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ELECTRICAL TRANSPORT AND PHYSICOCHEMICAL PROPERTIES OF GROUNDWATER FROM KUNKURI, CHHATTISGARH, INDIA.

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ABSTRACT

Electrical conductivity provides a direct physical insight into ionic charge transport in nat- ural aqueous systems. In the present study, groundwater samples collected from Kunkuri, Jashpur District, Chhattisgarh (India), were analyzed from a physics-oriented perspective with emphasis on electrical transport behavior and supporting physicochemical properties. Electrical conductivity measurements were performed using a digital conductivity meter with a calibrated cell constant of 1.297 cm^{-1}. The measured conductivity was found to be 0.443 mS/cm at room temperature, indicating moderate ionic mobility. Physicochemical parameters such as pH, total dissolved solids, hardness, calcium, magnesium, chloride, and alkalinity were analyzed to correlate ionic concentration with electrical conduction. The re- sults show that groundwater from the study area behaves as a low-ionic-strength electrolyte and satisfies drinking water standards prescribed by BIS and WHO.

KEYWORDS: Electrical conductivity, ionic transport, groundwater physics, cell constant, electrolyte conduction.

INTRODUCTION

Electrical conduction in groundwater occurs due to the migration of dissolved ions under an applied electric field. Such natural waters behave as weak electrolytes, where conductivity

depends on both the concentration and mobility of ionic charge carriers. From a physics perspective, electrical conductivity serves as a macroscopic manifestation of microscopic ionic transport phenomena.

Groundwater quality studies are traditionally approached from chemical and environ- mental viewpoints; however, conductivity measurements provide a direct physical parame- ter linking electrolyte theory to natural systems. Kunkuri, located in Jashpur District of Chhattisgarh, depends largely on groundwater for domestic use. Understanding its electri- cal transport behavior is therefore important from both applied physics and environmental standpoints.

Theoretical Background

The electrical conductivity (σ) of an electrolyte solution is related to the conductance (G) by the relation:

$$\sigma = K \times G \qquad (1)$$

Where K is the cell constant, which depends on electrode geometry and is defined as:

$$\kappa = \frac{l}{A} \qquad (2)$$

Here, l is the distance between electrodes and A is the effective electrode area.
At the microscopic level, conductivity is governed by ionic transport:

$$\sigma = \sum_i n_i q_i \mu_i \qquad (3)$$

Where n_i is the number density, q_i the ionic charge, and μ_i the mobility of the ith ionic species.

MATERIALS AND METHODS

Study Area and Sampling

Groundwater samples were collected from Kunkuri, Jashpur District, Chhattisgarh, India. The region is characterized by mixed geological formations influencing groundwater miner- alization. Samples were collected in pre-cleaned polyethylene bottles and transported to the laboratory for analysis.

Electrical Conductivity Measurement

Electrical conductivity was measured using a digital conductivity meter (Model 611) equipped with a conductivity cell of known cell constant ($K = 1.297\ cm^{-1}$). The instrument measures solution conductance, which is converted into conductivity using Equation (1). Calibration was performed using a standard potassium chloride (KCl) solution. Measurements were carried out at room temperature (~21°C) after stabilization.

Physicochemical Analysis

Physicochemical parameters including pH, total dissolved solids (TDS), total hardness, cal- cium, magnesium, chloride, alkalinity, turbidity, color, odor, and taste were analyzed follow- ing standard procedures recommended by APHA and BIS.

RESULTS

The measured electrical conductivity of the groundwater sample was 0.443 mS/cm (443μS/cm). Using the cell constant, the corresponding conductance was calculated as:

$$G = \frac{\sigma}{K} = \frac{0.443}{1.297} \approx 0.341\ \text{mS} \qquad (4)$$

Table 1: Physicochemical properties of groundwater from Kunkuri.

Parameter	Value
pH	6.88
Electrical Conductivity	443 μS/cm
Total Dissolved Solids	226.12 mg/L
Total Hardness	234.08 mg/L
Calcium (Ca^{2+})	72.49 mg/L
Magnesium (Mg^{2+})	12.93 mg/L
Chloride (Cl^{-})	52.43 mg/L
Total Alkalinity	131.04 mg/L
Turbidity	0.1 NTU
Color	Nil
Odor / Taste	Agreeable

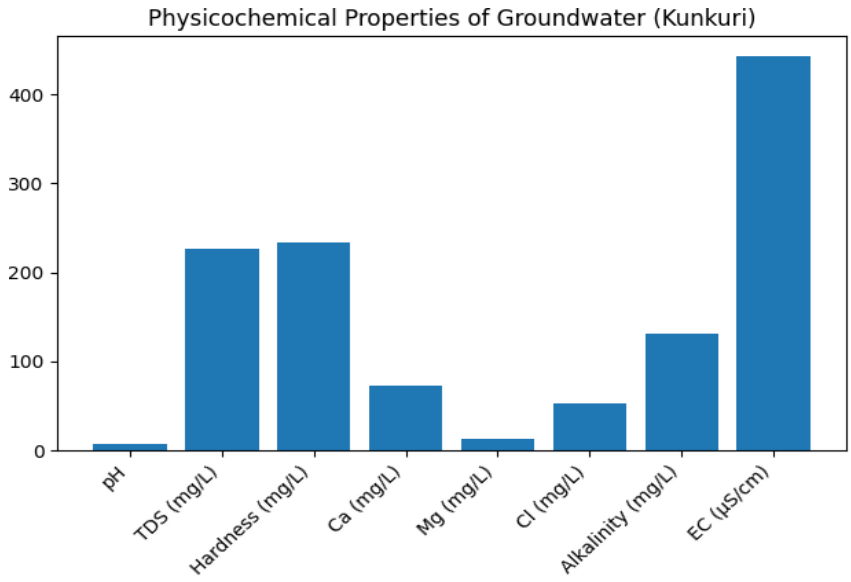

Figure 1: Graphical representation of physicochemical properties of groundwater from Kunkuri.

DISCUSSION

The observed conductivity indicates moderate ionic transport within the groundwater. The near-neutral pH and moderate TDS suggest chemical stability and low ionic strength. Di- valent ions such as calcium and magnesium contribute significantly to conductivity due to their higher charge. The measured values are consistent with freshwater electrolyte systems and align with classical electrolyte transport theory.

CONCLUSION

The present study demonstrates that groundwater from Kunkuri exhibits electrical transport characteristics of a low-ionic-strength electrolyte. The measured conductivity of 0.443 mS/cm, obtained using a calibrated cell constant, reflects moderate ionic mobility and charge carrier concentration. Physicochemical parameters further support the suitability of ground- water for domestic use. The study highlights the relevance of electrical conductivity as a physical parameter for groundwater characterization.

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