* The soils having anomalous haloes of

  i. Cu, Zn, Mo at Kurella is suspected to be derived from outcrops R1 and R6.

  ii. Zn and Cu at south west of Kurella and Dharmasagarpalli is suspected to be derived from outcrops R3 and R8, respectively, and

  iii. Zn, Cu, Co, W and Mo at Maisampalli appears to be derived from outcrops R15 and R20. The priority areas for locating mineralisation are Maisampalli, Kurella and Dharmasagarpalli.

* Apart from above mentioned localities, isolated anomalous concentration of some target elements are noticed at Regonda, Arepalli, Gotlamitta, Ramachandrapuram and Ramannapeth. These localities may prove drilling targets for the buried mineralisation.

CHAPTER V

LAKE SEDIMENT GEOCHEMICAL SURVEY

INTRODUCTION : Minerals and rocks that are stable in primary environment are often unstable at the earth surface and consequently undergo chemical changes as equilibrium is reestablished with the surfacial conditions. Krauskopf (1967) has identified that factors such as ionization, addition of water and CO_2, hydrolysis, oxidation and pH influences the chemical reactions in the secondary environment. The elements than are locked in the primary minerals are dispersed in the soils. When soils are reworked by water, stream sediments are produced. The sediments are transported and deposited in the lakes. During these processes, secondary geochemical haloes and dispersion trains are formed. Geochemical prospecting for ore deposits involving use of secondary haloes and dispersion trains, at present, are among the most important techniques.

Allan et al. (1973), Hornbrook et al. (1975), Hornbrook and Garret (1976) and Parslow and Dwairi (1976) have used the lake sediment geochemical survey on a reconnaissance scale for the identification of mineral deposits. Where lakes are abundant, the sediments trapped in the lake, if properly collected, can represent the best composite of materials from the catchment area.

Rose et al. (1979) summarised the transportation of metals in the secondary geochemical landscape is in a number of ways viz; clastic particles, adsorbed or incorporated within an organic or inorganic material and as dissolved material entering the lake. Levinson (1974) proposes the distinction between near shore sediments and centre lake sediments. The near shore material range in size from clay to boulders. The sediments originate by input of streams, by erosion of lake shore or drowning of older surfacial material. Thus the near shore sediments reflects the geology and mineralisation if any, in the area.

In contrast to the near shore sediments Levinson (1974) further states that the centre lake sediment as material predominantly consisting of silt and clay size particles. Apart from these constituents, the centre lake sediments may contain a high proportion of precipitated or flocculated organic matter.

In the present investigation lake sediment survey is based on 103 lakes sampled from an area of about 150 km^2. As active lake sediments constitute clastic and hydromorphic material from seepages, clastic material eroded from the bank and hydromorphic material adsorbed or precipitated from the water, near shore lake sediment were collected at the confluence points of the streams with the lakes.

The underlyian rationale behind the lake sediment survey must be emphasised that, such method are made with no intention to pin-point specific outcrops of mineralisations, but the objective is to develop geochemical guide for the identification of suitable zones of economic interest in Koheda area. The geochemical data of the lake sediments is given in the Table 2.4 of chapter II.

The Table 5.1 gives the statistical information about the range, average, standard deviation and threshold values for the elements analysed in the lake sediments. The threshold value is calculated and is in accordance with the procedure mentioned in chapter IV.

ASSOCIATION OF ELEMENTS IN THE LAKE SEDIMENTS : The Table 5.2 represents the correlation matrix computed from the lake sediment geochemical analysis given in Table 2.4 of chapter II. As mentioned in the preceeding chapters, when the patterns of elemental distribution are more subtle, the correlation coefficient provides meaningful information about the association of the elements in the lake environment. Studies relating to the behaviour of elements in the lake environment is envisaged by the examination of the correlation Table 5.2. The basis of element grouping which significantly correlate is similar to the grouping of elements as mentioned in the proceeding chapters.

The significant level of correlation has been fixed at plus 0.5 and the groups so derived are 1) Cu - Ni - Pb,

Table No. 5.1 : Shows a comprehensive statistical information of geochemical analysis of lake-sediment samples from Koheda area.

Sr.No.	Elements	Range (ppm)	Average (ppm)	Standard Deviation (ppm)	Threshold (ppm)
1	Cu	43 - 1404	65.27	14.47	94.22
2	Pb	23 - 185	45.12	13.46	72.05
3	Zn	47 - 1368	71.73	13.37	98.47
4	Co	6 - 36	11.37	3.44	18.24
5	Cr	28 - 193	69.72	19.30	108.33
6	Ni	7 - 338	31.42	16.54	64.68
7	Fe	1440 - 110880	30622.74	16273.65	63170
8	Mn	74 - 990	209.61	83.79	377.21
9	Mo	2 - 40	8.05	4.26	16.57
10	W	10 - 72	23.14	10.01	43.16

2) Zn - Cu - Ni, 3) Co - Cr - Fe - Mn and 4) Mo - W. The number of groups and number of elements of each group has to a certain extent changed, compared to the elemental correlation in the soils. This can be inferred to be due to the refinement of elemental association in the lake conditions. The lake environment is largely influenced by the variables such as climate, vegetation, depth, area, inflow and outflow of the lakes and geology of the area (Rose et al. 1979).

Imprints of soils and bedrock are retained in the lake sediments in the form of significant correlations between the pairs Cu - Zn, Zn - Ni and Mo - W. This implies that to a certain extent the variables of the soil and rock environment are retained in the lake environment.

The association of Cu with Pb and Cu with Zn in the lake sediments are largely due to their geochemical resemblance (Levinson 1974). The association of Ni with Pb is due to their immobile fraction in the secondary environment, (Rose et al. 1979). The association of Cu with Pb, Zn with Ni and Cu with Ni in the lakes of Koheda area, is partly the reflection of the primary environment. Sato (1992) found similar imprints of primary environment in the surfacial conditions. This is because of low temperature prevailing near the earth surface. Hence, the reaction rates are often so slow that the primary minerals tend to persist metastably in the secondary environment. Therefore, the association mentioned above in Koheda area are partly the reflection of the geology.

The association of Co and Cr with Fe and Mn is due to their co-precipitation in the form of Fe and Mn oxides (Sato 1992). On examination of the correlation matrix Table 5.2 it is observed that Cr has greater affinity with Fe and Co has greater affinity with Mn.

Rose et al. (1979) and Pandias and Pandias (1984) have reported geochemical resemblance of W and Mo in the hypergene environment. These two elements form anionic complexes in aqueous solution and are dispersed hydromorphically. Similar association of W and Mo is noticed in the soils and lake sediments of the Koheda area.

The Figures 5.1 to 5.10 illustrates the distribution of Cu, Pb, Zn, Co, Cr, Ni, Fe, Mn, Mo and W respectively in the lake sediments. It may be recalled that these lake sediments represents the best composite of material from the catchment area. The Figures 5.1 to 5.10 depicts lake basins either anomalous or barren areas based on the elemental concentration.

Lake sediment geochemistry is discussed under two broad headings :

1 : Combination of anomalous distribution of the elements, and

2 : Distribution of lake chains in Koheda area.

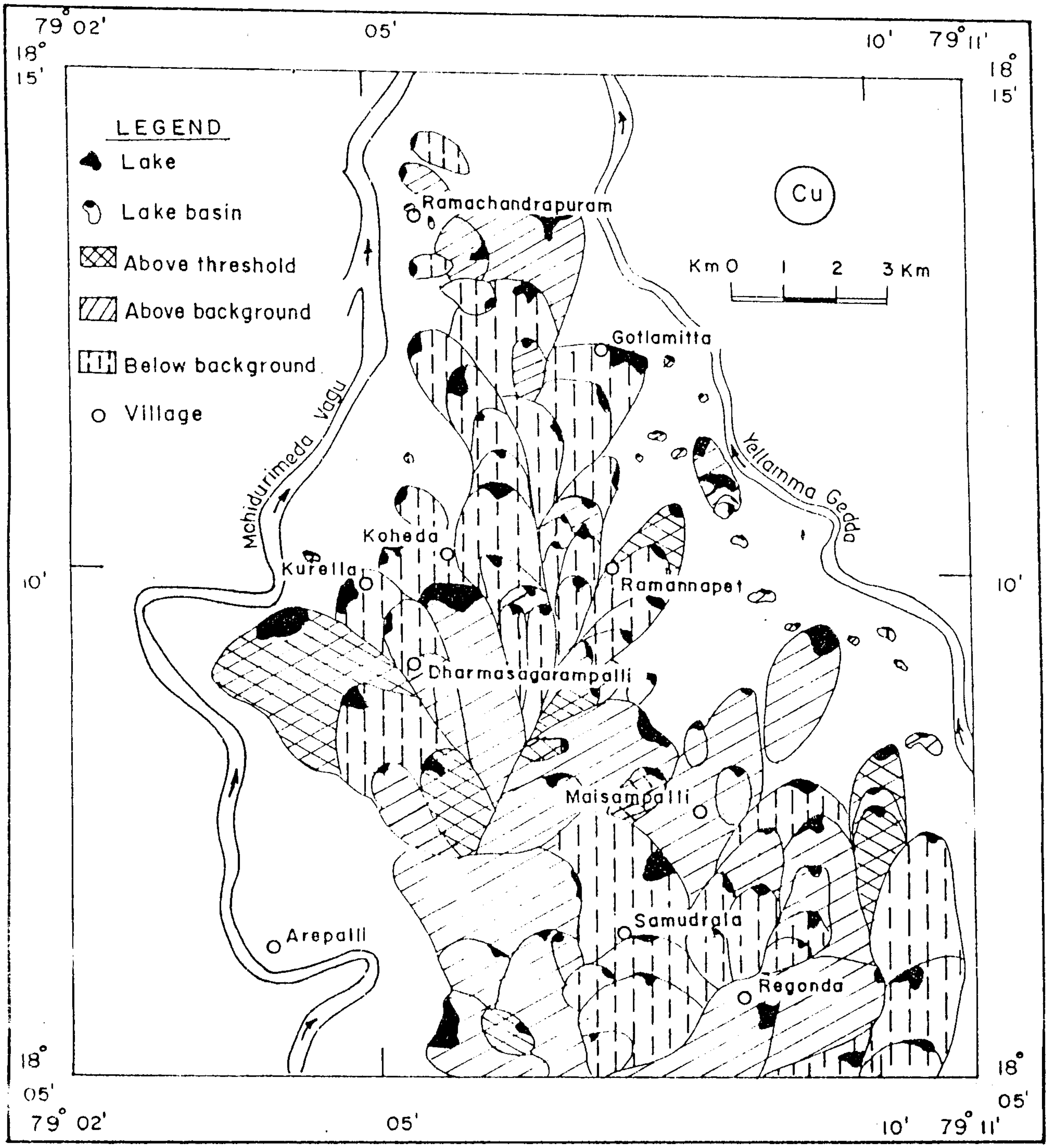

FIG. NO.5.1: DISTRIBUTION OF COPPER IN THE LAKE SEDIMENTS

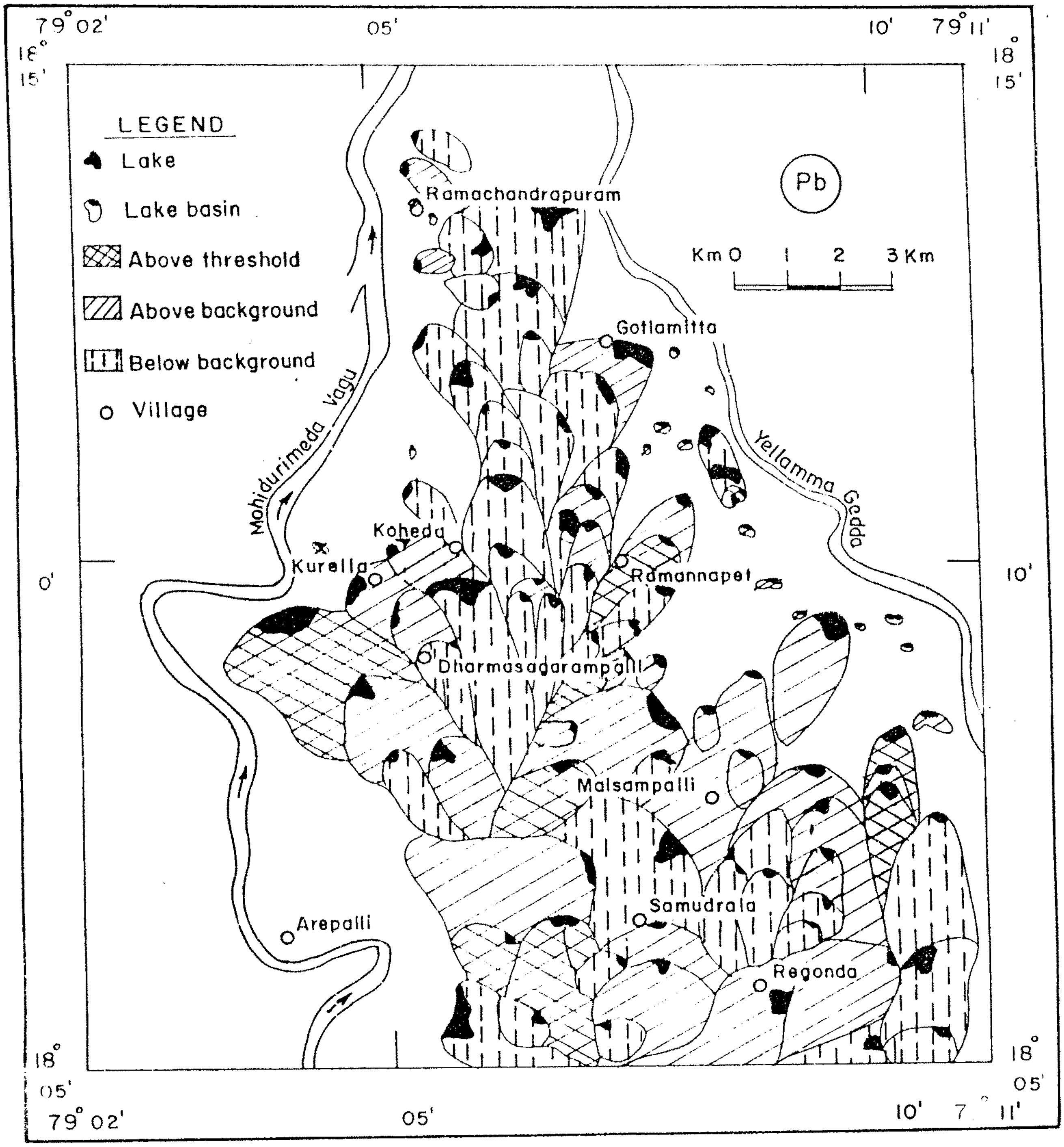

FIG. NO.5.2: DISTRIBUTION OF LEAD IN THE LAKE SEDIMENTS

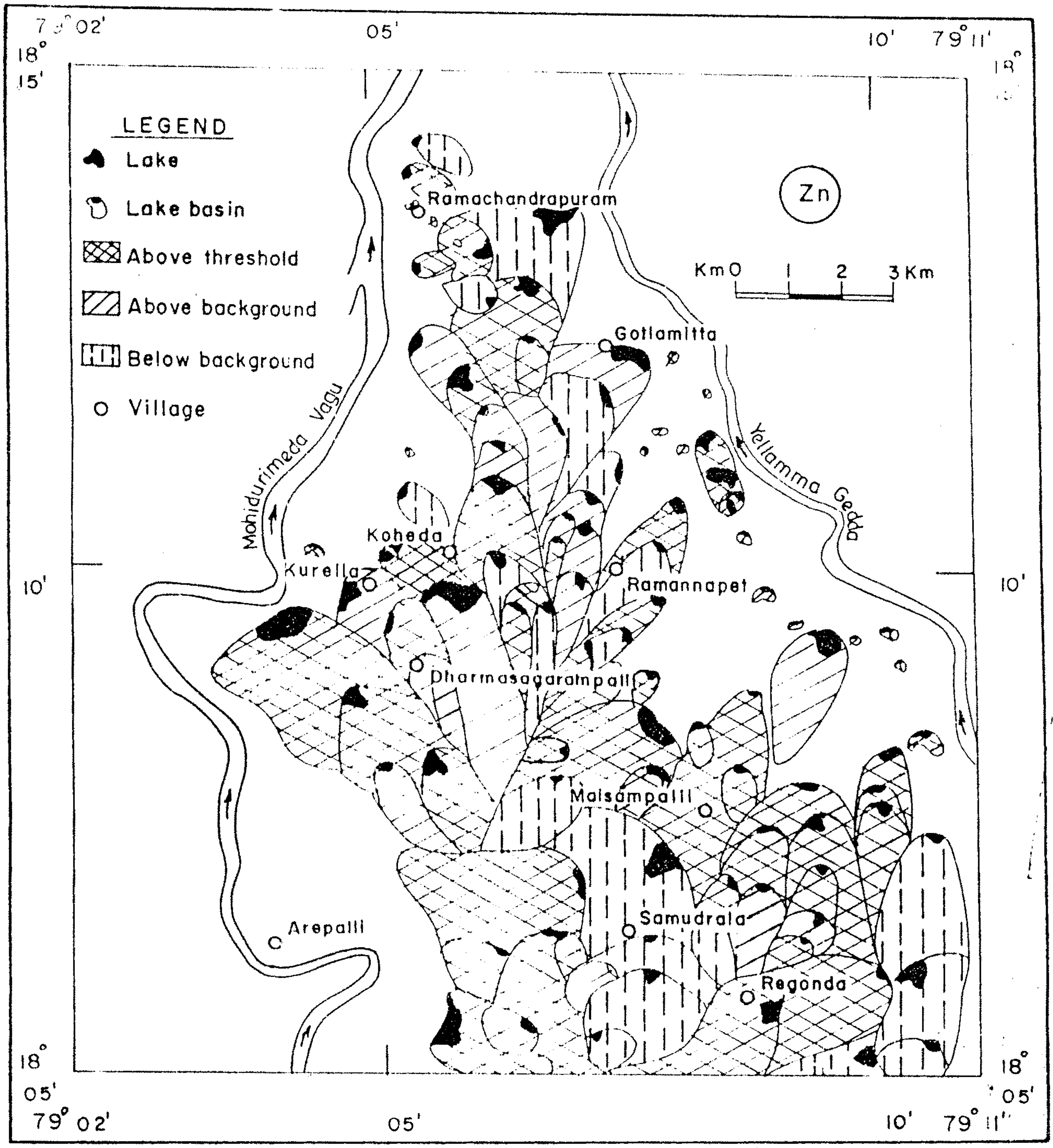

FIG. NO.5.3:DISTRIBUTION OF ZINC IN THE LAKE SEDIMENTS

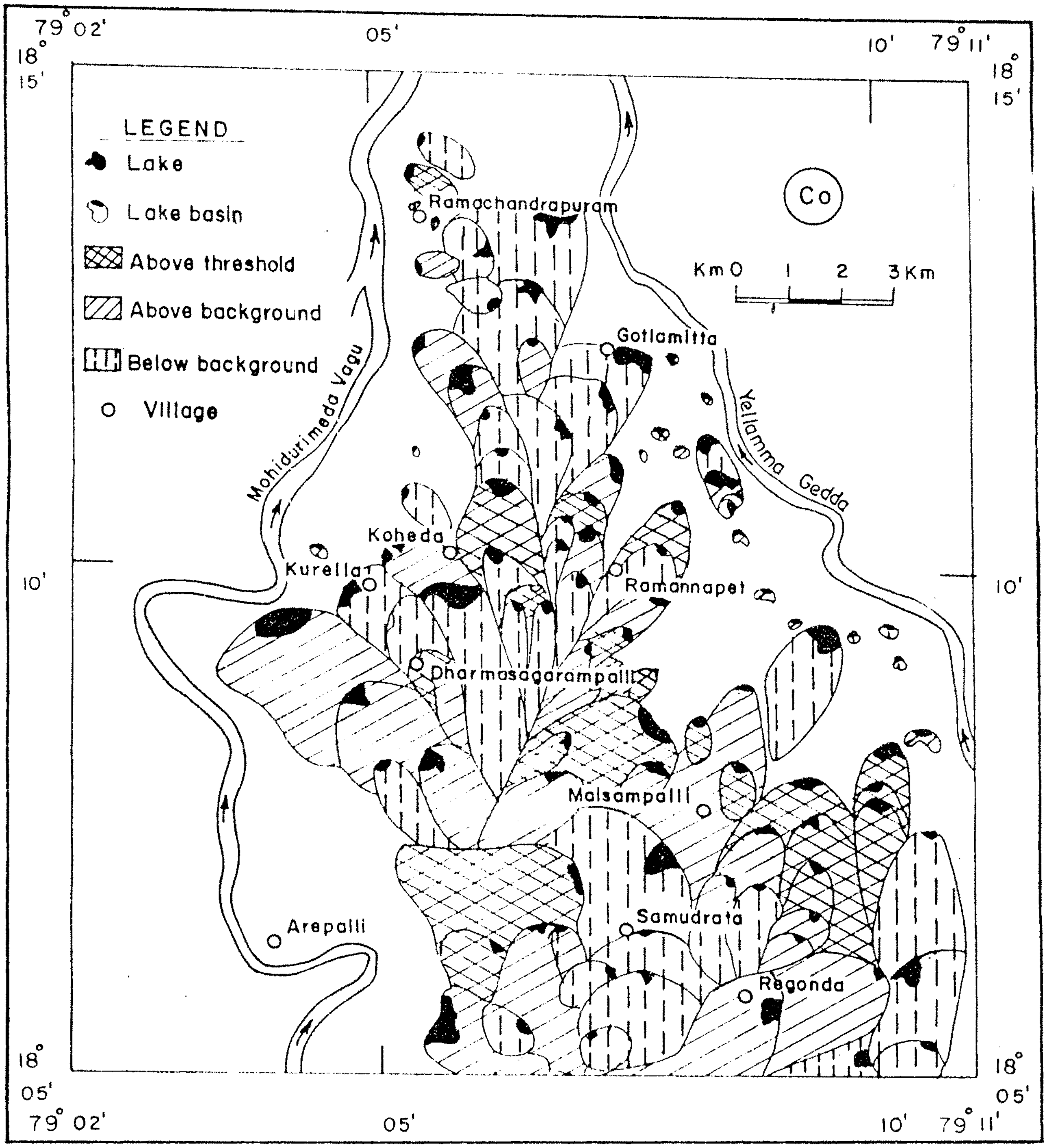

FIG.NO.5.4: DISTRIBUTION OF COBALT IN THE LAKE SEDIMENTS

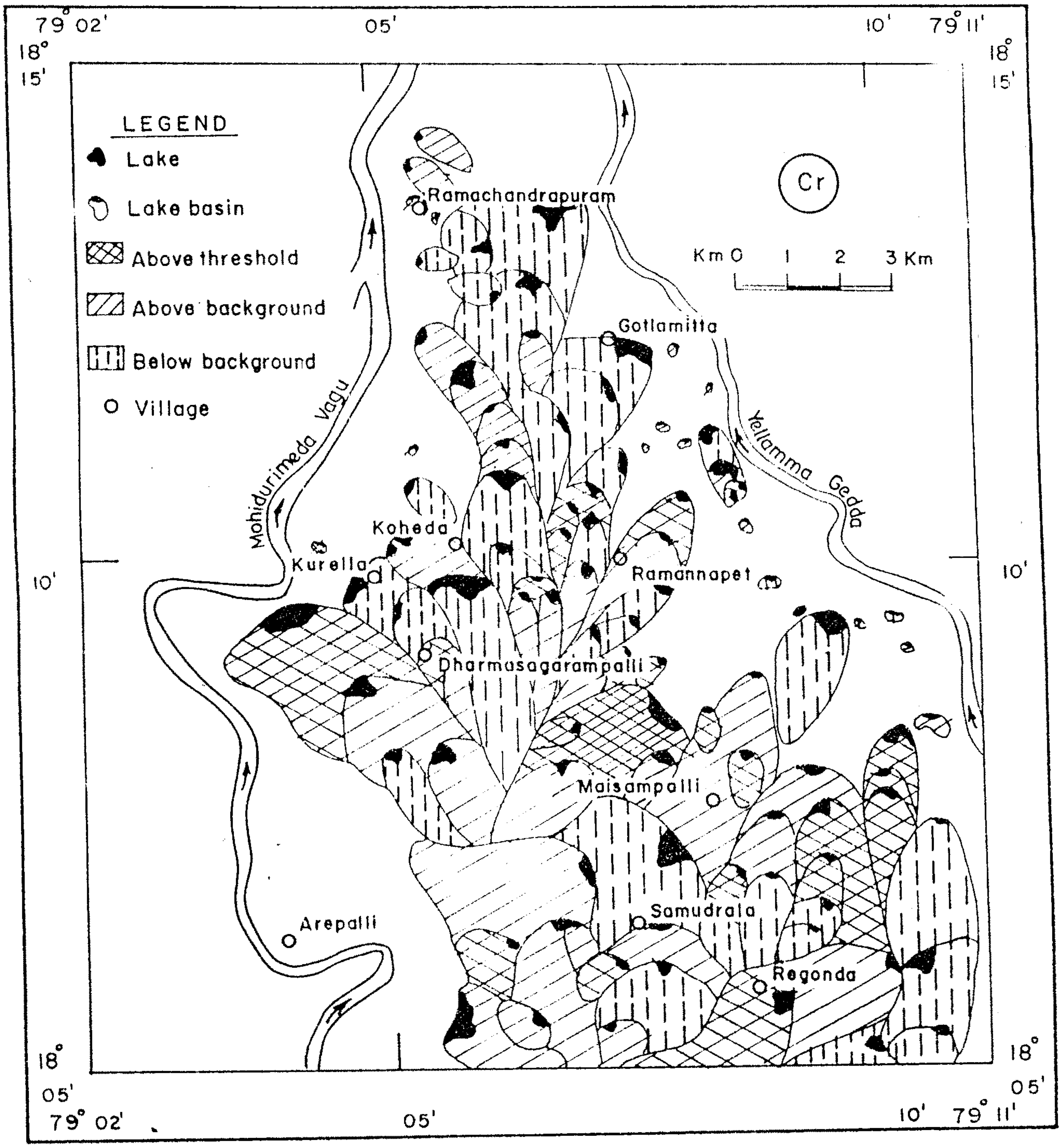

FIG.NO.5.5: DISTRIBUTION OF CHROMIUM IN THE LAKE SEDIMENTS

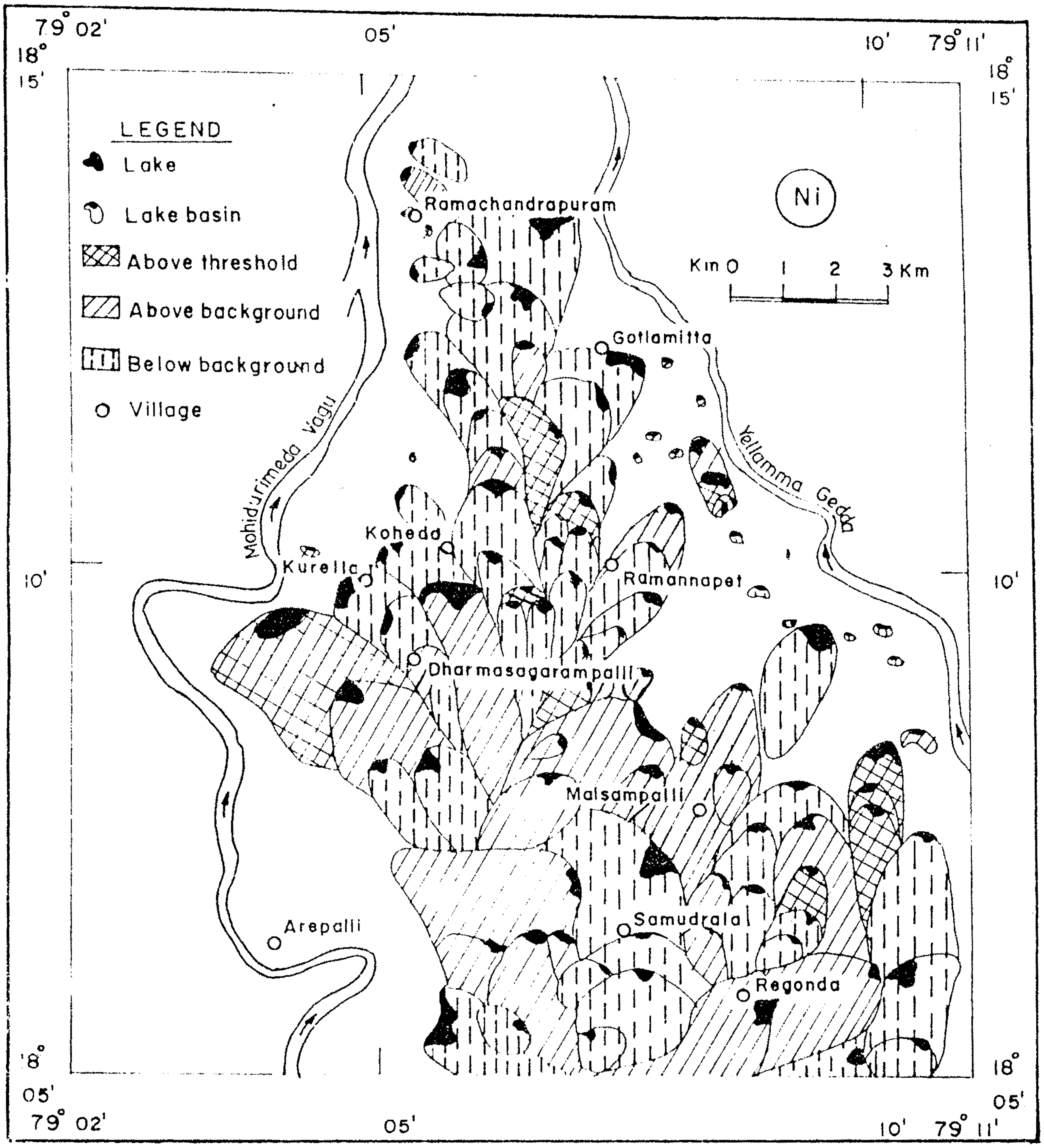

FIG NO.5.6:DISTRIBUTION OF NICKLE IN THE LAKE SEDIMENTS

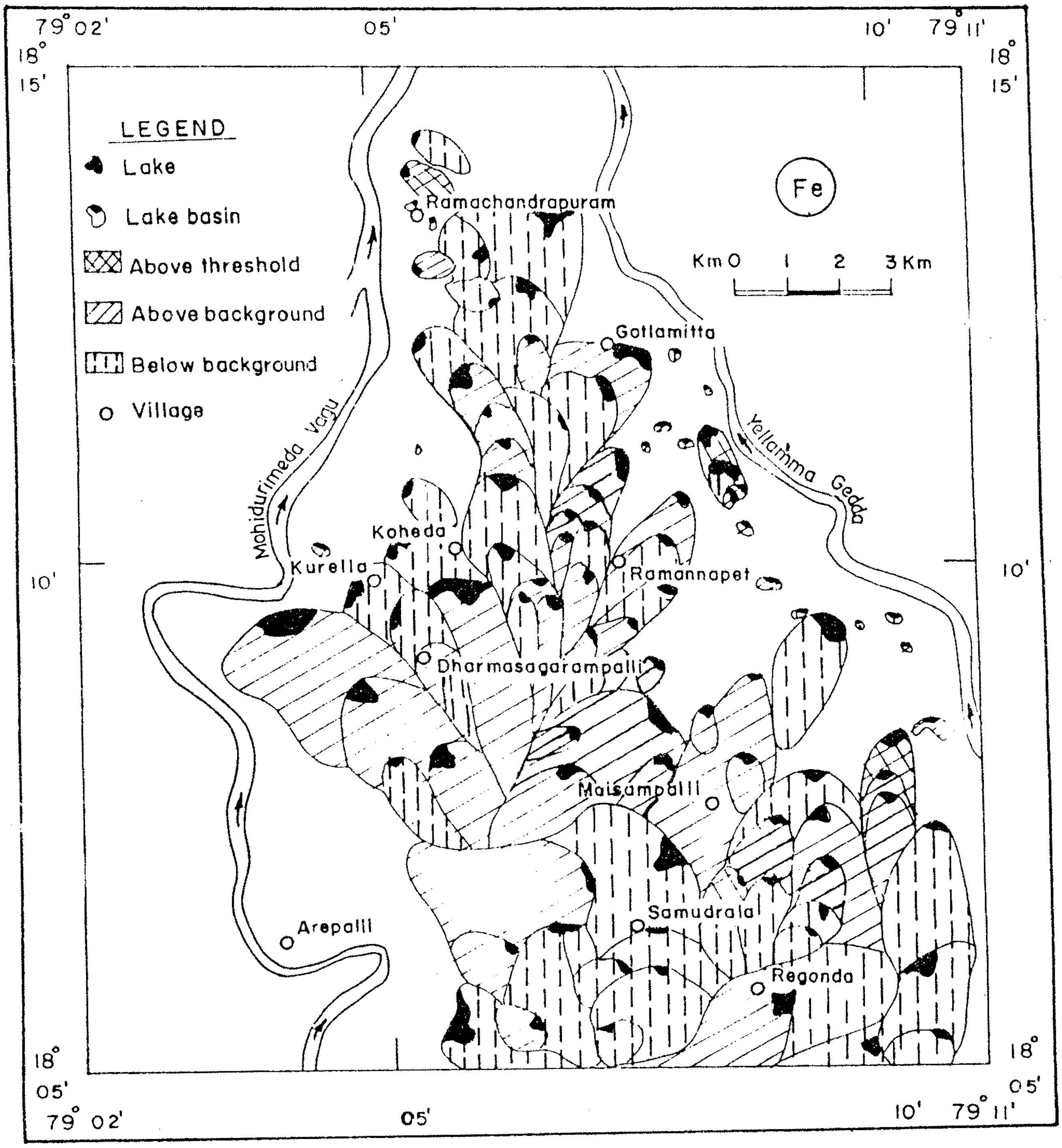

FIG. NO.5.7: DISTRIBUTION OF IRON IN THE LAKE SEDIMENTS

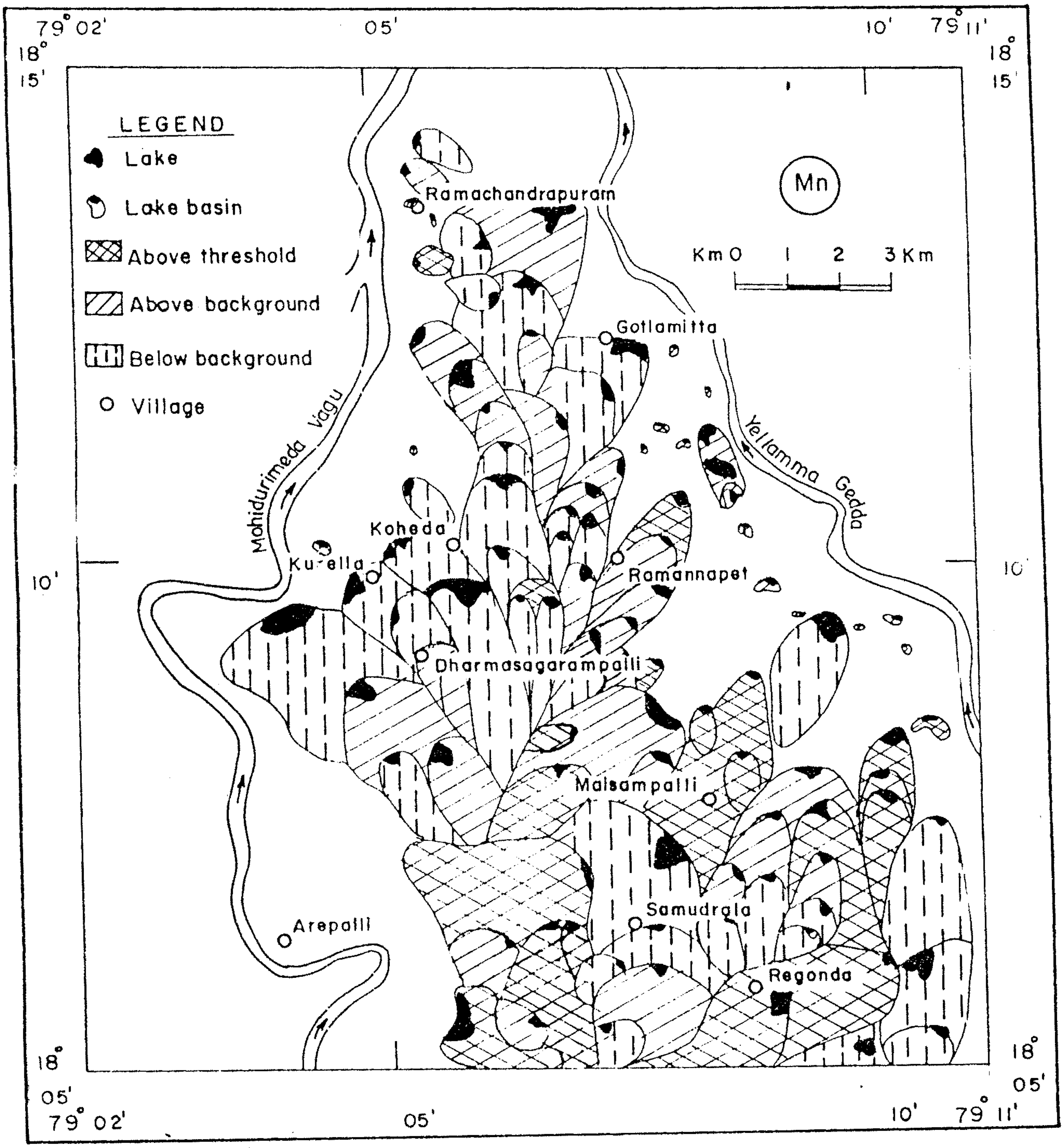

FIG. NO.5.8:DISTRIBUTION OF MANGANESE IN THE LAKE SEDIMENTS

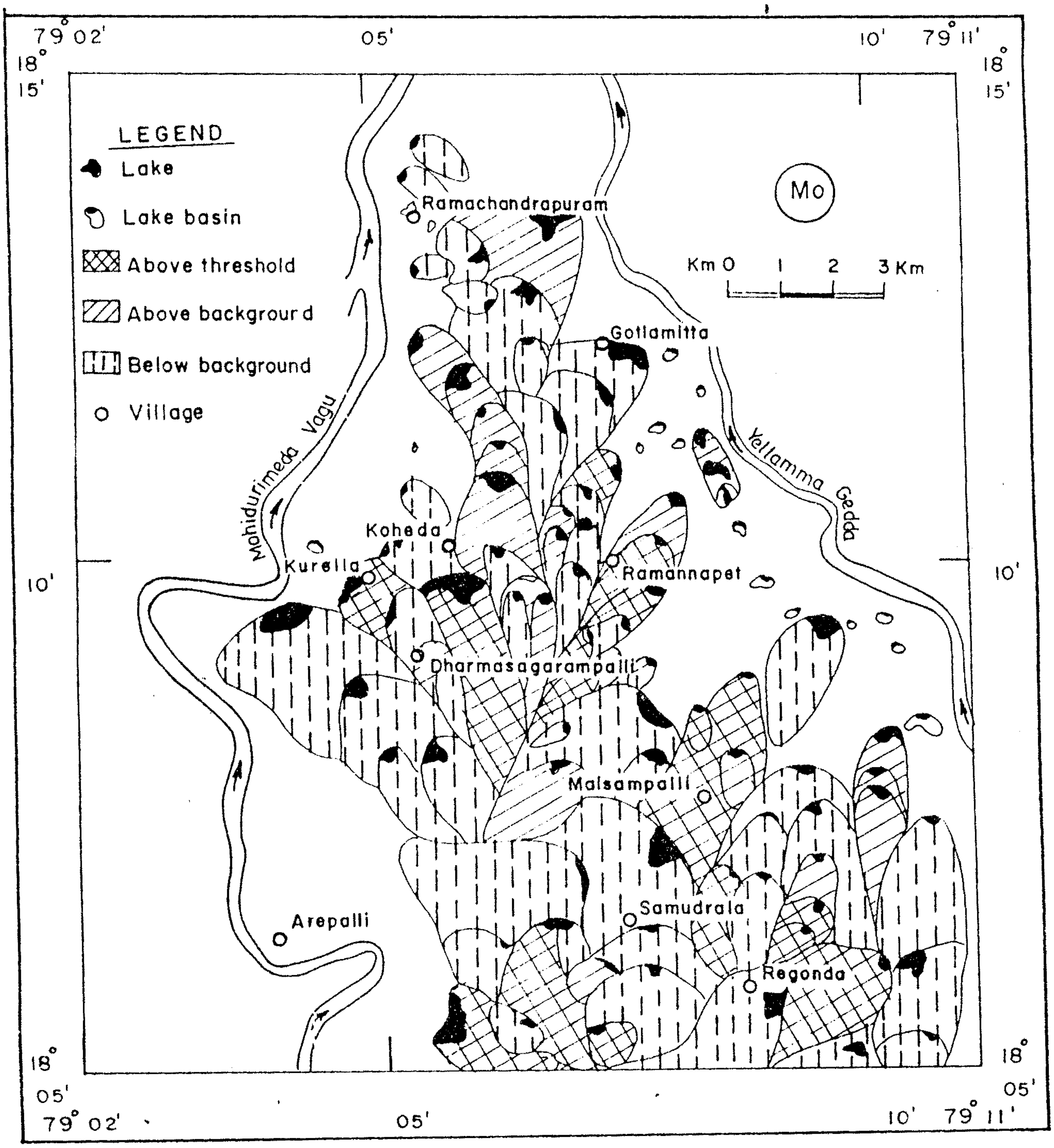

FIG.NO5.9:DISTRIBUTION OF MOLYBDENUM IN THE LAKE SEDIMENTS

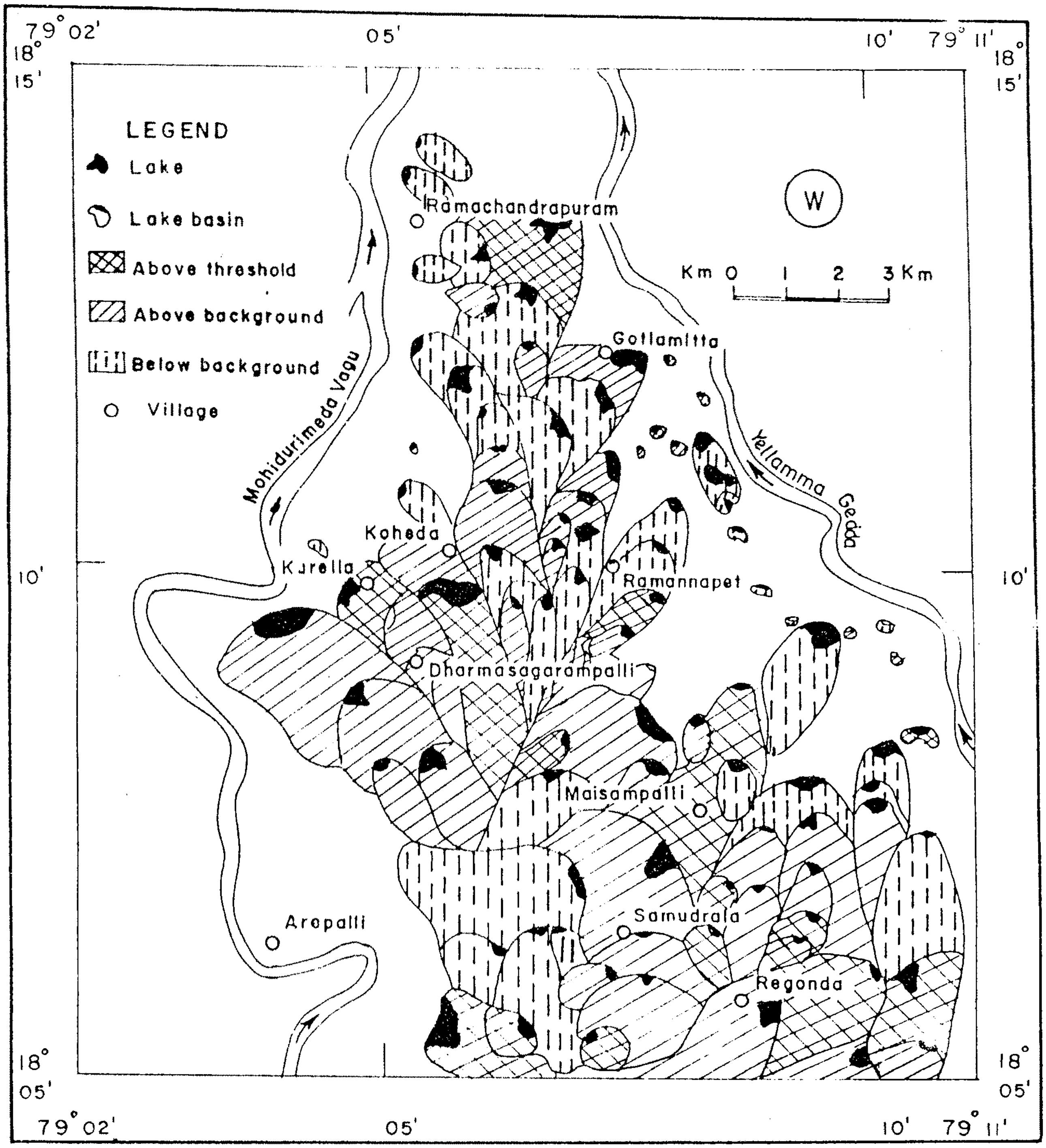

FIG. NO.5.10: DISTRIBUTION OF TUNGSTEN IN THE LAKE SEDIMENTS

Table No. 5.2 : Shows the correlation coefficient matrix for the elements analysed in lake sediments from Koheda area.

	Cu	Pb	Zn	Co	Cr	Ni	Fe	Mn	Mo	W
Cu	1.000	0.477	0.668	0.041	0.170	0.863	-0.068	-0.032	0.275	0.138
Pb	-	1.000	0.385	0.414	0.459	0.518	0.169	0.434	0.135	-0.097
Zn	-	-	1.000	0.133	0.206	0.583	-0.015	0.149	0.252	0.237
Co	-	-	-	1.000	0.702	0.309	0.520	0.731	0.078	-0.019
Cr	-	-	-	-	1.000	0.361	0.582	0.551	0.070	-0.017
Ni	-	-	-	-	-	1.000	0.142	0.197	0.267	0.050
Fe	-	-	-	-	-	-	1.000	0.471	-0.030	-0.020
Mn	-	-	-	-	-	-	-	1.000	0.033	-0.071
Mo	-	-	-	-	-	-	-	-	1.000	0.350
W	-	-	-	-	-	-	-	-	-	1.000

COMBINATION OF ANOMALOUS DISTRIBUTION OF THE ELEMENTS : The Fig. 5.11 is prepared from the combination of only the anomalous concentrations for various elements shown in the Figures 5.1 to 5.10. On careful examination of the Fig. 5.11 the following aspects are noticed,

1. The lakes between Maisampalli and Ramannapeth show different combinations of Cu, Pb, Zn, Co, Cr, Ni, Mo, W, Fe and Mn. The anomalous values in the sediments might be derived from the near by soils and rock outcrops R20 and R15.

2. The lakes between Dharmasagarpalli and Kurella show anomalous concentrations of Mo, W and Zn. These anomalies are suspected to be derived from adjacent soils and outcrops R6 and R7.

3. Lakes from the region southwest of Samudrala show combination of Mo, W, Zn, Co, Cr and Pb anomalies. The anomalies are suspected to be derived from adjacent mineralised soils.

4. Lakes located towards south east of Gotlamitta show combination cf anomalies of Mo, Zn, W, Cu and Co. These anomalies are suspected to be derived from the mineralised soils in the proximity.

On observation of the Fig. 5.11 it is noticed that widespread anomalies are developed for Zn, Mo, W, Cu and Co

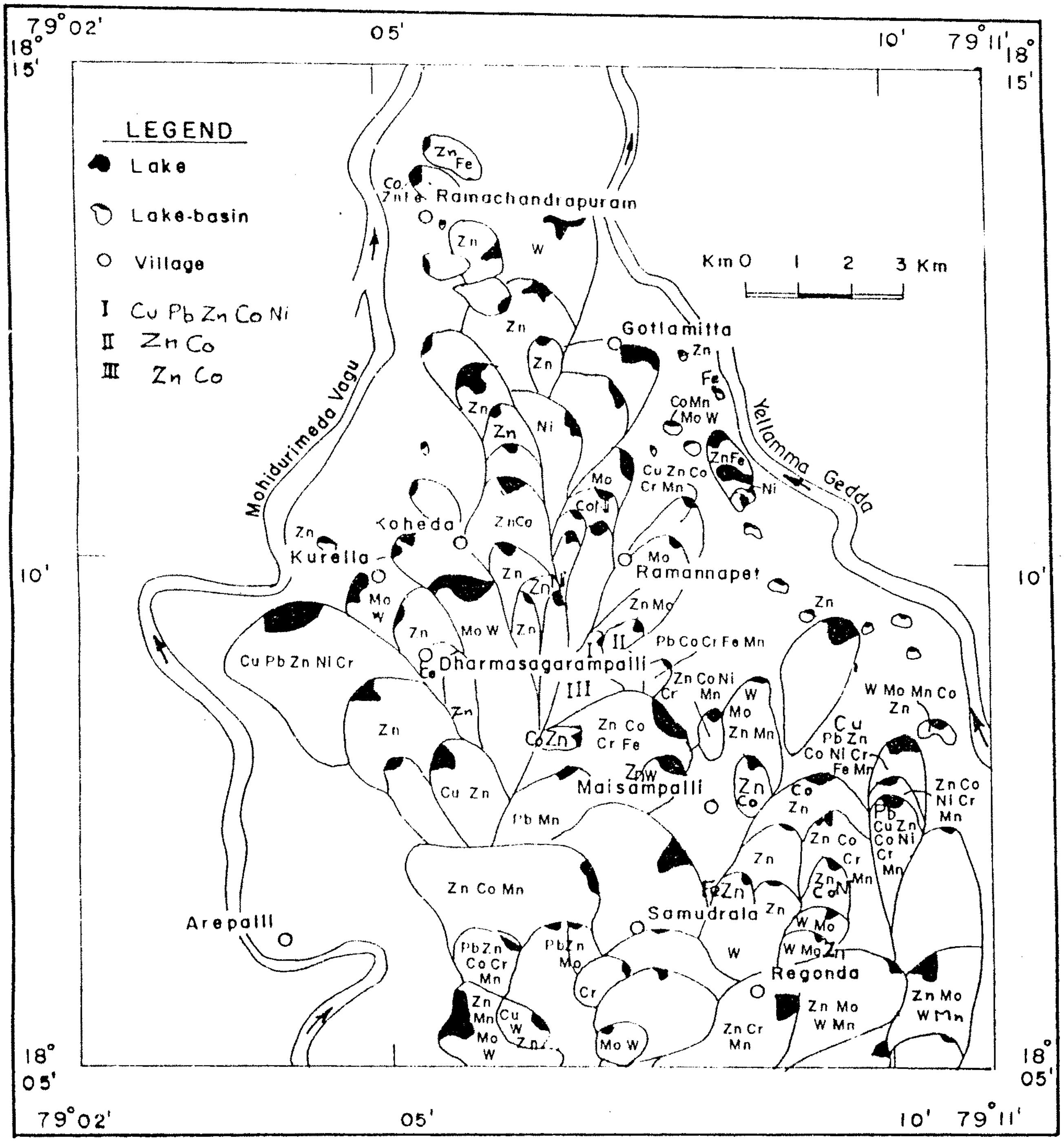

FIG.
NO.5.11:COMBINATION OF ANOMALOUS AREAS OF VARIOUS ELEMENTS IN THE LAKE SEDIMENTS

in the lake sediments. These elements exhibit various combinations in this region. Thus, the elements mentioned above can act as indicators for the proximity of productive plutons. Therefore, the said elements may be considered as target elements.

DISTRIBUTION OF LAKE CHAINS IN KOHEDA AREA : Lake sediment anomalies are developed because of the influx of stream sediments. When the anomalous metal enters at a number of points along the drainage section, in such case the anomalies tends to be more erratic. On the other hand, the anomalous element entering at some point along the stream course will show an increase in concentration to a well developed anomalous pattern and a sharp cut-off. Anomalies that are clastic in origin decay down drainage mainly by dilution (Levinson 1980, Hornbrook et al. 1975, Cameron 1977, Coker et al. 1979).

It is observed that in the present study area, the streams form series of lakes before they confluence either with Mohidermedda Vagu in the west or Yellammagedda in the east. Considering the significant anomalies recognised in the lithogeochemical and soil geochemical surveys, series of lakes have been selected to study the enhancement and or decay patterns of target elements. The lake chains are shown in Fig. 5.12. These lake series are as follows :

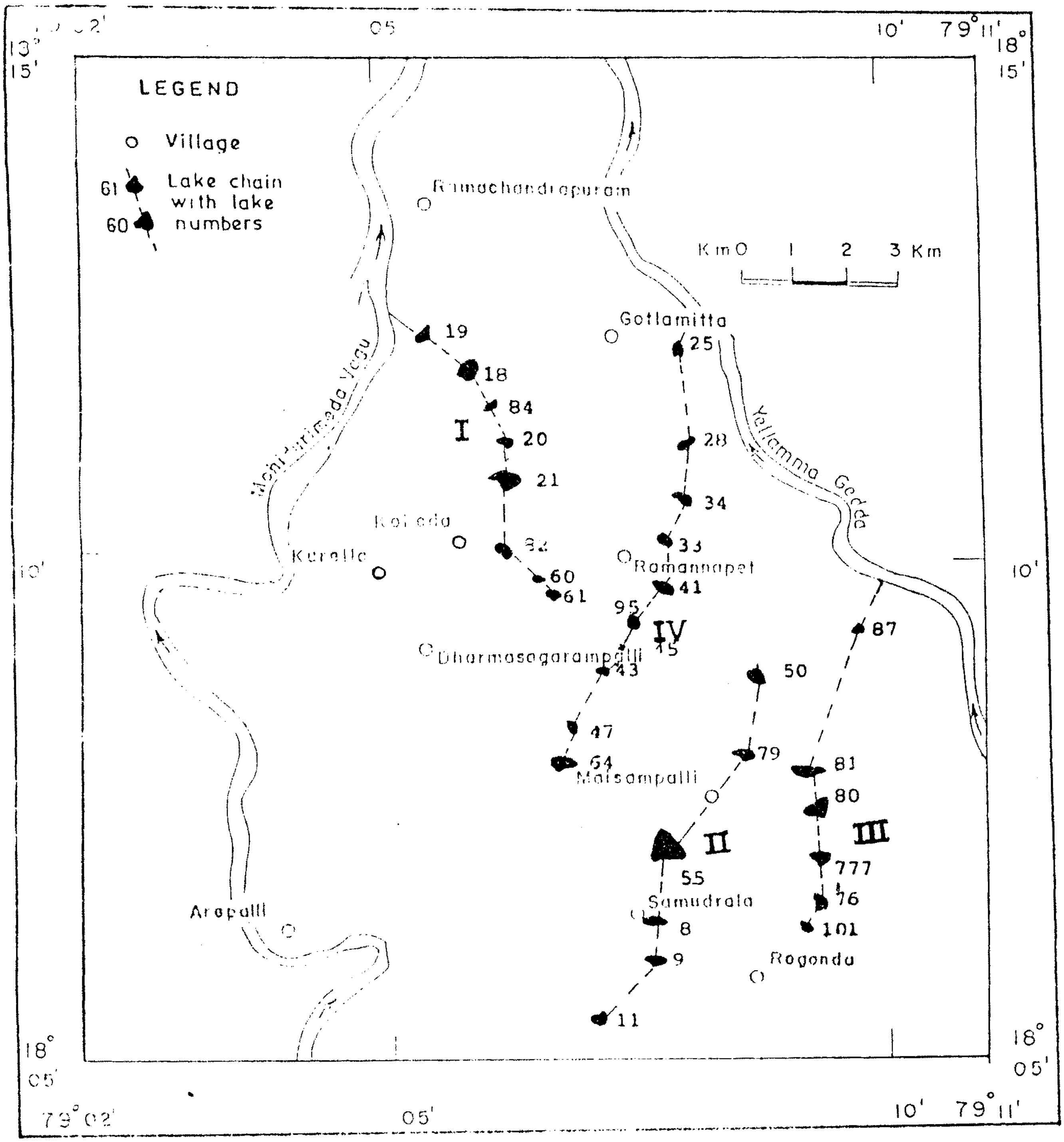

Fig No. 5.12 : Shows the location of selected lake chains in Koheda area.

I. The lake chain consisting of lakes 61, 60, 82, 21, 20, 84, 18 and 19 have a down drainage distance of 4.85 kms. These lakes are located between Koheda and Mohidermedda Vagu.

II. The lake chain consisting of lakes 101, 76, 77, 80, 81 and 87 have a down drainage distance of 5.05 kms. These lakes are found between Regonda and east of Ramannapeth.

III. The lake chain consisting of lakes 11, 9, 8, 55, 79 and 50 have a down drainage distance of 6.90 kms. These lakes are found between south of Samudrala and north of Maisampalli. and

IV. The lake chain consisting of lakes 64, 47, 43, 45, 95, 41, 33, 34, 28 and 25 have a down drainage distance of 6.90 kms. These lakes are situated between west of Maisampalli and Ramannapeth.

DISTRIBUTION OF Cu, Zn, Co, Mo and W ALONG THE LAKE CHAINS :

The concentration of target elements in different lakes along the surface drainage could be due to different modes of occurance of these metal ions. The precipitation of the metal ions from water is controlled by the reactions involving sediments and water. Rose et al. (1979) summarised about the physio-chemical factors in precipitation of metal ions in a system consisting of water and sediments. Perel'man (1967) describes the precipitation barriers for different elements in surfacial environment which are as follows :

1. Oxidation type - Fe and Mn oxides.
2. Reducing type - U, V, Cu, Se, Ag, Fe, Zn, Pb, Hg, Ni, Co, As, Mo and W.
3. Alkaline type - Ca, Mg, Sr, Mn, Fe, Cu, Zn, Pb and Cd.
4. Sulphate-carbonate type - Ba, Sr and Ca. Lastly
5. Adsorptive type - Fe, Mn, Clays and Organic matter.

Cameron and Allan (1973), Hornbrook et al. (1975) and Cameron (1977 b) have used successfully the geochemistry of lake sediments in the identification of sulphide deposits. Cameron (1977 b) has identified the anomalous dispersion train of Zn in the lake chain having a down drainage distance of over 7 kms. The systematic decay pattern observed by Cameron (1977 b) was attributed to a single entry point of anomalous source. The anomalies noticed in the lake sediments is due to the compensation of decrease in the hydromorphic metal concentration (Cameron, 1977 b).

The distribution of Cu, Zn, Co, Mo and W (Target elements) in different lake chain sediments is illustrated in Figures 5.13, 5.14, 5.15 and 5.16.

The distribution of target elements in the sediments of lake chain I, show a systematic decay pattern (see Fig. 5.13).

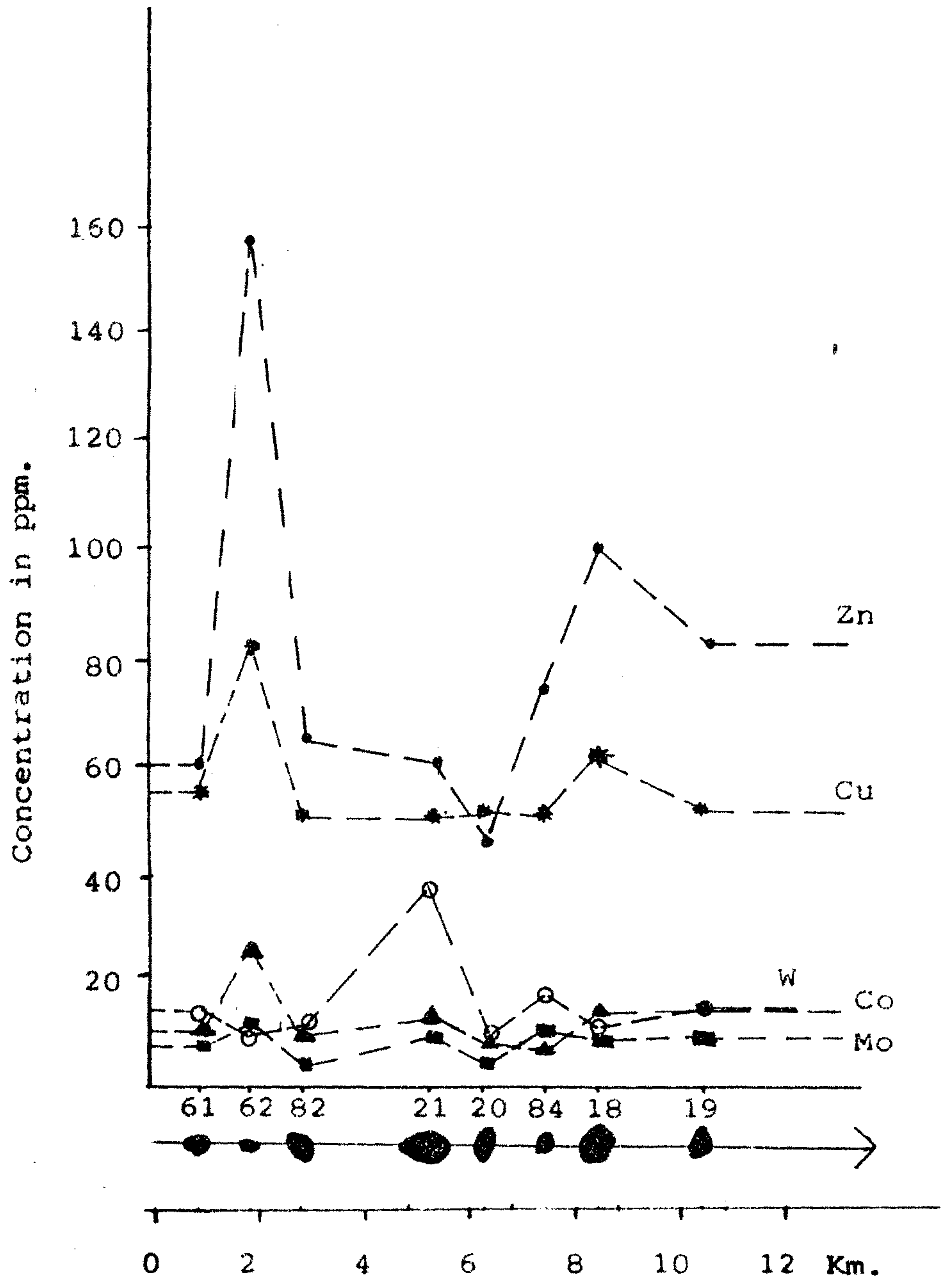

Fig.No. 5.13 : Distribution of Zn, Co, Cu, Mo and W along the lake chain I.

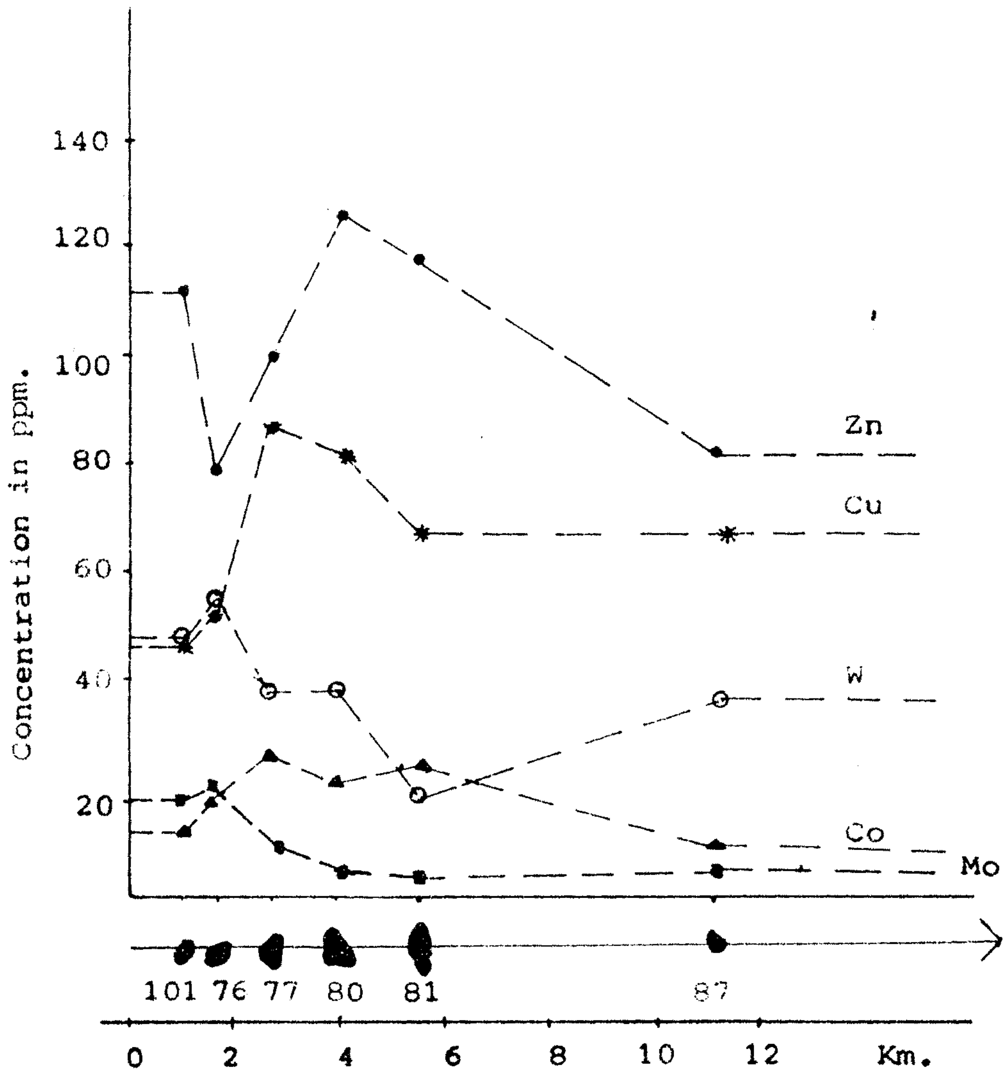

Fig. 5.14 : Distribution of Zn, Co, Cu, Mo and W along the lake chain II.

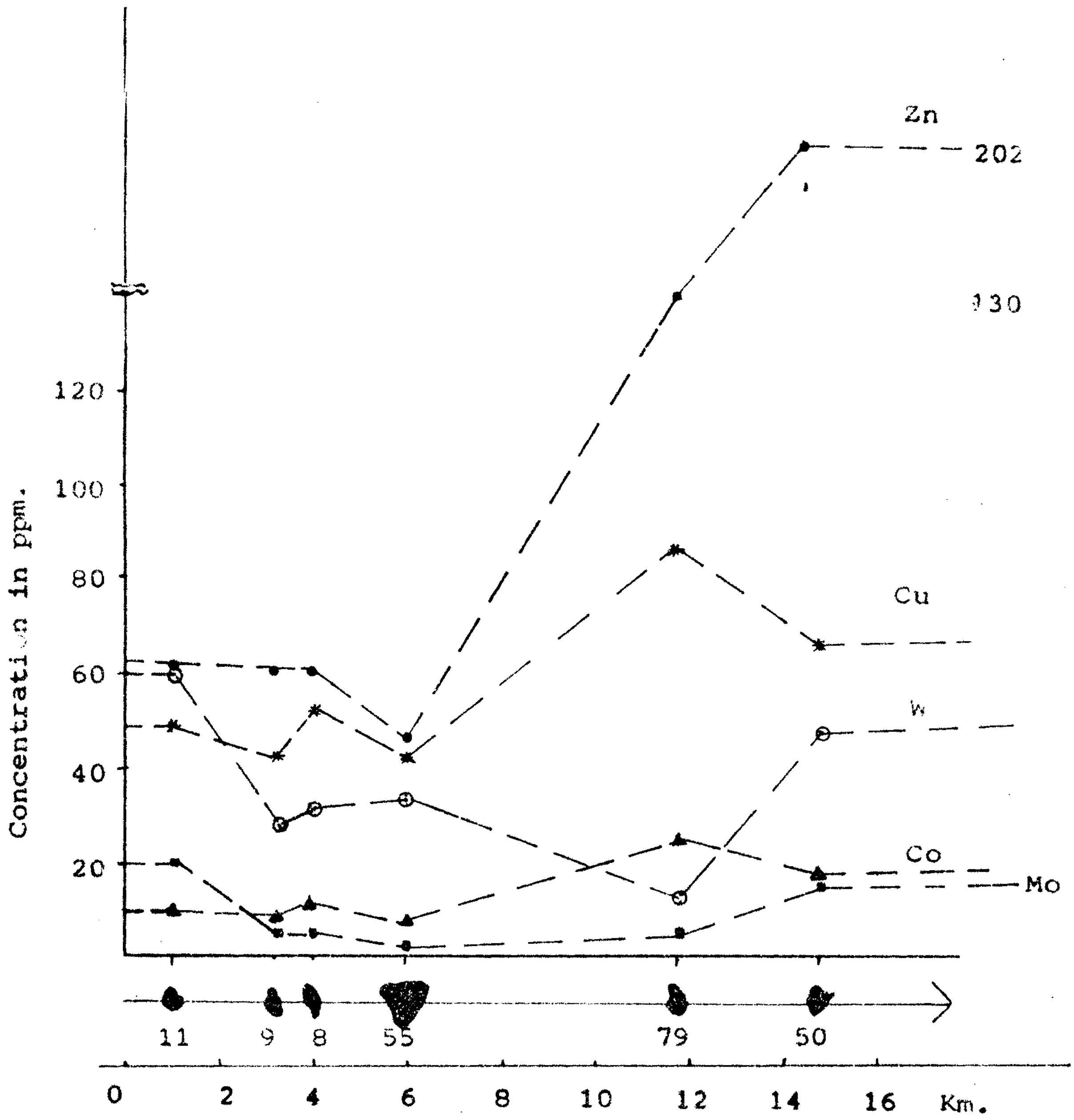

Fig.No. 5.15 : Distribution of Zn, Co, Cu, Mo and W along the lake chain III.

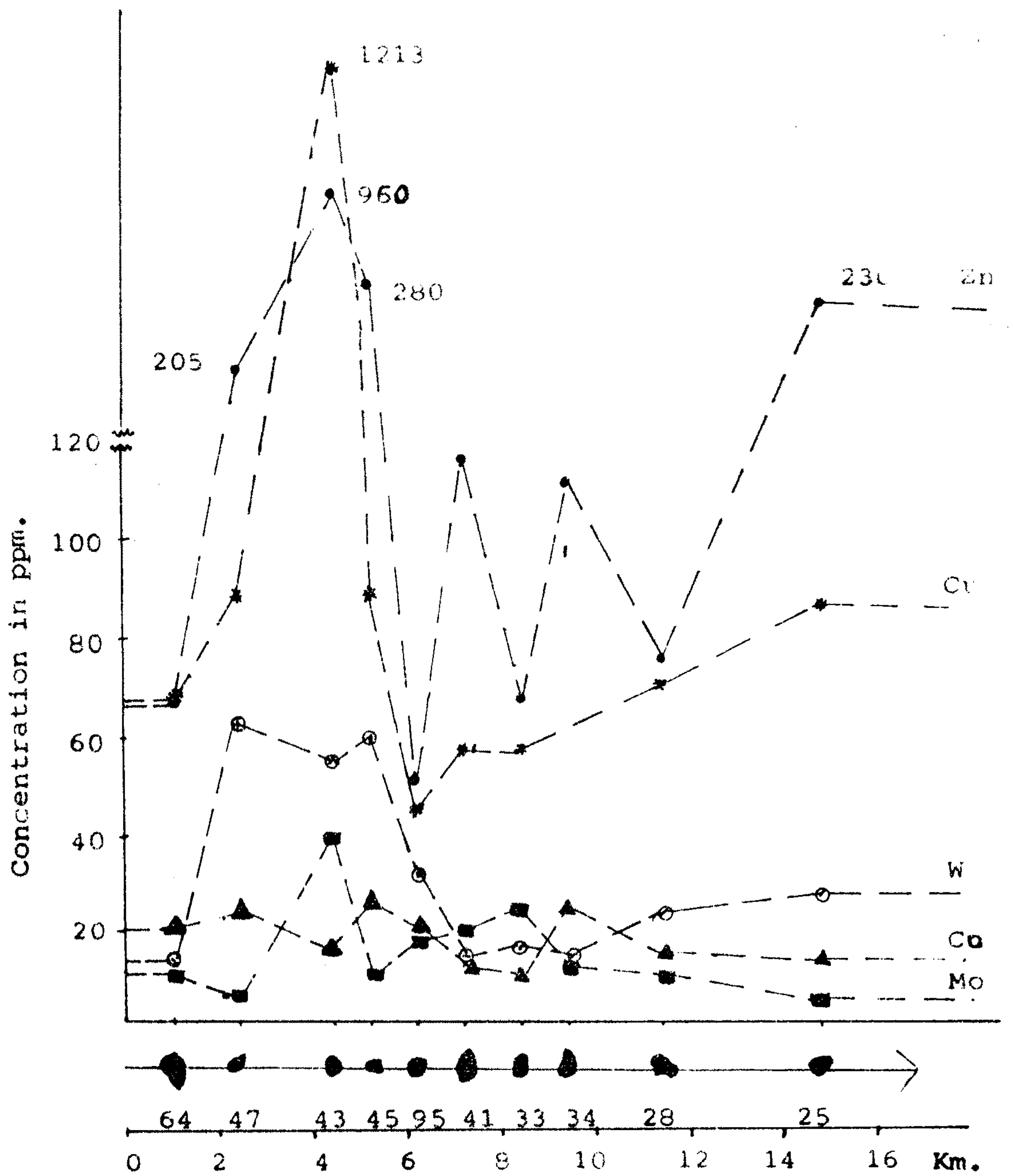

Fig.No. 5.16 : Distribution of Zn, Co, Cu, Mo and W along the lake chain IV.

The anomalous concentration of some elements in the upstream direction, indicate the proximity of mineralised soils. The distribution of the target elements along the drainage reflects a single entry point.

The Fig. 5.14 depicts the distribution of Cu, Zn, Co, Mo and W in the sediments of lake chain II. The decay pattern of the elements along this lake series is similar to the one described above. The anomalous values along this lake chain in the upstream direction is attributed to the mineralised soils and outcrops around Regonda.

The distribution of target elements of the lake chain III located between south west of Samudrala and Maisampalli is illustrated in the Fig. 5.15. The above average concentrations of some target elements noticed in the upstream and downstream directions of the drainage exhibit a multiple entry points. The anomalous sources for the target elements are the mineralised soils and outcrops R17 and R20 near Maisampalli and outcrops around west of Samudrala.

The Fig. 5.16 illustrates the distribution of Cu, Zn, Co, Mo and W in the sediments of the lake chain IV. The lakes of this series are located between west of Maisampalli and Ramannapeth. The distribution patterns of the target elements along this lake chain indicate a multiple points of entry. The suspected source for the anomalous concentration in the upstream direction of lake 45 for the said elements is due to the mineralised soils and outcrops designated as R8 and R20, located at Dharmasagarpalli and Maisampalli, respectively.

Therefore, the studies related to the sediments of lakes from the Koheda area reflect the utility of such surveys in locating the mineralised plutons.

CONCLUSIONS : It is noticed that there are abundant number of lakes in the Koheda area. The geochemical studies of the sediments trapped in the lake have furnished the following aspects :

* The imprints of rocks and soils are to some extent retained in the lake sediment geochemistry in the form of significant correlations between the elements Cu-Zn and Mo-W. Apart from these, the combination of anomalies of different elements in the lake sediments reflect their genetic association and the possibility of mineralised bedrock in the area.
* It is noticed that the anomalies of zinc are prolifically developed in a number of lake sediments. This is followed by copper and cobalt.
* Zinc, molybdenum and tungsten anomalies in the lake sediments act as pathfinders for the molybdenite - copper deposits in the area.

* Studies related to the distribution of target elements along the chain series 2 and 4 show the presence of ore plutons in Regonda and Maisampalli.

Thus, the lake sediment geochemistry is rapid, cost effective and reconnaisance method in identification of mineralisation in Koheda area.