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New K-Ar ages from the Lampang basalt, northern Thailand

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Abstract: Two samples of the Lampang basalts were collected from the southern Mae Moh basin, northern Thailand. They are aphyric basalts consisting of plagioclase, olivine, clinopyroxene, opaque minerals, and interstitial glass. Chemically both are of basanite composition. Their K-Ar ages may give the lower limit of the formation age, because of the Ar loss due to the hydration. But one of the ages, 0.6 ± 0.2 Ma, is presumably not greatly deviated from the formation age. This indicates that the Lampang basalt is one of the youngest igneous activity in Southeast Asia. It may be indicative of high heat potential in the crust or the upper mantle under the northern part of Thailand.

1. Introduction

Late Cenozoic basalts are widely distributed in Southeast Asia (Fig. 1), and occur locally in northern Tailand. Many hot springs also occur in northern Thailand (e. g. BARR et al., 1979), but the surface distribution of the basaltic rocks is not correlative with the hot springs. Nevertheless, the basalts are the only known evidence of recent igneous activity.

This paper presents K-Ar ages of two samples from the Lampang basalt, collected from the southern Mae Moh Basin, northern Thailand (Fig. 2). The authors thank Dr. S. M. BARR, Acadia University, Canada for critical reading of the manuscript, and Mr. K. Uto, Geological Survey of Japan for helpful suggestion. They also thank Messrs. K. TURALTAMKUL, V. PAIJITPRAPAPAN and C. CHAPHYEN, Department of Mineral Resources Thailand for their aid in field studies.

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2. Locality and occurrence

The Lampang basalt underlies the southern part of the Mae Moh Basin (Fig. 2). It consists of several flows and locally pyroclastic debris associated with vents (BARR, and MACDONALD, 1981). One of the samples (82Z0401) for the present study was collected from a pillow basalt cropping out along the railroad cutting at 18°15′30″ N and 99°39′00″ E. The pillows range from 0.5 to 1 m in radius (Plate I-1) and display radial cracks and concentric zones of vesicles at the margins. Inter-pillow breccia is also present. The other sample (82Z0402) was collected from a massive basalt flow overlying gravel deposits (Plate I-2) at 18°07′32″ N and 99°37′52″ E.

3. Sample description

The texture of basalt 82Z0401 is aphyric and hypocrystalline. Principal constituents are plagioclase, olivine and clinopyroxene. Fresh glass occurs interstitially. Plagioclase is of andesine composition, and occurs as euhedral prismatic crystals up to 0.5 mm long. Dendritic growth is typically present at contacts with glass (Fig. 3). Olivine occurs

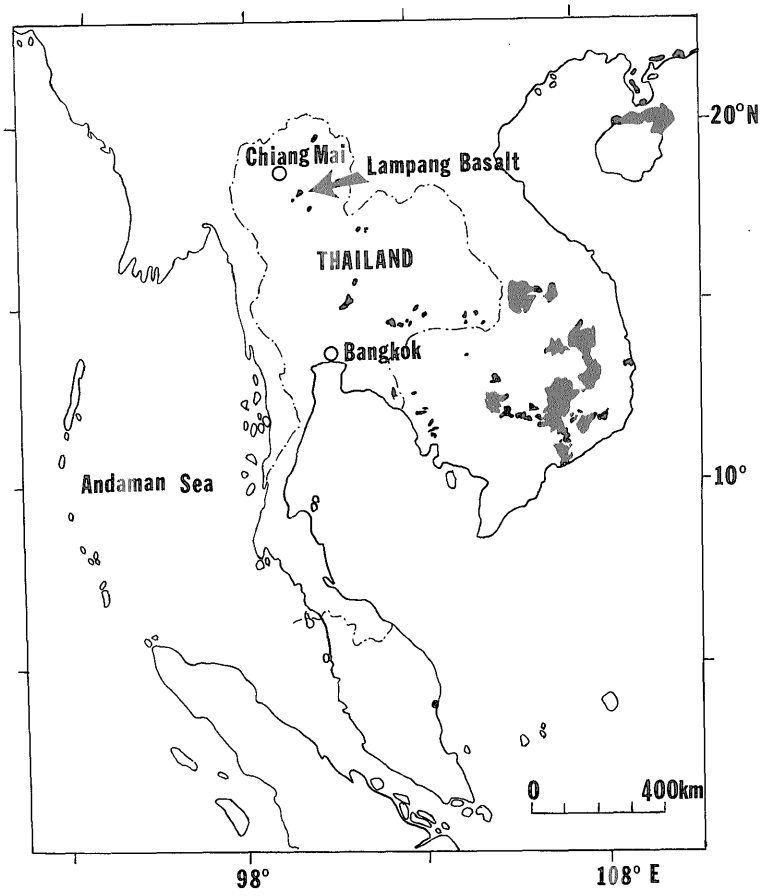

Fig. 1 Distribution of Late Cenozoic basalts in Southeast Asia after Geologic Map of Asia and the Far East (ECAFE, 1971).

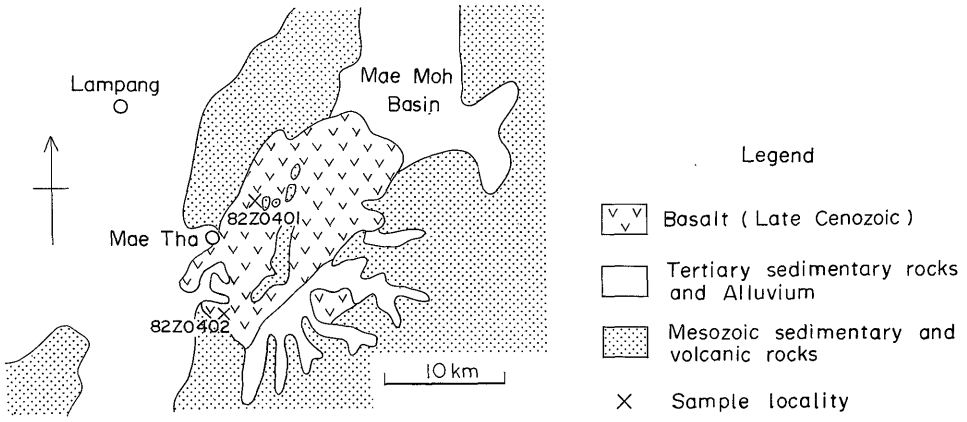

Fig. 2 Distribution of the Lampang basalt and sample localities.
Geology is based on the geological map of northern Tailand, scale 1 : 500,000 compiled by Geological Survey Division, Department of Mineral Resources of Tailand (1982).

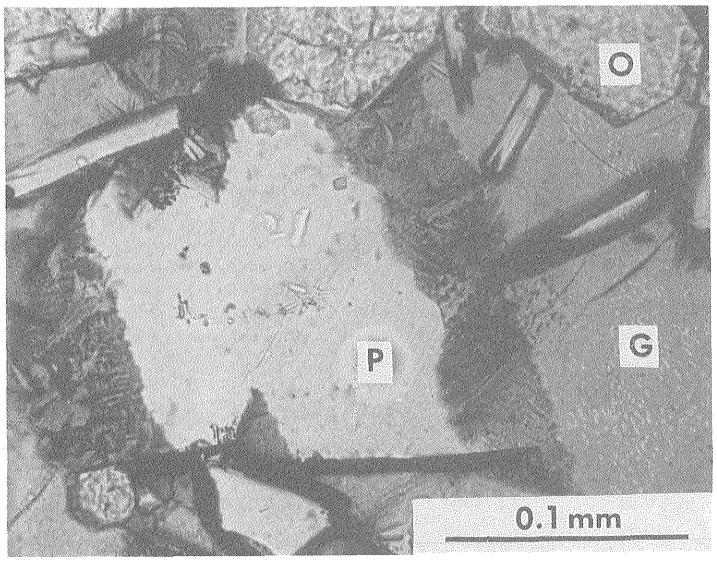

Fig. 3 Photomicrograph of sample 82Z0401. Dendritic growth is observed on the surface of plagioclase, Abbreviations: P: plagioclase, O: olivine, G: glass. Scale: 0.1 mm, plane polarized light.

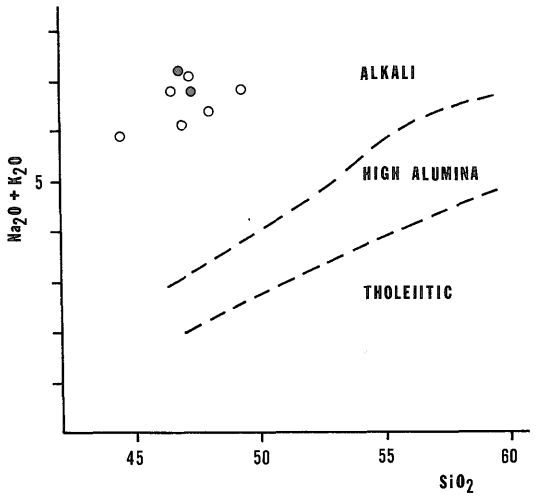

Fig. 4 Total alkalis, plotted against SiO_2 for the Lampang basalt. Open circles are present data, and solid circles are the data from BARR and MACDONALD (1978, 1981). Dashed lines represent boundaries of Japanese basalt types (KUNO, 1966).

as euhedral to subhedral crystals up to 0.5 mm in size. It locally contains minute opaque minerals and glass inclusions. Clinopyroxene forms prismatic crystals up to 0.05 mm in length. Scattered vesicles are lined by carbonate minerals. Sample 82Z0402 is petrographically similar to 82Z0401 except that some silicate and opaque minerals have lattice-like dendritic forms.

Chemical analyses and CIPW normative mineralogies are given in Table 1. Both samples contain normative nepheline. They are classified as basanite (YODER and TILLEY, 1962), and are chemically similar to several previously analyzed samples of Lampang basalt (BARR and MACDONALD, 1978) (Fig. 4).

4. K-Ar ages

Whole-rock K-Ar ages of samples 82Z0401 and 82Z0402 were determined by Teledyne Isotopes, and yielded ages of 0.8 ± 0.3 Ma and 0.6 ± 0.2 Ma, respectively (Table 2). Previous K-Ar age determinations of samples from the Lampang basalt gave ages less than 0.2 Ma, but those data are not reliable because of argon loss (BARR et al., 1976). The present samples are apparently fresh, but they have been somewhat affected by alteration, judging from $H_2O(+)$ contents (Table 1). Obsidian with $H_2O(+)$ contents higher than 1 wt % has probably been affected by radiogenic Ar loss (KANEOKA, 1971), and hydration of glass in the Lampang basalt samples presumably also affects the K-Ar ages, especially

Table 1 Chemical composition and CIPW norms for the Lampang basalt. Samples were analyzed by the Tokyo Coal and Mineral Laboratory.

Sample No.	82Z0401	82Z0402
SiO_2	47.31	46.70
TiO_2	2.15	2.41
Al_2O_3	17.28	17.18
Fe_2O_3	1.75	2.39
FeO	6.47	6.11
MnO	0.17	0.18
MgO	6.77	7.04
CaO	7.58	7.78
Na_2O	3.74	4.02
K_2O	3.04	3.23
P_2O_5	0.78	0.83
$H_2O(+)$	2.37	1.17
$H_2O(-)$	0.34	0.28
CO_2	0.08	0.37
Total	99.83	99.69
or	18.53	19.50
ab	20.02	16.02
an	22.06	19.71
ne	6.68	10.13
wo (di)	4.81	5.93
en (di)	3.14	4.13
fs (di)	1.34	1.32
fo	9.98	9.65
fa	4.70	3.40
mt	2.62	3.53
il	4.21	4.68
ap	1.91	2.00
Total	100.00	100.00

Abbreviations for normative minerals:
or: orthoclase, ab: albite, an: anorthite,
ne: nepheline, wo: wollastonite,
en: enstatite, fs: ferrosilite,
di: diopside, fo: forsterite, fa: fayalite,
mt: magnetite, il: ilmenite, ap: apatite.

of the pillow basalt with $H_2O(+)$ content of 2.37%. Hence both samples may give a minimum age of crystallization. However, the $H_2O(+)$ of sample 82Z0402 is only slightly over 1 wt% and hence the deviation from the crystallization age is presumably not great.

Most flows of the Lampang basalt show normal magnetic polarity, except the lower flow, and some flows overlie the gravel deposits containing Early Paleolithic pebble tools (BARR et al., 1976). The K-Ar age of sample 82Z0402, from a flow overlying gravel deposits, is consistent with the paleomagnetic and archeological evidence.

Table 2 K-Ar ages of the Lampang basalt

Sample Nos.	K (%)	^{40}Ar rad (10^{-5}ccSTP/g)	Atm^{40}Ar (%)	Age (Ma)
82Z0401	2.69	0.008	7.9	0.8±0.3
	2.70	0.009	8.5	
82Z0402	2.74	0.007	10.1	0.6±0.2
	2.76	0.007	10.3	

The constants for age calculation are
$\lambda_\beta = 4.96 \times 10^{-10}\,yr^{-1}$,
$\lambda_\varepsilon = 0.581 \times 10^{-10}\,yr^{-1}$ and $^{40}K = 1.167 \times 10^{-4}$ atom per atom of natural potassium.

Late Cenozoic basaltic activity began about 13 Ma ago in Southeast Asia, and some basalts appear to be younger than 3.5 Ma (BARR and MACDONALD, 1981). The present age determination indicates that the Lampang basalt is one of the youngest in Southeast Asia.

5. Implication

Although the hot spring distribution dose not correlate with the basalt, some of the high heat flow anomalies appear to be correlative with the basaltic activity. High heat flow (more than 2.0 HFU) has been measured around Phrae (THIENPRASERT and RAKSASKULWONG, 1984), where the Lampang and Den Chai basalts are distributed. The age of the latter basalt is 5.64 Ma (BARR and MACDONALD, 1981). At the western margin of Khorat plateau a NNE-trending high heat flow anomaly also occurs (THIENPRASERT and RAKSASKULWONG, 1984), and basaltic rocks are distributed at Khok Samrong on the south of the anomaly. The age of one of the basaltic rocks is 11.29 Ma (BARR and MACDONALD, 1982).

In continental regions, Cenozoic basalts are typically associated with high heat flow anomalies. For example, at Urach geothermal field, West Germany (HAENEL, 1976; MÄUSSNEST, 1982), a high temperature anoma-

ly is located at the center of a number of nephelinite pipes whose K-Ar ages are 30-11 Ma (LIPPOLT et al., 1973). The Cenozoic basalts are also regionally associated with high heat flow anomalies in the Basin and Range in North America (LEEMAN and ROGERS, 1970) and in eastern Australia (SAAS, 1964; MORGAN, 1968). This is considered to be due to thermally anomalous upper mantle and lower crust (LEEMAN and ROGERS, 1970; HAENEL 1982). Although the deep crystal structure in northern Thailand is not known, the presence of late Cenozoic basalt including the Lampang basalt, is probably indicative of high heat potential in the crust or the upper mantle under the northern part of Thailand.

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タイ北部ランパン玄武岩の新しい K-Ar 年代値

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要　旨

メモ盆地南部から採取したランパン玄武岩2試料につき，化学分析を行うとともに K-Ar 年代を求めた．これらはともに斜長石，かんらん石，単斜輝石，不透明鉱物及び間隙充塡状のガラスからなる無斑晶質のベイサナイトである．これらは 0.8±0.3 Ma，0.6±0.2 Ma の K-Ar 年代を示すが，ガラスの水和による Ar の散逸が考えられるので，厳密にはこれらの年代は形成年代の下限を与えているといえる．しかし後者では岩石中の水の含有量が少ないので，形成年代から大きな隔りはないものと考えられる．ランパン玄武岩は東南アジアの大陸地域における最も若い火成活動の1つであるといえる．この若いアルカリ玄武岩の噴出がみられるタイ北部では，地殻及び上部マントルの熱的ポテンシャルは高いかもしれない．

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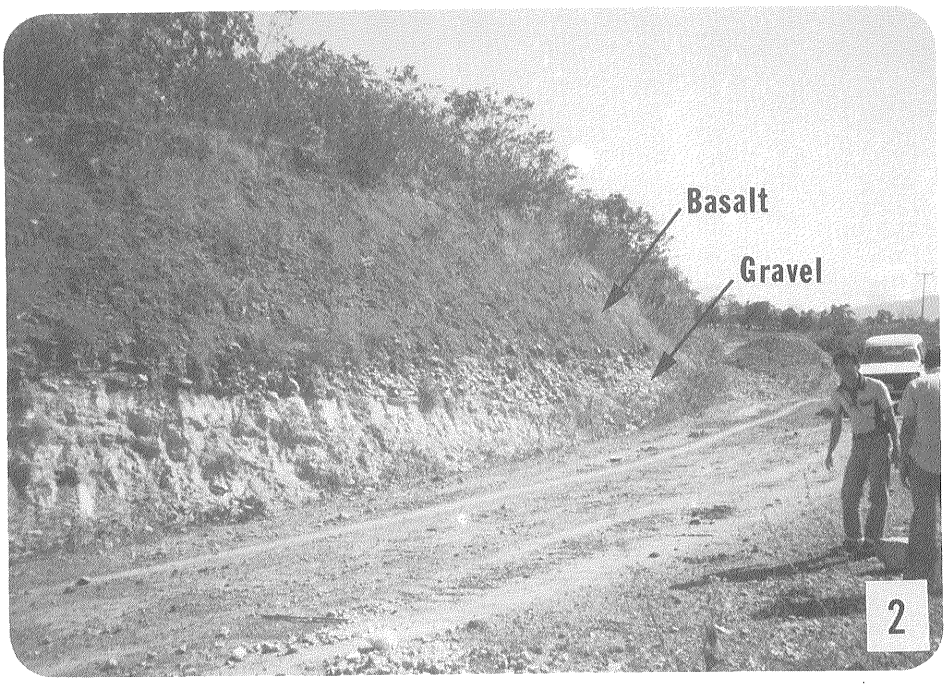
1 Outcrop of pillow basalt (sample 82Z0401) in the southern Mae Moh Basin.



2 Outcrop of basalt (sample 82Z0402) overlying the gravel deposit in the southern Mae Moh Basin.