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MODELING OF THE MONOZOUNGOUDO POROUS RESERVOIR IN BENIN

MODELISATION DU RESERVOIR POREUX DE MONZOUNGOUDO AU BENIN

HOUNTONDJI B., CODO F.P., AINA M.P.

Laboratory of Water and Environmental Sciences and Techniques (LSTEE), University of Abomey-Calavi (UAC), Benin.

babilassrock@yahoo.fr

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ABSTRACT

The methodology used in this paper for modeling the Monzoungoudo reservoir consists of a synthesis of hydrodynamic modelling data. The hydraulic approach to the reservoir was carried out by modelling to arrive at a synthetic description. A characterization of the reservoir of strong homogeneities could be highlighted, both vertical and lateral.

Modelling, from the perspective of validation of this synthetic model, has shown the impact of the hydraulic phenomenon.

In the short term, the best modelling of the Monzoungoudo reservoir will result in better addressing the main problem related to resource prediction (definition of production height).

Keywords: Modeling, porous reservoir, drilling, Monzoungoudo, Benin.

RESUME

La méthodologie utilisée dans cet article pour la modélisation du réservoir de Monzoungoudo, consiste en une synthèse des données de modélisation hydrodynamique.

L'approche hydraulique du réservoir a été réalisée par la modélisation pour parvenir à une description synthétique. Une caractérisation du réservoir de fortes homogénéités a pu être mis en évidence, à la fois verticales et latérales.

La modélisation, dans l'optique de la validation de ce modèle synthétique, a montré l'incidence du phénomène hydraulique.

A court terme, la meilleure modélisation du réservoir de Monzoungoudo aura pour conséquence de mieux aborder le problème principal lié à la prévision de la ressource (définition de la hauteur productrice).

Mots clés : Modélisation, réservoir poreux, forage, Monzoungoudo, Bénin.

INTRODUCTION

A model is by definition a simplified representation of a complex system (Dassargues A., 1991). Hydrodynamic data are the basic information for modeling the Monzoungoudo reservoir.

These hydrodynamic data processed in this study come from drilling measurements whose geological objective is the exploitation of the Monzoungoudo water reservoir, and the purpose of water production for consumption, agriculture and industry.

The main objective is the production of water with very high continuous flows above 0.7 m3/h on average. The sustainability of the flow, with an acceptable drawdown, can only be ensured if it is possible to estimate the distant transmissionivity and lateral continuity of the medium-distance reservoir. As a result, the characteristics of the reservoir in the immediate vicinity of the production well must be accurately assessed. Also, given the mode of operation, it is necessary to accurately estimate the thickness of the productive layer. For water drilling measurements, the recording of a systematic flow meter during the production test provides the actual local production height in the reservoir, as well as the vertical distribution of production. The flowmeter allows a detailed study of the structure of the tank before. It is used to locate producer levels and estimate production.

MATERIAL AND METHOD

The following sections describe the material and methodology adopted in this study.

METHOD

Detailed knowledge of the hydrodynamic parameters of the reservoir is an essential advance information to understand its natural state and to attempt to explain the anomalies found during the exploitation of the groundwater resource.

The many initial raw data from the trials and more generally the end-of-survey reports were processed, collecting and analyzing the data acquired on the forges for all operations carried out in the Monzoungoudo region.

Location of drilling

The two F1 and F2 hydraulic boreholes in the Monzoungoudo reservoir are located in the localities of Mozoungoudo Centre and Monzoungoudo South respectively. F1 drilling is located at the longitude of 02-31'31.8" East and at latitude 07-04'25.4" North, while the F2 drilling is located at the longitude of 02-31'31.4" East and at latitude 07-04'25.4" North. Both boreholes have the characteristics required for detailed analysis.

Study area

Monzoungoudo is a village located in the commune of Ouinhi more precisely in the district of Ouinhi- Centre. It is bounded to the north by the villages of Ouzogon and Adjogbé, to the south by the village of Manfougbon, to the east by the plateau department and to the west by the villages of Monzounkango and Ahikon (Figure 1.1). This village is located in the coastal sedimentary basin. It has six (06) localities: Adjazoungo, Mafougbon, Monzoungoudo Centre, Alidjinouhoué, Ayèhoué and Davèzoumè.

Figure 1 shows the geographical location of the study area in Benin.

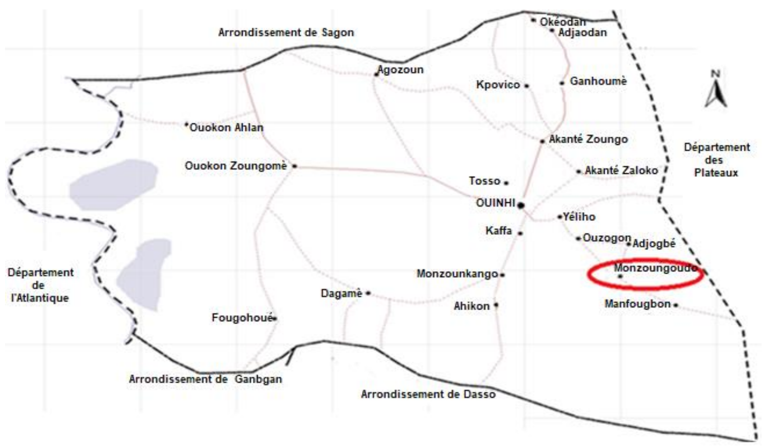

Figure 1: Geographical location of study area

DRILLING DATA ANALYSIS

This section aims to collect point data from drilling for the construction of the drilling database.

Gathering information

The majority of the information comes from the consultation of the survey end reports (or file of the works executed). The information collected is raw data that usually requires interpretation, as it is an indirect measure of the parameters sought. The raw information collected can be categorized into three groups:

Geometric settings

These parameters define the geometry of the drilling and capture in the reservoir. This geometric information is very useful is obtained from the General Directorate of Water (DGEau) of Benin and is summarized in Table 1 for the two hydraulic drillings of Monzoungoudo.

Table 1: Geometric features and hydrodynamic parameters of Monzoungoudo drilling

Geometric features and hydrodynamic parameters of Monzoungoudo drilling (source: DGEau Benin, 2012)		
Parameters	**Drilling F1**	**Drilling F2**
Drilling depth H (m)	247	244.18
Drilling Diameter D (m)	0.126	0.126
Flow rate Q (cm^3 /s)	2000	2000
Acceleration of gravity g (m/s^2 ou N/kg)	9.81	9.81
Pressure at the head of drilling p_2 (bars)	4.16	4.16
Drilling depth H' at the roof of the reservoir (m)	201	201
Static pressure in the reservoir p_{st} (bars)	28.14	28.14
Rugosité absolue du tuyau ε (mm)	0.12	0.12
Density of the fluid $\boldsymbol{\rho}$ (kg/m3)	1000	1000
Dynamic viscosity $\boldsymbol{\mu}$ (centipoise)	0.89	0.89
Kinematic viscosity $\boldsymbol{\vartheta}$ (m^2/s)	$0.89\ 10^{-6}$	$0.89\ 10^{-6}$
Permeability k (Darcy)	21	21

Hydrodynamic parameters

Hydrodynamic parameters are deduced from the approximation of two types of measurements: the completion of the flowmeter profile (flowmetry) carried out in production and the recording of the production-pressure recovery test. The production flow profile provides identification, location and relative flow of the different producing layers, hence the determination of the cumulative net productive thickness of the reservoir.

Geological parameters

These are essentially the main markers necessary for the interpretation of the different layers of terrain crossed. These parameters concern the lithology of the land and are obtained from the General Directorate of Water (DGEau) of Benin and summarized in Tables 2 and 3 for the two hydraulic drillings of Monzoungoudo.

Table 2: F1 drilling lithological cup

Lithology	Upper depth (m)	Lower depth (m)	Description
Clay	0	3	Lasteric clay
Clay	3	15	Yellow clay
Clay	15	57	Plastic clay passed limestone
Limestone	57	75	Shelled limestone
Clay	75	135	Clay level calco clay
Clay	135	184	More or less limestone pyreous grey clay
Limestone	184	201	Clay and limestone alternation
Sandy clay	201	214	Sandy clay
Argile	214	247	White quartz-to-medium-grained quartz-salt sand

Table 3: F2 drilling lithological cup

Lithology	Upper depth (m)	Lower depth (m)	Description
Clay	0	3	Lasteric clay
Clay	3	15	Yellow clay
Clay	15	57	Plastic clay passed limestone
Limestone	57	75	Shelled limestone
Clay	75	135	Clay level calco clay
Clay	135	184	More or less limestone pyreous grey clay
Limestone	184	201	Clay and limestone alternation
Sandy clay	201	214	Sandy clay
Argile	214	244,18	White quartz-to-medium-grained quartz-salt sand

Data processing

The flowmeter results are obtained after the resolution of the following equation (Hountondji, 2019):

$$P_{st} = P_2 + \rho_w gH + \frac{\mu Q}{ek} + 0.06642\rho_w \frac{H}{D^{4.8}} Q^{1.8} V^{0.2} \tag{1}$$

Where:

ρ_w = density of the water;

V = Darcy velocity;

e = productive thickness of sheet;

μ = dynamic viscosity of the fluid;

k = intrinsic permeability of the medium

p_2: pressure at the head of drilling

p_{st}: static pressure in the reservoir

D: diameter of the borehole

Q: flow rate

In the equation (1) the known variable is the depth H and the one to be determined is the Q flow. The values derived from the resolution of the equation (1) will allow the flowmeter profile to be traced in relation to the vertical structure of the reservoir.

RESULTS AND DISCUSSIONS

Since Monzoungoudo's two drilling rigs (F1 and F2) have virtually the same lithologies, we will present the results only for F2 drilling and then generalize thereafter.

Taken back to vertical hills, the flowmeter profile made in relation to the producing horizons of the reservoir shows the allure of Figure 2.

The detailed analysis of the parameters of the different production layers at the right of the F2 drilling of Monzoungoudo, allowed to highlight the vertical structure of the reservoir of this village. This very particular structure is illustrated in Figure 2.

In terms of production, this figure highlights a very large vertical heterogeneity observed on all Monzoungodo drilling. A number of general points are made:

- Production corresponds to a porous structure, with two producer levels,
- These very thin, metric-thick layers are spread over a vertical range of around 201 m up to 244.18 m,

- The cumulative total production thickness (in the order of 43.18 m) remains low compared to the total thickness of the reservoir of this village (approximately 17.68%),

The detailed vertical structure of the Monzoungoudo reservoir production, which has been highlighted by the hydraulic drilling, allows for a more realistic estimate of fluid velocity (natural flow).

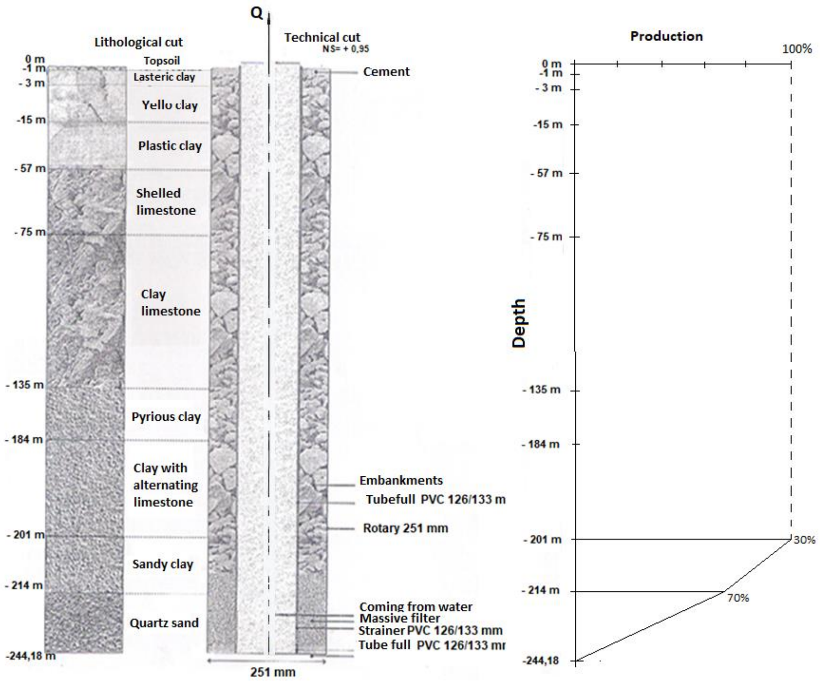

Figure 2: The flowmeter profile performed against different producer levels on Monzoungoudo's F2 drilling

CONCLUSIONS

The flowmeter profile is a fundamental hydrodynamic graph whose construction on the Monzoungoudo boreholes has yielded a great deal of information about the vertical structure of the reservoir vis-à-vis production.

The first level of interpretation is to locate the production layers and identify their individual contribution to the total flow by profile analysis. Therefore, the depth of the roof (201 m) and the wall (244.18 m) of the productive layer, its relative production, as well as the productive thicknesses, are deduced. The combined fuel provides the cumulative net productive thickness (43.18 m) of the reservoir.

REFERENCES

BONNET M. (1969). Manuel d'hydraulique des systèmes de captage et drainage, Rapport BRGM 69 SGL 225 HYD

BOUTADARA Y., REMINI B., BENMAMAR S. (2020). Quand les foggaras d'Adrar se réveillent. Larhyss Journal, ISSN 1112-3680, N°41, pp. 149-180

BRGM (1995). Guide de bonne pratique et de contrôle des forages d'eau pour la protection de l'environnement, Rapport 38261

DASSARGUES A. (1991). Modèles mathématiques en hydrogéologie et paramétrisation. Annales de la Société Géologique de Belgique, T. 113 (fascicule 2) - 1990, pp. 217-229.

DE MARSILY G. (1985). Détermination expérimentale de la vitesse d'écoulement de la nappe géothermique du Dogger en région parisienne. Rapport final, contrat CCE no EGC. 2-07-F 5(SP).

DGEau (2012). Carte hydrogéologique du bassin sédimentaire côtier du Bénin. Impressum : Deutsche Gesellschaft fur Internationale Zusammenarbeit (GIZ) Gmbh, Allemagne.

FORKASIEWICZ J., MARGAT J., PEAUDECERF P. (1976). Essais sur les forages artésiens jaillissants et les sources-Rapport BRGM, 41p.

HOUNTONDJI B. (2019). Hydrodynamique du Système Réservoir-Puits de production de Monzoungoudo pour son approvisionnement en eau, Thèse de Doctorat de l'Université d'Abomey-Calavi, Bénin, 141 p.

MARTIN J.C., MENJOZ A., ROJAS. J. (1988). Caractérisation hydrodynamique et thermique du réservoir de Dogger du bassin parisien. Jigastock 88, Versailles, France.

MAJDOUB R., DRIDI L., M'NASRI S. (2014). Caractérisation de la nappe profonde Gafsa nord suite à la surexploitation des eaux souterraines, Larhyss Journal, ISSN 1112-3680, No17, pp. 179-192.

REMINI B., SOUACI B.E. (2019). Le Souf : Quand le forage et le pivot menacent le Ghout ! Larhyss Journal, ISSN 1112-3680, No 36, pp. 7-22.