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GEOSPATIAL ANALYSIS OF STREAM-SEDIMENT GEOCHEMICAL DATA FOR BASEMETAL MINERALIZATION STUDIES AROUND SLEEMANABAD AREA DISTRICT KATNI, MADHYA PRADESH

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Abstract : The geo-spatial analysis of geochemical data has several environmental and geological applications. The Sleemanabad area is dominated by carbonates. Thin bands of jasper and ortho-quartzite are intercalated with chert, manganiferous chert, argillaceous chert, and chert in the carbonate-dominated layers. The lower Sleemanabad region, which is characterised by carbonates, contains phyllite and chert interbands.. The area is drained by a number of streams and nallas. Important streams in the region include Sapaipara Nala, Katni Nala, Niwar Nala, and Sinrar Nala. In the present study the geospatial analysis of the geochemical data of stream sediments has been attempted to study the regional distribution of Cu,Pb and Zn elements in the area. The geochemical analysis have been done by using atomic absorption spectroscopy. These elements were studied in order to integrate them with geological and environmental characteristics of the area. The study showed that the distribution of the investigated elements is primarily controlled by the bed rock chemistry. The abundance of these elements is discussed in relation to local geological conditions such as bedrock, climate, weathering, mobility.

Keywords - Geo-spatial, geochemical, stream-sediment, atomic absorption spectroscopy.

I. INTRODUCTION

The use of stream sediments is one of several geochemical techniques that can be used to investigate the source of heavy metals by using a geochemical method (Rollinson, 2014). Multi-element associations identified in stream sediments can provide an indication of the geology of the catchment in regional exploration programs (Levinson, 1974).

It is not efficient at determining a mineral deposit hidden deep beneath various types of covering layers (Yilmaz et al., 2015) that is formed by weathering mineralized rocks and soils that enter streams to form sediment, so the source of mineralization is often difficult to determine. Problems of this type are typical of geochemical patterns (Fletcehr, 1990, 2005).

Geochemical stream sediment method is inefficient because it is difficult to determine mineral deposits that are hidden beneath various types of bed layers. Data sources that are unevenly distributed present the biggest challenge to analyzing stream sediment data (Farahbakhsha et al., 2019).

Geochemical sedimentary stream methods are applied around the Sleemanabad area based on the terrigenous sediment texture controlled by transportation, the morphology of the temporary depositional environment, and the mineral composition. By using stream sediment data, this study aims to determine the distribution of copper, lead, and zinc in the area.

II. STUDY AREA

Sleemanabad is an area in the district Katni located on the National Highway 7 (Nagpur - Allahabad section) and well connected with West Central Railway line that connects Jabalpur and Katni. There is an airport in Jabalpur that is the closest to the city. The area is easily accessible throughout the year due to all-weather roads (Figure 1).The Sleemanabad area exposes metabasalts, quartzites, metaconglomerates, metacherts, Banded Iron Formation, phyllites and dolomitic marbles as part of the Precambrian Mahakoshal Group.

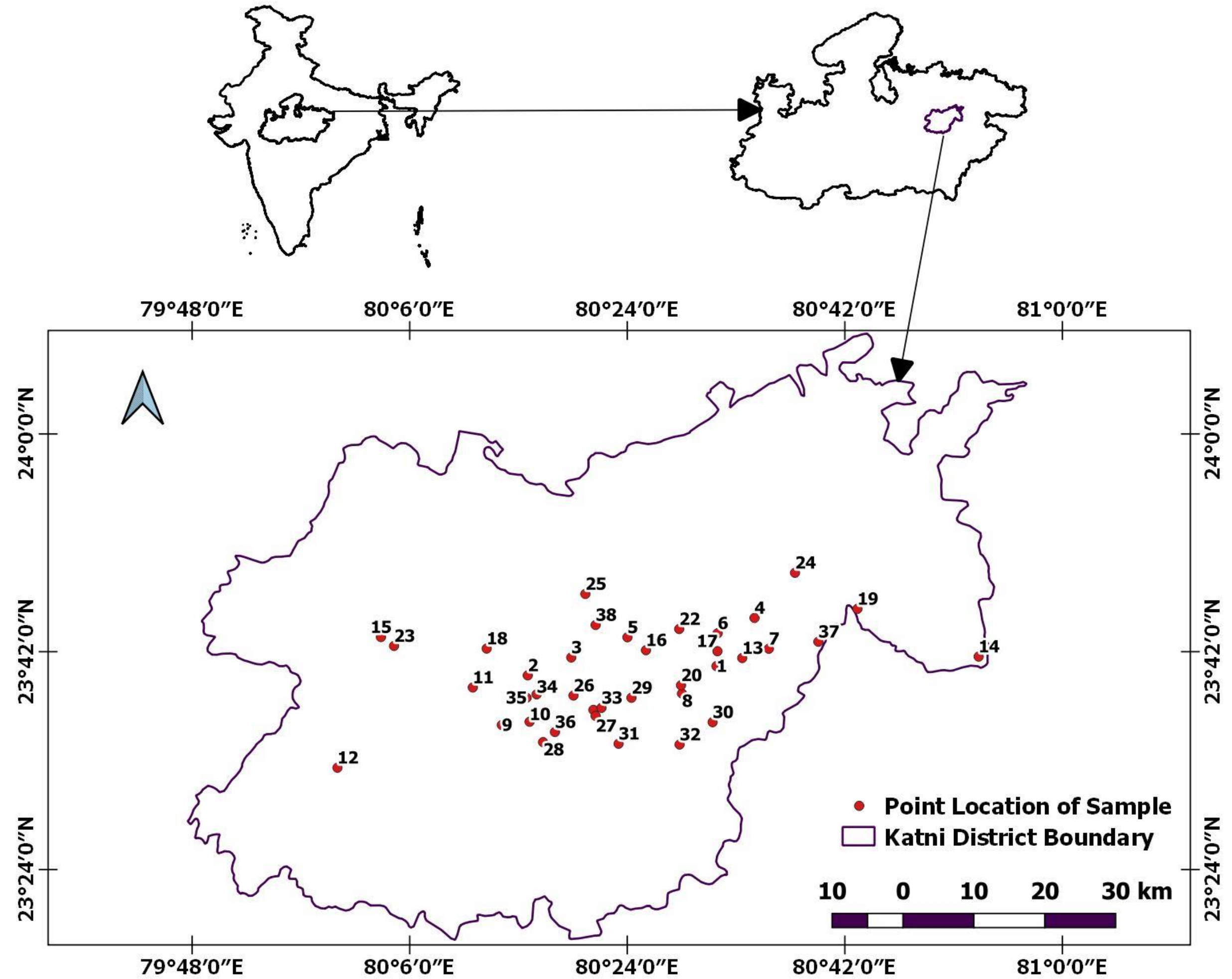

Figure 1. Study area map showing sample locations

Table 1. Location of samples

S.No.	Sample No.	Location	
		Latitude	Longitude
1.	SS01	23°40'48"	80°31'22"
2.	SS02	23°40'2"	80°15'45"
3.	SS03	23°41'31"	80°19'21"
4.	SS04	23°44'47"	80°34'31"
5.	SS05	23°43'11"	80°25'23"
6.	SS06	23°43'31"	80°31'28"
7.	SS07	23°42'14"	80°35'42"
8.	SS08	23°38'32"	80°28'31"
9.	SS09	23°35'56"	80°13'36"
10.	SS10	23°36'12"	80°15'54"
11.	SS11	23°39'2"	80°11'12"
12.	SS12	22°57'10.8"	80°44'16.8"
13.	SS13	23°32'24"	80°14'11"
14.	SS14	23°41'28"	80°33'30"
15.	SS15	23°41'36"	80°54'19"
16.	SS16	23°43'12"	80°3'36"
17.	SS17	23°42'7"	80°25'32"
18.	SS18	23°42'2"	80°31'27"
19.	SS19	23°42'15"	80°12'21"
20.	SS20	23°45'32"	80°43'2"
21.	SS21	23°39'13"	80°28'26"
22.	SS22	23°37'11"	80°21'11"
23.	SS23	23°43'52"	80°28'17"
24.	SS24	23°42'28"	80°4'41"
25.	SS25	23°48'31"	80°37'52"
26.	SS26	23°46'46"	80°20'31"
27.	SS27	23°38'22"	80°19'32"
28.	SS28	23°36'41"	80°21'22"

29.	SS29	23°34'31"	80°17'1"
30.	SS30	23°38'11"	80°24'20"
31.	SS31	23°36'10"	80°31'3"
32.	SS32	23°34'23"	80°23'16"
33.	SS33	23°34'19"	80°28'19"
34.	SS34	23°37'21"	80°21'51"
35.	SS35	23°38'28"	80°16'29"
36.	SS36	23°38'11"	80°15'39"
37.	SS37	23°35'21"	80°19'23"
38.	SS38	23°42'49"	80°39'48"

III. GEOLOGICAL SETTING

The Mahakoshal Group of rocks are characterized by a volcanic-sedimentary sequence. In conjunction with the metabasic sediments of basaltic composition, the sediments include, conglomerate, quartzite, chert, chert, stromatolitic , limestone Banded Iron Formation and the dolomite (Figure 2). The Mahakoshal Group has been considered to be a basement group because of high grade gneisses in a narrow belt form that are situated in the area. It was found that the Mahakoshal Supracrustals are intruded by serpentinised ultramafic bodies composed of, peridotite, and pyroxenite and dunite. According to Bandyopadhyay et al., 1990 this sequence is intruded by syn-to post-kinematic granitoids that are about 1800 Ma and 2400 Ma old based on a Rb-Sr age dating. During the formation of the Supracrustal rocks, three phases of deformation have taken place, of which the first two phases are more prominent (Roy & Bandyopadhyay, 1990). Throughout the entire belt of metamorphism, green schist facies of metamorphism can also be seen, however, higher grade minerals can also be found at localities. In the north of the region, the Mahakoshal Group of rocks is overlain by the Vindhyan Supergroup of rocks, while in the south of the region, the Gondwana Supergroup is unconformably overlain by the Mahakoshal Supracrustals.

A copper ore deposit near Sleemanabad was discovered by Olperts in 1870, which revealed this area's geological significance.Hughes and Hacket mapped the area. There is also a mention of this area in Oldham, Datta, and Vredenberg's memoir (1901). During 1904-06, Dutt prospected for basemetal in the Imaliya area. During 1969 to 1972, Chande & Bhoskar (1972) carried out detailed investigations for basemetals in Imaliya, Bhula, and Nawalia. Devrajan and Shrivastava (1995) measured gold values in quartz veins and altered metabasalts around Bhula area during 1994-95, although they did not mention the presence of base metal occurrences. Roy 2000 studied the stratigraphy and tectonics of Mahakoshal Belt (Table 1). From some of the streams around Tivari, Devri, and Banehri, Banereji (2002) found gold values between 100 ppb and 130 ppb when conducted Regional Geochemical Stream Sediment sampling in the area.

Table 1. Lithostratigraphy of the Mahakoshal Group (after Roy et al., 2000)

	Sleemanabad area (Western Mahakoshal belt)	Chitrangi- Gurahar Pahar- Dudhamaniya area (Eastern Mahakoshal belt)
Intrusives	Quartz porphyry, quartz reefs, mafic dykes	Gold bearing quartz –carbonate veins, quartz reefs, dolerite. Granite-granodiorite-intrusive pluton belt along the southern margin. Jhirgadandi Granite and equivalents. Lamprophyre and syenite in Sidhi.
Dudhamaniya Formation	Not exposed	Alternating sequence of BIF (mixed oxide-sulphide-silicate facies) and phyllite - - - - - - - - - - - gradational contact- - - - - - - - - -
Parsoi Formation	Dominantly phyllite with bands of greywacke , quartz wacke, quartz arenite and basal polymictic conglomerate	Dominantly phyllite with bands of greywacke , quartz wacke, quartz arenite. Occasional presence of carbonaceous phyllite.
Sleemanabad Formation Or Agori Formation	Mostly carbonates (stromatolitic at many places) with bands of bedded and massive chert, rare manganiferous chert, BIF, quartz- arenite and	Quartz -arenite and carbonate in the lower part, massive and bedded chert , BHJ, highly carbonated and fragmented meta- basalt, thin argillites
Sidhi Gneissic complex (Basement)	Gneissic complex with associated mafic, ultramafic rocks and metasediments	

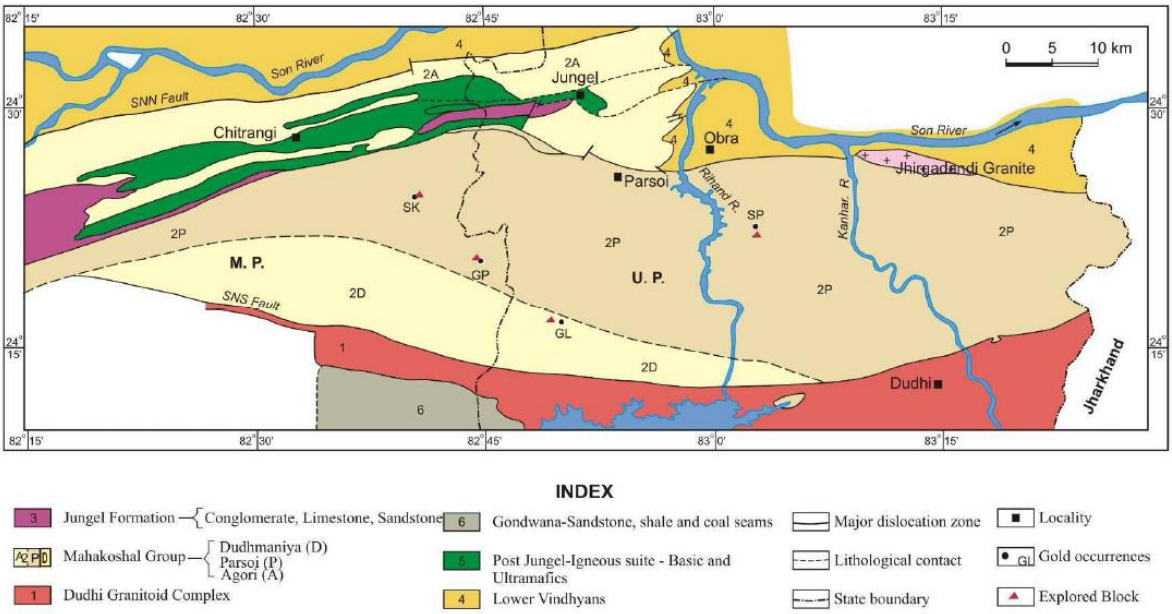

Fig.2. Regional map of Mahkoshal belt (after Sharma, 2000).

There are two lithological associations associated with Mahakoshal Group of rocks in Sleemanabad. The Sleemanabad Formation is dominated by carbonates, while the Bhitrigarh Formation is dominated by clastic and argillite. They are separated by an impersistent polymictic conglomerate horizon. Among the carbonate-dominated units, chert, ortho-quartzite, manganiferous chert, argillaceous chert, and thin jasper bands are intercalated. As opposed to clastic dominated units, meta volcanics often interlayer or interfinger these rocks (Devarajan & Shrivastava, 1994-95) (Table 2). Phyllite & chert interbands are present in the carbonate dominated lower Sleemanabad Formation. The upper Bhitrigarh Formation, which is dominated by clastic and argillite, consists of phyllite, quartzite and conglomerate with rare metavolcanics. Occasionally, quartz carbonate veins and quartz veins are seen intruding these zones.

Table-2: Generalized Stratigraphy of the area (Devarajan & Shrivastava, 1995)

Lower Cretaceous	Gondwana Supergroup	Chandia Beds	Fine to medium grained Sandstone.
---------- Faulted Contact ----------			
Proterozoic	Vindhyan Super group		Sandstone, shale, conglomerate.
---------- Unconformity ----------			
Early Proterozoic to Archaean	Mahakoshal Group	Intrusives	Quartz veins, Quartz porphyry veins. Mafic and Ultramafic intrusives.
		Bhitrigarh Formation	Phyllite with bands of quartzite, Conglomerate.
		---------- Unconformity ----------	
		Sleemanabad Formation	Dolomite, Limestone with bands of BIF, Manganeferous chert, quartzite and metabasalts, pyroclastics.
Base Not Seen			

IV. METHOD

Samples are taken from the stream sediment layer at the top to the bottom, where the top is dominated by fine-sized fraction while the bottom is of coarse-sized fractions dominance. Randomly the distance of the sample point takes into account the conditions of the river bed, topography and lithology. A total of 38 samples (Table 1) were taken from stream sediments at different geographical coordinates (Figure 1).

Geochemical analysis of stream sediment composition data (Table 3) is used to obtain the amount of elements and its geochemical properties in the study area. Each sample is placed in a polyethylene bag to be dried by an oven at a temperature of 100°C then smoothed with a preparation machine at the Laboratory. Furthermore, each sample undergone chemical composition analysis with Atomic Absorption Spectrometry (AAS). In order to find out statistical figures for the mean concentration, standard deviation, and anomalous value of the chemical analysis, it has been fed into a computer and descriptive analysis has been performed on the results in order to find out statistical figures.

Table 3. Concentrations of various elements in the stream sediments of the study area.

S.No.	Sample No.	Concentration (ppm)		
		Cu	Pb	Zn
1.	SS01	30	90	40
2.	SS02	40	110	40
3.	SS03	10	100	30
4.	SS04	20	80	0
5.	SS05	40	90	10
6.	SS06	30	30	10
7.	SS07	40	30	10
8.	SS08	10	55	20
9.	SS09	10	80	20
10.	SS10	20	45	30
11.	SS11	25	40	20
12.	SS12	30	30	20
13.	SS13	15	50	20
14.	SS14	90	20	20
15.	SS15	80	10	20
16.	SS16	90	10	30
17.	SS17	20	0	10
18.	SS18	30	30	80
19.	SS19	30	10	110
20.	SS20	40	10	100
21.	SS21	30	0	10
22.	SS22	30	10	20
23.	SS23	35	10	80
24.	SS24	30	20	90
25.	SS25	20	10	20
26.	SS26	20	10	30
27.	SS27	90	30	30
28.	SS28	70	100	40
29.	SS29	70	80	40
30.	SS30	100	20	30
31.	SS31	80	20	30
32.	SS32	80	30	100
33.	SS33	115	20	30
34.	SS34	110	10	30
35.	SS35	100	10	40
36.	SS36	30	10	50
37.	SS37	30	20	40
38.	SS38	80	10	30

V. RESULT AND DISCUSSIONS

Important statistical parameters of elemental data in stream sediments based on geochemical results shown here in Table 4.The values for Copper in stream sediments of Sleemanabad area range between 10 and 115 ppm. Mean Cu concentration works out to be 48.95 ppm and Standard Deviation is 31.95 ppm. The anomalous value calculated by the formula mean +2 Standard Deviation works out to be 112.84 ppm. Copper values found higher in south east part of the study area. (Figure 3)

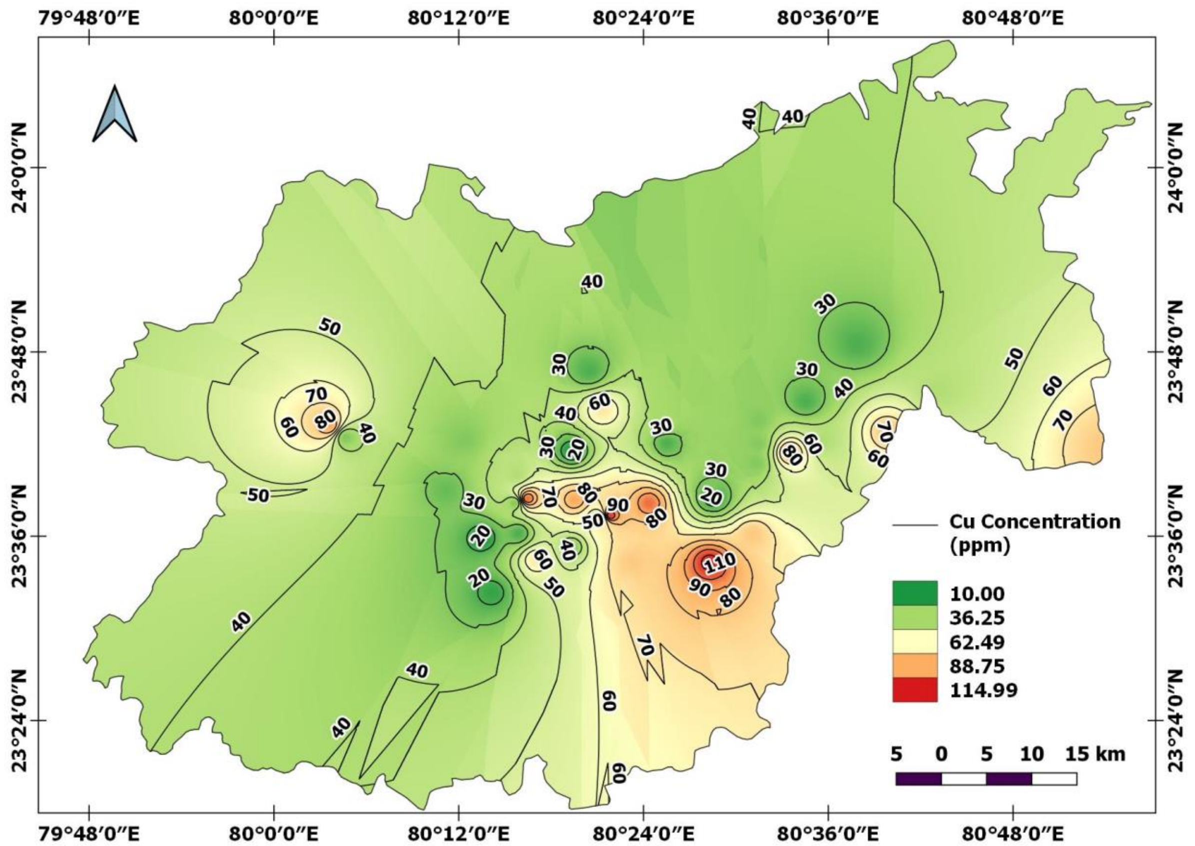

Figure 3. Spatial distribution of Cu Concentration map.

The values of Pb in stream sediments of the area vary between 0 and 110 ppm. The mean concentration of Pb in stream sediment samples is 34.74 ppm. Its standard Deviation value is 32.74 ppm. and the anomaly value calculated by using mean+2 standard deviation formula comes out to be 99.67 ppm (Figure 4). The higher Pb values are found to confined at the central portion of the study area.

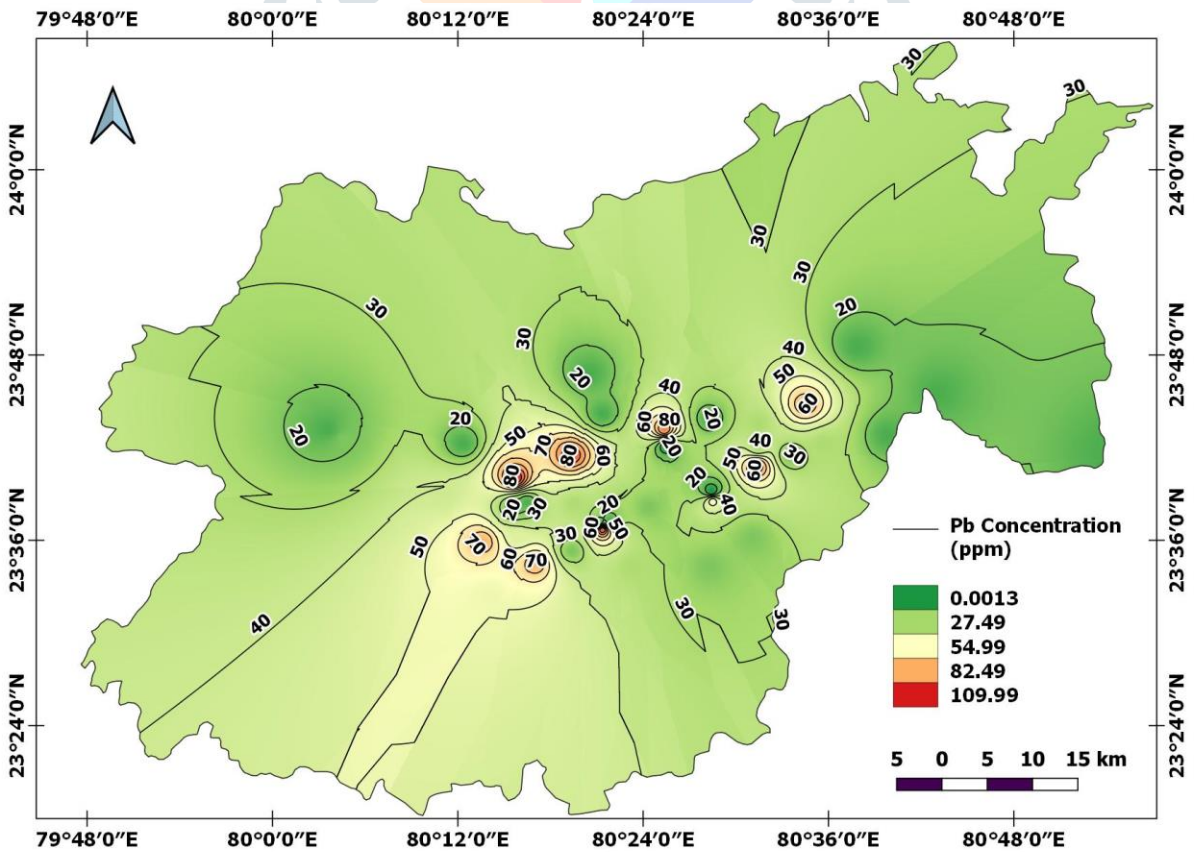

Figure 4. Spatial distribution of Pb Concentration map.

Table 4. Important statistical parameters of elemental data in stream sediments

Element	Mean	Median	Mode	Standard Deviation	Sample Variance	Kurtosis	Skewness	Range	Anomaly
Cu	48.95	32.50	30.00	31.95	1020.48	-1.04	0.60	115.00	112.84
Pb	34.74	20.00	10.00	32.47	1053.98	-0.17	1.05	110.00	99.67
Zn	36.58	30.00	30.00	27.44	752.84	1.32	1.38	110.00	91.45

The concentration of Zn in stream sediments is variable between 0 and 110 ppm. The mean value is 36.58 ppm and the standard deviation is 27.44. The anomalous value of zinc works out to be 91.45 ppm for the area. The zinc values found higher at north east, north west and central part of the study area (Figure 5).

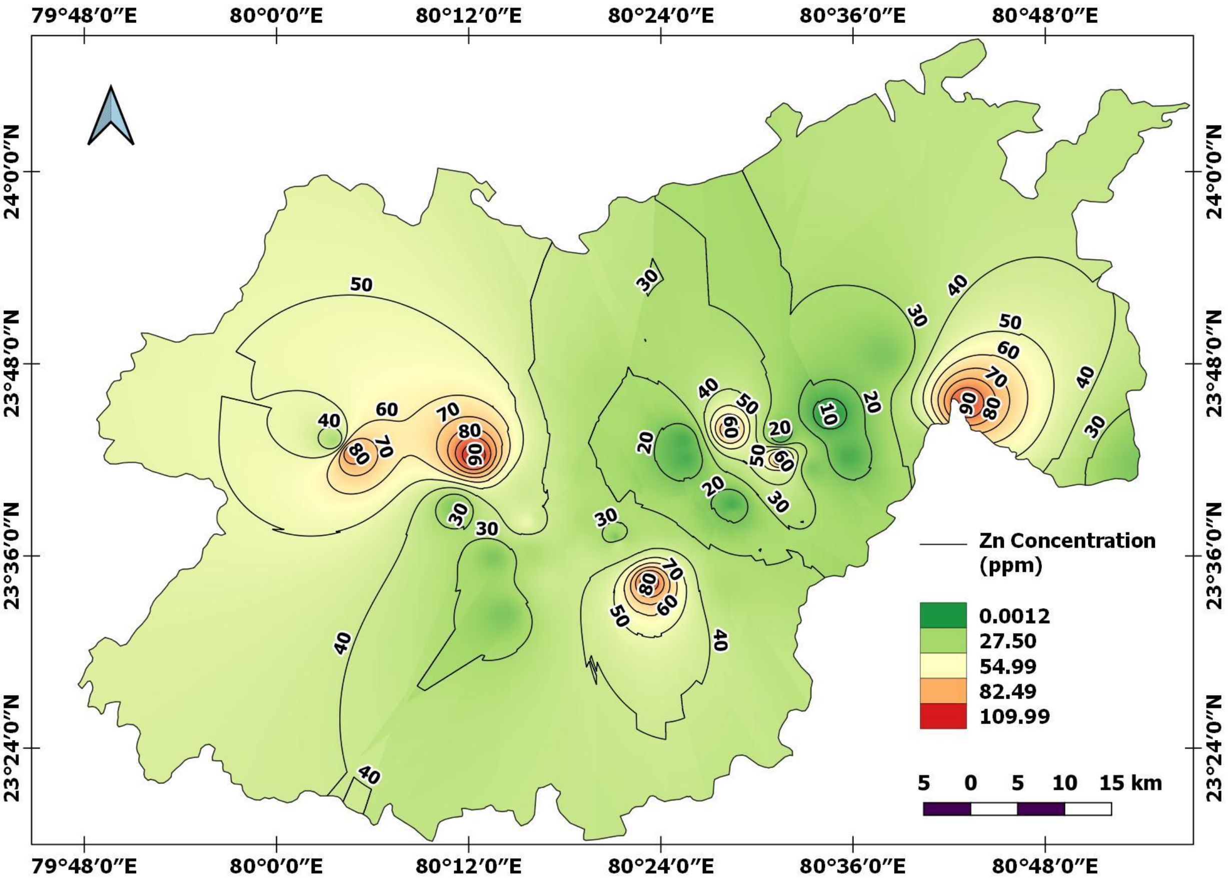

Figure 5. Spatial distribution of Zn Concentration map.

VI. Conclusions

This study suggests that stream sediment exploration can identify regional metalliferous regimes, which can be used to define exploration areas. Mineral deposits may exist in the study areas as observed in the geospatial distribution pattern of Cu, Pb, and Zn. . In the south-east part of the study area, copper values are higher, which indicates the potential for Cu mineralization. Within the study area, Pb mineralization is limited to the central portion where as zinc values were higher in the north east, north west, and central areas. A variety of factors might have played a role in the distribution of these elements in stream sediments, including bedrock chemistry, dispersion mechanisms, mobility of elements weathering, climate, and distance from the mineralized bedrock.

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