The hydrogeology of the Uitenhage Artesian Basin with reference to the Table Mountain Group Aquifer

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Abstract

The Uitenhage Artesian Basin (UAB) lies in the Eastern Cape and is South Africa's most important artesian groundwater basin, supplying approximately 1 400 Mℓ/yr (44 ℓ/s) of water from springs for domestic use to Uitenhage, as well as supporting large citrus irrigation schemes. Groundwater from this basin has been extensively utilised from the early part of the 20th century, including periods of over-exploitation resulting in the declaration of a groundwater control area to limit abstraction to sustainable rates.

The aquifer comprises fractured Table Mountain Group (TMG) sandstones confined in the eastern part of the basin by overlying Cretaceous siltstones and mudstones, resulting in artesian conditions. The Coega Fault is a major structural feature dividing the basin into separate systems, viz. the southern Swartkops Aquifer and the northern Coega Ridge Aquifer, that are hydrogeologically independent of each other. The Elands River syncline divides the Swartkops Aquifer further into the Kruisrivier and Bethelsdorp Units.

Borehole yields commonly range from 5 to 10 ℓ/s and the groundwater quality is excellent with low salinities. Water hardening, however, is required due to the acidic and corrosive nature of the groundwater, typical of other Table Mountain Group aquifers in South Africa. Using ^{14}C data, the age of the groundwater in the basin ranges from 1 500 to 28 000 years with a calculated flow rate of 0.8 m/a. From the chloride mass balance method, recharge rates are determined to be 25 to 55% of annual rainfall. Groundwater temperatures generally show that depths of groundwater strikes do not necessarily correspond with depth of origin, indicating a complex groundwater circulation pattern within the basin.

Whilst the UAB has been well studied locally, a basin-scale hydrogeological characterisation is considered to be necessary, followed by recommendations and formulation of a management plan to ensure the continued sustainability of groundwater supply from this national asset.

Introduction

The UAB is South Africa's largest and hydrogeologically most important artesian groundwater basin, supplying surface-water and groundwater for agricultural, domestic, commercial and industrial uses. It covers an area of about 3 700 km^2, occurring mostly within the Port Elizabeth and Uitenhage Districts in the Eastern Cape, and is recharged by rainfall on the Groot Winterhoek and Zunga mountain ranges to the west. Groundwater from this basin currently supplies approximately 15% of the total municipal requirements of Uitenhage, one of the Eastern Cape's largest industrial areas, indicating the strategic importance of this basin. However, by the same token, the urbanised nature of the central and eastern portions of the UAB has resulted in pressure on this vulnerable water resource. Increasing demand on the resource has resulted in an increase in the potential for over-exploitation and contamination.

Hydrogeological conditions along the Coega Ridge and in the Kruisrivier region in the basin changed after 1908 from a free-flowing artesian system to a sub-artesian system. This was due to the arrival of drilling machines in the area and the resultant rapid increase in the number of boreholes drilled to augment the yield from the artesian basin for irrigation. In 1950 the Hall Commission heard evidence regarding the weakening flow conditions in the UAB. As a result of substantial pressure from farmers in the region, the basin was declared a Subterranean Government Water Control Area (SGWCA) in 1957. The Uitenhage SGWCA that encloses the central and eastern portion of the UAB is shown in Fig. 1 and covers an area of 1 125 km^2.

Since the declaration of a control area, the UAB has been extensively researched with various groundwater studies having been conducted during the latter half of the 20th century. These studies were commissioned primarily to characterise the hydrogeology of the basin and to determine the effect of various influences affecting the flow conditions within the aquifer. This paper is a synthesis of the characteristics of the UAB with reference to the hydrogeology of the TMG.

Physiography

The western part of the basin is dominated by high west-northwest striking mountain ranges (viz. the Groot Winterhoek, the Elands and the Zunga Berge) comprising the main catchment area and the lower-lying Van Stadens Berg to the south. Towards the east, the mountain ranges are fringed by low-lying terraced coastal plains that dip gently seawards and surround an extensive alluvial floodplain and estuary. Isolated koppies – formed by inliers of TMG sandstone – project through the soft Cretaceous strata in the coastal area and along Coega Ridge.

The basin enjoys a moderate mean annual precipitation of 636 mm with rain during all seasons, mostly due to orographic influences. The rainfall is, however, variable over the whole basin with the highest falls in the mountainous catchment (760 mm/a) decreasing to 435 mm/a at Uitenhage. The region has a temperate climate with warm summers and mild winters and annual evaporation in the region of 1 650 mm.

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Received 3 October 2000; accepted in revised form 12 July 2001.