Hydrogeochemistry of Organic Carbon in Groundwater of Pondicherry Region

Carbon is an essential element found in rocks and minerals, playing a key role in sustaining life by serving as an energy source. One of its forms, dissolved organic carbon (DOC), is a useful indicator of water pollution, particularly from landfills and natural sources. This study investigated DOC levels in layered coastal aquifers of the Pondicherry region. Groundwater samples (93 sites) were collected across the major lithological formations and seasons. The collected samples were examined for heavy metals and isotopes of $\delta^{18}O$, $\delta^{2}H$, $\delta^{13}C$. Higher DOC and electrical conductivity (EC) were observed in Alluvial samples, indicating anthropogenic influence, while SWM samples showed lower DOC levels, suggesting dilution by rainwater.

Increased HCO^{-}_{3} and DOC levels in Upper and Lower Cuddalore, other Tertiary and mixed aquifers suggest calcite dissolution due to CO_2 from organic matter degradation. Stable isotope data indicate that enriched $\delta^{18}O$ and $\delta^{2}H$ isotopes (Fig.1), along with high DOC. This might be a result of contribution from evaporated waters or sewage infiltration.

Lower DOC with enriched $\delta^{18}O$ in Alluvium, Cretaceous, and Lower Cuddalore samples suggest landfill decomposition or bacterial activity. Some samples showed recharge from evaporated water and anthropogenic DOC input, while kankar in soil exhibited relatively lighter $\delta^{13}C$. A few samples from Lower Cuddalore and Cretaceous formations, fall close to the GMWL, suggesting direct recharge or anthropogenic influence. Enriched $\delta^{18}O$ with lower d-excess in certain formations indicates evaporation before recharge, likely from lakes or reservoirs. Isotope data suggests new sources influenced by precipitation or storm runoff in Lowe Cuddalore, Cretaceous and other Tertiary aquifers, while lower d-excess indicates recharge from evaporated sources through lateral flow or surface runoff retention.

$\delta^{13}C$ analysis suggests lignite/peat leaching in Upper Cuddalore and marine organic deposits in Cretaceous formations. Heavy metal and DOC analysis revealed strong correlations between Fe and Sr in Upper Cuddalore and Other Tertiary formations. SWM samples from Alluvium, Upper Cuddalore, and Cretaceous exhibited elevated DOC and Radon levels, potentially due to prolonged residence time, agricultural pollution, or landfill leaching. A positive correlation between organic carbon and iron was observed in Upper Cuddalore but was weaker in Lower Cuddalore and Other Tertiary and absent in Alluvial aquifers.

Statistical analysis indicates inter-aquifer mixing of parental and anthropogenic factors, with DOC migration from Lower to Upper Cuddalore driven by reducing conditions associated with Marcasite (Fig.2). A good positive correlation has often been observed between the contents of dissolved organic carbon and metal concentrations in few samples irrespective of formation, which is due to the metal bonding by organic substances, since a

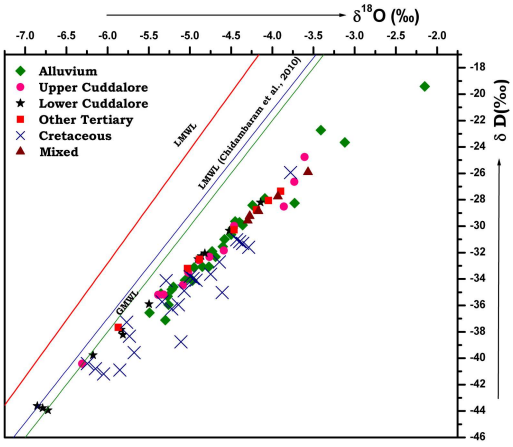

Fig.1: Conceptual diagram showing the relation between $\delta^{18}O$ and δD for groundwater samples

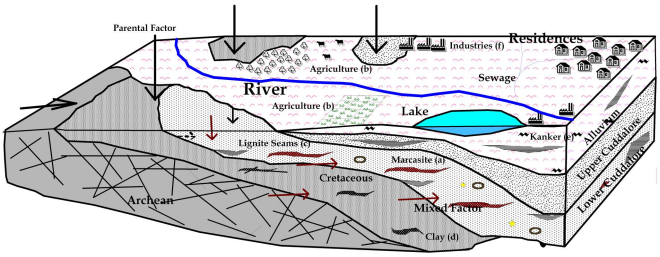

Fig.2: Systematic diagram shows the hydrochemical set up of the study area. (a) Marcasite shows FeS_2 oxidation (b) In agriculture shows addition of K, NO_3 and PO_4 (c) Industries shows NO_3 and PO_4 influences. (d) Lignite show DOC reduction processes (e) Clay show ion exchange, DOC reduction processes (f) Kankar show dolomite or calcite weathering

number of mechanisms produce simultaneous accumulation of organic material as well as typical metals. Vulnerability assessment highlights high susceptibility in the East and Southeast of Alluvial and Upper Cuddalore sandstone formations, while Cretaceous aquifers in the Southwest and Northeast are more prone to anthropogenic impacts, affecting groundwater quality. This study underscores the importance of monitoring DOC and associated parameters to assess groundwater vulnerability and potential contamination sources in coastal aquifers.

Highlights of the work carried out by **Thilagavathi Rajendiran** under the supervision of **Dr. S. Chidambaram (Guide)** as a part of her doctoral thesis work. She was awarded a Ph.D. degree from Department of Geology, Annamalai University Tamil Nadu in 2015. Supported by BRNS with sanction letter No. F: 36(4)/14/14/2014 Dated 16 July 2014.