Study of trace elements in groundwater of in and around Hingoli Region, Maharashtra, India
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Abstract: The present paper deals with trace elements geochemistry from the groundwater of Hingoli area, Maharashtra, India. Over a period of three years from 2009 to 2012, during the post-monsoon and pre-monsoon seasons. Fifty three groundwater samples were collected and analysed for trace metals with SPECTRO XEPOS, Advanced XRF Spectrometer, at environmental magnetic studies lab, Indian Institute of Geomagnetism, New Panvel New Mumbai. Trace elements such as Fe, Cu, Ni, Pb, Mn, Cd, As, Se, Co, Hg, Zn, Cr etc. are detected by XRF Spectrometer. Concentration of Fe, Mn, Cd, Se, Co, Hg, Zn are well within the permissible limit. Trace element analyses show high concentration levels for Cr, Ni and As in almost all groundwater samples. (as per WHO guidelines for drinking water quality 2011 and BIS 1991). Except Cr, Ni and few localities of As overall groundwater quality is suitable for drinking and agriculture. The elevated concentrations of trace elements are combined effects of geogenic, sources as well as excessive use of chemical fertilizers. It is recommended to control anthropogenic activities adequately in order to minimise the pollution problems.

Key words: Trace elements, groundwater, Higoli, Maharashtra India.

I. Introduction
Water is the most essential substance for living things and it supports the life processes and without water it would not have been possible to sustain life on this plane (Javid Hussain et al., 2012). Water is one of the most vital resources for the sustenance of human, plants and other living beings. It is required in all aspects of life and health for producing food, agricultural activity and energy generation. Groundwater is rarely treated and presumed to be naturally protected, it is considered to be free from impurities, which are associated with surface water, because it comes from deeper parts of the earth (R.N. Tiwari, et. al., July, 2013). The total quantity of water on earth is approximately 14 trillion cubic meters (Parveen F., U. Asghar and T.H. Usmani, 2007). Trace elements are the important part of the material basis of medical effects (Guo et al., 2005). Heavy metals are sometimes called trace elements of the periodic table (Javid Hussain et al., 2012). Heavy metals are among the most persistent pollutants in the aquatic ecosystem because of their resistance to decomposition in natural conditions (Khan A.T., 2011). It has long been recognized that large area of the globe contain human population characterized by having trace elements deficiency, or excess including chronic poisoning (Romic D.M., 2012). Sediments and suspended particles are also important repositories for trace metals, e.g Cr, Cu, Mo, Ni, Co and Mn (Javid Hussain et al., 2012). Heavy metal pollution is an important factor in the present environmental deterioration. The heavy metals can be absorbed by the medicinal plants and into our human bodies, which can cause great harm (Ying Guo et. al., 2011). So it is very important for us to determine the content of these heavy metals in the groundwater. Complex processes control the distribution of trace elements in ground water, which typically has a large range of chemical composition (Hem, 1970, Drever, 1982, Appelo and Postama, 1993). The trace element composition of groundwater depends not only on natural factors such as the lithology of the aquifer, the quality of recharge waters and the types of the interaction between water and aquifer, but also an human activities, which can alter these fragile groundwater system, either by polluting them or by changing the hydrogeological cycle (Helena et al., 2000). Contamination of the environment with toxic heavy metal has become one of the major causes of concern for the human kind (Aweng et al., 2011). Chemical substances such as heavy metals are one of the factors which contribute to environmental pollution, and it was believed that it can disturb the living ecosystem (Kobata Pendias et al., 2011). Some metals present in trace concentration are important for physiological functions of living tissue and regulate many biochemical processes (Fakhare Alam and Rashid Umar, 2013). The same metals, however, in higher concentrations may have severe toxicological effects on human being (Chapman, 1992). At the same time the deficiency of trace elements is equally harmful. But the trace metals can be toxic and even lethal to humans even in relatively low concentrations because of their tendency to accumulate in the body (Domenico and Schwartz, 1998). Groundwater contamination and its management have become need of the hour, because of their far reaching impacts on human health. Many naturally occurring major, minor and trace elements in drinking water may have...
significant effect on human and animal health either through its deficiency or through excessive intake (Frengstad et al., 2001).

II. STUDY AREA
The study area is a part of Kayadhu basin, bounded by latitudes 19°42’ & 19°44’ and longitudes 77° 7’ & 77° 10’ the area includes Hingoli City, is a head quarter of district located on the bank of Kayadhu River. Apart from this, the area consists of seven villages like Devulgaon Rama, MIDC area Hingoli, Andharwadi, Gadipura, Ganeshwadi, Warud Gawali etc. The study area covers an area of about 36 sq.Km² (Toposheet 56E/2; Fig.1). The major sources of employment are agriculture, horticulture and animal husbandry. The MIDC area of Hingoli consists of some Industries like, PVC pipe Industry; oil industry etc.

Fig.1: Location of study area
III. MATERIAL AND METHODS

During the post-monsoon season from 2009, 2010 & 2011 and pre-monsoon season from 2010, 2011 & 2012, 53 groundwater samples were collected from bore and dug wells analysed for trace metals with SPECTRO XEPOS, Advanced XRF Spectrometer, at environmental magnetic studies lab, Indian Institute of Geomagnetism, Mumbai. The SPECTRO XEPOS HE uses a 50 Watt end-window X-ray tube to excite the samples. The target changer, with up to 8 polarization and secondary targets, offers many different excitation conditions ensuring optimum determination of the middle to heavy elements. The application range covers the elements from Na to U. A shutter improves the stability of the system by enabling the sample to be changed without having to turn off the X-ray tube. Consistent X-ray tube performance is ensured by the uninterruptible power supply (UPS) that compensates for power fluctuations. Measurements can be conducted in a He gas atmosphere or in a vacuum; many applications even in air.

A. Sample Presentation

Not only powerful analytical components, but also exact sample presentation is critical for exceptional analytical performance. This was a special consideration during development of the SPECTRO XEPOS HE. The precision of the sample changer and a new generation of sample trays dramatically reduce the effects of mechanical and physical fluctuations; improving analytical results. The analyzer can handle samples with diameters of 32 mm, 40 mm and 52 mm. The sample chamber can be equipped with a sample spinner for 40 mm sample cups to further improve the measurement results for inhomogeneous samples or irregular surfaces.

IV. Result and Discussion

A. Hydrogeology

The area consist of Deccan Trap, it contains different types basaltic flows, separated by red bole. The occurrence of groundwater mostly found in shallow and deep aquifer. The Deccan Trap consists of four types of rocks like compact, amygdaloidal, vetricular, and tachylitic basalt. The groundwater mostly found in compact basalt due to the presence of secondary porosity i.e. Fracture and joints in the rock. Depth of the dug wells is from 5.18-54.87 mt. and 12.19-122 mt. for bore wells. The soil thickness is about 0.2 mt to 12.19 mt. and average is 2.94 mt.

The chemical composition of groundwater of the study area is shown in Table 1. The chemical composition of the groundwater is controlled by, nature of geochemical reaction, velocity and volume of groundwater flow, lithology, precipitation and role of human activity (Matthes and Harvey, 1982; Reddy, Subba Rao and Reddy 1991, Bhatt and Sakalani, 1996.)

<table>
<thead>
<tr>
<th>Parameters</th>
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<th>Max</th>
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<td>-</td>
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<td>0.1</td>
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<td>Mn</td>
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<td>-</td>
</tr>
<tr>
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<td>0.00006</td>
<td>0.01</td>
<td>0.01</td>
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<td>0.00009</td>
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<td>-</td>
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<td>-</td>
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<td>-</td>
<td>5.0</td>
</tr>
<tr>
<td>Cr</td>
<td>1.1</td>
<td>5.8</td>
<td>-</td>
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</table>

Table 1. Statistical measures of trace elements of Hingoli Region Maharashtra, India

B. Trace Elements

Graphical representation of trace elements in study area.
Iron
Iron is an essential element in human body (Moore, 1973) and is found in groundwater all over the world; higher concentrations of iron cause bad taste, discoloration, staining, turbidity, esthetic and operational problem in water supply systems (Dart, 1974; Vigneshwaran and Vishwanathan, 1995). Deficiency of iron results in hyochromic macrobiotic anemia; one of the world's common health problems (R.N. Tiwari, et. al,2013). The limit of concentration of iron in drinking water ranges between 0.3 (desirable limit) to 1.0 mg/L (permissible limit). In the study area, all the samples show (<1.0 mg/L) of iron is within the WHO limit.

Copper
Copper is an essential element, concentrated in several enzymes, and its presence in trace concentrations is essential for the formation of haemoglobin (R.N. Tiwari, et. al., July, 2013). An over dose of copper may lead to neurological complication, hypertension, liver and kidney dysfunctions (Krishna and Govil, 2004; Khan et al., 2010). Ingestion of copper causes infant death, short lived vomiting diarrhea etc (Barzilay, 1999). In the present study its value ranged from 0.2 to 1mg/L, and average is 0.81mg/L which is above the permissible limit as suggested by WHO (1993) and BIS (1991).

Nickel
Nickel is present in a number of enzymes in plants and microorganism (R.N. Tiwari, et. al., July, 2013). In the human body, nickel influences iron adsorption, metabolism and may be an essential component of the haemopoiitic process. Acute exposure of nickel in the human body is associated with a variety of chemical symptoms and signs such as nausea, vomiting, headache, giddiness etc (Barzilay, 1999). The BIS (1991) has recommended 0.02 mg/L as maximum permissible concentration in drinking water. In the study area, Ni concentrations range from 1.4 to 2.6mg/L, and average is 1.83 mg/l. The primary source of nickel in drinking water is leaching from metals in contact with drinking water such as pipes and fittings However, it may also be present in some ground waters as a consequence of dissolution from nickel ore bearing rocks (R.N. Tiwari, et. al., July, 2013). The geogenic source appears to be responsible mainly for the nickel concentrations in groundwater of the study area (Tiwari and Dubey, 2012).

Lead
Lead occurs geologically in association with sulphide minerals and may be present in generally elevated concentration in areas with ores and coal (Reimanne and Decarita, 1998). Lead is toxic to the central and peripheral nervous system causing neurological and behavior effects. The consumption of lead in higher quantity may cause hearing loss, blood pressure and hypertension and eventually it may be prove to be fatal. In the present study, lead concentration ranged from 0.00003 mg/l to 0.00013 mg/l. It is observed that all groundwater samples have lead values within the permissible limit (BIS, 1991).

Manganese
Manganese is one of the most abundant elements in the earth's crust, it usually occurs together with iron and is widely distributed in soil, sedimentary rocks and water (R.N. Tiwari, et. al., July, 2013).The most abundant compounds of manganese are sulphide, oxide, carbonate and silicate (In the present study, the concentration of averaged at 0.81mg/L which is within the permissible limit (0.3 mg/L). Manganese is regarded as one of the least toxic elements but its excess amount in the human body may cause growth retardation, fever; fatigue and eye blindness, and may affect reproduction (R.N. Tiwari, et. al., July, 2013).

Cadmium
Cadmium is a cumulative environmental pollutant and its exposure to the body results damage of the kidney, and causes renal dysfunction, arteriosclerosis, cancer etc (Goel, 1997; Robards and Worsfold, 1991). In the present study, the concentration of cadmium ranged from 0.00001 mg/L to 0.00016 mg/L, which is well within the permissible limit as recommended by BIS (1991) and WHO (1993) respectively. The concentration of cadmium in water samples of the study area may be attributed to the runoff from the agricultural sector where pesticides as well as cadmium phosphatic fertilizer are being used (R.N. Tiwari, et. al., July, 2013).

Arsenic
Arsenic is a semi-metallic element found in soils, groundwater, surface water, air, and some foods (U.S. Agency for Toxic Substances and Diseases Registry (ATSDR), 2005). Arsenic occurs naturally in the earth’s crust, with higher concentrations in some geographic areas, and in some types of rocks and minerals (U.S. Agency for Toxic Substances and Diseases Registry (ATSDR), 2005). When combined with elements other than carbon, it is called “inorganic arsenic.” Arsenic and inorganic arsenic compounds can be emitted into air and then deposited into water and soil during industrial operations such as ore mining and smelting, and during volcanic eruptions and forest fires (U.S. Agency for Toxic Substances and Diseases Registry (ATSDR). 2005; U.S. Environmental Protection Agency. 2000). Chronic inorganic arsenic exposure is known to be associated with adverse health effects on several systems of the body, but is most known for causing specific types of skin lesions (sores, hyper pigmentation, and other lesions) and increased risks of cancer of the lung and skin ingesting contaminated foods or soil (predominantly via hand-to-mouth activity) (U.S. Agency for Toxic Substances and Diseases Registry (ATSDR). 2005; U.S. Environmental Protection Agency. 2003; Subcommittee on Arsenic in Drinking Water, N.R.C. 1999). Groundwater can be contaminated with arsenic from natural sources of arsenic, or by mining and smelting.
operations (U.S. EPA, Toxicity and Exposure Assessment for Children’s Health). The arsenic in study area ranging from 0.2 mg/l to 0.03mg/l and, average is 0.22 mg/l. All the water samples of study area are below the WHO standards.

Selenium (Se):
Selenium in the study area ranges from 0.00003mg/l to 0.00009mg/l. All water samples had measurable concentrations of Selenium. However, all are below the WHO limit. WHO permissible limit for selenium is 0.04 (V. Hanuman Reddy, 2012).

V. Conclusion
The Ni, Cr, and As is generally elevated in most localities, originating from geologic formation. The continuous higher intake Ni and Cr may cause toxic effects to the human health. The elevated concentrations of trace elements are combined effects of geogenic, sources as well as excessive use of chemical fertilizers. It is recommended to control anthropogenic activities adequately in order to minimise the pollution problems. Except Ni, Cr and As concentration. Overall groundwater quality is good for drinking and agricultural purposes.

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