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MULTIVARIATE ANALYSIS OF STREAM SEDIMENTS GEOCHEMICAL DATA FROM PART OF EGBE-ISANLU SCHIST BELT

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ABSTRACT

The aim of this study is to evaluate the relationship between elements association, employing principal component analysis in geochemical data of stream sediments from part of Egbe-Isanlu schist belt. Twenty-four elements were subjected to this analysis using SPSS (Statistical Package for Social Sciences) software. Five component factors were extracted and it account for 88.71% of the cumulative percent of the variance. Factor 1 (Co-Ba-Mn-Pb-Fe-Zr-Cr) is an association probably defined by iron mineralization with contributions from basic and ultramafic rocks. Factor 2 (Rb-Cs-Li-Sn-Sc-Sr-Zn-Ga) is defined by granitic lithology which reflect parent rock influence. Factor 3 (Y-Ce-La-Th-U) is a rare earth element and heavy mineral factor that suggest base metal deposit bearing lithology. Factor 4 (Mo-Cu-Nb-Ni) suggest the occurrence of sulphide mineralization associated with basic/ultramafic rocks. Factor 5 (Zn-Sr-Zr-Sn) is an association generated from weathering. The inference from the first factor establishes the presence of iron mineralization in the study area which is consistent with the earlier occurrences reported.

KEYWORDS: Elements Association, Principal Component Analysis, Mineralization, Cumulative percent, Egbe-Isanlu schist belt.

INTRODUCTION

Geochemical responses can reflect a number of processes that have occurred within a surveyed area depending on the nature of the material sampled and the method of analysis used to make the geochemical determinations. In some cases, individual elements may reflect specific geochemical processes independently of other elements but typically the responses of most elements reflect multiple processes (Grunsky, 1997).

Various forms of multivariate statistics including cluster analysis, discriminant analysis, the analysis of single element and multi-element distributions, principal component and factor analysis and variants thereof have been applied with significant success and these methods when properly applied can provide significant insight into the discovery of the geochemical processes which directly and indirectly infer geological processes associated with background lithological variation, regional metamorphism and alteration associated with mineralization (Smee and Grunsky, 2003). Principal component and factor analysis was employed in this study in order to extract useful elements that could be targeted for future prospecting.

Geology of the Area

The area covered by this study is situated in Egbe- Isanlu schist belt which forms part of the Precambrian Basement Complex of Nigeria (Fig. 1). The area is bordered by longitude 05° 40′E to 05° 50′E and latitude 08° 00′N to 08° 07′N.

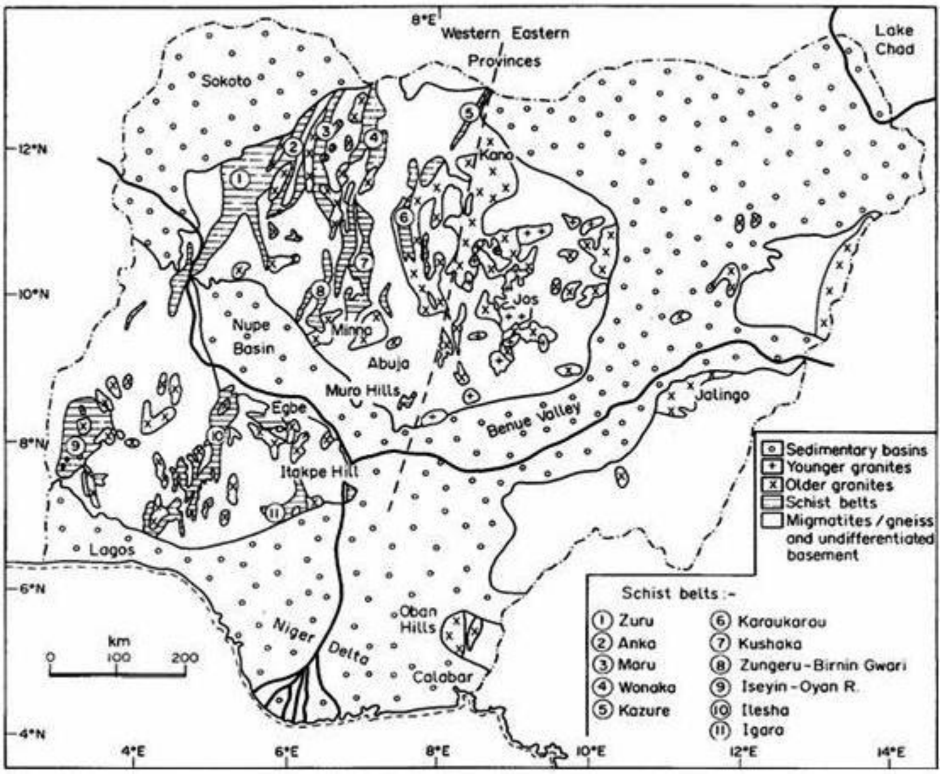

Figure. 1: The study area. (Woakes *et al*., 1987).

The Precambrian Basement of Nigeria has been classified into four major petro-lithological units that are distinguishable and they include the Migmatite-gneiss complex, the schist belts (metasedimentary and metavolcanics), the older granites (Pan African granitoids) and the undeformed acid and basic dykes (Grant, 1970; McCurry and Wright, 1971; Oyawoye, 1972; Rahaman, 1988; Burkey and Dewey, 1972 and Dada, 2006). The part of Egbe-Isanlu schist belt accessed is underlain by Quartz-mica schist, amphibolites, granites, quartzites and gneisses (Fig. 2).

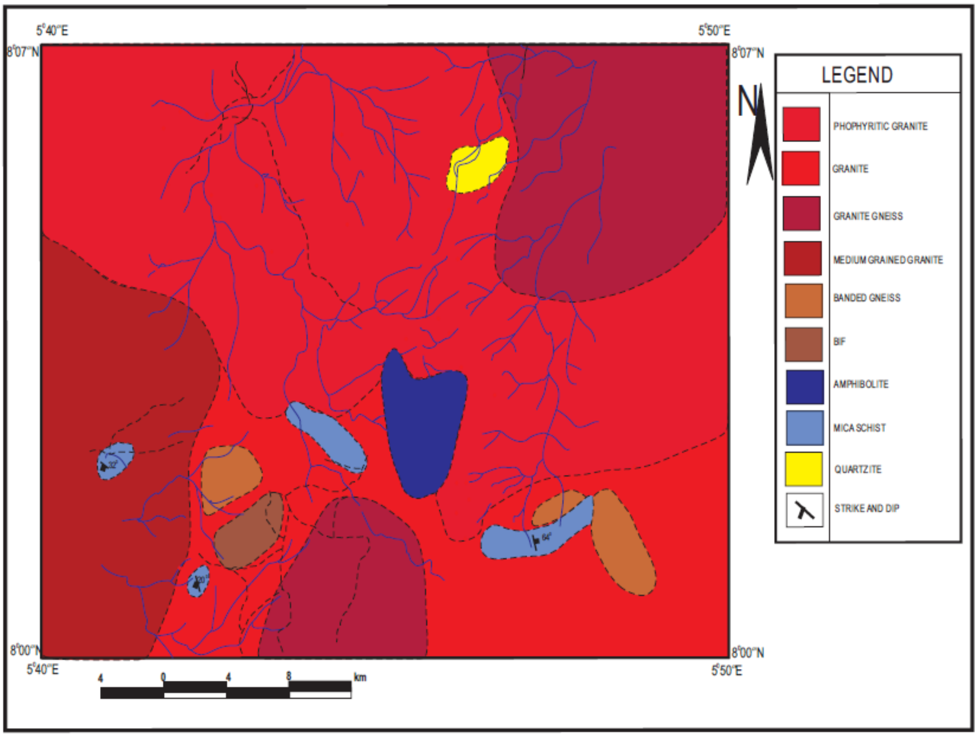

Figure 2: Geological map of the study area

The schist belts comprise low grade metasediments dominated by belts trending north to south which are best developed in the western half of Nigeria. These belts are considered to be Upper Proterozoic supracrustal rocks which have been infolded into the migmatite-gneiss complex. The lithological variation of the schist belts include coarse to fine grained clastics, pelitic schists, phyllites, banded iron formation, carbonate rocks (marbles/dolomitic marbles) and mafic metavolcanics (amphibolites). Some may include fragment of ocean floor material from small back-arc basins (Rahaman, 1976; Grant, 1978).

MATERIALS AND METHODS

Fifty stream sediments samples were collected randomly at a depth of 20-25cm from active river junctions; the samples were labeled appropriately and transported to the laboratory. Twenty representative samples were air-dried, disaggregated and sieved. The sieved fraction were homogenized and sent to ACME Laboratories, East Vancouver, Canada for analysis. The concentrations of 24 minor and trace elements (Co, Ba, Mn, Pb, Fe, Zr, Cr, Rb, Cs, Li, Sn, Sc, Sr, Zn, Ga, Y, Ce, La, Th, U, Mo, Cu, Nb and Ni) were determined by Inductively Coupled Plasma Mass Spectrophotometer (ICP-MS) and the data obtained from the chemical analysis of the stream sediments were further subjected to statistical analysis. Factor analysis and correlation coefficient between pairs were done using SPSS (version 22) software.

RESULTS AND DISCUSSION

The result of the factor analysis of twenty stream sediments samples data set for 24 elements are summarized in Tables 1, 2 and 3. The number of factors extracted to describe the variance of the geochemical data set was determined by using the sum of the squares scree plot. Table 1: shows the factor loading and communality obtained from the analysis. Five component factors were extracted from the principal component analysis and they explained 41.14%, 22.79%, 13.33%, 7.23% and 4.21% of the variance respectively.

Table 1: Rotated Component Matrix (Varimax with Kaiser Normalization) and Communality

Variables	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Communality
Co	.961	.028	-.062	-.038	.122	.920
Ba	.924	.143	.005	.006	.099	.970
Mn	.915	.030	.067	.100	.038	.866
Pb	.875	-.031	.287	.044	-.122	.832
Fe	.841	.069	-.041	.409	.059	.944
Zr	.706	.225	.186	.104	-.499	.945
Cr	.675	-.194	-.149	.169	-.145	.853
Rb	.001	.918	.181	.219	-.077	.885
Cs	-.090	.903	.103	-.007	.050	.927
Li	-.056	.887	.060	.097	-.122	.935
Sn	.019	.726	.172	.492	.307	.949
Sc	.528	.722	.208	.179	-.192	.566
Sr	.069	.687	.289	.284	.497	.885
Zn	.063	.678	.504	.145	.306	.917
Ga	.355	.659	.488	.283	-.193	.929
Y	.001	.234	.955	.150	-.004	.949
Ce	.052	.093	.953	.041	.168	.817
La	-.102	.113	.948	.057	.156	.888
Th	.068	.214	.924	.042	-.174	.912
U	.121	.161	.912	.175	-.154	.837
Mo	.371	.135	.174	.847	-.126	.841
Cu	.372	.322	.059	.825	.210	.893
Nb	-.364	.194	.313	.739	-.160	.843
Ni	.475	.467	.016	.665	.240	.989

The cumulative percent of the extracted sums of squared loading was 88.71 for component 5 (Table 2**).** The cumulative percent of the variance for the five components were 25.56%, 22.92%, 22.42% and 13.25% respectively. The Varimax with Kaiser Normalization and

rotated solution gave cumulative percent of 88.71% of rotation sums of squared loading for component 5 which is the same as the value revealed in the unrotated principal component analysis extraction loading.

Table 2: Total Variance Explained showing Factor Groups

Component	Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	9.874	41.141	41.141	6.134	25.560	25.560
2	5.470	22.794	63.934	5.500	22.916	48.476
3	3.201	13.338	77.272	5.381	22.420	70.895
4	1.736	7.231	84.503	3.180	13.249	84.144
5	1.010	4.207	88.710	1.096	4.566	88.710

Correlation analysis presented a wide variation in the correlation coefficient between element pairs with values ranging from -0.001 between Mn and Li to 0.964 between Ba and Mn. Pb, Co, Fe, Cr, Ba and Mn exhibit very strong correlation which may be attributed to their natural association in oxidized environment and classification as lithophile and siderophile elements. Other elements with fairly strong correlation include Ce, U, Th, La and Y which indicate lithophile association. Factor analysis of the stream sediments revealed five factors with elemental associations that gave more incite to the known geology and mineralization in the study area.

The five-factor models extracted from the rotated principal component analysis are: Factor 1 which comprises of Co-Ba-Mn-Pb-Fe-Zr-Cr account for 26% of the total variance which makes it a pronounced factor and may define an association controlled by mineralization and lithology. The associations of Mn-Fe-Ba probably indicate iron mineralization. This is in accordance with the reported occurrence of iron formation (Olobaniyi, 1997) in the study area. The association of Co-Pb-Zr-Cr as well as their strong correlation is indicative of the occurrence of basic and ultrabasic rocks in the study area. Factor 2: (Rb-Cs-Li-Sn-Sc-Sr-Zn-Ga). This is the second factor and it account for 23% of the total variance. It is related to base metal bearing granites and associated with k-feldspar and mica. It reflects the influence of the parent rock and suggests a granitic/pegmatitic lithology within the area (Rose et al., 1979; Levinson, 1981). Factor 3 with Y-Ce-La-Th-U is the third factor and it account for 22% of the total variance. It may be considered as the REE and resistate heavy mineral factor suggesting base metal deposit bearing lithology. Factor 4: (Mo-Cu-Nb-Ni) accounts for 13% of the total variance. This factor suggests the occurrence of sulphide mineralization associated with basic and ultramafic rocks in the area. Factor 5: (Zn-Sr-Zr-Sn) is an association generated from weathering (Nuhu, 2014) and it account for 4% of the variance of the five factors.

CONCLUSION

The employment of principal component analysis as a tool within the multivariate class has aided the interpretation of geochemical data obtained from stream sediment analysis. Five factors were extracted from the rotated principal components. The elemental associations obtained may be related to the parent rocks (gneisses, granites and metavolcanics) or mineralization. The presence of Mo-Cu-Pb-Co-Zn suggests sulphide mineralization probably associated with the basic and ultrabasic rock in the study area. The presence of Fe-Mn suggests iron mineralization which establishes the reported occurrence of such in the study area.

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