# ROCKS AND MINERALS

ORTLEB & CADICE

12 Coloured Overhead Transparencies and 3 Spiritmaster Pages

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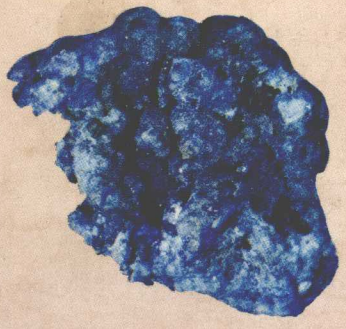


# Teacher's Guide

# ROCKS AND MINERALS

By Edward Ortleb and Richard Cadice

CONTENTS



## TO THE TEACHER:

This book represents an exciting new development in the world of education. The book contains 12 prepared full colour transparencies which are perforated for easy removal. Three spirit duplicating masters are included for either testing or additional student exercises. To use the duplicating material, you merely remove the perforated duplicating master from the book, attach it to any liquid duplicator, and run off the desired quantity.

Our science series is specifically designed by outstanding educators in the field of science to lend itself to a lecture and desk-work programme.

### Page 1—THE EARTH'S INTERIOR

CONCEPTS: The earth is made up of three main layers—crust, mantle, and core.

BACKGROUND INFORMATION: The crust, about 16 to 48 km thick, is the outer lay... coal, petroleum, gas, rock and minerals a... crust. Granite rock makes up a large pa... The mantle, about 2880 to 3200 km thick... layer. This layer is a rock layer with l... common kind of rock. Even though the ... hot, most rocks within it are solid rather than liquid because of great pressures exerted on it. Beneath the mantle is the inner layer called the core. The core, the centre of the earth, is about 3520 km thick. Geologists believe the core is made up of a mixture of dense molten nickel (90%) and molten iron (10%). If a person were able to travel to the centre of the earth, he would sense a steady increase in temperature. For every 1 km of depth, the temperature rises 12.5 °C. Geologists estimate the temperature of the mantle to be about 1150 °C the core might be as high as 3927 °C. The heat is believed to be formed because the materials within the earth's interior are highly compressed.

FOR FURTHER STUDY: 1. Find out about the chemical elements found in the earth's crust. 2. Find out about the Moho, the inner and outer layers of the core.

### Page 2—IDENTIFYING MINERALS

CONCEPTS: 1. Geologists have a variety of tests to aid in the identification of minerals. 2. In the field the scientist observes the physical properties and performs simple tests to identify minerals.

BACKGROUND INFORMATION: The identifi... can be accurately performed in the ...nical analysis. However, in the field ...ary for the geologist to make iden... ...es this by observing the physical ...l by performing simple chemical and ...

**Acid Test**—Dilute acid will cause carbonate minerals to effervesce. Calcite, the principal mineral constituent of limestone and marble, will fizz readily on contact with acid. Dolomite, a magnesium calcium carbonate, also bubbles with acid.

**Crystal Shape**—In most minerals there are distinctive crystals. Crystals are an indication of the internal ar-

rangement of the atoms. Geologists generally recognize six crystal systems—cubic, tetragonal, hexagonal, monoclinic, triclinic, and orthorhomic. Some minerals do not have atoms arranged in crystals and are called amorphous.

**Streak Test**—Certain minerals leave a characteristic colour-streak when rubbed across a piece of unglazed tile or porcelain. This streak of powdered mineral may be noticeably different than that of the colour of the whole mineral. An unglazed tile is a part of every geologist's field pack.

**Hardness Test**—Minerals vary in their hardness, that is, in their ability to scratch another substance or be scratched. The geologist Mohs devised a scale of hardness utilizing ten common minerals. Talc was given the first position. It is very soft. Diamond, the hardest natural substance, has the number ten position. Minerals can be tested for hardness by comparing their ability to scratch or be scratched by the reference minerals in the scale.

**Other Tests**—Cleavage: Some minerals have a tendency to split along zones of weakness. The cleavage planes are characteristic of the mineral. Relative density: Geologists often compare the weight of a mineral specimen to that of the weight of an equal volume of water and establish a ratio. This ratio is called relative density and is a means of comparing minerals.

FOR FURTHER STUDY: 1. Find examples of minerals belonging to each of the 6 crystal systems. 2. Find out about other tests of mineral identification such as the bead test. 3. Find out about such terms as lustre fracture, and fluorescence as applied to mineral characteristics.

**Page 3—COMMON MINERALS**

CONCEPTS: 1. Oxygen, silicon, and aluminum comprise over 80% of the elements found in the earth's crust. 2. These elements and others make up minerals. 3. Minerals are natural substances having definite crystal structure and chemical composition. 3. Minerals make up the rocks of the earth's crust.

BACKGROUND INFORMATION: The earth's crust is composed of naturally occurring elements. The most abundant of the elements are oxygen (46.7%), silicon (27.7%), aluminum (8.1%), iron (5.0%), calcium (3.6%), sodium (2.8%), potassium (2.6%), and magnesium (2.0%). These eight elements make up nearly 99% of the earth's crust. Some of the elements are found as free atoms or molecules. However, most of the elements are found in naturally occurring combinations called minerals. Minerals have definite physical and chemical properties. The rocks which make up the earth's crust are made up of minerals. Many rocks contain several kinds of minerals. Certain minerals are most commonly found to be the building block of rocks.

**Feldspar** is the most abundant mineral found on our earth. Two varieties of feldspar are common—orthoclase (potassium aluminum silicate) and plagioclase (sodium or calcium aluminum silicate). Both varieties have a pearly lustre and two cleavage planes. Feldspar is one of the minerals in granite.

**Quartz** is also a very abundant mineral. It is characterised by its hardness and hexagonal-prism crystals. Quartz is silicon dioxide. Common rocks having the mineral quartz are flint and sandstone.

**Mica** is an interesting mineral. It has perfect cleavage in one plane and therefore can be split easily into thin sheets. Mica contains the elements oxygen, silicon, aluminum, iron, magnesium, potassium, and hydrogen. The mineral has many economic uses.

**Hornblend** has six-sided crystals and is a complex silicate mineral. It is a dark colour. The mineral is often found in granite rocks.

**Calcite** is composed of calcium carbonate and is the main constituent of limestone. The crystals have rhombic cleavage and may be milky white or clear. Calcite is soft and can be scratched with a coin.

**Olivine** is a green magnesium iron silicate. It has a glassy lustre and a hardness slightly less than quartz. Olivine is found in many volcanic rocks and in stoney meteorites.

FOR FURTHER STUDY: 1. Find out about other common minerals such as the pyroxenes and the iron minerals. 2. Find out about the commercial uses of feldspar and mica. 3. Find out about the various types of quartz such as amethyst, agate, and cairngorm.

**Page 4—FORMATION OF IGNEOUS ROCKS**

CONCEPTS: Igneous rocks are formed from hot, molten material called magma.

BACKGROUND INFORMATION: Igneous rocks are formed from molten material deep below the earth's crust. The hot molten material is called magma, which is under tremendous heat and pressure. Magma may force its way up near the surface of the earth through cracks in the rock strata. Lava, liquid magma that reaches the earth's surface, flows from volcanoes, cools rapidly, and forms rocks with small, fine-grained crystals or glassy appearances. Some examples of glassy, small crystal rocks are basalt, pumice and obsidian. Magma blocked from reaching the earth's surface by rock layers above it cools slowly below the land surface. Rocks formed under these conditions have large crystals and are coarse-grained in appearance. Some examples of this kind of rock are granite, gabbro, and diabase.

FOR FURTHER STUDY: 1. Find out about uses of pumice and granite. 2. Find out about lava and volcanic bombs. 3. Grow crystals from solution of salt, epsom salt, or sugar in water. (Allow the water to evaporate.)

**Page 5—KINDS OF IGNEOUS ROCKS**

CONCEPTS: Igneous rocks are usually divided into two categories—intrusive and extrusive.

BACKGROUND INFORMATION: Intrusive igneous rocks, formed below the surface and slowly cooled, have large crystals. These coarse-grained rocks

contain minerals that are recognizable by the eye or with a hand lens. Common examples are gabbro, granite, and quartz. Granite is found in many colours—white, pale pink, brownish red, yellow, and green. Three common minerals found in granite are feldspar, quartz, and mica. Because of its strength and durability, granite is used for a variety of things—ornamental columns, bridge piers, and road construction. It can be cut into different shapes and sizes and given a high polish. Quartz is easily recognized by its bright lustre and glasslike crystals that may be colourless, white, red, or dark grey. Extrusive igneous rocks, formed above the surface and rapidly cooled, have small crystals. These include such rocks as basalt, pumice, and obsidian. Basalt, a common igneous extrusive rock, is found in different colours—dark grey or green, purple, and black. When a basalt rock is broken, the broken surfaces are fine-grained and dull or velvety. Basalt is often crushed and used to surface roads. Sapphires have been found in basalt. Pumice, formed from lava, is very porous and lightweight. The lava cooled so rapidly that the gases did not have time to escape; the gases remained trapped while the lava cooled giving the rock a sponge-like appearance. Pumice can float in water. Pumice is found in many colours—white, yellow, grey, brown, and dull red. Where there have been violent volcanic eruptions, especially on islands in the Pacific Ocean, pumice is very common. Powdered pumice is used for cleaning and polishing purposes, including our teeth. Obsidian, formed from lava, is often called natural or volcanic glass. It is glassy-looking with no true crystals; it has the same chemical composition as commercial glass. Obsidian is found in different colours—black, grey, red, and brown. The colour is due to millions of tiny dustlike particles. Indians used obsidian a great deal for knives, arrowheads, spearheads, and jewellery.

FOR FURTHER STUDY: 1. Find out about tuff, flow or fluxion, and felsites. 2. Find out about common igneous rocks and minerals in your area. 3. Find out about the work of a lapidary.

**Page 6—FORMATION OF SEDIMENTARY ROCKS**

CONCEPTS: 1. Nearly all sedimentary rocks are formed from layers of sediments that have been compressed under water for long periods of time. 2. Most sedimentary rocks form layers or beds.

BACKGROUND INFORMATION: Sediments carried by streams accumulate beneath ponds, lakes, and oceans and become compressed to form layers or beds of sedimentary rock. When sediment-laden streams empty into larger bodies of water, the loss in velocity causes the larger and heavier particles to be deposited first. Smaller and lighter particles are carried away and settle farther from the mouth of the stream. The weight of the water plus the weight of the top layers press the sediment of the bottom layers tightly together. Chemicals found in the water deposit between the particles of sediment, fill the tiny spaces, cement, and form the sediment into rock layers. Common examples of sedimentary rock include conglomerates, formed by a compressed mixture of gravel usually deposited where rivers empty into larger bodies of water, sandstone, formed by compressed sand grains, and shale, formed by compressed layers of clay, mud, and/or silt. Some kinds of sedimentary rocks are formed by sediments which include the remains of tiny plants and animals and dissolved chemicals such as salt and calcium carbonates found in ocean water. Some examples are limestone and gypsum which are formed from corals, plants, shells, and dissolved chemicals.

FOR FURTHER STUDY: 1. Find out why fossils are most often found in sedimentary rock. 2. Find out how bituminous coal fields were formed. 3. Find out about loess, adobe, and clay.

**Page 7—KINDS OF SEDIMENTARY ROCKS**

CONCEPTS: 1. Sedimentary rocks are stratified because sediments settled in layers or beds. 2. The processes that formed sedimentary rocks millions of years ago are at work today.

BACKGROUND INFORMATION: Sedimentary rocks may vary in appearance and in their formation, producing a wide variety of rocks. Limestone is formed from marine organisms. It is rocks composed of the mineral calcite. Limestone is found in many colours—white, grey, black, red, and brown. Beds of limestone, often interbedded with shale, vary in thickness and often contain many fossil remains. It is used for building purposes—crushed and used in making Portland cement, floors, foundations, fertilizers, and insulation. Sandstone is made up of millions of sand grains cemented together. The material that cements the sand grains determines the colour and hardness of the sandstone. Colour of sandstone may be white, grey, yellow, buff, brown, or red. Sandstone is very porous; it can be soft, or it can be hard enough to be used for building purposes. Conglomerate rock, a mixture of gravel and pebbles, is cemented together by various materials. Rivers emptying into oceans or seas often produce vast beds of conglomerate rock. Conglomerate rock is used as decorative wall-stonework, building purposes, and crushed stone for roads. Shale, formed by clay or mud under pressure, is a thinly layered rock. It is found in many colours—grey, the most common, black, green, red, and brown. Some shales are used in making brick, tile, cement, and fertilizer. Oil is extracted from one kind. Bituminous coal, a compact mixture of plants and organic sediments, is known as soft coal. Some layers are shiny while others are dull. The colour of bituminous coal ranges from grey-black to a deep black. Bituminous coal beds are found throughout the world and range in thickness from a few inches to several feet.

FOR FURTHER STUDY: 1. Find out how salt is formed and mined. 2. Find out about anthracite coal, lignite, and peat. 3. Find out how layering in sedimentary rocks helps geologists tell about the relative age of rocks.

**Page 8—FORMATION OF METAMORPHIC ROCKS**

CONCEPTS: 1. Metamorphic rocks are formed from igneous, sedimentary, and other metamorphic rocks. 2. They are changed by heat and pressure. 3. Metamorphism causes a change in the texture and/or mineral composition of the rock.

BACKGROUND INFORMATION: Within the earth's crust, rocks are subjected to pressure and heat. The weight of overlaying rock strata may produce great pressures on the rocks below them. This great pressure causes a physical readjustment or alignment of the mineral particles. Pressure on rocks may also be caused by the folding of strata as in the mountain building process. As one goes deeper and deeper into the earth's crust, there is a corresponding increase in temperature. The average temperature increase is 12.5 °C for every km down within the crust. Temperatures around magma (liquid rock) intrusions are very high and may cause changes within the surrounding rocks. Often very hot gases and liquids associated with magma also cause a change in adjacent rocks. New elements may be added or elements may be removed. Water which may be part of the chemical structure of a mineral may be removed. All of these changes can cause an alteration in the chemical composition of the rock. Metamorphic rocks are characterized by change in their texture due to recrystalization and/or their change in chemical composition.

FOR FURTHER STUDY: 1. Find out about the effects of metamorphism on rocks containing fossils. 2. Find out the meaning of **dynamic** and **thermal** metamorphism.

**Page 9—KINDS OF METAMORPHIC ROCKS**

CONCEPTS: 1. Metamorphism usually produces notice-changes within the rocks altered. 2. In some cases the changes have produced rocks which are more economically useful to man.

BACKGROUND INFORMATION: Metamorphism can occur among igneous, sedimentary, and other metamorphic rocks. Often the original characteristics are profoundly changed. Metamorphic rocks may be more crystalline, more massive (dense), or have minerals arranged in parallel layers.

**Marble**—Limestone changes into marble. Various impurities in the limestone give marble its characteristic colour. Marble, because of its compactness, is an excellent building stone and is used for statues.

**Quartzite**—This rock comes from sandstone. Sandstone is composed of sand particles cemented together by various other materials. When crushed, sandstone breaks around the individual particles. Quartzite, however, has particles cemented by a silica material and when crushed, the rock breaks through the particles.

**Slate**—Sediments such as silt form the sedimentary rock, shale. When shale is subjected to metamorphism, it changes to slate. Slate is impervious to water, resistant to weathering, and easily splits into thin sections. These qualities have been utilized for its use as a roofing material. Volcanic ash may metamorphose into slate.

**Gneiss**—The various igneous granites may become changed into the rock called gneiss. It usually has a coarsely banded appearance consisting of successive dark and light bands. The dark bands may be the minerals biotite or hornblende and the light bands, the minerals quartz or feldspar.

**Anthracite Coal**—Bituminous coal becomes hard coal, anthracite. This rock is harder and has a greater carbon content than soft coal. Anthracite coal is found in areas of mountain building activity. Further metamorphosis may change it into graphite.

FOR FURTHER STUDY: 1. Locate the marble quarries in N. Italy. 2. Find out about the metamorphic rock, schist.

**Page 10—FORMATION OF SOIL**

CONCEPTS: 1. Weathering causes the break up of rock materials. 2. Soil is the material on the earth's crust that supports plants. 3. Soil is composed of weathered rock and humus.

BACKGROUND INFORMATION: Rock material that is on or immediately below the surface of the ground is subject to processes which tend to break up the rock into smaller pieces. These processes are called weathering and include such things as temperature changes, the wedging action of ice, the abrasive force of wind and water, and the activities of plants and animals. Heating and cooling of rock surfaces cause expansion and contraction which gives rise to small fractures. Water seeping into fractures and cracks may freeze and wedge apart fragments from the original surface. Wind-carried particles and water-carried particles have an abrasive action on rock and slowly wear away surfaces. Roots of plants in rocks may force apart fragments. Animal burrowings rearrange and wear away rock materials. Bare rock is the habitat for many types of lichens, specialized plants. The metabolic process of lichens causes a chemical dissolution of rock surfaces. Small patches of rock particles are established by this action and weathering which allow certain species of moss to grow. The "hair-like" structures of mosses allows more rock and decaying organic matter to accumulate. Soon a sufficient amount of humus is present to permit various grasses and herbs to become established that are able to exist in dry habitats. As other organisms move in, the amount of organic material is increased and soon there are formed pockets of soil deep enough for small shrubs to begin growing. The root systems of the plants help to retain the soil. Other soils may become established by the deposition of glacial material or of stream and wind sediments. The rate of soil formation may take as long as several hundred years for an inch of soil.

FOR FURTHER STUDY: 1. Find out about the succession of soil layers called the soil profile. 2. Find out about lichens. 3. Compare soils of the desert and jungle.

**Page 11—ORES**

CONCEPT: An ore is a rock or mineral mass that contains sufficient metal to be mined.

BACKGROUND INFORMATION: Rocks are made up of one or more minerals. Minerals are naturally formed chemical elements or compounds. Minerals may be grouped into four categories—gem minerals (diamonds, rubies, jade), silicious minerals (talc, feldspar, quartz), non-metallic minerals (sulphur, calcite, salt), and metal ore minerals (gold, mercury, bauxite). Gold ore, used in jewellery and coins, is a deep yellow colour. It is formed in various shapes—grains, nuggets, sheets. Zinc ore, bluish-white in colour, is not found in a pure form, but occurs usually as the carbonate, oxide, or sulphide. Sulphide is the main source of commerical zinc. The United States is a world leader in the production of zinc. The principal use of zinc is in galvanising iron and steel (prevents rust). It is also used in the making of batteries, paint, varnish, and glue. Most bauxite ore, a source of aluminum, lies near the surface of the land. Most bauxite deposits are barely ten feet thick. Cooking utensils, aircraft parts, and sheet metal are made of aluminum purified from bauxite. Galena ore, a common lead mineral, has a lead grey colour with a bright metallic lustre. Its crystals are usually large and cubed shaped. Lead is extracted from this heavy ore and is used to make pipes and batteries. Copper ore, with its reddish colour, has a metallic lustre. Copper occurs as crystals, grains sheets, or irregular masses which fill cracks in rocks. Because copper is malleable and ductile, it is used for many purposes—wire, coins, and electrical products. Haematite ore, with its brick red colour, is called red iron ore. It is a heavy ore with no lustre. This ore is a source of iron and steel which is used in thousands of products.

FOR FURTHER STUDY: 1. Find out how diamonds and rubies are formed. 2. Find out about magnetite and its early uses. 3. Find out about mercury, pitchblende, graphite, and talc.

**Page 12—USES OF ROCK**

CONCEPTS: 1. Man has found economic use for many kinds of rocks. 2. Many industries have been established for the extraction, processing, and utilisation of rock materials.

BACKGROUND INFORMATION:

**Granite** is a coarse rock composed of the minerals feldspar, quartz and/or hornblende or biotite. The red and grey varieties are commonly seen. Because of the hardness of its mineral constituents, granite has great strength and can be given a high polish. For these reasons it has been used as a building stone and for monuments.

**Slate** is quarried mostly in N. Wales. Its hardness, impermeability to water, and the ease with which it can be split into layers have made it an important roofing material.

**Marble** is an important building stone. The variegated varieties are popular. The colours are due to impurities in the original limestone. The pure white marble is sought after for sculpturing. Large marble quarrying operations are carried on in N. Italy and Skye.

**Gravel** is a term applied to various unconsolidated rock sediments which have a diameter of 2mm or more. Gravel may be composed of various kinds of rocks. The most common gravel used for concrete is found along streams or as glacial debris. It is often composed of flint which has been worn smooth by tumbling action. Gravel is also used as a road fill.

**Clay** is a soft material composed mostly of weathered feldspar. It is a component of many soils. The purer clays are used for making bricks, ceramics, and pottery.

**Limestone** is a sedimentary rock found abundantly throughout the world. It has been used as a building stone for centuries. The white, crystalline varieties of limestone have been used as substitutes for marble. Limestone is burned with clay to form cement. Cement can be mixed with water and when allowed to dry becomes as hard as natural rock. Cement mixed with sand and gravel forms concrete.

**Coal** is a kind of rock that was formed from decaying vegetation of Paleozoic swamps. Bituminous coal is a sedimentary rock. Metamorphism may change it into anthracite coal. The high carbon content of coal makes it a good fuel.

**Sulphur** is a nonmetallic substance. It is yellow in colour and very soft. Sulphur is mined in the USA, Sicily and Japan and is used for the manufacture of sulphuric acid, an important chemical to many industries. Sulphur is mixed with rubber to form vulcanised rubber.

FOR FURTHER STUDY: 1. Find out about the beautiful white marble from Carrara, Italy. 2. Find out how coal and sulphur are mined. 3. Find out about the use of clay in ceramics.

# ANSWERS

**Unit 1**—Review Quiz—Identification

1. a—conglomerate b—sedimentary 2. a—obsidian b—igneous 3. a—granite b—igneous 4. a—shale b—sedimentary 5. a—sandstone b—sedimentary 6. a—marble b—metamorphic

**Unit 2**—Review Quiz—True or False and Completion

True or False: 1. T, 2.T, 3. F, 4. T, 5. F, 6. F, 7. T, 8. T, 9. T, 10. F

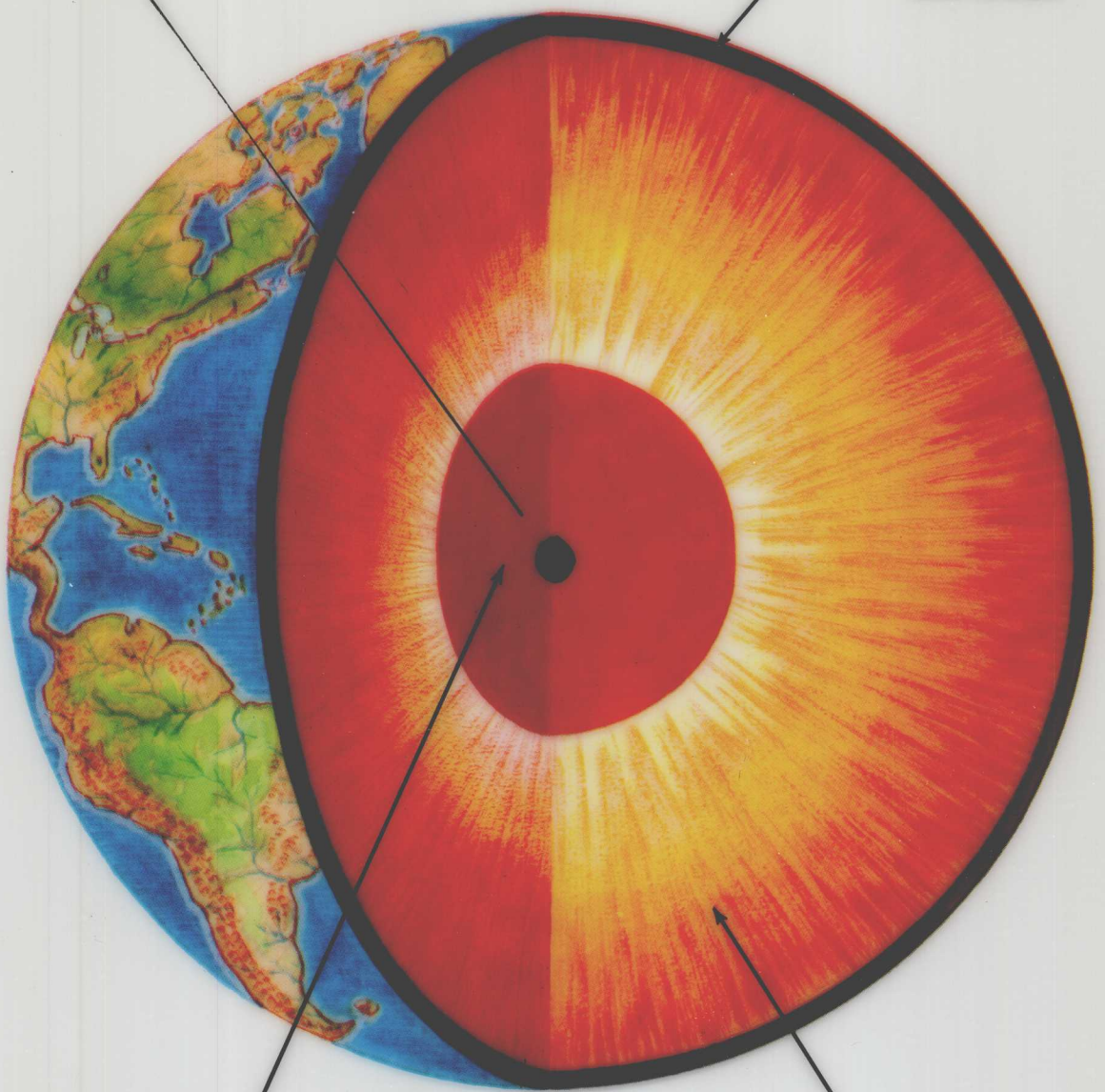
Completion: 1. core, 2. tile (porcelain), 3. conglomerate, 4. mica, 5. limestone (sedimentary), 6. metamorphic, 7. iron, 8. sulphur, 9. ore, 10. soil

**Unit 3**—Review Quiz—Matching Questions and Multiple Choice

Matching Questions: 1. e, 2. i, 3. g, 4. h, 5. a, 6. c, 7. l, 8. f, 9. b, 10. d

Multiple Choice: 1. 10-30, 2. weathering, 3. large, small, 4. magma, 5. feldspar, 6. igneous, 7. gold 8. shale, 9. limestone, 10. granite

# THE EARTH'S INTERIOR



# IDENTIFYING MINERALS


Carbonate Minerals
Calcite
Dolomite

## ACID TEST

Galena

Cubic

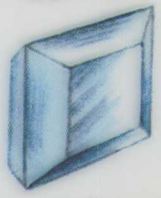
Quartz

Hexagonal

Sulphur

Orthorhombic

Gypsum



Monoclinic

## CRYSTAL SHAPE

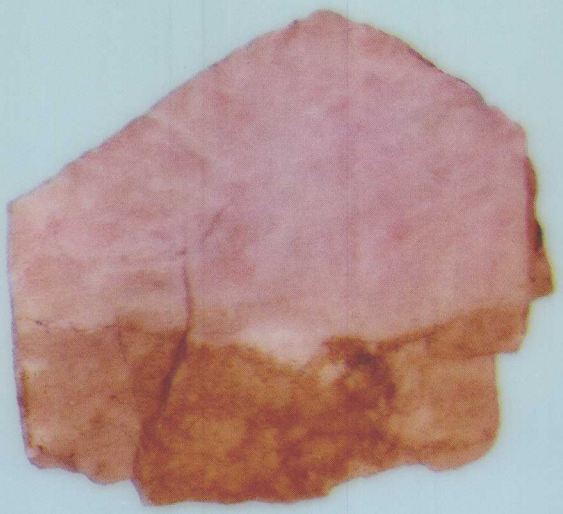

| Streak Colour | Mineral |
|---|---|
| lead grey | galena |
| green | olivine |
| yellow-brown | limonite |
| red-brown | haematite |
| black-green | pyrite |
| scarlet | cinnabar |
| light blue | azurite |

## STREAK TEST

1. Talc — softest →
2. Gypsum
3. Calcite
4. Fluorite →
5. Apatite
6. Feldspar
7. Quartz
8. Topaz →
9. Corundum
10. Diamond – hardest →

## HARDNESS TEST

# COMMON MINERALS

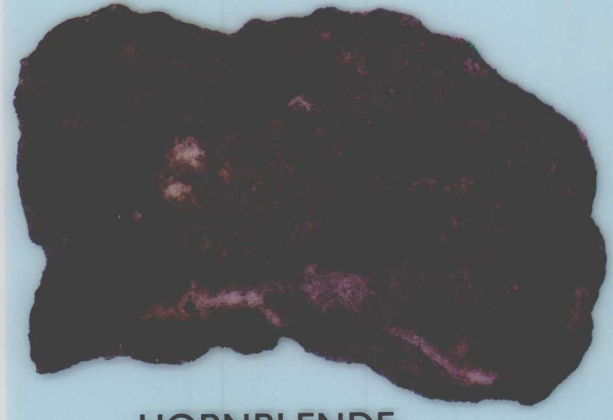


FELDSPAR

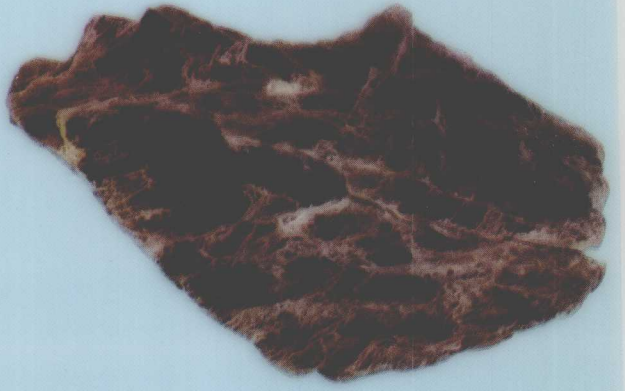
OLIVINE

QUARTZ

CALCITE



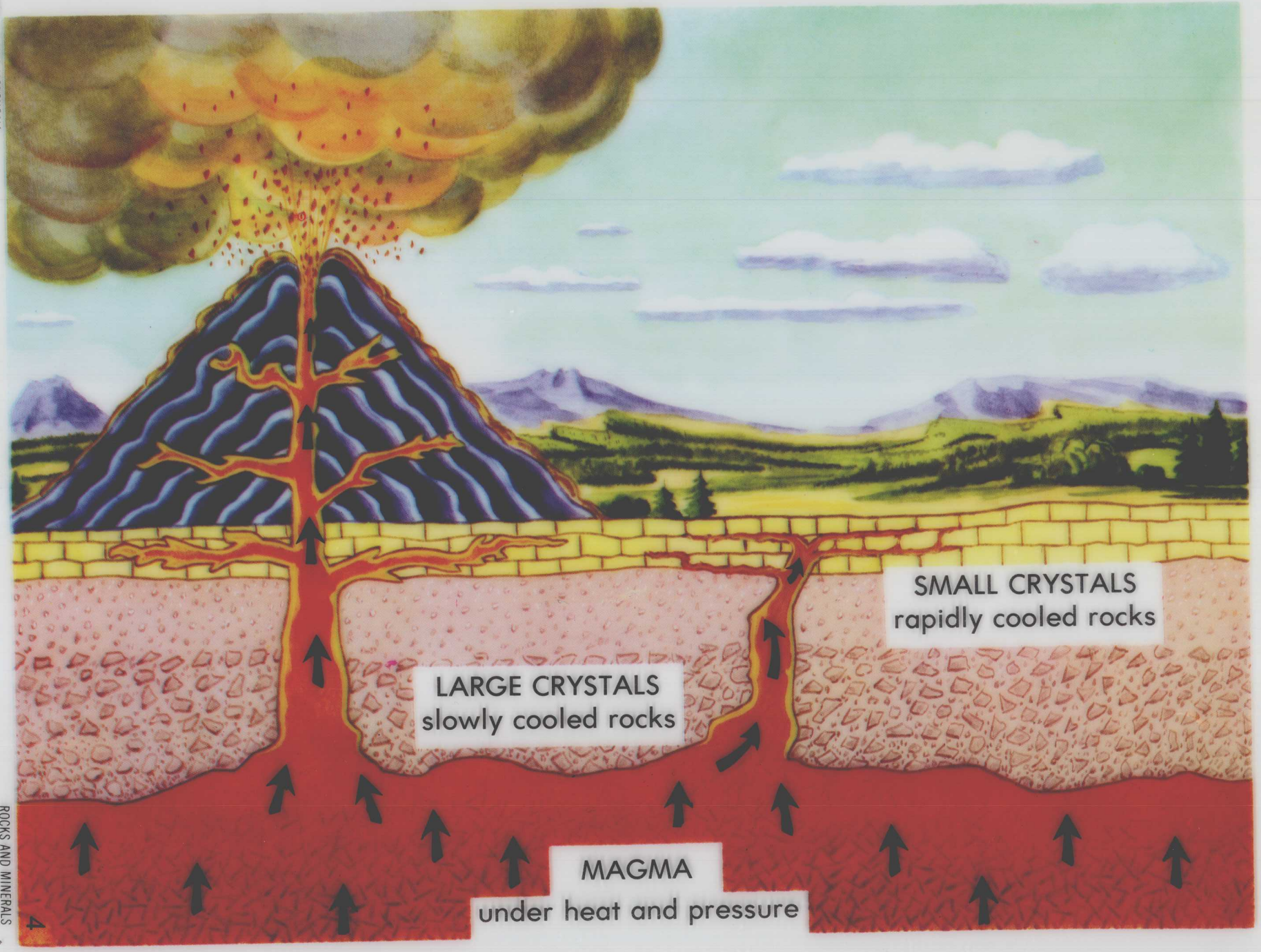
HORNBLENDE



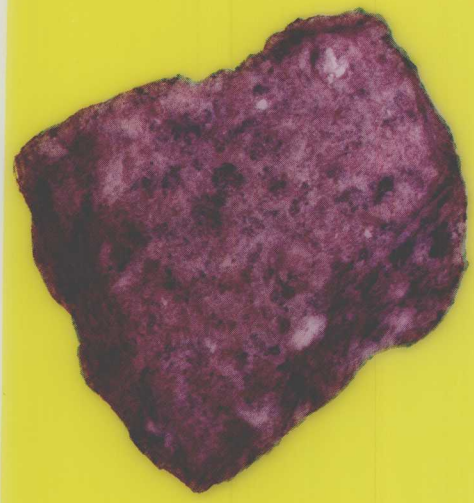
MICA

# FORMATION OF IGNEOUS ROCKS





# KINDS OF IGNEOUS ROCKS

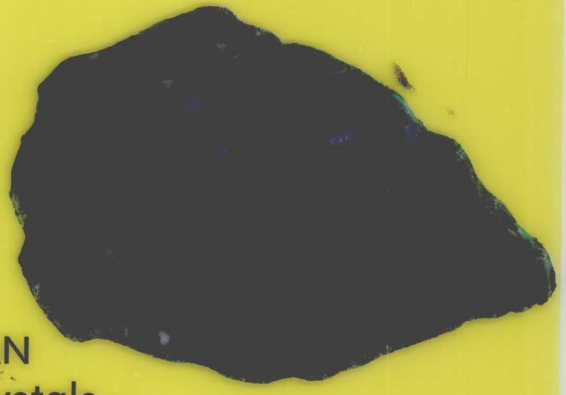


GRANITE
Large crystals—
formed below surface

BASALT
Small crystals—
formed above surface

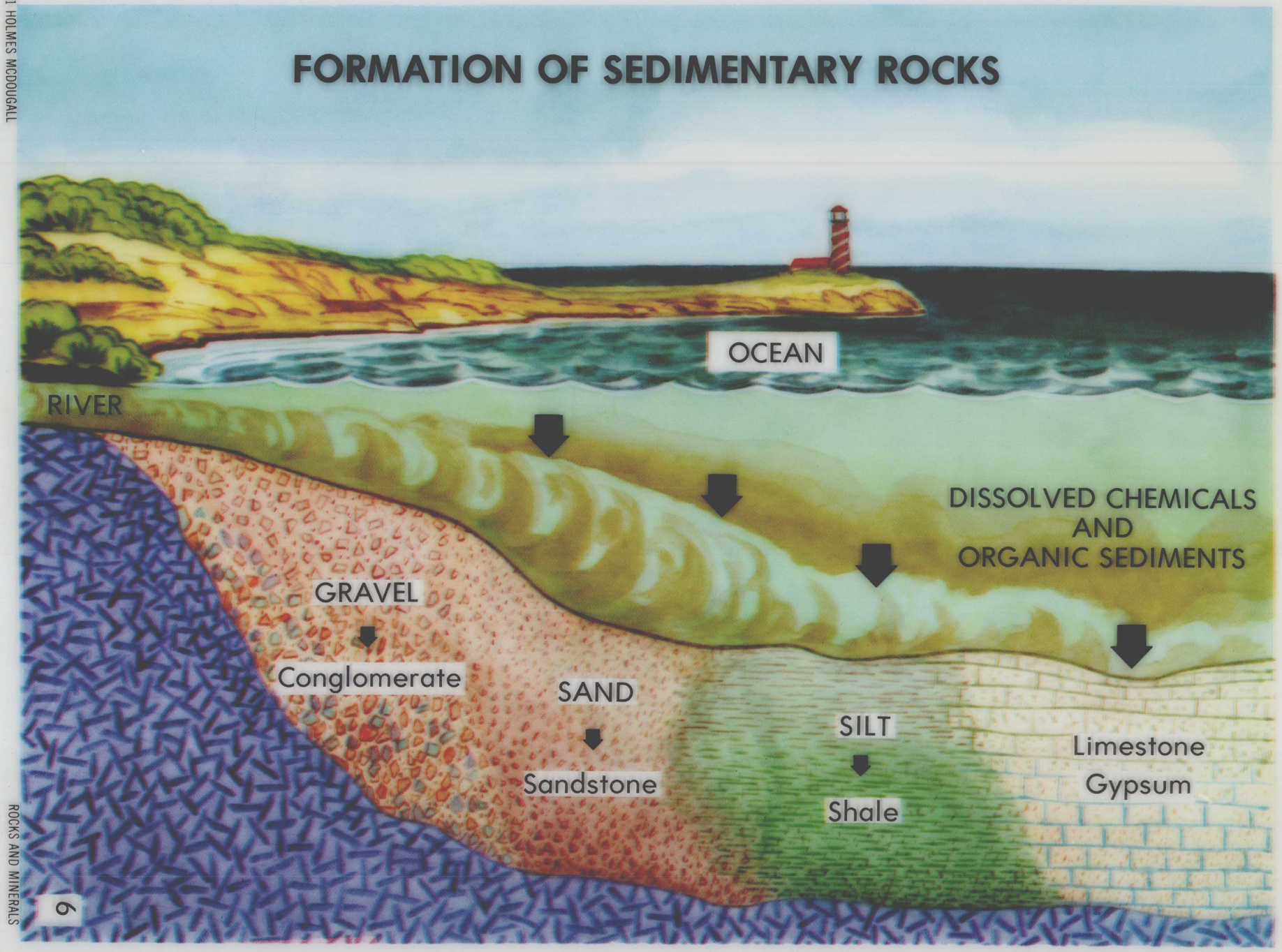
PUMICE
Small crystals—
formed above surface

QUARTZ
Large crystals—
formed below surface



OBSIDIAN
Small crystals—
formed above surface

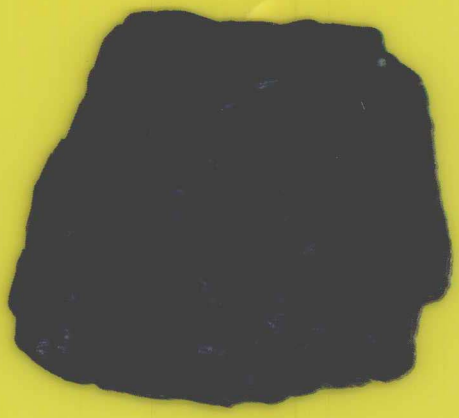
# FORMATION OF SEDIMENTARY ROCKS




Sediments from rivers accumulate and form layers of rock.

# KINDS OF SEDIMENTARY ROCKS

LIMESTONE
Lime sediments



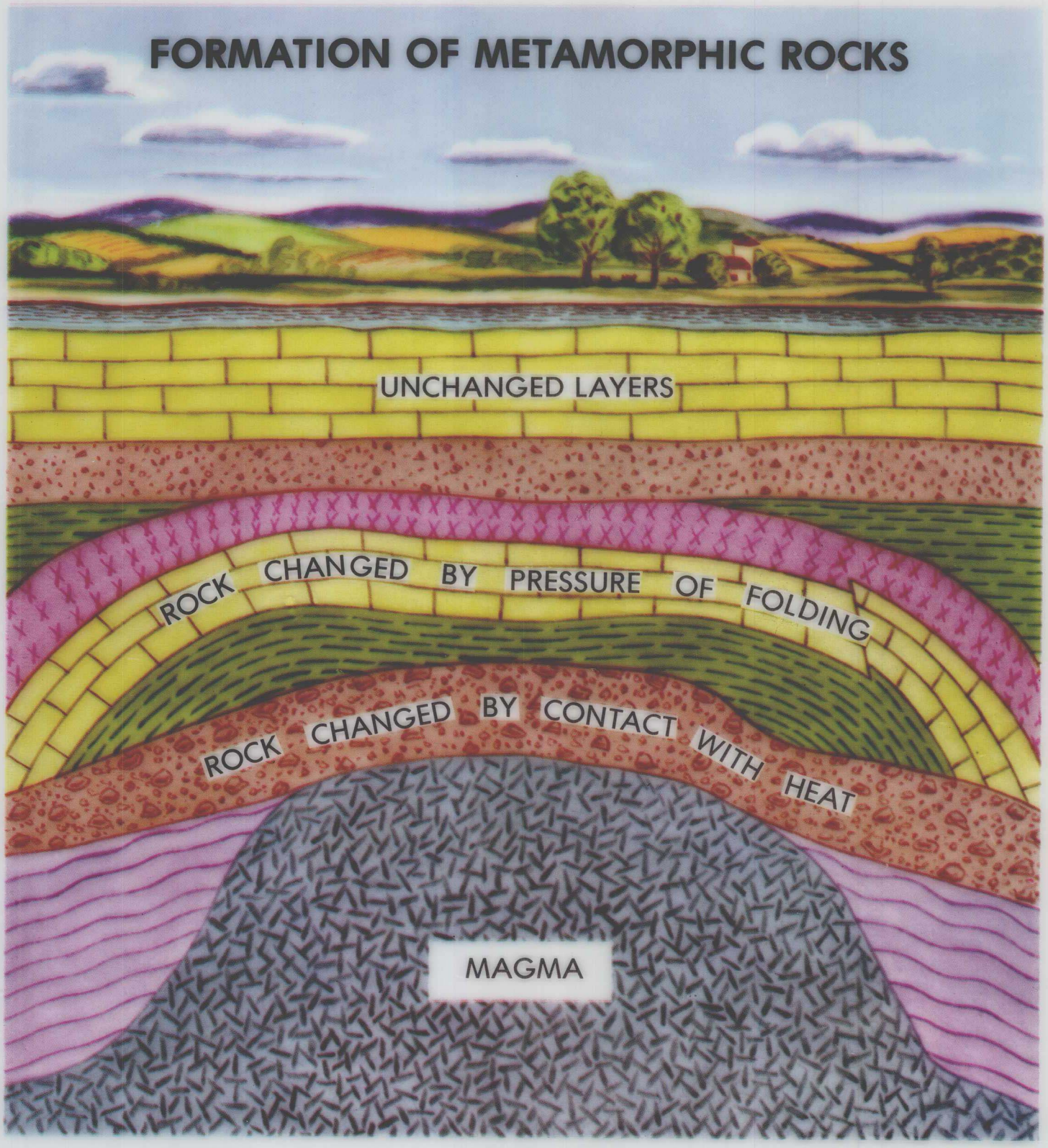
BITUMINOUS COAL
Mixture of plants and organic sediments

CONGLOMERATE
Mixture of gravel and pebbles

SHALE
Clay or mud sediments

SANDSTONE
Tiny grains of sand

# FORMATION OF METAMORPHIC ROCKS

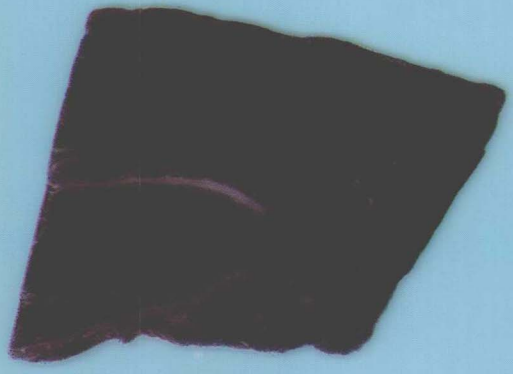



Formed at depths under the earth's surface
in regions of great heat and pressure.

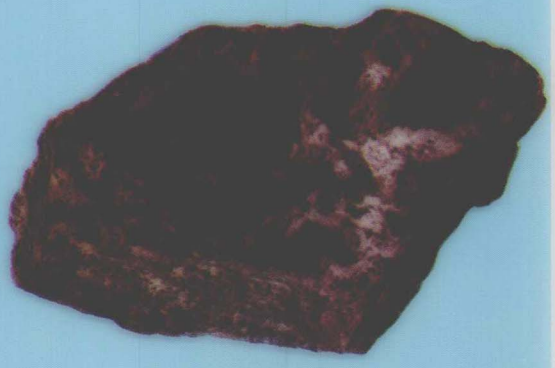
# KINDS OF METAMORPHIC ROCKS

MARBLE
from limestone

QUARTZITE
from sandstone



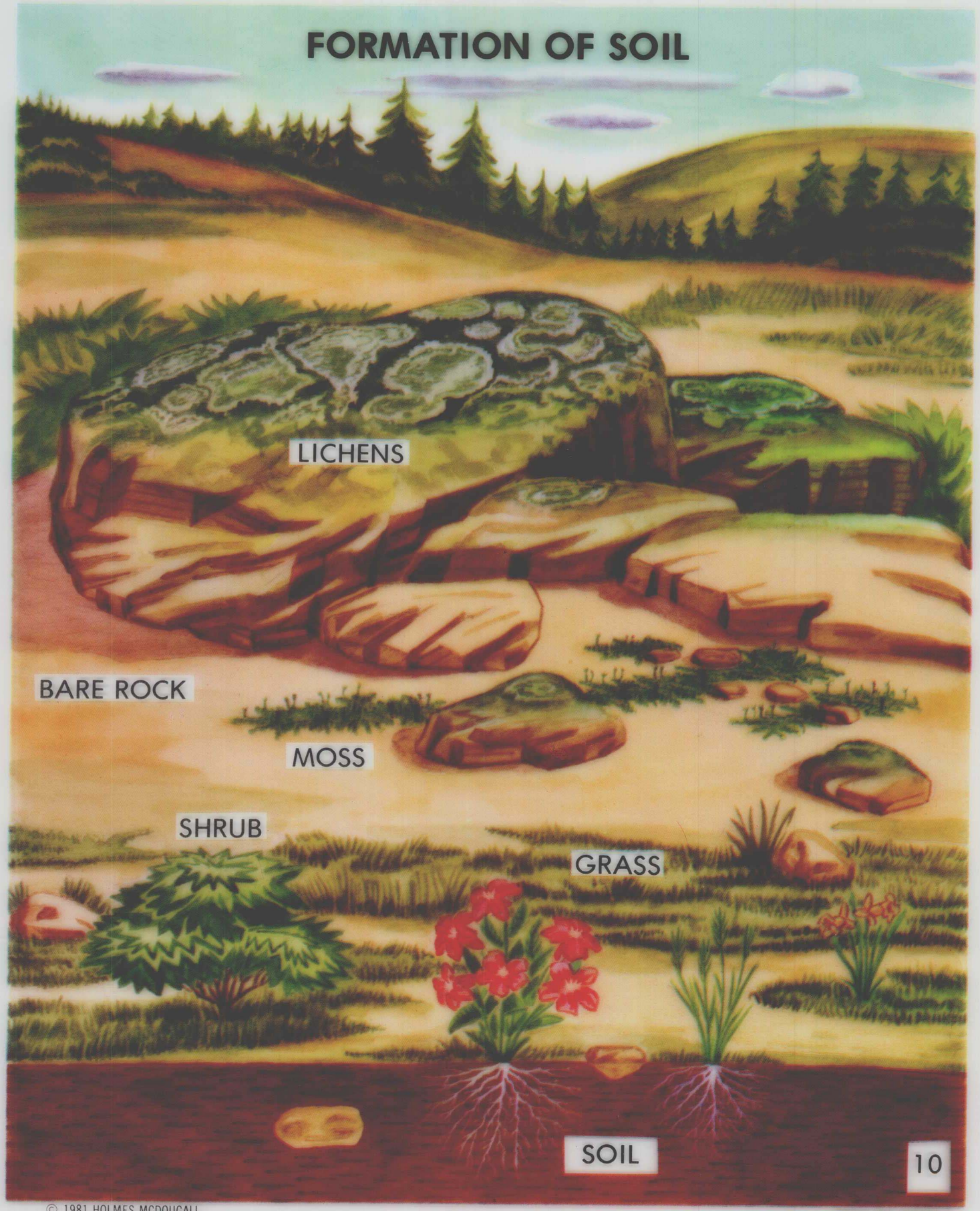
SLATE
from shale



GNEISS
from granite

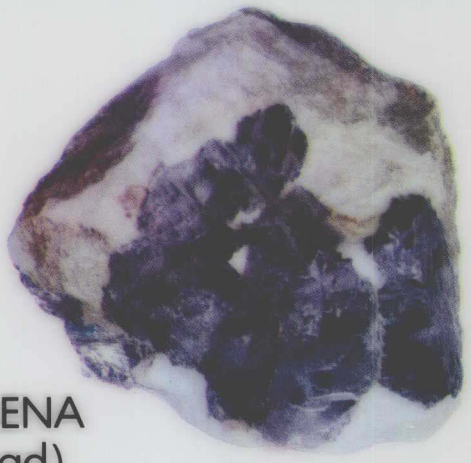
ANTHRACITE COAL
from bituminous coal

# FORMATION OF SOIL



# ORES

BAUXITE
(Aluminum)
Cooking Utensils—Aircraft



GALENA
(Lead)
Pipes—Batteries

GOLD
Jewellery—Coins

ZINC BLENDE
Galvanised iron and steel

COPPER
Wire—Coins

HAEMATITE
(Iron)
Steel—Motor Cars