CHAPTER 6

DISCUSSION AND CONCLUSION

6.1 Occurrence and Petrography

The Mae Tha basalt is Pleistocene in age and is considered to be part of the Late Cenozoic basalts in mainland Southeast Asia. It occurs as scattered masses of highly variable sizes, covering an area of approximately 142 km^2 between Amphoe Mae Moh and Amphoe Mae Tha, Changwat Lampang. This basaltic pile commonly forms a low-lying land inbetween high mountains, which are made up of Permian limestone, Permo-Triassic volcanic rock, Triassic volcaniclastic - sedimentary strata (Lampang Group), Tertiary sedimentary rock and Quaternary gravel beds, except for the vicinities of small cinder cones. The basalt also rests unconformably on the older rocks, and consists mainly of subaerial lava flows; subaqueous lava flows and pyroclastic debris are locally present. These lava flows and pyroclastic debris have largely experienced extensive weathering and decomposition, giving rise to brown and brownish yellow soil with *in situ* float basalts. The eruptive products are well exposed along cliffs and slopes of hills, road cuts and railway cuts. At least 6 subaerial lava flows with individual thicknesses varying from more or less 1 m to greater than 12 m. Their internal structures can be divided into vesicular base, massive with platy and columnar joints at center, and vesicular top.

The least-altered Mae Tha basaltic samples have colors varying from medium dark gray to dark gray, and are dense and fine-grained, but for the sample from the chill margin of basalt pillow that is grayish black with glassy texture. These basalts range texturally from phyric to microphyric, except for the sample from chill margin of basalt pillow that is vitrophyric. The most common phenocryst and microphenocryst assemblages are olivine + plagioclase + chromian spinel ± Fe-Ti oxide, and olivine + plagioclase + clinopyroxene + chromian spinel ± Fe-Ti oxide. The most abundant phenocrysts/microphenocrysts in individual samples are olivines. In addition, quartz

megacrysts and Permo-Triassic (?) volcanic xenoliths have been sporadically detected in some samples. The groundmass commonly shows felty texture and uncommon trachytic texture, except for the sample from chill margin of basalt pillow that has glassy groundmass. The primary groundmass constituents are made up largely of plagioclase laths with subordinate intergranular olivines and pink clinopyroxenes, and minor Fe-Ti oxides; many samples contain variable amounts of brown glass and quenched crystals. In addition, clinopyroxenes in a few samples of the basalts with hypocrystalline groundmass are subophitic to plagioclase laths. Amygdale and veinlets are rarely present.

6.2 Chemical Characteristic

Chemically, the least altered Mae Tha lavas have a limited range of SiO_2 content (46.12-51.23 wt%) and mg# (0.60-0.70) with variable values for total alkalis (5.89-8.10 wt%) and K_2O/Na_2O ratios (0.82 ± 0.20 on average). In terms of their SiO_2, Na_2O+K_2O and normative minerals, all are alkalic, with normative nepheline varying from 0.53 to 13.56%. These alkalic basaltic lavas are constituted largely by basanite, basaltic trachyandesite and trachybasalt; very few are phonotephrite. Accordingly, they are best assigned to transitional trachybasaltic to basanitic series. The alkalic nature is well supported by the values for Nb/Y of representative samples that are in a range of 1.39-1.75. These lavas form coherent patterns on MgO variation diagrams with relatively constant incompatible-element ratios, e.g. Zr/Nb = 3.47 ± 0.10, Nb/Y = 1.55 ± 0.17, Ba/K = 0.04 ± 0.01, P/K = 0.14 ± 0.03, Zr/Ba = 0.26 ± 0.05, Zr/K = 0.011 ± 0.003, Zr/P = 0.07 ± 0.01, Ba/Sr = 1.097 ± 0.04, Ba/P = 0.27 ± 0.05, and Y/Zr = 0.18 ± 0.08, implying that they are essentially comagmatic. The patterns also show that olivine, chromian spinel, clinopyroxene and Fe-Ti oxide were the earliest phases to crystallize and then followed by plagioclase. REE patterns for the representative samples show LREE enrichment and relative HREE depletion with chondrite-normalized La/Yb ranging from 11.47 to 12.86. The values for SiO_2, mg#, Ni (90-251 ppm) and Cr (128-329 ppm), and phenocryst/microphenocryst assemblages signify that they do not represent primary magma compositions. The Mae Tha basaltic

lavas are analogous to those of the alkalic basalts from southern part of Gregory rift, Kenya, typical of continental rift basaltic lavas, 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 by 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, both the hypotheses mentioned above need transitional trachybasaltic to basanitic magma that is equilibrated with a amphibole-bearing lherzolite as the parental magma for Mae Tha basalts. Such a primary magma might have been produced by a small degree of partial melting of either a fertile mantle or a mantle intermediate between depleted and fertile mantles at pressures slightly greater than 10 kb (35 km depth). The parental magma might have ascended and accumulated in a shallow magma chamber (approximately 5 kb pressure, i.e. 17-18 km depth). Processes involved at this shallow level probably included magma mixing, crystal fractionation and upper crustal contamination. The sequence of low-pressure fractionation might have been olivine, chromian spinel, clinopyroxene and Fe-Ti oxide in the earlier stages, and then followed by plagioclase as suggested by geochemical patterns. Finally, the derivative magma erupted on to the earth's surface,

producing the Mae Tha 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.