GEOCHEMISTRY OF INTRUSIVE IGNEOUS ROCKS AT THOEN DISTRICT, LAMPANG PROVINCE

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Abstract

The study of the geochemistry of intrusive igneous rocks in Thoen District, Lampang Province, aims to investigate their geochemical composition, classify the intrusive igneous rocks, and determine the geological environment in which these rocks formed. The intrusive igneous rocks in the study area appear as small outcrops that are not recorded on existing geological maps. Geochemical analysis was conducted on 21 least-altered rock samples, allowing for rock classification based on their chemical composition. The samples were categorized into six types: monzonite, granite, granodiorite, diorite, gabbroic diorite, and quartz monzonite. Based on chemical composition, the rocks can be divided into four groups: felsic volcanic rocks, felsic intrusive igneous rocks, intermediate igneous rocks, and mafic igneous rocks. Additionally, the study identified the magma series of the intrusive igneous rocks in the study area as belonging to the shoshonite series and the calc-alkaline series. This suite can be classified as I-type granite. Furthermore, the findings suggest that these rocks formed in a within-plate continental setting, a volcanic arc environment and mid oceanic ridge basalt. Geochemical evidence further supports that these intrusive rocks, observed as small outcrops in Thoen District, Lampang Province, are part of the Eastern Granite Belt of Thailand.

Introduction

The intrusive igneous rocks in Thoen District, Lampang Province, were formed by the intrusion of magma that cover by Quaternary alluvial sediments (Fig. 1). According to the study by Thanitta Suetrong (2024), petrographic analysis was conducted to examine the mineral composition of the rocks. The study found small rock outcrops, which are not shown on the geological map, classified as I-type granite. These rocks are presumed to be part of the Eastern Granitic Belt of Thailand. The researcher aims to study the intrusive igneous rock samples through geochemical analysis to determine their geochemical composition, classify the rock types, and identify the tectonic setting of the igneous rocks in the study area.

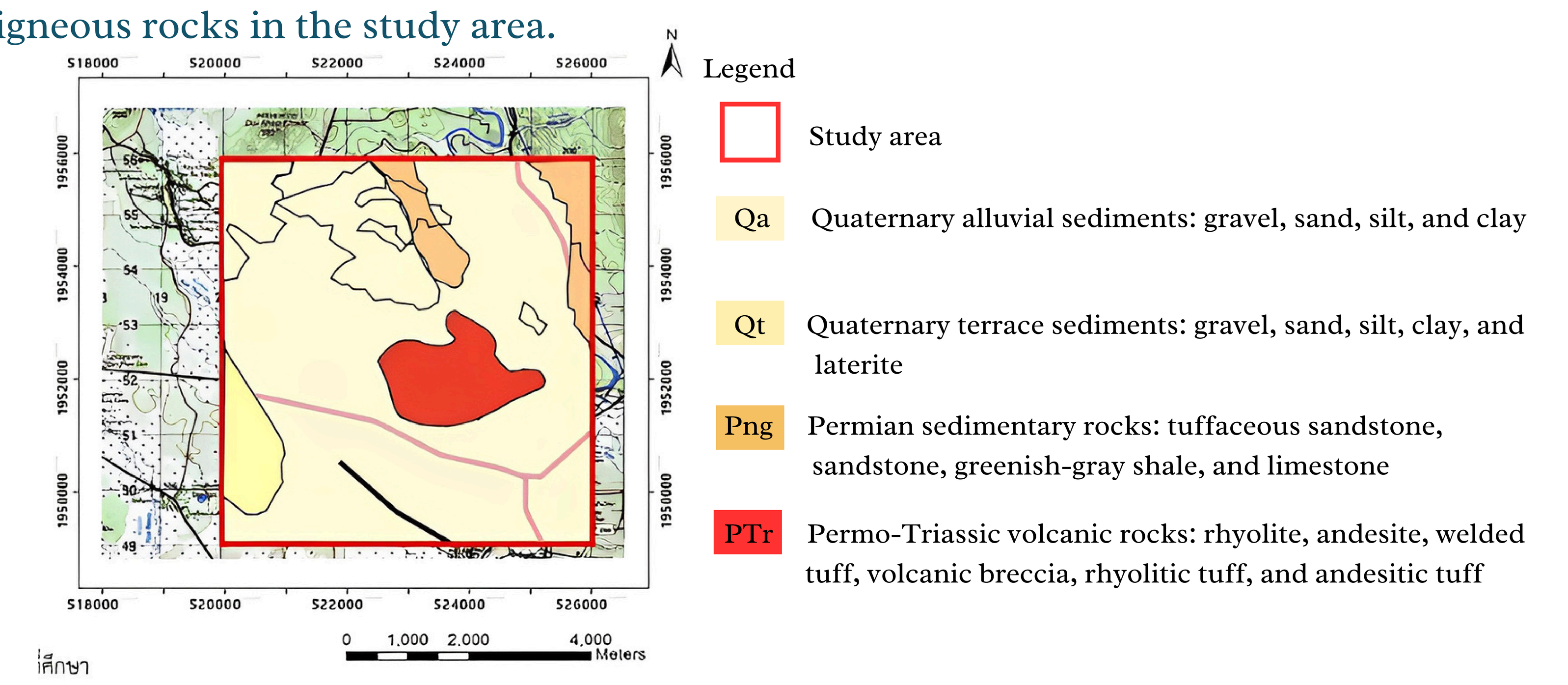

Figure 1.Geology map of study area (from Thanitta Suthrong, 2024)

Methodology

- Sample selection of rocks (Fig. 2).

Step 1: No evidence of the evolution of secondary minerals.
Step 2: There is not much xenolith and xenocryst present.
Step 3: No signs of metamorphism are present

Figure 2. Use this image to show the sample selection of rocks.

- Prepare samples for geochemical analysis (Fig. 3).

Step 1: Use a hammer to break rock samples into pieces about 4-5 centimeters in diameter.
Step 2: Crush into rock flakes about 1-2 centimeters in size using a rock chip crusher.
Step 3: Select rock flakes that are free from veins, metamorphism, weathering, xenoliths, and xenocrysts.
Step 4: Clean the samples and then dry them in an oven at 100 degrees Celsius.
Step 5: Grind the rock flakes using a fine rock crusher.
Step 6: Chemical analysis.
- Major oxides
- Trace elements
- Loss On Ignition

Figure 3. Use this image to show the prepare samples for geochemical analysis.

Results

Based on the analysis of 21 samples, the results are presented in Table 1 and are least altered in alteration box plot (Fig. 4). The rocks are granite, granodiorite, monzonite, diorite, gabbroic diorite, and quartz monzonite on TAS classification diagram (Fig.5) and classified into four groups as Group I, II, III, and IV. The rocks are calc-alkaline magmas and show co-magmatic trend that occurred from magma differentiation (Fig. 6). The tectonic settings of Group I, II, and III were determined to be I-type granite in post-collision and mid-oceanic ridge (Fig. 7-8) and Group IV rock is island arc and active continental margin (Fig. 10).

Table 1. The chemical analysis results present the major element oxides, trace element concentrations, and the loss on ignition (LOI).

Samples	TH14	TH20	TH02	TH08	TH092	TH13	TH15	TH16	TH17	TH03	TH05	TH10	TH122	TH18	TH01	TH04	TH06	TH07	TH091	TH11	TH121
Major oxide (wt%)																					
SiO2	73.16	73.03	70.12	71.94	75.18	74.02	72.65	70.85	70.9	65.32	59.76	56.64	64.67	64.34	59.47	57.36	65.63	50.49	63.62	56.05	57.63
TiO2	0.06	0.07	0.21	0.19	0.05	0.18	0.18	0.17	0.28	0.44	0.43	0.64	0.45	0.5	0.61	0.65	0.45	0.8	0.44	0.55	0.66
Al2O3	14.94	15.02	14.93	14.75	13.99	14.1	14.55	14.97	14.68	15.24	15.76	14.88	14.45	15.56	15.04	14.94	15.3	12.85	16.73	12.76	13.99
T-Fe2O3	0.6	0.67	1.53	1.42	0.53	1.04	1.37	1.52	1.89	3.59	5.12	6.33	3.19	3.66	5.95	6.64	3.6	7.79	2.83	6.16	6.21
MnO	0.02	0.02	0.04	0.03	0.01	0.02	0.03	0.04	0.04	0.06	0.12	0.11	0.06	0.05	0.16	0.12	0.06	0.14	0.06	0.12	0.12
MgO	0.21	0.25	0.57	0.54	0.16	0.34	0.54	0.29	0.72	2.2	3.66	5.05	2.09	2.54	6.61	4.95	2.25	9.33	2.01	8.37	6.13
CaO	1.38	1.41	2.14	2.25	1.27	1.06	1.93	3.11	2.37	3.43	6.91	6.96	4.44	4.07	7.23	6.01	3.28	9.95	6.17	6.61	6.15
Na2O	5.03	4.94	3.58	3.6	3.48	3.57	3.46	3.51	3.19	3.15	4.26	2.81	2.95	3.01	3.17	2.6	2.89	2.26	3.88	1.99	2.52
K2O	3.19	3.19	4.18	4.22	4.43	4.36	4.38	4.16	4.38	4.17	0.93	3.08	5.05	3.9	3.72	2.98	4.38	2.38	1.92	4.37	3.34
P2O5	0.02	0.02	0.06	0.05	0	0.03	0.05	0.05	0.08	0.15	0.12	0.3	0.15	0.18	0.24	0.21	0.16	0.33	0.14	0.19	0.19
LOI	0.44	0.58	0.96	0.9	0.86	0.88	0.76	0.72	0.78	0.94	0.58	1.3	0.68	0.9	0.7	1.72	1.36	1.52	1.04	0.74	1.06
original sum	99.03	99.18	98.32	99.89	99.96	99.6	99.89	99.38	99.3	98.69	97.62	98.1	98.17	98.71	102.89	98.17	99.36	97.85	98.84	97.9	98
trace elements (ppm)																					
Ba	1851	1857.7	956.98	868.77	769.4	1224.9	903.6	850.05	960.95	935.56	213.62	1224	1407.4	1488.9	1001.8	873.78	925.82	1089.4	595.95	1818.5	1027.7
Rb	144.34	139.76	250.49	268.77	219.26	220.91	249.23	255.19	252.9	211.46	37.95	111.1	144.16	146.78	151.53	115.86	78.56	184.98	52.44	113.04	134.11
Sr	1429.7	1437.8	392.51	383.49	350.27	290.02	364.8	455.78	334.1	362.04	229.73	513.66	380.07	583.26	333.25	315.09	502.82	407.24	522.69	379.82	324.77
Y	27.2	27.03	40.59	40.69	35.02	35.28	39.75	38.89	42.83	40.16	24.32	31.89	36.43	31.76	23.16	33.71	25.51	35.72	24.56	30.02	35.17
Zr	131.78	136.49	141.1	129.21	98.31	142.2	126.31	120.89	157.26	167.03	73.39	140.49	169.23	175.46	145.54	138.06	144.12	168.11	182.92	145.32	100.63
Nb	15.52	19.07	20.54	19.37	25.29	21.92	18.87	16.71	19.5	15.06	18.43	15.46	22.68	12.92	8.45	14.29	15.22	15.17	16.62	16.3	19.61
Ni	19.31	20	34.03	19.37	21.69	27.07	35.69	29.95	33.26	65.37	22.79	97.56	59.83	72.76	142.9	138.94	271.51	75.11	59.77	295.08	175.94
Cr	9.22	16.07	31.56	193.49	9.37	161.1	69	75.34	108.26	156.72	147.95	282.88	65.46	197.66	367.9	242.11	652.97	208.85	79.18	691.27	398.16
V	5.89	7.6	16.26	16.69	1.17	18.22	14.85	11.75	22.61	42.88	33.13	63.67	34.08	49.45	55.72	64.06	59.06	45.62	31.93	56.37	69.18
Sc	0.6	4.37	6.61	6.99	3.79	10.61	5.18	4.39	5.5	12.74	15.09	23.23	4.25	10.97	18.31	19.29	22.33	12.7	6.49	16.41	19.34
Th	11.44	12.52	23.42	22.26	18.8	31.08	23.42	24.29	35.3	24.72	8.53	20.74	25.62	20.45	21.75	17.89	17.62	18.32	37.71	19.88	13.87

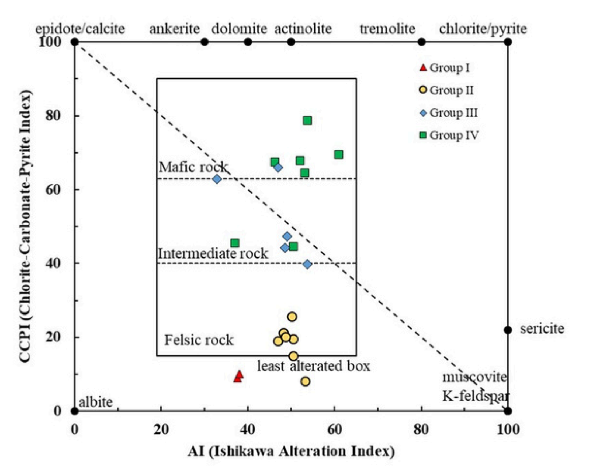

Figure 4: The Alteration Box Plot (Large et al., 2001).

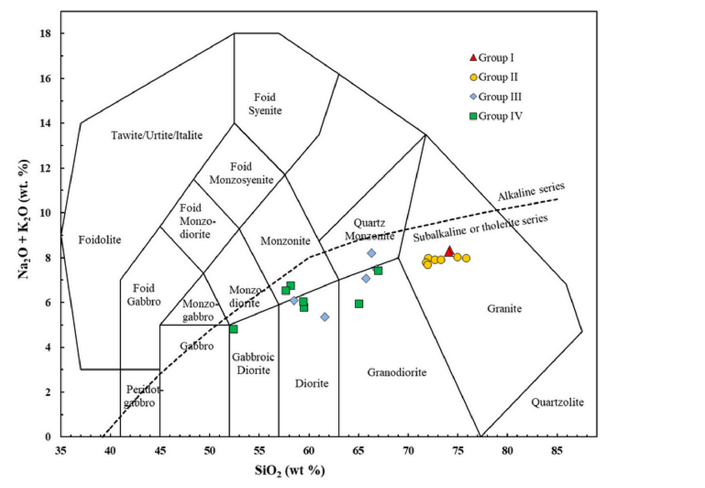

Figure 5: The TAS diagram illustrates rock classification based on chemical composition (Cox et al., 1979).

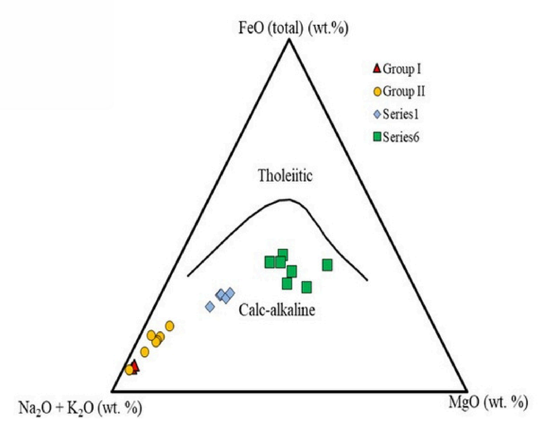

Figure 6: The AFM ternary diagram illustrates the classification of magma series (Irving and Baragar, 1971).

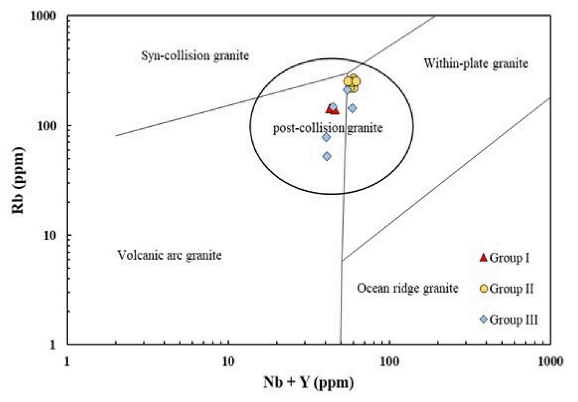

Figure 7: The tectonic setting classification diagram (Pearce et al., 1984).

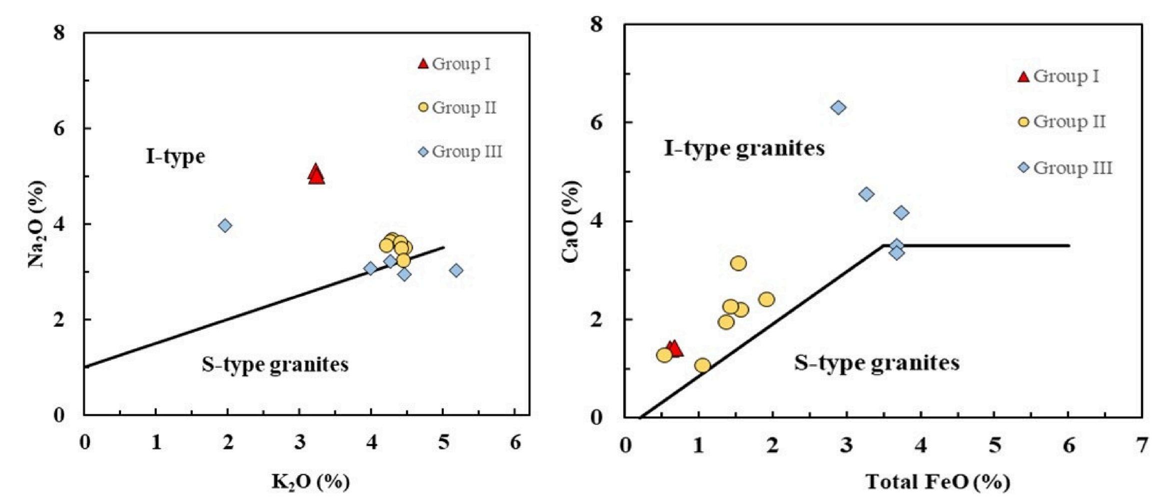

Figure 8: The granite classification diagram (Chappell and White, 1984).

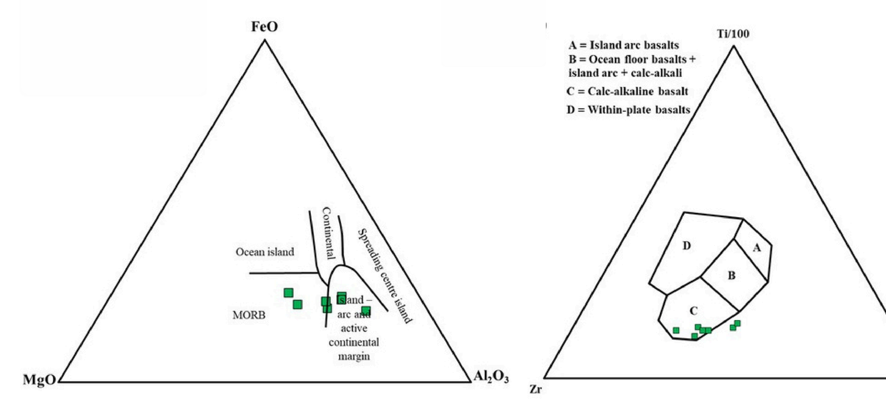

Figure 9: Tectonic setting classification diagram determined Pearce & Cann (1973)

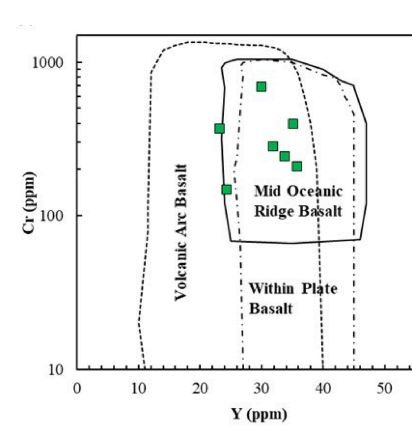

Figure 10: Tectonic setting classification diagram Pearce (1982)

Conclusion

The samples were categorized into six rock types: monzonite, granite, granodiorite, diorite, gabbroic diorite, and quartz monzonite. The classification of rocks based on chemical composition can be divided into four groups as follows: Group I felsic volcanic rocks, Group II felsic intrusive igneous rocks, Group III intermediate igneous rocks, and Group IV mafic igneous rocks. The magma series of the intrusive igneous rocks in Thoen area as belonging to the shoshonite series and calc-alkaline series. Group I, II, and III can be classified as I-type granite and these rocks formed in post collision granite and mid oceanic ridge basalt and Group IV is intermediate to mafic rock that formed in island arc and active continental margin. Geochemical evidence further supports that these intrusive rocks, observed as small outcrops in Thoen District, Lampang Province, are part of the Eastern Granite Belt of Thailand.

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