Curriculum-Vitae

Anita Punia, PhD

Institute postdoctoral fellow (IPDF),
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Gender: Female
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Research interest

Environmental Geochemistry

Hydrogeochemistry

Remote sensing and GIS

Academic education

2014-2017	**Ph.D.** (Environmental Sciences), School of Environmental Sciences, Jawaharlal Nehru University, New Delhi.
2015-2017	**M.Sc.** (Distance Education) in Environmental Sciences from Bharathiar University securing 60.4%
2008-2010	**M.Sc.** (Water Resources Management) from TERI University, New Delhi (2010) securing CGPA 6.16
2004-2007	**B.Sc.** (Biotechnology, Chemistry and Zoology) from Kanoria Mahila Mahavidyalaya, Jaipur, University of Rajasthan securing 67.04 %
2002-2004	**Senior Secondary** from Board of Secondary Education, Rajasthan securing 68.62%
2001-2002	**High School** from Board of Secondary Education, Rajasthan securing 79.17%

Details of PhD

Title: **Abundance and Behaviour of Heavy Metals in the Khetri Copper Mine Environment, Rajasthan**

Name of Supervisor: **Dr. N. Siva Siddaiah**,
Associate Professor, School of Environmental Sciences (SES), Jawaharlal Nehru University (JNU), New Delhi

Brief Summary: Systematic field and laboratory studies on the distribution and behavior of heavy metals in mine tailings, surface soils, ground water and vegetables from the Khetri copper mining region of Rajasthan were carried out to understand the impact of copper mining on the immediate environment. The salient findings are physiochemical characteristics of tailings; nature, mineralogy and geochemical makeup of soils; behavior of heavy metals in tailings and soils; quality and chemical composition of waters; heavy metal abundances in several types of vegetables; probable source(s) of various elements in both water and soils in addition to the status of heavy metal pollution in the environment of the region.

Work experience

02-2019 to till date	Institute Postdoctoral Fellow at Department of Civil Engineering, IIT Guwahati
01-2019 to 02-2019	Guest faculty at Delhi Technological University, New Delhi. Taught Engineering geology, remote sensing and GIS.
08/2017 to 07/2018	Independent research scholar with Prof. PK Joshi, Jawaharlal Nehru University to learn the applications of remote sensing & GIS
01- 2011 to 02-2014	Worked as Assistant Director (Project) at International Academy of Environmental Sanitation & Public Health (Previously known as Sulabh International Academy of Environmental Sanitation & Public Health), Palam, New Delhi. Prepared proposals covering water and sanitation, training programmes on water, sanitation and hygiene (WASH), solid and liquid waste management etc for submission to Ministry of Drinking Water and Sanitation. Worked and handled pilot projects sponsored by WHO- India and played various roles such as surveys, data compilation and their analysis, organization of workshops, conducting training and other project related activities.
05-2010 to 09-2010	Worked at J.M. EnviroNet Pvt. Ltd., Gurgaon as an Environmental Scientist.

Awards and Achievements

1. Received **UGC-CSIR JRF** (Junior Research Fellowship) grant from University Grants Commission (UGC) in Earth, Atmospheric, Ocean and Planetary Sciences, during the time period of 01.01.2015 to 31.12.2016. The junior research fellowship (JRF) is awarded to the research scholar who qualify in the National Eligibility Test-Junior Research Fellowship (NET-JRF) conducted by the UGC and the UGC-Council of Scientific and Industrial Research (UGC-CSIR) joint test.

2. Received **UGC-CSIR SRF** (Senior Research Fellowship) grant from University Grants Commission (UGC) in Earth, Atmospheric, Ocean and Planetary Sciences, during the time period of 01.01.2016 to 12.12.2017.
3. Qualified UGC-NET in Environmental Sciences of December, 2013 and June, 2014
4. Qualified CSIR-UGC NET in Earth, Atmospheric, Ocean and Planetary Sciences of December, 2013
5. Qualified CSIR-UGC JRF in Earth, Atmospheric, Ocean and Planetary Sciences of June, 2014 (Availed)
6. Best poster in National Conference on Environmental Pollutants: Impact Assessment and Remediation (NCEPIAR), School of Environmental Sciences, JNU, New Delhi, 18-19th March, 2016
7. Received "*Gargi*" award from Government of Rajasthan during 2003 and 2004. The "*Gargi*" award is awarded to meritorious girls in the state of Rajasthan. The award money is given to girls those secured above 75% marks in the 10th and 12th examination conducted by the Board of Secondary Education, Rajasthan.

Publications

1. Joshi PK and Punia A* (2019) Thermal infra-red imaging to identify surface mines. *Mine Water and the Environment,* **38(3)**, 700-704.
2. Punia A and Siddaiah NS* (2019) Mobility and behaviour of heavy metals in copper mine tailings and neighboring soil at Khetri, India. *Mine Water and the Environment,* **38(2)**, 385-390.
3. Punia A, Siddaiah NS* and Singh SK (2017) Source and assessment of heavy metal pollution at Khetri copper mine tailings and surrounding soil, Rajasthan, India. *Bulletin of Environmental Contamination and Toxicology*, **99**, 633-641.
4. Punia A and Siddaiah NS* (2017) Assessment of heavy metal contamination in groundwater of Khetri copper mine region, India and health risk assessment. *Asian Journal of Water Environment and Pollution*, **14(4)**, 9-19.
5. Punia A* and Siddaiah NS (2019) Impact of Aravalli ranges and Thar desert on the distribution of major oxides in the soils of Khetri copper mine region. *Journal of Applied Geochemistry*, **21(2)**, 269-275.
6. Punia A and Siddaiah NS* (2017) Accumulation and Distribution of Heavy Metals in Vegetables of Khetri Copper Mine Region, Rajasthan. *International Journal of Innovative Research in Science Engineering and Technology,* **6(6)**, 11725-11732.

Communicated

1. Punia A (2018) Factors influencing the occupational health hazards of mine workers: A Review. Under Review
2. Punia A, Joshi PK and Siddaiah NS (2018) Characterizing Khetri copper mine environment using geospatial tools. Under Review

3. Punia A (2019) A review on scope of bioremediation and phytoremediation of mine tailings. Communicated

Papers presented at conferences

1. Punia A and Siddaiah NS (2017) "Copper: From Ore to Environment at Khetri, Rajasthan". National Conference on Environmental Pollutants: Impact Assessment and Remediation (NCEPIAR), School of Environmental Sciences, Jawaharlal Nehru University, New Delhi, 29th March, 2017 **(Oral)**
2. Punia A and Siddaiah NS (2017) "Accumulation and distribution of heavy metals in vegetables of Khetri copper mine region, Rajasthan". National Seminar on Recent Advances in Environmental Toxicology, Department of Biosciences, Jamia Millia Islamia New Delhi, 13-14th February, 2017 **(Oral)**
3. Punia A and Siddaiah NS (2016) "Toxicity of copper tailings over a time period: A case study form Khetri, Rajasthan". International Conference on Strategies for Environmental Protection and Management, JNU, New Delhi, 11-13th December, 2016 **(Poster)**
4. Punia A and Siddaiah NS (2016) "Abandoned mines and their environmental risk: A case study from Khetri, Rajasthan". National Conference on Environmental Pollutants: Impact Assessment and Remediation (NCEPIAR), JNU, New Delhi, 18-19th March, 2016 **(Poster)**
5. Punia A, Siddaiah NS and Singh SK (2015) "Geochemistry and grain size distribution of copper mine tailings, Khetri Rajasthan and its impact". National Seminar on Past and Present Geochemical Processes Impacts of Climate Change, Jawaharlal Nehru University, New Delhi, 22-23rd December, 2015 **(Poster)**

Training programs

11-12-2017 22-12-2017	to	GIAN (Global Initiative For Academic Network) course on "Dendrecology: Application of Tree-Ring Analysis to Ecological Science"
01/2010 05/2010	to	Four months major project on "Adsorption properties of red mud and bagasse fly ash" at The Energy and Resources Institute (TERI), New Delhi
24-05-2009 25-07-2009	to	Two months minor project on "Trend analysis of Meteorological Data- A case study" by using Kendall, Mann Kendall and S-Rho models at National Institute of Hydrology (NIH), Roorkee.
8-10-2012 10-10-2012	to	Training programme on "Social Impact Assessment" organized by Centre for Science and Environment (CSE), New Delhi

Hands on Software

ArcGIS	ERDAS
R	SPSS
SigmaPlot	Aquachem
Grapher	X'pert highscore
ENVI	Corel Draw

Memberships

Life member of Indian Society of Applied Geochemists (ISAG) (Member ID 589)

Member of European Association of Geochemistry, France (Member ID 2019-0173)

Introductory student member of Geochemical Society, Washington (Member ID 208131)

Extra-Curricular activities/Workshops

Participated in the Naipunya Workshop for researchers on 23rd February, 2017.

Participated in National Science Day (2017) held on 28th February, 2017 at Convention Centre, Jawaharlal Nehru University, New Delhi.

Participated in Yoga Workshop from 17th to 20th June, 2016 and in the International Day of Yoga on 21st June, 2016.

Volunteered in conference Tropical Ecology congress: Tropical Ecosystems in a changing World, held during 10-12th December, 2014 at School of Environmental Sciences, Jawaharlal Nehru University, New Delhi.

Won 3rd prize at HDJ Ram Shishu Sadan Senior Secondary School, Pilani, Rajasthan in "Bhartiya Sanskriti Gyaan Pariksha, 2001" organized by International Gayatri Parivaar, Haridwar.

Raised funds for the purpose of the education and other programme for needy girl child organized by the "Help Care Society", New Delhi, 1997 at School JLNCA, Pilani, Rajasthan.

Anita Punia, PhD

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TECHNICAL COMMUNICATION

Thermal Infrared Imaging to Identify Surface Mines

P. K. Joshi[1] · **Anita Punia**[1]

Received: 8 January 2019 / Accepted: 5 August 2019 / Published online: 13 August 2019

Abstract
Mines show spectral resemblance with other landscape features; hence, their identification with satellite imagery can be difficult. To address this, land surface temperature (LST) derived from thermal infrared images of satellite remote sensing data was used to differentiate mines. Higher surface temperatures were observed for mined land than other classes (built-up and fallow land) in nighttime data. This indicates that the increased surface temperature of the other classes is due to solar heating while geothermal and pyrite oxidation contribute warmth at mined sites. Nighttime LST can be used to locate mines and their spatial extent despite the low spatial resolution of satellite data. It also confirms a mine's heat island phenomenon due to geothermal energy.

Keywords Geothermal energy · Land surface temperature · Remote sensing · Renewable energy

Introduction

Mining and its impacts is a global environmental issue (Hudson-Edwards 2016). The extent of mining's adverse environmental impacts depends on the magnitude of ore extraction and waste management strategies. Spatial tools including remote sensing are widely used to monitor and map mined land and its surrounding environment (Rathore and Wright 1993). However, the spatial resolution of satellite data often poses challenges in mapping small, inactive or abandoned mines.

Mine water in abandoned and operating mines are recognized as a potential source of geothermal energy (Hall et al. 2011; Watzlaf and Ackman 2006). Identification of these sites is important for the potential establishment of geothermal energy extraction infrastructure. Geothermal energy is a renewable energy source that can be used for heat production (Banks et al. 2019) and electricity generation (Clauser 2006). Among renewable energy sources, geothermal energy is considered to be one of the most promising options due to its relatively low pollutant emissions and energy generation cost (Popiel et al. 2001).

The spectral resolution of satellite data can help identify surface mines often missed due to spatial resolution and the heterogeneity of the mining landscape. For this, indices such as normalized difference water index [NDWI = (green − NIR)/(green + NIR)] (McFeeters 1996), normalized difference vegetation index [NDVI = (NIR − red)/(NIR + red)] (Rouse et al. 1973), bare soil index {BSI = [(SWIR + R) − (NIR + B)]/[(SWIR + R) + (NIR + B)]} (Li and Chen 2014), and normalized difference built-up index [NDBI = (SWIR − NIR)/(SWIR + NIR)] (Zha et al. 2003) are used to distinguish water bodies, vegetation, barren land, and built-up land, respectively. Developing a spectral index for identification of surface mines is difficult as their spectral signature is similar to areas with low moisture and vegetative cover, such as barren and built-up land.

Mining leads to loss of vegetation and soil moisture, increasing ambient and surface temperatures. Thus, remotely sensed spectral data captured in the thermal infrared (TIR) band can assist in identifying and mapping mining landscapes. Additionally, the feasibility of mine water for geothermal energy can be assessed. With this premise, we have used the TIR imaging capability of Terra Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) satellite data to identify surface mines in the Aravalli ranges of Rajasthan and their geothermal energy potential. These ranges are famous for sulphide mineralization, and surface and underground mines. An active surface mine

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TECHNICAL ARTICLE

Mobility and Behaviour of Metals in Copper Mine Tailings and Soil at Khetri, India

Anita Punia[1] · **N. Siva Siddaiah**[1]

Received: 22 February 2018 / Accepted: 22 December 2018 / Published online: 3 January 2019

Abstract

The mobility and behaviour of metals (Cu, Zn, Ni, Cr, and Pb) in mine tailings and neighbouring soils were studied in the Khetri copper mine region, Rajasthan, India. Single reagent extraction was used to assess the mobility and availability of metals, while sequential chemical fractionation (water soluble, acidic, and reducible) was used to evaluate their behaviour in the environment. Samples were divided into two different physical grain size fractions to assess the impact of grain size on extraction. The mobility trend in both tailings and soil followed the order Ni > Zn > Cu. Metals of lithogenic origin (Cr and Pb) were less extracted in the water soluble fraction or non-residual fractions than those associated with mining. The acid leachable fraction was high in the tailings due to the presence of sulphide minerals. Hence, acidification of tailings would enhance leaching of metals. Results of single and sequential chemical extraction indicate that the Cu, Zn, and Ni are anthropogenic, as they were mostly associated with the non-residual fraction of the soil.

Keywords Single reagent extraction · Sequential chemical fractionation · Major oxides · Khetri copper mine

Introduction

Metal-rich tailings and waste dumps are susceptible to dispersal by wind and water, and can contaminate the environment with metals (Lee et al. 2001). In the presence of water and oxygen, sulphides present in the tailings and overburden can generate acid mine drainage (AMD), leading to acidification and leaching of metals. Assessment of total concentrations of metals is not sufficient for environmental studies because their potential availability is also important. Single reagent extraction and sequential fractionation of metals are commonly used to assess availability, and to identify the mobile pollutant pool (source) in soil and sediments (Tack and Verloo 1991; Ure 1996). For pollution studies, sequential fractionation must be carried out to assess the potential bioavailability of metals (Ma and Rao 1997; Khorasanipour et al. 2012; Moore and Aghazadeh 2012).

The mobility and behaviour of metals near copper mines has been studied in different parts of the world (Hansen et al. 2005; Ramirez et al. 2005; Giri and Singh 2017). The present study was carried out in the Khetri region, which is located in the state of Rajasthan, India, and has been famous for copper mining since historical times. The region lies in a semi-arid part of the country (Fig. 1a). The altitude of the study area is 550 m above mean sea level, with a geographic location of latitude N 28°04.070′ and longitude E 75°49.294′. The mean annual rainfall in the region is around 500 mm. In summer, the temperature ranges from 12 to 45 °C and during winter, it ranges from 2 to 25 °C.

Mining is currently going on at Banwas, Madhan-Kudhan, and Kolihan. Banwas and Kolihan have more than 70 Mt of ore with 1.14–1.7 wt% Cu, while Madhan-Kudhan contains 66 Mt of ore with an average of 1.12–1.71 wt% Cu (Knight et al. 2002). Chaandmari is an abandoned surface mine near the Kolihan mines. Agricultural and residential areas are present in the immediate vicinity of the Khetri mines. Geologically, the rocks are garnet-chlorite-amphibole schists, andalusite—and graphite-bearing biotite schists, phyllites, and amphibole or feldspathic quartzites, folded into regional synclines and anticlines (Das Gupta 1968).

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s10230-018-00582-1) contains supplementary material, which is available to authorized users.

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Source and Assessment of Metal Pollution at Khetri Copper Mine Tailings and Neighboring Soils, Rajasthan, India

Anita Punia[1] · **N. Siva Siddaiah**[1] · **Saurabh K. Singh**[1]

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Abstract We present here the results of the study on metal pollution by identifying source, abundance and distribution in soil and tailings of Khetri copper complex (KCC) mines, Rajasthan India. The region is highly contaminated by copper (Cu) with higher values in the soil near overburden material (1224 mg/kg) and tailings (111 mg/kg). The average Cu (231 mg/kg) concentration of soil is ~9, 5 and 32 times higher than upper crust, world average shale (WAS) and local background soil (LS), respectively. However this reaches to ~82, 46 and 280 times higher in case of tailing when compared. The correlation and principal component analysis for soil reveals that the source of Cu, Zn, Co, Ni, Mn and Fe is mining and Pb and Cd could be result of weathering of parent rocks and other anthropogenic activities. The source for Cr in soil is both mining activities and weathering of parent rocks. The values of index of geo-accumulation (I_{geo}) and pollution load index for soil using LS as background are higher compared to values calculated using WAS. The metal rich sulphide bearing overburden material as well as tailings present in the open environment at KCC mines region warrants a proper management to minimize their impact on the environment.

Keywords Metal sources · Principal component analysis · Pollution load · Khetri copper complex mines · Rajasthan · India

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Metal contamination is a major concern of the present time due to its persistence in the environment and human health risks. Industrialization, urbanization and mining activities along with agricultural activities lead to metal contamination of soils. Among these, the effect of mining activities is one of the most dangerous depending on the metal being mined (Krishna et al. 2013). Metals present in the soil are easily accumulated by the crops and directly impact the human beings (Chen et al. 1999; Tripathi et al. 1997). Metals such as Cu, Fe, Mn, Zn and Ni plus Cr are essential for organism's growth, while Cd and Pb are not essential biologically but cause adverse health impacts like renal failure, liver damage and chronic toxicity in the humans (Sathawara et al. 2004). Hence understanding the abundance of metals, identification of their source and assessment of dispersal paths are important to monitor and minimize the impact on environment and human health.

Metal contamination of soil due to copper mining is well reported by many researchers from different parts of the world (Qin et al. 2012; Rastmanesh et al. 2011; Gómez-Álvarez et al. 2011; Meza-Figueroa et al. 2009; Wang et al. 2004; Ali et al. 2004). In India, very little is known on the soil pollution due to copper mining (Pandey et al. 2007). The Khetri copper complex mines located in north-western India are active for the last several decades and generated large quantities of sulfide rich tailings and overburden materials. Approximately 25,000 tons/year of tailings are being generated and dumped in the open area at Khetri (Mishra et al. 2008). Yadav and Rajamani (2003) suggested KCC mines as the source for the observed higher concentrations of Cu (0.39 μg/m^3) in the aerosols of Delhi.

As per the available literature, no systematic study has been carried out to understand the abundance and distribution of metals in mine tailings and soils of the region. This makes it more important to investigate, document and report

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Assessment of Heavy Metal Contamination in Groundwater of Khetri Copper Mine Region, India and Health Risk Assessment

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Received May 1, 2017; revised and accepted August 23, 2017

Abstract: The present study determines the abundance of heavy metals (Cu, Zn, Fe, Ni, Co, Mn and Pb) in the groundwater (pre and post monsoon) of the Khetri copper mine region, India and evaluates the pollution indices and risk assessment to assess the suitability of groundwater for human consumption. In majority of the groundwater samples, the concentration of heavy metals exceeds the desirable limits set by WHO, 2011 and Bureau of Indian Standards (BIS), 2012, whereas, average Fe concentration is 1.65 and 1.9 ppm during pre and post monsoon season respectively, which is above the BIS permissible limit (0.3 ppm) probably due to oxidation of iron-rich sulfides. Principal component analysis (PCA) and correlation matrix indicate a common source i.e. anthropogenic activity (mines) for Cu, Co, Ni and Mn. The calculated pollution indices namely contamination index (CI) and index of environmental risk (I_{ER}) for the heavy metals suggest that majority of the studied groundwater samples are in the slightly contaminated zone. However, a few of the samples close to mines, overburden rocks and tailings fall in the highly contaminated zone indicating their unsuitability for drinking purposes. The calculated hazard quotient for non-carcinogenic health effects is in the acceptable limit for all the groundwater samples except samples from Chaandmari (an abandoned mine), while the Health Index (HI) is in the medium range for all the samples barring a few samples.

Key words: Heavy metals, groundwater, Khetri copper mines, pollution indices, risk assessment.

Introduction

Sulphide-rich waste generated from mining activities is one of the major causes for deterioration of environment. (Fergusson, 1989). A study by Nasrabadi (2008) on groundwater surrounding the Sungun open cast copper mine in Iran shows concentrations of Fe and Al higher than the permissible limit prescribed by US Environmental Protection Agency (EPA). Bech et al. (1997) reported high concentrations of As and Cu in soil and plants around the Andes copper mine of Northern Peru.

Amari et al. (2014) found heavy metal (Cu, Fe, Pb, Cd, Zn, Co, Cr, Ni, Se and As) concentration in the groundwater from the Kettara mine area within the acceptable limits of Italian Standards, despite relatively higher concentrations of heavy metals in Acid Mine Drainage (AMD) of the mine tailings. The observed low abundances of heavy metals in the groundwater were attributed to dry climatic condition which inhibits the metal mobility (Amari et al., 2014).

In India, copper is being mined extensively since historical times at Khetri in the state of Rajasthan in north western part of the country. In the process, huge

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IMPACT OF MINES AND THAR DESERT ON THE DISTRIBUTION OF MAJOR OXIDES IN THE SOILS OF KHETRI COPPER MINE REGION

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Abstract

The present study was carried out to assess distribution of major oxides in the soil of Khetri Copper Mine region which lies in close proximity to Aravalli Ranges and the Thar Desert. Major oxide geochemistry of soil shows similarity with both parent rock and the loess of the Thar Desert soil. Wide variation in Loss on Ignition (LOI) indicates the presence of different types of soils such as sediments and aeolian in the region. Average FeO content is found to be higher compared to Upper Continental Crust (UCC) and the World Average Shale (WAS), indicating the abundance of either pyrite or an pyrrhotite or an impact of mine activity. A-CN-K diagram has confirmed the close resemblance of soils with WAS and loess. A-CNK-FM indicates the presence of both felsic and mafic rocks in the region. Negative correlation of SiO_2 with Al_2O_3, P_2O_5, TiO_2, FeO and MnO confirms the origin of soils due to weathering of the parent rock. Calculated weathering indices such as the chemical index of alteration (CIA) and chemical index of weathering (CIW) indicate moderate weathering in the region compared to UCC. The study confirms significant impact of mines and the Thar Desert as well on the distribution of major oxides in this semi-arid region.

Keywords: Soil; Major oxides; Geochemistry; Weathering; Khetri Copper Mines.

1. Introduction

Soil is an essential component for human being's survival. It is important to maintain the quality of a soil for the survival of human beings. The chemical composition or geochemistry of soil is majorly controlled by weathering intensity (Nesbitt et al. 1980; Nesbitt and Young 1989; Condie et al. 1995). During weathering, the mobile elements get leached out from the parent rock or are depleted while the immobile elements either remain or get enriched. The soils formed from felsic and mafic rocks have different geochemical properties. The soils formed from felsic rocks have high silica content and less Fe while vice-versa is true for mafic rocks.

In semi-arid regions, aeolian process plays an important role in adding the new material to the soil (Amundson, 2005) and deserts are normally dust sources (Smalley and Krinsley 1978). Loess deposits are composed of silt size particles and are accumulated by wind blown dust (Pye 1995). Aeolian and loess deposits are as important as the parent rock to understand the geochemistry of the region. Additionally, mines are active in the region of this study and they have significant impact on soil geochemistry. Thus it is important to study the geochemical characterics of the soils derived from mines, aeolian processes and the Aravalli Ranges. Understanding the geochemistry of a soil in a mining region is important for monitoring and assessment of its quality.

Presence of the Aravalli Ranges and the close proximity to Thar Desert entails geochemical assessment of soils of Khetri region. Additionally, the study region being mining activity dominated and the presence of sulphides in the region appear to have influenced the geochemistry of soils. Hence, the present study is carried out to understand the impact of mines and loess from Thar desert on major oxides distribution in the soil of Khetri Copper Mine region.

2. Study Area

Khetri Copper Belt (KBC) is known for mining since historical times. It is located 550 m above mean sea level in the geographic location latitude N 28°04.070′ and longitude E 75°49.294′. Temperature shows wide variation during day and night. During summer temperature varies from 12 to 45°C and in winter it is from 2 to 25°C. It lies in a semi-arid region of the country with a mean annual rainfall of around 500 mm. During summers, in the month of May and June strong dusty wind blows in the region from the N-W and S-W directions.

Geologically, the NW-SE transverse Kantli Fault separates the Khetri Belt into northern and southern parts