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Geophysical and hydrochemical study of the seawater intrusion in Mediterranean semi arid zones. Case of the Korba coastal aquifer (Cap-Bon, Tunisia)

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ABSTRACT

Coastal aquifers serve as major sources for freshwater supply in many countries around the world, especially in arid and semi arid zones. The fact that coastal zones contain some of the densely populated areas in the world makes the need for freshwater even more acute. The intensive extraction of groundwater from coastal aquifers reduces freshwater outflow to the sea and creates local water aquifer depression, causing seawater migration inland and rising toward the wells. This phenomenon, called seawater intrusion, has become one of the major constraints imposed on groundwater utilization. As seawater intrusion progresses, existing pumping wells become saline and have to be abandoned.

In this paper, we have the results of the seawater intrusion study of the Korba aquifer by the geophysical and hydrochemical methods. In order to locate the zones affected by saltwater intrusion, 38 Vertical electrical sounding (VES) were distributed over the coastal area between Korba and Oued Lebna. The interpretation of these electric soundings using Winsev software, based on mechanical boreholes, carry out iso-resistivity and iso-depth maps of seawater intrusion. The maps of apparent iso-resistivity having different lengths of line and the pseudosections differentiate dry grounds, grounds saturated with fresh water and those saturated with brackish water and saltwater. Mapping of the boundaries between freshwater and saltwater is an ideal application for resistivity surveys because of the high electrical conductivity of the saltwater and its contrast with that of fresh water. The correlation of the different electric surveys allowed realizing geo-electric sections showing the vertical configuration of seawater intrusion. It comes out from this study that saltwater intrusion reached approximately a distance of 3 km inland.

The high groundwater salinity anomaly observed in Diar El Hajjej, Garaet Sassi and Takelsa-Korba zones was explained by the presence of seawater intrusion in these areas. This hypothesis is based on high chloride concentrations, the inverse cationic exchange reactions, and the lower piezometric level compared to sea level.

1. Introduction

Saline water intrusion into aquifers of many coastal areas has resulted in acute environmental problems. Excessive withdrawal of groundwater, as well as significant decrease in recharge of the aquifer due to less rainfall, has largely aggravated the hazard. The extent of saline water intrusion in any coastal area is influenced by the nature of geological formations present, hydraulic gradient, rate of withdrawal of groundwater and its recharge (Freeze and Cherry, 1979). Previous studies were interested in the seawater intrusion problem (Demirel, 2004; Duque et al., 2008; Frohlich et al., 2008; Gaaloul et al., 2003).

Surface geophysics is important for the investigation of the hydrogeology at depth, as well as for providing critical data on the geometry and characteristics of a source aquifer (Boughriba et al., 2006; Guasmia, 2008; Mhamdi et al., 2006). A geophysical study, based on 38 electrical resistivity measurements, was carried out in the coastal parts of the Korba aquifer. The purpose of this study is primarily to improve the knowledge of the aquifers at shallow levels and also to obtain a new geological, hydrological, hydrochemical and electrical model for the Korba aquifer.

1.1. Geographic situation

The study area, covering 430 km^2 (Paniconi et al., 2001), is located in northeastern Tunisia, within the eastern coastal Plain of Cap-Bon (Fig. 1). This aquifer is bounded to the South by Oued

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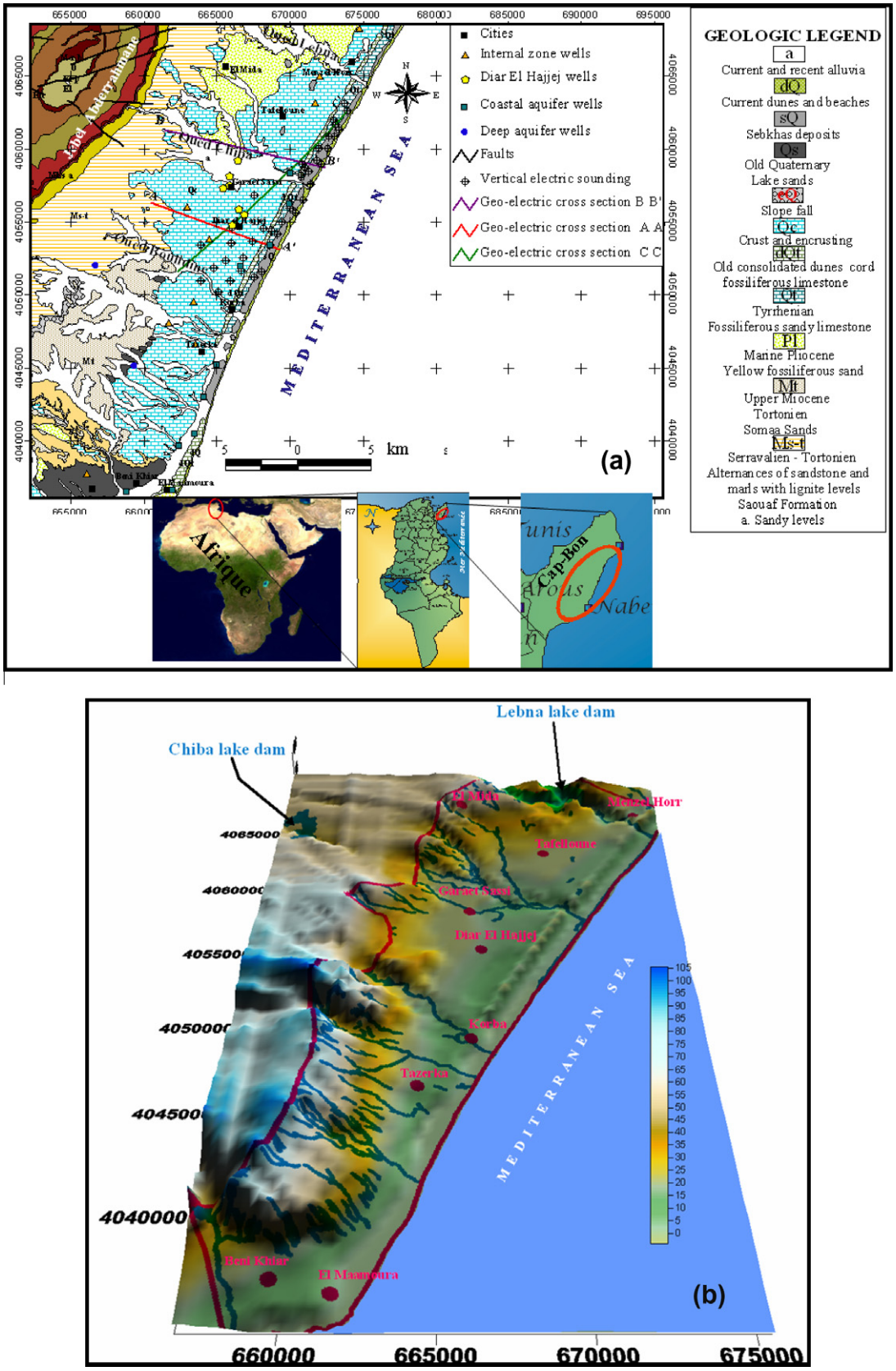

Fig. 1. Geology and samples and VES location in the Korba aquifer and 3D view of the studied area.