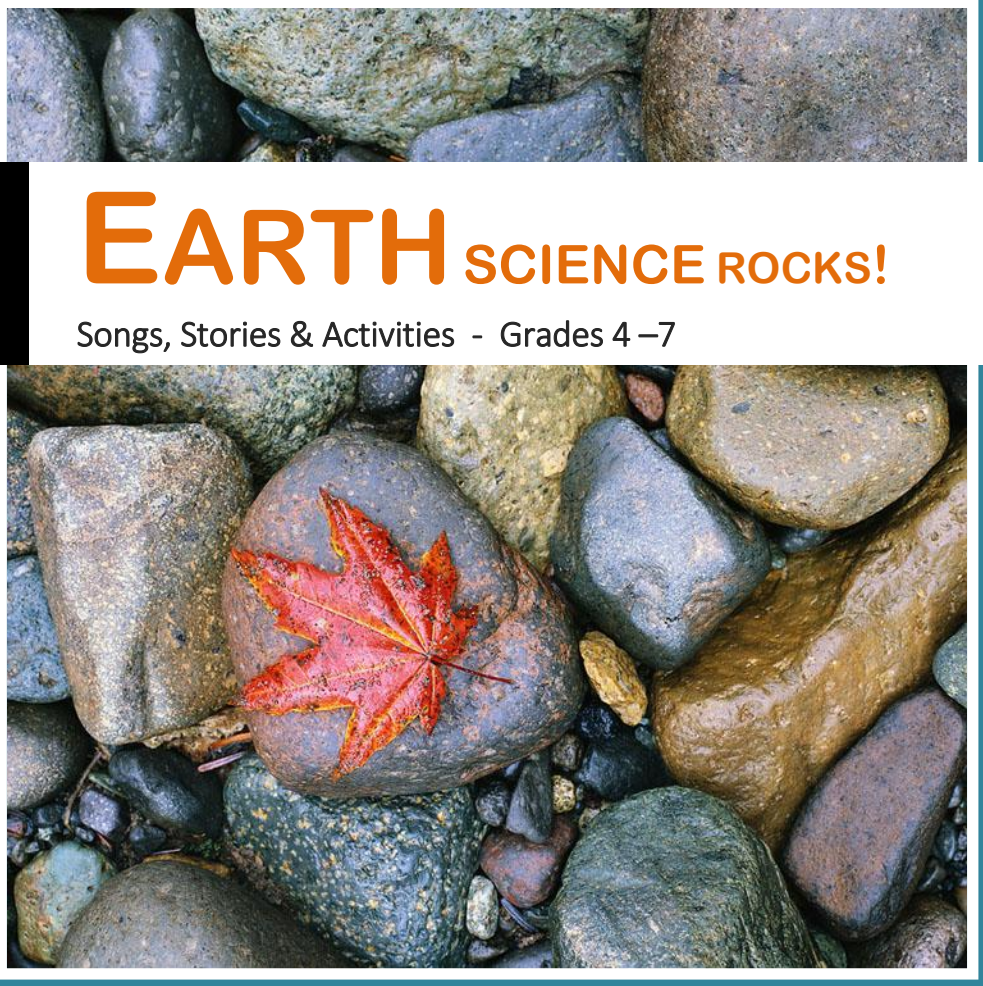
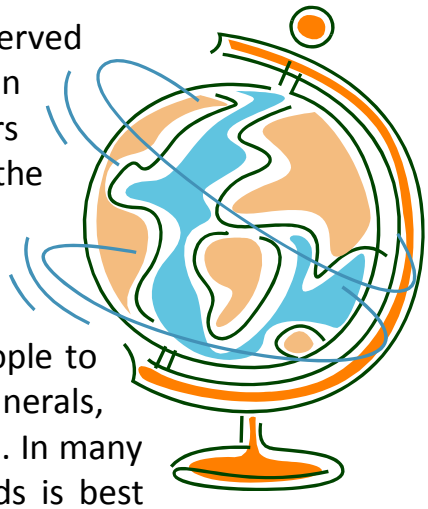


EARTH SCIENCE ROCKS!

Songs, Stories & Activities - Grades 4 –7

By Marjorie V. Reynolds

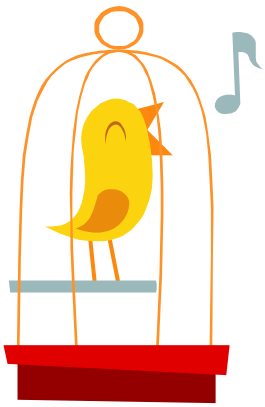
About the Author



Marjorie V. Reynolds, Ph.D., of St. John's, Newfoundland, served as a professional educator for many years, helping children with learning challenges, including twenty-four years teaching in classrooms and serving as a school clinician at the Child Guidance Centre of Greater Winnipeg. Her fascination with earth sciences, and as a 'rockhound' collecting mineral and rock specimens, has taken her around the globe. She has spent countless hours motivating young people to learn and appreciate the beauty and value of rocks and minerals, and to understand their importance and use in everyday life. In many schools, and even in some Hollywood studios, Dr. Reynolds is best known as 'The Rock Lady'.

This FREE activity e-book was developed as a learning tool for primary grade school teachers and students, and can be downloaded at:
www.ManitobaRocks.info

SONGS



Manitoba Minerals

(Tune: Alouette)

Manitoba, Manitoba minerals
Manitoba, that's the place to be!
We salute the garnet gems
That we find around Snow Lake
Garnet gems…at Snow Lake
Oh-hhh!
Manitoba, Manitoba minerals,
Manitoba, that's the place to be!

We salute the Bissett gold,
All the gold around Rice Lake
Gleaming gold…at Bissett
Garnet gems…at Snow Lake
Oh-hhh!
Manitoba, Manitoba minerals
Manitoba, that's the place to be!

We salute the spodumene
Mixed with quartz at Bernic Lake
Spodumene…at Bernic Lake
Gleaming gold…at Bissett
Garnet gems…at Snow Lake
Oh-hhh!
Manitoba, Manitoba minerals
Manitoba, that's the place to be!

We salute the nickel ore
Lustrous nickel at Lynn Lake
Nickel ore…at Lynn Lake
Spodumene…at Bernic Lake
Gleaming gold…at Bissett
Garnet gems…at Snow Lake
Oh-hhh!
Manitoba, Manitoba minerals
Manitoba, that's the place to be!

We salute the copper ore
Nickel, too, in Thompson mines
Copper ore…in Thompson mines
Nickel ore…at Lynn Lake
Spodumene…at Bernic Lake
Gleaming gold…at Bissett
Garnet gems…at Snow Lake
Oh-hhh!
Manitoba, Manitoba minerals,
Manitoba, that's the place to be!

We salute the Tyndall stone
With fossils in the Garson Quarry
Tyndall stone…in Garson Quarry

Copper ore…in Thompson mines
Nickel ore…at Lynn Lake
Spodumene…at Bernic Lake
Gleaming gold…at Bissett
Garnet gems…at Snow Lake
Oh-hhh!
Manitoba, Manitoba minerals,
Manitoba, that's the place to be!

We salute the sphalerite
Found at Lalor near Snow Lake
Sphalerite…near Snow Lake
Tyndall stone…in Garson Quarry
Copper ore…in Thompson mines
Nickel ore…at Lynn Lake
Spodumene…Bernic Lake
Gleaming gold…at Bissett
Garnet gems…at Snow Lake
Oh-hhh!
Manitoba, Manitoba minerals,
Manitoba, that's the place to be!

Dreaming of Tanco

(*Tune: Somewhere, My Love*)

Next spring, my friends…there will be rocks to find
But now the snow…covers the thought in mind.
The Tanco mine yields a rubidium ore
Now there are dreams of going back there for more.

Next spring, we'll go again, my friends,
Next spring, as soon as the grass breaks through!

We'll drive our cars out to the Tanco mine,
Warm is the breeze, the weather's usually fine.
"Til then, rockhounds, dream of lepidolite,
Spod, mica, quartz---at the Tanco pegmatite.

Gold in Manitoba

(*Tune: This Land is Your Land*)

This land is gold land…this land has gold mines
From the great north snowfields, to the southern parklands
From Snow Lake and Flin Flon, to the eastern border
This land has gold for you and me!

As we drive across each…Manitoba highway
We see above us, the bright blue skyway
On the land beside us, there's gold with pyrite
This land of gold's the place to be!

We travel this land in…old timers' footsteps
To the glittering gold mines, at Bissett and Rice Lake
And from the distance, their voices call us
This land had gold for you and me!

Out in the Field

(*Tune: Home on the Range*)

I'll look for some land
Where trees and rocks stand
Where no rockhound has e'er been before
'Tis there I'll enjoy
Watching clouds in the sky
While I sample the earth for some ore!

Out, out in the field
Where no rockhound has e'er been before
Where good ore is found, many minerals abound
And the land is so rich to explore.

When I go near Snow Lake
And the right road I take
There I find lots of garnets, for sure
At their beauty I gaze
As I stand in a daze
And admire all the gemstones galore. *(chorus)*

I'll head further west
Filled with hope, joy, and zest
"Til I come to an untrammeled field
Geiger counter in hand
I'll roam through the land
For the gold, as the earth starts to yield. *(chorus)*

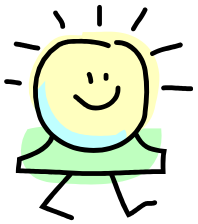
Seeking Selenite

(*Tune: Good King Wenceslas*)

Bright-eyed rockhounds went to dig
Right along Winnipeg's floodway
Where the mud was soft and thick
Very near the highway
Brightly shone the sun that day
But we had some showers
Just enough for slippery mud
And we stayed for hour--s!

First we looked for spots of white
That had reached the surface
Busy digging out a hole
Clearly we had a purpose
After digging down three feet
Working with supreme care
We did find to our dismay
Styrofoam was crush-ed there.

Persevered where others quit
Hope had kept us working
Metal coat hang-ers in mud
Probed for something lurking
All at once we hit a bump
Diligence rewarded
One clear selenite crystal found
Took two hands to hol-d it!



Load the Trunk

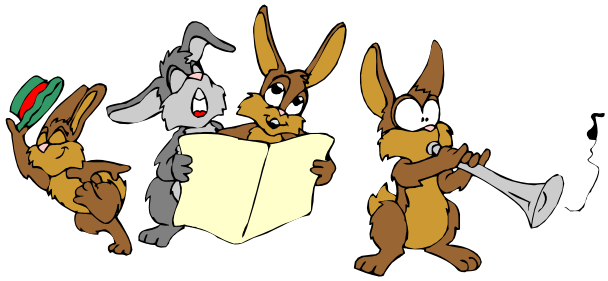
(Tune: Deck the Halls)

Load the trunk with rocks to polish,
Oh, oh, oh, oh, oh, oh, oh, oh, oh!
Re-arrange the pails and boxes,
Oh, oh, oh, oh, oh, oh, oh, oh, oh!

Souris has so many treasures,
Ho, ho, ho, ho, ho, ho, ho, ho, ho!
To prepare for yuletide pleasures,
Ho, ho, ho, ho, ho, ho, ho, ho, ho!

Busy days are now a-coming,
Oh, oh, oh, oh, oh, oh, oh, oh, oh!
Saws and polishers are humming,
Oh, oh, oh, oh, oh, oh, oh, oh, oh!

See the agate, wood, and jasper,
Ooo, la, la, la, la, la, la, la, la!
Sparkling in the joy of shininess
Ooo, la, la, la, la, la, la, la, la!



Quality Control assures us
Ooo, la, la, la, la, la, la, la, la!
That the stones are smooth and glorious
Ooo, la, la, la, la, la, la, la, la!

Moved by glaciers, they made history
Ooo, la, la, la, la, la, la, la, la!
Now unfolds this cycle's destiny
Ooo, la, la, la, la, la, la, la, la!

We Three Rockhounds

(Tune: 'We Three Kings')

We three rockhounds for pet-ri-fied wood
Went to Souris, there it was good
First, to the Rock Shop, for per-mission
And there we understood…

> *O---rock of wonder, rock of might*
> *Rock with natural beauty bright*
> *We shall find you, we'll admire you*
> *Lead us to your present site.*

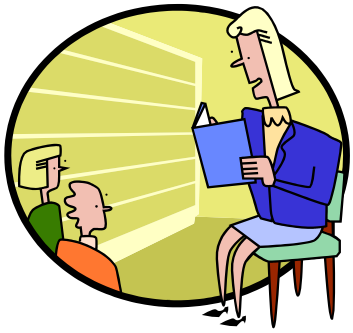
Brought by glacier from a snow land
Settled in Souris, looking so grand
Safe forever, wandering never
Now here with us in sand...

O---rock of wonder, rock of might
Rock with natural beauty bright
We shall find you, we'll admire you
Lead us to your present site.

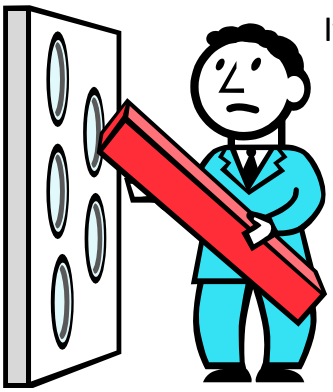
Gentle polish we offer to you
Gold and silver protection we'll do
Pendant or bracelet---genuine jewelry
Loving your beauty anew…

O---rock of wonder, rock of might
Rock with natural beauty bright
We shall find you, we'll admire you
Lead us to your present site.

STORIES



From Knotty to Gneiss



It often happens that a knotty or challenging problem, over time, can have its components amplified for easier viewing and aligned for better insight and understanding. Since the constituents of the human body are found in the dust of the earth, and since rocks log or record nature, the rock cycle might be viewed as a metaphor for the human condition.

Let's start with sediments; they began to happen a long time after the beginning of the first rock.

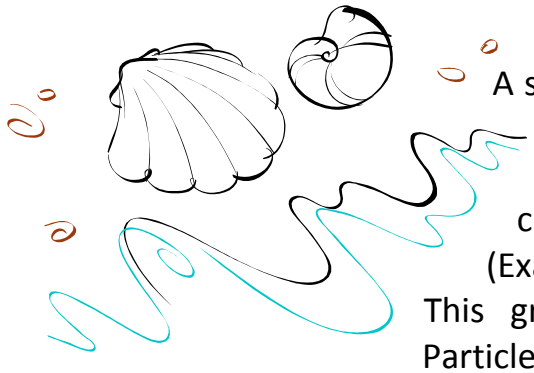
The term *sedimentary* comes from the Latin *sedimentum* and means *settling.* The new rocks form by the settling and the layering of pieces of weathered rock. One layer covers another layer. One category of sedimentary rocks forms as a result of water, wind, and/or ice.

The sediments (knots, knotty materials, knotty problems) --- clay, pebbles, and sand---are known as mechanical 'detrital' (worn away by friction) or 'clastic' (fragmentary) pieces. In human terms, these might represent areas of life that we might shed through a long and sometimes challenging process of maturation, preparing us at last for a 'renewed' self.

Conglomerates (big knots) in sedimentary rock are composed of gravel or large-sized rounded pebbles. They have been tossed around quite a lot by water---sometimes very deep water. Rough water does the job much faster than calm water. Smooth water would require a lot of time to soften so many rough edges.

Breccias are freshly-broken fragments (or stressors) which have been cemented together without having their edges made smooth and refined. They have to await another 'cycle' for some fine-tuning or polishing.

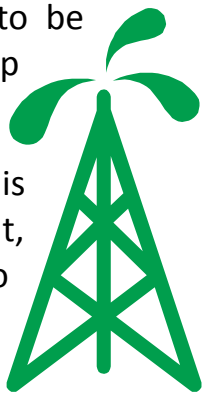
Sandstone has smaller particles (knots), but the composition is the same.



A second group of sedimentary rock is formed by the hardening of compressed seashells composed of carbonate minerals and silica. Minerals become crystallized in solution (as in sea water), (Example: limestone made of calcite and dolomite). This group is known as chemical sedimentary rock. Particles carried by streams also build deposits. With multiple layers built up over many thousands of years, the sediments (knots) become compressed by heavier and heavier weight.

Shale is a fine-grained sedimentary rock composed of clay or silt-sized particles (small knots). These particles split along planes (areas of weakness) and form 'platy' slabs. Clay particles are flat plates which are compressed into rocks, aligning the crystals to make them horizontal.

The alignment is termed 'bedding'. Layers result as an accentuation of bedding planes. Shale often contains tiny crystals and particles too small to be observed with the naked eye. This fine-grained material can trap liquids---oil and water.



The most distinctive feature of sedimentary rocks is 'stratification'. It is cover-up after cover-up until the pressure becomes so great that, eventually, change---transformation---happens! Nature handles it so well that the change is appropriate, beautiful, and serves a purpose. The characteristics have changed, morphed to become stronger, and the rock gets a new name.

The term *metamorphic* is derived from the Greek word for *change of form.* Metamorphic rocks form from the alteration of other rocks. They have been changed, or 'morphed', through the action of heat and/or pressure. The result is a reorganization of the components of the rock.

In some instances, the change covers a large region. In other cases, the change occurs in only one small area.

Humans, too, often may change only one small area of their lives or character at a time and, at other times, may experience a major, overall change.

Sometimes, minerals formed in a given condition become unstable in a different setting, experiencing change in attitude or orientation. The chemical constituents re-combine in a form which is more stable in meeting the new condition. The result is re-crystallization, a new structure.

The process involves heat, pressure, and fluids. Heat makes the chemicals more mobile and allows them to combine more easily. It causes the minerals to re-crystallize, either forming new crystals or increasing the grain size. (Example: limestone)

Sometimes pressure in rocks reaches great depths---a depth of five miles will result in 50,000 pounds per square inch. The effect is similar to that of heat. Sometimes the pressure on rocks over a long period of time pushes the individual grains into alignment. The extreme case is known as '*foliation*'--- rocks are squeezed until they bend or break.

A refining process goes through the 'soul' of the earth. Mixtures of hot gases and solutions, fluids, are associated with 'magmatic' activity.

Change takes place beneath the surface before it becomes observable. Fluids enable crystallization by carrying the chemicals. A characteristic feature of metamorphic rocks is a change in texture. The grain size tends to increase. The result: the crystal form is greater, stronger, and often more dramatic and more beautiful.

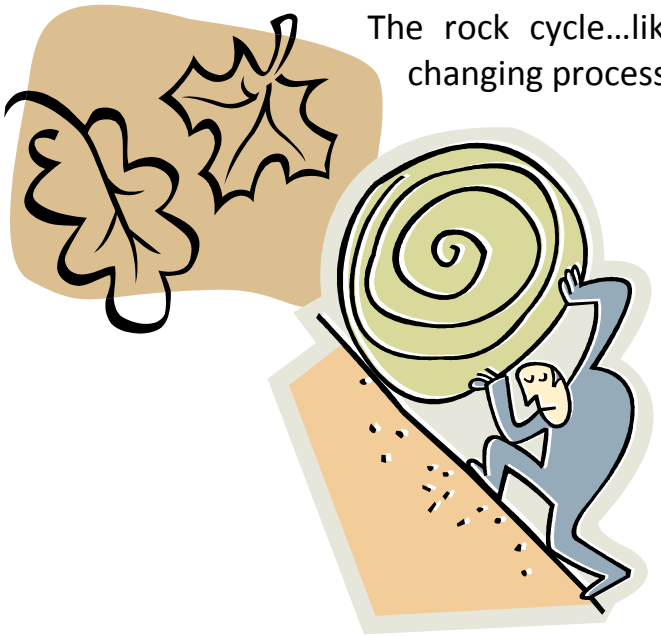
Slate is formed from the low-grade metamorphism of shale. Some minerals re-crystallize to become mica or chlorite. The alignment of the mineral grains allows the slate to break along flat sheets. Schist, re-crystallized from any other rock, tends to break between the layers but often has an uneven surface. Some minerals in schists are: chlorite, hematite, mica, and talc.

Gneiss (pronounced '*nice*'), a coarse-grained (enlarged crystals) banded rock, is produced by high-grade metamorphism. It does not split along planes of weakness. In gneiss, minerals are arranged in parallel layers.

Quartz and feldspar (light) alternate with ferromagnesian (dark) minerals, creating 'banding'. The knots have not disappeared, but are reframed as part of the developmental stages in the transformation of a 'petros' (Greek word for 'rock').

A rock which has been re-formed to make the piece more balanced, strong, and well-organized, such as gneiss (*nice!*), displays both physical beauty and mathematical elegance to the trained geological eye. A nicely-polished, brightly-colored, metamorphic rock is always a delight to observe.

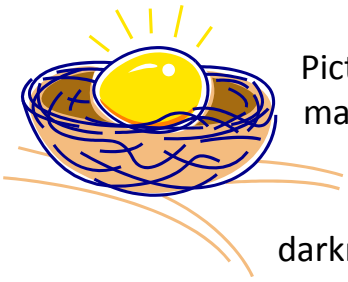
All types of rocks are involved in a 'cycle' in which some of them become changed gradually into others. Rocks are constantly being abraded, deformed, melted, pushed, rolled, soaked, and squeezed. Chemical elements in rocks are repeatedly separated and re-mixed by geological processes.



The rock cycle…like the seasons in nature, is an ever-changing process.

From Darkness to Light: Igneous Rocks

Igneous rocks form the 'foundation' of all rocks on earth---and perhaps on other known rocky planets as well. These rocks are made up of only a few minerals (quartz, feldspar, mica, amphibole, pyroxene, and olivine are the most common). A very well known and common igneous rock is granite. Some large crystals grow in the darkness of the earth and are almost unobservable when the rock cools above the surface. Below the earth's crust… is total darkness. To get to the light, requires some effort and movement.

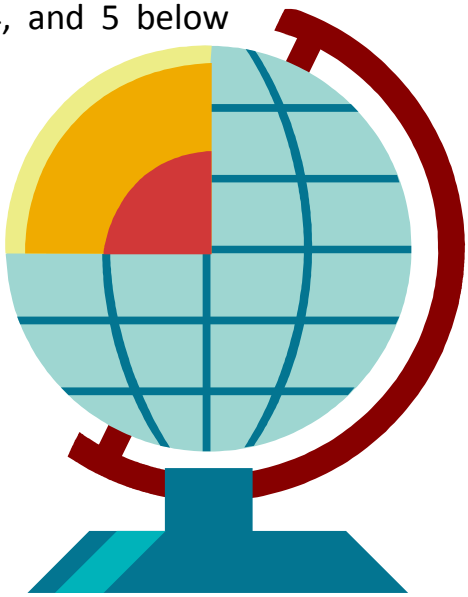


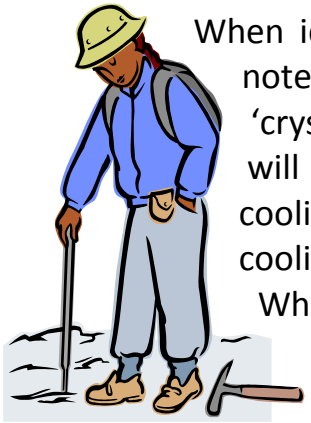
Picture a chick developing inside an egg, then magnify the effect many hundreds of thousands of times over, and you will understand more about what's taking place as rock forms below the earth and struggles to 'break through', from darkness to light.

A rock's 'texture' is determined by the way magma enters the crust of the earth. When a hot, molten mass of magma crystallizes, or consolidates, it forms igneous rock. When carbon is erupting within the earth, it has to reach the light and air at the earth's surface within five-to-six hours to form 'diamond'. Otherwise, carbon will form slowly as graphite. Both diamond and graphite are valuable and useful.

The earth consists of seven layers: (Numbers 3, 4, and 5 below constitute about 67 % if the earth's mass)

1. Inner core: solid; Ni-Fe
2. Outer core: liquid; Ni-Fe; moving constantly
3. Lower mantle
4. Transition zone
5. Upper mantle
6. Crust (about 50 km deep)
7. Atmosphere





When identifying a rock, one important geological highlight to make note of is 'grain' size. Grain size is related to the speed of 'crystallization' (how quickly cooling occurs). The details of cooling will produce different 'textures'. There can be two stages in the cooling process, as in porphyry, (example: when magma has a slow cooling period deep in the crust, large phenocrysts can develop). When the magma moves higher into the crust, or to the surface, the remainder of the magma will crystallize more rapidly and will produce a finer-grained matrix.

In a coarse-grained rock, (example: gabbro and granite), the crystals are easily identifiable. In a medium-grained rock, (example: diorite), the 'grains' can be seen with a hand lens. In fine-grained lava, (example: rhyolite and basalt), since the grains cannot be observed by a hand lens, a polarized light is used on a thin slice of the rock to observe the beauty of the crystals. Some magma originates in the earth's mantle at hundreds of miles below the surface. Low in silica, it is 'ultra-basic'. Basic rocks have a low composition of silica and have dark coloration; acid rocks have a high composition of silica and are light in color.

Ultra-basic rocks are rich in iron and magnesium. Magma from the mantle is ultra-basic, yet, it can have a variety of rock through magmatic differentiation.

In terms of chemistry of rocks, it is possible for rocks with over 65 % silica to come from magma from the earth's mantle. Pre-existing rocks can produce magma of high silica content.

In the development of a rock from molten material within the earth, igneous rocks represent the final product of the magma. Igneous rocks are rich in volatile elements and they consist mostly of silicates. Deep in the earth, they form by the fusion of pre-existing solid matter. Partial melting of the layer of earth just below the crust---the upper mantle---produces primary magma. Usually it is basaltic. It comes to the surface through eruptions or by injection into cracks in the crust.

Other magma, derived from basaltic melt, also comes to, or near, the surface. Rock masses which originated on the surface, or are residing there, sometimes sink to considerable depths below the crust and reach pressures at which some minerals with low melting points are fused, or melted. These magmatic masses, or 'anatectic' magmas, produce new igneous rocks. They tend to move upward slowly, usually into fractures, and are seen as veins of granitic composition. Magmas tend to re-crystallize, and to be re-molded.

The first minerals to crystallize from basalt at high temperature are spinels (chromites) and sulfides. At lower temperatures, olivine (rich in iron and magnesium) crystallizes. It is followed by pyroxene, amphiboles, and micas. Primary basaltic magma and granitic anatectic magma tend to occur apart from each other. Basalts and their derivatives comprise a high percentage of volcanic rock and they occupy much of the ocean beds.

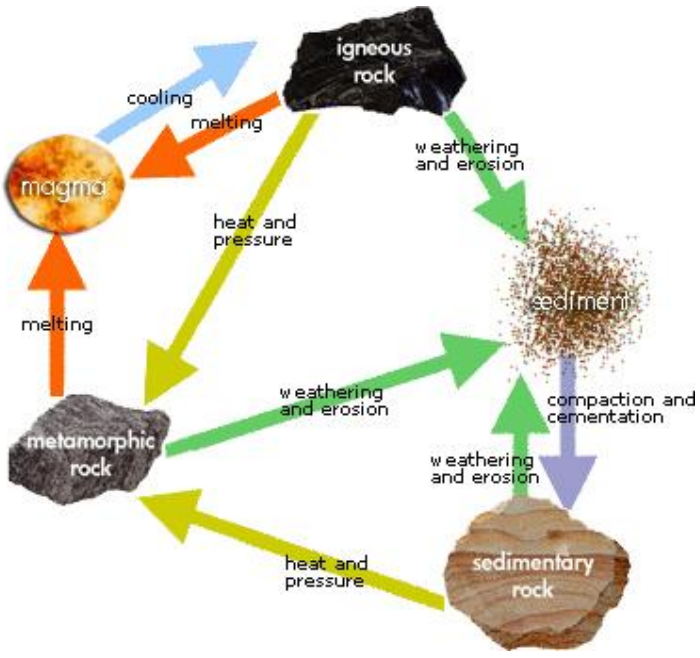
Granites and their derivatives make up the greater part of the plutonic rocks and are found, mainly, on land---often in the form of 'batholiths'. Primary basalt, formed by partial melting of 'ultra-mafic' (very high in iron-magnesium silicates) rock in the mantle often comes to the surface through fissures. Sometimes there is a mixture of un-melted matter with new magma or from conditions in which equilibrium has not been reached. Rarely found, they are known as 'hybrid' rocks.

To summarize, there are **TWO** types of rock development:

a. **Extrusive:** when lava cools rapidly fine-grained rocks are formed by the crystallization of magma which solidified at the earth's surface, (example: basalt and andesite)(Did you know when a volcano erupts under water, it produces glass…?)
b. **Intrusive:** formed from pre-existing rocks below the earth's surface. (Magma was an intruder!)

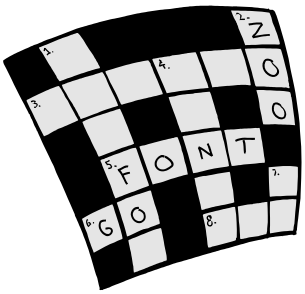
Some igneous rocks form when the lava rises above the crust of the earth---as soon as they enter the light and air. Others form below the crust---without breaking through to the surface. Still others, after spending some time in the light above the earth's surface, sink back into the darkness, only to become 'remolded' or changed before entering the light again.

The rock cycle continues…



(Above image: rockcycle.synthasite.com)

FUN STUFF!



QUIZ: Know Your Manitoba Rocks and Minerals

1. The building stone quarried at Garson is known as _____ stone.
2. Cesium, extracted from the mineral _____, is mined at the Tanco mine.
3. _____, found at the Tanco mine, is used for "spare part" surgery. It is the only metal that is not rejected by body fluids.
4. Garnet is an indicator mineral for _____.
5. Manitoba's first documented gold discovery occurred in 1911 at _____ Lake.
6. Crystallized gypsum, found at the Winnipeg Floodway, is known as _____.
7. Most of the petrified wood, found at Souris, is wood that has been replaced by _____.
8. Arborg has a supply of _____ which can be used as paper filler.
9. The lithium mineral, _____, is known as a weather stone. On sunny days, it is a grey-blue color. It changes to a lilac shade when rain is about to come. It is found at Bernic Lake.
10. Exploration in the Wekusko dike area, near Snow Lake, shows potential for the presence of _____.
11. In March, 2007, using their own geophysical method of electromagnetic imaging, Alan Vowles (geophysicist) and David Koop (geophysical technician) discovered a significant deposit of zinc, copper, and gold at _____, near Snow Lake.
12. At _____ Lake, Gossan Resources owns 50% interest in a large vanadium and titanium deposit. The application of vanadium in an electrical charge is likely to bring increased demand for its use in lithium-based batteries and for e-vehicles.
13. Recent mapping in the Manasan Falls area indicates that the super-crustal area is likely to be at least _____million years old.
14. _____ Lake is Manitoba's most important gold exploration area.

ANSWERS - Know Your Manitoba Rocks and Minerals

1. **Tyndall** stone
2. **Pollucite**
3. **Tantalum**
4. **Diamonds**
5. **Rice**
6. **Selenite**
7. **Agate**
8. **Kaolin**
9. **Lepidolite**
10. **Diamonds**.
11. **Lalor**
12. **Pipestone**
13. **4,600** million years old
14. **Rice**

Mixed up rockhounds!

Two rockhounds, Joe and Sam, were on the way to Souris to get a piece of petrified wood for a rock and minerals show. Their best pals, 'Hu' (a Chinese friend, whose name is pronounced 'Hoo'), 'How' (Howard), 'Wat' (Watson), 'Wen' (Wendy), and 'Wy' (Wylie), were not free to go along with them on the trip. Find out how Joe and Sam finally got things sorted out. *(Thanks to Bud Abbott and Lou Costello for the original idea!☺)*

Joe: Hey, Sam, who's on duty at the booth at the Forks, when?
Sam: Not Hu. Wy. I don't know a thing about Wen.

Joe: Who or why?? I didn't ask you that! I asked who's working when!
Sam: I told you…not Hu. Wy.
Joe: …What do you mean why? By the way, isn't Wen away with Wy?

Sam: Maybe. But, How's working…sound OK to you?
Joe: Of course. Work's always okay with me, but I was just asking 'when'!
Sam: Yeah, well if Wen's busy with Hu, and Hu knows about Wy, I know Wat's right about the petrified wood, so let's think about How!

Joe: I wasn't worried about 'how', I simply asked you 'when'!
Sam: Wen!? Wen wasn't even considered for the polishing.

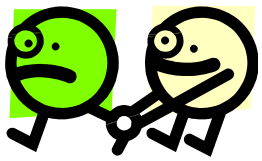
Joe: Okay. Let me try this again. Exactly 'who' will do it…and 'when'?
Sam: I don't know why you keep asking. I already told you. Hu's busy, so's Wen.

Joe: Oboy. So…'what' will help us now?
Sam: Not a chance! Wat's off to Bissett to visit a gold mine.

Joe: Huh!? Who's going to Bissett with 'what'?
Sam: No. I already told you. Hu's busy. So's Wen. So Wat's going.

Joe: What?!? Sam, what on earth's up?
Sam: I've been trying to tell you. Wat's gone off to Bissett on his own.

Joe: But, I didn't ask about Wat. Enough of this! Let's just go, pick up the petrified wood, and get this show on the road!



Sum Fun

Which sum is greater, the left or the right?

987654321	123456789
87654321	12345678
7654321	1234567
654321	123456
54321	12345
4321	1234
321	123
21	12
1	1
_____	_____
_____	_____

Answer: *.Sum Fun answer:*
Both total the same number:
1,083,676,269

Explore…and learn more at…

www.ManitobaRocks.info