Continental J. Earth Sciences 2: 1 - 6, 2007

ECONOMIC POTENTIALS OF THE PEGMATITES OF ERUKU AREA, SOUTHWESTERN NIGERIA.

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ABSTRACT
The close proximity of the pegmatites of Eruku area to the strongly mineralized pegmatites of Egbe area and lack of published work on those from the former formed the basis of this research. Sub-parallel, steeply-dipping, lenticular/podlike pegmatite bodies occur in the Eruku area, southwestern Nigeria. They are emplaced within the late Proterozoic to early Paleozoic crystalline basement complex rocks. Some of these pegmatites are mineralized while others are barren. The barren pegmatites are sources of industrial minerals like feldspar and quartz. The mineralized pegmatites are also sources of feldspar and quartz and, in addition, columbite – tantalite, cassiterite, garnet and coloured varieties of tourmaline. Structural features present in the pegmatites include their linear disposition, crude zoning within the rocks and occurrence of some minerals across the contact zone. Available geochemical data indicate that the mineralized pegmatites classify as Li-Be$\pm$Ta pegmatites. They are genetically related to differentiation and progressive crystallization of a fertile granitic magma under non-equilibrium conditions during the cooling period, while the barren ones may be products of metamorphism in a high grade metamorphic terrain.

KEYWORDS: *Pegmatites, potential, mineralized differentiation, crystallization, petrogenesis.*

INTRODUCTION

The Eruku area, about 140km east of Ilorin, is located west of the Egbe area, which was studied by Jacobson and Webb (1946) and east of the Osi area, which was also studied by King and de Swardt (1949). The area falls within longitudes 5^0 19'E - 5^0 33'E and 8^0 04'N - 8^0 12'N (Fig.1).

There is no published work on the area, yet it shares a common boundary with the well studied Egbe area, which is known for rare-metal bearing pegmatites. Also, there is an upsurge in demand for precious and semi-precious minerals due to new trends in technology and fashion. This calls for discovery of more sources to cope with the demand. These factors formed the basis for carrying out geological and geochemical studies in the area with a view to possibly identifying more mineralized pegmatites. Geological mapping was carried out on scale1:25,000.

The pegmatites were carefully observed, during the course of mapping for their field and mineralogical characteristics with a view to identifying those with high mineralization potentials. Whole rock and mineral sampling was done during the mapping exercise. Thin-section slides were also prepared for petrographic studies. Carefully selected biotite, muscovite and feldspar samples were pulverized at the workshop of Geology Department, Obafemi Awolowo University, Ile-Ife, Nigeria. The samples were milled to $\leq 40\mu$. Major oxides and minor elements were analyzed for through ICP-MS method using $LiBO_2/L_{12}B_4O_7$ fusion and HCl-HNO_3-$HClO_4$-HP digestion respectively. The rare earth elements were analyzed for using ICP-ES. All analyses were done at ACTLABS, Ontario. Canada, through Petroc Services Ltd, No. 10 Alfonso St., Shasha, Ibadan, Nigeria.

Table 1: Result of Geochemical Analysis

	MUSCOVITE SAMPLES								BIOTITE SAMPLES				FELDSPAR SAMPLES	
	1L1	1L5	1L7	1L11	1L18	1L28	226	4L2	1L3	2L11	2L13	1L35	4L6	2L21
K	19400	95800	76200	81900	72300	93100	81700	98100	71200	97100	93600	94400	69000	100000
Ba	681	89	102	113	70	90	115	87	252	95	38	485	36	226
Rb	139	1732	1940	1927	1164	894	1886	1858	569	955	1428	575	1804	576
Sr	223	3	4	2	3	5	3	5	64	5	9	80	8	95
Zr	76	2	2	3	3	3	4	3	40	3	52	1	10	0.5
Ga	23	96	82	>100	74	96	100	80	48	>100	24	18	>100	19
Cs	4	75	86	54	97	62	56	96	50	50	59	5	99	3.6
Li	25	703	902	348	945	780	352	918	29	121	702	10	632	16
Be	3	4	6	14	1	10	13	1	3	7	2	2	2	1
Nb	19	326	430	498	338	306	502	344	58	228	425	1.53	1166	2.11
Ta	1.5	29	41	110	29	30	43	39	16	29	42	1.2	103	0.8
Sn	4	172	378	421	143	309	406	109	140	104	109	0.3	136	0.1
K/Cs	4850	1277	886	1517	745	1502	1459	1022	1424	1942	1586	18880	697	27778
K/Ba	28	1076	742	725	1033	1034	710	1128	283	1022	2463	195	1917	442
K/Rb	140	55	39	43	62	104	43	52	125	102	66	164	38	174
Rb/Sr	0.6	577	485	964	388	179	629	372	9	191	159	115	226	6
Rb/Cs	35	23	23	36	12	14	34	19	11.38	19	24	160	18	993
La	58	2	1	<1	43	1	0.1	1	22	1	41	1	26	<1
Ce	114	0.4	3	0.5	93	2	0.6	4	101	4	33	95	48	0.6
Nd	44	0.2	1.4	0.2	40	46	0.7	1.5	46	1.2	36	0.5	24	0.3
Sm	10	0.1	0.3	0.1	11	0.2	0.3	0.7	11	0.3	11	0.2	12	0.1
Eu	1.6	<.1	0.1	<0.1	0.2	0.2	1.2	0.2	0.2	<1	0.1	0.1	0.1	0.2
Tb	1.1	<1	<1	<1	0.8	0.6	0.4	<1	1.1	<1	<1	<1	1.1	<1
Yb	3	0.4	0.4	0.1	0.5	0.5	0.3	0.1	1.2	0.1	0.2	0.3	1.7	0.5
Lu	07	0.2	<1	<1<1	<1	0.1	0.2	<1	0.2	<1	0.1	<1	0.2	0.1

* All values in ppm except for K which is in %

Although gh detailed petrographic and structural analyses are beyond the scope of this preliminary report, yet a brief petrogenesis of the pegmatites has been proposed based on the available petrographic and structural data.

It is hoped that this report will prove useful in further search for materials in the ceramic, chemical and technological industries.

The pegmatites

The pegmatite bodies in the study area are variable in character: simple, complex, crudely zoned, unzoned, tabular, lenticular, feebly albitized or graphic. Some of them are deeply weathered and their presence only registered by relics of feldspar, rock quartz, muscovite and schorl, lying on the ground while the others are still emplaced. They cross-cut all rock types in a generally NW-SE direction. Some of them are deformed while the others are massive. An impressive, relatively undeformed body occurs in the north central part of the study area and constitutes about 60% of the small hill. Many others are low-lying. The pegmatites vary in sizes between less than 1m to 30m in width and 5m to 205m in length. They are either vertical in orientation or dip at high angles.

The bodies exhibit sharp textural and mineralogical changes. They also occur in sub-parallel swarms with occasional pinch-and-swell structures along their strikes. The swells are known to be loci of mineralization in certain complex rare-metal pegmatites from southwestern Nigeria (Adedoyin, 2005; Adedoyin *et al*. 2006). In the larger bodies, crude border, wall, intermediate, and core zones could be identified. The contact zone is fine-grained while the core is coarse-grained being composed essentially of large crystals of (up to 12cm across) quartz. Many of the pegmatites are dilational. Around their border, xenoliths of the gneisses were found within the pegmatites while slender prismatic schorl and muscovite are oriented in oblique manner. The basic mineralogy of the pegmatites appears to be microcline + albite + quartz + muscovite ± biotite ±garnet. Microcline is the most prominent feldspar. It is pink in colour and measures between <1cm and 10.5cm across. The size of the deposit also appears to be a function of the grain size. Quartz is dominantly milky but a few crystals are transparent. In some of the pegmatites, crystals of

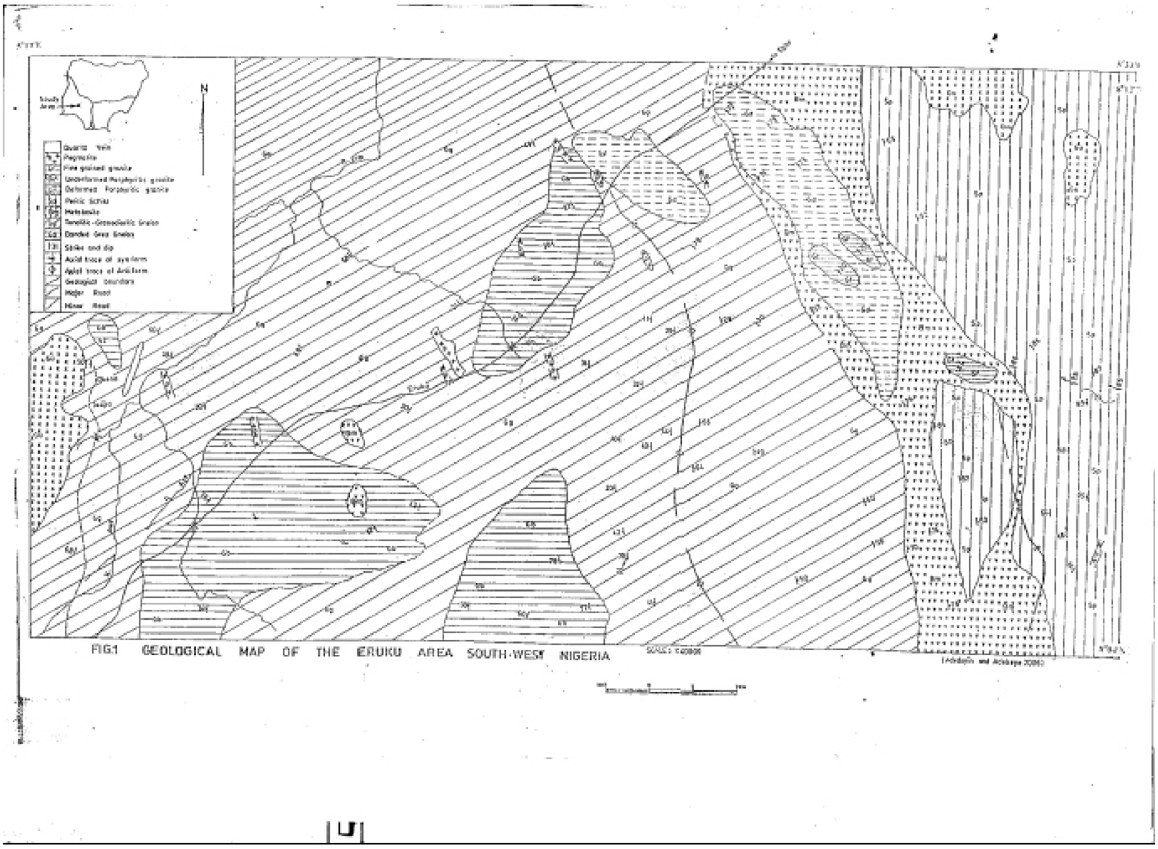

FIG.1 GEOLOGICAL MAP OF THE ERUKU AREA SOUTH-WEST NIGERIA

cassiterite occur as disseminated grains between 0.1 – 1.6 mm in size while tiny, cloudy crystals of beryl were picked in the north central part of the area.

Geochemistry

Major, trace, and rare earth elements were analyzed for in micas and feldspar. Results of the analyzed samples and some geochemical ratios are presented in Table 1. Concentration of some major, minor and trace elements in muscovite and, to some extent feldspar and biotite have proved useful in discriminating the pegmatite deposits. This is a preliminary result and therefore, our conclusions are regarded as tentative in the light of limited analytical results. A sharp contrast exists between elemental conntrations in the samples, whether trace or rare earth elements. Rb and Nb are fairly enriched in the micas while the Sn content is only fairly enriched in muscovite. A close relationship exists between Nb and Ta. About 9% of Ta occurs in every columbite – tantalite association. Although tiny impure crystals of beryl were picked, yet beryllium content is unimpressive. The K/Rb ratios are low while the K/Ba and K/Sr ratios are generally higher in the micas (Table 1).

DISCUSSION

In the past, efforts in the search for mineralized pegmatites were concentrated within the NE- SW pegmatite belt, but in recent times, efforts are now directed at places outside the belt. This has yielded results as new deposits have been discovered away from the belt (e.g. Ekwueme and Matheis, 1995; Garba, 2003). However, Eruku area is sandwiched between Jacobson and Webb's (1946) Egbe area and King and de Swardt's (1949) Osi area. Jacobson and Webb (1946) reported occurrence of mineralized pegmatites but

King and de Swardt(1949) observed none. The present study concentrates on this horizon that lies between 'mineralized' and 'barren' zones.

This investigation shows that the pegmatites in the Eruku area could be classified into two: The first class comprises the microcline + quartz + muscovite ± biotite – bearing bodies. These are barren. Some of them

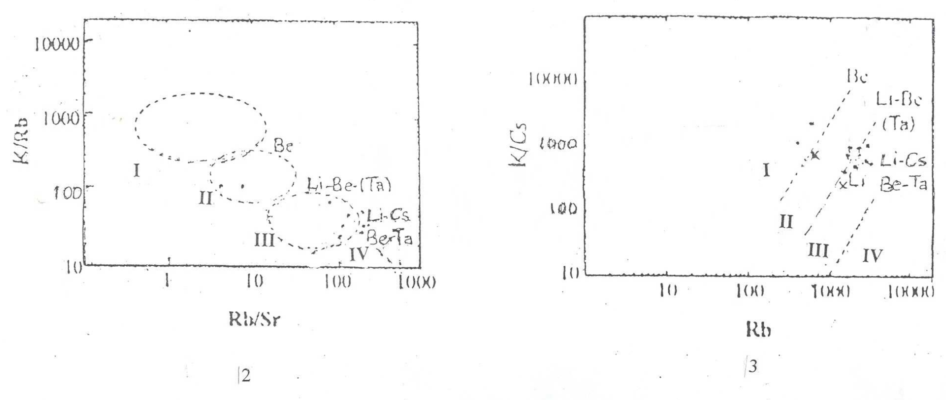

Fig 2 & 3. Correlation plots between major and trace elements for muscovites and K-feldspar (After Galliski et al, 1977). I Barren pegmatites II. Be – bearing pegmatites . III. Complex and albite-spodumene type pegmatites. IV. Albite pegmatites. • Muscovites x Feldspar.

are only sources of large crystals of microcline and quartz. The second class is comprised of microcline + quartz + muscovite + schorl ± garnet ± cassiterite – bearing pegmatites. They are mineralized. The barren pegmatites are more abundant than the mineralized types.

The pegmatites cut various rock types in the area. Their linear and dilational dispositions indicate forceful emplacement into pre-existing zones of weakness within Older Basement units under active tensional strain conditions. Field evidences e.g. occurrence of xenoliths of country rocks in them point to their magmatic origin. They have possibly been formed from differentiation of magma of a fertile granite. The zoning as well as the mineralogical and textural variations between adjacent zones within the pegmatite deposits is related to progressive crystallization from the border to the core. These differences are due to fractionation and progressive reactions between remnant crystals and incoming fluids. According to Cameron *et al* (1949), these reactions are best attained under non-equilibrium conditions. The fractionation is supported by the low K/Rb but high K/Ba and R/Sr ratios

Differences in thermal states between the host rocks and the pegmatites are indicated by the fine-grained nature of the contact zone. This phenomenon develops when a magma forced into relatively cold country rocks is chilled by the lower temperature of the country rocks. Existence of black tourmaline in oblique orientation across the borders indicates that the emplacement was accompanied by mobility from a generation of ascending fluids. The barren pegmatites are older than the mineralized types, being cut by the latter. Kinnard (1984) ascribed upper Proterozoic and Palaeozoic times to barren and mineralized pegmatites, respectively. He also related the earliest pegmatites to shallow-depth plate collision granitoids and the latter ones to orogenic/anorogenic Older Granites. The mineralized pegmatites in the Eruku area thus appear to be genetically related to the late stage emplacement of the granites. The high K/Ba and Rb/Sr but low K/Rb ratios in the muscovite species also point to a granitic origin (Garba, 2003).

Concentrations of trace elements in white micas have on many cases proved useful in appraising the economic potentials of mineralized pegmantites (Gordiyenko, 1971; Garliski, *et al*, 1977; Kuster, 1990). Results of geochemical analysis have been applied to discriminate barren and mineralized pegmatites (e.g Matheis and Caen-VAchette, 1983; Kuster, 1990; Oyarzabal, 2004). K/Cs vs Rb and K/Rb vs Rb/Sr discriminating diagrams (Fig.2 and 3) show that the mineralized pegmatites are Li-Be$\pm$Ta pegmatites. Also compared to some mineralized pegmatites e.g. Kushaka and Magami areas (Garba, 2003), the mineralized pegmatites are more enriched in columbite – tantalite mineral as observed from the results of geochemical analyses. Adedoyin *et al* (2006) are of the opinion that presence of schorls on the surface of a pegmatitic deposit is an indication of its high potential for mineralization.

CONCLUSION

Mineralized and barren pegmatites occur in the Eruku area. The barren ones are simple in mineralogy and character and are sources of only ceramic and industrial minerals. The mineralized pegmatites are complex and contain some minerals such as columbite – tantalite, beryl, tourmaline, cassiterite and garnet. Massive, clean quartz veins occur in the northwestern part of the area and are being worked by artisan miners. The purity of the quartz veins makes them favourable sources of raw materials for glass, soap and scouring powder industries.

ACKNOWLEDGEMENTS

The authors thank Mr. Sunday Abiola of Ekiti Local Government Secretariat, Araromi-Opin, Kwara State, Nigeria, for providing free accommodation during the fieldwork. Mrs. Felicia Omidiran of The Lord is good Computer Centre, Offa Rd/Lajorin, Ilorin, Nigeria, is also thanked for carefully typing the manuscript.

REFERENCES

Adedoyin, A. D. (2005): Aspects of the Geochemistry of Pegmatites from selected localities from southwestern Nigeria. Unpubl. M. Sc. Thesis, Univ. Ilorin.

Adedoyin, A. D., Adekeye, J.I.D. and Alao, D. A. (2006): Trace element geochemistry of selected pegmatites from southwestern Nigeria. Nigerian Journal of Pure & Applied Sciences, University of Ilorin. 1:2023-2035.

Cameron, E. N., Jahns, R. H., McNair, A., and Page, L. R. (1949): Internal structure of granitic pegmatites. Econ. Geol. Monogr. 2: 115pp.

Ekwueme, B. N. and Matheis, G. (1995): Geochemistry and Economic value of pegmatites in the Precambrian Basement Complex of southeastern Nigeria: Magmatism in relation to diverse tectonic settings (R.K. Srivastava and R. Chandra, Eds., New Delhi, IBH publishing Co. 1:375-392).

Garba, I. (2003): Geochemistry discrimination of newly – discovered Rare-metal bearing and Barren Pegmatites in the Pan-African (600$\pm$ 150Ma). B112: B287 – B292.

Garliski, M., Perino, E., Gasquez, J., Marquez Zavalia M., and R. Olsina (1977):Geoquimica de feldspatos potasicos y muscovitas como guia de exploracion de pegmatitas graniticas de algunos distritos de la provincial pegmatitica pampeana. Rev. Asoc Geol. Arg. 52:24-32.

Gordiyenko, V. V. (1971): Concentration of Li, Rb and Cs in potash feldspar and muscovite as criteria for assessing the rare metal mineralization in granite pegmatites. Internation Geo Review, 13: 134-142.

Jacobson, R. and Webb, S. (1946): The Pegmatites of Central Nigeria. Geological Survey Bulletin. 17:1-73.

King, B. C. and de Swardt, A.M.J. (1949): The Geology of the Osi Area, Ilorin province. Geological Survey of Nigeria. Bull No. 20.

Kinnaird, J.A. (1984): Contrsating styles of Sn-Nb-Ta-Zn Mineralization in Nigeria. Journal of African Earth Sciences, 2: No.2:81-90.

Kuster, D. (1990): Rare-metal pegmatites of Wamba, Central Nigeria – Their formation in relation to Late Pan-African granite. Mineralium Deposita 25: 25-33.

Matheis, G. and Caen-Vachette, M. (1983): Rb – Sr Isotopic metal-bearing and barren pegmatites in the Pan-African reactivation zone of Nigeria. J. Afri. Earth Sci 1: 35-40

Oyarzabal, J. (2004): Geologica, meneralogia, geoquimica y Petrogenesis de yacimientos pegmatiticas de! Distrito Totoral, Sierra de San Luis, Argentina. Tesis Doctoral UNC. Cordoba, Argentina.

Received for Publication: 01/05/2007
Accepted for Publication:

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