SUMMARY: Rocks and minerals in 1000 words or less.
- There are two main types of rock materials: bedrock and sediments.
- All sediments eroded from bedrock.
- There are three types of bedrock: metamorphic, igneous and sedimentary bedrock.
- Igneous bedrock was once melted.
- Sedimentary bedrock once was sediments.
- Metamorphic bedrock was once something else before it was altered by heat and pressure.
- The story of a rock is its story along the several paths of the rock cycle.
- When someone hands you a rock, they have handed you a piece of sediment.
- When someone asks you “what kind of rock is this” they are asking you “what kind of bedrock did this piece of sediment come from?”

SUMMARY: The rock cycle
- Processes of erosion and deposition produce sediments.
- Processes of lithification harden sediments into layers of sedimentary bedrock.
- Metamorphism changes rocks physically and chemically into metamorphic bedrock.
- Melting and crystallization produce igneous bedrock.
Analysis of Utah Landforms
The Rock Cycle

Game plan -
REVIEW why the rock cycle is (a) important to understand;
(b) not understood.
BLOOM’s taxonomy of learning... an understanding of rocks
and minerals underpins an understanding of Earth science,
and... I think Earth science is the great integrating science...
and so approachable... Earth science in our backyard.
CONCEPTS - go to http://www.earthscienceeducation.
org (web page of Colleen Bliss, teacher, Draper Elementary
translating Earth Scien Ecducation’s texts onto the web...
lucky me).
BIG IDEAS.
1 - Bedrock versus sediments
2 - Minerals versus rocks
3 - The rock cycle is the story of a rock... it is the SCIENCE
you want to understand and teach

At the end of today’s session you should be familiar with the
paths of the rock cycle.

4 PRODUCTS - to memorize... in order to understand the rock cycle
sediments and 3 types of bedrock

<table>
<thead>
<tr>
<th>SEDIMENTS</th>
<th>BEDROCK</th>
</tr>
</thead>
<tbody>
<tr>
<td>loose, not firmly attached to Earth's rocky crust</td>
<td>frim, coherent, continuously attached to earth's rocky crust.</td>
</tr>
<tr>
<td>the products of weathering, erosion, transport, and deposition.</td>
<td>Sedimentary bedrock</td>
</tr>
<tr>
<td></td>
<td>Metamorphic bedrock</td>
</tr>
<tr>
<td></td>
<td>Igneous bedrock</td>
</tr>
<tr>
<td></td>
<td>once was sediments</td>
</tr>
<tr>
<td></td>
<td>physically and/or chemically altered by heat and pressure</td>
</tr>
<tr>
<td></td>
<td>once was melted</td>
</tr>
</tbody>
</table>
CHAPTER FIVE
THE STORY:
THE ROCK CYCLE

This chapter is the most important section of this book. If you only can tell a little bit of a rock’s story, if you are not skilled in recognizing rock types and don’t know any rock names (think of them as characters of the story) at least tell the basic plot of the story that the rock tells. The plot is always the same theme... the rock cycle.

You can think of it as a journey...

```
The rock came from there... Now it is here.... it will be going there.
```

You can think of it as a recycling factory...

```
Process #1 made it a ___ rock: Then process #2 made it a ___ rock:
Then process #3 made it a ___ rock again: Next process #4 will ....
```

You can think of it as a simple cycle...

```
A ___ rock becomes a ___ rock: which becomes a ___ rock: which
becomes a ___ rocks: which becomes a ___ rock: which becomes.....
```

You can think of it as cycles within cycles...

```
A ___ rock gets recycles as a ___ rock and then takes a different
path to become a ___ rock, and then ..... 
```

You can think of it as a bicycle with the rock cycle in the crust and the mass and heat transfer in the interior

```
The uneven distribution of heat within the interior of the earth produces convection and igneous rocks; it drives movements of the crustal plates; collisions and spreading cause uplifts and downwarps; differences in topography result in erosion and deposition and ..... 
```

Your challenge is to figure out where a rock is in the rock cycle. Every rock is somewhere on the journey. Every rock is somewhere in the recycling process. Then you can tell the story of the rock’s past and the rock’s future. Then you are teaching earth science.

TEACHER FEEDBACK: _____ Good; _____ OK; _____ Please improve.
COMMENTS:
All the bedrock of Salt Lake County was made from earlier rocks that were:
- disintegrated into fragments (sediments) that then became consolidated into a new rock (sedimentary rock).
- were subjected to heat and pressure that transformed many of the minerals and welded them into a new rock (metamorphic rock).
- or were heated to such an extent that they melted, then cooled and recrystallized and formed a new rock (igneous rock).

Every rock is somewhere in the rock cycle. The story of the rock is the story of rock cycle: where the rock is now on the rock cycle, the path it took on the rock cycle to get to where it is now, and the path on the rock cycle it will take into the future.

The rock cycle can be illustrated in several ways. Here are four ways to describe the rock cycle:
1) a simple cycle with way points and pathways (adapted: Prentice Hall).
2) Earth’s recycling system (Earth Science Education).
3) the rock cycle as a journey (Earth Science Education), and
4) two cycles, one internal and one external (Dynamic Earth).

All these ways of telling the story have the same theme:

There are **four** products:
- sediments
- sedimentary rocks
- metamorphic rocks
- igneous rocks.

There are **four** processes:
- Sedimentation (weathering, erosion, and transport)
- Lithification (making sediments firm and coherent)
- Metamorphism (altering the physical and chemical characteristics of minerals of rocks)
- Melting and crystallization.
TEACHING MOMENT:
Study each of these diagrams and use whichever ones help you understand the rock cycle the best.

1) Jump onto the cycle where it says metamorphic rocks.

*Find the place on the cycle that says "metamorphic rock." This means metamorphic bedrock.*

2) What is the immediate past history of this rock? Where has the rock been on the rock cycle?

*Note the arrows leading to "metamorphic rock."
Note how the arrows are one-way paths... from one rock type via a process to the next rock type.
The arrows are the processes.
The process that results in metamorphic bedrock is called metamorphism.
Three paths lead to metamorphic bedrock:
- From sedimentary rock via metamorphism,
- From igneous rock via metamorphism, and
- (and a loop that is not always shown), From metamorphic rock to metamorphic rock via metamorphism.*

3) What will become of this rock? Where can it go on the rock cycle?

*Three paths leave the metamorphic rock stop of the rock cycle:
- the weathering pathway to "sediments"
- the melting and crystallization pathway to "igneous rocks"
- the metamorphosis pathway to "metamorphic rocks."
*Note: metamorphic rocks cannot take a direct path to "sedimentary rocks."*

This is the story of "metamorphic bedrock."
This is the story of the metamorphic bedrock at the mouth of Little Cottonwood Canyon, of much of the bedrock of Antelope Island, and of some difficult-to-find outcrops of metamorphic bedrock on the northern boundary of Salt Lake County and Davis County.

TEACHER FEEDBACK: _____ Good; _____ OK; _____ Please improve.
COMMENTS:
The "Classic" Rock Cycle

This is the "simple" rock cycle found in many texts. Your students may be expected to understand it. Note the one-way paths (follow the arrows). This version of the rock cycle conveys the unending, cyclic nature of the rock cycle. Rocks can go round and round and round the cycle, as long as they follow the arrows. Note how this version of the rock cycle has five processes and five products.

TEACHER FEEDBACK: ___ Good; ___ OK; ___ Please improve.
COMMENTS:
The rock cycle as a journey.

THE PROCESSES:
- Sedimentation
- Lithification
- Metamorphism
- Melting and crystallization

The story of a rock can be told as the story of a journey. The rock was at a rock type and then took a path (a rock process) to another rock type. The rock will continue on a path (a rock process) until it becomes another rock type. Reminder: note the one-way paths.
One-way paths of the rock cycle

SEDIMENTARY ROCKS → SEDIMENTS → IGNEOUS ROCKS → METAMORPHIC ROCKS → SEDIMENTARY ROCKS

Sedimentation
Lithification
Metamorphism
Melting and crystallization

TEACHING MOMENT:

Color the paths... the processes.

Sedimentation: 4 routes to Sediments
Lithification: 1 route to Sedimentary Rocks
Metamorphism: 3 routes to Metamorphic Rocks
Melting and crystallization: 1 route to Igneous Rocks
Earth's Recycling System
FIGURE 1.18 The rock cycle, an interplay of internal and external processes. Rock material in the continental crust can follow any of the arrows from one phase to another. At one time or another it has followed all of them. Within the mantle circuit, magma rises from a depth and forms new igneous rock in the lithosphere. The old lithosphere descends again to the mantle where it is eventually remixed. Reservoirs are labeled in capital letters; paths representing processes are labeled in lowercase letters.

From: Dynamic Earth, p. 21, First edition. Used with permission.

This depiction of the rock cycle shows:
- The importance of forces within the Earth and how heat in the upper mantle drives the creation of new igneous rock that is added to the Earth's crust.
- How solar energy drives the surficial processes of sedimentation.
- How crustal forces such as continental drift and the buoyancy of crustal materials drive most metamorphic processes and some lithification and igneous processes because of the increased heat and pressures at depth.
CYCLES

It is useful to envision interactions within the Earth system as a series of interrelated cycles, groups of processes whereby materials and energy move among the Earth’s reservoirs. Earth system science helps us study how materials and energy are stored and how they are cycled among the four principal reservoirs of the Earth system—the atmosphere, the biosphere, the hydrosphere, and the lithosphere. Because this book is about physical geology, it has focused mainly on processes in the lithosphere. However, the systems approach tells us that it is unreasonable—even impossible—to consider one part of the Earth system in isolation from the rest. Physical geology deals with processes in the lithosphere and the interior of the Earth, but these are intimately associated with processes in the hydrosphere, the atmosphere, and the biosphere. In this book, you have not only learned geology but some oceanography, hydrology, meteorology, physics, chemistry, biology, and astronomy as well.

Using the concept of cycles, we can trace the movement of energy and materials from one reservoir to another (Figure 12.3). The cycles that are particularly important in physical geology are:

**THE EARTH SYSTEM**

**Figure 12.3**