

Assessment of Groundwater Chemistry and Quality Characteristics in an Alluvial Aquifer and a Single Plane Fractured-Rock Aquifer in Bloemfontein, South Africa

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Abstract : The evolution of groundwater chemistry and its quality is largely controlled by hydrogeochemical processes and their understanding is therefore important for groundwater quality assessments and protection of the water resources. A study was conducted in Bloemfontein town of South Africa to assess and compare the groundwater chemistry and quality characteristics in an alluvial aquifer and single-plane fractured-rock aquifers. 9 groundwater samples were collected from monitoring boreholes drilled into the two aquifer systems during a once-off sampling exercise. Samples were collected through low-flow purging technique and analysed for major ions and trace elements. In order to describe the hydrochemical facies and identify dominant hydrogeochemical processes, the groundwater chemistry data are interpreted using stiff diagrams and principal component analysis (PCA), as complimentary tools. The fitness of the groundwater quality for domestic and irrigation uses is also assessed. Results show that the alluvial aquifer is characterised by a Na-HCO₃ hydrochemical facie while fractured-rock aquifer has a Ca-HCO₃ facie. The groundwater in both aquifers originally evolved from the dissolution of calcite rocks that are common on land surface environments. However the groundwater in the alluvial aquifer further goes through another evolution as driven by cation exchange process in which Na in the sediments exchanges with Ca²⁺ in the Ca-HCO₃ hydrochemical type to result in the Na-HCO₃ hydrochemical type. Despite the difference in the hydrogeochemical processes between the alluvial aquifer and single-plane fractured-rock aquifer, this did not influence the groundwater quality. The groundwater in the two aquifers is very hard as influenced by the elevated magnesium and calcium ions that evolve from dissolution of carbonate minerals which typically occurs in surface environments. Based on total dissolved levels (600-900 mg/L), groundwater quality of the two aquifer systems is classified to be of fair quality. The negative potential impacts of the groundwater quality for domestic uses are highlighted.

Keywords : alluvial aquifer, fractured-rock aquifer, groundwater quality, hydrogeochemical processes

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