CHAPTER 6

DISCUSSION AND CONCLUSION

6.1 Occurrence and Petrography

Thoeng basalt is Pleistocene in age and is considered to be part of the Late Cenozoic basalts in mainland Southeast Asia. It forms scattered plateaux, covering an area of about 85 km^2, in the territories of Amphoe Muang, Amphoe Phaya Meng Rai, Amphoe Thoeng and Amphoe Pa Daed, Changwat Chiang Rai, and is unconformably underlain by Permian and Permo-Triassic sedimentary and volcanic sequences. These plateaux might have been the same mass prior to differential weathering and erosion, and have a maximum cumulative thickness of 45 m. At least 5 flows, with individual thicknesses up to greater than 10 m, have been recognized. Their internal structures can be divided into vesicular base, massive with platy and columnar joints at center, and vesicular top.

The least-altered Thoeng basaltic samples have dark grayish black to dark greenish black colors and show slightly to highly megacrystic textures. Common phenocrysts and microphenocrysts are olivine and plagioclase; clinopyroxene and Fe-Ti oxide may scarcely exist as additional microphenocrysts. Some samples may contain rare Fe-Ti oxide, apatite and quartz xenocrysts, and basaltic xenoliths. These megacrysts often show disequilibrium features including rounded edges, embayed outlines and sieve features. The groundmass is fine- to very fine-grained, and varies texturally from felty to trachytic; many are partly subophitic. The primary groundmass constituents are made up mainly of plagioclase laths with subordinate clinopyroxene and olivine, and minor Fe-Ti oxide mineral; many samples contain variable amounts of devitrified dark brown glass. Amygdale and veinlets are rarely present.

6.2 Chemical Characteristic

Chemically, the least altered Thoeng lavas have a limited range of SiO_2 content (47.9-54.8 wt%) and mg# (0.41-0.57) with variable values for total alkalis (2.0-6.1 wt%) and K_2O/Na_2O ratios (0.43 ± 0.14 on average). Their iron-enrichment pattern in the earlier stage of differentiation and iron-depletion pattern in the more evolved lavas preclude the possibility of calc-alkalic affinities. In terms of their SiO_2, Na_2O+K_2O and normative minerals, almost all are tholeiitic, and a few are alkalic, with normative nepheline up to 2.1%. Accordingly, they are best classified as transitional tholeiitic lavas. The transitional tholeiitic nature is well supported by the values for Nb/Y of representative samples that are in a range of 0.38-1.04. These lavas form coherent patterns on variation diagrams with relatively constant incompatible-element ratios, e.g. Ba/K = 0.02 ± 0.01, P/K = 0.17± 0.04, Zr/Y = 4.0 ± 1.1 and Zr/Ba

= 0.6 ± 0.2, implying that they are essentially comagmatic. The patterns also show that the order of crystallization is olivine+plagioclase, clinopyroxene and then Fe-Ti oxide. REE patterns for the representative samples show slight-moderate LREE enrichment and relative HREE depletion with chondrite-normalized La/Yb ranging from 3.3 to 8.2, implying that garnet has involved in their petrogenesis. The values for SiO_2, mg#, Ni (41-175 ppm) and Cr (38-282 ppm), and phenocryst/microphenocryst assemblages signify that they do not represent primary magma compositions. The Thoeng basaltic lavas are analogous to those of Boina centre in the Central Western Afar rift, typical of continental rift basaltic lavas of transitional tholeiitic series, as exemplified by their REE and N-MORB normalized multi-element patterns.

6.3 Origin

The current idea relevant to generation of the Late Cenozoic basalts in mainland Southeast Asia is that the basaltic magmas have erupted in a continental rift environment. Two models, i.e. mantle plume and large-scale plate interaction, have been proposed to account for the intra-plate volcanism. The mantle plume hypothesis (e.g. Barr and James, 1990; Hoke and Campbell, 1995) is hindered by the lack of discernible age progression and poorly defined isotopic anomaly (Smith, 1996; Flower and Hoang, 1996). At least ten plumes under Asia are required to explain the above features (Smith, 1996). The large-scale plate interaction resulted from continent-continent collision between India and Eurasia plates is supported by an excellent correlation with lithospheric structures, generally following sutures and boundaries between microplates, or major fault/fracture systems (e.g. Jungyusuk and Khositanont, 1992; Smith 1996).

According to the data presented in this study, either the hypothesis mentioned above needs transitional tholeiitic picritic magma that is equilibrated with garnet lherzolite as the parental magma for Thoeng basaltic lavas if the source rock is normal mantle. Such a magma might have derived from mixing of depleted mantle melt (tholeiitic picrite) and enriched mantle melt (alkalic picrite), or a mantle with compositions intermediate between depleted and enriched mantles under high-pressure regime (P>25 kb). The parental picritic magma probably ascended into the crust-mantle boundary. At this depth, the magma was likely to delay as the magma was denser than the lower crust, and olivine fractionation and lower crustal contamination might have operated, giving rise to transitional tholeiitic magma with high normative olivine. Subsequently, the residual magma might have continued ascending and accumulated in a shallow magma chamber (P<10 kb). Processes involved at this shallow level probably included magma mixing, crystal fractionation and upper crustal contamination. The sequence of low-pressure crystallization might have been olivine, plagioclase, clinopyroxene and then Fe-Ti oxide as partly suggested by geochemical patterns. Finally, the derivative magma erupted to the earth's surface, producing Thoeng basaltic suite. Although crustal contamination did take place as indicated by petrographic evidence, the effect of contamination cannot be chemically assessed. Further isotopic studies are needed to elaborate the discussed petrogenetic model.