IOSR Journal of Applied Geology and Geophysics (IOSR-JAGG)
e-ISSN: 2321–0990, p-ISSN: 2321–0982.Volume 7, Issue 3 Ser. I (May. – June. 2019), PP 01-07
www.iosrjournals.org

The Geochemical Contraints in the Origin of the Saiya-Shokobo Younger Granite Complex, Central Nigeria

Aga, T.[1] and Haruna, A. I.[2]
[1]*Department of Geology, University of Jos, Jos, Nigeria*
[2]*Department of Applied Geology, Abubakar Tafawa Balewa University, Bauchi, Nigeria*
Corresponding Author: Aga, T.

Abstract: *The Saiya-Shokobo Younger Granite Complex is one of the several anorogenic granite suite in central Nigeria which intruded the Basement Complex. The complex is found to comprise of felsic rocks like; rhyolite, biotite-granites, biotite micro granites, hornblende biotite granites and syenites. The complex is also found to be associated with mafic rocks like gabbroic diorites and diorites which, at some portions have formed hybrid rocks. Aegirine - arfvedsonite-, rebeckite- and quartz- feldspar- granites are the porphyritic rocks that form the ring complex. The rock chemistry of twenty eight (28) representative samples was carried out on the energy dispersive x-ray fluorescence (EDXRF) for twelve (12) major and thirty seven (37) trace and REE elements. Agpaitic index and alumina saturation index suggest that most of the samples are peraluminous to metaluminous. The widely used SiO_2 vs K_2O classify most of the granite samples as high K rocks while the mafic gabbroic diorites and diorites as calc-alkaline. Use of the popular Pearce et al discrimination diagrams for tectonic interpretation of granitic rocks (($(Na_2+K_2O)/CaO$ vs Zr+Nb+Ce+Y and Nb vs 1000*Ga/Al), all the samples were plotted in both diagrams in WPG, as well as in the field of A-type granites in the Y vs Nb diagram. The enrichment of high field strength (HFS) elements in the investigated granites confirms their A-type identity and exclude them from other granitic types. Spidergraph show negative Sr anomaly suggesting the feldspar fractionated nature of the granitoids where plagioclase played an important role in the evolution of the A-type magmatism. The magma that gave rise to the granitoids most likely came from the lithospheric mantle.The enrichment of Zr and Nb in the rocks indicate Nb-Sn-W mineralization. The northern parts of the Complex contains Pb>15 which confirms that they are tin-bearing or productive granitoid suites.*

Keywords: *A-type, Anorogenic, Granite, Saiya-Shokobo, Mineralization.*

Date of Submission: 23-05-2019 Date of acceptance: 08-06-2019

I. Introduction

The Younger Granite Ring Complexes are located in the southern part of a 200 km wide zone, along the 9th meridian and extending 1250 km from Andrar Bous in northern Niger to Afu in the margin of the Benue Trough in Nigeria . The form and general pattern of the ring centres may have been controlled by pre-existing lines of weakness in the Pan African basement (Kinnaird et al, 1985) (Fig. 1).The Saiya-Shokobo Younger Granite Complexes is one of the fifty three anorogenic alkaline Younger Granite Complexes in the Nigerian Pan African Basement Complex (Macleod et al, 1971). The granite suite is located approximately forty five (45) kilometres north of Jos, the Plateau State capital.Saiya-Shokobo Complex constitute a significant window to the detailed understanding of the magmatic evolutionary trends and metallogenic characteristics of the Nigerian Younger Granites as a whole. This is because of the prominent occurrence of mafic rocks which may represent the more primitive magma in the Younger Granite Province. The complex is found associated with gabbroic and doleritic enclaves, peralkaline and peraluminous igneous rocks (Figure 1). Details on the field geology and mineralogy of the Saiya-Shokobo Complex have been discussed by the authors elsewhere (Aga and Haruna, 2019a in press)

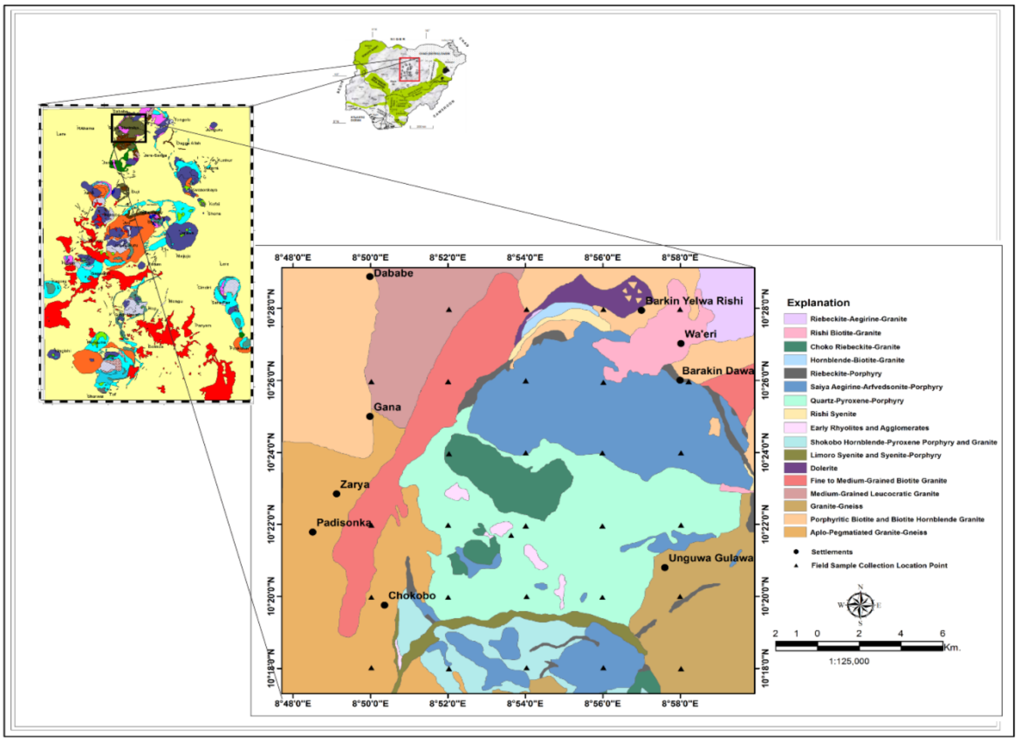

Fig.1: Top = Geological Map of Nigeria Showing the Location of the Younger Granite Ring Complexes (After Obaje, 2009); Left = Map of Younger Granites Ring Complexes of Nigeria (Modified After Kinnard et` al, 1985); Centre = Geological Map of Saiya-Shokobo Younger Granite Complex

Anorogenic, A-type granites are characterized by high SiO_2, Na_2O+K_2O, Fe/Mg, Ga/Al, Rb, Nb, Zr, Ta, Y, Cs, Ga, U, Th, REE (except Eu) and low abundances of MgO, CaO, Mg, Ba, Sr, P, Ti, Ni, Cr, Co, V (Collins et al,1982 and Whalen et al, 1987). Many models have been proposed to the origin of A-type granitoids. These models can be grouped into two broadly speaking due to the

challenge of linking the various petrological and geochemical properties of granitic rocks to the sources, processes and tectonic settings that produced them.

One popular approach was first proposed by Chappell and White (1974) and emphasizes the sources of granitic rocks as a key factor that controls their characteristics. This approach originally classified granites into two types: I-type (from igneous source rocks) and S-type (from sedimentary source rocks). Such a classification is intrinsically independent of tectonic processes. This scheme has been further developed into the I-S-A-M-H classification scheme in which “A” indicates anorogenic (Loiselle and Wones, 1979), “M” represents “mantle-derived”, and “H” denotes “hybrid” types (Castro et al., 1991). Although this classification scheme is useful, the different types may overlap. For instance, S-type granite can also be classified as A-type granite, and highly felsic I-type granites generally have an A-type affinity.

Another approach is to analyze tectonic environments using trace element discrimination diagrams, such as those proposed by Pearce et al. (1984). This is the main approach adopted in this study because the fields on the discriminant diagrams reflect source regions and crystallization histories. The purpose of this paper is to provide a geochemical data on the Saiya-Shokobo A-type granite and associated mineralization, so as to infer their petrogenesis and tectonic setting.

GEOCHEMISTRY

The rock chemistry of twenty eight (28) representative samples was carried out on the energy dispersive x-ray fluorescence (EDXRF) for twelve (12) major and thirty seven (37) trace and REE elements. The sample preparation and analysis were carried out at the Geochemistry laboratory of the Nigerian Geological Survey Agency in Kaduna. The samples analyzed comprise of three (3) rhyolite samples, five (5) diorites, two (2) gabbroic diorites, one (1) granodiorite and seventeen (17) granites of varying textural compositions. The detailed geology and petrography of the samples is described elsewhere (Aga and Haruna, 2019a). The discrimination and correlation diagram are plotted to characterize each granite type and to discuss the petrogenesis and mineralization of the granites from the study area.

Major, Trace and REE Element Classification

The result of the chemical analyses are given in the tables 1, 2a and 2b below. The concentration of SiO_2 in the granites are high SiO_2 (53 - 74.6) as compared to the gabbroic diorites (50 -52.24). The inverse relationship exist with respect to the total iron, highest in a diorites (18.42) and lowest in a granite (1.45). The average values of TiO_2, Na_2O and K_2O for the gabbroic diorites are 3.58, 0.19 and 3.185 which are comparatively lower to the granites: 6.733, 0.34 and 5.2035 respectively. However, the average concentration of the gabbroic dolerites for Al_2O_3, CaO and MgO are 16.21, 5.636 and 5.05 are comparatively higher than the granites: 12.319, 0.95 and 0.14365 respectively. The granites ranges from peralkaline to peraluminous, the gabbroic dolerites are metaluminous; Agpaitic Index (AI= molecular portion of Na_2O+K_2O/Al_2O_3) and alumina saturation index (A/CNK = molecular $Al_2O_3/Na_2O + K_2O + CaO$) ratio < 1 peraluminous (corundum and anorthite normative; AI >1) (Fig. 4). The Na_2O-Al_2O_3-K_2O triangular diagram plot most of the samples within the metaluminous-peraluminous region (Fig. 5). Further, the widely used SiO_2 vs K_2O diagram classify most of the granites as high-K rocks, with the exception of the granodiorite that belong to the shoshonite series. Meanwhile, the mafic gabbroic diorite and diorite samples belong to the calc-alkaline series (Fig. 6).

Tectonic setting and Petrogenesis

The geochemical nature of the studied A-type granites are critically tested using the standard common schemes as well as the adopted three-tiered geochemical classification scheme of granites rocks. As the extreme Fe*O enrichment relative to MgO (high FeO*/MgO) is a typical signature of A-type granitoids, all the present granite samples are grouped as A-type granite on the Fe* {FeO*/(FeO+MgO)} vs SiO_2, Na_2O+K_2O-CaO vs SiO_2 and Zr vs 1000*Ga/Al diagrams (Figs. 7, 8 and 9).

Table 1: Major Element Concentration of Saiya-Shokobo Younger Granite Complex

Sample ID	Location	Petrology	SiO_2	CaO	MgO	SO_3	K_2O	Na_2O	TiO_2	MnO	P_2O_5	Fe_2O_3	Al_2O_3	H_2O^+
AT 1	Saiya - Shokobo	Gabbroic Diorite	50	8	4.5	0.28	0.87	0.28	2.1	0.2	0	4.9	19	8.08
AT8	Saiya - Shokobo	Granite	73.81	0.34	0.003	0	5.5	0.88	0.36	0.064	0	3.89	12.63	1.6
AT10	Saiya - Shokobo	Granite	72.96	0.82	0.04	0	5.5	1.01	0.43	0.16	0	2.85	12.67	2.08
AT11	Saiya - Shokobo	Gabbroic Diorite	52.24	3.32	5.6	0	1.83	0.6	5.06	0.25	0	14.4	13.42	3.14
AT12	Saiya - Shokobo	Diorite	58.3	3.46	6.2	0	2	0.43	3.14	0.21	0	11.72	10.46	2
AT13	Saiya - Shokobo	Granodiorite	59.9	7.3	0.43	0.36	4.11	0.73	1.71	0.31	0.004	9.8	10.04	3.86
AT16	Saiya - Shokobo	Granite	72.06	0.72	0.03	0	7	1.43	0.97	0.25	0.02	4.46	12.21	1.1
AT21	Saiya - Shokobo	Granite	74.43	0.02	0	0.63	4.01	0.89	0.21	0.062	0	2.51	13.86	1.84
AT25	Saiya - Shokobo	Granite	73.2	2.07	0.63	0.006	1.4	1.02	1.93	0.19	0	2.81	13.06	1.01
AT27	Saiya - Shokobo	Rhyolite	74.2	1.73	0.18	0.43	5.2	0.67	0.22	0.032	0	2.34	13.81	1.64
AT28	Saiya - Shokobo	Granite	72.46	1	0.34	0.032	7.4	2.54	0.23	0.06	0	2.34	12.21	1.2
AT38	Saiya - Shokobo	Granite	73.89	1.4	0.08	0.06	5.1	0.69	1.09	0.24	0	3.08	13.01	1.4
AT32	Saiya - Shokobo	Granite	68	1.12	0.008	0.068	10.3	0.14	1.48	0.092	0	2.94	11.48	2.94
AT33	Saiya - Shokobo	Diorite	53	6.5	2.23	0	0.4	1.86	3.16	0.36	0	18.42	1.06	2.06
AT35	Saiya - Shokobo	Rhyolite	70	0	0	0	9.18	1.02	1.11	0.039	0	4.28	10.08	3.42
AT45	Saiya - Shokobo	Diorite	57.1	2.33	8.84	0.13	1.08	0.33	3.24	0.27	0	8.24	12.34	5.6
AT49	Saiya - Shokobo	Diorite	58	6.1	3.81	0.7	1.7	0.16	2.81	0.22	0.04	10.46	10.6	4.08
AT53	Saiya - Shokobo	Rhyolite	73.74	1.68	0.2	0.23	5.14	0.43	0.506	0.09	0	0.96	13.66	1.72
AT54	Saiya - Shokobo	Granite	74.02	0.29	0.002	0.23	4.18	0.07	0.62	0.13	0.08	4.59	13	1.44
AT59	Saiya - Shokobo	Granite	74.6	1.03	0.04	0.02	5.12	0.93	0.69	0.12	0.13	2.64	13.46	1.16
AT61	Saiya - Shokobo	Diorite	58.6	9.7	0.82	0.56	1.34	0.63	3.52	0.25	0.03	10.06	10.71	2.24
AT66	Saiya - Shokobo	Granite	73.02	0.96	0.13	0.42	8.14	2.06	0.15	0.053	0	0.42	12.76	1.4
AT67	Saiya - Shokobo	Granite	72.8	1.46	0.1	0.06	3.4	0.43	2.18	0.075	0.01	4.1	13.4	1.51
AT70	Saiya - Shokobo	Granite	75.6	0.98	0.28	0.62	4.5	1.04	0.27	0.066	0	1.45	13.02	1.06
AT75	Saiya - Shokobo	Granite	73.9	0.38	0.03	0.43	4.02	0.76	0.55	0.23	0	3.64	13.86	2.08
AT78	Saiya - Shokobo	Granite	73.3	0.76	0.02	0.4	6.02	0.78	0.3	0.061	0	0.78	13.98	2.71
AT83	Saiya - Shokobo	Granite	72.96	1.9	0.73	0.06	3.69	0.67	0.98	0.032	0	2.02	13.06	2.86
AT3	Saiya - Shokobo	Granite	73	0.98	0.03	0.39	8.03	0.71	0.3	0.042	0	2.42	12.98	1.43

Table 2a: Trace and REE Concentration of Saiya-Shokobo Younger Granite Complex

Sample ID	Location	Petrology	V	Cr	Cu	Sr	Zr	Ba	Zn	Ce	Pb	Ni	Ga	As	Y	Ir	Au	Pt	Rb	Pd	Nb	Co
AT1	Saiya - Shokobo	Gabbroic Diorite	39	24	300	2830	570	200	450	20	190	<0.001	30	<0.001	61	7	<0.001	<0.001	19	0.001	<0.001	0.001
AT8	Saiya - Shokobo	Granite	30	4	210	265	1100	97	136	19	200	0.17	18	2	34	24	<0.001	<0.001	12	174	<0.001	0.025
AT10	Saiya - Shokobo	Granite	9	<0.001	250	200	3120	105	420	140	260	<0.001	130	10	36	<0.001	0.41	<0.001	54	500	0.17	0.015
AT11	Saiya - Shokobo	Gabbroic Diorite	62	<0.001	420	2250	140	700	58	0.001	92	<0.001	2	<0.001	29	<0.001	<0.001	<0.001	39	0.001	<0.001	5
AT12	Saiya - Shokobo	Diorite	85	4.6	420	2040	1200	1000	350	0.001	810	47.21	<0.001	<0.001	32	6.1	0.01	<0.001	31	0.001	<0.001	3.9
AT13	Saiya - Shokobo	Granodiorite	90	4.6	310	2150	4510	2000	300	60	600	<0.001	24	<0.001	28	45	0.2	<0.001	17	120	1	<0.001
AT16	Saiya - Shokobo	Granite	4.6	<0.001	520	0.001	7840	<0.001	1300	170	470	<0.001	31	4	87	5.6	<0.001	<0.001	13	110	<0.001	0.04
AT21	Saiya - Shokobo	Granite	<0.001	<0.001	250	0.001	600	120	220	0.54	190	23	190	4	7	0.1	1.6	<0.001	116	570	0.001	0.0001
AT25	Saiya - Shokobo	Granite	10	<0.001	260	1590	1100	200	250	61	480	<0.001	11	<0.001	16	2	6.78	<0.001	26	780	0.002	<0.001
AT27	Saiya - Shokobo	Rhyolite	<0.001	<0.001	200	53	400	1100	50	20	50	<0.001	3	6	5	1.7	<0.001	<0.001	76.7	0.001	0.0002	0.001
AT28	Saiya - Shokobo	Granite	10	<0.001	180	300	290	<0.001	86	87	100	0.065	80	64	5	22	0.8	<0.001	52.1	0.001	<0.001	0.002
AT38	Saiya - Shokobo	Granite	82	170	330	910	2600	5000	180	0.001	<0.001	<0.001	5	<0.001	21	<0.001	3	28.8	37	320	<0.001	0.005
AT32	Saiya - Shokobo	Granite	<0.001	<0.001	460	3100	3650	3300	100	0.001	370	15.02	20	7	40	49	41	<0.001	75	0.001	0.002	0.004
AT33	Saiya - Shokobo	Diorite	89	150	300	1900	1200	300	570	70	<0.001	20	2.01	30	130	<0.001	<0.001	11	57	130	0.001	<0.001
AT35	Saiya - Shokobo	Rhyolite	<0.001	<0.001	66	0.874	1010	301	15	61	200	<0.001	33	22	19	7.1	<0.001	<0.001	153	250	2.001	<0.001
AT45	Saiya - Shokobo	Diorite	40	0.10	320	1920	1300	1000	400	0.001	0.021	<0.001	3	<0.001	40	52	<0.001	<0.001	33	87	0.002	<0.001
AT49	Saiya - Shokobo	Diorite	60	16	380	1830	1200	<0.001	370	0.001	<0.001	25	<0.001	<0.001	43	<0.001	0.2	<0.001	36	0.001	<0.001	<0.001
AT53	Saiya - Shokobo	Rhyolite	2	<0.001	200	290	600	<0.001	73	62	100	<0.001	40	5	31	2	<0.001	31	78.1	0.001	0.001	<0.001
AT54	Saiya - Shokobo	Granite	280	11	370	0.001	5960	<0.001	120	200	410	<0.001	21	<0.001	73	<0.001	<0.001	<0.001	60	750	5	0.001
AT59	Saiya - Shokobo	Granite	5	0.7	270	360	2510	1000	170	120	<0.001	<0.001	13	8	26	29	0.21	<0.001	30	470	<0.001	0.001
AT61	Saiya - Shokobo	Diorite	350	40	360	2290	1500	700	520	0.001	0.051	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	22	950	<0.001	0.001
AT66	Saiya - Shokobo	Granite	<0.001	<0.001	250	1630	190	670	42	59	150	<0.001	58	5	8.3	2	0.6	<0.001	39	0.001	<0.001	0.004
AT67	Saiya - Shokobo	Granite	60	58	270	500	1200	<0.001	80	55	100	<0.001	7.5	5	19	25	1.4	0.041	42	1200	<0.001	<0.001
AT70	Saiya - Shokobo	Granite	<0.001	<0.001	270	160	142	300	120	62	200	<0.001	6	49	23	20	1.8	<0.001	72.1	200	0.007	0.002
AT75	Saiya - Shokobo	Granite	30	8	260	0.001	2740	600	327	20	790	<0.001	24	<0.001	27	<0.001	<0.001	<0.001	10	110	2.001	<0.001
AT78	Saiya - Shokobo	Granite	100	12	180	150	600	910	20	20	100	11	19	6.4	16	<0.001	1.4	<0.001	7.78	380	<0.001	0.005
AT83	Saiya - Shokobo	Granite	20.18	6.26	250	1070	1720	150	180	18	100	<0.001	8.4	4	6	25	<0.001	<0.001	85.2	0.001	0.001	<0.001
AT3	Saiya - Shokobo	Granite	4.18	0.45	300	14	2520	210	203	10	100	4.74	36	15	59	<0.001	<0.001	<0.001	20.7	140	<0.001	0.006

Table 2a: Trace and REE Concentration of Saiya-Shokobo Younger Granite Complex

Sample ID	Location	Petrology	Cd	Ru	Eu	Re	Hg	Ag	Ta	W	Hf	Yb	In	Se	U	Th	Sb	Sn	Ge
AT 1	Saiya - Shokobo	Gabbroic Diorite	0.002	2.8	65	6.001	30	<0.001	<0.001	<0.001	11.24	2	<0.001	6.4	<0.001	<0.001	7.7	15.21	3.1
AT8	Saiya - Shokobo	Granite	0.001	30	170	10	1.01	2.77	51	1.08	20	10	1.9	0.005	0.001	<0.001	<0.001	<0.001	0.7
AT10	Saiya - Shokobo	Granite	0.002	<0.001	20	5.3	<0.001	<0.001	71	12	14.04	5.3	2.6	0.004	0.001	<0.001	<0.001	0.047	4.5
AT11	Saiya - Shokobo	Gabbroic Diorite	<0.001	8.6	38	<0.001	2	1.4142	<0.001	<0.001	11	<0.001	8	<0.001	0.05	0.002	0.2	7.12	<0.001
AT12	Saiya - Shokobo	Diorite	<0.001	<0.001	33	0.54	<0.001	0.78	<0.001	<0.001	2.01	0.7		0.02	<0.001	<0.001	0.2	51.07	15
AT13	Saiya - Shokobo	Granodiorite	0.02	<0.001	33	<0.001	6	<0.001	81	4.34	51	0.084	1.5	0.054	<0.001	<0.001	<0.001	9.3	7
AT16	Saiya - Shokobo	Granite	<0.001	31	23	<0.001	0.54	2.4	40.24	12.3	9.5	<0.001	4.1	<0.001	0.21	0.002	<0.001	10.151	<0.001
AT21	Saiya - Shokobo	Granite	0.002	0.36	120	4.8	<0.001	2.6	72	0.98	8.8	0.001	2	6.4	<0.001	<0.001	0.45	5.31	0.02
AT25	Saiya - Shokobo	Granite	0.001	3	27.78	<0.001	<0.001	1.7	40.4	2.86	12	0.001	1.3	7.3	0.003	0.001	1.6	7.54	1.1
AT27	Saiya - Shokobo	Rhyolite	<0.001	32	84	2	<0.001	<0.001	0.21	0.042	2.744	<0.001	2.2	37	0.102	0.003	4.5	<0.001	<0.001
AT28	Saiya - Shokobo	Granite	0.001	27	55	<0.001	0.642	<0.001	<0.001	<0.001	12	<0.001	3.4	0.005	0.001	0.002	<0.001	4.61	7
AT38	Saiya - Shokobo	Granite	0.002	1.33	22	<0.001	4.32	<0.001	60	4.24	24	2.022	3.7	<0.001	<0.001	<0.001	3.8	6.32	<0.001
AT32	Saiya - Shokobo	Granite	<0.001	<0.001	110	0.055	4	1.9	<0.001	<0.001	20	<0.001	5	<0.001	0.011	0.2	0.1	8.34	<0.001
AT33	Saiya - Shokobo	Diorite	<0.001	<0.001	390	<0.001	28	<0.001	21	2.06	40	20	0.7	<0.001	<0.001	<0.001	0.4	10.05	0.3
AT35	Saiya - Shokobo	Rhyolite	0.002	11	<0.001	<0.001	<0.001	2.4	70	14	17	<0.001	6.1	<0.001	<0.001	<0.001	3.6	10.53	0.05
AT45	Saiya - Shokobo	Diorite	0.001	<0.001	370	1.554	20	<0.001	12.08	2.34	8	0.006	1.9	<0.001	<0.001	<0.001	3	3.54	0.002
AT49	Saiya - Shokobo	Diorite	<0.001	1.23	340	0.24	2	0.54	<0.001	<0.001	24	0.122	0.455	<0.001	0.003	0.008	3.3	15.32	<0.001
AT53	Saiya - Shokobo	Rhyolite	0.055	33	140	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	0.044	2.5	0.002	<0.001	<0.001	2.9	3.32	<0.001
AT54	Saiya - Shokobo	Granite	<0.001	<0.001	240	0.004	<0.001	7.5	67	2.46	<0.001	<0.001	4	<0.001	5	2.011	10	0.881	<0.001
AT59	Saiya - Shokobo	Granite	0.003	<0.001	220	<0.001	<0.001	<0.001	64	2.26	29	<0.001	4.7	<0.001	<0.001	<0.001	0.022	6.122	<0.001
AT61	Saiya - Shokobo	Diorite	0.008	1.32	36	10	20	<0.001	152	7.73	2.87	0.003	0.5	17.4	<0.001	<0.001	3.6	5.11	<0.001
AT66	Saiya - Shokobo	Granite	0.002	27	20	<0.001	<0.001	<0.001	<0.001	<0.001	20	0.004	4.4	<0.001	<0.001	<0.001	<0.001	10.551	<0.001
AT67	Saiya - Shokobo	Granite	0.0005	0.31	120	10	0.8	0.9	163	6.4	39	<0.001	3.3	37	0.0102	0.0006	2.4	3.521	2
AT70	Saiya - Shokobo	Granite	<0.001	33	15	33	<0.001	4	21	12	20	0.003	2.4	0.0004	<0.001	<0.001	<0.001	12.411	<0.001
AT75	Saiya - Shokobo	Granite	0.002	<0.001	320	20	<0.001	0.014	28	0.96	47	<0.001	2	7.3	0.0003	0.007	<0.001	0.53	<0.001
AT78	Saiya - Shokobo	Granite	0.006	<0.001	11	1	<0.001	<0.001	46	2.22	20	<0.001	2.5	0.005	0.001	0.002	<0.001	6.31	<0.001
AT83	Saiya - Shokobo	Granite	<0.001	<0.001	15	30	<0.001	<0.001	<0.001	20.06	0.0003	<0.001	8	0.006	0.31	<0.001	12.3	0.021	
AT3	Saiya - Shokobo	Granite	<0.001	7.1	8.7	7	<0.001	2	70	11	39	3	4.3	8	0.006	0.84	0.004	10.3	<0.001

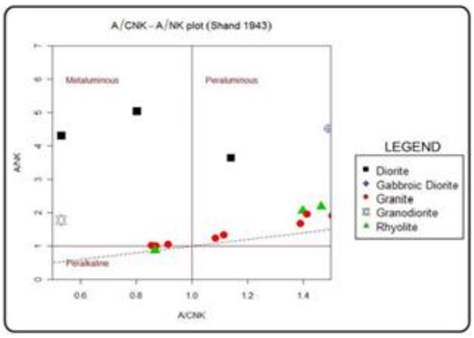

Fig. 4: ANK vs A/CNK diagram for rocks

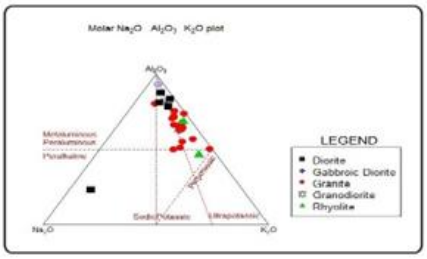

Fig. 5: Molar Na_2O-Al_2O_3-K_2O triangular diagram

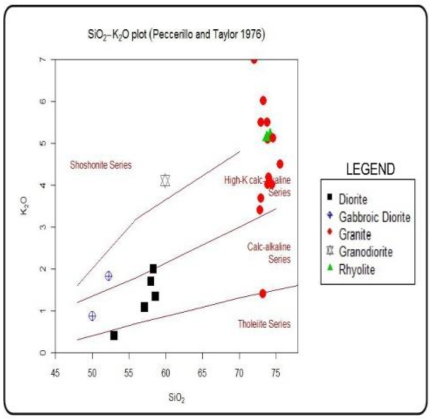

Fig. 6: SiO2 vs K_2O diagram with Field

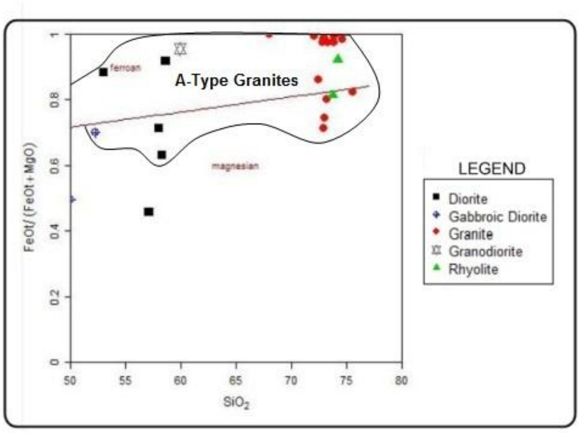

Fig. 7. Chemical Classification using FeO*/(FeO+MgO) vs SiO_2

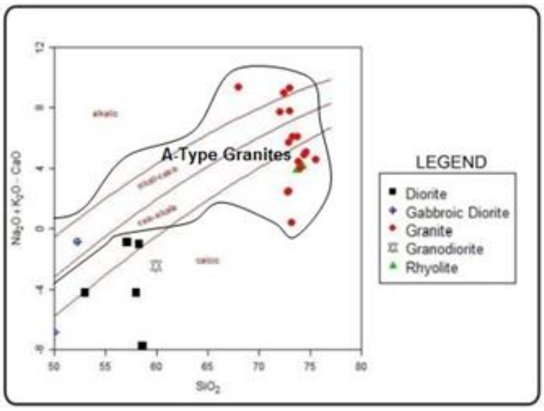

Fig**. 8:** Chemical Classification using Na_2O+K_2O-CaO vs SiO_2

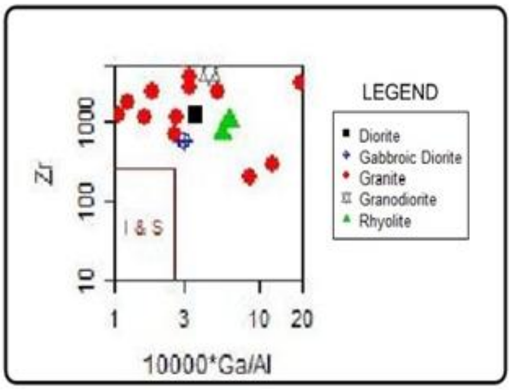

Fig. 9: Zr vs 1000*Ga/Al diagram

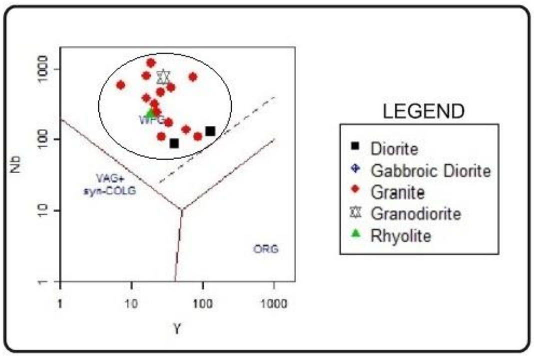

Fig. 10: Tectonic discrimination diagram Nb vs **Y**

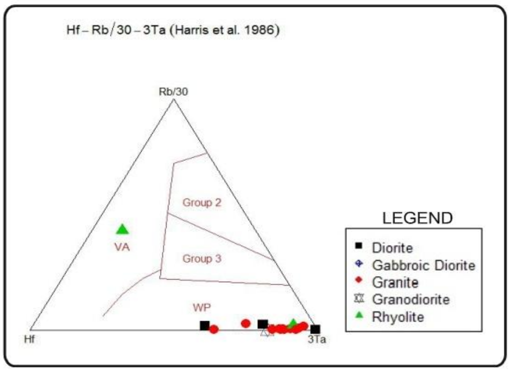

Fig. 11: Hf-Rb/30-3Ta Triangular diagram

The projection of the field samples on Frost et al modified alkali-lime index vs SiO_2 also plot the rocks within the A-type field (Fig. 8). Use of the popular Pearce et al trace element discrimination diagrams (Fig. 9 and Fig. 10), for tectonic interpretation of granites rocks (Y vs Nb and Y+Nb vs Rb), all samples were plotted in both diagrams in WPG, as well in the field of A-type granites in the Y vs Nb diagram, delineated by Stern and Gottfried. The Hf-Rb/30-3Ta triangular diagram also plot the rocks as within plates (Fig. 11). These diorites and gabbroic diorites are high in MgO, FeO*, CaO, Sr while the granitoids are high SiO_2, Na_2O, K_2O, Fe/Mg, Y and show both the LREE and HREE (Eby and Kochhar, 1990).

Spidergraphs show negative Sr, Th, Nb and Yb anomalies, indicating either the retention of plagioclase and accessory minerals in the source during partial melting or their separation during fractionation (Fig. 12). It also supported by their high Zr, Y and low Ti contents, characteristic of acid magmas generated within-plate tectonic environment. Enrichment in the high field strength (HFS) elements is a characteristic feature of alkaline A-type granites in general. The high enrichment of these elements in the investigated granites confirm their A-type identity and exclude them from other granite type on the Zr vs 1000Ga/Al diagram (Fig. 9). All of the REE patterns have strong negative Eu anomalies and exhibit concave downward shapes of obvious positive slopes due to heavy REE enrichment relative to middle and light REE. The heavy REE are more greatly depleted suggesting absence of garnet in the source, since heavy REE are highly com-patible in garnet (Wilson, 1989). This further indicate that, if mantle participation is assumed in the source material, a shallow mantle is preferred rather than deep one where spinal stability is favored rather than garnet (Ragland, 1989).The enrichment of Zr and Nb in the rocks indicate Nb-Sn-W mineralization. The northern parts of the Complex contains Pb>15 which confirms that they are tin-bearing or productive granitoid suites.

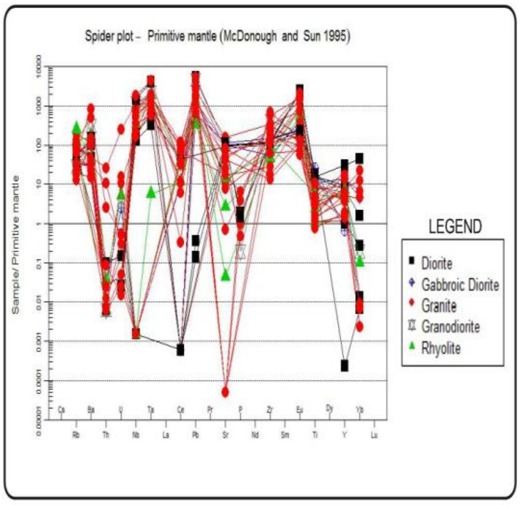

Fig. 12. Spidergraph - Primitive Mantle

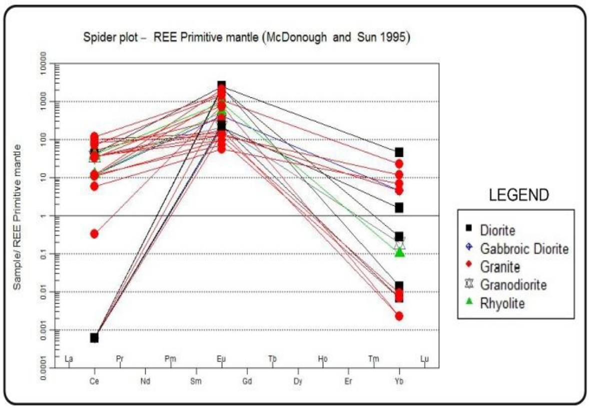

Fig. 13. Spidergraph - REE Primitive Mantle

II. Conclusion

From the field relations and petrographic studies (Aga and Haruna, 2019a) and the geochemistry of the A-type Saiya-Shokobo Younger Granite Complex, the following petrogenetic model is likely. The mafic magmasmost probably derived from the upper part of the lithosphericmantle were emplaced in a deep crustal magma chamber. Duringtheir ascent, these magmas may have undergone high fractionati**o**nand possibly minor contamination by crustal material. The secondstage was characterized by fractionation of the mafic magma**s**in the magma chamber to produce the more felsic members of thesuite with crustal assimilationnot being significant at thisstage.

Acknowledgement

T. Aga acknowledge the support of Topgems Prolific Nigeria Limited, Jos, Nigeria for the geological investigation of the Sara-Fier Younger Granite Complex. Messrs Yaharo, E.D. and Bulus, D. of the Nigerian Geological Survey Agency, Kaduna are appreciated for their support and encouragement during chemical analyses. Dr. E. Allu is thanked for making out time during her post-doctoral research work at Central University in South Africa to download and send relevant materials that improved the initial manuscript.

References

[1]. Castro, A., Moreno-Ventas, I. and de la Rosa, J.D. (1991): H-type (Hybrid) Granitoids: A proposed Revision of the Granite-type Classification and Nomenclature. Earth-Science Reviews 31, 237-253.

[2]. Collins, W. J., Beams, S.D., White, A.J.R.and Chappell, B.W. (1982): Nature and origin of A-type granites with particular reference to Southeastern Australia. Contributions to Mineralogy and Petrology. Vol. 80. Pp. 189-200.

[3]. Eby, G.N. and Kochhar, N. (1990): Geochemistry and Petrogenesis of the Malani Igneous Suite, North Peninsular India. Journal of Geological Society of India, Vol. 36. Pp. 109-130.

[4]. Frost, B. R., Barnes, C. G., Colins, W.J., Arculus, R.J., Ellis, D.J. and Frost C.D. (2001): A geochemical classification for granitic rocks. Journal of Petrology. Vol. 42. Pp. 2033-2048.

[5]. Kinnaird, J.A. (1985): Hydrothermal Alteration and Mineralization of the Alkaline Anorogenic Ring Complex of Nigeria. Journal of African Earth Science. Vol. 3. Pp. 229 – 251.

[6]. Loiselle, M.C. and Wones, D.R. (1979): Characteristics and Origin of Anorogenic Granites. Geological Society of America Abstracts with Programs. Vol. 11. P468.

[7]. Macleod, W.N; Turner, D.C and Wright, E.P. (1971). The Geology of Jos Plateau. Geol.Surv.Nigeria Bull. No.32.Vol.2. 160pp.

[8]. McDonough, W.F. and Sun, S.S. (1995). The Composition of the Earth. Chemical Geology.Vol 120. Pp 223-253.

[9]. Maniar, P.D and Piccoli,P.M (1989). Tectonic Discrimination of Granitoids. Geological Society,American Bulletin.No 101.Pp 635-643.

[10]. Middlemost, E.A. (1985): Magmas and Magmatic Rocks. An Introduction to Igneous Petrology. Longman Group, UK. Pp. 73-87.

[11]. Pearce, J.A. and Norry, M.J. (1979): Petrogenetic Implications of Ti, Z, Y and Nb variations in volcanic rocks. Contributions to Mineralogy and Petrology. Vol. 69. Pp. 33-47.

[12]. Pearce, J.A; Harries, N.G and Tindale, A.G (1984):Trace Element Discrimination Diagrams for the Tectonic Interpretation of Granitic Rocks. Journal of Petrology.Vol.25.Pp 956-983.

[13]. Ragland P.C. (1989): Basic Analytical Petrology. Oxford University Press. New York.

[14]. Shand, S.J. (1947): Eruptive Rocks. Their Genesis, Composition, Classification, and Their Relation to Ore-Deposits. J. Wiley & Sons, New York.

[15]. Stern R.J and Gottfried D. (1989): Discussion of the paper "Late Pan- African Magmatism and Crustal Development in Northeastern Egypt". Geological Journal. Vol. 24. Pp. 371–374.

[16]. Whalen, J. B., Currie, K. L. and Chappell, B. W. (1987): A - type granites: Geochemical characteristics, discrimination and petrogenesis. Contributions to Mineralogy and Petrology. Vol. 96. Pp. 407-419.

[17]. Wilson, M. (1989): Igneous Petrogenesis: A Global Tectonic Approach. Unwin Hyman Ltd.

Aga, T.. " The Geochemical Contraints in The Origin of The Saiya-Shokobo Younger Granite Complex, Central Nigeria." IOSR Journal of Applied Geology and Geophysics (IOSR-JAGG) 7.3 (2019): 01-07.