GEOCHEMICAL SOIL SURVEY OF ERUKU AND ENVIRONS SOUTH WESTERN NIGERIA

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ABSTRACT

Geochemical exploration of Eruku and its environs within Osi Migmatite gneiss complex and Egbe Schist belt was carried out using soil survey. A total twenty five samples collected from the B-horizon at a depth of 20cm-25cm were selected and analysed for trace and rare earth element concentration. The analytical results were subjected to multivariate statistical analysis; univariate analysis and geochemical distribution map (Isograde) were also plotted for the elements. The multivariate statistical analysis reveals a total of eleven factor groups, five of which are 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. The integration of all the analysis reveals that the study area has anomalous concentration of cassiterite, tantalite and columbite minerals hosted by pegmatites that intrude the country rocks. This work in Eruku therefore establishes similarity in the mineralization type and their host rock with those in Egbe.

Keywords: Mineralization, soil, geochemical data, cluster groups, isograde plotting, Eruku, Southwest Nigeria.

INTRODUCTION

Geochemical exploration play an important role in the investigation of ore deposits, this is because it employ chemical dispersion of metallic elements in soils from weathered bedrock (Lecomte et al. 1975). Trace element studies of lateritic soil profiles revealed 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).

The study area is underlain by rocks of the Precambrian Basement Complex composed of amphibolitic rock suggested to be the Sudbury Type (Bafor, 1981,1988) and sediments found in the area originate from weathering of igneous rocks from the area, probably Older Granite of the Basement Complex (Rahaman, 1988). The pegmatites of the Egbe-Isanlu area are rich in Sn-Ta-Nb mineralizations (Dada, 1978). The mineralized pegmatites round Eruku and Ogbom have well formed crystals of quartz, K feldspar, mica, beryl and tantalite. The pegmatites hosted by gneisses in this area into barren and mineralized pegmatites (Adedoyin and Adekeye, 2007). The Egbe- Isanlu schist belt is proposed to have originated by the deformation and metamorphism of sediments volcanic sequence resulting from episodic uprise of mantle plumes (Olobaniyi, 1997). Thus the study of trace element in soils could be useful in identifying the underlying bedrock (Zeissinck, 1971).

This research attempt to locate the mineralized zones in the study area using soil survey; as well as delineating and confirming the occurrence of cassiterite, tantalite, columbite and beryl mineralization potential and then compare the mineralization type present in the area with those of Egbe East.

GEOLOGY OF THE STUDY AREA

The area under investigation is situated in the Precambrian Basement Complex of Southwestern Nigeria estimated to be of Late Proterozoic to Early Paleozoic age (Jacobson and Webb 1946, King and De Swardt 1949 and Kinniard, 1984). It is located approximately 124km east of Ilorin and 8km west of Egbe (Fig.1). It is bordered longitudes 5° 23′E and 5° 30′ E and latitudes 8° 05′ N and 8° 13′ N covering a total area of 224.44km^2. Eruku soil is underlain by gneiss, migmatite, granite, gabbro and pegmatite (Adedoyin and Adekeye 2007).

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 northeastern 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 (Adedoyin and Adekeye 2007).

METHODOLOGY

This research work involves soil sampling during the field work exercise, geochemical analysis of the soil samples, processing and interpretation that constitute the laboratory work. A total of twenty five soil samples were collected from the B- horizon at about 20-30cm depth (Fig.3). Samples were sundried and pulverized using agate mortar. 10gram of each sample was weighed and sent for further preparation and elemental analysis using Inductively-Coupled Plasma Atomic Emission Spectrophotometer. The INAA was carried out according to the procedure by Hoffman, 1992) at Activation Laboratory Limited, Ancaster Ontario, Canada. The geochemical result was subjected to statistical analysis using SPSS software and isograde plotting.

RESULT PRESENTATION

The result of the geochemical analysis in which the concentration of elements in the soil samples are 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). According to Rose et al. (1979), univariate statistical method of analysis of data are good in summarizing large set of reconnaissance data which help to identify regions favourable for mineralizations. The background and threshold values were also determined (Table 3). Hawkes and Webb (1964) further noted that the mean plus twice standard deviation can be used to establish the threshold. Pearson correlation is used to study inter-element relationships (Table 4).

DISCUSSION

The geochemical result that the concentrations of Ba (>400ppm), Rb (130ppm) and Sr (100ppm) were high in most samples (Table 1). Ba and Pb have relative low mobility in oxidizing environmental conditions (Andrew- Jones 1968). The concentrations of Nb (> 10ppm), Sn (3 ppm) 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 (Bottrill, 2008), 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 (Imeokparia, 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. Matheis (1979) suggested that special attention should be given to petrogenetic indicators of rare-metal specialization elements such as Li, Rb, Cs, and Be. 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. Li, Rb, Cs and Be can be used as exploration aids for rare – metal pegmatites (op cit), the rare metal pegmatites in northcentral Nigeria are enriched in these elements (Akintola and Adekeye 2008). 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 (Adekeye and Akintola, 2005). 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. Cluster plot shows fusion at each successive stage of the analysis (Imeokparia, 1981), thereby helps to visualize cluster analysis' progress (Fig.4).

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 elemental associations identified during this study are related to the underlying parent rocks which include gneiss, migmatite, granite, gabbro and pegmatite. The high concentration of Ba, Sr, Rb, Be, Sn, Nb and Ta which are strongly correlated with each other suggest cassiterite, tantalite, columbite and beryl mineralization. The anomalous concentration of these elements occur in the Northeastern quadrant of the study area which are characterized by pegmatites and granites likely to be their host. These results have shown that the mineralization type and potential are consistent with those in Egbe east of the study area.

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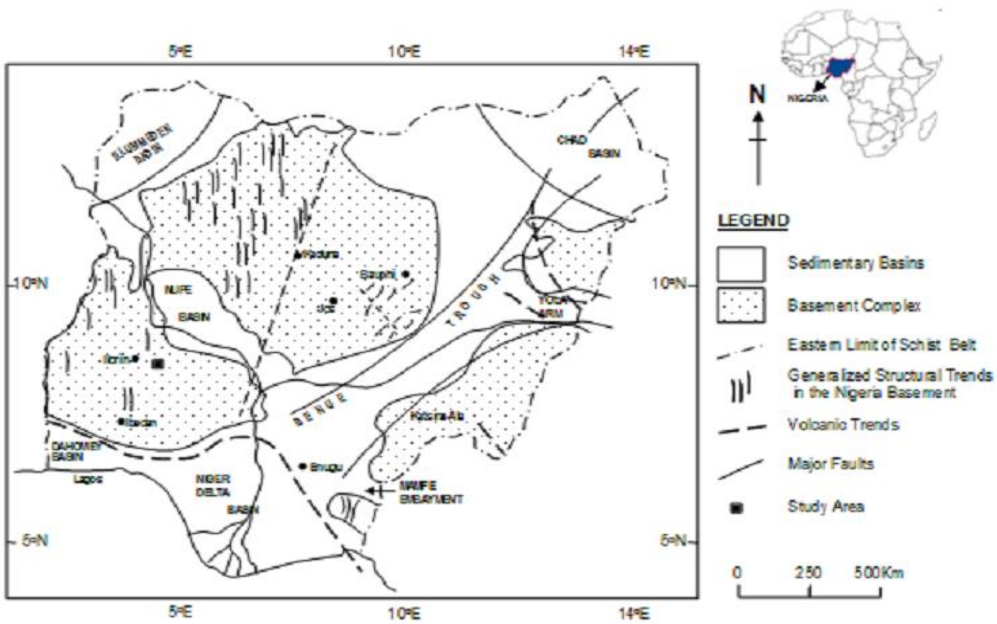

Fig.1: Map of Nigeria showing study area (after Kogbe, 1976)

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

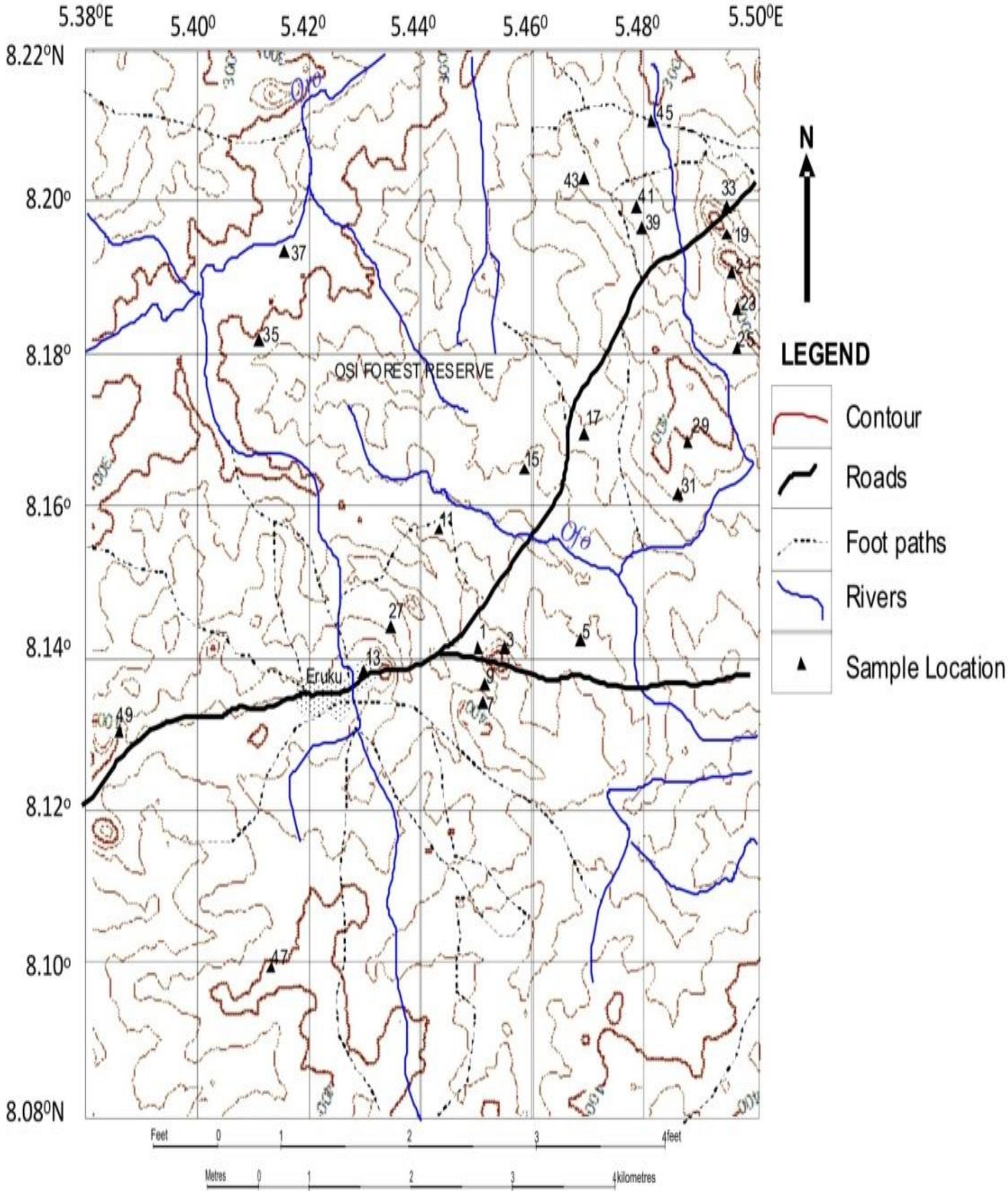

Fig.2: Map of Study Area Showing Sampling Points

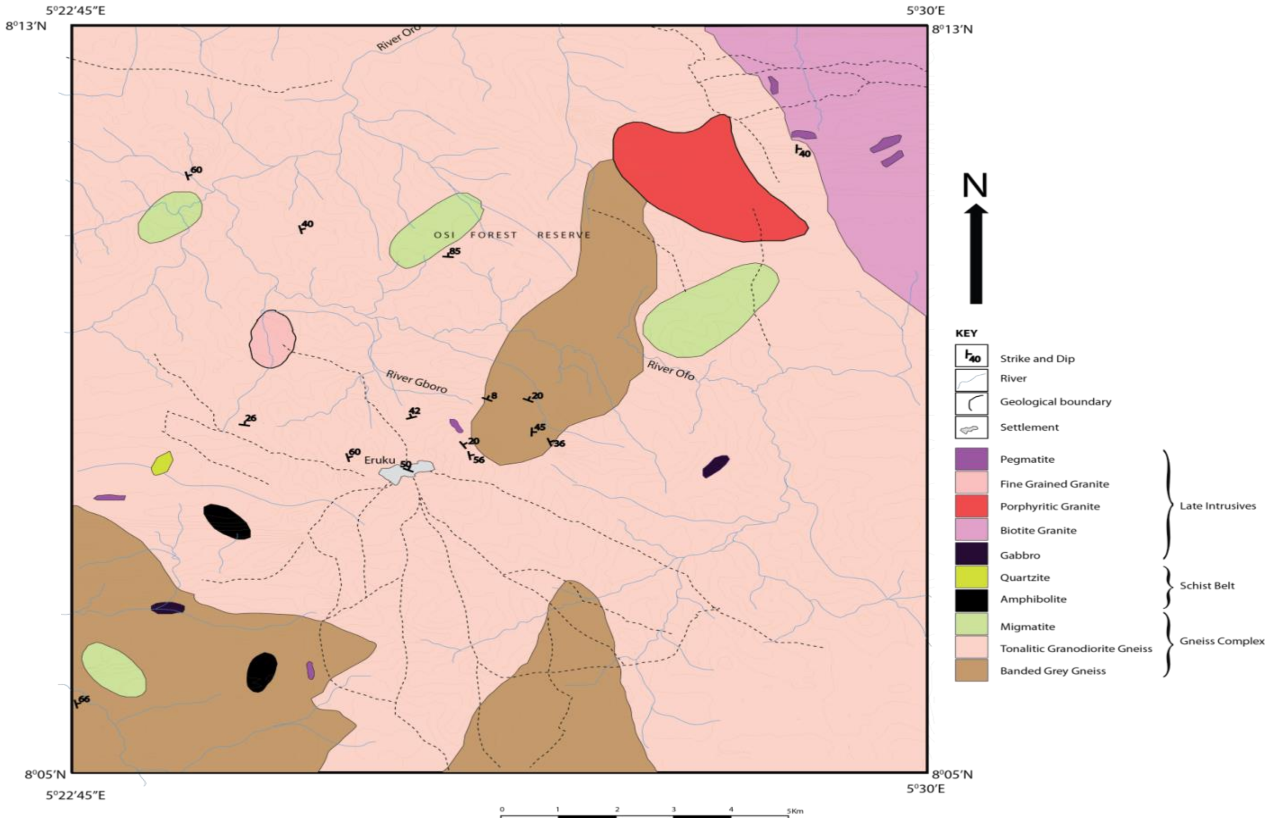

Fig.3: Geological Map of Study Area (Modified after Bamigboye and Adekeye, 2011)

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

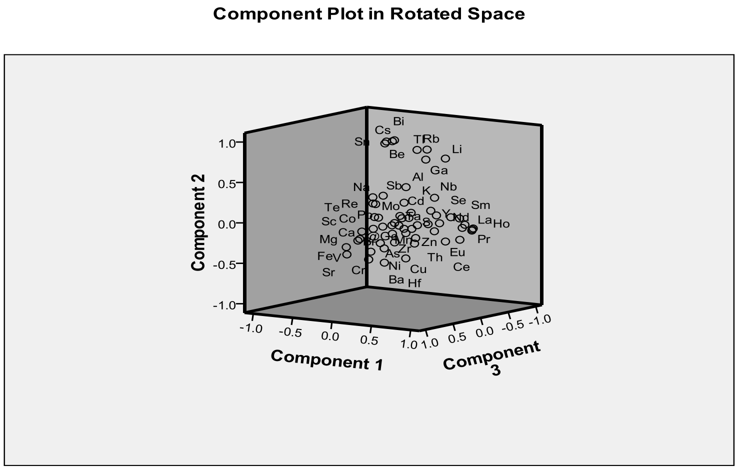

Fig. 4: 3D Cluster plots for factor analysis

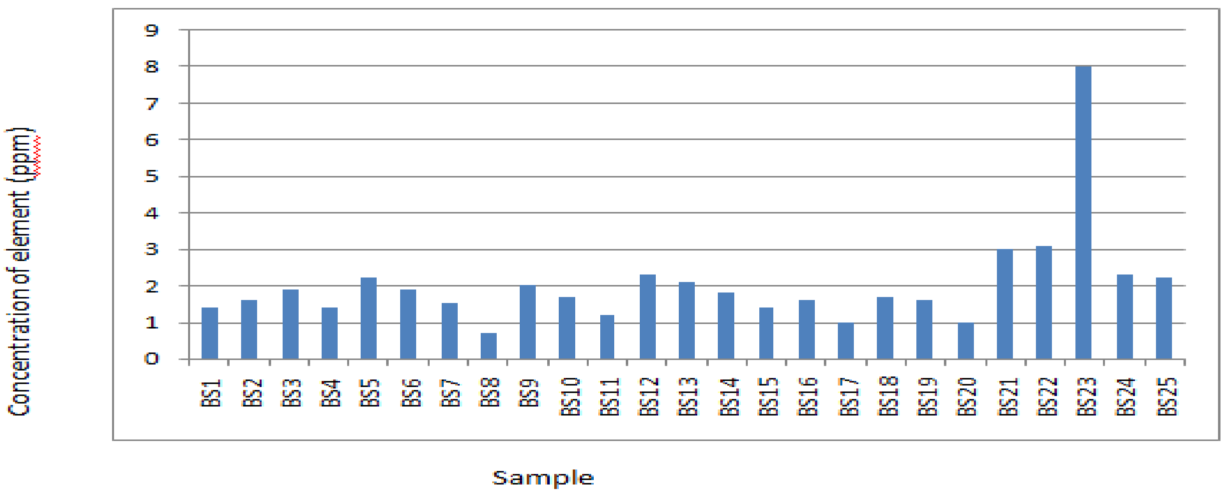

Fig. 5: Bar chart for Be

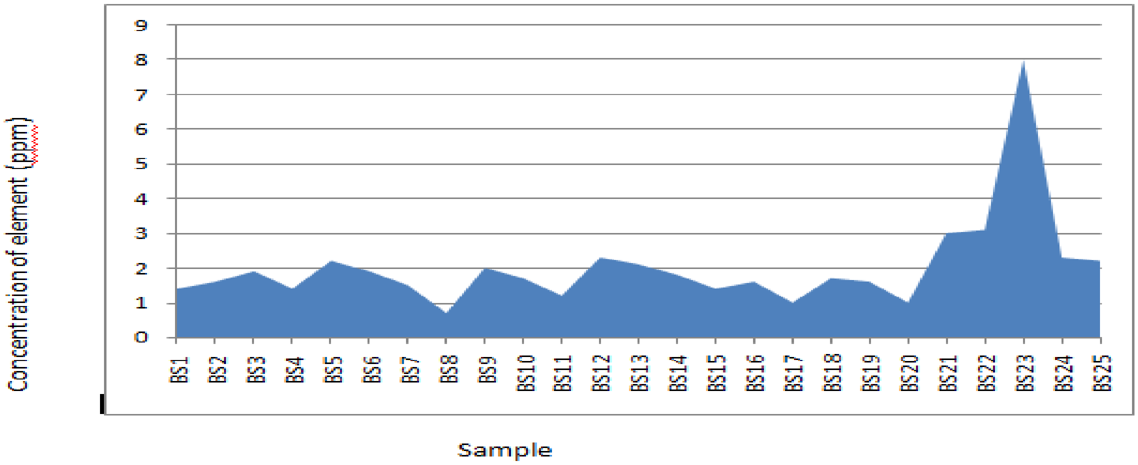

Fig. 6: Area chart for Be

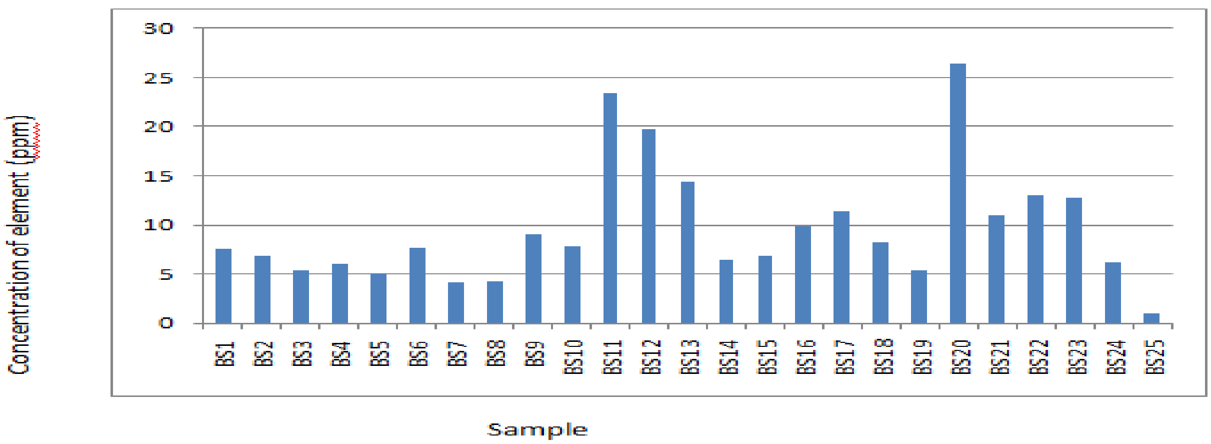

Fig. 7: Bar chart for Nb

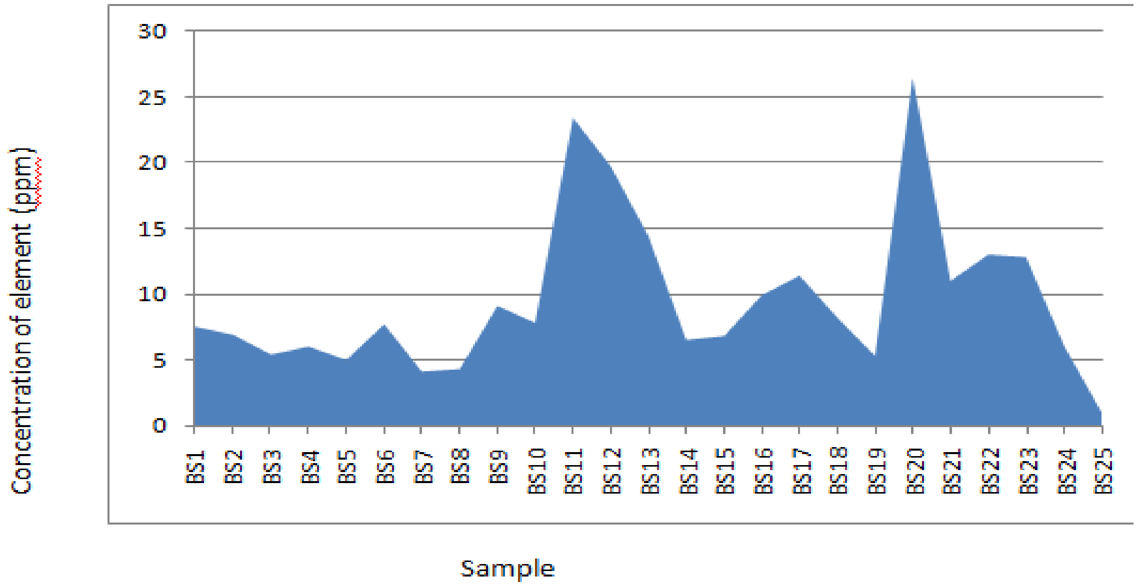

Fig. 8:Area chart for Nb

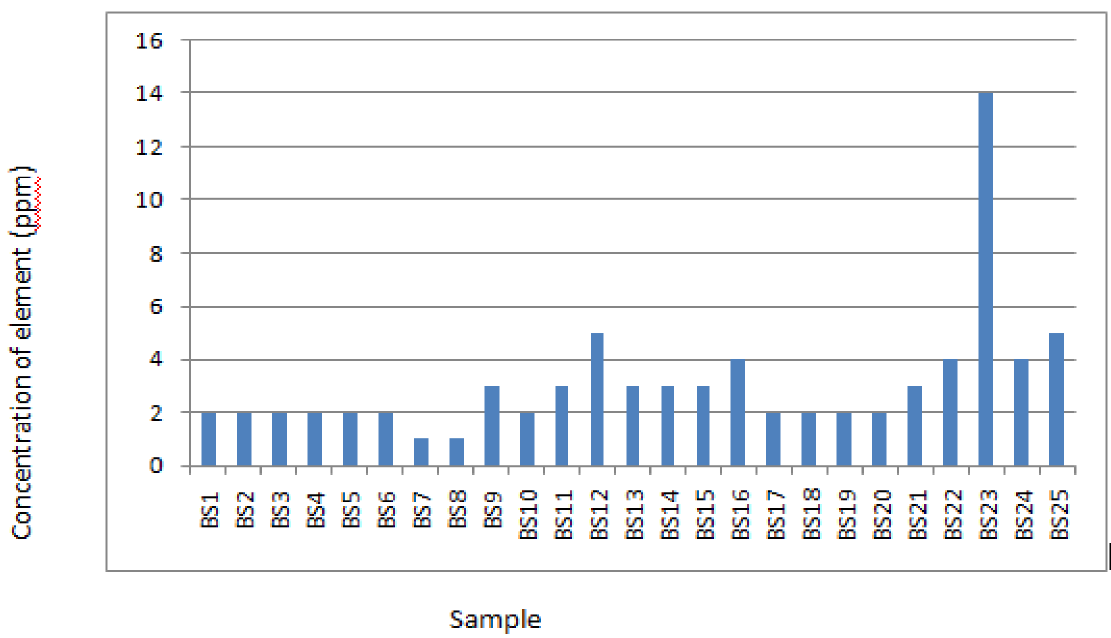

Fig. 9: Bar chart for Sn

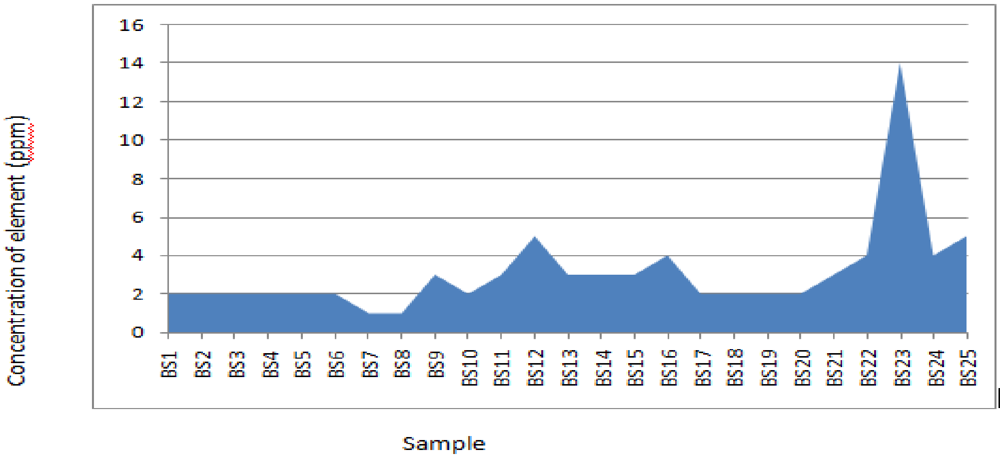

Fig.10: Area chart for Sn

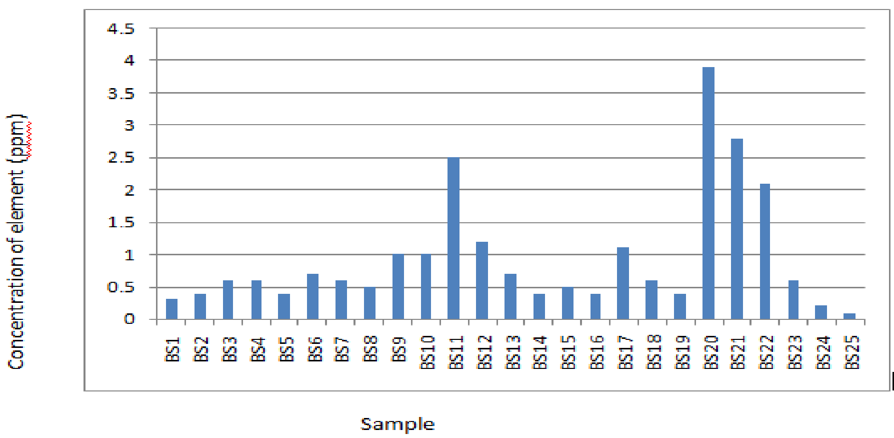

Fig.11: Bar chart for Ta

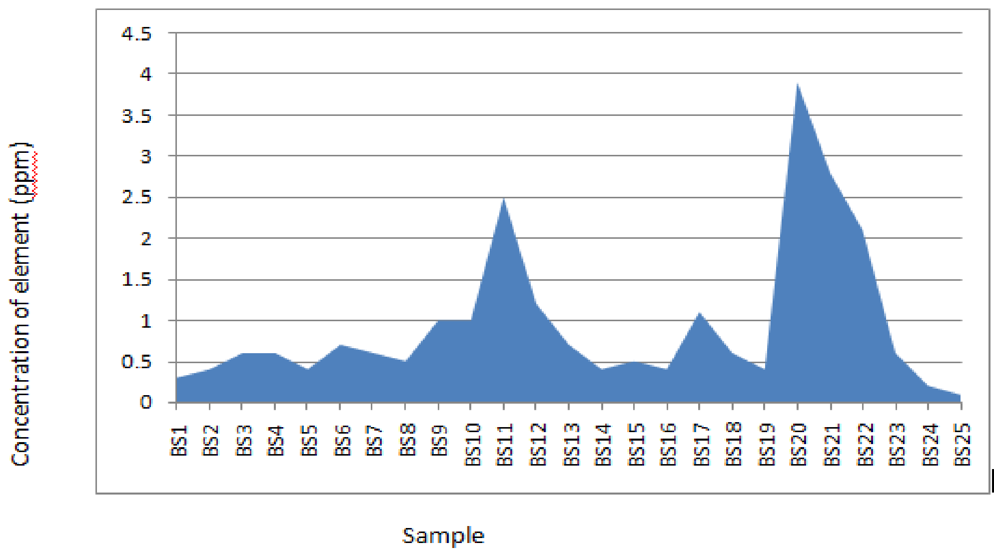

Fig.12: Area chart for Ta

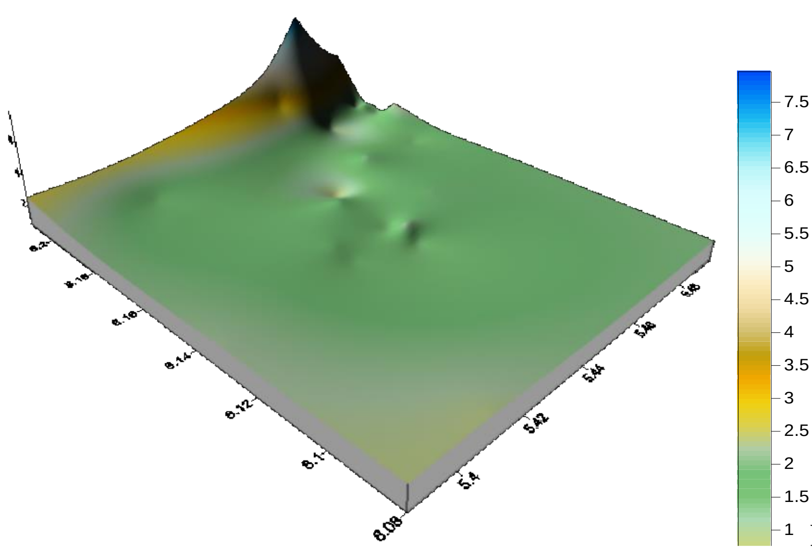

Fig.13: Isograde plot for Be

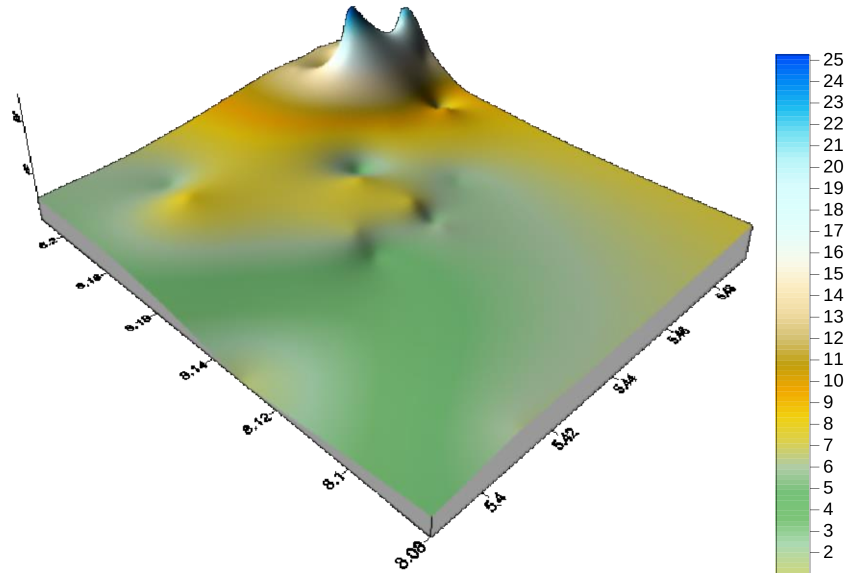

Fig.14: Isograde Plot for Nb

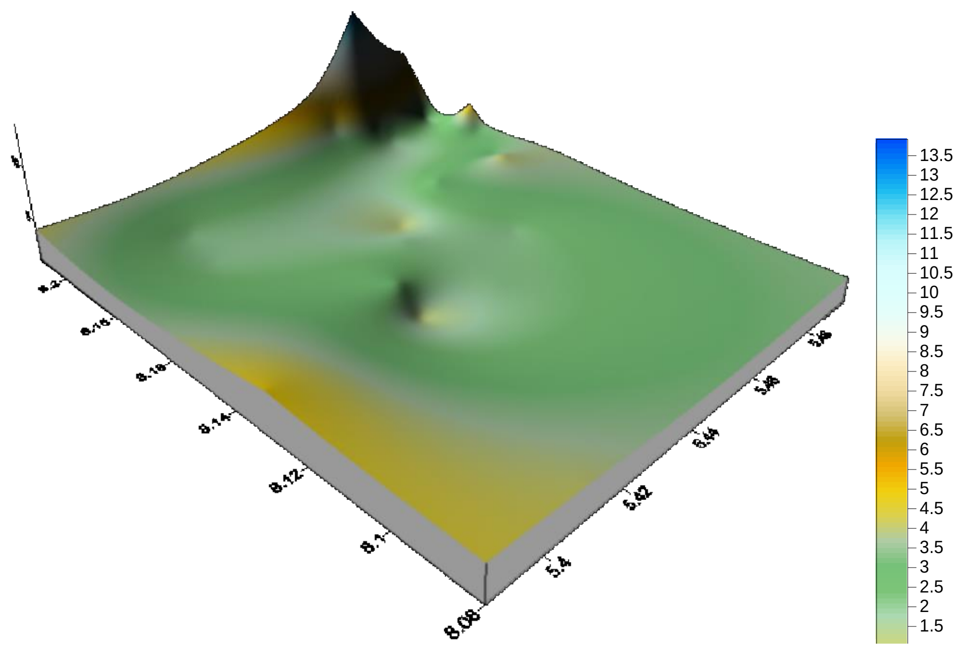

Fig 15:Isograde plot for Sn

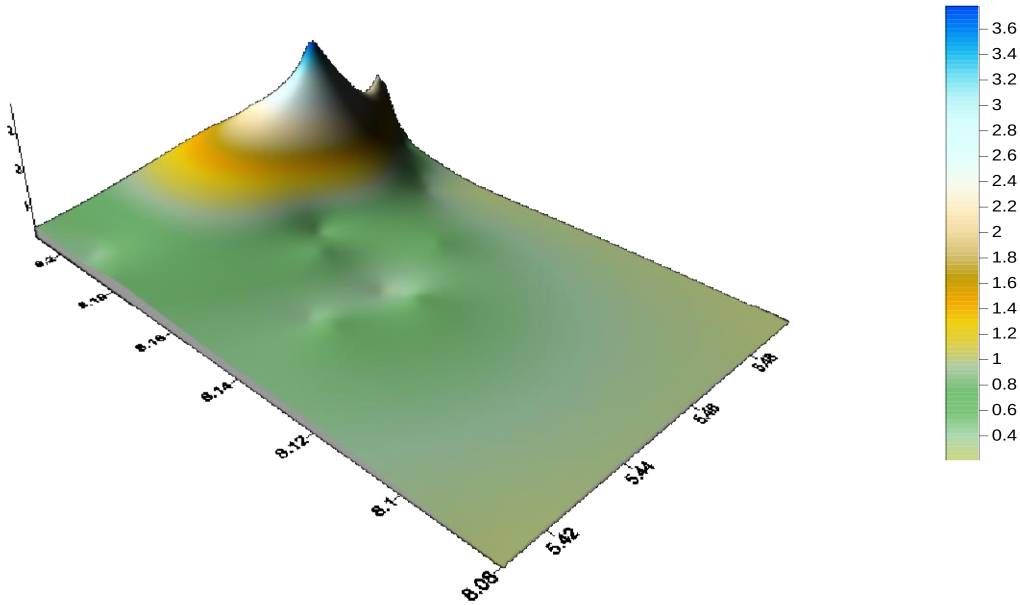

Fig.16: Isograde Plot of Ta

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