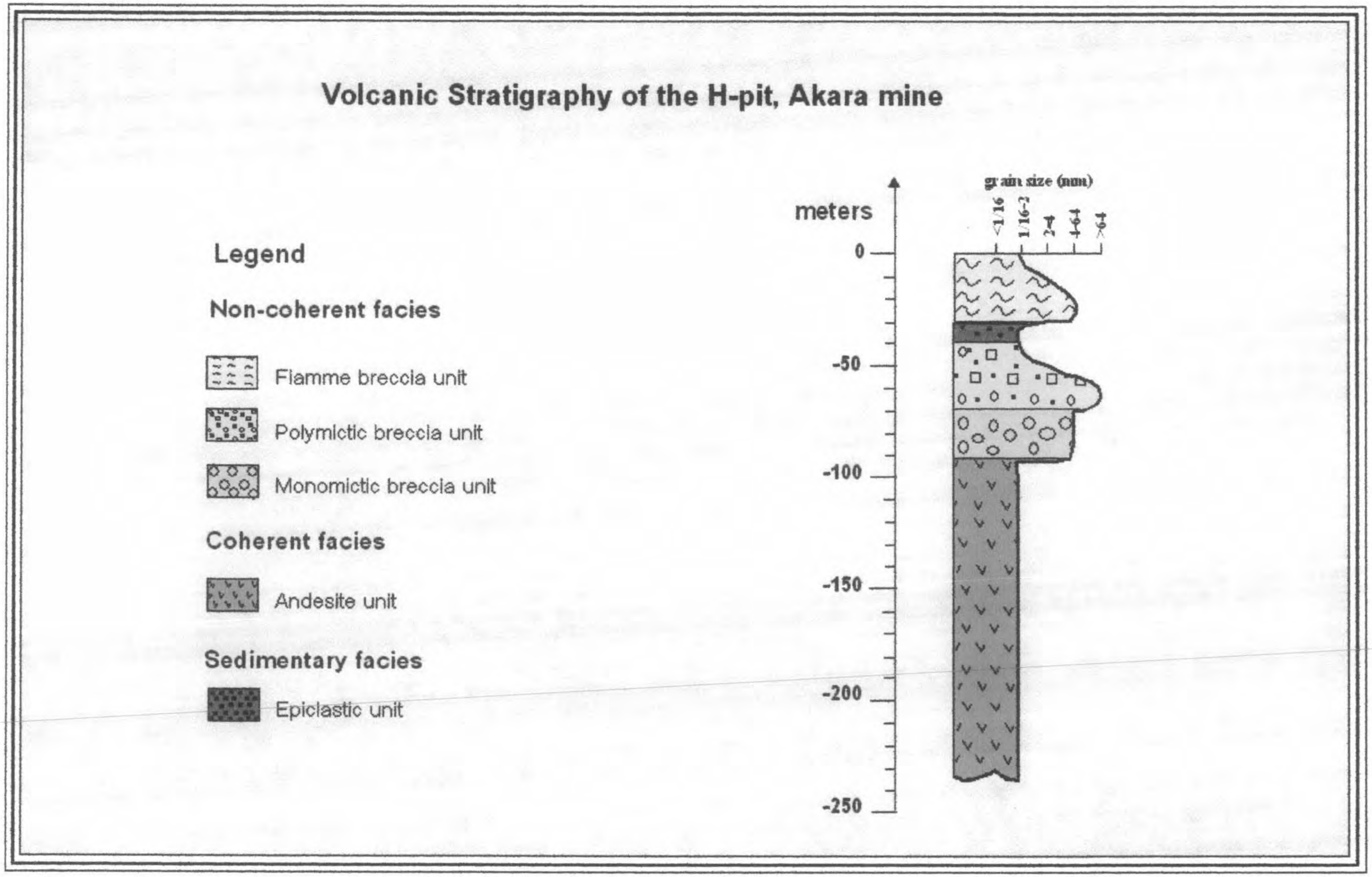

Figure 3.4. Stratigraphy of the H-Pit, Chatree gold mine, Phichit, Central Thailand from geological survey and drill hole data.

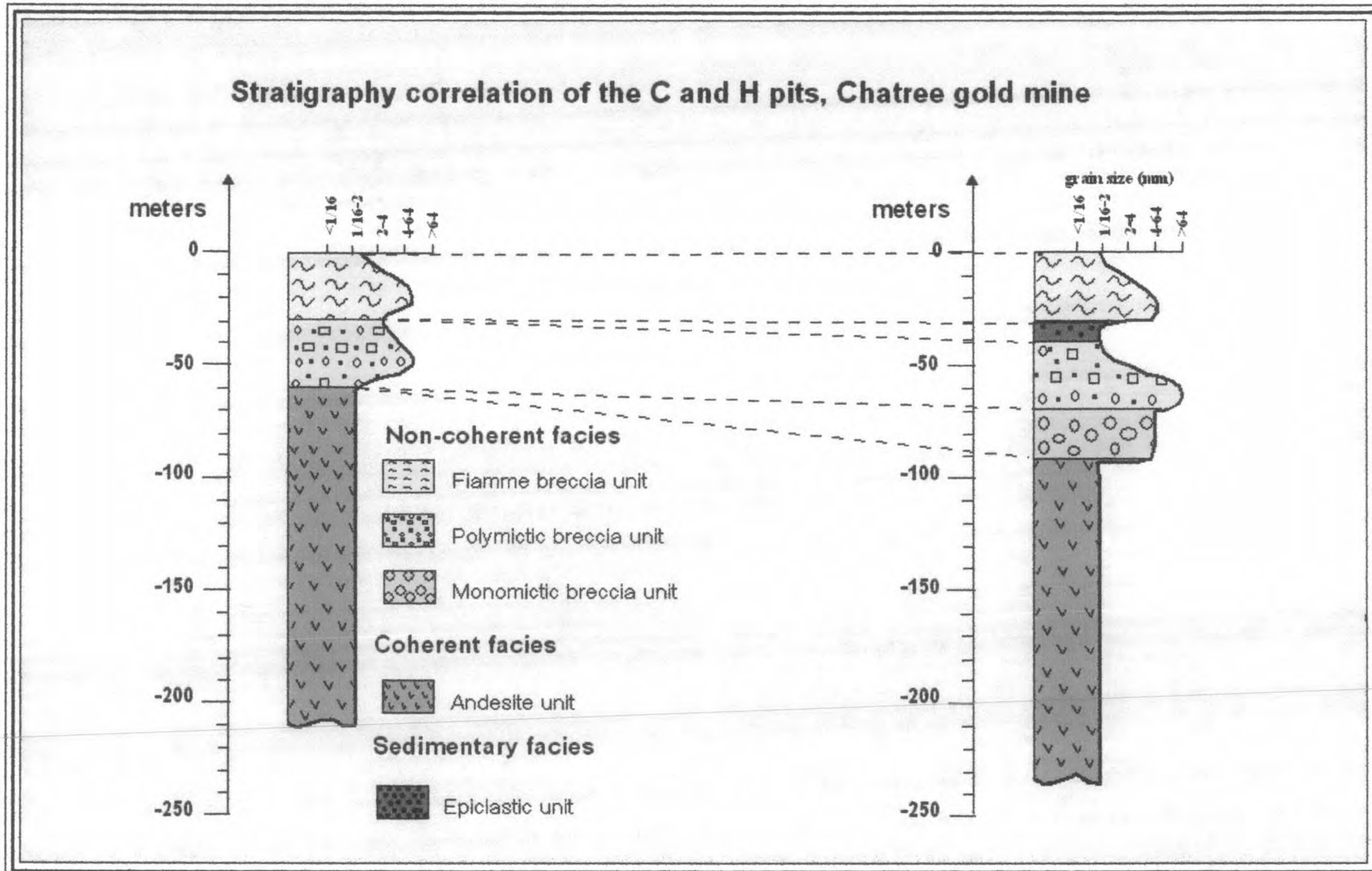

Figure 3.5. Volcanic stratigraphy corelation of the C-H Pit, Chatree gold mine, Phichit, central Thailand, fromgeological survey and drill hole data.

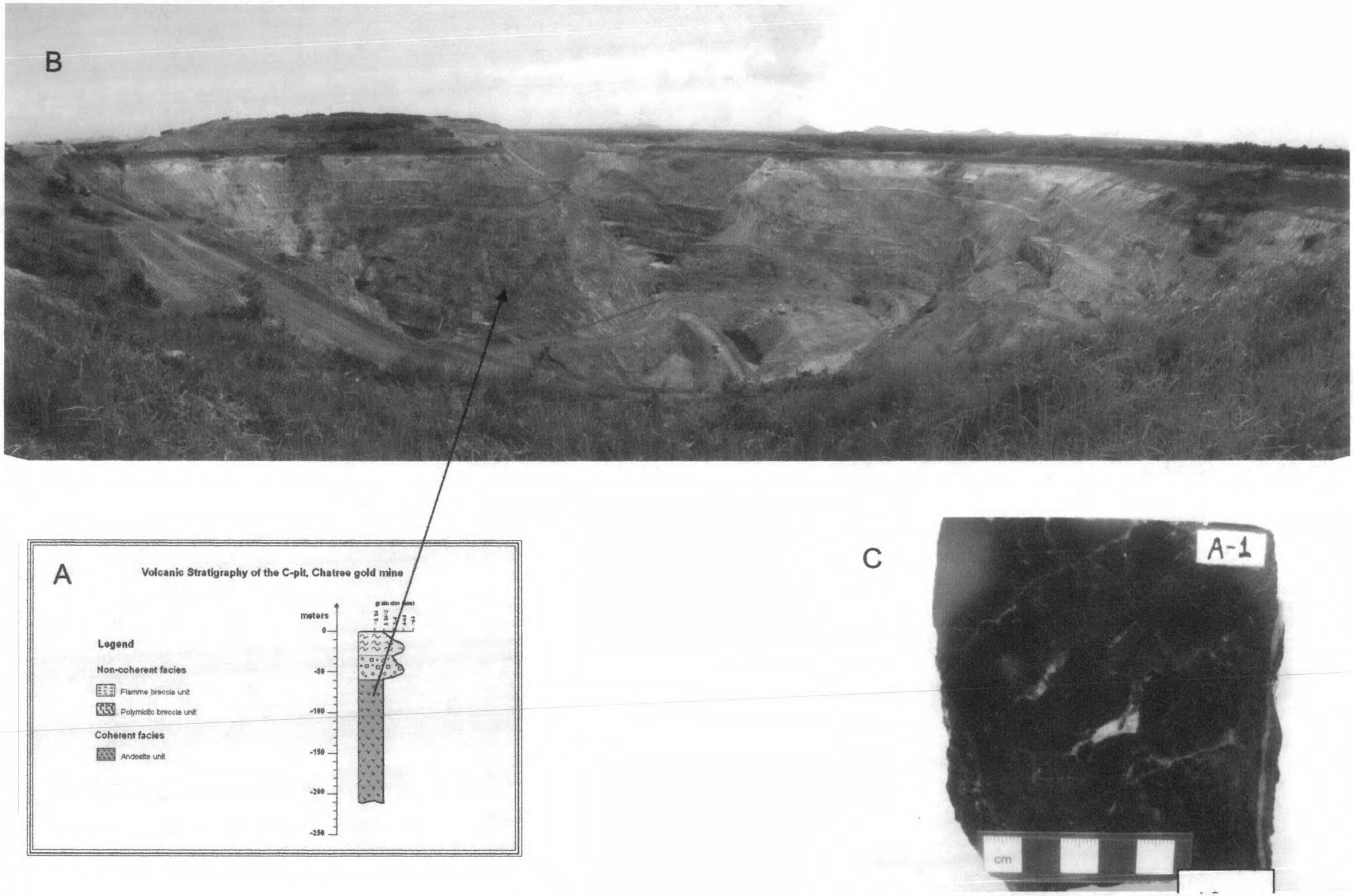

Figure 3.6. Coherent volcanic unit in the C pit, Chatree gold mine, Phichit, showing (A) location of the unit in the stratigraphic sequence, (B) nature of exposure , view looking southwest, and (C) a close-up view of

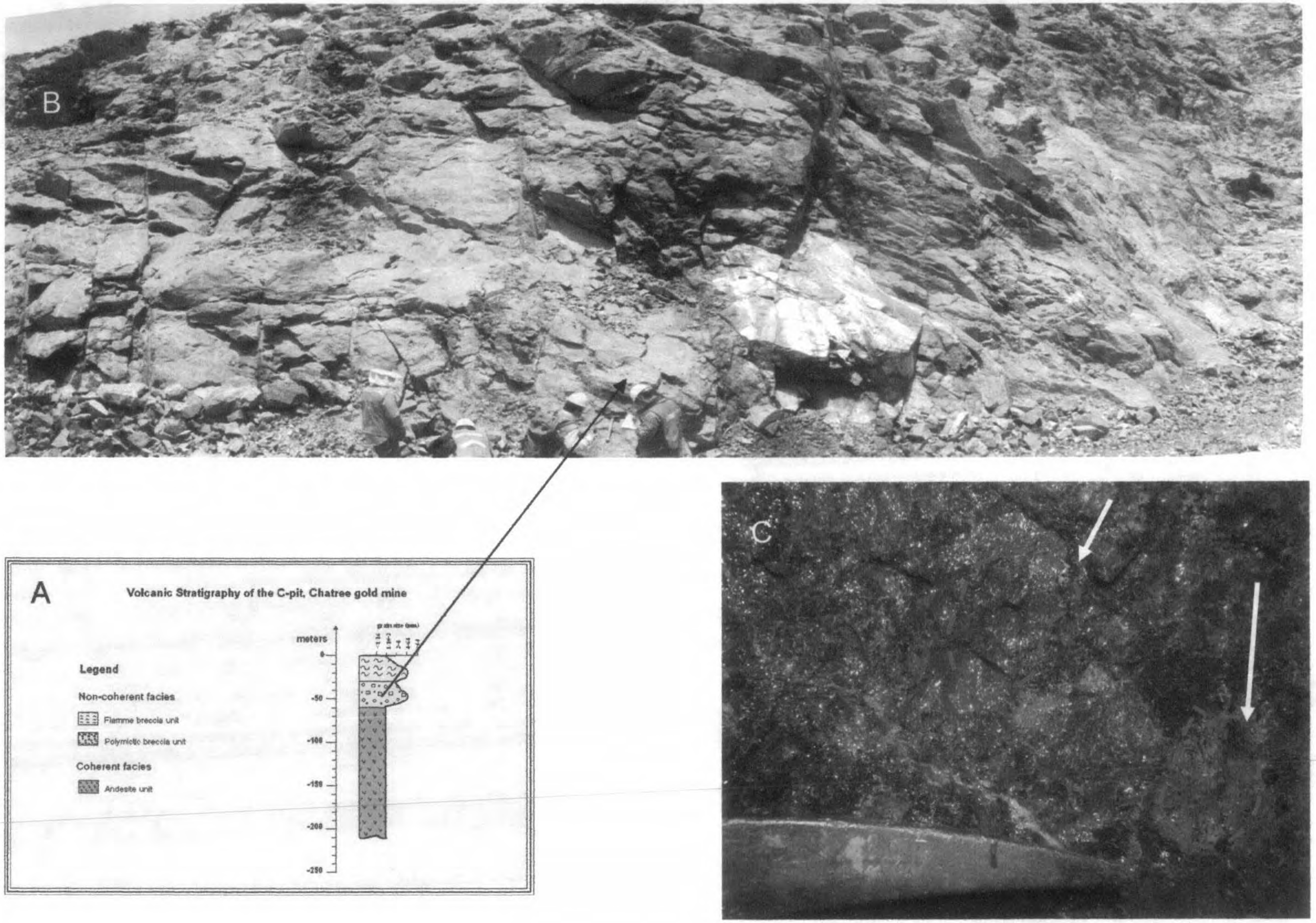

Figure 3.7. Polymictic breccia unit in the C pit, Chtree gold mine, Phichit, showing (A) location of the unit in the stratigraphic sequence, (B) exposure of polymictic breccia, view looking northeast, and (C) a close-up view of polymictic breccia with various sizes and vari-colors of volcanic fragments (arrowed).

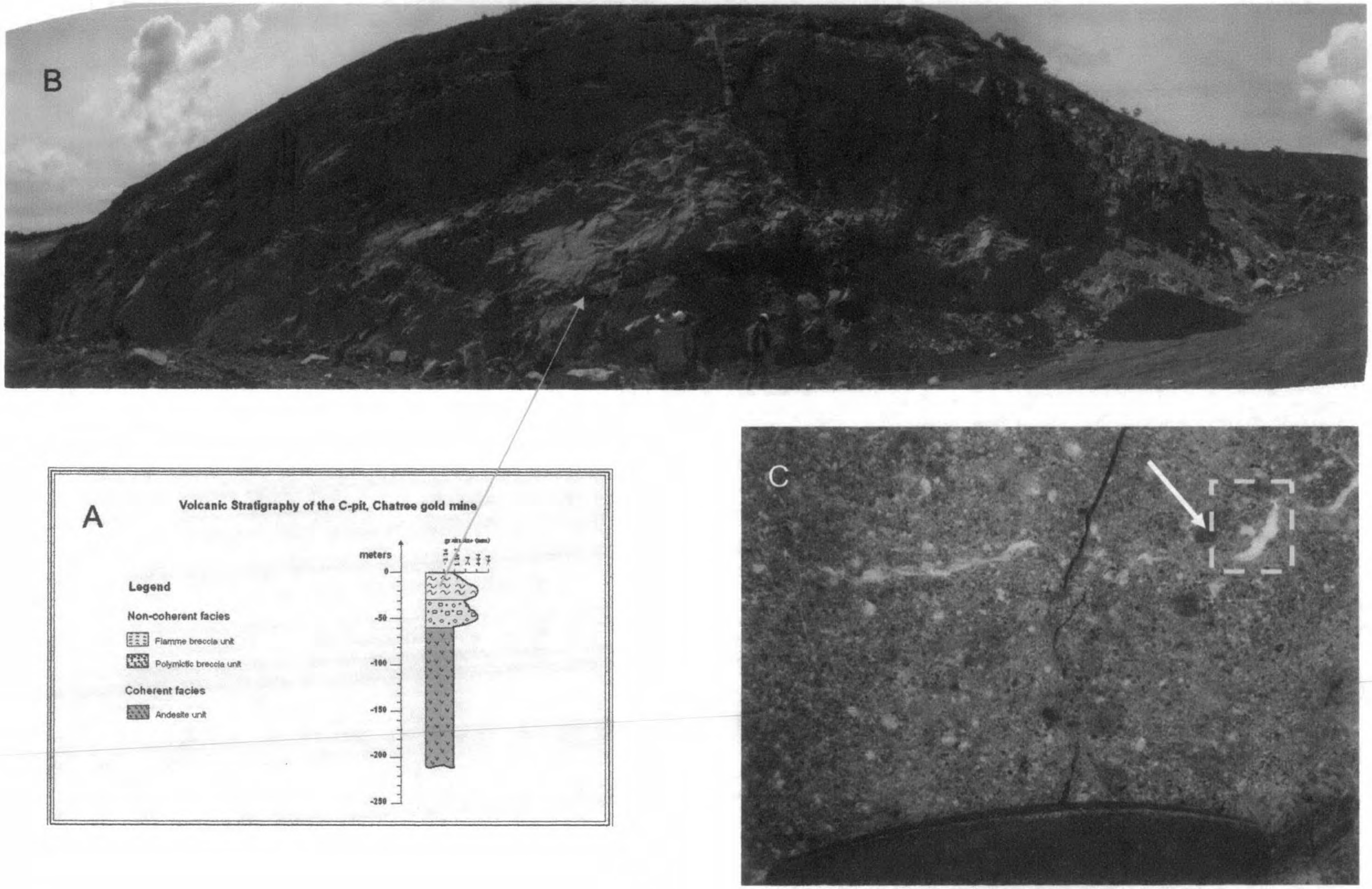

Figure 3.8. Fiamme breccia unit of the C pit showing (A) location of the unit in the stratigraphic sequence (B), exposure of fiamme Volcanic, view looking NS (200°) and (C) a close-up view of breccia, showing tenticular glasseous fragment.

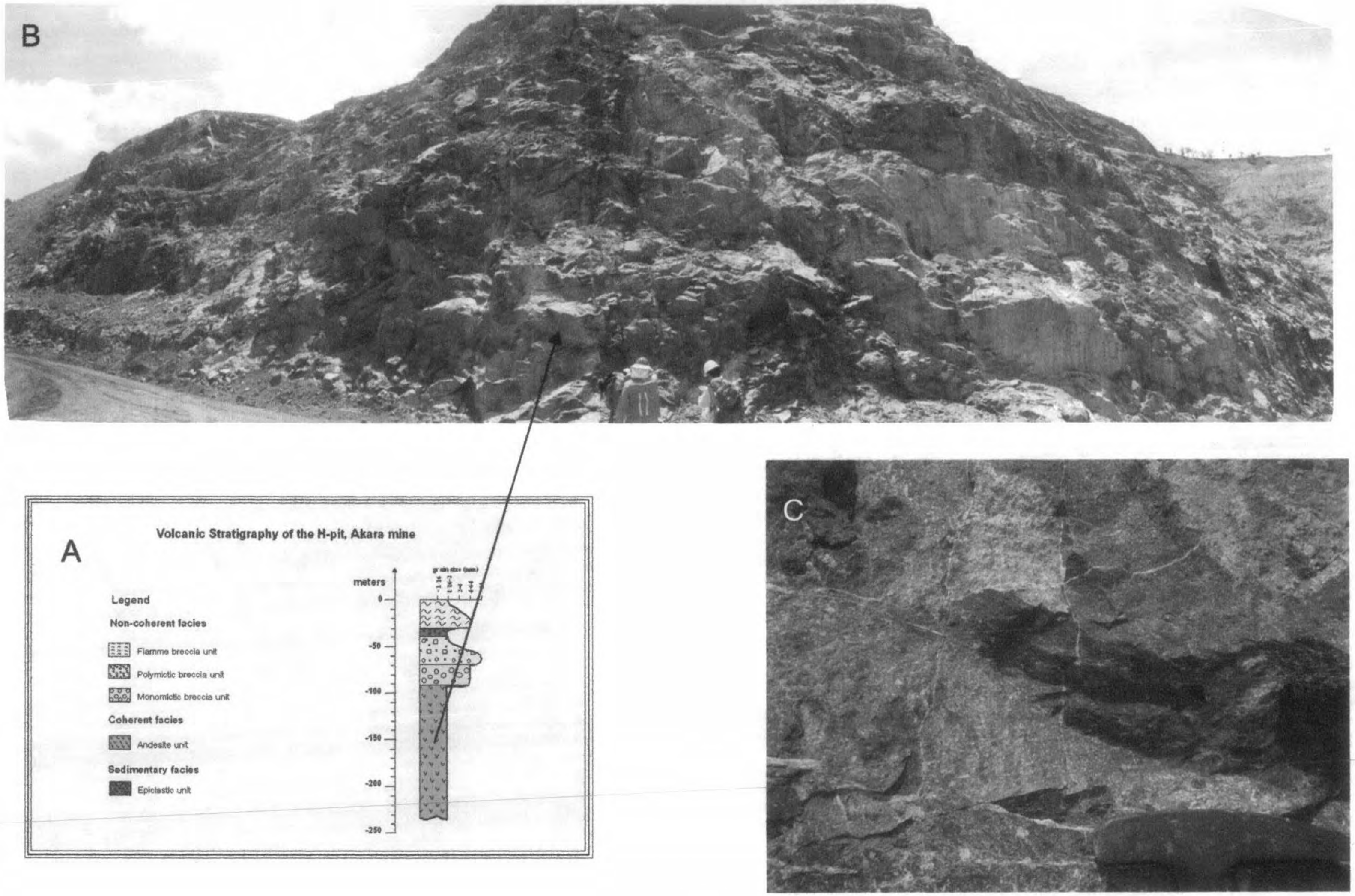

Figure 3.9. Coherent volcanic unit in the H pit, Chatree gold mine, Phichit, showing (A) location of the unit in the stratigraphic sequence, (B) nature of exposure with splitting joints dipping to the west. and (C) a close-up view of andesite.

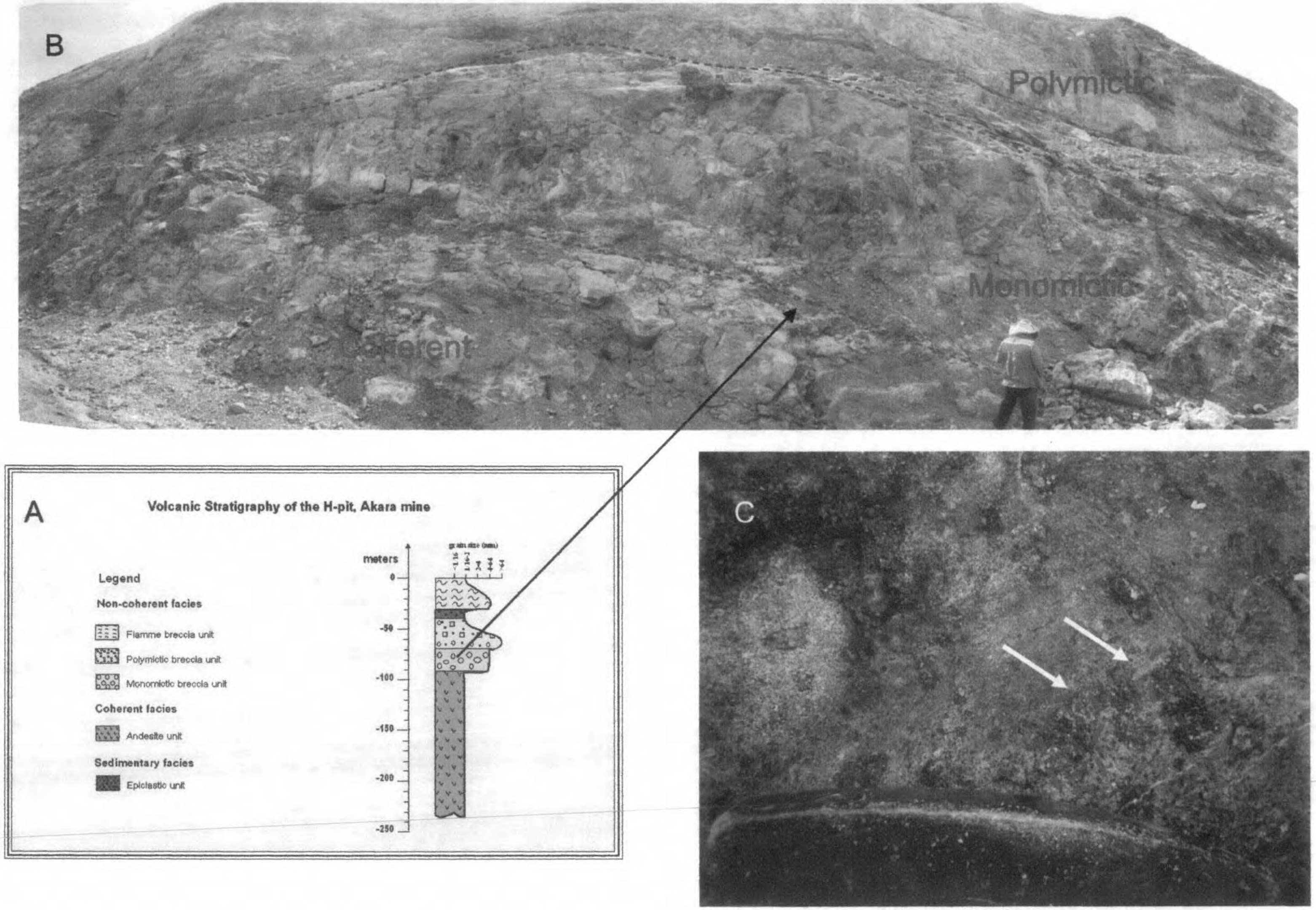

Figure 3.10. Monomictic breccia unit in the H pit, Chatree gold mine, Phichit, showing (A) location of the unit in the stratigraphic sequence, (B) showing exposure and contact between monomictic breccia (bottom) and polymictic breccia(top), view looking south, and (C) a close-up view of monomictic breccia with various sizes of dark-colored fragments (arrowed).

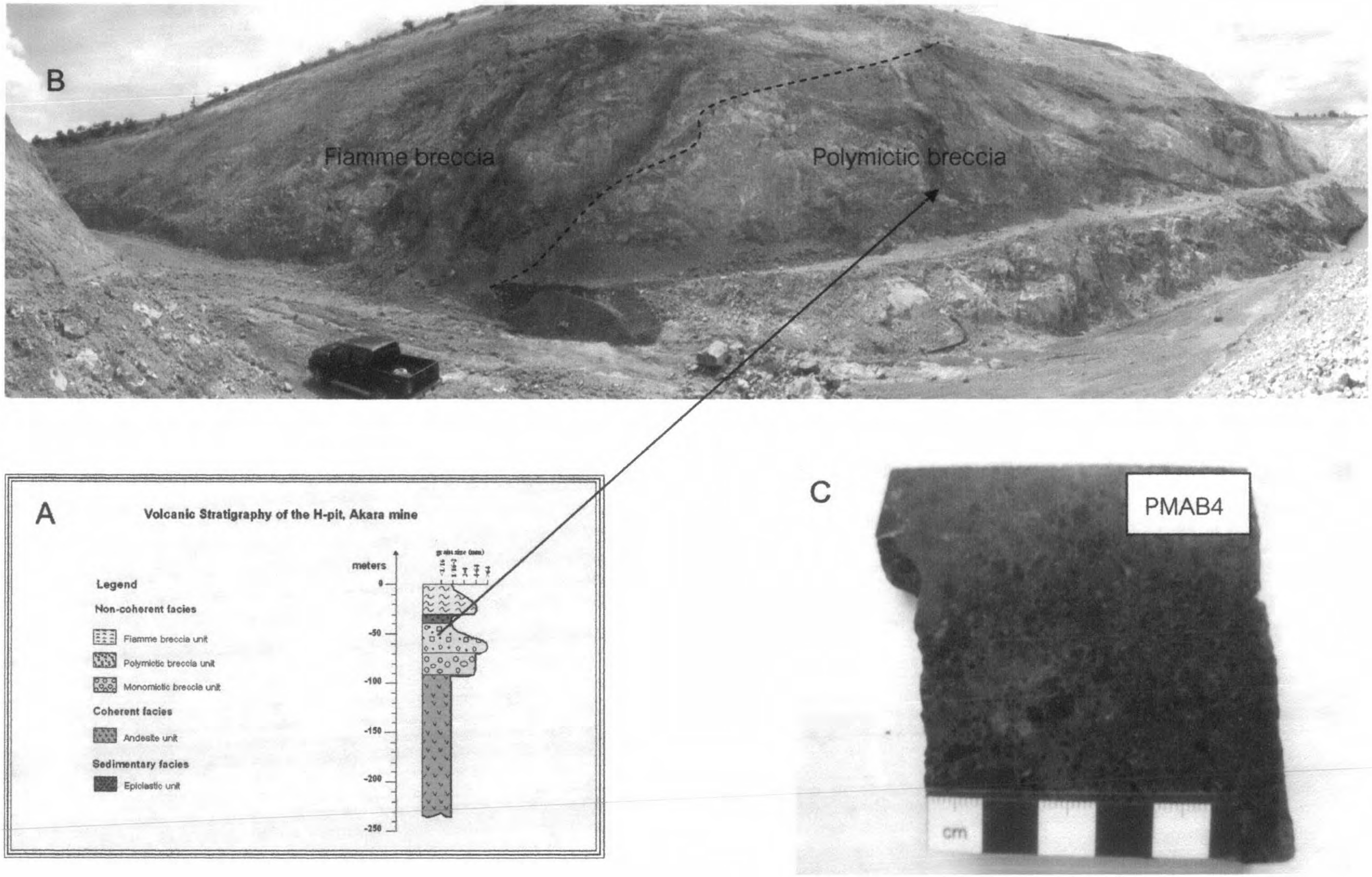

Figure 3.11. Polymictic breccia unit in the H pit, Chtree gold mine, Phichit, showing (A) location of the unit in the stratigraphic sequence, (B) exposure of polymictic breccia, view looking southeast, and (C) a rock slab of polymictic breccia with various sizes of vari-colored volcanic fragments (arrowed).

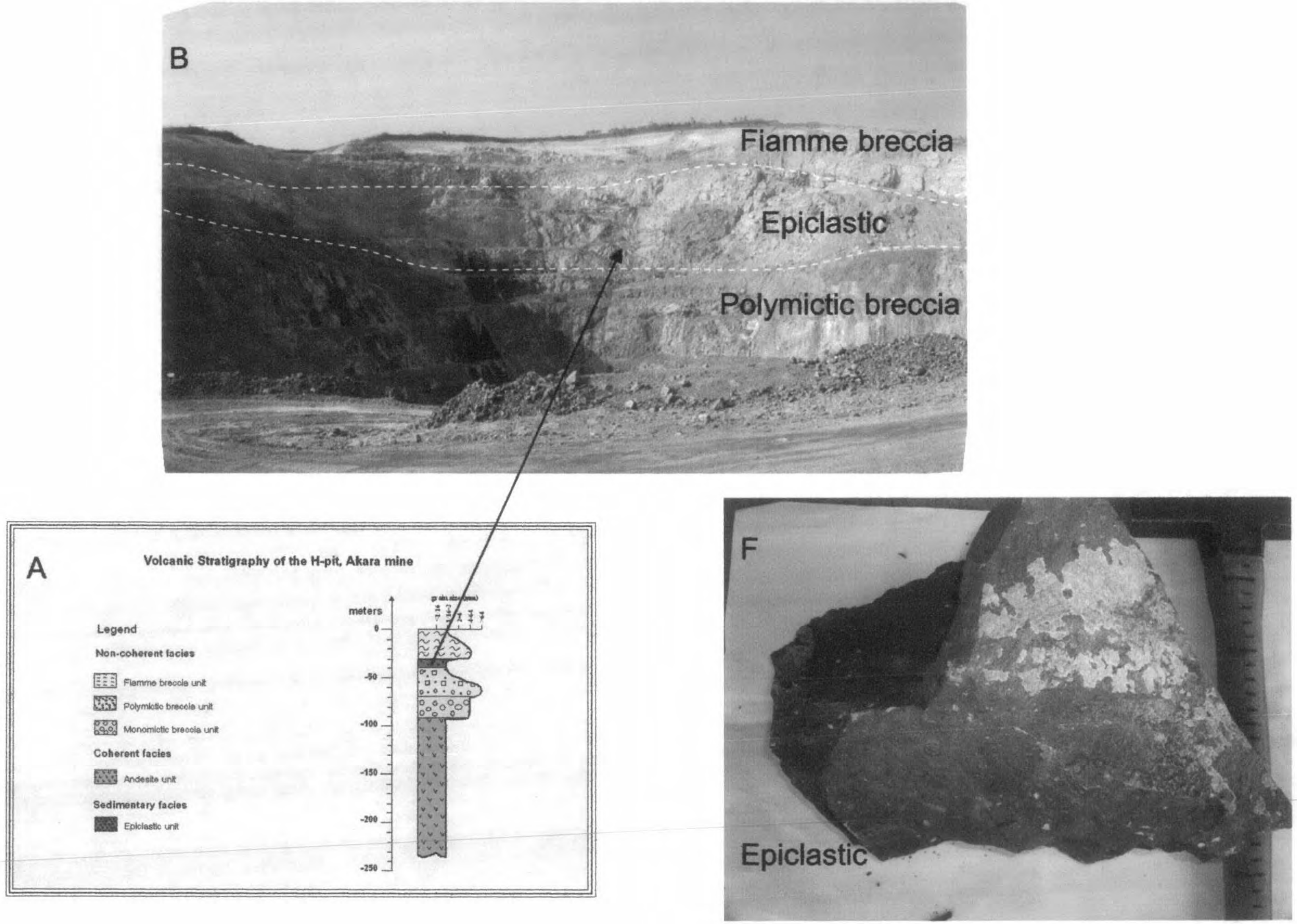

Figure 3.12 Epiclastic unit in the H pit, Chtree gold mine, Phichit, showing (A) location of the unit in the stratigraphic sequence, (B) exposure of epiclastic unit showing the 10 m thick epiclastic unit, lying between the fiamme unit (top) and polymictic unit (bottom), and (C) hand-speciment of fine-grained clastic rock with thin film of gold-barren calcite vein.

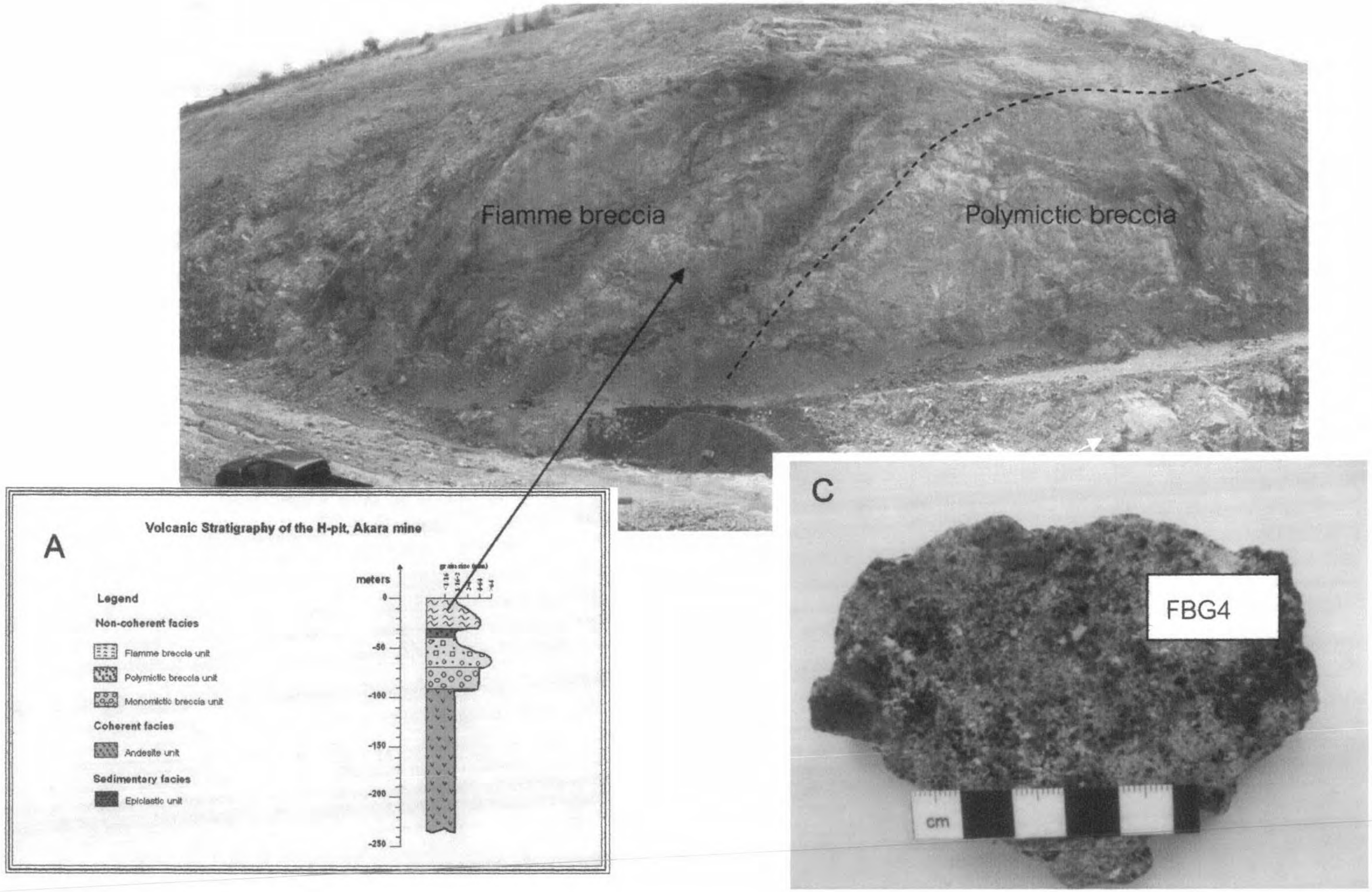

Figure 3.13. Fiamme breccia unit of the H pit showing (A) location of the unit in the stratigraphic sequence (B), exposure of fiamme volcanic view looking SE(150^0)and (C) a rock slab of fiamme breccia.

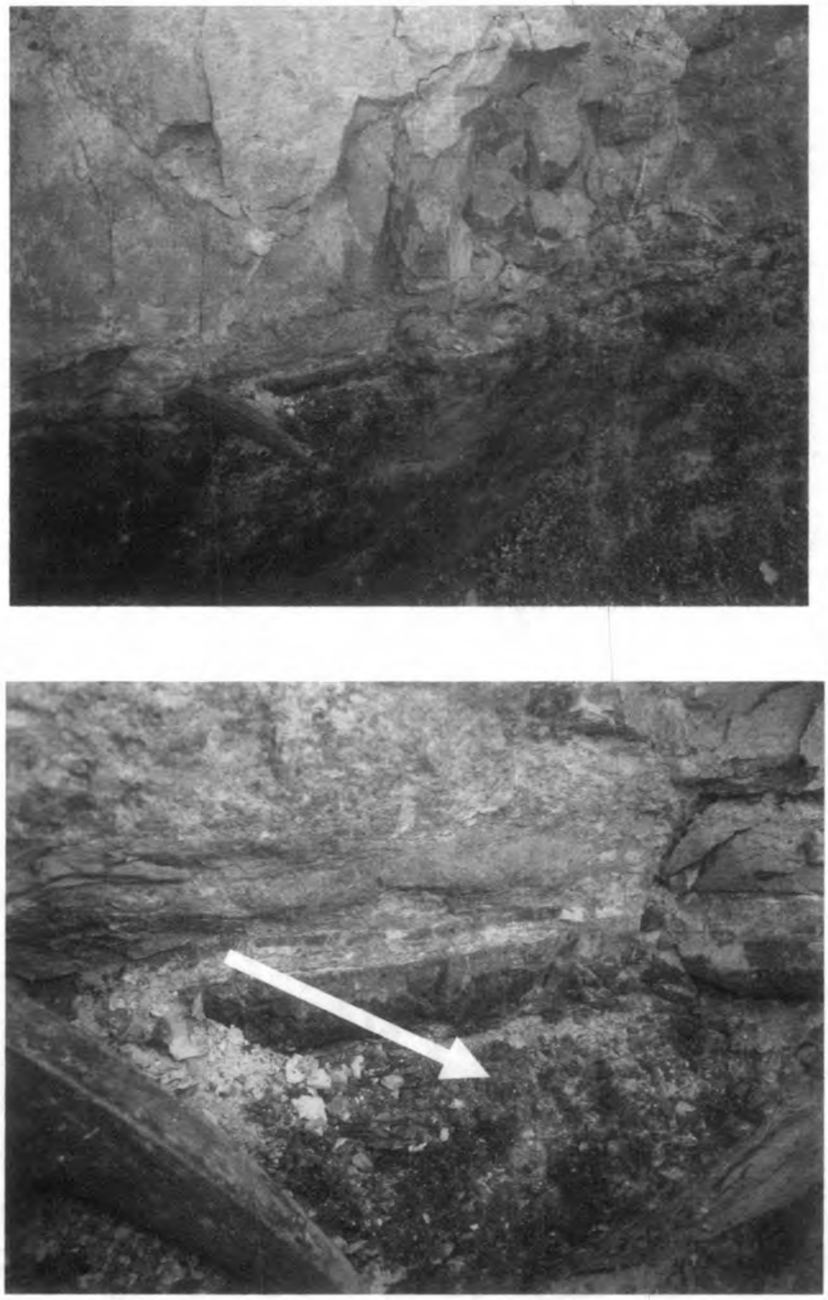

Figure 3.14. Chill margin crowed, occurring at coherent, in the H pit, Chatree gold mine, Phichit Province.

Figure 3.15. Flow structure observed in the coherent unit in the H pit, Chatree gold mine, Phichit Province.

3.2.3 Dike rocks

Several sequences of volcanic rocks in the Chatree gold mine were cross cut by several sets of dikes. Generally, the dike rocks have intermediate composition, however few are mafic. The dikes which are present in the mapped C-H pit can be grouped into 2 sets of dike based upon their structural orientations one in the north-south trend and the other in the northeast-southwest trend.

Dikes of the northeast-southwest direction

Dikes trending in the northeast-southwest direction cross cut the volcanic host rocks as shown in the geologic map reported by Tangwattananukul, 2006. Field investigation shows that the dikes of this direction can be traced longer than 100 m, though discontinuously. Its width range from less than 30 cm up to 80 cm. The northeast-southwest trending dike rocks consist almost entirely of porphyritic andesite with minority of trachytic and basaltic andesite.

The collected dike samples have mostly gray tone in color ranging from brownish gray to dark greenish gray. They have textures ranging from slightly to strongly porphyritic. Phenocrysts in these dike samples include plagioclase, pyroxene, amphibole, feldspars and opaque mineral with size from less than 1 mm up to slightly more than 2 mm. Groundmass phase is mostly fine-grained with size much less than 1mm Figure 3.1 shows mafic dike (black) cross-cutting porphyritic andesite and lithic tuff host rock (lighter color) with the shap contact.

Under mesoscopic analysis, dike samples contain phenocrysts and microphynocrysts of pyroxene, unidentified mafic minerals (completely replaced by secondary minerals), feldspars, and subordinate amount of plagioclase. Petrographic investigation by Tangwattananukul (2006) reveals that the pyroxene phenocrysts, are mainly clino-pyroxene (augite) and are present about 10-15% of the model volume. The pyroxene occurs as subhedral and sometimes as euhedral crystals. The matrix consists almost of medium-grained to fine grained plagioclase laths, olivine, pyroxene and opaques. Plagioclase laths are the most abundant phase representing 45-50% of the total groundmass in most of the dike samples. They are randomly arranged and sometimes exhibit slight foliation in the groundmass portions. Generally groundmass component shows much less alteration than those of the volcanic host rocks. If present, they are chlorite, calcite, epidote and quartz minerals.

Dikes of the north-south direction

Dikes of the north-south direction crosscut dikes of the northeast-southwest direction, therefor the former postdated the latter. Thickness of these north-south trending dikes vary from 15 cm to more than 100 cm. The dikes can be traced to more than 200 m. Dike rocks are mainly medium-grained gabbro and diabase, both of which are commonly dark gray in colors. Most rocks show subophitic, intersertial and glomeroporphyritic texture. According to Tangwattananukul,(2006) subhedral to euhedral crystals of clinopyroxene, feldspar and plagioclase with groundmass materials consisting of the same assemblage as these of the northeast-southwest direction plus minor-quartz, biotite, cholite, sericite and opaque mineral.

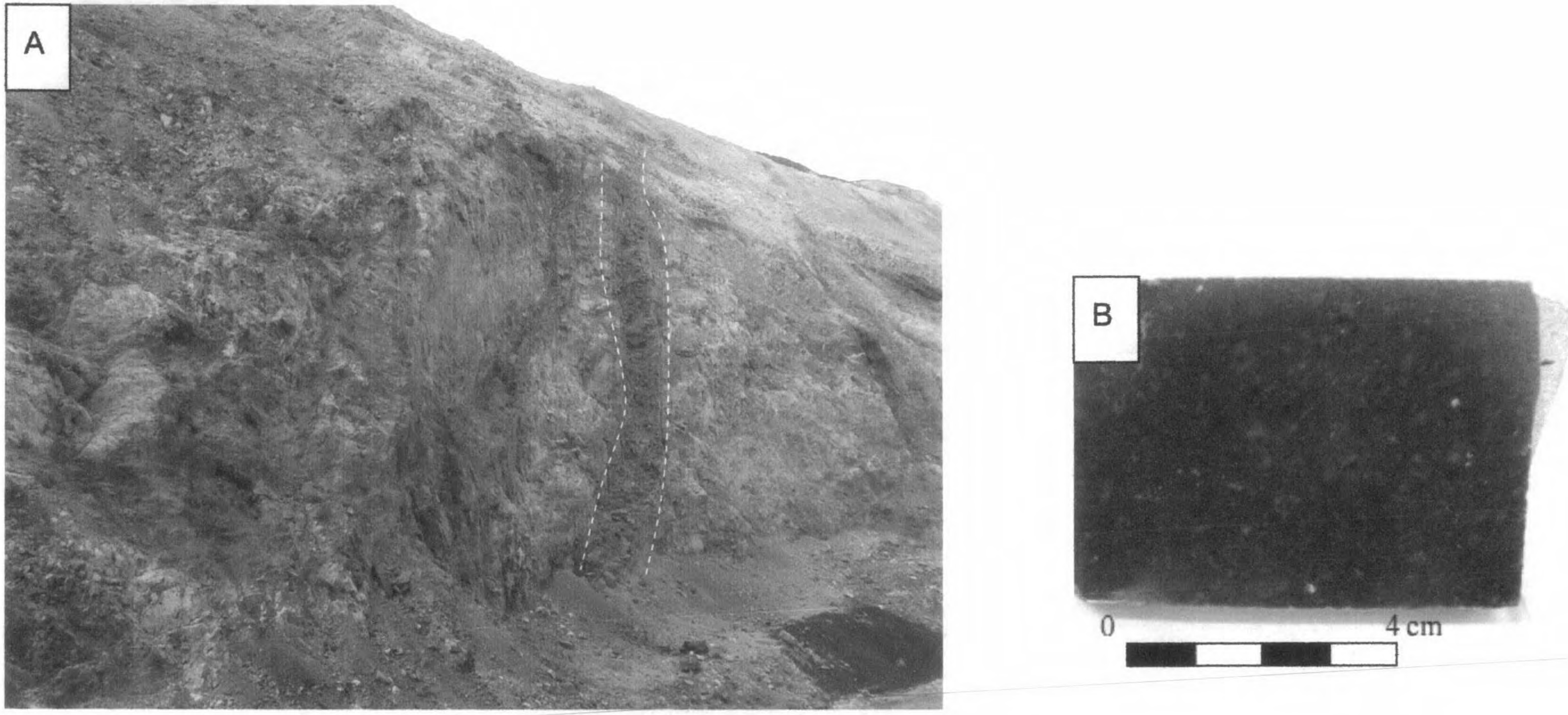

Figure 3.16. (A) Mafic dike rocks (1 m thick) with almost vertical dip direction cross cutting the polymictic breccia unit, in the H pit, Chatree mine, Phichit, (view looking east).(B) Handspecimen of dike rock in H pit showing amphibole phenocrysts.

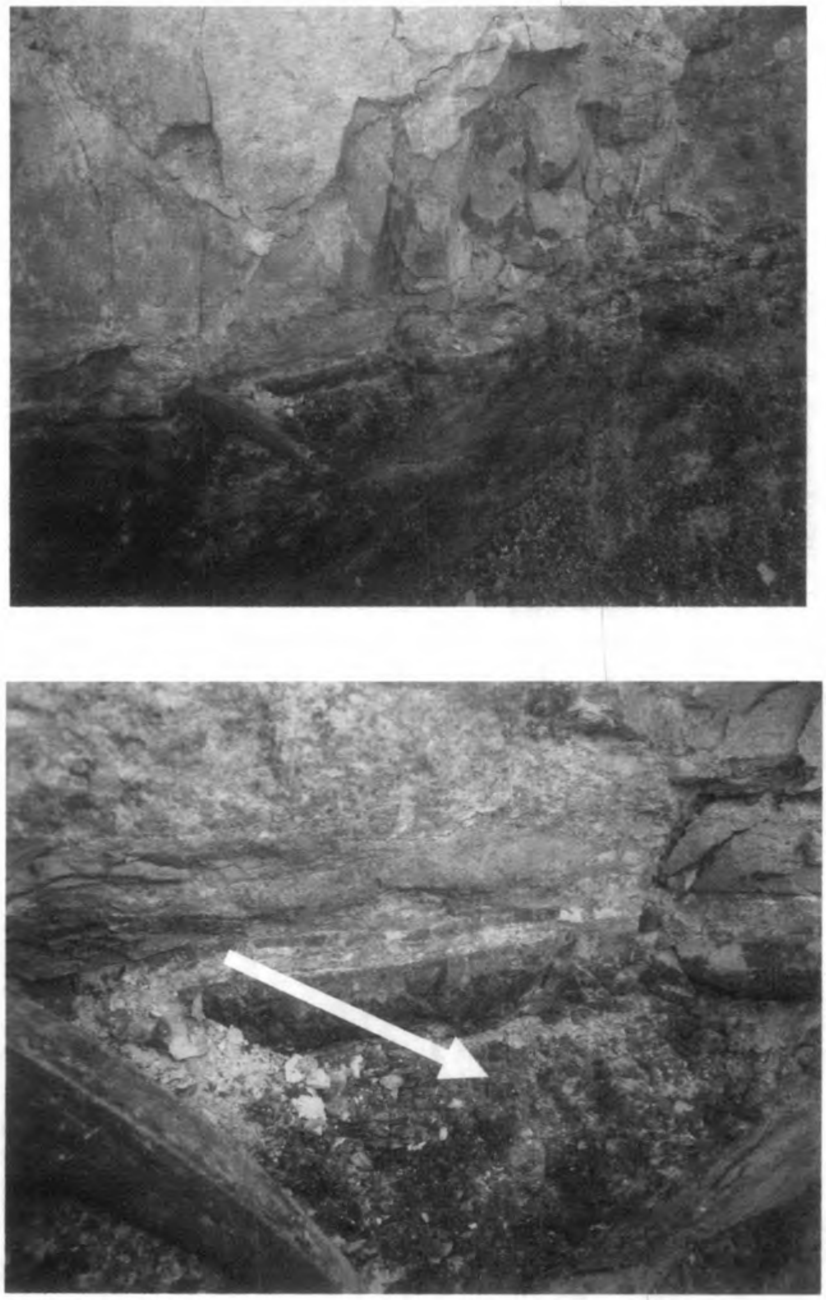

Figure 3.17. Chill margin crowed, occurring at coherent, in the H pit, Chatree gold mine, Phichit Province.

Figure 3.18. Flow structure observed in the coherent unit in the H pit, Chatree gold mine, Phichit Province.

3.3 Alteration & Mineralization

Styles of Alteration

In the Chatree gold mine, hydrothermal processes affecting the studied coherent and noncoherent volcanic units lie within two different manners-one as vein filling and the other as pervasive alteration of primary constituents.

Vein alteration

Veins and veinlets, ranging in thickness from < 0.5 mm to at least 8 cm, are present throughout the C-H pit mapped area. In general, they contain hydrothermal assemblages similar to those of the strongly altered host rocks and difficult to correlate between drillholes due to insufficient core recovering. A detailed list of the hydrothermal mineral assemblages found in veins is studied from Deesawat (2002).

Fault breccia veins occurred as angular breccia fragments of wall rocks breccia and previous vein materials which are cemented by micro – to cryptocrystalline quartz – adularia and equigranular, fine grained quartz – adularia assemblages. Rock fragments are intensely silicified, and vugs are almost entirely filled by euhedral quartz crystals, except in the upper level or near surface. Vein walls are irregular but have shape in contact with the wall rocks.

Pyrite, chalcopyrite, sphalerite are common in veins/veinlets of the C-H pits, though become minor as compared with silicate groundmass in this vein style.

Pervasive alteration

Fluid/rock interaction including mineral leaching, replacement and direct deposition of minerals from solution into pore spaces are the main characteristic of pervasive alteration the mature of minerals formed (i.e., rank of alteration which may in part reflect permeability). The other is the proportion of primary mineral being altered (i.e., rank of alteration) . In the study area, the intensity and mineralogy of this alteration style is generally continuous over several hundred meters in both its vertical and lateral extents. Variations in alteration rank do exist, however, where progressive interaction between hydrothermal fluids and host rocks occurred.

Different types of alteration were identified at the mine pits and by core logging and petrological study. Types of alteration can be classified into 6 patterns as described in the next section below.

3.3.2 Types of Alteration

1. K–silicate plus porphyritic alteration

K–silicate is generally found in wall rock alteration, and mostly occurs from alteration of plagioclase to K–feldspar associated with quartz. K–feldspar that occurs from this alteration style is mostly found in the lower part of core at depth 40-50 meters approximately, or at the ban of the studied mine pits. In addition, in the area of K-silicate alteration, porphyritic alteration is also found. Mineral assemblage that was found comprise calcite, chlorite, and albite. Calcite characterizes calcite patches along rims of feldspar crystals and patching inside K-feldspar that is altered from the original plagioclase. Chlorite occur from alteration of glass and mafic minerals (hornblende). It is generally found in andesite and sometimes found interstitial among grains of feldspar. Blackish green spots can be observed as well in hand specimens.

2. Cherty quartz alteration

This kind of alteration is characterized by the presence of dark grey to grayish black quartz vein. Generally, it is found as very fine to fine-grained quartz, usually smaller than 0.2 mm, This kind of alteration occurs in the breccia wall rock. Occasionally, it penetrates in voids and fractures or cut as veins / veinlets through the volcaniclastic country rocks at depth between 45-48 meters approximately. The vein thickness varies from 6 mm to 28 mm.

3. Milky quartz alteration

This alteration is characterized by muddy white quartz and is generally found as coarse-grained quartz (0.2-0.4 mm). which occurs in volcanic wall rocks. Perhaps, comb structure is also found and shows the deposition of solution of silica in the space by gravity or cut as vein/ veinlet through volcanic host rocks. In general, their vein of alteration ranges in thickness from 20 to 80 mm. In several places, its veins cross-cut the cherty quartz vein.

4. Quartz-calcite vein / veinlet alteration

Generally, this alteration is found overlying the milky and cherty quartz zone and in the core at depth between 10-30 cm. Size of quartz-calcite vein/ veinlet is approximately 2.0 mm. Quartz vein / veinlet is associated with adularia, which is rhombic and characterize similar to quartz that can be classified by optic and XRD method.

5. Clay alteration

Deuteric alteration is the characteristic of this alteration style., which is white and yellowish white or red due to associated with iron oxide. Clay alteration is often pronounced in the upper part of the volcaniclastic wall rocks, giving a pale green color even to samples that contain appreciable amount of K-feldspar.

6. Lateritic alteration

No detailed description was made for this kind of alteration in the C-H pit. However, according to Deesawat (2002), there exists the lateritic alteration which occurs as thin layers. This kind of alteration rage in thickness from less than 10 cm up to 120 cm, but averaging 1 m. The alteration zone is regarded as secondary and perhaps due to deutiric alteration. The zone is characterized by brownish red duricrust not only in the mapped pits but also at the top part of at the depth of about 15 cm from surface.

3.3.2 Mineralization

C Pit

The C ore body is one of the major orebodies of the Chatree gold mine. It strikes almost north-south (350°) and dips at fairly constant angle-an average of 40° to the west. The ore body occurs as massive veins (up to 4 m) at the southern mapped C pit with minor breccia and become stockworks (less than 30 cm) in the northern part, particularly at and near surfaces. At the northern part the orebody is massive toward the hanging wall and become stockwork toward the footwall. In the south it has "overturn corn-shaped" structure near surface and becomes thin zones at depth. Ore breccia is predominant particularly grey silica breccia mainly confined to the footwall both at the north and the south of the mapped C pit. Multiple-stage breccia also has been observed and mostly overprinting the grey breccia stage. Grey ore breccia is generally characterized by angular clasts of mainly porphyritic andesite, minor fine-grained volcano sedimentary rocks and fiamme breccia. The grey matrix is composed largely of cryptocrystalline quartz and sparsely distributed fine-grained pyrite. The grey silica material is believed to be gold barren. However, it is believed to play an important role as ground preparation for ore deposition. The orebody is characterized by crustiform-colloform bands of alternating grey silica, quartz-carbonate-sulphides and quartz-carbonate-chlorite. Cream to brown coarse-grained calcite and dolomite bands (less than 0.2 cm to 2 cm thick) are common in both C-H mapped pits and usually dilute gold grade. At the southern part of the C pit the mineralization styles are predominant with quartz-carbonate-pyrite with subordinate quartz-carbonate-chlorite assemblages. Gold grade is often diluted by coarse-grained calcite/dolomite (Figure 3.17).

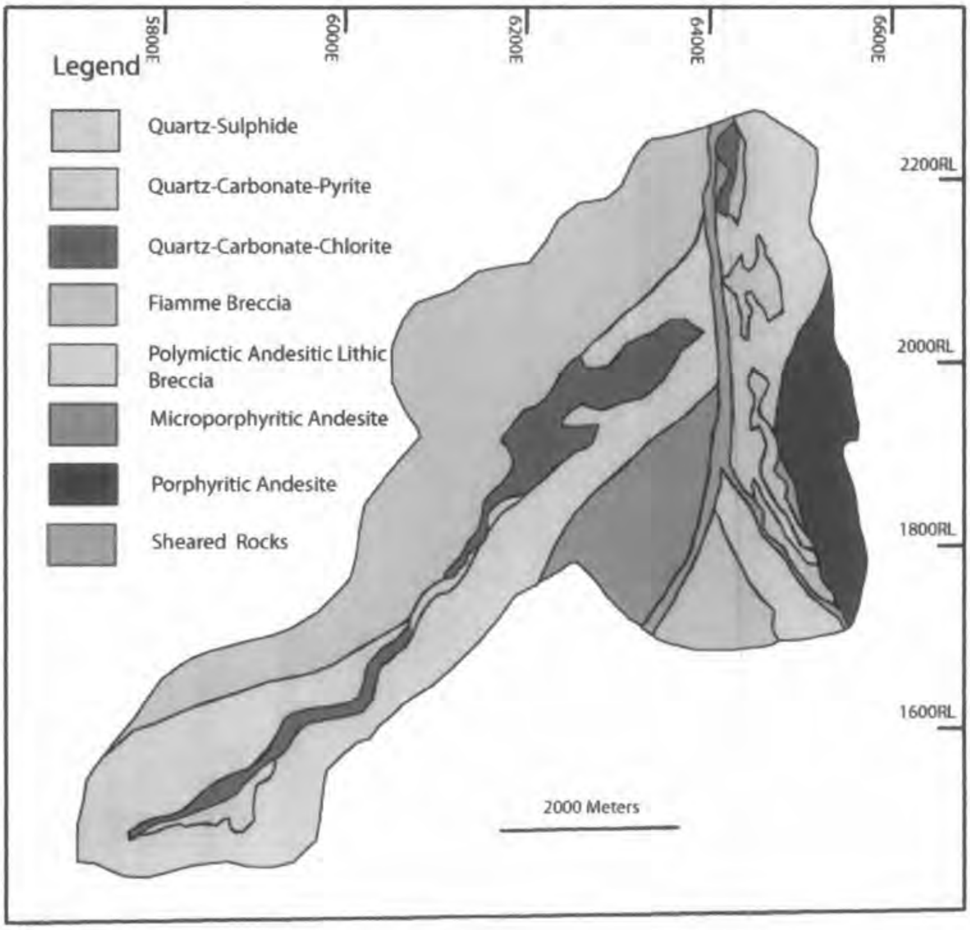

Figure 3.19. Simplified geologic map of the C-H pit showing simplified geology and mineralization styles (Salam et al., 2006)

H pit

The H ore body has the strike in the northeast-southwest direction (040°) and dips to the north-west at about 30° -40° near surface and becomes gentle about 10-20 at depth, particularly at the northern part of the H mapped pit. The orebody zone also splayed at depth into three smaller zones (Figure 3.18). The H ore body extends quite long distance in the SW direction to the south and probably to the nearby P pit. At the surface the orebody at the H-north and C-central is about 100 meter apart and become closer at depth (32 m from surface). From the drill-hole correlation, it is found that these two mineralization zones possibly merge at deeper level. The H ore body is hosted by polymictic andesitic breccia and matrix rich in lithic fragments with sharp contact with hanging wall. This fiamme–like breccia forms part of the polymictic breccia and is not hydrothermally altered at least 10 to 15 meters thick zone. Colloform-crustiform banding is also a characteristic texture in H pit and tends to confine to the more massive veins. Here quartz-carbonate-chlorite band (up to 2 cm thick) is more predominant in comparision with that of the southern C pit. The mineralization styles are complicated and consist of 3 stages. The first stage is characterized by quartz-pyrite-sulphide assemblage in the central and southern parts of the H pit. Quartz-carbonate-pyrite assemblage is the second stage and widely spread throughout the H mapped pit. Quartz-carbonate-chlorite and quartz-carbonate-chlorite-sulphide assemblages are identified as the latest stage and mainly confined to the north and central parts of the H pit. According to Deesawat (2002) and Lunwongsa (personal communication), the later two stages usually carry high gold grade, up to almost 40 ppm.

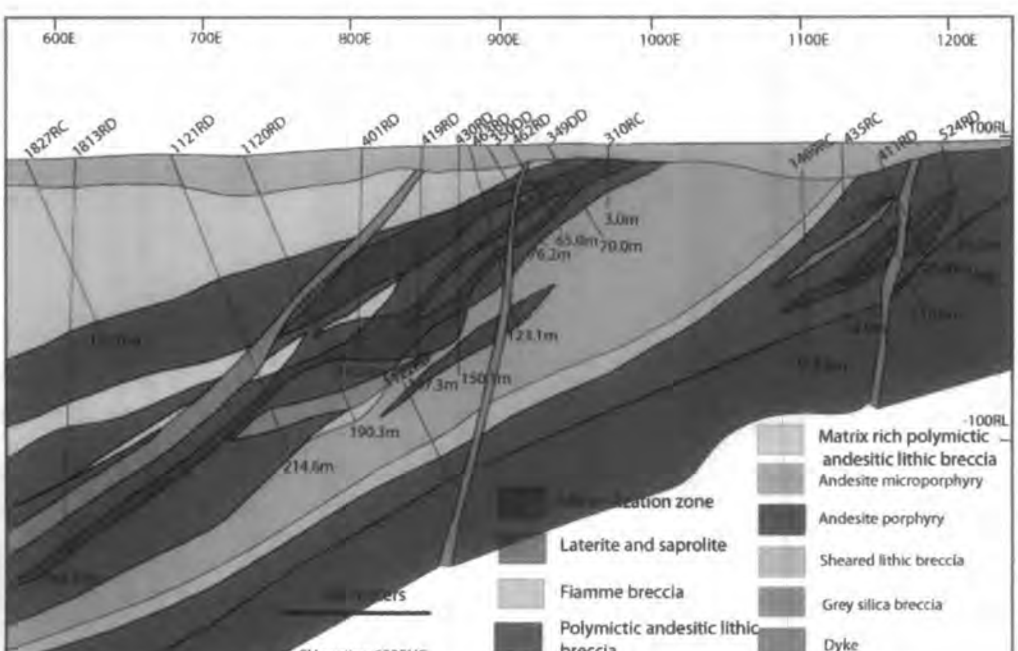

Figure 3.20. Northwest-southeast geologic cross section of the C-H pits showing the relationship between mineralization and host rocks, Chatree gold mine, Phichit Province (modified after Salam ,2006).

: Note that mineralization zone is to some extent concentrated in the monomictic breccia unit.