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Geochemical Characterization of Migmatites in Funtua Sheet 78 North-East, Scale 1:50,000 North Western Nigeria

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Abstract

In this present study detailed chemical analyses for major and trace elements were done on a total of 20 samples of the rocks investigated using the AAS, XRF and FP (Flame Photometry) The study area is shown to extend into the north western areas of northern Nigeria and even beyond. The age of D_1 and D_2 deformations and metamorphisms in the FTNE is therefore shown to be Pan-African. At least two geotectonic episodes or intense phases of ductile deformation were identified in the field to have affected the rocks. The rocks have been strongly foliated with crystals showing strong preferred orientations. Fresh and partly weathered rocks exhibited on the extent and effects of wall-rock alterations that must have accompanied the Pan-African orogeny. The harmonized Analytical results showed that the rocks are saturated with respect to silica, and contain moderate to elevated concentrations of Al_2O_3, comparable to most pelitic rocks. There appears to be no consistency in the relative concentration of Alkalis in the rocks, and this possibly indicates a mixed nature of the source materials. Both MgO and CaO compositions portray sedimentary character of the protoliths of the rocks. Migmatite have average of 65.78% SiO_2, 16.12% $A1_20_3$, 2.84% Fe_2O_3, 1.87% MgO, 3.90% CaO and 2.66% Na_2O and 3.08% K_2O respectively. In terms of trace elements they contain 13.61ppm Cr, 16.82ppm Cu and 32.19ppm Zinc. Results of the chemical analyses which is akin to geochemical characterization based on the major and trace elements indicates the FTNE migmatites to be I-type, which also underly the younger metasediments. They originated from a sedimentary protolith, sedimentary origin for the other gneisses. These have led to the interpretation of geochemical evolution and the production of a geologic map on a scale of 1:50,000.

Keywords: *Geochemistry, Migmatites, Major Oxides, Trace Elements, Funtua NE*

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Background to the Study Three (3) petrological units characterize the migmatite-gnesis complex, they are: A granodioritic and or tonalitic gneiss which is now known or early gneiss (Myers, 1978; Rahaman 1988; Sinitsin, 2001). It is present in most outcrops, Mafic to ultramafic component which, where it outcrops, often appear as discontinuous lenses or concordant with minor amount of ultramafite which has biotite as the major mineral. Also observed, where it constitutes the paleosome to the migmatitic rocks, it is present in subordinate amount to the early gneiss (Ajibade et al., 1979) and Pegmatite, fine-grained gneissic-granites, aplite quartz-oligoclase veins, porphyritic granites are varied group of rocks with essential features of felsic components. The features may or may not be present together on a single rock outcrop. Different types of meta-igneous rocks (nortably migmatites) and surbodinate gneisses such as banded gneiss, agmatites, nebulites etc. Result from the varying different relationship between these components (Rahaman &Ocan, 1978; Sheth et al, 2002). The simple banded structure observed in most outcrops is misleading and is the result of strong deformation and migmatitic process. The preservation of rocks of definite sedimentary origin within the migmatite gneiss complex has led most authors to have concluded that the early gneissic-granites originated from a sediment protolith. Rahaman *et al.* (1983; Adekoya, 1995) carried out a field petrograhic and geochemical study involving major, minor and REE of the three components of the migmatites in parts of southwestern Nigeria.

The Migmatite-gniess complexes is generally considered as the true basement complex and the most widespread component unit in the Nigerian Basement. There is a heteregenous assemblage comprising migmatites-gniess complex, orthogneiss, paragneiss, and basic and ultrabasic rocks that were deformed and metamorphosed. Evidencesfrom petrographic studies (Ajibade, 1988) indicate that the reworking of Pan-African has led to the formation of new minerals and re-parkin/grecrystallization of many minerals constituents of the Migmatite and surbodinate schist and gneiss complex by partial melting. In this, there involved many of the rock types which exhibit the metamorphism of amphibolite facies. The Migmatite, schist and gneissic granite complex posses ages range from 2,100 ma to 650 ma. They are also identified by some researches as Migmatite-gneiss and metasediments (schist and quartzites) complexes They together occupy up to more than half of the surface area of the Nigerian Basement, as noted by Rahaman *et al* (1983) who observed that the rocks recorded three major geological events (Okonkwo & Winchester, 1995) The first, at 2,500 Ma involved the initial processesthat led to the formation of crust, and of crustal growth by the orogenic actions and sedimentation. The Eburnean was the next phase, which was believed to be between the ages 2,000 + 200 Ma marked by the gneissic-granites in SW Nigeria. It was followed by ages ranging from 850 to 500 Ma which represent the imprint of the Pan-African orogenic event, which overrides many geochronological datings in the granite rocks and also gave rise to the formation and evolution of gneissic-granites, migmatites and surbodinates, and other similar rock units. Close studies of the period of evolution with the development of the Birrimian in the West African Craton is so striking. Although mineral deposits such as the iron, gold and manganese and are associated with those rocks of the Birrimian times, and the same age rocks in Nigeria are scattered and mineralized. Understanding the characteristics geochemistry (Shannon, 1976) mechanisms as well as mineralization and rate will be a first step towards managing the geochemical characterization of an area that has been basement complex of varied history and geological distribution, with respect to age and tectonic setting.

Study Area

The Funtua NE is part of Lower palaeozoic terrain of NW Nigeria. Geographically, the area cut across Kankara, Bakori, Malumfashi and Faskari Local Government areas in Katsina State and covers a total land area of approximately 745.29km^2. The study area of Funtua north east (FTNE) falls within longitudes and latitudes 7^0 15',7^0, and 11^0 45', 12^0 00' (Figure 1)The area is characterized by series of discontinuous ridge of inselbergs (gneiss and granite) in the western side which made it a slightly rugged landscape. Some areas around far western and eastern parts are inaccessible due to intense flooding especially in the rainy seasons.The study area is however easily accessible through some federal roads: two well tarred roads of trunk 'A' and 'B' which link the area from Maimashekari village on Sheme-Kankara road and the other one passes through Danmarke to Burdugau in the south east.

Climate, Relief and Drainage

The natural vegetation of the mapped area is largely Sudan savanna type and is characterized by two main seasons; rainy season which is from April to October and dry seasons (or Hamattan) for the remaining periodswhich is typical of northern Nigeria, and which is characterized by sharp regional variances depending on rainfall (Babsal and Co.,1998).Generally, the seasons are moved by the movement of the Inter Tropical Air Mass or Inter Tropical Convergence zone (ITCZ) a zone where dry and often dust-carrying air from the northern Hemisphere, known locally as hammattan collide with moist air from the southern Hemisphere or Atlantic. The study area receives an average precipitation of 1,200 mm in the south per year to 650 mm down in northern Nigeria (Kankara, 2002) Dry season is marked by low humidity and has Harmattan wind that blows from Sahara.

The area is a gently undulating peneplained surface, consisting of an extensive superficial cover which rises to an altitude of between 570m and 600 m above mean sea level. This prevailing low relief is attributed to the predominance of metasediments and to the absence of intrusives. It also consists of a series of residues of ridges (of metasediments) and prominent inselbergs (of gneisses and granites) which makes the terrain to appear rugged. The highest points are Dutsen Wawa, Dutse Mai Zuma, Dutse Mai Amarya, Baka-Zari, Dutsen Mashi, Dutsen Mununu, Duwatsun Zango, Yan Ajera and Mai Dorayi inserlbergs form the Bakkai complexes (see Table 1) Na-Doshe inserlberg is located at the western border of the area. The lowest points in the project area are found at the areas close to Kwakwaren-Nabadau, around river valleys, with a gradual decrease in slope towards southeast.

Methodology

Twenty (20) major lithological units were identified and sampled during the mapping (reconnaissance survey and actual field investigation),using a 1:50,000 scale and this covered a total land area of approximately 153km^2. The Funtua NE is part of Nigerian Basement. Each lithological unit have beendescribed in accordance with reference to their locations in the map provided. For the geological mapping, migmatitic lithological units were identified and as well, their structures, field and contact relationships. Laboratory analysis was carried out to ascertain the various percentages of minerals, by the use of AAS, XRF and FP.

Results and Interpretations

Geology of the Study Area

The migmatite-gneiss and quartzo-feldspathic veins could have been produced by high grade metamorphism of pre-existing granites through transitional processess of granitisation and gneissification, that results in the formation of homogenous migmatite (gneiss) after losing its banding through mixing the leucosome and paleosome (Wright, 1979). The P-T condition of metamorphism and the composition of the original rocks are some of the factors controlling the formation of migmatites, especially in gneiss regions. They generally developed in metamorphic terrains formed during regional metamorphism (Dada *et al.,* 1993) The development of the stromatic migmatites is as a result of metamorphic segregation, external metasomatisrn and anatexis of an originally banded rock (see plate i). Brecciation and injection of magma could have led to the formation of the magmatitic migmatite. Pegmatitic and aplitic injections along zones of brittle fractures and fold axial planes in these rocks are very common. They were observed on several outcrops. There are pegmatite 'pods' at the extreme western corner of the area, at Zango village. This is an indication of granitic intrusion from the adjacent areas. The Migmatites originate as meta-igneous rocks with incomplete metamorphism through intense heat and pressure, associated with deformation. Fabic or variety of textures and structures are changed. Foliation occurs when minerals in the rocks form in parallel planenaturally. Foliation also occurs among the rocks when different minerals are assembled together and put under compression, also exist if the rock arebroken-up or cleavages developed.

Migmatite-Gneiss Rocks

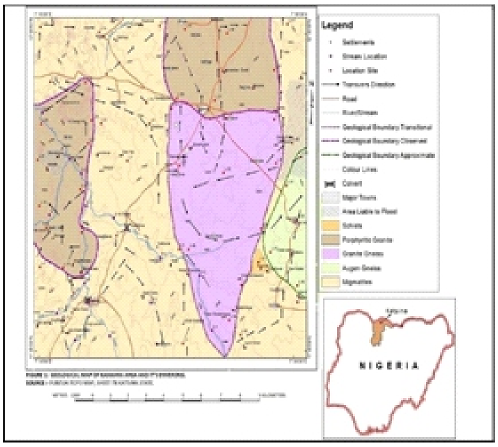

Fig. 1: Geological map of the study area showing the migmatites

Plate i: Typical migmatite at *GidanKare*, along Kankara-Sheme road.

Table1: Geochronometric Samples Description, Locality and Co-Ordinates of Migmatites

Sample No.	Description/ Lithological Name	Nature of Outcrop	Locality	Co-ordinates	
				Elvtn.	Long/Lat.
FTNE 106	Migmatite	Whaleback (Low Lying)	Gidan Kare, 15½km from Sheme Town	1886ft	$11^0$46,184’N 7^0 16.746’E
FTNE 12	Migmatite	Whaleback (Low Lying)	River Kyarika, 22km West of Kankara	1868ft	11^0 47.505’N 7^0 17.191’N
FTNE 42	Migmatite	Whaleback	Western Site of River Fetsa	1786ft	$7^0$17.694’E 7^0 17.684’E
FTNE 90	Migmatite	Whaleback	2km After Mabai	1887ft	11^0 50.273’N 7^0 18.584’E
FTNE 15	Migmatite	Bouldry Inserlberg	Sheme-Kakumi Road	1880ft	11^0 50.074’N 7^0 19.365’E
FTNE 148	Migmatite	Example of Whaleback	18km East of Sheme	1868ft	$11^0$49.530’N $7^0$19.503’E
FTNE 13	Migmatite	Whaleback	1km after Zari Kwari	1905ft	11056.403’N 7^0 21.605’E
FTNE 84	Migmatite	Bouldery Outcrop	Close to Zango	1886ft	11^0 57.161’N 7^0 16.723’N
FTNE 88	Migmatite	Bouldery Outcrop	Migmatite with Pegmatite Pods	1817ft	11^0 57.166’N 7^0 16.156’E
FTNE 91	Migmatite	Bouldery Outcrop	At Tsadara Tsohuwa	1956Ft	$11^0$54.786’N 7^0 21.786’E
FTNE 7	Migmatites	SW of River Baure	Whaleback	1838ft	$11^0$59.08’N $7^0$23.00’E
FTNE 20	Migmatites	Close to Kwakare Village	Whaleback	1706ft	$11^0$51.00’N $7^0$29.08’E
FTNE 110	Migmatites	2km from Makambaci R	Whaleback	1710ft	$11^0$59.00’N $7^0$22.58’E
FTNE 73	Migmatites	500m East of Faru	Whaleback	1789ft	$11^0$59.58’N $7^0$21.06’E
FTNE 101	Migmatites	500m SW of Kwakware	Whaleback	1809ft	$11^0$51.01’N $7^0$29.50’E
FTNE 44	Migmatites	35km N of R. Makamfaci	Whaleback	1806ft	$11^0$59.63’N $7^0$26.07’E
FTNE 39	Migmatites	500m NE of Garongozai	Whaleback	1821ft	$11^0$46.83’N $7^0$21.90’E
FTNE 27	Migmatites	Kaurawa -Pauwa Road R.Galma	Whaleback	1800ft	$11^0$59.50’N $7^0$20.02’E
FTNE 97	Migmatites	Whaleback	Goga Outcrop, Zurunkutun	1892	$11^0$53.96’N $7^0$24.78’E
FTNE 108	Migmatites	Whaleback	Outcrop 500m East of Malali	1880ft	$11^0$56.30’N $7^0$20.00’E

Source: Fieldwork, 2008

The migmatites mainly outcrops like whale-back ridges and whalebacks, limited in occurrences but more frequently distributed around southern Funtua NE, as indicated. They also occur along streams as small low-lying hills. They are found to occupy the largest area of about 50%, stretching from the north-western corner of the mapped area to the south-western portion, and it also occur further to the eastward (as shown: localities FTNE 73, FTNE 101, FTNE 20, FTNE 15, FTNE 7)The Migmatite-gniess show evidences of partial melting (See platesii and iii; see Table 2). The migmatites are generally medium grained, pink-grey banded, even textured rocks. The banding varying in size from microscopic to cm, and may be regular or discontinuous forming streaks, pinch and swell structures and mafic knots which demonstrated that the simple banding structures observed in most outcrops are as a result of the strong deformations and migmatic processes which have dragged units of different ages and compositions into parallelism. Different migmatite gneisses are formed, as a result of the different.

Plates ii: Low-lying migmatite-gneisses characterizing SW (500m south of Gambo Karfi village),

Plate iii: Low-lying Migmatite-gneisses at SE of Guga village, both characterizing the SW portion of Funtua North-East.

Relationship between the different components of early gneiss, amphibolites, granitic gneiss, pegmatites and aplite dykes that characterize the migmatite-gneiss-quartzite complex. As can be noted migmatites are border rocks between igneous and metamorphic rocks. They do not form prominent outcrops they normally occur as low-lying ridges. At Gidan Kare, exactly 15.5km from Sheme town is a locality, FTNE 106, whichhas ptigmatic folding and is a typical migmatite. As temperature increases rocks are transformed or moved from schist to gneiss to migmatites to granites. The rock can be called gneissic and granitic rock that is a combination of or overlapping of igneous and metamorphic rocks together. Evidences for partial melting in the rocks of the area is seen in their occurrence. They could be seen in localities FTNE 27, 39, 44, 101, 20, 12, 42. Migmatite of locality FTNE 106 show deformationinto ptigmatic folding. Similar outcrop of the same lithology is also found along river Kyarika, as locality FTNE 12 with well defined joint systems. The joint readings are 114^0, $154^0$and 48^0. The direction of deep and foliation is 20^0NE.There is also a pegmatite vein. Locality 10 also has the same lithological unit, found along River Fetsa, close to Mununu village. It has quartz and black tourmaline minerals, feldspar and a pegmatite.

In the coarse grained elongated variety, the quartz crystals are elongated or flatterned and which can give rise to a strong foliated texture. Foliation in migmatites is weak due to sub-aquant nature of the crystals. This texture suggests equilibrium condition in the rock. In the foliated texture, segregation and banding has modified the preferred directional orientation. The migmatite texture could also reflect equilibrium condition, the unequal interfarcial angles due to elongated form of the crystals. Quartz crystals are medium to coarse grained with no fluid inclusion in them. In the simple foliated textures, larger polygonal textures of feldspar minerals are displayed. Few aplitic and pegmatitic dykes/ veins of various dimensions in the migmatite are encountered and they trend mostly in north-south direction.At the areas around Bakkai, Zango and Shemen-Makarya, the granitoids experience marginal contact with a lot of pegmatite pods, and that is where they are bounded by migmatites-gniess. Granitoids extend to the upper northern end, at the northern part of Kankara town. They occupy about 20% of the total area. The outcrops form low ridges aligned in NE-SW and probably have gradational boundaries with the strongly lineated, pink-grey migmatites with an even-grained texture coarser than in the other gneisses.

The rocks vary in dimensions from great elongate batholiths, tens of kilometers long and several kilometres across, aligned more or less parallel to the structural grain, to small sub circular stocks only a kilometer or two across. The larger bodies tend to be foliated and many of them are porphyritic, with feldspars reaching several centimeters in size, whereas the smaller intrusions are unfoliated and generally fine-grained. They mostly exist in the extreme NW corner, especially at Kaurawa-Pauwa road and at Ungwan Alhaji Yuguda. Most of the inselbergs that characterize many of the landforms in the Funtua north east are formed by erosion of these granitic masses, with their characteristic exfoliation weathering patterns. Where they are emplaced in the basement, the batholithic granites are commonly elongate and concordant and have gradational boundaries with surrounding gneisses and migmatites. The basement rocks become progressively more granitic in appearance as the intrusions are approached. For example, pegmatitic and aplitic veining becomes more common, there is metasomatic growth of feldspar crystals and banding becomes more diffuse. The smaller granite bodies generally have sharp boundaries that cut across the basement structures. Where they are emplaced into the supracrustal belts, however, even the larger granites generally have sharp cross-cutting boundaries. Intrusions of whatever size within the supracrustals may affect contact metamorphism of the schists and phyllites, leading to the development of 'spotted' rocks, due to the growth of minerals such as cordierite and andalusite.

Features of the larger concordant batholithic-granites indicate that they are syntectonic; that is to say, they were emplaced during the climax of deformation and metamorphism, when temperatures and pressures were at a maximum, and there was extensive incomplete metamorphism and metasomatism. Pegmatites are extensively developed in them. Theunfoliated nature of the smaller cross-cutting (discordant) granites indicates that they evolved later, following the first climax of metamorphism. There are, of course, all gradations between these two extremes, and in some areas it has been possible to identify a number of stages of granite emplacement, according to initial relationships, textures and composition. Porphyritic granites contain variable amounts of inclusions of country rocks, particularly around their margins. In the larger batholithic granites, with their more pervasive and gradational boundaries, these inclusions have been largely 'digested', obscuring their original nature, and modifying the granite, generally making it more basic. In the smaller crosscutting bodies, however, original textures and lithologies can often be identified example biotite-rich gneisses, amphibolites and folded metasediments because the inclusions are rarely altered to any extent. The intrusions are not all of granitic composition. The larger batholiths range from adamellite to granodiorite, but the smaller bodies are more variable, with compositions between true granite and diorite and syenite being represented; and gabbros are also sometimes seen. These other intrusive rock types almost certainly represent new additions to the crust, that is to say they are probably derived from beneath the crust, in the upper mantle. This may apply to some of the granitic intrusions also, but many of the large syntectonic batholithic masses are probably products of deep-seated metasomatism and partial melting of older rocks that is they represent crustal remobilization and recycling, rather than new additions to the continental crust.

Plate iv: Contact of a migmatite, banded and mylonitic gneisses at Tudun Amiru

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In the southwest there is deformation which was poly-phasal, with primary deformed and ductile structures which were in contact with expansion and contraction of rocks affected by orogenic circlewere followed by secondary brittle structures. Also, there has been primary ductile deformation produced the regional tectonic folds and faults, and tight to isoclinal unpronounced folds (see plate iv).

Table 2: Chemical (Weight Percent) Compositin of Migmatites

Sample No.	**F 7**	**F 12**	**F13**	**F 20**	**F 15**	**F 110**	**F 73**	**F 101**	**F 44**	**F 39**
$Si0_2$	64.53	64.41	68.44	65.62	69.56	67.72	61.07	64.81	65.20	63.82
Al_20_3	18.38	16.63	12.83	16.41	12.77	18.02	17.72	15.06	17.24	18.03
Ca0	3.56	2.42	2.67	5.66	2.81	2.38	4.06	5.01	3.06	5.61
K_20	2.66	3.90	3.56	3.05	3.55	2.56	2.62	2.61	3.82	2.77
Na_20	2.00	2.47	2.63	2.79	2.52	3.03	2.97	3.31	3.48	2.92
Mg0	2.46	1.76	1.47	1.37	1.50	1.69	2.06	1.84	1.82	2.59
P_20_5	0.06	0.81	0.69	0.52	0.70	0.72	0.79	1.21	1.06	0.28
Fe_20_3	2.64	2.85	2.58	1.93	3.00	1.78	3.45	2.52	3.06	2.57
$Ti0_2$	0.38	0.82	0.43	0.88	0.68	0.71	0.56	0.81	0.52	0.44
Mn0	0.07	0.071	0.091	0.073	0.084	0.022	0.062	0.043	0.032	0.046
LOI	2.11	2.63	2.45	1.46	2.26	1.26	3.31	1.33	1.23	1.06
Total	**98.85**	**98.77**	**97.84**	**99.76**	**99.43**	**99.90**	**98.67**	**98.55**	**100.48**	**100.14**

Table 3: Chemical (Weight Percent) Compositin of Migmatites

Sample No.	F 106	F 90	F 27	F 97	F 42	F 91	F88	F 84	F 108	F 148	Averg. of 20 samples	Range of 20 samples
$Si0_2$	62.28	68.01	61.82	61.61	65.82	67.57	69.21	67.07	69.28	67.87	65.78	61.07 -69.56
Al_20_3	16.61	12.83	18.02	18.03	16.06	17.23	17.7	14.21	12.61	16.08	16.12	12.61 -18.38
Ca0	4.32	4.26	5.06	2.68	4.55	3.62	2.88	4.62	3.81	4.43	3.90	2.67 – 5.66
K_20	3.31	2.81	2.72	3.46	3.22	2.47	2.44	3.82	2.62	3.61	3.08	2.56 – 3.90
Na_20	2.92	1.97	2.21	3.06	3.46	3.26	2.05	1.12	2.26	2.82	2.66	1.12 – 3.48
Mg0	1.67	2.62	2.58	1.99	0.87	1.82	2.07	2.01	1.55	1.71	1.87	1.37 – 2.59
P_20_5	0.62	0.81	0.31	0.67	0.56	1.28	0.17	0.32	0.41	0.14	0.65	0.06 – 1.28
Fe_20_3	2.33	2.66	2.26	3.71	3.28	2.16	4.06	2.51	3.23	4.16	2.84	1.78 – 4.16
$Ti0_2$	0.61	1.42	0.51	0.32	0.36	0.88	1.09	0.32	0.71	0.62	0.65	0.32 – 1.42
Mn0	0.062	0.028	0.011	0.061	0.084	0.072	0.081	0.076	0.005	0.027	0.058	0.011–0.091
LOI	2.44	1.62	2.22	2.04	1.24	0.22	0.16	0.68	1.02	0.06	1.54	0.06 – 3.31
Total	**97.10**	**99.04**	**97.72**	**97.63**	**99.50**	**100.58**	**101.91**	**96.76**	**97.56**	**101.53**	**99.10**	

Table 4: Trace Elements Composition (ppm) of Migmatites

Sample No.	F 7	F12	F13	F 20	F 15	F 110	F 73	F 101	F 44	F 39
Cu	17.6	18.9	17.3	11.4	19.4	15.0	16.2	17.6	11.9	18.6
Co	55.2	55.0	51.0	22.9	61.7	24.5	29.2	36.6	48.0	54.2
Ni	13.5	13.7	10.5	7.5	8.0	11.7	8.1	12.06	9.2	7.8
Zn	38.5	32.7	35.0	29.6	29.4	26.8	26.2	31.1	35.6	38.5
Rb	88.8	110.4	112.6	107.1	98.8	89.10	99.2	106.2	100.6	109.8
Cr	15.6	12.5	15.0	13.0	12.5	14.6	14.8	16.4	15.01	12.2
Pb	38.6	52.3	27.4	26.3	26.9	44.5	48.06	39.08	51.6	50.7
Sr	268.0	390.1	263.7	288.3	287.0	279.8	264.08	312.2	357.7	261.6
Zr	199.0	220.0	326.3	205.0	311.5	350.09	206.5	280.8	179.6	300.7
Ba	983.0	1,274.0	1,660.5	889.2	957.0	1,400.9	1,676.8	1001.2	1,128.7	1,100.7
La	28.0	19.4	21.0	30.7	30.5	22.0	31.2	28.2	26.7	20.6

Table 5: Trace Elements Composition (ppm) of Migmatites

Sample No.	F 106	F 90	F 27	F 97	F 42	F 91	F 88	F 84	F 108	F 148	Avrg. of 20 sample	Range of 20 samples
Cu	18.6	20.1	11.2	13.4	18.3	15.3	17.4	19.0	20.2	18.9	16.82	11.2 – 20.2
Co	21.6	60.1	59.6	60.2	38.8	28.7	29.3	58.3	58.4	51.0	45.22	21.6 – 61.7
Ni	7.5	13.0	7.5	8.0	12.2	9.8	10.4	11.4	11.2	11.8	10.24	7.5 – 13.7
Zn	30.8	30.8	31.2	32.2	29.9	28.0	28.6	38.5	35.5	35.0	32.19	26.2 – 38.5
Rb	87.7	89.6	120.8	92.2	96.7	90.6	102.2	106.3	107.5	107.5	101.12	87.7 – 120.8
Cr	13.3	12.0	15.8	15.0	11.5	12.6	13.6	13.2	12.0	11.5	13.61	11.5 – 16.4
Pb	44.0	45.6	44.5	49.1	48.2	38.6	51.2	51.2	22.8	27.5	41.41	22.8 – 52.3
Sr	262.0	264.8	372.1	254.4	301.8	308.3	382.7	371.0	324.2	291.2	305.3	254.4 -390.1
Zr	200.8	198.2	327.1	300.2	219.0	206.8	287.0	261.0	262.2	306.7	257.4	179.6-350.09
Ba	900.0	902.0	1,550.2	1,666.7	1,760.6	952.5	890.6	891.2	1,124.4	1,281.0	1199.6	889.2-1,760.6
La	21.0	22.6	28.7	31.5	34.4	30.0	28.2	29.0	19.4	20.8	26.20	19.4 – 34.4

Sources for the Tables: Feildwork, 2008

Geochronology

Summaries of available radiometric data on the Nigeria Basement Complex are available in Rahman (1988a), and Ajibade et al (1987) which are akin to results presented in tables 2-5.

The most significant result obtained since then are:

a. Model Nd T_{DM} ages for amphibolites in the Kaduna migmatite yield ages of 3.51+0.38Ga (Dada, 2006).
b. Model Nd T_{DM} ages for grey-gneiss from Egbe-Kabba area yield Eburnean ages 2.5-2.1 Ga (Dada et al., 1993).
c. Migmatisation in the Toro area is dated at 581+10Ma (Dada, 2006).

These results when taken together with existing data that provided evidences for four main events that affected the Migmatite-Gnesis Complex. They were:

a. Early development of crystal at 3.5 Ga and metamorphisms that occurred later at 3.0 Ga
b. An intrusive event of the later period of Achaean that intruded between 2.8-2.5 Ga which involves the dynamism of juvenile body to the crust.
c. An organic event spanning from about 2.1 Ga
d. Pan-african and the older granites emplacement at 650ma ago.

A new data compiled byJacobson (1963) and that of Dada (1993) about Kaduna migmatite provide the first definitive evidence of rock of Achaean age in Nigeria. The data support the division of the Nigeria Basement Complex into two distinct terrains, Western and Eastern domains (Ferreira et al., 1998)

Results of Geochemical Analysis

Tables 2-5 displayed the results of chemical analysis for both major and trace elements of migmatites in the study area. There seems to be a clear understanding of the genesis of migmatites occurring in Funtua north east (Bassey, 2009)The comparable values between the lithologies of Funtua NE and those in the upper, middle and oceanic crust, and the Asthenosphere or very rigid zone suggests that those rocks evolved from similar source area. The basis of the trace element geochemical parameter, it can also be concluded that the younger metasediments are metamorphosed shale-greywacke are sequences derived from the upper crust where acid magmatic rocks are dominant.

The chemical analyses of elements in the migmatites and their trace elements were presented at tables 2-5. The migmatites form both the high-silica (69.56%) $SiO_2$and a low-silica (61.07%) group. The high-silica group contains lower contents of all oxides except SiO_2. It seems that the high silica migmatites have been leached of their mobile oxides relative to the low Silica migmatites which have a normal migmatite composition. The approximately high contents of K_2O (mean: 3.08) as compared to that of Na_2O (mean: 2.66%), suggest the possibility of hydrothermal alteration processes in all the samples. Fe_2O_3(total) vary in both the low and high silica rich migmatites between 1.0 to 2.7.

Discussion

Considering the evidences from the major and trace elements contents, it can be suggested that these rocks are possibly of mixed igneous and sedimentary parentages. From field work to geochemical analyses a research was coming closer to reality about the various rocks surveyed.

Geochemical analyses are a junction where major and trace elements were studied. Geochemistry, strictly speaking may be defined as the study of the geochemical character of elements as they are found in the rocks of a given area, and this implies to studying a rock toward the original magma that formed it. It is the description of the percentages of each mineral in a rock. Textural descriptions, visual estimates and mineralogy was done to ascertain the geochemistry of different lithologies, although it was not a major target of the research. The least of the granite rocks to be used for geochemical analyses are coarse grained porphyritic rocks. The research is focused on generation of reliable geochemical data of rocks in the FuntuaSheet 78 NE, northwestern Nigeria. Geochemical data of the rocks may have becomescanty or poor because researches in geology are now mostly focused on mineralDepositsand structural geology orgeophysical survey, in the search for hydrocarbons and water. It is because of this level of poor geochemical data that this research intendsto unravel. Thisstudy is necessary because a relatively large proportion of geochemical investigation islacking. The use of geochemistry as the major source of portable mineralization andgeochemical characterization in NW area of northern Nigeria has assumed a highproportion that attention has turned fully to it Geochemical characterization is a keysource in its usefulness, availability of its trace and major elements and their relativeabundance and abstraction depends on certain factors. Many researchershave expanded a lot on Geology and geochemistry of the granitic and migmatiticBasement rocks in NW Nigeria.

Conclusion

The aim of geochemical analyses in this research is to find the ratio of certain elements, example K-Rb, Sr-Rb ratios. Going by this believe, thus it could be concluded that thelithologies were once put 1under one block called Pangea, before it disintegrated further. In addition to that, the minor elements with non-mobility charactershare same nature of protoliths with the sedimentary rocks under pressure or migmatites with those of the gneissic complexes. This also provided clue that they were from the same the sequences of supracrustal. The proposed geochemical model of evolution of the rocks in FTNE is in agreement with that for some neighboring belts whose geochemistry was ascribed to ensialic processes. As already observed, there are significant similarities between rock-types, structural and metamorphic events in the Funtua north east granitic and migmatite-gniess rocks and thearea at the western part.

Dating of early or ancient Proterozoicera from the research has similarity to other Borborema Province, the African provinces, and Congo craton. Validity of the Eburnean event was highlighted, and it was re-affirmed that these tectonic units may have been part of a larger continental landmass, the Pangea. Likewise, similarities in post-Transamazonian (or post Eburnean) metamorphic and magmatic events in the Borborema and African provinces suggest that they shared a common origin and remained in close proximity until when Atlantic Ocean was opened. Economically, the rocks meet the standard for use as constructional and building materials. The availability of Ca, Na and K minerals can aid manufacture of Sodium bicarbonate, bicarbonate and hydroxides, in agriculture as acid soil ameliorants and nutrients status enhancer. Because of their economic potential the granites can be put into one or more uses, and abundant evidences show that the granites are being quarried for other domestic and industrial purposes.

Recommendations

A part from the above statements, further recommendations are suggested below:

1. The study recommends a much more detailed analysis of the rocks, taking into considerations their character variation with depth and lateral change.
2. Though the rocks does not meet the standard for use for some other particular purposes more research should be carried out to see if the lithologies can be put into any use.
3. It is required that the Federal Government of Nigeria should encourage small scale miners to invest in the deposits. The result of the analysis provides that more mineral deposits can be sourced from the rock outcrops.
4. Apart from these deposits, others occur in many areas of Nigeria, which have equally high economic value. In view of this, Government should encourage more researches.
5. Geological and topographical maps of the country should be updated and made available and affordable to researchers.

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