Science Focus 7 - Unit 5

Teaching Notes

Edquest Resources 2001

Topic 1 – Minerals (pgs. 354-360)

Rocks contain naturally occuring, non-living minerals. Most minerals are rare and can be elements (pure substances) or compounds (combinations of pure substances). Minerals are not only found in rocks, but they are also found in your body.

Moh's Hardness Scale

- Friedrich Mohs developed a scale with 10 values of 'hardness' in 1812 (see Table 5.1 p. 355)
- Diamond is the hardest and talc is the softest (check the table to find out how hard common objects, like your fingernail)

Crystals

- Crystals are the building blocks of minerals. They occur naturally, having straight edges, flat sides and straight angles.
- There are 6 different crystal types: cubic, tetragonal, hexagonal, orthohombic, monoclinic and triclinic (Table 5.2 p. 355)

Identification of Minerals

The properties that can be used to identify minerals are:

- **Lustre**: this refers to the 'shininess' of the mineral (how light is reflected off the surface)
- **Colour**: colour can vary even within the same mineral, like corundum (it can be white, blue or red), depending on what other elements are present.
- **Streak**: a streak is the color, of the powdered form, of the mineral. (it can be made by scratching a porcelain tile)
- **Cleavage and Fracture**: is the way a mineral breaks apart. If it breaks along smooth, flat surfaces or planes, it has cleavage. If it breaks with rough or jagged edges, it has fracture.
- **Transparency**: it can be **transparent** (see through), **translucent** (shadowy), **opaque** (non-see through).

Applications

- Iron and pyrite help the blood carry oxygen
- Kidneys produce crystals, called kidney stones
- Calcium and dolomite help regulate water in body cells
- Diamonds are used in surgery, razor blades, computers, dentistry, oil drilling and a glass-cutter's wheel has diamonds embedded in it.

Topic 2 - Rocks and The Rock Cycle (pgs. 361-372)

Rocks are classified into 3 major groups

Igneous Rock

- forms when hot magma (or lava) cools and solidifies
- **Magma** is melted rock found below the Earth's crust
- Types of Igneous rock are:
  - **intrusive** (cooled and hardened magma below the Earth's surface
  - **extrusive** (rock that forms when **lava** – *magma released during a volcanic eruption* - cools on the surface)

- Magma can contain **crystals**, their size depending on how quickly or slowly the rock cools (large crystals form when the rock cools slowly)
- Investigation 5-B Forming Crystals p.362-363

Sedimentary Rock

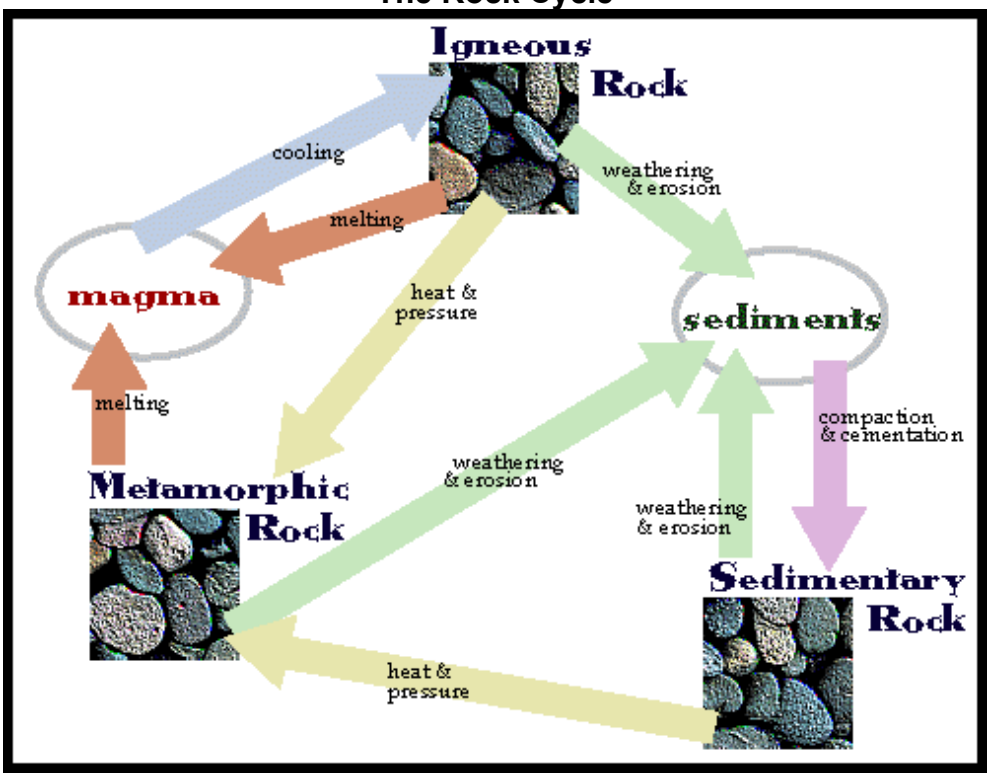
- is formed from sediment (loose material – rock, minerals, plant and animal remains - that is layered and **compacted** together by the pressure of the material above it)
- **stratification** is the visible evidence of the layers
- **cementation** - some of the minerals that dissolve with the addition of water, makes a natural cement that glues the pieces of sediment together.

Types of sedimentary rock include:
- shale (formed from fine clay or mud)
- sandstone (sand, made of quartz)
- conglomerate (pebbles and small stones cemented together)
- limestone (**organic sedimentary rock**, containing fossils - plant and animal remains)

Metamorphic Rock

This type of rock has changed its form from what it was originally. It is formed below the Earth's surface by extreme pressure and heat
- the parent rock will become another type of rock depending on how much pressure and heat is used to change it
- example: **shale → slate → schist**

The Rock Cycle



http://www.cotf.edu/ete/modules/msese/earthsysflr/rock.html

another visual

http://duke.usask.ca/~reeves/prog/geoe118/geoe118.001.html

Rocks are constantly changing. The Rock Cycle does not have a set order as they are weathered, consolidated, buried, melted and solidified

Techniques for Identifying Rocks

- appearance
- type of mineral/s present (viewed through a microscope)

Sediment and Soil

Some sediment becomes soil

- **soil formation** is determined by climate, type of rock present, amount of water, organic material, air spaces, living organisms in the soil.
- decaying material in the soil is called **compost,** when mixed with other matter, it becomes the dark-coloured portion of the soil called **humus**
- humus is rich in nitrogen, phosphorus, sulphur and potassium, which dissolve in water, making the soil **fertile** (supplying nutrients for plant growth)

Soil Profiles

Soil forms slowly over time.
It has been classified into layers, giving it a soil profile.

- **topsoil** (dark rich soil containing humus and small grains of rock
- **subsoil** (lighter in colour with little or no humus – contains minerals that have been leached from the topsoil) **Leaching** is the removal of materials in the soil that can be dissolved in water.
- the bottom layer contains partly weathered rock and minerals leached from above and closely resembles the **parent rock** below it.

Applications

- Igneous derived from Latin *ignis*, meaning *fire*
- Building and road construction, pulp and paper and ornamentation uses limestone (which is easily cut and shaped) and sandstone (which is easily mined)
- Space rocks land on the surface from Meteorites – which are highly magnetic and similar to earth rocks
- **Granirex** (made from granite) is a building material that is only 1cm thick. Find out more at http://www.granirex.com/

Also: this link provides details about the residential and commercial use of this product
http://www.cdkstone.com.au/granirex/gprodspc.htm

Topic 3 – Erosion (pgs. 373 – 381)

Erosion is the movement of rock and mineral grains from one place to another. **Weathering** (3 types) breaks down and wears away rock, creating sediment.

Mechanical Weathering

- the physical break-up or disintegration of rocks, caused by gravity, temperature change and **frost wedging**
- mechanical weathering 'wears away'
- sedimentation 'builds-up'

Chemical Weathering

- chemicals, present in the earth's surface or atmosphere, can be dissolved in water and react in the chemical decomposition of rocks and minerals (acid rain)

Biological Weathering

- living organisms (plants, animals, bacteria and fungi) can breakdown rock
- plant roots, acidic fluids produced by roots, bacteria, fungi and some insects and small animals can cause chemical reactions

The Changing Surface of the Earth

- agents of erosion include: glaciers, gravity, wind, and water
- changes can occur **gradually** (glaciers) or **suddenly** (flash floods, landslides, rock slides)
- large rocks caught up in a glacier and then left behind when the glacier recedes are called **erratics**
- sediment that is push away, as the glacier moves forward, are called **moraines**
- scratches, made in the bedrock, by glaciers carrying rocks are called **striations**
- gravity causes landslides and rock slides – eg. Frank Slide (a **retaining wall** can often be used to hold back unstable material – but this is not always the best protection)
- wind carries rock particles across the landscape, eroding the land by **abrasion** (planting vegetation, contour farming and reduced tillage can reduce the effects of wind erosion)

Water in Motion

- Water is one of the most powerful causes of erosion
- Sudden or incremental changes occur due to the movement of water - rivers, rain, ocean waves
- When a river becomes mature it begins to meander (curving its bed from side to side)

Applications

- Dinosaur Provincial Park (The Badlands)
- Road repair due to frost wedging
- Frank Slide Interpretive Centre
- Okotoks 'Big Rock' – an erratic
- Moraines in Banff national Park
- Athabasca River deepens the quartzite rock, making a canyon
- **Caving** – 'Discover what treasures the spaces hold' (especially the Castleguard Cave, near the Columbia Icefield (It is 18km long)

WRAP-UP p. 381

>>>> A good review of Topics 1 – 3 in this Unit <<<<

Topic 4 – The Moving Crust (pgs. 382 – 394)

The Earth's Interior

http://www.hcrhs.hunterdon.k12.nj.us/science/four.html
The **crust** is the top layer of the Earth. Below it is the **mantle**, which is made of rock material (upper part is solid, lower part is partly melted. The upper mantle and crust are called the **lithosphere**. Below the mantle is the core. The **outer core** is made up of mainly liquid iron and nickel, while the **inner core** is solid.

Evidence for Continental Drift

- Alfred Wegener
(http://www.hcrhs.hunterdon.k12.nj.us/science/alfred.html) collected evidence to explain the various shapes of the continents and how they were all together at one time.

Biological Evidence

- fossil evidence was found on different continents, like *mesosaurus, kannemeyerid* and *lystrosaurus* (see map on p. 383)
- along with the fossils and the interlocking shapes of the continents, Wegener concluded that the continents were joined together as one supercontinent **pangaea (pangea)**.
(http://www.hcrhs.hunterdon.k12.nj.us/science/pangea.html)
- his explanation is called the **Theory of Continental Drift**.

Evidence from Rocks

Mountain ranges were also compared:
- the Appalacian in North America and the range in Britain and Norway were made of the same kind and age of rock
- **Trilobites** in the Himalayas suggested that India was once part of Antarctica, which broke off and collided with Eurasia, putting the fossils of trilobites, from the bottom of the sea, high into the Himalayans.

Geological Evidence of Climate

- coal provided more evidence, because in order for it to form, a rich tropical plant environment must have been present – coal is found in moderate to cold climates
- evidence of even greater climatic changes were found in places likely covered by glaciers (these places are now far too warm to support the presence of glaciers), this suggested that the continents may have once been part of the south pole.

Response to Wegener

- after his findings were published, in a book called *The Origin of the Continents and Oceans,* Wegener's ideas were rejected, because the scientific community did not agree with his assumptions and explanation that the moon might be responsible for the movement of the continents.
- after his death, advances in new technology and the work of a Canadian Scientist led to a new theory that explained Wegener's observations

Advances in New Technology

- **sonar** (sound wave technology) identified the Mid-Atlantic Ridge
- **magnetometers** (electronic instruments that detect the direction and strength of a magnetic field) the magnetic field in the Atlantic sometimes pointed south, instead of north (these were called reversal strips)
- igneous rock contains **magnetite**, which lines itself with the Earth's magnetic field, as the rock hardens on the surface, the mineral particles maintain their alignment with the magnetic field, indicating that the reversal strips must have formed at a different time
- the pattern of magnetic reversal strips along the Mid-Atlantic Ridge meant the sea floor was spreading, leading to the **Theory of Sea Floor Spreading**. (as new rock forms, it takes on the magnetic polarity of the the Earth at the time of formation)

Deep Sea Drilling

- confirmation of the theory of sea floor spreading was provided by the ship, ***Glomar Challenger***, which brought drill samples up from the ocean floor (younger rock was closer to the ridge and older rock was closer to the continents)
- **lava** that cools very quickly on the ocean floor is called **'pillow lava**'.

The Theory of Plate Tectonics

All the evidence collected indicates that the Earth's crust is broken up into plates (see Figure 5.43, p. 390), which are moving on the Earth's mantle. The new theory is called the **Theory of Plate Tectonics**. Plates pushing together are called **converging plates**, whereas plates pulling aprt are called **diverging plates**. Tuzo J. Wilson (a Canadian Scientist) helped form this new theory, by suggesting the plates slide past each other.

Convection Currents

- a **convection current** is the circular flow within a fluid that is caused by the rising of warmer particles and sinking of cooler particles
- scientists believe it is this action, within the mantle, which is causing the plates to move
- the plates that collide, or converge have one plate above and the other below (these places are called **subduction zones**)
- subduction zones occur where the convection currents, in the mantle, cool and sink

Applications

- a **unifying theory** is one which explains several different natural events and landforms (volcanoes, earthquakes and mountains)
- **So**und **N**avigation **a**nd **R**anging (SONAR)
- **s**elf-**c**ontained **u**nderwater **b**reathing **a**pparatus (SCUBA)
- Submersibles are small submarines that enable divers to go deeper, protecting them from the pressure of the water
- satellites and lasers are used to measure incremental change (change that happens slowly) in plate movements
- '**black smokers**' are deep-sea (ocean floor) vents, where tube worms use the sulphur from the vents as an energy source

Topic 5 – Earthquakes (pgs. 395 – 405)

Earthquakes occur when tectonic plates move suddenly

Measuring Earthquakes

- scientists called **seismologists** use a **seismograph** to record the intensity of an earthquake
- the seismograph must be attached to **bedrock** (the solid rock that lies beneath the soil and looser rocks) to feel the vibrations on the plate
- a marking pen, inside the seismograph, records the vibrations on a rotating drum (modern seismographs are electronic)
- the measurement scale used is called the **Richter scale** (table 5.3, p. 396)

Earthquake Waves

- **seismic waves** are the energy waves that travel outward from the source of the earthquake.
- **aftershocks** are actually smaller earthquakes

Types of Earthquake Waves

- **Primary** or **p waves** are the fastest and can push through solids, liquids and gases
- **Secondary** or **s waves** travel more slowly and can only pass through solids
- **Surface waves** are the slowest of all, but their rolling motion can be very destructive (like a ripple effect on water)
- primary waves are bent or refracted as they travel (the area where they do not come through the other side of the earth is called a **shadow zone** – Figure 5.52, p. 398)

Locating an Earthquake

- it is possible to determine the location of an earthquake by the interval between the p waves and the s waves (the farther apart they are, the further away the earthquake is
- the source of an earthquake deep in the crust is called the **focus**, where the p waves and s waves originate
- the surface waves come from the **epicentre** (the location on the surface directly above the focus)

Earthquake Zones

- the zones of greatest intensity (8 or more on the Richter scale) 1 off Canada's west coast, 8 in Mexico, and 8 in Alaska

Types of Rock Movement in Earthquakes

- where the plates meet, the rock is under great pressure, which can make it bend and stretch – when the pressure is too great, the rock breaks suddenly creating a **fault**
- there are three types of movement, of the tectonic plates, along a fault (see Figure 5.54, p. 403):
  - **Normal Faults**, (pulling action, which breaks rocks apart) – *North Atlantic*
  - **Reverse Faults** (compression, where rocks are squeezed, causing them to bend and break) – *Marianas Trench, near Japan*
  - **Strike-Slip** or **Transform Faults** (shear causes slipping, which makes the jagged edges break off) – *Pacific Plate*

Preparing for Earthquakes

- stabilize furniture, storage of heavier items close to the floor, earthquake-resistant designs (allow building to bend a little)

Other Effects of Earthquakes

- **tsunamis** (Japanese word meaning 'harbour wave') are huge waves that happen when an earthquake occurs under the ocean
- **avalanches** or **rock slides** occur in mountains as a result of an earthquake
- type of foundation upon which building are constructed can have an effect on the severity of the earthquake (**liquification**)

Applications

- Ancient predicting device used a pot with eight dragon heads on it, with little balls inside the heads and frogs to catch the balls (the frog that caught the ball indicated the direction of the earthquake) p. 395
-Animals: rabbits hop wildly for several minutes, deep-sea fish swim close to the surface, catfish jump out of the water, bees evacuate their hives, and mice are dazed before an earthquake

Topic 6 – Volcanoes (pgs. 406 – 411)

A **volcano** is an opening in the Earth's crust that releases lava, steam and ash when it **erupts** (becomes active). The openings are called **vents**. When volcanoes are not active, they are called **dormant**.

Famous Volcaoes

- the most active volcano on the Earth is **Kilauea** in Hawaii (**Loihi** is a new volcano forming beside the main island in Hawaii – creating a new island)

- **Krakatau**, in Indonesia (blast was heard 4800km away and tsunamis waves were 30 m high)

- **Mount St. Helens**, in Washinton (sideways and vertical eruptions)

- **Mount Vesuvius**, in southern Italy (City of Pompeii was buried – it is due for another large eruption because it is sealed with a 'rock plug' that could blast 1.5 km upwards)

- **Mount Pinatubo**, in the Phillipines (ash circled the globe and cooled temperatures around the world)

Current Volcano update:
http://volcano.und.nodak.edu/vwdocs/current_volcs/current.html

- volcanoes that form a circle around the Pacific Ocean are called the **Ring of Fire** (derived from the circle of volcanoes that pour out red hot lava, fire and steam)

Applications

- Volcanoes on **Lo**, one of **Jupiter's moons** have been photographed using Vidicon – a type of TV camera mounted on the Voyager spacecraft, using an electron gun and photoconductor

- those on **Mars** and our **moon** have been extinct for millions of years, while those on **Venus** may still be erupting

- the largest volcano found in our universe is the extinct **Olympus Mons** on Mars

Topic 7 – Mountains (pgs. 412 – 417)

Mountain building takes many years. ***Cordillera*** is Spanish for mountain range.

Mountain Formation and Distribution

- most mountains are large areas that have uplifted due to the movement (converging, diverging or sliding) or heating of tectonic plates, where the build up of heat and pressure can cause folding and faulting
- sedimentary rock under slow, gradual pressure can fold (bend like plastic because they are made soft by the heat) or break – and can be changed to metamorphic rock in the process
- the upward, or top part of folded rock is called **anticline**, the bottom is called **syncline**
- rock that is too brittle to fold under heat and pressure, will break, called **thrust faulting**
- when older rock ends up on top of younger rock as a result of thrust faulting, the result is the formation of **fault block mountains**
- movement of rock along a fault can be vertical or horizontal and can be traced by the location of the '**basement rock**' on both sides of the fault (see Figure 5.68, p. 413)
- mountains can be formed by the convergence of continental and oceania plates (the Continental plate is lighter and rides over the Oceanic plate) a combination of processes creates **complex mountains**

Ages of Mountains

- mountains that are jagged at the top are 'young' mountains, while those that are more rounded (due to erosion and weathering) are 'old' mountains

Applications

- subduction of the **Juan de Fuca** plate (off the west coast of North America) has caused folding, faulting and uplifting, as well as magma has created volcanoes.
- the Himalayas are the youngest mountain range with the highest mountains (and still growing)
- one of the oldest ranges is the **Laurentian Mountains**, in Quebec (they are being worn down)

WRAP-UP p. 417

>>>> A good review of Topics 4 – 7 in this Unit <<<<

Topic 8 – Fossils (pgs. 418 – 422)

Fossils are preserved impressions in rock that tell us when, where, and how living organisms lived and behaved millions of years ago.

Types of Fossils

Remains of dead plants and animals that have been protected from scavengers can become fossilized in a number of ways:

- **petrified** (rock-like) fossils preserve the bones of dead animals by using silica
- an outline or impression from the carbon residue on rock surfaces can provide a **carbonaceous film**
- **original remains** may be preserved in tar, amber or peat bogs
- **trace fossils** are evidence of animal activity, like worm holes, footprints, and burrows

Dinosaur Finds

(Dinosaur Provincial Park is a world UNESCO Heritage site, where over 36 species of Dinosaur have be found – nearby, Burgess Shale in B.C. is also renowned because of the rich deposits of fossilized marine animal soft-body parts)

- ***Trilobites*** date back before the dinosaurs roamed the Earth
- ***Ammonites*** are common fossils found in Alberta
- ***Oviraptor*** (when a clutch of eggs were found with a fossil of this dinosaur, it was thought it was a scavenger, but further evidence indicates it was likely an overprotective parent)
- ***Gigantosaurus***, found in Argentina is heavier than Tyrannosaurus Rex, a carnivore.
- ***Seismosaurus***, a huge plant eater, was found in Mexico (its tail could move faster than the speed of sound)
- ***Bambiraptor***, a dinosaur, found by a 14 year old boy in Glacier National Park, Montana, may help to provide the link between birds and dinosaurs

Fossil Mould and Cast Formation

An animal dies in mud and gets covered by more sediment. The body dissolves, leaving a **mould**, which is then filled with more sediment and hardens into rock, making a **cast** of the original animal.

Topic 9 – Geologic Time (pgs. 423 – 427)

The **principle of superposition** states that in undisturbed layers of rock, the **oldest layers are always on the bottom** and the **youngest layers are always on the top**.

As new layers of sediment form sedimentary rock, the layers can be identified. This layering is called **strata**.

Geologists use a technique called **relative dating**, to find the order in which events occurred. The relative age of the rock is determined by its position within the strata. Fossils found in a layer can help to identify the age of the rock. If the fossil was on the Earth for a short time and widespread then it is called an **index fossil**.

Clues from Technology

- Over billions of years, some elements will change into other elements – uranium is such an element - in 4.5 billion years, half of the uranium will change into lead (which will not change). The uranium is called the **parent element**. This time period is called the **half-life** of uranium
- By measuring the amounts of change in a sample, scientist can clculate the absolute age of the rock. This is called **Radiometric Dating**
  http://pubs.usgs.gov/gip/geotime/radiometric.html
- Scientists also use a process called **radiocarbon dating** (which uses carbon-14, a rare form of carbon, as its parent material)
  http://www.cs.colorado.edu/~lindsay/creation/carbon.html
- All organisms take in carbon-14 to build cells and tissue. The carbon-14 changes to nitrogen gas (when the animal dies) in a half-life of 5730 years. The amount of carbon-14 left in the tissue allows scientists to determine the age of the remains

Geological Time Scale

The **geological time scale** is a division of Earth's history into smaller units based on the appearances of different life forms.
(see Figure 5.87, p. 426)

The largest divisions are called **eons**, which are divided into **eras** and then further divided into **periods**.

Rodinia (Figure 5.85) was the first supercontinent and ***Pangaea*** (Figure 5.86) was the second supercontinent (Ref. p. 425)

Topic 10 – Fossil Fuels (pgs. 428 – 432)

Petroleum is a naturally occurring mixture of **hydrocarbons**, such as bitumen, coal, oil and gas.

It is found in sedimentary rock basins, which were formed from the sediments of tiny plants and animals deposited in the mud and silt.

The soft parts of these organisms were transformed into solid, liquid or gas hydrocarbons called **fossil fuels**. (**Coal** is usually formed from plants that grew on the land, **oil** from water-based plants and animals and **natural gas** from land-based or water-based plants and animals)

– Another theory suggests that fossil fuels were trapped inside the Earth, at the time of its formation, and have been slowly rising to the surface.

Finding and Mining Fossil Fuels
(Western Canada Sedimentary Basin)

- Surface rock is studied and samples from deep below the surface to identify traps where oil and gas have accumulated within rock formations

- **Bitumen** is a heavy, almost solid form of petroleum. Some deposits can be mined (because they are close to the surface – like, in the Athabasca Tar Sands - sometimes using steam, or hot water to separate the oil and the sand)

- There are three ways that oil and gas can be trapped
  (see Figure 5.91, p. 429):

  - **A … thrust fault**
  - **B … normal fault**
  - **C … reef**

WRAP-UP p. 433

>>>> A good review of Topics 8 – 10 in this Unit <<<<