Geophysical Investigations for Groundwater in Outita, Morroco, using ERT Method

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***Abstract*—Morocco is a country in semi-arid to arid climate. Rainfall is irregular in time and space. Surface water undergoes very large fluctuations due to the hydraulicity of the year. Hence, the use of groundwater resources that play a very important role in supplying water to rural populations and irrigation.**

In this context a geophysical survey was carried out in Outita. The interpretation of ERT profiles oriented West-East showed a horst and graben structure and revealed the existence of water-bearing formations at depths of around 300m. To determine the lateral extent of these formations, two ERT profiles oriented in the North-South direction were carried out.

Keyword- Aquifer, Prerifaine Nappe, ERT Method, Geophysical Survey, Gharb Basin

I. INTRODUCTION

In order to identify and characterize formations that may be potential aquifers to meet the rural population's increased requirements for drinking water and irrigation in Outita plain (Fig.1), geophysical data produced in the area have been interpreted. This region is part of Gharb basin. This basin is bounded on the north by the Prérif, on the east by the prérifaines rides, on the south by the Moroccan Meseta and on the West by the Atlantic Ocean.

The Gharb basin knew many subsidences during certain periods, with a paroxysm in the Pliocene ([1]-[2]). The former works reflect the structural complexity of Gharb basin in general and particulary its eastern boundary.

This makes the determination and monitoring of the formations, constituted by permeable deposits likely to correspond to aquiferous levels, very difficult ([3]-[4]). The recognition of this limit is confronted with difficulties posed by the lack of data. This requires synthetic studies involving the local geology and a conduct geophysical survey based on electrical resistivity. This approach allowed the identification and highlighting of aquifer levels and the complex structure of the prérifaine ridges - Gharb basin limit.

The aims of the survey are the following:

1- Recognizing the different shallow and deep geologic formations as possible in this unexplored area.

2- Detecting the groundwater potentiality.

3- Identifying the structural characteristics of subsurface sequences.

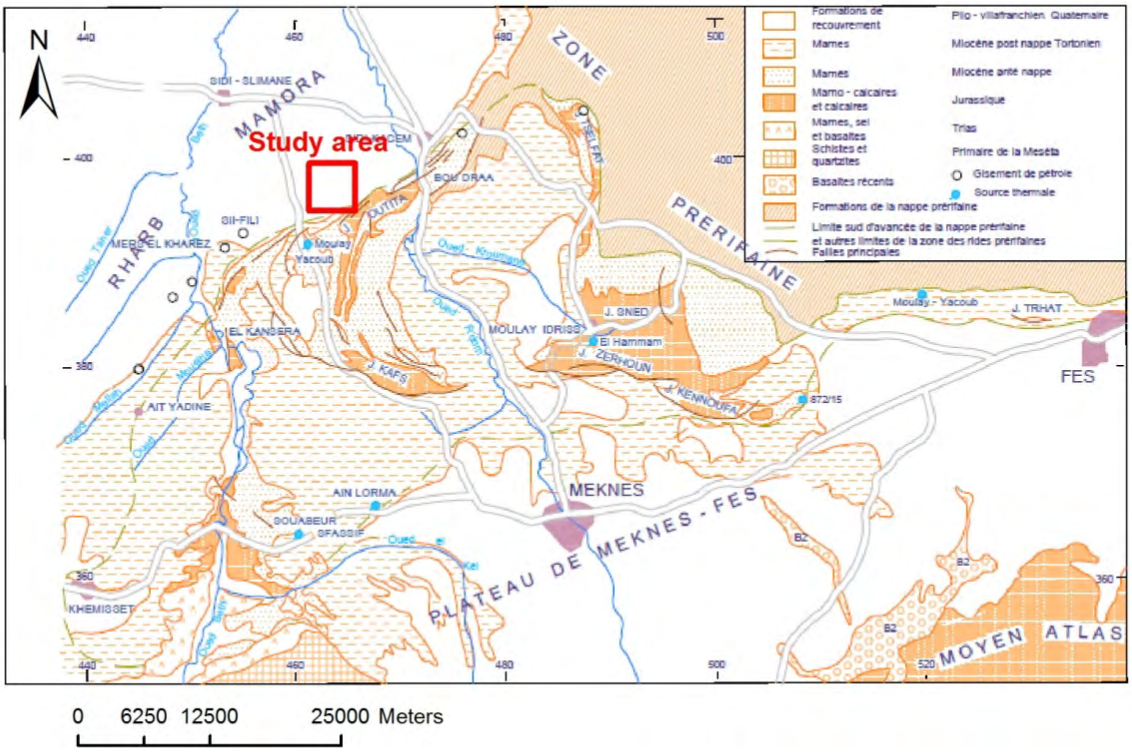

Fig.1 Geographical and geological situation of the study area [5]

II. METHODOLOGY

Electrical resistivity surveys have progressed from conventional vertical soundings to techniques such as ERT, which provides two and even three-dimensional high-resolution electrical images of the surface [6].

This electrical geophysical prospecting method consists of determining the distribution of a physical parameter that is characteristic of the subsoil (the resistivity) on the basis of a very large number of measurements of apparent resistivity made from the ground surface [7]. By measuring the electrical potential difference induced by an electrical current passing through a material, the resistance of that material can be calculated. By measuring the electrical potential difference induced by an electrical current passing through a material, the resistance of that material can be calculated. Variations in geoelectric behaviour make it possible to obtain 2D profiles. This technique constitutes one of the most effective non-destructive instruments available for studying and characterising discontinuities in the subsoil [8]. We used for this study a hybrid Wenner–Schulumberger array. This array arrangement is moderately sensitive to both horizontal and vertical structures. The median depth of investigation for this array is about 10% larger than that for the Wenner array for the same distance between the outer (C1 and C2) electrodes [9]. We used RES2DINV software to invert the apparent resistivity values of the real resistivity of the subsoil. The inversion routine used by this program is based on the smoothness constrained least-squares method ([10]-[11]). The 2-D model used by this program divides the subsurface into a number of rectangular blocks. The optimization method basically tries to reduce the difference between the calculated and measured apparent resistivity values by adjusting the resistivity of the model blocks. A measure of this difference is given by the root-mean squared (RMS) error.

Data sets were collected for eight 2D profiles (Fig. 2). Six ERT profiles were placed in parallel to the West-East direction. As a follow up to the observed results, two ERT lines were surveyed along the N–S direction, at the 1260m and 2700m points on W–E line, to determine the lateral extent of an observed high resistivity region (Fig. 2).

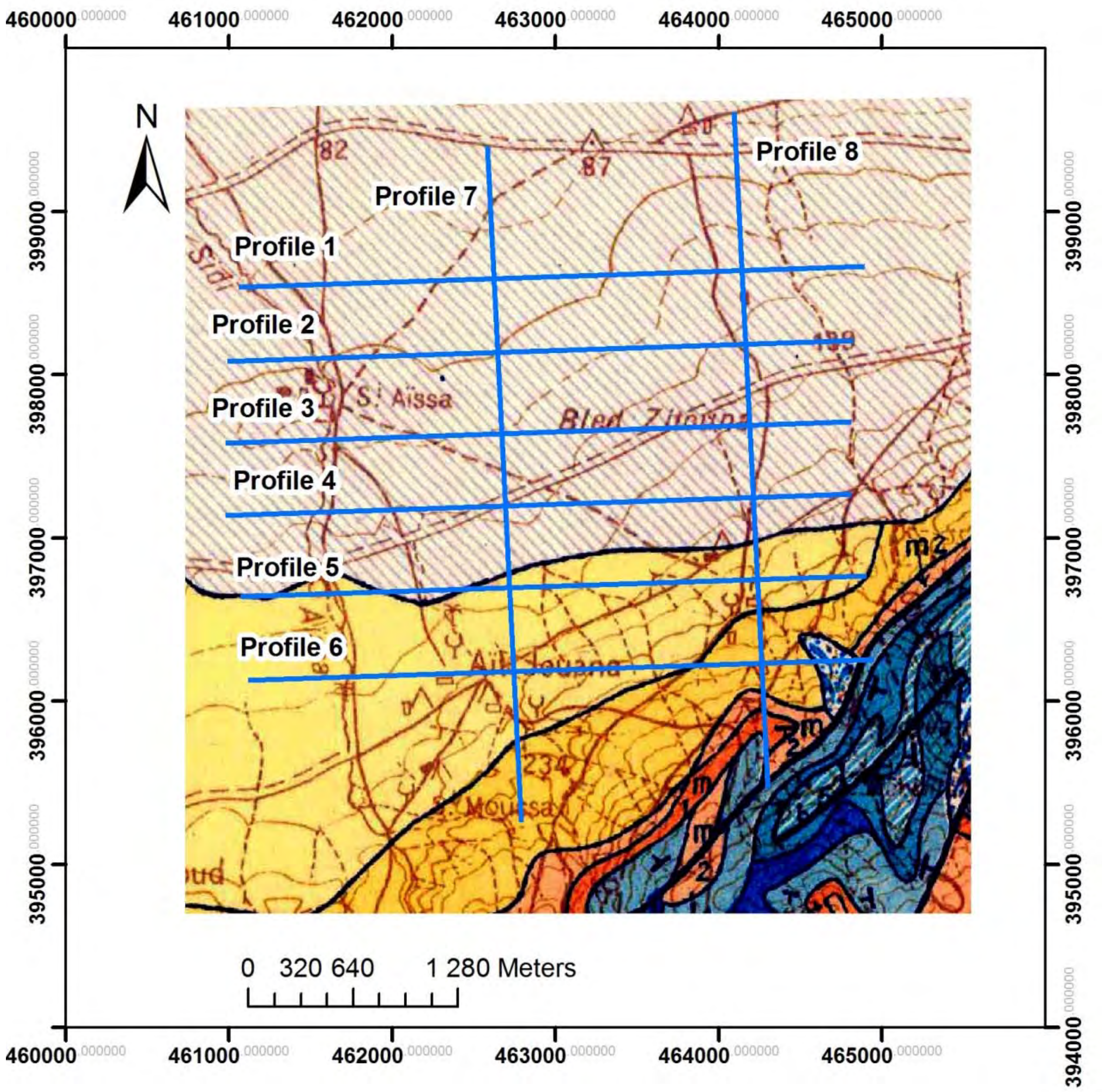

Fig. 2. Location of the ERT profiles

III. Results and discussions

The geoelectrical profiles (Fig. 3) showed resistivity values that varied laterally and in depth. We distinguish three levels according with the obtained resistivity values. In the upper part, there is a level with high resistivity. It corresponds to conglomerates that crop out in places. There is a second level with very low levels of resistivity. It corresponds to marly Neogene deposits. Finally, there is a third level that is deep and characterized by high resistivity. It corresponds to sandstones that are possible water bearing layer.

The 7th and 8th profiles show that sandstone layer is at 300m deep (fig.4). Its extent for the 1260m point on the line W-E is from the point 1440m 2160m point on the N-S line (profile7). While for 2700m point on the W-E line it extends from the point 1680m on the N-S line to the southern border (profile8).

The Neogene basin of the Gharb has become deformed at its borders what is due to tectonic movements of the Prerif and prerifaines ridges ([12]-[13]). The subparallel sections to the ridge (fig 3) show resistant formations with shape of horst and graben that sink deep leaving place for marly Neogene deposits. These marly deposits are very thick in north of the study area.

The perpendicular sections to the ridge (fig.4) also show the same structure of horst and graben. Approaching the ridge, the resistant complex is shallower; it is reached at 300 m.

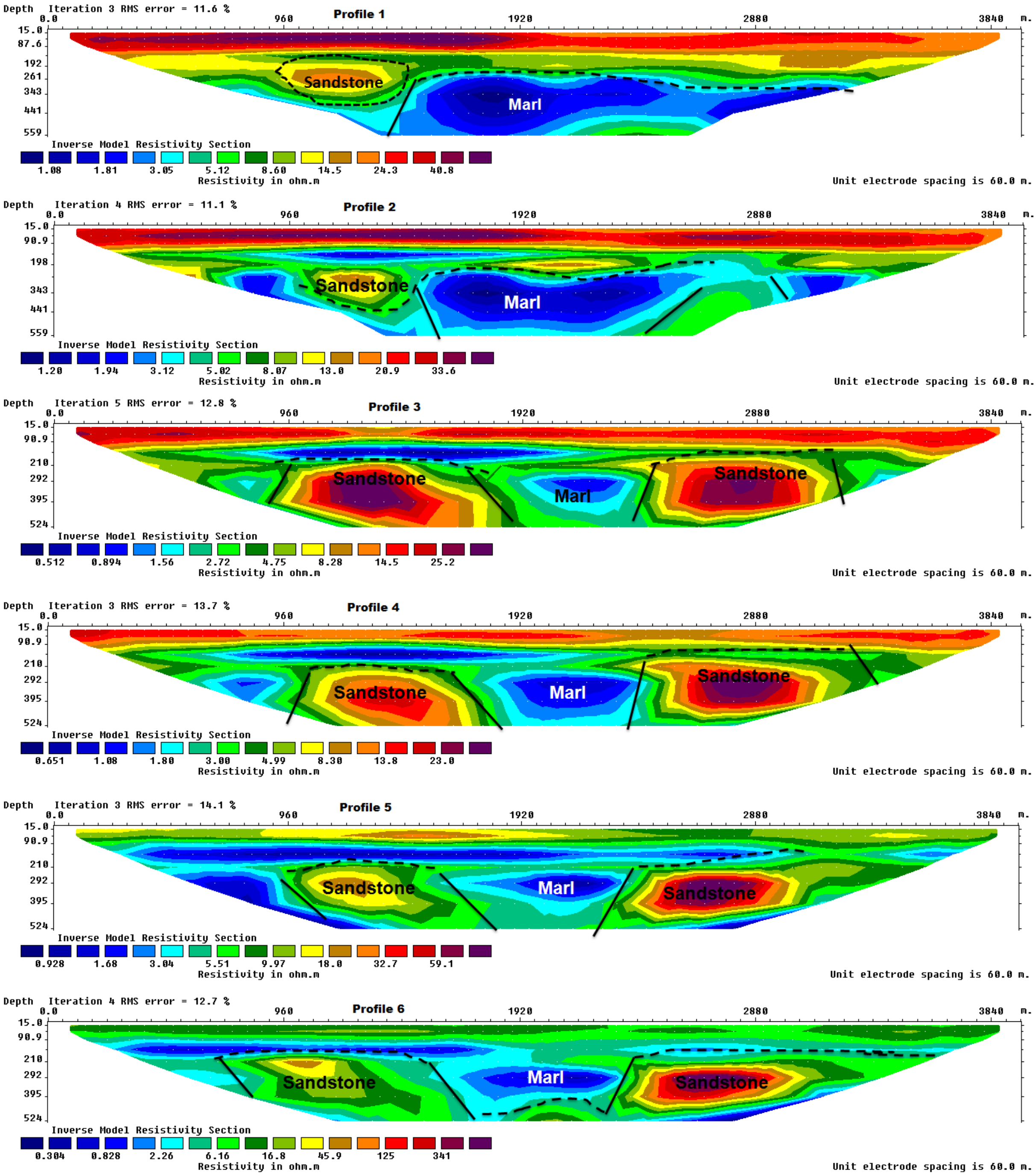

Fig. 3. Inverse model resistivity section along the west-east direction.

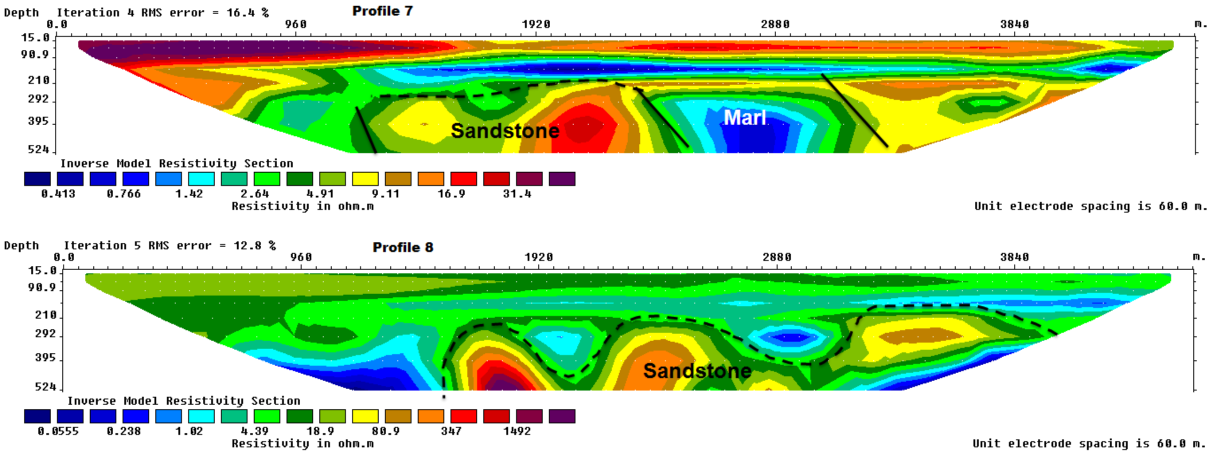

Fig. 4. Inverse model resistivity section along the north-south direction.

IV. CONCLUSION

Gharb Basin has been the subject of several geological, geophysical and sedimentological studies; however, the eastern boundary of the basin remains unknown. The geoelectric survey has shown the geological complexity of this boundary. The geoelectric profiles show a structure in horst and graben.

Neogene marls are very thick and dip when approaching the ridge. While sandstones which are a possible water bearing layer become shallower and reach 300m depth. they have a great extension for the 2700m point on the W-E line.

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