

THE GEOMETRY OF THE AQUIFEROUS SYSTEM OF THE TERRAGUOLT'S GRABEN BY THE GRAVIMETRY AND THE ELECTRIC PROSPECTING

Ali Brahmia¹, Azzedine Hani² et Christian LAMOUREUX³

¹ *Faculté des sciences, département des sciences de la terre. Université Hadj Lakhdar de Batna,*

05000 Batna, Algérie. alibrahmia@hotmail.com

² *Faculté des Sciences de la Terre, Département de Géologie. Université de Annaba, BP 12, 23000*

Annaba, Algérie.

³ *UFR des Sciences de la Terre, UMR 8110 Processus et Bilans des Domaines Sédimentaires, Bât.*

SN5, Université des Sciences et Technologies de Lille, 59655 Villeneuve d'Ascq cedex, France.

Abstract

The goal of the present survey is the determination of the shape of Terraguolt's graben aquifer system. The gravimetric survey brings a satisfactory answer in this sense that the residual anomaly map made appear a negative anomaly of - 20 mGals and that the gradient delimits the graben enough well.

The electric survey on the basis of the geologic informations and the few mechanical boring achieved in the plain permits to retail the facies of the replenishment better. Indeed some either the length of the current electrode AB line, the center of the plain makes appear of weak values of apparent resistivity, the shalky limestone's substratum of age superior Maestrichien is not reached in spite of a length of AB line = 3000m. Whereas the borders appear with resistivities more importants, in the center of the plain these last become more and more weak with the increase of the AB length. The shape of the graben is illustrated well in the electric cross sections and is confirmed by the interrelationship of the lithostratigraphique's columns of the mechanical boring.

The interpretaton of mechanical boring data shows two principlals aquifers : the first one is included in the karstified limestone of upper Maestrichien and the second one is in the replenishment constituted by sand, and gravel, pebble. This replenishment is estimated at 1200 m thickness. The piezometric maps shows that the aquifers are feeded from the the East and South mountains borders.

Keywords: " GRABEN", "TERRAGUOLT", "ELECTRIC SURVEY", "GRAVIMETRIC SURVEY", "LIMESTONE".

1. GOAL OF WORK

The goal of this work is the determination of the geometry of Terraguelt's graben that constitutes with its replenishment an aquiferous system important.

2. STUDIED SITE

The region of Terraguelt is in the constantine's high plains, limited at the North by dhebel. Tiguilaline, to the East by Dj. Terraguelt, to the South by the mounts of Ain Beida and to the west by the plains of Ain Beida and Berriches (fig. 1).

The region has a semi-arid climate with an average precipitation of 325 mm and 15.4°C as an average temperature.



Figure 1. Situation map of the studied area

3. STRATIGRAPHY

The region of Terraguelt is characterized by three geological units (fig.2):

3.1 The recent formations:

3.1.a : Quaternary: essentially formed of present and recent alluviums along the Wadis, arable earths, formations of slope, ploygénic glaze (silts, sands, gravels, pebbles and the chalky crusts of Villafranchien age).

3.1.b: Continental Mio-Pliocène: it is a yellow or ochers clays, badly cemented orange conglomerates, sandstone and of lacustrine limestones.

3.2 Allochthonous formations :

- **Miocène marine transgressif:** is formed of sandstone.

- **Coniacien and Sontonien:** 100-120 gray marls m showing on the surface in the region of Bir Bou Haouch,

- **Turonien:** to the basis 50 to 60m of marno-chalky surmounted by 25 to 30 m of biomicrites.

- **Cénomanién supérieur :**150-170 m of gray marls to small intercalations of marly limestones

- **Vraconien and Cénomanién basal:** of the gray marls to small intercalation of marly limestone.

- **Albien:** it is constituted of marls and gray and brunette clays.
- A formation triasique argilo-gypseuse varicolore and that includes blocks of dolomies.

3.3. North-Aurésian autochthonous formations:

- **Marine Miocène:** constituted of conglomerates, clays and sandstone.
- **Sénonian sommital:** it is formed of chalky limestone to whitish break in *Inocérames* in benches décimétriques rich in ferruginous nodules 100 m thick.
- **Middle and basal Sénonian:** it is a marly formation about 300 m thick with intercalations of nodular chalky layers.
- **Turonien:** it is constituted of marly limestones and marls.
- **upper Cénomaniens:** it is a marly formation to *rotalipores*.
- **Vraconien and the lower Cénomaniens:** these formation is similar to those of the basis of the Sénonien.

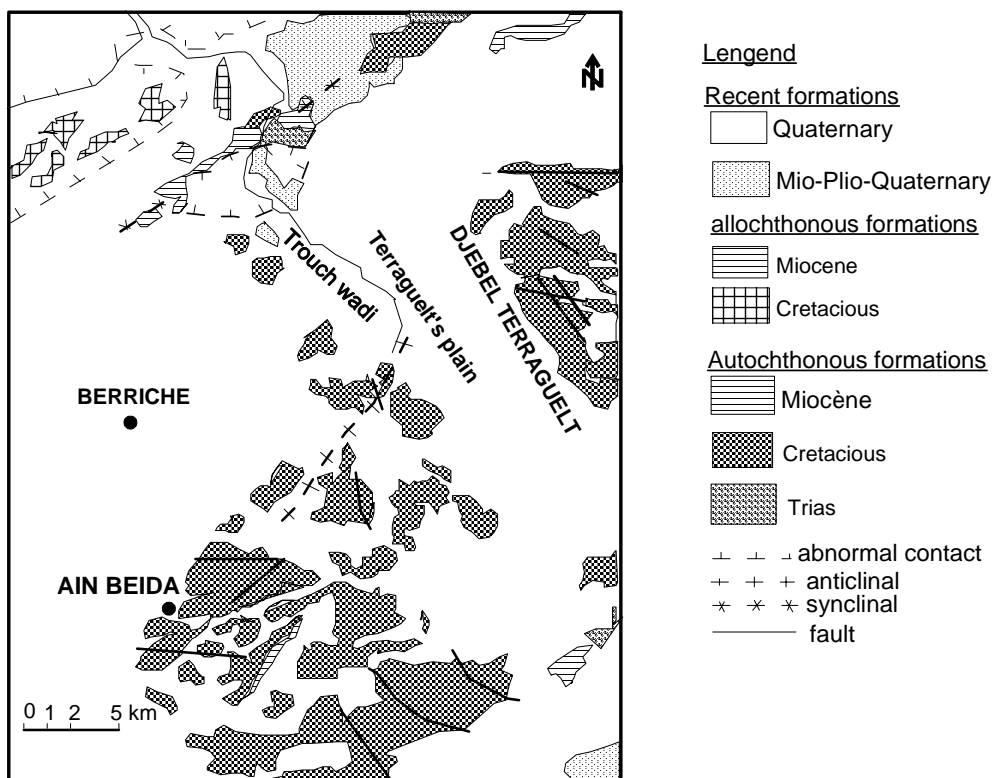


Fig.2.simplified geological map of studied area

4.TECTONICS

On the geological map there are four main orientations of faults :

- NW-SE
- NNW-SSE
- E-W
- N-S.

The folds of limestones have a direction N 40° E

5. MATERIAL AND METHODS

5.1. The two geological maps of Berriche and Ain Beida, scale 1/50 000.

5.2 The spoliation of the data of 23 borings distributed on a large part of the plain.

5.3 Two methods of geophysical prospecting have been used to reach our aim:

- several cards of isorésistivities to different current electrodes spacings, (ALGEO, 1979), have been reinterpreted as well as two electric cross sections.

- the interpretation of the Terraguelt's gravity data survey (Zerdazi, 1990)

5.4. Piézométric investigations done on wells (May 2006)

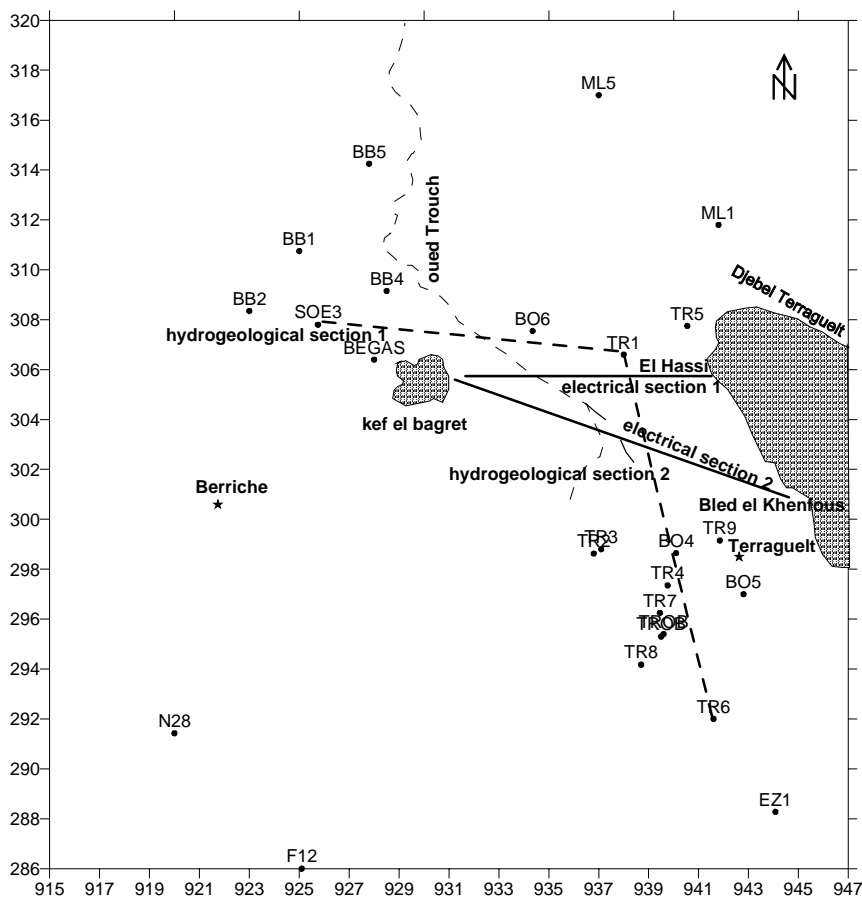


Fig.3. situation map of electric, hydrogeologic cross sections and borings

6. RESULTS

6.1. Identification of the aquifers:

The processing of the boring data allowed us to recognize the following aquifers (fig. 4):

1 - an aquifer constituted of pebbles, gravels and sands sometimes mixed with a few clay. The thickness is from 3 m (TR1) to 194 m (TR7), confined in its major part under a red clay roof sometimes gritty or by a chalky crust of a variable thickness going until 32. In the SouthEast part of the plain this aquifer becomes free. In the plain's borders this aquifer directly rests on the karstified limestone of upper Maestrichien .

2 - an aquiferous of upper Maestrichtien fissured and karstified limestones outcrops in border and constitue the main reliefs of the area.

The hydrogeological sections 1 and 2 shows that the limestones aquifer is deeping abruptly under the first aquifer in lateral borders, and progressively from the South to the North.

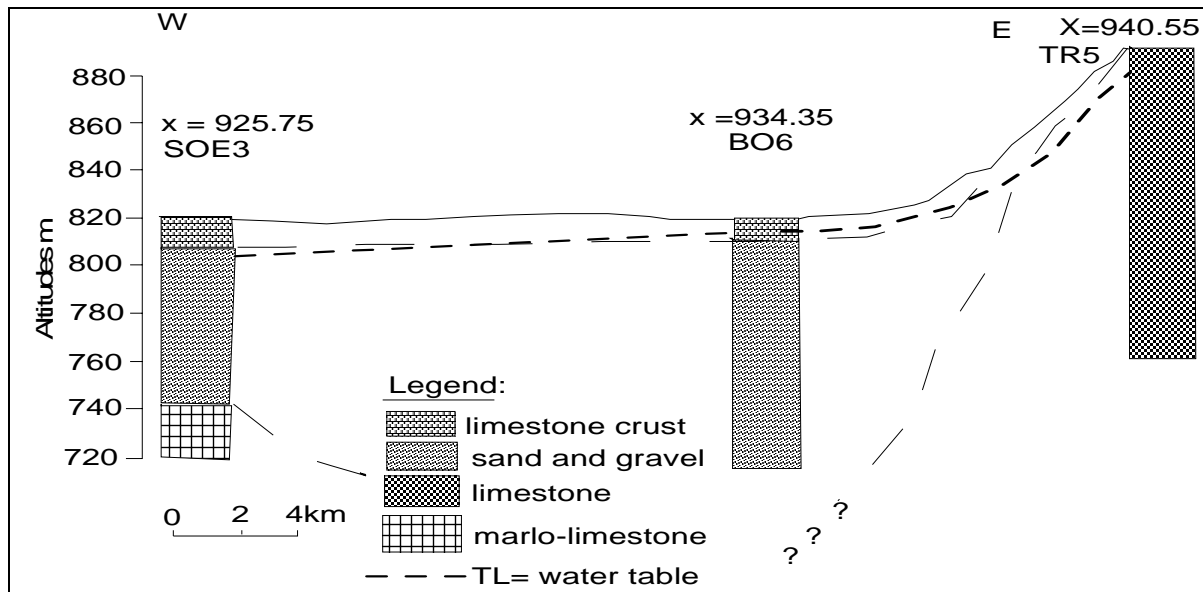


Fig.4. hydrogeological cross section from boring data, showing main aquifers

The piézométric map (may 2006) shows an out-flow of the underground waters toward the center of the plain with a convergence zone in the west of the djebel Terraguelt.

The underground waters comes from the chalky maestrichiens limestones situated in East, West and South of the plain. The hydraulic gradient is strong in East border and weak in the South (fig.5)

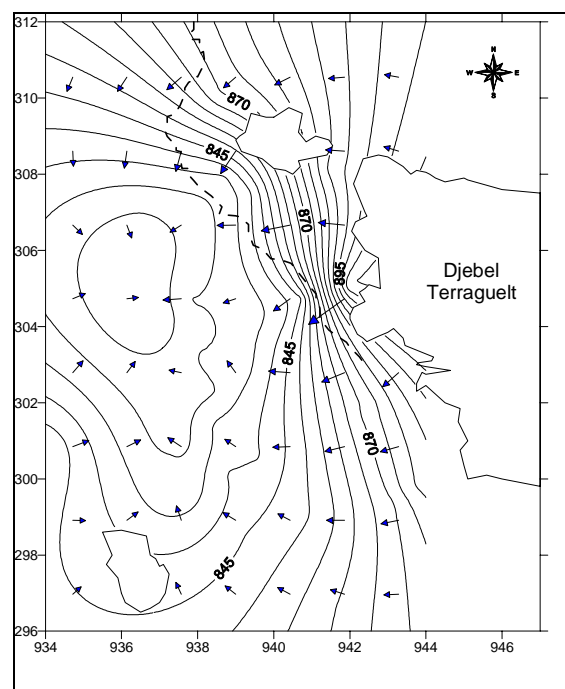


Figure.5. Piézométric map of Terraguelt's plain (may 2006)

6.2. Interpretation of the electric survey data :

For an adequate understanding of the stratigraphy of sedimentary cover, the depth to basement and the shape of the Terraguelt's plain formed by fissured and karstified limestones, we reprocessed the apparent isorésistivities maps to different spacings of current electrodes (AB).

6.2.1. The apparent isorésistivities maps:

- AB = 80m (fig.6) :

For this spacing the investigating depth is of 8 to 20m, from this map the center of the plain, the apparent resistivities are lower to 20 ohms.m bordering the main river that drains the

plain. On the other hand on the reliefs of karstified and mineralized limestones the values are raised more of the order of 40 ohms.m notably Terraguelt's djebel.

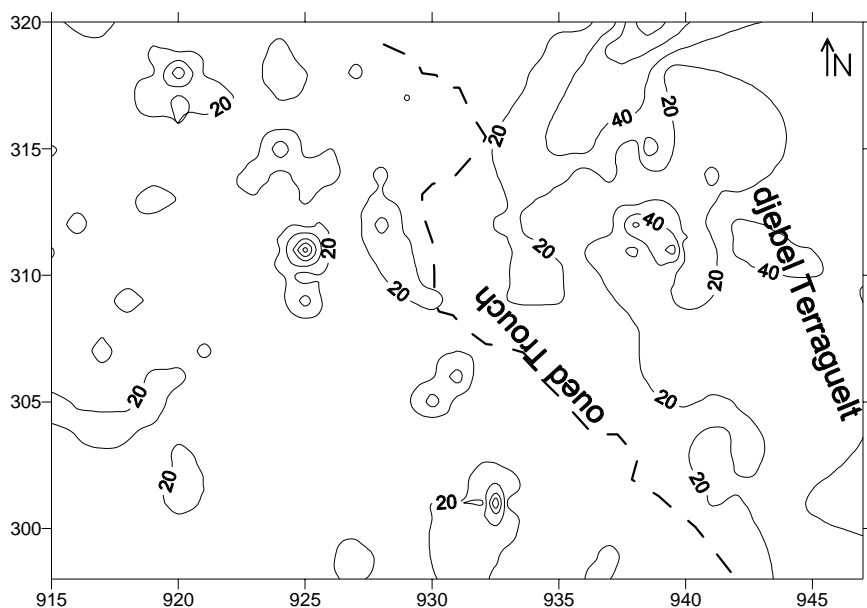


Fig.6. isorésistivity map. AB = 80m

- AB = 400m (fig.7) :

The investigating depth is 40 to 100m to the neighborhood of Terraguelt djebel, the apparent resistivities are of 10 to 55 ohms, in the center, they are lower than 10 ohms.m, in West border they are from 15 to 60 ohms.m.

These values in borders of the plain always correspond to karstified, mineralized limestones and saturated in water contrary to the weak values recorded in the middle of the plain that corresponds to the different Mio-Plio-Quaternary replenishment.

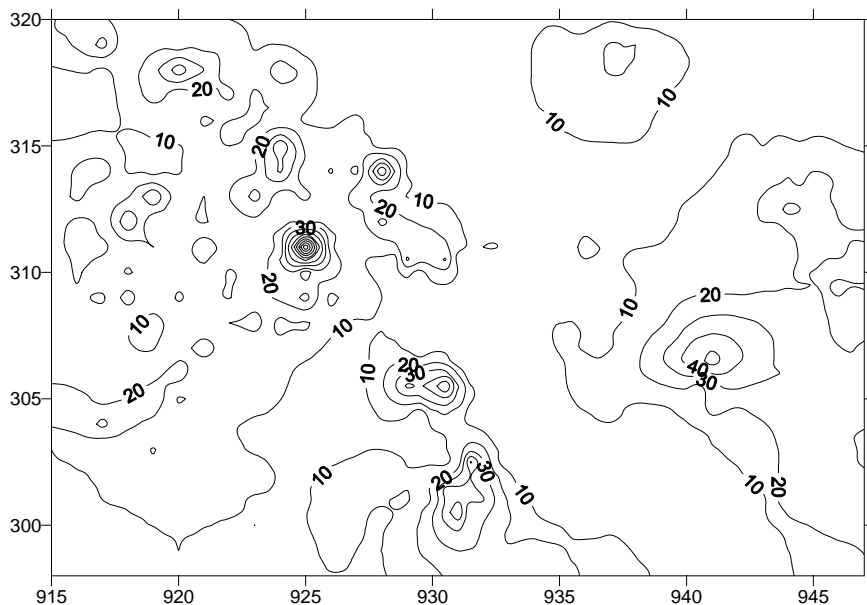


Fig.7. Isorésistivity map. AB = 400m

- AB = 3000m (fig.8) :

The depth investigation is 300 to 750m in AB, this map shows in the center of the plain values inferior to 10 ohms.m, that means that the limestones are even deeper and that the replenishment becomes more thick to a few hundreds of meters.

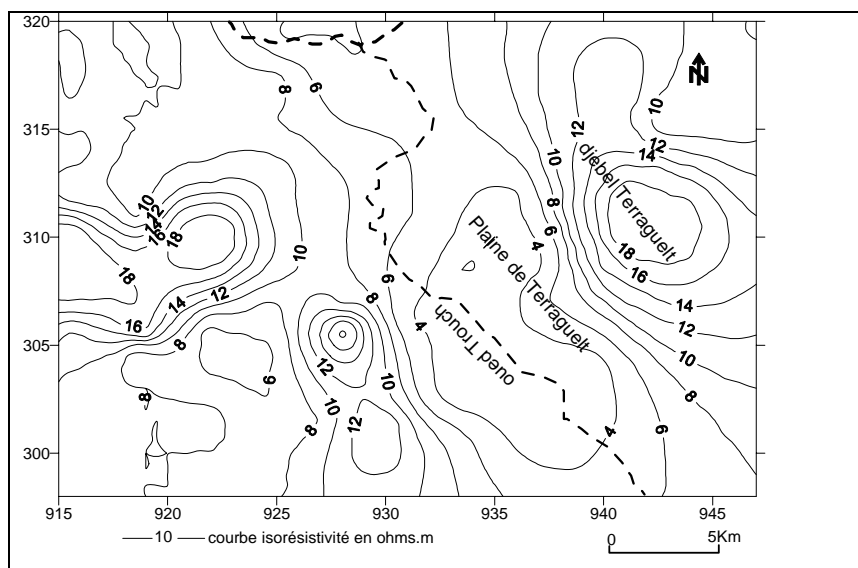


Fig.8. Isorésistivity map. AB=3000 m

6.2.2. Interpretation of the electric cross sections :

- Nr 1(fig.9):

This electric cross section1 oriented E-W (fig. 9) shows in East border of the plain an horizon of 50-100 ohms.m probably affected to the chalky upper Maestrichiens karsitified limestones covered by another horizon of 10-20 ohms.m that becomes thicker while approaching of the middle of the plain that we can affect to the important deposits of alluvium.

In part and in surface this cross section shows a small nearsurface horizon of 40 to 60 ohms.m that can be interpreted by a chalky crust met in the logs of boring.

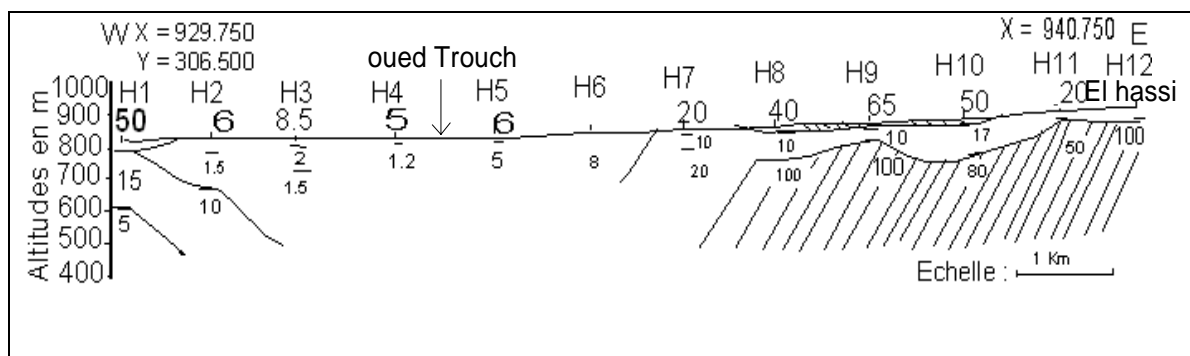


Figure.9. Electrical cross section 1

- Nr 2 (fig.10):

It is oriented NW-SE in order to connect the two borders of the plain of a sixty of ohms.m joining a thick formations of very weak values in the middle of the plain and notably to the neighborhood of Trough wadi.

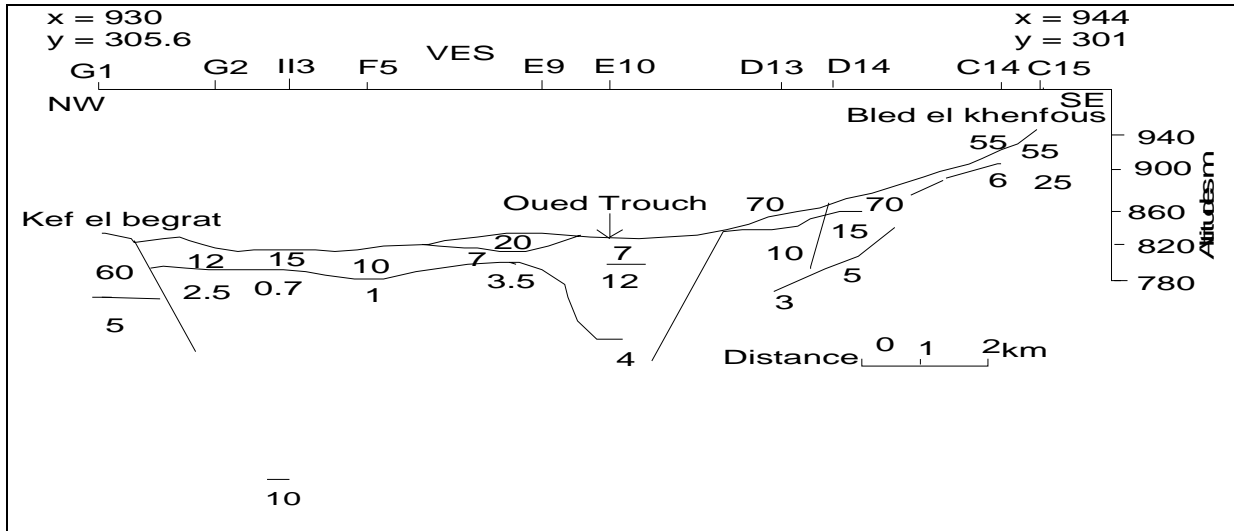


Figure.10. Electrical cross section 2

6.3. Interpretation of the gravimetric data :

The graphic interpretation of the residual anomaly map shows a negative anomaly of -20 mgals in the center of the plain oriented SE-NW while changing direction in the north of the plain to become NE-SW (fig.11)

In this map the we have a high gradient of curves on both sides of the center of the anomaly that means that the transit of strong density lands (chalky Maestrichiens limestones) to the lands of weak density (marls, clays, sands, gravels and pebbles) is abrupt.

From the South to the North, the gradient becomes weaker explained by the progressive deepening of the limestones.

The graphical interpretation of this anomaly allowed us to estimate the depth of the chalky karstified limestones aquifer (base of alluvium deposit) to **1200m**.

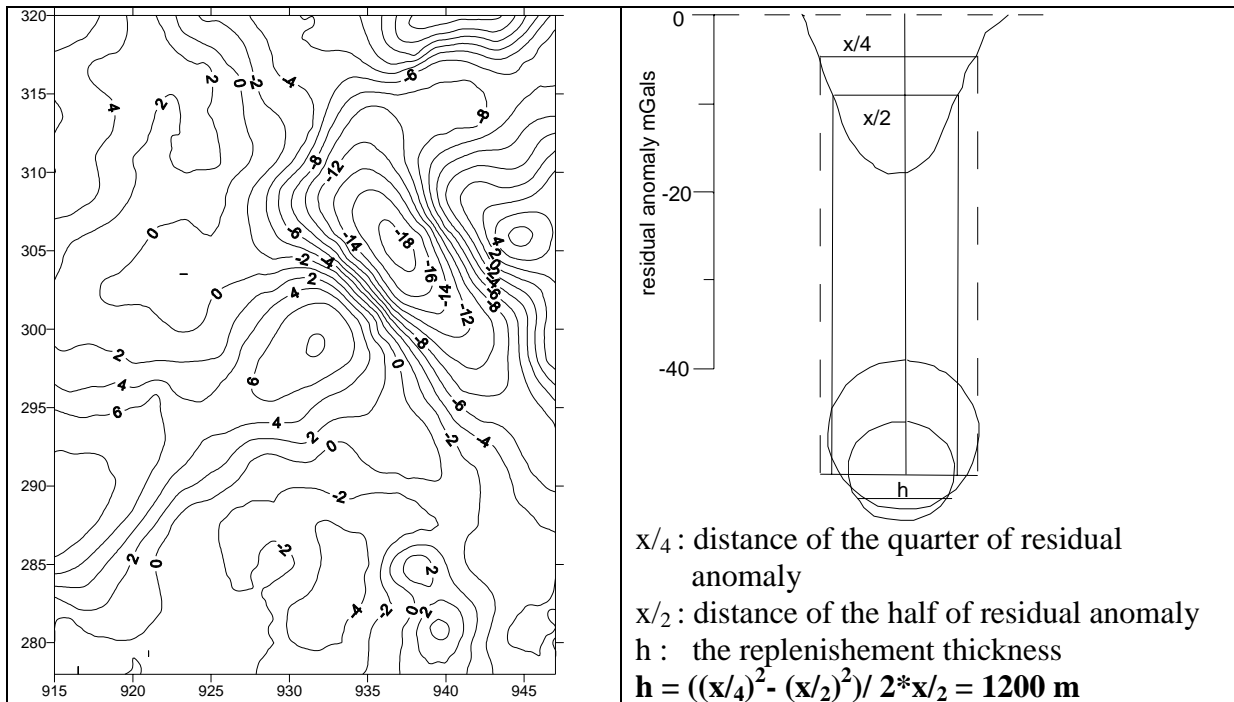


Fig.11. Residual gravimetry map of Terraguelt's area and its interpretation.

6.4. Interpretations of the columns of boring data:

The lithostratigraphic interrelationship between the boring TR6 (South), B04 and TR1 (North) shows a deepening of the chalky upper Maestrichiens limestones from the South to the North under the alluvium replenishment (fig.12).

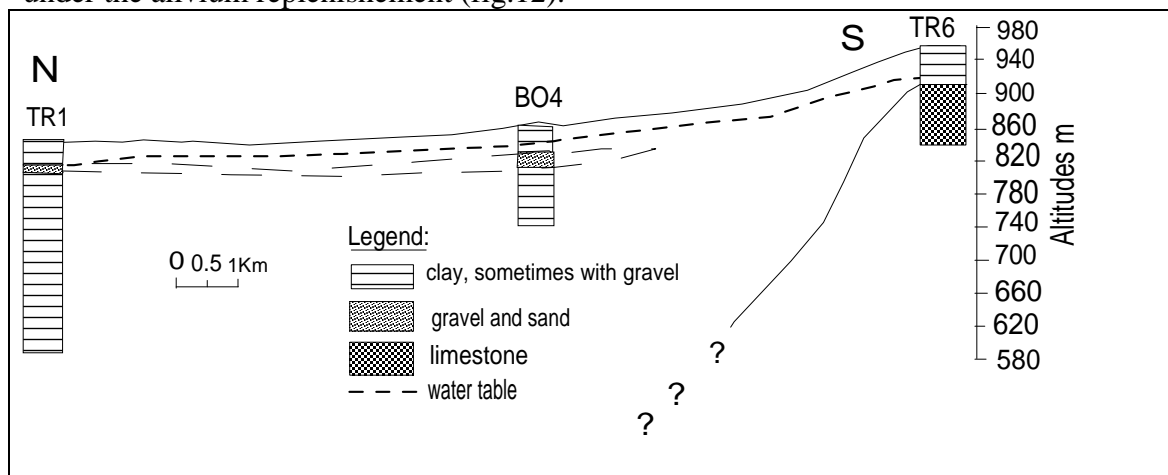


Fig.12. The lithostratigraphic interrelationship between borings from South to North.

7- DISCUSSION OF THE RESULTS

- The spoliation of the data of boring permitted to identify two aquifers, the first one in a pebbles, gravels and sands horizon but the absence of the deep boring doesn't permit to know its maximal thickness, the second is accommodated in the chalky karstified limestones of upper Maestrichiens that constitutes the base of the Mio-plio-Quaternary which is sometimes deepening abruptly to constitute an important graben.
- the interpretation of the electric survey maps doesn't permit to identify the different aquifers horizons in the center of the plain in spite of the different spacing of current electrodes.

The limestones are identified in border of the plain but the electric method doesn't bring any information on them in the middle in spite of a length of electrode of AB current = 300

- The electrical cross sections show the aspect of downfall of the limestones near the borders of the plain but in the center hundreds of meters of formations are very conductors.
- the gravimetry brings an acceptable answer on the geometry of the aquifers of the limestones with an abrupt downfall in East and West border, from the South to the North it is on the other hand progressive, until 1200m in the center of the plain.

GENERAL CONCLUSIONS

We can conclude that:

- the plain of Terraguelt has a geometry of a graben filled by movable sediments (marl, clay, sands, gravels and pebbles) that can reach the hundreds of meter thick.
- Two main aquifers are identified in this plain, one constituted of sands, gravels and pebbles whose maximal thickness is not reached for lack of perfect boring in the center of the plain, the second one is formed by fissured and karstified Maestrichiens limestones, the last one constitute the base of the first one in the border before deepening in the center hundreds of meters.
- the thickness of the replenishment is estimated to 1200m
- These two aquifers are in hydraulic link in border.

- The flow of underground waters is mainly coming from the reliefs in the East and the South of the plain.

Références :

- [1] ALGEO.(1979) - Prospection géophysique dans la zone de Terraguelt prospection électrique, rapport interne D.H.W.
- [2] Meyer.De Stadelhofen.C (1991) - Application de la géophysique aux recherche d'eau, technique et documentation-Lavoisier.Paris-France.
- [3] Vila.J.M (1973) - Carte géologique de Berriche (Jean Rigal), échelle :1/50 000
- [4] Vila.J.M (1973) - Carte géologique de Ain Beida, échelle : 1/50 000
- [5] Vila.J.M (1977) - Carte géologique de Constantine, échelle : 1/200 000
(Toulouse –III)
- [6] Zerdazi A. (1990). Etude gravimétrique du môle de Ain M'lila et de l'atlas saharien septentrional oriental (NE Algérie). IGL, Lausanne.