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PHENOMENAL CHANGES IN GROUND WATER POLLUTION CAUSED BY COPPER SMELTER AT KHETRI ZONE (INDIA) PART–II

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ABSTRACT

Looking for a rational approach for comparative study of various ground water samples taken from Khetri copper smelter zone at latitude 27° 58' and 28° 07' north and 75° 54' east longitude in survey of India topographical sheet No 44 P and 45 M shown in MAP No. 1, the results of 40 years of study show an increasing and very conclusive postulate in regards to the increase in conductivity, chloride, and sulphate. Total hardness and decrease in pH causing pollution, due to seepage of effluent or other relevant causes. Even recycling process is unable to check the increasing trends of above parameters.

Key words : Ground water pollution, Mining activity, Geology and Lithology, Seepage.

INTRODUCTION

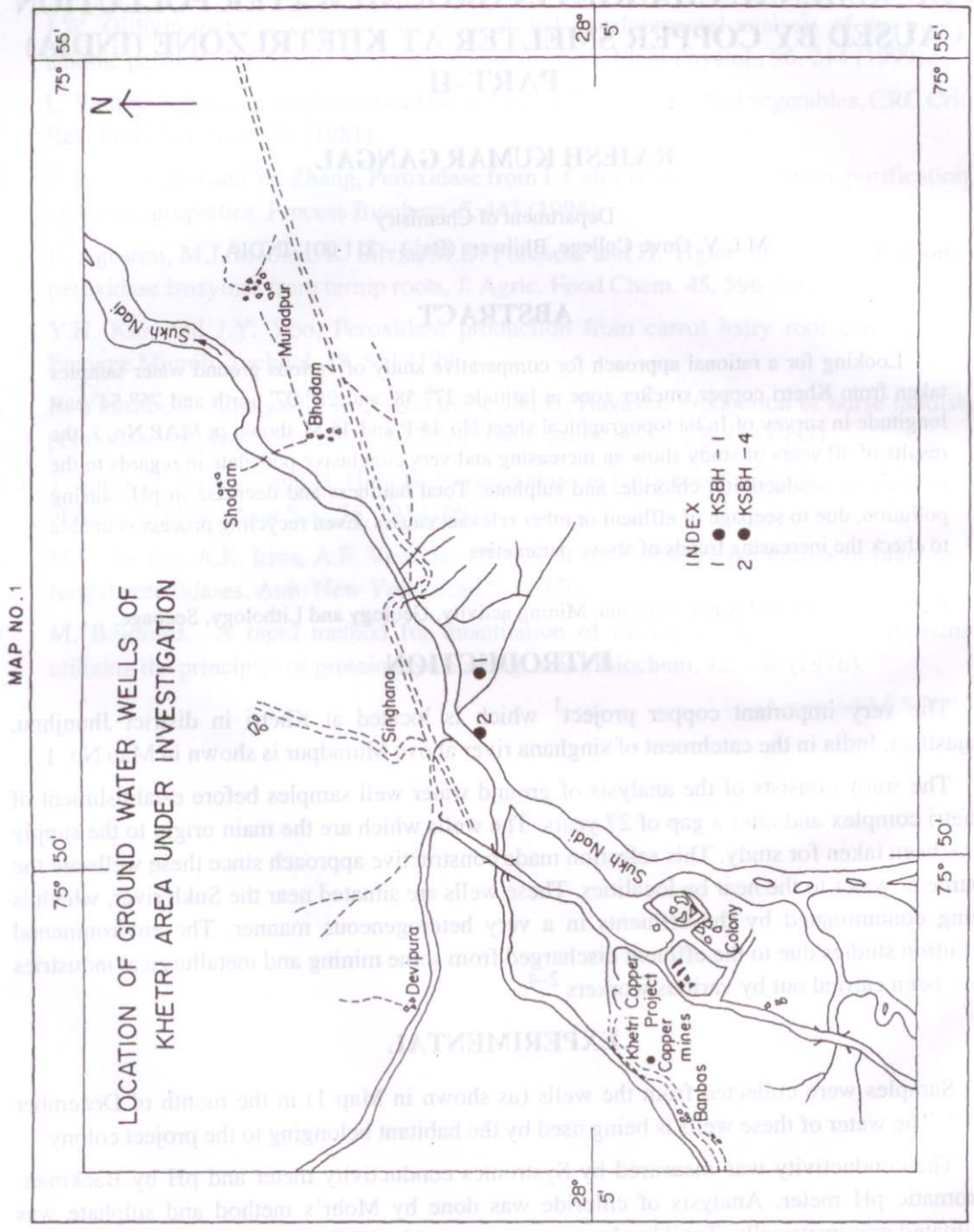
The very important copper project[1] which is located at Khetri in district Jhunjhnu, Rajasthan, India in the catchment of singhana river above Muradpur is shown in Map No. 1.

The study consists of the analysis of ground water well samples before establishment of Khetri complex and after a gap of 27 years. The wells which are the main origin to the supply have been taken for study. This selection made constructive approach since these wells are the source of water to the near by localities. These wells are situated near the Sukh river, which is being contaminated by the effluents in a very heterogeneous manner. The environmental pollution studies due to the effluent discharged from some mining and metallurgical industries have been carried out by various workers [2–4].

EXPERIMENTAL

Samples were collected from the wells (as shown in Map 1) in the month of December 2002. The water of these wells is being used by the habitant belonging to the project colony.

The conductivity was measured by Systronics conductivity meter and pH by Backman-zeromatic pH meter. Analysis of chloride was done by Mohr's method and sulphate was estimated gravimetrically. Total hardness was measured by EDTA titration methods[5].


MAP NO. 1
LOCATION OF GROUND WATER WELLS OF
KHETRI AREA UNDER INVESTIGATION
N
75° 55'
28° 5'
75° 50'
28° 5'
INDEX
1 ● KSBH - 1
2 ● KSBH - 4
Sukh Nadi
Muradpur
Bhodam
Shodam
Singhana
Devipura
Khetri Copper Project
Copper mines
Colony
Banbas

RESULTS AND DISCUSSION

The pollution has been examined on the following basis :

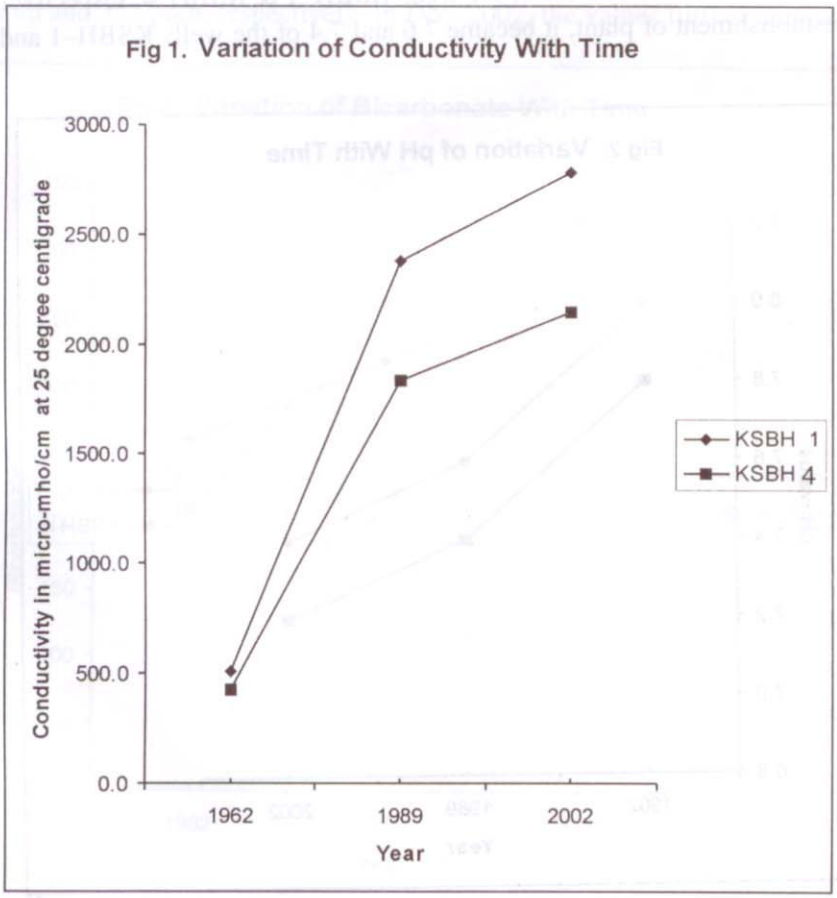
(a) Effect on Conductivity

On examining the Tables 1 and 2, it is observed that before the establishment of Khetri copper plant i.e. in 1962, the conductivities of water samples were 505 micro mhos/cm at 25°C of well No. KSBH–1 and 425 micro mhos/cm at 25°C of well No. KSBH No. 4, respectively as shown in Fig.1.

After 27 years of establishment of Khetri copper plant, fertilizer plant, sulphuric acid production plant, conductivity has increased to 2384 micro mho/cm at 25°C and 1839 micro mhos/cm at 25°C of the same well i.e. KSBH–1 and KSBH–4.

After 40 years (Dec. 2002) the conductivity increase of KSBH–1 and KSBH–4 wells was 2784 micro mho/cm at 25°C and 2148 micro mhos/cm, respectively (Fig. 1).

Fig 1. Variation of Conductivity With Time

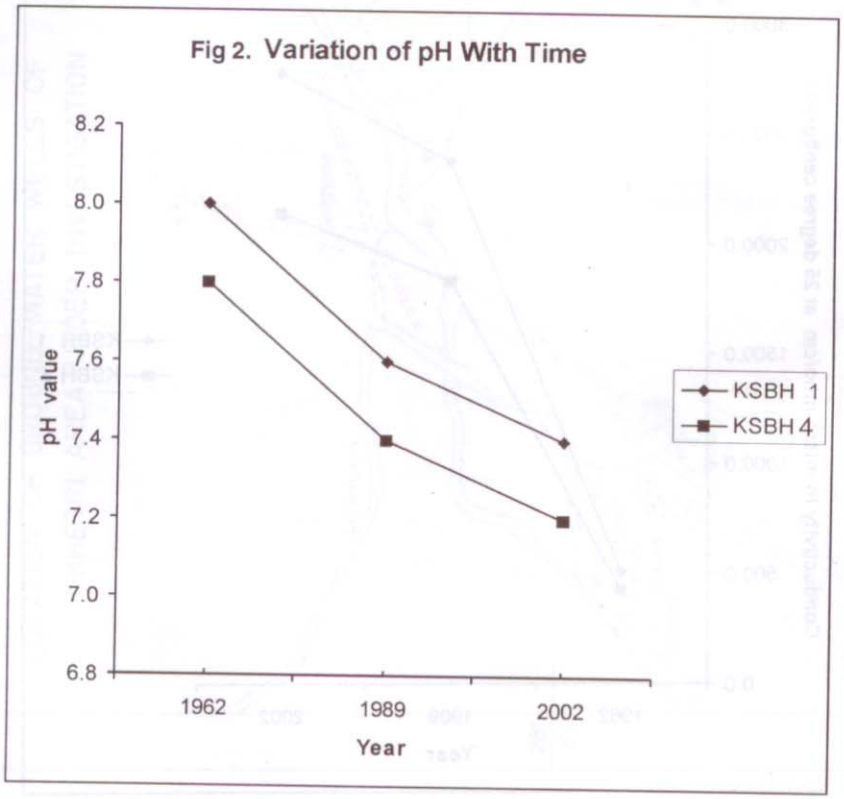


Consequently, this contamination in the ground water is only due to the presence of copper plant, fertilizer plant and acid generating plant in the vicinity of the area as well as the geological atmosphere in a very subjective way. Geology and Lithology[6] of the area have been seen by bore hole study. Drill holes show mineralisation starting near the contact of schist and amphibole rock and extending well into the later formation. Magnetic concentration in the amphibole rock increases towards the contact between amphibole rock and felspathic quartzite. Minerals in the area are Pyrite, Chalcopyrite and Pyrhotite occurring in schist and phyllite in an irregular network type.

As the lithology of the area is hosted by sand stone, granite and other minerals, chalcopyrite etc., Hence in due course of time, seepage of effluent originated from the plant source may ruin the originality of the area.

(b) Effect on pH

On examining the Table 1 and 2, it is observed that before the establishement of Khetri copper plant the pH were 8.0 and 7.8 of the wells KSBH–1 & KSBH–4, respectively and after 27 years of establishment of plant, it became 7.6 and 7.4 of the wells KSBH–1 and KSBH–4, respectively.



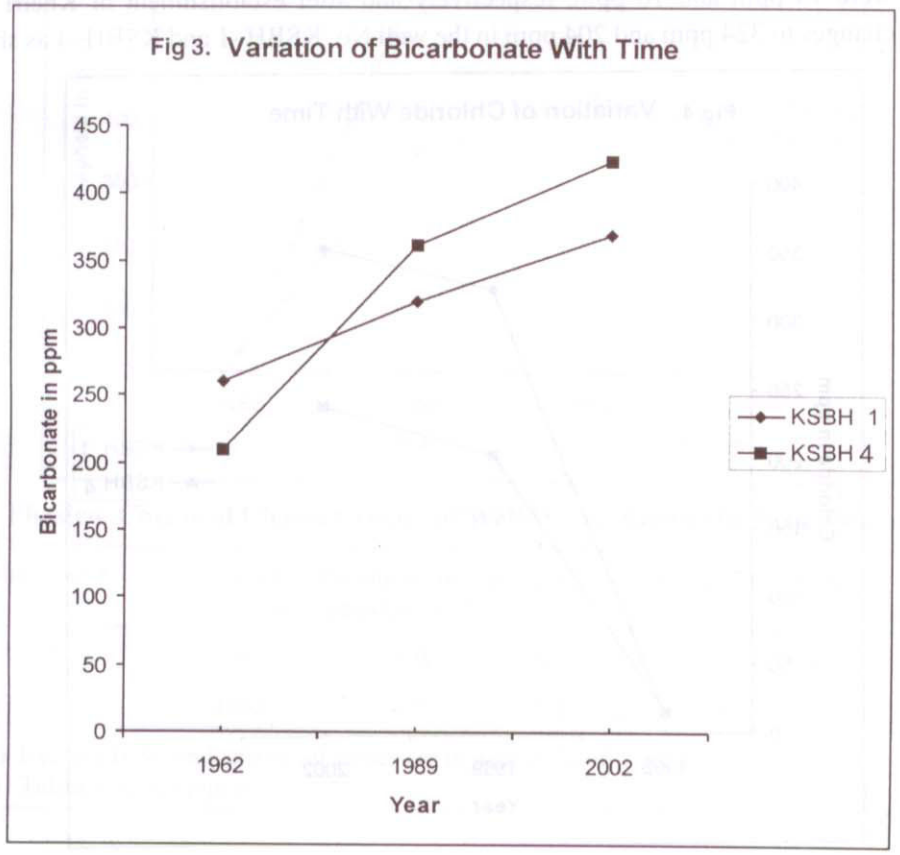
In Dec. 2002, the pH further decreased to 7.4 and 7.2 for KSBH–1 and KSBH–4, respectively. The most abundant reason could be that pyrites is exposed to the atmosphere and as a result, it is oxidized. In case of pyrite, sulphuric acid is released. This can pollute water through mine excavations, although not directly due to the mining activity itself but due to the disposal of wastes into abandoned quarres, gravel pits and strip mines, causing ground water pollution from leachetes.

Ground water pollution can occur as a result of loss of the leaching agent into the ground water system. Map 1 shows that both the wells are near the bank of the river 'Sukh' and effluent from plant is going directly into the river, hence through seepage pH is shifting towards acidic nature (Fig. 2). This is also confirmed by these results.

(c) Effect on Bicarbonate Concentration

The bicarbonate values in 1962 were 260 ppm and 210 ppm for the wells KSBH–1 and KSBH–4, respectively and after 27 years of establishment of Khetri copper plant, these values were 320 ppm and 362 ppm, respectively. In Dec. 2002, the values further increases upto 370

Fig 3. **Variation of Bicarbonate With Time**



and 400 ppm, respectively of wells KSBH–1 and KSBH–4 as shown in Fig. 3. The bicarbonates are predominantly present in fresh water and low salinity under ground water. Hard mineral[7] dissolves sparingly in water with ease. CO_2 dissolves in water (rain water) and it immediately dissociates to a number of inorganic compounds.

$$CO_2 \text{ (gas)} \rightleftharpoons CO_2 \text{ (dissolved)}$$

$$CO_2 + H_2O \rightleftharpoons H_2CO_3 \text{ weak carbonic acid}$$

$$H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$$

Bicarbonates is mainly derived from the leaching of lime stone, dolomite and marl as the water contains carbonic acid.

(d) Effect on Chloride Concentration

The chloride concentration changes dramatically as before the establishment of Khetri copper project that is in 1962. The values of chlorides of the two wells i.e. KSBH–1 and KSBH–4 were 14 ppm and 16 ppm, respectively and after establishment of Khetri copper project, it changes to 324 ppm and 204 ppm in the well No. KSBH–1 and KSBH–4 as shown in

Fig 4. Variation of Chloride With Time

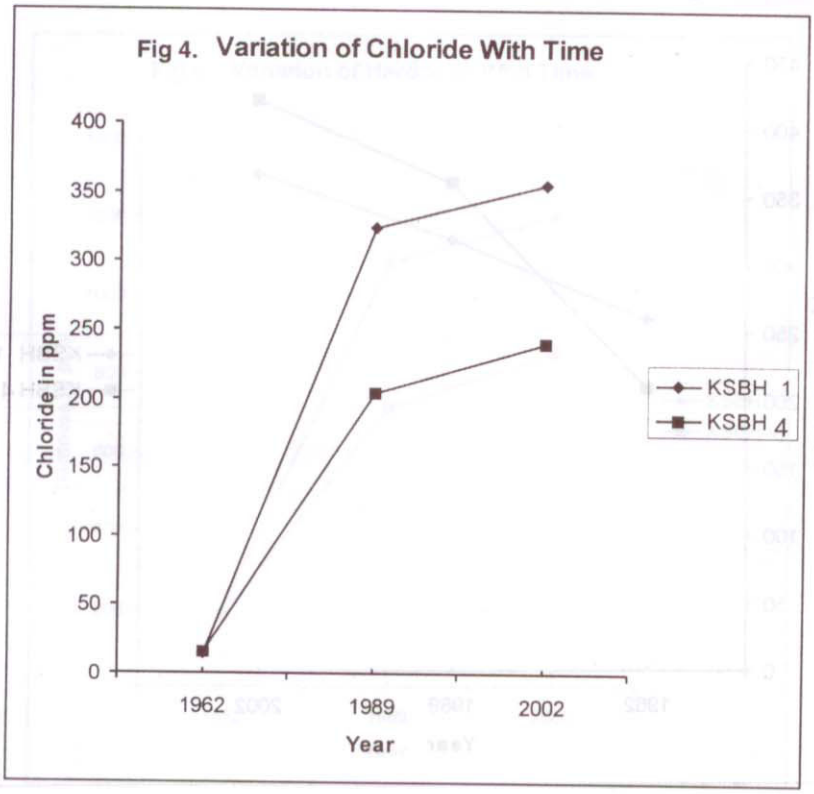


Fig. 4. In the year 2002 (Dec.), the chlorides concentration further increases to 356 ppm and 240 ppm of the wells KSBH–1 and KSBH–4, respectively.

These results show that due to copper smelter, sulphuric acid plant fertilizer plant, effluents like fumes of sulphuric acid along with the oxides of sulphur, hydrochloric acid, carbon dioxide etc. which gets precipitated in some or the other form with lapse of time.

From the lithological point of view, the chlorides present in micas could be the main reason for increasing chloride concentration due to interaction with acid granite (as it contains mica and micas are rich in chlorides).

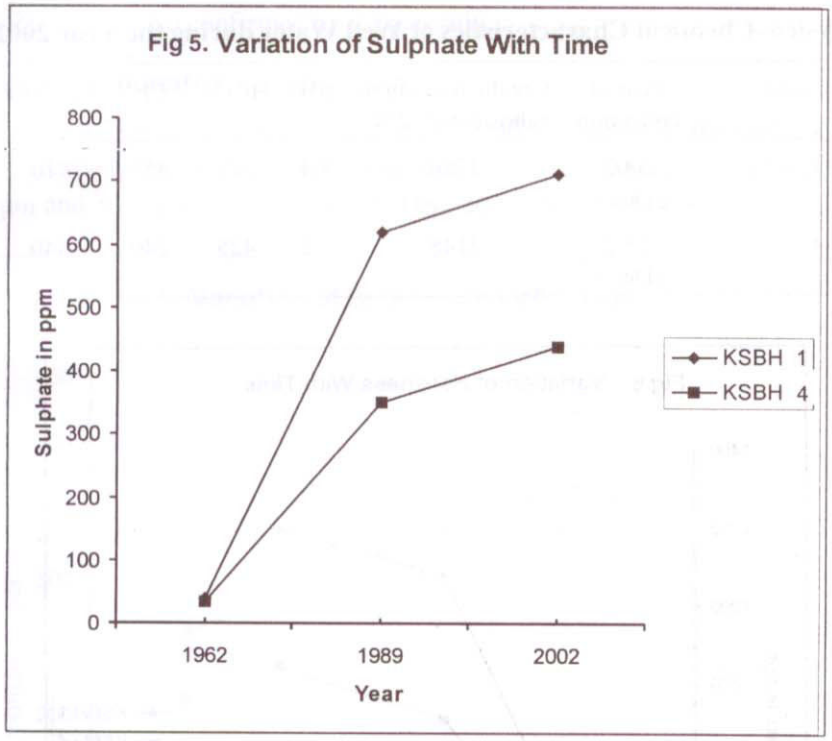


Table 1. Physico–Chemical Characteristics of Well Water during the Year 1962.

S. No.	Name of well	Year of collection	Conductivity in μ mhos/cm at 25°C	pH	HCO_3	Cl^-	Sulphate	Total Hardness
1.	KSBH–1	1962	505	8.0	260	14	40	195
2.	KSBH–4	1962	425	7.8	210	16	35	180

Note : (i) Except pH & conductivity all values are in ppm in Table 1, 2 and 3.
(ii) Taken from the report

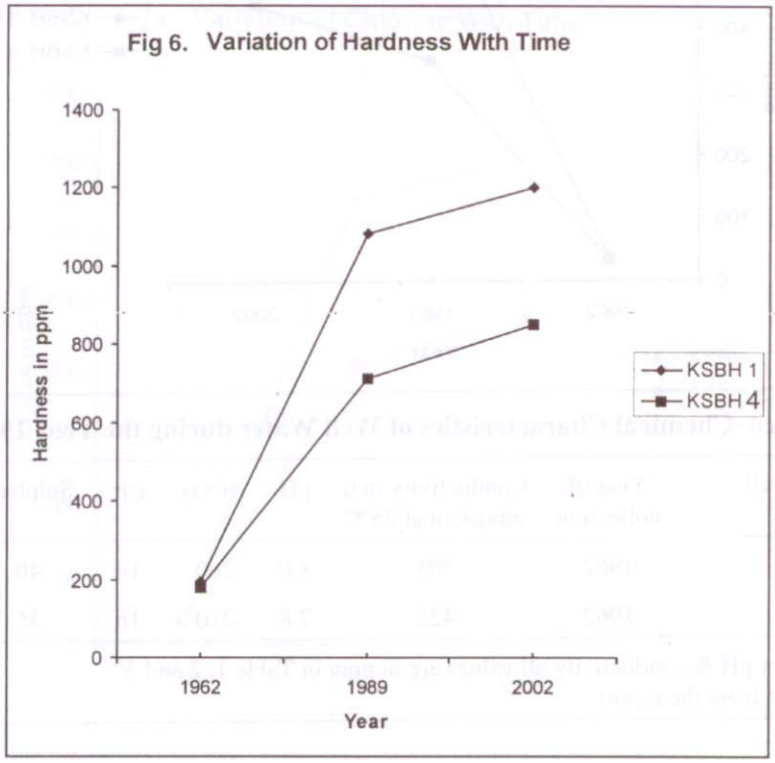
"Geology and ground water conditions in Singhana area, Jhunjhnu district, Rajasthan" by D. K. Dutt, K. R. Karanth and J. P. Shrivastava, Geological Survey of India.

Table 2. Physico–Chemical Characteristics of Well Water during the Year 1989

S. No.	Name of well	Year of collection	Conductivity in μ mhos/cm at 25°C	pH	HCO_3^-	Cl^-	Sulphate	Total Hardness
1.	KSBH–1	1989	2384	7.6	320	324	620	1082
2.	KSBH–4	1989	1839	7.4	362	204	351	715

Table 3. Physico–Chemical Characteristics of Well Water during the Year 2002 (Dec.)

S. No.	Name of well	Year of collection	Conductivity in μ mhos/cm at 25°C	pH	HCO_3^-	Cl^-	Sulphate	Total Hardness
1.	KSBH–1	2002 (Dec.)	2784	7.4	370	356	710	1200
2.	KSBH–4	2002 (Dec.)	2148	7.2	425	240	440	850



(e) Effect on Sulphate Concentration

Sulphate concentration before establishment of Khetri copper plant were 40 ppm and 35 ppm but after 27 years of its establishment, it has increased dramatically to 620 ppm and 351 ppm for the wells No KSBH–1 and KSBH–4, respectively (Fig. 5). One of the most important fact is that sulphate concentration is increasing due to the oxidation of pyrite and other sulphides distribution in igneous and sedimentary rocks[8]. Second important factor for this increase is that during metallurgical operation from the blast furnace produces SO_2 and SO_3, which are coming into the atmosphere and during course of time and through soil, these are reaching the ground water by effluent through seepage.

(f) Effect on Hardness

The total hardness before establishment of Khetri copper project was 195 ppm and 180 ppm of the wells KSBH–1 and KSBH–4, respectively. After 27 years of its establishment, the total hardness has gone dramatically to 1082 ppm and 715 ppm of the same above mentioned wells (Fig. 6). In the year 2002 it further increases i.e. KSBH–1 well show total hardness 1200 ppm and KSBH–4, 850 ppm.

One of the reason of increasing total hardness may be seepage of effluent, bearing the calcium ions from the fertilizer plant. Due to hardness, now a days, these wells are not being used for drinking water purposes.

On comparing Table 1 and 2, one conclude that (1) increasing conductivity (2) decreasing pH value (3) dramatic increase in chloride, sulphate, total hardness and bicarbonate can be correlated with copper smelter, sulphuric acid plant, fertilizer plant, effluent etc. It is due to mainly air borne H_2SO_4, HCl, CO_2 etc., which gets precipitated with passage of time together with liquid effluent passing into the river Sukh (Khar Khar Nala). This accounts for increase in conductivity, decrease of pH and heightened chloride, sulphate and hardness. This is the price one has to pay for establishing a heavy industry like copper, fertilizer, acid plant in the vicinity of Khetri without taking proper care for disposals.

The year 1962 was taken as standard for domestic water supply. It is to be pointed out that the quality of water for domestic and potable supply was of bicarbonate nature counter balancing the ill effects to the mankind. But after 40 years of establishment of a heavy industry, this is the price, the area has to pay in the form of deteriorated loss of ecological imbalance[9], which may be hazardous for the human race. The conditions are not super critical yet, but they are alarming. The effluent and discharges from the industry need to be properly controlled to avoid further damage to the environmental as a whole.

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