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GEOCHEMICAL DISTRIBUTION OF Cu and Zn IN STREAM SEDIMENTS IN THE REGION BETWEEN TAŞKÖPRÜ AND GÖKÇEAĞAÇ (KASTAMONU)

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ABSTRACT

This study was carried out in an area covering approximately 290 sq. km. between Taşköprü and Gökçeağaç (Kastamonu) to determine the geochemical distributions of Cu, Pb., and Zn in stream sediments. With this objective in mind, 349 stream sediment samples were collected. The hot extract chemical analysis data were then evaluated statistically and interpreted by taking some geological parameters into consideration.

The findings of this study are, the existence of a single log-normal population for Cu and three log-normal populations for Zn, and the correlation of anomalous Cu and Zn values with metabasalts which are regionally known as host for the Küre type massive sulfide ore deposits.

ÖZET

Bu çalışma Taşköprü-Gökçeağaç (Kastamonu) arasında 290 km^2 lik bir alan kaplayan bölgede; Cu, Pb ve Zn elementlerinin derekumundaki jeokimyasal dağılımlarının incelenmesi amacıyla yapılmıştır. 349 adet derekumu örneği bu görüş altında alınmıştır. Sıcak analizleri yapılan örnekler sonra, istatistiksel ve bazı jeolojik parametreler ile değerlendirilmiştir.

Bu çalışmanın sonucunda Cu için logaritmik normal tek bir topluluk, çinko için de logaritmik normal üç topluluk saptanmış, Küre tipi masif sülfid yatakların ana kayacı olan metabazaltlar Cu ve Zn değerlerinde anomalileri oluşturmuşlardır.

INTRODUCTION

The study area is situated to the NE of Taşköprü and SW of Gökçeağaç townships of Kastamonu, in Northern Anatolia, covering 1:25.000 scale topographic map sheets Kastamonu E32–c3 and c4 (Figure 1).

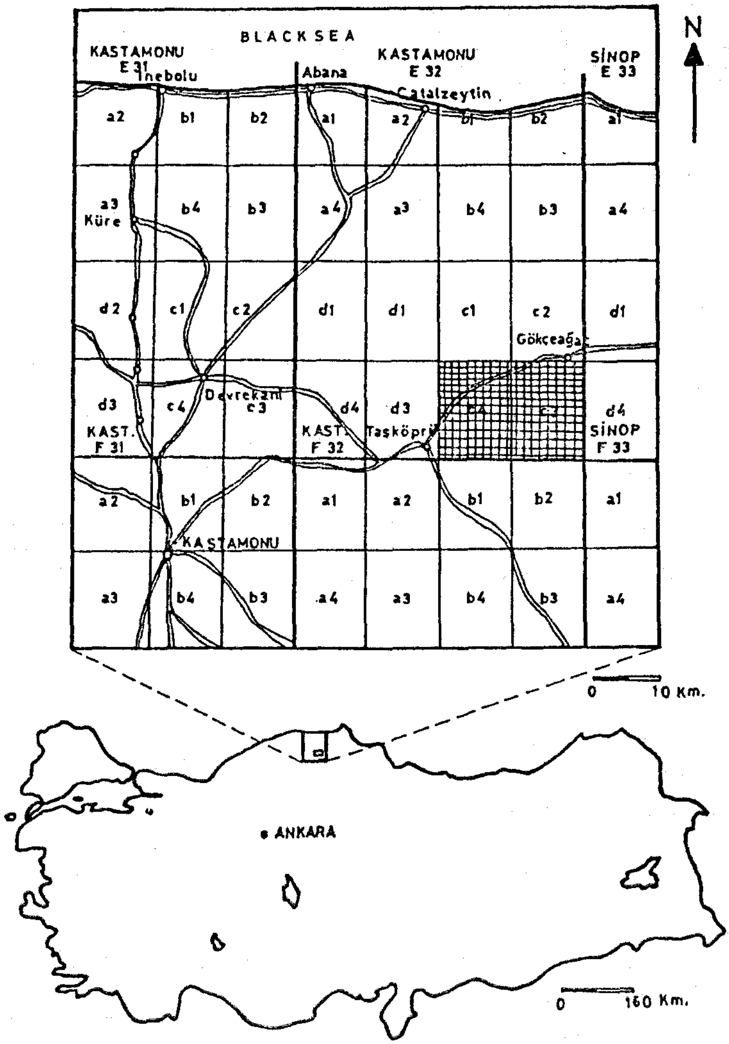

Figure 1. Location map

The main objectives of this study are to determine geochemical distributions of Cu, Pb, and Zn in stream sediments; to define anomalous areas which may be related to mineralization; and to establish the areal variation of such populations in relation to some geological parameters.

Leading to these objectives, 349 stream sediment samples were collected and analysed for Cu, Pb., and Zn. Upon determining the sensitivity and precision of the analyses, their results have been evaluated statistically. Finally, probable anomalous areas have been defined and their relation to mineralization is interpretated by investigating areal variation of each statistical population.

The geology of the area is seen in Figure 2. The rock types belonging to an ophioloitic complex of Mesozoic age dominate the area. Expected ore type in the region is "Cyprus type" massif sulfide ore deposit in metabasalts and metadiabases as those present in Küıe (Kastamonu).

GEOCHEMICAL METHOD

Sampling locations were selected at the office prior to the field work. Sample collection is planned and carried out in a way that one sample in taken from every one square km. This provided a homogeneous sample distribution pattern. As the area had a good dendritic type of drainage, it was not difficult to obtain an almost homogeneous sampling pattern. The location of sample was shifted several meters up or down the stream if the sampling spot was subjected to man-made contamination. Samples were dried and sieved down to – 80 mesh fraction and sent to the Central Laboratory of the Mineral Research and Exploration General Directorate (MTA) in Ankara.

The chemical analyses were performed by an atomic absorption spectrophotometer according to the procedure given by Köksoy and Topçu (1976). In the analyses, hot extraction method is used. The precision of the analytical methods was determined at a 95 % confidence level, from the analyses of some duplicated samples, using the formula given in Youden (1951). The precision and sensitivity of the applied method for geochemical analyses are shown in Table 1. In natural conditions, Pb displays an abundance of 1–25 ppm. However, as can be seen from Table 1, the sensitivity of the AAS used in the Pb analysis is 40 ppm. This shows that Pb values less than 40 ppm are statistically insignificant and should not be used in the statistical treatment. In this study, only Cu and Zn data are taken into consideration and the use of

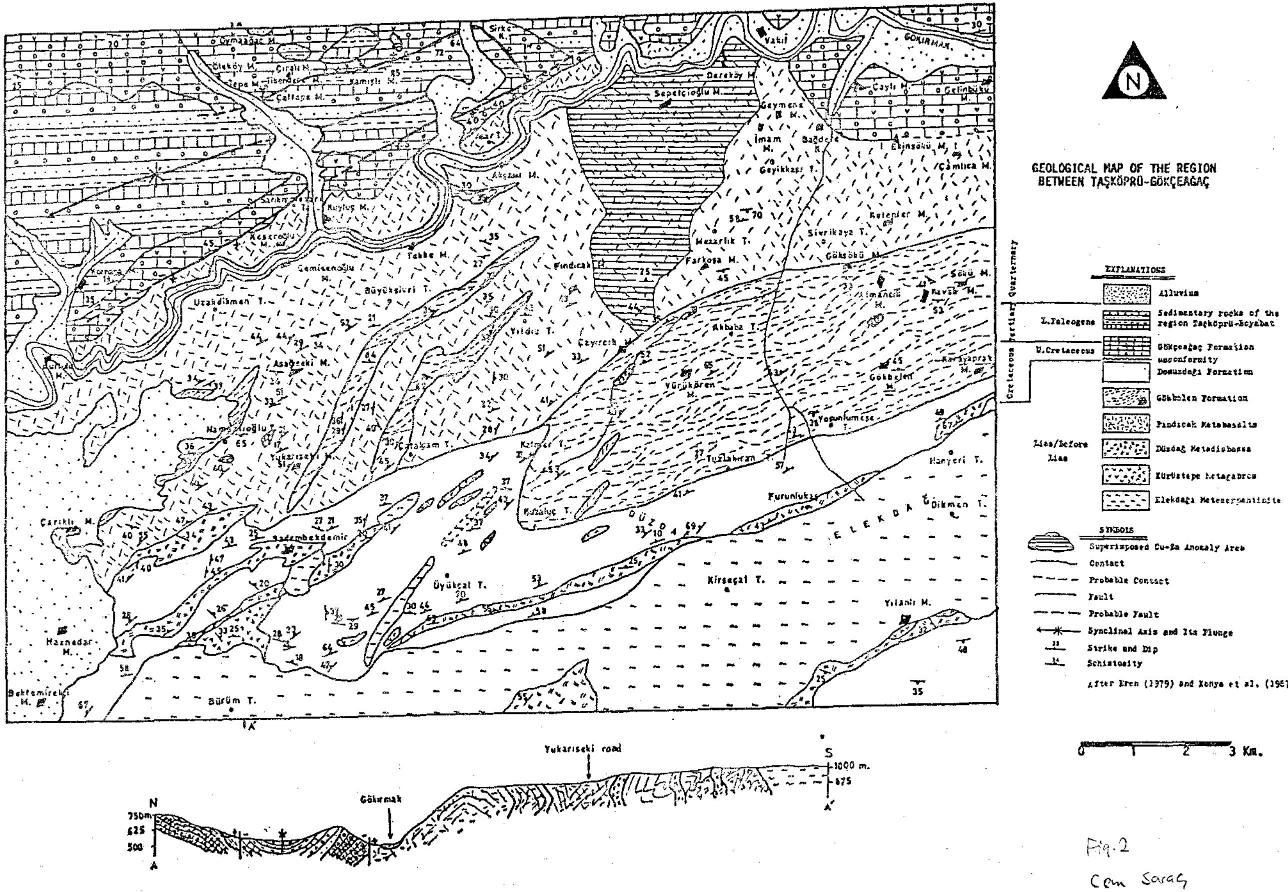

Figure 2. Geological map of the region between Taşkoprü and Gökçeağaç

a more sensitive analytical method (e.g. colorimetric) is necessary to create a more reliable Pb data (Saraç, 1987).

	Detection limits (ppm)	Precision ∓ %
Cu	5	13
Pb	40	15
Zn	10	15

Table 1. The precision and sensitivity of the applied method.

STATISTICAL TREATMENT OF Cu AND Zn VALUES

In order to determine if the results of the Cu analyses display a log-normal or arithmetic normal distribution, data were classified (Table 2)

Arithmetic Class limits	Frequency	Sum of Freq.	Cum % Freq.
195.1 — 210.0	1	1	.29
180.1 — 195.0	1	2	.57
165.1 — 180.0	1	3	.86
150.1 — 165.0	1	4	1.15
135.1 — 150.0	5	9	2.58
120.1 — 135.0	3	12	3.44
105.1 — 120.0	10	22	6.30
90.1 — 105.0	14	36	10.32
75.1 — 90.0	33	69	19.77
60.1 — 75.0	45	114	32.66
45.1 — 60.0	90	204	58.45
30.1 — 45.0	72	276	79.08
15.1 — 30.0	71	347	99.43
.1 — 15.0	2	349	100.00

Table 2. Arithmetic classification of Cu

and first the arithmetic class intervals were plotted against which showed that cumulative percentile frequencies (Figure 3), the resultant curve is a concave one, implying that the distribution is not arithmetic but logarithmic. Then according to the equation, Log I = (Log R) / n (Sinclair, 1976), the number of logarithmic class intervals were estimated (Table 3) which were plotted against cumulative percentile frequencies on a log–probability paper (Figure 4). Confidence limits in Figure 4 were drawn (Figure 5) after the method given in Lepeltier (1969).

In order to find out if the distribution consists of only one or more than one population, the chi square test was applied according to Kutsal and Muluk (1978). According to this the chi square values are calculated as 14.76. The theoretical value for the chi square (at 95 % level) is

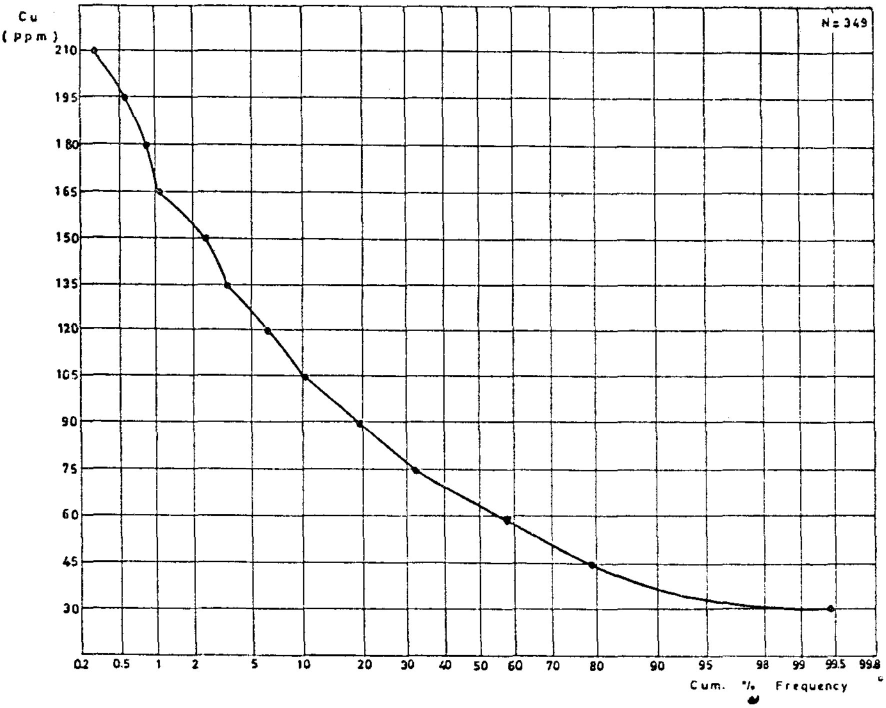

Figure 3. Arithmetic vs probability distribution graph of Cu (if it was an arithmetic distribution, a line rather than a curve would be expected).

Logarithmic Class limits	Arithmetic Class limits	Frequency	Sum of Freq.	Cum. % Freq.
2.25 — 2.33	177.8 — 213.7	2	2	.57
2.17 — 2.25	147.9 — 177.7	4	6	1.72
2.09 — 2.17	123.0 — 147.8	5	11	3.15
2.01 — 2.09	102.3 — 122.9	15	26	7.45
1.93 — 2.01	85.1 — 102.2	22	48	13.75
1.85 — 1.93	70.8 — 85.0	29	77	22.06
1.77 — 1.85	58.9 — 70.7	42	119	34.10
1.69 — 1.77	49.0 — 58.8	61	180	51.58
1.61 — 1.69	40.7 — 48.9	36	216	61.89
1.53 — 1.61	33.9 — 40.6	36	252	72.21
1.45 — 1.53	28.2 — 33.8	29	281	80.52
1.37 — 1.45	23.4 — 28.1	28	309	88.54
1.29 — 1.37	19.5 — 23.3	21	330	94.56
1.21 — 1.29	16.2 — 19.4	13	343	98.28
1.13 — 1.21	13.5 — 16.1	5	348	99.17
1.05 — 1.13	11.2 — 13.4	1	2349	100.00

Table 3. Logarithmic classification of Cu

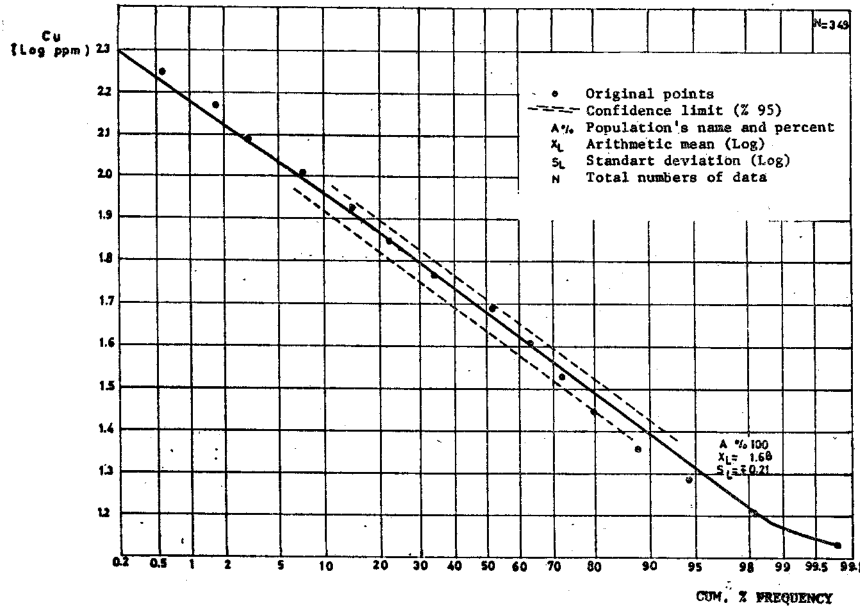

Figure 4. Logarithmic vs probability distribution graph of Cu

19.68, namely $X^2_{calc} < X^2_{table}$, therefore it is concluded that in the Cu data of only one population is involved and the threshold value separating the anomalous values from the background values is 126 ppm which is calculated from the relationship mean + 2 standard deviation, x + 2 sd.

The same procedure is applied in the statistical evaluation of the Zn values. The arithmetic classification shown in Table 4 yields a concave curve (Figure 6), therefore the data has a logarithmic distribution. The information given in Table 5 is illustrated in Figure 7.

The main Zn curve (resultant curve in Figure 7) was divided into three populations according to Sinclair (1976) as the calculated X^2 value is significantly larger than that theoretical value namely, X^2calc > X^2table (26.79 > 16.92). Partitioning of the Zn data into populations was carried out using the method described in Sinclair (1976), Saraç (1987), and, Aral and Saraç (1988); this publication). The inflection points partitioning each population are shown in Figure 7. Three major populations A, B, C are discerned based on the Sinclairs' method. Besides these populations, mixed populations such as A + B and B + C are also identified where two populations are overlapped each other to some

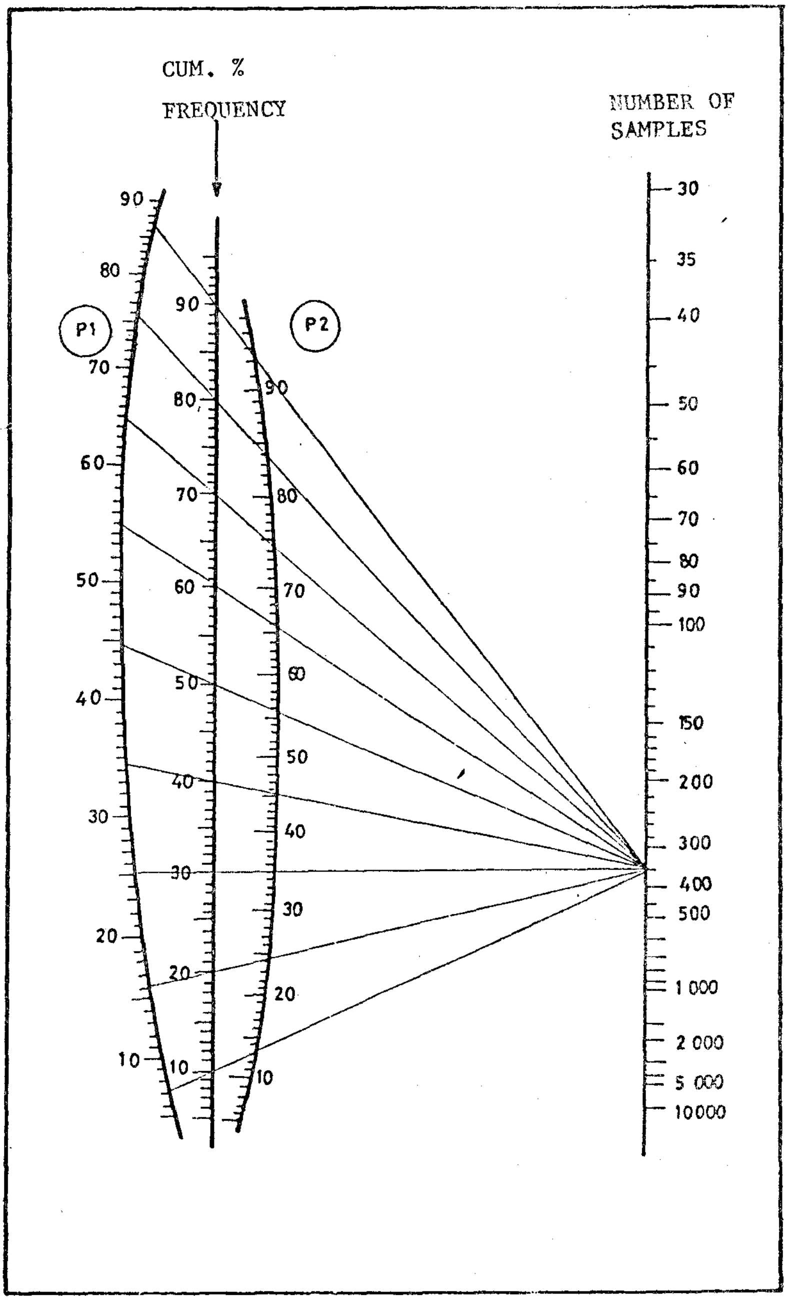

Figure 5. Establishing graph of the confidence limits (at 95 % level)

Arithmetic class limits	Frequency	Sum of Freq.	Cum. % Freq.
180.1 — 195.0	1	1	.29
165.1 — 180.0	2	3	.86
150.1 — 165.0	2	5	1.43
135.1 — 150.0	2	7	2.01
120.1 — 135.0	4	11	3.15
105.1 — 120.0	4	15	4.30
90.1 — 105.0	26	14	11.75
75.1 — 90.0	44	85	24.36
60.1 — 75.0	79	164	46.99
45.1 — 60.0	102	266	76.22
30.1 — 45.0	67	333	95.42
15.1 — 30.0	16	349	100.00

Table 4. Arithmetic classification of Zn

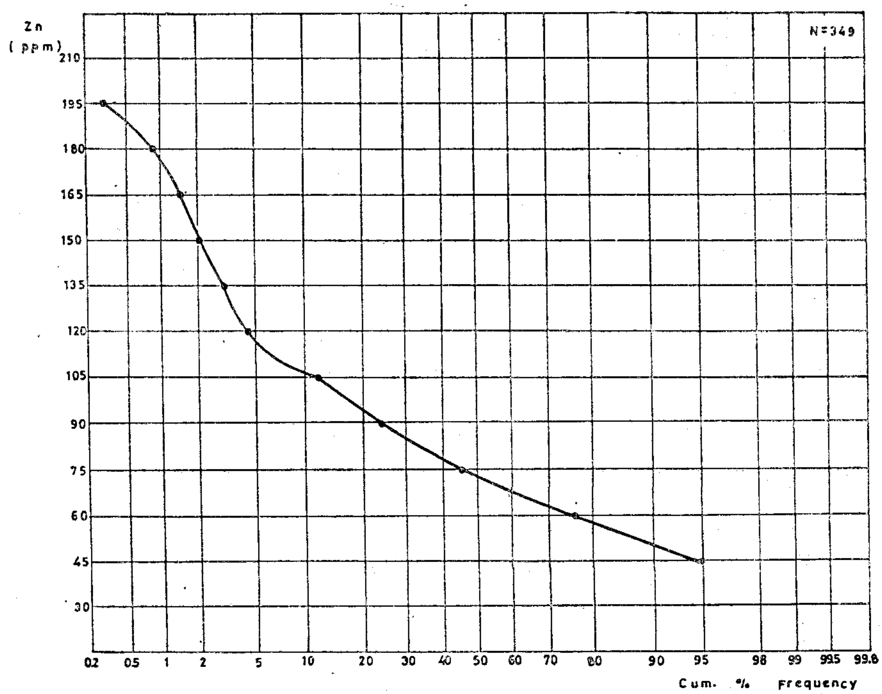

Figure 6. Arithmetic vs probability distribution graph of Zn

extent. Various statistical parameters of these mixed populations are given in Table 6.

Logarithmic Class limits	Arithmetic Class limitis	Frequency	Sum of Freq.	Cum. % Freq.
2.25 — 2.33	177.8 — 213.7	2	2	.57
2.17 — 2.25	147.9 — 177.7	3	5	1.43
2.09 — 2.17	123.0 — 147.8	7	12	3.44
2.01 — 2.09	102.3 — 122.9	7	19	5.44
1.93 — 2.01	85.1 — 102.2	33	52	14.90
1.85 — 1.93	70.8 — 85.0	53	105	30.09
1.77 — 1.85	58.9 — 70.7	80	185	53.01
1.69 — 1.77	49.0 — 58.8	75	260	74.50
1.61 — 1.69	40.7 — 48.9	32	292	83.67
1.53 — 1.61	33.9 — 40.6	32	234	92.84
1.45 — 1.53	28.2 — 33.8	13	336	96.28
1.37 — 1.45	23.4 — 28.1	6	342	97.99
1.29 — 1.37	19.5 — 23.3	6	348	99.71
1.21 — 1.29	16.2 — 19.4	—	348	99.71
1.13 — 1.21	13.5 — 16.1	1	349	100.00

Table 5. Logarithmic classification of Zn

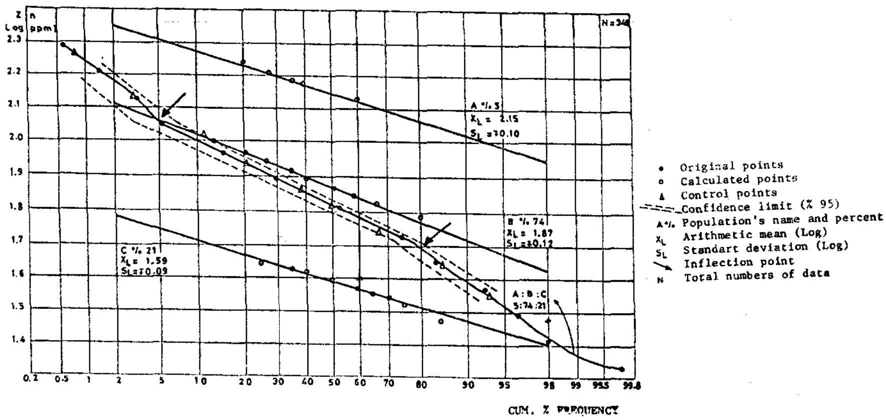

Figure 7. Logarithmic vs probability distribution graph of Zn

Population	Percent %	Number of Samples	Mean Log	Mean Arith	Stan. Devi. Log
A	5	17	2.15	141	0.10
B	74	259	1.87	74	0.12
C	21	73	1.59	39	0.09

Threshold Values	Population's Name	Number of Samples
	Pop. A	10 A
129 ppm Zn		
	Pop. A+B	7 A + 31 B
89 ppm Zn		
	Pop. B	132 B
60 ppm Zn		
	Pop. B+C	96 B + 2 C
43 ppm Zn		
	Pop. C	71 C
Total: 17 A + 259 B + 73 C = 349		

Table 6. Various statistical parameters of the mixed populations.

DISCUSSION AND CONCLUSIONS

In order to find out whether the anomalous values are brought about by lithological differences or by actual mineralization their areal distribution is examined. Such a study showed the following:

— 64 % of the anomalous Cu values (> 126 ppm) correlate with the Fındıcak Metabasalts.

— 87 % of the moderately anomalous Cu values (48 – 125 ppm) correlate with volcanic component of the ophiolitic suite.

— Cu values < 48 ppm (background) correlate with U. Cretaceous –L. Paleocene sediments.

— 88 % of the Zn values which represent population A (> 129 ppm) correlated with the Fındıcak Metabasalts.

— 98 % of population B (43–129) ppm) coincides with the rock units other than serpentinite.

— 56 % of population C (< 43 ppm) correlates with Elekdağı serpentinite, 23 % of it with sedimentary rock and 21 % is with other rock units.

The above indicates that, the distribution of anomalous Cu and Zn values coincides with the outcrops of Fındıcak Metabasalt (Figure 2) which is an important component of the ophiolites. Such strong correlation among Cu and Zn with the metabasalts are in agreement with the fact that Küre (or Cyprus) type massive sulfide deposits in the region is found in similar environment in pillow lavas.

Correlation coefficient between Cu and Zn values is 0.496 which is significant at 95 % level of confidence. Such a correlation is geochemically not surprising because Küre type massive sulfide mineralization usually provide such geochemical anomalies.

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