Lab 5: Dating methods

An example of using dating methods

How do we, in fact, know anything about the timing of the events of the last Ice Age? How do we know that the height of the last glaciation was 14,000 years ago in this area, and that the Puget Lobe glacier (which at one point extended from Vancouver to Olympia) had significantly receded by 13,500 years ago? This lab will begin to address some of these issues concerning perhaps the greatest unknown in geology: time. Any method used to get the age of an event or to determine several events relative sequence is called a dating method.

The drawing below shows a small map of a current alpine glacier. North is to the top of the map and a scale is given. The contour interval is 100 feet. The letters and numbers refer to localities; that is, places where datable materials were found. The glacier’s current boundaries are marked, and the line the runs south from the glacier’s toe is a meltwater stream.

1. a. In what direction is the glacial ice flowing? Hint: The answer is “downhill” but I am actually looking for a compass direction.

b. Is there evidence that the glacier was larger in the past? What is this evidence? (Hint: look at the contour lines south of the glacier)

2. So if the glacier is receding, doesn’t that contradict your answer to question 1b? Why not?
The glacier, clearly, is in a recessional phase, but your answer so far cannot give any numerical information about the rate of recession or other such quantities.

3. Examine wood sample D-A1 found at locality A. The wood slab was sawn from the largest living tree found in the area of the locality (note: unfortunately, the tree is no longer living). Also examine lichen sample D-A2 found at the same locality. The white filter paper “circles” represent different lichen (yes, I know, but do you know how hard it is to keep lichen alive in the classroom!?) organisms.

a. Which is the oldest lichen? How can you tell?

b. Measure the lichen’s diameter (distance across the middle) in centimeters (use the rulers provided).

c. What assumption can we make about the timing of the lichen colonizing the rock? (In other words, what event is coincident with the first lichen colonizing the rock?)

4. The bad news is that the lichen, by themselves, provide no numbers about the timing of the event in question 3c. How can you obtain a numerical age on the event in question 3c? (Hint: see part b or look up “dendrochronology”)

5. Why did the wood slab have to be from the largest living tree? What assumption are we making here?

6. Examine wood sample D-B1 and lichen sample D-B2, both from locality B. Again, the largest living tree was slabbed to obtain the wood sample.

a. Making the same assumptions about the lichen sample as in question 3, measure the oldest lichen’s diameter on D-B2 (in centimeters).
b. Does this lichen’s size, compared to the D-A2’s size, surprise you? Why or why not, given the location of locality B versus locality A? (In other words, why should it be smaller?)

7. Using the wood slab D-B1, estimate the numerical age of the glacier-related event at locality B. Your answer should not be just a number; there should be a phrase like “at least” or “at most” or “exactly” in front of the number.

8. Obtain a piece of graph paper (put a title on it “Lichenometry plot”) and label the vertical axis “Time (years)” and the horizontal axis “Lichen diameter (centimeters)”. Plot the locality A and locality B information on this graph and connect the two points with a line. Extend the line in both directions beyond the points. Don’t forget to attach your graph when you turn this assignment in.

9. What does the point (0,0) (the origin of the plot) represent? Should your line go through the origin? Wait, a better question is, what assumption allows you to put your line through the origin? (Hint: it has to do with the glacier’s recessional rate)

10. Look at the lichen sample D-C1. Measure the diameter of the oldest lichen. Note that the furthest south moraine (locality C) has no tree data. Using your lichenometry graph, estimate the age of the moraine.
Questions 11 through 20 refer to the diagram below, which is a cross-section of the crust in central Oregon. The letters refer to the events which placed those rocks there; for instance, "A" represents the deposition of the shale layers near the bottom and "C" represents the intrusion of the steeper dike.

Relative dating methods

11. Order the lettered units from oldest (least recent) to youngest (most recent).

12. The surfaces between formations G and I and between E and F are unconformities. Name each type (see the table on the last page). Significantly, what event happened between E and F which did not occur between G and I?

13. Suppose this cross-section is exposed in a deep canyon of the Deschutes River and you happen to be lucky enough to be wandering in the area. You find (oh, happy day) fossil F-1 near the top of layer E. What is it? What is the youngest geologic period that layer E could have been deposited? What is the oldest geologic period it could be?

14. Later in your exploration, you come upon fossil F-2 near the top of layer G. What is it? What is the youngest geologic period that layer G could have been deposited? What is the oldest geologic period it could be?
15. a. Which strata (write the letter) must be Mesozoic in age?

b. Which strata may be Mesozoic (in part or wholly) in age?

c. Given the answers to a and b above, what limits relative dating methods, in terms of figuring out when in the geological timescale you are?

**Numerical (absolute) dating**

16. a. Recall dendrochronology as a dating technique used to figure out the age of the lahar near Orting. Is dendrochronology a relative or numerical dating technique? Is it a radiometric or non-radiometric dating technique?

b. Can any numerical dating method be used to figure out the ages of the sedimentary layers? Can any numerical dating method be used to figure out the ages of the fossils?

17. Which radiometric numerical dating methods may be appropriate for dating the dikes? Warning: not all methods are suitable, given the type of rock a dike is. Please cite a reference (author, book title, edition, page number) for your information source.
18. Suppose a research team finds the numerical ages of the dikes to be 40 million years (My) for the younger one and 220 My for the older one, using the method(s) you listed above. Are the dates consistent or inconsistent with your answers to questions 13 and 14? Explain why. On the cross-section in the front, label the dikes with their ages and lightly color in the layers which are between those ages.

19. Suppose another research team uses potassium/argon dating and determines that the orthoclase crystals in layer I are 325 My. Is it reasonable to conclude that layer I is of late Paleozoic age? Short answer: NO! What is the reason for the apparently errant date (assume their lab technique was superb)?

20. If petrified wood is found in layer G, give two reasons why you can't use carbon-14 dating.