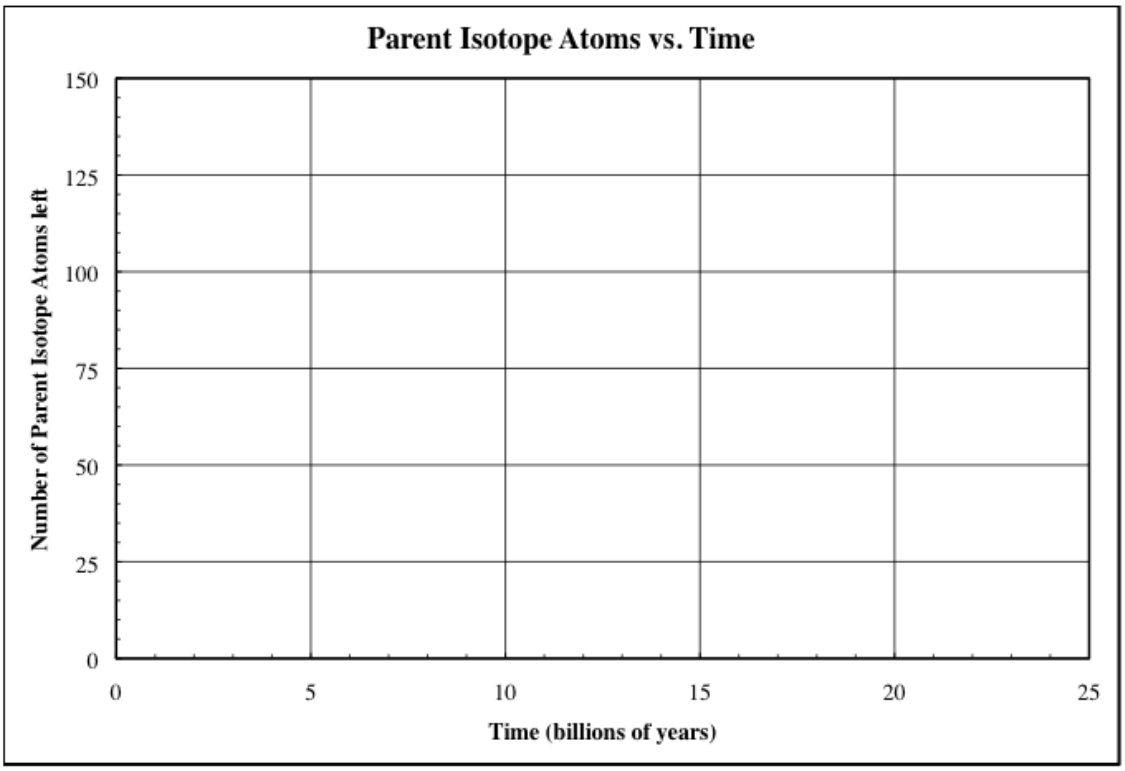
Lab 3 – Geochronology **Due Friday October 12th**

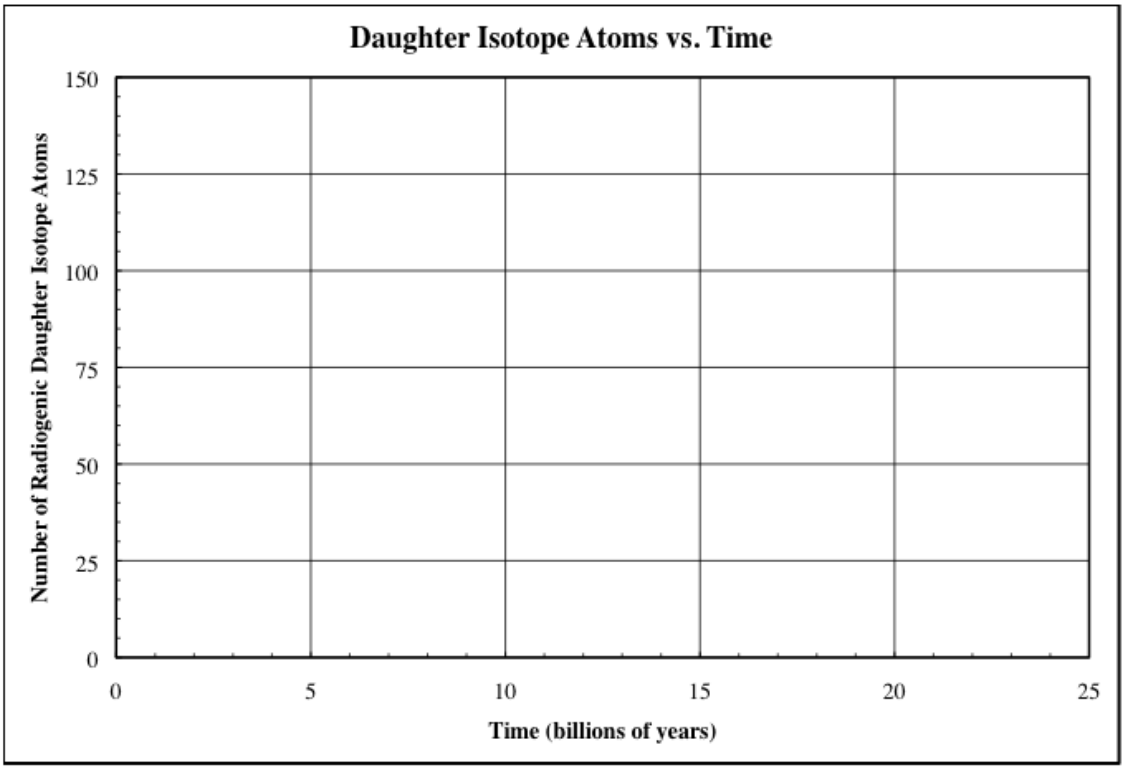
Part 1: Introduction to geochronology

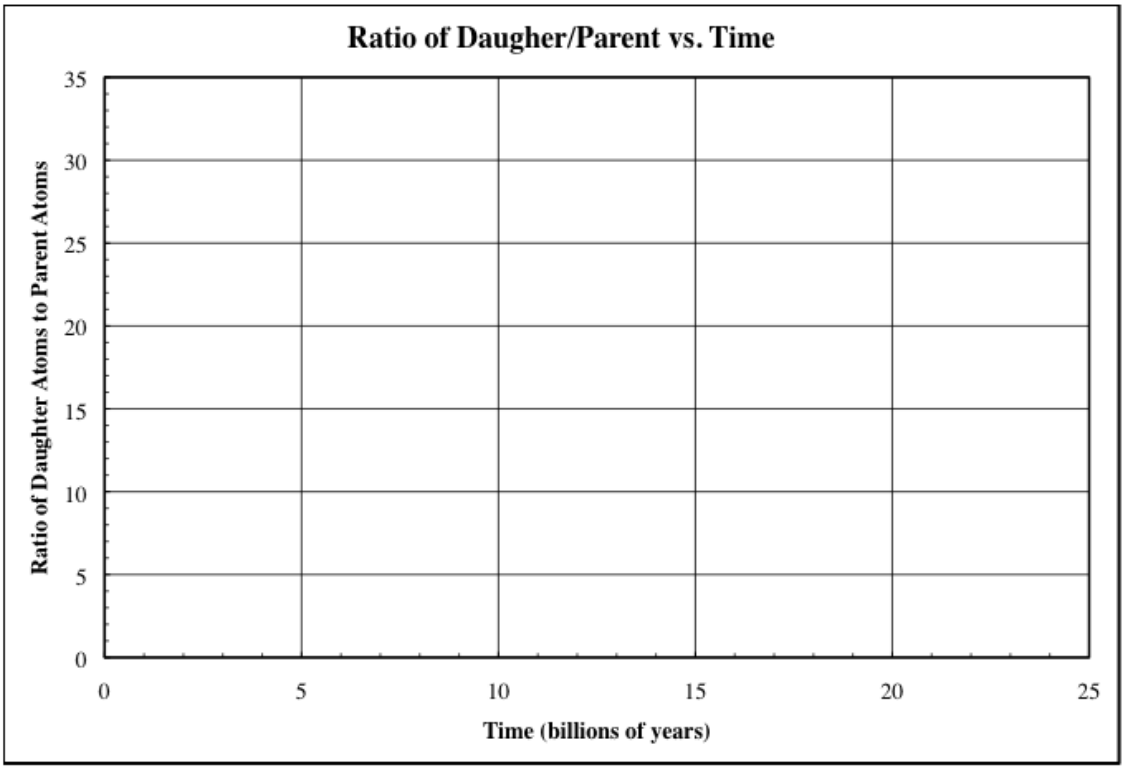
1. Radioactive decay.

a. Fill in the table below, which is based on the decay of ^{238}U (half-life = 4.47 Gyr) to ^{206}Pb, and use the information to generate plots of the abundance of parent and daughter isotopes and the ratio of daughter/parent through time.

$t_{1/2}$ (number of half-lives passed)	0	1	2	3	4	5
Percentage of parent-isotope atoms left	100	50				
Number of parent-isotope atoms left	128					
Number of radiogenic daughter-isotope atoms	0					
n_d/n_p (ratio of daughter:parent isotope atoms)	0					
Time since formation (Ga)	0	4.47	8.94	13.40	17.87	22.34




Daughter Isotope Atoms vs. Time
Number of Radiogenic Daughter Isotope Atoms
150
125
100
75
50
25
0
0
5
10
15
20
25
Time (billions of years)


Ratio of Daugher/Parent vs. Time
Ratio of Daughter Atoms to Parent Atoms
35
30
25
20
15
10
5
0
0
5
10
15
20
25
Time (billions of years)

Based on the previous plots, what is the essential piece of information required to date a sample?

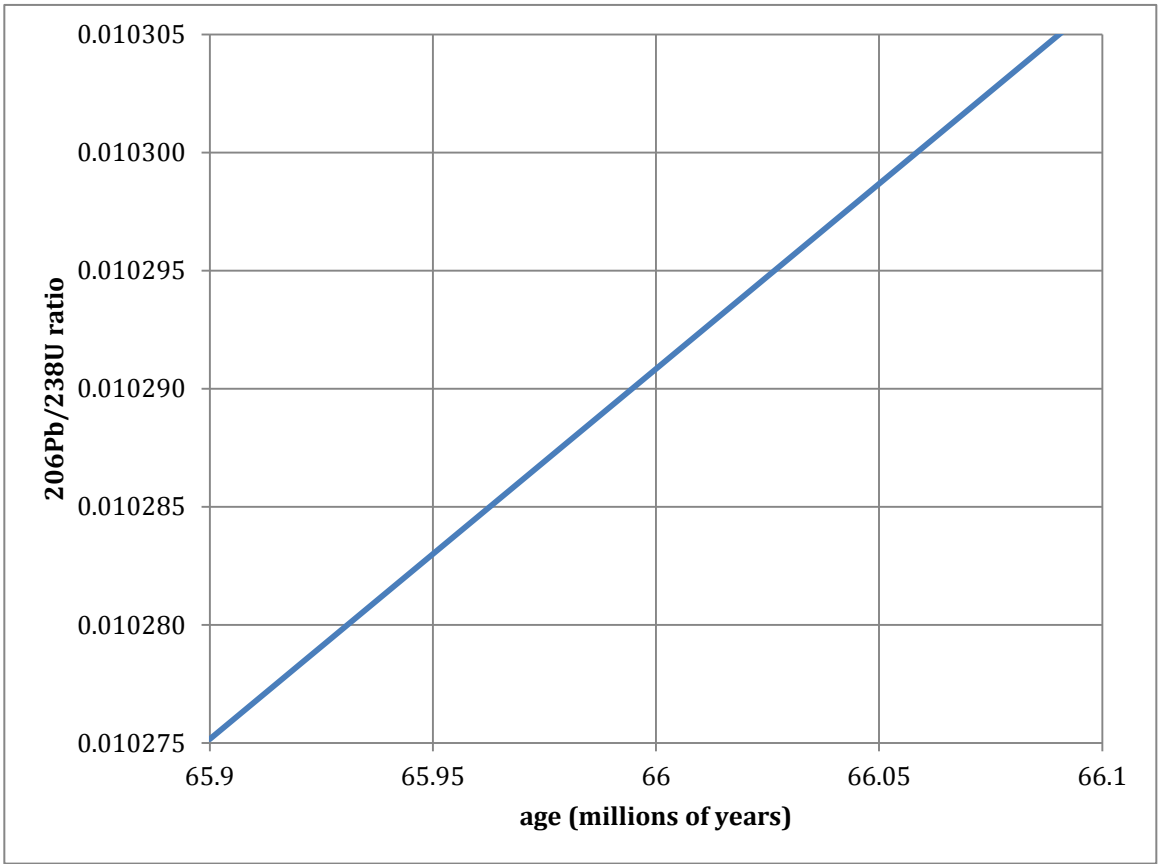
At what time in Earth's history (roughly, estimate a range) is the ^{238}U-^{206}Pb system most sensitive/accurate?

Part 2. Application: dating volcanic rocks

Sample A

Sample is a volcanic ash that is stratigraphically just **below** the K-T boundary.
Pb analysis determined that there are 1,242 ^{206}Pb atoms.
U analysis determined that there are 120,543 ^{238}U atoms.

1. What is the age of your sample? Use this graph to help you:



2. You've determined that the uncertainty in your ratio determination is 0.03%. What is the uncertainty in your age?

Sample B

Sample is a volcanic ash from just **above** the K-T boundary.
Pb analysis determined that there are 1,417 ^{206}Pb atoms.
U analysis determined that there are 137,570 ^{238}U atoms.

1. What is the age of your sample?

2. You've determined that the uncertainty in your ratio determination is 0.045%. What is the uncertainty in your age

3. Estimate the timing of the K-T extinction. Give an uncertainty for your age.

Sample C

Sample is some impact material from the meteorite impact crater near the Yucatan Peninsula, Mexico.
Pb analysis determined that there are 1,360 ^{206}Pb atoms.
U analysis determined that there are 132,156 ^{238}U atoms.

1. What is the age of your sample?

2. You've determined that the uncertainty in your ratio determination is 0.15%. What is the uncertainty in your age?

Sample D

Your sample is from the Deccan Traps, a huge series of lava flows in India.
Your Pb analysis determined that there are 1,500 ^{206}Pb atoms.
Your U analysis determined that there are 146,654 ^{238}U atoms.

1. What is the age of your sample?

2. You've determined that the uncertainty in your ratio determination is 0.92%, or 0.00009. What is the uncertainty in your age?

Based on this geochronologic data, what conclusions can you draw about the fate of the dinosaurs?

Extra credit: the reliability of radiometric dating depends on us knowing how much of a radioactive isotope has decayed to its daughter product. In this lab we have established what is required to date a sample, but what are some potential problems that might come up in this endeavor?

12.001 Introduction to Geology
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