The Composition of the Earth’s Crust

Mineral and Rock Composition

Here’s our planet earth, the third member of our solar system. We know very little of the solar system but what we know about the earth are based on our experience. The part of the earth that all of us have experienced is the outer layer called the crust.

The earth’s crust is a thin layer of material that covers the earth’s surface. This layer varies in thickness from 2 – 30 miles (3 – 48 kilometers). It is composed of rocks and soil, both of which influence our lives in many ways. Soil, the medium from growing plants, supports our agricultural economy. From the rocks we construct our shelters and create materials or living.

Let’s start with what rocks are composed of. Rocks are built from minerals. Minerals in turn are constructed from natural elements and compounds. These elements and compounds are chemical in nature and give minerals a fixed or unchanging chemical composition. They also give minerals differing physical characteristics. Thus, because of their unique chemical compositions, minerals such as gold, silver, and diamonds look and feel different. Diamonds are extremely hard, while gold is malleable, which means it can be molded into many shapes.

Most minerals are made from nonliving substances. Many have crystal shapes. These are three-dimensional and easy to recognize. The crystalline structure of many minerals provides geologists with a clue of how the minerals were formed. Crystals might be quite large or very small.

LINK: http://en.wikipedia.org/wiki/Minerals
LINK: http://en.wikipedia.org/wiki/Crystals

Why are minerals so important to us?

Minerals make up the greatest portion of the earth’s crust. If you were to dig a well, most of what you would shovel up in the soil would be minerals. We can look at minerals in another way. Most of the soil our trees and crops grow in is minerals. Many of our buildings –metal, glass, cement, and bricks---are made from minerals. We would be hungry ad have no protection from the weather without minerals. Up to this date, geologists have identified more than 2500 minerals. Of these 250 are said to be plentiful on the earth. Only 25 minerals are found on the earth’s surface and in most surface rocks. Most of them are made of only eight elements.

<table>
<thead>
<tr>
<th>Element</th>
<th>Approx. Abundance (by weight)</th>
<th>Example of mineral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen</td>
<td>47</td>
<td>Quartz</td>
</tr>
<tr>
<td>Silicon</td>
<td>28</td>
<td>Mica</td>
</tr>
<tr>
<td>Aluminum</td>
<td>8</td>
<td>Mica</td>
</tr>
<tr>
<td>Iron</td>
<td>5</td>
<td>Prayxines</td>
</tr>
<tr>
<td>Calcium</td>
<td>4</td>
<td>Mica</td>
</tr>
<tr>
<td>Sodium</td>
<td>3</td>
<td>Feldspar</td>
</tr>
<tr>
<td>Potassium</td>
<td>25</td>
<td>Mica</td>
</tr>
<tr>
<td>Magnesium</td>
<td>2</td>
<td>Prayxines</td>
</tr>
</tbody>
</table>
Notice that oxygen, the one element crucially needed to sustain life on earth, is the most abundant.

Summary:
1. The thin, outer layer of the earth is the crust.
2. The crust is made of rocks and soil.
3. Rocks are made of minerals.
4. Minerals are made of elements and compounds.
5. Each mineral has a fairly fixed chemical composition.
6. There are over 2500 minerals on earth.
7. Only 25 minerals are commonly found on the earth’s surface and in surface rocks.

Three Major Rock Groups
Natural chemical elements combine to form minerals. The minerals either exist by alone or combine to form rocks in the earth’s crust. Geologists have classified these rocks into three major groups: Igneous, Metamorphic, or Sedimentary.

Igneous Rocks
Geologists believe the earth was originally hot molten material called magma. Magma is very similar to hot, molten rock that flows from volcanoes today. Lava is magma that has reached the earth’s surface. Over millions of years, as the earth evolved, the magma slowly cooled. It finally solidified into rock. This rock was formed from the cooling magma is what we call igneous rock.

We can talk about magma cooling in two places: on the earth’s surface or deep within the crust. Magma that cools on the surface is of volcanic origin. Igneous rocks that cool within the earth’s crust are called intrusive rocks. The volcanic rocks that cool on the surface are termed extrusive. Very few igneous rocks are extrusive, since there are few volcanoes in the world. Igneous rock comes from “fire” or “magma.”


Sedimentary Rocks
Sedimentary rocks are formed differently than igneous rocks. The name sedimentary gives us a clue. Sediment is the material that settles on the bottom of something else, usually a liquid. An example of the sediment is a cup of hot cocoa.

Sedimentary rocks are composed of materials that have been worn down by wind, water, or ice and deposited somewhere. These materials can be small rock fragments, minerals, or the remains of plants and animals.

Many of the world’s most common rocks are sedimentary rocks. That’s why, of the three major rock groups, this group is probably the most familiar to us in real life.
Sedimentary rocks are classified into three subgroups: Clastic sedimentary, Chemical particulates, and organic sedimentary.

The first subgroup is clastic. The name “clastic” comes from the Greek word klastos, which means broken. This gives us some help in remembering that clastic sedimentary rocks are simply rock fragments. Scientists are so concerned about these fragments that they classify them by size. Examples are sandstone and shale.


The second subgroup is sedimentary rocks that settle out of water solutions. Although “chemical precipitates is a longer name, it provides a hint of the meaning. These rocks are formed from chemical compounds settling out of water solutions. That is, chemical of some sort settle out of water to form rocks. Examples: Limestone and Dolomite.


The last subgroup, organic sedimentary rock, is formed of living or once-living substances settling out of water. Plants and animals (or their skeletons) separate from water to form rocks. Coal is a well-known example of an organic sedimentary rock. The sites of some coal deposits were once thick swamps. The dense plant life decayed and separated from the swamp water.

LINK: http://en.wikipedia.org/wiki/Limestone

Metamorphic Rocks

Our third rock group is metamorphic rocks. In general, these rocks are formed when great temperatures and pressure are placed on preexisting rocks. For instance, say we have a deposit of shale. Shale is found in layers and is claylike, with fine grains. Along comes an earthquake, a small shift of a portion of rock. The portion of earth moved by the earthquake is moved on top of the shale deposit, pushing it deeper into the ground. Over time more shifts deposit the shale deeper and deeper into the earth. When it deep enough, there is enough pressure and heat to turn the shale into slate. Slate is also a fine grained and layered rock. Thus we have changed one rock into another. Metamorphic rocks are very hard and often banded or layered. If you subject a rock to enough heat, it melts and becomes magma.

LINK: http://en.wikipedia.org/wiki/Metamorphic_rock
The Rock Cycle

How are rocks formed? We have already learned that a rock may change from one group to another when subjected to the forces of nature. For example, silt can be deposited on a lake bottom and becomes sedimentary shale. When subjected to enough heat and pressure shale becomes slate. Slate can be worn down and deposited somewhere to become another sedimentary rock, or it could be subjected to enough heat and pressure to turn into magma and then into igneous rock. This making or breaking down of rock is called the rock cycle.

Steps in the Rock Cycle

We begin with magma. Magma is the molten material from which the first rocks of the earth were formed. It is the primary source of all rocks and is found today under the earth’s crust. It is not one of the three rock types.

The cooling of magma forms igneous rocks. The magma may cool beneath the earth’s surface, forming such rocks as granite. Granite is found in the upper ten miles of the earth. Or, the magma may cool on the surface as lava from volcanoes.

Natural forces may break up igneous rocks. The rocks are pounded and crushed into fragments. The fragments can then be transported by wind or water action and deposited somewhere. These deposits are called sediment. As the sediment accumulates, those fragments become buried near the bottom become compressed. The compressed sediment becomes sedimentary rock. Shale, sandstone, and limestone are formed in this manner.

Forces of nature can further alter both igneous and sedimentary rocks. If these two groups of rocks come into contact with pressure and greater temperatures, they form into metamorphic rocks. This can be a very subtle process. We’ve already seen how sedimentary rock, shale, is turned into slate. Another example is marble, which is made when limestone is submitted to extreme heat and pressure. An igneous rock that changes into a metamorphic rock is granite. Subjected to pressure and greater temperatures, it will form gneiss.

If the temperature and pressure become extreme, rocks melt. Then they become magma again. This process occurs deep within the earth. Thus rock masses can pass through the entire rock cycle, from magma to igneous rock to sedimentary rock and or metamorphic rock and back to magma. We rarely see magma. The rocks we see on the surface are igneous, sedimentary, or metamorphic rocks.