

## Section Objectives

- Name the three main types of sedimentary rock and give an example of each.
- Describe several identifiable sedimentary rock features.

# 10.3 Sedimentary Rock

Sedimentary rock is made up of accumulations of various types of sediments. **Compaction** and **cementation** are the processes that form sedimentary rock. During compaction, the weight of overlying sediments causes pressure, pushing the fragments together and squeezing out air and water from the fragments. In cementation, water carries dissolved minerals through the sediments. These minerals are left between the fragments of sediment and provide a cement to hold the fragments together. Geologists classify sedimentary rocks according to the kind and size of sediments that form them.

## Formation of Sedimentary Rocks

One class of sedimentary rock is made up of rock fragments carried away from their source by water, wind, or ice and left as deposits elsewhere. Over time, the separate fragments may become compacted and cemented into solid rock. The rock formed from these deposits is called **clastic sedimentary rock**. A second class of sedimentary rock, called **chemical sedimentary rock**, forms from minerals that have been dissolved in water. A third class, called **organic sedimentary rock**, forms from the remains of organisms.

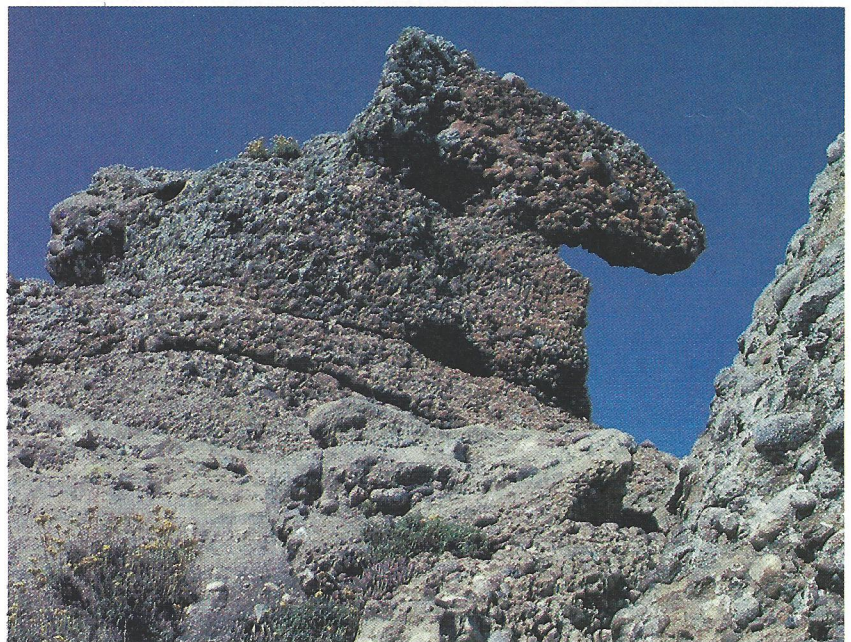
### Clastic Sedimentary Rocks

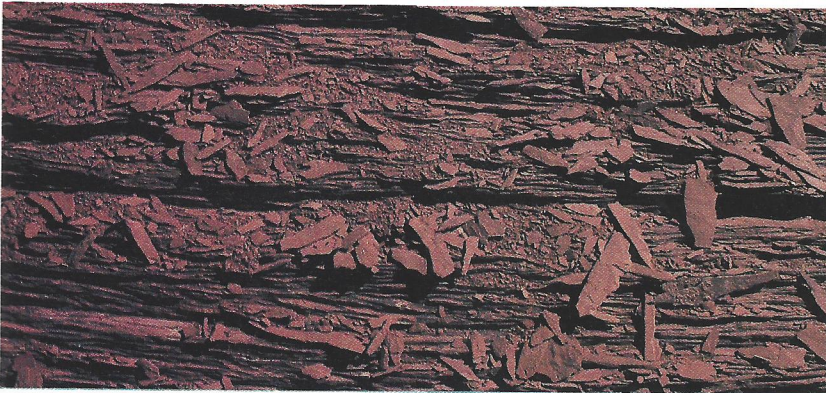
Clastic sedimentary rocks are classified by the size of the sediments they contain. One group consists of gravel-sized fragments that are cemented together by minerals. Rock composed of rounded gravel-sized fragments, or pebbles, is called a **conglomerate**. If the fragments are angular and have sharp corners, it is called a **breccia** (BRECH-ee-uh). In conglomerates, as shown in Figure 10-7, and breccias, the individual pieces of sediment can be easily seen.

**Figure 10-7. Conglomerate rock is composed of rounded, pebble-sized fragments held together by a cement (left). The formation on the right is made up of conglomerate rock.**



**Conglomerate**





**Figure 10–8.** Magnified view of sandstone and shale. Sandstone (top) is made up of small quartz grains cemented together by the mineral calcite. The flaky clay particles in shale (bottom) compress into flat layers.

Another group of clastic sedimentary rocks is made up of sand-sized grains that have been cemented together. These rocks are the sandstones. Since most sediments of sand-grain size are made of quartz, quartz is the major component of sandstone. Many sandstones have pores between the sand grains through which liquids, such as groundwater and crude oil, can move.

A third group of clastic sedimentary rock is shale, which consists of clay-sized particles cemented and compacted under pressure. The flaky clay particles are usually pressed into flat layers that will easily split apart. Figure 10–8 shows these characteristic layers.

### **Chemical Sedimentary Rocks**

Some sedimentary rocks are not made up of rock fragments but are chemical in origin. These rocks form from minerals that were once dissolved in water. Some form from dissolved minerals that precipitate, or settle, out of the water as a result of a change in temperature. For example, a certain type of chemical limestone forms when cool currents lower the temperature of warm ocean water, and calcite precipitates, settles, and eventually solidifies on the ocean floor.

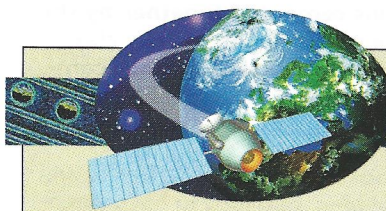
Another type of sedimentary rock results when water evaporates and leaves behind the minerals dissolved in the water. The dissolved minerals left behind form rocks called **evaporites**. Gypsum and halite, or rock salt, are two examples of sedimentary rocks formed by rapid evaporation. An example of extensive evaporite deposits can be found on the Bonneville Salt Flats near Great Salt Lake in Utah.

## Organic Sedimentary Rocks

The third class of sedimentary rocks is *organic*, which means “formed from the remains of living things.” Coal and some limestones are both examples of organic sedimentary rocks. Coal forms from decayed plant remains that are buried and compacted into matter that is mostly carbon. You have learned that chemical limestones can be precipitated as a chemical sediment. However, the formation of organic limestones begins when the mineral calcite is removed from sea water by marine organisms, such as coral, clams, oysters, and plankton. These organisms use the calcite to make their shells. When they die, their shells become limestone. Chalk is a type of limestone made up of the shells of tiny, one-celled marine organisms. The chalk originally formed as mud at the floor of an ancient sea. The white cliffs of Dover, in England, are made up of chalk.

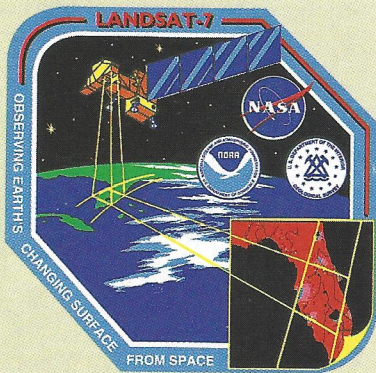
## Sedimentary Rock Features

Sedimentary rocks have a number of easily identifiable features. These include stratification (layering), ripple marks, mud cracks, fossils, and concretions.



# SCIENCE & TECHNOLOGY

## Landsat Maps the World



▲ *Landsat 7* is the latest in the *Landsat* series of earth observation satellites.

Landsat satellites have been recording images of the earth for over two decades. In that time, these earth-scanning satellites have logged more than a million images. As Landsat satellites periodically rescan regions, they create a visual history of the earth's changing landscapes. It is the longest continuous record of the earth's landmasses ever created.

Landsat images resemble aerial photographs. Each image records about 30,000 km<sup>2</sup> of the earth's surface. Landsat images are not ordinary photographs, however. Each satellite uses a scanning sensor system

called a *thematic mapper* (TM) to create multispectral images. The TM sensors detect not only visible light, the light recorded by an ordinary camera, but also other parts of the electromagnetic spectrum that the human eye cannot detect, such as infrared light. This capability gives Landsat images much more detail than conventional photographs would have.

The thematic mapper detects seven segments, or bands, of the electromagnetic spectrum besides visible light. It assigns a different color to each band to produce false-color images. The use of bright artificial colors makes it easier to interpret the images. Vegetation appears pink or red, land that is

## Stratification

Layering, or **stratification**, of sedimentary rock occurs when there is a change in the kind of sediment being deposited. The type of deposit varies for a number of reasons. Changes in river currents or sea level, for example, may result in a different kind of sediment. The stratified layers, or beds, vary in thickness depending on how long each type of sediment was being laid down. Although most water-deposited strata are laid down horizontally, some sediments deposited by wind, such as sand dunes, are characterized by cross-bedding. Cross-bedding is shown in Figure 10–9.

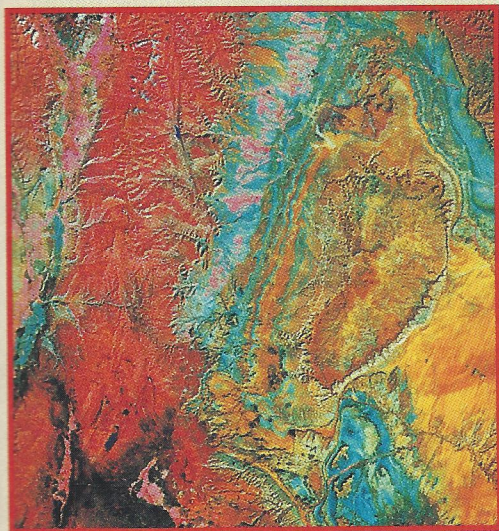
When various sizes and kinds of materials are deposited within one layer, a type of stratification called graded bedding will occur. Graded bedding occurs as different sizes and shapes of sediment settle to different levels. Where in the layer do you think the largest and heaviest grains of sediment settle?

## Ripple Marks and Mud Cracks

Some sedimentary rocks clearly display *ripple marks*. Ripple marks are formed by the action of wind or water on sand. When the sand becomes sandstone, the ripple marks may be preserved.



**Figure 10–9.** Notice the cross-bedding in the rock layers. This type of pattern generally indicates wind deposits, such as sand dunes, or a rapidly changing stream bed.



◀ Enhanced-color Landsat image of the uranium-rich San Rafael Swell, 200 km southeast of Salt Lake City.

create a thematic map. A thematic map is a map that illustrates a particular subject or feature. Selecting different combinations of bands allows cartographers to highlight features such as river deltas, geologic faults, and mineral deposits.

Landsat images appeal to earth scientists in a variety of fields. Landsat images have enabled cartographers to map remote areas of the world. They have allowed hydrologists to find unmapped

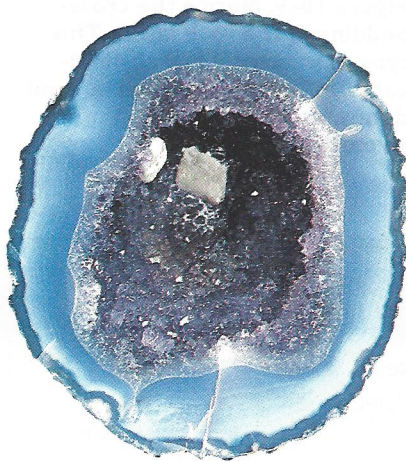
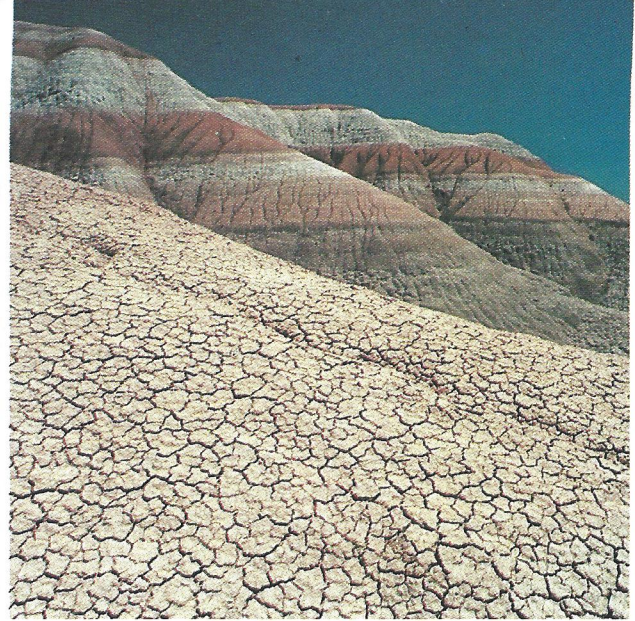
lakes. Landsat images have also helped geologists discover oil in the Sudan, tin in Brazil, and copper in Mexico.

More recently, ecologists have begun to use Landsat images to see changes in the earth's environment. With a series of images of the same region, taken years apart, ecologists can monitor the effects of processes such as urbanization, deforestation, and soil erosion. With so many useful applications, Landsat satellites are likely to continue working well into the next century.

*How might cartographers use Landsat images to check the accuracy of maps?*

rich in iron oxides appears yellow or orange, and urban areas appear grayish blue.

Once a satellite radios an image back to earth, cartographers can use computers to



**Figure 10-10.** Features of sedimentary rock may include ripple marks (top, left), mud cracks (top, right), and geodes (bottom).

The ground in Figure 10-10 shows *mud cracks*, another feature of sedimentary rock. Mud cracks result when muddy deposits dry and shrink. The shrinking causes the dried mud to crack. A river flood plain or dry lake bed is a likely place to find mud cracks. Once the area is again flooded, new deposits fill in the cracks and preserve them as the mud hardens to solid rock.

### Fossils

**Fossils** are the remains or traces of ancient plants and animals. They are usually preserved in sedimentary rock. As sedimentary deposits pile up, plant and animal remains are buried. Harder parts of these remains may be preserved in the rock. More often, even the harder parts dissolve, leaving only an impression in the rock. Fossils are valuable in helping earth scientists learn about the development of the earth's crust. Fossils are discussed in detail in Unit 5.

### Concretions

Sedimentary rocks sometimes contain lumps, or nodules, of rock with a composition different from that of the main rock body. These nodules are known as **concretions**. Concretions form when minerals precipitated from solutions build up around an existing rock particle.

Groundwater sometimes deposits dissolved quartz or calcite inside cavities in sedimentary rock. The quartz or calcite crystallizes into beautiful forms inside the cavities, as shown in Figure 10-10. The crystal cavities are called *geodes*.

## Section 10.3 Review

1. How does clastic sedimentary rock differ from chemical sedimentary rock?
2. What kind of sedimentary rock forms from the remains of decaying organisms?
3. What term describes the remains or impressions of plants and animals in sedimentary rock?
4. You suspect that a rock you have found is sedimentary rock. What features would you look for to confirm your identification?