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GEOCHEMICAL AND ISOTOPIC FEATURES OF A CONFINED AQUIFER SYSTEM OF MARINE ORIGIN, PAMPEAN PLAIN OF CÓRDOBA, ARGENTINA

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In Córdoba province (Argentina), people use groundwater from Confined Aquifers Systems (CASs) for different activities. Therefore, it is necessary to carry out comprehensive studies for the planning of a more sustainable use considering that groundwater renewal times can be of several thousands of years. The objective of this research is to evaluate geochemical and isotopic features of groundwater from a confined aquifer system made up by marine sediments in the central Pampean plain (Argentina). This CAS is multilayered and formed by thin (5 m) sand-pebble lenses of variable extension and clay deposits, linked to the Neogene period. These layers are situated at different depths (between 230-300 m) and are represented by fossiliferous sands interbedded with very thick greenish clay sediments. The marine CAS is characterized by fresh-brackish groundwater that evolves from bicarbonate to sulfate sodium type in the flow direction. The interpretations made from ^{2}H, ^{18}O and ^{3}H results suggest that groundwater is old. The ^{14}C age for C CAS (10,800 BP) indicates groundwater recharged during Holocene cold periods during the last glaciation.

INTRODUCTION AND OBJECTIVE

Appropriate legal and institutional contexts are vital in order to guarantee that water resources are managed and used sustainably. These include regulations whose implementation ensure a secure balance between water availability and use, and protect the resource against contamination and over-abstraction for the security of forthcoming generations. The science sector is the responsible to produce conceptual and numerical models that explain aquifers behavior, their hydraulic and geochemical characteristics and their relationships with other parts of the hydrological cycle. This information is essential to groundwater use and management.

Most of the groundwater participates in the hydrological cycle although the geochemical features and residence time may vary a lot. Groundwater all around the world is the most abundant liquid fresh water resource, but it is not always available for human consumption, as a result of its natural quality or contamination processes. Furthermore the groundwater residence time may be very long, often of thousands of years, especially in deep aquifers or under arid conditions. Then, the continuous use of these deep old resources without or scarce recharge may be unsustainable (Kazemi et al., 2006).

When a groundwater flow systems is studied, it is necessary to recognize that it has an intrinsic complexity (Turnadge and Smerdon, 2014). A groundwater sample will generally be the result of mixing that can be attributed to processes such as mechanical dispersion, chemical diffusion, and preferential flow, each of which has the potential to complicate environmental tracer interpretation. The use of geochemistry and stable and radioactive isotopes are of great interest for the development of hydrogeological models, to identify water origin and age, water mixing from different origins, water residence time in aquifers, relation between sediment/rock and groundwater, among others.

When confined aquifers are studied, complementary tools to identify old groundwaters are stable isotopes which are used as indicators of recharge during past climates (cool vs. warm, pluvial vs. arid). As was stated by Clark (2015), these do not provide quantitative measurements of subsurface residence time, but do provide useful constraints on age as well as providing important paleoclimate information. About dating, tritium-free groundwaters are considered to be greater than about 50 years old. Beyond about 1,000 years, radiocarbon remains the most useful and routine approach to date old ground waters.

In the South of Cordoba province (Argentina), groundwater resources support all the human activities (human consumption, industry, irrigation, etc.). Consequently, more comprehensive studies are necessary for the planning of a more sustainable use considering geochemistry and groundwater renewal times in the different aquifer systems. The aim of this work is to evaluate groundwater geochemical and isotopic features in a confined aquifer system of marine origin in the central Pampean plain (Argentina). Also, the links between atmospheric, surface and groundwater systems were investigated in order to improve the entire system understanding and to provide guidelines for water resources planning and management.

STUDY AREA

The study area covers 5,950 km^2 and is located between the coordinates 32°30' and 33°30' S and between 63°00' and 63°45' W (Figure 1). The climate is subhumid-tempered characterized by a mean temperature of 16.5 ºC and an average annual precipitation of 850 mm. The selected zone is a plain area that has great geomorphological, stratigraphic, hydrodynamic and geochemical peculiarities (Blarasin and Cabrera, 2005; Degiovanni, 2005; Blarasin et al., 2014). It offers several and different possibilities of groundwater uses for diverse regional human activities which must be planned. The