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Soil Geochemical Survey of Eruku and Environs

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ABSTRACT
The study area, Eruku and its environs, is located approximately 124km east of Ilorin and lies within Osi migmatite gneiss complex to the west and Egbe schist belt in the east. The area falls within longitudes $5^0$23'E and $5^0$30'E and latitudes $8^0$05'N and $8^0$13'N represented in Osi sheet 224SE . Detailed mapping and sampling of rocks and soils were carried out in this area. The soil samples were collected from the B horizon at a depth of 20cm-25cm. Twenty-five selected soil samples were analyzed for trace and rare earth elemental concentration using ICP, INAA, MS and ICP-MS analytical methods. The result of the geochemical analysis was thereafter subjected to statistical analysis and isograde plotting.

The multivariate statistical analysis shows a total of eleven factor groups. Seven of the factor groups are of importance in the study area with five related to mineralization. The correlation coefficients of some selected elements show that Be is strongly correlated with Rb, Ga, Sn and Ta while Nb is strongly correlated with Ta. The area and bar charts show that the highest concentrations of Be, Nb, Sn and Ta are in the northeastern part of the study area. The isograde plots show that almost all the elements have their peaks in the northeastern part of the study area.

From the integration of geochemical and multivariate analyses, and isograde plotting, the study area has anomalous concentration of cassiterite-tantalite-columbite minerals. These mineralizations are hosted by pegmatites that intrude the country rocks in the study area. This establishes similarity in terms of host rocks and mineralization type of the Eruku area compared to Egbe.
Keywords: Mineralization, soils, geochemical data, cluster groups, isograde plotting, Eruku.

INTRODUCTION

The study area, Eruku and its environ is located approximately 124km east of Ilorin and 8km west of Egbe (Fig.1). The area studied is appropriately 224.44km^2 located within longitudes $5^0$23'E and $5^0$30'E and latitudes $8^0$05'N and $8^0$13'N represented in Osi sheet 224SE. The climate of Eruku and its environs is typically of the tropical climate. The vegetation is typical of guinea savanna characterized by tall slender grasses, sparsely distributed trees and denser vegetation around the river courses. The area is well drained by Rivers Agboro, Ofo, Aru, Gburugburu, Aye, Ela and Oro and their tributaries. The common drainage patterns are dendritic and trellis. The settlement is typical of linear settlement with some houses clustering around a particular region to form a conubated settlement.

This work is aimed at identifying the mineralized zones in the study area using soil sampling survey. Also, it is aimed at comparing the mineralization type present in the area with those of Egbe east of the study area. Ultimately, it is to delineate and confirm the occurrence of cassiterite, tantalite, columbite and beryl mineralization potential.

Dada (1978) and Bafor (1981,1988) worked in Egbe-Isanlu area and recognized the Sudbury type mineral association of rocks in this area. Rahaman (1988) found out that the sediments found in the area originate from weathering of igneous rocks from the area, probably Older Granite of the Basement Complex. Olobaniyi (1997) envisaged Egbe-Isanlu schist belt to have originated by the deformation and metamorphism of sediment volcanic sequence with the volcanic component resulting from the episodic uprise of mantle plumes. He also reported that the mineralized pegmatites (e.g. around Eruku and Ogbom) have well formed crystals of quartz, K feldspar, mica, beryl and tantalite. The maiden work in Eruku and its environs by Adedoyin and Adekeye (2007) grouped the pegmatites hosted by gneisses in this area into barren and mineralized pegmatites.

The role of geochemical exploration in the investigation of ore deposits are based on the chemical dispersion of metallic elements in soils from weathered bedrock (Lecomte et al. 1975). It has been observed from the results of trace element studies in lateritic soil profiles that most trace elements retain more or less their bedrock concentrations during pedogenetic development; thus characteristic differences in bedrock composition are still reflected by the trace element pattern of the sampling horizons (Matheis, 1981).

GEOLOGY OF THE STUDY AREA

The study area, Eruku and its environs, lies between the Egbe schist belt in the east and Osi migmatite-Gneiss complex in the West. It falls within the Precambrian Basement Complex of Southwestern Nigeria estimated to be of Late Proterozoic to Early Paleozoic age by Adekeye and Adedoyin (2007). The rocks can be grossly divided into five namely: gneiss, migmatite, granite, gabbro and pegmatite (Fig.2).

The gneisses cover about 80% of the total area studied. They dominate the area and are very extensive. The gneisses can be divided into banded gneiss and granite gneiss. The gneisses trend mainly in north-eastern direction. They have sharp contact with the granitic rocks that are present in the study area. The migmatites occur in the eastern and southwestern part of the study area (Fig. 2). The migmatites are associated with gabbro. They occur essentially as pockets of rock within the gneiss. The granites in the mapped area have sharp contact with the gneiss. They are found in the northeastern part and in the western part of the mapped area. The granites have been intruded by pegmatites in some parts of the study area (Fig.2). The gabbro occur as boulders and cobbles arranged in south-western-northeastern direction. They often occur as xenoliths within the gneisses and migmatitic rocks. The pegmatites occur as intrusive rocks. They are hosted essentially by granites and gneisses. They can be divided into the mineralized and barren pegmatites.

METHODOLOGY

This research work was carried out in two phases. The first phase is the fieldwork exercise while the second phase involves laboratory analysis. A total of 25 soil samples were collected from the B-horizon of about 20-30cm depth (Fig.3). 10gram of each sample was weighed and sent to Activation Laboratory Limited, 1336, Sandhill Drive, Ancaster Ontario, Canada for further preparation and analysis. The result of the geochemical analysis was subjected to statistical analysis using SPSS software and isograde plotting.

DATA PRESENTATION

The result of the geochemical analysis in which the concentration of elements in the soil sample is shown in Table 1.The geochemical result was subjected to simple statistical analysis to determine simple statistical parameters, Pearson correlation, multivariate analysis and isograde plotting. The simple statistical parameters were determined using SPSS software (Table.2).The background and threshold values were also determined (Table 3) .Pearson correlation is used to study inter-element relationships (Table 4). Cluster analysis is a multivariate statistical method for identifying homogenous groups of objects called clusters (Table 5).It helps to detect natural grouping in data. Cluster plot shows fusion at each successive stage of the analysis, thereby helps to visualize cluster analysis' progress (Fig.4).The area and bar charts shows the concentration of elements in the study area (Figs.5-12) The isograde plots link areas of equal concentration of elements together (Figs. 13,14,15 and 16).

DISCUSSION

It was observed from the geochemical result that the concentrations of Ba (>400ppm), Rb (130ppm) and Sr (100ppm) were high in most samples (Table1). The concentrations of Nb (>10ppm), Sn (3ppm) and Ta (1ppm) were relatively high in some samples. From the Pearson correlation (Table 4), it was observed that the correlation coefficient of Sn with Be is 0.926, Nb is strongly correlated with Ta (0.796). Eleven (11) factor groups were identified. Factors 1 to 7 are the most important because it shows the association of wide range of elements (Table 5). Factor 1 which has Nd, Pr, Tb, La, Sm, Eu, Dy, Ho, Y, Ce and Er are produced from weathering of rocks within the study area. Hence, it is influenced by lithology and not related to mineralization (Imeokpara, 1981; Levinson, 1981).

Factor 2 which comprises of Sn, Cs, Bi, Be, Rb, Tl and Li is related to granites (Rose et al. 1979, Levinson, 1981), particularly base metal bearing granites. Factor 3 comprises of Ca, Mg, Sr and Fe. Factor 4 comprises of Ti, Co, Mn, Na, V and Ni. In which Co, V and Ni are related to ultramafic rocks. Factor 5 containing Yb, Lu, Te, Ta and Nb, is related to mineralization. They occur in highly differentiated granites, which host numerous rare metals particularly tantalite-columbite bearing pegmatites. Factors 2 and 5 are probably due to mineralized weathered bedrock within Eruku and its environs (Table 4). Li, Be, Nb, Ta, Sn, U, W, Zr and rare earth elements tend to be preferentially concentrated in residual fluids which is typical of pegmatites. Factor 6 has U, P, Th, Cr, Mo and Se while Factor 7 consists of Hf, Zr and Ba which are related to pegmatitic intrusion found within the study area. The elements in Factors 8 to 11 are not important in mineral exploration with the exception of As in factor 10 which is a pathfinder element for gold.

The bar and area charts show the highest concentration of Be, Sn and occur in sample BS23, while that of Nb and Ta occur in BS20 (Figs.5-12).These elements are typically associated with rare-metal pegmatites (Fig.2).The isograde plots of Be, Sn, Ta and Nb occur in the northeastern quadrant of the study area. The local threshold values for Nb, Sn,Ta and Be are 22 ppm, 11 ppm, 3 ppm and 6.5 ppm respectively were determined from the isograde plots(Figs.13-16).

CONCLUSION

The study area lies within the basement complex and is underlain by gneiss, migmatite, granite, gabbro and pegmatite, the gneiss covers about 80% of the study area. The migmatites are associated with the gabbro.

The granite has sharp contact with the gneiss. They have been intruded by both rare-metal and barren pegmatites.

The geochemical result shows that Ba, Sr and Rb have high concentration in all the samples analysed. The Pearson correlation shows that Be is strongly correlated with Sn, also Nb is strongly correlated with Ta. Eleven factor groups were identified from the cluster analysis. Factors 2 and 5 are influenced by mineralization. The isograde plots show that most elements have their peaks in the northeastern quadrant of the study area. The local threshold values from the isograde plots for Nb ,Sn, Ta and Be are 22ppm, 11ppm, 3ppm and 6.5ppm respectively.

It is observed from the integration of geochemical result, statistical analysis and isograde plotting that the area is enriched in cassiterite, tantalite, columbite and beryl. The peaks of the isograde plots suggest the metallogenic potential of the pegmatites and/ or granites in the northeastern quadrant of the study area. The mineralization is concentrated in the northeastern part of the study area, therefore, establishing the mineralization type as found in Egbe east of the study area.

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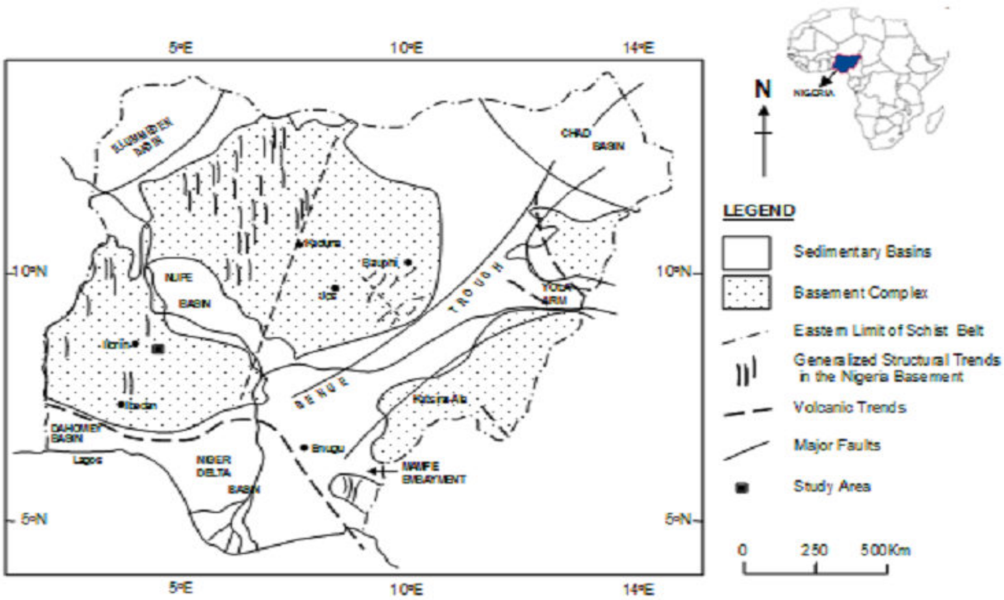

Fig.1: Map of Nigeria showing study area (after Kogbe,1976)

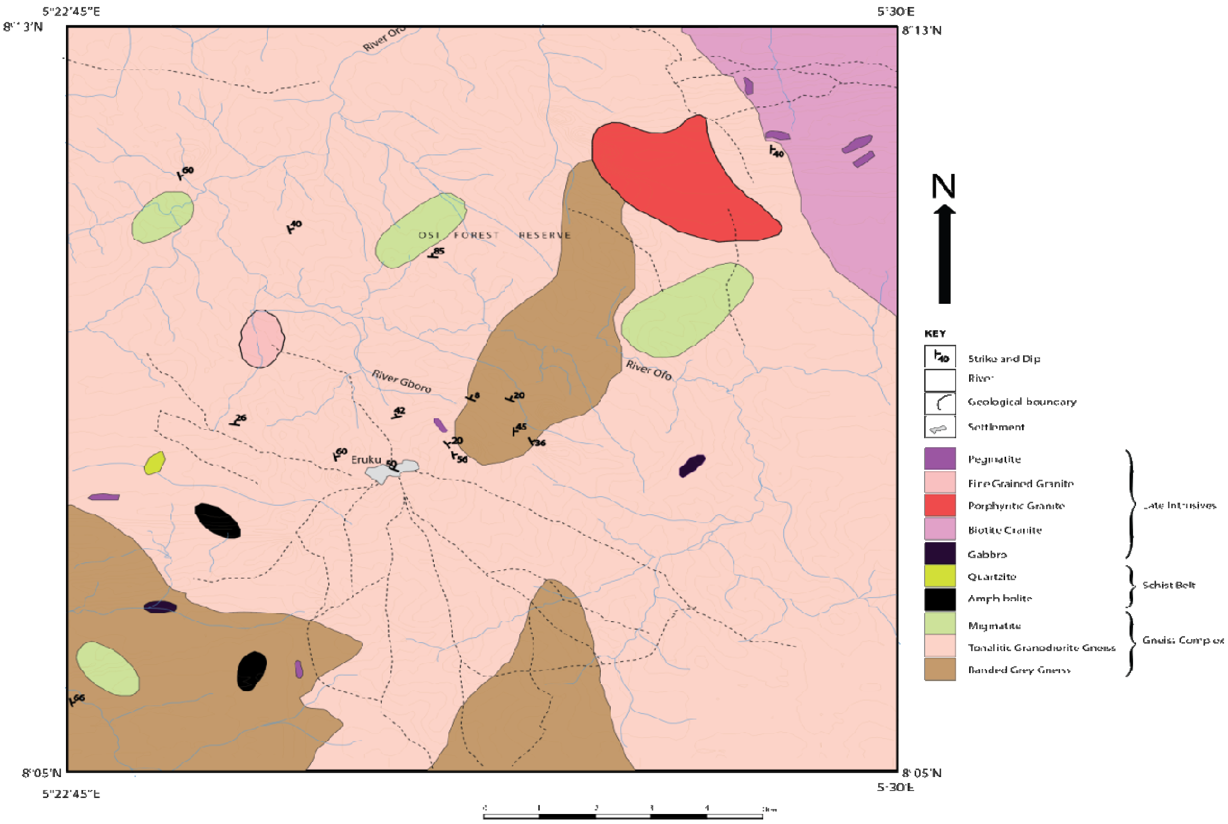

Fig.2: Geological Map of Study Area

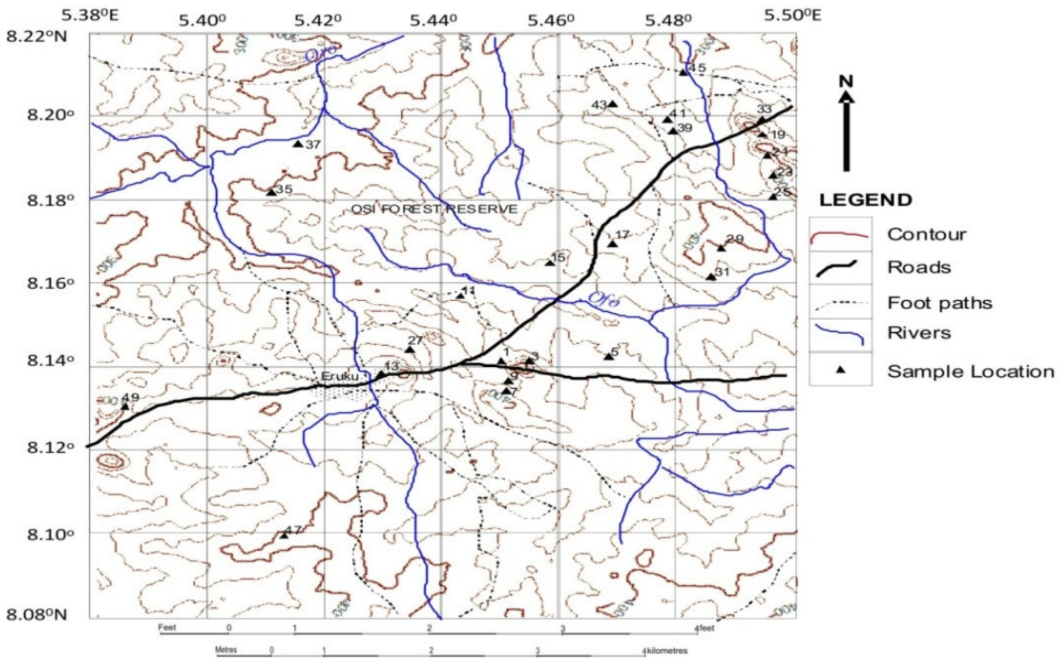

Fig.3: Map of Study Area Showing Sampling Points

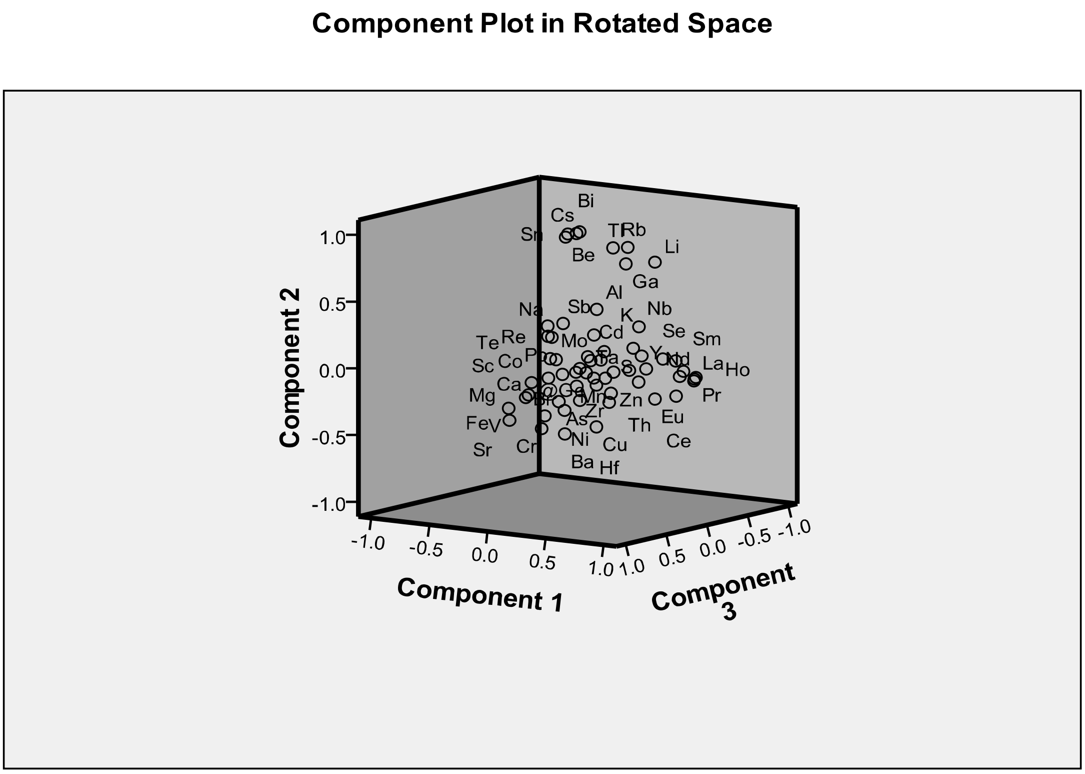

Fig. 4: 3D Cluster plots for factor analysis

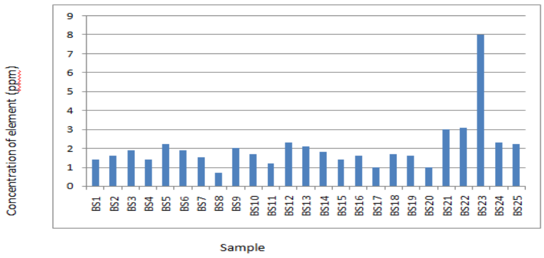

Fig.5: Bar chart for Be

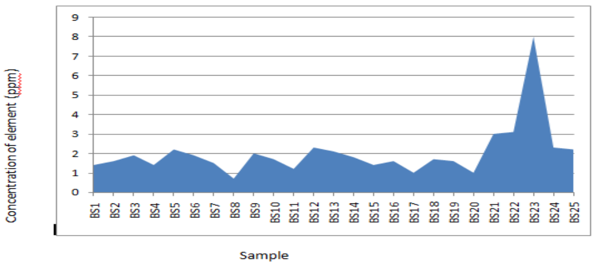

Fig. 6:Area chart for Be

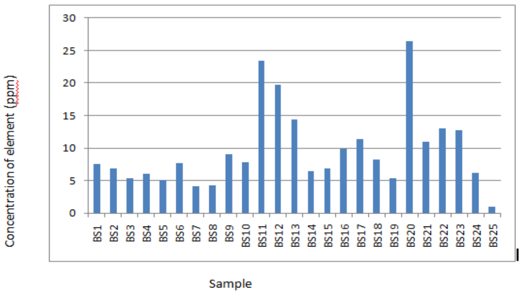

Fig. 7: Bar chart for Nb

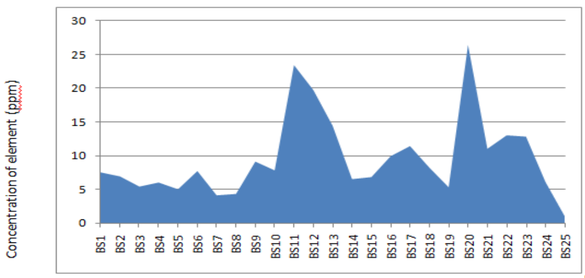

Fig. 8:Area chart for Nb

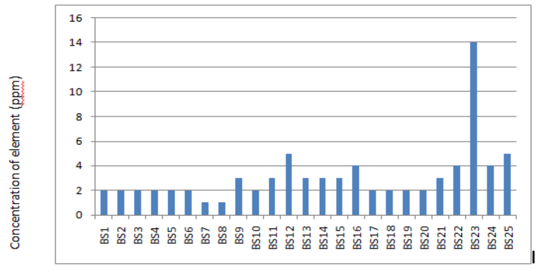

Fig. 9: Bar chart for Sn

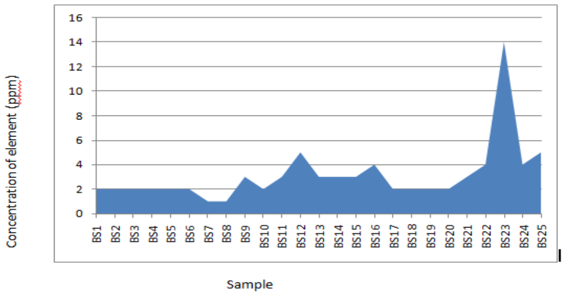

Fig.10: Area chart for Sn

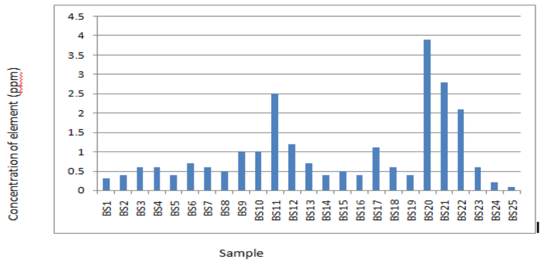

Fig.11: Bar chart for Ta

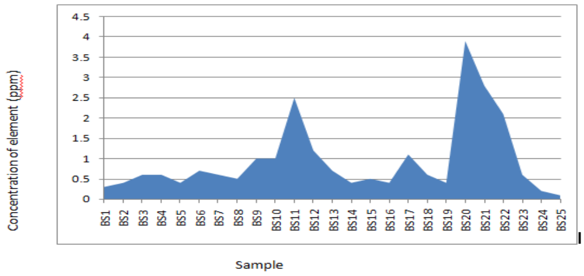

Fig.12: Area chart for Ta

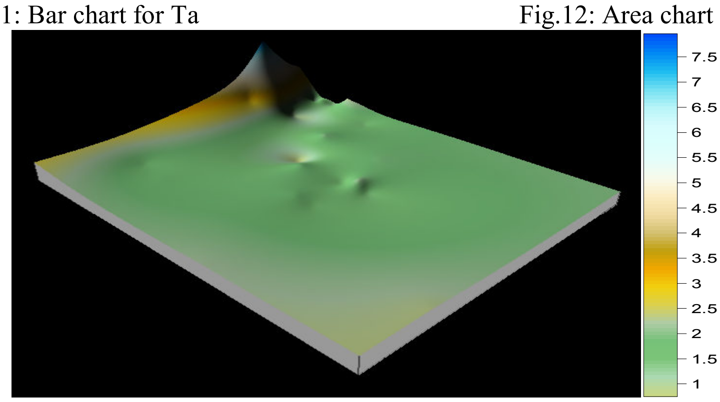

Fig.13: Isograde plot for Be

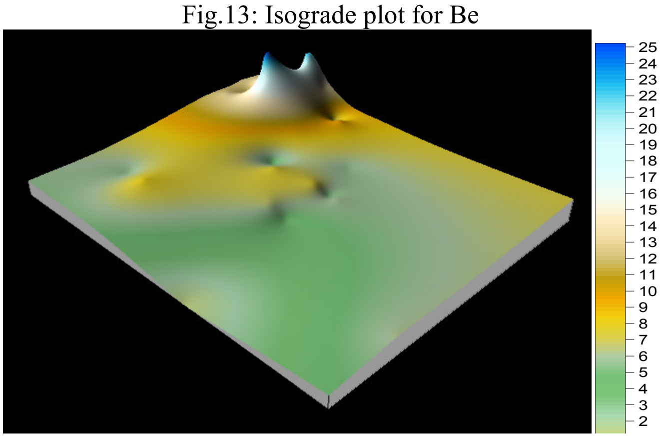

Fig.14: Isograde Plot for Nb

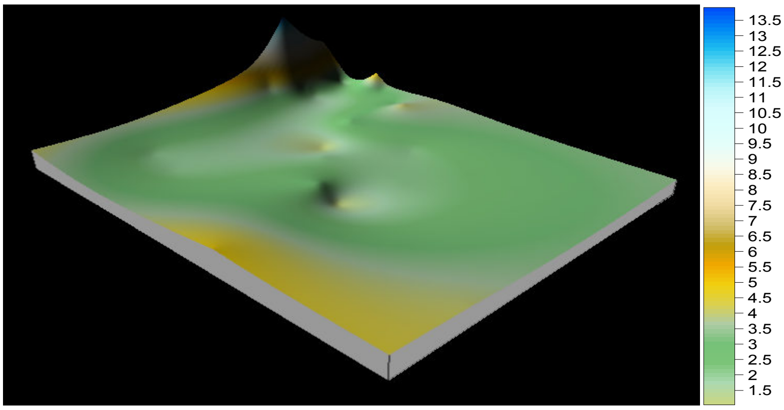

Fig 15:Isograde plot for Sn

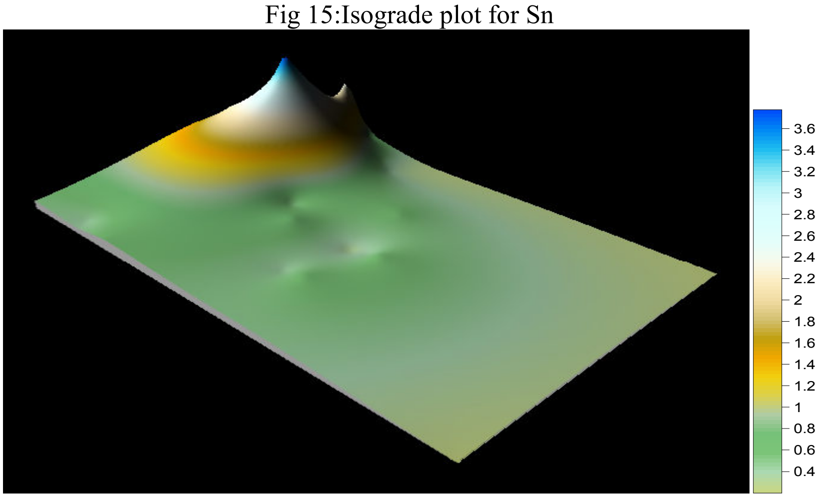

Fig.16:Isograde Plot of Ta

Table1: Geochemical data showing concentration of some elements in soils of Eruku and its environs

Element/Sample	Cu	Ni	Fe	Be	Ba	Sr	Li	Mn	Nb	Rb	Sn	Sr	Ta
BS1	10.1	6.3	2.68	1.4	935	134	9.6	446	7.5	139	2	134	0.3
BS2	18	12.5	3.96	1.6	485	132	18.4	649	6.9	135	2	132	0.4
BS3	9.5	6.9	2.74	1.9	620	128	11.5	553	5.4	171	2	128	0.6
BS4	12.6	6.5	2.52	1.4	882	135	6.8	348	6	140	2	135	0.6
BS5	14.1	7	2.75	2.2	322	102	13.9	724	5	183	2	102	0.4
BS6	10.8	7	2.97	1.9	872	131	17.8	594	7.7	129	2	131	0.7
BS7	12	6.1	2.7	1.5	672	127	8.8	390	4.1	110	1	127	0.6
BS8	11.1	6.8	2.34	0.7	1020	110	4.4	250	4.3	95.9	1	110	0.5
BS9	10.4	9.6	3.36	2	966	125	15.7	491	9.1	107	3	125	1
BS10	15.5	5.9	2.86	1.7	809	85.5	14.5	370	7.8	95.8	2	85.5	1
BS11	9.8	13.7	3.65	1.2	156	27.8	10.3	1310	23.4	153	3	27.8	2.5
BS12	11.1	5.7	3.49	2.3	893	59.9	40.6	586	19.7	161	5	59.9	1.2
BS13	12.1	5.6	2.24	2.1	662	63.9	33.7	653	14.4	180	3	63.9	0.7
BS14	16.4	11.4	4.38	1.8	578	265	11.8	619	6.5	68.8	3	265	0.4
BS15	12.4	11.7	4.33	1.4	966	267	6.3	649	6.8	93.7	3	267	0.5
BS16	9.8	6.7	2.05	1.6	393	32.7	30.2	424	9.9	180	4	32.7	0.4
BS17	13.4	7.1	2.47	1	197	26.9	23.9	504	11.4	205	2	26.9	1.1
BS18	16.6	12.9	3.02	1.7	557	158	11.3	657	8.2	86.6	2	158	0.6
BS19	20.5	11.7	2.54	1.6	704	171	11.1	519	5.3	102	2	171	0.4
BS20	13.5	9.8	2.68	1	609	68.1	12	273	26.4	123	2	68.1	3.9
BS21	8.8	6.1	2.8	3	641	123	19.7	440	11	127	3	123	2.8
BS22	10.3	7	2.52	3.1	453	96	35.9	637	13	189	4	96	2.1
BS23	7.9	3.8	1.35	8	136	32.9	45.4	244	12.8	325	14	32.9	0.6
BS24	9.4	8.5	4.11	2.3	872	174	15.9	633	6.1	136	4	174	0.2
BS25	12	7.9	3.15	2.2	714	162	16.6	625	1	130	5	162	0.1

Table 2: Elements with corresponding statistical general parameters

Element	Mean	Median	Mode	Std.Dev.	Minimum	Maximum	Sum
Be	2.02	1.70	1.40	1.37	0.70	8.00	50.60
Nb	9.59	7.70	1.00	6.05	1.00	26.40	239.70
Sn	3.12	2.00	2.00	2.51	1.00	14.00	78.00
Ta	0.98	0.60	0.40	0.92	0.20	3.90	23.50

Table 3: Background and threshold values of selected elements in soil samples

Element	Background Value	Threshold Value
Be	2.02	4.76
Nb	9.59	21.69
Sn	3.12	8.14
Ta	0.98	2.82

Table 4: Pearson Correlation

	Be	Nb	Sn	Ta
Be	1			
Nb	0.071	1		
Sn	0.926	0.187	1	
Ta	-0.041	0.796	-0.057	1

Table 5: Rotated components matrix (Varimax with Kaiser Normalization)

	1	2	3	4	5	6	7	8	9	10	11
Gd	.967	.038					.026		.077		
Nd	.963					.132		.022	.020		
Pr	.957					.127	.035				
Tb	.946	.124		.066					.073		
La	.928						.161			.120	.088
Sm	.925			.040	.042	.170	.075			.103	.075
Eu	.898			.334	.015						
Dy	.890	.144	.226	.067	.265			.006			
Ho	.815	.077							.149	.014	
Y	.773		.319	.028	.413	.064	.055	.162			.077
Ce	.704					.136			.178		
Er	.682			.060							
Zn	.582		.392								
Sn		.969									
Cs		.945									
Bi		.935									
Be		.930	.030					.107			.028
Rb		.794									
Tl		.788									
Ga	.425	.780									
Li	.438	.745									
Ba		-.489	.290				.393				
Ca	.207		.935								
Mg			.922								
Sr			.907								
Ti				.924							
Co			.090	.915							
Mn	.159			.914				.170			.087
Na		.301	.271	.831							
V				.646							
Ni				.619	.128	.395					
Fe	.152		.624	.538							
Yb					.956						
Lu					.922						
Te					.854						
Ta					.571						
Nb		.204			496						
U						.761					
Th						.586					
Cr						.524					
Mo			.318			.518					
Hf							.867				
Zr							.857				
Cu			.269				-.503				
Pb								.797			
K		.255							.714		
Sb										.770	
As										.615	
Br			.072							.514	
Cd											.891