

Lab 1: Rocks, Fossils and Time

This lab is an introduction to types of rocks and fossils and to the geological time scale. We will come back to rock types in later labs. The geological time scale is key to the course, so spend time familiarizing yourself with it. You will need to have memorized the major periods and their dates by the end of the course.

Rocks

Rocks are the substance of the earth. Rocks are aggregations of minerals, where minerals are solid substances with distinct chemical compositions and physical characteristics. Every rock was formed at a particular time in a particular way and has had a particular history. Historical geology is thus the history of rocks, but more importantly historical geology is the study of the history of the earth and its life as inferred from the histories told by its rocks.

Rocks come in three basic types:

- 1) **Igneous rocks.** These are rocks that have solidified from completely melted material. Lava is perhaps familiar to most people, and it is the molten material that comes to the surface in volcanic eruptions. Lava cools rapidly when it comes in contact with air or water to form an igneous rock called basalt. Granite is another familiar igneous rock that has cooled and solidified deep in the interior of the earth. The rate and conditions under which molten material solidifies, plus the composition of the molten material, determine what minerals form and thus what type of igneous rock is produced.
- 2) **Sedimentary rocks.** Sedimentary rocks are recycled rock. They are composed of particles that have been eroded from other rock units – igneous, sedimentary, or metamorphic – and deposited again at the earth's surface by water currents, air currents, or gravity. Sedimentary rocks are dominantly composed of the minerals quartz or calcite and most have laminations, which means that they have a layered structure due to being laid down bit by bit. Limestone and sandstone are perhaps the most familiar sedimentary rocks.
- 3) **Metamorphic rocks.** Metamorphic rocks are rocks that have been warmed-over. They were formed either as igneous or sedimentary rocks, but were subsequently altered by heat and pressure while deep within the earth's surface, just as the ingredients of a cake are altered by cooking. The original minerals of the rock are changed and recombined by the high temperatures and pressures. Depending on how thoroughly the rocks are 'baked', they retain more or less of their original characteristics. The name 'metamorphic' comes from the metamorphosis that these rocks undergo. Familiar metamorphic rocks include marble and slate.



Lava cooling into basalt.
(USGS photo.)



Limestone cliffs.
(PD Polly photo)



Contorted layers of marble.
(H Berry photo)

Fossils

Fossils are the remains or traces of once living organisms. Often these remains are shells, stems, bones, or teeth because these hard skeletal structures are more likely to remain intact as they are buried, fossilized, and sometimes metamorphosed. These skeletal fossils are often called macrofossils. But other types of fossils exist as well. Trace fossils are impressions or burrows of prehistoric organisms, including worm tubes in the beds of vanished oceans, burrows of extinct beavers in ancient soils, and tracks of dinosaurs across lithified mud flats. Chemical fossils are traces of chemicals such as amino acids, ancient DNA, or chlorophyll that have been left by organisms. Usually these chemicals degrade with time so that they are more common in geologically recent periods than in more ancient ones. Impressions are similar to trace fossils, but tend to be unusual impressions, such as the shape of the entire body of a fish, not just the bones, or the impression of the texture of a dinosaur's skin left in a sedimentary rock. In some cases, the whole body of an organism can be preserved: entire insects and lizards have been found in fossilized amber; whole mammoths and woolly rhinoceroses have been frozen in Siberia and Alaska; mummified llamas have been recovered in dry Andean desert caves. Microfossils are microscopic fossils, either of tiny organisms such as ocean plankton or of tiny parts of organisms such as the teeth of small animals. In this course we will mostly see macrofossils or impressions.

Fossils are also for convenience divided by biological group:

Invertebrate Fossils: Shells and other structures of animals such as clams, corals, urchins, starfish, and sponges are commonly found in sedimentary rocks that were formed in shallow oceans. They are referred to as 'invertebrate' fossils to distinguish them from vertebrates, which are animals with back bones.

Vertebrate Fossils: The bones and teeth of vertebrates – fish, amphibians, reptiles, birds, and mammals – are also preserved in the fossil record. These fossils are not as common as invertebrate ones, both because the structure of bone and teeth is more delicate than shells, so less frequently preserved, but also because vertebrate animals are less numerous than invertebrates.

Plant Fossils: Woody stems and trunks, impressions of leaves and barks, and pollen are all common in the fossil record. In fact, fossil pollen is an important tool for understanding the age of rocks and the environment that existed when the rocks were formed.

Geologic Time Scale

One of the most important tools of the geologist is a simple table known as the geologic time scale (see next page). We'll learn more about the time scale, its development, and its interpretation later in the class.

Geological time is broken down into subdivisions of various scales, including very long eras, shorter periods, even shorter epochs, and so on down to very small scales. Every rock formation is placed into this time scale based on its age (of course, some rocks are easier to place than others). Geologists in the 19th and 20th centuries, and continuing to some extent now, spent considerable effort figuring out these time divisions and placing rocks into them.

The ages of the units at the right of the chart are determined independently using various methods for dating rocks.

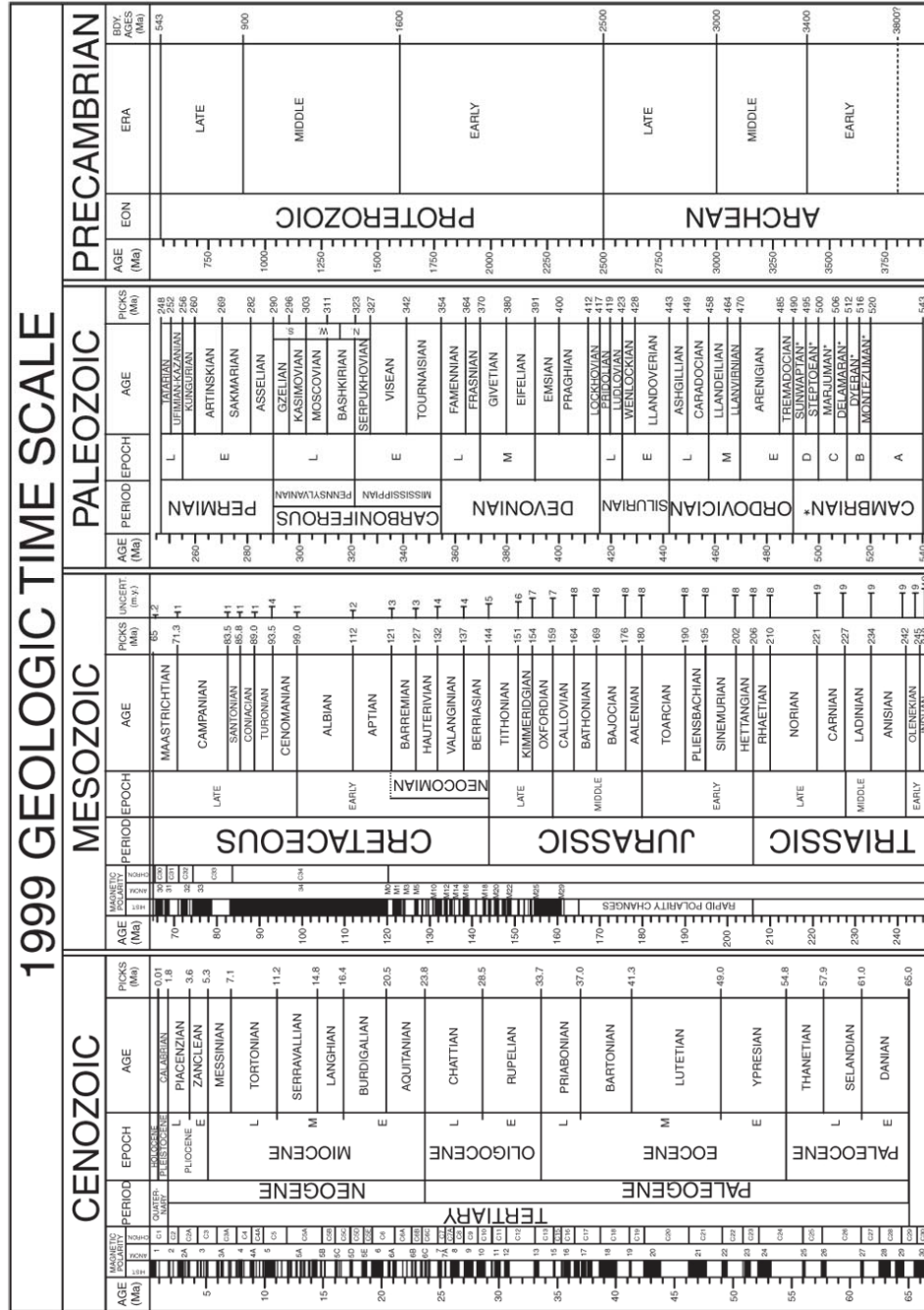
Basic Geologic Time Scale

The table below contains the basic parts of the geologic time scale, the parts that all geologists (including those who pass G112) know. Each cell in the table can actually be subdivided as many times as there are rock layers on the earth of that particular age. Compare it with the one on the next page.

By the end of the course (or even by the first midterm) you'll want to know the names of the eras, periods, and epochs on this chart. You'll also want to know the ages of the era boundaries, though not necessarily the periods and epochs.

Era	Period	Epoch	Age (millions of years ago)	
Cenozoic	Quaternary	Holocene	1.8	
		Pleistocene		
	Neogene	Pliocene		
		Miocene		
	Paleogene	Oligocene		24
		Eocene Paleocene		65
Mesozoic	Cretaceous			
	Jurassic	142		
	Triassic	202		
Paleozoic	Permian		251	
	Pennsylvanian		292	
	Mississippian		320	
	Devonian		354	
	Silurian		417	
	Ordovician		440	
			495	
	Cambrian		545	
Proterozoic				
Archean			2.5 billion	
			4.6 billion	

Detailed Geologic Time Scale from the Geological Society of America



Lab 1 Worksheet

(to be turned in at the end of the lab)

1. With the instructors, visit exhibits on rocks and fossils in the first floor lobby (invertebrate fossil record), first floor hallway (fossil cabinet by department offices), second floor hallway (G103 Rocks), third floor hallway (sedimentary rocks, mammal fossils, plant fossils), and fifth floor (plant fossils, invertebrate fossils). Look for features that help identify the type of rock or fossil that you see.
2. In the lab, look at the 6 specimens laid out on the table. For each identify it as either rock or fossil, identify its type (igneous, sedimentary, or metamorphic for rocks and vertebrate, invertebrate, or plant for fossils), and give the range of possible age in millions of year for each using the geologic time scale and the time subdivision recorded on the label.

	<u>Rock or Fossil?</u>	<u>Type</u>	<u>Age</u>
1.	_____	_____	_____
2.	_____	_____	_____
3.	_____	_____	_____
4.	_____	_____	_____
5.	_____	_____	_____
6.	_____	_____	_____