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PETROCHEMISTRY, Pb ISOTOPE SYSTEMATICS, AND GEOTECTONIC SETTING OF THE GRANITE GNEISSES IN ILESHA SCHIST BELT, SOUTHWESTERN NIGERIA

AKINDELE O. OYINLOYE

ABSTRACT

The petrology, geochemistry, geotectonic setting and common Pb isotope model ages for the granite gneisses in Ilesha schist belt have been studied and presented in this paper. These gneisses, apart from the normal rock-forming silicates, contain apatite, monazite, ilmenite and zircon in trace amounts. The occurrence of monazite in the assemlage for these rocks indicates crustal input into their original precursor rock. The K/Na ratios, greater than one (1) and AFM plots for the Ilesha schist belt gneisses suggest that they are calc-alkaline in nature, and related to a subduction tectonic setting. Low U/Pb and Th/Pb ratios (0.10 to 0.31 and 0.33 to 1.35, respectively) and normal Pb content (30-47 ppm) show that the common Pb component of these gneisses have not been contaminated with radiogenic Pb. Common Pb model ages obtained for the granite gneisses indicate that they were probably emplaced around 2640 Ma and deformed during the Proterozoic. Plumbotectonic plots for the gneisses suggest that they were formed in an orogen where a crustal plate has been subducted into the mantle to form a mixed hydrous precursor magma for the protocontinent from which the gneisses were derived.

KEY WORDS ; plumbotectonic, protocontinent, orogen, tectonic, radiogenic, errochron.

INTRODUCTION

Nigeria lies in the Pan - African mobile belt of West Africa where rocks have undergone polycylic metamorphism and deformation. The basement complex in Nigeria is very extensive starting from the southwest and extending to the northwest and north central parts of the country. (Fig 1). The schist belts, which occur prominently in the southwestern and northwestern areas of Nigeria (Fig. 1), form an important component of the basement complex. These belts have been well studied because most of them contain gold, iron, tin, marble, and tantalum and niobium mineralisation. The Nigeria schist belts which have been described as similar to Archaean greenstone belt, (Wright and Mc-curry 1970), extend over a distance of 400 km along NE-SW trends parallel to the line of the Ifewara-Zungeru major fault, represented by IZF in Figure 1. The northwestern schist belts are separated from the southwestern belts by the narrow Nupe Cretaceous basin. Some workers believe that the schist belts in Nigeria are Archaean, Mid-Preterozoic or Late Proterozoic based on isotopic dating and lithological characteristics observed in these belts (e.g. Russ 1967, Odeyemi 1981, Dada 1989, Ogezi 1988, Oversby 1975, Grant 1970, Ranaman 1988, Annnor 1995). On the basis of petrological, geochemical, structural mapping and geotectonic studies other workers have concluded that the schist belts are Pan-African in age; (e.g. Mc-Curry 1976, Rahaman et al., 1988). Tubosun et al., (1984), Rahaman (1991) observed that the Pan-African metamorphic imprint on the earlier basement rocks especially on the migmatite-gneisses and granitoids is very prominent.

Many attempts have been made to date rocks of the basement complex in Nigeria. Grant (1970) obtained a Rb-Sr isochron age of 2200 ± 124Ma for the Ibadan granite gneiss. Overseby (1975) obtained a Pb-Pb date of 2750Ma for feldspar separates from an applite occurring at Ibadan. Grant et, al., (1972) obtained a Rb-Sr age of 1120±124Ma on the Ile-Ife granite gneiss. This age which was interpreted as a metamorphic age (Hubbard 1975), and evidence for a Kibaran metamorphic activity in Nigeria, rather than an igneous orogeny, (Ajibade and Woakes 1989). Rahaman et al., (1983), also obtained a Rb-Sr age of 1904±18Ma on Igbeti granite gneiss. On the basis of U-Pb zircon dating, the Ile-Ife granite yielded an age of 1825± 12 Ma, (Lancelot and Rahaman, 1984). The Kabba-Okene granodiorite gneiss in the Egbe–Kabba schist belt yielded Early Proterozoic (2100Ma) U-Pb age according to Annor (1995).

According to Ajibade and Woakes (1989), the southwestern schist belts consist of two distinct generations, one represented by

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migmatite-gnessis complex sequence probably of Archaean to Early Proterozoic age and the other believed to be of Late Proterozoic age. These authors were of the opinion that the Iseyin-Oyan River group and western half of the Ilesha schist belt (including Ile-Ife) belong to older sequence.

The most prominent structural features in the schist belts are the synclinal and anticlinal folds approximately displayed in a NE direction (*Ajibade et al.*, 1989). These are similar to those described in the northwestern schist belts by Grant (1978) and Odeyemi (1981). These deformations are considered to be related to the Pan-African themotectonic deformation Odeyemi (1988). The schist belts consist predominantly of pelites, which are represented by phyllites, garnet bearing carbonaceous schist, mica schist, chlorite schist and graphite schists of argillaceous origin, (Adekoya 1988).

The Ilesha schist belt is one of the most

Table 1: Chemical data for representative samples of granite gneisses from the Ilesha schist belt southwestern Nigeria.

SPL	BGG1	PGG2	BGG3	PGG4	BGG5	PGG6	BGG7	PGG8	BGG9
SiO_2	75.79	71.14	73.21	71.39	70.83	77.57	70.12	71.68	76.77
TiO_2	0.03	0.60	0.33	0.46	0.39	0.26	0.41	0.38	0.16
Al_2O_3	11.80	12.88	13.83	14.66	12.75	11.99	16.08	15.77	13.25
Fe_2O_3	1.53	3.47	1.64	3.04	3.28	1.31	2.21	2.44	1.76
MnO	0.02	0.45	0.02	0.06	0.04	0.02	0.03	0.03	0.04
MgO	0.44	1.37	0.51	0.93	0.71	0.32	0.61	0.55	0.24
CaO	0.44	1.49	0.95	0.62	1.51	0.43	2.23	1.72	1.24
Na_2O	1.60	1.95	1.61	3.38	1.34	1.39	2.87	2.74	2.30
K_2O	6.58	5.30	6.32	4.47	5.52	6.41	4.75	4.78	4.73
P_2O_5	0.06	0.16	0.03	0.12	0.09	0.02	0.94	0.03	0.04
LOI	1.14	0.82	3.09	0.96	2.78	0.59	0.64	0.66	0.05
TOTAL	**99.52**	**99.63**	**101.54**	**100.29**	**99.24**	**100.31**	**100.89**	**101.05**	**100.58**
Trace element in ppm									
Pb	30	37.00	38.00	38.00	40.00	41.00	46.00	47.00	40
Ba	645	1180	1634	1510	1125	1067	1207	1030	402
Sn	5.00	10.00	nd	8.00	8.00	2.00	12.00	nd	nd
Zn	110	63.00	54.00	75.00	35.00	79.00	66.00	36.00	30
Cu	180	76.00	52.00	57.00	151	89.00	56.00	50.00	51
Ni	62.00	26.00	15.00	17.00	17.00	16.00	15.00	15.00	11
Cr	38.00	44.00	12.00	17.00	5.00	8.00	3.00	3.00	nd
S	442	114	118	189	134	326	115	404	120
Cs	20.00	18.00	46.00	20.00	8.00	17.00	15.00	nd	10
V	45.00	53.00	38.00	30.00	28.00	32.00	19.00	23.00	15
Co	222	144	125	89.00	184	140	153	162	151
Rb	166	230	193	226	207	187	187	194	263
Sr	154	26.3	194	327	310	465	377	145	146
Y	8.00	30.00	22.00	14.00	32.00	36.00	17.00	41.00	42
Zr	455	288	330	352	242	321	314	247	144s
Nb	4.00	20.00	19.00	18.00	20.00	24.00	20.00	23.00	20
U	Nd	6.00	1.00	5.00	9.00	4.00	1.00	1.00	06
Th	14.00	50.00	42.00	38.00	34.00	21.00	24.00	35.00	20
Ca	1.00	17.00	23.00	25.00	17.00	6.00	20.00	19.00	11
Ta	3.00	1.00	5.00	7.00	4.00	nd	nd	nd	nd
Sc	1.00	1.00	13.00	nd	nd	nd	8.00	5.00	4
Cd	1.00	9.00	nd	9.00	7.00	11.00	5.00	nd	2
K/Na	4.11	2.72	3.93	1.32	2.40	4.61	1.70	1.74	2.06
U/Pb	-	0.16	0.03	0.13	0.23	0.10	0.02	0.25	0.15
Th/Pb	0.46	1.35	1.11	1.00	0.85	0.51	0.52	0.5	0.5

Table 1 contd

SPL	BGG10	PGG11	BGG12	PGG13	BGG14	PGG15	BGG16	PGG17	BGG18
SiO_2	75.47	72.43	73.30	71.18	75.77	75.22	75.69	76.47	75.71
TiO_2	0.18	0.41	0.36	0.44	0.19	0.23	0.18	0.16	0.15
Al_2O_3	13.60	14.74	14.58	14.87	13.29	13.13	13.71	13.06	13.10
Fe_2O_3	1.76	2.29	2.41	2.85	1.84	1.33	1.88	1.71	1.68
MnO	0.05	0.01	0.01	0.12	0.05	0.25	0.04	0.04	0.04
MgO	0.46	0.64	0.51	0.65	0.37	0.47	0.25	0.24	0.25
CaO	0.94	1.51	1.58	1.55	0.96	0.98	1.39	1.36	1.17
Na_2O	2.29	2.27	1.84	1.77	2.26	2.27	2.49	2.53	2.44
K_2O	5.27	5.99	5.37	5.78	5.05	5.69	4.55	4.51	4.93
P_2O_5	0.04	0.24	0.19	0.21	0.04	0.04	0.03	0.03	0.04
LOI	0.97	0.58	0.73	0.98	0.06	0.81	0.41	0.39	0.68
TOTAL	**101.03**	**101.81**	**100.88**	**100.40**	**100.42**	**100.43**	**100.62**	**101.10**	**100.29**
Trace element in ppm									
Pb	30	35	32	40	32	39	38	38	40
Ba	350	783	500	450	645	1180	1634	1510	1125
Sn	10	Nd	10	8	5	11	10	6	7
Zn	36	56	30	51	61	52	53	50	42
Cu	56	52	56	50	50	60	52	53	66
Ni	15	14	16	15	22	26	21	17	6
Cr	2	09	3	2	40	38	42	16	18
S	115	212	110	45	146	108	125	116	120
Cs	nd	12	10	8	20	18	42	25	30
V	25	27	25	15	45	50	37	34	35
Co	160	133	150	152	122	140	130	108	121
Rb	275	171	200	215	160	150	230	200	250
Sr	150	164	150	140	150	250	190	302	300
Y	35	21	35	30	10	25	20	14	30
Zr	151	291	246	230	450	280	320	350	240
Nb	18	19	18	22	4	20	18	16	18
U	6	8	10	8	2	6	1	5	9
Th	10	20	21	21	14	16	12	10	8
Ca	18	19	11	20	1	12	20	25	16
Ta	Nd	3	4	2	3	1	5	6	7
Sc	8	23	10	15	1	1	2	5	4
Cd	1	2	2	6	1	3	4	6	5
K/Na	2.30	2.64	2.91	3.27	2.13	2.51	1.82	1.78	2.02
U/Pb	0.20	0.23	0.31	0.20	0.06	0.51	0.03	0.13	0.23
Th/Pb	0.33	0.57	0.66	0.53	0.43	0.41	0.32	0.26	0.40

Major elements are reported in oxide weight percent; trace elements reported in parts per million; Fe_2O_3* total iron reported as Fe_2O_3, nd. below detection limit; SPL - sample; LOI loss on ignition. PGG Pink granite Gneiss, BGG = Biotite Granite Gneiss.

prominent in southwestern Nigeria. This is separated into two dissimilar lithological groupings by the Ifewara-Zungeru major fault (Fig 2). In the western section of the belt, the lithology includes amphibolites, hornblende gneiss, banded gneiss, biotite schist, talc tremolite schist quartz-muscovite schist and granites (Fig 2). In the eastern half, the terrain consists of granite gneiss migmatite-gneiss, quartz-muscovite schist and granites. Except for the Ile-Ife and Ibadan granite gneisses, the gneisses in Ilesha schist belt, especially around Iperindo and Iwaraja, have not been dated. In this study, the petrochemistry and Pb-Pb geochemistry of gneisses from Iperindo and Iwaraja granite gneisses are studied with a view to discussing the age and tectonic setting of these rocks.

MATERIALS AND METHODS OF ANALYSIS

Extensive fieldwork was carried out at

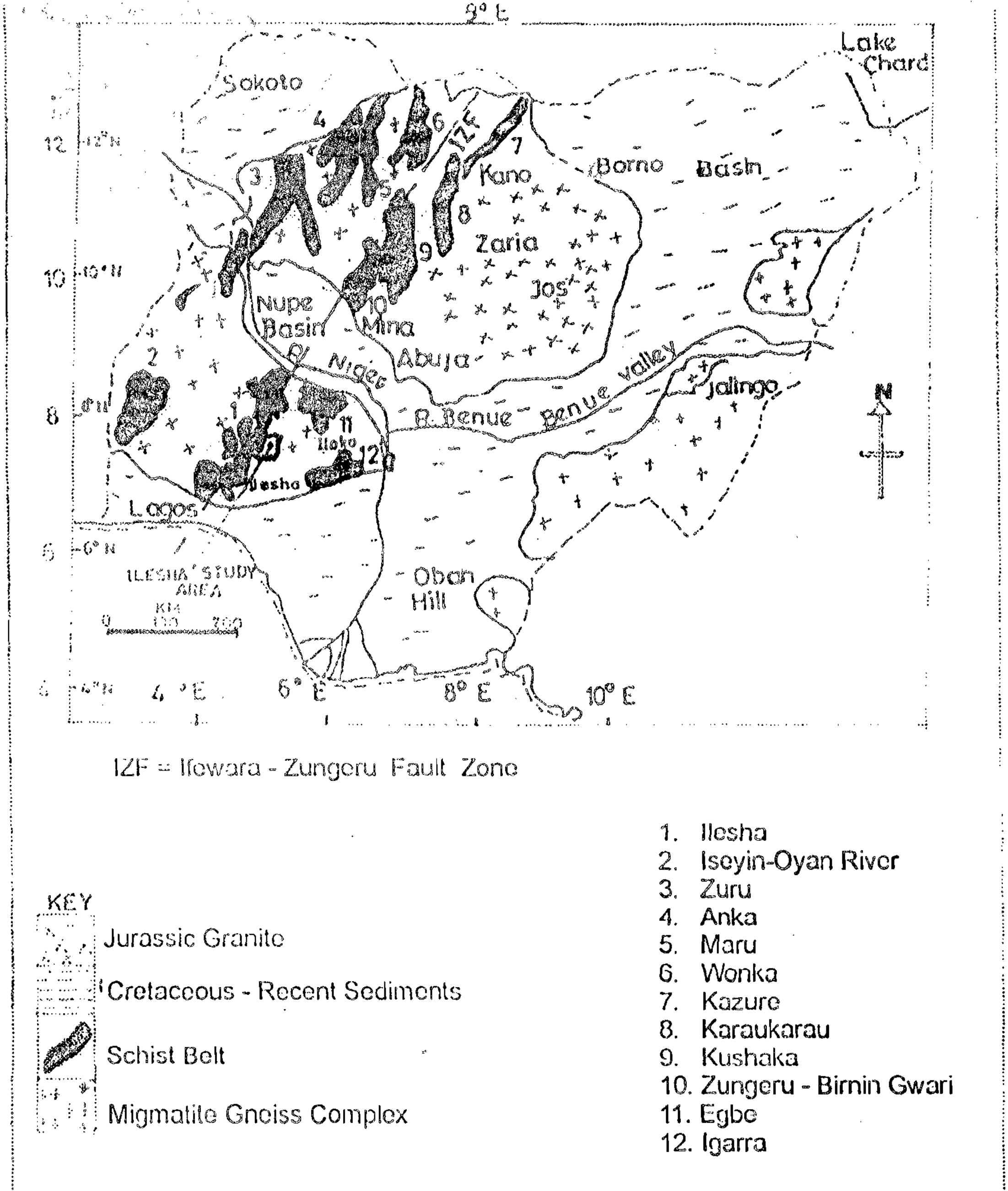

Fig. 1. Geological Map of Nigeria (modified from Ajibade et al., 1989)

Ilesha area to study the field relationships of the rocks in the belt in space and time and to collect rock samples for petrological and chemical analyses.

The petrography was studied on conventional – thin sections. Chemical analysis for major and trace elements were carried out on rock beads and compressed rock powder pellets respectively using an X-Ray Fluorescence (XRF) equipped with a computer and printer.

Rare earth elements (REE) were determined using the Inductively Coupled Plasma (ICP) source spectrometer. Rock samples (0.5 g of powdered rock) were first dissolved in HCl and then in HF – $HClO_4$. The residue which did not dissolve completely was fused with NaOH. Chromatographic glass columns were used for the REE separation. 20 g of resin was loaded on to columns giving a settled height of 10 cm The

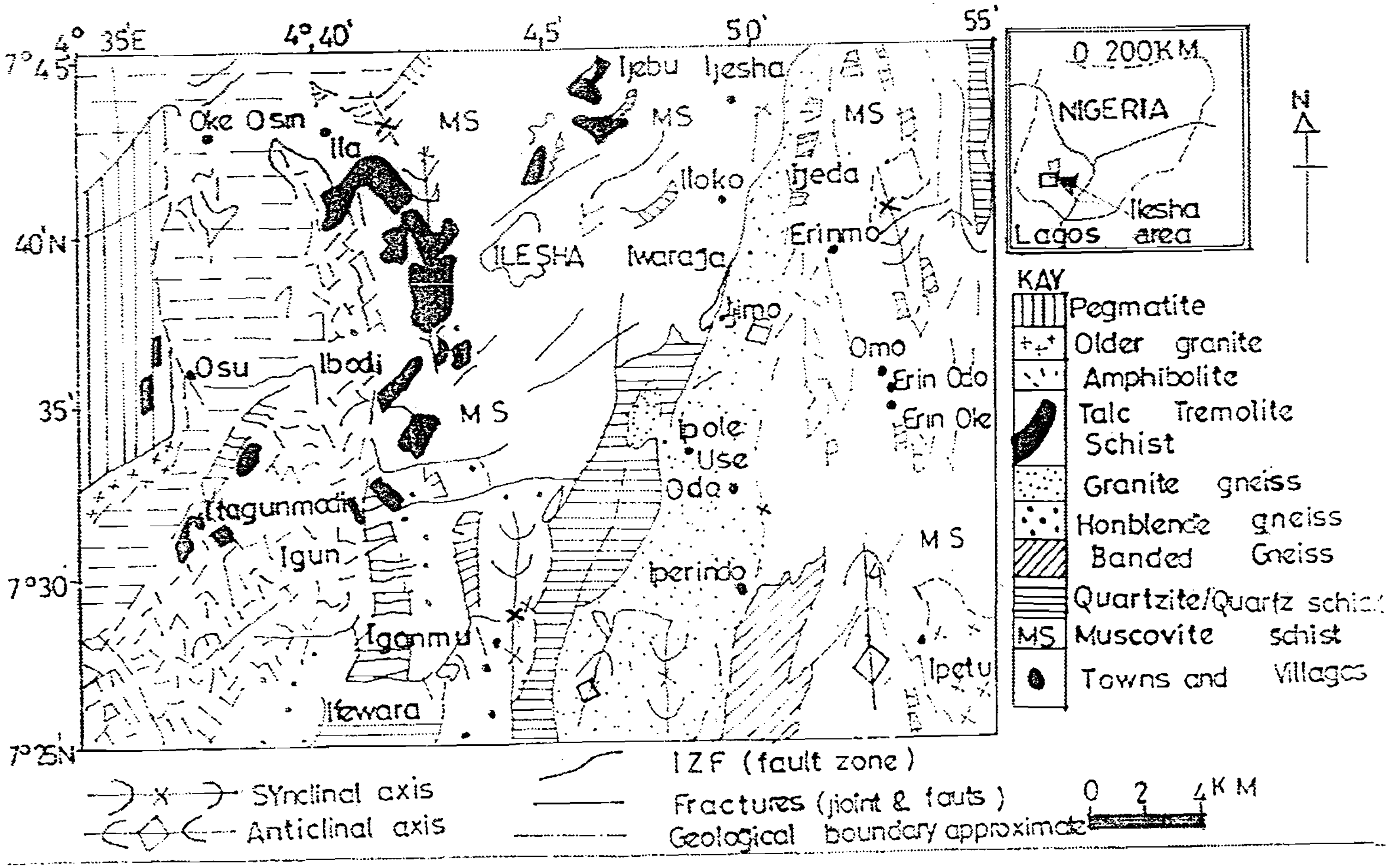

FIG. 2. Geological Map of ilesha Schist belt (modified from Elueze 1982)

Table 2: Absolute REE Data (in ppm) for the granite gneisses from the Ilesha schist belt, SW Nigeria

SAMPLES	BGG1	BGG2	BGG3	AVERAGE	PGG1	PGG2	PGG3	AVERAGE
La	85.50	82.80	78.80	82.87	51.70	54.30	59.40	55.13
Ce	152	148	141	141	96.69	100.96	111	102.89
Pr	15.57	15.59	15.22	15.46	10.16	10.73	11.74	10.88
Nd	55.18	55.12	55.34	55.21	36.16	37.89	41.28	38.45
Sw	8.25	8.25	8.77	8.51	6.23	6.51	6.89	6.54
Eu	1.30	1.38	1.84	1.51	0.68	0.80	0.79	0.76
Gd	5.74	6.60	6.88	6.51	5.12	5.74	5.72	5.53
Dy	4.21	5.59	5.86	5.22	5.57	6.45	6.11	6.04
Ho	0.70	0.99	1.04	0.91	1.07	1.24	1.13	1.15
Er	1.91	3.10	3.02	2.68	3.41	4.20	3.52	3.71
Yb	1.34	2.22	2.48	2.01	3.72	4.24	3.50	3.82
Lu	0.21	0.34	0.37	0.31	055	0.64	0.50	0.56
Total	**332**	**330**	**321**	**328**	**221**	**234**	**252**	**235**
LREE	318	312	101	310	202	211	231	215
HREE	14	18	20	18	19	23	21	20
LREE/HREE	22.71	17.33	15.05	17.82	10.63	9.17	11	10.75

LREE - Light Rare Earth Elements: HREE Heavy Rare Earth Element

SPL - Samples. Mean calculated with 1 standard deviation

BGG = Biotite Granite Gneiss

LREE = Light Rare Earth Elements

HREE = Heavy Rare Earth Elements

PGG Pink Granite Gneiss

REE were held quantitatively on the resin and were eluted with 500ml of 4*N*HCl. The solution was filtered and evaporated to dryness. The REE were subsequently redisolved in 5ml of 10% HCl and then injected into the ICP source spectrometer for analysis.

The ICPSS used was Philips model PV8210 1.5-m which is capable of evaluating spectral lines and measuring the REE concentration in each sample. Precision level attained was better than 1%.

Pb-Pb isotope analysis was carried out at the NERC isotope Geoscience Laboratory, Keyworth United Kingdom. Analysis was made using a Finigan MAT 261 Mass-Spectrometer equipped with Pb multicollector. Pb isotope ratios were corrected for mass fractionation effects at 0.16% a. m. u., according to repeated runs of NBS 981. The absolute values of NBS 981 common lead obtained are: $^{206}Pb/^{204}Pb = 16.991$, $^{207}Pb/^{204}Pb = 15.661$, and $^{208}Pb/^{204}Pb = 37.839$. Samples were briefly leached in 3*N* HC1. The precision level attained for Pb-Pb isotopic analysis was better than 0.2% for the whole rock and feldspar runs. The 2σ error for isotopic dilution analysis of Pb concentration is 2%. The whole rock $^{207}Pb/^{204}Pb$, $^{208}Pb/^{206}Pb$ and $^{207}Pb/^{206}Pb$ ratios for each sample are shown on Table 2.

Petrography

The biotite granite gneiss is foliated, folded and deformed. It displays prominent synclinal and anticlinal axes, (Fig. 2). Where gneissic banding is prominent, mafic and felsic bands alternate. The mafic bands are composed of biotite, hornblende, garnet and minor chlorite in places while the felsic bands are composed of quartz, muscovite and feldspars. At Iperindo, narrow and wide quartz veins are common on the biotite granite outcrops and these veins are deformed forming ladder folds and minor faults. Commonly, quartz veins vary from less than 1 cm to about 30 cm in width. At Iwaraja (Fig. 2) the gneiss contains abundant pink K – feldspar and hornblende. Pinch and swell structures are common on the Iwaraja granite gneiss. The general strike of rocks in this belt is NE – SW and dips are to the west at about 75^0 on the average. Plunge angles of folds are from 40-70^0 in a NE direction.

In thin section, the gneisses are composed of quartz, biotite, K – feldspar, minor plagioclase hornblende, garnet and chlorite. Accessory components include apatite, monazite, ilmenite and zicorn. Polished sections revealed that pryrrhotite, pyrite, minor sphalerite and galena are present as primary sulphides. The occurrence of monazite in the mineral assemblage of these rocks is an indication of a sedimentary input into its original precursor rocks (Allan Bromley pers. comm. 1992).

RESULTS AND DISCUSSION

Geochemistry: Major Elements

Major element chemical data for 18 representative samples of the gneisses are shown in Table 1. The concentrations of SiO_2, $A1_2O_3$, Na_2O and K_2O in these rocks reflect their rock forming silicate contents as described in thin section study. The consistently higher K_2O than Na_2O (thus K_2O/Na_2O ratios greater than 1) in these gneisses is an evidence of more abundant potassium bearing rock forming silicates, (microcline especially) than sodic feldspar as observed in field and microscopic studies. Martins (1986) suggested that Archaean calc-alkaline granitic rocks typically have K_2O/Na_2O ratio greater than 1. Total iron (Fe_2O_3), MgO, CaO and P_2O_5 contents of these gneisses are very low reflecting their less mafic character. On the AFM diagram (Fig. 3) all the gneisses plot in the calc-alkali fractionation trend reflecting development of felsic silicates more than fero-magnesian minerals as rightly observed in thin sections of these gneisses. Igneous rocks plotting in the calc-alkaline fractionation trend on the AFM diagram are generally interpreted to be related to subduction zone tectonic setting where the mantle has been metasomatized to form a mixed magma (Wilson 1991).

Trace and Rare Earth Elements (REE)

Rb is relatively highly concentrated in these gneisses (Table 1) due to substitution of Rb for K in microcline and biotite which are relatively

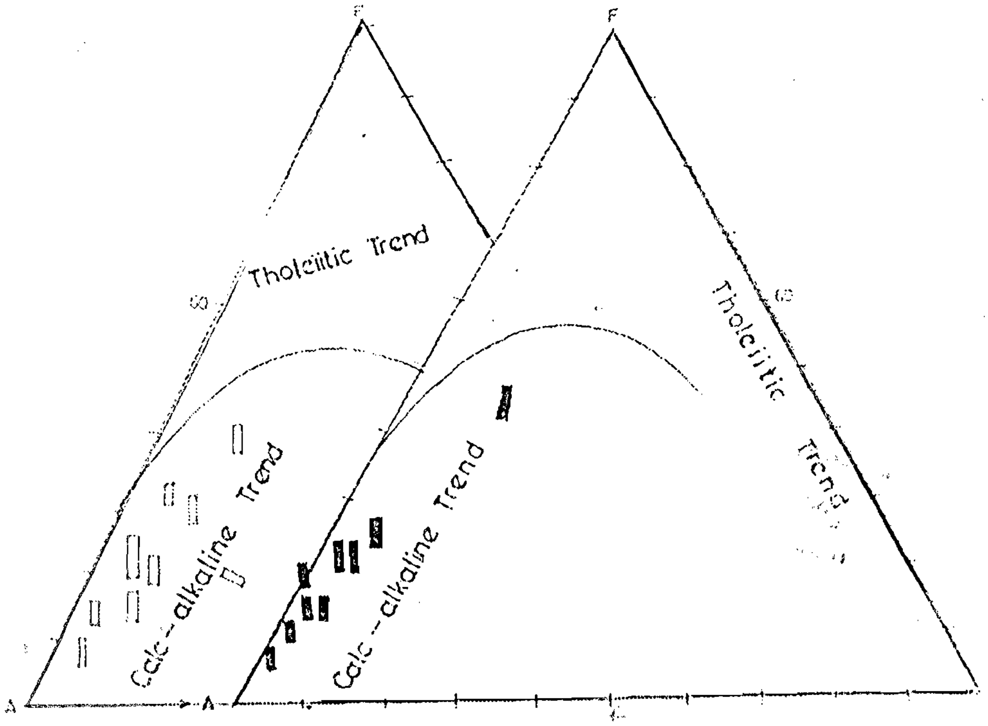

Fig. 3 AFM diagrams for the biotite granite gneiss (BGG) and the pink granite greiss, (PGG) from Ilesha schist belt. A = $K_2O + Na_2O$ wt%
F = total iron as Fe_2O_3 wt% M = MgO wt%
Filled rectangles are biotite granite gneiss samples, open rectangles are the pink granite gneiss samples.

abundant in the rocks. Sr is equally relativeky abundant in these rocks (Table 1) due to plagioclase and hornblende contents in which Sr can substitute for Ca. Zr content reflects the presence of apatite and ziron which habour this element. Y content reflects hornblende component which contain Y in these rocks. P content reflects the presence of the trace amount of apatite. P is reported as P_2O_5 and forms part of the major elements in these rocks.

The concentration of Ni, Cr, Co and V are relatively low (Table I) reflecting the acid nature of these gneisses. Moreover, these gneisses have been affected by the Pan - African thermotectonic episodes which resulted to remelting and recrystallisation with consequent enrichment in K, Rb, Ba, and Ce in comparison with Ni, Co, V, and Cr. Cu and Zn contents of the gneisses are not anomalous. They are probably associated with the silicates and the primary sulphides in the gneisses. Sn is perhaps associated with biotite in these rocks. The concentration of Pb in these gneisses (10-47ppm) fall within the range for granitic rocks (Faure, 1986). U contents vary from 0-10ppm in all the samples studied (Table I), while Th varies from 10-50ppm. The ratios of U/Pb and Th/Pb are very low, 0.10 to 0.31 for

Table 3: Lead chemical data for the Ilesha schist belt granite gneisses

Whole Rock Sample	**206Pb** 204Pb	**207Pb** 204Pb	**208Pb** 204Pb	**208Pb** 206Pb	**207Pb** 206Pb
WGJ4	26.083	17.174	44.942	1.7232	0.6585
P23C7	20.555	16.100	41.151	2.0021	0.833
P29C1	16.992	15.662	38.656	2.2751	0.9217
P29C2	17.4468	15.663	37.307	2.1358	0.8966
P2AC3	18.698	15.801	39.800	2.1286	0.8450
P30C1	19.951	16.062	39.817	1.9959	0.8051
Feldspar samples					
WGW3	27.058	17.138	45.541	1.6834	0.6334
P24C4	18.423	15.800	38.270	2.0774	0.8577
P25C9	18.295	15.756	38.397	2.0988	0.8612
P2AC9	18.809	15.799	38.314	2.0370	0.8399
P30C5	17.459	15.673	37.427	2.1439	0.8977
P33C7	18.042	15.767	39.237	2.1748	0.8739

Whole rock
Sample

Slope	1.sig	initial Ratio	MSWD	Age	2.sig.	
0179	0.002	12.481	16	2644	37	- 38

Feldspar
Samples

Slope	1.sig	initial Ratio	MSWD	Age	2.sig	
0.092	0.003	14.078	13	1472	147	- 148

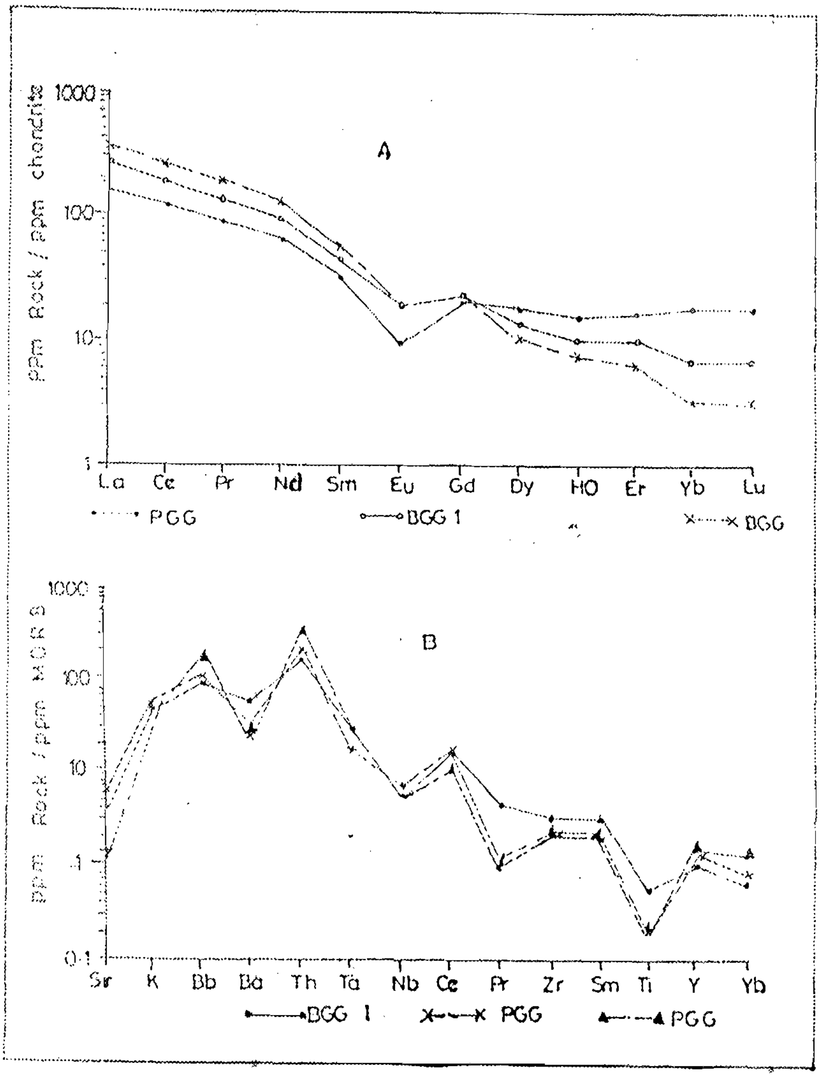

Fig. 4A = Chondrite normalised REE patterns for the pink granite gneiss (PGG) and the biotite granite gneiss (BGG)
4B = Spidergrams of BGG and PGG samples. Only 3 samples were used for each of these plots to avoid clustering at a point.

U/Pb and 0.33 to 1.35 for Th/Pb, (Table I).

The absolute concentration of the rare earth elements (REE) in these gneisses is reported in Table 2. Average total REE in the BGG is 328 pm of which light rare earth elements (LREE, La-Eu) account for 310ppm and HREE (Gd-Lu), 18ppm.

Chondrite normalized REE patterns for these gneisses, are similar, with gradually stepped features from La to Eu and are marked by Eu depletion (Fig. 4A). The similarity in patters suggests that these rocks are genetically related. The concentration of the LREE in these rocks reflects the presence of LREE-enriched minerals such as monazite, which typically indicates crustal contribution to the original magma of the precursor rock from which the gneisses were derived. These rocks show well developed negative Eu/Eu* anomalies (0.20 and 0.17) which also indicates plagioclase fractionation in these rocks.

When the MORB normalized extended trace elements are plotted for the PGG and BGG, they all show the same pattern with marked peaks at Ce and Sm (Fig. 4B) which suggests that these rocks contain LREE enriched minerals. Similarly, troughs shown at Nb and Ti may indicate derivation form a subduction related source rock, (Thompson et al., 1984, Pearce, et al., 1984).

Pb-Pb Isotope Geochemistry

U and Th, bearing minerals often contain radiogenic Pb while common Pb comes from minerals like K – feldspar, galena and other suphides. These minerals which contain common

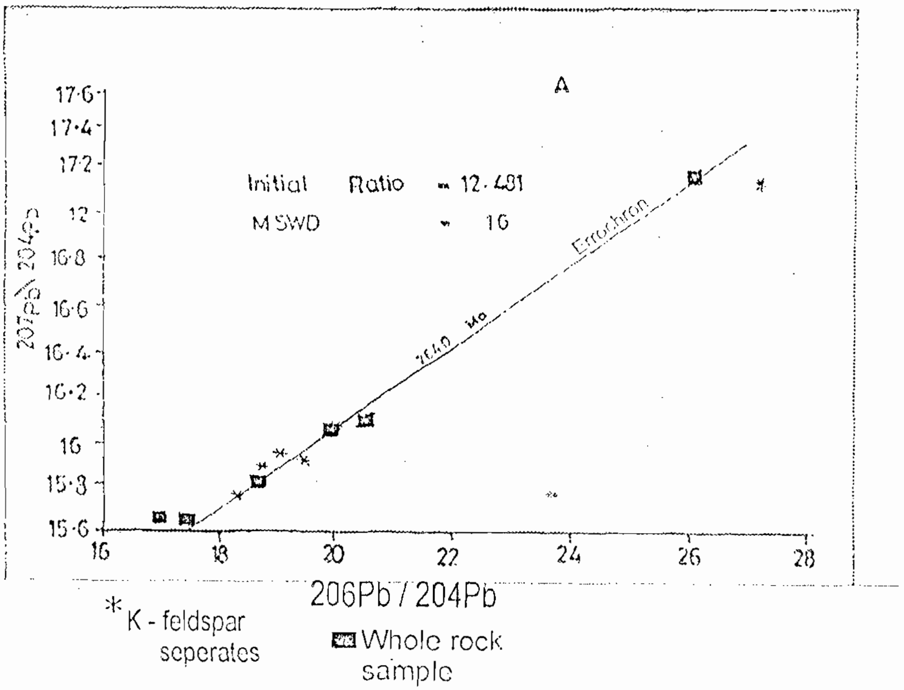

Fig 5. Pb - Pb whole rock and K - feldspar separates errochron diagram for biotite-and pink granite gneisses from Ilesha schist belt.

Pb always have low U/Pb and Th/Pb ratios (Faure, 1986) as recorded for the gneisses in Ilesha schist belt (Table I). The isotopic composition of Pb contains record of the chemical environments in which it resided. The U/Pb and Th/Pb ratios of rocks may be changed by metamorphic processes affecting such rocks. Low U/Pb and Th/Pb ratios in a rock suggest that the Pb isotopic composition does not change appreciably with time (Faure 1986) hence the rationale behind using the whole rock and K – feldspar samples from the Ilesha schist belt gneisses, since they satisfied the above conditions, as described above. The Pb isotopic data for the Ilesha schist belt is presented in Table 3. Of the whole rock samples analysed for Pb-Pb isotope, five are from the biotite granite gneiss from Iperindo area while the other sample WGJ4 is from the Iwaraja granite gneiss (Fig. 2). The five Pb samples from the biotite granite gneiss show a limited scatter on the Pb-Pb errochron, (Fig. 5A), but with a well defined trend. WGJ4 from the pink granite gneiss also plots on the same trend line. The Pb – Pb results for the five K-feldspar separates (plotted in addition) are mostly from the main southern granite gneiss (Fig. 2) and these results are comparable to the equivalent whole rocks. The exception, NGW3 is from the more northernly pink granite gneiss. The results for all the whole rock samples fit well to the indicated best fit line which corresponds to a two stage errochron for 2640Ma with an initial ratio of 12.481 and MSWD of 16 (Fig. 5A). Most of the feldspar separates appear to plot on a different trend (Fig. 5B) which could be an episode of disturbance around 1470Ma. The Pb-Pb data for the K – feldspar gave an initial ratio of 14.078 and MSWD of 13, (Table 3, Fig. 5B).

On plotting the Pb-Pb data on the Zarman and Doe (1981) Pb-Pb evolutionary curves (Fig. 6), 3 of the whole rock samples plot between the 2 curves (OR and UP) and 2 plot outside the curves. All the feldspar data plot between the 2 curves, (Fig. 6). This suggests formation within an orogen where crustal materials descended into the mantle and were partially melted to generate the initial precursor rock magma from which these rocks were formed (cf, Zartman and Doe 1981). It will be recalled that the geochemical plots (Figs. 3, 4A and 4B) as well as petrology indicate that the granite gneisses were derived from a mixed source (mantle and crust).

Pb model dates are often not very accurate especially for metamorphic rocks whose Pb compositions are sensitive to metamorphism and alteration. However Pb model dates can be used to constrain the age of metamorphic rocks and disturbance events if applied with caution. The main error can result from contamination by radiogenic U-bearing minerals in a metamorphic rock. Unsupported radiogenic Pb in feldspars or rocks can be significantly decreased by careful leaching with hydrofluoric acid (Faure 1986) or 3*N* HCl (Manhes et al, 1978) because the excess radiogenic Pb dissolves more readily than the common Pb which enters the feldspar at the time of rock crystallization hence the brief leaching of rock and K – feldspar Pb samples in 3*N* HCl before analysis as described earlier in this paper. Again Pb model dates can be improved and made more reliable by the two – stage model of Pb evolution hence interpretation of Pb model dates in this paper is based on the two stage model age of Stacey and Kramers (1975). The Pb model dates obtained for the gneisses are compared with other dates on rocks in southwestern Nigeria in order to constrain the age of the granite gneisses. Unfortunately, there are no direct dates for rocks from the Ilesha schist belt at present. However, Grant et al, 1972 obtained a Rb – Sr isochron age of 2205±70Ma for the Ibadan granite gneisses which is about 80km from Ilesha schist belt.

Oversby (1975) also obtained a Pb-Pb model date of 2750Ma for K – feldspar separates from an aplite at Ibadan. The Ibadan aplite age compares favourably with the 2640Ma Pb-Pb errorchron age obtained for the Ilesha schist belt gneisses in this study. Rahaman et al, (1988) on the basis of U-Pb in zircon confirmed much the same age (2500±200Ma) for the Ibadan granite gneiss. Grant (1970) suggested that the Ile-Ife granite gneiss (about 32km) from the Ilesha schist belt is 1120±124Ma old, though Ajibade et al, (1987) rightly concluded that this is a metamorphic age of no significance. Rahaman and Lancelot (1984) using on U – Pb zircon dating obtained an upper Concordia intercept age of 1825±27Ma and a lower intercept age of 567±26Ma for the Ile – Ife granite gneiss. The 1825Ma age is regarded as the actual time of emplacement of the Ile – Ife granite gneiss while 567Ma age is interpreted as the minimum age of the main Pan-African event which caused radiogenic Pb-Pb loss. These authors concluded that the western section of the Ilesha schist belt rocks (Fig. 2) belong to Archaean – Early Proterozonic age, based on the geological relationship to the neighbouring granite gneiss and ages obtained at Ibadan and Ile-Ife as

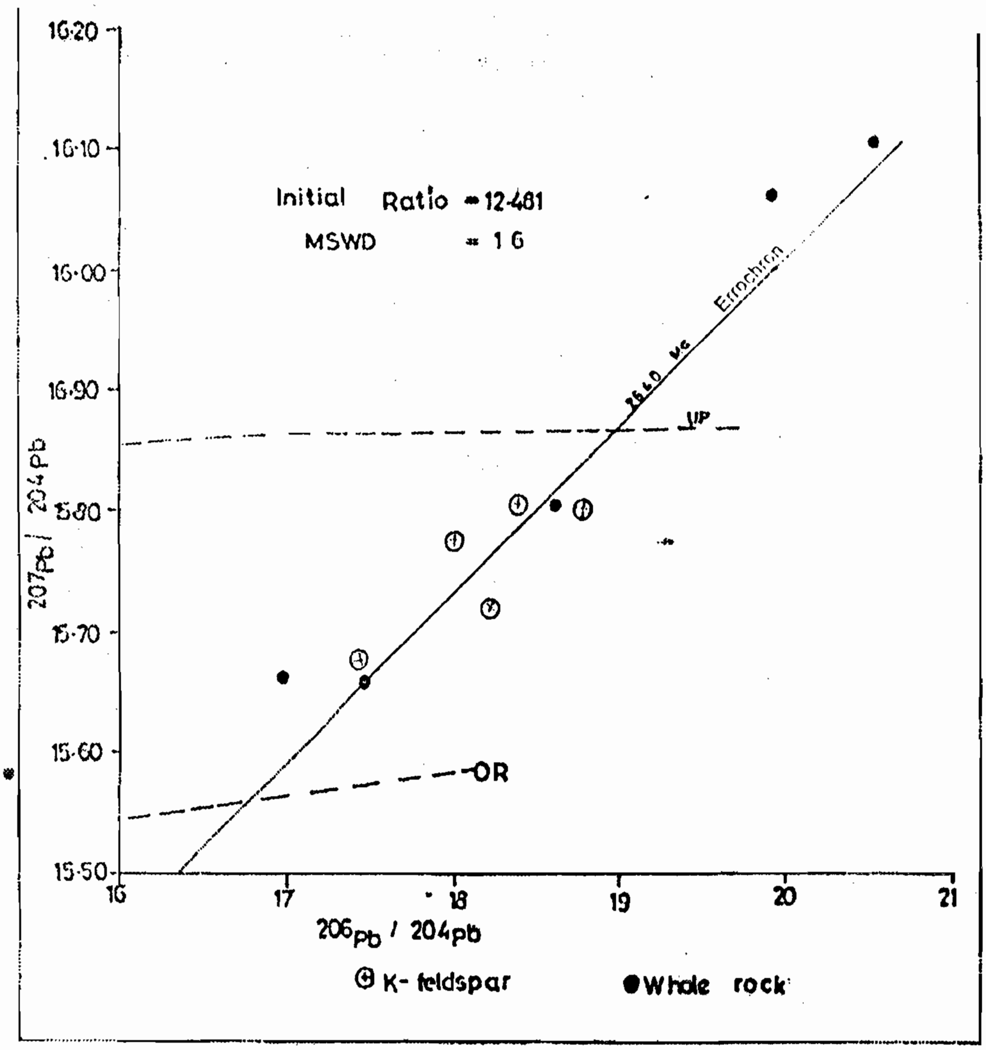

Fig. 6 = Plumbotectonic plots using Pb - Pb from K - feldspar and whole rock samples from the granite gneisses in Ilesha schist belt.
OR = Orogen, UP = Upper crust (method after Zartman and Doe 1981).

explained above. In the same vein it will be logical to suggest tht the Pb-Pb model date of 2640Ma obtained for the Ilesha granite gneiss in this study falls within the age range (Archaean - Early Proterozoic) which have earlier been obtained for similar rocks at Ibadan and Ile – Ife using other methods and Pb-Pb model dating as discussed above.

CONCLUSIONS

Petrological and geochemical studies carried out in this study indicate that the granite gneisses from the Ilesha schist belt were derived from mixed (igneous and sedimentary) sources with a significant crustal component.

Pb-Pb model dates for the Ilesha schist belt gneisses indicate that the rocks were probably emplaced at about 2640Ma and underwent later metamorphic disturbance during the Proterozoic. Plumbotectonic plots for both granite gneisses and the feldspar content revealed that these rocks were formed from a mixed hydrous magma, originating in an orogen.

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