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Groundwater Quality of Khetri Block of Jhunjhunu District, Rajasthan, Northwest India

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Abstract: ***Groundwater quality is affected in the semi-arid region of northeastern part of Rajasthan. Hydro-chemical analysis is carried out with an aim to identify fresh and contaminated groundwater zones. Mining is a definitive factor in a country's economy. Mining is an economically beneficial activity, generating jobs and opportunities in the local area. Mining activities occur in less than 0.01% of the continental area and directly contribute~5-7% of global GDP (Gross Domestic Product). Here we take an example of the Khetri copper mining complex, located in Khetri copper belt, consisting a smelter complex, multiple occurrences and various deposits over time and studied basic water quality parameters viz. Cl^-, F^-, pH, TDS of the Khetri tehsil, Jhunjhunu District, Rajasthan a proxy for identifying potential groundwater site influenced by the complex. It is important that the effect of mining activities on groundwater is regularly monitored, so that any conditions caused be remedied.***
Keywords: Groundwater, copper, groundwater, Khetri, phytoremediation, Rajasthan

I. INTRODUCTION

The north-western part of India is a semi-arid zone. It forms an ephemeral system consisting of various seasonal rivers in the Khetri block (Shekhawati river basin and Kharkhada river, and, Sukh River). Flora, fauna, civilization, and, industry in the area is strongly dependent on groundwater as it remains a primary resource. The Khetri mining complex consists of various deposits and occurrences of copper. A copper smelter also existed till the year ~2008, but, is now inoperative. The Khetri area consists of greater than 50% of copper reserves of India. Its presence also ranks Rajasthan second in copper production after Madhya Pradesh. [1] The average annual rainfall is ~560 mm. The Khetri block has an approximate groundwater availability of ~25.62 million cubic meters (MCM), whereas, ~26.79 MCM of water is required for agriculture, 7 MCM domestic and ~1 MCM is required for industrial use. The Khetri block in the Jhunjhunu district is overexploited in groundwater. [2]

II. GEOLOGY AND HYDROGEOLOGY OF THE STUDY AREA

A major part of the block, covered by the rocks of Delhi Supergroups and later intrusive. Delhi supergroups represented by quartzite, marbles, schists, and phyllites of Alwar Group and quartzite, mica-schist, gneiss, assemblage of succeeding Ajabgarh Group, they have been intruded by amphibolite, granite and rhyolite, which is considered to have provided material for base-metal mineralization in the considered area. Copper deposits are located in various places viz. Kolihan, Chandmari, Banwas, Madhan-Kudhan, Akwali, Satkui, Dholamala [3]. Some of this area is covered by recent to sub-recent blown sands. Delhi supergroup and post-Delhi intrusives are Quartzites, Schists, and, phyllites are mainly intruded by amphibolite, granite, pegmatites, and, quartz veins.

Table 1. Stratigraphy of the Delhi Supergroup [4]

Proterozoic	Intrusives	Malani Igneous Suite
		Erinpura Granite
		Godhra Granite
		Sendra Ambaji Granites
		Kishangarh Syenite
		Phulad Ophiolite Suite
	Delhi Supergroup	Ajabgarh Group
		Alwar Group
		Raialo Group

	Aravalli Supergroup	
Archean	Bhilwara Supergroup	

Main aquifers being quartzite and alluvium in the area, in a hydrogeological sense, the area is divided in three units these are younger, and, older alluvium (Quaternary), and quartzites (Alwar Schists and Phyllites of Delhi Supergroup). Groundwater occurs as either confined to semi-confined in aquifer conditions and also in fracture zones. The overexploitation of groundwater has resulted in lowering of the water table and depletion of aquifers.

Younger alluvium consists of unconsolidated to semi consolidated sand and laid-down deposits of silt, gravel, pebbles, boulders etc. the thickness of lithounits up to 50 m. older alluvium is also heterogenous assemblage of unconsolidated to loosely consolidated sand, silt, clay, and, kankar, which at places contain lenses of coarse sand and gravel. The thickness of older alluvium ranges between to 80-100m. this unit is brown to reddish brown loamy-fine, and generally non calcareous. physiochemical properties of these soils are generally moderate in nutrition status and poor to moderate in water holding capacity. [2] the hydrogeological map of the study area along with the boundary of the watershed areas is given in Fig. 1. The location of the Khetri copper mining complex is marked in all subsequent maps in star.

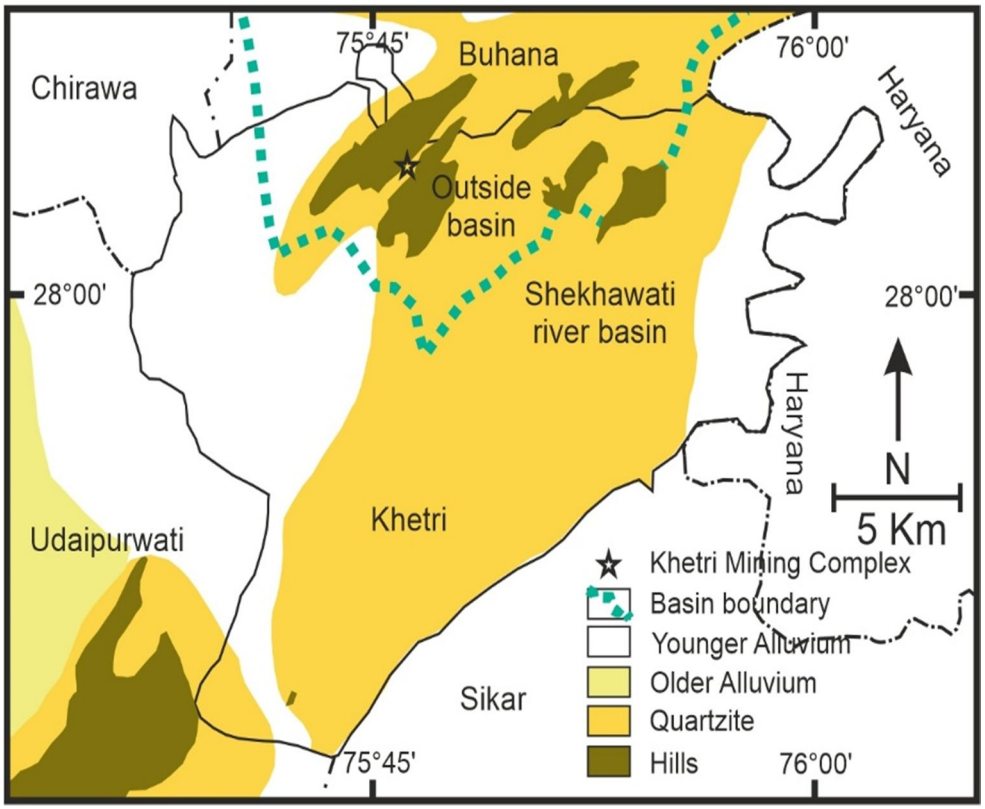

Fig. 1. Map showing the study area with hydrogeological units. Modified after [2]

III. GROUNDWATER QUALITY

Out of the 346 samples monitored, the groundwater quality in Khetri block of Jhunjhunu district, Rajasthan is generally classified as acidic and alkaline with a pH range from 4.8-8.5. a total of 13 samples out of 346 have a pH less than 7 which indicates acidic conditions which can be caused by mining activities and dissolution of copper, zinc, and other base metals present in the deposit or belt. A large bulk of the samples (330) shows pH greater than 7 which may be caused by the presence of weak basic salts [5]. The findings indicate the larger bulk of water samples are suitable for drinking and other purposes based on pH in accordance with World Health Organization (2011) [6] and Bureau of Indian Standards (2012) [7] water standards. Total Alkalinity ranges from 7.8-580 mg/L, alkalinity controls the dissolution of chlorine and fluorine in groundwater by dissolution. [8]

The distribution of pH and total alkalinity values in the Khetri block is observed in Fig 2 and Fig. 3.

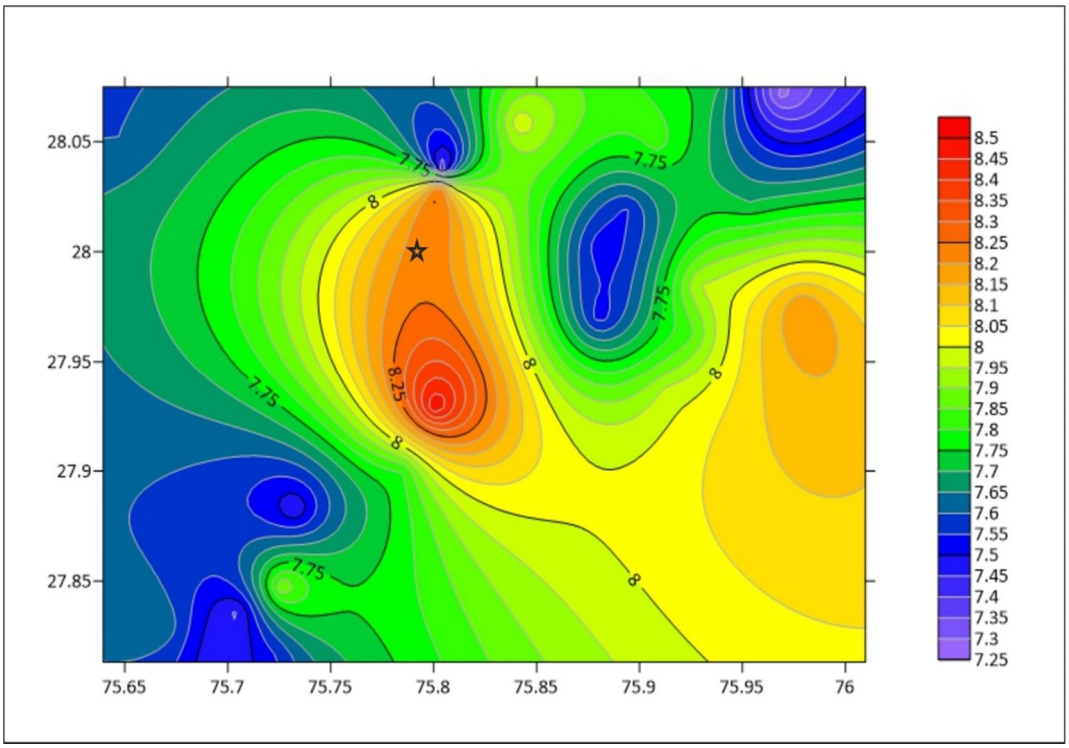

Fig. 2. pH spatial distribution in the Khetri block.

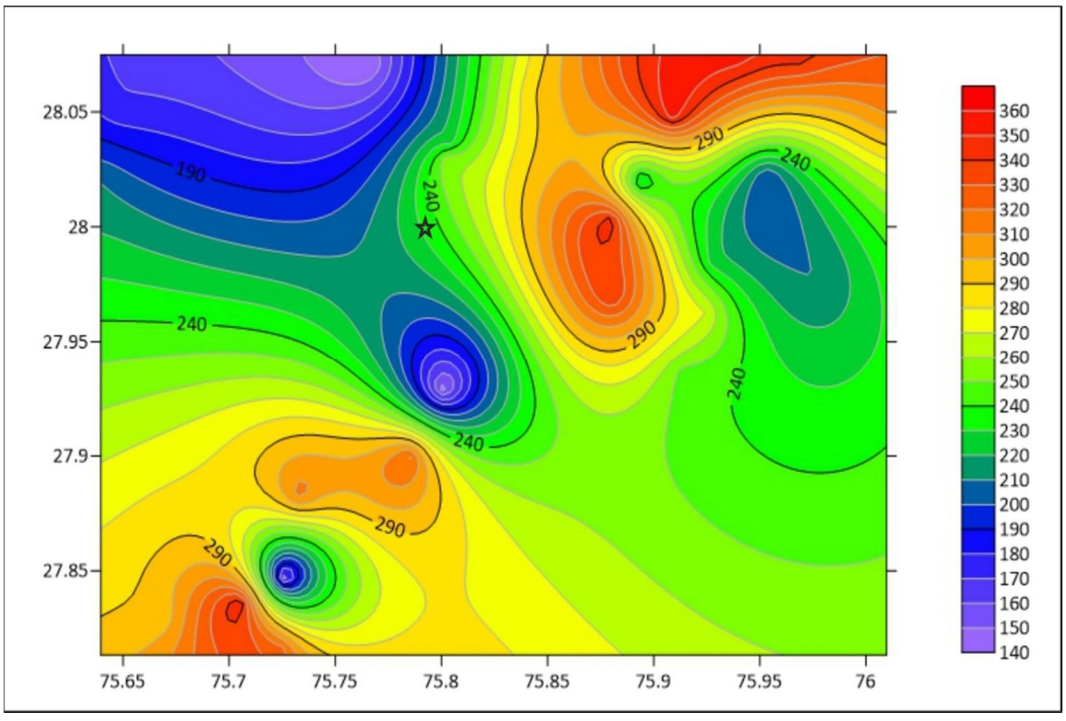

Fig. 3. Alkalinity spatial distribution in the Khetri block.

The total dissolved solids (TDS) values range from 280-2000 mg/L with the area averages being 921 mg/L. All the samples are in permissible limits. A total of 45 samples in the area is having TDS values less than 500 mg/L [6] which are acceptable limits so that the water is suitable for human, biological, and, industrial use. The distribution of TDS values in the Khetri block is observed in Fig 4.

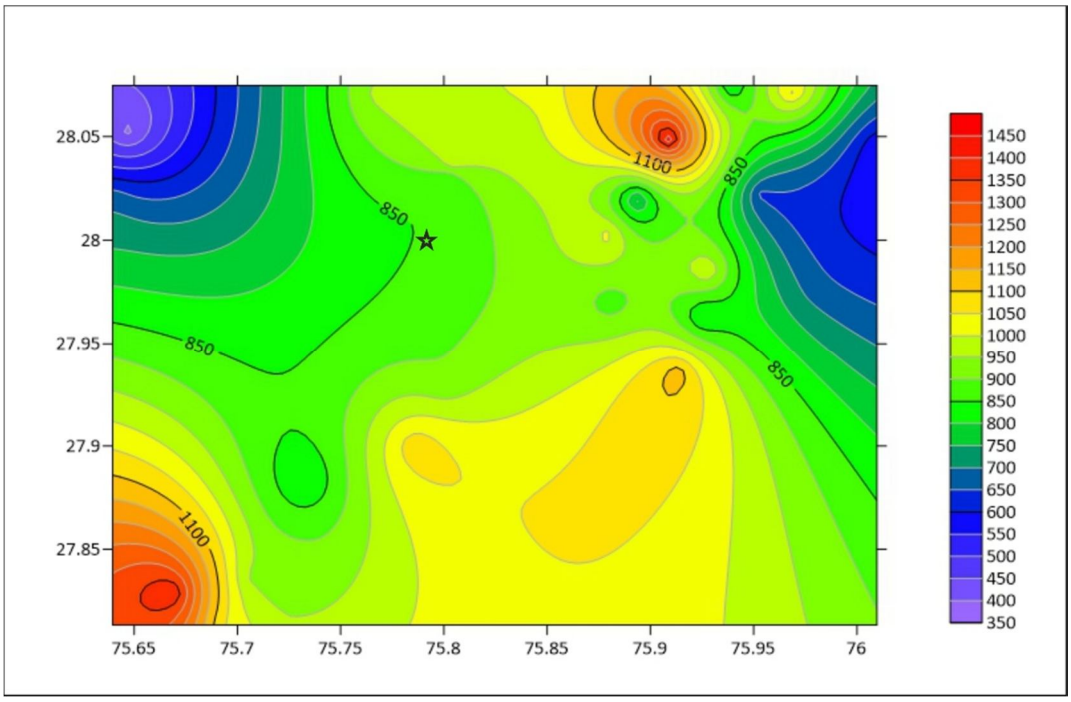

Fig. 4. TDS spatial distribution in the Khetri block.

The Electrical conductivity (EC) of groundwater typically ranges between 513 and 3636 micro-siemens/cm(μS/cm), indicating good to moderate quality in most places. The electrical conductivity of the water is proportional to the ions dissolved in them. The distribution of average electrical conductivity values in the Khetri block is observed in Fig 5.

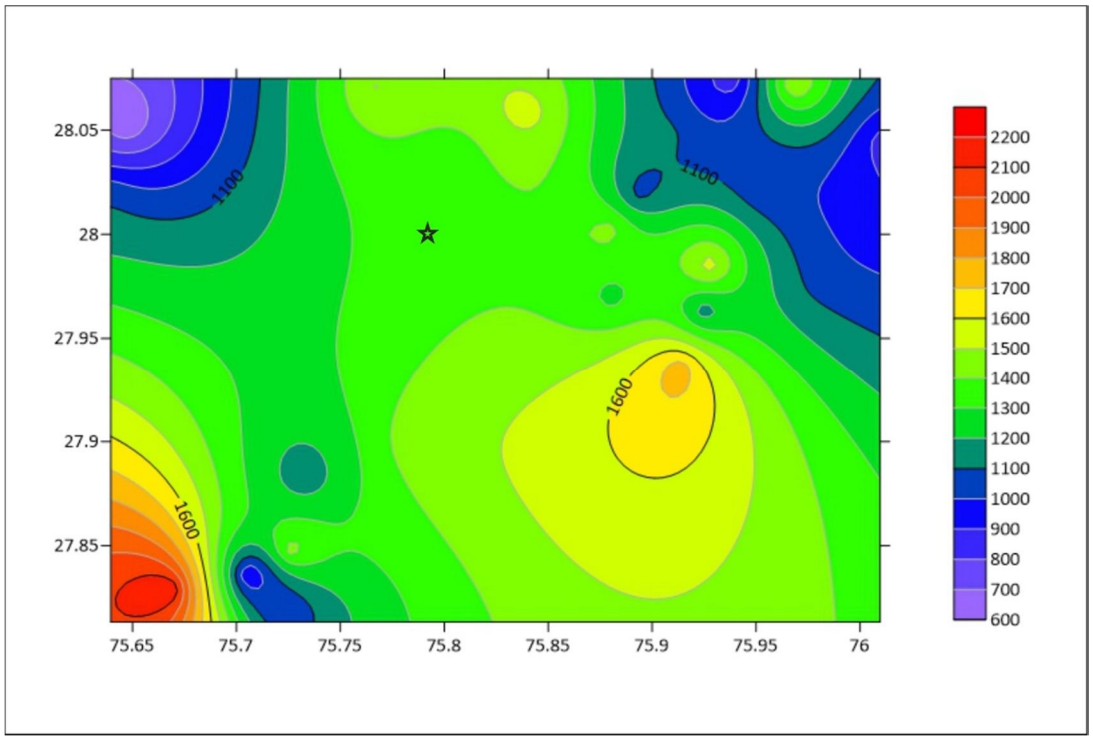

Fig. 5. Average electrical conductivity spatial distribution in the Khetri block.

WHO states the acceptable range of chloride groundwater ranges 200-500 mg/L, whereas fluoride limits acceptable 0.5 mg/L for drinking purposes and permissible limits to 1.5 mg/L [6] [7]. The chloride values range from 60-1000 mg/l. Of all the samples 39 samples show range of chloride ions greater than 500 mg/L. The fluoride values range from 0.1-1.5 mg/l with 133 samples falling the acceptable range. Chlorine and fluorine being present in apatite, amphiboles, micas are responsible for the increase in chloride ions by the process of dissolution. The intrusive rocks of post Delhi age area possible source for chlorine in the groundwater. Majority of samples again fall in the permissible limits. The distribution of chloride and fluoride values in the Khetri block is observed in Fig. 6 and Fig. 7 respectively.

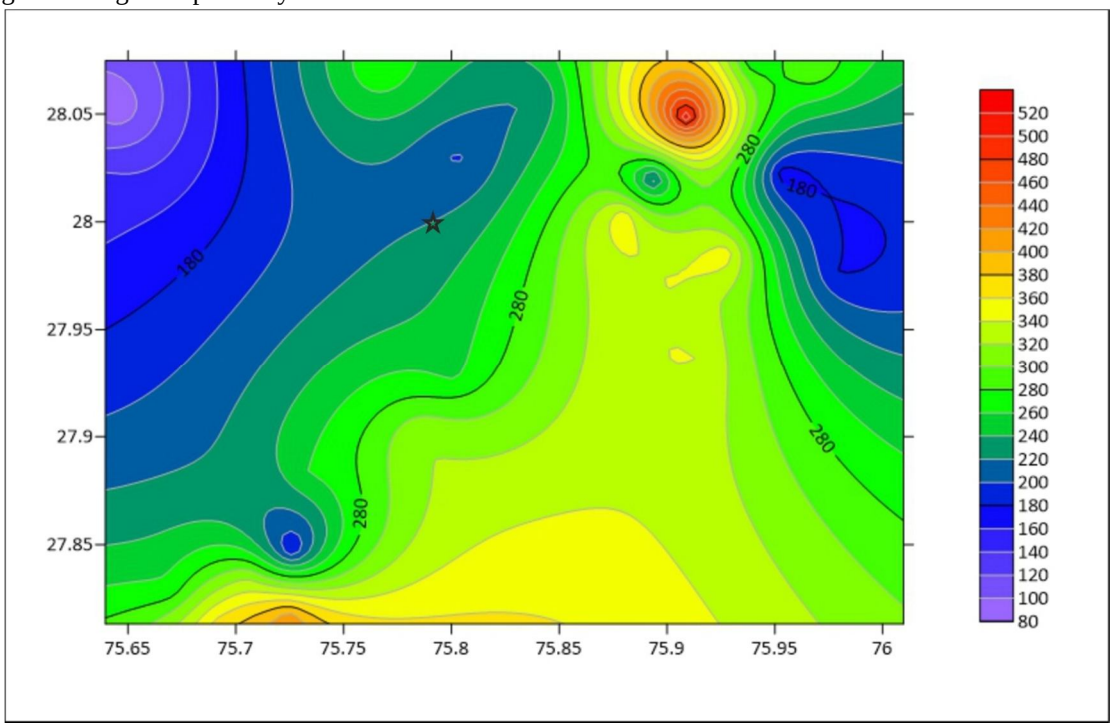

Fig. 6. Chloride spatial distribution in the Khetri block.

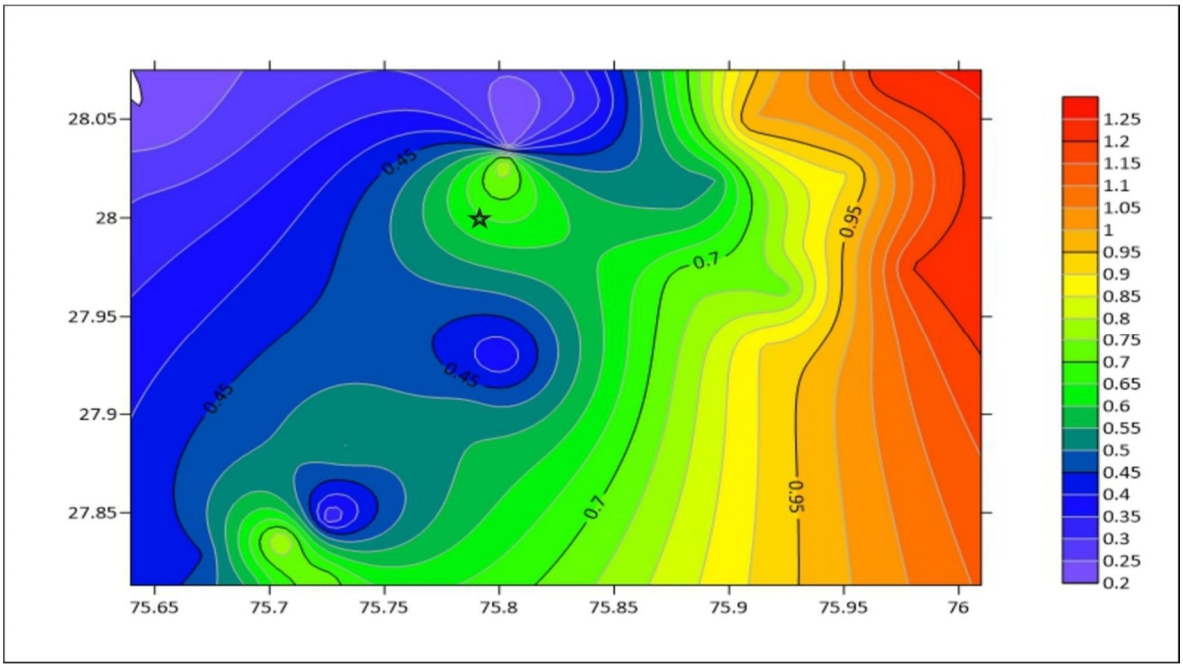

Fig. 7. Fluoride spatial distribution in the Khetri block.

IV. CONCLUSIONS

The groundwater is potable in major parts of the district including Khetri, except in certain isolated pockets where quality issues exist. There is no record of major water quality issues reported for the Khetri block, whereas some other blocks in the district which face fluoride and nitrate hazards.

The maximum values of chloride and TDS values and minimum values of total alkalinity in the area coincide to a point which is plotted in the Fig. 8. This indicates to accumulation of contaminated water and recharge in the outside basin (Fig. 1) As Khetri is a copper mining complex, possible phytoremediation methods include controlled plantation of *Plantago lancelota* and *Ricicus communis* for the phytoremediation of copper. [9]

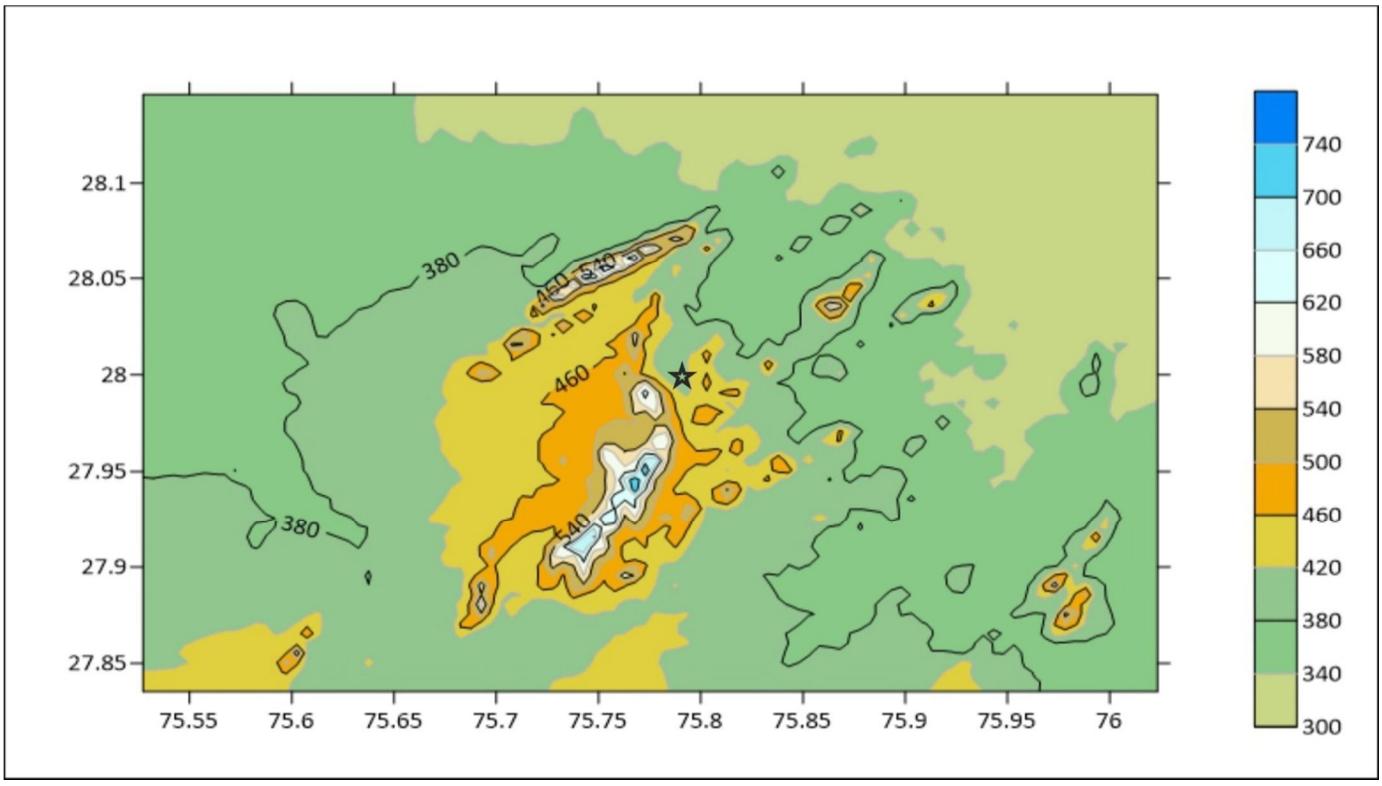

Fig. 8. General topography of the area showing location of maximum concentration values of Chloride and TDS

V. ACKNOWLEDGEMENT

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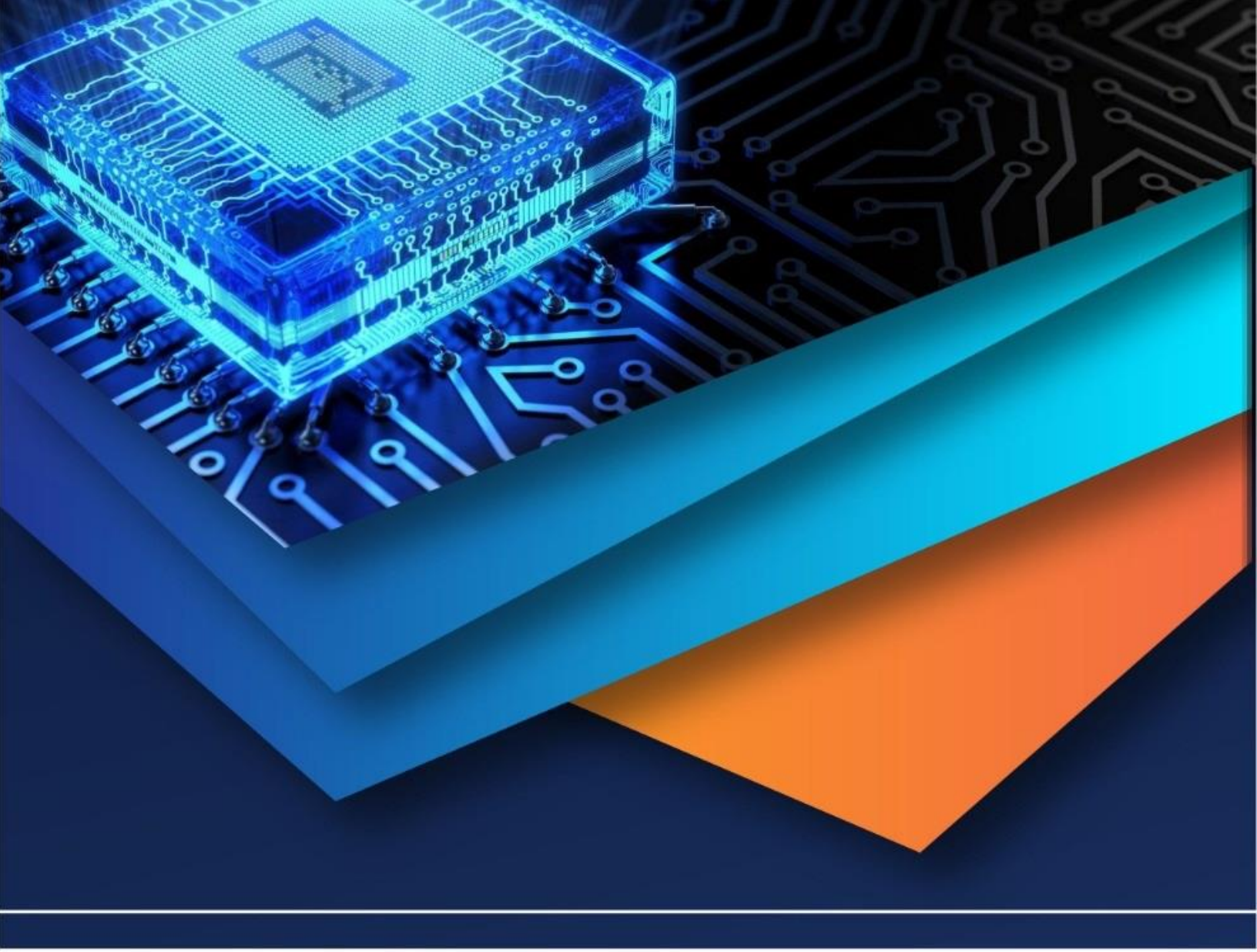

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