

## One Pebble's Story...

Two billion years ago, molten magma cooled about ten miles underground. It took about a million years to harden into granite. Two hundred million years ago, continents collided. The granite rock which had moved to within a mile of the surface by the erosion and removal of surface rock was shoved a couple of miles down and put under tremendous pressure as continental plates ground together. The minerals in the granite became re-crystallized. The result was a hardened rock with many layers. It had become a metamorphic rock called gneiss.

About 2 million years ago, the rock was exposed on the surface. Glaciers formed. Ice up to 2 miles thick crept along the surface. One day, about a million years ago, the glacial ice plucked our pebble (still attached to a giant boulder). As it was dragged along beneath a mile or more of ice, pieces flaked off and the large boulder became a number of smaller, rounder and smoother cobbles. Over a period of four or five glacial episodes, most cobbles were worn into smooth, small pebbles, including ours. Some had moved into southeastern Indiana about 10,000 years ago as the glaciers melted. Chilled water flowed away from the dying glacier slowly moving the pebble. Within the last 10,000 years, our pebble has moved dozens of miles to the Falls. Today, anyone can find a gneiss pebble on the river bank.



A Gneiss Pebble

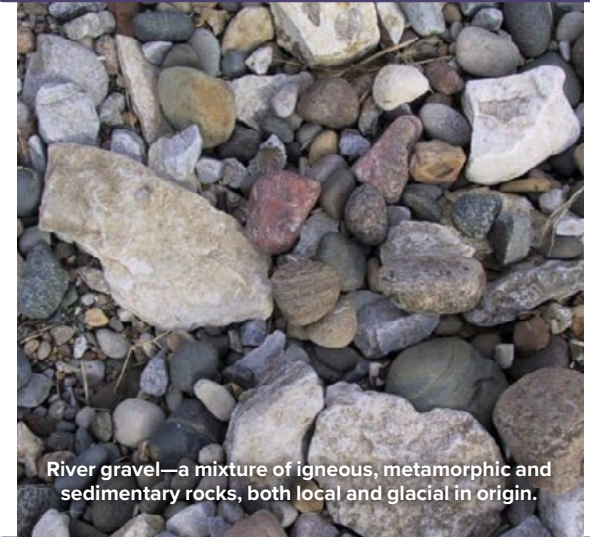
## A trick to see the detail

Get your pebble wet. A wet pebble shows colors and patterns quite vividly. Greenstone looks greener. The hues of quartzite become more noticeable. The feldspar in granite becomes bright red, orange or pink. Epidote, an olive-green mineral that occurs in some granites, shows brighter.



Diorite (top), granite (right) and basalt (left) look more interesting when they are wet.

## THE STORY OF River Pebbles



River gravel—a mixture of igneous, metamorphic and sedimentary rocks, both local and glacial in origin.

The pebbles along the river bank seem ordinary. Most are small and smooth. Young children rub them and say they are “soft.” Pick up a pebble and look at it (please leave your pebble here for others to enjoy). Do you know the story of river pebbles at the Falls of the Ohio?

Each one has its own story. You will find pebbles that are orange, red, green, yellow, white, brown, gray, black and combinations of colors. Some may be mottled, banded, sparkling in the sunlight, and others bisected by lines. Others may have fossils. To understand a pebble's history, you must know what type of rock it is.



**Igneous rocks** were once molten, reaching temperatures from 500 to 2,000 degrees Fahrenheit. Fast cooling rocks show tiny crystals, which may be seen as they sparkle in the sun. *Basalt* is an example of a fast cooling rock formed from lava. Slow-cooling rocks form larger intergrown crystals which are easier to see. *Granite* is one of the most well known igneous rocks, formed from slow cooling magma (lava deep within the earth). It is also the source of one of geology's oldest puns: You can take this rock for granite!



Examples of Igneous rocks

**Metamorphic rocks** are created when mountains (like the Appalachians) are being formed. As continents collide, rocks get mashed together. They can be pushed up to form towering mountains or shoved deep into the earth where temperatures can be thousands of degrees and the pressure can be thousands of pounds per square inch. This causes the rock's appearance to change - that is where the word "metamorphic" comes from.

Two very common pebbles are gneiss (pronounced "nice") and quartzite. Gneiss was originally granite, but has been altered. Recognizable by its colorful banded texture, it is often green, pink, red or orange. Quartzite was originally sandstone. Sand-sized quartz grains were fused together, so it can be quite hard. Quartzite can be any color and contains a fine granular texture that may be seen under magnification.

**Sedimentary rocks** are formed by sediment (like mud or sand) that is compressed by the weight of overlying material. It may be cemented together with minerals. Rounded pebbles of limestone (gray to whitish color) are most common. The source of this rock may be tributaries entering the Ohio River or the channel cutting into the bedrock, upstream from the Falls.

Look for fossils in some these pebbles, which can be 450 million years old, some 60 million years older than the fossils at the Falls. Chert is a hard rock formed from silica - quartz. (Flint is a dark gray variety of chert, agate is a banded variety.) Chert occurs as irregular blobs in the limestone at the Falls. It breaks into sharp-edged fragments. Rounded chert pebbles have been tumbled around for a long time. Sandstone is another sedimentary rock that can be found at the Falls. It is brown to orange in color and looks like it is made of grains of sand.



Examples of Sedimentary rocks



Examples of Metamorphic rocks

## Where do these rocks come from?

How is it that we can find the three different types of rock jumbled together so thoroughly on the river bank? There are no exposures of igneous or metamorphic rock along the Ohio River.

The answer can be found by rolling back the clock to the Ice Age. Geologists call this time the Pleistocene. Between 2 million and 10,000 years ago there were a number of episodes when glaciers - huge masses of moving ice - came down from the Canada into southern Indiana. As the glacial ice shoved its way from the north, it plucked millions of tons of rock from the earth's surface and carried them along inside the ice. The harder rocks were ground together almost to a polish. Soft rocks were pulverized to sand, silt and clay. When the glacial ice melted, the rocks were released. Many pebbles were carried by fast-moving streams of melt water. Those you see here found their way into the Ohio River as deposits and were moved along the river bottom.

## How does the river expose the pebbles?

The Ohio River has been shifting around in its valley since its creation by the burial of the Teays River under the first glaciers nearly 2 million years ago. Today, the river we see is the channel that shifted some 8 to 12,000 years ago. Before that, the river flowed through what would be downtown Louisville. There are millions of tons of pebbles under streets, sidewalks and buildings. Some are excavated as deep basements and are built beneath any buildings over six stories tall.

Pebbles are dredged from the river on a regular basis to maintain the shipping channel. Others are removed from sand and gravel pits along the river's edge—and those pebbles may find their way into the local landscape or as aggregate in concrete.