TARAS SHEVCHENKO NATIONAL UNIVERSITY OF KYIV

INSTITUTE OF GEOLOGY

DEPARTMENT OF MINERALOGY, GEOCHEMISTRY AND PETROGRAPHY

ADVANCED MINERALOGY

Guidelines for practical works

Obtained qualification: Master Degree

Program Subject Area: Earth Science

Programme: Applied Geology

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Guidelines for practical works for discipline "Advanced mineralogy" (Obtained qualification: Master Degree, program subject area: Earth Science, programme: Applied Geology) / I.Kvasnytsia - e-book, 2021 - 18 p.

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A set of tasks for practical work is proposed, which is aimed at improving the quality of mastering theoretical knowledge and acquiring practical skills by students in studying the discipline "Advanced Mineralogy".

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PREFACE

The discipline "Advanced mineralogy" aims to provide specialists with higher education the knowledge necessary to understand minerals and their behaviour, the features of their formation, distribution patterns in geological formations and skills in the development of mineralogical methods, search criteria and evaluation of mineral resources based on the results analysis of regional mineralogical research.

The objective of the "Advanced mineralogy" course is introduction the basic modern concepts necessary to understand minerals and their behaviour, as well as the main trends and the current state of regional and mineralogical research in the world; highlighting the features of the mineral composition and constitution, morphology, properties and genesis of minerals from different mineralogical provinces.

The course provides knowledge about the characteristics of the mineral composition and constitution, morphology, properties and genesis of economically important and rare minerals. The discipline examines modern approaches and concepts of modern mineralogy. Familiarization of students with the basic mineralogical principles of regionalization of geological formations is carried out.

In addition to lectures, the curriculum provides for practical work, the purpose of which is consolidation of theoretical material and acquire practical skills in identifying economically significant and rare minerals and their features for further determining the patterns of distribution and formation of minerals in geological formations, as well as developing mineralogical methods, search criteria and assessment of mineral resources based on the results of the analysis of regional mineralogical studies.

The guidelines include 2 modules, which are designed for 28 hours of practical work:

1. Physical properties of minerals
2. Identifying minerals in hand specimen
3. Economic minerals: Industrial Minerals (native elements, halides, carbonates, borates, sulfates)
4. Economic minerals: Industrial Minerals (phosphates, oxides, silicates)
5. Economic minerals: Ore minerals (metal sulfides)
6. Economic minerals: Ore minerals (oxides)
7. Economic minerals: Ore minerals (native elements, silicates, carbonates, chromates, molybdates, wolframates, arsenates and vanadates)
8. Economic minerals: Precious metals
9. Precious Gemstones
10. Semi-precious Gemstones
11. Rare minerals

Practical classes description: Classification, description, and interpretation of economic minerals, including identifying ore and industrial minerals, gemstones and rare minerals. Interpretations include processes of formation.

MODULE 1. PHYSICAL PROPERTIES OF MINERALS AND IDENTIFYING IN HAND SPECIMEN

Class #1. ***Physical Properties of Minerals*** (2 hours)

Students should have knowledge of basic chemistry and properties of minerals equivalent to what they would learn in a previous (mineralogy) class and be able to identify minerals based on their physical properties.

Concepts goals for this activity: Become more familiar with mineral properties.

In Class: Students identify minerals using a given list of minerals.

In tray #1, there are 15 minerals.
1) Using your text (and any other sources you wish), test the physical properties of each mineral and try to identify each mineral.
2) Record your results in your lab notebook using a format similar to that of the table below.

#	*mineral*	*formula*	*habit*	*cleavage fracture*	*hardness tenacity*	*luster colour*	*streak*	*other*

A list of minerals: pyrite, calcite, quartz, tremolite, sulphur, biotite, labradorite, magnetite, gypsum, nepheline, apatite, flourite, plagioclase, galena, halite

Class #2. ***Identifying Minerals in Hand Specimen*** (2 hours)

Students should be able to identify unknown minerals based on their physical properties.

Concepts goals for this activity: Learn to identify unknown minerals based on their physical properties

In Class: Students identify unknown minerals.

In trays #2-4, there are 45 unknown minerals.

1) Using your text (and any other sources you wish) and the skills you developed in previous class, test the physical properties of each mineral and try to identify each mineral.

2) Record your results in your lab notebook.

3) Write a few sentences explaining how you were able to identify each mineral.

MODULE 2. ECONOMIC MINERALS, GEMSTONES AND RARE MINERALS

Theme 1. Economic minerals

Economic minerals are the most important raw materials for most industrialized countries *(Christidis, 2011).* Infrastructure improvement and growth of the manufacturing sector requires a reliable supply of good quality construction minerals and a wide range of other industrial mineral raw materials *(Inglethorpe, et al, 1993).* Industrial minerals and rocks are a group of naturally occurring materials excluding gemstones, metallic ores, groundwater and fuels (coal, oil and gas). These materials are of great economic value as main raw materials for the construction, glass, abrasive, paper, chemical, ceramics, metallurgical and agricultural industries *(Wilson & Amavilah, 2007).*

Economic minerals may be classified based upon different factors (often group membership depends on end-use and economic factors), for example, construction materials, ceramic materials, metallurgical and refractory materials, abrasive materials, general manufacturing materials, and chemical and fertilizer materials *(Wilson & Amavilah, 2007).*

According to *(Christidis, 2011)*, economic minerals include five major groups of raw materials:

1. Raw materials which are utilized by the industry as minerals (e.g. talc, asbestos, micas, feldspars) or bulk rocks (e.g. bentonite, perlite, limestone) because of their special physical and/or chemical properties.
2. Raw materials which are source of non-metals (pyrite for S, apatite for P, borates for B and fluorite for F).
3. Raw materials which may be source for metals (bauxite for Al, chromite for Cr or ilmenite for Ti), but which may also be used in certain industrial applications because of their characteristic physical and chemical properties.

4. Natural construction materials including building and ornamental stones and aggregates (granite, marble, limestone sand and gravel etc).

5. Synthetic materials which may be monomineralic or may consist of several phases (zeolites, industrial diamonds, lime, dead burnt or caustic magnesite, smectite etc). Geopolymers is a new type of materials which can be included in this group.

Class #3-4. ***Economic minerals: Industrial Minerals*** *(native elements, halides, carbonates, nitrates, borates, sulfates)* (4 hours)

Students should:

- understand the basic classification system;
- be able to identify unknown minerals based on their physical properties.

Concepts goals for this activity:

1) Learn to identify industrial minerals.
2) Learn to group and classify minerals according to their physical properties.

In Class: students look at industrial minerals (native elements, halides, carbonates, nitrates, borates, sulfates), learn to distinguish and identify them in hand specimen. Students examine a tray of minerals and record their physical properties, composition, and habit. They note chemical and physical similarities and differences and why there are several varieties of minerals in each group.

Trays #5-8 contain minerals of the different groups: native elements, halides, carbonates, borates, sulfates).

1) Fill in the table below:

#	*Mineral*	*Formula*	*Mineral group*	*Industrial application*
1.	barite			
2.	borax			
3.	calcite			
4.	colemanite			
5.	diamond			
6.	graphite			

7.	gypsum			
8.	halite			
9.	sulfur			
10.	trona			
11.	ulexite			

2) While at each tray, examine each mineral and record its physical properties, chemical composition, habit, etc. in your lab notebook.

Class #5-6. ***Economic minerals: Industrial Minerals*** *(phosphates, oxides, silicates)* (4 hours)

Students should:

- understand the basic classification system;
- be able to identify unknown minerals based on their physical properties.

Concepts goals for this activity:

1) Learn to identify industrial minerals.
2) Learn to group and classify minerals according to their physical properties.

In Class: students look at minerals (oxides, phosphates, network silicates, chain silicates, sheet silicates, etc.), learn to distinguish and identify them in hand specimen. Students examine a tray of minerals and record their physical properties, composition, and habit. They note chemical and physical similarities and differences and why there are several varieties of minerals in each group.

Trays #9-12 contain minerals of the different groups of oxides, silicates and phosphates.

1) Fill in the table below:

#	*Mineral*	*Formula*	*Mineral group*	*Industrial application*
1.	albite			
2.	andalusite			
3.	apatite			
4.	chabazite			

5.	corundum			
6.	garnet			
7.	kaolinite			
8.	kyanite			
9.	microcline			
10.	mordenite			
11.	muscovite			
12.	orthoclase			
13.	palygorskite			
14.	phlogopite			
15.	pyrophyllite			
16.	quartz			
17.	saponite			
18.	sepiolite			
19.	talc			
20.	vermiculite			
21.	wollastonite			

2) Examine each mineral and record its physical properties, chemical composition, habit, etc. in your lab notebook.

Class #7. ***Economic minerals: Ore minerals*** *(metal sulfides)* (2 hours)

Students should:

- understand the basic classification system;
- be able to identify unknown minerals based on their physical properties.

Concepts goals for this activity:

1) Learn to identify ore minerals.
2) Learn to group and classify minerals according to their physical properties

In Class: Students study hand samples of ore minerals (metal sulfides), learn to distinguish and identify them in hand specimen. Students examine a tray of minerals and record their physical properties, composition, and habit. They note chemical and physical similarities and differences and why there are several varieties of minerals in each group.

Trays #13-14 contain metal sulfides.

1) Fill in the table below:

#	*Mineral*	*Formula*	*Ore of what metal?*
1.	argentite		
2.	arsenopyrite		
3.	bismuthinite		
4.	bornite		
5.	chalcocite		
6.	chalcopyrite		
7.	cinnabar		
8.	cobaltite		
9.	covellite		
10.	galena		
11.	molybdenite		
12.	opriment		
13.	pentlandite		
14.	pyrite		
15.	pyrrhotite		
16.	realgar		
17.	sperrylite		
18.	sphalerite		
19.	stibnite		

2) Examine each mineral and record its physical properties, chemical composition, habit, etc. in your lab notebook.

Class #8. ***Economic minerals: Ore minerals*** *(oxides)* (2 hours)

Students should:

- understand the basic classification system;
- be able to identify unknown minerals based on their physical properties.

Concepts goals for this activity:

1) Learn to identify ore minerals.
2) Learn to group and classify minerals according to their physical properties

In Class: Students examine a trays of oxides and record their physical properties, composition, habit, and occurrence. Students fill in a table giving the metal, formula of several ore minerals. They note chemical and physical similarities and differences of the minerals.

Trays #15-16 contain oxides.

1) Fill in the table below:

#	*Mineral*	*Formula*	*Ore of what metal?*
1.	bauxite		
2.	cassiterite		
3.	chromite		
4.	columbite-tantalite		
5.	cuprite		
6.	goethite		
7.	hematite		
8.	ilmenite		
9.	magnetite		
10.	manganite		
11.	pyrolusite		
12.	rutile		
13.	tenorite		
14.	uraninite		

2) Examine each mineral and record its physical properties, chemical composition, habit, etc. in your lab notebook.

Class #9. ***Economic minerals: Ore minerals*** *(native elements, silicates, carbonates, sulphites, molybdates, wolframates, arsenates and vanadates)* (2 hours)

Students should:

- understand the basic classification system;
- be able to identify unknown minerals based on their physical properties.

Concepts goals for this activity:

1) Learn to identify ore minerals.
2) Learn to group and classify minerals according to their physical properties.

In Class: Students examine trays of native elements, silicates, carbonates, sulphites, molybdates, wolframates, arsenates and vanadates and record their physical properties, composition, and habit. Students fill in a table giving the metal, formula, and mineral group of several ore minerals. They note chemical and physical similarities and differences and identify the rock samples and minerals they contain.

Trays #17-18 contain native elements, silicates, carbonates**,** sulphites, molybdates, wolframates, arsenates and vanadates.

1) Fill in the table below:

#	*Mineral*	*Formula*	*Ore of what metal?*	*Mineral group*
1.	anglesite			
2.	azurite			
3.	barite			
4.	beryl			
5.	carnallite			
6.	celestite			
7.	cerussite			

8.	chyrsocolla			
9.	dolomite			
10.	electrum			
11.	lepidolite			
12.	magnesite			
13.	malachite			
14.	monazite			
15.	native copper			
16.	native gold			
17.	olivine			
18.	rhodochrosite			
19.	scheelite			
20.	siderite			
21.	spodumene			
22.	sylvite			
23.	witherite			
24.	wolframite			
25.	zircon			

2) Examine all of the mineral samples and record their physical properties, chemical composition, habit, occurrence, and use in your lab notebook.

Class #10. ***Economic minerals: Precious metals*** (2 hours)

Students should:

- understand the basic classification system;
- be able to identify unknown minerals based on their physical properties.

Concepts goals for this activity:

1) Learn to identify ore minerals.
2) Learn to group and classify minerals according to their physical properties.

In Class: students look at most common precious metals, learn to distinguish and identify them in hand specimen. Students fill in a table giving the metal, formula of several ore minerals. Students examine trays of ore minerals and record their physical properties, composition, habit, occurrence, economic value, and use and answer questions about colour, luster, density, and availability.

Trays #19-22 contain the precious metal.
1) Fill in the table below:

#	*Mineral*	*Formula*	*Economic use*	*Valuable metal price (US$/kg)*
1	native gold			
2	native silver			
3	palladium			
4	platinum			

2) Examine the different minerals and varieties and record their physical properties, chemical composition, habit, occurrence, economic value and use in your lab notebook.

Theme 2. Gemstone and rare minerals

Gems are materials used for adornment or decoration that must satisfy several criteria: they must be relatively rare, hard, and tough enough (shock resistant) to resist "normal" wear and withstand corrosion by skin contact (sweat) and cosmetics *(Fritsch & Rondeau, 2009)*. Less than 200 materials are considered relatively common gems; the rest are "rare".

Class #11. ***Precious Gemstones*** (2 hours)

Students should:

- understand the basic classification system;
- be able to identify unknown minerals based on their physical properties.

Concepts goals for this activity:
1) Learn to identify key gemstones
2) Identify key properties useful for mineral identification.

In Class: students look at gemstones, learn to distinguish and identify them in hand specimen. Students fill in a table giving formula and mineral group of several gemstones. Students examine trays of gemstones and record their physical properties, composition, habit and answer questions about colour, luster, density, transparency.

Trays #23 contain gemstones.
1) Fill in the table below:

#	*Mineral*	*Formula*	*Mineral group*
1.	aquamarine		
2.	diamond		
3.	emerald		
4.	garnet		
5.	heliodor		
6.	kunzite		
7.	opal		
8.	ruby		
9.	sapphire		
10.	spinel		
11.	tanzanite		
12.	topaz		
13.	tourmaline		
14.	zircon		

2) Examine the different gemstones and record their physical properties, chemical composition, habit in your lab notebook.

Class #12-13. ***Semi-precious Gemstones*** (4 hours)

Students should:

- understand the basic classification system;
- be able to identify unknown minerals based on their physical properties.

Concepts goals for this activity:
1) Learn to identify key gemstones
2) Identify key properties useful for mineral identification.

In Class: students look at gemstones, learn to distinguish and identify them in hand specimen. Students fill in a table giving formula and mineral group of several gemstones. Students examine trays of gemstones and record their physical properties, composition, habit and answer questions about colour, luster, density, transparency. Trays #24 contain gemstones.

1) Fill in the table below:

#	*Mineral*	*Formula*	*Mineral group*
1.	agate		
2.	amber		
3.	amethyst		
4.	ametrine		
5.	apatite		
6.	azurite		
7.	charoite		
8.	citrine		
9.	fluorite		
10.	garnet		
11.	jade		
12.	jadeite		
13.	labradorite		
14.	malachite		
15.	moldavite		
16.	nephrite		
17.	pearl		
18.	petrified wood		

19.	prehnite		
20.	rhodonite		
21.	rose quartz		
22.	rutilated quartz		
23.	sodalite		
24.	sunstone		
25.	tiger eye		
26.	turquoise		

2) Examine the different gemstones and record their physical properties, chemical composition, habit in your lab notebook.

Class #14. ***Rare minerals*** (2 hours)

Students should:

- understand the basic classification system;
- be able to identify unknown minerals based on their physical properties.

Concepts goals for this activity:

1) Learn to identify rare minerals.
2) Learn to group and classify minerals according to their physical properties.

In Class: Students examine trays of rare minerals and record their physical properties, composition, and habit. Students fill in a table giving the formula, and mineral group of several rare minerals. They note chemical and physical similarities and differences and identify the rock samples and minerals they contain.

Trays #25 contain rare minerals. Examine all of the mineral samples and record their physical properties, chemical composition, habit, occurrence, and use in your lab notebook.

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