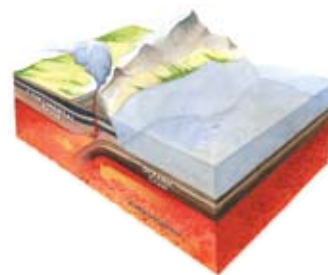


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PLANET EARTH

Our study of the earth must start with its place in the solar system. It is one of nine planets circling the sun. The inner four planets, including the earth, are solid.

The next four planets are much larger than the earth and made entirely of gas. They have no solid material. The outermost planet, Pluto, is solid once again.

Scientists have sent up probes to Venus and Mars, our nearest neighbors, and found them to be most inhospitable to life. The others are even worse. Mercury is much too close to the sun; it would be too hot to support life. The outer planets are so far from the sun that their temperatures are extremely low. Only the earth is capable of supporting life.

As it revolves around the sun, earth has a slight tilt, giving us the seasons throughout the year. As it rotates on its axis, we have a day and night cycle, each 24 hours.

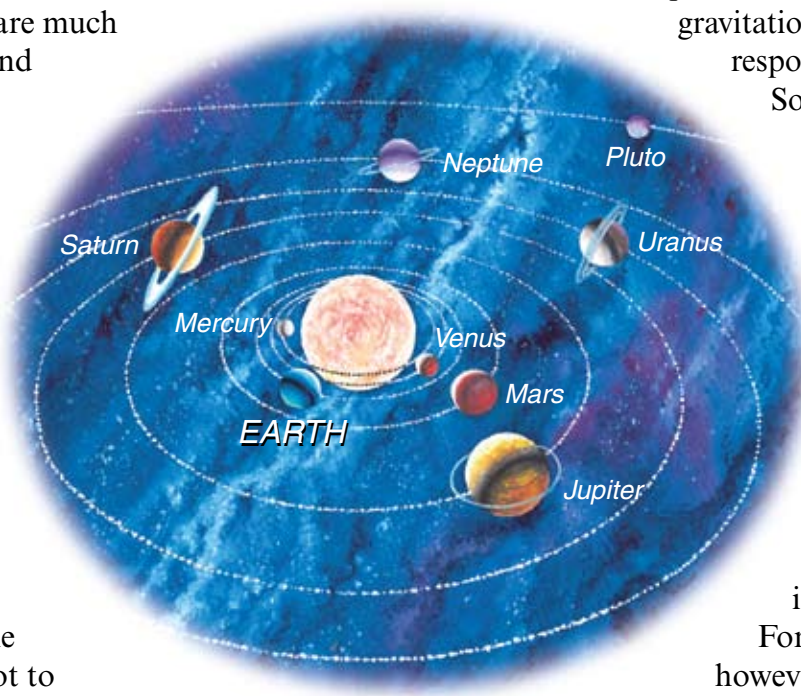
While many of the planets have moons, their moons are quite small when compared to the planets they circle. Our moon, however, is almost one-quarter the size of the earth and its gravitational pull on the earth is responsible for the daily tides.

So many things about the earth make us recognize that it was designed for life — our life — by a wise and powerful God.

The earth is a sphere, rather ball-shaped. Actually, it is a little bit pear-shaped with its diameter at the equator a little larger than its diameter at the poles.

For practical purposes, however, we can consider it a sphere, with an average radius of 3,963 miles (6,368 km).

As far as we know, no other planet in the solar system contains water. Necessary for life, the earth has it in abundance, stored primarily in the oceans, which are far deeper, on average, than the continents are high. If the earth's solid material were completely smooth, water would form a worldwide ocean approximately 8,500 feet (2,591 m) deep!

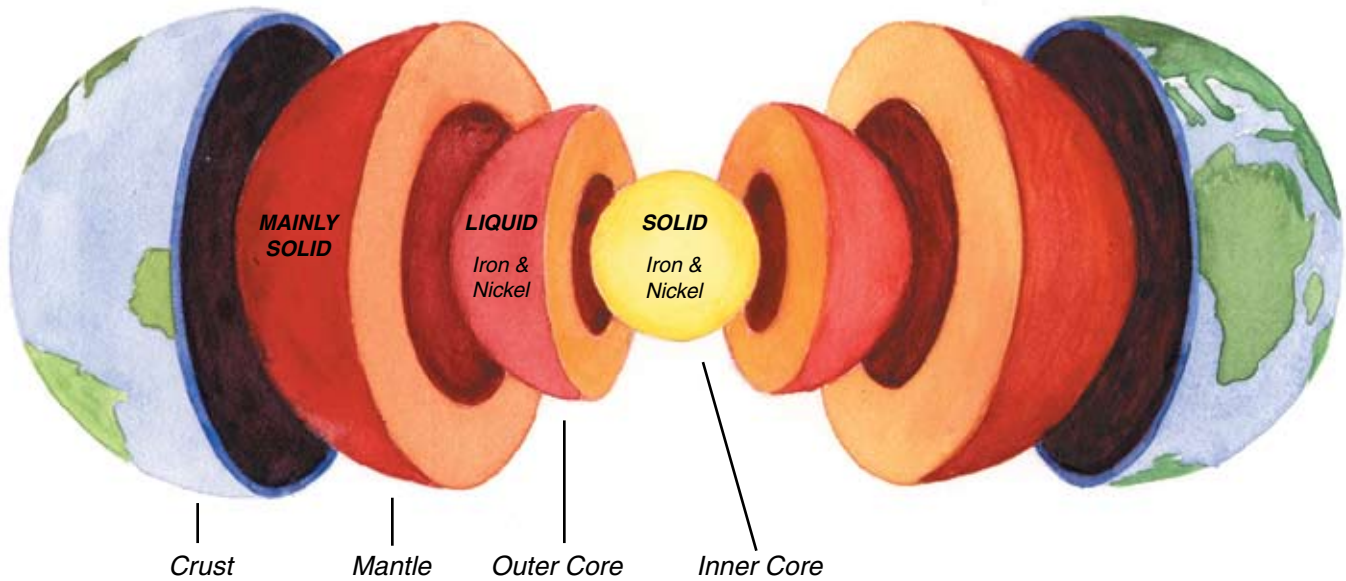


The earth is the third planet from the sun (above). Along with the other three closest planets, it is made up of solid material. The outer planets such as Saturn (left) are composed entirely of gases, except Pluto.

Inside the Earth

On the surface of the earth we see soil, rock, and water, all surrounded by atmosphere. These things comprise only the thin outer skin of the earth. The rest is quite different.

crust, located in the bottom of the Pacific Ocean, but these efforts have not yet been successful. The lower parts of the crust differ from the upper parts, but still we have not directly observed anything other than the crust of the earth.



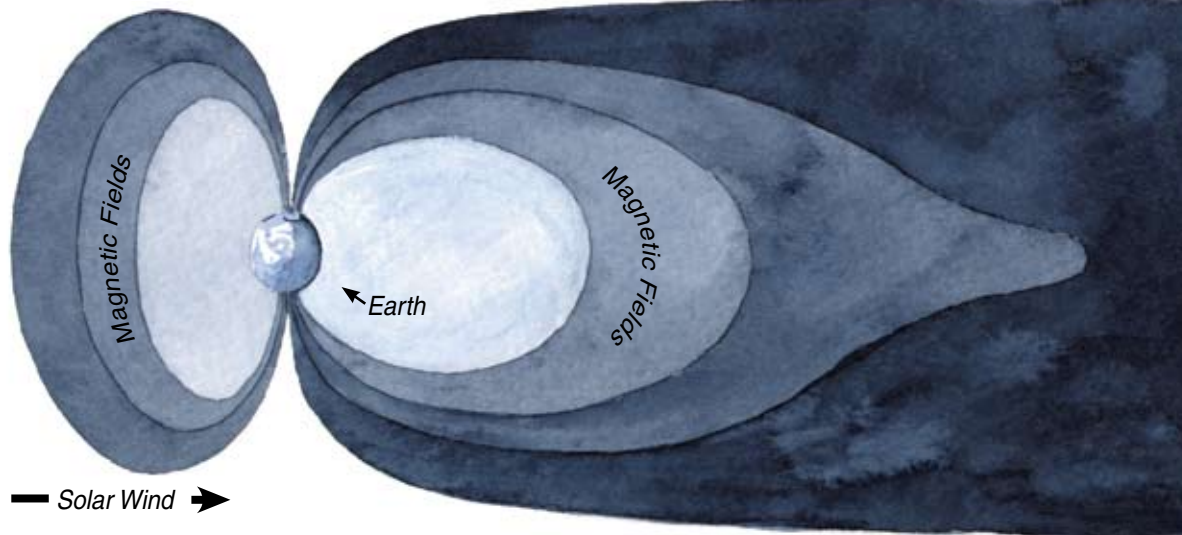
No one has actually drilled deep inside the earth, but by studying the way energy waves travel through the earth, we have a pretty good idea of what is deep inside.

The interior of the earth is made up of four main sections. The crust is very thin and consists of the continents and oceans. The mantle is the largest at 1,900 miles (3,000 km) thick. The outer core is so hot that it is molten liquid, while the inner core is under so much pressure that it is solid.

The earth is divided into three main zones. The crust of the earth is the thin outer skin. On the crust are continents and oceans. In some places the crust is at a lower elevation than others, but the difference is very slight compared to the overall size. In fact, if the earth were the size of an orange, and you could hold it in your hand, you would not be able to feel the difference between the highest mountain and the deepest ocean basin.

Efforts have been made to drill through the thinnest part of the

— Solar Wind →

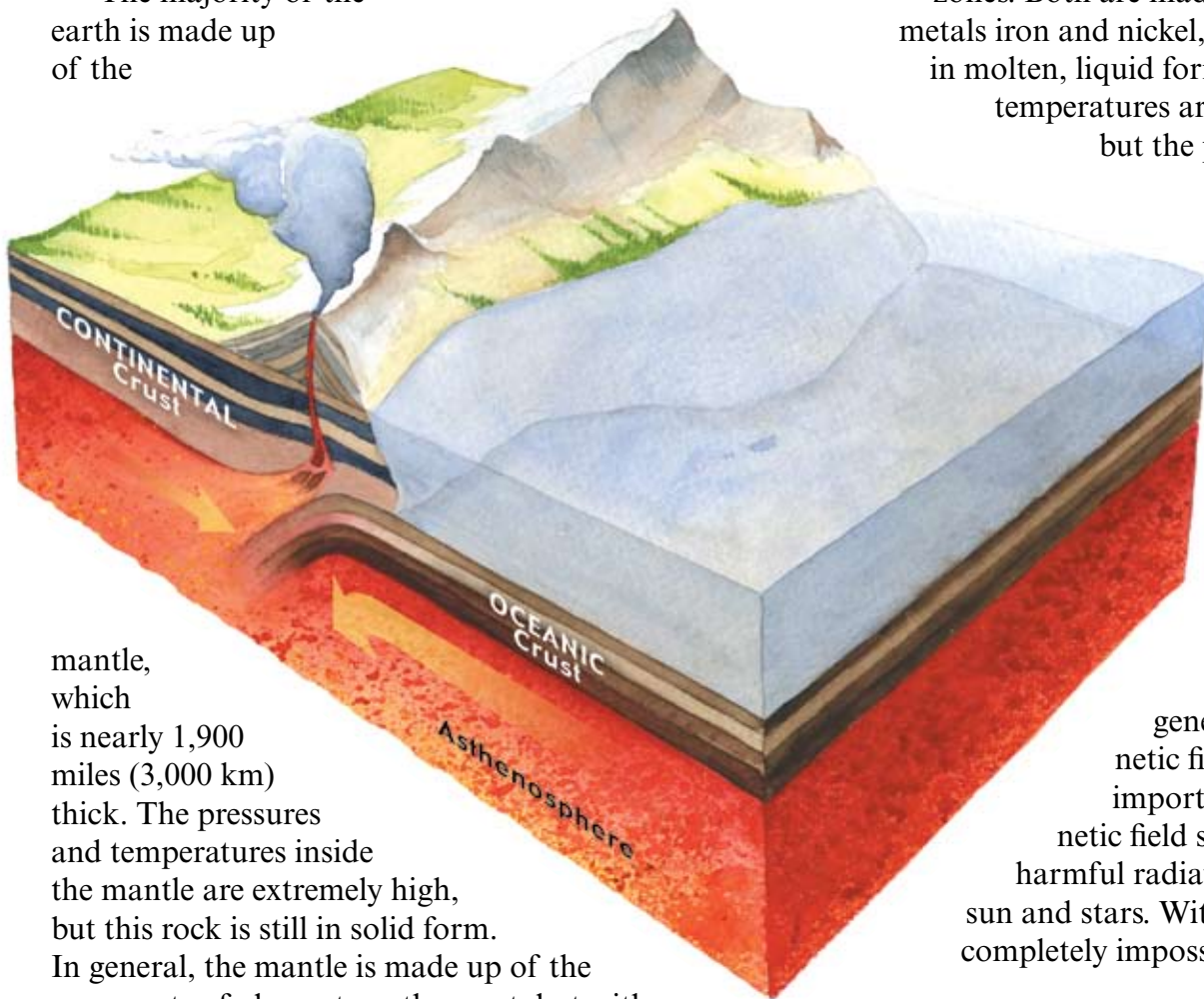


— Solar Wind →

The invisible magnetic field around the earth is a result of the earth having an iron core, in much the same way that an iron bar magnet produces a magnetic field.

The crust varies from 3.7 to 6.8 miles (6 to 11 km) thick in the ocean and 15 to 56 miles (25 to 90 km) or so on the continents. Compared to its radius, this is almost like a thin onion skin around the sphere of the earth.

The majority of the earth is made up of the



mantle, which is nearly 1,900 miles (3,000 km) thick. The pressures and temperatures inside the mantle are extremely high, but this rock is still in solid form. In general, the mantle is made up of the same sorts of elements as the crust, but with a higher percentage of the elements that pack into more dense minerals.

Scientists have come to suspect that there is a zone in the very uppermost part of the mantle

called the asthenosphere. The material here is quite hot and deforms a little more easily than regular rock. In some ways it appears our continental crust actually “floats” on this asthenosphere.

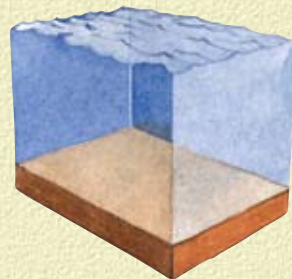
The core of the earth is divided into two zones. Both are made up primarily of the metals iron and nickel, but the outer zone is in molten, liquid form. The pressures and temperatures are intense down there,

but the pressures are so great in the inner core that the molten liquid returns to solid form.

Even though we only know about them from theory, it does appear that electrical currents flowing in the outer core’s conductive metal generate the earth’s magnetic field. This is extremely important because the magnetic field shields the earth from harmful radiation coming from the sun and stars. Without it, life would be completely impossible on planet Earth.

The crust can be broken up into plates that seem to “float” on the upper part of the mantle called the asthenosphere. Rifts can occur where the plates come together.

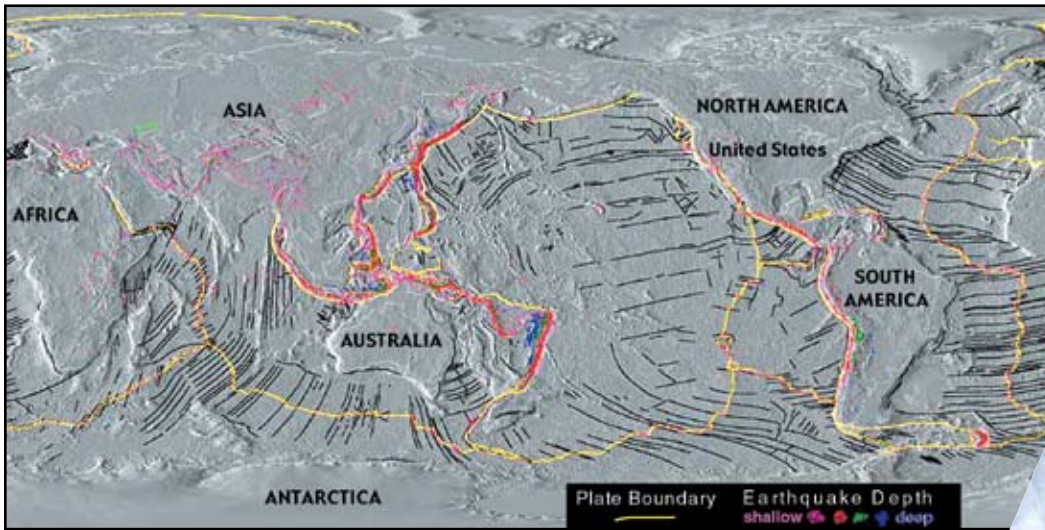
WHY THE EARTH IS UNIQUE FOR LIFE



All life depends on water. If the earth’s solid material were completely smooth, it would be covered by water 8,500 feet (2,591 m) deep!



The gravity of the moon pulling on the earth causes the oceans to rise and fall forming the tides.



Most earthquakes (colored dots) occur along the edges of the plates (yellow). Volcanoes are also more frequent along these plate boundaries.

The earth is made up of elements that combine together to form minerals which make up rocks. If they combine in a geometric pattern, they form crystals (below).



The Crust

Even though the crust is a very minor portion of the total volume of the earth, it is the most interesting. It has the most variety and is, of course, most useful to man. It can be divided into two categories. The continental crust is made up primarily of rocks of granitic composition often covered by sedimentary rock, and the oceanic crust is made up primarily of basaltic rock. Since basaltic rock is more dense than continental granitic rocks, the continents rest at a higher elevation than the oceans. The deeper ocean basins thus contain a vast volume of water, allowing the land surface on which we live to be exposed.

Scientists have long noted that earthquakes tend to occur in certain zones. By plotting the locations of these earthquakes on a map and connecting them with lines, one sees that the crust of the earth is divided up into huge regions called “plates.” There are not too many earthquakes on the interior of these plates, but around the edges the earth-

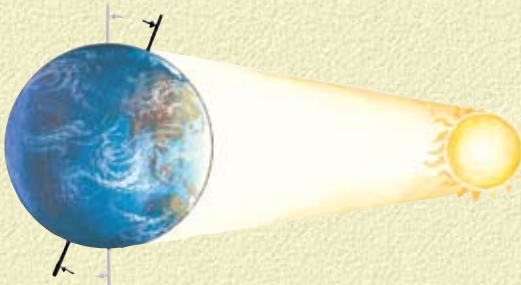
quakes tend to occur frequently. Volcanoes also tend to occur on the edges of these plates.

All substances are made up of atoms, or elements. Some are larger, and thus heavier than others. Over 100 different types of atoms and even more varieties of atoms exist on planet Earth; but just a few elements make up the majority of the crust’s weight. If we look at those that make up the crust, we see that oxygen dominates, making up almost one-half of its volume. The next is silicon, which is a very common atom in rocks.

The atoms tend to combine into groups called minerals, and it is these minerals which make up rocks. Sometimes these minerals combine in regular geometric patterns forming crystals.

Surrounding the entire crust, of course, is the atmosphere. This provides not only the air that

we breathe but a further shield for us from harmful cosmic radiation, and also gives us weather. Because of the atmosphere, we can have rain and usually a blue sky. Without it life would be impossible.



The earth is the perfect distance from the sun to keep it the right temperature, and the earth’s tilt causes the seasons.



The atmosphere not only provides air for breathing, but also deflects harmful space radiation and refracts solar radiation.

2. INORGANIC

Limestones

Calcium carbonate can be derived from inorganic sources as well as organic sources. Inorganic deposits are usually fairly small in lateral extent, and form today in places where the water has a great deal of mineral material dissolved in it, such as in caves or around mineral springs. Stalactites and stalagmites are formed in this way.



Dolomite

A rock similar in many ways to limestone is known as dolomite, with atoms of magnesium included in the calcium carbonate. Perhaps this is accomplished by the replacement of individual atoms of calcium with magnesium, but the origin of large dolomite beds is not at all understood.



The upper and lower dark layers in this photo are two coal seams in a bluff from Prince, Utah.

do accumulate today in swamps, we know of no instances where peat changes into coal under normal circumstances. Furthermore, some coal deposits cover large areas with extremely flat beds, but peat swamps are always small in comparison and quite irregular. No doubt about it — the past was different from the present.



Coal is used as fuel for power in many industries (left).

Cave formations are primarily found in limestone. They were formed as groundwater evaporated, leaving its dissolved minerals behind (right).



Evaporites



When seawater evaporates, it leaves behind the minerals dissolved in it.

Since seawater has many different minerals, including metals, dissolved in it, the evaporated remains of

seawater make quite a mixture.

Sometimes, however, pure salt is found — so pure that it can be mined and put right on the kitchen table. Very few impurities or organic remains are found in it. These could not be the remains of evaporated sea water, but appear to

have been formed when a huge volume of mineral-laden water came up through the ocean floor basalts and released its dissolved content when it hit the cold ocean waters. Although called evaporites, a more proper term would be precipitates. Other rock types in this category would be gypsum and anhydrite, none of which are forming today in quantities equal to those of the past.



Salt crystals (left) can often be mined directly out of the ground with very few impurities and used for table salt (above).

CHARACTERISTICS OF SEDIMENTARY ROCKS

Water is almost always in a near horizontal position when it deposits its load. Thus, the resulting beds are fairly flat. Each depositional episode of moving water will leave behind a pancake-type layer of sediments. Another pancake layer may be deposited later, on top of the first layer, separated from it by a bedding plane.



Ripple Marks and Crossbeds

Waves washing over a flat beach will leave ripple marks, but ripple marks are also found on many rock surfaces. Since nearly identical ripple marks are preserved on many bedding planes between rock layers we can discern that moving water flowed over them when the sediments were still muddy. Extremely large ripple marks are known as crossbeds and are more easily compared to huge sand dunes in an otherwise flat desert. But dry sand dunes in a desert would seldom be preserved, lacking any water to cement the grains together. On the other hand, huge underwater sand dunes can be preserved one after the other, until an entire thick deposit of crossbeds can be seen intersecting the flat-lying bedding planes.

Crossbedding can be clearly seen in the layers of Checkerboard Mesa in Utah.



Mud Cracks

The camera lens cap shows the scale of the mud cracks above.

When wet mud dries out it will crack into a series of polygons, and when the mud hardens, the cracks remain. In just the same way, mud can crack underground as the mud dries out, even after being buried by other sediments. As the mud hardens into stone, the cracks are preserved.

Concretions



Sometimes hard nodules are formed underground.

These rather circular objects are thought to form around some fossil or other nucleus.

Usually a nodule is harder than any rock which may surround it, and when the rock erodes, these nodules remain.

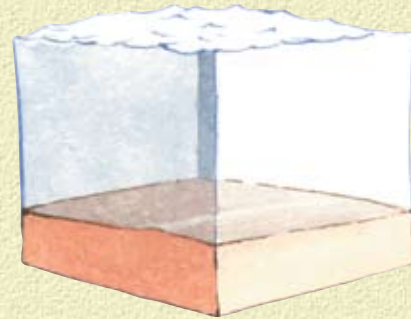
Geodes

Sometimes concretions form that are hollow and lined inside with crystals. When sliced open, these can be extremely beautiful and are used as decorations in homes.

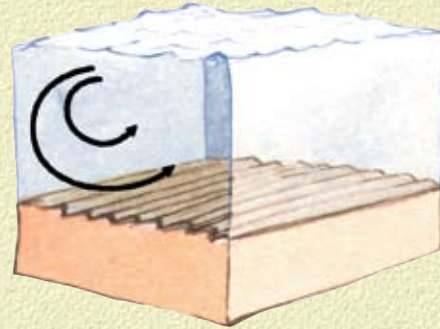


These bookends are from a section of a geode that has been cut and polished.

HOW RIPPLE MARKS ARE FORMED



Sediments under water, such as sand, settle to the bottom.



Currents in the water push the muddy sediments into ripples (above) in much the same way that the wind blows sand into dunes. The sediments later harden into sedimentary rock (below).



III. METAMORPHIC ROCKS

The Greek words *meta*, which means “change,” and *morphe*, which means “form,” are used together to mean “to change form.” A caterpillar can metamorphose into a butterfly, for instance.

In just the same way, certain rocks appear to have undergone major changes and turned into some rather different sort of rock. Nothing like this is going on today on the scale of the past.

Slate



When shale is subjected to heat and pressure, it can be metamorphosed into slate. It readily splits into thin,

even slabs and is

used for roofing, blackboards, and decorative sidewalks.



Schist

It is thought that if slate continues to undergo heat and pressure it will become a rock

called schist that contains

abundant mica. This rock can be split much like slate, but the plates are much more crumpled.

Gneiss

(PRONOUNCED “NICE”)

A highly metamorphosed, banded rock, gneiss is characterized by alternating bands of different minerals. These different bands are of unknown or varied origin and may be the metamorphosed remnants of sedimentary rocks or igneous rocks.



Layers of schist and marble can be seen in the photo at the left. Note the hammer for scale.

Slate is often used for blackboards in schools (right).

