MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH

UNIVERSITY OUARGLA-MERBAH KASDI

Institute of Technology

Department: Applied Engineering

Project Graduation in order to obtain the diploma of

License

Field: Science and Technology

Specialty: Measure, Metrology and Quality

Realized by:

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Theme:

Assessment of Production Logging Tools for Optimizing Oil and Gas Well Performance

Defended on 14/06/2023 before the examination committee composed

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2023 / 2022

Acknowledgment:

First and foremost, I extend my heartfelt gratitude to God, our Creator, for granting us the strength and resilience to successfully complete this work. As we bring this manuscript to a close, I reflect upon the years of research conducted at Kasdi Merbah University, Institute of Applied Science and Technology under the invaluable guidance of Prof. Nigro Belkhir.

I would like to express my deep appreciation to Professor Kadri Mohammed for bestowing upon me the honor of serving as the chair of the jury for this thesis. His expertise and discerning evaluation have immensely contributed to the refinement and validation of my research. I'm truly privileged to have had the opportunity to present my work before such a respected and esteemed individual.

Additionally, I would like to extend my profound gratitude to Prof. El faker for graciously accepting the responsibility of reviewing my work. His valuable insights and constructive feedback have undoubtedly enhanced the quality and rigor of my research. I am sincerely thankful for his time and expertise.

My heartfelt thanks also go out to the entire staff of the Institute of Applied Science and Technology Professors(Mechri Mohammed; Mahboub; settou belkhir). Their dedication, support, and collaboration have fostered an environment conducive to academic excellence. Their contributions have been invaluable in our research endeavors, and I am grateful for the collective efforts of each and every member.

DEDICATION:

I would like to dedicate my graduation thesis to express my heartfelt gratitude to God for His abundant blessings and guidance throughout my academic journey. I am immensely grateful to my dear father, mother, sister Ahlem, Ghania, brothers Okba, El-Arabi . Their unwavering support, love, and encouragement have been pivotal in shaping my success. Each of them has played a unique role in my life, offering guidance, motivation, and strength when I needed it the most. I am truly blessed to have such an incredible family who has stood by my side every step of the way. This achievement would not have been possible without their love, sacrifices, and belief in me.

Finally, I want to express my heartfelt gratitude to myself. I want to thank myself for believing in me, for doing all the hard work, for never taking a day off, and for never quitting. I want to thank myself for always being a giver and trying to give more than I receive. I want to thank myself for striving to do more right than wrong, and for simply being true to myself at all times.

ABSTRACT:

The production logging tool (PLT) is an essential equipment used for managing productive hydrocarbon reservoirs. Its primary function is to measure the selective production potential of different layers simultaneously contributing to the well.

The objective of this study is to examine the significance of the production logging tool (PLT) in productive reservoirs and its applications. It plays a crucial role in identifying and locating various production issues such as water and gas coning .

For this study, a specific well, OMM412, located in the Hassi Messaoud field, was selected to establish a production profile. The analysis and evaluation of the data using EMERAUD software have revealed the following findings:

The PLT log results for well OMM412 indicated that the interval between 3438.3m and 3457m is the primary source of the substantial gas production. As a result, performing a cement squeeze in this interval effectively reduced the high gas flow and significantly increased the oil flow.

Key-words: PLT, Production problems, interpretation

الملخص:

أداة تسجيل إنتاج البئر (PLT) هي معدات أساسية لإدارة الحقول الهيدروكربونية الإنتاجية، وتطبيقها الأساسي هو قياس الإمكانية الإنتاجية الانتقائية للطبقات التي تتدفق في البئر بشكل متزامن.

يهدف هذا العمل إلى دراسة أهمية أداة تسجيل إنتاج البئر (PLT) في الحقول الإنتاجية وتطبيقاتها، ودورها في تحديد وتحديد المشاكل المختلفة في الإنتاج مثل تشكل المياه والغاز... الخ

خلال هذه الدراسة، تم اختيار بئر معين ينتمي إلى حقل حاسي مسعود (OMM412) لإنشاء ملف إنتاج لكل بئر.

أظهر تحليل وتقييم البيانات باستخدام برنامج EMERAUD المعلومات التالية:

أظهرت نتائج سجل PLT للبئر OMM 412 أن مصدر الكمية الكبيرة من الغاز المنتج هو الفترة (3438.3 م - 3457 م). وبالتالي، أدى حقن الإسمنت في هذه الفترة إلى تقليل تدفق الغاز العالي بشكل ملحوظ مع زيادة ملحوظة في تدفق النفط.

كلمات مفتاحية:PLT ، مشاكل الانتاج، تحليل البيانات

Table of content:

CHAPTER I

OVERVIEW OF THE HMD FIELd

CHAPITRE II OVERVIEW OF ALL LOGGING OPERATIONS INCLUDING (MUD-LOGGING-LOGGING WITH A SPECIAL FOCUS ON PLT)

Chapter III PRODUCTION LOGGING FOR IDENTIFYING AND REMEDYING POOR WELL PERFORMANCE

List of figures:

List of Tables:

List of Abbreviations and Symbols:

API: American Petroleum Institute

Bg: Gas volumetric factor ($stdm^3/m^3$)

Bo: Oil volumetric factor ($stdm^3/m^3$)

μo: Oil viscosity (Cp)

CCL: Casing Collar Locator

CFS: Continuous Flow Meter Spinner

d: Density

Fdd: Differential Pressure Fluid Density

GOR: Gas-Oil Ratio (m^3/m^3)

GR: Gamma Ray

HMD: Hassi Messaoud

hu: Net pay thickness (m)

LCP: Liner Perforated and Slotted

m: Meter

Pg: Reservoir pressure (Kgf/cm^2)

PLT: Production Logging Tools

PVT: Pressure, Volume, Temperature

Qg: Gas flow rate (m^3/hr)

Qo: Oil flow rate (m^3/hr)

Qw: Water flow rate (m^3/hr)

WOC: water-oil-contact

GOC: gas-oil-contact

GOR:Gas-Oil Ratio

WC: Water cut

GENERAL INTRODUCTION:

Oil and gas well performance is a critical factor for the success of the petroleum industry. Efficient and effective management of production processes can significantly increase the yield and profitability of the industry. The optimization of well performance is a key aspect of production management, and there are a variety of tools and techniques that can be used to achieve this goal. One such tool is production logging, which involves the acquisition of downhole data to assess the condition of the well and its production performance Production logging tools are essential for the evaluation of well performance and identifying problems that could affect production. By providing detailed information on the flow of fluids within the wellbore, production logging tools enable engineers and operators to diagnose problems, such as sand or scale buildup, water or gas breakthrough, and poor cementation or perforation, and implement effective remedial measures. Therefore, it is essential to assess the effectiveness of different production logging tools for optimal well performance. In this study, we aim to evaluate the effectiveness of different production logging tools for optimizing oil and gas well performance. We will conduct a comprehensive literature review to identify the most commonly used tools in the industry, their advantages and limitations, and their applications. We will also present the results of our study, which involves the use of data collected from production logs, and discuss the practical implications of the findings for the oil and gas industry. The recommendations made in this study will be useful for optimizing well performance and increasing the efficiency and profitability of the petroleum industry.

Chapter I
Overview of the HMD Field

I Overview of the HMD Field:

Introduction:

The Hassi Messaoud field is located in the central part of the Algerian Sahara and is known for its productive oil wells, mainly in the Cambrian reservoirs. It represents one of the most complex fields in the world in terms of its area and estimated reserves, which are approximately 7,075.73 million standard cubic meters. It is the largest oil field in Algeria, with 1,800 producing and injecting wells. Throughout its geological history, this field has undergone intense tectonic evolution characterized by compressive and distinctive phases. Additionally, the reservoir has undergone diagenetic transformation during burial over geological time, resulting in its current configuration. The profitability of investing in the Hassi Messaoud field is closely linked to the significant production extracted from this reservoir in recent years, estimated at approximately 946.97 million standard cubic meters. This parameter depends on the characteristics of the reservoir, fluids, and traversed drains.(2)

I.1. The geographical situation:

Hassi Messaoud is located 650 km from Alger's SE and 350 km from the Algerian-Tunisian border .Its location in Lambert coordinates is as follows (1):

X = 790,000 – 840,000 East.

Y = 110,000 – 150,000 North.

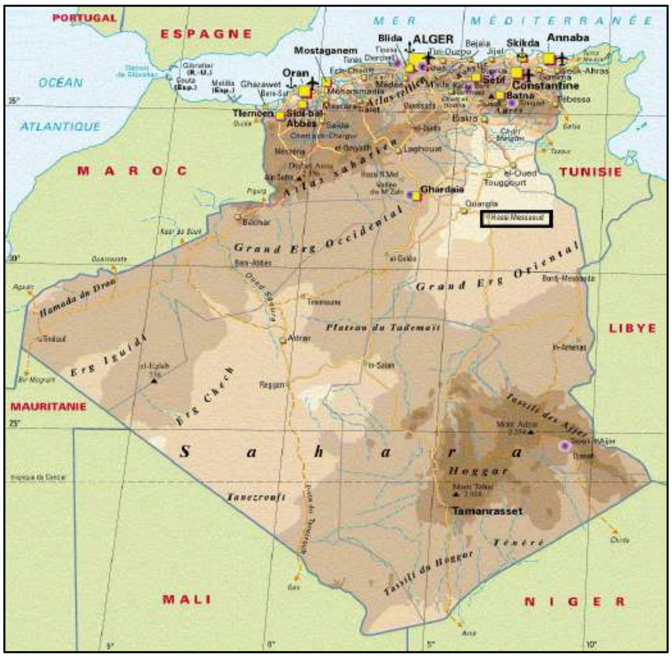


Figure I.1: Geographical location of the Hassi Messaoud field (2)

I.2. Geological Setting:

The Hassi Messaoud field is located in the central part of the Triassic province. With its size and reserves, it is the largest oil field in Algeria, covering an area of nearly 2,200 km2 (Figure I.2).

It is bordered by:

•To the northwest, by the Ouargla fields (Gellala, Ben Kahla, and Houd Berkaoui.(

•To the southwest, by the El-Gassi, Zotti, and El Agreb fields.

•To the southeast, by the Rhoude El Baguel and Mesdar fields.

Geologically, it is bounded by:

•To the west, by the Oude M'ya depression.

•To the south, by the Amguid El Biod ridge.

•To the north, by the Djammaa-Touggourt structure.

• To the east, by the Dahar highlands, Rhoude El Baguel, and the Ghadames depression (2).

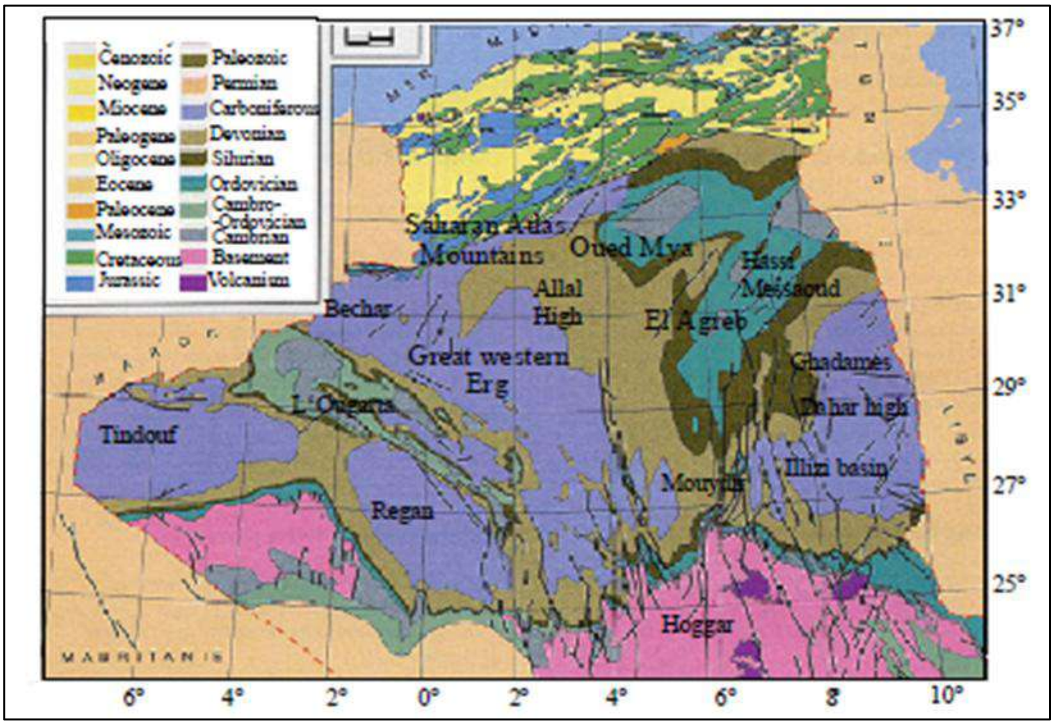


Figure I.2: Geological and structural map of Algeria (2)

I.3Research History:

On January 16, 1956, SN.REPAL initiated the first drilling, MD1, following a refraction seismic survey, not far from the Hassi-Messaoud camel driver's well.

On June 15 of the same year, this drilling revealed a significant oil accumulation in the Cambrian sandstones at a depth of 3,338 meters.

In May 1957, the OM1 well was drilled in the northern concession of the Hassi-Messaoud field, 7 km to the NNW of MD1, by the French Petroleum Company (CFP(A)). This well confirmed the presence of a large oil reservoir in the Cambrian sandstones.

Currently, the field is divided into 25 production zones. These zones are relatively independent and consist of a group of wells that communicate with each other and behave similarly in terms of reservoir pressure (2).

I.4 Stratigraphy of the field:

On the Hassi Messaoud ridge, a significant part of the stratigraphic series is absent. These are Paleozoic deposits resting on a granitic basement that eroded in the center of the structure during the Hercynian phase. Therefore, Mesozoic deposits rest in discordance on the Combro-Ordovician. As one moves towards the field's periphery, the series becomes more complete. From bottom to top, the following units are distinguished (2):

I.4.1**basement:**

Encountered around 4000 meters deep, it consists mainly of pink porphyroid granite.

I.4.2**Infracambrian**:

This is the oldest lithological unit encountered by drilling in the region, particularly north of the structure. It consists of red clayey sandstones.

I.4.3**Paleozoic:**

On the basement, Paleozoic formations rest in discordance; this is the Pan-African unconformity.

I.4.3.1 Cambrian:

It consists mainly of heterogeneous sandstones, ranging from fine to very coarse, interspersed with micaceous claystone passes. Four (04) lithozones are distinguished:

- **Lithozone R3:**
  Its average thickness is 370 m. It consists of medium to very coarse-grained feldspathic and micaceous sandstones, conglomerates at the base with abundant clayey cement, admitting passes of ferruginous sandstones and silty clay.
- **Lithozone R2:**
  Its average thickness is 100m. It consists of medium to coarse-grained micaceous sandstones, poorly sorted with fairly abundant clayey cement and admitting intercalations of silts. Stratifications are often oblique.
- **Lithozone Ra:**
  Its average thickness is 125m. It consists of medium to coarse-grained anisometric quartzite sandstones, with clayey and siliceous cement, admitting many centimeter to decimeter-sized passes of siltstones. Stratifications are often oblique to cross-bedded, sometimes horizontal. Tigillites are present in the upper part of the series. The entire Ra was eroded in the center of the field.
- **Lithozone Ri:**
  Its average thickness is 42m. It consists of fine, well-sorted isometric quartzitic sandstones, glauconitic with clayey and siliceous cement, with an abundant presence of tigillites.

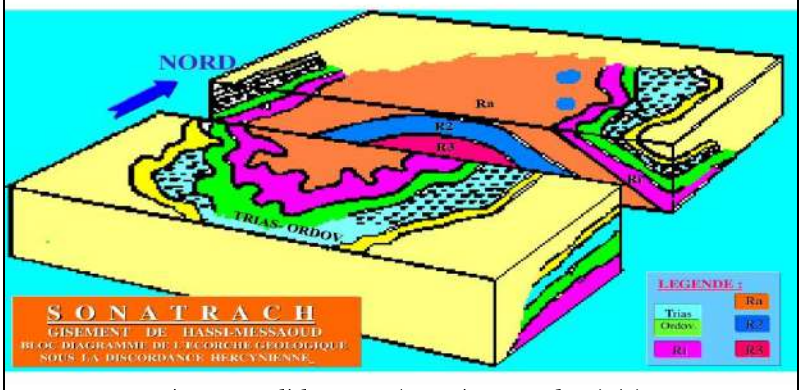


Figure I.3 : lithozones (Ra, Ri, R2, and R3) (2)

I.4.3.2 Ordovician:

Four (04) lithological units are distinguished from bottom to top:

•Alternation zone: Its average thickness is 20 meters. It is named for the numerous passes of indurated clays alternating with fine isometric quartzite beds.

•El-Gassi clays: Its average thickness is about 50 meters. This formation is made up of shale-like, indurated clay presenting a green to black color, rarely red. This clay can be glauconitic or carbonate, with fauna (graptolites) indicating a marine deposition environment. This formation is mainly encountered on the west to southwest periphery of the Hassi-Messaoud field.

•El Atchane sandstones: Its average thickness varies from 12 to 25 meters. This formation consists of fine to very fine sandstones, gray-beige to dark-gray. These sandstones can be clayey or glauconitic, admitting numerous clayey and silty passes.

• Hamra quartzites: Its average thickness varies from 12 to 75 meters. These are fine quartzitic sandstones, with rare clay intercalations.

I.4.4 Mesozoic: it is subdivided as follows:

I.4.4.1 Triassic:

It unconformably overlies the Cambrian in the center and the Ordovician on the flanks of the structure. It is subdivided into three (03) units:

•**Sandy Trias:** its thickness varies from 0 to 75 meters .

It constitutes the first filling of the Paleozoic relief and is subdivided into several units that differ in their lithologies and their diagraphic responses. Locally, it overlies an eruptive flow filling deep Hercynian erosion valleys.

•**Clayey Trias: its** average thickness is 113 meters .

It consists of more or less silty, brown-red to variegated, dolomitic and anhydritic clays, and banks of slightly silty and dolomitic clay .

•**Saliferous Trias:** its average thickness is 844 meters.

It is made up of massive salt beds with intercalations of anhydrite and slightly silty and dolomitic clay at the top.

I.4.4.2 Jurassic: its average thickness is 340 meters .

The Jurassic is a clayey-sandy formation with limestone intercalations at the top (Malm) and alternating marine lagoon facies at the base (Dogger and Lias).

•**Lias:** its average thickness is 300 meters .

The transition from Triassic to Lias is characterized by a zone of dolomitic marl known as the "B" horizon, which is a seismic marker. The Lias is subdivided into five (05) distinct levels alternating with each other throughout the thickness .

•**Dogger:** its average thickness is 320 meters .

The Dogger is subdivided into two (02) formations; the lagoon Dogger at the base and the clayey Dogger at the top .

•**Malm:** its average thickness is 225 meters .

It is characterized by clay and marl deposits with intercalations of limestone and dolomite banks accompanied by some traces of anhydrite.

I.4.4.3 Cretaceous: its average thickness is 1620 meters.

It consists of seven stages; from bottom to top, they are:

•**Neocomian:** its thickness is 182 m .

It includes two levels :

At the base, a sandy layer made up of sandstones and some layers of clay with sandstone layers. At the top, a clay layer represented by clays with numerous intercalations of limestone and dolomite .

•**Barremian:** its average thickness is 280 meters .

It is composed of fine to medium-grained carbonate sandstones with anhydrite beaches, alternating with levels of sandy and dolomitic clay.

•**Aptian:** its thickness is 25 meters .

It is represented by two dolomitic banks sandwiching a clay level. The Aptian-Barremian boundary coincides with the Cairo-Dolomitic bar, which represents a good seismic marker .

•**Albian:** its average thickness is 350 meters .

Composed of sandstone and fine sand, with intercalations of silty clay, it represents a vast aquifer .

•**Cenomanian:** its average thickness is 145 meters .

Alternation of reddish-brown anhydrite and clay, gray marl, and dolomite. The Cenomanian-Albian boundary coincides with the transition from evaporitic to sandier Albian series .

•**Turonian:** its average thickness varies from 70 to 120 meters .

Alternation of dolomitic limestone and clayey limestone, dolomitic limestone and chalky limestone, with limestone

•**Senonian:** Its average thickness is 450 meters.

At the base, there is a lagoon series with massive salt beds and alternating layers of anhydrite, dolomite, and gray clay. At the top, there is a carbonate series with beds of clayey dolomitic limestone and anhydrite.

I.4.5 **Cenozoic**: Its average thickness is 360 meters.

It consists of dolomitic limestone in the Eocene and a sandy-type cover in the Mio-Pliocene.

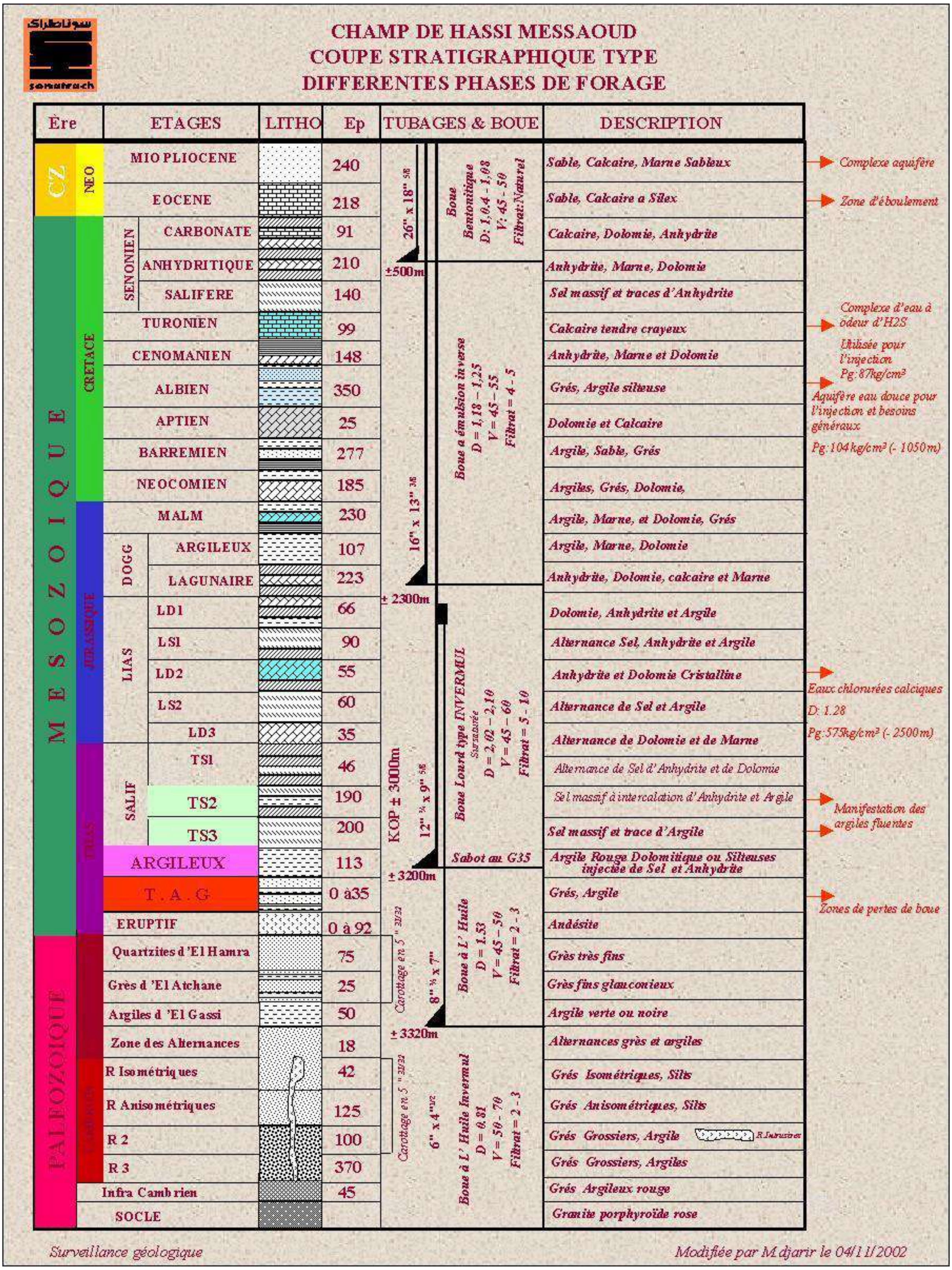


Figure I.4: Map of the zones of the Hassi Messaoud field and positions of tested wells. (1)

I.5 Field Tectonics:

The structure of the Hassi Messaoud field appears as a vast flattened anticlinal dome with a general NE-SW direction. The faults affecting the reservoir are of two types:

•The sub-meridian N.NE - S.SW faults as well as other faults perpendicular to them of NW-SE direction, highlight the tectonic Horst and Graben character.

•The fractures without offsets that had a major effect on the reservoir's fracturing (2).

I.5.1 Structuring of the Hassi-Messaoud field:

The structural evolution of the deposit is the result of several tectonic phases that can be summarized chronologically as follows:

I.5.1.1 Ante-Triassic structuring:

•Pan-African phase:

It is a compressive phase with an E-W direction, due to a continental collision between the rigid West African craton and the plastic East African block (Bertand and R.Caby 1978), causing brittle tectonics, represented by a network of faults of NE-SW and NW-SE directions followed by intense erosion that settled until the Cambrian, leading to the formation of a pediplane called the infra-tassilian surface. This pediplane marks the beginning of a Saharan cratonic history.

Distensive movements of NW-SE directions occur in the Cambro-Ordovician, which led to the stretching of the continental crust followed by tectonic subsidence and later thermal subsidence; this stretching causes a set of normal faults (NE-SW) pre-existing in the basement accompanied by volcanism (Beicip/Franlab 1979).

•Early Eo-Caledonian or Ante-Tramadocian phase:

Dated to about 500 million years ago, this phase is marked by the transgressivity of isometric sandstones (Ri) known on the flanks of the field, after the placement of the reservoir (Ra). A Tardi-Cambrian structure occurred with erosion and faults already established along a NE-SW direction and accompanied by volcanism (Beicip/Franlab 1979).

•Caledonian phase:

Dated to about 400 million years ago, this phase is regionally known for the absence of Devonian and Carboniferous sediments throughout the El Biod platform. Note that a non-deposition hypothesis for these sediments was chosen rather than Hercynian erosion, as the remodeled facies at the base of the sandy Triassic come from the Cambro-Ordovician. This phase would have begun in the Silurian or Lower Devonian (MASSA-NICOL-1971).

•Hercynian phase:

Dated from 225 to 280 million years ago, this phase is responsible for a large NE-SW direction bulge accompanied by faults of the same orientation, which compartmentalize the reservoir into blocks with their own behavior (Horst, Graben). There is erosion of the entire Paleozoic cover above the field and the radial arrangement of large valleys of excavation. During this phase, one can say that there was a tightening in the NW-SE direction, i.e., perpendicular to the major faults.

I.5.1.2 Post-Triassic structuration:

The effects of this phase are relatively weak and correspond only to 50 to 100 meters of structural closure (2950-3050 m). These deformations are accompanied by a NW tilting of about 200 meters between the SE and NW parts, which took place during the Mesozoic. The NS closure is much more important than the WE closure and could be due to Eocene tectonic movements with a NNW-SSE compression direction. (Beicip/Franlab 1979).

•Austrian phase: Dated at around 100 million years, this phase is an EW shortening, it accentuated structural closure and caused fracturing along ancient faults that have probably been reactivated. It is almost synchronous with the formation of hydrocarbons, as the formation of these began in the Jurassic and continued during the Cretaceous.

•Atlas phase: This is a phase whose compression is in the NNE-SSW direction, posterior to the formation of hydrocarbons, so it is probably responsible for permeability barriers due to a shift in reservoir levels.

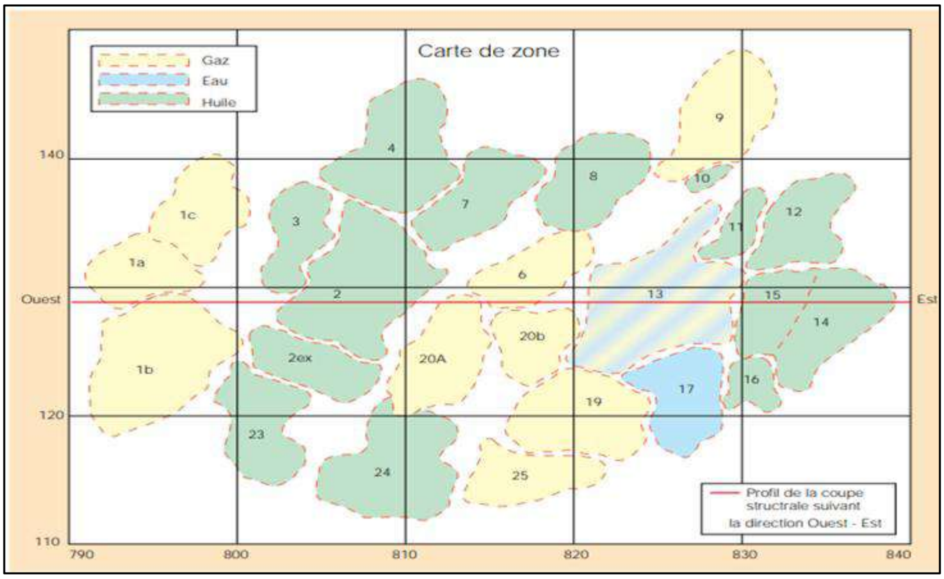
I.5.1.3 Current structuring:

This structuring shows a closure of 300 meters between the edges and the top of the deposit, it is compressive with NS shortening, and has undergone a slight epirogenic readjustment. The latter has a general NE-SW elongation and shows local culminations with amplitudes of the order of a hundred meters, the known faults' throw does not exceed 70 to 80 meters. (Beicip/Franlab)

I.6 The division of the Hassi Messaoud field:

Le champ de Hassi Messaoud a été divisé en 25 zones en fonction de la production. Ces zones sont plutôt autonomes et comprennent un groupe de puits qui communiquent entre eux et réagissent de manière similaire en termes de pression de réservoir.

The Hassi Messaoud field has been divided into 25 zones based on production. These zones are relatively independent and consist of a group of wells that communicate with each other and behave similarly in terms of reservoir pressure (1)



FigureI: and positions of tested wells (2)

I.7 Petroleum aspect:

I.7.1 Source Rock:

•**Silurian:** The Silurian clays are the source rock, the hydrocarbon-generating source for the entire Saharan platform. This source is represented by black, carbonated, and radioactive clays, very rich in organic matter, with a thickness ranging from 20 to 70 meters. The organic matter is of an amorphous nature. The presence of Tasmanaceae confirms the marine origin of this matter, and its oil contribution is evident. Currently, it can be said that after the dis-migration of hydrocarbons generated in the Paleozoic, there was a second, more significant generation phase that ended at the end of the Cretaceous due to the decrease in subsidence. The Silurian is preserved to the north of the Hassi Messaoud field, to the West (in the Oued Mya basin), to the SW (Moydir basin), and to the East (Ghadames basin).(2)

I.7.2 Cover Rocks:

The cover of the Ordovician reservoirs is respectively provided by the outpouring of eruptive rocks as well as the thick series of Triassic or Jurassic evaporites.

I.7.3 Traps:

Traps refer to the most favorable zones for the presence of hydrocarbon accumulations, characterized by a lower pressure and temperature than that of the source rocks and by a barrier that forces the hydrocarbons to accumulate (A.PERRODON.1985). There are three types of traps:

•**Structural Traps:** These traps are the result of tectonic movements such as anticlines or fault traps.

•**Stratigraphic Traps:** It is the combination of two different environments corresponding to the passage from a permeable to an impermeable environment, such as sandy lenses, bevels, etc.

•**Mixed traps:** They are both structural and stratigraphic, such as the HMD structure (anticline truncated by the Hercynian unconformity). In the Oued Mya basin and the northeast of Hassi Messaoud, the recognized traps so far are of a stratigraphic and structural (mixed) type.

I.7.4 Hydrocarbon migration:

The hydrocarbon accumulations of the Hassi Messaoud field and any neighboring field probably come from the two basins, Ghadamès and Illizi to the east, and Oued Mya to the west.

Primary migration and feeding of these deposits occurred within the Silurian, followed by migration through the Triassic sandstone levels at the contact of the Hercynian unconformity (secondary migration).

The Cambro-Ordovician reservoirs outcropping at the Hercynian unconformity are fed from the Triassic sandstones and the erosion surface which are located up dip to the north and northwest relative to the migration pathway.

I.8 Characteristics of the reservoir and fluids:

•Formation (Cambrian-Ordovician).

•Thickness (up to 200 m).

•Depth (between 3100 and 3380 m).

•Variable reservoir pressure: Pg = 120 to 400 Kgf/cm^2.

•Reservoir temperature: T = 118°C.

•Average porosity: Φ = 5 to 10%.

•Permeability highly variable: K = 0 to 1 Darcy.

•Light oil.

•Average surface density: do = 0.8; (API = 45.4

•Dissolution GOR variable: GOR = 100 to 5000 m^3/m^3.

•Viscosity: μo = 0.2 Cp.

•Average bottomhole volume factor: Bo = 1.7 stdm^3/m^3.

The primary drainage method used throughout the Hassi Messaoud field was natural depletion, characterized by a high initial pressure, a significant difference between this pressure and the bubble point pressure, and high compressibility (1).

CHAPITRE II

Overview of all Logging operations including (Mud-logging- Logging with a special focus on PLT)

II.8 .Overview of Mud logging:

Introduction:

The completion of an oil well requires the presence of various activities, among which geological monitoring (Mud Logging) is essential in drilling operations. Mud Logging is primarily focused on geological monitoring, collection and analysis of samples, and monitoring drilling parameters to detect the presence of hydrocarbons.

The term "Mud Logging" is composed of two words: "Mud," which refers to drilling mud, and "Logging," which means recording data. Technically, it involves recording data or information transmitted by the drilling mud.(3)

II.1.1Definition of Mud logging:

Mud logging is the continuous monitoring and analysis of drilling mud or drilling fluid during oil and gas drilling operations. It involves collecting real-time data to gather information about geologic formations, hydrocarbon presence, and drilling parameters.

A specialized team of geologists and technicians performs mud logging at the drilling rig. They collect samples of drilling mud and examine the cuttings brought to the surface. These cuttings are analyzed to determine the rock type, porosity, permeability, hydrocarbon content, and other geological characteristics of the formations being drilled.

The data obtained from mud logging provides valuable insights into subsurface conditions and helps in decision-making during drilling. It assists in identifying potential hydrocarbon reservoirs, evaluating drilling efficiency, detecting formation pressures, monitoring well stability, and assessing drilling risks.(3)

Figure II.1: Mud logging Unit and its Interior(3)

II.1.2The goal of Mud Logging is to:

- Improve drilling efficiency.
- Evaluate the complete formation.
- Prevent disasters before they occur and drill safely.

II.1.3The role of the mudlogging unit:

- Description and interpretation of drilling cuttings.
- Monitoring of gas during drilling.
- Tracking the volume of drilling mud and immediately informing the personnel in charge of any changes in this volume.
- Confirming with the supervisor the depth at which casing can be set.
- Recording drilling data and plotting graphical curves (Mud-Log, Drill-Log, Pressure Log, Gas Log).
- Producing a final report of the drilled well.
- Monitoring drilling parameters and informing the personnel in charge of any potential anomalies.

II.1.4Description of the Mud Logging Cabin:

. (3)The Mud Logging cabin consists of two compartments

II.1.4.1 Technical Monitoring Section:

Real-time monitoring of drilling parameters is carried out by the Mud Logging team.

(3)**Figure II.2:**GEODESK Interface for Geological and Drilling Monitoring Program

With the help of sensors installed in various locations

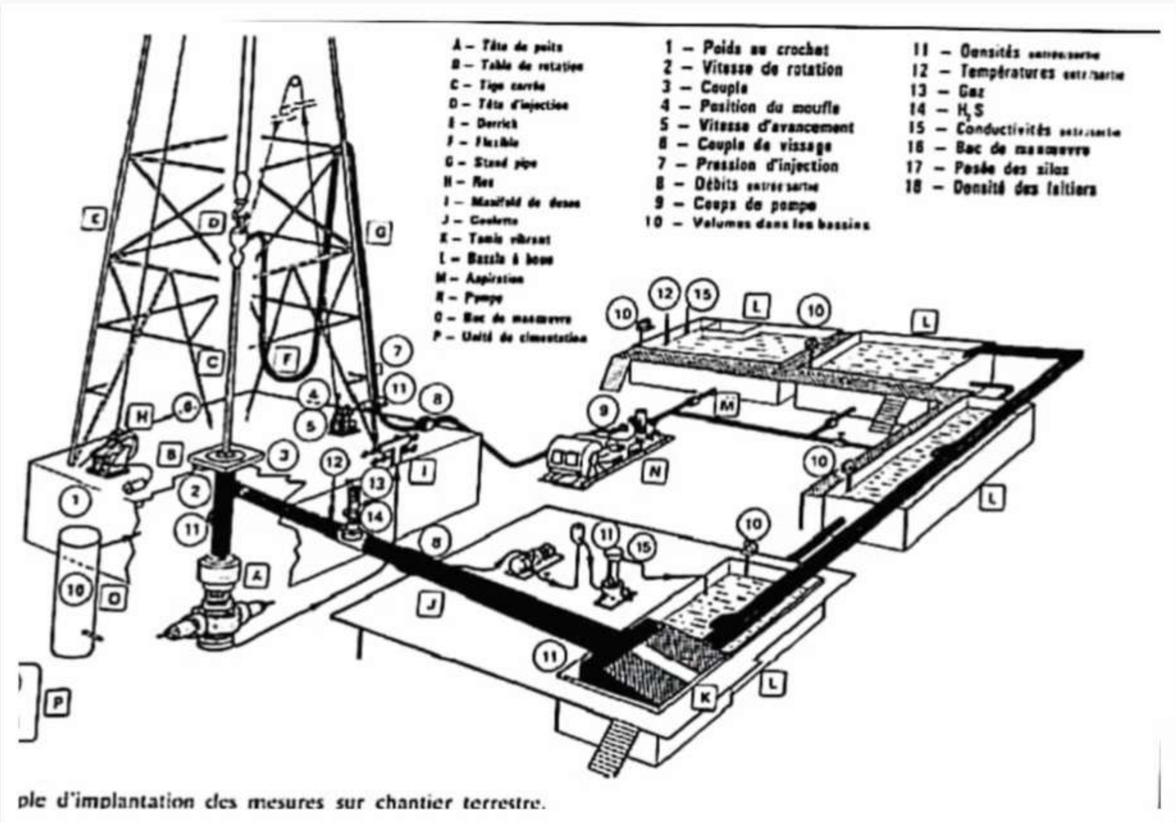
- **Captures:**

A sensor is a physical measuring instrument that transforms a physical or chemical variation in the environment where it is installed into a difference in voltage or electrical resistance in the connected circuit. The sensor needs to be powered by an electrical voltage. The signal emitted by the sensor can be analog (continuous variation of the signal) or in pulses.

Different sensors are installed on the drilling apparatus, and their mission is to detect signals so that the computer system in the cabin can perform calculations and acquire and store the database.

Therefore, the sensor is the most important element or tool for acquiring a parameter. And each parameter is essential for a complete database and/or any (3)calculation in a drilling monitoring mission.

- **Position on the rig:**



. (3)**Figure II.3:** Locations of Sensors on the Drilling Probe

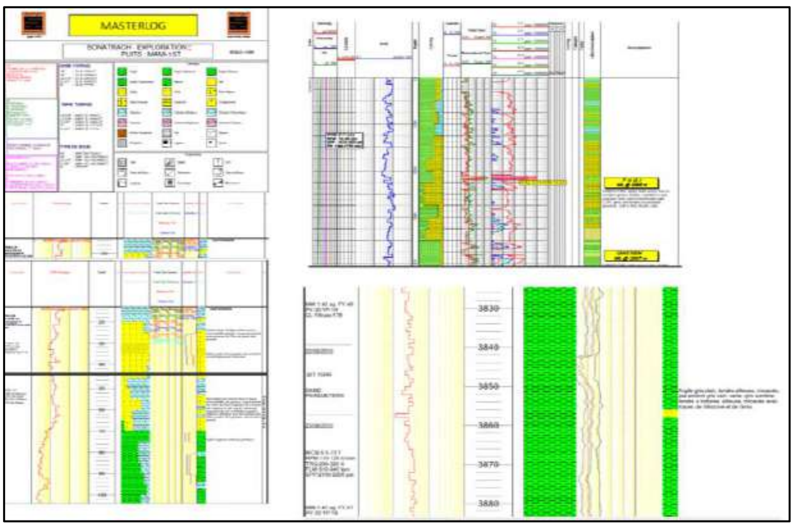
- **Different types of captures:**

. (3)**Figure II.4:** Sensors Used in the Mudlogging Cabin

II.1.4.2 Geology section:

The mud logging cabin is equipped with special equipment for the processing of cuttings brought to the surface by the drilling mud. A lithological description is necessary, showing the rock type, hardness, color, degree of sphericity, and other characteristics.

Subsequently, all these descriptions are entered into the program to generate various logs such as the Master log, Pressure Log, Drill Log, etc., in the form of figures (3).



(3)**Figure II.5:** Master Log

II.2 Overview of Logging:

Introduction:

Logging is a critical process used in industries such as geology, petroleum exploration, and drilling. It involves recording and analyzing data during drilling or geological activities to understand subsurface conditions and resource potential. Logging techniques use various tools to measure parameters like lithology, porosity, fluid types, and temperature. Well logging, mud logging, wireline logging, and logging-while-drilling (LWD) are different types of logging. The collected data are processed and integrated with other geological information to create subsurface models for reservoir characterization and decision-making. Logging aids in optimizing drilling operations, assessing reservoir viability, and guiding production strategies for efficient resource extraction (4).

II.2.1 definition of Logging:

To overcome these drawbacks, the technique of well logging, also known as logging, emerged in 1927. Well logging refers to the continuous recording of variations in a given parameter as a function of depth.

Well logs are recorded during a pause or at the end of drilling, and the measured parameters are only accessible with a certain delay after the drilling operation, hence the term "delayed logs" (see Figure II.6).

Tools or probes designed for this purpose are lowered into the borehole at the end of a cable that connects them to surface instruments controlling the operations. These tools are either grouped in a truck or housed in a fixed cabin for offshore drilling.

By correlating the measured parameters and their variations with the physical and/or chemical properties of geological formations and the fluids contained within them, well logging provides an unparalleled instrument for studying rocks and their potential contents.

There are close relationships between the recorded physical parameters and geological parameters. A "geophysical facies" can be defined as the sum of characteristics observed by well logs at a given level. The "geophysical facies" remains unchanged for the same level during multiple successive recordings with the same tools in the same borehole. As a result, any modification in a geological parameter should be reflected in one or more physical parameters, and vice versa. Well logs are therefore very useful for interwell correlations and provide valuable :information on lithological variations (4).

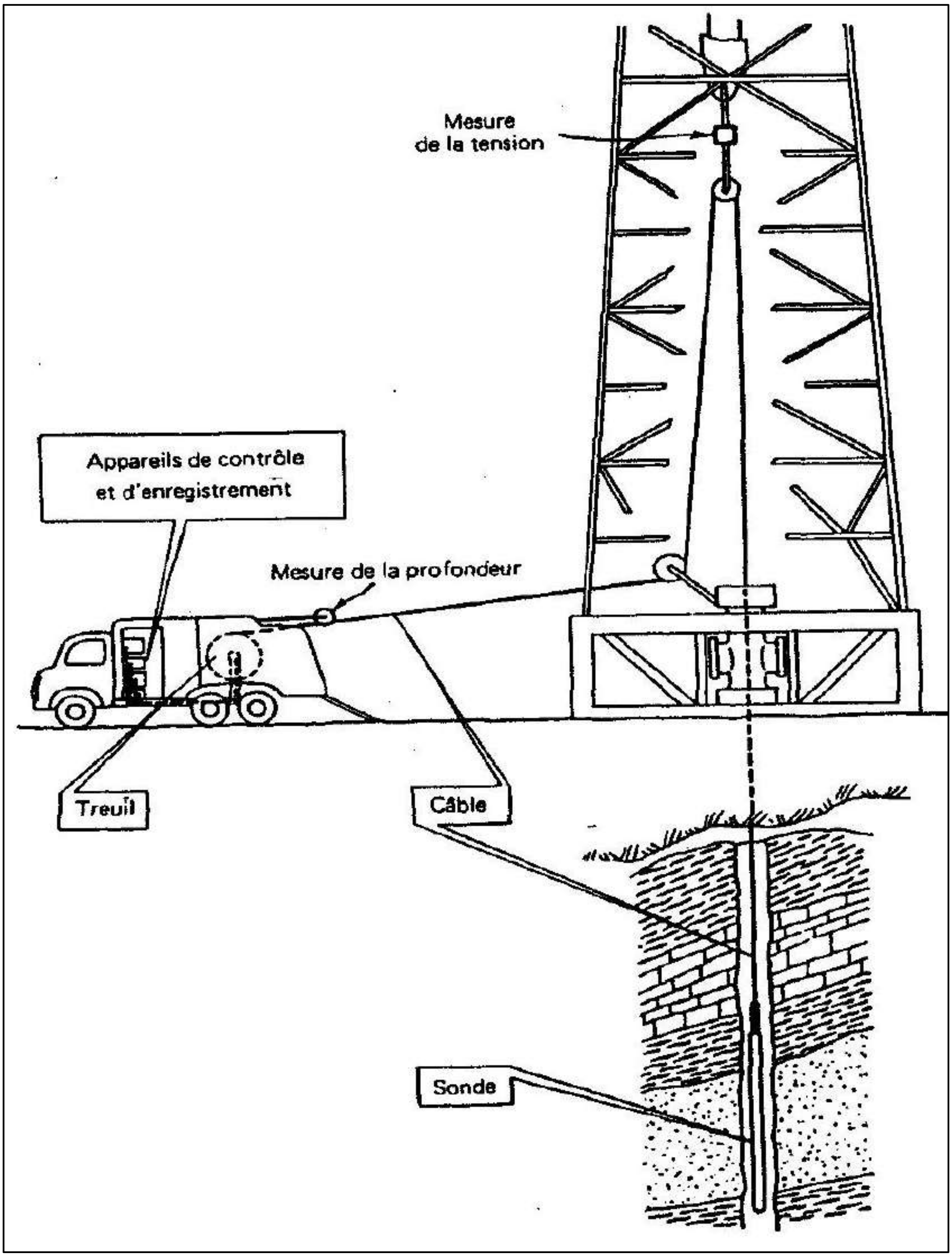


Figure II.6: Delayed Logging (3)

II.2.2Technical Logging Equipment:

The ensemble of equipment used for well logging includes:

- A large and powerful winch, on which several thousand meters of cable are wound. The cable is an essential component with both mechanical and electrical roles. Attached to one end of the winch, it terminates at the other end with a quick connector that allows mechanical and electrical connection with the tool lowered into the borehole. The cable transmits electrical energy to power the tool and enables the return of signals emitted by the tool back to the surface. The cable's movement, or cable spooling, allows depth measurements to be taken. Depth measurement is not perfect as the cable is subjected to significant forces. It can elongate due to its weight or aging, some tools can stick to the borehole wall, and mud deposits can accumulate on the cable or pulley. Therefore, one of the first steps before any interpretation is to calibrate the well logs.

- Control and command circuits for measurement devices, as well as information processing equipment. These are assembled in panels that are placed in suitable supports based on the tools used.

- Tools refer to the devices that are lowered into the borehole at the end of the cable. This can range from simple electrodes to tools with multiple pads and production logging tools used in petroleum exploration.

- A recording system, where the film or paper advancement was synchronized with the cable spooling, and recording was done based on depth. Nowadays, digital recorders are used.

The logging operation requires careful coordination and integration of these technical components to ensure accurate and reliable measurements of various parameters for geological analysis and reservoir evaluation (4).

II.3. overview of PLT:

Introduction:

The evaluation and characterization of a reservoir involve measuring several parameters through various recordings. In this chapter, we will focus on production well logging (PLT), which includes four important measurements for quantitative analysis by reading flow rate, density, and qualitative analysis by temperature and pressure. These measurements are used to determine flow properties and identify different issues such as fluid influx into the well.

II.3.1Definition of PLT:

The PLT is a set of tools used to perform production logging. These tools are combined, and their configurations are well-defined in the planning of the PLT operation. PLT tools provide point-by-point information diagnostics on fluid flow, such as water, oil, and gas, and they give an indication of perforation efficiency. PLT is essential for forecasting because it allows for the measurement of SIP (Skin Integrity Parameter) and transient regime background recordings (1).

II.3.2Uses of PLT:

PLT provides information acquired during well production, which takes place in a tubing under pressure, necessitating the use of high-pressure control equipment. The tools must have a diameter small enough to be lowered into the production tubing. These tools can be simple (flow meter, pressure gauge, etc.) or combined as Production Logging Tools (PLT). Some of the main uses of PLT include:

II.3.2.1 Reservoir evaluation:

PLT is used for reservoir evaluation from the following perspectives:

1. Knowledge of reserves.

2. Increasing well potential during the life of the reservoir by identifying intervals that do not contribute to production.

3. Estimating production based on bottom-hole pressure.

4. Measuring effluent rates from each interval (knowledge of reserves).

5. Understanding the productivity index during the life of the reservoir.

6. Tracking depletion progress.

7. Understanding the dip of the layers.

8. Understanding the nature and petrophysical properties of the reservoir (lithology, porosity, and water, oil, and gas saturation) at different depths.

9. Continuously monitoring reservoir performance using flow profiling, well testing, and completion efficiency (1).

II.3.2.2 Well treatment evaluation:

PLT is used to determine the flow profile and productivity or injectivity index for different zones in the vicinity of the well before and after stimulation.

II.3.2.3 Well problem diagnosis:

Common issues include water and gas influx, mechanical problems, and leaks in tubing, casing, and packers due to poor cementing. PLT can also identify zones responsible for unwanted fluid influx (such as coning and formation fluid contamination) and flows behind the casing.

II.3.2.4 Completion performance evaluation:

For new wells, injection wells, and recompletion wells, parameters measured include flow rate, density, temperature, and effluent pressure. Auxiliary measurements such as diameter are also taken, and bottomhole samples are collected for PVT studies in the laboratory (1).

II.3.2.5 Other uses:

1. Understanding the well (well diameter, inclination, casing cementing, and layer-well connection).

2. Comparing multiple wells using correlations that highlight depth, thickness, and facies variations.

3. Providing information about oil recovery enhancement projects.

4. Identifying reservoir boundaries to develop the deposit.

II.3.3The recordings of PLT:

The study of PLT operation is carried out in a well, to obtain the following information (1):

1. Flow rate recordings using the rotation of the helix.

2. Fluid density recordings using differential pressure and attenuation of the radioactive source.

3. Temperature measurements in the well using resistance variation.

4. Pressure measurements in the well using strain gauges and crystal gauges.

5. Gas percentage recordings (gas holdup).

6. Water percentage recordings (water holdup).

II.3.4Types of PLT operations:

A. Closed well:

- Determine fluid levels.
- Detect cross-flow.
- Reference log (e.g., temperature).
- Flowmeter calibration.

B. Open well:

- Determine the intervals of interest.
- Pressure, flow rate, and density measurements.
- Production or injection profile.
- Production or absorption zone.

II.3.5The interpretation of PLT:

PLT measurements offer various types of information about a well, including flow velocity, fluid density, temperature, pressure, and percentages of gas and water. PLT operations can be conducted with a closed or open well to determine fluid levels, detect Cross-flow, identify intervals of interest, and analyze production or injection profiles and zones. Interpreting PLT data involves both qualitative and quantitative analyses, with pressure and temperature recordings informing qualitative analysis and flow and density recordings informing quantitative analysis (1).

II.3.6The equipment for the PLT operation:

II.3.6.1 Laboratory Unit:

1. The wireline unit is used in vertical wells for real-time signal recording (Telemetry connection). The laboratory truck receives the recordings from the PLT tools through a cable in the form of continuous electrical pulses, which are digitized by a computer, allowing them to be obtained as logs, i.e., data in relation to depth directly.

2. The slickline unit (DSL) is used in vertical wells to record signals indirectly (MPLT) (non-instantaneous): The recordings are tracked throughout the operation, and the data is stored in an internal recording memory and retrieved at the end of the operation.

The coiled tubing unit is used in horizontal wells (1).

Figure II.7: Laboratory Unit (1).

II.3.6.2 Pressure control equipment:

PLT operations need to be conducted in producing wells, which means they are often under pressure. Special equipment has been designed to ensure a perfect seal at the wellhead during the descent or ascent of the tools. A diagram of the high-pressure control equipment is provided in Figure II.8, and it includes the following components from bottom to top (1):

1. Safety valve

2. Catcher to hold the tool in case it gets stuck in the stuffing box and falls due to cable failure.

3. A tubing hanger, which can be up to 10 meters long to accommodate the tools.

4. Blowout preventer (BOP), which is a safety closure device placed between the circulating valve and the tubing hanger, enabling quick closure on the cable in case of leakage.

5. Ball-type safety valve.

6. Grease seal system.

7. Hydraulic stuffing box.

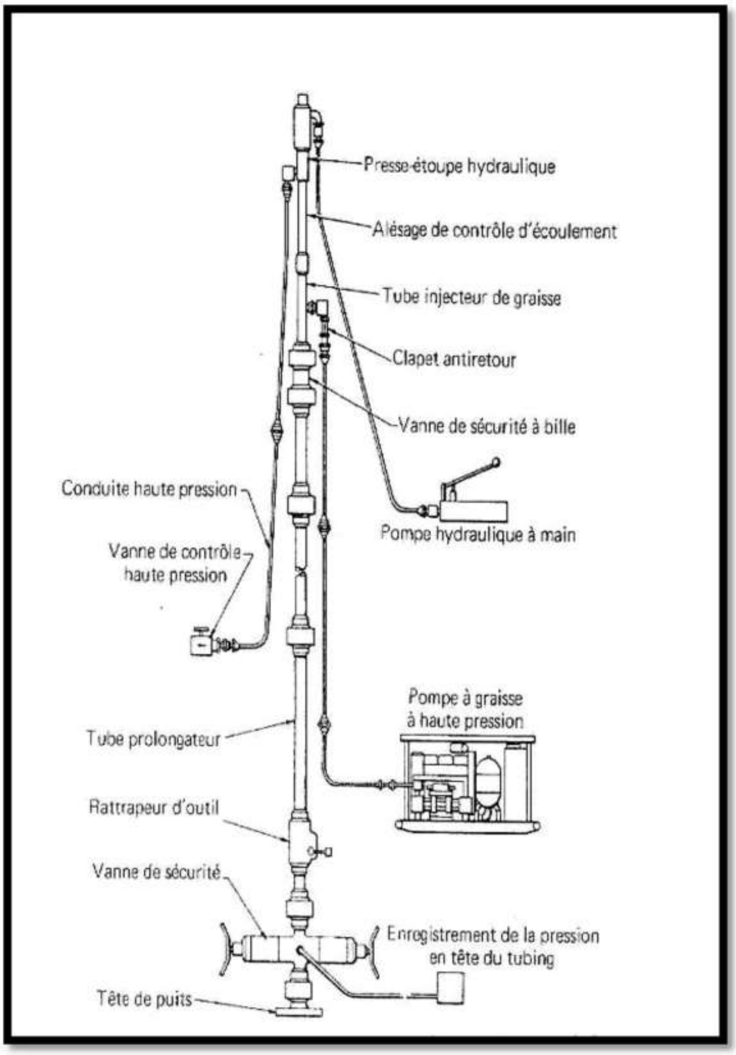


Figure II.8: Pressure Control Equipment (1).

II.3.6.3 Description of PLT Tools:

Various types of conventional probes and optional tools can be mentioned for PLT operations, including:

- Flowmeter (Spinner)
- Caliper
- Temperature
- Pressure
- Density
- GR/CCL (Gamma Ray/Casing Collar Locator)
- Telemetry
- Water and Gas Hold-up

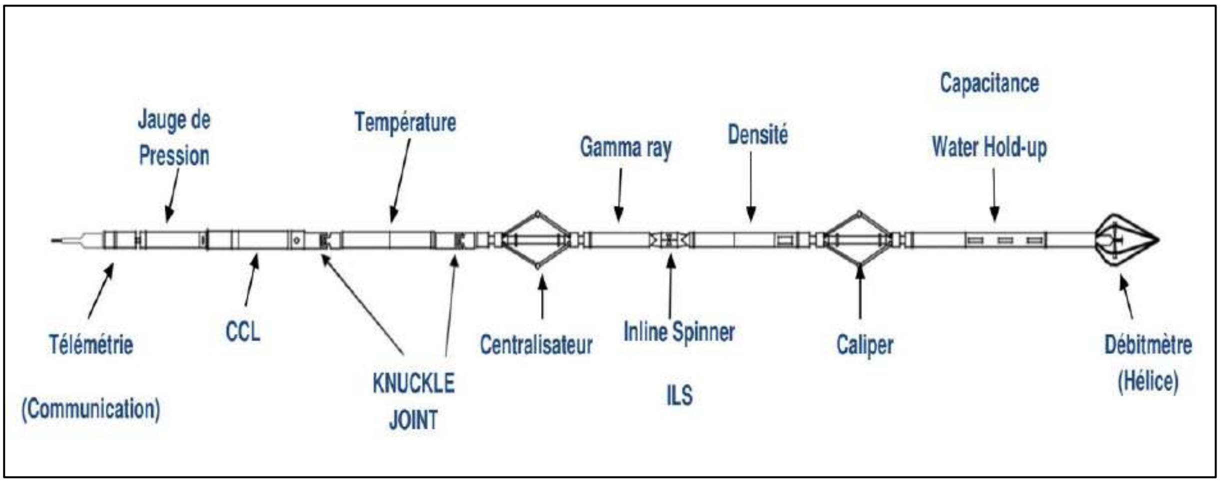


Figure II.9: PLT Tool String (1).

A Flowmeter Tools:

The flowmeter consists of a highly sensitive helical spinner that makes contact with the fluid. The rotation of the spinner generates an electric current or pulse, which is measured by surface equipment and converted into revolutions per second (RPS). The RPS value allows us to determine the fluid velocity. The spinner has a critical speed known as the threshold. Below this speed, the helical spinner cannot rotate.

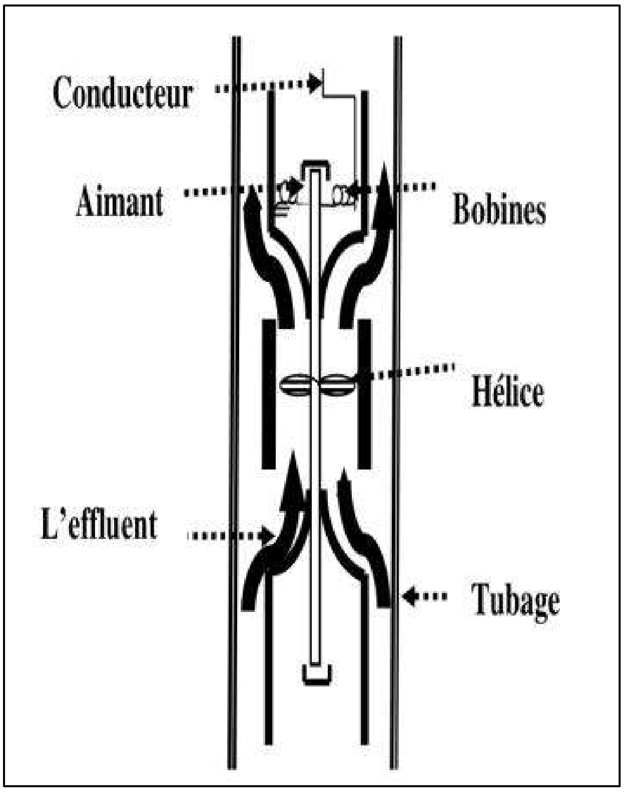


Figure II.10: Explanatory Diagram of Flowmeter (1).

The importance of flow measurement tools includes:

- Detection of production zones.

- Estimation of flow rates for each zone.

- Determination and evaluation of stimulation programs.

There are three types of flowmeters:

1. Caged fullbore spinner: Used for recording measurements in the casing.

2. Continuous flowmeter spinner (CFS): Used for measurements in the tubing.

3. In-line spinner: A secondary spinner used in case of failure of the primary flowmeter.

Figure II.11: Various Types of Spinners (1).

B. Fluid Identification Tools:

In multiphase flow, when the total flow rate is known, fluid identification tools are used to determine the individual phase fractions. Typical fluid identification tools include:

B.1 Capacitance Water Hold-up:

Water and hydrocarbons have different dielectric constants. The average dielectric constant is translated into frequency by the tool as the well flows. By knowing the frequencies, we can calculate the volumetric fraction of the water phase as follows:

A cross-sectional cut is made, and the percentage of each fluid (water, gas, oil) is determined relative to the total fluid surface. The measurement is binary: If the reading is equal to 0, it means a water droplet passed through the probe (conducting water). If the reading is equal to 1, it means a hydrocarbon droplet passed through the probe (non-conducting hydrocarbon) (1).

Figure II.12: Capacitance Water Hold-up Tool (1).

B.2 Density:

Density measurement is carried out using two methods. One method utilizes gamma radiation in horizontal wells, while the other method, known as Fluid Density Distribution (FDD), is used in vertical and inclined wells. The FDD method is based on measuring the differential pressure gradient of the fluids in the well. These measurements are used for fluid identification and multiphase production profiling.

Figure II.13: Density Tools (1).

C. Depth Correlation Tools:

C.1 Casing Collar Locator (CCL):

Used to locate the joints between casings, this tool detects changes in the volume of metal such as casing or tubing connections, as well as perforations.

C.2 Gamma Ray: Gamma ray tools are standard devices used for log correlation between wells. The gamma ray tool is always combined with a CCL tool in the PLT tool string for the following purposes:

1. Confirming the depth of perforations or intervals.
2. Locating the depths of productive zones and damaged areas.
3. Determining lithology.

Figure II.14: Depth Correlation Tools (1).

D. Calipers:

Production calipers are used to determine the diameter of the wellbore within the production interval and facilitate the interpretation of flowmeter data. They are equipped with three or four arms and provide an average reading or two diameter readings taken at 90° angles.

Figure II.15: Casing Caliper (1).

E. Temperature Measurement:

It involves using a thermometer combined with a PLT tool that measures the temperature in real-time during descent or ascent. The results of temperature measurements are used for:

1. Locating production or injection zones.

2. Identifying gas influx.

3. Monitoring fluid movement behind the casing.

F. Pressure Measurement:

The pressure gauge includes quartz piezoelectric strain gauges that can operate at temperatures exceeding 150°C and bottomhole pressures of up to 20,000 psi. This tool provides the bottomhole pressure when the well is shut-in or under pressure, as well as the pressure variation with flow rate changes. It can provide valuable information about well productivity and reservoir performance.

G. Telemetry: Telemetry is typically used by wireline operations to transmit data from the bottom of the well to a real-time acquisition system. Telemetry systems consist of multi-pin connectors that enable communication with various PLT tools.

Figure II.16: Telemetry (1).

II.1Optimization of the PLT Operation:

A. Factors for a Successful PLT:

1. Operation program (objectives).

2. Control strategy (well conditions, flow rate).

3. Configuration of PLT tool string (detectors).

4. Logging interval (entire section).

5. Measurements in steady-state conditions (both shut-in and flowing well).

6. Well stability (lifting while open).

7. Cable speed (choice of speed and number of passes).

8. Surface flow rate (accuracy of estimated value).

B. Causes of a Poor PLT:

1. Insufficient shut-in time for well stabilization.

2. Production flow from the well without proper stabilization.

3. Incorrect positioning of perforations.

4. Incorrect logging interval.

5. Inappropriate selection of detectors.

6. Unsuitable choice of spinner.

7. Misplacement of the PLT tool string.

8. Inadequate selection of tool advancement speed.

9. Unsuitable logging plan.

10. Presence of tool imperfections within the PLT equipment.

Chapter III
Production Logging for Identifying and Remedying Poor Well Performance

III.1Production Logging for Identifying and Remedying Poor Well Performance:

Introduction:

The main goal of production logging is to evaluate the well or reservoir performance. A look at several scenarios of poor well performance and recommendations for production logging tools for diagnosis.

Production logging encompasses a number of well-logging techniques run on completed injection or production wells. The main goal is to evaluate the well or reservoir performance. It is used as a well diagnosis tool to aid in uncovering the cause of poor well performance, measure the effectiveness of various workover operations, and provide a time-lapse surveillance of injection/production profiles to support reservoir management. In many cases, production logs indicate remedial action to be taken to improve well productivity. Production profiling in vertical and horizontal wells have their own challenges and proper planning and execution is required for achieving desirable output from these logs (5).

III.1.1Identifying the Cause of Poor Well Performance:

Production logging is typically used as a supplement to pressure-transient testing in diagnosing poor well performance. The first question to answer is whether the cause is related to the reservoir or completion. In many cases, a combination of the two data analyses is needed such as identifying which interval has a low productivity index (5).

Some of the more typical production problems are

A. Poor initial performance

- Damaged zone causing significant skin effect around wellbore, plugged or ineffective perforations
- Poor depth control during completion
- Improperly sized tubing
- Drawing down below bubblepoint pressure
- Thief zones created by comingling high- and low-pressure zones

B. Excessive gas or water production

- Encroachment of water-oil-contact (WOC) or gas-oil-contact (GOC), water or gas coning
- Fingering through high-permeability zones
- Channeling from a nearby zone
- Casing damage
- Leaking bridge plug

C. Abnormally low productivity

- Reservoir pressure decreases
- Near-wellbore permeability loss due to particulate movement
- Fracture closure, restriction due to sand fill, plugged perforation or gravel pack
- Increase in hydrostatic head due to increased production of a heavy phase

D. Miscellaneous problems

- Sand production
- Tubing, casing, or packer leaks

III.1.2Well Diagnostic Needs(5):

Multiphase Flow in Production Wells	Single-Phase Injection Wells
Low Productivity	Low Injectivity
Excessive Water Production	Abnormally High Injectivity
Excessive Gas Production	Low productivity in Offset Producers
	High Water Production
Drilling/Well Completions	
Well Treatment Design and Evaluation	
Fracture-Height Measurement	
Mud Kick or Lost Circulation	
Evaluation of Perforation Performance	

Locating Top of Cement

III.1.3 Multiphase Flow in Production Wells:

1. **Surface Indication of Poor Behavior/Logging Objective: Low Productivity**

A. Possible Causes:

1. Low formation permeability
2. Plugged perforations
3. Near-wellbore damage
4. Wellbore restrictions
5. Channeling or crossflow

Recommended Logging Service: Flow profile (press-temp-spin), Pressure buildup test

Comments: Production profile measured with spinner indicates low-productivity intervals. Pressure transient tests will also distinguish between low permeability and near-wellbore or perforation damage. Channeling or crossflow may be indicated by temperate or flowmeter logs.

2. **Surface Indication of Poor Behavior/Logging Objective: Excessive Water Production**

B. Possible Causes:

1. High permeability
2. Channeling
3. Coning

Recommended Logging Service: Temperature, spinner and density or capacitance
Comments: A combination of spinner and density or capacitance log can be used to locate water entries. Water channeling may be located with the temperature log. Some special tests or sequence of logs run at different rates may confirm coning.

3. **Surface Indication of Poor Behavior/Logging Objective: Excessive Gas Production**:

C. Possible Causes:

1. High-permeability zones
2. Production from gas cap
3. Channeling
4. Coning directional permeability, barriers, poor pattern placement, etc.

Recommended Logging Service: Temperature, spinner, density and dielectric
Comments: Temperature log may indicate production by cool anomalies. Combination of spinner and density (gradient or gradio) logs may locate gas entries (5).

III.1.4Single-Phase Injection Wells:

1. **Surface Indication of Poor Behavior/Logging Objective: Low Injectivity**

A. Possible Causes:

1. Low formation permeability
2. Plugged perforations
3. Near-wellbore formation damage
4. Wellbore restriction

Recommended Logging Service: 1. Flow profile (Press-Temp-Spin), Pressure falloff test

Comments: Injection profile measured with spinner will indicate low-injectivity intervals. Comparison with core data or open-hole logs may distinguish between low permeability and plugged area (perforations or formation).

2. **Surface Indication of Poor Behavior/Logging Objective: Abnormally High Injectivity**:

B. Possible Causes

1. Channeling
2. Tubing Leak
3. Casing leak
4. Packer leak
5. Fractured reservoir

Recommended Logging Service: Temperature and spinner log, Step-rate test, Falloff test

Comments: Temperature log can indicate channels or leaks. Spinner can suggest channeling or leaks by shape of profile or measured fluid velocity. A fractured reservoir is suggested by absence of channels or leaks as determined by logs. This can be confirmed with a step-rate or falloff test.

3. **Surface Indication of Poor Behavior/Logging Objective: Low Productivity in Offset Producers**

C. Possible Causes:

1. Channeling or leaks
2. Problems in producers
3. Reservoir problems – directional permeability, barriers, poor pattern placement, etc.

Recommended Logging Service: Temperature and spinner log, Falloff test

Comments: If no problems are found in injection well, production well should be tested with production logs and/or pressure-transient tests.

4. **Surface Indication of Poor Behavior/Logging Objective: High Water Production**

A. Possible Causes:

1. High-permeability zones

Recommended Logging Service: Temperature and spinner log

Comments: Injection profile measured with spinner should locate high-permeability zones. Temperature log may indicate a high-permeability zone in a young well (5).

III.1.5 Drilling/Well Completions(5):

Surface indication of poor behavior/logging objective	Possible causes	Recommended logging service	Comments
Well treatment design and evaluation	Required workover	Flow profile logs (Press-Temp-Spin-Gradio-and/or-DIEL)	Many well treatments require flow profile before and after treatment for design and analysis.
Fracture-height measurement		Shut-in temperature	Temperature log measures fracture height based on cooling by the fracture fluid.
11111Mud kick or lost circulation	Underground blowout	Temperature log	Temperature log responds to flow into the formation similar to an injection well.
Evaluation of perforation performance		Flow profile logs (Press-Temp-Spin-Gradio-and/or-DIEL)	Performance of perforations is inferred from the productivity or injectivity of zones

			perforated.
Locating top of cement		Temperature log	Temperature log run shortly after cementing shows region opposite cement resulting from heat of hydration.

III.1.6 Production Logging in Horizontal Wells:

Well flowing conditions are different for horizontal and vertical wells, which require modifications to the tools and interpretations techniques. Phase segregation and fluid stratification are observed in horizontal wells. These phenomena lead to multiphase flow thus making the responses of production tools unpredictable.

The main challenge facing production logging in horizontal wells is that trapped fluids can directly affect production and influence the data from a production log, especially for sensors such as spinners and capacitance tools. Because horizontal wells have doglegs and undulations, stagnant water may lie either inside or outside the casing in low areas at the bottom of the well, and stagnant gas may accumulate on the high side of hole undulations. However, applications of modern production-logging methods have helped to make significant production gains. Conventional production logging could not evaluate the individual interval contributions or identify the sources of water production. This led to development of new technology tools with a range of small sensors that covered the full width of the wellbore and could be placed close together to improve depth resolution. The latest techniques provide real-time holdup and velocity profiles along a vertical axis of the borehole cross-section. The sensors distinguish between gas and liquid using optical refractive index measurements. Thus, it gives a better understanding of production regimes and defining accurate flow profiles, which consequently help in planning more efficient workover or production strategies and improve ultimate hydrocarbon recovery (5).

III.2 The case study:

INTRODUCTION:

The Hassi Messaoud oil field encounters several issues and changes such as decreasing oil productivity, increasing GOR (Gas-Oil Ratio), and water cut, which vary from well to well. Moreover, a single well can have multiple factors of different origins. In this chapter, a well (OMM412) located in the oil production field of Hassi Messaoud in the Ouargla province has been chosen as it has experienced problems directly impacting its productivity. In order to identify breakthrough points as early as possible, Production Logging Tool (PLT) campaigns are systematically conducted each year in oil production wells. This chapter will examine both the production logging operations, measurement results, and available options for remedial actions (1).

III.2.1 Utilized Data:

Data provided by the PLT recordings and generated by the Emeraude software (Production profiles of each well (Figure IV.1), productive zones with their contributions, and damaged intervals.)(1)

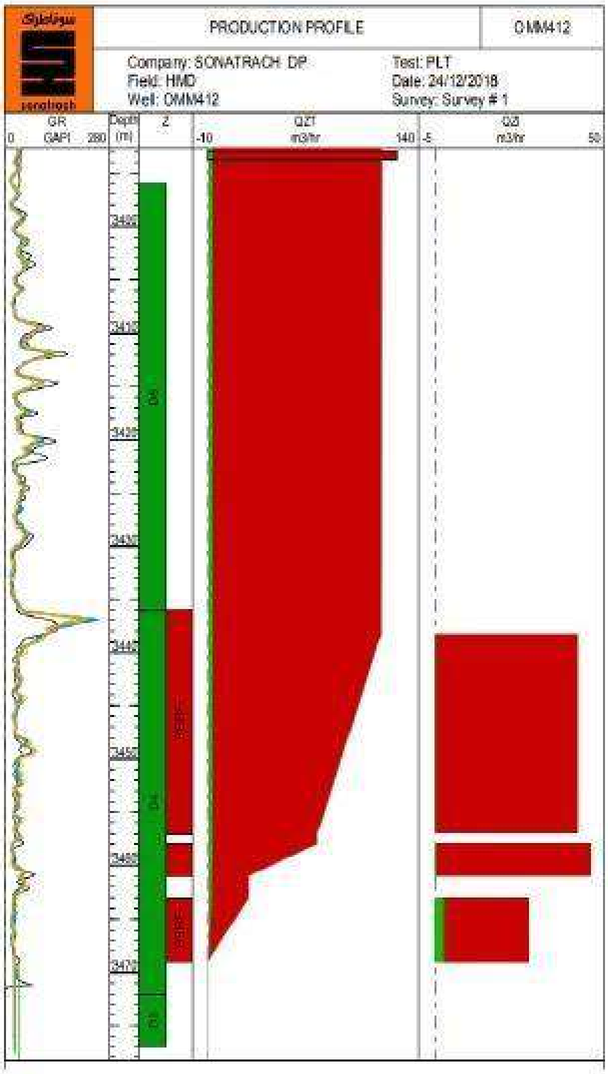
OMM412 (PLT executed on 24/12/2018)

- **Gauge data:** Measurement of oil flow rates (Qo), gas flow rates (Qg), water flow rates (Qw), Gas-Oil Ratio (GOR), Water cut (WC)
  OMM412 (Before the implementation of the solution on 18/11/2018, after the implementation of the solution on 28/10/2019)
- **Geological data:** Depth, thickness, net pay thickness, etc.

Note: These data are obtained from the Sonatrach Company's data bank.

III.2.2 Presentation of the utilized diagraphic data:

In order to identify breakthrough points, PLT (Production Logging Tool) campaigns were conducted in the selected well for this study (Figure IV.1) (1).



Profile de production du puitsOMM412

D'après le PLT réalise le 24/12/2018.

Figure III.1: Profile of the studied well's production (OMM412)

III.2.3 Discussion of the Data:

In order to delve deeper into the study and highlight the various issues localized in the field through PLT.

III.2.3.1 Gas breakthrough:

A gas breakthrough is observed in well OMM412 within the interval 3438.3m - 3457m.

A. Well OMM412:

It is an oil-producing well, drilled in 1997 in zone 1A, and was put into production in October 1997 with an oil flow rate of 8.5 m^3/h and a Gas-Oil Ratio (GOR) of 102 m^3/m^3,In March 2017, the oil flow rate (Qo) became 1.81 m^3/h, while the Gas-Oil Ratio (GOR) was approximately 6906 m^3/m^3. This indicates that the well experienced breakthrough right from the start of its production, which is evident in the oil production history curves since January 1997 (1).

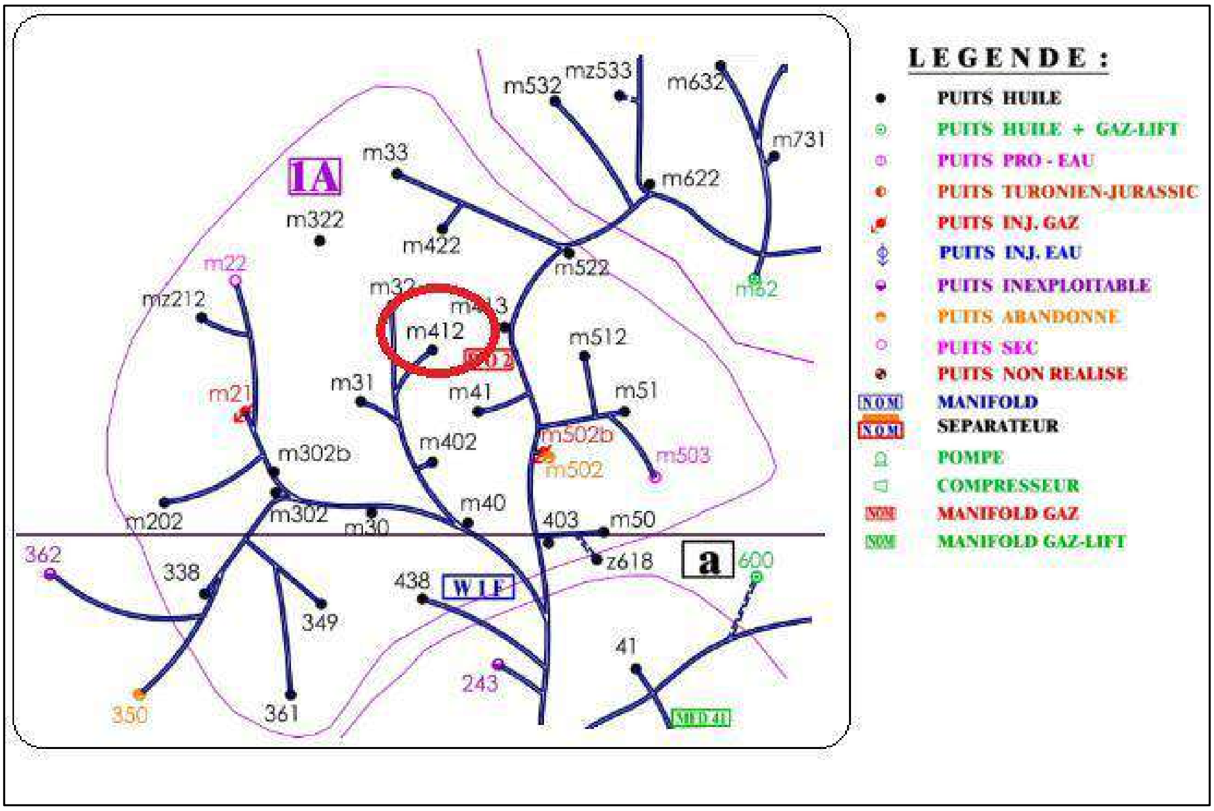


Figure III.2: Location of well OMM412 in the Hassi Messaoud field.

Table III.1 :1 :Contributions by phase of well OMM412 determined by the Emeraude software:

Zones m	Qw res. m3/hr	Qo res. m3/hr	Qg res. m3/hr	W O G
Inf. 1 (3438.3-3457.0)	0.00	0.10	42.08	
Inf. 2 (3458.0-3461.0)	0.00	0.47	45.46	
Inf. 3 (3463.0-3469.0)	0.00	2.40	24.99	

B. Analysis of PLT data and evaluation of solution:

The interpretation of the PLT has shown the intervals of perforations that contribute to production as follows:

- Interval 3438.3m - 3457m:
  Produces approximately 3.51% of oil and 36.82% of gas.
- Interval 3458m - 3461m:
  Produces approximately 16.34% of oil with over 40% of gas.
- Interval 3463m - 3469m:
  Produces the majority of the oil quantity, approximately 83.17%, associated with 23.19% of gas.

Based on the interpretation, it is observed that there is no water in all zones of the production section, indicating that the majority of the gas quantity comes from the upper zone (3438.3m - 3457m). Based on the production profile, they concluded that it is necessary to isolate the interval 3438.3m - 3457m with a cement squeeze to minimize the significant amount of gas produced from this interval.

The figure below presents the results of gauge tests that were conducted for evaluation (1).

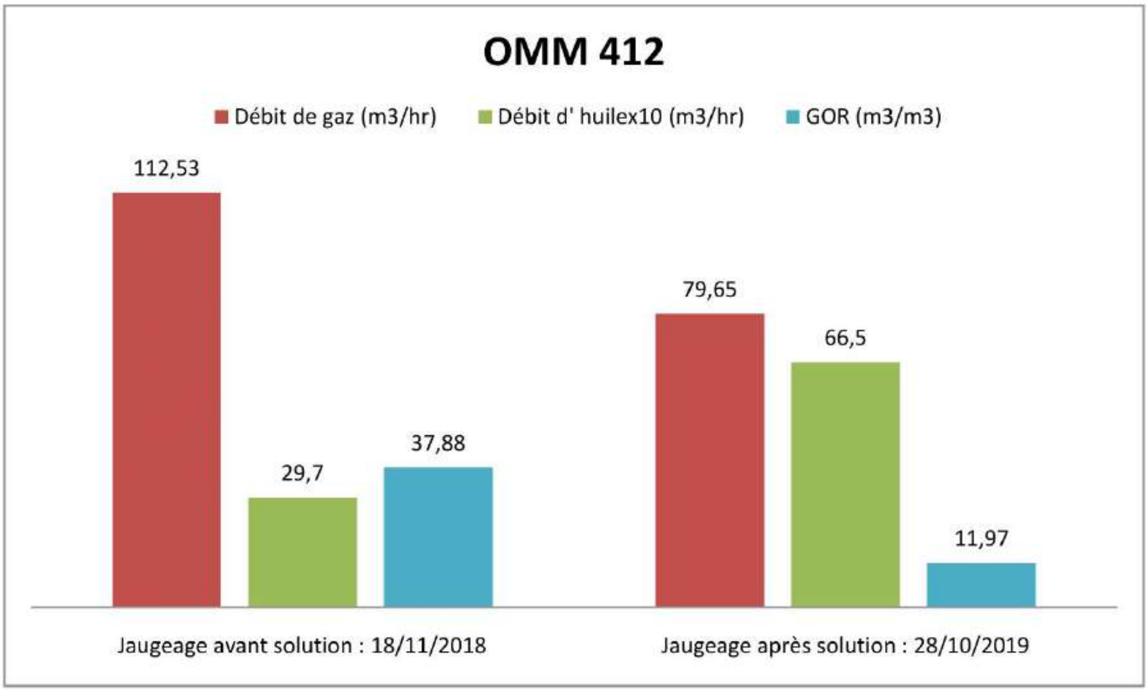


Figure III.3: Comparison between the well gauge data of OMM412

Before the squeeze operation, it is observed that the GOR value is very high, reaching approximately 37.88 m^3/m^3. This explains the low oil flow rate compared to gas. After the squeeze operation, there was an increase in the oil flow rate to approximately 6.65 m^3/h, while the gas flow rate decreased to 79.65 m^3/h and the GOR level decreased (1).

Conclusion:

The analysis and evaluation of the aforementioned data using the EMERAUD software have led us to the following conclusions:

- The PLT log result on well OMM 412 indicated that the source of the large quantity of gas produced is the interval (3438.3m - 3457m). Consequently, the cement squeeze in this interval has reduced the high gas flow rate and resulted in a significant increase in the oil flow rate.

Conclusion Générale

Conclusion:

the assessment of production logging tools plays a crucial role in optimizing the performance of oil and gas wells. These tools provide valuable insights into the downhole conditions and help identify potential issues that may hinder production efficiency. By analyzing data such as flow rates, pressures, fluid properties, and downhole temperatures, production logging tools enable operators to make informed decisions and implement targeted interventions to enhance well productivity.

Through the use of production logging tools, operators can accurately evaluate the well's inflow and outflow profiles, identify production anomalies such as fluid channeling or mechanical obstructions, and optimize the placement of artificial lift systems or stimulation treatments. This detailed understanding of well behavior and performance enables operators to minimize production bottlenecks, improve reservoir management strategies, and ultimately maximize hydrocarbon recovery.

Furthermore, production logging tools provide real-time monitoring capabilities, allowing operators to assess well performance continuously. This enables proactive decision-making and timely interventions to address any deviations from expected production profiles, avoiding costly downtime and optimizing production rates.

It is important to note that the selection of appropriate production logging tools depends on various factors such as well characteristics, reservoir conditions, and specific objectives. Each tool has its strengths and limitations, and a comprehensive assessment should consider factors such as tool accuracy, reliability, ease of deployment, and cost-effectiveness.

Overall, the assessment of production logging tools is a vital component in the optimization of oil and gas well performance. By leveraging these tools effectively, operators can gain valuable insights, troubleshoot production issues, and implement targeted strategies to enhance well productivity, maximize hydrocarbon recovery, and ultimately achieve improved operational and economic outcomes.

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ANNEXES

Annex A : Presentation of a Well Log

The presentation of a well log is crucial. The header of the log should include several pieces of information (4).

-Company name

-Well number and coordinates

-Tool used

-All other logs recorded simultaneously during the same operation

-Depth - driller: The depth reached by the drilling operation

-Depth - logger: The maximum depth reached by the log

-Btm log interval: The depth at which the log truly begins

-Top log interval: The depth at which the log is stopped

-Type of fluid in the hole: The type of fluid filling the borehole, including mud type with its characteristics such as density, viscosity, pH, etc.

-Source sample: The location from which the mud sample was taken, usually during the last circulation in the mud pit

-Rm (mud resistivity): Resistivity of the mud

-Rmf (mud filtrate): Resistivity of the filtrate

-Rmc (mud cake): Resistivity of the mud cake

Annex B: Example of Well Log Presentation

DATE: LOG :

COMPANY :

WELL NUMBER: COORDINATES: COUNTRY :

ALTITUDE:

OPERATOR :

DEPTH ORIGIN:

DRILLING DEPTH :

HOLE DIAMETER :

CASING :

MUD INFORMATION:

Mud Type: Sample Source:

Density: Viscosity :

Rm (Mud Resistivity) at Temperature T:

Rmf (Mud Filtrate Resistivity) at Temperature T:

Roc (Mud Cake Resistivity) at Temperature T:

BOTTOM HOLE TEMPERATURE (B.H.T).

Surface Temperature:

Time Since Last Circulation :

OTHER LOGS PERFORMED:

VERTICAL SCALE SELECTED:

RECORDING SPEED:

REMARKS:

Additional Definitions: Time since last circulation: The time elapsed from the last circulation until the log was recorded.

Permanent datum: The reference level used in the log.

Casing: Refers to the tubular casing installed in the well .

KB: Kelly Bushing, a reference point used for depth measurements in drilling operations.