

Hydrochemical characterization of groundwater aquifer using multivariate analysis, Minna, North Central Nigeria

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Abstract

This study examines the hydrochemical facies and groundwater flow patterns present in the crystalline basement aquifer of Minna in North Central Nigeria. Their aerial distribution was mapped and attempts to explain the controlling processes responsible for the various facies. Sixteen water samples were collected from wells and analyzed for various parameters including pH, total dissolved solids (TDS), electrical conductivity (Ec), K⁺, Na⁺, Ca⁺, Mg⁺, Cl⁻, HCO₃⁻ and SO₄⁻ using standard procedures of water analysis. The analytical results present the abundance of ions in the following order Na>Mg>Ca>K → Cl>SO₄>HCO₃. Chloride is the dominant anions found in the groundwater of the study area. Piper trilinear for the study area shows that there is a mixture of two types of water with variable concentrations of major ions. These are Na + K – Cl – SO₄ water type and Ca + Mg – Cl – SO₄ water types. This means that groundwater in the area is mainly made up of mixtures of the alkaline and alkaline earth metals and predominantly Cl⁻ - SO₄-water type. Hydrochemical data analysis revealed four sources of solutes. The processes responsible for their enrichment include: chemical weathering, leaching of the overlying sediments, domestic activities, climatic condition and the flow pattern of the aquifer. The factors have contributed to the changes of the groundwater chemistry. Correlation analysis of the data set of hydrochemical constituents in the groundwater suggests that the aquifer is mainly controlled by TDS, Ec, pH, Na and chloride. There is positive strong correlation between Ec and TDS, TDS and Na, Ec and pH which indicates that there is strong evidence of anthropogenic activities on major ions present in the groundwater and weathering of sodium, potassium minerals in the study area. The groundwater flow trends dominantly N-S, NE-SW, NW-SE and somewhat E-W, which suggests that the groundwater in the study area is structurally controlled and the rocks were affected by the Pan-African Orogeny (600 ± 150Ma).

Key words: Hydrochemical Facies, Groundwater Flow Pattern, Water Chemistry, Factor Analysis.

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