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Granitic rocks from Pos Selim-Kampung Raja new road: petrochemistry of the Selim granite (a preliminary study)

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Abstract: The Selim granite consists of coarse grained porphyritic biotite granite to medium to fine grained granite. The coarse grained porphyritic biotite granite has higher Fe_2O_3 and Na_2O and has lower FeO compared to the medium to fine grained granite. Both granites overlap in many of the major element contents especially SiO_2. However Ba and Rb increases from the coarse grained porphyritic granite to equigranular medium to fine grained granite. Both granites are controlled by the same mineral assemblage during magma evolution that is K-feldspar, plagioclase and biotite. REE profile show that both granites may represent the evolved part of the Western Belt granite.

Abstrak: Granit Selim boleh dibahagikan kepada dua jenis granit yang berbeza iaitu granit biotit porfiritik berbutir kasar dan granit berbutir halus ke sederhana. Kajian geokimia menunjukkan kedua-dua batuan granit mempunyai kandungan SiO_2 yang bertindih. Granit biotit porfiritik berbutir kasar mempunyai Fe_2O_3 dan Na_2O yang lebih tinggi dan kandungan FeO yang lebih rendah berbanding dengan granit berbutir halus ke sederhana.

INTRODUCTION

This paper will study in detail the petrography and geochemistry of the Selim granite, at km 0 to km 3.4 of the new Pos Selim to Kampung Raja highway, Perak. Our preliminary mapping of the granite indicate that the main body of the Selim granite consists of two units, that is, coarse grained porphyritic biotite granite graded into equigranular medium to fine grained biotite granite. The granite is part of the four granitic bodies which has been identified along the new Pos Selim to Kampung Raja highway, Perak (Fig. 1). In this paper we will examine the geochemical difference between the two units of the granite.

FIELD CHARACTERISTICS

The field descriptions mention in this section is based on the field data obtained along the highway. The coarse grained porphyritic biotite granite can be found at km 0 to km 1.0 and km 3.0 to 2.5. The medium to fine grained biotite granite occur in the middle, between km 1.0 to km 2.0. Contacts between both granites are sharp. The latter is intruded by numerous tourmaline and aplite veins and dykes. The coarse grained porphyritic biotite granite has a weak foliation with phenocrystic K-feldspar trending parallel to each other. The medium to fine grained biotite granite varies gradationally from medium grained granite to fine grained granite, both granites characterized by blue quartz. Intensity of both aplite and tourmaline veins and dykes also increase to the centre of the pluton. The rocks are more equigranular and consist of less ferromagnesium minerals compared to the coarse grained porphyritic biotite granite.

PETROGRAPHY

Coarse grained porphyritic biotite granite

The porphyritic Selim granite is characterized by large phenocryts with size ranging from 5 to 8 cm and phenocryst-matrix ratio is about 50:50. Mineralogy of the granite in decreasing abundance is K-feldspar, quartz, plagioclase, biotite, muscovite, apatite, secondary epidote, tourmaline. Large K-feldspar phenocrysts up to 7 cm long are common. The phenocrysts usually consist of microcline microperthite.

Plagioclases range from 0.7 to 4 mm is size and may occur as discrete phenocrysts or as glomeroporphyritic aggregates showing resorbed outlines in the mafic members of the granites. Quartz in the porphyritic granite is mostly anhedral and sometimes occurs as subgrains with the size ranging from 1 to 3 mm. Biotite occur as discrete plates, as ragged shreds in mafic clots and as small flakes associated with granoblastic aggregates of quartz and plagioclase. The pleochroism scheme is typically pale brown to dark brown but the green varieties also occur. Muscovite occurs as texturally secondary flakes usually resulting from alteration of plagioclase and K-feldspar. Tourmaline commonly occurs as interstitial skeletal network, which are most apparent in leucogranitic composition.

Medium to fine grained granite

This medium to fine grained granite is different from coarse grained porphyritic biotite granite by their phenocrysts with the size up to 5 mm and phenocryst-matrix ratio is about 10:90. Mineralogy of the granite is K-feldspar, quartz, plagioclase, biotite, secondary muscovite, apatite, secondary epidote and tourmaline. K-feldspar consists of microcline microperthite, ranging from 0.5 to 2.5 mm in size and from subhedral to anhedral in shape. Plagioclase is less abundance than K-feldspar with the same range in size and shape. Quartz is mostly anhedral with two obvious ranging sizes, less than 1 mm and more than 1 mm. The latter usually form phenocrysts and occasionally contain apatite inclusions. Biotite occurs as small flake associated with granoblastic aggregates of quartz and plagioclase in small percentages (<10%) with secondary muscovite. The pleochroism scheme is typically pale brown to dark brown and occasionally contain zircon and opaque inclusions with pleochroic rim. Tourmaline occurs as an individual mineral which are most apparent as inclusions in K-feldspar.

GEOCHEMISTRY

Sixteen samples (10 coarse grained porphyritic biotite granite and 6 equigranular medium to fine grained biotite granite) from the newly built road across the Selim granite were analysed for major and trace elements (Table 1). All the samples are numbered (in meter) according to their location across the pluton. No outcrop are exposed between km 1.5 (CH 1500) to km 2.5 (CH 3000). The silica content of the Selim granite is between 74.26 to 77.12% SiO_2 for both coarse grained porphyritic biotite granite and equigranular medium to fine grained granite are overlap, 74.26–76.89% SiO_2 and 75.35–77.12% SiO_2 respectively. Harker diagrams for the major and trace element oxides of the Selim granite are shown in Figure 2 and 3 respectively. Generally the equigranular medium to fine grained granite has lower TiO_2, FeO, MgO, K_2O, Ba and Sr and higher Fe_2O_3, Na_2O, Rb and Pb compared to the coarse grained porphyritic biotite granite.

Variation of major (FeO, Fe_2O_3, SiO_2, and Na_2O) and trace (Ba and Zr) elements from the samples collected along the road (km 0 to km 1500) of the pluton is shown in Figure 4. Fe_2O_3 and Na_2O increase whereas FeO, Zr and Ba decrease from the margin to the centre of the pluton. SiO2 generally show no trend from the margin to the centre of the pluton.

Figure 5 show the variation of Ba and Rb across the Slim pluton. The porphyritic granite (CH 350, CH 800, CH 950 and CH 1030) contain less Ba compared to the medium to fine grained biotite granite samples (5 samples: CH 1190, CH 1170, CH 1190, CH 1230, CH 1280). Both elements show a mirror image trend, Ba in the coarse grained porphyritic biotite granite is lower compared to the medium to fine grained biotite granite in contrast to Rb.

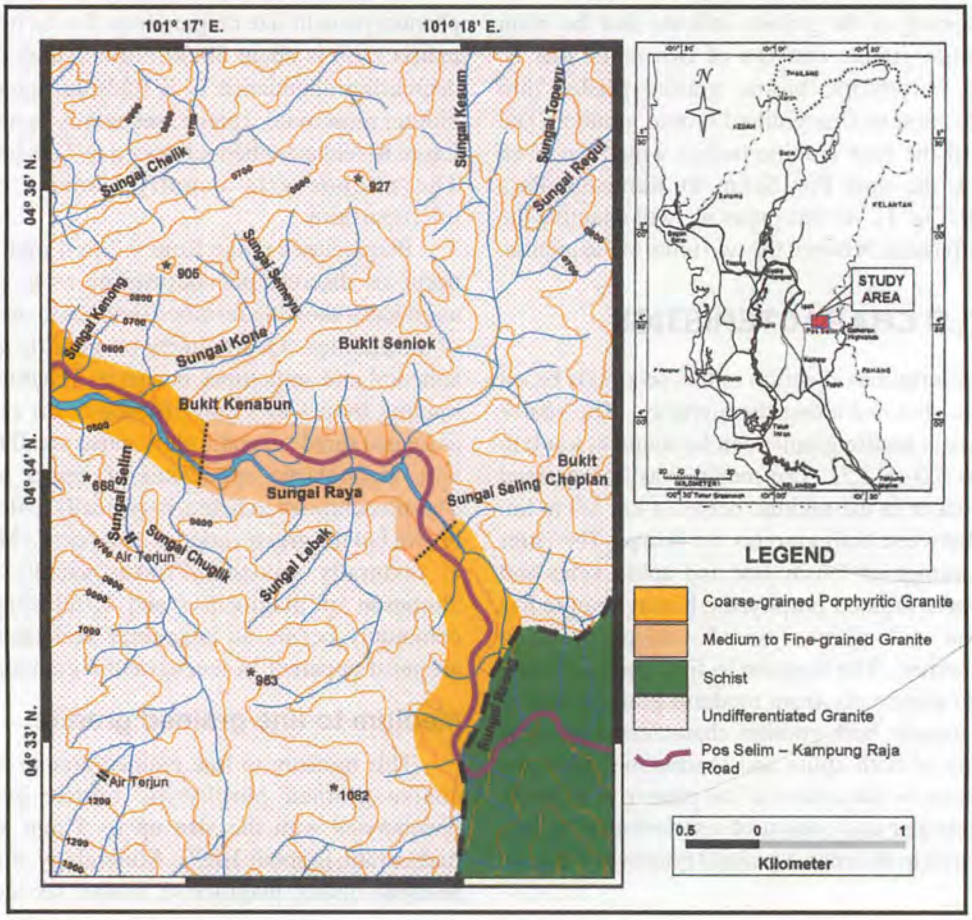

Figure 1. Geology map of the Selim granite along the Pos Selim-Kampung Raja Highway.

Table 1. Geochemical analyses of the Selim granite.

	Outer	Outer	Outer	Outer	Inner	Inner	Inner	Inner	Inner	Inner	Outer	Outer	Outer	Outer	Outer	Outer
Sample No	CH350	CH800	CH950	CH1030	CH1090	CH1170	CH1190	CH1210	CH1230	CH1280	CH3020	CH3040	CH3270	CH3300	CH3340	CH3364
Major element in wt%																
SiO_2	75.61	75.34	76.18	76.15	76.76	75.8	75.37	75.39	77.12	75.94	75.19	74.45	76.89	74.26	75.87	75.92
TiO_2	0.25	0.1	0.1	0.1	0.03	0.06	0.11	0.14	0.1	0.11	0.19	0.2	0.17	0.18	0.16	0.12
Al_2O_3	12.85	12.43	13.04	12.4	13.04	13.04	12.78	12.96	12.53	12.99	13.01	13.49	11.95	13.56	12.68	11.95
Fe(tot)	1.66	1.24	1.18	1.28	0.79	1.12	1.14	1.21	1.04	1.72	1.55	1.68	1.54	1.66	1.61	1.21
MnO	0.03	0.04	0.04	0.04	0.03	0.04	0.04	0.04	0.03	0.04	0.04	0.04	0.02	0.04	0.04	0.03
CaO	0.71	0.36	0.51	0.39	0.33	0.42	0.47	0.23	0.1	0.46	0.38	0.52	0.31	0.55	0.35	1.15
K_2O	6.07	5.3	5.47	5.27	4.74	4.81	5.2	5.42	5.17	5.27	5.79	5.8	5.31	5.32	5.48	5.43
P_2O_5	0.07	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.01	0.12	0.12	0.1	0.12	0.14	0.1
MgO	0.24	0.01	0.03	0.01	0.01	0.01	0.04	0.01	0.01	0.01	0.19	0.15	0.05	0.14	0.11	0.08
Na_2O	2.55	2.94	3.16	2.93	3.71	3.52	3.16	3.28	2.87	3.26	2.93	2.75	2.52	3.02	2.49	2.44
Total	100.04	97.78	99.73	98.59	99.45	98.83	98.32	98.69	98.99	99.81	99.39	99.2	98.86	98.85	98.93	98.43
Trace element in ppm																
Ba	237	59	85	47	38.6	37.4	65.1	67.5	30.1	42.2	192	211	104	165	129	165
Ni	13.6	14.2	13.3	15.6	14.2	14.6	15.4	14.8	10.8	13.2	9.8	14.5	13	14.4	13.2	9
Pb	51	57.5	54.9	56.4	61.6	71.2	64.2	69.5	79.8	59	44.3	47.1	35	33	38.9	37
Rb	478	716	734	718	797	775	746	762	717	741	559	567	549	577	593	542
Sr	66.1	31.8	31.1	28.9	19.7	24.8	27.9	30.9	24.6	25.9	45	50.7	42.7	46.8	40.6	44.7
Th	55	52.5	46.6	49.4	19.2	40.5	44.4	46.7	44.5	40	39.4	43.3	40.1	37.9	39	32.4
V	11.9	9.9	6.8	5.4	8.5	8	7.9	8.4	7.8	7.9	11.8	10.2	6.5	11.7	7.5	9
Zr	146	107	96.8	105	53.2	89.3	99.4	101	103	96.5	113	128.4	107	112	107	95.1
Zn	27.9	29.2	30.2	29.7	21.9	54.6	30.9	37.4	42.5	27.9	29.8	30.9	16.4	28	26.4	20.8
Cu	5.7	3.5	4.8	4.4	2.9	9.1	4.9	4.5	6.7	5	4.9	3.95	3.7	4.9	4.4	3.5
Cr	191	199	149	210	194	211	155	205	166	179	184	216	177	184	204	173
Sc	6.3	5.4	6.3	5.6	5.9	4.6	5.1	6.3	5.8	5.4	6.9	5.15	4.8	5.7	3.9	4.5

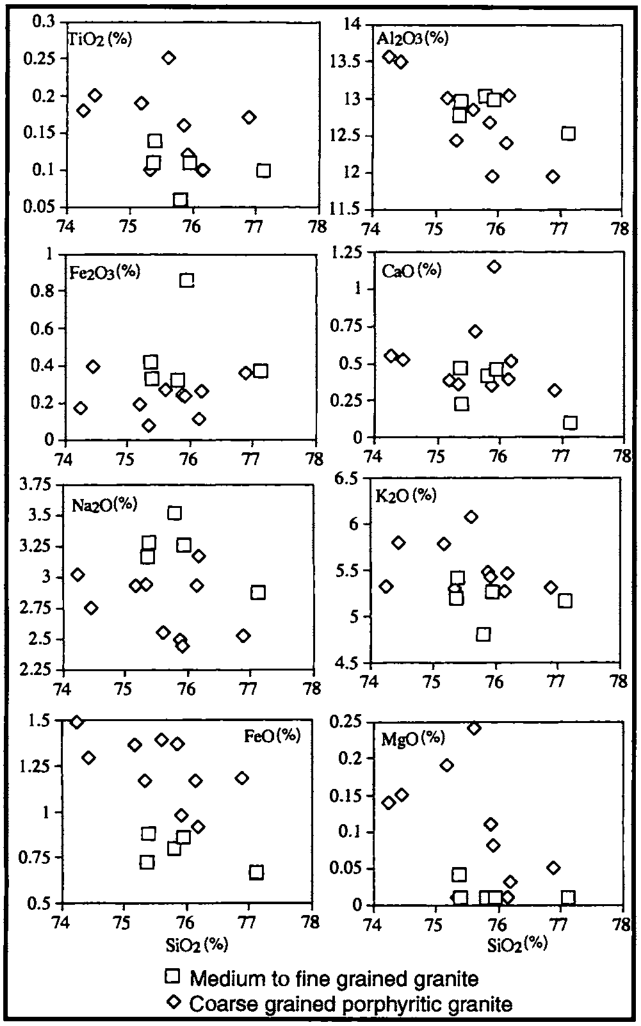

Figure 2. Harker diagrams for the major and trace element oxides for the Selim granite.

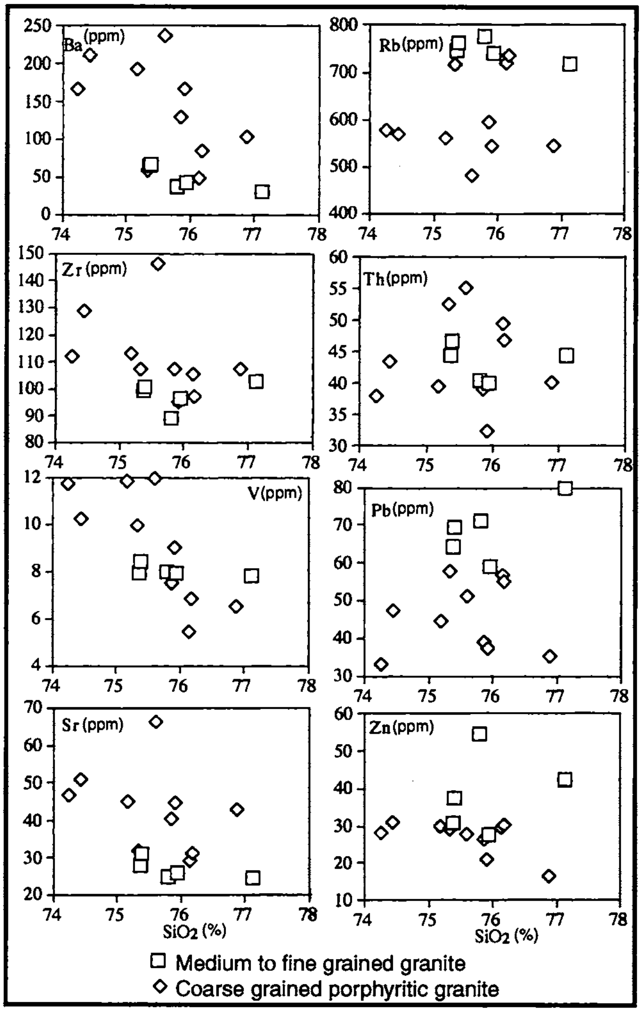

Figure 3. Harker diagrams for the trace element oxides for the Selim granite.

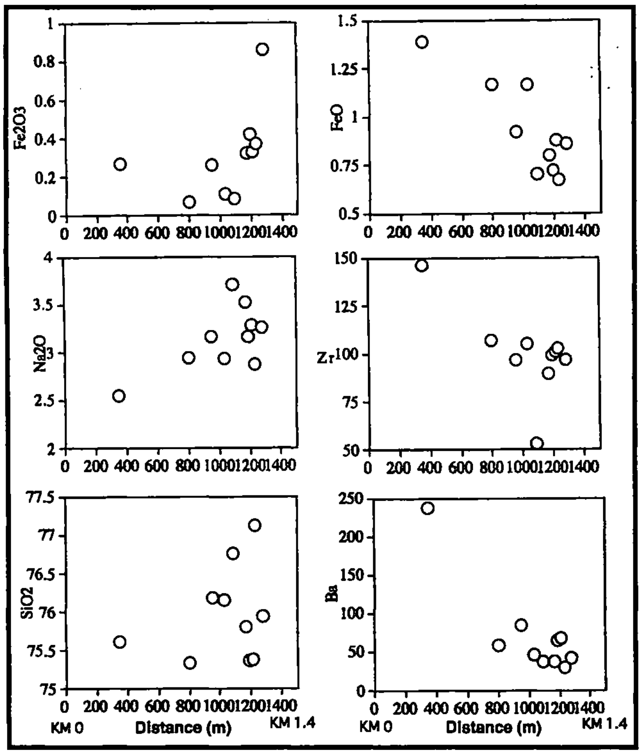

Figure 4. Plot of major (FeO, Fe_2O_3, SiO_2, and Na_2O; in %) and trace (Ba and Zr; in ppm) elements from the margin (km 0) to the centre (km 1500) of the Selim granite.

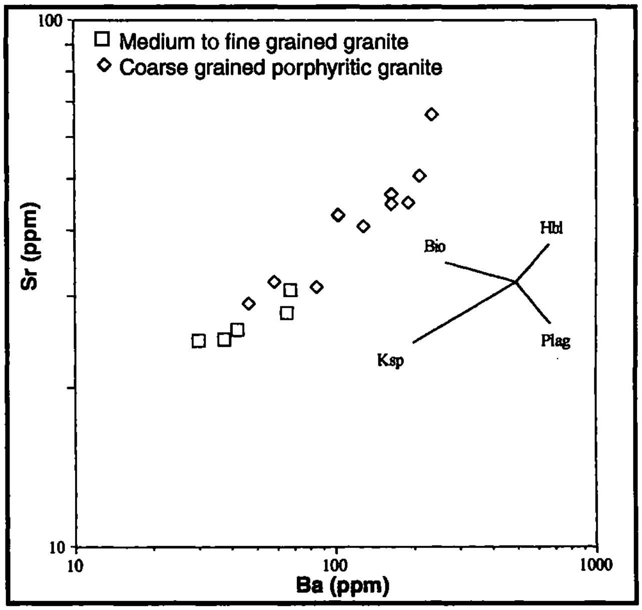

Figure 7. Ba vs Sr log plot for the Selim granite. Note that both granites (porphyritic and fine to medium grained granite) controlled by the same mineral assemblage during the magmatic evolution.

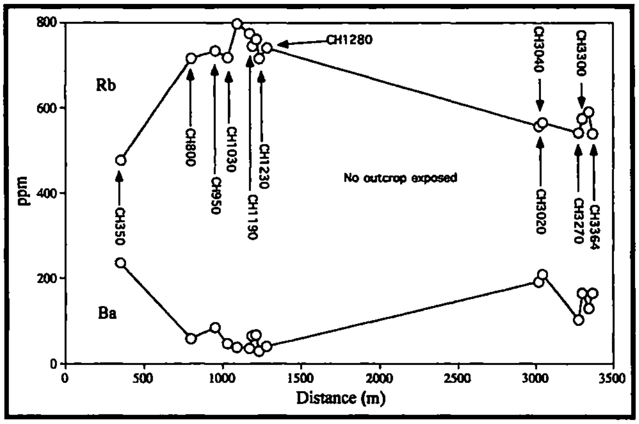

Figure 5. Geochemical variation of Ba and Rb (in ppm) across the Slim granite (km 0 to km 3500).

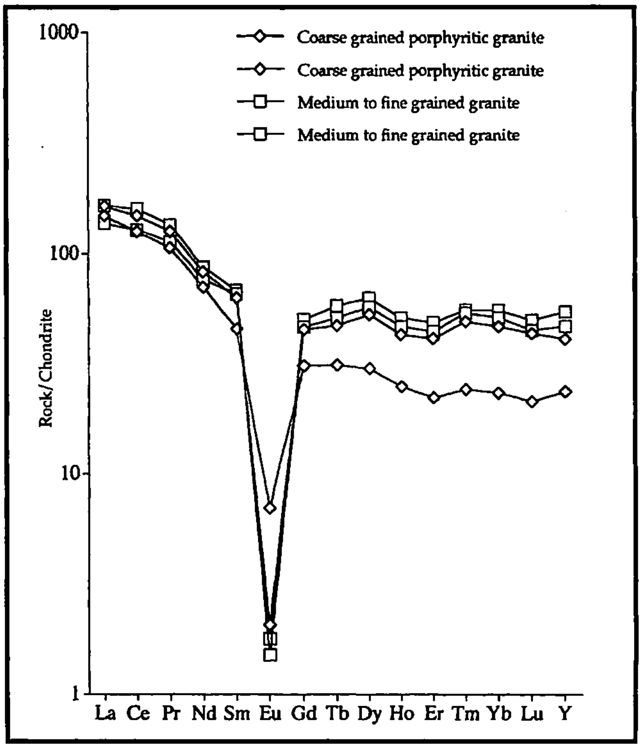

Figure 8. REE profile of the granite from the Selim granite.

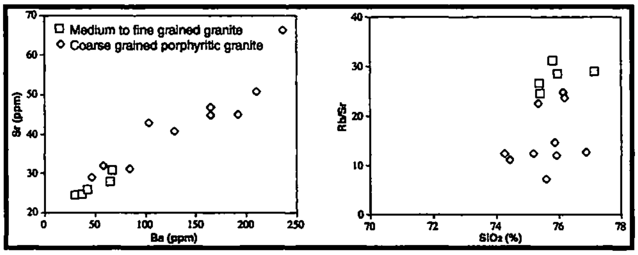

Figure 6. (a) Ba vs Sr diagram (b) Rb/Sr vs SiO_2 diagram for the Selim granite.

The decrease of Ba concomitant with Sr as illustrated in Figure 6a suggests that K-feldspar, biotite and plagioclase are being removed in differentiation sequence for both coarse grained porphyritic granite and equigranular medium to fine grained granite. Rb/Sr ratio (Fig. 6b) for the equigranular medium to fine grained granite (inner unit) is higher than coarse grained porphyritic granite (outer unit). This suggests that the inner unit is more evolved compared to the outer units.

The importance of K-feldspar, biotite and plagioclase in the differentiation is consistent with large ion lithophile (LIL) modelling. Inter-element LIL variation diagram for pairs Ba-Sr is shown in Figure 7. Also shown in each of the diagram is the vector diagram representing the net change in composition of the liquid after 30% Rayleigh fractionation by removing K-feldspar, hornblende, plagioclase or biotite. The trends are consistent with fractionation of plagioclase, K-feldspar and biotite. Thus the LIL log-log plot suggests that crystal fractionation plays an important role in the magmatic evolution of the Selim granite magma (cf Azman 2000, 2001).

Four samples from the Selim granite were analysed for REEs (Fig. 8). All samples are enriched in HREE and depleted in LREE. The typical 'seagull' shape profile shown by all the samples from the Selim granite is similar to REE profiles of other highly evolved granites (e.g. Ludington 1981; Whalen 1983). The large Eu anomaly (indicating plagioclase fractionation) shown by all the samples is similar to REE profiles of highly evolved granites and pegmatites elsewhere (e.g. Ludington 1981; Whalen 1983).

CONCLUSIONS

1. The Selim granite consists of two components that is Coarse grained porphyritic granite and medium to fine grained biotite granite. The pluton possibly zoned from outer coarse grained porphyritic biotite granite to inner medium to fine grained biotite granite.
2. Both granites overlap in many of the major element contents especially SiO_2. However Ba and Rb increases from the coarse grained porphyritic granite to equigranular medium to fine grained granite.
3. Both granites are controlled by the same mineral assemblage during magma evolution that is K-feldspar, plagioclase and biotite.

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