ИНОСТРАННЫЙ ЯЗЫК

ТЕХНОЛОГИЯ ПРОИЗВОДСТВА РАБОТ ПО ОБОГАЩЕНИЮ ПОЛЕЗНЫХ ИСКОПАЕМЫХ

Методические указания к практическим занятиям для студентов специальности 21.05.04

FOREIGN LANGUAGE

TECHNOLOGIES FOR MINERAL PROCESSING

САНКТ-ПЕТЕРБУРГ
2019

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Кафедра иностранных языков

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ИНОСТРАННЫЙ ЯЗЫК. Технология производства работ по обогащению полезных ископаемых: Методические указания к практическим занятиям / Санкт-Петербургский горный университет. Сост.: *И.С. Облова, О.А. Кочергина.* СПб, 2019. 50 с.

Методические указания предназначены для практических занятий со студентами специальности 21.05.04 «Горное дело» (специализация «Обогащение полезных ископаемых») и согласованы с программой по иностранному языку для студентов неязыковых вузов.

Изучение предложенного материала направлено на совершенствование навыков просмотрового и коммуникативного чтения.

Научный редактор доц. *Ю.В. Крючкова*

Рецензент канд. фил. наук *А.И. Архангельская* (Санкт-Петербургский государственный университет)

ПРЕДИСЛОВИЕ

Данные методические указания предназначены для студентов специальности «Горное дело», специализация « Обогащение полезных ископаемых», изучающих английский язык.

Материалы предназначены для аудиторной работы студентов по дисциплине «Иностранный язык» и соответствуют рабочей программе по данному направлению подготовки. Целью работы является развитие навыков просмотрового и коммуникативного чтения студентов технических специальностей. Предложенные аутентичные материалы и разработанный комплекс упражнений к ним направлен на совершенствование навыков устной и письменной иноязычной речи в ситуациях профессионально-ориентированного общения. Тематика текстов затрагивает современные проблемы развития минерально-сырьевого комплекса.

В методических указаниях имеются приложения, в которых представлены основные правила употребления времен в английском языке, а также упражнения на закрепление навыков их использования, список химических элементов, алгоритм чтения формул и уравнений, а также даны рекомендации по написанию научных статей и подготовке устных научных докладов.

MODULE I. What is a mineral deposit?

Task 1. Warm-up questions:
1) What do you know about mineral deposits?
2) Do you know what methods are used to mine resources nowadays?
Task 2. Read the text paying attention to the words in bold. Find their correct pronunciation and meaning in the dictionary.

The process of finding or exploring for a mineral **deposit**, extracting or mining the resource, recovering the **resource**, also known as **beneficiation**, and reclaiming the land mined can be described as the "life cycle" of a mineral deposit. The complete process is time consuming and expensive, requiring the use of modern **technology** and **equipment**, and may take many years to complete. Sometimes one entity or company completes the entire process from **discovery** to **reclamation**, but often it requires multiple groups with specialized experience working together. Mineral deposits are the source of many important **commodities**, such as copper and gold, used by our society, but it is important to realize that mineral deposits are a **nonrenewable** resource. Once mined, they are **exhausted**, and another source must be found. New mineral deposits are being continuously created by the Earth but may take millions of years to form. Mineral deposits differ from **renewable** resources, such as agricultural and timber products, which may be replenished within a few months to several years.

The technical definition of a mineral is a naturally occurring, inorganic, **homogeneous** solid with a definite **chemical composition** and an ordered atomic arrangement. In more general terms, a mineral is a substance that is (1) made of a single element like gold (Au) or a compound of elements like salt (NaCl) and (or) (2) a building block of rock (for example, granite is composed primarily of the minerals quartz and feldspar). Minerals may be metallic, like gold, or nonmetallic, such as talc. Oil, natural gas, and coal are generally considered to be "energy minerals" and are not discussed in this report. Additional mineral resource terms are:

1. **Aggregate**—a rock or mineral material used separately and as filler in cement, asphalt, plaster, and other materials.

2. **Alloy**—a substance having metallic properties and composed of two or more chemical elements, of which at least one is a metal.

3. **Element**—a substance whose atoms have the same atomic number.

4. **Metal**—a class of chemical elements, such as iron, gold, and aluminum, that have a characteristic luster, are good conductors of heat and electricity, and are opaque, fusible, and generally malleable and ductile.

5. **Ore**—the naturally occurring material from which a mineral or minerals of economic value can be extracted.

6. **Rock**—a naturally formed material composed of a mineral or minerals; any hard consolidated material derived from the Earth. Minerals occur in a range of concentrations, not all of which have economic significance:

• A mineral **occurrence** is a concentration of a mineral (usually considered in terms of some commodity, such as copper, barite, or gold) that is considered valuable by someone somewhere or that is of scientific or technical interest.

• A mineral deposit is a mineral occurrence of sufficient size and grade (concentration) to enable **extraction** under the most favorable conditions.

• An ore deposit is a mineral deposit that has been tested and is known to be of sufficient size, grade, and **accessibility** to be mined at a profit. Testing commonly consists of surface mapping and sampling, as well as drilling through the deposit.

Task 3. Match the following words and their definitions.

A. mineral	1. a group of hard rock-forming minerals consisting of aluminium silicates of potassium, sodium, calcium or barium: the principal constituents of igneous rocks. The group includes orthoclase,

	microcline, and the plagioclase minerals.
B. crystal	2. a group of minerals containing silicon and oxygen linked in tetrahedral units, with four oxygen atoms to one silicon atom.
C. gemstone	3. slices of rock that have been fixed to a glass slide with adhesive and carefully ground to 0.030 mm, a thickness at which most rocks are nearly transparent. Such sections are particularly useful for studying mineral textures and intergrowths, as well as for classifying rock types.
D. crystal structure	4. a chemical bond formed when electrons are shared between two atoms. Usually each atom contributes one electron to form a pair of electrons that are shared by both atoms.
E. hardness	5. a form of personal adornment, manifesting itself as necklaces, rings, brooches, earrings and bracelets. It may be made from any material, usually gemstones, precious metals or shells.
F. feldspar	6. a grouping of crystal structure that are categorized according to the axial system used to describe their atomic lattice structure. A crystal's lattice is a three dimensional network of atoms that are arranged in a symmetrical pattern.
G. jewelry	7. the tendency of crystalline materials to split along define

	crystallographic structural planes. These planes of relative weakness are a result of the regular locations of atoms and ions in the crystal, which create visible smooth repeating surfaces.
H. silicate minerals	8. a naturally occurring solid chemical substance formed through geological processes and having a characteristic chemical composition, a highly ordered atomic structure, and specific physical properties.
I. metallic bond	9. a natural inorganic solid with a specific internal structure and a chemical composition that varies only within specific limits. A unique arrangement of atoms or molecules in a crystalline liquid or solid.
J. crystal system	10. the type of chemical bond that is present in all metals, and may be thought of as resulting from the sea of valence electrons which are free to move throughout the metal lattice.
K. thin section	11. a homogenous solid made up of an element, chemical compound or isomorphous mixture throughout which the atoms or molecules are arranged in a regularly repeating pattern.
L. covalent bond	12. the resistance of a mineral to scratching, one of properties by which minerals may be described.
M. cleavage	13. a mineral or petrified material that when cut and polished can be used in jewelry.

Task 4. Now cover the right column with a piece of paper and try to remember as many definitions related to the terms in the left column as you can.

Task 5. Decide if the sentences are true or false. Correct the false ones.

1. An alloy is a mixture of metals.
2. A metal is a material (an element, compound, or alloy) that is typically hard, opaque, shiny, and has good electrical and thermal conductivity.
3. A mineral is a naturally occurring chemical compound, usually of crystalline form and abiogenic in origin.
4. Both a mineral and a rock have one specific chemical composition.
5. The process of finding or exploring for a mineral deposit is beneficiation.

MODULE II. Where and how do mineral deposits occur?

Text A. The Rock Cycle and Plate Tectonics

Task 1. Warm-up questions:

1) Mineral deposits are produced at the Earth's active centers. Will plate tectonics become a divining rod?

2) Do you know what processes determine the mineralization?

Task 2. Read the text and take a note of the parameters of plate tectonics.

Two cycles determine how mineral deposits are formed— the rock cycle and the tectonic cycle. Heat from the Earth's interior melts some of the rocks in the crust (the upper part of the lithosphere). Molten rocks lower in density than the surrounding cooler material rise toward the Earth's surface and eventually cool and harden near to or on the surface. The composition, temperature, pressure, and cooling process of the molten material determine the minerals and rock types formed. These are called igneous rocks and contain original or primary minerals. When these rocks are subjected to chemical and physical processes, such as freezing and thawing, they break apart into smaller fragments forming sediments. These smaller particles that compose the sediments can be physically transported and redeposited by gravity, water, and wind. If the redeposited particles are bound together by compaction or cementation (formation of new secondary minerals in the spaces between the loose particles), sedimentary rocks are formed. In regions where the Earth's interior temperature and pressure are high enough to change the chemical composition and mineralogy of buried igneous or sedimentary rocks, without completely melting them, metamorphic rocks are formed. Distinct groups or assemblages of minerals are typically associated with the formation of each of the three major rock types—igneous, sedimentary, and metamorphic rocks. Plate tectonics play a major role in the processes of mineral and rock formation. In geologic terms, a plate is a large, "rigid" slab of solid rock. The word tectonics comes from the Greek root "to build." The term plate tectonics refers to the process by which the Earth's crust is formed and moved. The theory of plate tectonics states that the Earth's outermost layer, the crust, is fragmented into a dozen or more plates of various sizes that are moving relative to one another as they are slowly transported on top of and by hotter, more mobile material. Scientists now have a fairly good understanding of how the plates move and how earthquake activity relates to such movement. Most movement occurs along narrow zones between plates where the effects of tectonic forces are most evident.

There are four types of plate boundaries:

• Divergent boundaries—where new crust is generated as the plates pull away from each other.

• Convergent boundaries—where crust is destroyed as one plate dives under another.

• Transform boundaries—where crust is neither produced nor destroyed as the plates slide horizontally past each other.

• Plate boundary zones—broad belts in which boundaries are not well defined and the effects of plate interaction are unclear.

Task 3. Discuss the following questions in pairs.

1. What is a rock cycle?
2. How many types of plate boundaries are known?
3. What determines the process of mineral deposit formation?

4. Why is the structure of a mineral so important?
5. What is the nature of minerals?

Task 4. Prepare a presentation about the rock cycle described in the text.
Task 5. Role play “A visit to the Mining museum”

Student A. You are a guide working in the Mining museum. You are going to take a group of the Polytechnic University students around the Mining museum and show them how a mineral is formed. Spend 5-10 minutes planning the tour. Describe the processes. Think of the possible questions you may be asked by the visitors.

Student B. You are a student of the Polytechnic University visiting the Mining museum. Make up 7-10 questions you are going to ask the guide as you walk around the museum.

Text B. Mineral Deposits

Task 1. Warm-up questions:
1) Name naturally occurring elements.
2) Which of them is present in the Earth’s crust?

Scan the article and see if your guesses were correct.

Task 2. Now read the article below and answer the following questions.
1. How many elements does the Earth’s crust contain?
2. Why cannot the mining industry use most rocks in the Earth’s crust as sources of metals or other elements?
3. When are mineral deposits formed?

The Earth’s crust contains more than 100 naturally occurring elements. The crust, which ranges from 6 to 30 miles (10 to 50 km) thick, can be subdivided into two distinctly different parts - the oceanic crust and the continental crust - which differ in composition. Some of the common elements that make up the crust are in order of abundance oxygen (O), silicon (Si), aluminum (Al), iron (Fe), calcium (Ca), sodium (Na), potassium (K), and magnesium (Mg). Although the same elements are present in both types of crusts, their concentrations are slightly different. Many useful mineral commodities in the crust are present in very low abundances. The mining industry cannot use most rocks in the Earth's crust as sources of metals or other elements because concentrations are too low to warrant extraction. Instead, the mining geologist looks for rocks where the desired mineral has been concentrated by some natural process.

Mineral deposits occur in various tectonic and geologic settings. Some mineral deposits may be formed in one place but be transported to another geographic location as a result of tectonic forces or other geologic processes. Thus, the study of tectonic processes and regional geology is important in understanding the distribution of mineral deposits.

Gold, for example, can be concentrated with other minerals in veins that form in fractures in rocks deep underground (typically, igneous rocks). Tectonic forces uplift these rocks forming mountain ranges where weathering and erosion expose the veins at the Earth's surface. Because mountain ranges are constantly worn down by erosion caused by water, ice, and wind, some of the gold veins are eventually deposited as nuggets, flakes, or flour-size material in sediments in streams and rivers.

The gold, along with other minerals like platinum and garnet, is sometimes extracted directly from gravels (sedimentary rocks) in the streambed. Mineral deposits also form when preexisting rocks are deeply buried and changed over geologic time by heat and pressure (metamorphic rocks); for example, limestone is changed by metamorphism into marble.

Task 3.

a. Here are some of the words from the text. Check you know what they mean. Try to remember the sentence in the passage in which you saw them.

like	marble	preexisting	commodities	occur	present	determine

b. In pairs, look back at the passage and check.

c. Decide what part of speech they are (noun, verb or adjective). Then, underline the verbs. Which nouns go with them? Compare with your partner.

Task 4. Give definitions to the following terms.

- the Earth's crust
- a mineral deposit
- a geologist
- a vein
- weathering

Task 5. Work in pairs to act out a dialogue between the member of the Alaska Mineral Resource Assessment Program and the person who is to assess the mineral resources of one public domain.

MODULE III. Mineral deposit models

Task 1. Warm-up questions:

1) Do you agree with the following definitions?

- A "mineral occurrence" is a concentration of a mineral (usually, but not necessarily, considered in terms of some commodity, such as copper, barite or gold) that is considered valuable by someone somewhere, or that is of scientific or technical interest. In rare instances (such as titanium in a rutile-bearing black sand), the commodity might not even be concentrated above its average crustal abundance.
- A "mineral deposit" is a mineral occurrence of sufficient size and grade that it might, under the most favorable of circumstances, be considered to have economic potential.
- An "ore deposit" is a mineral deposit that has been tested and is known to be of sufficient size, grade, and accessibility to be producible to yield a profit. (In these days of controlled economies and integrated industries, the "profit" decision may be based on considerations that extend far beyond the mine itself, in some instances relating to the overall health of a national economy.)

2) Do you know any traditional or cutting-edge techniques of mineral deposit modeling?

Task 2. Read the abstracts below and comment on the structure. Is it complete or not? What would you change?

To better understand and predict how and where mineral deposits might occur, scientists develop mineral deposit models. These models are based on existing knowledge of regional geology and the characteristics of known mineral deposits. Similar mineral deposit types can be grouped together under a particular deposit model.

Mineral deposit models can aid in identifying areas favorable for finding valuable deposits. There are hundreds of deposit models, and new models are being constructed as new types of deposits are identified.

The U.S. Geological Survey (USGS) has produced a number of publications describing various mineral deposit types. A few examples of deposit model types are (1) deposits related to mafic and ultramafic intrusions in stable environments, (2) deposits related to marine mafic extrusive rocks, (3) deposits in clastic sedimentary rocks, (4) deposits related to regionally metamorphosed rocks, and (5) deposits related to surfical processes and unconformities.

Task 3. a) Look at the way these nouns are formed.

noun	**stem**	**suffix**
prediction	predict (verb)	+ (a)tion
constructor	construct (verb)	+ (e) or
equipment	equip (verb)	+ ment

b) Using a dictionary, check that you understand the meaning of the words below and put them into the correct columns in the table. In which does the pronunciation change?
organize, disagree, prepare, construct, relate, develop, base, produce, describe

ment	**ness**	**ity**	**tion**	**or**

Task 4. Continue the following sentences using your own ideas and the information from the text.

Scientists develop ….

Mineral deposit models are based on….

Similar mineral deposit types can be grouped….

Mineral deposit models can aid in ….

A few examples of deposit model types are….

Task 5. Study the following sentences with the focus on the worlds in bold and replace them with the appropriate synonyms on the right.

1. To better understand and predict how and where mineral deposits might occur, scientists develop mineral deposit models.	A. anticipate B. forecast C. measure
2. These models are based on existing knowledge of regional geology.	A. past B. real C. actual
3. New models are being constructed as new types of deposits are identified.	A. installment B. debit C. stake
4. Similar mineral deposit types can be grouped together under a particular deposit model.	A. unrelated B. identical C. homogeneous
5. The U.S. Geological Survey (USGS) has produced a number of publications describing various mineral deposit types.	A. a few B. few C. the number

MODULE IV. How are mineral deposits found?

Task 1. Give Russian equivalents to the following words and word combinations.

distribution; favorable areas for; ground-based survey; investigations; adjoining areas; visible.

Task 2. Choose the most suitable heading from the list A-D for each paragraph of the text.

A. Satellite Imagery
B. Geophysics
C. Geochemistry
D. Geology

__________Finding a mineral deposit is the first step in the mining life cycle. Technologies used include, but are not limited to, exploration geology, geophysics, geochemistry, and satellite imagery.Geology is the study of the planet Earth—the materials of which our planet is made, the processes that act on these materials, the products formed, and the history of the planet and its life forms since its origin. Geologic investigations include reviews of the geologic literature, field surveys, and geologic mapping to determine areas favorable for mineral deposits.

__________Geophysical exploration involves searching for favorable mineral deposits using the physical properties of rocks, such as magnetic intensity and electrical conductivity. Geophysical investigations may include aeromagnetic or gravity surveys, ground-penetrating radar studies, or the use of seismic waves to show contrasting rock types. The selected rock units of interest might then be mapped and sampled to identify areas favorable for mineral deposits, and adjoining areas may also be investigated for the presence of mineral deposits.

__________Geochemistry is the study of the distribution and amounts of elements in minerals, ores, rocks, soil, water, and the atmosphere and the study of the circulation of the elements in nature on the basis of the properties of their atoms and ions. Geochemical investigations commonly include soil sampling, stream sediment sampling, and rock sampling; even plants are also sampled in some studies. Various techniques are used to examine and measure the abundance, or concentration, of elements contained in the sample. The results may be used to define favorable areas for mineralization.

_________The use of satellite imagery has become a valuable tool for exploration geologists. Geologists are now able to perform large-scale surveys of remote unexplored regions for the presence of geologic structures and key minerals that may indicate areas favorable for mineral deposits. Ground-based surveys are expensive, and one can often experience difficulty in mapping large-scale structures. However, large geological structures are often readily visible on satellite imagery. The National Aeronautics Space Administration (NASA) presents an excellent tutorial on the use of remote sensing.

Table 1. Average abundance of geochemically scarce metals from ore deposits in continental crust

Element	Average abundance in continental crust, in percent
Copper	0.0058
Gold	0.0000002
Lead	0.0010
Mercury	0.0000002
Molybdenum	0.00012
Nickel	0.0072
Silver	0.000008
Tin	0.00015
Tungsten	0.00010
Uranium	0.00016

Task 3. Complete the following sentences and translate them.
1. Finding a mineral deposit is …
2. Geology is …
3. Geophysical exploration involves …

4. Geochemistry is …
5. The use of satellite imagery has become a valuable tool for …

Task 4. Make up 5 yes-no questions and 5 questions with a question word. Discuss them with your partner.

Task 5. Discuss in groups what you have learnt about finding mineral deposits.

MODULE V. How big is the deposit and how much is it worth?

Task 1. Warm-up questions:
In pairs, think about two or three mineral deposits you know and discuss the following questions:

- What are the main functions of these deposits? (What do they do?)
- What are their different applications? (What are they used for?)

Task 2. Read the following article and find out how to determine if the mineral deposit has enough value to be mined.

The next step in the mining life-cycle is to identify and measure the known resources in order to determine if the mineral deposit has enough value to be mined. Identifying the size and grade of the deposit is accomplished by collecting drill-core samples of the ore body.

These samples are analyzed for the concentration of elements of economic value. For a metallic commodity like gold, analyses are usually reported in ounces of pure gold (Au) per ton of rock. In other words, for every ton of rock removed, one can expect to retrieve a predetermined number of ounces of the desired commodity based on the results of an average sampling over the entire ore body. This measurement is called "grade of ore."

Ore grades for metals such as iron, copper, lead, and zinc are often expressed in weight percent. A higher grade means more of the commodity per ton of rock. For a nonmetallic commodity, such as sand and gravel or limestone, the resource is identified in terms of volume (cubic yards or meters) or weight (short or metric tons). The quality of ore is based on the amount and distribution of various grain sizes, from fine sand to gravel and boulders, or for limestone, the percent of calcium.

Task 3. In pairs discuss the term *economic value*. Give some examples of economic valuable mineral deposits you are familiar with.

Task 4. Find a word in the text that has the similar meaning to the following. The first letter of each word is given to help you.

1. The objective is to determine (i_________) mineralized areas worthy of further investigation towards deposit identification.
2. It would be difficult to find buyers of low-quality (l_______) deposits.
3. The world knows that we can achieve (a__________) great things by working together.
4. The ore bed (b____) consists of primary and secondary mineralization.
5. The quality of ore depends (b______) on the amount and distribution of various grain sizes.

Task 5. Do you agree with the following statements? Give your reasons.

1. Identifying the size and grade of the deposit is never accomplished by collecting drill-core samples of the ore body.
2. The measurement called "grade of ore" means that for every ton of rock removed; one can expect to retrieve a predetermined number of ounces of the desired commodity.
3. Ore grades for metals such as iron, copper, lead, and zinc are often expressed in benefit units.
4. A higher grade means less of the commodity per ton of rock.
5. Sand, gravel and limestone are examples of metallic commodity.

MODULE VI. Examples of mining methods

Text A. Types of mining methods

Task 1. What do you know about types of mining methods? Compare your answers with your partner's one.

Task 2. Read the text and find out if you were right.

Three main types of mining methods used to recover metallic and nonmetallic minerals are

1. underground mining,
2. surface (open pit) mining,
3. placer mining.

The location and shape of the deposit, strength of the rock, ore grade, mining costs, and current market price of the commodity are some of the determining factors for selecting which mining method is used.

Higher-grade metallic ores found in veins deep under the Earth's surface can be profitably mined using underground methods, which tend to be more expensive. Large tabularshaped ore bodies, having long vertical or horizontal dimensions, or ore bodies lying more than 1,000 feet (300 m) below the surface are generally mined using underground methods as well.

The underground mining method is accomplished by drilling and blasting rock, in order to access and separate ore from the surrounding waste rock.

The blasted material is called muck. The muck is moved to the surface by truck, belt conveyor, or elevator. Once at the surface, the material is sent to a mill. Lower grade metal ores found closer to the surface may be profitably mined using surface mining methods, which generally cost less than underground methods. Many industrial minerals are also mined using surface mining methods, as these ores are usually low in value and were deposited at or near the Earth's surface.

Generally in a surface mine, hard rock must be drilled and blasted, although some minerals, such as diatomite, are soft enough to mine without blasting.

Large mechanical shovels fill trucks with the broken rock that is then trucked out of the mine for processing. Placer mining is used to recover valuable minerals from sediments in present-day river channels, beach sands, or ancient stream deposits. More than half of the world's titanium comes from placer mining of beach dunes and sands. In placer operations, the mined material is washed through a trommel to eliminate the coarse materials and a sluice box to concentrate the "heavies." A trommel is a revolving cylindrical sieve used to size rock, and the bottom of the sluice has ridges (called riffles) and depressions to trap heavy minerals, such as gold, one of the heaviest minerals. Platinum and tin can also be recovered in this manner.

Task 3. Answer the following questions.

1. What are the most metallic and nonmetallic minerals extracted from?
2. How is muck moved to the surface?
3. Where can lower grade metal ores be found?
4. What minerals are soft enough to be mined without blasting?
5. Why is placer mining used?

Task 4. Think of more questions you might ask about.

Task 5. Speak about the main types of mining methods.

Text B. Recovery methods

Task 1. What do you know about the recovery methods? Compare your answers with your partner's one.

Task 2. Read the text and find out if you were right.

Regardless of the deposit type and mining process, one must separate the ore from the waste rock; once it has been removed from the ground.

The mineral commodity can be separated from the waste rock by using one or more methods, and the separation is usually done in a mill. One type of milling or recovery method is called floatation. The ore is crushed into a very fine powder, and the powder is put into agitated, frothy slurry.

Minerals may sink to the bottom or stick to the bubbles and rise to the top, where they are skimmed off. This process is used to separate the valuable metals from waste rock, after which the recovered metals are sent on for further processing.

The waste material is either used as backfill in the mine or sent to a tailings pond, where the water is removed. Cyanide heap leaching is one method used to extract lowgrade gold from rock mined using open-pit methods. Again the rock is crushed and placed on a "leach pile" on a lined pad.

A cyanide solution is sprayed or dripped on top of the pile. As the leach solution percolates down through the rock, the gold dissolves into the solution. This "pregnant" solution is then captured, and the gold is recovered by further processing. After the waste rock is cleaned, it may be used to backfill in the mine pit, when the mineral deposit is exhausted.

Task 3. Answer the following questions.

1. How is ore separated from the waste rock?
2. Where is separation usually done?
3. What is floatation?
4. Why is a cyanide solution sprayed or dripped on top of the pile?
5. When is the mineral deposit exhausted?

Task 4. Think of more questions you might ask about.

Task 5. Speak about the main recovery methods.

Text C. Reclamation processes

Task 1. Warm-up questions.

1. How does the mining industry recognize the potential impacts of mining operations on the environment?
2. Why is reclamation needed?

Task 2. Read and translate the following text.

The reclamation process takes place throughout the mining life cycle. The process of reclamation includes maintaining water and air quality and minimizing flooding, erosion, and damage to wildlife and habitat caused during the mining life cycle.

The final step in the reclamation process is often topsoil replacement and revegetation with suitable plant species. Habitats must be maintained or restored to their prior condition once the mining process is completed. If displaced, native flora and fauna are reintroduced. Water used during the milling process is collected and reused or cleaned before being restored to the hydrosphere. Underground mines may be backfilled or sealed or may be preserved for bat habitat.

Open-pit mines are often backfilled or reshaped to become natural areas or pit lakes suitable for waterfowl and fish. Tailings ponds may be drained, covered and planted with vegetation, or turned into wetlands.

Task 3. Answer the following questions.

1. How is ore separated from the waste rock?
2. Where is separation usually done?
3. What is floatation?
4. How many stages does the process of reclamation consist of?
5. How may tailings ponds be used?

Task 4. Think of more questions you might ask about.

Task 5. Speak about the main stages of reclamation methods.

APPENDICES

Appendix 1

ENGLISH GRAMMAR IN USE

Task 1. Study the following charts paying attention to the difference in the situations.

Names of Past Forms	Situations	Time expressions used with
Past Simple	Past actions which happened one after the other.	Yesterday, last week/month/ year, ago, then, just now,when, in 1975
	Past habit or state.	
	Complete action or event which happened at a stated past time.	
	Action which happened at a definite past time although the time is not mentioned. This action is not connected with the present.	

Past Continuous	Actions in the middle of happening at a stated past time.	While When As
	Past action in progress interrupted by another past action. The longer action is in the Past Continuous, the shorter action is in the Past Simple.	
	Two or more simultaneous past actions.	
	Background description to events in a story.	
Past Perfect	Past action which occurred before another action or before a stated past time.	Just, never, after, already(affirmative), yet (negations and questions), since (for a starting point in the past), for (over a period of time), before, by the time.
	Complete past action which had visible results in the past.	
	The Past Perfect is the past equivalent of the Present Perfect.	
Past Perfect Continuous	Actions continuing over a period up to a specific time in the past.	For since
	Past actions of certain duration which had visible results or effects in the past.	
	The Past Perfect Continuous is the past equivalent of the Present Perfect Continuous.	
Used to	Expresses past habits or states. We can use Past Simple instead of "used to".	

Was going to	Expresses unfulfilled arrangements or unfulfilled plans in the past, or actions one intended to do but did not or could not do.	

Remember how to form the past tenses

NOTE:
V – infinitive without to
(2k) – form of verb from the second column of irregular verbs
(3k) – form of verb from the third column of irregular verbs

PAST SIMPLE

AFFIRMATIVE	NEGATIVE	INTERROGATIVE
I We You They **V**+ed /(2k) He (went, played) She It	I We You They didn't **V** He (go, play) She It	I we you Did they **V ?** he (go, play) she it

PAST CONTINUOUS

AFFIRMATIVE	NEGATIVE	INTERROGATIVE
I He She was **V**+ing It (going)	I He She wasn't **V**+ing It (going)	I he Was she **V**+ing ? it (going)

We You were **V**+ing They (playing)	We You weren't **V**+ing They (playing)	we Were you **V**+ing ? they (playing)

PAST PERFECT

AFFIRMATIVE	NEGATIVE	INTERROGATIVE
I We You They He had **V**+ed/(3k) She (gone, played) It	I We You They He had not **V**+ed /(3k) She (gone, played) It	I we you they Had he **V**+ed /(3k) ? she (gone, played) it

PAST PERFECT CONTINUOUS

AFFIRMATIVE	NEGATIVE	INTERROGATIVE
I We You They He had been **V**+ing She (going, playing) It	I We You They He hadn't been **V**+ing She (going, playing) It	I we you they Had he been **V**+ing ? she (going, playing) it

USED TO

AFFIRMATIVE	NEGATIVE	INTERROGATIVE
I We You	I We You	I we you

They used to **V** He (go, play) She It	They did not use to **V** He (go, play) She It	Did they use to **V ?** he (go, play) she it

WAS GOING TO

AFFIRMATIVE	NEGATIVE	INTERROGATIVE
I He She was going to **V** It (play)	I He She wasn't going to**V** It (play)	I he Was she going to **V**? it (play)
We You were going to **V** They (play)	We You weren't going to **V** They (play)	we Were you going to **V**? they (play)

Task 2. Describe the same habitual or repeated actions in the past tense. Make any other necessary changes according to the model:

We often meet at international conferences.
We met at international conferences last year.

1. We often meet at the plenary sessions.
2. I rarely see Dr. Smith in the morning.
3. I always shake hands with him.
4. He generally keeps his word.
5. He generally buys a lot of physics books.
6. Smith always deals with interesting problems.
7. He usually gives a thorough analysis of his results.
8. He often begins his papers with a review of data.
9. Smith never speaks quickly.
10. He seldom reads long papers.
11. His colleagues sometimes hold their meetings at the laboratory.

Task 3. Describe the following non-permanent actions using construction *"used to"* and give general questions and negative sentences. Make any other necessary changes according to the model:

He gave a lecture on organic chemistry last Wednesday.
He used to give lectures on organic chemistry.
He didn't use to give lectures on organic chemistry.
Did he use to give lectures on organic chemistry?

1. She gave an interesting lecture last Monday.
2. Mr. Brown wrote a scientific article about his research in the last metallurgical journal.
3. We knew about all new works on metallurgy two years ago.
4. Young scientists met at scientific conference in May.
5. I sent him reprints of my papers some days ago.
6. I read all of his papers that were published last year.

Task 4. Put the right forms of verbs in the text.

A German doctor and chemist called Agricola (1494-1555) (1) one of the first people to describe mining and the production of metals in a famous illustrated book written in Latin, then the language of science. His book was in use for over 200 years. His real name was George Bauer; Bauer (2) ___the German world for farmer, and Agricola the Latin one.

He was a school master first teaching Latin and Greek, at Zwickau in Germany. Later he (3) ____to Italy to study medicine, and became a doctor. Then he (4) ___to Germany to study metals and mining and (5) ___his great work "About Metals". He (6) ___working as a doctor as well, and also (7) _____Mayor of Chemist in Saxony. The King of Saxony (8) ___so impressed with his work that he not only (9) __Agricola a pension, but also (10) ___him from paying taxes.

№	1	2	3	4	5
1	has been	was	were	had been	are
2	am	are	is	was	were
3	went	go	gone	is going	goes
4	return	was returning	returns	had returned	returned
5	published	publishing	publishes	to publish	publish

6	continue	continued	to continue	continuing	is continuing
7	become	had become	was becoming	had been becoming	became
8	were	been	was	to be	is
9	gave	give	given	gives	was giving
10	excuses	excuse	to excuse	have excused	excused

Task 5. Put the right forms of the verbs in the text.

Russian scientists Anosov and Chernov (11) _____the foundation of metallography as a science.

In 1828-1841 Anosov (12) ____numerous investigations of steel at the Zlatoust iron and steel plant. In 1831, first in the world, he (13) ___to use the microscope for the examination of metals. With the microscope, Anosov (14) ___the structure of the steel and its changes depending on the addition of different elements (Ti, Cr, Mn, V and others) to it. The results of the investigation (15) ___very valuable.

Chernov working at the Obukhov plant, (16) ____that the state of the steel changed during its heating and cooling. He (17) ___these transitions from one state to another with the letters *a, b, c,* named afterwards "Chernov's critical points". He (18) ___what critical points the steel was to be heated for its hardening or for its forging in order to produce good and sound articles. Thus, he (19) ____the interdependence between the structure of the steel and its properties.

№	1	2	3	4	5
11	lay	lays	laid	was laying	had laid
12	carried on	carried off	carried away	carried over	carried out
13	began	begin	was begining	begun	had begun
14	examines	examined	were examining	had been examining	had examined
15	was	is	are	were	been
16	find out	was finding	found out	had found	finds out

		out		out	
17	designated	designate	designates	designating	to designate
18	explaining	to explain	explains to	explaine	explains
19	determine	determines	determined	determining	to determine

Appendix 2

THE LIST OF CHEMICAL ELEMENTS

Ag – argentums [a:´ʤəntəm] =silver - серебро

Al – aluminium [ˏæljuˊmiəm]– алюминий

Ar – argon [ˊa:rgɔn] –аргон

As-Arsenic [ˊa:s(ə)nik] – мышьяк

Au-aurum [ˊɔ:rəm] =gold [gould]– золото

Ba –boron [ˊbɔ:rɔn – бор

Be – beryllium [ˊbɛ(ə)riəm – бериллий

Bi-bismuth [ˊbizməθ] - висмут

Br- bromine [ˊbroumi:n]– бром

C –carbon [ˊka:bən]–углерод

Ca- calcium [ˊkælsiəm]– кальций

Ce- cerium [ˊsi(ə)riəm]– церий

Cd – cadmium [ˊkædmiəm]– кадмий

Cl – chlorine [ˊklɔ:ri:n] – хлор

Co – cobalt [ˊkoubɔ:lt] - кобальт

Cr – chromium [ˊkroumiəm]– хром

Cs – caesium [ˊsi:ziəm] – цезий

Cu –cuprum, copper [ˊkɔpə] – медь

F - fluorine [´flu(ə)ri:n] – фтор

Fe – ferrum [´ferəm]=iron [´aiən]– железо

Ga – gallium [´gæliəm] –галлий

Ge – germanium [ʤə:´meniəm]– германий

H – hydrogen [´haidrəʤən]– водород

He –helium [´hi:liəm]– гелий

Hg – hydrargyrum [hai´dra:ʤirən]= mercury [´mə:kjuri] – ртуть

I – iodine [´aiədin]– йод

Ir – iridium [i´ridiəm] – иридий

K – kalium [´keiliəm] = potassium[pə´tæsiəm]- калий

Li – lithium [´liθiəm]– литий

Mg – magnesium [mæg´ni:ziəm – магний

Mn – manganese [ˏmæŋgə´ni:z]– марганец

Mo – molybdenum [mə´libdənəm] – молибден

N – nitrogen [´naitrəʤ(ə)n]– азот

Na – natrium [´neitriəm]= sodium [´soudiəm]– натрий

Ne – neon [´ni:ɔn]- неон

Ni – nickel [´nik(ə)l]- никель

O - oxygen [´ɔksiʤ(ə)n]- кислород

P – phosphorus [´fɔsf(ə)rəs]– фосфор

Pl – plumbum [´plʌmbəm]= lead - свинец

Pl – platinum [´plæ´tinəm]– платина

Pu – plutonium[plu:touniəm] – плутоний

Ra – radium [´reidiəm]–радий

Rb –rubidium [ru:´bidiəm]- рубидий

S – sulphur [´sʌlfə]– сера

Sb- antimony [´æntiməni]– сурьма

Sc – scandium [´skændiəm]– скандий

Se – selenium [si´li:niəm]- селен

Si – silicone [´silikoun]– кремний

Sn stannum [´stænəm]= tin [tin] – олово

Sr – strontium [´strɔntiəm]– стронций

Te – tellurium [´təl(j)u(ə)riəm]- теллур

Th – thorium [´θɔ:riəm]– торий

Ti – titanium [t(a)i´teiniəm]- титан

U – uranium [´əm]- уран

W – wolfram [ju´reiniəm]= tungsten

Zn – zinc [´ziŋk]– цинк

Zr –zirconium [zə:´kouniəm]– цирконий

Appendix 3

HOW TO READ CHEMICAL FORMULARS AND EQUATIONS

$CH_4+2O_2 \rightarrow CO+2H_2O$

[´si: ´eitʃ ´fɔ: ´plʌs ´tu: ´mɔlikju:lz əv ´ou ´tu: ´givs ´si: ´ou ´plʌs ´tu : ´ mɔlikju:lz əv ´eitʃ ´tu: ´ou]

$H^+ + NaHCO_3 \rightarrow Na^+ + H_2CO_3 \rightarrow Na^+ + H_2O + CO_2$

[´haidrədʒən´aiən´ plʌs ´en´ei´eitʃ ´si: ´ou ´θri: ´givs ´neitriəm ´aiən ´plʌs ´eitʃ ´tu: ´si: plʌs ´si: ´ou ´tu:]

$4HCl+O_2=2Cl_2+2H_2O$

[´fɔ: ´mɔlikju:lz əv´eitʃ ´si: ´el ´plʌs´ou´tu: ´givs´tu: ´mɔlikju:lz əv ´si: ´el ənd ´tu: ´mɔlikju:lz əv´eitʃ´tu: ´ou]

$AcOH \leftrightarrow AcO^- + H^+$

[´ei ´si ´ou´eitʃ´fɔ:mz ənd iz ´fɔ:md frəm ´ei ´si: ´ɔksidʒ(ə)n´aiən´plʌs´haidrədʒən´aiən]

Appendix 4

RECOMMENDATIONS FOR SCIENTIFIC REPORT WRITING

The framework or structure of research reports is as follows.

Preliminaries **1.** The title	The fewest words possible that adequately describe the paper.
2. Acknowledgements	Thanking colleagues, supervisors, sponsors, etc. for their assistance.
3. List of contents	The sections, in sequence, included in report.
4. List of figures/tables	The sequence of chart or diagrams that appear in the text.
Introduction **5.** The abstract	An extremely concise summery of the contents of the report, including the conclusions. It provides an overview of the whole report for the reader.
6. The statement of the problem	A brief discussion of the nature of research and reason for undertaking it. A clear declaration of proposal and hypotheses.
Main body **7.** Review of literature	A survey of selective, relevant and appropriate reading, both of primary and secondary source materials. Evidence of original and crucial thought applied to book and journals.
8. Design of the investigation	A statement and discussion of the hypotheses, and the theoretical structure in which they will be tested and examined, together with the methods used
9. Measurement used	Detailed descriptions and discussion of testing devices used. Presentation of data supporting validity and reliability. A discussion of the analysis to be applied to

10. Results	the results to test the hypotheses. The presentation in a logical order of information and data on which can be made to accept or reject the hypotheses.
Conclusion **11.** Discussion and conclusion **12.** Summary of conclusion	The presentation of principles, relationships, correlations and generalizations shown by the result. The interpretation of the results and their relationship to the research problem and inferences, and the implications for the research. The making of recommendations. A concise account of the main findings, and the inference drawn from them.
Extras **13.** Bibliography **14.** Appendices	An accurate listing in strict alphabetical order of all the sources cited in the text. A complication of important data and explanatory and illustrative material, placed outside the main body of the text.

Appendix 5

RECOMMENDATIONS FOR AN ORAL SCIENTIFIC REPORT PRESENTATION

The escalation of all scientific activities has resulted not only in a vast increase in specific publications but also in meetings, symposia, international conferences and lectures. With the ever increasing pressure on time of all professional people it is obviously important that the time spend at such meetings should be used as efficient as possible. This can only be achieved if the lectures and communications are given effectively. But it is surprising how many scientists, even quite ones, go on making the most elementary blunders when given their talks.

Preparation

If you aim at achieving success, read your paper in front of mirror even if you dislike doing it.

Many people are nervous about speaking in front of an audience. Before you begin, try to relax. Breathe deeply, and speak with authority. When you appear confident, you will make your audience feel comfortable. They will relax and enjoy your enthusiasm.

Some criticism of those is responsible for generation organization. Is it too much to ask someone who knows where the light switches are, and how to work the auxiliary aids?

Nothing is more annoying to find that lecturer wishes to show this first slide when no one knows how to switch off the lights, or how to switch on projector.

A time limit should always be emphasized to speakers.

Speaking strategy

The most important thing is that the audience should be able to hear what the speaker is saying. Some lecturers appear to think that they are confiding a deadly secret to a few people around and speak so that those in front of rows hardly hear what is being said.

While you reading and speaking in front of an audience:

Control your voice.

- Speak loudly and clearly so that your audience can hear you.
- Don't rush. Take time to pause between sentences to give meaning your words.
- Use an upbeat and modern pace. You may want to vary your pace to enhance certain portion of your review and to keep your audience interested.
- If you try to speak as monotonously as can, the listeners will start thinking of their own affairs or dozing off.
- You may want to rise or lower your voice to represent different characters, to show emotion, or to enliven descriptive language.

Try to behave properly

- Even if you cannot help feeling excited, stop swinging the pointer over the heads of the listeners, keep from waving hands; abstain from shouting and blowing your nose loudly.
- Do not hide your head in your paper. Look up from time to time and make eye contact with your audience.
- Concentrate on looking relaxed and self-confident. Don't shuffle your feel, move your paper excessively, or sway from side to slide.

Use visual aids

Such as charts, diagrams, photographs, and transparence to make difficult information clear to your audience. Proceeded demonstrating slides, tables, graphs and you will succeed in hitting the target.

What should a slide do?

Many people fail to realize what a slide should do. Some think that it is only necessary to photograph a few tables (usually very extensive ones) and sections of the text, and give a talk round them. Slides can be used for an excellent talk if the speaker is experienced and knows how to select and design the material on the slides. Unfortunately, what happens is that a slide containing a vast amount of information in tabular or graphical form is projected on the screen and when the audience has understood about half of it the lecturer moves on the text.

We expect not only scientific knowledge from a lecturer but also intelligence, but this is often lacking.

A slide should never attempt to9o make more than one point, the number of figures or statements should be strictly limited, and the matter should be clearly seen at the back of the theater.

Placards pinned up on the wall have the advantage that those seriously interested can go up afterwards and inspected them.

Why should slides so often be shown upside down or sideways? This may be the fault of the person who has made the slide, but there is no excuse for any of these annoying interruptions to flow of the speaker's ideas. It should be regularly duty of the organizers of any lecture or meeting to check all this before the meeting in order to ensure that everything should go smoothly once the meeting has starting.

Summing up

Summing up, express your appreciation and gratitude to all the people present, keeping strictly to the table of ranks.

When the formal procedure is over, providing you were a success, do not forget to invite everybody for refreshment and a cup of tea or coffee.

Glossary

Aggregates -particles of rocks. Natural sand, gravel, and crushed rock are important aggregates used in the construction industry.

Aluminum - is the most abundant metallic element in the Earth's crust. Bauxite ore is the main source of aluminum. Aluminum is used in automobiles and airplanes (36%), bottling and canning industries (25%), building and electrical (14%) and in other applications (25%).

Asbestos - asbestos is a class of minerals that can be readily separated into thin, strong fibers that are flexible, heat resistant, and chemically inert. Asbestos minerals are used in fireproof fabrics, yarn, cloth, and paper and paint filler. Asbestos is used to make friction products, asbestos cement pipes and sheets, coatings and compounds, packing and gaskets, roofing and flooring products, paints and caulking, and chemical filters. Fibers are dangerous when breathed, so uses must protect against fibers becoming airborne.

Anticline - layers of rock folded into the shape of an arch. The youngest rock layers are on the outer layer of the arch, and the oldest layers are at the core of the fold. Anticlines with reservoir-quality rocks in their core and impermeable rocks in the outer layers of the fold are excellent traps for oil and gas and are therefore important in petroleum exploration and extraction. The opposite of a syncline.

Asthenosphere - the layer of the Earth's interior below the lithosphere. The "plastic-like"material in the asthenosphere is weak, able to flow and convect, and the rigid tectonic plates of the lithosphere rest on and move over the asthenosphere.

Average crustal abundance - the average amount of an element contained in the Earth's crust.

Basalt - is an extrusive igneous rock. Crushed basalt is used for railroad ballast, aggregate in highway construction, and is a major component of asphalt.

Barium - is an element, derived primarily from the mineral barite, and used as a heavy additive in oil-well-drilling mud, paints, rubber, plastic and paper; production of barium chemicals; and glass manufacturing.

Bedrock - solid rock that underlies unconsolidated material (sediments) near the surface.

Beneficiation - improvement of the grade of ore by milling, floatation, sintering, gravity, concentration, or other process.

Beryllium - is an element commonly associated with igneous rocks, has industrial and nuclear defense applications and is used in light, very strong alloys for the aircraft industry. Beryllium salts are used in x-ray tubes and as a deoxidizer in bronze metallurgy. The gemstones of beryl, a beryllium mineral, are emerald and aquamarine.

Bromine - recovered commercially through the treatment of seawater brines, is used in leaded gasoline, fire extinguishers and retardants, well-completion fluids, and sanitary preparations. Bromine is the only liquid nonmetallic element.

Byproduct - a secondary or additional product; something produced, as in the course of a manufacture, in addition to the principal product.

Cadmium - is used in plating and alloying, pigments, plastics, and batteries. Cadmium is obtained from the ore minerals Sphalerite (Zn,Cd) S and Greenockite (CdS)

Cement - is used for building materials, stucco, and mortar. Cement is "a mixture of powdered lime, clay, and other minerals that crystallize to form a hard solid when water is added (hydraulic cement) or as a binding material in concrete".

Chromium - is used in the production of stainless and heat-resistant steel, full-alloy steel, super alloys and other alloys. Chromium is obtained from the ore mineral Chromite (Mg, Fe) (Cr, Al, Fe)2O4

Clays - there are many different clay minerals that are used for industrial applications. Clays are used in the manufacturing of paper, refractories, rubber, ball clay, dinnerware and pottery, floor and wall tile, sanitary wear, fire clay, firebricks, foundry sands, drilling mud, iron-ore pelletizing, absorbent and filtering materials, construction materials, and cosmetics.

Cobalt - half of the consumption of cobalt is used in corrosion- and abrasion-resistant alloys with steel, nickel, and other metals for the production of industrial engines. Other uses of cobalt metal include magnets and cutting tools. Cobalt salts are used to produce a blue color in paint pigments, porcelain, glass, and pottery. Cobalt is obtained from the ore minerals Linneaite ($Co3S4$), Cobaltite (Mg, Fe) (Cr, Al, Fe)$2O4$, and (Fe,Ni,Co)1-xSx.

Commodity - an article of trade or commerce, especially an agricultural or mining product that can be processed and resold.

Copper - copper is used in electric cables and wires, switches, plumbing; heating, electrical, and roofing materials; electronic components; industrial machinery and equipment; transportation; consumer and general products; coins; and jewelry.

Covergent boundary - a boundary where two of the Earth's tectonic plates are moving toward one another. Most convergent plate boundaries are called "subduction zones" because one of the plates moves down, or is "subducted," beneath the other. A subduction zone is usually marked by a deep trench on the sea floor. An example is the Cascadia Subduction Zone offshore of Washington, Oregon, and northern California. Earthquakes in subduction zones are common.

Diatomite - is a rock composed of the skeletons of diatoms, single-celled organisms with skeletons made of silica, which are found in fresh and salt water. Diatomite is primarily used for filtration of drinks, such as juices and wines, but it is also being used as filler in paints and pharmaceuticals and environmental cleanup technologies.

Divergent boundary - a boundary where two of the Earth's tectonic plates are moving away from each other. This generally occurs along "oceanic spreading ridges," submarine features that are impressive mountain ranges. New ocean floor is produced along the spreading ridges as molten rock (magma) from the Earth's mantle rises into their crests (axes) to form new oceanic crust. About an equal volume of old crust is lost each year along convergent plate boundaries, so the overall size of the Earth stays the same.

Dolomite - is the near twin-sister rock to limestone. Like limestone, it typically forms in a marine environment but also as has a primary magnesium component. Dolomite is used in agriculture, chemical and industrial applications, cement construction, refractories, and environmental industries.

Erosion - the general process by which the materials of the Earth's crust are loosened, dissolved, or worn away and simultaneously moved from one place to another by natural agencies.

Fault - a fracture or crack along which two blocks of rock slide past one another. Blocks can be displaced vertically (vertical fault) or horizontally (lateral or strike-slip fault). Movement on active faults may occur rapidly, in the form of an earthquake, or slowly.

Feldspar - is a rock-forming mineral. It is used in glass and ceramic industries; pottery, porcelain and enamelware; soaps; bond for abrasive wheels; cement; glues; fertilizer; and tarred roofing materials and as a sizing, or filler, in textiles and paper applications.

Fluorite - is used in production of hydrofluoric acid, which is used in the pottery, ceramics, optical, electroplating, and plastics industries. It is also used in the metallurgical treatment of bauxite, as a flux in open-hearth steel furnaces, and in metal smelting, as well as in carbon electrodes, emery wheels, electric arc welders, and toothpaste as a source of fluorine.

Garnet - is used in water filtration, electronic components, ceramics, glass, jewelry, and abrasives used in wood furniture and transport manufacturing. Garnet is a common metamorphic mineral that becomes abundant enough to mine in a few rocks.

Germanium - most germanium is recovered as a byproduct of zinc smelting. It is also found in some copper ores. Applications include use in fiber-optic components, which are replacing copper in long-distance telecommunication lines, as well as in camera lenses and other glasses and infrared lenses.

Gold - is used in dentistry and medicine, jewelry and arts, medallions and coins, and in ingots. It is also used for scientific and electronic instruments, computer circuitry, as an electrolyte in the electroplating industry, and in many applications for the aerospace industry.

Grade of ore - the concentration of a desired commodity within an ore deposit.

Granite - can be cut into large blocks and used as a building stone. When polished, it is used for monuments, headstones, countertops, statues, and facing on buildings. It is also suitable for railroad ballast and for road aggregate in highway construction.

Graphite - is the crystal form of carbon. Graphite is used as a dry lubricant and steel hardener and for brake linings and the production of "lead" in pencils. Most graphite production comes from Korea, India, and Mexico.

Gypsum - processed gypsum is used in industrial or building plaster, prefabricated wallboard, cement manufacture, and for agriculture.

Halite (salt) - is used in the human and animal diet, primarily as food seasoning and as food preservation. It is also used to prepare sodium hydroxide, soda ash, caustic soda, hydrochloric acid, chlorine, and metallic sodium, and it is used in ceramic glazes, metallurgy, curing of hides, mineral waters, soap manufacture, home water softeners, highway deicing, photography, and scientific equipment for optical parts.

Hydrosphere - the hydrosphere includes all water on Earth.

Igneous rock - rock formed when molten rock has cooled and solidified, either intrusive (granite) cooling inside the Earth or extrusive (basalt) cooling on the surface.

Industrial Diamond - industrial diamonds are those that can not be used as gems. Large diamonds are used in tools and drilling bits to cut rock and small stone. Small diamonds, also known as dust or grit, are used for cutting and polishing stone and ceramic products.

Iron ore - is used to manufacture steels of various types and other metallurgical products, such as magnets, auto parts, and catalysts. Most U.S. production is from Minnesota and Michigan. The Earth's crust contains about 5% iron, the fourth most abundant element in the crust. Lead Lead is used in batteries, construction, ammunition, television tubes, nuclear shielding, ceramics, weights, and tubes or containers. The United States is largest producer (mainly from Missouri), consumer, and recycler of lead metal. Limestone, along with dolomite, is one of the basic building blocks of the construction industry. Limestone is used as aggregate, building stone, cement, and lime and in fluxes, glass, refractories, fillers, abrasives, soil conditioners, and a host of chemical processes. Magnesium Magnesium (see dolomite) is used in cement, rubber, paper, insulation, chemicals and fertilizers, animal feed, and pharmaceuticals. Magnesium is obtained from the ore minerals Olivine $(Fe,Mg)_2SiO_4$, Magnesite $MgCO_3$, and Dolomite $CaMg(CO_3)_2$. Manganese Manganese is essential to iron and steel production. Manganese is obtained from the ore minerals Braunite $(Mn,Si)_2O_3$, Pyrolusite MnO_2, and Psilomelane $BaMn_9O_{18}•2H_2O$.

Lithosphere - the outermost shell of the Earth, which is composed of a mosaic of a dozen or so large, rigid slabs of rock called "lithospheric" or "tectonic" plates.

Mafic - dark-colored intrusive igneous rock, such as basalt, composed chiefly of minerals such as olivine and pyroxene that contain abundant magnesium and iron. The term mafic also applies to dark-colored minerals rich in iron and magnesium as a group and to metamorphic rocks composed of these minerals. Metallic mineral A naturally occurring substance that has metallic properties, such as high luster, conductivity, opaqueness, and ductility; pertaining to minerals from which a metal or metals can be extracted.

Mercury - is extracted from the mineral cinnabar and is used in electrical products, electrolytic production of chlorine and caustic soda, paint, and industrial and control instruments (thermometers and thermostats).

Metamorphic rock - any rock derived from preexisting rocks by mineralogical, chemical, and (or) structural changes, essentially in the solid state, in response to marked changes in temperature, pressure, shearing stress, and chemical environment, generally at depth in the Earth's crust.

Mica - minerals commonly occur as flakes, scales, or shreds. Sheet muscovite (white) mica is used in electronic insulators, paints, as joint cement, as a dusting agent, in welldrilling mud and lubricants, and in plastics, roofing, rubber, and welding rods.

Mineral - a naturally occurring inorganic element or compound having an orderly internal structure and characteristic chemical composition, crystal form, and physical properties.

Mineralization - the process or processes by which a mineral or minerals are introduced into a rock, resulting in a valuable or potentially valuable deposit.

Mineral deposit - a mineral occurrence of sufficient size and grade (concentration) that it might, under the most favorable of circumstances, be considered to have economic potential.

Mineral occurrence - a concentration of a mineral (usually considered in terms of some commodity, such as gold) that is considered valuable by someone somewhere or that is of scientific or technical interest. In rare instances, the commodity might not even be concentrated above its average crustal abundance.

Mining life-cycle - the processes of deposit exploration and identification; quantitative and qualitative measurement of the deposit; extraction of material and ore beneficiation; and site reclamation.

Molybdenum - is used in stainless steels (21%), tool steels (9%), cast irons (7%), and chemical lubricants (8%), and in other applications (55%). It is commonly used to make automotive parts, construction equipment, gas transmission pipes, and as a pure metal molybdenum is used as filament supports in light bulbs, metalworking dies, and furnace parts because of its high melting temperature (2,623°C).

Muck - the material left behind after blasting during the underground mining process.

Nickel - is vital as an alloy to stainless steel, and it plays a key roll in the chemical and aerospace industries. Leading producers are Canada, Norway, and Russia. Phosphate rock Primarily a sedimentary rock used to produce phosphoric acid and ammoniated phosphate fertilizers, feed additives for livestock, elemental phosphorus, and a variety of phosphate chemicals for industrial and home consumers. The majority of U.S. production comes from Florida, North Carolina, Idaho, and Utah.

Non-metallic mineral - a naturally occurring substance that does not have metallic properties, such as high luster, conductivity, opaqueness, and ductility.

Ore deposit - a mineral deposit that has been tested and is known to be of sufficient size, grade, and accessibility to be producible at a profit.

Platinum Group Metals (PGMs) - PGM's include platinum, palladium, rhodium, iridium, osmium, and ruthenium. These elements commonly occur together in nature and are among the scarcest of the metallic elements. Platinum is used principally in catalytic converters for the control of automobile and industrial plant emissions; in jewelry; in catalysts to produce acids, organic chemicals, and pharmaceuticals; and in dental alloys used for making crowns and bridges.

Potash - is an industry term that refers to a group of water-soluble salts containing the element potassium, as well as to ores containing these salts. Potash is used in fertilizer, medicine, the chemical industry, and to produce decorative color effects on brass, bronze, and nickel.

Pyrite (fools gold) - is used in the manufacture of sulfur, sulfuric acid, and sulfur dioxide; pellets of pressed pyrite dust are used to recover iron, gold, copper, cobalt, and nickel.

Quartz crystals - are popular as a semiprecious gemstone; crystalline varieties include amethyst, citrine, rose quartz, and smoky quartz. Because of its piezoelectric properties (the ability to generate electricity under mechanical stress), quartz is used for pressure gauges, oscillators, resonators, and wave stabilizers. Quartz is also used in the manufacture of glass, paints, abrasives, refractories, and precision instruments.

Reclamation - the process of reestablishing stable soils and vegetation in disturbed areas.

Sandstone is used as a building stone, road bases and coverings, construction fill, concrete, railroad ballast, and snow and ice control. Silica Silica is used in the manufacture of computer chips, glass and refractory materials, ceramics, abrasives, and water filtration; and is a component of hydraulic cements, a filler in cosmetics, pharmaceuticals, paper, and insecticides; as an anti-caking agent in foods; a flatting agent in paint, and as a thermal insulator.

Sedimentary rock - a “clastic” rock resulting from the consolidation of loose fragments of mechanically formed fragments of older rocks (sandstone), a “chemical” rock formed by precipitation (salt), or an “organic” rock composed of the remains or secretions of plants and animals (certain limestones).

Silicon - is used in iron, steel, and aluminum, as well as in the chemical and electronic industries.

Silver - is used in photography, chemistry, electrical and electronic products (because of its very high conductivity), fine silverware, electroplated wire, jewelry, coins, and brazing alloys and solders.

Spreading center - associated with a divergent boundary. A spreading center is an area where new crust is formed.

Sulfur - is widely used in manufacturing processes, drugs, and fertilizers.

Subduction zone - associated with a convergent boundary. A region where one crustal block descends beneath another crustal block

Syncline - layers of rock folded into the shape of a trough or "U." The youngest rock layers are at the core of the fold, and the oldest layers on the outer surface of the fold. Synclines do not usually form traps for oil and gas.

Talc - the primary use for talc is in the production of paper. Ground talc is used as filler in ceramics, paint, paper, roofing, plastics, cosmetics, and in agriculture. Talc is found in many common household products, such as baby (talcum) powder, deodorant, and makeup. Very pure talc is used in fine arts and is called soapstone. It is often used to carve figurines.

Tectonic plate - one of the several large, relatively strong "plates" that constitute the Earth's outer layer. Convection in the underlying astenoshere causes these plates to move relative to each other at an average rate of less than an inch per year. Movements on the faults that define plate boundaries produce most earthquakes.

Tectonics - a branch of geology dealing with the broad architecture of the outer part of the Earth, that is, the regional assembling of structural or deformational features, a study of their mutual relations, origin and historical evolution.

Tin - is used in the manufacture of cans and containers, electrical equipment, and chemicals.

Titanium - is a metal used mostly in jet engines, airframes, and space and missile applications. In powdered form, titanium is used as a white pigment for paints, paper, plastics, rubber, and other materials.

Trona - is used in glass container manufacture, fiberglass, specialty glass, flat glass, liquid detergents, medicine, food additives, photography, cleaning and boiler compounds, and control of water pH. Trona is mined mainly in Wyoming.

Tungsten - is used in steel production, metalworking, cutting applications, construction electrical machinery and equipment, transportation equipment, light bulbs, carbide drilling equipment, heat and radiation shielding, textile dyes, enamels, paints, and for coloring glass.

Ultramafic - igneous rocks with very low silica content (less than 45%), usually composed of greater than 90 % mafic minerals. Such rocks are typical of the Earth's mantle.

Unconformity - a surface or break between layers of rock representing a substantial gap in geologic time. For example, such a break exists where a rock unit overlies the heavily eroded surface of an older rock unit.

Uranium - is a radioactive material used in nuclear defense systems and for nuclear generation of electricity. It is also used in nuclear-medicine x-ray machines, atomic dating, and electronic instruments.

Vein - a fracture in rock that has been sealed with minerals precipitated from a solution.

Weight percent - the percentage of a component relative to the total weight of an item. A common way to express concentrations of an element, sometimes referred to as mass percent.

Zeolites - some of the uses of zeolite minerals include aquaculture (for removing ammonia from the water in fish hatcheries), water softener, catalysts, cat litter, odor control, and removing radioactive ions from nuclear-plant effluent.

Zinc - is used as protective coating on steel, as die casting, as an alloying metal with copper to make brass, and as chemical compounds in rubber and paint. Additional uses include galvanizing iron, electroplating, metal spraying, automotive parts, electrical fuses, anodes, dry-cell batteries, nutrition, chemicals, roof gutters, cable wrapping, and pennies. Zinc oxide is used in medicine, paints, vulcanizing rubber, and sun-block lotions.

Zirconium - is a metal recovered from zircon. Zircon is used in mineral form in refractory products, where it is valued for its high melting temperature of 2,550°C. Some zircon is processed by chemical leaching to yield elemental zirconium. The best known use for zirconium metal is in nuclear reactors, where zirconium contains the fuel.

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ИНОСТРАННЫЙ ЯЗЫК

ТЕХНОЛОГИЯ ПРОИЗВОДСТВА РАБОТ ПО ОБОГАЩЕНИЮ ПОЛЕЗНЫХ ИСКОПАЕМЫХ

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РИЦ Санкт-Петербургского горного университета
Адрес университета и РИЦ: 199106 Санкт-Петербург, 21-я линия, 2