GEOL 1010 INTRODUCTION TO GEOLOGY
SEDIMENTARY ROCKS: PRODUCTS OF WEATHERING AND EROSION

The notes below are meant to substitute for the lecture that was interrupted by the power outage on
Wednesday. To supplement these notes, I strongly urge you to go through the segment on weathering and
erosion on the GEODE disk that came with your textbook – its pretty good and fun. Also, pull take a look
at the sedimentary rocks in your mineral kit, some of which are listed below.

Some examples of sedimentary rocks are:
1. conglomerate (no. 29 in Wards rock/mineral kit)
2. sandstone (no. 30 in Wards rock/mineral kit)
3. shale (no. 32 in Wards rock/mineral kit)
4. limestone (no 34 in Wards rock/mineral kit)
5. coal (no. 35 in Wards rock/mineral kit)

What do all of these rocks have in common? They are composed of pieces of broken-down pre-existing
rocks and/or organic material. There are five steps that lead to the formation of sedimentary rock from pre-
existing rock. The steps are:
1. Weathering – the breakdown of pre-existing rock into smaller pieces
2. Erosion – the removal of weathered rock from the place where the weathering happened
3. Transportation – movement of the weathered rock to its eventual site of deposition – possibly
   hundreds or thousands of miles of movement
4. Deposition – the weathered rock collects in layers
5. Lithification – the weathered rock is compacted and glued into sedimentary rock.

This five-step process that leads to the formation of sedimentary rocks from pre-existing rocks is a
fundamental part of how nature shapes the Earth’s surface. Rocks at the Earth’s surface – especially rocks
high in mountain ranges - get broken down and recycled into sedimentary rocks. We will go through each
step, beginning with weathering.

Weathering
Weathering is the breakdown of pre-existing rock into smaller pieces and sometimes into new minerals at
the same time. The pre-existing rock may be of any type – igneous, sedimentary or metamorphic. An
overriding, basic concept is that at the Earth’s surface, rocks are worn down by rain, snow, wind, changing
temperature and other factors. Relative to our lifetimes, rocks may seem very stable, but relative to
geologic time periods, rocks don’t last long at all on the Earth’s surface. Weathering produces sediment,
which is broken down, weathered rock. Sometimes non-geologists call sediment dirt, but lets stick to the
term sediment.

There are two main types of weathering: mechanical and chemical.

Mechanical Weathering
Mechanical weathering refers to the physical breakdown of rock into smaller pieces. You could
mechanically weather a rock by hitting it with a hammer. In nature, the primary causes of mechanical
weathering are:

1. Freeze – thaw or frost wedging. When water freezes, it expands. Rocks naturally have cracks in
   them that form because most rocks in the past were covered by other, overlying rocks. When the
   overlying rocks are eroded away to expose the deeper rocks, the deeper rocks have tremendous
   pressure released from them. The release in pressure causes them to expand and crack. When
   they reach the Earth’s surface, water can get in the cracks then freeze, expand and crack them
   more. The water then melts during the daytime or perhaps during the summer, and the process is
   repeated when the temperature drops again. This is called freeze-thaw or frost wedging, and it is
   most common in mountainous areas.
2. Plants. Plants mechanically breakdown rocks with their roots, just as trees can break sidewalks or
even the foundations of houses with their roots.
3. Abrasion. This refers to the effect of water, wind or ice (glaciers) causing sand and other sized pieces of sediment to scrape and hit against rock, thereby breaking it apart.

4. Heating – cooling. Extremes of temperature between day and night cause rock to expand and contract, which can slowly break apart the rock. This type of mechanical weathering can be important in deserts, where the temperature difference between night and day is large, and water and plants are scarce and therefore do less weathering.

The pieces of rock produced by mechanical weathering are called detrital sediment, or detritus for short. Detritus is classified and named based on the size of rock pieces involved:

1. mud – so small that it feels slippery between your fingers or even against your teeth. Flour is mud-sized.
2. Silt – very small pieces, but just barely feels gritty, especially if you rub it on a tooth.
3. Sand
4. Gravel – pebble – sized
5. Cobbles – softball – sized rocks. Sometimes roads are made of cobbles, especially in Europe.
6. Boulders – big

**Chemical Weathering**

Most chemical weathering involves the chemical action of water on the minerals in rock. Many rocks form at some depth in the Earth’s crust under conditions that are very different from the cold, wet, oxygen-rich conditions of the Earth’s surface, and they chemically breakdown on the Earth’s surface. For example, consider a plutonic rock that formed from magma at 1800°F 10 miles deep in the Earth. At first thought, you might think that the minerals in such a rock are very tough, and would last forever on the Earth’s surface. But just the opposite is true. Such a rock will tend to contain minerals that are stable and strong at conditions of high temperature, no water and high pressure. Those same minerals will tend to be chemically unstable on the Earth’s surface. Indeed, the minerals at the top of Bowens Reaction Series (the igneous minerals that form at the highest temperatures), are the most susceptible to chemical weathering on the Earth’s surface.

Chemical weathering affects rocks in two ways:

1. Dissolution. This term refers to water simply dissolving rock. When a rock is dissolved, it is broken down into individual atoms or molecules (a few atoms bonded together) – which are very small pieces! The dissolved particles then are held in the water, and are carried away if the water moves. The rock limestone is particularly susceptible to being dissolved. You can cause dissolution to salt crystals by putting them in a pot of water – especially hot water.

2. Formation of new minerals. In many instances, water chemically reacts with pre-existing minerals to form new minerals. The minerals at the top of Bowens Reaction Series (the igneous minerals that form at the highest temperatures), are the most susceptible to this, because they form at the highest temperatures of the common igneous minerals. The minerals that form are stable in the cold, wet, oxygen-rich conditions of the Earth’s surface, but are unstable at high temperatures and pressures within the Earth. Two main types of minerals are formed by chemical weathering:
   a. Clay minerals – this is an important point: most clay minerals are products of weathering, and are stable at the Earth’s surface, but not deep underground (or in a high-temperature kiln, such as is used to make ceramics).
   b. Rust-type minerals – minerals that contain iron can rust, in almost exactly the same way that metal rusts.

Chemical weathering produces dissolved material (called the dissolved load in water), that consists of atom and molecule – sized pieces that of course are extremely small. It also produces new minerals, which usually are mud-sized particles (e.g., clay). In fact, sometimes people use the term ‘clay sized’ instead of ‘mud sized’ because clay produced from weathering almost always occurs as very small individual grains. In this class, let’s stick to the term ‘mud-sized’ to avoid confusion between a size of particles and a type of mineral (clay).