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Geochemistry and Petrogenesis of Siwana Peralkaline Granites, West of Barmer, Rajasthan, India

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Abstract

The bimodal Malani suite, West of Barmer, Rajasthan is characterized by discontinuous, ring shaped outcrops of Siwana peralkaline granite with minor outcrops of basalt. The peralkaline, within- plate and A-type nature of granite are evident by its chemical characteristics. The granite is characterized by high Na_2O+K_2O, Fe/Mg, Zr, Nb, Y, Zn ; low Al_2O_3, CaO and Sr and is significantly low in absolute abundance of trace and REE elements compared to type area Siwana granite. The granite is correlated to the "Pan-African" event and its petrogenesis and tectonic significance are discussed.

Key words: Geochemistry, bimodal suite, Malani igneous suite, Siwana granite, petrogenesis.

Introduction

Eversince the discovery of mineralization in petrologically diverse group of peralkaline, anorogenic, high level plutons and their cogenetic volcanics of extensional regime, there is a renewed interest in these rocks which led to the identification of several of these during last few years. The Malani Igneous Suite (MIS) in Barmer district of Southwestern Rajasthan is characterized by widespread isolated occurrences of peralkaline rocks in Barmer district. The main exposures are around Siwana, Mungeria, Bisala, Chauthan and Taratra town. Among these occurrences the Siwana complex had been extensively studied (Murthy, 1962; Kochhar, 1984; Bhushan and Mohanty, 1988; Eby and Kochhar, 1990; Dhar et al., 1996, Vallinayagam and Kochhar, 1998; Maheshwari and Sial, 1999 and Bhushan and Chittora, 1999), whereas the MIS exposed in other areas has not been studied in detail. Nevertheless limited information is available in the literature related to these occurrences (Venkatraman and Murthy, 1968; Chawade, 1989 and Bhushan, 1995). The purpose of this paper to provide geochemical characteristics of granitic plutons exposed in the vicinity of Barmer around Mungeria, Taratra, Chauthan and other towns.

Geological Setting

The western side of Barmer town is characterized by the presence of denudational and aeolian landforms. The area is represented by widespread isolated occurrences of granite with minor occurrences of rhyolitic rocks. These granitic occurrences are often separated by vast areas of sand cover and sand dunes. The geological map (Fig. 1) of the investigated area shows presence of granitic plutons at many places. The margins of various granitic bodies shown in the map are generally inferred as exposures which are often discontinuous with intervening sand cover.

Besides the prominent occurrences near Chauthan, Taratra, Jasai, Mungeria and Redana (25°50'45":

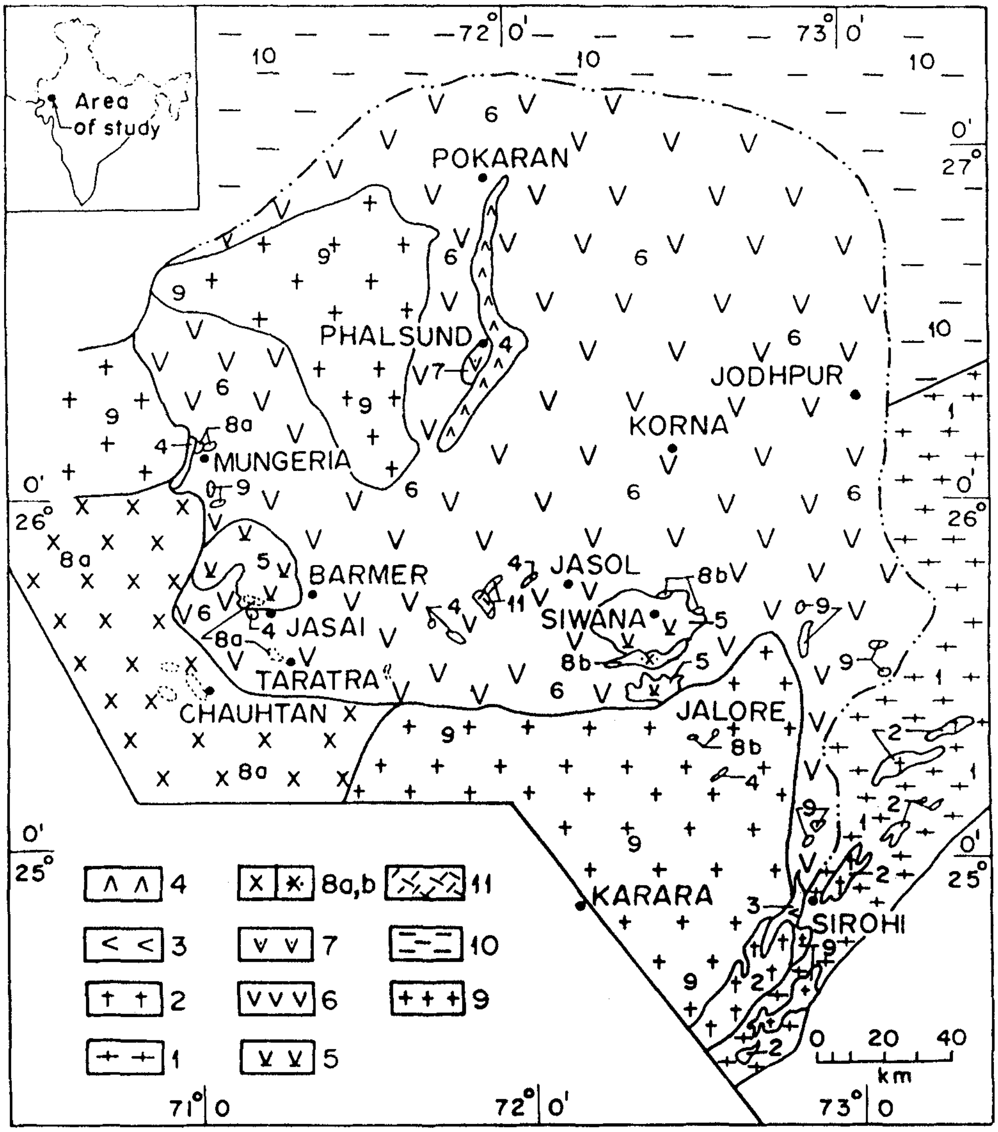

Fig. 1. Geological sketch map of western Rajasthan (modified after Bhushan, 1995). 1-Erinpura granite; 2-Abu granite; 3-Sindreth volcanics; 4-Basalt; 5-Peralkaline rhyolite; 6-Peraluminous rhyolite; 7-Rhyolite tuff; 8-Siwana granite (a) Barmer (b) Siwana; 9-Jalore granite; 10-Cover sediments; 11-Tertiary alkaline granite.

70°56'30") areas, smaller bodies of granite are also exposed around Ranigaon (25°50'45":70°58'45"), Balera (25°55'48": 70°54'00"), Ati (25°52'45":70°58'15") and Baisala (25°52'48": 70°58'30") town. It may be inferred from the regional outcrop map that the granite bodies of Chauthan, Redana and Mungeria form a part of crescent shaped discontinuous outer ring of hills, while the granites of Taratra, Balera and Jasai form another discontinuous inner ring close to Barmer town. The granitic bodies show considerable variation in their color and texture. The marginal part of the bodies are fine grained and sometimes porphyritic compared to central part which is generally coarse grained and shows typical granitic texture.

The rhyolitic rocks are generally siliceous and are interstratified with tuffs, representing the explosive phases of eruption. The granitic rocks cut the rhyolitic flows and a number of rhyolite porphyry dykes also cut these rhyolitic flows. The rhyolites are dominantly of commenditic and pantelleritic type (Bhushan, 1995). Crawford and Compston (1970) suggested an age of 745±10 Ma for rhyolite from Barmer. Dhar et al. (1996) reported 723±6 Ma as the pooled Rb-Sr age of the Siwana granitoid. Rathore et al. (1999) suggested an age of 700 Ma for the peralkaline Siwana granite.

Besides these rhyolite and granite, the area is also characterized by the presence of small outcrops of basalt mainly around Taratra and Jaṣai. The exposures are generally observed at ground levels and are in general never found in association with volcanics and granites except at few places. Field studies indicate that basalt is overlain by commenditic and pantelleritic flows. The preponderance of silicic flows over the basic volcanics indicates bimodal nature of MIS rocks exposed to the west of Barmer town. The investigated area is characterized by the presence of a number of dykes of felsic and mafic composition. Plug like bodies of gabbro and anorthosite have also been recorded. The relationship of these rocks with granite is not clear.

Petrography and Mineral Chemistry

The peralkaline granites show considerable variation in grain size and modal contents of ferromagnesian minerals. These are one-feldspar granites containing essentially microperthitic orthoclase with varying degrees of exsolution. Other minerals are quartz, alkali pyroxene and /or alkali amphibole and accessories like zircon, sphene, rutile, magnetite. These granites are hypersolvus type (Tuttle and Bowen, 1958), where plagioclase occurs as perthitic intergrowth. Presence of minor amount of microcline and plagioclase has also been noticed in few samples. Quartz grains occasionally contain inclusions of zircon and aegirine needles. Aegirine and aegirine-augite constitute the main mafic minerals. The aegirine-augite appears to be an earlier phase and occurs as idiomorphic crystals and at places, are rimmed by riebeckite. Riebeckite is frequently observed in peralkaline granites and appears to have formed before or alongwith feldspar crystallization.

The silicic volcanics of the area are generally aphyric to sparsely phyric. The phenocrysts are mainly of quartz and alkali feldspar, with minor amounts of aegirine and riebeckite phenocrysts. Quartz is generally corroded and embayed in nature. Feldspar of orthoclase composition generally occurs as an altered, euhedral to subhedral crystal and is occasionally fractured.

Selected samples of granite from different parts of the study area (i.e. West of Barmer), have been analysed for major and incompatible trace elements. The major and trace element analyses were carried out on XRF using a Phillips PW-1400 Spectrometer on powder pellets (after methods of Franzini et al., 1975; Leoni and Saitta, 1987) at Istituto di Mineralogia, Universita di Ferrara, Italy. Data precision, accuracy of method and international standards utilized are listed in the above mentioned papers. The REE analysis was carried out on ICP at Lakefield Geosol Ltd., Brazil. The microprobe analyses were carried out using CAMECA SX50 machine, with a beam current of 20 microA and an acceleration potential of 15 KV. Counting time was 5 seconds and routine corrections were done using ZAF program.

Microprobe analyses of alkali feldspar, aegirine and riebeckite of the peralkaline granites are provided in Table 1. The microprobe analysis of alkali feldspar identifies it

Table 1. Electron probe micro analysis of the minerals of Barmer peralkaline granites.

Feldspar								
Sample No.	MUG2	MUG2	MUG2	MUG2	CG5	CG5	CG5	CG5
SiO_2	65.68	65.34	69.31	68.44	65.28	67.4	64.65	66.21
TiO_2	0	0	0	0	0	0	0	0
Al_2O_3	18.41	18.37	18.69	19.17	18.38	18.54	18.23	17.93
FeO	0.18	0.193	0.896	0.216	0.369	1.358	0.045	0.047
MnO	0	0	0	0	0.032	0	0	0
CaO	0	0	0	0	0.005	0.076	0	0.003
MgO	0.001	0.007	0	0	0.009	0.016	0.001	
Na_2O	0.256	0.265	11.65	9.79	0.205	9.038	0.673	0.293
K_2O	16.13	15.98	0.15	3.04	16.455	3.314	15.57	15.836
Total	100.67	100.16	100.7	100.66	100.74	99.75	99.2	100.33
Si	12.03	12.03	12.06	12	11.98	12	12.02	12.13
Ti	0	0	0	0	0	0	0	0
Al	3.97	3.98	3.83	3.96	3.98	3.89	3.99	3.87
Fe^{2+}	0.029	0.03	0.13	0.032	0.057	0.2	0.243	0.007
Mn	0	0	0	0	0.005	0	0	0
Mg	0	0.002	0	0	0.001	0.02	0	0.001
Ca	0	0	0	0	0.002	0.003	0	0
Na	0.091	0.095	3.933	3.33	0.073	3.12	0.243	0.104
K	3.772	3.754	0.034	0.679	3.858	0.75	3.692	3.703
Scat	19.9	19.89	19.99	20.016	19.97	19.99	19.95	19.83
mg	0.949	6.07	0	0	2.35	9.07	0	10.21
OxNum	32	32	32	32	32	32	32	32

MUG2-Mungeria; CG5-Chauthan.

Table 1. *Contd.*

	Riebeckite				Aegirine				
Sample No.	CG5	CG5	CG5	CG5	CG5	CG5	MUG2	MUG2	MUG2
SiO_2	48.79	47.982	49.546	49.659	50.963	51.011	51.379	51.241	51.03
TiO_2	1.851	1.933	1.712	2.033	2.735	2.694	0.75	0.717	0.699
Al_2O_3	1.412	1.411	1.153	0.213	0.138	0.161	0.253	0.203	0.247
FeO	29.607	30.392	30.304	31.305	29.07	29.157	29.676	28.873	29.782
MnO	0.708	0.636	0.991	0.802	0.448	0.52	0.243	0.323	0.207
CaO	5.592	5.533	2.834	1.768	3.265	3.471	6.27	6.07	5.366
MgO	3.639	3.667	2.996	2.212	0.251	0.247	0.043	0.008	0.03
Na_2O	5.49	5.643	6.738	7.272	12.638	12.516	9.457	9.425	9.94
K_2O	1.029	1.019	1.484	1.597		0.011	0.004	0.041	0.016
Total	100.143	100.217	99.781	98.893	99.548	99.788	98.149	97.025	97.484
Si	7.689	7.601	7.846	7.969	2.078	2.076	2.827	2.845	2.831
Ti	0.219	0.23	0.204	0.245	0.084	0.082	0.031	0.03	0.029
Al	0.262	0.263	0.215	0.04	0.007	0.008	0.016	0.013	0.016
Fe^{2+}	3.901	4.026	4.013	4.201	0.991	0.992	0.003	0.002	0.003
Mn	0.094	0.085	0.133	0.109	0.015	0.018	0.011	0.015	0.01
Mg	0.855	0.866	0.707	0.529	0.015	0.015	0.004	0.001	0.002
Ca	0.944	0.939	0.481	0.304	0.143	0.151	0.37	0.361	0.319
Na	1.677	1.733	2.069	2.262	0.999	0.988	1.009	1.014	1.069
K	0.207	0.206	0.3	0.327	0	0.001	0	0.003	0.001
Scat	17.954	18.063	18.082	18.13	4.334	4.331	5.637	5.626	5.666
mg	17.971	17.7	14.982	11.186	1.516	1.488	0.258	0.049	0.179
OxNum	24	24	24	24	8	8	8	8	8

MUG2-Mungeria; CG5-Chauthan.

as K-feldspar with minor amount of plagioclase of albitic composition. The pyroxene is aegirine and is enriched in Ti, Fe and Na. Replacement of Si by Al is negligible in the aegirine. The structural formula of aegirine from granite of Mungeria area is (Na 1.009-1.094, Ca 2.82-0.370) (Fe 1.339-1.381, Ti 0.029-0.040, Al 0.013-0.016) (Si 2.825-2.846)O_8. The pyroxenes are ferrian-aegirine as per classification proposed by Morimoto et al. (1988). Chemistry of the alkali amphibole suggests it to be riebeckite, characterized by high Ti, Fe and Na and impoverished in Mg, Ca and K. The structural formula of riebeckite is (Na 5.49-7.27) (Fe 29.60-31.30) (Si 47.98-49.65)O_{24}.

A comparison of mineral chemistry of Siwana peralkaline granites (Vallinayagam and Kochhar, 1998) with the granites under study indicates that the alkali amphiboles in these different occurrences are compositionally similar and have evolved from richterite to riebeckite (magmatic subsolidus trend after Strong and Taylor, 1984) and the pyroxene evolved from hedenbergite to aegirine through aegirine augite (acmite-hedenbergite trend). According to the experimental work of Mukherjee and Roy (1981), the alkali amphibole of peralkaline granite from Siwana has a field of magmatic crystallisation starting from P_{H_2O} between 3 and 3.5 Kb and about 650°C under Ni-NiO buffered oxygen fugacity. An abrupt depressuration of the magma possibly broke down the sodic amphibole into aegirine.

Geochemistry

The major and trace element analyses are given in Table 2. The REE analysis of a granite sample from Mungeria has been compared with average REE contents of granites from Siwana area in Table 3. The granites are peralkaline in nature (Fig. 2) as characterized by presence of acmite in their norms and agpaitic index >1[Mol(K_2O+Na_2O)/Al_2O_3], and Shands Index [Al_2O_3/(CaO+Na_2O+K_2O) vs Al_2O_3/(Na_2O+K_2O)] as proposed by (Maniar and Piccoli, 1989). They are chemically similar to A-type granitoids with high Na_2O + K_2O, Fe/Mg, Zr, Nb, Y, Zn and low Al_2O_3, CaO and Sr. They plot in anorogenic field of Batchelor and Bowden (1985). The study granites plot in the field of within plate granites in Rb v/s Nb+Y tectonic discrimination diagram (Fig. 3, fields after Pearce et al., 1984 and according to Whalen et al., 1987). The granites are classified as anorogenic alkali ring complex type granite using the multivariate discriminant scheme suggested by Agrawal (1995).

An important characteristic feature of the peralkaline granites under study is their enrichment in incompatible trace elements similar to other peralkaline granites (Tauson, 1967). The composition of the Siwana peralkaline granite has been compared with that of the West Barmer granite in Table 2. A perusal of chemical data support the observation of Bhushan (1995) that Siwana granites are distinctly different in their major element chemistry from granites occurring close to Barmer town. The granites under

Table 2. Major and trace element composition of Barmer peralkaline granites.

S.No.	1	2	3	4	5	6	7	8	9	10
Sample No.	MUG2	MUG5	MUG6	MUG7	TG2	TG3	TG4	TG7	CG2	CG3
Major elements (Wt %)										
SiO_2	76.4	76.3	74.8	75.2	76.4	75.1	75.3	77.3	72.2	72.4
TiO_2	0.2	0.2	0.3	0.2	0.3	0.2	0.3	0.3	0.3	0.8
Al_2O_3	11.5	11.3	10.9	11.1	11.0	12.1	11.1	10.6	12.4	11.4
Fe_2O_3	2.4	2.5	3.6	3.2	3.0	3.7	4.1	3.3	4.3	5.5
MnO	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1
MgO	0.0	0.0	0.1	0.1	0.0	0.0	0.1	0.0	0.1	0.1
CaO	0.5	0.3	1.2	0.8	0.3	0.5	0.3	0.2	0.6	0.5
Na_2O	4.4	4.7	4.1	4.2	4.4	8.1	4.6	3.7	5.1	4.8
K_2O	4.5	4.4	4.1	4.3	4.6	0.1	4.0	4.3	4.7	4.4
P_2O_5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LOI	0.2	0.4	1.0	0.9	0.0	0.1	0.1	0.3	0.2	0.1
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Trace elements (ppm)										
Pb	26.0	29.0	10.0	16.0	22.0	42.0	14.0	56.0	27.0	31.0
Zn	105.0	214.0	119.0	208.0	226.0	103.0	196.0	196.0	164.0	123.0
Ni	5.0	5.0	5.0	5.0	5.0	3.0	6.0	9.0	4.0	4.0
Co	1.0	2.0	2.0	2.0	1.0	1.0	3.0	3.0	3.0	2.0
Cr	3.0	4.0	4.0	5.0	4.0	3.0	7.0	16.0	4.0	3.0
V	5.0	2.0	6.0	0.0	5.0	5.0	3.0	6.0	10.0	7.0
Rb	140.0	215.0	105.0	114.0	1.7	1.0	129.0	99.0	99.0	76.0
Sr	34.0	10.0	29.0	23.0	65.0	44.0	55.0	33.0	50.0	28.0
Ba	132.0	27.0	538.0	345.0	237.0	77.0	158.0	158.0	129.0	70.0
Th	17.0	15.0	12.0	17.0	16.0	9.0	16.0	20.0	9.0	11.0
Nb	22.0	10.0	4.0	31.0	8.0	13.0	51.0	39.0	8.0	36.0
Zr	991.0	729.0	1135.0	1328.0	1514.0	880.0	2050.0	2096.0	1095.0	1025.0
Y	156.0	160.0	143.0	168.0	162.0	115.0	178.0	231.0	122.0	100.0
La	92.0	25.0	76.0	73.0	86.0	43.0	93.0	121.0	79.0	59.0
Ce	183.0	67.0	147.0	143.0	158.0	147.0	199.0	222.0	164.0	116.0
Zr/Nb	45.0	72.9	283.8	42.8	189.3	67.7	40.2	53.7	136.9	28.5
Zr/Ce	5.4	10.9	7.7	9.3	9.6	6.0	10.3	9.4	6.7	8.8
Zr/Y	6.4	4.6	7.9	7.9	9.3	7.7	11.5	9.1	9.0	10.3

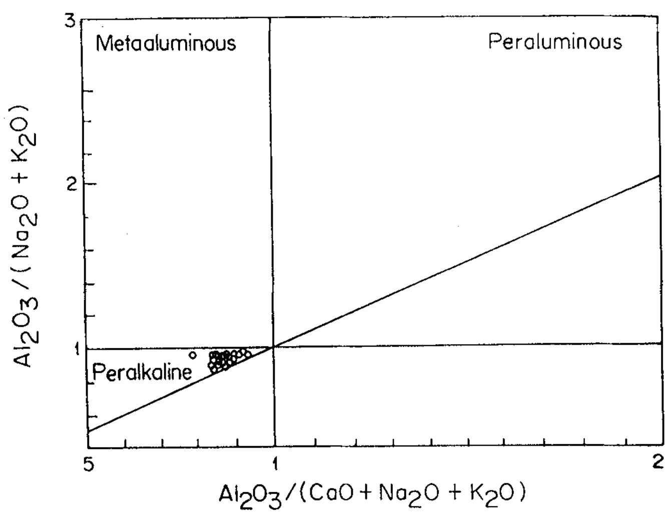

Fig. 2. Shand's Index Plot for the peralkaline granites from Barmer (Maniar and Piccoli, 1989).

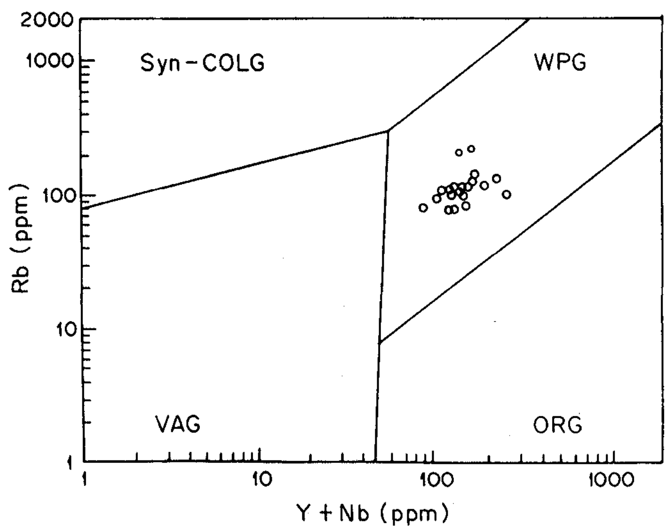

Fig. 3. Rb vs (Nb+Y) tectonic discrimination diagram for peralkaline granite from Barmer town (fields after Pearce et al., 1984).

Table 2. *Contd.*

S.No.	11	12	13	14	15	16	17	18	19	20	21	22	23
Sample No.	CG4	CG5	CG7	CG8	BG1	BG4	BSG1	BSB4	JG1	ATG1	BG	SGK	SGB
Major elements (Wt %)													
SiO_2	74.3	73.1	74.8	73.9	75.9	73.9	77.6	74.4	74.6	72.9	74.84	70.06	69.79
TiO_2	0.3	0.3	0.2	0.4	0.3	0.2	0.1	0.3	0.3	0.2	0.27	0.35	0.57
Al_2O_3	11.5	12.5	11.3	10.5	15.8	11.5	11.6	11.2	12.5	14.4	11.18	10.66	8.87
Fe_2O_3	3.1	3.6	4.1	5.8	4.0	4.4	1.6	4.1	2.9	2.2	3.57	4.78	7.62
MnO	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1		0.07	0.1	0.14
MgO	0.5	0.2	0.0	0.0	0.0	0.0	0.0	0.4	0.1	0.0	0.08	0.25	0.66
CaO	1.4	0.7	0.1	0.2	0.3	0.3	0.4	0.7	0.2	0.3	0.49	0.7	0.29
Na_2O	4.0	4.9	4.8	4.1	4.5	4.4	5.0	4.5	5.3	5.3	4.74	4.82	4.23
K_2O	4.3	4.6	4.6	4.9	4.2	5.2	3.5	4.3	4.0	4.2	4.16	4.42	4.4
P_2O_5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	0.07	0.1
LOI	0.5	0.0	0.2	0.0	0.0	0.1	0.2	0.1	0.1	0.5	0.2	1.26	0.85
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.6	99.95	99.59
Trace elements (ppm)													
Pb	27.0	21.0	37.0	31.0	23.0	18.0	24.0	24.0	27.0	9.0	26	71	n.a.
Zn	93.0	193.0	270.0	182.0	145.0	176.0	246.0	142.0	194.0	60.0	168	400	n.a.
Ni	6.0	5.0	6.0	6.0	5.0	5.0	4.0	5.0	5.0	4.0	5	10	n.a.
Co	4.0	2.0	1.0	2.0	2.0	3.0	1.0	2.0	2.0	1.0	2	1	n.a.
Cr	8.0	4.0	1.0	4.0	7.0	3.0	6.0	5.0	3.0	2.0	5	1	n.a.
V	11.0	10.0	5.0	4.0	13.0	7.0	3.0	10.0	7.0	7.0	6	8	n.a.
Rb	77.0	79.0	177.0	111.0	97.0	122.0	93.0	7.0	111.0	105.0	98	345	n.a.
Sr	39.0	44.0	28.0	29.0	10.0	11.0	30.0	15.0	60.0	51.0	34	20	n.a.
Ba	130.0	124.0	51.0	109.0	133.0	108.0	391.0	28.0	337.0	422.0	185	113	n.a.
Th	1.0	14.0	41.0	14.0	12.0	8.0	9.0	8.0	15.0	11.0	14	37	n.a.
Nb	4.0	36.0	66.0	54.0	12.0	38.0	0.0	28.0	11.0	21.0	25	172	220.4
Zr	396.0	1218.0	1316.0	1301.0	1487.0	1462.0	576.0	1125.0	851.0	781.0	1094	3661	2948
Y	88.0	124.0	234.0	190.0	139.0	135.0	110.0	98.0	139.0	97.0	144	562	1967
La	29.0	72.0	118.0	85.0	86.0	71.0	37.0	89.0	102.0	29.0	73	281	768
Ce	9.0	155.0	237.0	189.0	163.0	150.0	109.0	103.0	138.0	68.0	143	640	1665
Zr/Nb	99.0	33.8	19.9	24.1	123.9	38.5		40.2	77.4	37.2	43.76	21.28	13.37
Zr/Ce	44.0	7.9	5.6	6.9	9.1	9.7	5.3	10.9	6.2	11.5	7.65	5.72	1.77
Zr/Y	4.5	9.8	5.6	6.8	10.7	10.8	5.2	11.5	6.1	8.1	7.59	6.51	1.49

S.No. 1-20 Granite from Barmer town; 21-Av. of 20 Barmer granite; 22-Granite from Siwana (Av. of 7; Eby and Kochhar, 1990); 23-Granite from Siwana area (Av. of 17; Bhushan, 1995).

Table 3. REE analysis of study granite and its comparison with granite from Siwana area.

Sample	M 1	SGK	SGB
La	35	281	230
Ce	89	640	539
Nd	48	340	110
Sm	11	74	64
Eu	0.99	6.83	6.6
Gd	9.45	78	n.d
Tb	0	14	12
Dy	11.73	0	n.d
Ho	2.94	20	n.d
Er	8.14	0	n.d
Yb	7.46	61	38
Lu	1.1	9	5

M1-Study area; SGK-Siwana granite (Av. of 7; Eby and Kochhar, 1990); SGB-Siwana granite (Av. of 16; Bhushan, 1995).

study are characterized by high SiO_2, Al_2O_3 and CaO; low Fe, MgO and TiO_2 and low absolute abundances of incompatible elements like Zr, Nb, Ce and Y and REE as compared to Siwana granites (Table 3).

High values of incompatible trace elements like Zr, Nb, Ce and Y are characteristics of granite under study. The

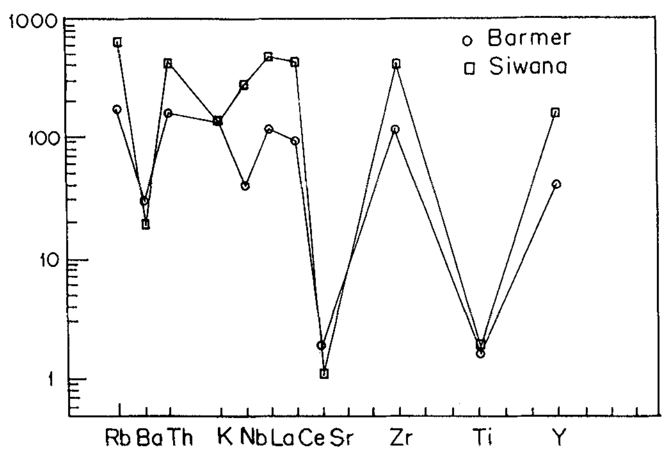

Fig. 4. Primordial mantle-normalized (normalizing factors from Wood et al., 1979) spiderplot for peralkaline granite. Siwana (Eby and Kochhar, 1990); peralkaline granite (Av.) from Barmer.

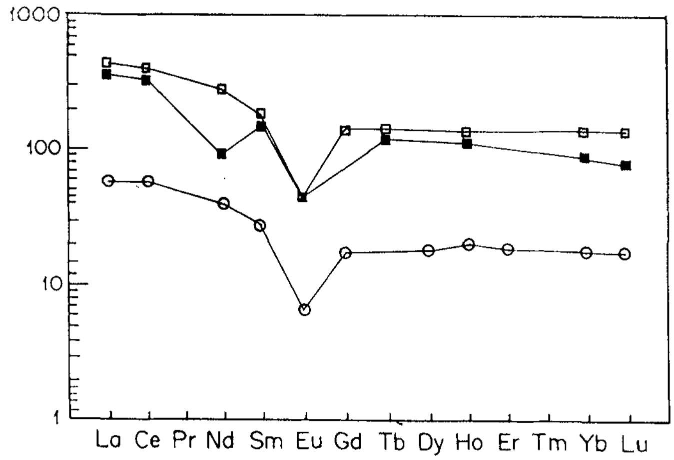

Fig. 5. Chondrite- normalized REE spiderplot for Siwana peralkaline granite. □ Siwana (Eby and Kochhar, 1990); ■ Siwana (Bhushan, 1995); O Mungeria town (study area).

multi-element primitive mantle normalized spidergram (Fig. 4) illustrates that the granites from Barmer town are enriched in Rb, U, Y and Zr, a characteristic of A-type granitoids and are strongly depleted in Ti and Sr. Negative Ti anomaly can be interpreted as reflecting ilmenite fractionation. Nb shows low negative anomaly which is typical of crustal material (Wilson, 1989). The negative anomaly shown by Ba and Sr can be attributed to low-pressure feldspar fractionation and are typical for A-type granitoids (Pearce et al., 1984). Siwana granite is characterized by very high absolute abundances of Rb, Ce, Th, Y and Zr in comparison to granites from Barmer town (Fig. 4). The Chondrite normalized REE pattern of Mungeria granite (Fig. 5) shows LREE enrichment and low Eu/Eu* ratio (0.30).

Discussion

Peralkaline and associated rocks are among the most distinctive igneous suites, and these are generally characteristic of extensional tectonic environment, forming high level plutons, often with a cogenetic volcanic carapace. The petrographic interpretation of peralkaline rocks appears to be as varied as the number of occurrences, and as such many hypotheses have been proposed for their genesis. The anorogenic peralkaline complexes have not been studied in detail by researchers in the past but with the discovery of mineralization in these rocks, a number of peralkaline anorogenic occurrences have been reported globally in the last couple of years (Currie, 1989).

The peralkaline rocks are the products of a complex set of processes and no petrogenetic model can satisfactorily explain the origin of these rocks (Eby, 1990). Any petrogenetic model must account for the relatively anhydrous and incompatible HFS element -enriched character of the magma. The models proposed include (i) partial melting of relatively anhydrous lower crustal source rocks (Collins et al., 1982; Clemens et al., 1986), (ii) tonalitic to granodioritic source rock (Anderson, 1983) and (iii) granulite source (Collins et al., 1982). Vapour absent breakdown of hydrous minerals provides the volatile components necessary for partial melting, while accessory phases provide the large contents of highly charged cations.

The normative Q-Or-Ab abundances and association of granite under study with volcanics strongly suggest their emplacement at relatively high crustal levels. The possibility of derivation of these granites by fractional crystallization of mantle derived material is ruled out by (i) the preponderance of peralkaline rocks over basic rocks and (ii) the extreme enrichment of some incompatible trace elements i.e. Zr, Nb and Ce and depletion of Sr and CaO in these rocks (Currie, 1989), as the concentration of these elements in the mantle- derived magma is expected to be significantly lower than the one crustal derived.

The Malani peralkaline granites of Rajasthan have been studied mainly around Siwana. Role of crust (Eby and Kochhar, 1990; Bhushan and Chittora, 1999) as well as mantle (Dhar et al., 1996) have been proposed. However, consensus on the issue of origin of granites from Siwana has not been arrived. The correlative mineralogy, chemical characteristics and tectonic setting of the peralkaline granite from Barmer and Siwana indicate their generation under a common thermal event. The difference in absolute abundances of elements between Siwana and Barmer granite may however, be attributed to the heterogeneous nature of source (Bhushan, 1995).

The peralkaline rocks with low abundance of associated mafic rocks are peculiar to continental rift zones (Wilson, 1989) and partial melting of metasomatised crust seems to be the most probable source for these peralkaline rocks (Currie, 1989). Leat and Thorpe (1986) suggested that the basalts of within-plate character associated with peralkaline rocks denote zones of crustal extension. Peralkaline magma is generated by the extension and thinning of continental lithosphere. The role of continental crust in the evolution of granite from Barmer town is supported by high concentration of incompatible elements and low Sr contents. The rising basaltic magma from the mantle under extensional tectonic regime may provide the required heat to promote melting of the lower crust (enriched in LILE, HFSE and halogens). The basaltic magma itself may be enriched in halogens and alkalis and these components may escape and further enrich the magma (Bailey, 1978).

The Malani Igneous Suite, incorporating the peralkaline granites of western Rajasthan marks an important late Proterozoic thermal event in the continental evolution of this part of subcontinent. The Pan-African tectono thermal event (900-450 Ma) has resulted in crustal accretion in Gondwanaland prior to its fragmentation and plate tectonic movements (Kennedy, 1964). Stern and Hedge (1985) have described six magmatic episodes from 780 to 540 Ma from eastern Egypt. The late Proterozoic magmatic event "Malani Suite" representing at least four magmatic episodes from 780 to 680 Ma (Rathore et al., 1996, 1999) is, therefore, correlatable to this global thermal event. A-type rocks of similar age (750 to 550 Ma), formed under extensional tectonic regime have also been reported from southern India (Santosh and Drury, 1988; Rajesh and Santosh, 1996; Rajesh et al., 1996), indicating the fact that these wide apart occurrences of A-type rocks have resulted through a common thermal event during the Pan-African.

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