Realization and Interpretation of Hydrodynamic Characteristics (Permeability Transmissibility and Specific Discharge) from Pumping Tests in the Area of Tebessa in the far East of Algeria

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ABSTRACT

The present work was realized in the semi-arid region of Tebessa, some 230 km in the south of Annaba. The interpretation of some pumping test results conducted to the calculation of different transmissibilities (Y) whenever pumping test data were missing specific discharge (X) values were used.

A regression line had been fitted to these two (02) variables (r=0.929). hence theoretical values of Y were obtained.

The permeabilities were mapped using geophysical profiles on which the wells had been placed and therefore the thickness (e) was obtained. The relationship K = T/e gives the value of K for each well.

The analysis of computer mapping permits to classify the three parts of the plain according to the values of Q/S, T and K. From a ground water flows stand point, the aquifer is more interesting as these values become higher. Our result show an important decrease of these values from Ain chabro to Bekkaria and Tebessa.

GEOLOGICAL LOCATION

Tebessa (Fig. 1), known in the olden days as the vest, is an ancient town, characterized nowadays by art and history. Its distinguishable carpets and its roman wall are many centuries old.

Border town with Tunisia, it is located in the North-East of Algeria, at the threshold of the Sahara desert. It is bordered to the North by Annaba (230 Km), to the South and East by Tebessa mountain range and to the West by Djebel Doukkane.

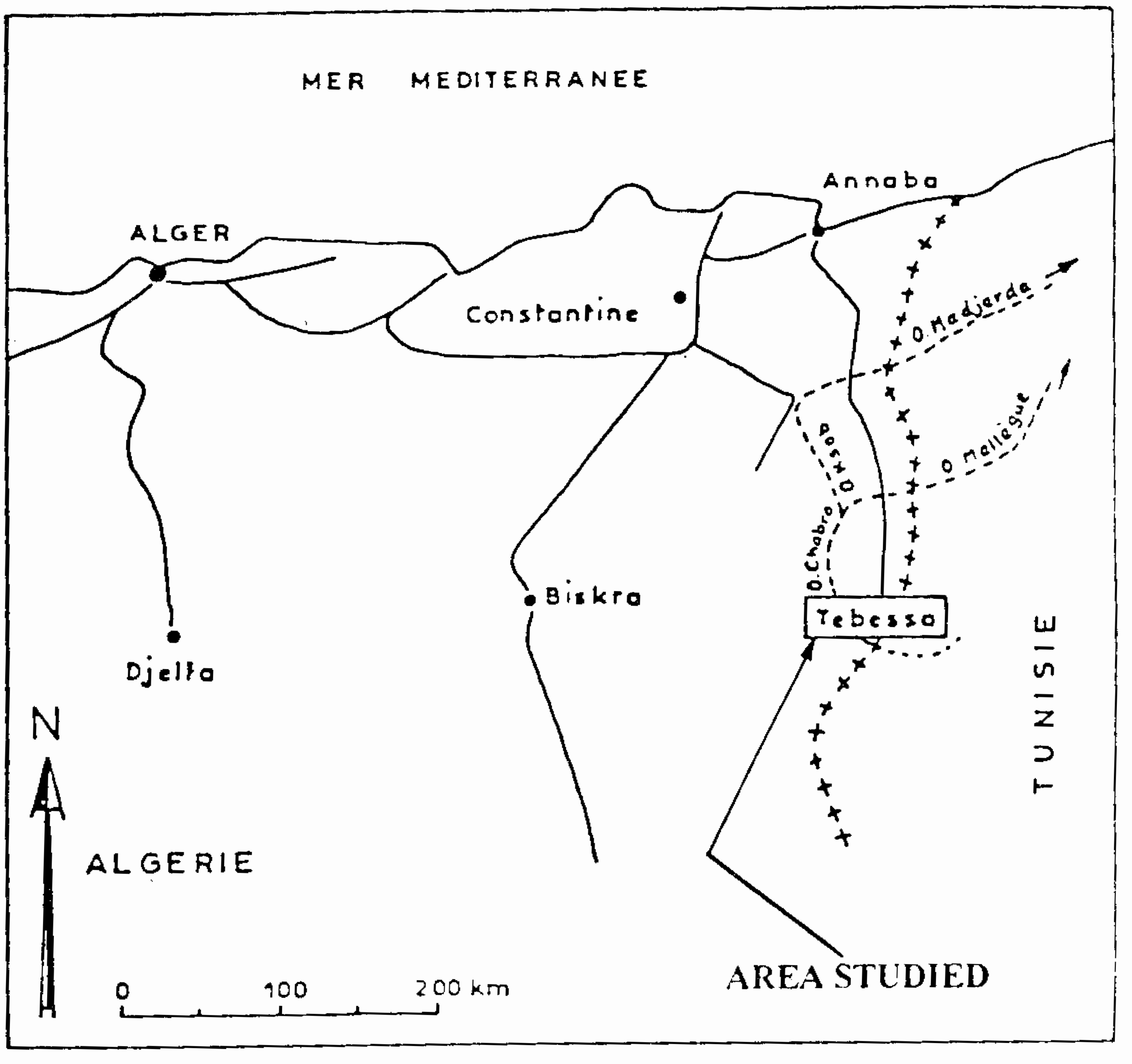

Figure 1. Geographical situation

GEOLOGICAL BACKGROUND

Geological context

The region studied is part of Oued Medjerda basin and Mellegue sob-basin (Fig. 2).The total surface of the area studied is 1.200 km^2. The limits are approximately:

- to the North, the road Ain-Chabro - Djebel Boulhaf
- to the South, the water divide of Draa elma Labiod and Doukkane.
- to the West, Djebel-Tazbent
- To the East, the water divide of the highland (Beld-ben Falia, Gouraye and Djebel DYR)

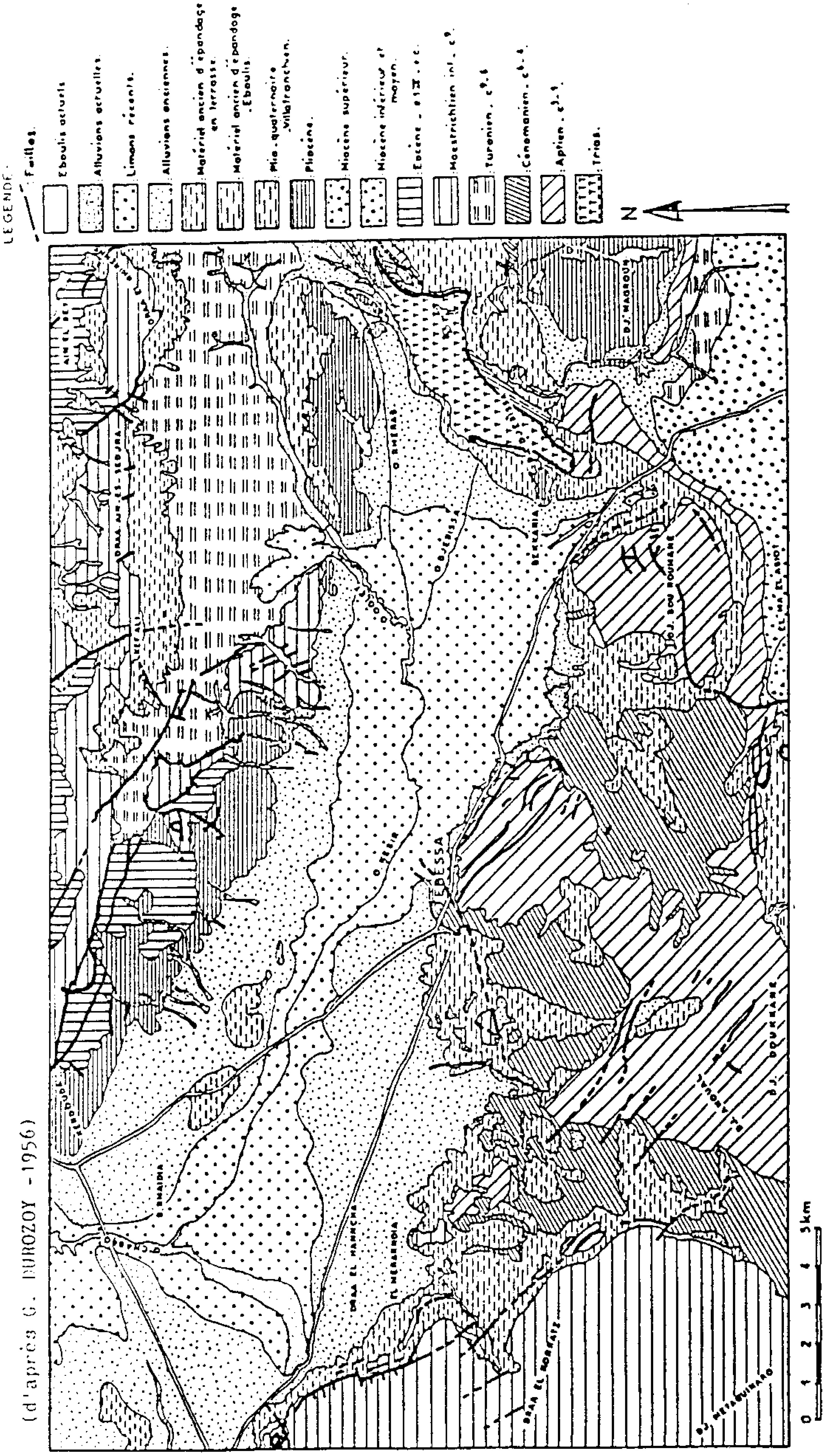

Figure 2. Geological map

Facies description

Present and recent alluvions: this formation is not very important made of calcareous gravel.

Recent silt: it is due to the presence of alteration and leaching of nearby marl.

Calcareous crust: it is a calcareous formation whitish, sometimes punky, with concretionary aspect, cementing brechic calcareous elements.

Breccia and gravel of ancient out pouring: these cemented breccias are in general slope formations with a thickness of few meters the calcareous elements are angular.

Plio-quartenary: It is made of conglomeratic formations better observed near recent fractures.

Pliocene: Overlies to a great extent the Eocene limestones in the North-East border of the lowland and the Maestrichien of the North-East border.

Chabro-Tebessa-Bekkaria trench

The back filling surface falls progressively from 900 m at Bekkaria to 770 m at Ain Chabbro.

The graben which is filled with an alternation of several hundred meters of gravel, sand marl and silt is a mater trap with deep aquifers reached by the bore holes and a phreatic aquifer where wells are located.

HYDROCLIMATOLOGY

Climatology

Tebessa has a climate of continental type (Fig. 3). Annual rainfall is of about 400 mm/year. E.T.R. computed using Coutagne Formula, is some 350 mm which gives an R.U.U of about 30 ± 5 mm. According to J.C Fontes (oral communication 1986) and using the isotope method, in Beni-Abbes (Algeria), for an aquifer seven meters deep and a rainfall of 30 mm/year, the R.U.U is 2 mm.

Hydrology

Springs are situated at the border of the lowland. They originate in the calcareous formations, except of Ain Bekkaria, Ain Khanga and Ain Tnoukla which originate in the sandy miocene formations.

Aïn El Gaïd spring is a result of the out pouring of the alluvial aquifer with a low flow rate.

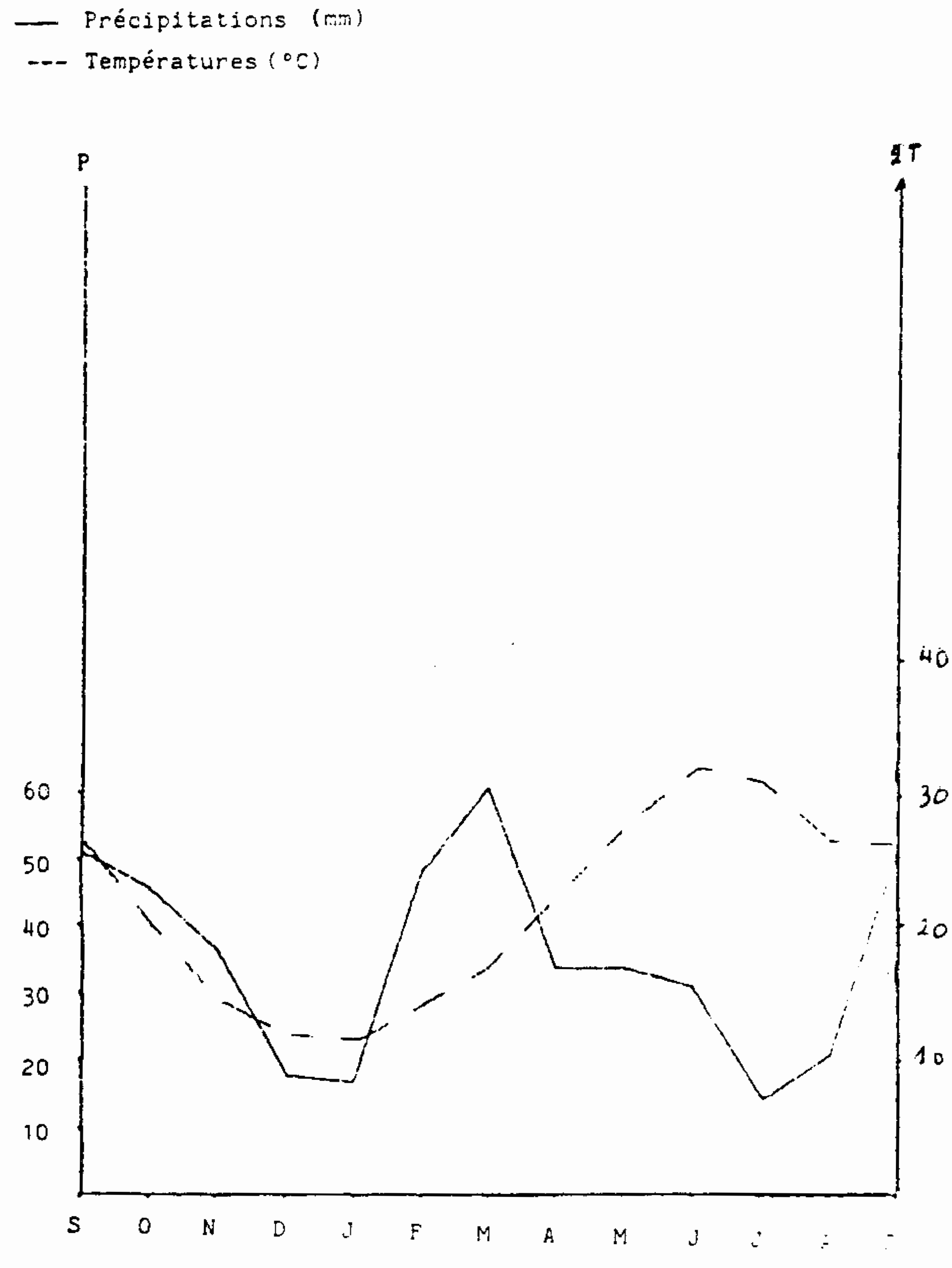

Figure 3. Pluviometric curve of Tebessa

UNDERGROUND HYDROLOGY

Hydraulic characteristics

Transmissivity (T) is defined as the product of the horizontal permeability coefficient and the thickness of the aquiferous strata: T = Ke this parameter characterizes the aptitude of the aquifer to transmit water. It's dimension is $L^2 T^{-1}$.

Storage coefficient (S) is the volume of water liberated by one square meter of the aquifer when the hydraulic charge varies by one meter (one meter abatement).

Hydraulic charac BOREHOLE	Td m^2/s	T uprise m^2/s	TM m/s	K	S
BE_1	$8x10^{-3}$	$9x10^{-3}$	$8.5x10^{-3}$	$8x10^{-4}$	
EK_1	$2x10^{-4}$			10^{-5}	
W_2.Bis	$2x10^{-3}$	$3x10^{-3}$	$2.5x10^{-3}$	$2x10^{-4}$	$3.8x10^{-2}$
AC_1	$3.7x10^{-3}$	$4.5x10^{-3}$	$4.1x10^{-3}$	$4x10^{-5}$	
M_2Bis	$6x10^{-4}$			$1.5x10^{-5}$	
J_{2-3}	$1.8x10^{-3}$			$2x10^{-5}$	
Z_1Bis	$4x10^{-3}$	$1.6x10^{-3}$	$2.8x10^{-3}$	$4x10^{-4}$	
Q_5	$2.3x10^{-3}$	$8x10^{-4}$	$5.15x10^{-4}$	$1.6x10^{-5}$	
V_4	$3.9x10^{-4}$	$4x10^{-4}$	$3.95x10^{-4}$	$2.6x10^{-5}$	
T_2	$2.8x10^{-4}$	$2x10^{-5}$	$2.4x10^{-5}$	$8x10^{-7}$	

Conclusion: Transmissivity and permeability values are rather low.

Cartography of hydrodynamic characteristics

Levels P1, P2 and P3 being mapped, it is of interest to map permeability values compiled from specific flow rate and transmissivity values

Methodology:

To plot the three maps, Cartplot programm and borehole record chart (INRH) were used. Flow rate a rabatement and transmissivity values are used as well in a first stage specific flow rate are computed which allowed a correlation log (Q/S)- Transmissivity to be made.

Correlation was carried out using cartplot and the following relation given:

$$Y = 2.686\ X - 1.494 \quad \text{with } r = 0.929 \qquad (1)$$

Equation (1) allows transmissivity to be computed by substituting in each borehole X by log (Q/S).

In order to draw the permeability map, geophysical profiles and boreholes allowed the determination if the thickness e in each aquifer (see previous chapters P1, P2 and P3). Relation K=T/e allows the permeability value for each borehole to be computed.

Remarks:

N.B: In order to discuss the three maps, the lowland is divided in three parts: Ain-Chabro, Tebessa and Bekkaria.

We discuss the results shown as maps starting from the crude of Q/S, then from the computed transmissivity and last from the permeabilities deduced from the latter.

*Specific Discharge rate map (Fig.4):

- Ain-chabro: The highest values are located in this zone, values are ranging from 100 to 1000 m^2/j.
- Tebessa: Values are rather low, ranging from 60 to 80 m^2/j.
- Bekkaria: Specific Discharge rate values are higher than those of Tebessa, they range from 80 to 100 m^2/j, with $Q/S_{max} = 1.1 \times 10^3\ m^2/s$

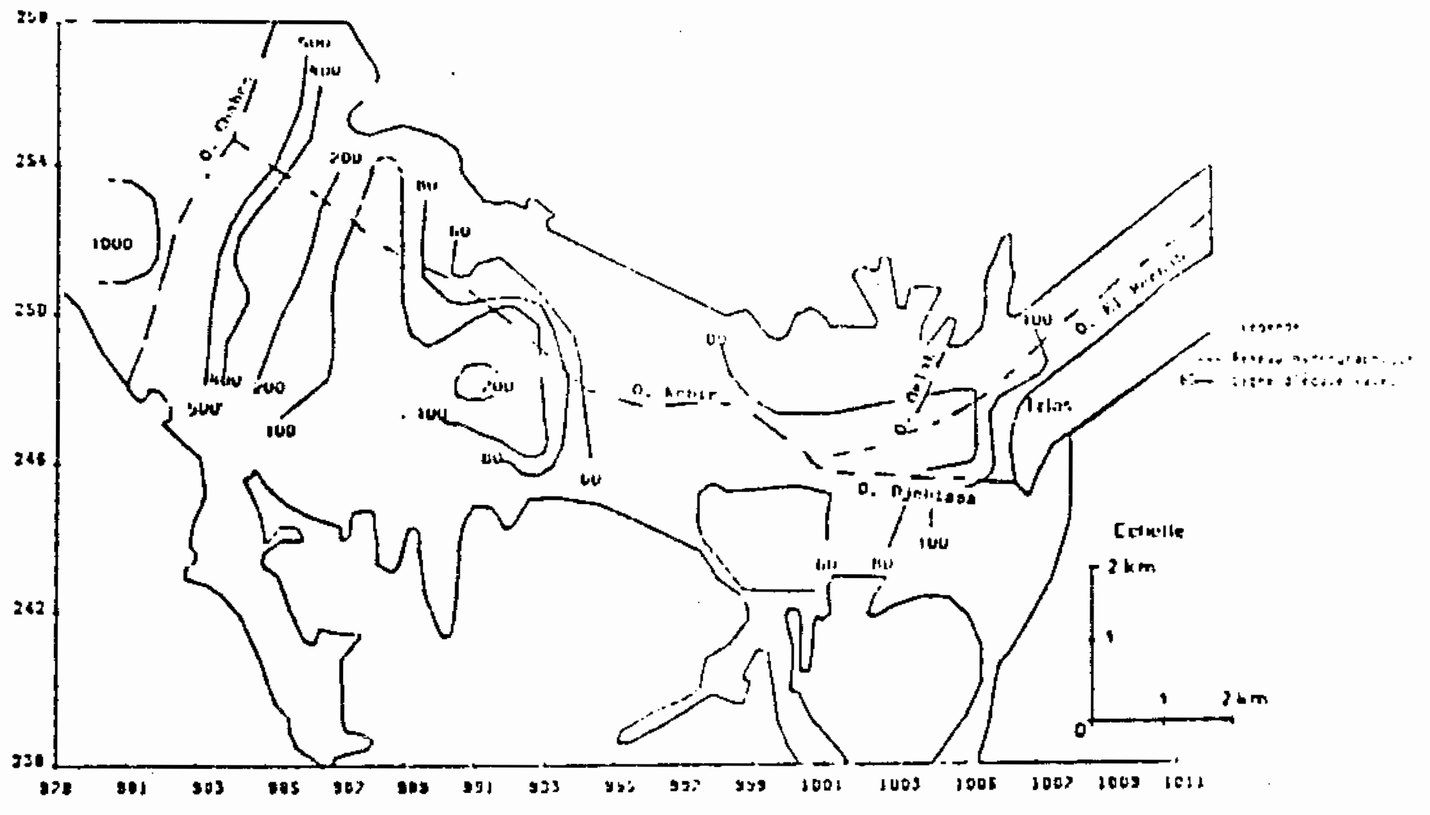

Figure 4. Map of specific discharge (m^2/j)

*Isotransmissivity map (Fig.5):

- Ain-chabro: The highest values located in this area the lowland, values ranging from 300 to 2000 m^2/j.
- Tebessa: Values are low, ranging from 3 to 9 m^2/j.
- Bekkaria: The values fluctuates between 9 and 15 m^2/j. They are higher than in Tebessa and $T_{max} = 10^{-4}\ m^2/j$.

*Isopermeability map (Fig.6):

- Ain-chabro: values vary between 3 and 55 m/j. The highest permeability values are concentrated in this area, with $K_{max} = 6 \times 10^{-4}$ m/s
- Tebessa: values are low, ranging from 3 to 9 m/j, with $K_{max} = 10^{-4}$ m/s.
- Bekkaria: Values fluctuates between 9 and 15 m/j. They are higher than in Tebessa with $K_{max} = 3 \times 10^{-4}$ m/s

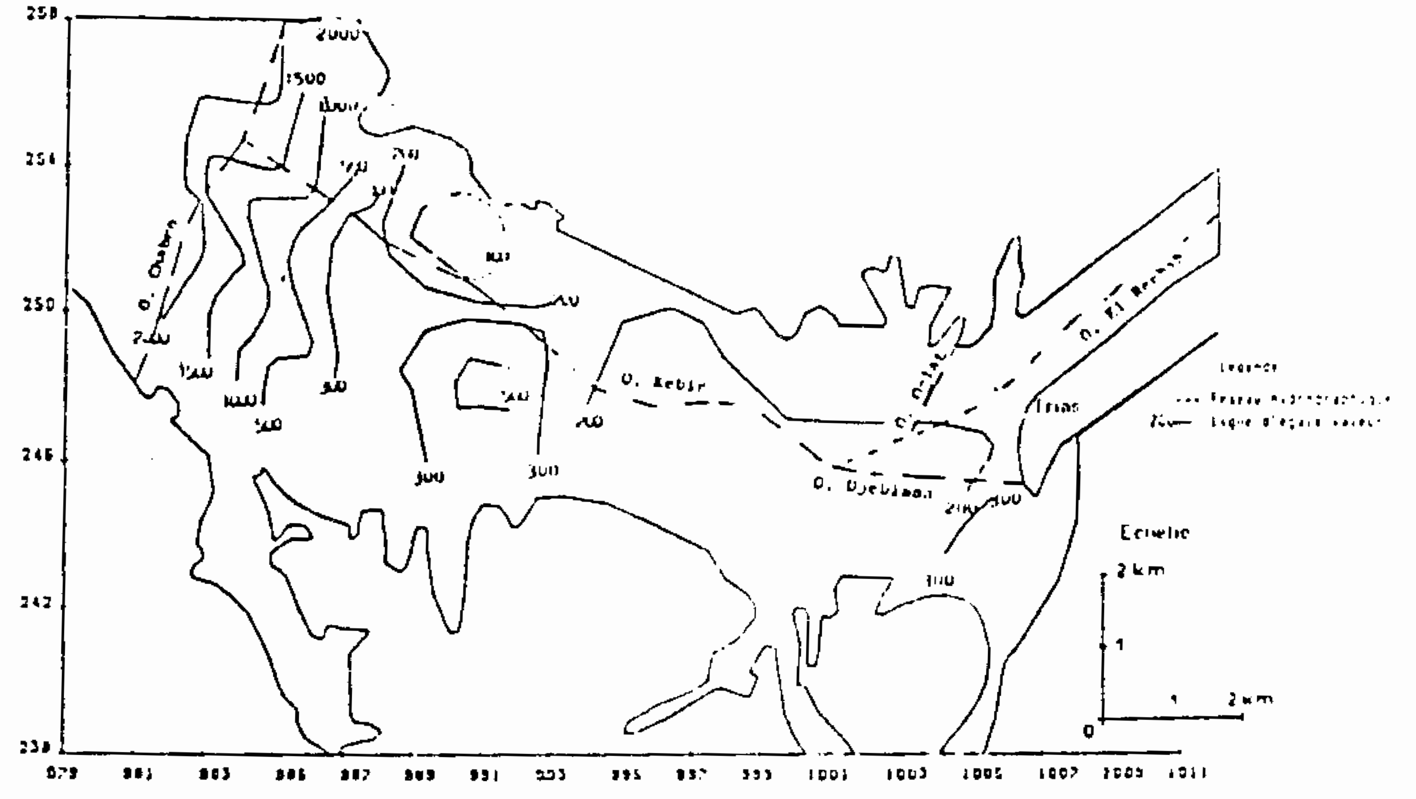

Figure 5. Map of transmissibility (m^2/j)

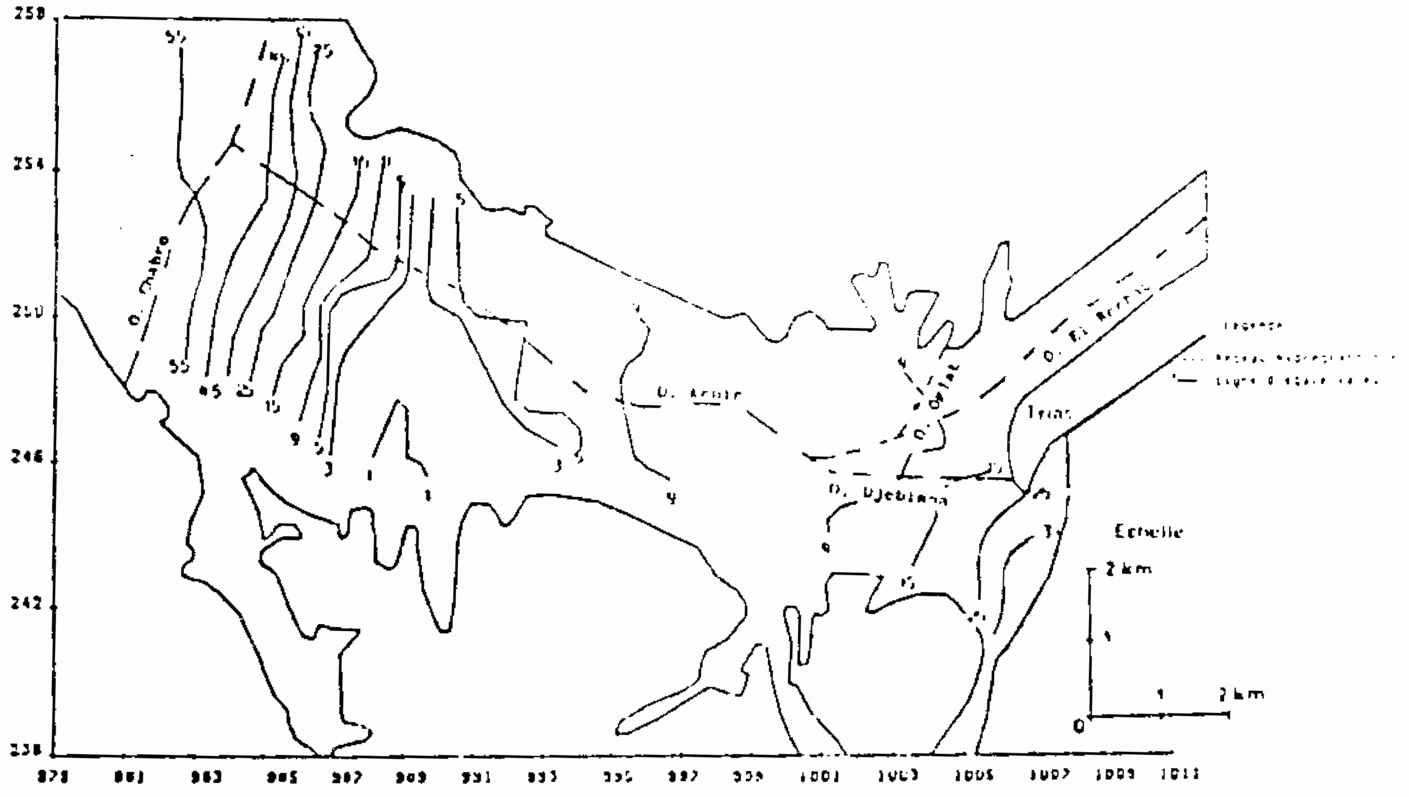

Figure 6. Map of permeability (m/j)

CONCLUSION

The analysis allows us to classify the lowland according to the Q/S, T and K values.

It is well known that higher Q/S, T and K value, the more the area is of interest as far as flow is concerned. As it was pointed out in the analysis of the various maps, we can classify the studied areas in this order: Ain-chabro, Bekkaria, Tebessa.

If a borehole is to be drilled, the suitable site is Ain-chabro, then Bekkeria and lastly Tebessa, in this order.

Finally, there is no contradiction between the three maps, they rather confirm each other.

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