**Министерство науки и высшего образования Российской Федерации**

**Федеральное государственное бюджетное образовательное учреждение высшего образования**
**Санкт-Петербургский горный университет**

**Кафедра иностранных языков**

# ИНОСТРАННЫЙ ЯЗЫК

## АНГЛИЙСКИЙ ЯЗЫК ДЛЯ БУДУЩИХ СПЕЦИАЛИСТОВ В ОБЛАСТИ ГЕОЛОГИИ НЕФТИ И ГАЗА

***Методические указания к практическим занятиям для студентов специальности 21.05.02***

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# ENGLISH AS A SECOND LANGUAGE

## ENGLISH FOR FUTURE SPECIALISTS IN THE FIELD OF PETROLEUM GEOLOGY

**САНКТ-ПЕТЕРБУРГ**
**2019**

УДК 621.316.722;621.316.1 (073)

**ИНОСТРАННЫЙ ЯЗЫК. Английский язык для будущих специалистов в области геологии нефти и газа:** Методические указания к практическим занятиям / Санкт-Петербургский горный университет. Сост.: *О.Ю. Гагарина, С.А. Свешникова.* СПб, 2019. 30 с.

Методические указания предназначены для студентов специальности 21.05.02 «Прикладная геология» и соответствуют программе по дисциплине «Иностранный язык». Предлагаемый комплекс упражнений направлен на совершенствование навыков просмотрового и изучающего чтения аутентичных профессионально-ориентированных текстов. Методические указания могут быть использованы на занятиях со студентами 2-го курса.

Научный редактор доц. *Е.А. Варлакова*

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# ПРЕДИСЛОВИЕ

Данные методические указания предназначены для учебно-методического сопровождения курса английского языка для студентов неязыковых вузов, обучающихся по специальности 21.05.02 «Прикладная геология».

Изучение материала нацелено на развитие навыков просмотрового и изучающего чтения текстов по специальности, а также их перевода на русский язык; овладение студентами иноязычной коммуникативно-речевой компетенцией, позволяющей будущему специалисту осуществлять профессиональную коммуникацию на иностранном языке; формирование активного словарного запаса, который включает наиболее употребительные термины и слова общетехнического характера.

Методические указания состоят из тематических разделов, каждый из которых посвящен одному из аспектов, связанных с геологией нефти и газа. Задания для чтения и перевода составлены на материале аутентичных текстов и сопровождаются упражнениями, направленными на активизацию когнитивной деятельности обучающихся, освоение нового лексического материала, и способствуют развитию коммуникативных навыков в сфере профессионального общения на английском языке.

## UNIT 1. PETROLEUM SYSTEMS AND ELEMENTS OF PETROLEUM GEOLOGY

### Text 1

### PETROLEUM SYSTEM

**Read the text and insert the missing words from the box into the gaps:**

| |
|---|
| associated processes |
| formation |
| geochemists |
| oil or gas seep |
| petroleum geology |
| reservoir rock |
| sedimentology |

Petroleum system is a core concept of (**a**) **…** -the study of oil and gas formation and exploration with its (**b**) **…** such as oil origin, occurrence, migration and their accumulation - which unifies interdependent processes and key elements in the formation of hydrocarbons. The (**c**) **…** of hydrocarbons involves processes such as trap formation, generation-migration-accumulation of hydrocarbons and key elements which encompass source rock, (**d**) **…** , and seal or cap rock. Studying petroleum system helps petroleum geophysists and (**e**) **…** knowing and understanding the nature of the trap and petroleum region by basing on paleontology, stratigraphy and (**f**) **…** of a geographic region in order to identify petroleum system. A region is said to have a petroleum system if and only if there are a presence of (**g**) **…** on area or in water, with the regardless of having big quantity.

*By Donatien Ishimwe, Junior student in petroleum Chemistry, American University of Nigeria*

### Text 2

**1. Read the words and find their Russian equivalents in the text below:**

| | |
|---|---|
| anticline seal | precursor |
| bulk rock | reflection seismology |
| cap rock | syncline seal |
| limestone | trap |
| permeability | wire lines log |

**2. Read the text and choose the best title for each paragraph (1-5). There is one extra title.**

**A. SEISMOLOGY**
**B. SOURCE ROCK**
**C. CAP ROCK**
**D. RESERVOIR ROCK**
**E. ELEMENTS OF PETROLEUM GEOLOGY**

1. Source rocks, trap, seal and reservoir rock are the key elements of petroleum systems which are provided by the interpretation of data from reflection seismology and electromagnetic geophysical techniques performed in a particular geographic area. Each of these elements is evaluated in a particular way to determine the potentiality of the system.

2. The source rock is a subsurface sedimentary rock unit(s) which is made of shale or limestone. It contains the precursors of hydrocarbon formation, organic matters (from decays of ancient biological species) which were subjected to high temperature for longtime. The source rock host the processes that involve in the formation oil and gas until they start to immigrate toward the upper or nearer rock(s) named reservoir due to the fluidity of oil and gas. The source rock is evaluated using the geochemistry methods.

3. This element is a kind of porous or permeable lithological unit(s) which retains the immigrating oil and gas from source rock. Oil and gas usually accumulate on the top of water and they are always there relatively to their difference of densities. The reservoir rock are basically analyzed by means of assessing their porosity a permeability but also its analysis takes ranges into various fields such as stratigraphy, structural analysis, sedimentology, paleontology and reservoir engineering disciplines. In case the reservoir has yet been identified, key characteristic crucial to hydrocarbons explorationists are bulk rock

volume and net-to-gross ratio. The bulk rock volume (gross volume of the rock above the water-hydrocarbons contact) is obtained from of sedimentary packages while the net-to-gross ratio (the proportion of sedimentary packages in a reservoir rock) estimations are gotten from analogues and wire lines logs. The net volume of reserves is equal to bulk rock volume multiplied by the net-to-gross ratio.

4. It is a lithological unit(s) with low permeability which restricts hydrocarbons to escape from the reservoir. It is made of chalks, shale or evaporites. Its analysis bases on assessing the extent and thickness to know how much cap rock is efficient to oil and gas retention. According to lithological deformation that might have been happen, the cap rock may be found in various types. The tectonic movements the crust experiences cause the anticline and syncline seals and the matter of consequences of their shapes; the convex form is more enjoyable to petroleum exploration than concave one. That is why always the seismology experiments are always carried out to assess how well they can reach the reservoir by aiming at seal with a concave shape as to ease and make efficient the petroleum exploration.

**3. Translate this text into Russian and learn new words you come across.**

## Text 3

## SOURSE ROCKS AND HYDROCARBON GENERATION

**1. Read the text and say if the following statements are *True* or *False*:**

1. Newspapers write true about oil and gas.
2. Plankton are the diverse collection of organisms
3. Lake-floor environment rich with oxygen is kindly for plankton transformation into hydrocarbons.
4. Shale with organic matter tends to be gray or black.
5. Depth, temperature and pressure are equally important transformation of organic material into kerogen.
6. Range of temperature called oil window is wide, from 100C to 200C.
7. Oil and gas are formed in similar conditions.
8. Hydrogen decomposes at temperatures over two hundred degrees Celsius.

News stories often incorrectly imply that oil and gas are derived from buried trees or the carcasses of dinosaurs. In fact, the hydrocarbon molecules of oil and gas are derived from organic chemicals, such as fatty molecules called lipids that were once in plankton. Plankton is made up of very tiny floating organisms including single-celled and very small multicellular plants (algae) as well as protists and microscopic animals. Typically, most planktonic organisms range in size from 0.02 to 2.0 mm in diameter. When the organisms die, they sink to the floor of the lake or sea that they lived in, and if the water is relatively "quiet" (nonflowing), accumulate.

If the sea-floor or lake-floor environment is rich with oxygen, dead plankton may be eaten or oxidized and transformed into CO2 and CH4 gas, which bubbles away. But in oxygen-poor waters, the organic material can survive long enough to mix with clay and form an organic-rich, muddy ooze, that can then become buried by still more sediment so that it becomes preserved. Eventually, pressure due to the weight of overlying sediment squeezes out the water, and the ooze becomes compacted and, eventually, lithified to become black, organic shale. (Shale that does not contain organic matter tends to be gray, tan, or red.) Organic shale contains the raw materials from which hydrocarbons form, so we refer to it as a source rock.

If organic shale becomes buried deeply enough (2 to 4 km), it gets warmer, since temperature increases with depth in the Earth. Chemical reactions take place in warm source rocks and slowly transform the organic material in the shale into a mass of waxy molecules called kerogen (figure above). Shale containing 15% to 30% kerogen is called oil shale. If oil shale warms to temperatures of greater than about 90C, kerogen molecules break into smaller oil and natural gas molecules, a process known as hydrocarbon generation. At temperatures over about 160C, any remaining oil breaks down to form natural gas; and at temperatures over 225–250C, organic matter loses all its hydrogen and transforms into graphite (pure carbon). Thus, oil itself forms only in a relatively narrow range of temperatures, called the oil window.

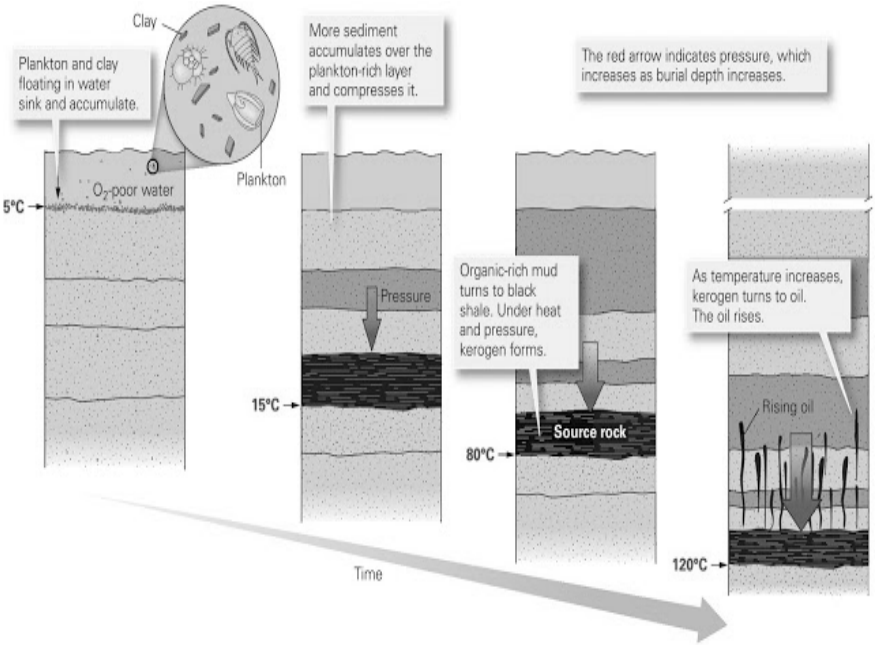



*Figure 1. The formation of oil. The process begins when organic debris settles with sediment. As burial depth increases, heat and pressure transform the sediment into black shale in which organic matter becomes kerogen. At appropriate temperatures, kerogen becomes oil, which then seeps upward.*

**2. Make up 10 questions to the text and ask your partner to answer them.**

## UNIT 2. HYDROCARBONS

### Text 1

### WHAT ARE OIL AND GAS?

**Read the text and insert the missing words from the box into the gaps.**

| | |
|---|---|
| evaporate<br>fossil fuel | natural gas<br>organic chemical |

| | |
|---|---|
| hydrocarbons | short chain |
| liquid form | the size |
| molecules | the viscosity |

For reasons of economics and convenience, industrialized societies today rely primarily on oil (petroleum) and natural gas for their energy needs. Oil and natural gas, both (**a**) **…** , consist of hydrocarbons, chain-like or ring-like (**b**) **…** made of carbon and hydrogen atoms. Chemists consider hydrocarbons to be a type of (**c**) **…** .

Some (**d**) **…** are gaseous and invisible, some resemble a watery liquid, some appear syrupy, and some are solid. (**e**) **…** (ability to flow) and the volatility (ability to evaporate) of a hydrocarbon product depend on (**f**) **…** of its molecules. Hydrocarbon products composed of (**g**) **…** of molecules tend to be less viscous (meaning they can flow more easily) and more volatile (meaning they (**h**) **…** more easily) than products composed of long chains, because the long chains tend to tangle up with each other. Thus, short-chain molecules occur in gaseous form ( **(j) …**) at room temperature, moderate-length-chain molecules occur in (**k**) **…** (gasoline and oil), and long-chain molecules occur in solid form (tar).

***NOTES***

**hydrocarbon** – /hʌɪdrə(ʊ)ˈkɑːb(ə)n/ углеводород
**viscosity** – /vɪˈskɒsɪti/ вязкость
**volatility** – /ˌvɒləˈtɪlɪti/ летучесть

## Text 2

## HYDROCARBON SYSTEM

**Read the text and translate it into Russian.**

Oil and gas do not occur in all rocks at all locations. That's why the goal of controlling oil fields, regions that contain significant amounts of accessible oil underground, has sparked bitter wars. A known supply of oil and gas held underground is a hydrocarbon reserve; if the reserve consists dominantly of oil, it is usually called an oil reserve and if it consists dominantly of gas, it's a gas reserve. The development of a reserve requires a specific association of materials, conditions, and time. Geologists refer to this association as a hydrocarbon system. We'll now

look at the components of a hydrocarbon system, namely the source rock, the thermal conditions of oil formation, the migratory pathway, and the trap.

## Text 3

## CRUDE OIL

**1. Read the text and insert missing phrases from the box into the gaps:**

| |
|---|
| **1.** making the two countries' reserves equal to about twice the known reserves of conventional oil<br>**2.** Certain regions will act as a sample of a broader region<br>**3.** can differ greatly in its composition<br>**4.** one-sixth are aromatics, and the rest are asphaltics<br>**5.** Light oils are more valuable<br>**6.** containing mostly complex hydrocarbons<br>**7.** it actually makes up a minority of crude oil currently in reserve<br>**8.** if the level of hydrocarbons relative to organics and metals is low, making its density as high |

Crude oil is a liquid found naturally in rock, (**a**) **… ,** with some additional organic material. It is the major fuel used on the planet, and is used in the production of many synthetic materials like plastics as well.

This oil can come in many different weights and colors, and (**b**) **…** . As little as half of the composition of heavy oils can be made up of hydrocarbons, while the lightest oils can be up to 97% hydrocarbons. There are four main hydrocarbons found in crude oil, in varying amounts depending on the oil. Around half of the hydrocarbons in most unrefined oil are naphthenes, one-third are paraffins, (**c**) **…** . The color can range from pure black or dark brown to greenish or yellowish, depending on the composition.

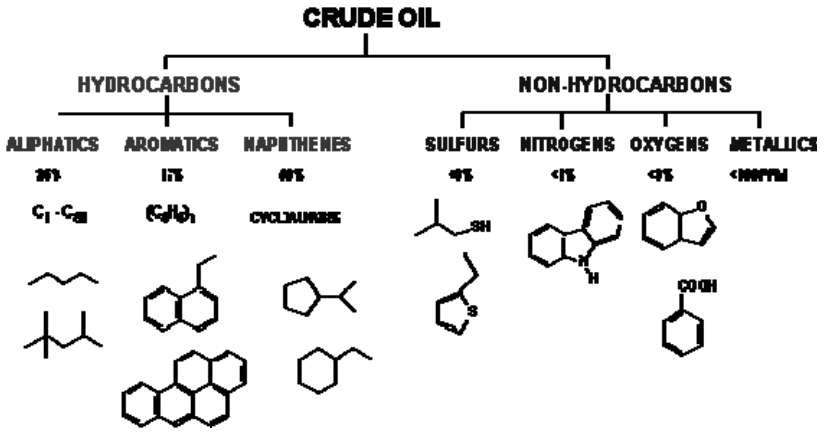



*Figure 2*

Crude oil is considered light if the level of hydrocarbons relative to organics and metals is high, making its density low, and it is considered heavy (**d**) **…** . Additionally, unrefined oil is classified as sweet if it has very little sulfur in it, and is classified as sour if it has a great deal of sulfur in it. So a crude oil will usually be called something like a sweet, light oil, or a sour, heavy oil. Sweeter oils are more valuable than sour oils, because most countries have sulfur regulations for environmental reasons, and sweet oils require less treatment to remove the sulfur. It actually makes up a minority of crude oil currently in reserve than heavy oils, because more gasoline can be created from a smaller amount. Different regions on earth tend to have different types of oil, so unrefined oil is often classified based on where it comes from. (**e**) **…** , since they are seen as relatively representative of that broad region. For example, Dubai-Oman oil is a sour crude oil, and is used to benchmark most sour crude from the Middle East; West Texas Intermediate is a sweet, light oil; and the OPEC Reference Basket is a composite oil sample that averages oils from all over the Organization of the Petroleum Exporting Countries.

While conventional unrefined oil is currently the major source of petroleum on the planet, (**f**) **...** . A bit less than one-third of the unrefined oil known on the planet is in conventional form. Another one-sixth is a heavy oil, and a quarter is extra-heavy oil. Another one-third, roughly equal to the amount of conventional oil, is in the form of oil sands, or

crude bitumen. This is not a liquid form of crude oil, but is mixed with sand into a somewhat solid form. Huge reserves of bitumen can be found in Venezuela and Canada, which also contain large amount of extra-heavy oil, (**g**) **…** .

**2. Match the words from texts with their definitions.**

| | |
|---|---|
| **1.** hydrocarbon | **a)** liquid substance at the bottom of a river, lake, or the sea |
| **2.** ooze | **b)** a rock made from sediments derived from other rock and organic matter that are compacted or cemented together |
| **3.** source rock | **c)** a naturally occurring, yellowish-black liquid found in geological formations beneath the Earth's surface |
| **4.** organic shale | **d)** a scientific term that describes the resistance to flow of a fluid |
| **5.** petroleum | **e)** a storage space for fluids. These fluids may be water, hydrocarbons or gas |
| **6.** viscosity | **f)** an organic compound consisting entirely of hydrogen and carbon |
| **7.** reservoir | **g)** a liquid found naturally in rock, containing mostly complex hydrocarbons, with some additional organic material |
| **8.** crude oil | **h)** a rock that is capable of generating or that has generated movable quantities of hydrocarbons |

## UNIT 3. HYDROCARBON MIGRATION AND ACCUMULATION

### Text 1

### MIGRATION

**1. Read the passage and answer the following questions:**

a) What does petroleum migration mean?
b) What types of migration were mentioned?

Migration of hydrocarbons is a little-understood but critical process of the petroleum system. The short definition is: Movement of petroleum from source rock toward a reservoir or seep. Primary migration is expulsion of petroleum from fine-grained source rock, while secondary migration moves petroleum through a coarse-grained carrier bed or fault to a reservoir or seep. Tertiary migration occurs when petroleum moves from one trap to another or to a seep.

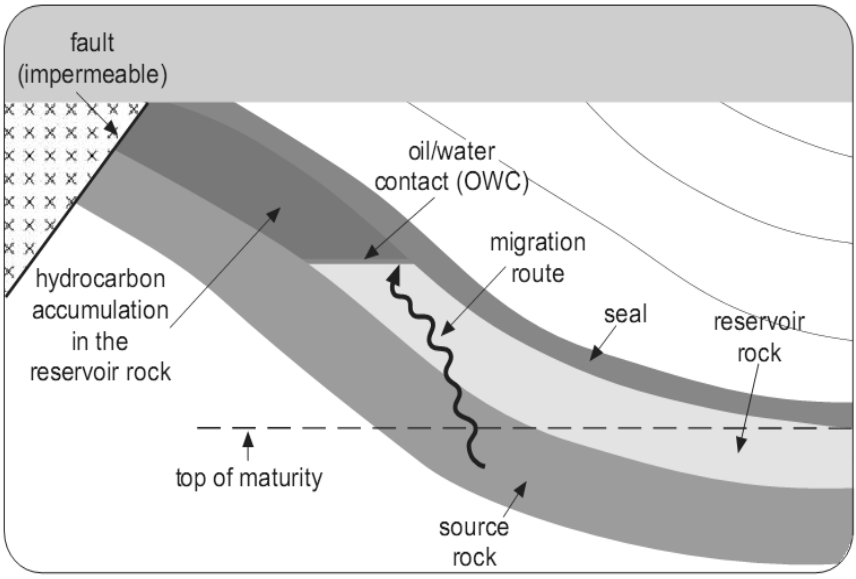



*Figure 3*

**2. The following questions are vital for understanding the complications of the process, read the next passage, translate it into Russian and answer the questions.**

**1.** How does oil escape from the source rock?
**2.** Does oil migrate out of the trap?
**3.** Why do you think there are marked differences in oil gravity, wax content, and sulfur content in lateral and stratigraphically successive sands?
**4.** Why are there differences in water salinity for multiple sands in one structural trap?
**5.** What is the role of faults in transporting and trapping hydrocarbons?

**6.** Why are there barren sands within sequences of productive sands?
**7.** How is cross-formational flow of hydrocarbons accomplished?
**8.** Does the form change during migration and, if so, which form is dominant under what conditions?
**9.** How can we estimate the timing, volumes, and compositions of transported hydrocarbons?

Hydrocarbons migrate as a separate phase, primarily due to buoyancy. This force causes them to move vertically at geologically rapid rates. Lithologic layers slow or restrict the vertical movement of hydrocarbons. Seals deflect the hydrocarbons laterally up dip through underlying beds to a trap or spill point. Lateral migration is also facilitated by meteoric groundwater flow. Flow rates for compaction-driven water generally are too slow to significantly affect hydrocarbon flow.

The properties of reservoirs and carrier beds (dip, relative permeability, etc.) control the rate of migration and thus the specific direction of the bulk of hydrocarbons under seals.

Less is known about migration than any other process involved in the accumulation of hydrocarbons in the subsurface. It is generally described as that unknown process or group of processes that enable petroleum to move from a source to a reservoir.

Hydrocarbon migration has been observed only rarely and indirectly in the natural environment under atypical conditions. Observation is difficult because it occurs either too rapidly, too slowly, or elsewhere. As such, migration is generally inferred rather than demonstrated. Conclusions about migration are based on snapshots in reservoir and source-rock systems. Laboratory migration experiments are limited in their applications by the time frame and the ability to reproduce subsurface conditions.

The movement of hydrocarbons through an entire stratigraphic section is generally ignored. Geochemists usually focus on migration out of source rocks, and reservoir engineers usually study migration within carrier beds (reservoir-quality rocks). Little is known, though much is inferred, about cross-facies flow required when source rocks and reservoir-quality rocks are not adjacent to one another.

Physical conditions constraining migration through stratigraphic sections are pressure, temperature, permeability, capillarity, surface tension, molecular size, and density. The main chemical constraint is solubility of migrating hydrocarbons. Detailed chemical correlations made of reservoired hydrocarbons with source rocks strongly indicate that the migration process does not significantly affect the overall geochemistry of the migrated hydrocarbons. However, general differences exist between the chemical composition of oils and the source rocks to which they are chemically correlated. These differences must be explained.

Materials trapped in diagenetic overgrowths offer snapshots of the migration process. Studies of these materials by microanalytical techniques such as fluid inclusion analysis, microfluorescence, and cathodoluminescence offer potential for great advances in our understanding of the migration process and our ability to recognize and perhaps predict migration pathways and timing.

Hydrocarbon migration consists of four stages: primary, secondary, tertiary, and remigration.

**Primary Migration** — The process of loss of hydrocarbons from the source rock.

**Secondary Migration** — Migration from source to reservoir along a simple or complex carrier system. Includes migration within the reservoir rock itself.

**Tertiary Migration** — Migration to the surface, either from a reservoir or source rock. Also called dismigration.

**Remigration** — Migration from one reservoir position through an intervening section into another reservoir position in the same or a different reservoir.

## Text 2

## ACCUMULATION

**Read the passage and make its written translation.**

Petroleum accumulates and is stratified according to its fluid phases and the amounts of formation water. Gas is lightest and accumulates above oil, which overlies water. The quality of gas dissolved in oil depends on pressure, temperature, and hydrocarbon characteristics.

Petroleum accumulates in the highest permeable portions of the reservoir because of hydrodynamics, this is why the highest area of an anticline is usually the best place to drill an exploratory well. Petroleum accumulations probably require long period of time to form, particularly in reservoirs of low permeability. Mobility of fluids within a reservoir is enhanced by increasing permeability.

## UNIT 4. TYPES OF PETROLEUM RESERVOIRS

### TEXT 1

**Read the text and insert missing phrases from the box into the gaps:**

| |
|---|
| **1**. in shale as well as sandstone |
| **2**. The size of the balls in either case |
| **3.** to decrease in the deeper and older layers |
| **4.** the pore spaces and would represent a porosity of 47,6% |
| **5**. the ability of the fluid to flow through the rock to the well |
| **6.** always expressed in percentage |

In order to evaluate the potential of the reservoir, the petroleum geologist must have the following data: 1) the capacity of the rock to contain fluid, 2) the relative amount of fluid present, and 3) (**a**) **…** . This last is determined by two factors, porosity and permeability.

Porosity is the capacity of the rock to hold fluids. Or, it is the volume of the non-solid or fluid portion of the reservoir divided by the total volume. Thus porosity is (**b**) **…** . To visualize the concept of porosity, imagine a box full of balls of equal size stacked on the top of each other so that only the most outward points of each ball touch the ones above, below, and to the sides. The spaces in between the balls would be (**c**) **…** , the highest that can be expected.

If the same balls were arranged into layers so that the upper layers nested into the ones below, the porosity would be reduced to 25.9%. (**d**) **…** . would make no difference as long as they were all the same size. Since in reservoirs the rocks are never all the same size, nor stacked in neat columns, actual porosity may range from 3% to 40% (very rare) with a usual porosity in the area of 20%.

Porosity as high as 20% usually occurs only in the "younger" layers near the surface, as porosity tends (**e**) **…** . This decrease is caused by the weight of the succeeding layers, the effect of time on the rock, and by particles becoming cemented together. This pattern of depth affecting porosity is apparent (**f**) **…** , although porosity is generally lower in shale since it is more compacted, and old shales at great depth have been compressed much more than sandstone at a similar level.

## TEXT 2

## GEOLOGIC CLASSIFICATION OF PETROLEUM RESERVOIR

**1. Read the words and find their Russian equivalents:**

dome shaped reservoir
anticline
faulting
impermeable layer
cutoff surfaces
lense-type reservoir

**2. Read about types of petroleum reservoirs and discuss the differences among them. Translate the text into Russian.**

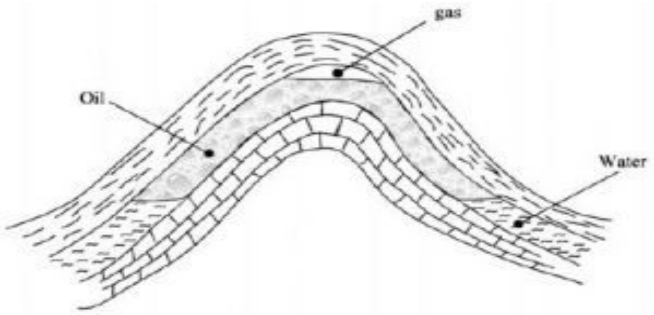
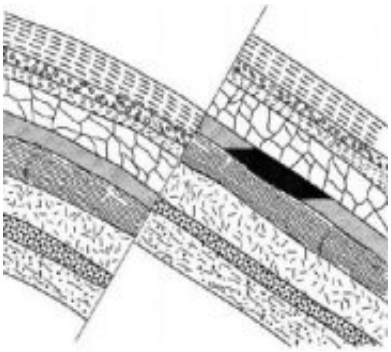



*Figure 4*

Petroleum reservoirs exist in many different sizes and shapes of geologic structures. It is usually convenient to classify the reservoirs according to the conditions of their formation as follows:

**1. Dome-Shaped and Anticline Reservoirs:** these reservoirs are formed by the folding of the rock layers as shown in **Figure 4**. The dome is



circular in outline, and the anticline is long and narrow. Oil and/or gas moved or migrated upward through the porous strata where it was trapped by the sealing cap rock and the shape of the structure.

*Figure 5*

**2. Faulted Reservoirs:** These reservoirs are formed by shearing and offsetting of the strata (faulting), as shown in **Figure 5**. The movement of the nonporous rock opposite the porous formation containing the oil/gas creates the sealing. The tilt of the petroleum-bearing rock and the faulting trap the oil/gas in the reservoir.

**3. Salt-Dome Reservoirs:** This type of reservoir structure, which takes the shape of a dome, was formed due to the upward movement of large, impermeable salt dome that deformed and lifted the overlying layers of rock. As shown in **Figure 6**, petroleum is trapped between the cap rock and an underlying impermeable rock layer, or between two impermeable layers of rock and the salt dome.

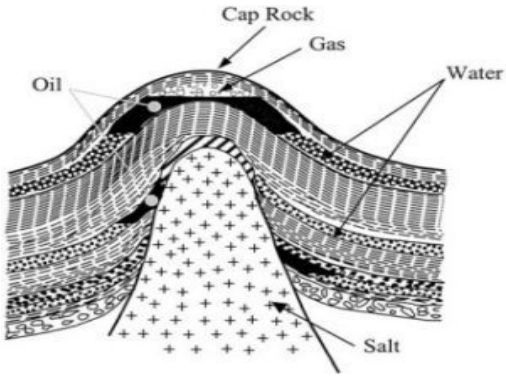



*Figure 6*

**4. Unconformities:** This type of reservoir structure, shown in **Figure 7**, was formed as a result of an unconformity where the impermeable cap rock was laid down across the cutoff surfaces of the lower beds.

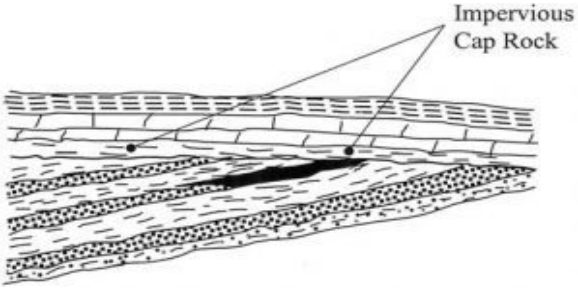



*Figure 7*

**5. Lense-Type Reservoirs:** in this type of reservoir, the petroleum bearing porous formation is sealed by the surrounding, nonporous formation. Irregular deposition of sediments and shale at the time the formation was laid down is the probable cause for this abrupt change in formation porosity.

**6. Combination Reservoirs:** in this case, combinations of folding, faulting, abrupt changes in porosity, or other conditions that create the trap, from this common type of reservoir.

**2. Match the words from column A to the words from column B to form word combinations.**

| A | B |
|---|---|
| common | trap |
| petroleum | rock |
| cap | reservoir |
| geologic | type |
| porous | surface |
| faulting | structure |
| abrupt | strata |
| impermeable | change |
| cutoff | deposition |
| irregular | layer |

## TEXT 3

## RESERVOIR DRIVE MECHANISMS

1. **Read the passage and translate it into Russian.**

At the time oil was forming and accumulating in the reservoir, the pressure energy of the associated gas and water was also stored. When a well is drilled through the reservoir and the pressure in the well is made to be lower than the pressure in the oil formation, it is that energy of the gas, or the water, or both that would displace the oil from the formation into the well and lift it up to the surface. Therefore, another way of classifying petroleum reservoirs, which is of interest to reservoir and production engineers, is to characterize the reservoir according to the production (drive) mechanism responsible for displacing the oil from the formation into the wellbore and up to the surface. There are three main drive mechanisms.

**2. Work in three groups. Each group should read and translate one chosen part of the text and retell it to the rest of the class.**

**Group 1**

### Solution-Gas-Drive Reservoirs

Depending on the reservoir pressure and temperature, the oil in the reservoir would have varying amounts of gas dissolved within the oil (solution gas). Solution gas would evolve out of the oil only if the pressure is lowered below a certain value, known as the bubble point pressure, which is a property of the oil. When a well is drilled through the reservoir and the pressure conditions are controlled to create a pressure that is lower than the bubble point pressure, the liberated gas expands and drives the oil out of the formation and assists in lifting it to the surface. Reservoirs with the energy of the escaping and expanding dissolved gas as the only source of energy are called solution-gas-drive reservoirs. This drive mechanism is the least effective of all drive mechanisms; it generally yields recoveries between 15% and 25% of the oil in the reservoir.

**Group 2**

## Gas-Cap-Drive Reservoirs

Many reservoirs have free gas existing as a gas cap above the oil. The formation of this gas cap was due to the presence of a larger amount of gas than could be dissolved in the oil at the pressure and temperature of the reservoir. The excess gas is segregated by gravity to occupy the top portion of the reservoir. In such reservoirs, the oil is produced by the expansion of the gas in the gas cap, which pushes the oil downward and fills the pore spaces formerly occupied by the produced oil. In most cases, however, solution gas is also contributing to the drive of the oil out of the formation. Under favorable conditions, some of the solution gas may move upward into the gas cap and, thus, enlarge the gas cap and conserves its energy. Reservoirs produced by the expansion of the gas cap are known as Gas-cap-drive reservoirs. This drive is more efficient than the solution-gas drive and could yield recoveries between 25% and 50% of the original oil in the reservoir.

**Group 3**

## Water-Drive Reservoirs

Many other reservoirs exist as huge, continuous, porous formations with the oil/gas occupying only a small portion of the formation. In such cases, the vast formation below the oil/gas is saturated with salt water at very high pressure. When oil/gas is produced, by lowering the pressure in the well opposite the petroleum formation, the salt water expands and moves upward, pushing the oil/gas out of the formation and occupying the pore spaces vacated by the produced oil/gas. The movement of the water to displace the oil/gas retards the decline in oil, or gas pressure, and conserves the expansive energy of the hydrocarbons. Reservoirs produced by the expansion and movement of the salt water below the oil/gas are known as water-drive reservoirs. This is the most efficient drive mechanism; it could yield recoveries up to 50% of the original oil.

*NOTES*

**reservoir drive mechanism** – механизм, вызывающий истечение нефти из пласта

**solution gas** – растворенный в нефти газ

**bubble point pressure** – давление насыщения пластового флюида

**liberated gas** – десорбированный газ, свободный газ

**gas cap drive** – режим газовой шапки

**water drive** – водонапорный режим

**solution gas drive reservoir** – коллектор нефти с режимом растворенного газа

## UNIT 5. CLASSIFICATION OF PETROLEUM

### TEXT 1

**1. Read the passage and answer the questions.**

a) What does the price of specific barrel of crude oil depend on?
b) What is the difference between "heavy" and "light" oil? Between "sweet" and "sour"?
c) How does the length of hydrocarbons influence on its property?

For several decades now the crude oil or petroleum industry has classified the raw crude by the location from which it was extracted. In other words, oil is classified by geographic region. However, all oils from a particular region are not created equal. Further classification of petroleum, derived from the density of the raw petroleum (API gravity) and its various non-hydrocarbon components (especially sulfur), is then added to the geographic designation. The end result of all this classification helps determine the price of a specific barrel of crude as well as how much demand there is for that particular oil.

In general, if the crude oil contains high levels of sulphur the petroleum classification is termed "sour", if it has relatively low levels of sulphur the petroleum classification is termed "sweet". If the raw petroleum is of a high density then the petroleum classification is termed "heavy" and if it is of a low density the petroleum classification is termed "light". Density of oil is determined by the length of the hydrocarbons it contains. If it contains a great deal of long-chain hydrocarbons, the

petroleum will be denser. If it contains a greater proportion of short-chain hydrocarbons it will be less dense. Besides chain length, the ratio of carbon to hydrogen also helps to determine the density of a particular hydrocarbon. The greater the amount of hydrogen in relation to carbon, the lighter the hydrocarbon will be. Less dense oil will float on top of denser oil and is generally easier to pump.

***NOTES***
**API gravity** – плотность сырой нефти в градусах АНИ (Американского нефтяного института)

**2. Retell the text.**

**TEXT 2**

**Read the text and translate it into Russian.**

The hydrocarbons in crude oil can generally be divided into four categories:
**Paraffins**: These can make up 15 to 60% of crude and have a carbon to hydrogen ratio of 1:2, which means they contain twice the amount of hydrogen as they do carbon. These are generally straight or branched chains, but never cyclic (circular) compounds. Paraffins are the desired content in crude and what are used to make fuels. The shorter the paraffins are, the lighter the crude is.
**Napthenes**: These can make up 30 to 60% of crude and have a carbon to hydrogen ratio of 1:2. These are cyclic compounds and can be thought of as cycloparaffins. They are higher in density than equivalent paraffins and are more viscous.
**Aromatics**: These can constitute anywhere from 3 to 30% of crude. They are undesirable because burning them results in soot. They have a much less hydrogen in comparison to carbon than is found in paraffins. They are also more viscous. They are often solid or semi-solid when an equivalent paraffin would be a viscous liquid under the same conditions.
**Asphaltics**: These average about 6% in most crude. They have a carbon to hydrogen ratio of approximately 1:1, making them very dense. They are generally undesirable in crude, but their 'stickiness' makes them excellent for use in road construction.

## TEXT 3

**Read the text and insert missing phrases from the box into the gaps:**

| |
|---|
| **1**. to transport<br>**2**. lighter crude commands<br>**3.** sweet petroleum<br>**4.** gasoline and diesel<br>**5**. the petroleum classification<br>**6.** field of petroleum<br>**7.** the form of harmful emissions |

When considering **(a) …** it is important to consider the fact that the overall classification will have an effect on the value, not just the physical properties. For example, petroleum with a geographical classification from one region of the world may be expensive **(b) …** to another region of the world regardless of the suitability of the raw petroleum as an overall substance. In general, **(c) …** a higher price because it contains more hydrocarbon chains that can be easily refined to make **(d) …** , which are in high demand. The lower the sulphur content, the higher the price as well because low-sufur, sweet crude requires less refining.

Classification of petroleum also indicates the best use for a particular **(e) …** . One oil type is not necessarily "better" than another, but rather the different types are useful in different applications. Light crude oil is preferable for refining into gasoline as it produces a far higher yield than heavy. In a similar fashion, **(f) …** is often more desirable than sour petroleum as its use will cause far less impact on the environment in **(g) …** as it is burned. These basic classifications of petroleum are further enhanced by a full molecular description gained through a crude oil assay analysis.

# UNIT 6. PETROLEUM RESERVOIRS CLASSIFICATION

## TEXT 1

**1. Read the text and draw a diagram to illustrate the petroleum reservoirs classification.**

Estimates of **undiscovered resources** are arrived at by means of geological, geophysical, and geochemical data. Based on compilation of these data into geological models and maps, hydrocarbon plays are defined. Discovery of petroleum accumulations in such plays is contingent upon that a set of geological factors is in place simultaneously. Undiscovered petroleum resources can be subdivided into two categories: speculative resources and hypothetical resources. Speculative resource is referred to the unmapped prospects that have not yet been mapped in the basin. **The unmapped resources** are estimated by play assessment methods. The total resources of such plays comprise both discovered and undiscovered resources. The unmapped resources are the difference between the plays' total resources and the discovered and mapped resources. In general, most organizations carry out play assessments only on the undiscovered resources. A statistical aggregation of all play assessments will give the estimate of the total undiscovered resources.

**Hypothetical resources** comprise resources which are mapped in the form of prospects, but which have not yet been discovered by drilling. It is uncertain if the estimated resources are actually in place. Prospects may be identified in undrilled frontier provinces as well as in reservoirs underlying or adjacent to producing fields. The resource estimates are given a probability of discovery. The estimates of the total hypothetical resources are given by statistic aggregation of the risk-weighted resource estimate of each prospect in a play or a basin.

The **discovered petroleum resources** can be sub-divided into potential resources and reserves. **Potential resources** is defined as the discovered resources that are recoverable but not economically producible at a specific date due to economic, political, environmental or technological reasons. Potential Resources include all volumes of known hydrocarbons that lack the technology to be produced or are economically unacceptable in today's environment. While these volumes do not meet the requirements to be classified as reserves, they are a potential resource to the country where they exist. **Reserves** are those quantities of petroleum, which are anticipated to be commercially recovered from known accumulations from a given date forward. All reserve estimates involve some degree of uncertainty. The uncertainty depends chiefly on the amount of reliable geologic and engineering data

available at the time of the estimate and the interpretation of these data. The relative degree of uncertainty may be conveyed by placing reserves into one of two principal classifications, either proved or unproved.

**Proved reserves** are those quantities of petroleum which, by analysis of geological and engineering data, can be estimated with reasonable certainty to be commercially recoverable, from a given date forward, from known reservoirs and under current economic conditions, operating methods, and government regulations. Proved reserves can be categorized as developed or undeveloped. If deterministic methods are used, the term reasonable certainty is intended to express a high degree of confidence that the quantities will be recovered. If probabilistic methods are used, there should be at least a 90% probability that the quantities actually recovered will equal or exceed the estimate. Establishment of current economic conditions should include relevant historical petroleum prices and associated costs and may involve an averaging period that is consistent with the purpose of the reserve estimate, appropriate contract obligations, corporate procedures, and government regulations involved in reporting these reserves.

**Unproved reserves** are based on geologic and/or engineering data similar to that used in estimates of proved reserves; but technical, contractual, economic, or regulatory uncertainties preclude such reserves being classified as proved. Unproved reserves may be further classified as probable reserves and possible reserves. Unproved reserves may be estimated assuming future economic conditions different from those prevailing at the time of the estimate. The effect of possible future improvements in economic conditions and technological developments can be expressed by allocating appropriate quantities of reserves to the probable and possible classifications.

**Probable reserves** are those unproved reserves which analysis of geological and engineering data suggests are more likely than not to be recoverable. In this context, when probabilistic methods are used, there should be at least a 50% probability that the quantities actually recovered will equal or exceed the sum of estimated proved plus probable reserves. Possible reserves are those unproved reserves which analysis of geological and engineering data suggests are less likely to be recoverable than probable reserves. In this context, when probabilistic

methods are used, there should be at least a 10% probability that the quantities actually recovered will equal or exceed the sum of estimated proved plus probable plus possible reserves.

**2. Explain the difference between discovered and undiscovered reserves; between prove and unproved reserves; between probable and potential reserves.**

**3. Read definitions of some terms, translate them into Russian and learn new terms:**

**Free and associated gas**: There are several definitions of free and associated gas in the oil industry. Some organizations and companies define associated gas only as dissolved gas, which means that gas cap is regarded as free gas.

**A prospect**: is a mappable, possible petroleum accumulation that is relying on a reservoir entrapped by sealing rocks and charged with hydrocarbons. The prospect is called a lead if it is a very low probability of existence of one of the three factors.

**A play**: is a geographically and stratigraphically delimited area where a set of specific geological factors is in place simultaneously, thus making it possible to discover petroleum in producible quantities. Such geological factors are reservoir rocks, traps, mature source rocks and migration paths, plus the condition that the traps were formed before the migration of petroleum came to an end. All fields, discoveries and prospects within the same play are characterized by the play's specific set of geological factors and can therefore be distinguished from fields, discoveries and prospects of other plays.

**Confirmed plays**: contain a minimum of one discovery of producible quantities of petroleum. It is thus confirmed that the critical factors are in place simultaneously for these plays.

**Unconfirmed plays**: contain no discovered petroleum for the time being. This may be a result of having drilled only dry wells in the play, or of not having started exploration activities.

**A petroleum deposit**: is defined as an accumulation of petroleum in a geological unit limited by the rock characteristics by structural or stratigraphic boundaries, contact surface between petroleum and water in

the formation, or a combination of these. All the petroleum comprised is in pressure communication through liquids or gas.

**A discovery**: is a petroleum deposit or several petroleum deposits combined (i.e. they have been discovered in the same exploration well) in which the existence of mobile petroleum has been made probable through testing, sampling or logging.

## БИБЛИОГРАФИЧЕСКИЙ СПИСОК

1. Petroleum systems and petroleum elements of geology [Электронный ресурс]. Режим доступа: https://connect.spe.org/blogs/donatien-ishimwe/2014/09/05/petroleum-systems-and-elements-of-petroleum-geology
2. Petroleum source rocks [Электронный ресурс]. Режим доступа: https://www.intechopen.com/books/recent-insights-in-petroleum-science-and-engineering/petroleum-source-rocks-characterization-and-hydrocarbon-generation
3. Hydrocarbon system [Электронный ресурс]. Режим доступа: https://www.coursera.org/lecture/oilandgas/the-hydrocarbon-system-QFkkS
4. Reservoir drive mechanism [Электронный ресурс]. Режим доступа: https://wiki.aapg.org/Reservoir_drive_mechanisms5. Stepper motor driving. [Электронный ресурс]. Режим доступа: http://users.ece.utexas.edu/~valvano/Datasheets/Stepper_ST.pdf
5. Society Petroleum Engeenires [Электронный ресурс]. Режим доступа: https://www.spe.org/industry/petroleum-reserves-definitions.php

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# ИНОСТРАННЫЙ ЯЗЫК

## АНГЛИЙСКИЙ ЯЗЫК ДЛЯ БУДУЩИХ СПЕЦИАЛИСТОВ В ОБЛАСТИ ГЕОЛОГИИ НЕФТИ И ГАЗА

***Методические указания к практическим занятиям для студентов специальности 21.05.02***

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# ENGLISH AS A SECOND LANGUAGE

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