*Jr. of Industrial Pollution Control 21 (2)(2005) pp 389- 396*


# TRACE ELEMENTS IN GROUNDWATER OF PARADIP AREA

**R.N. BARIK*, B. PRADHAN AND R. K. PATEL**

* Deptartmen of Chemistry, National Institute of Technology, Rourkela - 769 008, India

**Key words :** Trace elements, Groundwater.

## ABSTRACT

**The concentrations of the trace elements Fe, Cu, Pb, Mn, Zn were studied in groundwater of Paradip area. The degree of trace element pollution and the suitability of groundwater for drinking purpose was assessed. The concentration of Pb found to be present above maximum permissible limit. More than permissible limit of Fe was found around the indstrial area. The concentrations of Zn, Cu and Mn are well below the maximum permissible limit as recommeded by ISI (1983) for drinking purpose.**

## INTRODUCTION

The importance of groundwater for the existence of human society cannot be overemphasized. Groundwater is the major source of drinking water in both urban and rural area. Besides, it is an important source of water for the agricultural and industrial sector. Water utilization projections for 2000 put the groundwater usage at about 50%. Being an important and integral part of the hydrological cycle, it's availability depends on the rainfall and recharge conditions. Till recently it had been considered a dependable source of uncontaminated water. Groundwater crisis is not the result of natural factors. It has been caused by human actions. Much of ill health which affects humanity, especially in the developing countries can be traced to lack of safe and whole some water supply. There can be no state of positive health and well being without water. Water is not only a vital environmental factors to all form of life, but it has also a great role to play in Socio-economic development of human population (Park, 1997). Groundwater is the cheapest and most practical means of providing water to small communities. It is subjected to less contamination and has high mineral content. Today the groundwater resource are contaminated by the constant addition of industrial, agricltural and domestic water. The extent of groundwater pollution depends on rainfall pattern, depth of water table distance from the sources of contamination, soil properties, such as permeability (Chattergee, 1994, De, 1995). Water pollution is a growing hazard in many developing countries owing to human activity. The present investigation was undertaken with a view to study the trace elements in the groundwater around Paradip area.

## STUDY AREA

Paradip is one of the major Ports of India and is the important port for the Sea borne trade of the eastern part of the country spread over states such as Orissa, and West Bengal. The natural resources and industrial products of this wide spread hinterland are immense and the value of the mineral trade of the country passing through the port of Paradip is considerably higher than many other major ports of India.. The port has become a nucleus for the industrial and economic development of this part of the state. A port based fertilizer plant - Paradip Phosphate Ltd. has been set up since 1984. M/s Oswal Chemicals and Fertilizers Ltd. have also set up another fertilizer complex at Musadiha - 4 km. from Paradip Port , to manufacture 2 millions tones of Phosphatic fertilizer per annum. Indian Oil Corporation Limited has already started the work for setting up of a refinery of 9 MMTPA capacity at Abhaychandrapur - 5 km. from Paradip port. The Ministry of Industries and commerce has also identified Paradip for setting up of a special economic zone (SEZ). Outside the port township the people are using water from well, river and pond directly for drinking and other domestic purpose. The sludge from general cargo handling berth are dumped on the ground affects vegetation and mangrove forests. The sewage of the port township , 70% of which is treated by septic tanks and the rest about 3400m/day is discharged to Atharabanki river. Paradip area is enclosed with water bodies in three directions, i.e. North, South and East. Bay of Bengal is on the South Eastern side, Mahanadi river is flowing on the Northern side and draining from west to east. Paradip area being a low lying landmass has salinity in a number of creeks and ponds with rich aquatic growth. The Paradip area is at a latitude of 20'-15'-55.44" towards North and Longitude of 68'-40'-34.62" towards East i.e. 210 nautical miles South of Calcutta and 260 nautical miles North of Visakhapatanam. Analysis of past records reveals that the area receive an average of 1480 mm rainfall and average of about 90 rainy day in a year. Rain is the major mode of precipitation of the area. The maximum temperature of the area was 41.4°c and minimum temperature was 8.9°c . The annual average wave height vary from 1.5 mtrs. to 2.5 mtrs. in summer and 0.9mtrs. to 2.5 mtrs. in winter. The maximum wave height was 5.30mtrs. The Tide varies from a maximum to minimum range of 3.50mtrs. to 0.40mtrs. respectively. It is observed that normally the wind in the area is light to moderate. The direction of the wind is mostly from the direction between North and East from October to March and South and West from April to September. The annual average wind speed has been observed to be 35 to 42 km/hr in Summer and



**Table- 1**
**Concentration of trace elements in groundwater (Pre-monsoon, 2003)**

| Sampling Point | Location | Fe in mg/L | Cu in mg/L | Pb in mg/L | Mn in mg/L | Zn in mg/L |
|---|---|---|---|---|---|---|
| 1. | .Santra (D) | 0.80 | ND | 0.02 | 0.01 | 0.02 |
| 2. | Krushna Chandrapur(B) | 0.69 | ND | ND | 0.01 | 0.01 |
| 3. | Bahartari(D) | 0.64 | ND | 0.02 | 0.03 | ND |
| 4. | Bhutmundei(B) | 0.98 | 0.005 | ND | 0.02 | ND |
| 5. | Pipal (D) | 0.94 | 0.003 | 0.01 | 0.01 | ND |
| 6. | Singtali (D) | 0.74 | ND | 0.01 | ND | 0.03 |
| 7. | Chakradharpur (B) | 0.86 | ND | 0.02 | ND | 0.02 |
| 8. | Jhimani (D) | 0.72 | ND | 0.01 | ND | 0.02 |
| 9. | Mangrajpur (D) | 0.82 | ND | 0.01 | 0.02 | ND |
| 10. | Nimidihi (D) | 0.96 | 0.002 | 0.02 | 0.01 | 0.03 |
| 11. | Paradipgarh .(D) | 1.06 | 0.023 | 0.09 | 0.04 | ND |
| 12. | Balidia (D) | 0.78 | 0.005 | 0.07 | 0.01 | 0.04 |
| 13. | Nuagar (B) | 0.82 | 0.009 | 0.09 | 0.03 | 0.03 |
| 14. | Agnasi (B) | 1.27 | 0.024 | 0.10 | 0.08 | 0.02 |
| 15. | .Udaybat (B) | 1.42 | 0.05 | 0.12 | 0.10 | 0.03 |
| 16. | Mushadie (B) | 1.84 | 0.10 | 0.18 | 0.14 | 0.07 |
| 17. | Bijayachandrapur (B) | 1.45 | 0.06 | 0.11 | 0.06 | 0.04 |
| 18. | Niharuni (B) | 0.65 | 0.009 | 0.07 | 0.04 | 0.03 |
| 19. | Udaychandrapur (B) | 1.94 | 0.08 | 0.14 | 0.12 | 0.06 |
| 20. | Chauliapalanda (D) | 1.52 | 0.022 | 0.03 | 0.03 | 0.03 |

Note: all area average value ( i.e. Thre readings from each sampling point)
'D' for Dugwell and "B" for borewell.

**Table - 2**
**Drinking water quality**

| Trace limit | Requirement elements (mg/L) | Maximum desirable limit. Limit (mg/L) | Undesirable effect out side permissible the desirable |
|---|---|---|---|
| Iron | 0.3 | 1.0 | Beyond this limit, taste and appearance are affected, has adverse effect on domestic use and water structures and promoteiron bacteria. |
| Copper | 0.05 | 1.5 | Asringent taste, discoloration and corrosion of pipe fittings and utensils well becaused beyond this limit. |
| Lead | 0.1 | | No relation being a health parameters. |
| Manganese | 0.1 | 0.5 | Excess of Mn, creates serious and irreversible damage to brain. |
| Zinc | 5.0 | 15 | Beyond this it can cause astringent taste and an opalescence in water. |

Source: ISI (1983)

18 km/hr to 24 km/hr in Winter.

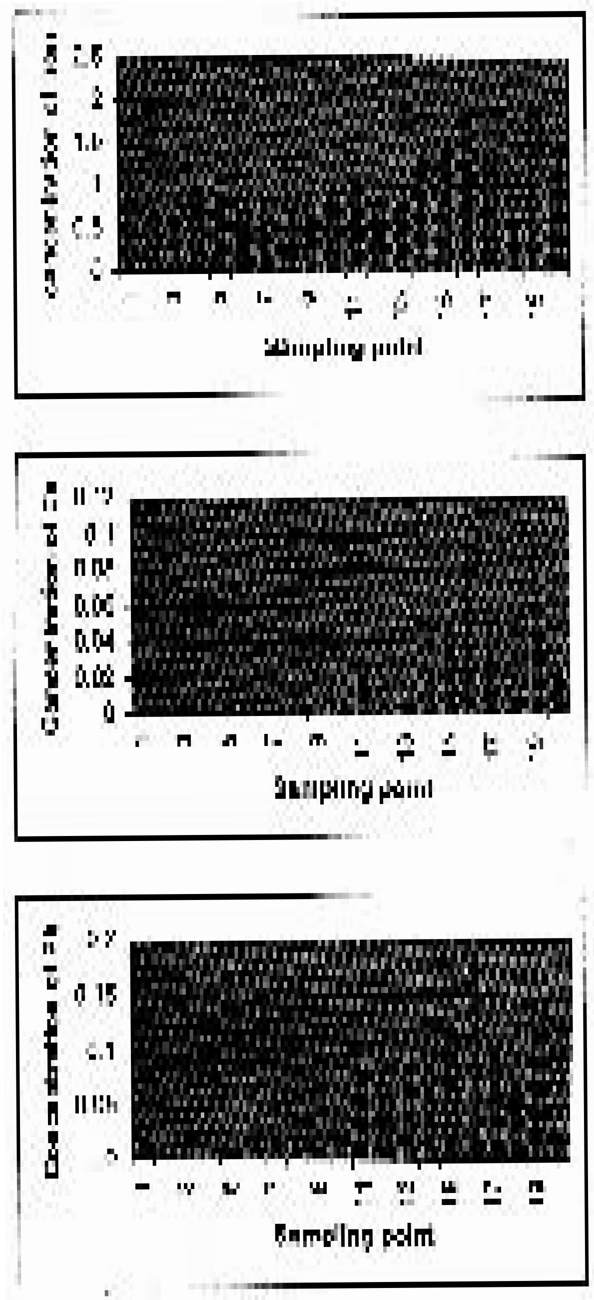
## MATERIAL AND METHOD

In the present investigation 20 groundwater samples were collected from bore wells and open wells in and around the coastal area of Paradip. Water samples collected in May'2003 in one litter plastic cans. Collected samples were analyzed for trace elements like Fe, Cu, Pb, Mn, and Zn by using Atomic Absorption Spectrophotometer following analytical methods prescribed by Brown *et al*. (1974).

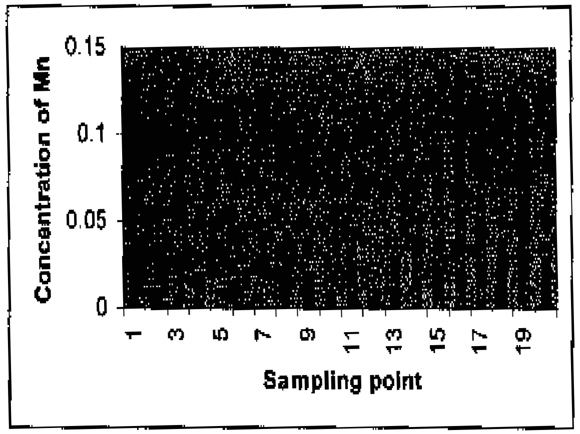
## RESULTS AND DISCUSSION

The concentrations of trace elements and the name of the sampling point are given in Table-1 and suitability of groundwater for drinking purpose are given in Table-2. In polluted water which cause health hazard , concentration of particular elements is more than the permissible limit for drinking water standard prescribed by ISI (1983). The sampling points 14,15,16,17,19 and 20 in the well were around the stream carrying industrial effluent . Iron may be present in ground water in varying quantities from 0.5 to 100 mg/L (Ernest, 1991). ISI (1983) and WHO(1984) have set a desirable limit of 0.3 mg/L and maximum permissible limit of 1.0 mg/L for drinking purpose. In the present study the iron content in sample point 11,14,15,16,17,19 and 20 was found to in the range of 1.06 to 1.94 mg/L, above the permissible limit, due to the location of the well in the vicinity of the stream carrying industrial effluent of Paradip Phosphate Ltd. Copper is ubiquitous in the environment and hence frequently present in water. Since copper is both an essential and potentially toxic element there may be risks to living being if there is too little or too much of copper in the environment. Large doses of copper irritate the stomach (Ross,1995). ISI has set a desirable limit of 0.05mg/L for copper. Copper when present in excess of lmg/L imparts an undesirable taste to drinking water, so maximum permissible limit of lmg/L is recommended by IS I (1983) and WHO (1984). In the sampling point 16, 17 and 19 copper concentration varied from 0.6 to 0.10mg/L which is below the maximum permissible limit recommended by ISI (1983) and WHO(1984). Lead is also a toxic element. The major fraction of lead in groundwater results from the seepage of industrial effluent and from lead containing dust fall out, which is thrown into the atmosphere by vehicles, then ultimately percolates down in the groundwater. Approximately 75% of lead in the gasoline burned by the vehicle are emitted as particles and the remainder of lead consumed in gasoline combustion is deposited in the engine and exhaust system. These particles which are thrown into the atmosphere can travel for long distances before getting into the water system. Thus lead in groundwater could be attributable to the seepage of industrial effluent and combustion of gasoline on highways (Ernst, 1991). Generally concentration of lead is too low and most of the time, it is below the detectable concentration in groundwater (Garress *et al,* 1965). In the present study of 20 samples lead was found to be present in all except samples point 2 and 4. In sample points 14,15,16,17





and 19 lead concentration varied from 0.10 to 0.18mg/L. In the sample point 16 lead concentration is 0.18 which exceeds the maximum permissible limit as recommended by ISI (1983), due to seepage of OCFL industrial effluent. Lead in high doses has been recognized as cumulative metabolic poison for some of the symptoms of acute poisoning such as tiredness, slight abdominal discomforts, irritability, anemia and in the case of children, behavioral



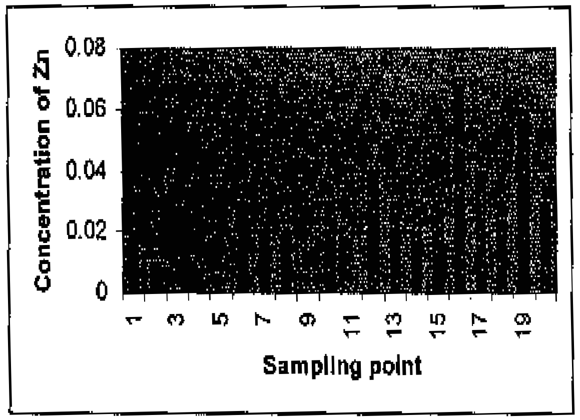




**Fig. 1-** Concentration of Fe,Cu, Pb,Mn, and Zn.

changes (Ramteke *et al.,* 1988). Manganese is a mineral that naturally occurs in rocks and soil and is a normal constituent of the human diet. It exists in well water in Connecticut as a groundwater mineral, but may also be present due to underground pollution sources. Manganese may become noticeable in tap water at concentrations grater than 0.05mg/L of water by imparting a colour, odour, or test of the water. However, health effects from manganese are not a concern until concentrations are approximately 10 times higher. The Department of public health recently set a drinking water action level for manganese of 0.5mg/L to ensure protection against manganese toxicity. This action level is consistent with the World Health Organization guidance level for manganese in drinking water. Exposure to high concentrations of manganese over the years has been associated with toxicity to the nervous system, producing a syndrome that resembles parkinsonism. This type of effect may be more likely to occur in elderly people. Manganese is unlikely to produce other type of toxicity such as Cancer or reproductive damage. In



the present study manganese concentrations varied from 0.1 to 0.14mg/L. In sample point 16 the manganese concentration exceeds the maximum permissible limit (0.5 mg/L) of ISI (1983), which could be due to seepage of OCFL industrial effluent. The toxicity of Zinc is generally low. Nevertheless, industrial and household affluent sometimes contain zinc concentration which can be harmful to the environment. Drinking water usually contains zinc levels below 0.2 mg/L (EPA, 1980). Resident water in galvanized water pipes can contain considerable higher amount up to 2-5mg/L, depending on the age of the pipes and Physico-chemical properties of the drinking water. Therefore ISI (1983) and EEC (1980) have set a maximum permissible limit of 5 mg/L for zinc, above which aesthetic quality of drinking water is impaired. Disorders of zinc metabolism are usually due to a deficiency rather than a surplus of zinc. In humanbeing the oral administration of high zinc does usually do not cause any side effect with exception of mild gastrointestinal complaints (Ernst, 1991). The zinc content is below the toxic limit in the groundwater samples collected under the present investigation.

## CONCLUSION

Concentration of Zinc in groundwater of the study area is well below the toxic limit. Concentration of Iron is observed to be more in the groundwater from the wells which are situated close to industries . Concentration of Cu and Mn are found below the maximum permissible limit and concentration of Pb is found above the maximum permissible limit, which could be attributable to seepage of industrial effluent.

## ACKNOWLEDGEMENT

We are greatful to Prof. S.K. Sarangi, Director, N.I.T. Rourkela and Dr. K.M. Purohit, Head, Department of Chemistry, N.I.T., Rourkela for his valuable help and for providing the laboratory facilities during the above study. We are also thankful to Paradip Municipal corporation for providing the necessary information.

## REFERENCES

Brown. E., Skougstad, N.W and Fishman, M.J. 1974. *Methods for collection and analysis of water samples for dissolved minerals and gases*. U.S Dept. Interior Book-S.P.160.

Chattergee, A.K. 1994. Water supply, waste disposal and environmental health^* Edn.) , Khanna publishers, New Delhi.

De, A.K. 1995. *Environmental Chemistry* ($3^{rd}$ Edn.). Welley Eastern Ltd.,New Delhi.

EEC(European Economic Communities) 1980. Richtlinic des Rates Vom. 15-7-1980 liber die qualitat Vom Wasser furden menschlichen Gebrauch. *Amtslelatt der Europaischen gemeinschaft* Vom. 30-8-1980. No.L229, pp.11-29.

Ernst. M. 1991. Metals and their compounds in the environment. VCH, weinheim pp. 894-1332.

Garrels, R.M. and Becker E. 1965. *Solutions, minerals and equlibria*. Harper and Row, New York. P.450.

ISI (Indian Standard Institution) 1983. Indian Standard specification for drinking water, IS ; 10500.

EPA ( Environmental Protection Agency)1980. Ambient water quality criteria for zinc. Publication 440/5-80-79. EPA office of water regulation and standards, criteria and standard division, Washington D.C.

Park, K. 1997. *Park's textbook of preventive and social medicine*. Banarsidas Bharat publishers, Jabalpur.

Patnaik, K.N, Satyanarayana, S.V. & Rout, S.P., 2002. Water Pollution from Major Industries in paradip area. *Indian J. Environ. HLTH*. 44 (3) : 203 - 211.

Ross, A.I. 1995. Lancet, 11.87 C. F. Holaen, W.S. 1970.

Todd, D. K. 1980. *Ground Water Hydrology*. Jhon willey & Sons. New York.

WHO (World Health Organization) 1984. *Guidelines for drinking water quality*. Vol. I.