Revisiting the 'Henry Problem' of density-driven groundwater flow: A review of historic Biscayne aquifer data

K. Udo Weyer
WDA Consultants Inc., Calgary, Alberta, Canada

ABSTRACT

Coastal groundwater flow investigations at Biscayne Bay, south of Miami, Florida, gave rise to the concept of density-driven flow of seawater into coastal aquifers creating a saltwater wedge. Within that wedge convection-driven return flow of seawater and a dispersion zone were assumed by Cooper et al. (1964) to be the cause of the Biscayne aquifer 'sea water wedge'. This conclusion was based on the chloride distribution within the aquifer and on an analytical model concept assuming convection flow within a confined aquifer without taking non-chemical field data into consideration. This concept was later labelled the 'Henry Problem', which any numerical variable density flow program has to be able to simulate to be considered acceptable.

Revisiting the above summarizing publication with its record of piezometric field data (heads) showed that the so-called sea water wedge has been caused by discharging deep saline groundwater driven by gravitational flow and not by denser sea water. Density driven flow of seawater into the aquifer was not found reflected in the head measurements for low and high tide conditions which had been taken contemporaneously with the chloride measurements. These head measurements had not been included in the flow interpretation. The very same head measurements indicated a clear dividing line between shallow local fresh groundwater flow and saline deep groundwater flow without the existence of a dispersion zone or a convection cell.

The Biscayne situation emphasizes the need for any chemical interpretation of flow patterns to be backed up by head data as energy indicators of flow fields. At the Biscayne site density-driven flow of seawater did not and does not exist. Instead, this site and the Florida coastline in general are the end points of local fresh and regional saline groundwater flow systems driven by gravity forces and not by density differences.