Environ Geochem Health (2012) 34:1–13
DOI 10.1007/s10653-011-9376-4

ORIGINAL PAPER

Water–rock interaction and geochemistry of groundwater from the Ain Azel aquifer, Algeria

Lazhar Belkhiri · Lotfi Mouni · Ammar Tiri

Received: 25 March 2010 / Accepted: 1 February 2011 / Published online: 19 February 2011

Abstract Hydrochemical, multivariate statistical, and inverse geochemical modeling techniques were used to investigate the hydrochemical evolution within the Ain Azel aquifer, Algeria. Cluster analysis based on major ion contents defined 3 main chemical water types, reflecting different hydrochemical processes. The first group water, group 1, has low salinity (mean EC = 735 μS/cm). The second group waters are classified as Cl–HCO_3-alkaline earth type. The third group is made up of water samples, the cation composition of which is dominated by Ca and Mg with anion composition varying from dominantly Cl to dominantly HCO_3 plus SO_4. The varifactors obtained from R-mode FA indicate that the parameters responsible for groundwater quality variations are mainly related to the presence and dissolution of some carbonate, silicate, and evaporite minerals in the aquifer. Inverse geochemical modeling along groundwater flow paths indicates the dominant processes are the consumption of CO_2, the dissolution of dolomite, gypsum, and halite, along with the precipitation of calcite, Ca-montmorillonite, illite, kaolinite, and quartz.

Keywords Cluster analysis · Factor analysis · PHREEQC · Water–rock interaction · Ain Azel aquifer · Algeria

L. Belkhiri (✉)
Department of Hydraulics, University Hadj Lakhdar, 05000 Batna, Algeria
e-mail: BELKHIRI_Laz@yahoo.fr

L. Mouni
Département de Génie des Procédés, Laboratoire de technologie des matériaux et de génie des Procèdes (LTMGP), Faculté de Technologie, Université de Bejaia, 06000 Bejaia, Algérie

A. Tiri
Research Laboratory in Applied Hydraulics, Department of Hydraulics, University of Batna, Batna, Algeria

Introduction

The hydrochemical processes help to get an insight into the contributions of rock–water interaction and anthropogenic influences on groundwater quality. These geochemical processes are responsible for the seasonal and spatial variations in groundwater chemistry (Matthess 1982; Kumar et al. 2006). Groundwater chemically evolves by interacting with aquifer minerals or internal mixing among different groundwater along flow paths in the subsurface (Domenico 1972; Wallick and Toth 1976; Toth 1984). Schuh et al. (1997) indicated that increase in solute concentrations in the groundwater were caused by spatially variable recharge, governed by microtopographic controls. Further, the weathering of primary and secondary minerals is also contributing cations and silica in the system (Freeze and Cherry 1979; Jacks 1973; Bartarya 1993).

Multivariate statistical techniques, cluster analysis (CA) and factor analysis (FA), are effective means of