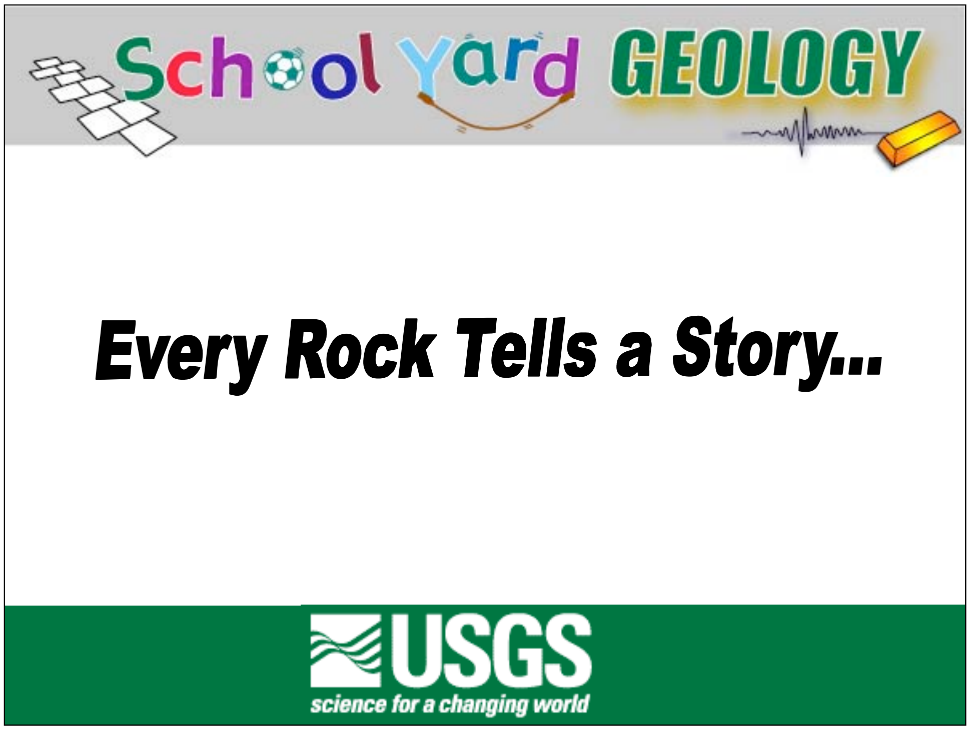
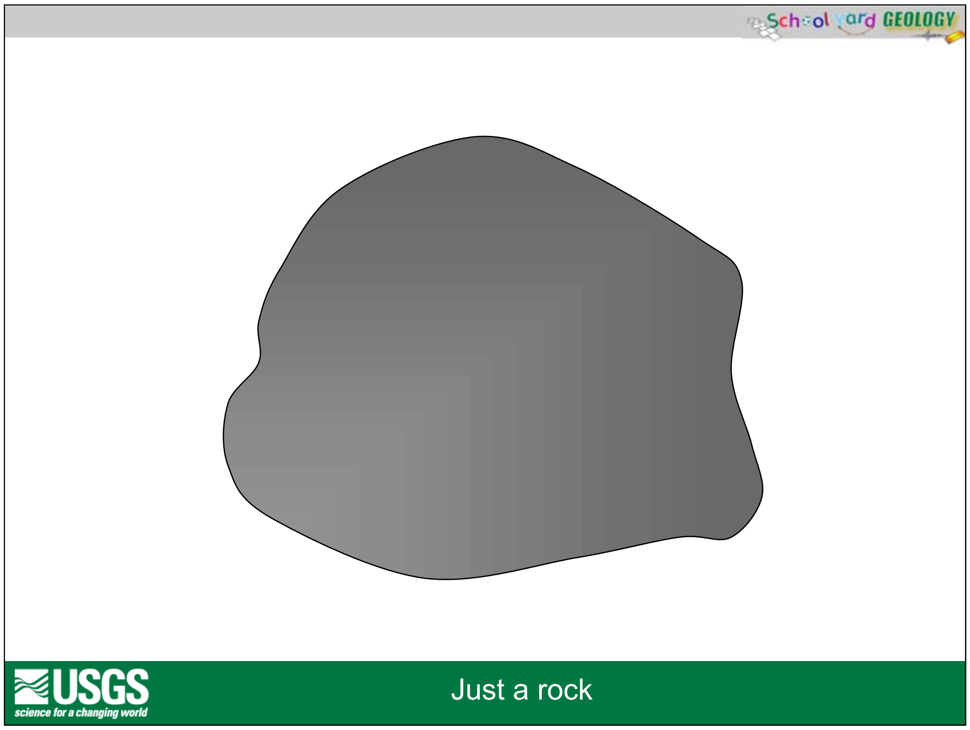


Every rock tells a story about how it formed, the environment where it has been, and what it has experienced. Each of these stories is a grand adventure. To learn a rock's story, we need to learn how to read the rock like a book.

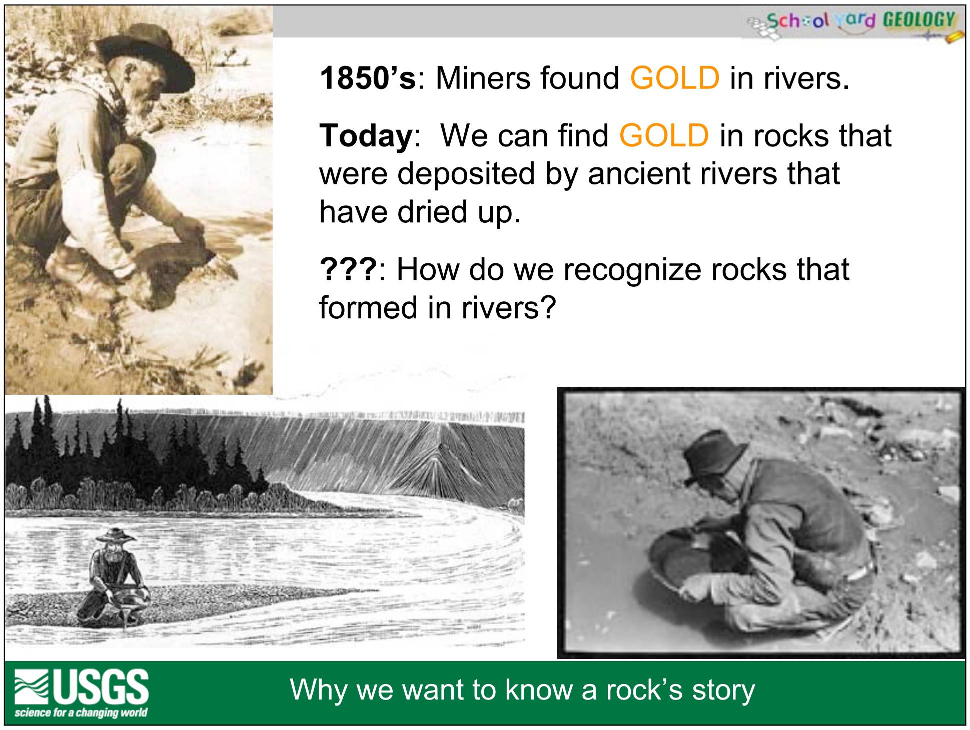
To start, I want you to picture a rock. When I say the word, "rock," what do you see (besides rock music)? What does it look like?



When I ask lots of people what a rock looks like, they think of this: A boring, plain, grey block. Raise your hand if the rock you pictured looked like this. But rocks aren't all like this.

<HOLD UP AND PASS OUT A SERIES OF INTERESTING ROCKS: Red ones, green ones, spotted ones, whatever you have available>.

Each of these rocks looks different. What do these differences tell us? How do we use these differences to read a rock's story?



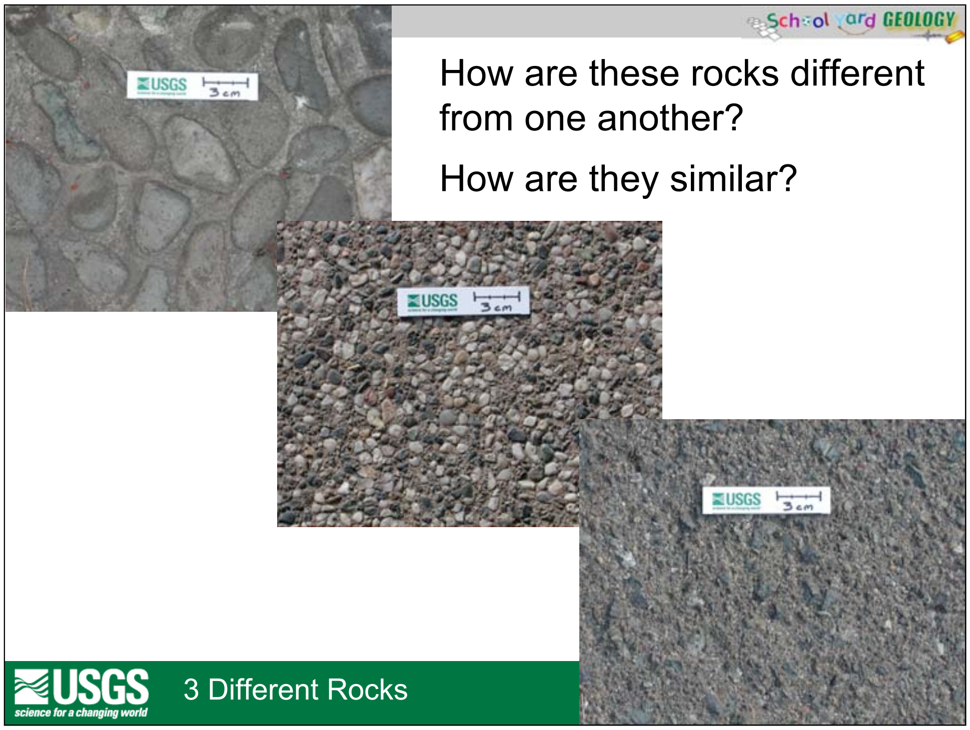
Before we discuss how to read a rock, why would we want to know a rock's history? <ASK FOR STUDENTS TO RAISE HAND AND MAKE SOME GUESSES>

Since most natural landscapes are made of rock, some people like to know about how the world got to look the way it does. Some people just like hearing a good story. And other people have a very specific interest in mind.

Gold miners successfully gathered gold from rivers in California. They worked so hard that they collected most of the gold from the existing rivers. However, there are some places they didn't look because they didn't know too much about geology. If we could determine which rocks formed the beds of ancient rivers that have gone away, we might be able to locate new sources of gold.

Our mission for today is therefore to look at different rocks and determine if they were ever part of an ancient river system.

(Note to teacher: The idea that gold is found in rivers is a slight oversimplification. While the reality is much more complex, the idea of using rock stories to determine ancient environments is essential to almost all resource extraction from gold and other metals to oil).



To start, let's look at three different rocks. Discuss with the person next to you what makes these 3 different rocks different. What do they have in common. You have 2 minutes to

<SHARE WITH A PARTNER>

What did you and your partner determine?

<WRITE IDEAS ON BOARD>

Color, size, shape, and texture are the biggest differences.

The biggest similarity is that they are all made of smaller pieces. Geologists give these pieces the name "GRAINS." (like grains of sand)

Schoolyard GEOLOGY

Images From: *USGS / US House of Representatives*
http://resourcescommittee.house.gov/subcommittees/emr/usgsweb/frames/main.html

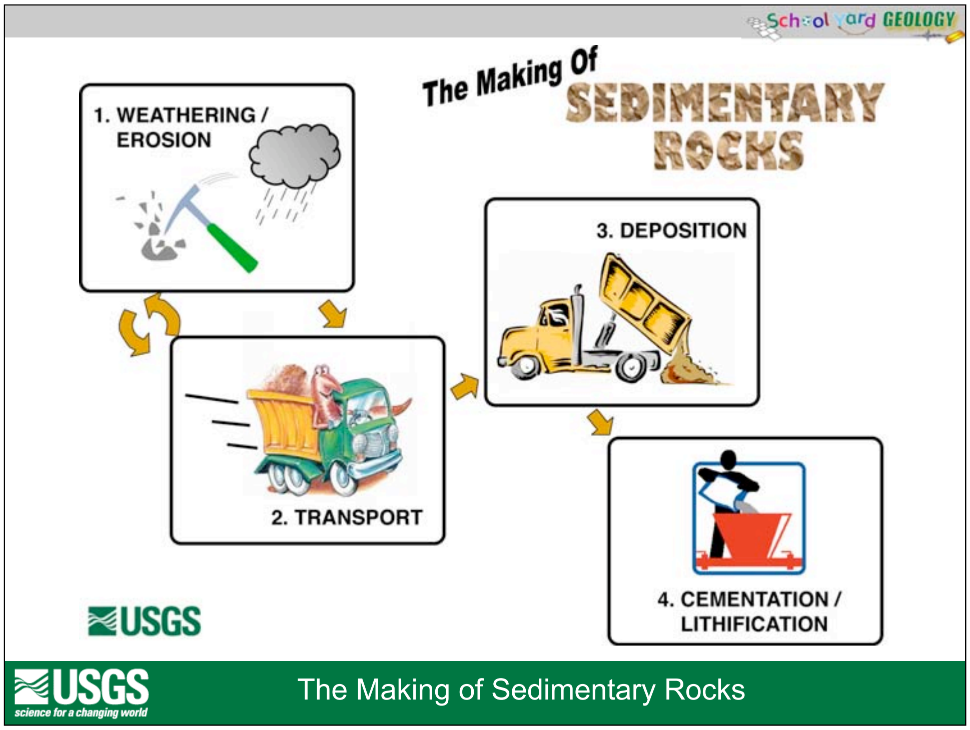
USGS science for a changing world

Color Gives Clues about Composition

The easiest criteria to distinguish rocks is COLOR. What is the rock on the left made out of (GOLD). And the one on the right (Silver). While it's not the only way to tell rocks apart, color can help you determine what a rock is made out of.

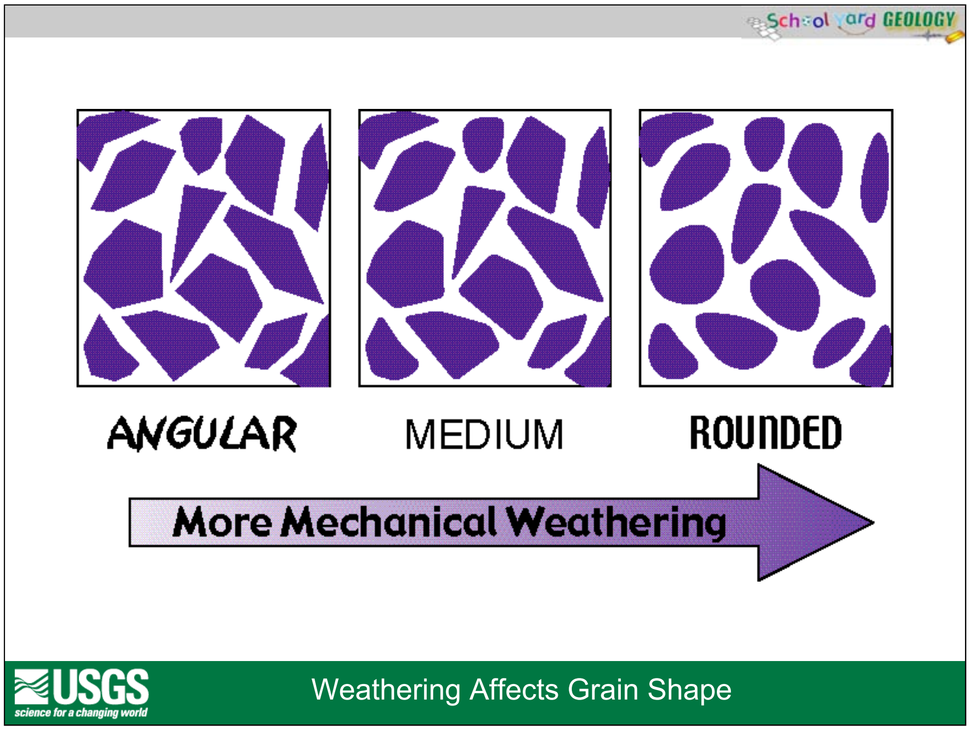
Because color names are somewhat subjective, geologists use a color chart, much like you see in paint stores so that everybody agrees that the name, "light greenish grey" means the same color.

http://www.swiss.ai.mit.edu/~jaffer/Color/RC



Every rock has a history, and we saw that many rocks are made of smaller pieces of other rocks that we called "grains." Rocks that are made up of other rocks are part of a class of rocks called "sedimentary rocks."

Each of those grains goes through its own adventure on its way to becoming part of the final rock that we pick up. It starts off as part of another rock. Wind, rain, and other agents break the rock down into smaller pieces. They often move the pieces far away from the original rock, until eventually they settle down somewhere else. Eventually, a pile of individual grains will get cemented together into one solid rock. Each of these stages affects the way the final rock looks. Let's focus on a few of them.

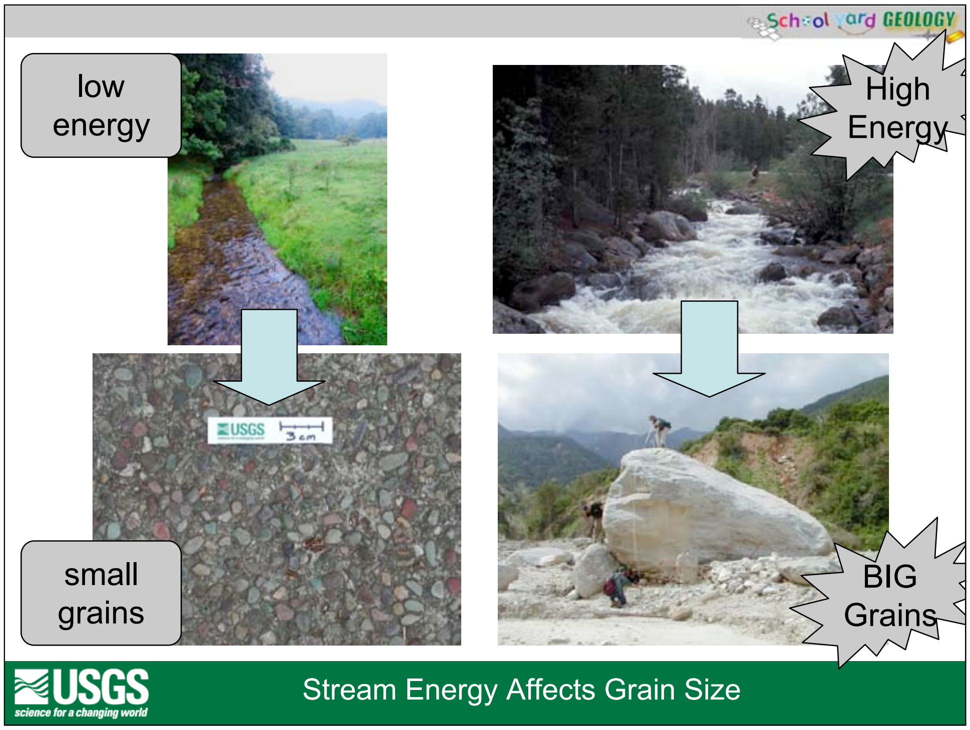


1. Erosion and Weathering affect grain shape:

When a rock first breaks, it is very sharp. We call this angular.

<DEMONSTRATION: Break a rock into pieces by pounding on it with a hammer. Get a volunteer from the class to take a few whacks. NOTE! Always wear safety glasses because splinters of the rock really do come flying out. The demonstration should be done at least 10 feet from the nearest student who is not wearing safety glasses. Sparks can fly and this is really cool. Pass around pieces of the broken rock.>

Over time, these rough edges get smoothed out. The smoother a rock is, the longer it has been exposed to weathering.



2. Transport affects grain size:

To move a pebble the size of your fingernail, it doesn't take much energy. But to move a boulder, it takes a lot more energy. It takes something big. So if you see a grain that is very large, you know that something with a lot of energy had to move it there.

<COMMON MISCONCEPTION: The main idea here is the amount of energy to MOVE the grains. Many students incorrectly think that a faster stream will result in smaller grains. It's true that a faster moving stream has more energy to break grains apart, but the little grains will be washed away by this high energy stream and be carried along until the stream slows down. So if you're looking for evidence of where a stream was fast and high energy, you have to look for places with big grains.>

School Yard GEOLOGY

Location	
Colors	
.....All the same color?	(underline most common colors above)
Grain Size	
.....Minimum grain size	___ cm
.....Maximum grain size	___ cm
.....Typical grain size	___ cm
.....All the same size?	
Grain shapes	Angular ... Medium Angular ... Medium Rounded … Rounded
Strength	
Other Comments	

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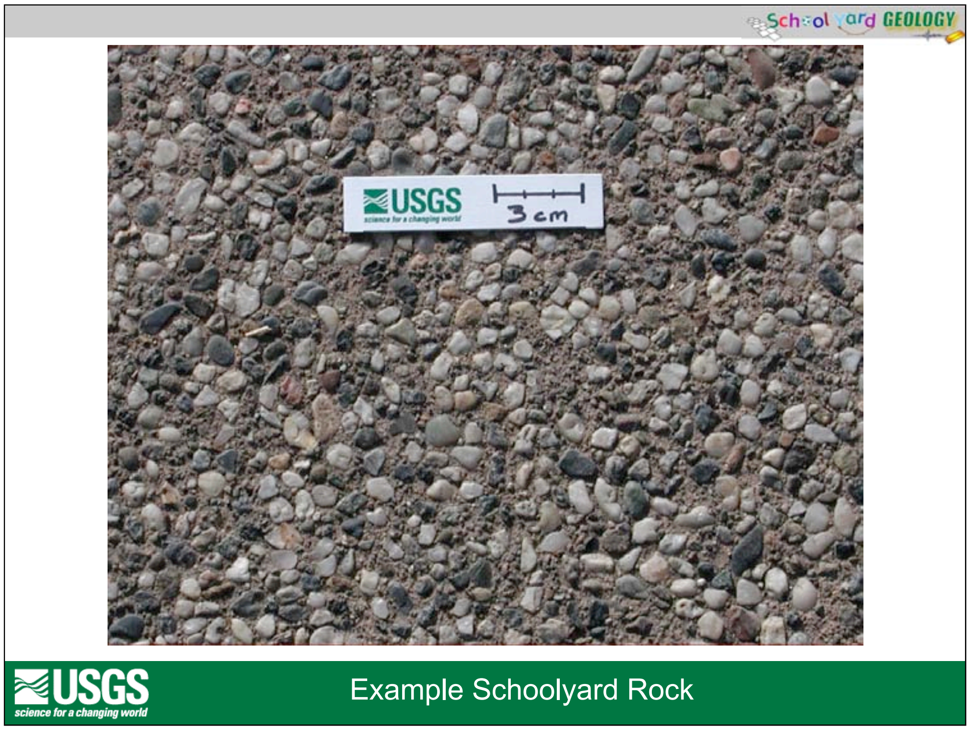
Rock Description Table

We've started to see the factors that give us information about rock stories. As geologists, we have to do this systematically by taking measurements and recording them.

<Go through how to record details on the chart. See examples at: http://quake.wr.usgs.gov/~dalessio/schoolyard/RockDescriptionExamples.html >

<NOTE To teacher: For younger students, you may want to simplify the grain shapes to "Angular … Medium … Rounded." The only problem is that most rocks are somewhere in between Angular and rounded, so it's good to force students to make a decision if the shape is closer to angular (medium angular) or closer to rounded (medium rounded).>



<Work through this example with your students. Have volunteers come up and measure the grain size on the screen. (it won't be the same as the ruler in the photo indicates.>

Location: outside Art Studio building, UC Berkeley (or, Mr. ___'s classroom wall :-)

Colors: About 50% milky white, 20% light grey, 25% dark grey. Some reddish grains (5%). Dominant Colors: dark grey and white

......All the same color?No.

Grain Size.....Minimum grain size: 0.5 cm.....

Maximum grain size1.5 cm

.....All the same size?Mostly. Most Grains are about 0.75 cm.

Grain shapes: Rounded, with a few medium rounded grains.

Strength: Very strong. (cannot be determined from the picture. You need to touch it to tell.

Other Comments: Some of the grains have fallen out, leaving behind rounded holes in the pavement.

If you saw a rock like this in nature…

…what could you deduce about where it formed?

Another Schoolyard Rock

Have students try this one on their own.

Encourage them all to get up out of their seats to come up and measure.

Then, return to the important idea of ROCK STORIES:

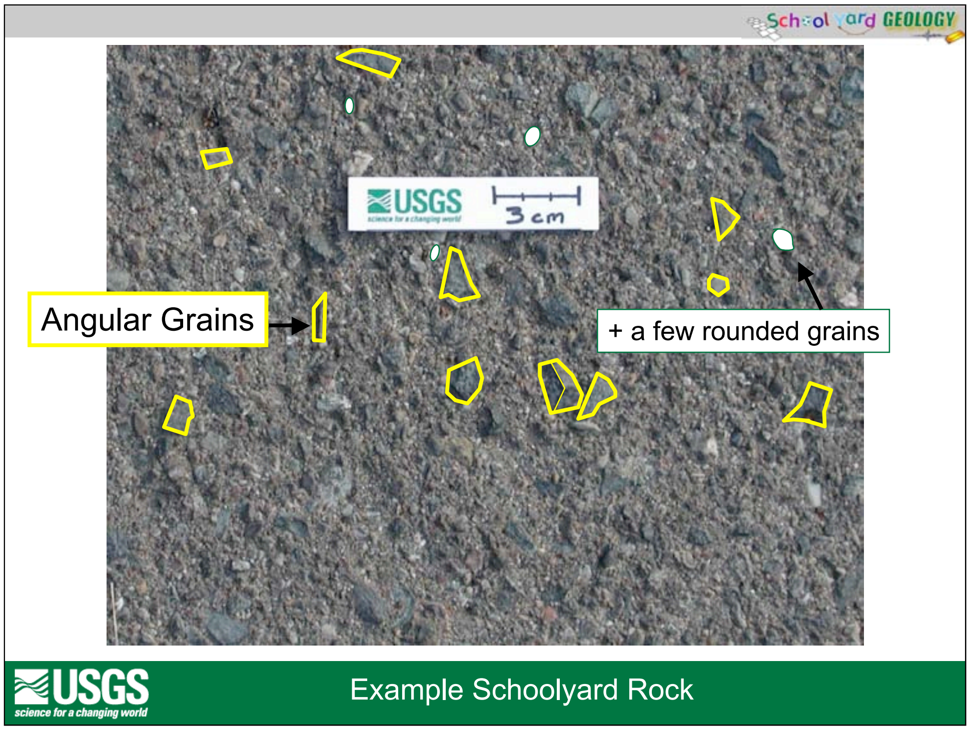
What does this description of the rock tell you about its history? What could we say about this rock if we saw it in nature?

Interpretation:

Natural tar seeps produce rocks with **all black** grains *held together by tar*. Beaches produce grains that are *all the same size*. Tar occurs near some California beaches.

Tar Seeps

One way to tell is to find rocks from other places that have characteristics in common with the rock we have. If we find rocks that are currently being formed that look a lot like the rock we're interested in, it's probably true that they both formed the same way. Here is an example from southern California. <Read interpretation above.>



Here is another example. Let’s go through this one quickly.

Note that each grain has its own history, so the fact that some grains are more rounded while most are angular means that these grains all came to this spot via different paths. They had different histories until they all ended up here at one point and got cemented together into a solid rock.

La Conchita Landslide, 1995.
Photograph by R.L. Schuster, U.S. Geological Survey
http://landslides.usgs.gov/html_files/landslides/slides/landslideimages.htm

Interpretation:

Landslides produce **angular** fragments spanning a *wide range of grain sizes*. Landslides are quick events that break the rocks apart but are not steady or long enough to round the grains

USGS science for a changing world — Landslides

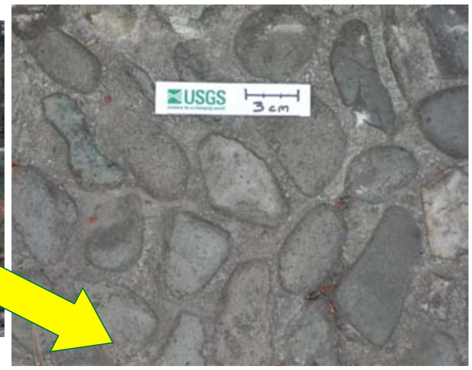
There are several more examples in this file, but at this point you can take your students outside to map real schoolyard rocks.

<COMMON MISCONCEPTION: Most students like to find a single small pebble and measure the dimensions of that one grain. While that's interesting, we want the student to recognize that the pebble is part of a larger rock outcrop that makes up the whole surface beneath their feet. Have them describe the rock as a whole, and not just one single grain. If they insist on finding a loose pebble, it's important that they recognize that the pebble is probably made up of smaller pieces as well. Often the grains making up that pebble are so small that you cannot see them or tell them apart from one another.>

Interpretation:

A **fast moving stream or river** is the only thing capable of moving **large** grains like these. The grains are rounded because they sat in the river for a while.

Image Copyright: *Oklahoma University*
http://www.earthscienceworld.org/imagebank/search/results.html?ImageID=hn86m8



Another example rock

Interpretation:

Beaches produce **small**, **rounded** grains. They are rounded because repeated wave action slowly wears the pieces down. They are small because waves are not strong enough to move large boulders.

Beaches

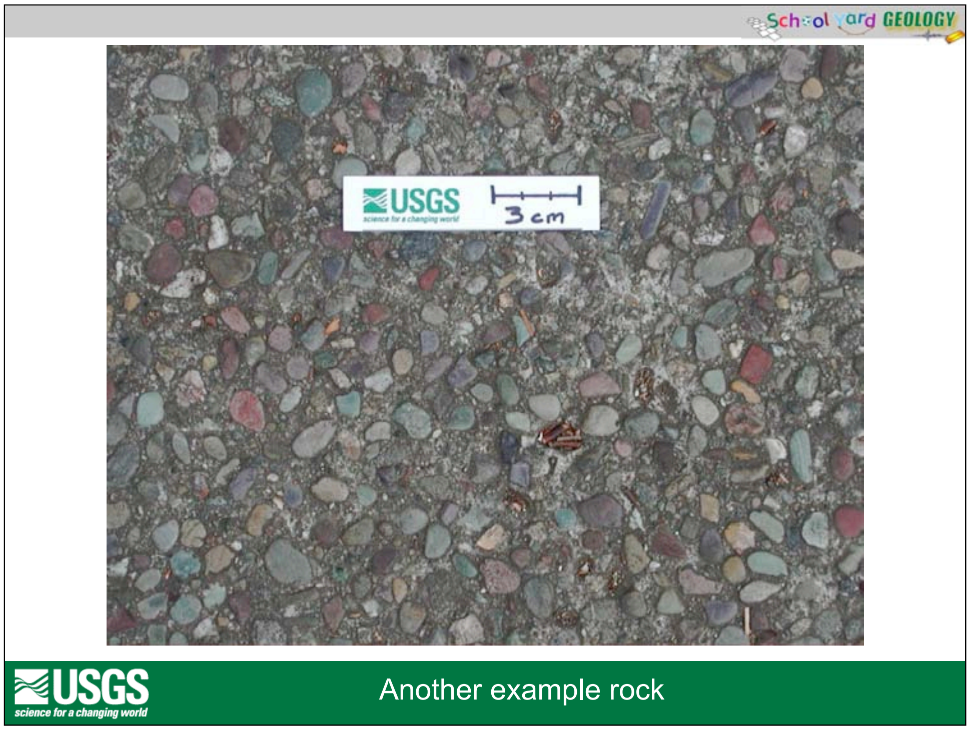
Another example rock

Interpretation:

How fast would water have to flow to push a **1 cm** pebble? It couldn't be too slow, but wouldn't have to be too fast either. A **small creek** would fit the bill. The **round** grains again indicate that it sat in the bed for a very long time.

Image Used by Permission from *Black Dove Stock Photography*.
http://www.deviantart.com/deviation/15053728/

Slow Moving Stream



Same interpretation as previous example from a slow moving stream.

Schoolyard GEOLOGY

Image Copyright: *Oklahoma University*, http://www.earthscienceworld.org/imagebank/search/results.html?ImageID=hn86m8

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High Energy Stream

Image repeated on its own slide.

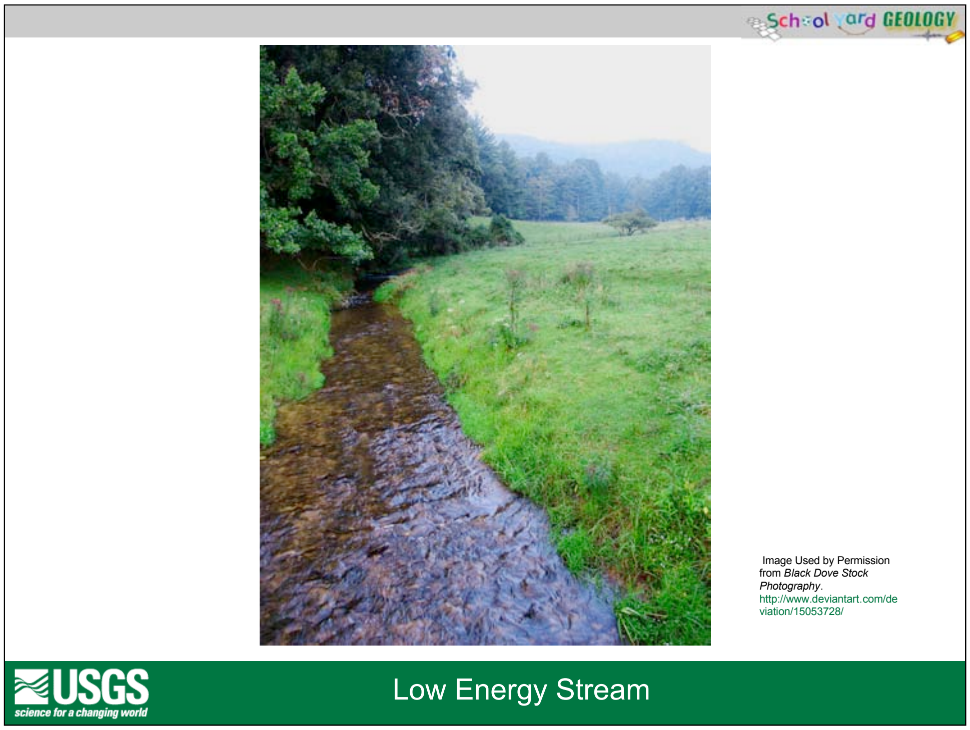

Image repeated on its own slide.

Pit is about 200 feet deep! Image From: *County of Marin*. http://www.co.marin.ca.us/depts/GJ/main/cvgrjr/2000gj/ssrq/SRRQREPT.pdf

USGS science for a changing world

Crushed Rock Quarry

You may find that none of the rocks in your schoolyard are rounded. The reason you find angular grains in your schoolyard's building materials may have something to do with the history of your city. Some older concrete is made with very rounded grains. Because they are rounded, we know that they came from an environment that smoothed them out -- probably the bottom of river bed. However, a lot of newer cement has very angular grains. Why the change? It turns out that most cities and towns have grown so much over the years that they have used up all of the easily accessible river gravels nearby. It is often cheaper to dig huge chunks of rock out of the ground and crush them into smaller pieces than to transport the naturally small gravel from far away places. In other words, many of the angular grains we see in concrete today are the product of instant "mechanical weathering" caused by machines. The smoother, rounded grains from older concrete are the product of lots of mechanical weathering over thousands of years by nature.