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Properties of Oil Reservoir Rocks and their Effect on the Presence of Oil

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خصائص صخور خزانات النفط وتأثيرها على وجود النفط

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Abstract:
The exploration and production of oil reserves are essential components of the global energy industry. Understanding the properties of oil reservoir rocks is crucial in predicting the presence and extraction potential of hydrocarbons. This project delves into the fundamental characteristics of oil reservoir rocks, emphasizing their lithological, porosity, permeability, and petrophysical attributes. It also explores the intricate relationship between these rock properties and the presence of oil, shedding light on how the geological characteristics of reservoir rocks influence oil accumulation, migration, and recovery. By examining case studies and empirical data, this study uncovers the various geological factors that play a pivotal role in oil reservoirs' productivity and longevity. Furthermore, it discusses the advanced technologies and methods used in reservoir characterization, such as well logging, core analysis, and 3D seismic imaging, which provide critical insights into the subsurface geology. These technologies help in optimizing oil extraction strategies, reducing exploration risks, and maximizing the economic viability of oil reservoirs. The findings of this assay highlight the significance of a multidisciplinary approach in reservoir characterization and management, where geologists, geophysicists, and petroleum engineers collaborate to assess the properties of oil reservoir rocks comprehensively. This collaborative effort not only aids in understanding the geological complexity but also assists in the sustainable development of hydrocarbon resources. Ultimately, this research contributes to the broader conversation on energy sustainability by improving our understanding of the interplay between rock properties and the presence of oil, ultimately enhancing the efficiency of oil exploration and production practices.

Keywords: Oil reserves, Reservoir characterization , Rock properties, Oil accumulation.

الملخص
يُعد استكشاف احتياطيات النفط وإنتاجها من المكونات الأساسية لصناعة الطاقة العالمية. ويعد فهم خصائص صخور مكامن النفط أمرًا بالغ الأهمية في التنبؤ بوجود الهيدروكربونات وإمكانية استخراجها. يتعمق هذا المشروع في الخصائص الأساسية لصخور مكامن النفط، مع التركيز على خصائصها الصخرية، ومساميتها، ونفاذيتها، وخصائصها البتروفيزيائية. كما يستكشف العلاقة المعقدة بين خصائص هذه الصخور ووجود النفط، ملقياً الضوء على كيفية تأثير الخصائص الجيولوجية لصخور المكامن على تراكم النفط وهجرته واستخراجه. من خلال دراسة الحالات النموذجية والبيانات التجريبية، تكشف هذه الدراسة عن العوامل الجيولوجية المختلفة التي تلعب دورًا محوريًا في إنتاجية خزانات النفط وعمرها الافتراضي. علاوة

على ذلك، تناقش الدراسة التقنيات والأساليب المتقدمة المستخدمة في توصيف الخزانات، مثل تسجيل الآبار، وتحليل العينات الصخرية، والتصوير الزلزالي ثلاثي الأبعاد، والتي توفر رؤى حاسمة حول الجيولوجيا تحت السطحية. تساعد هذه التقنيات في تحسين استراتيجيات استخراج النفط، وتقليل مخاطر الاستكشاف، وتعظيم الجدوى الاقتصادية لخزانات النفط. تسلط نتائج هذه الدراسة الضوء على أهمية اتباع نهج متعدد التخصصات في توصيف الخزانات وإدارتها، حيث يتعاون الجيولوجيون والجيوفيزيائيون ومهندسو البترول لتقييم خصائص صخور خزانات النفط بشكل شامل. لا يساعد هذا الجهد التعاوني في فهم التعقيد الجيولوجي فحسب، بل يساهم أيضًا في التنمية المستدامة لموارد الهيدروكربونات. وفي نهاية المطاف، يسهم هذا البحث في الحوار الأوسع نطاقًا حول استدامة الطاقة من خلال تحسين فهمنا للتفاعل بين خصائص الصخور ووجود النفط، مما يؤدي في النهاية إلى تعزيز كفاءة ممارسات التنقيب عن النفط وإنتاجه.

الكلمات المفتاحية :احتياطيات النفط، توصيف الخزانات، خصائص الصخور، تراكم النفط.

Introduction

The quest for energy resources has been a driving force behind technological advancements and economic growth for centuries. In today's world, as we continue to rely heavily on hydrocarbons for energy, the exploration and production of oil remain central to global energy security and economic stability. Within this context, understanding the intricate interplay between the geological properties of oil reservoir rocks and the presence of oil is of paramount importance. This project, titled "Properties of Oil Reservoir Rocks and Their Effect on the Presence of Oil," embarks on a comprehensive exploration of the geological factors that determine the feasibility and productivity of oil reservoirs. The Earth's subsurface is a complex, dynamic environment where oil accumulates in porous and permeable rocks over geological time scales. To successfully locate, extract, and manage these precious hydrocarbon reserves, it is essential to decipher the properties of the rocks that host them. This project delves into the multifaceted aspects of oil reservoir rocks, ranging from their lithology, porosity, and permeability to their petrophysical characteristics. By examining these properties, we gain crucial insights into the suitability of a rock formation as an oil reservoir and the potential for oil accumulation within it. In an era of increasing energy demands and growing environmental awareness, the efficient and sustainable development of oil reservoirs is of paramount importance. This project recognizes the necessity for a multidisciplinary approach that integrates geological knowledge, advanced technology, and engineering expertise. Geologists, geophysicists, and petroleum engineers collaborate to assess the properties of oil reservoir rocks comprehensively, ultimately influencing exploration strategies, production techniques, and environmental impact mitigation measures.

The study aims to unravel the nuanced relationship between these rock properties and the presence of oil. It investigates the mechanisms governing oil migration, entrapment, and recovery within reservoir rocks. Through the analysis of case studies, laboratory experiments, and field data, we seek to discern the geological conditions and processes that promote or hinder oil production. This research is not only crucial for the petroleum industry but also plays a significant role in addressing environmental concerns and optimizing resource management. Reservoir rocks are specific types of geological formations that have the essential properties to contain and store significant quantities of hydrocarbons, such as oil and natural gas. These rocks act as natural containers or reservoirs for these valuable resources. The primary properties of reservoir rocks that make them suitable for this purpose include (Porosity, Permeability, Cap Rock (Seal), Lithology, Depth and Temperature, Structural and Stratigraphic Traps). [1]

based on the study the types of reservoir rocks were determined commonly encountered in the oil and gas industry. These rocks vary in composition, porosity, permeability, and geological

characteristics. The most common types of reservoir rocks include (Sandstone, Limestone, Dolomite, Shale, Siltstone, Carbonate Rocks, Basalt, Conglomerate, Granite, and evaporites).[2]
An intensive study confirmed that the choice of reservoir rock type greatly affects oil and gas reservoirs' productivity and economic viability. Geologists and petroleum engineers use various techniques to assess the properties of these rocks and determine their suitability for hydrocarbon storage and extraction. [3]

Research Objectives

- To comprehensively characterize the geological properties of oil reservoir rocks, including lithology, porosity, permeability, mineral composition, and diagenesis.
- Investigation of Oil Migration: To investigate the mechanisms and pathways of oil migration from source rocks to reservoir rocks, including the role of geological structures and fluid dynamics.
- To identify and analyze the geological factors and structural traps that play a critical role in trapping and retaining oil within reservoir rocks.
- To develop advanced reservoir modeling techniques that integrate rock properties data to create more accurate reservoir models, facilitating better reservoir management and prediction of oil production.
- Understanding the relationship of oil productivity from the oil field to the characteristics of the oil reservoir.

By addressing these research objectives, the project aims to advance our understanding of how the properties of oil reservoir rocks influence the presence of oil and contribute to more effective and sustainable oil exploration and production practices.

1.1 The Formation of Oil and its migration to the oil reservoir

Oil formation begins with the accumulation of organic matter, such as plankton and algae, in specific sedimentary environments known as source rocks. These source rocks are normally fine-grained, organic-rich sedimentary rocks like shale or mudstone. Over time, these organic materials undergo chemical and physical changes through a process called diagenesis, which involves heat, pressure, and bacterial action. The formation of oil and its migration to reservoirs is a critical process in the hydrocarbon industry. Studies have demonstrated that reservoir charge history is important in understanding the formation and accumulation of hydrocarbons. [4] Vatandoust et al., (2020) investigated the charge history of the Oligocene – Lower Miocene Asmari Formation reservoir in the southern Dezful Embayment, SW Iran, highlighting the importance of source rocks reaching the gas generation window for hydrocarbon migration. Furthermore, the effect of faults and cracks on oil enrichment and production has been extensively studied. [5] Zeng et al., (2021) demonstrated that type-I faults significantly influence fluid flow, while type-II faults can enhance oil production capacity. Additionally, natural fractures have been identified as migration channels and storage spaces for tight oil, affecting the distribution and production of oil in reservoirs [6]. Micro-scale studies have also been conducted to understand the formation damage mechanisms of sandstone reservoirs. [7] Wang et al., (2021) conducted displacement experiments using sandstone samples and chemical reagents to analyze the physical properties and hydrocarbon enrichment characteristics of tight oil reservoirs in the Chang 7 Division of the Yanchang Formation, Xin'anbian Oilfield, Ordos Basin, China [8]. Overall, the quantitative evaluation of transport efficiency in fault-reservoir composite migration pathway systems and the analysis of tight oil accumulation conditions are crucial for predicting sweet spots in oil reservoirs [7,9]. Understanding the main controlling factors of oil accumulation, such as source rocks, reservoirs, caprocks, traps, and migration conditions, is essential for predicting favorable target

areas in oilfields [10]. The study of natural fractures in deep and unconventional reservoirs has also led to advancements in exploration and development methods and technologies [11] .

1.2 Oil Composition

The literature agrees almost entirely on the likely genesis of n-alkanes in petroleum. Typically, three sources are listed: n-alkanes created by living creatures, such as cuticular waxes, are maintained in kerogen and transported to petroleum [12,13]. Fatty acids generated by the hydrolysis of triglycerides (fats) as well as esters containing straight chain acidic and alcoholic components. Free n-alkanes are current in kerogens in relatively insignificant amounts. Although bitumens contain only a few wt. These n-alkanes have a high odd-even preference. The Carter Research Laboratory began extraction investigations on ancient sedimentary rocks to understand more about the organic content in rocks. The first extractions of typical marine shales were carried out on Oklahoma's Morrow, Atoka, and McAlester formations, using carbon disulfide, benzene, acetone, and alcohol. Subsequent study of this and other rock extracts indicated that most marine shales contain trace levels of soluble organic material, including hydrocarbons. Using combinations of carbon disulfide, benzene, acetone, and alcohol. Subsequent study of this and other rock extracts indicated that most marine shales contain trace levels of soluble organic material, including hydrocarbons. Despite much speculation, a survey of the literature finds that very few research have been undertaken on organic materials in sedimentary rocks. Previous studies found that ether extraction of ancient sediments produced an average of 3-7 percent of total organic carbon as a soluble extract. Unfortunately, no modern techniques, such as chromatography, are available for analyzing the extract; however, it is believed that part of it may consist of free oil. Later, there was an inability to find ether-soluble material in the shales directly above the reservoir sands of the Santa Fe Springs field in California. [14].

The above literature review explores the key aspects and recent developments related to oil source rocks. Oil source rocks play a vital role in the formation and accumulation of hydrocarbon reserves. Understanding their characteristics, distribution, and geologic processes is crucial for the petroleum industry in locating and evaluating potential oil reservoirs. The review covers topics such as the formation and types of oil source rocks, depositional environments, organic matter preservation, maturation processes, and exploration techniques. The purpose is to provide a complete review of the present state of knowledge regarding oil source rocks and highlight emerging research topics.

1.3 Reservoir Rocks

The reservoir rock is a porous formation capable of storing hydrocarbon reserves. It is made up of one or more subsurface lithological units, which can be either sedimentary or carbonate in origin. Reservoir rocks possess high permeability and porosity and are surrounded by sealed strata that trap hydrocarbons. [15].

Figure 1 depicts a cross-section of a reservoir. Hydrocarbons are extracted from subterranean permeable rock formations through production wells that are optimally drilled around the reservoir area. Reservoir rocks typically contain pores, and the fraction of these pores relative to the overall rock volume is referred to as effective porosity. For hydrocarbons to flow freely throughout the reservoir, these pores must be interconnected. A lack of impediments in the reservoir enhances permeability, which is defined as the ability of fluids to move within the pore spaces of the reservoir rock. The geological trap is a layer of rock that confines hydrocarbons in the subsurface. Above the trap, an impermeable rock layer prevents hydrocarbons from migrating to shallower layers or to the surface. Below the reservoir rock, a planar surface separates it from the underlying fluid, typically briny water. A reservoir rock can contain liquid, gas, or both, and the vertical distribution of porosity measures the void spaces within the rock.

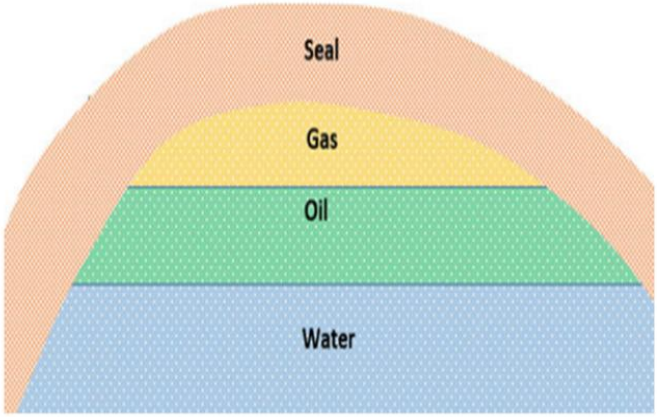

Figure 1. A reservoir cross section

Porosity is characterized as a unit fraction (0–1) or a percentage (0–100%). Porosity in most rocks' ranges from less than one percent to forty percent. Permeable rock is the main element of oil and gas reservoirs. Porous rocks can store fluids. Normally, oil and gas are produced from source rocks (kitchens), travel upwards, and become trapped beneath sealing layers (impermeable) that prevent oil and gas from escaping to the surface. Reservoir rock is divided into classic and carbonate hydrocarbon reservoirs. Clastic reservoirs, such as sandstone, are made up of tiny particles that have been buried and compacted in riverbeds over time. Carbonate reservoirs are often formed through biological processes and then buried and compacted for a long time. About 60% of hydrocarbons are found in clastic reservoir rocks, while 40% are located in carbonate reservoir rocks. Porosity is a crucial characteristic for determining hydrocarbon storage capacity. In carbonate formations, porosity typically ranges from 1% to 35%, with an average of 10% in dolomite and 12% in limestone. [16] .

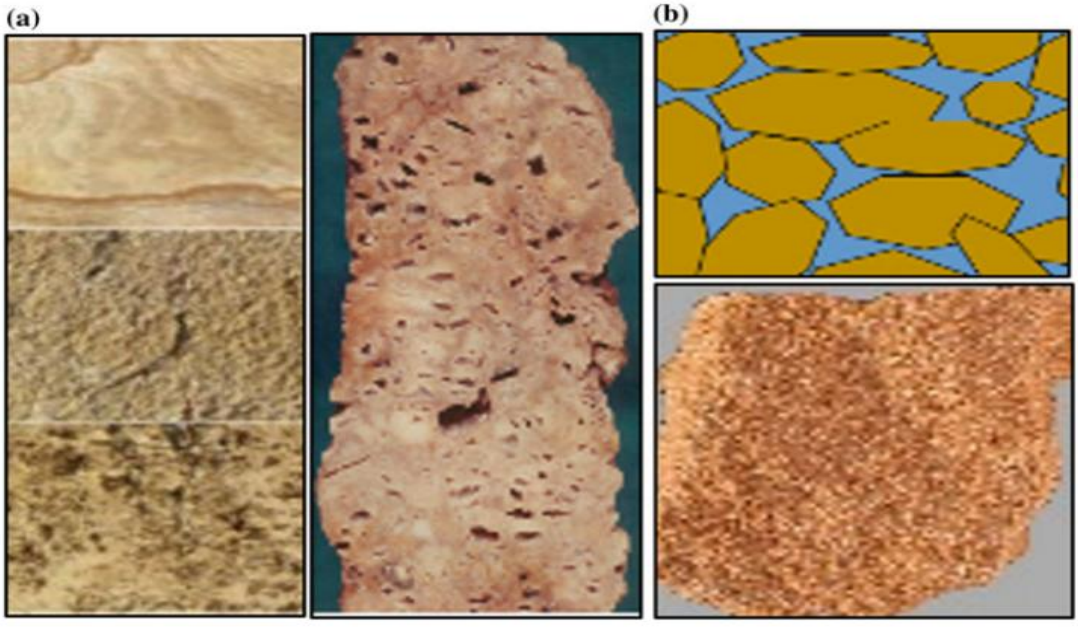

Figure 2. The Porosity in reservoir rocks

Material and methods

We conducted an extensive review of existing literature, scientific papers, and research studies related to identifying key theories, concepts, and methodologies used in previous studies.

Analyze and synthesize the information gathered to establish a solid foundation for the research project.
Summarize the findings of the study and draw conclusions regarding the influence of physical properties on the presence of oil in reservoir rocks. Provide recommendations for further research, exploration strategies, or reservoir management practices based on the study's findings.

2.1 Study questions

Creating a well-structured questionnaire is crucial to gather relevant data and insights on the properties of oil reservoir rocks and their impact on the presence of oil. and this questions that used in our questionnaire:

General Information:

- What is your current role or area of expertise in the oil and gas industry?
- How many years of experience do you have in the exploration and production of oil reservoirs?

Geological Properties:

- What types of rock formations have you encountered in your experience with oil reservoirs?
- How would you describe the porosity and permeability of the rocks in the reservoirs you have worked with?

Petrophysical Characteristics:

- What methods do you use to determine the petrophysical properties of oil reservoir rocks?
- How do you assess the relationship between rock properties and the presence of hydrocarbons?

Fluid Analysis:

- What techniques do you employ to analyze the composition of fluids within the reservoir rocks?
- How do you distinguish between different types of hydrocarbons present in the reservoir?
- Factors Influencing Reservoir Performance:
- What are the main factors, in your opinion, that influence the productivity of an oil reservoir?
- How do you prioritize these factors when making decisions related to reservoir management and production optimization?

Challenges and Future Directions:

- What are the current challenges in accurately assessing the properties of oil reservoir rocks and their effect on oil presence?
- In your view, what areas of research or technological advancements hold promise for improving our understanding of reservoir rock properties?

Overall Assessment:

- How would you rate the significance of understanding the properties of oil reservoir rocks for the successful exploration and production of oil?
- What additional insights or recommendations would you provide for better comprehending the relationship between reservoir rock properties and the presence of oil?

These questions target audience, which include geologists, reservoir engineers, Petro physicists, and other professionals involved in the oil and gas industry.

2.2 The Influence of rock Physical Properties on oil Migration and Formation of Oil

The purpose of studying the effect of rock physical properties on oil migration and formation is to understand how these characteristics affect the behavior, movement, and accumulation of

hydrocarbons within subsurface reservoirs. The physical properties of rocks play a critical role in controlling the presence, distribution, and producibility of oil. By studying this influence, the purpose is to:

1. Assess porosity and permeability: Examine the porosity and permeability of rocks to determine their capacity to store and transfer fluids. Permeability refers to a rock's ability to allow fluid flow through interconnected pore spaces, while porosity denotes the volume of void spaces within the rock. Understanding these characteristics is essential for identifying rocks with high potential for oil storage and movement.
2. Evaluate capillary pressure: Analyze the capillary pressure characteristics of rocks, which govern the ability of fluids to be retained or released within the pore spaces. Capillary pressure is influenced by the size, shape, and distribution of pores in the rock. Understanding capillary pressure helps in determining the mobility and accessibility of oil within reservoir rocks.
3. Investigate rock wettability: This term refers to the rock surface's affinity for oil, water, or gas. Wettability influences the distribution and flow of fluids within a reservoir. Understanding rock wettability aids in predicting the behavior of oil-water and oil-gas interfaces, as well as fluid displacement during production.
4. Analyze rock composition and mineralogy: Examine the composition and mineralogy of rocks, as different rock types have varying physical and chemical properties. Some minerals and rock types may have higher affinity for hydrocarbons, affecting oil retention and migration. Understanding the composition and mineralogy helps in assessing the suitability of rocks for oil accumulation and production.
5. Assess rock mechanical properties: Evaluate the mechanical properties of rocks, such as rock strength, elasticity, and deformation behavior. These properties influence the integrity and stability of reservoir rocks during oil migration and production processes. Understanding the mechanical properties helps in assessing the feasibility and challenges associated with oil extraction and reservoir management.
6. Determine thermal conductivity and heat transfer: Study the thermal conductivity of rocks, which influences the rate of heat transfer within the reservoir. Thermal conductivity affects the thermal maturation of organic matter, oil generation, and the movement of hydrocarbons. Understanding heat transfer properties helps in evaluating the thermal history and maturity of source rocks.
7. Support reservoir modeling and simulation: The knowledge gained from studying the influence of rock physical properties on oil migration and formation is crucial for reservoir modeling and simulation. It helps in incorporating realistic representations of rock properties into numerical models to accurately predict fluid flow, distribution, and production behavior.

Results and discussion

An overview of reservoir properties includes a comprehensive description of various characteristics and attributes of the oil reservoir. In this project "Properties of Oil Reservoir Rocks and Their Effect on the Presence of Oil," the overview of reservoir properties focus on the following key aspects:

- **Geological Formation:**
  Describing the geological setting of the reservoir, including the rock types, sedimentary environments, and depositional history.
- **Porosity:** Which refers to the volume of void spaces within the rock that can potentially hold fluids. Analyze the distribution of porosity within different rock formations and its impact on the storage capacity of oil within the reservoir.

- **Permeability:** Which indicates the ability of fluids to flow through the rock matrix. Discussing how variations in permeability influence the movement of oil within the reservoir and affect the efficiency of oil extraction processes.
- **Grain Size Distribution:** Distribution of grain sizes within the reservoir rocks, including information on grain shape and sorting. Analyze the implications of grain size distribution on the connectivity of pore spaces and the flow of fluids within the reservoir.
- **Structural Features:** Features present in the reservoir, such as faults, fractures, or folds, which impact the distribution and movement of fluids within the rock formations. Evaluate the significance of these structural features in relation to the presence and accumulation of oil.
- **Reservoir Fluid Properties:** The properties of the fluids present within the reservoir, including the type of hydrocarbons, their viscosity, density, and composition. Discuss how this fluid properties interact with the reservoir rocks and influence the distribution and accumulation of oil.

3.1 Impact of Rock Properties on Oil Production:

The effect of rock characteristics on oil production is an important factor to consider in the petroleum industry. Several research has been undertaken to better understand how varied rock qualities influence oil recovery and production efficiency. (Nasr et al., 2021) investigated the influence of silicon-based nanoparticles on enhanced oil recovery, emphasizing the potential advantages of employing nanoparticles to improve oil production processes.[17] (Santos et al., 2021) Conducted micro-scale experiments on non-Newtonian polymeric flow in carbonates, which shed light on the behavior of polymeric fluids in carbonate reservoirs.[18] (Andrianov et al., 2021) Investigated waterflood compliance control in carbonate reservoirs, focusing on the impact of water quality composition on the electrical characteristics of carbonate rock and nanospheres.[19] Lima et al. (2021) presented a study on geomechanically effects related to the production of a Brazilian reservoir, showcasing a coupled finite element approach for modeling the geomechanically effects induced by production and injection processes.[20] Pinilla et al. (2021) conducted a 3D CFD simulation of a horizontal well at the pore scale for heavy oil fields, providing insights into the behavior of oil flow in porous media.[21] Sajjad et al. (2021) explored the effect of compositional gradients in field development, demonstrating the significance of compositional convection in oil and gas reservoirs.[22] Fathi et al. (2021) studied shale pyroclastic effects on well performance analysis in shale gas reservoirs, highlighting the importance of considering the pyroclastic characteristics of the shale matrix in gas production.[23] Kudamanov et al. (2021) assessed the influence of tectonics on the sedimentation process of Western Siberian Upper Cretaceous deposits, emphasizing the impact of geological characteristics on reservoir properties.[24] Cudjoe et al. (2021) focused on evaluating the efficiency of saturating shale oil cores and analyzing hydrocarbon gas huff 'n' puff using nuclear magnetic resonance, aiming to understand the rock properties that affect diffusion and oil production.[25] Additionally, Fager et al. (2022) observed the impact of displacement properties on mobility and relative permeability, highlighting the importance of understanding how these properties affect oil flow in reservoirs.[26] Overall, these studies collectively contribute to the understanding of how rock properties influence oil production processes and underscore the importance of considering various factors, such as nanoparticle additives, water quality composition, geomechanically effects, and compositional convection, in optimizing oil recovery and production efficiency.

Identified properties of the oil reservoir rocks impact oil production. The porosity, permeability, and other rock properties impact the efficiency of oil extraction processes and the overall productivity of the reservoir. The higher the porosity, the higher the percentage of stored fluids, and the lower the porosity, the less possibility of storing fluids in the rocks.

3.2 Relationship between reservoir characteristics, and oil productivity in the field:

The relationship between reservoir characteristics and oil productivity is a crucial aspect of oil field development. Ye et al. (2020) conducted a study on the characteristics and vertical zonation of large-scale granitic reservoirs in the Penglai Oil Field, located in the Bohai Bay Basin of North China. Understanding the vertical zonation of reservoirs can provide valuable insights into optimizing oil productivity.[27] Julianto et al. (2020) emphasized the importance of geological characterization in forecasting oil field production. By utilizing decline curve analysis and geological modeling with software like Oasis Montaj, the authors highlighted the significance of understanding the geological features of the field for accurate production forecasting.[28] Wang (2021) focused on pressure transient analysis in vertically fractured multi-well systems. The study demonstrated that production well testing data can be influenced by adjacent wells, particularly in the subordinate phase of oil and gas field development, highlighting the interconnected nature of reservoir characteristics and oil productivity.[29] Kanevskaya et al. (2021) discussed the modeling of fracture acidizing, which involves reactive flow modeling in existing fractures and the oil-saturated matrix.[30] A sensitivity analysis of other parameters was also conducted, indicating the complexity of factors influencing oil productivity in the field. Zhao et al. (2021) proposed a method for calculating the productivity of water imbibition in volume-fractured reservoirs. By optimizing the reservoir volume fracturing scheme, the authors aimed to evaluate oil productivity and recovery through water counter-current imbibition, showcasing the importance of reservoir engineering techniques in enhancing oil productivity.[31] In conclusion, the reviewed literature highlights the significance of reservoir characteristics, geological characterization, pressure transient analysis, fracture acidizing modeling, and water imbibition evaluation in determining oil productivity in the field. Understanding these factors is essential for optimizing oil recovery and field performance.

The productivity of an oil field is influenced by various characteristics of the oil reservoir. Understanding these reservoir characteristics is crucial for optimizing oil production. Some key factors include:

3.2.1 Permeability: Permeability refers to the ability of the reservoir rock to allow fluids (such as oil and water) to flow through it. Higher permeability typically leads to better productivity, as it allows for easier movement of oil through the rock pores.

3.2.2 Porosity: Porosity is the measure of the void space within a rock. Higher porosity indicates more space for fluids to occupy. Oil reservoirs with higher porosity can store more oil and, if other conditions are favorable, can lead to higher productivity.

3.2.3 Saturation: Saturation is the percentage of pore space occupied by fluids. The proportion of oil, water, and gas in the reservoir affects its productivity. Higher oil saturation generally leads to increased oil production.

3.2.4 Reservoir Pressure: Reservoir pressure is the force that drives oil to the surface. Higher pressure can enhance oil productivity by facilitating the flow of oil through the reservoir. Reservoir pressure is maintained through natural mechanisms or enhanced oil recovery techniques.

3.2.5 Reservoir Depth: The depth of the reservoir influences the pressure and temperature conditions, which in turn affect oil productivity. Deeper reservoirs may have higher pressures, but they can also present technical challenges in drilling and extraction.

3.2.6 Rock and Fluid Properties: The properties of the reservoir rock (e.g., lithology, grain size) and the characteristics of the fluids (e.g., viscosity, density) also play a role. Certain rock and fluid properties can either facilitate or impede the movement of oil through the reservoir.

3.2.7 Geological Structure: The geological structure of the reservoir, such as faults and fractures, can impact oil productivity. Well-designed drilling and production strategies take into account the geological characteristics to maximize recovery.

3.2.8 Heterogeneity: Reservoirs are often heterogeneous, meaning that their properties can vary spatially. Understanding and characterizing this heterogeneity is important for optimizing well placement and production strategies.
3.2.9 Water and Gas Coning: Water and gas coning occurs when water or gas infiltrates the oil-producing zone. Effectively managing these challenges is essential for maintaining oil productivity and preventing premature water or gas breakthrough.
3.2.10 Enhanced Oil Recovery (EOR) Techniques: Water flooding, gas injection, and chemical injection are examples of Enhanced Oil Recovery (EOR) procedures that can increase oil recovery and production by modifying reservoir conditions.

Conclusion

The study explores the relationship between the geological and physical characteristics of reservoir rocks and oil occurrence. Key findings include high permeability and porosity, which promote oil flow and storage, and fluid dynamics, which determine oil field productivity. Reservoir pressure and depth, rock and fluid properties, geological structure, water and gas coning management, and enhanced oil recovery techniques are also crucial. A multidisciplinary approach combining geology, engineering, and fluid dynamics is essential for understanding oil reservoirs and ensuring efficient extraction and sustainable management. As the energy industry evolves, further research and technological advancements in reservoir characterization will be crucial for meeting global energy demands while minimizing environmental impact.

References

[1] Archie, G. E. (1950). Introduction to petrophysics of reservoir rocks. AAPG Bulletin, 34 (5), 943–961.
[2] Subramaniyan, S., et al. (2014). An overview of laboratory apparatuses to measure seismic attenuation in reservoir rocks. Geophysical Prospecting, 62 (6), 1211–1223.
[3] Shedid, S. A., & Ghannam, M. T. (2004). Factors affecting contact-angle measurement of reservoir rocks. Journal of Petroleum Science and Engineering, 44 (3-4), 193–203.
[4] Vatandoust, M., et al. (2020). Hydrocarbon migration and charge history in the Karanj, Paranj and Parsi oilfields, southern Dezful Embayment, Zagros fold-and-thrust belt, SW Iran. Journal of Petroleum Geology, 43 (3), 341–357.
[5] Li, Y., et al. (2021). Improved understanding of the origin and accumulation of hydrocarbons from multiple source rocks in the Lishui Sag: Insights from statistical methods, gold tube pyrolysis and basin modeling. Marine and Petroleum Geology, (134), 105361.
[6] Zeng, L., et al. (2021). The effect of multi-scale faults and fractures on oil enrichment and production in tight sandstone reservoirs: A case study in the southwestern Ordos Basin, China. Frontiers in Earth Science, (9), 664629.
[7] Wang, Z., et al. (2021). Formation damage mechanism of a sandstone reservoir based on micro-computed tomography. Advances in Geo-Energy Research, 5 (1), 25–38.
[8] Zhao, W., et al. (2021). Physical property and hydrocarbon enrichment characteristics of tight oil reservoir in Chang 7 division of Yanchang Formation, Xin'anbian oilfield, Ordos Basin, China. Petroleum Science, 18 (5), 1294–1304.
[9] Tang, Y., et al. (2022). Analysis of tight oil accumulation conditions and prediction of sweet spots in Ordos Basin: A case study. Energy Geoscience, 3 (4), 417–426.
[10] Li, T., et al. (2022). Analysis on the main controlling factors of oil accumulation in Putaohua reservoir of Long12 block in Daqing Longhupao oilfield. Geofluids, 2022, 4627263.
[11] Gong, L., & Lu, K. (2023). Advances in the study of natural fractures in deep and unconventional reservoirs. Frontiers in Earth Science, (10), 1096643.

[12] Baker, E. G. (1962). Distribution of hydrocarbons in petroleum. AAPG Bulletin, 46 (1), 76–84.
[13] Mathews, R. T., et al. (1972). Hydrocarbons and fatty acids in the Evergreen shale, Surat Basin, Queensland, Australia. Geochimica et Cosmochimica Acta, 36 (8), 885–896.
[14] Levorsen, A. (1954). Geology of petroleum. W. H. Freeman.
[15] Ganat, T. A. A. O. (2020). Fundamentals of reservoir rock properties. Springer.
[16] Schmoker, J. W., & Gautier, D. L. (1988). Sandstone porosity as a function of thermal maturity. Geology, 16 (11), 1007–1010.
[17] Nasr, M. S., Esmaeilnezhad, E., & Choi, H. J. (2021). Effect of silicon-based nanoparticles on enhanced oil recovery. Journal of the Taiwan Institute of Chemical Engineers, (122), 241–259.
[18] Santos, N. B. C., et al. (2021). Micro-scale experimental investigations of non-Newtonian polymeric flow in carbonates. Journal of Petroleum Science and Engineering, 207, 109269.
[19] Andrianov, A., et al. (2021). One approach to waterflood conformance control in carbonate reservoirs. In IOR 2021 (pp. 1–13). European Association of Geoscientists & Engineers.
[20] Lima, R. O., do Nascimento Guimarães, L. J., & Pereira, L. C. (2021). Evaluating geomechanical effects related to the production of a Brazilian reservoir. Journal of Petroleum Exploration and Production Technology, 11 (6), 2661–2678.
[21] Pinilla, A., et al. (2021). 3D CFD simulation of a horizontal well at pore scale for heavy oil fields. Journal of Petroleum Science and Engineering, 196, 107632.
[22] Sajjad, F. M., et al. (2021). The effect of compositional gradient in field development. In SPE Asia Pacific Oil and Gas Conference and Exhibition (Paper D012S032R007). SPE.
[23] Fathi, E., Belyadi, F., & Jabbar, B. (2021). Shale poroelastic effects on well performance analysis of shale gas reservoirs. Fuels, 2 (2), 130–143.
[24] Kudamanov, A. I., et al. (2021). Tectonics impact on sedimentation process of Western Siberian Upper Cretaceous deposits. In Tyumen 2021 (pp. 1–5). European Association of Geoscientists & Engineers.
[25] Cudjoe, S. E., et al. (2021). Assessing the efficiency of saturating shale oil cores and evaluating hydrocarbon gas huff ‘n’ puff using nuclear magnetic resonance. SPE Reservoir Evaluation & Engineering, 24 (2), 429–439.
[26] Fager, A., et al. (2022). Observations on the impact of displacement properties on mobility and relative permeability. Journal of Petroleum Science and Engineering, 208, 109435.
[27] Ye, T., et al. (2020). Characteristics and vertical zonation of large-scale granitic reservoirs, a case study from Penglai oil field in the Bohai Bay Basin, North China. Geological Journal, 55 (12), 8109–8121.
[28] Julianto, C., et al. (2020). Oil field development scenario with geological characterization in “Alpha” field of South Sumatra Basin. Khazanah: Jurnal Mahasiswa, 12 (2).
[29] Wang, S. (2021). Pressure transient analysis in vertically fractured multi-well system. In 82nd EAGE Annual Conference & Exhibition (pp. 1–5). European Association of Geoscientists & Engineers.
[30] Kanevskaya, R., & Novikov, A. (2021). Modelling of fracture acidizing. In Processes in GeoMedia—Volume II (pp. 89–105). Springer International Publishing.
[31] Zhao, L., et al. (2021). Method for calculating productivity of water imbibition based on volume fracturing stimulations of low permeability reservoirs. Geofluids, 2021, 6693359.

