



IJEAST

INTERNATIONAL JOURNAL
OF ENGINEERING APPLIED SCIENCE
AND TECHNOLOGY



VOLUME : 9 ISSUE : 04 Print / Issue Publication Date: 20-Nov-2024



ISSN : 2455-2143



DOI : 10.33564/IJEAST.2024.v09i04.003

Indexed In



WWW.IJEAST.COM

editor@ijeast.com



ENHANCED ENERGY EFFICIENCY OF WIRELESS SENSOR NETWORKS USING PROTOCOL BASED RESPONSE ROUTING (PBRR) IN OIL RIG

Okeke Nneka, Okorogu Victor N, Nnebe Scholastica U, Alagbu Ekene E, Oranugo Charles O
Department of Electronic and Computer Engineering
Faculty of Engineering
Nnamdi Azikiwe University Awka
Anambra State Nigeria

Abstract— A system called system-Based Response Routing (PBRR) was created to increase energy efficiency in wireless sensor networks (WSNs) installed on oil rigs. By optimizing routing choices in response to sensor responses, PBRR reduces energy usage and increases network lifetime. It ensures that vital information is transmitted on time while sparing less urgent data from energy use by prioritizing data transmission according to urgency. By using multi-hop routing techniques, PBRR saves energy costs and guarantees dependable monitoring under difficult circumstances. This method makes WSNs more practical for long-term deployment in difficult situations like oil rigs.

Keywords— WSN PBRR

I. INTRODUCTION

A wireless sensor network is made up of a number of wireless sensor nodes, or devices, that are typically used to record data on local occurrences according to Santhameena S. et al (2022). The computing and communication power of sensor nodes is restricted in accordance with Havashemi K. et al (2022). Sending data from scanning (sense) phenomena to the base station or several nodes designated as data collectors is the standard communication pattern in wireless sensor networks (WSNs) according to Xiong, C.W. et al (2022). The sensor node receives a request from the data collector or base station that includes information about the phenomena to be recorded, the sampling interval, and the overall sampling time as stated by Frey H. et al (2005). Delay is one of the many reasons why wireless sensor networks operate poorly. Data loss, which occurs when data is lost during data exchange operations in

WSN as a result of high traffic on the WSN, is another factor contributing to WSN's poor performance based on Rehan W. et al (2017).

The heavy traffic on the protocol line on the WSN is the cause of the high delay rate, which will lower the WSN's performance. The high rate of delay causes more data loss, which can lower the WSN's quality and performance. In order to minimize latency and data loss, we therefore require a solution to these issues according to Hamid M.A. et al (2011). Wireless Sensor Network technology is essential to the intelligent irrigation system's ability to communicate with one another in accordance with Singhal C. et al (2021). The effectiveness of intelligent irrigation can be enhanced by a variety of sensors. For example, a fuzzy logic method can be used to define the temperature and humidity variables in the system, allowing for more optimum watering stated by Lavanya G. et al (2019). The issue is that there are a lot of data collisions according to Mahesh N. et al (2022).

Data packets may collide with one another on a common channel in a collision, which is a physical network segment as stated by Cinar H. et al (2019). Data collision may occur when there are too many sensors since only the temperature and humidity sensors' data will be forwarded to the server. The tool will not function as well when the data collides as described by Yigit M. et al (2016), even blanking out the data and shutting off immediately.

II. PROPOSED ALGORITHM

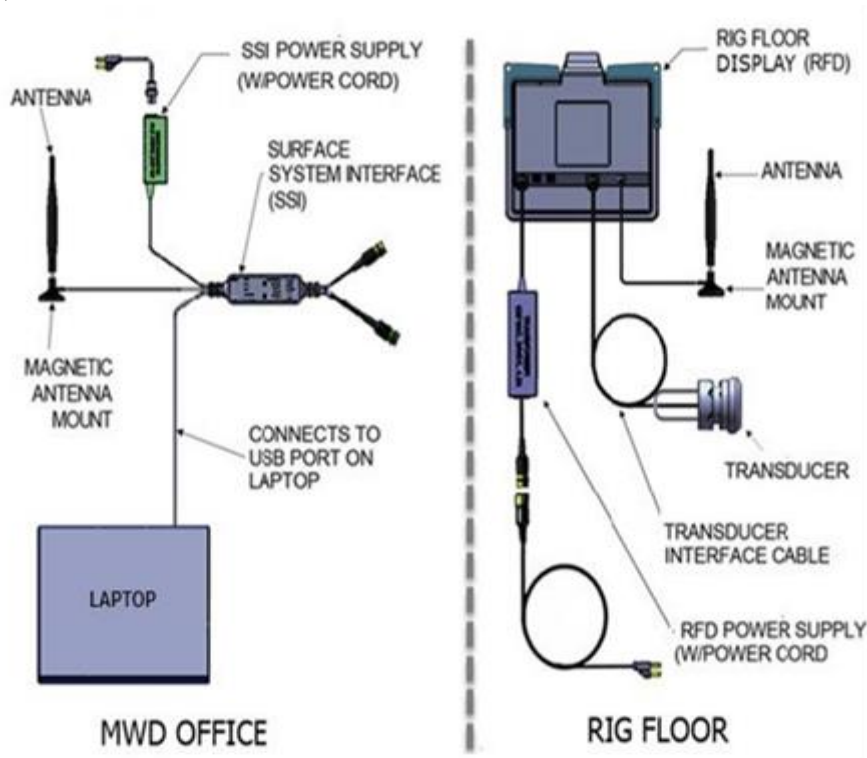
Materials used for the field experiment

The following equipment was used for carrying out the field experimentation in order to show the implementation of the proposed routing protocol. The specifications are also stated.

Acceleration Sensor:

| | |
|-------------------------------|------------------------------------|
| Manufacturer | DFROBOT |
| Type of sensor | accelerometer |
| Integrated circuit | LIS331HH |
| Accelerometer measuring range | ±6g, ±12g, ±24g |
| Kind of output | Digital |
| Operating current | 140µA |
| Processor Series: | PIC18 |
| Product: | MCUs |
| Product Type: | 8-bit Microcontrollers – MCU |
| Program Memory Type: | Flash |
| Factory Pack Quantity: | 15 |
| Subcategory: | Microcontrollers – MCU |
| Trade name: | PIC |
| Width: | 7.24 mm |
| Unit Weight: | 0.075839 oz |

SENSOR PLACEMENT





Pump stroke counter

MWD (MEASUREMENT WHILE DRILLING) TOOL

MWD is a system of **taking measurements while drilling a wellbore**. This allows measurements to be sent to the surface continuously while the hole is being drilled.

It is a general term for electronics that use sensors to calculate position and orientation. Inclination is the angle of the wellbore with respect to vertical and azimuth is the angle of the wellbore's direction with respect to North.

Once the measurements have been taken, the information needs to be encoded and sent up to the surface, where it can be interpreted by rig operators.

The MWD tool has three magnetic sensors:

- i. Magnetometer
- ii. Accelerometer
- iii. Telemetry sensor

LOGGING WHILE DRILLING (LWD)

Advances in drilling/logging technology have allowed the acquisition of log data via tools placed in the actual drilling assembly. LWD data may be stored downhole in the tools memory and retrieved when the tool is brought to the surface and/or transmitted as pulses in the mud column in real time while drilling.

Factors that might limit the ability to fully use both sets of data are:

1. **Drilling mode:** Data may be pulsed only if mud is pumped through the drill string.
2. **Battery life:** Depending on the tools in the string, tools may work in memory mode only between 40 and 90 hours after activation.
3. **Memory size:** Most LWD tools have a memory size limited to a few megabytes. Once the memory is full, the data will start to be overwritten. Depending on how many parameters are being recorded, the memory may become full within 20–120 hours.
4. **Tool failure:** It is not uncommon for a fault to develop in the tool such that the pulse data and/or memory data are not transmissible/recordable.

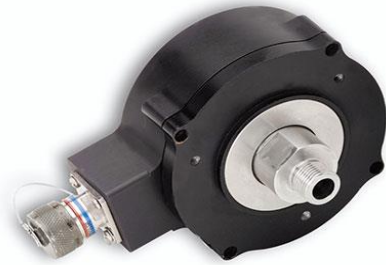
SENSORS ON THE DRILLING RIG

1. Surface sensor

- i. Draw work Encoder

This is a digital sensor. It is used primarily to track depth on the rig. It is also referred to as an optical encoder sometimes

because contains a disk internally that allows the passage of light at a specific intervals. The sensor allows the drawworks direction and speed to be determined. The sensor output is measured in pulses and a calibration must be performed on the rig to determine the amount of movement of the traveling block per revolution of the drawwork drum. The drawwork encoder is usually mounted on the drawwork shaft and temporary removal of the cooling system is often required.



DRAW WORK ENCODER

- ii. Hook load sensor: is used to measure the tension on the travelling block which



Hookload sensor

- iii. Standpipe pressure transducer



Standpipe Pressure Transducer

2. DOWNHOLE SENSOR
i. RESISTIVITY SENSOR

Resistivity logging is a method of well logging that works by characterizing the rock or sediment in a borehole by measuring its electrical resistivity. Resistivity is a fundamental material property which represents how strongly a material opposes the flow of electric current. In these logs, resistivity is measured using four electrical probes to eliminate the resistance of the contact leads. The log must run in holes containing electrically conductive mud or water, i.e., with enough ions present in the drilling fluid.

ii. GAMMA RAY SENSOR

The Gamma Log produced by these Gamma Ray Sensors is most commonly used for Geo-steering, correlation with existing open hole logs, identifying low and high radiation lithologies and depth correlation. Electronics are fully encapsulated for additional shock and vibration protection.

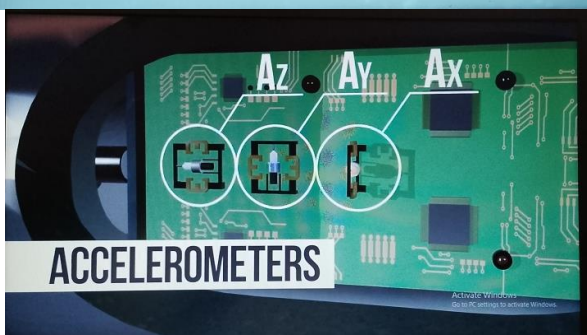
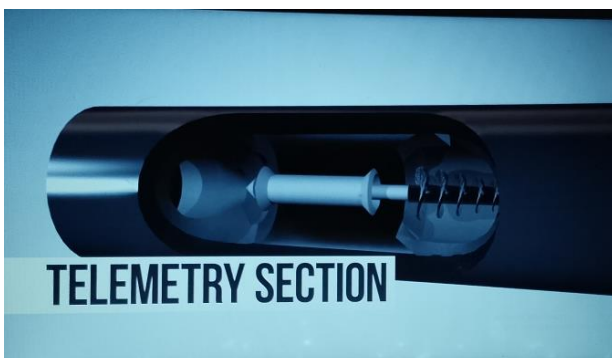
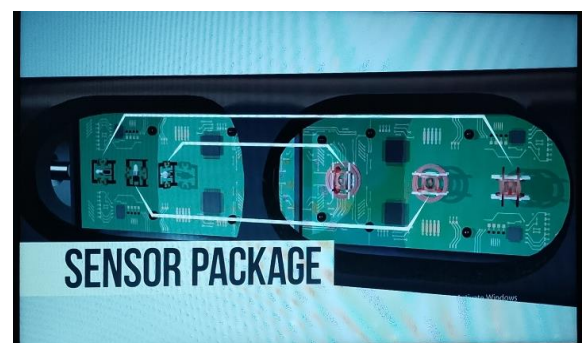
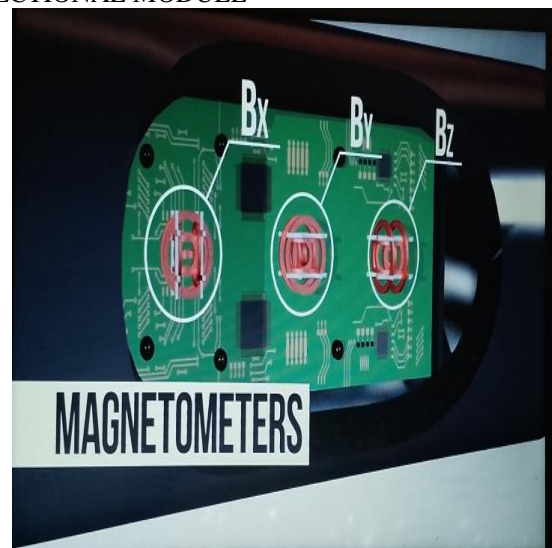
iii. Directional module (DM)

iv. PRESSURE SENSOR

Pressure sensors: are used to measure the force exerted by a fluid or gas on a surface or a container. They are crucial for oil and gas production because they indicate the condition and behaviour of the reservoir, the well, the pipeline, and the processing equipment. Pressure sensors help regulate the flow rate, prevent leaks, detect blockages, and avoid over pressurization or under pressurization.



DIRECTIONAL MODULE



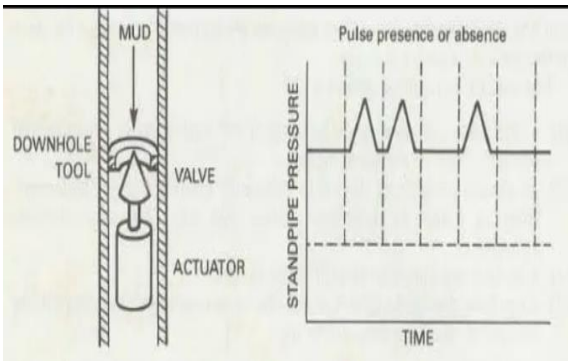
TELEMETRY SENSOR

Mud-Pulse Telemetry. During drilling, a special kind of mud (drilling fluid) is pumped down the drill string and then sent back to the surface. Electronics at the bottom of the hole drive a valve that can constrict and relax the flow of this mud, creating pressure pulses in the fluid that's circulating in and

out of the hole. The three common types of signals generated are positive pulse telemetry, negative pulse telemetry and continuous wave telemetry.

POSITIVE MUD PULSE TELEMETRY

This telemetry uses a flow restrictor that closes to increase standpipe pressure when activated. As the mud flows through the pipe, the pressure fluctuates as the flow restrictor opens and closes. The highs and lows of pressure are sensed by the transducer on the standpipe, the transducer then converts the pulses to electrical signals and sends it to the decoder.



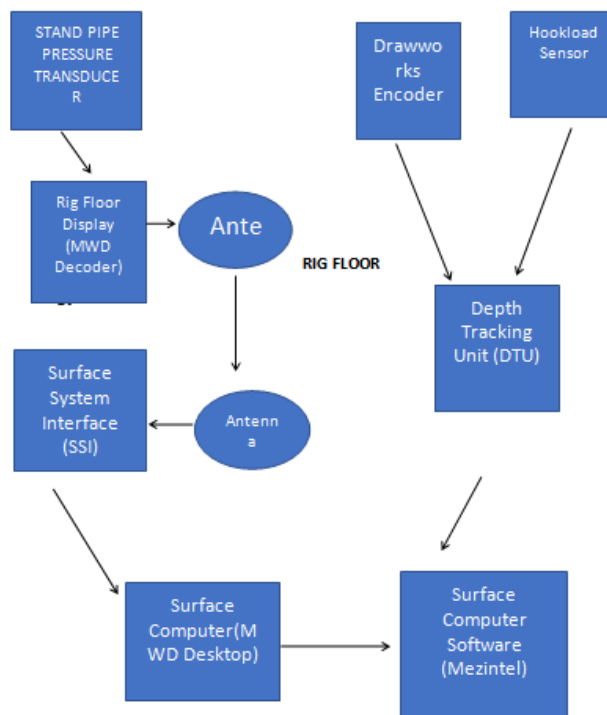
POSITIVE MUD PULSE TELEMETRY

3.1.1 Research Environment

Location: Delta State (Okporhuru Field)
 Lat - 5° 53' 47.404N Long - 5° 50' 13. 443E Depth: About 13,500ft
 Energy level of battery when activated
 Percentage ----- 94.06% Capacity ----- 27,278.21mAh
 Voltage ----- 28.50V Active time ----- 16hrs 26mins
 Retrieved after operation
 Percentage ----- 34.43% Capacity ----- 9,986.06mAh
 Voltage ----- 28.60V Active time ----- 78hrs 13mins

THE SYSTEM MODEL

In this section, a detailed explanation of the system model that will be used to implement and test the proposed protocols. Firstly, we present the WSN model, then, we explain the energy consumption model that will be used to test the proposed protocols. Finally, we present the simulator and the WSN simulation settings that will be used to test the proposed protocols.



III. RESULT AND ANALYSIS

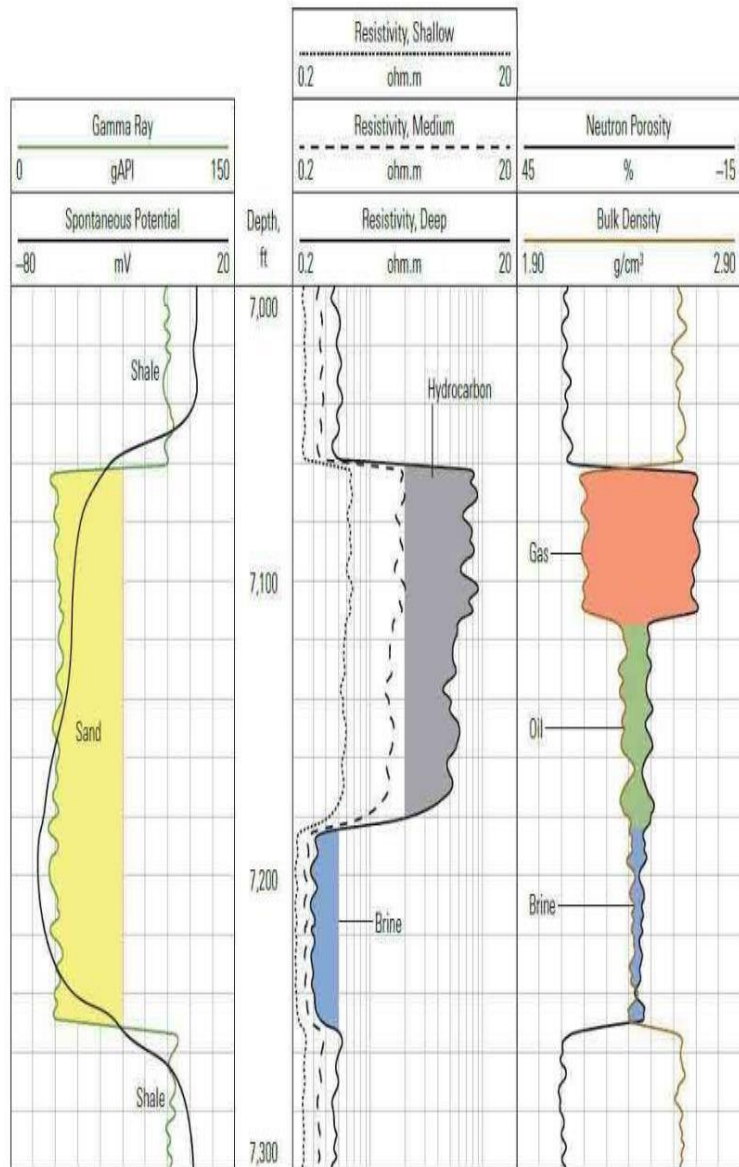
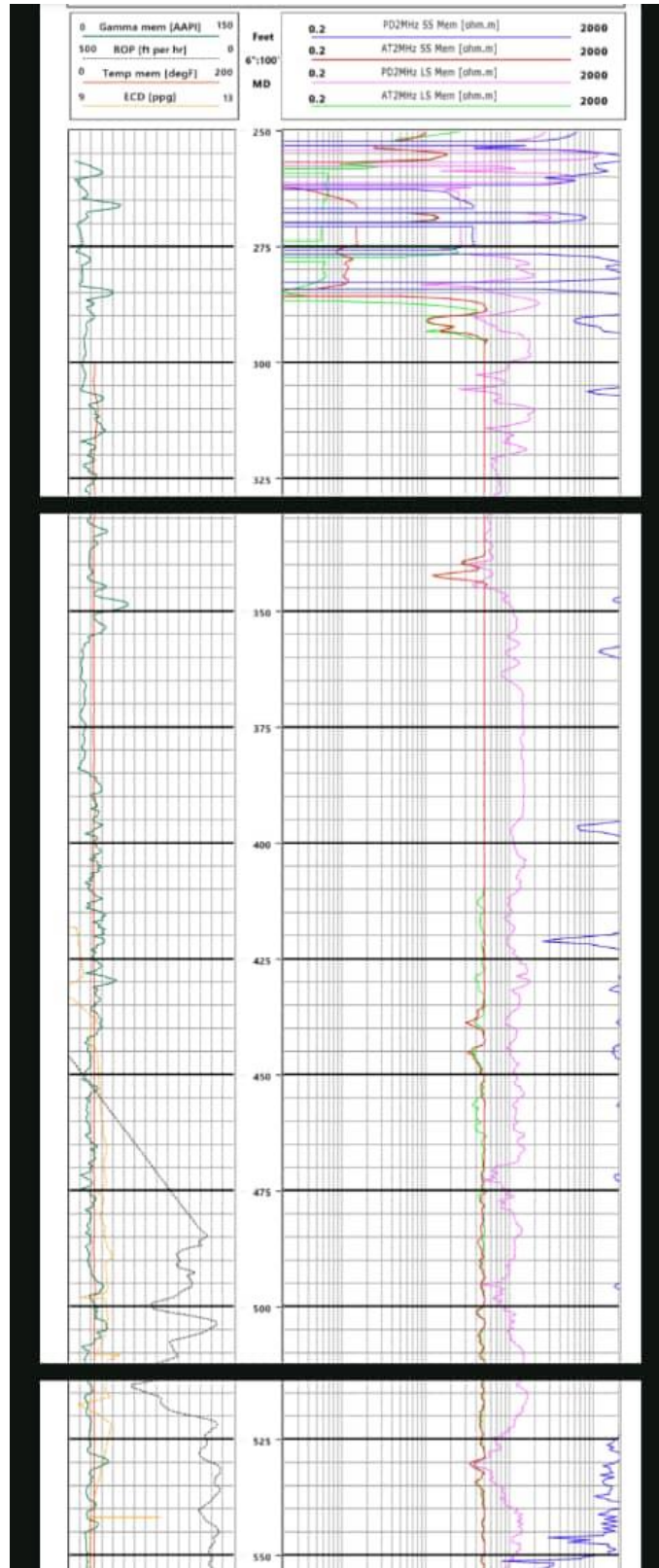
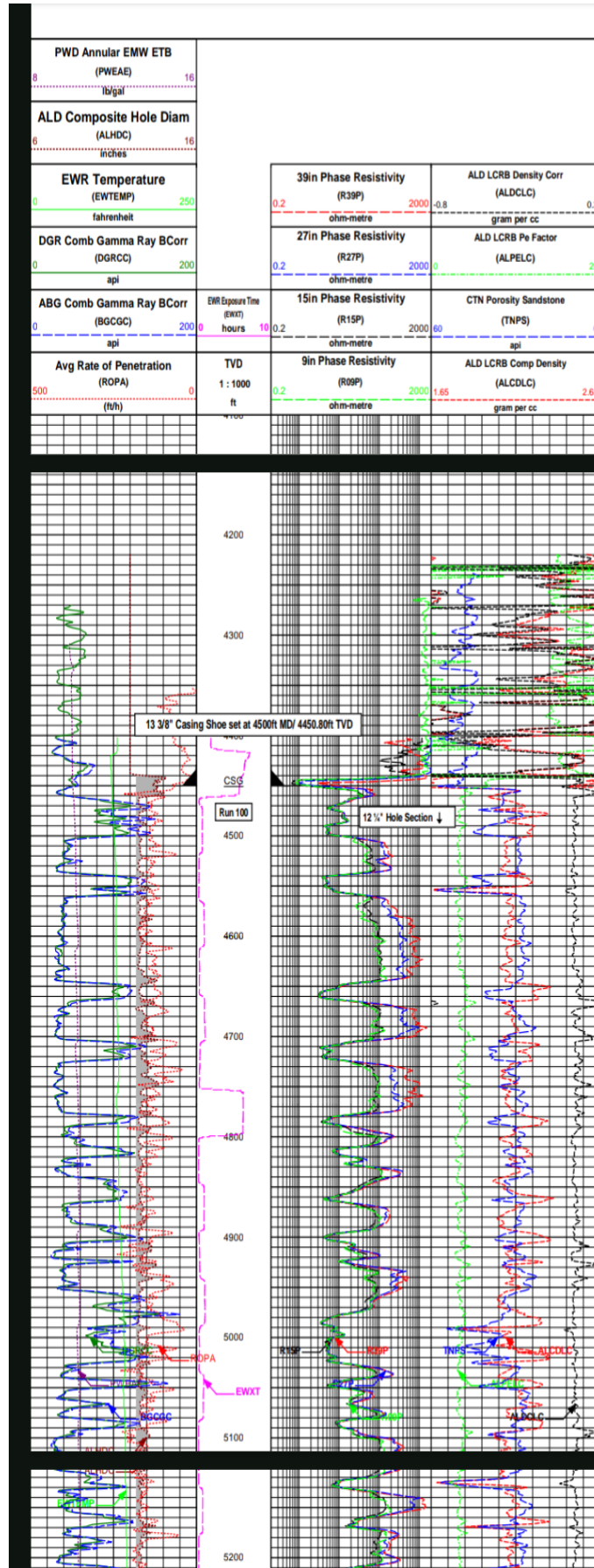


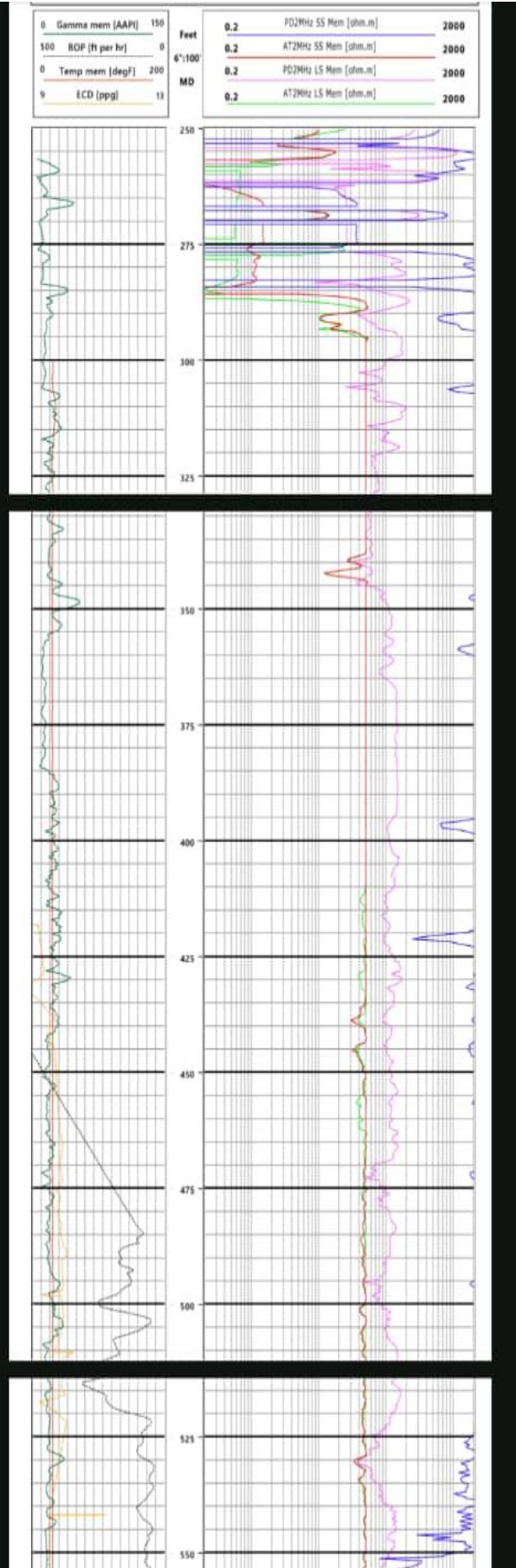
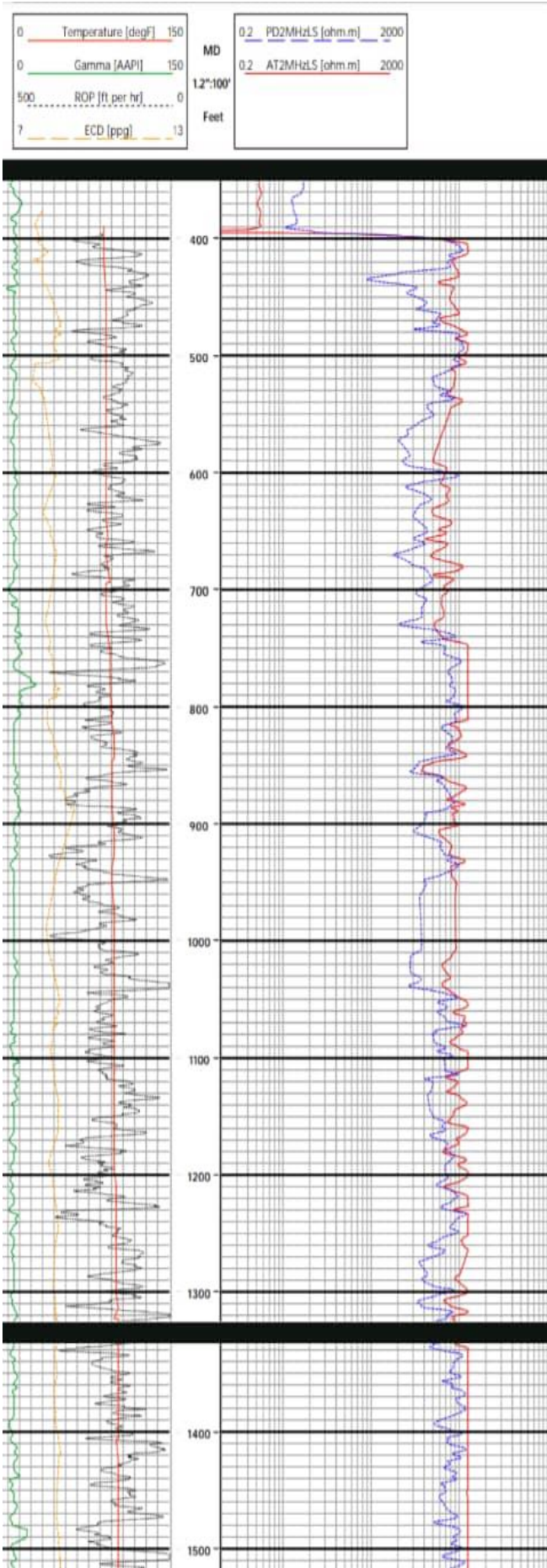
Figure 4.1 Shows the graphical representation of the throughput response.

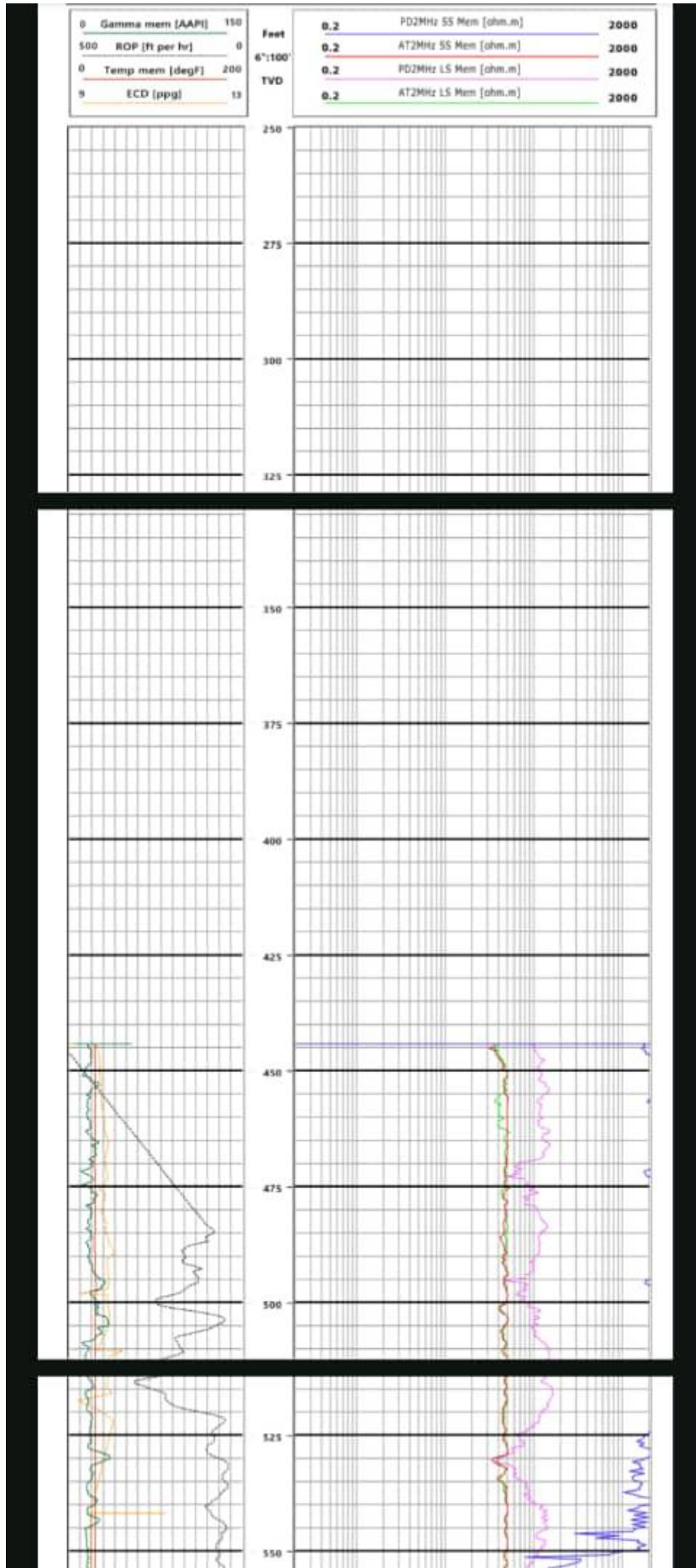
Fig. 4.1 is a graphical representation of gamma, resistivity, and neutron density logs. The gamma ray log shows the type of formation the drilling tool is passing through, either shale or sand. When the signal increases toward the positive, it indicates shale formation, while a decrease toward the negative indicates a sandy formation.

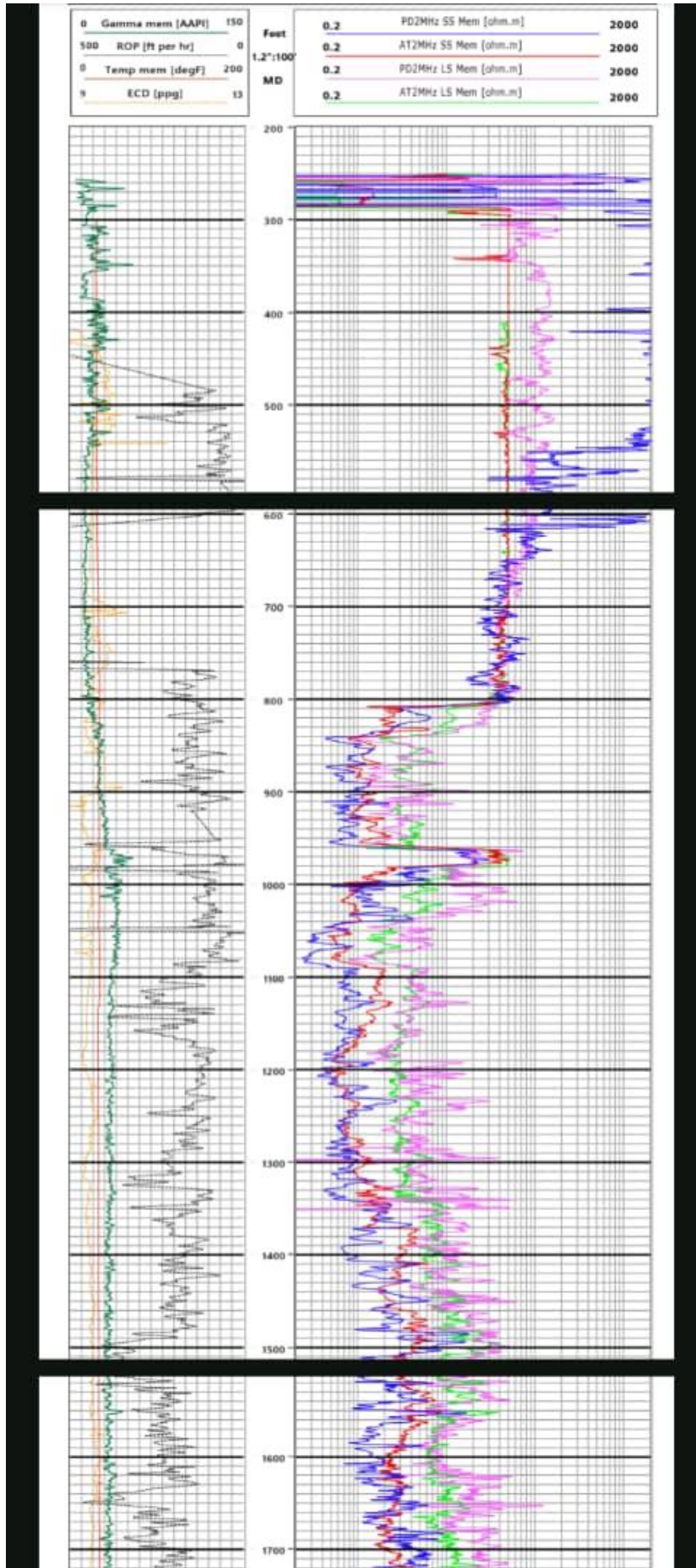
The resistivity graph identifies the presence of fluid in the formation, whether water or hydrocarbons, while the neutron density log specifies the type of fluid the drilling tool is encountering, such as gas, oil, or fresh water.

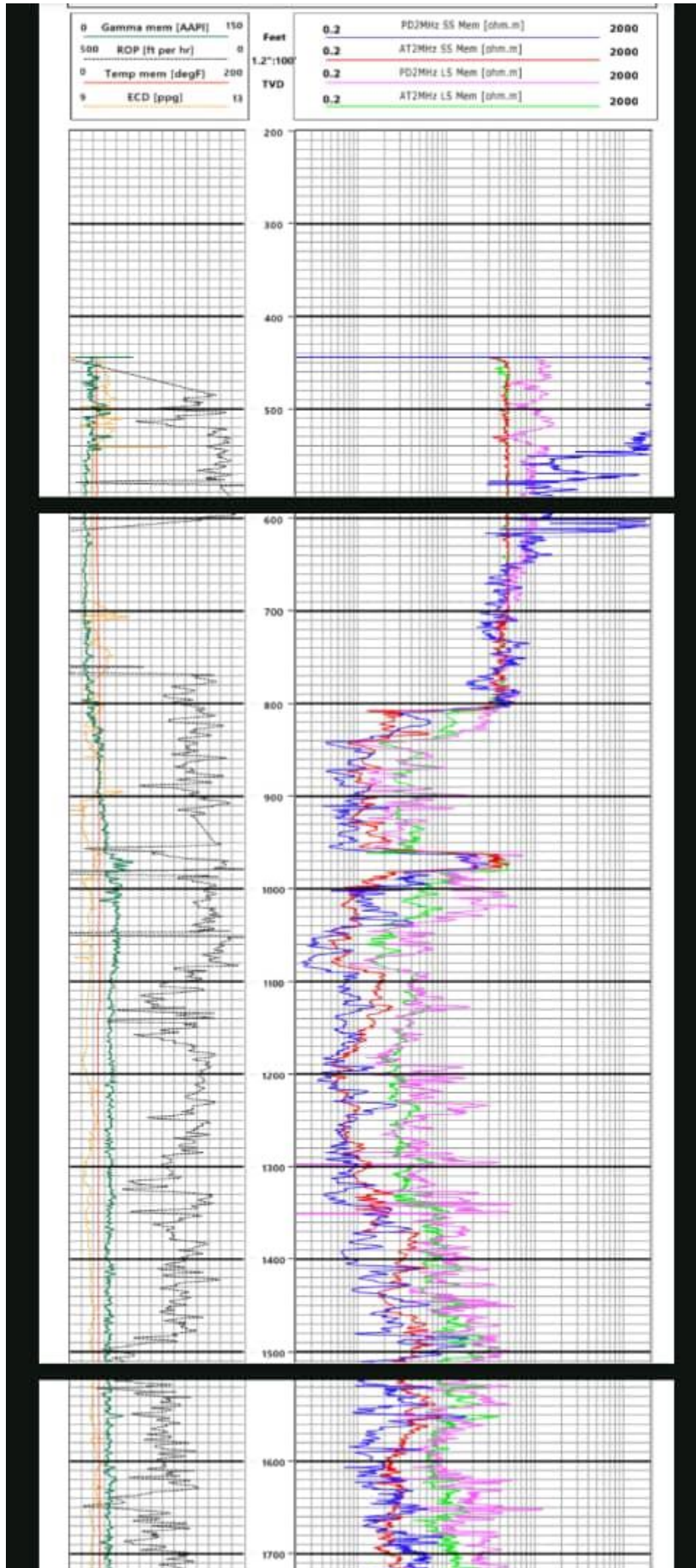


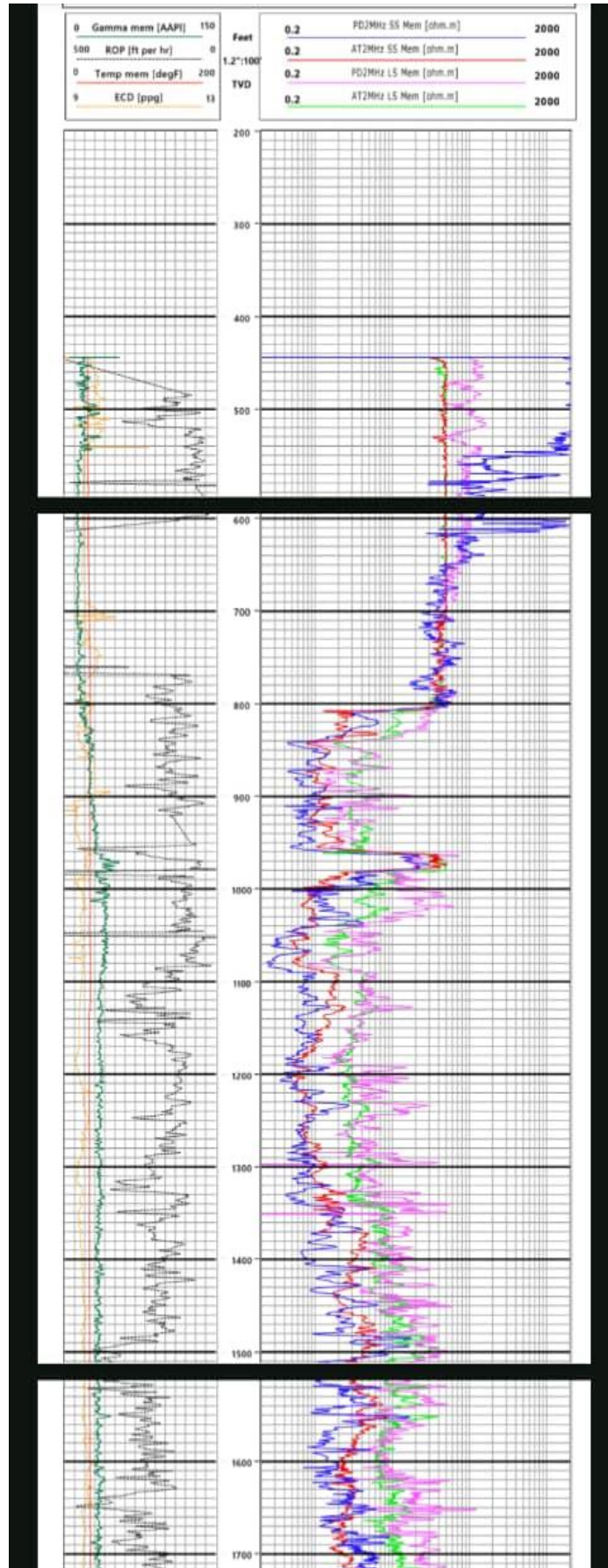


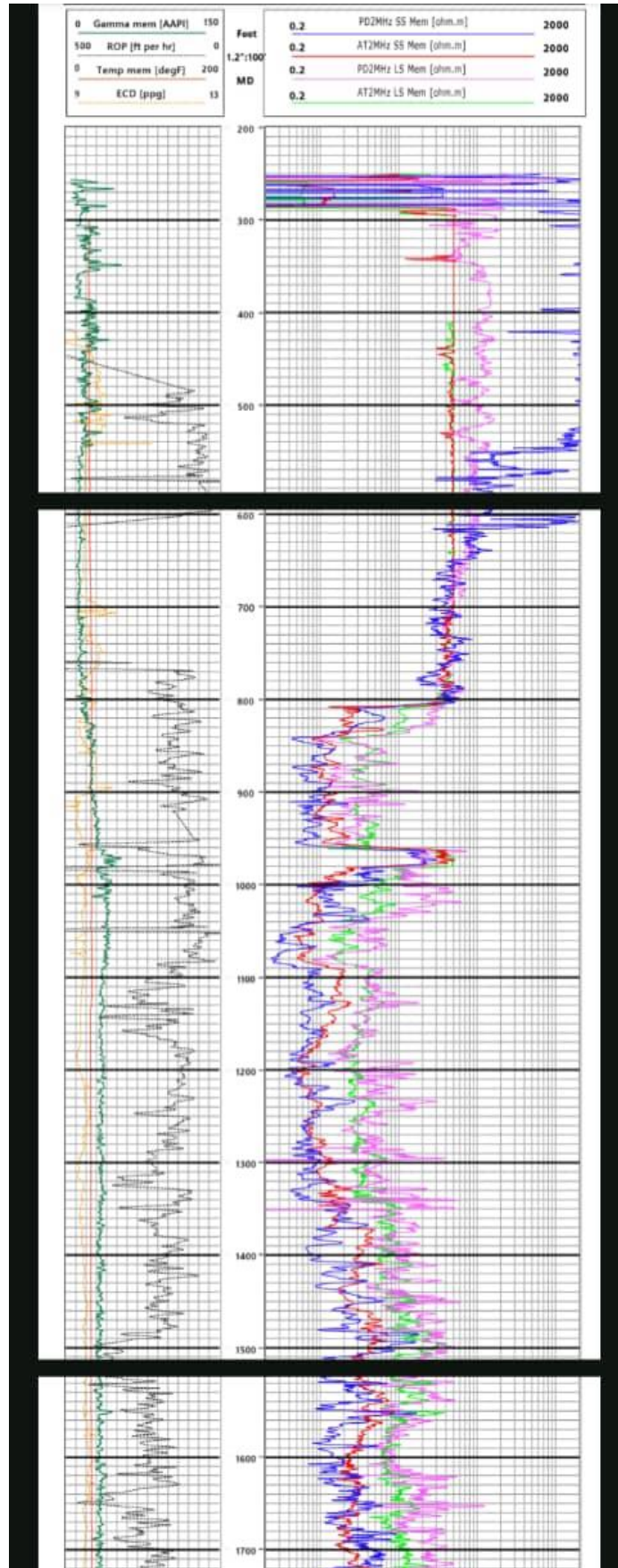


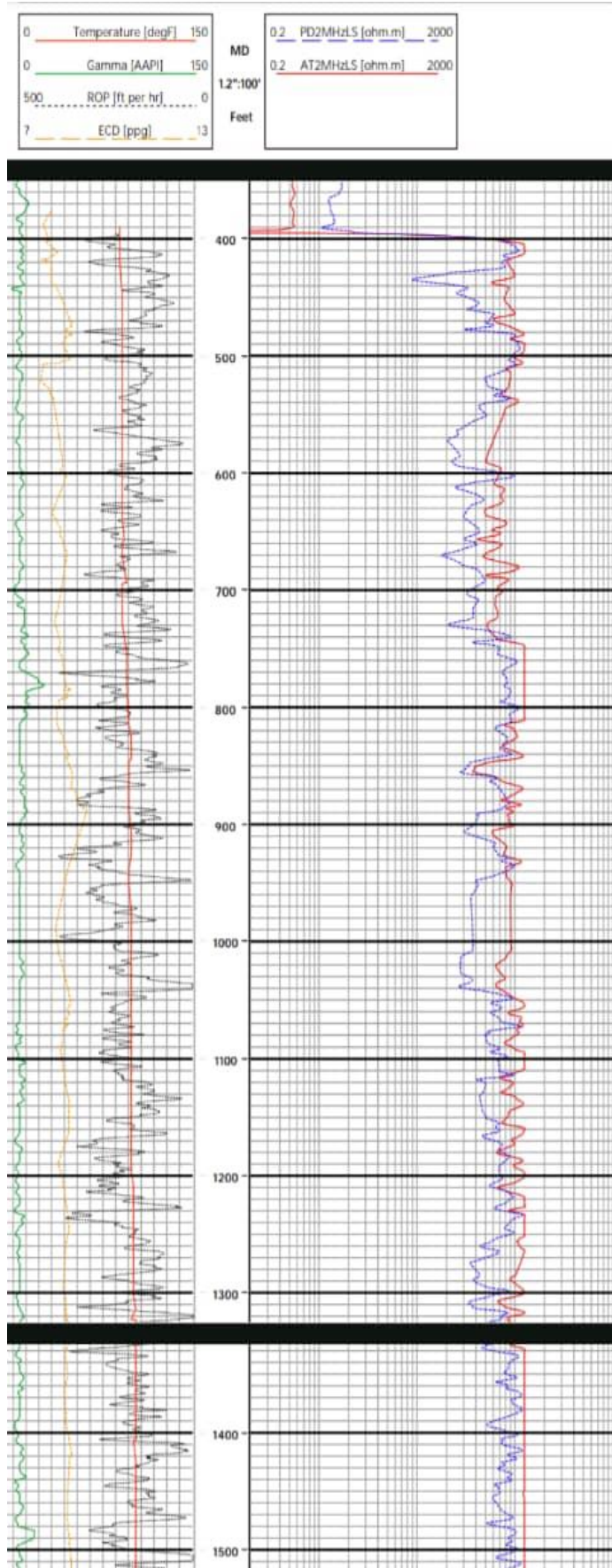


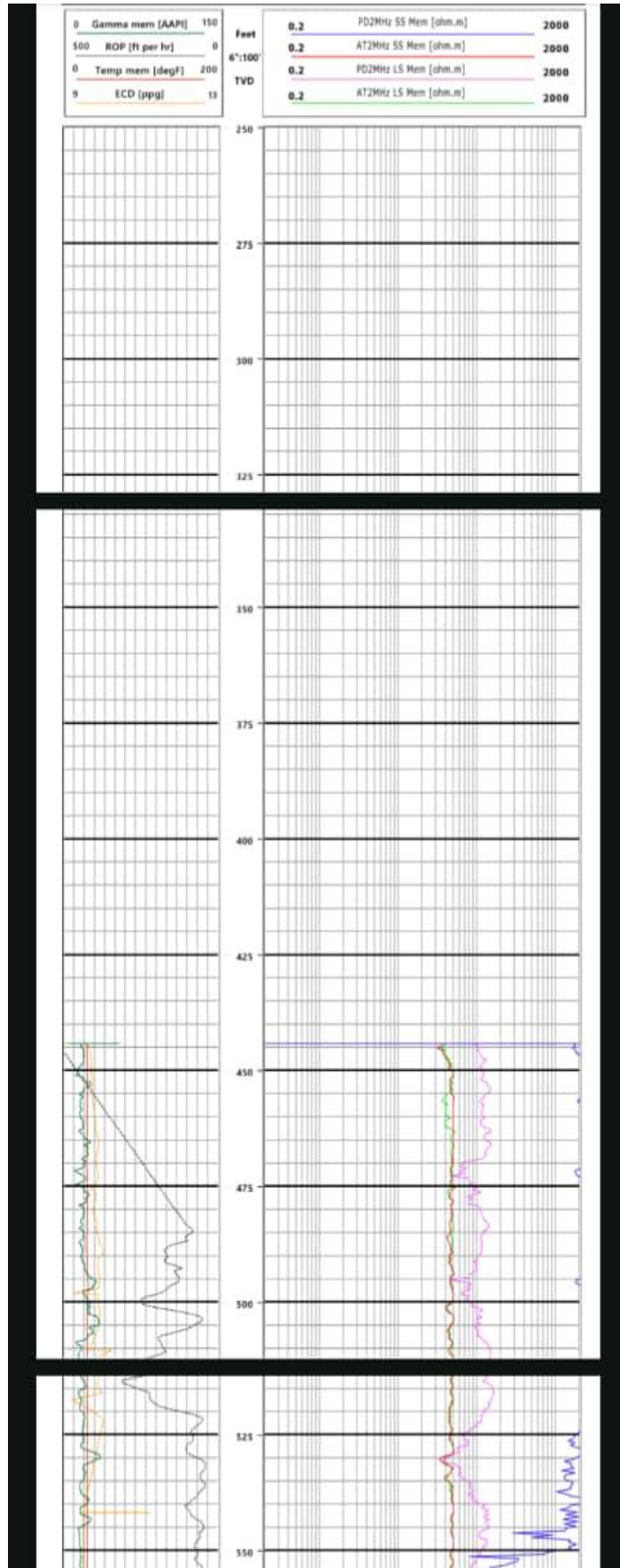


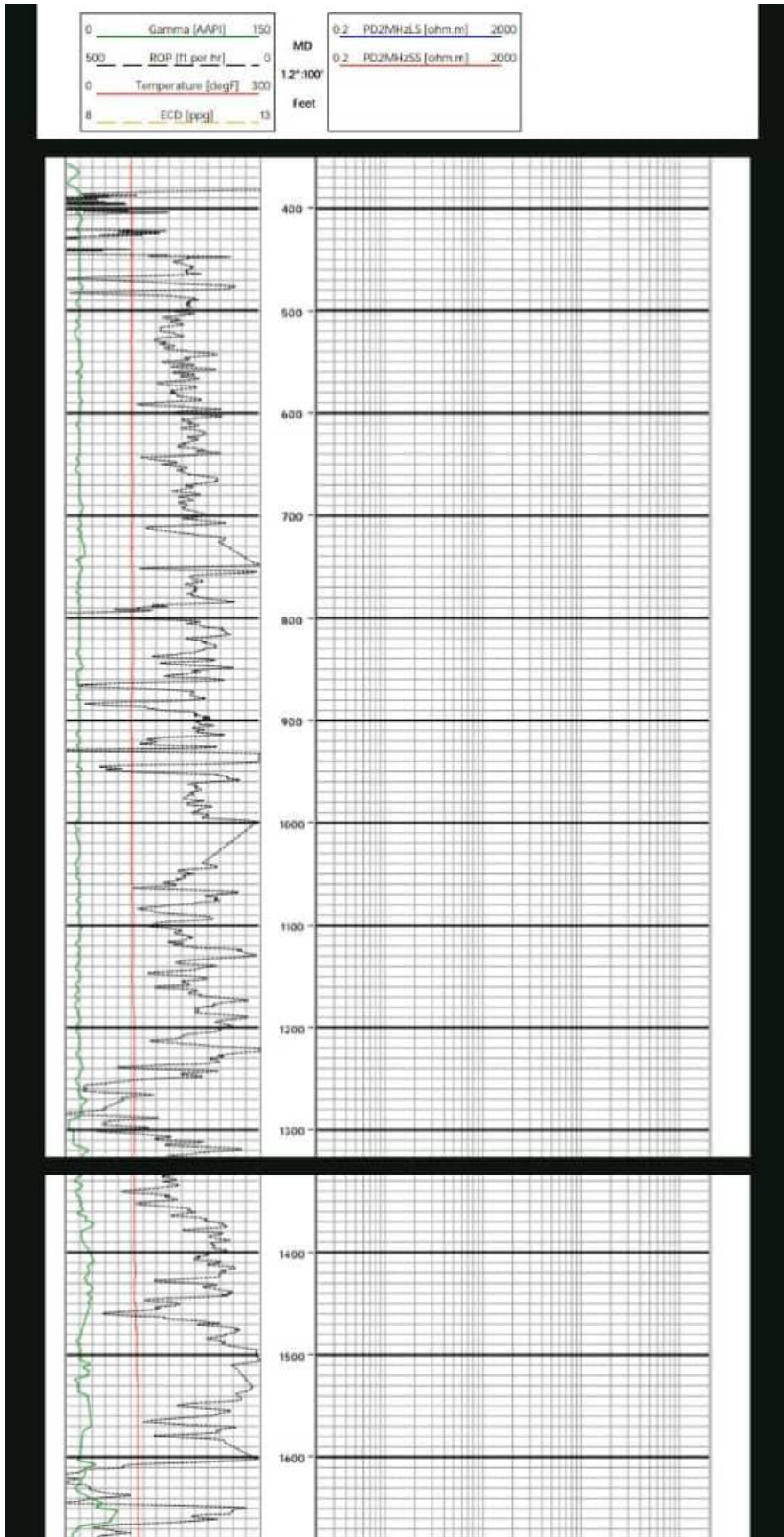














| MEASURED DEPTH(MD) | INCLINATION(INC) | AZIMUTH(AZI) |
|--------------------|------------------|--------------|
| 0.00 | 0.00 | 0.00 |
| 74.41 | 0.42 | 27.22 |
| 163.93 | 0.36 | 22.51 |
| 255.81 | 0.50 | 28.01 |
| 348.68 | 1.09 | 23.78 |
| 441.64 | 1.93 | 46.05 |
| 534.44 | 1.65 | 72.11 |
| 627.37 | 3.87 | 34.83 |
| 720.07 | 4.23 | 36.19 |
| 813.19 | 3.95 | 22.30 |
| 907.05 | 3.22 | 15.76 |
| 1002.27 | 4.18 | 6.03 |

IV. CONCLUSION

This thesis conceived and implemented Protocol Based Response Routing (PBRR), an addressing mechanism designed for use in linear networks, in an experimental testbed. We compared the PBRR LEACH and PEGASIS routing protocols. MATLAB Simulink is used to compare the respective performances of the three routing techniques. The simulation findings showed that the recommended routing protocol, PRRP, performs marginally better than LEACH and PEGASIS based on assessment metrics like throughput. The efficacy of PBRR against PEGASIS is 87.9%, and its efficiency against LEACH is 94.4%. The recommended PBRR was 75% effective against LEACH and 65.55% effective against PEGASIS, based on latency data. Plus, as this process is limited to linear or semi-linear networks. In an alternative network architecture, distinct Protocols could operate more efficiently.

V. REFERENCE

- [1] Ahmed, M., Salleh, M., & Ibrahim Channa, M. (2018). CBE2R: clustered-based energy efficient routing protocol for underwater wireless sensor network. *International Journal of Electronics*, 105(11), 2018.
- [2] Akhondi, M., R., Talevski, A., Carlsen, S., & Petersen, S. (2010). Applications of Wireless Sensor Networks in the Oil, Gas and Resources Industries. 24th IEEE International Conference on Advanced Information Networking and Applications.
- [3] Ali, S., Ashraf, A., Saad Bin Qaisar, Afridi, M., K., Saeed, H. (2024). SimpliMote: A Wireless Sensor Network Monitoring Platform for Oil and Gas Pipelines. *IEEE System Journal* 12(1).
- [4] Ayaz, M., Abdullah, A., Faye, I., & Batira, Y. (2011). An efficient Dynamic Addressing based routing protocol for Underwater Wireless Sensor Networks. *Computer Communications* 35 (2012), 475–486.
- [5] Guleria, K. & Verma, A., K. (2018). Comprehensive review for energy efficient hierarchical routing protocols on wireless sensor networks
- [6] Haque, K., F., Kabir, K., H., & Abdelgawad, A. (2020). Advancement of Routing Protocols and Applications of Underwater Wireless Sensor Network (UWSN)—A Survey. *J. Sens. Actuator Netw.* 2020, 9(19). doi:10.3390/jsan9020019
- [7] Jawhar, I. & Mohamed, N. (2009). A Hierarchical and Topological Classification of Linear Sensor Networks
- [8] Mohamed, R., E., Saleh, A., I., Abdelrazzak, M., & Samra, A., S. (2018). Survey on Wireless Sensor Network Applications and Energy Efficient Routing Protocols. *Wireless Pers Commun.*
- [9] Mohamed, R., E., Saleh, A., I., Abdelrazzak, M., & Samra, A., S. (2017). Energy-efficient routing protocols for solving energy hole problem in wireless sensor networks. 2016 Elsevier B. V.
- [10] Rault, T. (2015). Energy-efficiency in wireless sensor networks. Université de Technologie de Compiègne, 2015. English. ffNNT : 2015COMP2228ff.
- [11] Saeed, H., Ali, S., Rashid, S., & Qaisar, S. (2014). Reliable Monitoring of Oil and Gas Pipelines using Wireless Sensor Network (WSN) – REMONG. 2014 9th International Conference on System of Systems Engineering (SOSE), Adelaide, Australia.
- [12] Singh, S., K., Singh, M., P., & Singh, D., K. (2010). Applications, Classifications, and Selections of Energy-Efficient Routing Protocols for Wireless Sensor Networks. *International Journal of Advanced Engineering Sciences and Technologies (IJAEST)*. 1(2), 085 – 095.
- [13] Vijayakumaran, T., Subramaniam, S. K., Feroz, F., S., & Sujatha, R. (2024). Performance Analysis of Grid Configuration Wireless Sensor Network using Different Packet Frequency for Oil and Gas Downstream Pipeline. *Wseas Transactions on Communications*. DOI: 10.37394/23204.2024.23.1
- [14] Zabin, F., Misra, S., Woungang, I., Rashvand, H., F., Mal, N.-W., & Ahsan Ali, M. (2008). REEP: data-centric, energy-efficient and reliable routing protocol for wireless sensor networks. *IET Commun.*, 2008, Vol. 2(8), pp. 995– 1008. doi: 10.1049/iet-com:20070424



- [15] Zagrouba, R. & Kardi, A. (2021). Comparative Study of Energy Efficient Routing Techniques in Wireless Sensor Networks
- [16] Zaman, N., Low, T., J., & Alghamdi, T. (2015). Enhancing Routing Energy Efficiency of Wireless Sensor Networks. ICACT Transactions on Advanced Communications Technology (TACT). 4(2).

IJEAST

INTERNATIONAL JOURNAL
OF ENGINEERING APPLIED SCIENCE
AND TECHNOLOGY

ABOUT IJEAST

International Journal of Engineering Applied Science and Technology (IJEAST) is a peer-reviewed, open access journal that publishes high-quality research papers in the field of Engineering, Applied Science and Technology.

IJEAST aims to provide a platform for researchers, academicians, and professionals to share their innovative ideas, research findings, and practical experiences with the global scientific community.

FOCUS AREAS

- Engineering
- Applied Science
- Technology
- Innovation & Development
- Interdisciplinary Studies



PEER REVIEWED

All submissions are rigorously peer reviewed to ensure quality.



OPEN ACCESS

Free and unrestricted access to research for all.



GLOBAL REACH

Connecting researchers and professionals worldwide.



TIMELY PUBLICATION

We ensure a swift and efficient publication process.



For more information, visit our website

www.ijeast.com



INTERNATIONAL JOURNAL
OF ENGINEERING APPLIED SCIENCE
AND TECHNOLOGY

✉ editor@ijeast.com

🌐 www.ijeast.com

📍 India



2455-2143