

102 Physical Geology Lab

Chapter 13: Relative Age, Absolute Age, and Geologic Maps

Materials needed: pencil, eraser, lab notebook, Grand Canyon geologic map and corresponding rocks (provided by instructor)

Objectives:

1. Learn and be able to apply techniques for relative dating
2. Learn and be able to apply techniques for absolute age determination
3. Be able to apply relative and absolute dating techniques to field sites and interpret geologic history

Part I: Relative Age Determination

- Do Problem 1 (*Note: Read the directions carefully. Be sure to include any “geologic events” that occurred, such as erosion, tilting, folding, faulting, etc*)

Part II: Absolute Age Determination

- Do Problem 2 in your lab manual (*Note: use pencil!*)
- Astronomers think the Earth probably formed at the same time as all of the other rocky materials in our solar system, including the oldest meteorites. The oldest meteorites ever found on Earth contain nearly equal amounts of Uranium-238 and Lead-206. If the half-life of Uranium-238 is 4.5 billion years, what is the age of the Earth? Explain your answer.

Part III: Geologic Maps, Relative Age, Interpreting Geologic History

- Answer the questions on the following pages using the Geologic Map of the Eastern part of the Grand Canyon National Park, Arizona

Geologic Map for the Eastern part of Grand Canyon National Park, Arizona

Each rock unit found in the Grand Canyon can be identified on the map by its unique color and **map symbol** (a 2-3 letter code). Below is a list of a few of these map symbols (in bold), followed by a sample number that corresponds to a rock sample from the bins in front of you.

r = SED-N-1 (see jar of sediment)

Pk = S-F

Pc = S-C

Ph = S-A

Mr = S-H

P€n = S-E

P€c = I-C

P€g = I-M, I-A and I-E

P€i = I-I

P€s = M-G

P€v = M-B

P€br = M-C

P€r = M-D

1. Each of the sample names listed above is located in the bins on your tables. In order to answer the following questions, you need to look at these rock samples.
 - a.
 - i) Unit “r” on the map is river sediment – please examine this sediment (in jar labeled SED-N-1). Identify *at least* 2 minerals that you can see in this sediment.
 - ii) Find the area on your map that is outlined by a red box. Locate the river sediment (unit r) in this area. Which rock units surround the river sediment (list the rock type AND the rock symbol)?
 - iii) Could these rocks be the source for the sediment? (to answer this question: consider whether these rocks usually contain the minerals found in sediment “r”)
 - b. Rock units Ph, Pc, and P€n are clastic sedimentary rocks.
 - i) Identify each of these rocks using the corresponding rock samples
 - ii) Describe the environment in which they were formed in terms of relative energy levels (low energy flow; moderate energy flow; high energy flow).
 - c. Unit P€n is a clastic sedimentary rock that **contains** pieces of a metamorphic rock.
 - i) Identify the type of metamorphic rock that makes up the pieces in unit P€n (see corresponding rock sample).
 - ii) Look at the map legend: Is there a rock unit in the Grand Canyon that might be the source for these pieces of metamorphic rock (if so, name the unit)?
 - iii) Which rock is OLDER: P€n or the metamorphic rock found in P€n?
 - d. Samples I-A and I-E are two different rock types – *however*, they are listed as the same unit (P€g) on the Grand Canyon map.
 - i) Identify rocks I-A and I-E
 - ii) Why are they grouped together (i.e. how are they similar)?
 - iii) What is the main difference between them?
(*HINT*: use Table 3.2 to answer the above questions)

The following questions are a review of topographic maps and an introduction to geologic maps:

2. *i)* What is the elevation at the top Cedar Mountain (in the very SE corner of the map)? *ii)* What are the “formation names” of the rock units that make up Cedar Mtn.? *iii)* What is the name of the geologic **period** during which they were deposited (ask someone if you don’t understand this question!)? *iv)* So, what is their maximum age (in millions of years)? *v)* What is the youngest they could be? *vi)* Speculate on why Cedar Mtn. sticks up above the surrounding rocks (*hint*: think about what process might have formed it.)
3. Which way is the Colorado River flowing? How do you know?
4. If you were to hike from the Ranger Station (on the North Rim of the canyon) all the way down to the Colorado River (near the Phantom Ranch), how many vertical feet would you have to hike down? **NOTE:** There are red arrows on the map indicating the points for which you need to calculate elevation.
5. Throughout the map, P€g (granite) is found in contact with P€v (Vishnu schist). You can see this relationship in cross section A-A' *i)* Which of these two units is older? *ii)* What “geologic law” did you use to answer this question?

The following questions are about types of unconformities and relative ages:

6. Look at **the right side of** cross section **G-G'**. What kind of unconformity exists between the Cambrian sedimentary rocks (e.g. €t) and the Precambrian sedimentary rocks (e.g. P€d, P€s, etc)?

For questions 6-9 look at cross section B-B'

7. What kind of unconformity exists between Pk and Pt?
8. What kind of unconformity exists between the Cambrian Tapeats Sandstone (€t) and the Vishnu Schist (P€v)?
9. *i)* Which is older, the Hermit Shale (Ph) or the Kaibab formation (Pk)?
ii) What “geologic law” did you use to answer this question?
10. *i)* Which are older, the Roaring Spring/Uncle Jim Faults or the Permian sedimentary rocks (which include all rock units starting with the letter P(not P€))?
ii) How can you tell?
11. Use the graph from problem 2c to answer the following question: *i)* If the granite (P€g - in the question above) has a Daughter/Parent Ratio of 7, how many half-lives have elapsed? *ii)* If the half-life of the isotope in question (²³⁵U) is 713 million years, how old is the granite? *iii)* Cross section G-G' shows granite P€g in contact with the Tapeats Sandstone (€t). What is the oldest age possible for the Tapeats Sandstone?
12. Look at the **right half** of cross section G-G' (*i.e. from Johnson Point to G'*). Put all of these units in chronological order; include folding, faulting, tilting and erosion in your geologic history. **Assume all the faults occurred at the same time.**