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GEOLOGICAL AND GEOCHEMICAL ASSESSMENTS OF STREAM SEDIMENTS OF EJUKU AREA

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ABSTRACT

Geological and Geochemical assessments of Ejuku area, North-Central, Nigeria, was carried out with the aim of identifying the mineralization potential as well as delineating mineralized zones in the area. The geological investigation revealed that the area is underlain by porphyritic granite, medium-coarse granite, granitic and banded gneisses, amphibolite, quartzite and mica schist. Twenty five representative stream sediment samples were digested in aqua regia solution and analyzed by ICP-MS method for trace and rare earth elemental concentrations. The analysis of the stream sediment samples, revealed the following range of concentration for each element: Fe (0.59-4.97%), Mn (60-1273 ppm), Ce (19.3-608 ppm), La (2.5-307.5 ppm), Ba (8.5-149.8 ppm), Cr (9.0-125.2 ppm), V (3-121 ppm), Cu (6.78-40.10 ppm), Pb (2.18-30.19 ppm), Zn (3.7-44.0), Ag (2-24ppb), Ni (2.9-13.6 ppm), Co (0.9-18.6 ppm), U(0.57-11.18 ppm), Th (3.0-76.5 ppm), Rb (5.7-46.9 ppm), Au (0.2-0.9 ppb), Y (0.81-27.79 ppm) and Li (1.2-17.2 ppm). The correlation coefficient for the selected elements show very strong correlation between Pb, Co, Fe, Ba and Mn as well as between Th, La, Rb, Ce, Zn and Y. The isograde plots show that most elements have their peaks in the western and northeastern part of the study area. The study therefore revealed that the area is rich in manganese, iron, K-feldspar and mica which are hosted, possibly, by schist and amphibolites.

Keywords: Mineralization, Geochemical, Stream sediments, correlation, Isograde, Ejuku.

INTRODUCTION

The study area (Fig. 1) lies within longitudes $005^{\circ}\ 40'$ to $005^{\circ}\ 50'$ and Latitudes $008^{\circ}\ 00'$ to $008^{\circ}\ 07'$ covering a total area of 265 km^2. Ejuku area is located in the North-Central part of Nigeria and it is underlain by rocks of the Precambrian Basement Complex which have conformable field relationships and show great variations in grain size and mineralogical compositions (Olusiji, 2011). Studies related to lithostratigraphy, chronostratigraphy and aspects of economic geology have been undertaken in the study area. Bafor (1988) identified the geological and geochemical characteristics of the rocks in the study area and concluded that they include gneiss, schist, quartzite, amphibolites, metagabbros, metabasaltic tuff, granite, dolerite and pegmatites. The metaigneous rocks were characterized by low silica and moderate alumina, moderate to high MgO, FeO, CaO and low K_2O (Bafor, 1988).

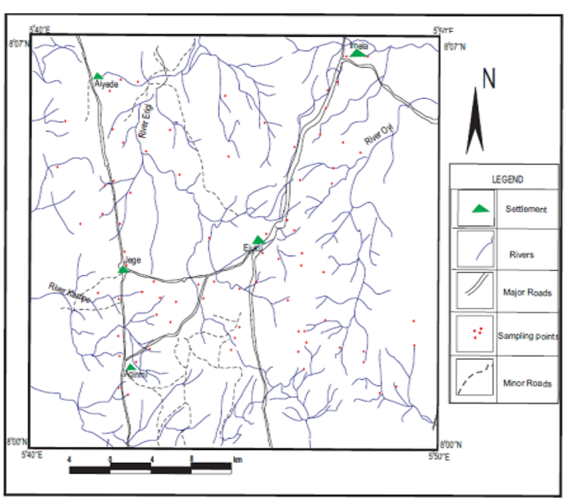

Fig. 1: Location map of the study area

Olobaniyi (1997) described the Iron Formation in the area as those related to volcanism or volcanic sequence that is, Algoma type. The amphibolites and associated rocks, according to Bafor (1981), were formed from a primitive basaltic magma of olivine tholeiite to quartz tholeiites in composition in an environment characterized by steep geothermal gradient. A low geothermal gradient which culminated in the mobilization of the basement was however identified around Egbe, east of the study area (Adedoyin *et al.*, 2013). The mineralizations in the adjacent areas are predominantly hosted by pegmatites and mica schists (Adekeye, 1999; Adekeye and Adedoyin, 2007; Bamigboye and Adekeye, 2011; Omorinoye and Adekeye, 2013) and they include beryl, mica, tantalite, magnetite, ilmenite, topaz, garnet, niobium, columbite, tourmaline and gold. This work therefore aimed at identifying mineralization potential and delineating mineralized zones in the study area. It is also aimed at comparing the mineralization type present in Ejuku with those in Eruku and Egbe areas where related studies have been carried out.

Geology of the area

Ejuku area lies within Egbe-Isanlu Schist Belt of the Precambrian Basement Complex of Nigeria. Geological investigation shows that the area is underlain by the following major groups of rocks, namely: gneisses, metasediments and metavolcanics as well as granites (Fig. 2). The gneissic rocks which include banded and granitic gneisses account for about 20% of the rocks in the area and are dominant in the southern and northeastern parts of the study area. The metasediments and metavolcanics comprising of quartz-mica schist, quartzites and amphiboles which occur mainly in the southern part of the study area account for 10% of the rocks in area. The granitic rocks on the other hand account for about 70% of the study area and include medium to coarse grained granite and porphyritic granite.

MATERIALS AND METHOD

The method applied in this study involves geological mapping on a scale of 1:50,000 and geochemical analysis. During the geological mapping stream sediments samples

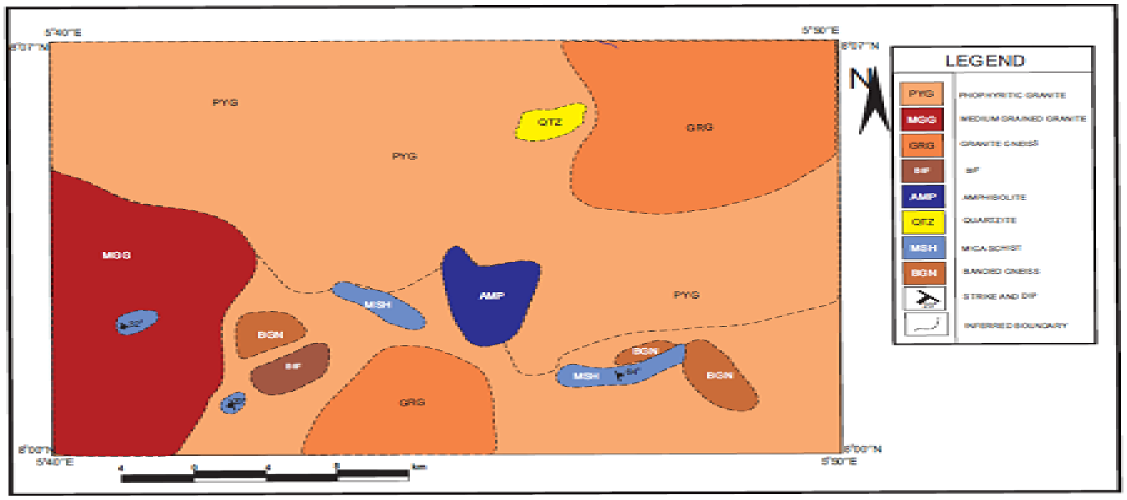

Fig. 2: Geological Map of the study area

were randomly collected at confluence points of active rivers at a depth of 20-25 cm. The global positioning system (GPS) was used to determine the actual sampling points and plotted on the topographical map of the study area (Fig. 3). Twenty five representative samples were prepared and analyzed for trace and rare earth elements at the ACME Analytical Laboratories Limited, Vancouver, Canada, using Inductively Coupled Plasma-Mass Spectrometry (ICP-MS).

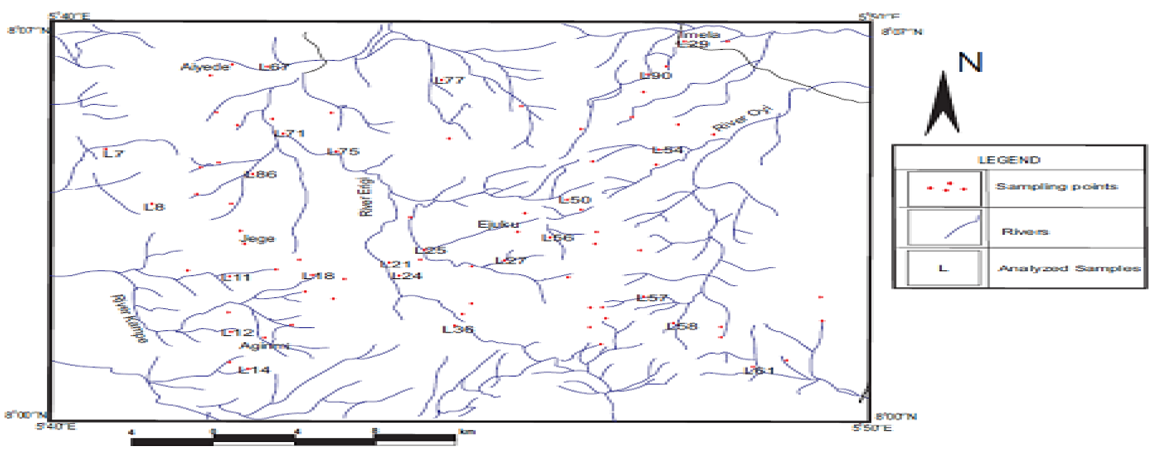

Fig. 3: Map of the study area showing the sampling points

RESULT PRESENTATION

The result of the geochemical analysis of the elements determined from the stream sediment samples analyzed is shown in Table 1. Mn has highest concentration in sample EJ14; Fe, Ba, V and Co has their highest concentration in sample EJ8 while Ce, La, U and Y have highest concentration in sample EJ4. Most of the analyzed elements have their lowest concentration in samples EJ13 and EJ22. The results of the correlation analysis of some selected elements (Table 2) show that Mn has high positive correlation coefficient with Pb, Co, Fe and Ba. High positive correlation coefficient also occur between Pb, Co, Mn, Fe, Ba and Cr; between Pb, Zn, Co, Mn, Fe, Ba, Rb, Li and Cu. Others with high positive correlation include, Zn, U, La, Rb, Ce and Th; La, Rb, Ce, Th and Y. Negative correlation exist between La, Li and Mn; Co, Mn, Fe, Cr, Ba and La as well as between Zn, La, Th, Ce, Li, Y and Cr. Isograde plot links together areas with equal concentration of elements. The regional and local threshold concentration values (Table 3) of selected analyzed elements were identified and used to produce isograde maps (Figs. 4 - 9).

Manganese with very high concentration in all analyzed samples has the same distribution pattern as Ba on the isograde map. It also has high correlation coefficient with Pb, Co, Fe, Cr and Ba. This may be due their relatively high mobility in oxidizing environmental condition which prevails in the drainage basin from which the samples were collected. It may also be because they are lithophile and siderophile elements (Goldschmidth, 1937). Ce has high correlation coefficient as well as the same distribution pattern with U, Th, La and Y. This may be due to their classification as lithophile elements. It also suggests that these elements might have moved from the same source and concentrated by their similar chemical behavior.

Table 1: Geochemical data of elements concentrated in stream sediments of Ejuku area

Samples/ Element	Fe	Mn	Ce	La	Ba	Cr	V	Cu	Pb	Zn	Ag	Ni	Co	U	Th	Rb	Au	Y	Li
EJ1	1.40	163	51.8	24.6	13.9	13.0	5	13.14	4.18	14.1	10	4.4	1.5	1.44	8.0	18.9	0.5	3.23	11.7
EJ2	2.65	284	38.4	18.0	52.9	41.2	29	27.94	7.77	18.0	15	13.6	5.8	2.57	8.3	32.0	<0.2	4.35	8.8
EJ3	2.05	365	79.5	30.1	64.2	20.5	32	18.38	9.48	24.5	10	10.0	8.0	3.03	14.0	46.9	0.2	7.20	17.2
EJ4	1.46	237	608.0	307.5	14.2	13.2	5	14.28	8.02	13.4	8	5.5	1.4	11.18	69.3	17.5	<0.2	27.79	5.3
EJ5	2.50	383	87.2	47.2	46.4	29.6	11	30.81	7.20	14.4	23	11.2	3.6	2.90	11.6	27.8	0.3	6.33	6.5
EJ6	1.07	210	58.0	17.2	25.9	13.5	8	10.02	7.33	13.5	<2	4.0	2.0	1.49	7.9	19.1	<0.2	2.64	3.5
EJ7	2.92	846	170.3	23.3	96.7	34.3	57	19.22	30.19	5.0	11	7.1	16.8	3.82	15.4	5.7	<0.2	5.31	2.7
EJ8	4.97	1088	90.3	8.9	149.8	61.5	121	24.68	20.53	7.6	13	11.7	18.6	2.89	5.2	9.7	<0.2	3.17	3.2
EJ9	2.01	209	385.7	158.0	24.7	18.3	9	15.94	13.33	22.8	9	7.0	2.6	7.16	76.5	33.6	0.3	20.35	9.2
EJ10	0.84	122	28.4	9.5	10.9	11.2	4	10.38	4.14	4.8	4	3.6	1.3	0.57	4.3	7.4	<0.2	1.48	1.2
EJ11	1.10	115	109.4	54.3	18.7	11.7	6	11.20	8.50	16.6	10	4.3	1.5	5.98	59.9	19.8	<0.2	11.87	5.4
EJ12	2.09	758	132.5	50.7	94.0	48.5	31	14.59	30.10	10.6	10	5.7	9.1	6.04	43.6	19.5	<0.2	10.32	3.4
EJ13	0.59	60	19.5	9.6	9.9	9.0	5	6.78	2.18	4.3	4	2.9	0.9	1.16	5.5	11.4	<0.2	1.88	2.1
EJ14	2.99	1273	134.3	49.8	131.5	66.2	41	28.39	27.04	21.7	20	10.4	14.4	4.37	41.4	31.3	0.6	9.94	5.8
EJ15	1.82	217	20.0	9.2	20.2	20.0	5	23.76	4.10	7.3	12	8.2	2.4	1.54	6.3	24.4	0.4	2.20	7.7
EJ16	2.81	313	74.1	6.7	28.8	69.6	42	18.71	24.03	5.0	9	6.6	6.1	2.62	8.8	7.3	<0.2	2.19	2.0
EJ17	1.90	160	26.3	10.1	23.9	39.9	28	15.41	6.87	7.8	5	5.5	3.2	1.45	4.2	8.9	<0.2	3.01	1.8
EJ18	2.73	397	144.7	40.4	44.7	50.1	42	21.00	17.83	14.0	10	10.4	8.6	2.42	19.2	19.2	0.4	5.62	6.5
EJ19	0.96	110	34.5	15.6	10.3	9.8	3	9.84	3.54	8.0	2	3.4	0.9	1.92	5.9	13.8	<0.2	2.33	3.3
EJ20	1.33	234	32.1	15.1	24.7	15.4	13	13.27	4.47	12.4	9	5.9	4.7	2.41	3.8	22.7	<0.2	3.05	2.8
EJ21	2.85	436	19.3	7.1	36.4	30.9	7	40.10	10.67	12.6	18	13.3	3.4	5.28	20.7	26.8	0.6	9.27	6.3
EJ22	1.36	270	26.3	2.5	31.7	26.1	32	8.07	6.04	3.7	3	3.1	3.8	0.71	2.2	5.6	<0.2	0.82	1.2
EJ23	2.75	304	29.5	3.4	24.6	125.2	50	11.80	11.77	5.1	4	6.2	7.8	1.07	3.0	7.3	<0.2	0.81	1.2
EJ24	1.04	123	28.1	12.7	8.5	16.5	4	14.09	3.21	10.6	12	5.0	1.3	0.79	4.7	6.4	<0.2	1.87	1.7
EJ25	2.36	381	491.0	212.9	46.5	34.0	16	32.02	19.84	44.0	24	12.2	5.5	6.51	63.1	28.2	0.9	21.21	5.7
EJ16	2.81	313	74.1	6.7	28.8	69.6	42	18.71	24.03	5.0	9	6.6	6.1	2.62	8.8	7.3	<0.2	2.19	2.0
EJ17	1.90	160	26.3	10.1	23.9	39.9	28	15.41	6.87	7.8	5	5.5	3.2	1.45	4.2	8.9	<0.2	3.01	1.8
EJ18	2.73	397	144.7	40.4	44.7	50.1	42	21.00	17.83	14.0	10	10.4	8.6	2.42	19.2	19.2	0.4	5.62	6.5
EJ19	0.96	110	34.5	15.6	10.3	9.8	3	9.84	3.54	8.0	2	3.4	0.9	1.92	5.9	13.8	<0.2	2.33	3.3
EJ20	1.33	234	32.1	15.1	24.7	15.4	13	13.27	4.47	12.4	9	5.9	4.7	2.41	3.8	22.7	<0.2	3.05	2.8
EJ21	2.85	436	19.3	7.1	36.4	30.9	7	40.10	10.67	12.6	18	13.3	3.4	5.28	20.7	26.8	0.6	9.27	6.3
EJ22	1.36	270	26.3	2.5	31.7	26.1	32	8.07	6.04	3.7	3	3.1	3.8	0.71	2.2	5.6	<0.2	0.82	1.2
EJ23	2.75	304	29.5	3.4	24.6	125.2	50	11.80	11.77	5.1	4	6.2	7.8	1.07	3.0	7.3	<0.2	0.81	1.2
EJ24	1.04	123	28.1	12.7	8.5	16.5	4	14.09	3.21	10.6	12	5.0	1.3	0.79	4.7	6.4	<0.2	1.87	1.7
EJ25	2.36	381	491.0	212.9	46.5	34.0	16	32.02	19.84	44.0	24	12.2	5.5	6.51	63.1	28.2	0.9	21.21	5.7

Table 2: Correlation coefficient of some selected elements

	Cu	Pb	Zn	Co	Mn	Fe	Th	La	Cr	Ba	Rb	Ce	Li	Y
Cu	1													
Pb	.349	1												
Zn	.461	.176	1											
Co	.349	.793	.018	1										
Mn	.467	.800	.105	.908	1									
Fe	.656	.660	.105	.824	.760	1								
Th	.163	.340	.620	-.026	.131	.013	1							
La	.119	.128	.570	-.132	-.024	-.046	.831	1						
Cr	.229	.532	-.107	.572	.474	.666	-.116	-.176	1					
Ba	.441	.755	.142	.927	.964	.780	.086	-.069	.421	1				
Rb	.489	.015	.721	-.005	.109	.106	.400	.278	-.176	.169	1			
Ce	.152	.291	.575	.026	.095	.080	.839	.977	-.095	.052	.239	1		
Li	.326	-.071	.548	-.014	-.001	.094	.241	.190	-.226	.084	.842	.165	1	
Y	.261	.249	.642	-.051	.096	.049	.939	.945	-.160	.054	.431	.934	.293	1

Table 3: Regional and local threshold values of selected elements

Element	Regional Threshold Value	Local Threshold Value
Ba	70	110
Mn	550	900
Fe	2.6	3.6
Au	0.5	0.7
La	140	200
Ce	250	400

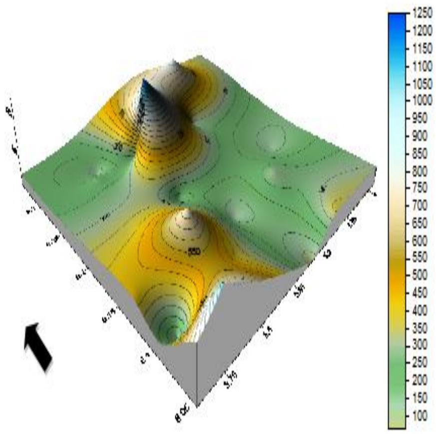

Fig. 4: Isograde map showing the distribution of Mn

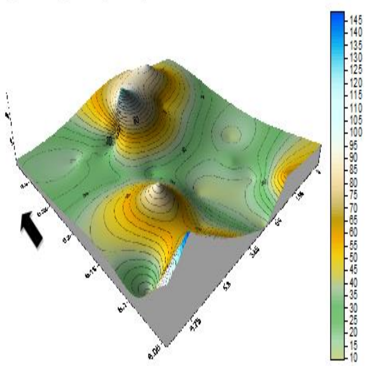

Fig. 5: Isograde map showing the distribution of Ba

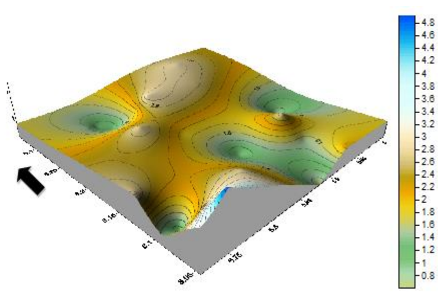

Fig. 6: Isograde map showing the distribution of Fe

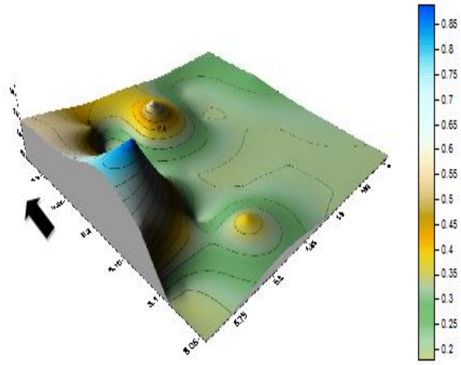

Fig. 7: Isograde map showing the distribution of Au

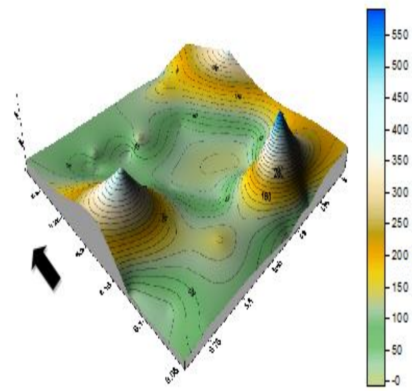

Fig. 8: Isograde map showing the distribution of Ce

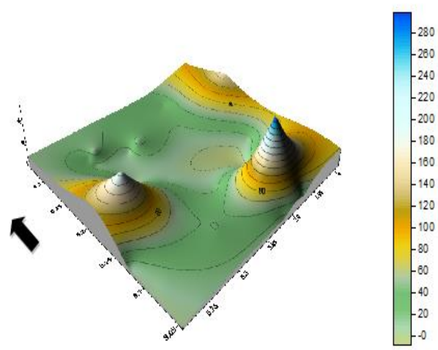

Fig. 9: Isograde map showing the distribution of La

DISCUSSION

Geochemical studies of the stream sediments in Ejuku area revealed high concentrations of Mn and Fe which are related to an Iron Formation (Mucke 2005). The Iron Formation in this area has been described as those related to volcanism or volcanic sequence, that is, Algoma type, this is because the iron is associated with the schist belt that is proposed to have originated by deformation and metamorphism of sediment-volcanic sequence with the volcanic component resulting from the episodic up rise of mantle plumes. The plumes spread laterally to initiate extensional tectonic regime that is followed subsequently by a compressional phase (Olobaniyi, 1997).

The study area is also known for its gold mineralization (Akande *et al*., 1988; Garba, 1988). Gold mineralization occurs in quartz-mica and quartz-sulphide veins and in alteration zones surrounding the veins in the primary environment. Syngenetic gold-sulphide mineralization in form of disseminations also occur in the amphibolites. Secondary gold enrichment occurs in the alluvial sediments of streams draining the area. Field evidences also suggest that vein mineralization in the area are distributed within shear zones which traverse biotite gneiss, amphibolite, schist and at sheared contacts of the Pan-African porphyritic granite (Dada et al., 2003). Ejuku area has very low Au values as observed in the geochemical result (Table 1). However, the presence of Cu, Pb, Zn and As suggests sulphide mineralization, possibly pyrite, galena, sphalerite and chalcopyrite which are pathfinders to gold mineralization.

In terms of mineralizations associated with pegmatites, previous studies revealed tantalum, columbite, niobium, cassiterite, beryl, tourmaline, garnet and gold mineralization (Adekeye, 1999; Bamigboye and Adekeye, 2011; Adedoyin, et al., 2013). However during this study, only pockets of pegmatite were found and there is no indication of the above mineralization both from the field work or geochemical result. The Isograde map reveals that Ce, Li and Rb as well as U, Th, Y and La have similar distribution pattern and common sites of anomalous concentration. Strong correlation is also recognized among these elements. These indicate close association of the elements in the study area which suggest the occurrence of felsic lithology, rich in K-feldpar and mica.

CONCLUSION

The study area is underlain by porhyritic granite, medium-coarse grained granite, granitic and banded gneisses, amphibolite, quartzite and mica schist. The geochemical result reveals high concentration of Fe (5%), Mn (1273 ppm), Ce (608 ppm), La (308 ppm), Ba (150 ppm), Cr (125 ppm) and V (121 ppm) in the stream sediments samples analysed. The distribution pattern of elements from the isograde maps revealed that most elements have their peaks in the west and north-eastern quadrants of the study area. It is therefore concluded that the area is rich in manganese, Iron Formation, garnet, K-feldspar and mica which are hosted by the schists, and amphibolites. These mineralizations are concentrated in the western and north-eastern part of the study area and are different from those reported in Eruku, west of the study area.

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