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Petrochemistry of Nakhon Ratchasima granitoid, Northeastern Thailand

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Abstract: Geochemical analysis is useful for delineating the granites genetically and tectonically associated hydrothermal mineralization and hence can be used as an exploration tool. Granitoid rocks from Nakhon Ratchasima, Northeastern Thailand were selected for X-ray Fluorescence (XRF) technique. These granitoid rocks belong to the eastern granite belt of Thailand as the suture complex of a Triassic collision. The main rock forming minerals of the Nakhon Ratchasima granitoids are: quartz + microcline ± orthoclase + plagioclase feldspar + biotite + muscovite. Based on their modal composition, the rocks are quartz monzogranite. According to their major element geochemistry, they are quartz monzogranite, alkaline granite rocks with a metaluminous character. Concerning their tectonic origin the studied rocks may relate to the island arc, continental arc and continental collision. The samples generally display an I-type character with respect to their mineralogy and major element composition.

Key words: Granitoid, Nakhon Ratchasima, Geochemistry, Tectonics

INTRODUCTION

Tectonic framework of Thailand and vicinity consist of two main continental cartons namely Shan-Thai to the west and Indochina to the east. In addition, two small tectonic cratons have been proposed between Shan-Thai and Indochina. They are Nakhon-Thai ocean floor (Paleotethys) connecting the western edge of Indochina craton and Lampang-Chiang Rai volcanic arc close to the eastern edge of the Shan-Thai craton. These cartons completely collided together in the Late Triassic (e.g., Bunopas, 1981; Bar and Macdonald, 1987; Hada *et al*., 1999; Singharajwarapan and Berry, 2000). Consequently, these events may have caused three suture zones of Thailand. These sutures may be indicated by exposures of granitoid rocks that appear to have been related to north-south granitoid belts in Thailand. Besides, three granitoid belts in Thailand are in geographic order from east to west including Eastern-, Central- and Western granite belts.

Moreover, it is widely accepted that metallic and non-metalic ores, especially those of hydrothermal origin are closely related to some types of granite in both space and time (Charusiri *et al*., 1993). A better understanding of the geochemistry and evolution of granites would be the benefit to mineral exploration in Thailand. Therefore, this study aims to present geochemistry data and to define types of Nakhon Ratchasima granitoid. This study also discusses the relevant tectonics of this granitoid.

MATERIAL AND METHOD

The study area is located in Nakhon Ratchasima Province area located in the NE Thailand and possibly related to the eastern granite belt (Figure 1). The subjects of the study are granitoids of the eastern granite belt that is dominated by quartz and two feldspars (alkali- and calcium-rich). Akali feldspar (plagioclase), oligoclase to andesine is significant (Charusiri *et al*., 1993). All samples were selectively sampling for whole-rock chemical analyses. X-ray Fluorescence (XRF) technique was applied for major elements. On the basis of their textures, the studied the Nakhon Ratchasima granitoid of the eastern graniotid belt can be classified as granites of medium-grained, inequigranular, hypidiomorphic-granular texture.

Result:

Whole-rock geochemical data of major element analyses of the Nakhon Ratchasima granitoids are listed in Table 1. Chemically, the samples are metalumious character of Maniar, *et al*. (1989) classification (Figure 2) and are quartz monzonite granitic in composition, plotting within the QAP diagram of Streckeisen (1974) as shown in Figure 3. They are rather siliceous (up to 67 % SiO2) and alkali-rich (up to 4.5 % Na_2O and 6 % K_2O). The K_2O/Na_2O ratios range between 1.41 and 2.01. Calcium and magnesium contents are high; 2.91-3.26 wt% CaO and 0.27-0.32 wt% MgO.

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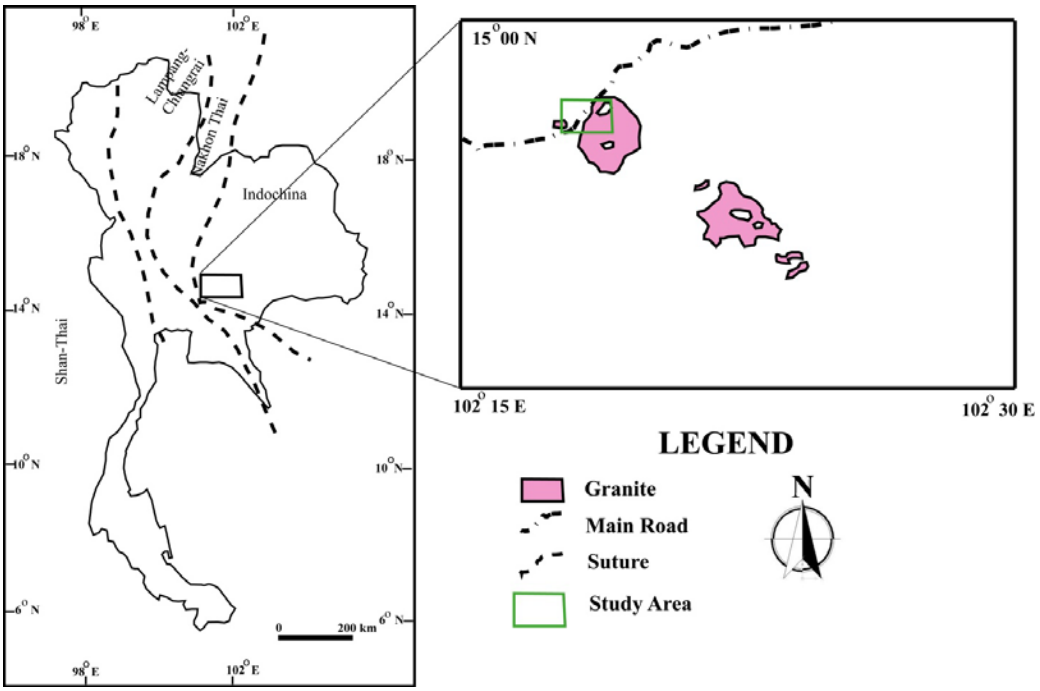

Fig. 1: Location of the study area situated in the Eastern granitoid belt.

Table 1: Representative major element data for the Nakhon Ratchasima granitoids (*=total iron).

Sample	NKR1	NKR2	NKR3	NKR4	NKR5
SiO_2	67.29	68.18	67.03	68.14	67.80
TiO_2	0.39	0.37	0.35	0.36	0.37
Al_2O_3	15.53	15.43	16.06	15.51	15.39
Fe_2O_3*	3.45	3.32	3.03	3.27	3.30
MnO	0.05	0.05	0.04	0.04	0.04
MgO	0.32	0.29	0.27	0.28	0.27
CaO	2.95	3.07	3.26	2.91	3.15
Na_2O	3.86	4.24	4.55	4.15	4.32
K_2O	6.27	5.11	5.43	5.39	5.39
P_2O_5	0.15	0.15	0.13	0.14	0.15
SO_3	0.04	0.08	0.12	0.09	0.11

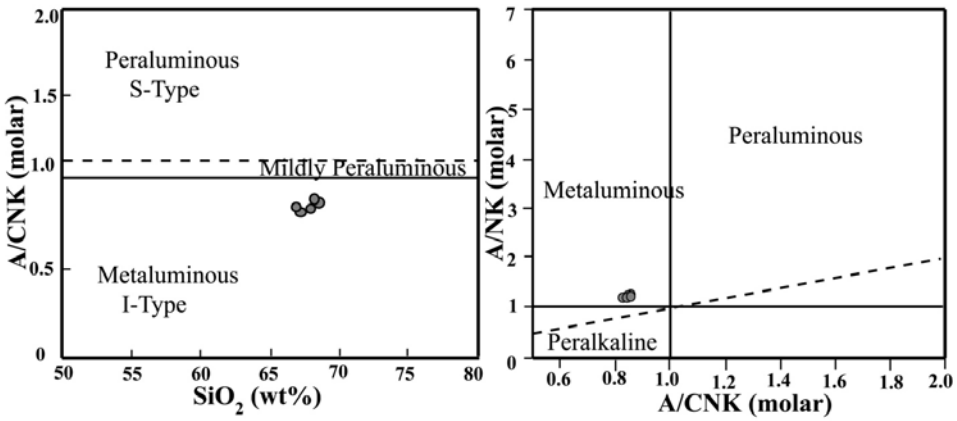

Fig. 2: Plots of molar ratios $Al_2O_3/(Na_2O+K_2O)$ (A/NK) vs. molar ratios $Al_2O_3/(CaO+Na_2O+K_2O)$ (A/CNK) (Maniar, *et al*., 1989).

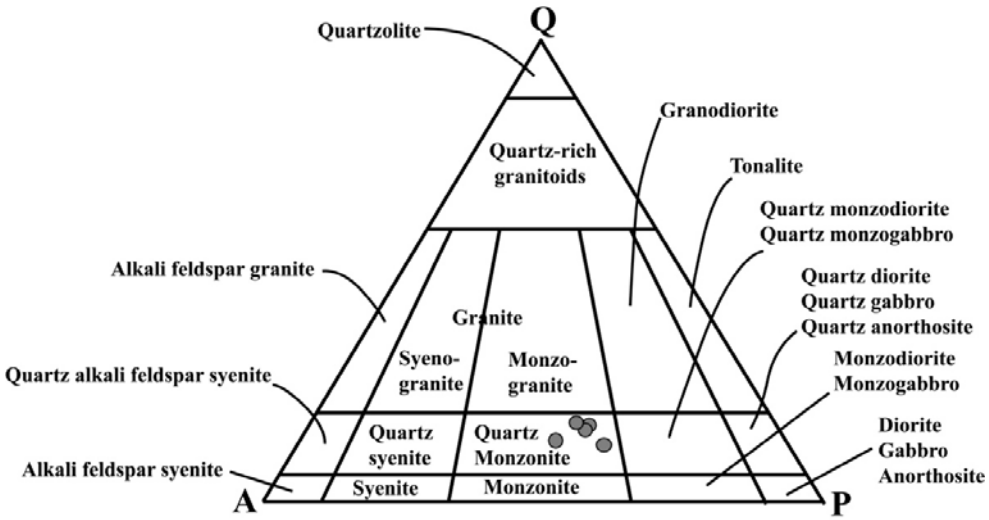

Fig. 3: Geochemical classification of plutonic rocks using parameters using QAP diagram of Streckeisen (1974).

The granitoid samples also represent alkali granites in the alkalis vs. silica diagram of Cox, *et al*. (1979) modified by Wilson (1989) as presented in Figure 4. The result of geochemical classification by De la Roche *et al*. (1980) is proved to be quartz monzonite (Figure 5). This is consistent with the modal QAP classification (Figure 3). The plot of Na_2O versus K_2O contents shows that the chemical characteristic of I-type after Chappell and White (1974) as shown in Figure 2.

According to Maniar *et al*. (1989) the chemical characteristics of granitoid rocks from different tectonic environments can be classified into seven classes; (1) island arc granitoids (IAG); (2) continental arc granitoids (CAG); (3) continental collision granitoids (CCG); (4) post-orogenic granitoids (POG); (5) rift-related granitoids (RRG); (6) continental epirogenic uplift granitoids (CEUG); and (7) oceanic plagiogranites (OP). The samples are failed into the IAG+CAG+CCG group (Figure 6). Hence, the studied samples are orogenic granitoids, i.e. plot to the IAG+CAG+CCG group. The geochemical data are also plotted into Batchelor and Bowden's diagram (1985) that gives the tectonic environments during granitoid formation, the analyzed granitoids turn to be of Late-Orogenic type.

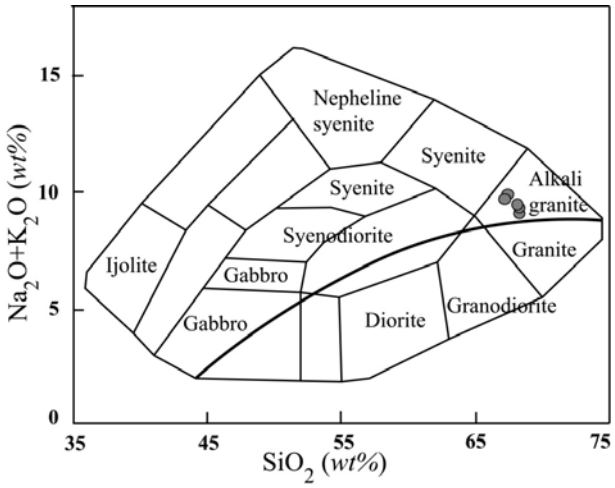

Fig. 4: The chemical classification and nomenclature of plutonic rocks using the total alkalis versus silica (TAS) diagram of Cox *et al*. (1979) adapted by Wilson (1989) for plutonic rocks. The curved solid line subdivides the alkali from subalkali rocks.

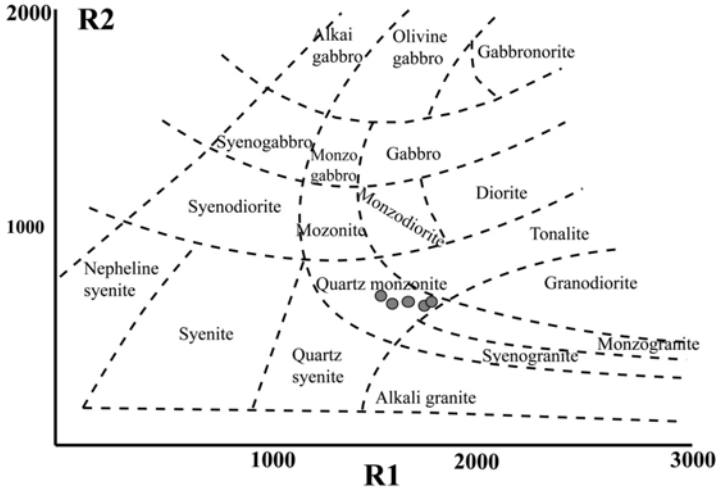

Fig. 5: Geochemical classification of plutonic rocks using parameters R1 and R2 (after De la Roche *et al*., 1980), calculated from milication proportions. R1 = 4Si-11(Na+K)-2(Fe+Ti); R2 = 6Ca+2Mg+Al.

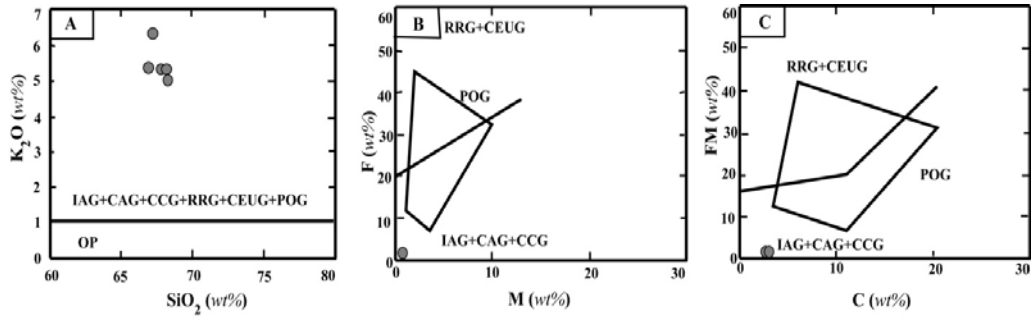

Fig. 6: (A) SiO_2 vs. K_2O; **(B)** MgO (M) vs. $Fe_2O_3^*$ (F) (*=total iron); **(C)** CaO vs. ($Fe_2O_3^*$+MgO) (*=total iron). Note: IAG = island arc granitoids, CAG = continental arc granitoids, CCG = continental collision granitoids, POG = post-orogenic granitoids, RRG = rift-related granitoids, CEUG = continental epirogenic uplift granitoids, OP = oceanic plagiogranites.

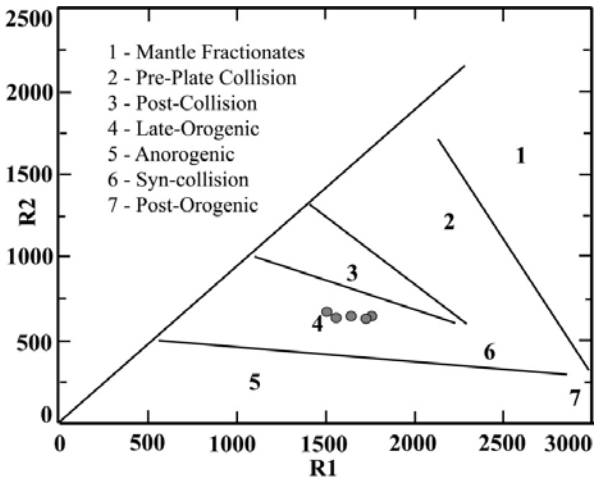

Fig. 7: Tectonical discrimination plots of Batchelor, Bowden (1985). R_1=4Si-11(Na+K)-2(Fe+Ti); R_2=6Ca+2Mg+Al.

Discussion and Conclusion:

The study of the petrochemistry of this granitoid belt is important for understanding of geologic evaluation of the basement. On the basis of their composition, the granites can be considered of similar character. The main rock forming minerals of the studied samples are considered to be quartz, microcline, plagioclase feldspar,

biotite and muscovite. Major element geochemistry study showed the development of these granitoids from farctional crystallization of alkaline, metaluminous magma in suture zone of tectonic setting with alkali granite character.

The tectonic study is classified as orogenous, late-orogenic type which may relate to the island arc, continental arc and continental collision granitoids. Therefore, the Nakhon Ratchasrima granitoid is properbly occurred in Late Triassic time after collision between Nakhon Thai and Indochina cratons.

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