CHAPTER VI

DISUSSION

In this chapter, there are enough lines of evidence from results of field, petrographic and geochemical analyses to discuss the overall picture of the studied volcanic rocks in the the Chatree mine. Four topics are discussed and explained below.

6.1 Volcanic Vent, Unit Association, and Depositional Setting

As stated in previous chapters, the volcanic architecture at the Chatree gold mine is dominated up to 100 m – thick succession of intermediate coherent and non - coherent units. These volcanic rocks were cross cut by dikes and sills of intermediate composition. These breccia rocks of non- coherent unit were derived from the break-up of earlier- formed coherent-unit lavas and recorded large-scale rapid collapse events of a nearly volcanic vent or edifice. As noted earlier, the studied brecciated rock is usually thick-bedded (beings 20-40 m thick). It is generally poorly sorted and dominated by dense, subangular andesitic fragments. These fragments are andesite, basalt and mudstone in the lower sequence. The fragment sizes vary from boulders to pebble in the lower portions and those clasts become smaller (or finer, in size) and grading into well-stratified coarse sandstone and tuffaceous sandstone in the upper portions.

It is interpreted based on the studied volcanic stratigraphy that the poor sorting, coarse nature, and large volume of breccias reflects high supply of fragments of clasts input due to collapse of the adjacent or nearby volcanic vent or edifice. In some layers, the clasts are commonly angular, possibly suggested that the volcanic fragments were rapidly deposited. Such dominantly dense nature, as well as the angular shapes of clasts, is consistent with the bulk of volcanic debris being sourced from brittle fractures. Based on stratigraphic logs, characteristics of the collapse events have been analyzed. In this regard, volcanic-clastic rocks of non-coherent unit can be further subdivided into 2 lithofacies, namely distal lithofacies and proximal lithofacies. The near-source (or proximal) lithofacies is dominated by massively-bedded and poorly-sorted polymictic breccia of andesitic to basaltic compositions. Dense and subangular fragments are very characteristic and evidently distinct to indicate that the unit even formed from relatively near source (proximal) vents.

The distal facies of the non-coherent unit is dominated by thinner beds of the polymictic breccia and an overall increase in the proportion of finer-grained epiclastic unit (including tuffaceous sandstone, carbonaceous sandstone, with intercalated limestone and siltstone). These finer-grained unit show distinct graded beds. The presences of the small-grain size unit suggested that the fine-grained sediments had adequate time for deposited without any disturbance during the stable period of source supply. It is interpreted that the sand and silt-dominated partials were probably held in suspension during tractional transport and when current velocity decrease, the finer particles deposited and filled out of the suspension, indication of density sorted gravity flow (Lowe, 1982). Such epiclastic sediments were therefore transported by a more dilute and turbulent gravity flow. The presence of abundant lighter clasts, carbonaceous materials are clearly good evident.

A mechanism for the whole volcanic breccia sequence is also interpreted as a basal traction of large particle in the lower part. In the middle part, a mechanism is characterized by a more cohesive flow similar to debris flow capable of supporting large clasts in a finer-grained matrix. The mechanism of the upper part is dominated by a turbulent flow of the smaller size fraction which was the product of a more transitional "slurry flow" between a turbidity current and debris flow.

The studied breccia unit of the C-H pits are dominated by the flow deposits. There is also a silicified pumice breccia associated with the monomictic breccia in the H pit – at depth and a polymictic, feldspar-rich pumice breccia higher up in the stratigraphic sequence. The occurrence of fossiliferous limestone in the lower sequence of epiclastic with associated breccia (Cumming et al., 2006) suggests a submarine deposition. This interpretation is different from that of Kromkham (2006) who concluded that sub-aerial deposition for the volcanic breccia and associated sediments. The presence of pumice indicates that a calderas close to the submarines depo-center. Woody fragments in the upper portion of the non-coherent unit (Cumming et al., 2006) pointed to the presence of on relatively steep slopes near by land mass.

It is likely that the debris flow on relatively steep slopes must play an important role in transport mechanism and commenced with the sliding and slumping of the fractured coherent unit of subaqueous volcanism (Cas and Wright, 1987). Sediments were carried several tens of kilometers from the source. It is also well documented that the debris flow deposit is always associated with strata volcano as in the case of Mount St. Helens (Mullineaux and Crandell, 1962).

The volcanic breccia rocks of the non-coherent unit possibly formed from a composite-cone volcano (see Fig.6.1) that was dominated by basaltic andesitic lavas in the initial stage. Then evolution by differentiation into more intermediate coherent lava occurred and subsequent collapse event took place. The composite cones generally had positive topographic relief with steep flanks that were formed form the continuous accumulation of eruptive products. In the case of the Chatree area, the association of intermediate and felsic volcanic rocks is consistent with derivation cone volcanoes.

6.2 Alteration, Mineralization and Ages.

Petrographic investigation from this work revealed that after the calc-alkaline volcanism, both the non-coherent and coherent units of these volcanic rocks were hydrothermally altered particularly by addition of silica in the form of several kinds of quartz. This corresponds very well with the geochemical results. Subaqueous (or marine) environment of volcano may have caused the mixture of sea water with magmatic water as evident by isotopic O and C results. The collapse of volcanic vent and the presence of several kinds of breccia may lead to a channel way for hydrothermal fluid to pass through. The fluids may be enriched in silica as shown by the present work and therefore precipitation of silica may have occurred in the first stage. The colloform and crustiform bands of quartz (Deesawat, 2005) suggested the multiple stages of silicification. The field and petrographic evidence in .not all the Chatree rocks in the C-H pits were subject to hydrothermal alteration and mineralization. The sedimentary of epiclastic deposits show entirely no alteration or mild alteration, probably suggesting that alteration may have occurred in the. It is considered that these rocks are mainly fined-grained and impervious so as to impede the rising of hydrothermal fluids which may be similar to the case of petroleum trap. Geochemical and/or assay data of thin sediments (Cumming et al., 2006) are in good agreement with this interpretation.

Geochronological synthesis of the volcanic rocks at the Chatree gold mine seems to support this scenario. The age of andesite rock (ca. 250 $\pm$ 6 Ma) was reported using LA ICP MS Ub zircon dating. The age of adularia hydrothermal feldspar as given by $Ar^{40} - Ar^{39}$ dating is at ca. 250 $\pm$ 0.9 Ma. So it is quite possible that the alteration and associated Au-Ag mineralzation may have a spatial and temporal relation to and occurred shortly after the main volcanic activity. According to the work of Kromkum (2006), gold occur as electrum inclusions within pyrite, disseminated and adjacent to chalcopyrite, galena, and sphalerite. Additionally gold is found in fine-grained quartz and cacite gangues. The Au/Ag ratios from the whole rock data is about 1:8 with gold grade of 2.1 g/t. The mineralized zone occurs within the alteration dominated by quartz, adularia, illite, pyrite, carbonate and sericite assemblage.

Figures 6.2 summarize the possible sequence of events responsible for the genesis of volcanic unit and its associate alteration and mineralization.

6.3 Tectonic setting

As explained earlier in this chapter, the volcanic-unit rocks of the Chatree gold mine may have occurred in the marine environment as strato-volcanic composite cone of in the arc setting environment (Cas and Wright, 1987). Evidentially, there are no supply of silicic material to the depocenter, and then it is considered to be far away from the continent. The sediments of the high level of the stratigraphy may derived from the source far away from the continent, viz. in this case the Indochina continent, Geochemically, the studied Chatree rocks belong to the calc-alkaline affinity which in general formed in the compression tectonic environment of arc setting. Wising trace-element whole-rock data, the rocks of the C – H Pits of the Chatree gold mine are mainly andesitic to basaltic rocks, with Zr – Zr/Y ratio indicating both continental arc (ratio < 2) and oceanic arc (ration > 3) setting (Peace, 1983). Some other element data (such as Ce/Sr vs. Cr and Cr vs. Y) point to arc setting for the Chatree studied volcanic rocks. REE pattern also shows a good consistent with the interpretation above arc setting.

It is therefore concluded herein that the east-dipping subduction of the Lampang – Chiang Rai oceanic plate breath the NakhonThai (oceanic) plate may have given rise to the generation of strato – volcanic cone of the Chatree during Permo – Triassic Period (250 Ma). Partial melting of oceanic slab may be responsible for the melts which in tura differentiate to form andesite. Eruption may have taken place as the coherent unit in the main environment of the Paleotethys ocean, subsequently collapse of the volcano may have caused the generation of non-coherent volcanic unit down slope as the proximal and distal subunits by submarine debris flow. Alteration with associated epithermal Au – Ag mineralization may have occurred shortly after the formation of both coherent and non-coherent volcanic rocks at ca. 250 Ma (Figure 6.3).

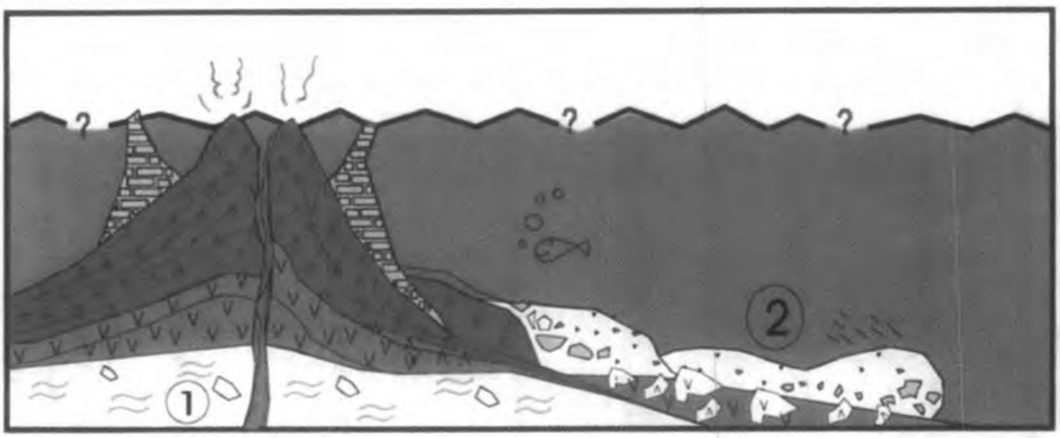

Figure 6.1. Schematic diagram of composite – cone volcano with (1) silicified volcanic breccia and lava, fragmenting andesite and basalt flows and (2) debris (slurry) flows down slope, Chatree gold mine, (modified from Cumming et al., 2006)

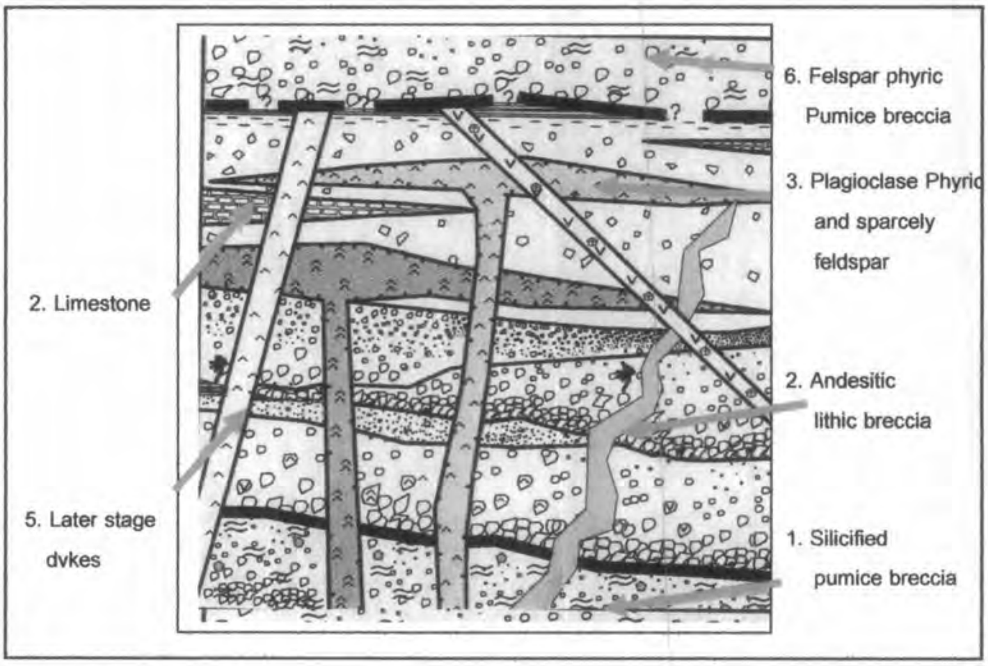

Figure 6.2A. Schematic model for the volcanic activity events and mineralization of the C-H pit in the Chatree gold mine (modified from Cumming et al., 2006).

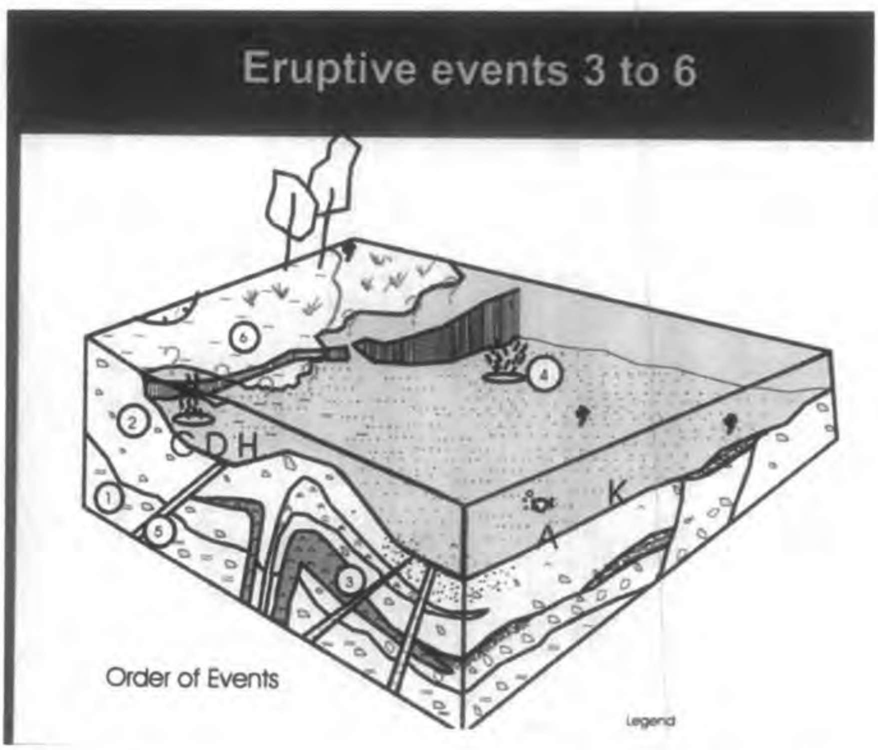

Figure 6.2B. Block diagram showing order of events for the Chatree volcanism in the Paleotethys submarine environment.

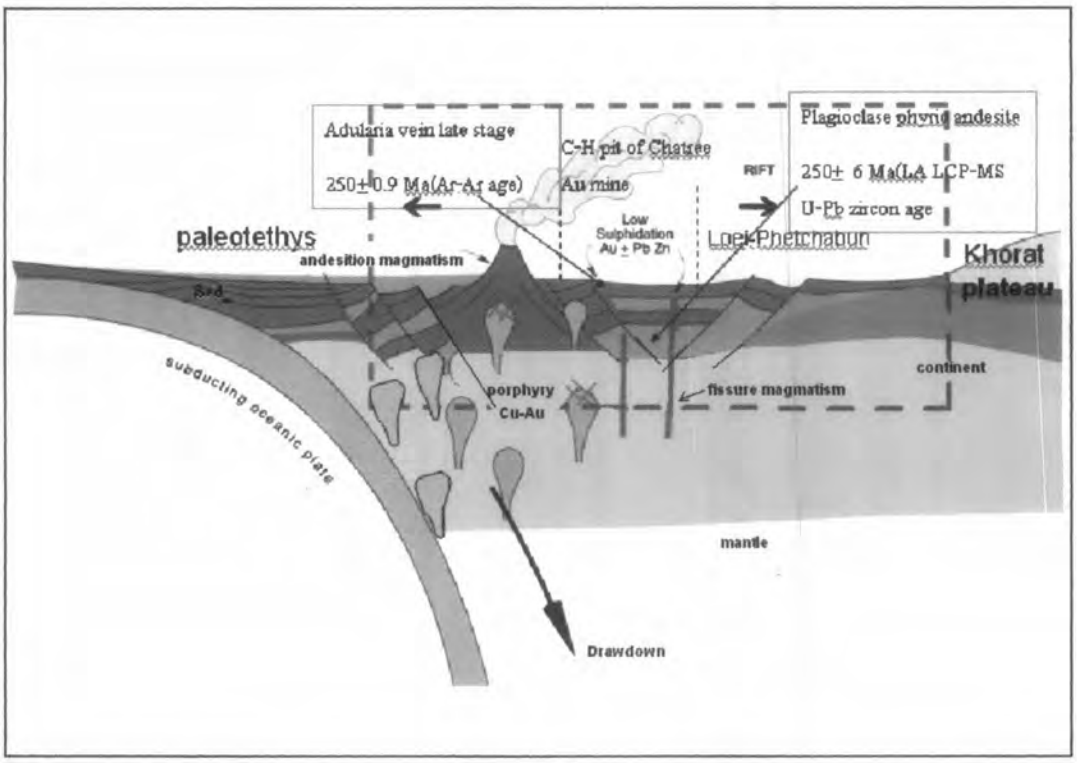

Figure 6.3. Tectonic setting at Chatree gold mine.

Conclusion

Based on field, petrographic, and geochemical investigations of the studied volcanic rocks of the Chatree gold mine in Pichit province, conclusions can be drawn as follows:

(a) The study area consists of 2 major units as coherent and non–coherent units. The coherent unit is older and characterized by andesite to basaltic lava rocks. The non-coherent unit is younger and dominated by volcanic breccia rocks with minor sediments.

(b) Three kinds of breccia rocks are grouped-monomictic, polymictic and fiamme units. Both coherent and non coherent units show multiple eruption under sea with variable hydrothermal alteration causing by fluids of sea water - magmatic origins ± low- sulfidation epithermal mineralization.

(c) The studied volcanic and associated rocks are of calc-alkali affinity and form parts of the strato-volcano in the subduction-related arc tectonic setting during the Permo-Triassic period nearby the western edge of the Indochina continental block.