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# Hydro chemical facies and physico-chemical characterization of thermal spring water of Unkeshwar, Maharashtra

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**Abstract**
The physical and chemical parameters of groundwater play a significant role in classifying and assessing water quality. Major ions constitute the most significant part of the total dissolved solids present in the groundwater and the concentration of these ions in ground water depends mainly on the hydro chemical processes that place in the aquifer system. The diagnostic chemical character of water solutions in hydrologic systems has been determined with the application of the concept of hydro chemical facies. The temperature of the thermal spring water not was 43and 45 $^0$ C, the pH value for water is 7.2 and 7.5. The observed trend of dissolved oxygen is controlled by temperature of water, i.e. 5.8 mg/L in November and 5.2 mg/L in March. The hardness of water was 138 mg/L to 138 mg/L. The magnesium decreased from 5.3 mf/L to 3.41 mg/L, the chlorides increased from136 mg/L to 284.3 mg/L in November to march whereas sulphates decreased from 72.81 mg/L to 13.7 mg/L. The Ca-Mg-Na plot conforms thermal water falls in Ca-Mg domain.

**Keywords:** Facies, ground water, hydro chemical, ions, thermal springs.

## INTRODUCTION

The tradition bound India as a cultural heritage considers thermal springs as a unique creation of god. But the scientific researches proved that thermal springs are simple natural phenomena, whenever sufficient heat is available to raise the temperature of subsurface water.

The springs are the concentrated ground water flow issuing at the surface as current flowing water. In thermal spring, the water forced up from moderate or great depths by other forces than hydraulic pressure, they may geyser, volcanic and thermal springs. The temperature of natural waters under consideration does not exceed 35 $^0$ C. The temperature of thermal springs in lavas of tertiary, quaternary and recent ages is usually attributed to volcanism [1]. India does contain large number of promising geothermal areas. In fact there are almost more than 300 known thermal springs. Thermal springs of Indian subcontinent (temperature range of about 30 to 100 $^0$ C) occur in groups along certain major tectonic trends, plate boundaries, continental margins and rifted structures. These springs are mostly non-volcanic type.

The physical and chemical parameters of groundwater play a significant role in classifying and assessing water quality. The hydro chemical study reveals quality of water that is suitable for irrigation, agriculture, drinking and industrial purposes. It was observed that the criteria used in the classification of waters for a particular purpose may not find the suitability standards for other purposes and better results can be obtained only by considering the combined chemistry of all the ions rather than individual or paired ionic characters [2]. Chemical classification also throws light on the concentration of various predominant cations, anions and their interrelationships.

The hydro chemical facies analysis (HFA) technique was developed in the 1960s as a tool for categorizing waters based on their major ion composition. One form of HFA is the Piper Diagram, in which major cations and major anions are plotted on ternary diagrams in order to illustrate which cations and anions dominate. When plotted in this fashion, the data can be used to illustrate the evolution of water quality as it migrates through the ground (typically from bicarbonate-rich water to chloride-rich water) or as it mixes with water of a different composition.

Unkeshwar thermal spring is the natural outlet of ground water discharge having temperature of water, fall above the mean annual air temperature of the region. This attempt is made to assess hydro chemical and physic chemical status of water.

## MATERIALS AND METHODS

### Study Area

Geographically, Unkeshwar lies between (19°34'–19°40'N and 78°22'–78°34'E), Unkeshwar thermal spring is located in Kinwat tahasil of Nanded district of Maharashtra. It falls in thermal field is 1 south of the Penganga river.

### Geology

Geothermal activity is in the form of hot springs spread over an area of 10 sq km with temperatures of 30°C 42°C. Reported reservoir temperature is about 100 $^0$ C [3].Geographical position occupies major portion of South East Deccan Continental basalt of India. It is unique, terrestrial on Deccan basalt amongst presently active systems.

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## Sampling and Analysis

Sampling and analysis is carried out of thermal spring water in the months of November and March as per standard methods [4 and 5]. And in situ determination of temperature, electrical conductivity, pH, dissolved oxygen and free carbon dioxide were carried out. HFA analysis is conducted by plotting mole fraction data on a ternary diagram.

## RESULT AND DISCUSSION

Analysis of the water carried out at the site and laboratory and results are given in table 1. The temperature of the thermal spring water not showing more fluctuation it was 43 $^0$ C and 45 $^0$ C in November and March respectively. This slight increase is attributed to present environmental temperature. Electrical conductivity of the thermal water in both the months shows slight elevation (5632 & 5858 µS/cm) in study months. The pH value for water is 7.2 and 7.5 likely to be constant it is due to buffering action of dissolved minerals. The observed trend of dissolved oxygen is controlled by temperature of water, i.e. 5.8 mg/L in November and 5.2 mg/L in March, because dissolved gases in water are directional proportional to temperature. The hardness increased from 138 mg/L to 138 mg/L, mainly due to calcium, the concentration of calcium also increased during the study months (138 mg/L to 149.6 mg/L) , the magnesium decreased from 5.3 mg/L to 3.41 mg/L, the absence of carbonate and comparatively less concentration of bicarbonates (30 mg/L & 25 mg/L), the hardness is permanent hardness. The chlorides increased from136 mg/L to 284.3 mg/L) in November to march whereas sulphates decreased from 72.81 mg/L to 13.7 mg/L it is attributed to reduction of sulpher by the organisms.

Table 1. Physico-chemical characteristics of thermal spring water in November and March

| Parameter | November | March |
|---|---|---|
| Temperature $^0$C | 43 | 45 |
| E C (S/cm) | 5632 | 5858 |
| TDS mg/L | 3550 | 6350 |
| pH | 7.2 | 7.5 |
| DO mg/L | 5.8 | 5.2 |
| $CO_2$ mg/L | 10.9 | 11.0 |
| $HCO_3$ mg/L | 30.0 | 25.0 |
| Total Hardness mg/L | 118 | 138 |
| Ca mg/L | 138 | 149.6 |
| Mg mg/L | 5.3 | 3.41 |
| Na mg/L | 100.3 | 109.2 |
| K mg/L | 3.5 | 4.0 |
| Cl mg/L | 136.3 | 284.0 |
| $SO_4$ mg/L | 72.81 | 13.7 |
| $PO_4$ mg/L | 0.5 | 0.6 |
| MPN count,no/100ml | | 21 |

Table 2. Cation and anion in month of November and March

| Ions in % | November | March |
|---|---|---|
| $Ca^{++}$ | 58.48 | 59.94 |
| $Mg^{++}$ | 03.69 | 0.99 |
| $Na+K^{+}$ | 37.81 | 39.04 |
| $Cl^{-}$ | 77.21 | 95.26 |
| $SO_4^{-}$ | 17.20 | 0.285 |
| $CO_3+HCO_3^{-}$ | 5.58 | 2.75 |

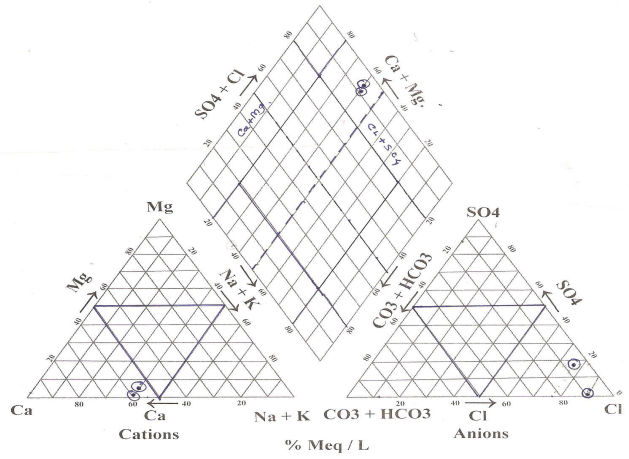


Fig 1. Thermal spring water plotted on piper trilinear diagram

The Ca-Mg-Na plot conforms thermal water falls in Ca-Mg cation domain where Ca ions dominated over Mg ions. On Cl-$SO_4$-$HCO_3$ plot, the water falls in Cl rich domain of geothermal water (Table 2 and Fig. 1). The classification water samples based on salinity hazards, the EC value exceeds 2250 mS/cm , of C4 &C5 class [2], the water is totally unsuitable for any purpose.

Water also shows dominance of $SO_4$ over $HCO_3$ suggests that during water rock reaction, interaction with sulpher environment.

## CONCLUSION

By taking account of all observations and discussion made on it, it is conclude that the high values of electrical conductivity and dissolved oxygen is controlled by the temperature and the rock material which comes in the path of upcoming water column. The slight increased in temperature from November to March is due to change in surrounding temperature. The dissolved oxygen in water is controlled by temperature. The pH of water is controlled by the buffering action of minerals. The higher values of Ca and Mg makes the water hard and high values of Cl and $SO_4$ causes permanent hardness. By considering the pattern from November to March the concentration values of Cl get increased but $SO_4$ decreased due to reduction of sulpher again controlled by temperature.

The water falls in Ca- Mg cation rich domain and Cl-$SO_4$ anion rich domain. In the water strong acid exceeds weak acid. No calcium hardness (secondary salinity) exceeds 50%. The thermal water mixing in to local stream may have multiple impacts on local ecological systems due to higher amount of TDS reduces the utility of water and influences metabolic activities like fresh water organisms. Most of the physic- chemical parameter and MPN count indicates the water is not suitable for drinking purpose.

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