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Procedia Earth and Planetary Science 7 (2013) 44 – 48

Procedia
Earth and Planetary Science

Water Rock Interaction [WRI 14]

Preliminary study of the groundwater geochemistry in the sub-desert area in Morocco: case of the Ziz-Ghris basins

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Abstract

The Tafilalet region has very significant economic advantages based on tourism and agriculture. This sub-desert area faces several challenges: water scarcity, intense evaporation, limited water resources, and intense agricultural development. The topic of this work is to study the non-exploited water resources in the study area and to try to understand their geochemistry. Water samples were collected from exploited shallow aquifers and the khettara system, and from thermal waters in order to explore for possible links between the different water systems.

Keywords: Tafilalet, groundwater geochemistry, thermal waters, fossil waters, heavy metals.

1. Introduction

Tafilalet lies in the southeastern Moroccan Atlas between latitudes 29°30 'and 32°30'. It occupies approximately 8.44% of the surface of Morocco and located in arid and semi-arid regions. It is bounded to the south and east by the Atlas Mountains, and by the Morocco-Algerian frontiers in the north. Like under every arid and sub-desert system, water is the precious matter that the local inhabitant does preserve and use carefully. In fact, since antiquity, the water is mainly managed by traditional water laws. It became distributed within traditional canals that are perpendicular to the superficial oueds direction (oueds Ziz and ghriss). The shallow aquifer was mostly exploited by an ancient water system distribution called *khattara* [1]. Using this system, every land owner receives a precise number of time units for the irrigation. The area of study does have other large non-exploited water resources, including surface fresh water sources, and thermal waters in the great complex of Tizi'n Test faults. The studied waters have high salinity and still unusual for any exploitation. The aim of this work is to understand the geochemistry of those waters, their extension, and the possible links existing by different aquifers, and finally to give an

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Selection and/or peer-review under responsibility of the Organizing and Scientific Committee of WRI 14 – 2013
doi:10.1016/j.proeps.2013.03.162

idea about the water quality. Two important hydrological Basins Ziz and Rheris and occupying 27,500 km² were studied in the Tafilalet.

2. Geological data

The study area extends from the High Atlas in the north to the Anti-Atlas to the south. Its center is a part of the pre-African foredeep between the High Atlas and Anti-Atlas. The Cretaceous basin contains the Errachidia area [2]. The outcropping formations are mainly Cretaceous, they overlie the Jurassic. The stratigraphy ranges from Precambrian to Quaternary. Precambrian constitutes the eastern extension of the anti-atlas and is covered by folded layers formed during Hercynian phases. The Precambrian crops in other small areas and comprises shale, Precambrian rhyolites associated with conglomerates and sandstones assigned to the Precmbrian. The Paleozoic comprises basal schists, quartzites and some intrusive rocks. It is reduced under large anticlines or some buttonholes. The Mesozoic in the High Atlas, basalts, Triasic marls and Clay licks levels, plays an important role as substratum. The Jurassic rocks form the major representative of the lithology in the High Atlas and crops out in the northern part the of the Errachidia-Boudnib basin. The Lower Lias is calcareous and dolomitic and forms the dominant rock constituent in the High Atlas Mountains [3]. The Upper Lias sedimentation is predominantly marly limestone with alternating green marls with inter-bedded marly limestone. The Dogger has neritic facies in the Sahara becoming limestone in the area. At the end, the Dogger becomes detrital. The Jurassic is continental and detrital; it starts with heterogeneous conglomerates and sandstones. During the Cretaceous, a major transgression invaded the South Moroccan region and covers the current path south reaching the Atlas Tafilalet. It presents variations in thickness and facies. In the Upper Atlas, the Cretaceous is represented by red marls of the Cenomanian, and the Turonian comprises limestones, and ends with Cretaceous continental facies (Fig. 1).

3. Water Resources

Both oued ziz and oued ghriss basins are the most important hydrological basins in the area, they take their origin in the High Atlas mountains, they have an irregular flow. In the last decades, the Moroccan authorities built several dams in the area in order to guarantee permanent water supply for drinking and agriculture, and to preserve the oasis system and its neighbourhood from spectacular floods that occur during winter and spring [1]. Groundwater in the province of Errachidia is used by the authorities and population to ensure a permanent water supply (Fig. 1). These aquifers are located along valleys and characterized by their small size and their direct dependence on the variation of the climate and exploitation [4]. The deep aquifers that are divided from north to south into three hydrogeological units well separated: The High Atlas, the Cretaceous basin of Boudnib-Errachidia-Tinghir and the Anti-Atlas. High Atlas contains a set of hydrogeological units communicating with each other (Lias and Dogger). These aquifers give rise to several sources. The Cretaceous basin of Errachidia includes two aquifers that are from top to the bottom: The Senonian aquifer, it's artesian between Bouanane Boudnib; The Turonian limestones aquifer of which gives rise to Tifounassine sources, and Meski Tarda .Water table from the Infracenomanien (ex.Ain El Ati) is locally artesian it is drained by a complex khettaras in south of the area Goulmima Tinjdad. This water resource is not exploited due to its salinity .The layers of the Anti-Atlas are exploited by khettaras and wells [5].