The Genesis of the Alkaline Rock Series of the Benom Complex, Central Belt of the Peninsular Malaysia

Mohd Rozi Umor[1*], Azman Abdul Ghani[2] and Hamzah Mohamad[1]

1. Geology Programme, School of Environmental and Earth Resources, Faculty of Science and Technology, National University of Malaysia, 43600 Bangi, Selangor, Malaysia, Tel: 603-89213156, Fax: 603-89215490
2. Geology Department, Faculty of Science, University of Malaya, 50603 Kuala Lumpur, Malaysia

* Corresponding author e-mail: umor@ukm.my

Abstract

The Genesis of the Benom Complex is important to reveal because of their history will give the whole view about the evolution of the Central Belt of the Peninsular Malaysia. In our study, we focused on the alkaline rock series of the Benom Complex. It is allocate as elongated body by the trend north-south at the western hill of Mount Benom. This series consists of gabbro, pyroxenite, diorite, syenite, and monzonite with the lesser amount of dolerite dykes and mafic microgranular enclaves. It was predominantly high-K, shoshonitic series with I-type characteristics. It was meta-luminous and classified as the magnesium pluton. They have very high total alkaline and LIL elements, i.e. Ba and Sr. Based on geochemical studied, we postulated that the genesis of the alkaline rock series in the Benom Complex can be explained by the model of the slab breakoff.

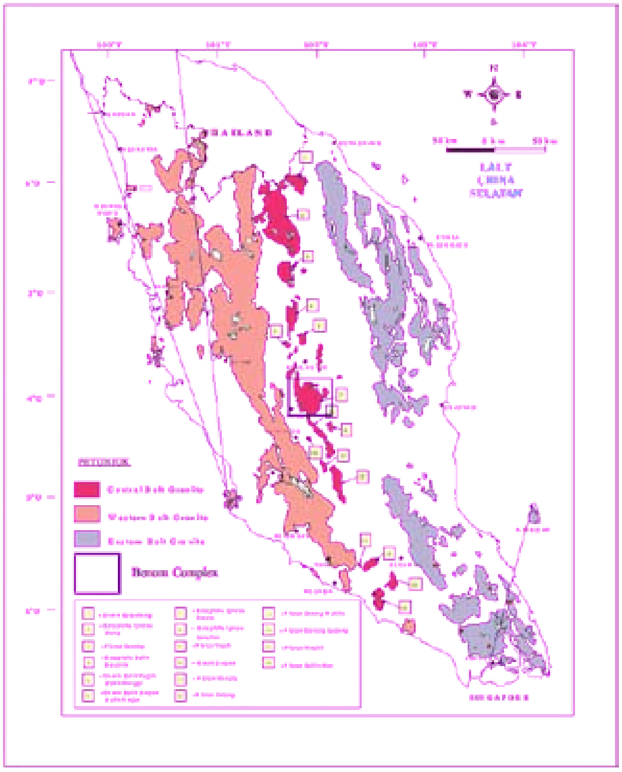
Keywords: Benom Complex, Central Belt Granite, Slab breakoff, Petrogenesis

1. Introduction

The Peninsular Malaysia was divided into three fold belts which were named as the Western Belt, the Central Belt and the Eastern Belt. The Central Belts form a long, narrow, isolated and well defined chain of plutons. It consists of 15 plutons from north to south (Fig. 1). Among these plutons the large and most well studied were the Benom Complex and the Stong Complex.
The Benom Complex consists of two rock series, the alkaline and the calc-alkaline rock series. In this paper, we will discuss specifically on the alkaline rock series from the Benom Complex about the distinct geochemical signature that guide us to suggest the genesis and tectonic development of the complex.

2. The Alkaline Rock Series of Benom Complex

The alkaline rock series is very interesting to study their origin and genesis. It is allocate as elongated body by the trend north-south at the western hill of Mount Benom. This series consists of fine to medium-grain gabbro and some place it turn into pyroxenite by increasing the mineral of pyroxene, strongly foliated K-feldspar diorite, strongly foliated megacrystic of K-feldspar of syenite, and megacrysts K-feldspar monzonite with the lesser amount of dolerite dykes and mafic microgranular enclaves (Fig. 2).



Figrue 1. The distribution of igneous plutons in the Central Belt of the Peninsular Malaysia.

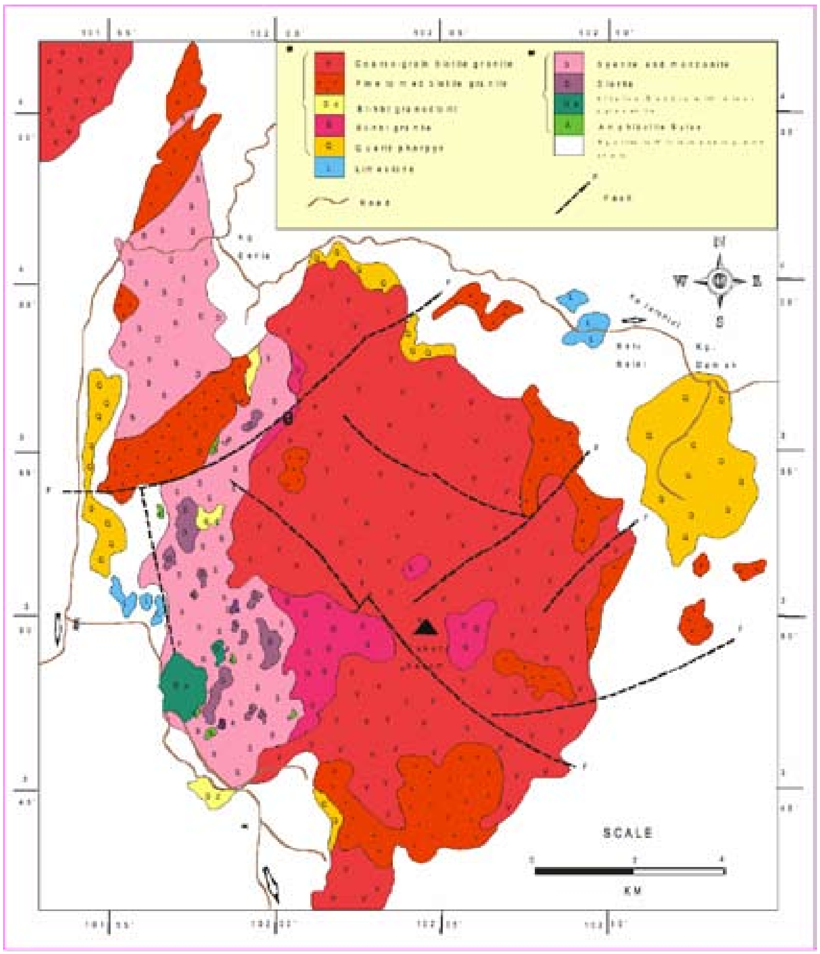


Figure 2. The distribution of rock type in the Benom Complex.

3. Geochemical Characteristics

The alkaline series are predominantly high-K, shoshonitic series with I-type characteristics. It was metaluminous and classified as the magnesium pluton. They have very high total alkali (5.3 to 8.32 ppm) and LIL elements, i.e. Ba and Sr (Table 1).

The Barium contain in gabbro from 2496 to 8002 ppm with the mean 3868 ppm, pyroxenite from 3690 to 6469 ppm with the mean 5374 ppm, diorite from 1810 to 4744 ppm with the mean 3109 ppm, syenite from 1949 to 7433 ppm with the mean 4332 ppm and monzonite from 2534 to 5843 ppm with the mean 3712 ppm.

Whilst the contain of Strontium for gabbro from 552 to 955 ppm with the mean 687 ppm, pyroxenite from 451 to 1228 ppm with mean 1016, diorite from 498 to 1342 ppm with the mean 812.82, syenite from 593 to 1643 ppm with the mean 988.76 and monzonite from 578 to 1107 ppm with the mean 850.86 ppm (Table 1).

4. Discussion

The Harker Diagram show the negative correlation for TiO2, MgO, CaO, Fe2O3 and MnO, whilst Na2O and K2O show the positive correlation with increasing SiO2. The correlation for Al2O3 is almost constant (Fig. 3). The overlapping value of SiO2 between diorite, syenite and monzonite is very clear and reflecting that magma mixing mechanism is important in their genesis.

The patterns of the multi-elements spider diagram show the depletion in Nb, La, P, Ti and Yb in all type of rocks. The positive anomalies show by Ba, Th, K, Pb, Nd and Y. Slightly different observed in pyroxenite and gabbro that have strong positive anomaly in Eu (Fig. 4). The pattern in these rocks almost similar to the Topsoil Suite (Whalen et al., 1996), Silurian plutonic suite (Whalen et al., 2006) and Dabie Orogenic Complex, Central China (Chen et al., 2002).

Table 1 : The geochemical data of the alkaline rock series from Benom Complex

Rock Type	Pyroxenite 11 Samples		Gabbro 34 samples		Diorite 25 samples		Syenite 45 samples		Monzonite 20 samples	
Major elements (wt%)	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
SiO_2	42.4-54.34	47.78	43.14-53.82	47.43	47.28-60.66	54.3	52.11-63.65	56.79	50.95-64.67	58.03
TiO_2	0.82-2.16	1.44	0.87-2.3	1.43	0.63-1.26	0.98	0.4-1.12	0.92	0.58-1.18	0.86
Al_2O_3	7.51-20.11	12.56	8.9-18.63	14.56	14.76-20.18	16.61	12.16-18.34	15.39	13.7-20.59	17.01
Fe_2O_3	6.08-17.0	9.18	7.19-15.48	9.76	4.2-8.89	6.82	4.29-8.88	6.58	3.28-11.8	5.65
MnO	0.09-0.16	0.12	0.11-0.19	0.15	0.09-0.24	0.13	0.04-0.14	0.11	0.05-0.14	0.09
MgO	3.56-18.80	10.35	5.01-12.49	8.58	2.45-8.09	5.19	1.45-7.37	4.43	1.79-8.28	3.87
CaO	4.94-14.64	10.31	5.91-12.62	9.71	2.69-9.23	6.1	2.48-9.22	5.66	2.69-7.48	4.87
Na_2O	0.18-2.88	1.33	0.25-2.76	1.63	1.35-3.23	2.33	0.81-3.15	2.36	2.04-4.9	2.85
K_2O	2.59-6.25	4.22	2.52-6.09	3.67	2.45-6.56	4.67	3.25-8.76	5.96	3.92-5.95	5.33
P_2O_5	0.07-2.26	0.85	0.01-1.37	0.85	0.32-0.82	0.56	0.39-1.22	0.62	0.27-0.79	0.49
Trace (ppm)										
Rb	41-92	66	45-110	67	67-189	109.82	66-189	112.53	74-190	133.64
Ba	3690-6469	5374	2496-8002	3868	1810-4744	3109	1949-7433	4332	2534-5843	3712
Sr	451-1228	1016	552-955	687	498-1342	812.82	593-1643	988.76	578-1107	850.86
Co	13-27	18.2	22-56	26.69	19-62	33	13455.00	23.1	18-38	27.8
Cr	42-199	127	50-333	185.81	33-252	124.21	14-176	97.95	11-164	91.84
Ga	11.5-20	17.5	14-22	18.81	14-20	17.56	13455	17.52	14-28	20.66
Cu	17-83	44.33	19.0-84.0	55.31	20-83	38.99	18-77	35.27	11.0-35.0	17.47
Hf	8.0 - 13.0	8	8.0-13.0	8.23	8.0-19.0	10.5	8.0-19.0	11.1	8.0-13.0	10.8
La	23-45	34.83	24-128	44.25	27-134	61.75	33-155	75.45	38-139	82.27
Nb	10.0 - 23.0	16.33	12.0-33.0	18.88	12.0-33.0	21.38	12.0-33.0	22.64	8.0-29.0	19.19
Ni	27-108	84.83	41-138	78.06	49-137	82.22	35-128	76.26	23-119	53.94
Pb	27-79	56.5	20-99	46.73	47-139	79.82	31-157	80.96	24-103	74.14
Ce	402-878	608	182-843	388	214-469	315	142-678	420	210-568	334
As	8.0 - 13.0	7.4	3.0-17.0	7.23	8.0-28.0	12.11	4.0-23.0	14.18	8.0-12.0	8.62
U	NA	NA	6.0-8.0	7.33	4.0-19.0	8.36	4.0-11.0	9.58	8.0-19.0	11.29
Th	38-88	53.48	4-102	34.25	2-133	59.73	16-93	49.15	26-113	65.69
V	136-216	187.17	138-372	256.63	120-199	145.72	96-195	142.69	87-145	118.41
Y	40-68	49.67	17.0-82.0	47.79	22-77	44.36	27-96	53.35	15-49	37.86
Zn	47-103	75.5	57-86	74	41-80	65.9	57-102	75.49	50-98	71.89
Zr	133-363	225	125-422	246.07	212-530	311.45	156-509	359.47	297-600	386.36
A/CNK	0.30 – 1.07 (0.50)		0.33 – 1.04 (0.61)		0.62 – 1.06 (0.84)		0.51 – 1.01(0.75)		0.66 – 1.10 (0.88)	
K_2O+Na_2O		5.55		5.3		7		8.32		8.18
K_2O/Na_2O		3.17		2.25		2.00		2.53		1.87

Using tectonic classification diagram by Pearce et al. (1984) show the alkaline rock series lies in the within plate granite (WPG) and can be classified as the post collision granite when they were plot using R1-R2 classification of Batchelor and Bowden (1985).

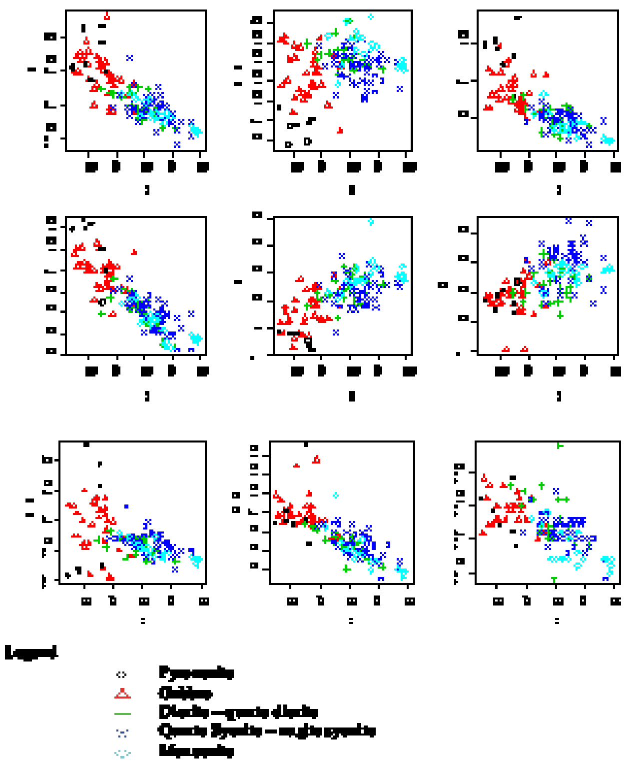


Figure 3. The Harker Diagram for the alkaline rock series of Benom Complex

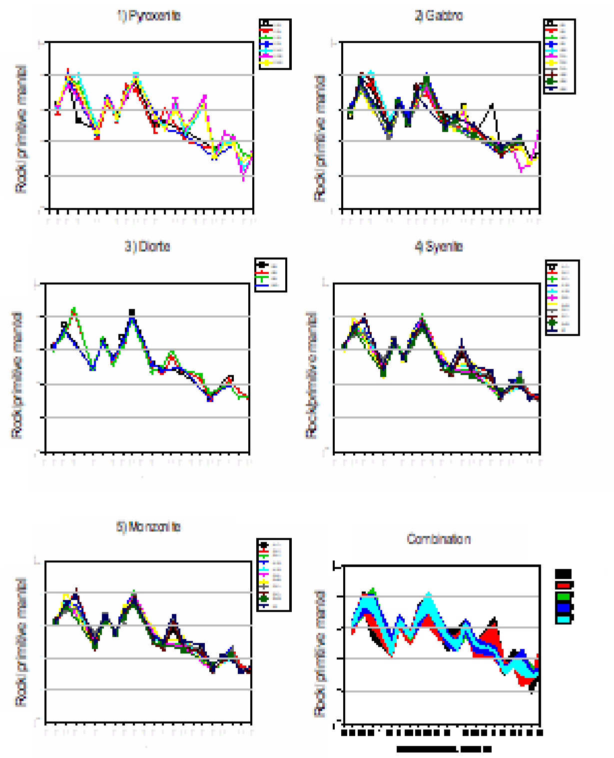


Figure 4. The Spider diagram pattern for each rock types in the Benom Complex. Normalized values from Sun & McDonough (1989).

5. Conclusion

The genesis of the alkaline rock series in the Benom Complex can be explained by the model of the slab breakoff which is the natural consequence of the attempted subduction of the continental crust is invoked to account for the injection of enrichment mantel lithospheric magma and intrusion upward as the mantle plume type magmatism

6. Acknowledgement

The authors are grateful to National University of Malaysia and University of Malaya for the financial support through short term grant (F0261/2007B: The Benom Complex, Pahang state; the assessment study of their origin).

References

Chen, B., Jahn, M., Wei, C. 2002. Petrogenesis of Mesozoic granitoid in the Dabie UHP Complex, Central China: Trace element and Nd-Sr isotope. Lithos 60, 67-88.

Pearce, J.A., Harris, N.B.W., Tindle, A.G., 1984. Trace element discrimination diagrams for the tectonic interpretation of granitic rocks. J. Petrol, 25, 956-983.

Sun, S.S., McDonough, W.E., 1989. Chemical and isotope systematic of oceanic basalt: Implications for mantle composition and processes. In: saunders, A.D., Norry, M.J. (Eds.), Magmatism in the Oceanic Basins. Geol. Soc. Spec. Publ. 42, pp. 313-345.

Whalen, J.B., Jenner, G.A., Longstaffe, F.J., Gariepy, C., 1996. Geochemical and isotop (O, Nd, Pb and Sr) constraints on A-type granite petrogenesis based on the Topsails igneous suite, New Foundland Appalachians. 37, 1463-1489.

Whalen, J.B., McNicoll, V.J., Staal, C.R., Lissenberg, C.J., Longstaffe, F.J., Jenner, G.A. and Breeman, O. 2006. Spatial, temporal and geochemical characteristics of Silurian collision-zone magmatism, Newfounland Appalachians: An example of a rapidly evolving magmatic system related to slab break-off. Lithos, 89, 377-404.