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УПРАВЛЕНИЕ ЦИФРОВЫХ ОБРАЗОВАТЕЛЬНЫХ ТЕХНОЛОГИЙ

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по дисциплине

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Аннотация

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Contents

Text 1. An oil system

Task 1. Read the following words and remember them:

accumulation – скопление, накопление, залежь;
field – месторождение;
source rock – материнская порода;
oil shale – нефтеносный сланец;
to be subjected – подвергаться;
hydrocarbons – углеводороды;
to expel – вытеснять, выталкивать;
density – плотность;
buoyancy – плавучесть;
fluid – флюид, жидкость;
to expand – расширяться, увеличиваться в объеме;
burial – заглубление;
oil seep – место просачивания нефти;
trap – ловушка;
porous rock – пористая порода;
reservoir – залежь нефти и газа, пласт, коллектор;
impervious – непроницаемый;
petroleum engineer – инженер-нефтяник;
objective – цель, задача.

Task 2. Read the text and try to understand it.

Accumulations of oil and gas – the fields – exist underground almost everywhere in the world. But it is necessary that certain conditions come together for those accumulations to develop. What is called the genesis of oil follows seven fundamental steps, each one is essential and very, very slow.

1. First, it is necessary to have organic matter capable of being transformed into oil, and in sufficient quantities: this is the source rock.

2. Then all favourable conditions for the transformation of this potential oil and gas must be present. When organic-rich rock such as oil shale or coal is subjected to high pressure and temperature over a long period of time, hydrocarbons form.

3. The new oil and gas then begin a migration towards the surface. The hydrocarbons are expelled from source rock by three density-related mechanisms: the newly matured hydrocarbons are less dense than their precursors; the hydrocarbons are light, and migrate upwards due to buoyancy, and the fluids expand as further burial causes increased heating. Most hydrocarbons migrate to the surface as oil seeps, but some will get trapped.

4. During this migration the hydrocarbons must meet a rock capable of hoarding them in large quantities: the reservoir. A reservoir rock is commonly a porous sandstone or limestone and oil is collected in the pores within the rock.

5. This reservoir must be impervious. A barrier (seal or cap) is therefore necessary: that is an impermeable rock to prevent the oil and gas from pursuing their way upwards. This rock is called the seal or cap rock.

6. Then, to accumulate quantities of oil and gas sufficient for profitable exploitation, the substratum must have a form sufficiently large and with a closed geology: this is the trap.

7. Finally, oil and gas must not be destabilized by attacks coming from the exterior. Good conditions for the preservation of hydrocarbons are necessary.

When teams of petroleum engineers study a zone, one of their principal objectives is to determine if these seven steps have, indeed, a good chance of happening. The totality of these seven steps is called an oil system.

Task 3. Find Russian equivalents for the following English words and expressions:

Organic matter; newly matured hydrocarbons; sufficient quantities; favourable conditions; less dense than precusors; to cause increased heating; capable of hoarding; sandstone or limestone; seal or cap rock; profitable exploitation.

Достаточное количество; песчаник или известняк; благоприятные условия; органическая материя; вновь образовавшиеся углеводороды; прибыльная эксплуатация; вызывать повышенный нагрев; менее плотные, чем предшественники; перекрывающая порода (порода-покрышка); способный накапливать.

Task 4. Answer the questions:
1. How are the accumulations of oil and gas called? 2. How is oil formed in the source rock? 3. Why must reservoir be impervious? 4. Where can hydrocarbons be accumulated in large quantities? 5. What is one of the principal objectives for petroleum engineers?

Text 2. Hydrocarbon exploration

Task 1. Read the following words and remember them:

exploration – разведка месторождения, поисково-разведочные работы;
deposit – залежь;
sophisticated – сложный;
extent – распространение, протяженность;
gravity survey – гравиметрические исследования;
depth conversion – глубинные построения;
lead – поисковый объект, возможная ловушка углеводородов;
prospect – перспективный объект при георазведке;

to evaluate – оценивать;
exploration well – разведочная скважина;
to drill – бурить;
expensive – дорогой;
to undertake – совершать, предпринимать.

Task 2. Read the text and try to understand it.

Hydrocarbon exploration (or oil and gas exploration) is the search for deposits of hydrocarbons, such as oil and natural gas, under the Earth's surface. Petroleum geologists and geophysicists are concerned with hydrocarbon exploration.

There are several exploration methods. Visible surface features such as oil seeps, natural gas seeps, pockmarks (underwater craters caused by escaping gas) provide basic evidence of hydrocarbon generation. However, exploration depends on highly sophisticated technology to detect and determine the extent of these deposits using exploration geophysics. Areas supposed to contain hydrocarbons are initially subjected to a gravity survey, magnetic survey, seismic survey to detect large-scale features of the sub-surface geology.

Features of interest (known as leads) are subjected to more detailed seismic surveys which work on the principle of the time it takes for reflected sound waves to travel through matter (rock) of varying densities. The process of depth conversion is also used to create a profile of the substructure. Finally, when a prospect has been identified and evaluated and passes the oil company's selection criteria, an exploration well is drilled in an attempt to conclusively determine the presence or absence of oil or gas.

Oil exploration is an expensive, high-risk operation. Offshore and remote area exploration is generally undertaken by very large corporations or national governments. Typical shallow shelf oil wells cost US$10 – 30 million, while deep water wells can cost up to US$100 million. Hundreds of smaller companies search for onshore hydrocarbon deposits worldwide, with some wells costing as little as US $100,000.

Task 3. Find Russian equivalents for the following English words and expressions:

Reflected sound waves; offshore and onshore deposits; to provide basic evidence; craters caused by escaping gas; visible surface features; shallow shelf oil wells; remote area exploration; to determine presence or absence; to detect large-scale features
Определить наличие или отсутствие; морские и наземные месторождения; отраженные звуковые волны; видимые особенности поверхности; предоставлять основные доказательства; разведка отдаленных месторождений; кратеры, образованные выделяющимся газом; нефтяная скважина на шельфе (мелководье); находить крупномасштабные структуры.

Task 4. Answer the questions:
1. What petroleum engineering specialists deal with hydrocarbon exploration? 2. What surveys are made to detect hydrocarbon deposits? 3. When is an exploration well drilled? 4. How much may offshore well drilling cost? 5. What is exploration well drilled for?

Task 5. Agree or disagree with the following statements:
1. Oil and gas exploration doesn’t depend on highly sophisticated technology. 2. Onshore hydrocarbon exploration is more costly than offshore. 3. Various types of surveys are made to detect the subsoil deposits. 4. An exploration well is drilled to determine the presence or absence of oil or gas. 5. Offshore and remote area exploration is generally undertaken by small companies.

Text 3. Petrophysics

Task 1. Read the words to the text and remember them:

property – свойство;
application – применение;
subsurface – недра, подземный пласт;
lithology – литология, литологические разновидности пород;
porosity – пористость;
water saturation – насыщенность водой,
permeability – проницаемость;
to acquire – получать, приобретать;
measurement – измерение;
borehole – ствол скважины;
well log – каротажная диаграмма, разрез по буровой скважине; **core measurements** – измерение образцов породы из скважины;
ore quality – качество руды/породы.

Task 2. Look through the text and find 13-15 international words. Translate these words.

Task 3. Read the text and try to understand it.

Petrophysics (from the Greek *petra*, "rock" and *physis*, "nature") is the study of physical and chemical rock properties and their interactions with fluids. A major application of petrophysics is in studying reservoirs for the hydrocarbon industry. Petrophysicists help reservoir engineers and geoscientists to understand the rock properties of the reservoir, particularly how pores in the subsurface are interconnected, controlling the accumulation and migration of hydrocarbons. Some of the key properties studied in petrophysics are lithology, porosity, water saturation, permeability and density. A key aspect of petrophysics is measuring and evaluating these rock properties by acquiring well log measurements (in which a string of measurement tools are inserted in the borehole), core measurements (in which rock samples are retrieved from subsurface), and seismic measurements. These studies are then combined with geological and geophysical studies and reservoir engineering to give a complete picture of the reservoir.

The properties measured or computed fall into three broad categories: conventional petrophysical properties, rock mechanical properties, and ore quality.

Petrophysics studies are used by petroleum engineering, geology, mineralogy, exploration geophysics and other related sciences. While most petrophysicists work in the hydrocarbon industry, some also work in the mining and water resource industries.

Task 4. Try to define the kind of measurements these descriptions correspond to:
1) Образцы породы извлекаются из подземного пласта для исследования и измерения. 2) Учитывается время, в течение которого отраженные звуковые волны проходят через породы, имеющие различную плотность. 3) Шнур с измерительными инструментами опускается в ствол скважины.

Task 5. Answer the questions:
1. What kinds of specialists must cooperate to understand the rock properties of the reservoir 2. What branches of industry may petrophysicists be employed? 3. What are key properties of rock studied by petrophysicical engineers? 4. How are rock properties measured by petrophysicists? 5. What categories are measured rock properties divided into?

Text 4. Conventional petrophysical properties

Task 1. Read the following words and remember them:

conventional – общепринятый;
description – описание;
grain size – размер зерна;
composition – состав, структура;
texture – текстура пород;
outcrops – выход пласта на поверхность;
resistivity – сопротивляемость;
to contain – содержать;
data – данные;
can be derived from – может быть получен (произведен) из;
formation testing – испытание пласта;
estimate – оценивать, рассчитывать.

Task 2. Read the text.

Most petrophysicists are employed to compute what are commonly called conventional (or reservoir) petrophysical properties. They are:

Lithology: A description of the rock's physical characteristics, such as grain size, composition and texture. By studying the lithology of local geological outcrops and core samples, geoscientists can use a combination of log measurements, such as natural gamma and neutron radiation, density and resistivity, to determine the lithology down the well.

Porosity: The percentage of a given volume of rock that has pore space and can therefore contain fluids. This is typically calculated using data from an instrument that measures the reaction of the rock to bombardment by neutrons or by gamma rays but can also be derived from sonic logging.

Water saturation: The fraction of the pore space occupied by water. This is typically calculated using data from an instrument that measures the resistivity of the rock.

Permeability: The quantity of fluid (usually hydrocarbon) that can flow through a rock as a function of time and pressure, related to how interconnected the pores are. Formation testing is so far the only tool that can directly measure a rock formation's permeability down a well. In case of its absence, which is common in most cases, an estimate for permeability can be derived from empirical relationships with other measurements such as porosity, NMR (nuclear magnetic resonance logging) and sonic logging.

Task 3. Find English equivalents for the following word combinations:

Образцы породы; как взаимосвязаны поры; каротажные работы (измерения в скважине); сочетание измерений; реакция породы на бомбардировку нейтронами и гамма-лучами; акустический каротаж; протекание жидкости в породе; единственный инструмент (метод); в случае его отсутствия; процент определенного объема пористой породы, которая может содержать жидкости; диаграмма ядерно-магнитного каротажа.

Task 4. Find the answers to these questions in the text.

1. What physical characteristics of rock does lithology describe? 2. How is porosity measured? 3. What is the only tool that can directly measure a rock formation's permeability down a well? 4. What measurements can geoscientists combine in order to determine the lithology down the well? 5. What petrophysical properties are called conventional?

Text 5. Rock mechanical properties

Task 1. Read the words and word combinations to the text and remember them:

compressional wave velocity – скорость продольной волны;
shear wave velocity – скорость поперечной волны;
compressive strength – предел прочности при сжатии;
flexibility – гибкость, подвижность;
converted-wave analysis – исследования методом обменных волн;
to determine – определить;
wireline logging – каротажная диаграмма, записанная прибором на кабеле;
to retrieve – извлекать;
core analysis – изучение керна (образцов породы из скважины);
to convey – помещать, перемещать;
log while drilling – каротаж во время бурения;
amount – объем;
wellbore – ствол скважины, шурф.

Task 2. Read the text and try to understand it.

Some petrophysicists use acoustic and density measurements of rocks to compute their mechanical properties and strength. They measure the compressional wave velocity of sound through the rock and the shear wave velocity and use these with the density of the rock to compute the rocks *compressive strength*, which is the compressive stress that causes a rock to fail. The rock flexibility is the relationship between stress and deformation of the rock. Converted-wave analysis is also used to determine subsurface.

These measurements are useful for design programs to drill wells that produce oil and gas. The measurements are also used to design dams, roads, foundations for buildings, and many other large construction projects.

Boreholes can be drilled to take samples of ore. Rock samples are taken to determine the ore quality at each borehole location. The wells can be wireline logged to make measurements that are used to examine the ore quality. Some petrophysicists do this sort of analysis. The information is mapped and used to make development plans.

Coring and core analysis is a direct measurement of petrophysical properties. In the petroleum industry rock samples are retrieved from subsurface and measured by core labs of oil company or some commercial core measurement service companies. This process is costly and takes a lot of time, thus it can not be applied to all the wells drilled in a field.

Well logging is used as a relatively inexpensive method to obtain petrophysical properties of downhole. Measurement tools are conveyed into downhole using either wireline or LWD (log while drilling) method.

Reservoir models are built upon their measured and derived properties to estimate the amount of hydrocarbon present in the reservoir, the rate at which that hydrocarbon can be produced to the Earth’s surface through wellbores and the fluid flow in rocks.

Task 3. Guess the meaning of the following phrases or look up in a dictionary:

compressive stress causes a rock to fail; relationship between stress and deformation; to design dams, roads, foundations for buildings; the information is mapped; this process is costly and takes a lot of time; fluid flow in rocks.

Task 4. Answer the questions to the text:

1. What measurements are used by petrophysicists to study mechanical properties of rock? 2. How can ore quality be examined? 3. Where can measurements of rock mechanical properties be applied? 4. Is core analysis applied to all wells drilled in a field? 5. What can cause a rock to fail?

Task 5. Try to define what sentences from the text are true or false.
1. Coring is time consuming and expensive process, thus it can not be applied to all the wells drilled in a field. 2. The rock flexibility is the relationship between lithology and porosity. 3. Well logging is used as a relatively inexpensive method to obtain petrophysical properties of downhole. 4. The measurements of mechanical properties of rock are made only in petroleum engineering. 5. Rock samples are taken to determine the ore quality at each borehole location.

Text 6. Reservoir modeling

Task 1. Read the words to the text and remember them:

purpose – цель;
to improve – улучшать, уточнять;
to make decisions – принимать решения;
to lead – вести, приводить;
to provide – обеспечивать, предоставлять;
to simulate – моделировать, воспроизводить;
to enable – позволять, создавать условия, давать возможность;
technique – технический прием, метод, способ;
quantitative – количественный;
range – область распространения.

Task 2. Read the text and try to understand it.

In the oil and gas industry, reservoir modeling involves the construction of a computer model of a petroleum reservoir for the purposes of improving estimation of reserves and making decisions about the development of the field.

Reservoir models are constructed to gain a better understanding of the subsurface that leads to proper well placement, reserves estimation and production planning. Models are based on measurements taken in the field, including well logs, seismic surveys, and production history.

Reservoir models typically fall into two categories:

– Geological models are created by geologists and geophysicists and have the aim to provide a static description of the reservoir prior to production.

– Reservoir simulation models are created by reservoir engineers to simulate the flow of fluids within the reservoir during its production lifetime.

Seismic-to-simulation work enables the quantitative integration of all field data into an updateable reservoir model built by a team of geologists, geophysicists, and engineers. Key techniques used in this process include integrated petrophysics and rock physics to determine the range of lithotypes and rock properties and geostatistical data.

The phrase "reservoir characterization" is sometimes used to refer to reservoir modeling activities up to the point when a simulation model is ready to simulate the flow of fluids. Commercially available software is used in the construction, simulation and analysis of the reservoir models.

Task 3. Find English equivalents for the following word combinations:

разработка месторождения; правильное расположение скважины; перед добычей (углеводородов); технология работ от сейсмоисследования до моделирования; время эксплуатации, срок службы; полевые (промысловые) данные; программное обеспечение; уточненная оценка.

Task 4. Answer the questions to the text:
1. What measurements are reservoir models based on? 2. What is the difference between geological models and reservoir simulation models? 3. What are reservoir models constructed for? 4. What specialists are involved in construction of computer reservoir model? 5. How do you understand the term "seismic-to-simulation work"?

Task 5. Agree or disagree with the following statements:
1. Reservoir modeling involves the construction of a computer model of a petroleum reservoir for the purposes of improving estimation of reserves and making decisions about the development of the field. 2. Reservoir simulation models are created by geologists. 3. Models are based on measurements taken in the field, including well logs, seismic surveys, and production history. 4. Commercially available software is used in the construction, simulation and analysis of the reservoir models. 5. Reservoir models typically fall into three categories.

Text 7. Reservoir simulation

Task 1. Read the words and word combinations to the text and remember them:

to predict – предсказывать, прогнозировать;
forecast – прогноз;
reliable – надежный;
to reduce – уменьшать, сокращать;
to identify – определять**;**
extensively – широко;

opportunity – возможность;
to increase – повышать;
oil recovery – объем добычи нефти;
to low viscosity – понизить вязкость;
steam soak – парообработка пласта;
steam flooding – нагнетание пара в нефтяной пласт;
to account for – учитывать, принимать во внимание;
heat loss – потеря тепла.

Task 2. Read the text and try to understand it.

Reservoir simulation is an area of reservoir engineering in which computer models are used to predict the flow of fluids (typically, oil, water, and gas) through porous rocks. Reservoir simulation models are used by oil and gas companies in the development of new fields. Also, models are used in developed fields where production forecasts are needed to help in making investment decisions. So as the creation of a reliable model of a field is often time-consuming and expensive, models are usually constructed where large investment decisions are needed. Improvements in simulation software have reduced the time to develop a model.

For new fields, models may help in development by identifying the number of wells required, the optimal completion of wells, the present and future needs for artificial lift, and the expected production of oil, water and gas.

Reservoir simulation is used extensively to identify opportunities to increase oil production in heavy oil deposits. Oil recovery is improved by lowering the oil viscosity by injecting steam or hot water. Typical processes are steam soaks and steam flooding. These processes require simulators with special features to account for heat transfer to the fluids present in the formation, the subsequent property changes and heat losses outside of the formation.

Task 3. Find Russian equivalents for the following English words and expressions:
time consuming and expensive; completion of well; artificial lift; heavy oil deposits; to inject steam or hot water; heat transfer; subsequent property changes
теплопередача; длительный и дорогостоящий (процесс); последующие изменения свойств; заканчивание скважины; залежи тяжелой нефти (нефти с низким удельным весом); закачивать в пласт пар или горячую воду; механизированная/насосно-компрессорная добыча.

Task 4. Answer the questions:
1. How do oil and gas companies use reservoir simulation models? 2. Is the process of reservoir model construction time-consuming and expensive? 3. How is reservoir simulation used in the developed fields and new ones? 4. How may oil recovery be improved? 5. When are simulators with special features required?

Text 8. Correlation of rock measurements

Task 1. Read the words to the text and remember them:

depth – глубина**;**
lateral – боковой каротаж, горизонтальная выработка;
to correlate – сопоставлять, находиться в соотношении;
fine-scale – мелкомасштабный;
insight – проникновение, представление, понимание;
to verify – проверять, подтверждать;
distribution – распространение, распределение;
layer – слой;
to encounter – встречаться.

Task 2. Read the text.

The first step in seismic-to-simulation work is establishing a relationship between petrophysical rock properties and elastic properties of the rock. This is required in order to find common ground between the well logs and seismic data.

Well logs are measured in depth and provide high resolution vertical data, but no insight into the inter-well space. Seismic are measured in time and provide great lateral detail but is quite limited in its vertical resolution. When correlated, well logs and seismic data can be used to create a fine-scale 3D model of the subsurface.

Insight into the rock properties comes from a combination of basic geologic understanding and wellbore measurements. Based on an understanding of how the area was formed over time, geologists can predict the types of rock. Well log and core measurements provide samples to verify that understanding.

Seismic data is used by petrophysicists to identify the tops of various lithotypes and the distribution of rock properties in the inter-well space. Seismic surveys measure acoustic impedance contrasts between rock layers. As different geologic structures are encountered, the sound wave reflects and refracts as a function of the impedance contrast between the layers. Acoustic impedance varies by rock type and can therefore be correlated to rock properties.

Once well logs are properly conditioned and edited, a petrophysical rock model is generated that can be used to derive the effective elastic rock properties from fluid and mineral parameters as well as rock structure information.

When the petrophysical rock model is complete, a statistical database is created to describe the rock types and their known properties such as porosity and permeability. Lithotypes are described, along with their distinct elastic properties.

Task 3. Find English equivalents for the following word combinations:
межскважинное пространство; каротажная диаграмма (разрез скважины); вертикальные данные с высоким разрешением; найти общую основу; измерение образцов породы из скважины; технология работ от сейсмосъемки до моделирования; верхняя часть литотипа; акустическое (волновое) сопротивление; должным образом обработаны и проверены; звуковая волна отражается и преломляется.

Task 4. Agree or disagree with the following statements:
1. Acoustic impedance varies by rock type and can therefore be correlated to rock properties. 2. As different geologic structures are encountered, the sound wave reflects and refracts 3. Based on an understanding of how the area was formed over time, geologists can create a petrophysical rock model. 4. Well log and core measurements provide samples to verify elastic properties. 5. A statistical database is created to describe the rock types and their known properties such as porosity and permeability.

Task 5. Answer the questions:
1. What does seismic survey measure? 2. What measurements can be used to create a 3D model of subsurface? 3. What kind of data do well logs provide? 4. How can geologists predict the types of rock? 5. Is petrophysical rock model generated before studying rock properties?

Указания к составлению рефератов и аннотаций текстов

Реферат (Review) — это сжатое, краткое изложение текста с основными фактическими данными, выводами и рекомендациями.

Требования к составлению реферата:

1. Реферат строится на основе ключевых фрагментов, выделенных из текста.
2. Реферат должен быть написан литературным языком с использованием научной терминологии, принятой в научной литературе по той или иной отрасли науки и техники.
3. Реферат должен объективно и точно отражать содержание первоисточника; нельзя вносить какие-либо изменения или дополнения по существу реферируемой работы.
4. Не следует в реферате излагать собственную точку зрения или критические замечания.

Структура реферата:

1. Выходные данные источника: фамилия и инициалы автора, заглавие, издательство, место, год издания (для журнала — название и номер).
2. Главная мысль, идея реферируемого материала.
3. Изложение содержания: реферируемый материал излагается в последовательности, в которой он приводится в тексте.
4. Выводы автора или результаты исследований.

Аннотация (Abstract / Summary) — это краткая характеристика текста с изложением наиболее важных положений. Основным отличием аннотации от реферата является то, что реферат дает представление о содержании оригинала, а аннотация — только о его тематике. Аннотация перечисляет, называет проблемы оригинала, но не раскрывает их.

Требования к составлению аннотации:

1. При составлении аннотации следует избегать сложных конструкций и предложений.
2. Аннотацию необходимо составлять, сохраняя логическую структуру текста.
3. Для обобщения информации рекомендуется использовать специальные обороты и фразы-клише, приведенные ниже.
4. Названия фирм, компаний следует давать в их оригинальном написании; аббревиатуры и различные сокращения необходимо использовать в соответствии с общепринятыми в справочной литературе.

Структура аннотации:

1) Выходные данные источника: фамилия и инициалы автора, заглавие, издательство, место, год издания (для журнала — название и номер).
2) Введение общей темы.
3) Предельно краткое изложение основных вопросов, рассматриваемых в тексте.
4) Общие выводы или заключения автора статьи, эмоционально-оценочное отношение составителя аннотации к аннотируемому тексту.

Список выражений, рекомендуемых для написания реферата и аннотации:

1. **The article (text) is entitled ... –** Статья озаглавлена...

The article is head-lined ... – Статья озаглавлена...

2. **The author of the article is ... –** Автор статьи ...

The article is written by ... – Статья написана ...

3. **It is (was) published in ... –** Она (была) опубликована в ...

4. **The main idea of the article is ... –** Основная идея статьи ...

The subject of information is ... – Тема сообщения ...

The article deals with ... – Статья рассматривает ...

The text is about ... – В тексте сообщается о ...

The article is devoted to ... – Статья посвящена ...

The article touches upon ... – Статья затрагивает ...

The article describes ... – Статья описывает ...

5. **The author reports (states, stresses, thinks)** ... – Автор сообщает (заявляет, подчеркивает, думает) ...

It is pointed out that... – Указывается, что ...

It is stressed that ... – Подчеркивается, что ...

It is shown that... – Показано, что ...

The problems of ... are considered – Рассматриваются проблемы ...

Special attention is given to ...– Особое внимание уделяется ...

An important information is given on ... – Предоставляется важная информация о ...

6. **The conclusion is made that ... –** Делается вывод о ...

Conclusions are drawn ... – Делаются выводы ...

The author comes to the conclusion that ...– Автор приходит к выводу, что...

7. **The article is of importance (interest) to ... –** Статья важна (представляет интерес) для ...

Пример составления аннотации к тексту **Correlation in Rock Measurements**

The text is entitled "Correlation in Rock Measurements". It is published in ... . The author of the text is ... .
The text is devoted to the study of rock properties in seismic-to-simulation work. It is pointed out that the insight into the rock properties comes from a combination of basic geologic understanding and wellbore measurements.
Special attention is paid to the principles of well logs and seismic measurements. It is stressed that when correlated, well logs and seismic data can be used to create a fine-scale 3D model of the subsurface.
It should be noted that the text is of interest to petrophysicists and geologists.

SUPPLEMENTARY READING

Formation evaluation tools:

Well Logging

Tools to detect oil and gas have been evolving for over a century. The simplest and most direct tool is well cuttings examination. Some older oilmen ground the cuttings between their teeth and tasted to see if crude oil was present. Today, a wellsite geologist or mudlogger uses a low powered stereoscopic microscope to determine the lithology of the formation being drilled and to estimate porosity and possible oil staining.

A portable ultraviolet light chamber or "Spook Box" is used to examine the cuttings for fluorescence. Fluorescence can be an indication of crude oil staining, or of the presence of fluorescent minerals. They can be differentiated by placing the cuttings in a solvent filled watchglass or dimple dish. The solvent is usually carbon tetrachlorethane. Crude oil dissolves and then redeposits as a fluorescent ring when the solvent evaporates. The written strip chart recording of these examinations is called a sample log or mudlog.

Well cuttings examination is a learned skill. During drilling, chips of rock, usually less than about 1/8 inch (6 mm) across, are cut from the bottom of the hole by the bit. Mud, jetting out of holes in the bit under high pressure, washes the cuttings away and up the hole. During their trip to the surface they may circulate around the turning drillpipe, mix with cuttings falling back down the hole, mix with fragments caving from the hole walls and mix with cuttings travelling faster and slower in the same upward direction. They then are screened out of the mudstream by the shale shaker and fall on a pile at its base.

Determining the type of rock being drilled at any one time is a matter of knowing the 'lag time' between a chip being cut by the bit and the time it reaches the surface where it is then examined by the wellsite geologist (or mudlogger as they are sometimes called). A sample of the cuttings taken at the proper time will contain the current cuttings in a mixture of previously drilled material. Recognizing them can be very difficult at times, for example after a "bit trip" when a couple of miles of drill pipe has been extracted and returned to the hole in order to replace a dull bit. At such a time there is a flood of foreign material knocked from the borehole walls (cavings), making the mudloggers task all the more difficult.

Coring

One way to get more detailed samples of a formation is by coring. Two techniques commonly used at present. The first is the "whole core", a cylinder of rock, usually about 3" to 4" in diameter and up to 50 feet (15 m) to 60 feet (18 m) long. It is cut with a "core barrel", a hollow pipe tipped with a ring-shaped diamond chip-studded bit that can cut a plug and bring it to the surface. Often the plug breaks while drilling, usually in shales or fractures and the core barrel jams, slowly grinding the rocks in front of it to powder. This signals the driller to give up on getting a full length core and to pull up the pipe.

Taking a full core is an expensive operation that usually stops or slows drilling for at least the better part of a day. A full core can be invaluable for later reservoir evaluation. Once a section of well has been drilled, there is, of course, no way to core it without drilling another well.

Another, cheaper, technique for obtaining samples of the formation is "Sidewall Coring". One type of sidewall cores is percussion cores. In this method, a steel cylinder—a coring gun—has hollow-point steel bullets mounted along its sides and moored to the gun by short steel cables. The coring gun is lowered to the bottom of the interval of interest and the bullets are fired individually as the gun is pulled up the hole. The mooring cables ideally pull the hollow bullets and the enclosed plug of formation loose and the gun carries them to the surface. Advantages of this technique are low cost and the ability to sample the formation after it has been drilled. Disadvantages are possible non-recovery because of lost or misfired bullets and a slight uncertainty about the sample depth. Sidewall cores are often shot "on the run" without stopping at each core point because of the danger of differential sticking. Most service company personnel are skilled enough to minimize this problem, but it can be significant if depth accuracy is important.

A second method of sidewall coring is rotary sidewall cores. In this method, a circular-saw assembly is lowered to the zone of interest on a wireline, and the core is sawed out. Dozens of cores may be taken this way in one run. This method is roughly 20 times as expensive as percussion cores, but yields a much better sample.

A serious problem with cores is the change they undergo as they are brought to the surface. It might seem that cuttings and cores are very direct samples but the problem is whether the formation at depth will produce oil or gas. Sidewall cores are deformed and compacted and fractured by the bullet impact. Most full cores from any significant depth expand and fracture as they are brought to the surface and removed from the core barrel. Both types of core can be invaded or even flushed by mud, making the evaluation of formation fluids difficult. The formation analyst has to remember that all tools give indirect data.

Wireline logging

The oil and gas industry uses wireline logging to obtain a continuous record of a formation's rock properties. Wireline logging can be defined as being "The acquisition and analysis of geophysical data performed as a function of well bore depth, together with the provision of related services." The measurements are made referenced to "TAH" - True Along Hole depth: these and the associated analysis can then be used to infer further properties, such as hydrocarbon saturation and formation pressure, and to make further drilling and production decisions. Wireline logging is performed by lowering a 'logging tool' - or a string of one or more instruments - on the end of a wireline into an oil well (or borehole) and recording petrophysical properties using a variety of sensors. Logging tools developed over the years measure the natural gamma ray, electrical, acoustic, stimulated radioactive responses, electromagnetic, nuclear magnetic resonance, pressure and other properties of the rocks and their contained fluids. For this article, they are broadly broken down by the main property that they respond to.
The data itself is recorded either at surface (real-time mode), or in the hole (memory mode) to an electronic data format and then either a printed record or electronic presentation called a "well log" is provided to the client, along with an electronic copy of the raw data. Well logging operations can either be performed during the drilling process (see Logging While Drilling), to provide real-time information about the formations being

penetrated by the borehole, or once the well has reached Total Depth and the whole depth of the borehole can be logged. Real-time data is recorded directly against measured cable depth. Memory data is recorded against time, and then depth data is simultaneously measured against time. The two data sets are then merged using the common time base to create an instrument response versus depth log. Memory recorded depth can also be corrected in exactly the same way as real-time corrections are made, so there should be no difference in the attainable TAH accuracy.

The measured cable depth can be derived from a number of different measurements, but is usually either recorded based on a calibrated wheel counter, or (more accurately) using magnetic marks which provide calibrated increments of cable length. The measurements made must then be corrected for elastic stretch and temperature.

There are many types of wireline logs and they can be categorized either by their function or by the technology that they use. "Open hole logs" are run before the oil or gas well is lined with pipe or cased. "Cased hole logs" are run after the well is lined with casing or production pipe.

Wireline logs can be divided into broad categories based on the physical properties measured.

Electric logs

In 1928, the Schlumberger brothers in France developed the workhorse of all formation evaluation tools: the electric log. Electric logs have been improved to a high degree of precision and sophistication since that time, but the basic principle has not changed. Most underground formations contain water, often salt water, in their pores. The resistance to electric current of the total formation—rock and fluids—around the borehole is proportional to the sum of the volumetric proportions of mineral grains and conductive water-filled pore space. If the pores are partially filled with gas or oil, which are resistant to the passage of electric current, the bulk formation resistance is higher than for water filled pores. For the sake of a convenient comparison from measurement to measurement, the electrical logging tools measure the resistance of a cubic meter of formation. This measurement is called *resistivity*.

Modern resistivity logging tools fall into two categories, Laterolog and Induction, with various commercial names, depending on the company providing the logging services.

Laterolog tools send an electric current from an electrode on the sonde directly into the formation. The return electrodes are located either on surface or on the sonde itself. Complex arrays of electrodes on the sonde (guard electrodes) focus the current into the formation and prevent current lines from fanning out or flowing directly to the return electrode through the borehole fluid. Most tools vary the voltage at the main electrode in order to maintain a constant current intensity. This voltage is therefore proportional to the resistivity of the formation. Because current must flow from the sonde to the formation, these tools only work with conductive borehole fluid. Actually, since the resistivity of the mud is measured in series with the resistivity of the formation, laterolog tools give best results when mud resistivity is low with respect to formation resistivity, i.e., in salty mud.

Induction logs use an electric coil in the sonde to generate an alternating current loop in the formation by induction. This is the same physical principle as is used in electric transformers. The alternating current loop, in turn, induces a current in a receiving coil located elsewhere on the sonde. The amount of current in the receiving coil is proportional to the intensity of current loop, hence to the conductivity (reciprocal of resistivity) of the formation. Multiple transmitting and receiving coils are used to focus formation current loops both radially (depth of investigation) and axially (vertical resolution). Until the late 80’s, the workhorse of induction logging has been the 6FF40 sonde which is made up of six coils with a nominal spacing of 40 inches (1,000 mm). Since the 90’s all major logging companies use so-called array induction tools. These comprise a single transmitting coil and a large number of receiving coils. Radial and axial focusing is performed by software rather than by the physical layout of coils. Since the formation current flows in circular loops around the logging tool, mud resistivity is measured in parallel with formation resistivity. Induction tools therefore give best results when mud resistivity is high with respect to formation resistivity, i.e., fresh mud or non-conductive fluid. In oil-base mud, which is non conductive, induction logging is the only option available.

Until the late 1950s electric logs, mud logs and sample logs comprised most of the oilman's armamentarium. Logging tools to measure porosity and permeability began to be used at that time. The first was the microlog. This was a miniature electric log with two sets of electrodes. One measured the formation resistivity about 1/2" deep and the other about 1"-2" deep. The purpose of this seemingly pointless measurement was to detect permeability. Permeable sections of a borehole wall develop a thick layer of mudcake during drilling. Mud liquids, called filtrate, soak into the formation, leaving the mud solids behind to -ideally- seal the wall and stop the filtrate "invasion" or soaking. The short depth electrode of the microlog sees mudcake in permeable sections. The deeper 1" electrode sees filtrate invaded formation. In nonpermeable sections both tools read alike and the traces fall on top of each other on the stripchart log. In permeable sections they separate.

Also in the late 1950s porosity measuring logs were being developed. The two main types are: nuclear porosity logs and sonic logs.

Porosity logs

The two main nuclear porosity logs are the Density and the Neutron log.

Density logging tools contain a caesium-137 gamma ray source which irradiates the formation with 662 keV gamma rays. These gamma rays interact with electrons in the formation through Compton scattering and lose energy. Once the energy of the gamma ray has fallen below 100 keV, photolectric absorption dominates: gamma rays are eventually absorbed by the formation. The amount of energy loss by Compton scattering is related to the number electrons per unit volume of formation. Since for most elements of interest (below Z = 20) the ratio of atomic weight, A, to atomic number, Z, is close to 2, gamma ray energy loss is related to the amount of matter per unit volume, i.e., formation density.

A gamma ray detector located some distance from the source, detects surviving gamma rays and sorts them into several energy windows. The number of high-energy gamma rays is controlled by compton scattering, hence by formation density. The number of low-energy gamma rays is controlled by photoelectric absorption, which is directly related to the average atomic number, Z, of the formation, hence to lithology. Modern density logging tools include two or three detectors, which allow compensation for some borehole effects, in particular for the presence of mud cake between the tool and the formation.

Since there is a large contrast between the density of the minerals in the formation and the density of pore fluids, porosity can easily be derived from measured formation bulk density if both mineral and fluid densities are known.

Neutron porosity logging tools contain an americium-beryllium neutron source, which irradiates the formation with neutrons. These neutrons lose energy through elastic collisions with nuclei in the formation. Once their energy has decreased to thermal level, they diffuse randomly away from the source and are ultimately absorbed by a nucleus. Hydrogen atoms have essentially the same mass as the neutron; therefore hydrogen is the main contributor to the slowing down of neutrons. A detector at some distance from the source records the number of neutron reaching this point. Neutrons that have been slowed down to thermal level have a high probability of being absorbed by the formation before reaching the detector. The neutron counting rate is therefore inversely related to the amount of hydrogen in the formation. Since hydrogen is mostly present in pore fluids (water, hydrocarbons) the count rate can be converted into apparent porosity. Modern neutron logging tools usually include two detectors to compensate for some borehole effects. Porosity is derived from the ratio of count rates at these two detectors rather than from count rates at a single detector.

The combination of neutron and density logs takes advantage of the fact that lithology has opposite effects on these two porosity measurements. The average of neutron and density porosity values is usually close to the true porosity, regardless of lithology. Another advantage of this combination is the "gas effect." Gas, being less dense than liquids, translates into a density-derived porosity that is too high. Gas, on the other hand, has much less hydrogen per unit volume than liquids: neutron-derived porosity, which is based on the amount of hydrogen, is too low. If both logs are displayed on compatible scales, they overlay each other in liquid-filled clean formations and are widely separated in gas-filled formations.

Sonic logs use a pinger and microphone arrangement to measure the velocity of sound in the formation from one end of the sonde to the other. For a given type of rock, acoustic velocity varies indirectly with porosity. If the velocity of sound through solid rock is taken as a measurement of 0% porosity, a slower velocity is an indication of a higher porosity that is usually filled with formation water with a slower sonic velocity.

Both sonic and density-neutron logs give porosity as their primary information. Sonic logs read farther away from the borehole so they are more useful where sections of the borehole are caved. Because they read deeper, they also tend to average more formation than the density-neutron logs do. Modern sonic configurations with pingers and microphones at both ends of the log, combined with computer analysis, minimize the averaging somewhat. Averaging is an advantage when the formation is being evaluated for seismic parameters, a different area of formation evaluation. A special log, the Long Spaced Sonic, is sometimes used for this purpose. Seismic signals (a single undulation of a sound wave in the earth) average together tens to hundreds of feet of formation, so an averaged sonic log is more directly comparable to a seismic waveform.

Density-neutron logs read the formation within about four to seven inches (178 mm) of the borehole wall. This is an advantage in resolving thin beds. It is a disadvantage when the hole is badly caved. Corrections can be made automatically if the cave is no more than a few inches deep. A caliper arm on the sonde measures the profile of the borehole and a correction is calculated and incorporated in the porosity reading. However, if the cave is much more than four inches deep, the density-neutron log is reading little more than drilling mud.

Lithology logs - SP and gamma ray

There are two other tools, the SP log and the Gamma Ray log, one or both of which are almost always used in wireline logging. Their output is usually presented along with the electric and porosity logs described above. They are indispensable as additional guides to the nature of the rock around the borehole. The SP log, known variously as a "Spontaneous Potential", "Self Potential" or "Shale Potential" log is a voltmeter measurement of the voltage or electrical potential difference between the mud in the hole at a particular depth and a copper ground stake driven into the surface of the earth a short distance from the borehole. A salinity difference between the drilling mud and the formation water acts as a natural battery and will cause several voltage effects. This "battery" causes a movement of charged ions between the hole and the formation water where there is enough permeability in the rock. The most important voltage is set up as a permeable formation permits ion movement, reducing the voltage between the formation water and the mud. Sections of the borehole where this occurs then have a voltage difference with other nonpermeable sections where ion movement is restricted. Vertical ion movement in the mud column occurs much more slowly because the mud is not circulating while the drill pipe is out of the hole. The copper surface stake provides a reference point against which the SP voltage is measured for each part of the borehole. There can also be several other minor voltages, due for example to mud filtrate streaming into the formation under the effect of an overbalanced mud system. This flow carries ions and is a voltage generating current. These other voltages are secondary in importance to the voltage resulting from the salinity contrast between mud and formation water.

The nuances of the SP log are still being researched. In theory, almost all porous rocks contain water. Some pores are completely filled with water. Others have a thin layer of water molecules wetting the surface of the rock, with gas or oil filling the rest of the pore. In sandstones and porous limestones there is a continuous layer of water throughout the formation. If there is even a little permeability to water, ions can move through the rock and decrease the voltage difference with the mud nearby. Shales do not allow water or ion movement. Although they may have a large water content, it is bound to the surface of the flat clay crystals comprising the shale. Thus mud opposite shale sections maintains its voltage difference with the surrounding rock. As the SP logging tool is drawn up the hole it measures the voltage difference between the reference stake and the mud opposite shale and sandstone or limestone sections. The resulting log curve reflects the permeability of the rocks and, indirectly, their lithology. SP curves degrade over time, as the ions diffuse up and down the mud column. It also can suffer from stray voltages caused by other logging tools that are run with it. Older, simpler logs often have better SP curves than more modern logs for this reason. With experience in an area, a good SP curve can even allow a skilled interpreter to infer sedimentary environments such as deltas, point bars or offshore tidal deposits.

The gamma ray log is a measurement of naturally occurring gamma radiation from the borehole walls. Sandstones are usually nonradioactive quartz and limestones are nonradioactive calcite. Shales however, are naturally radioactive due to potassium isotopes in clays, and adsorbed uranium and thorium. Thus the presence or absence of gamma rays in a borehole is an indication of the amount of shale or clay in the surrounding formation. The gamma ray log is useful in holes drilled with air or with oil based muds, as these wells have no SP voltage. Even in water-based muds, the gamma ray and SP logs are often run together. They comprise a check on each other and can indicate unusual shale sections which may either not be radioactive, or may have an abnormal ionic chemistry. The gamma ray log is also useful to detect coal beds, which, depending on the local geology, can have either low radiation levels, or high radiation levels due to adsorption of uranium. In addition, the gamma ray log will work inside a steel casing, making it essential when a cased well must be evaluated.

Types of Petroleum Traps

Geologists have classified petroleum traps into two basic types: structural traps and stratigraphic traps. Structural traps are traps that are formed because of a deformation in the rock layer that contains the hydrocarbons. Two common examples of structural traps are fault traps and anticlines.

An anticline is an upward fold in the layers of rock, much like an arch in a building. Petroleum migrates into the highest part of the fold, and its escape is prevented by an overlying bed of impermeable rock.

A fault trap occurs when the formations on either side of the fault have been moved into a position that prevents further migration of petroleum. For example, an impermeable formation on one side of the fault may have moved opposite the petroleum-bearing formation on the other side of the fault. Further migration of petroleum is prevented by the impermeable layer.

Stratigraphic traps are traps that result when the reservoir bed is sealed by other beds or by a change in porosity or permeability within the reservoir bed itself. There are many different kinds of stratigraphic traps.

Sometimes a petroleum-bearing formation pinches out; that is, the formation is gradually cut off by an overlying layer. Another stratigraphic trap occurs when a porous and permeable reservoir bed is surrounded by impermeable rock. Still another type occurs when there is a change in porosity and permeability in the reservoir itself. The upper reaches of the reservoir may be impermeable and nonporous, while the lower part is permeable and porous and contains hydrocarbons. Oil and natural gas may be extracted from the trap by drilling.

References

1. Серикбай И. Английский для нефтяников: пособие для самообразования. Алматы, 2009 – 164 с.
2. https://en.wikipedia.org/wiki/Hydrocarbon_exploration
3. https://en.wikipedia.org/wiki/Petrophysics
4. https://en.wikipedia.org/w/index.php?search=Formation+evaluation+tools&title=Special%3ASearch&ns0=1