IOSR Journal of Applied Geology and Geophysics (IOSR-JAGG)
e-ISSN: 2321–0990, p-ISSN: 2321–0982.Volume 2, Issue 2 Ver. II. (Mar-Apr. 2014), PP 97-102
www.iosrjournals.org

Geochemistry of Siwana Granites and associated Volcanic Rocks, Barmer District, Rajasthan

Dr. Anil Kumar Yadav
Associate Professor
Geology Govt. Dungar Collage, Bikaner Rajasthan

Dr. Deva Ram Meghwal
Assistant Professor
Department Geology Govt. Dungar Collage, Bikaner Rajasthan

Abstract: *In a cauldron (subsidence) structure of a huge crater at Siwana, peralkaline lava flows slope inward. Riebeckite-aegirine containing granite has intruded along the crator's edge in three stages. A ring dike resulted from the cone intrusion that followed. Alkali amphibole, quartz, aihite, Perthitic K-feldspar, and aegirine make up the majority of the alkaline granite's mineral composition. Chemically, the rock has significant alkali concentrations, with a total alkali content of up to 9.36 weight percent. It also contains unusually high levels of Sri, Nb, Zr, Y, La, and Ce. The presence of peralkaline granite at Siwana is a sign of rift-related magmatism in a distensional Late Proterozoic crustal regime since peralkalineplutonism is a prelude to pre-rift tectonics.*
Keywords: *PeralkalineSiwana, Alkali Concentration, K-Feldspar etc.*

I. Introduction:

The Siwana Granite is a component of the Late Proterozoic Malani Igneous Complex in the Barmer region of Rajasthan and is distinguished by the occurrence of alkali pyroxenes and amphiboles. There are ten granite bodies in the Malanivolcanics, of which two ring dykes and a pluton (Siwana Granite) are made of reibeckite/aegirine granite, six plutons (Jalore Granite) are made of biotite granite, and the remaining pluton (Malani Granite) is made of hornblende granite. A 290 Km2 region of the Siwana Granite is covered by discontinuous outcrops in an oval pattern. The elliptical ring structure is 30 x 22.5 km and has a longer NE-SW axis. From outer to inner contact with the rhyolites, the uninterrupted exposures on the southern edge imply a thickness of roughly 8 km. (Fig. 1). V. N. Mishra and A. M. Heron suggested that the circular layout at Siwana has a connection to the roots of a volcano due to the intrusive nature of Siwans Granite. A twofold plunging syncline was proposed by S. K. Bhuhan for the subsidence structure. For the first time, Anil Maheshwari et al. identified this as a cauldron subsidence characteristic with similarities to the Nigerian ring complex. According to Bhushan, cauldron subsidence is the reason why the alkaline granites of Siwana and Barmer were erected as ring dykes. The structure, according to Kochhar, is the result of intracratonic hot spot activity. Rb/Sr age determi nations determine that the alkaline granite of Siwana is somewhat younger than the Malani rhyolites.

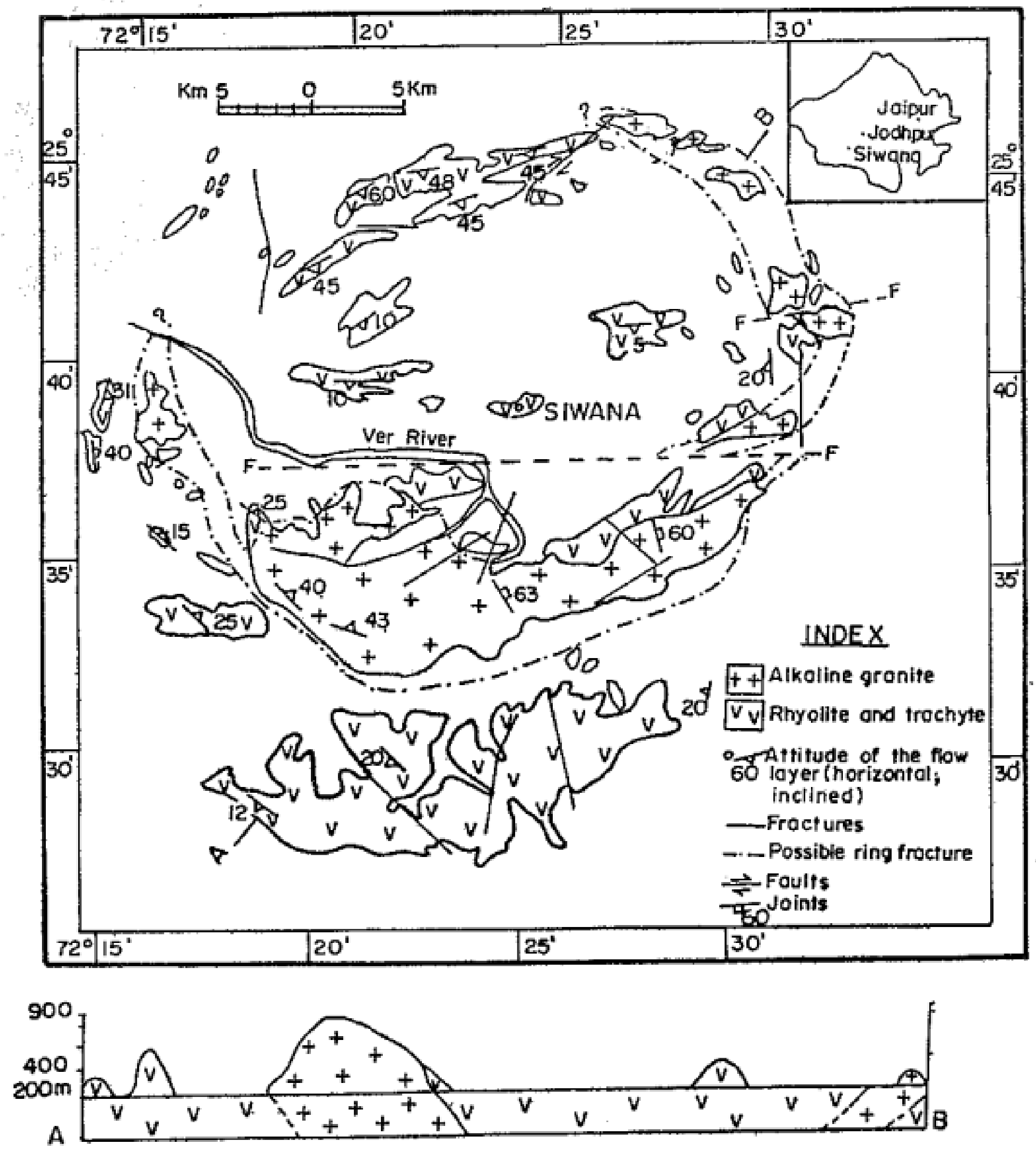


Figure 1. Geological map of Siwana ring structure, Siwana, Barmer district, Rajasthan

GEOLOGY

Leucogranite with homophanous, coarse to medium grains makes up the majority of the Siwana Granite. In the inner periphery of the ring structure, the earliest phase is seen along the rhyolite contact. There is discussion of the three invasive phases:

Porphyritic granite is phase one. The porphyritic granite has precisely squarishphenocrysts of string and braided perthite, as well as coarse tabular and zoned phenocrysts of creamy white to pink K-feldspar in a coarse to.redium grained light grey texture. The primary components of mafic rocks are aegirine and acmite, with riebeckite and arfvedsonite at their core. The radiating needles of aegirine and arfvedsonite in the spherulites are elongated with perthite and quartz. Aegirine's cleavage in some spots swerves, indicating a stress during crystallization.

Leucogranite, Phase I

On ChappanKaPahar (72°21'30"; 25°41'15"), the homophanousleucogranite reaches its greatest outcrop width of 8 km. It is made up of vitreous quartz and light grey alkali feldspar. Alkali pyroxene and amphibole, which come in a range of sizes and concentrations, are the mafic ingredients. As shown in a pegmatite vein, the amphibole crystal can reach a maximum size of 40 cm.

According to Sinneus, this leucogranite has a texture that clusters and lumps together alkali pyroxene and amphiboles, alternate layers of felsic and mafic minerals that are dominant in some areas, and a rhythmic layering pattern. Lamination is a mafic-rich parting that appears as primary flow layers and is inclined up 45 degrees toward the center of the ring.

Phase-II

Xenolithic fragments are lodged in these layers (iii, iv).

The observations mentioned above show the formation of primary density settled layers, where mafics have settled in distinct bands in successive iterations. These strata show the magma's flexible nature and run parallel to the angle of intrusion.

The ferromagnesian minerals sometimes concentrate as cogenetic enclaves, which the rising magma then drags into layers. The alkali feldspars have microcline microperthite under a microscope. The perthite always contains tiny inclusions of aegirine. Quartz can be found in both graphic intergrowth and subhedral grains.

X-ray diffraction (XRD) identifies the alkali pyroxene as acmite. It appears in prismatic clusters or at the rims of alkali amphiboles. Extinction angle on XC is very pleochroic and ranges from 5-7° on 010 cleavage (X==darkgreen, Y=lightgreen, Z=greenishyellow). Perthites also contain tiny acmite needle inclusions that range in color from green to colorless. According to Raval, U, these two types of acmite—inclusions and clusters—belong to two generations. Due to depressurization at the time of cauldron subsidence, they believed the second generation (clusters) of prismatic aegirine to be the breakdown result of arfvedsonite.

Arfvedsonite, which is strongly pleochroic (X=deep blue, Y=green, Z=greenish yellow; XAC0-5°), is the alkali amphibote that was detected by XRD. Although isolated grains of albite are also present, perthites are the predominant component. Zircon is a noticeable auxiliary mineral that is found in mafic clusters. Additionally present are rutile, sphene, and apatite.

Phase Ill

Granite porphyry and microgranite make up.

Since they pierce indiscriminately through the rhyolite and trachyte flows as well as the two phases of granite, the dykes and veins of granite porphyry stand out. They mostly comprise of fine-grained groundmass containing pink tabular feldspar phenocrysts. Amphiboles and alkali pyroxenes are always present.

Rhyolite and granite are in close contact with one another.

The inner ring's periphery contains a continuous zone of contact between the rhyolite and the granite. Only near Mokalsar (72°30'30", 25°36 15") and west of Indrana (72°16'45", 25°39'45") is the touch on the outer margin visible. It's crucial to note the following observations:Even ten meters from the contact, large rhyolite xenoliths can be seen in granite.Rhyolite is encroached upon by the mafic-rich granite's tongues and apophyses.Rhyolite and granite make a sharp touch without changing morphologically.The angle of the contact to the center is between 25 and 45 degrees.Rhyolite and ash flows abruptly come to a stop along the strike direction south of Mawari hamlet as a result of granitic intrusion. Rhyolite enclaves have been discovered within the granite at ChappanKaPahar.

GEOCHEMISTRY

Major Oxides

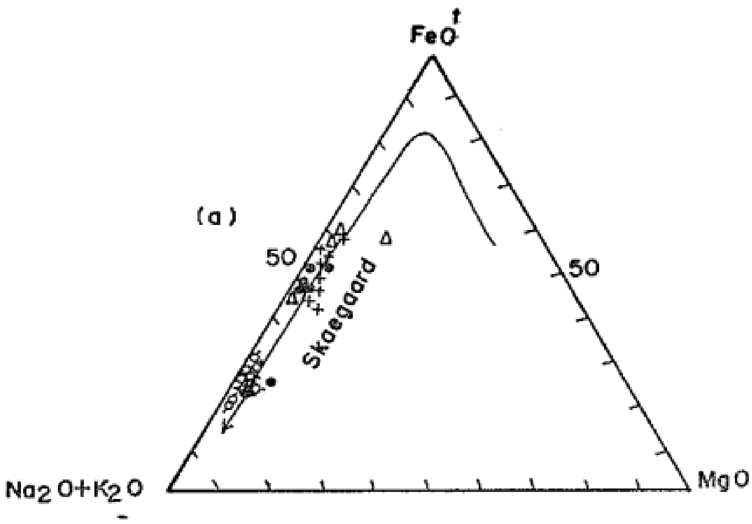
Major oxides have been examined in 18 samples (Table I). Twelve samples have been obtained in pairs along the ring structure, one each representing extrusive (rhyolite I trachyte) and intrusive (granite) rocks. The pairings are 1 & 11, 2 & 12, 3 & 13, 4 & 14, 5 & 15, and 6 & 16. The pairs of rocks are all peralkaline. Trachyte flows make up the majority of extrusive rocks, whereas granites are almost always found as intrusives. Plotted for comparison are the alkaline granites of Nigeria (4 samples), the Kola Peninsula (J pell(2007)), and Barmer (Anil maheshwari 2001). Rhyolites, trachytes, and all granites are agpaitic. In contrast to the volcanics, the granites stand out for having low Al2O3, FeO, CaO, and TiO2 and high SiO2, FeO3, MgO, and K2O+ Na2O. Siwana'strachytes are overexposed. When compared to comparable rocks from Barmer and Nigeria, the rocks from Siwana have more TiO2, Al2O3, and Fe2O3 and lower SiO2. Additionally provided in Table I are the CIPW normative values. All of the granites include acmite, which is a sign of their alkaline nature. In comparison to rhyolites, granites include more albite and magnetite and relatively less normative quartz. Siwana's granites have more normative orthoclase than those of other ring complexes.

All of Siwana'strachytes, several granites, and rhyolite have low D. I. Rhyolites have a propensity to lose TiO2 and gain SiO2 concentration when D.l. increases. With magmatic crystallization, thesetrerds of major and minor element variation form a cohesive whole. A secondary alkali enrichment cannot be ruled out in the absence of any replacement textures with resulting mineral assernments.

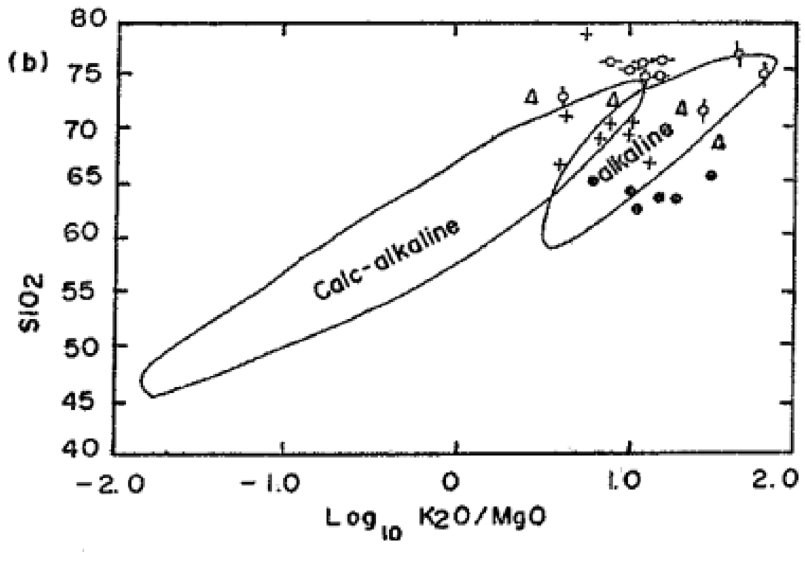
The rocks from Siwana and the Barmer-Nigeria-Kola peninsula cluster individually in the Fig. 2a (AFM) figure. Most of the samples are located close to the alkali-iron junction. The other complexes have less iron than the Siwana complex, which has an equal ratio of iron and alkalies. It's noteworthy to observe that while certain granites from Nigeria find a position in Roy A. B. (2000)'s alkaline field, all the granites from Barmer plot outside of it (Fig. 2b). Every sample from Siwana, with the exception of rhyolite and granite, is located in the alkaline field. Plots in the Q-A-P and the normative feldspar ternary (Fig. 3b; Sharma K. K. 1997) fall in the fields of alkali granite and granite, respectively. Albite, orthoclase, and normative quartz plots in Siwana The granite system's granitic rocks display the thermal valley's frequency maxima. So it is clear that a crystal liquid equilibrium (of Tuttle and Bowen 1958) produced the granitic rocks. It is obvious that the magmatic liquids were engaged in the formation of this granite as a result.

TABLE 1 CHEMICAL COMPOSITION (MAJOR OXIDES) AND CIPW NORMS OF SIWANA GRANITE

Sample no.	1	2	3	4	5	6	7	8	9	10
SiO_2	63.27	65.69	63.86	68.53	71.04	63.19	72.01	63.01	63.50	72.91
TiO_2	0.86	0.89	1.21	0.93	0.54	0.98	0.85	1.44	0.78	0.67
Al_2O_3	13.05	13.05	14.45	9.68	12.01	14.30	7.01	13.01	15.01	9.99
Fe_2O_3	9.11	5.58	3.97	5.05	3.87	0.41	4.02	8.99	8.85	08.07
FeO	1.64	3.27	4.14	6.06	3.02	3.98	6.01	2.04	0.35	0.05
MnO	0.15	0.20	0.13	0.18	0.11	0.19	0.15	0.21	0.05	1.49
MgO	0.23	0.14	0.20	0.26	0.25	2.34	0.53	0.29	0.56	0.45
CaO	0.73	0.87	1.52	0.32	0.17	0.66	1.01	1.56	0.41	0.25
Na_2O	4.72	5.04	5.23	1.71	3.78	4.51	3.78	5.99	4.68	3.78
K_2O	5.00	4.20	3.60	4.89	4.56	7.42	3.98	3.65	5.01	0.01
P_2O_5	0.08	0.08	0.15	0.04	0.07	0.31	0.18	0.15	0.19	0.21
LOI	0.86	0.62	0.71	0.52	0.41	0.78	1.05	2.01	1.31	3.77
ZrO_2	-	-	0.20	0.76	0.29	-	-	-	-	-
Total	99.70	99.63	99.37	98.93	100.12	99.07	100.58	102.35	100.70	101.65
DI	88.24	86.54	80.92	82.54	80.21	88.01	84.31	87.86	87.28	80.16
AI	1.02	0.98	0.86	1.01	1.01	1.05	1.39	0.99	0.90	0.51
Q	16.08	19.08	15.78	30.55	29.96	7.99	36.04	15.02	17.01	54.70
or	29.47	25.02	21.13	28.91	27.05	44.02	22.57	20.11	29.99	22.01
ab	38.77	42.44	44.01	22.53	32.98	32.98	15.01	46.01	39.01	1.57
an	-	0.56	5.56	-	0.98	-	-	-	1.18	1.99
R	-	-	-	-	0.41	-	-	-	1.03	5.13
ac	0.92	-	-	0.45	-	1.35	12.01	4.99	-	-
di	1.29	1.36	0.96	2.20	-	1.03	3.60	3.35	-	3.7
hy	-	-	2.64	5.05	2.50	8.54	7.99	-	1.18	-
mt	3.48	8.12	5.57	7.19	4.99	-	-	2.87	-	-
hm	6.08	-	-	-	-	-	-	5.55	9.05	6.99
il	1.52	1.67	2.28	1.82	1.03	1.92	1.57	3.01	0.78	1.76
ap	0.34	0.34	0.34	-	-	0.44	0.45	0.45	0.41	-
ns	-	-	-	-	-	1.01	0.46	-	0.20	0.28
w	0.46	0.58	-	-	-	-	-	-	-	-



(a)



(b)

Figure 2: (a) AFM plots of alkaline granites, rhyolites and trachytes from Siwana. Plots of alkaline granites from Nigeria and Kola peninsula for comparison.
(b) SiO_2 versus log 10 K_2O/MgO. The fields are after Rogers and Greenberg, 1981

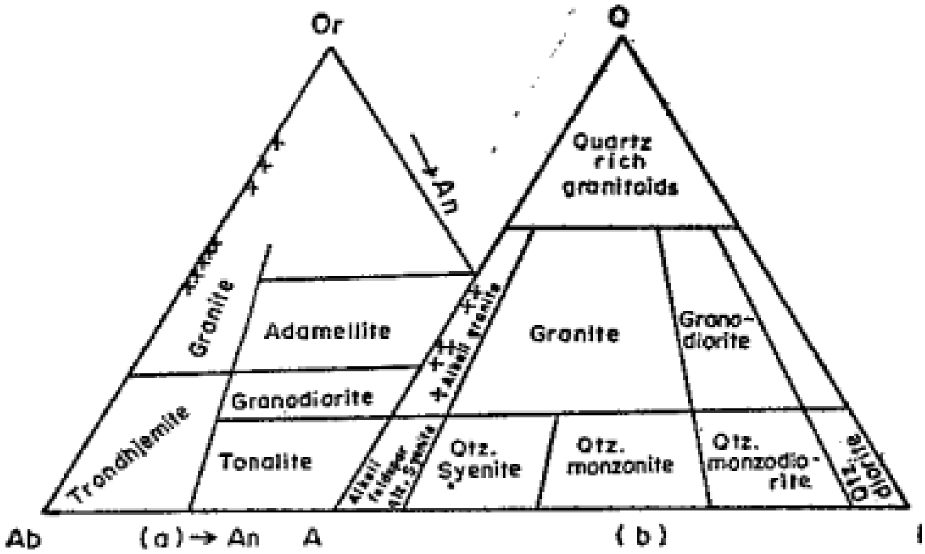


Figure 3: (a) Plots in normative feldspar ternary after O'Connor 1965 and (b) Q-A-P diagram after Streckeisen, 1973.

II. Discussion &Conclusions

The cogenetic link proposed by Venkataraman and Murthy between peralkalinevolcanics and granites is still unquestioned. However, despite the fact that trachytes are found in a number of locations, they classified all volcanics as rhyolites. Six pairs of samples taken from the interface between rhyolite and trachyte and granite have shown that there is no hydrothermal or contact metasomatic effect on the volcanics during granite intrusion. The volcanics contain multiple granite apophyses and a near-sharp edge contact, both of which point to the intrusive injection of latter. The ferromagnesian apophyseal minerals are found in a jigsaw pattern over the injection line.

Three water-borne conglomerate strata with a thickness range of 50 cm to 2 m are interbedded with ferruginous tuff at Siwana, which is located in the caldera's center. Step faulting affects these conglomerate beds, which are traceable up to 250 m and appear as interflow sediments. These conglomerate strata' presence of ripple lines, cross patterns, and graded bedding in the related fine ferruginous tuff points to a wet environment during deposition.

According to Murthy (1962), the ring pattern at Siwana was caused by cauldron subsidence and vertical intrusion of granite around the collapse structure's perimeter. The flow layers' inward dip steadily reduces as one moves closer to the center. The two flows and related pyroclastics are nearly horizontal at Siwana. As was previously mentioned, a depression was formed even before the volcano's eruption stopped. There must have been a steep-sided saucer-like situation present. The crater's edge would have witnessed the sinking or subsidence. These dilatational openings have been followed by the ascending granite magma, most likely at the same time as the volcanic vent was sealed as a result of a collapse. The inner margin of the granite and rhyolite contact is inclined at a moderate degree (24–25°) towards the center. The piecemeal stopping mechanism of intrusion along the sloping dilatational hole is indicated by the zigzag contact, the presence of xenoliths, and the homogenous composition of the granite. Due to the angle of the dilatational opening, the granite intrusion is not vertical but rather is clued 24–25°. Cone intrusion appears to have resulted from the granite magma force entirely ascending from a central magma chamber fanning each side of the crater borders.

The incursion, as previously described, has happened in three stages. The rupturing along the crater margin has occurred in pulses, with the first pulse involving the injection of porphyritic granite. The hon'lophanous coarse grained leucogranite intruded as the cone fracture opened. It can be seen from the spatial distribution of the three phases that the intrusion occurred from the inner to the outer boundary. It is interesting to see that the southern side of the ring's granite has a thickness that is four times greater than the northern edge (8:2). The north may be experiencing a thinning because of their increased distance from the source.

The center eruptions of the Malanis are typically associated with alkaline lavas The subsidence of the crater at Siwana is the result of fragmented stopping of depressurization or magma migration elsewhere. Alkaline magma was produced as a result of the residual magma that was high in volatiles and alkalies. The occurrence of peralkaline rhyolite (comendites) and trachyte flows shows that there was alkalinity even before granitic intrusion. The sealed conduit that leads to the formation of the master cone fracture prevents stress concentration around the volcano caused by resurgent volcanic activity.

Alkaline magmatism and regional uplift are characteristics of continental rifts. These regions typically cover the older crust. The younger granites found in Egypt are a product of rift-related magmatism. The trans-Aravalli region's alkali magmatism was connected to crustal dislocations by Narayan Das et al. in 1978. The South Delhi oceanic crust's low angle subduction beneath the old crustal block is likely what caused the Malani acid and calc-alkaline volcanism and accompanying plutonic episodes. Inferring the zone of active rifting in a distensional Late Proterozoic crustal regime is the peralkaline granite and related trachytes and rhyolites at Siwana.

References:

[1]. Bailey, D. K. 1974: Continental rifting and alka line magmatism. In Sorensen, H. (Er!.) The alkaline rorks. John Wiley and Sons, London, 148-159.

[2]. Bhushan, S. K. 1984: Classification of Malani Igneous Suite. Symposium on Three decades of developments in petrology, mineralogy, arid petrochemistry in India. Geof. Surv. md. Sp. Pub. 12, 199-205.

[3]. Greenberg J. K. 1981 : Characteristics and origin of Egyptian younger granites. Surnm. Bull. Geol. Soc. Amer. 92(1), 63-67.

[4]. A K. Choudhary, K Gopalan C. AnjaneyaSatry (1984) Present status of the geochronology of the Precambrian rocks of Rajasthan, Tectonophysics, **105**(1), 131-140.

[5]. Anil Maheshewariet. al. (2001) Geochemistry and Petrogenesis of SiwanaPeralkaline Granites, West of Barmer, Rajasthan, India, Gondwana Research **4**(1) 87-95.

[6]. M. Heron (1935) The Pre-Vindhyan Geology of Rajputana, Current science, **4**(2), 83-88.

[7]. J Pell (2007) Alkaline ultrabasic Rocks in British Columbia, Ministry of Energy, mines and Petroleum Resources.

[8]. S. K. Bhushan (2000) Malani Rhyolites- a review, Gondwana Research **3**(1) 65-77.

[9]. Srivastava, R. K., 1988. Magmatism in the Aravalli mountain range and its environs. *Geol. Soc. Ind. Mem. 7*, 77- 94.

[10]. Tuttle, 0. F. and Bowen, N. L. 1958: Origin of granite in the Ught of exper~imentaI studies in the system $NaAlSi_3O_8$, SiO_2, H_2O Cool. Soc. Amer., 74-153

[11]. Kochhar, N., 1996. A-type Malanimagmatism, northwestern peninsular India. In: Deb, M., Banerjee, D. M. (Eds.), *Proc. Seminar ‘Mineralization in the Western Indian Craton’*, Dept. Geology, Delhi University, pp. 10-15

[12]. Roy, A. B. (2001) Neoproteozoic crustal evolution of northwestern Indian shield: Implications on break-up and assembly of supercontinents. *Gondwana Res.*, **4**, (3), 289-306.

[13]. Snag et. al. (1999) Alkaline rocks of Samchampi-Samteran, District Karbi-Anglong, Assam, India, Proc. Indian Acad. Sci. **108** (1), 33-48.

[14]. V. N. Mishra (1963), palaeolithic culture of western Rajputana, Bulletin of the Deccan College Post-Graduate and Research Institute **21**, 85-156.