ESS 200 (Stapleton)

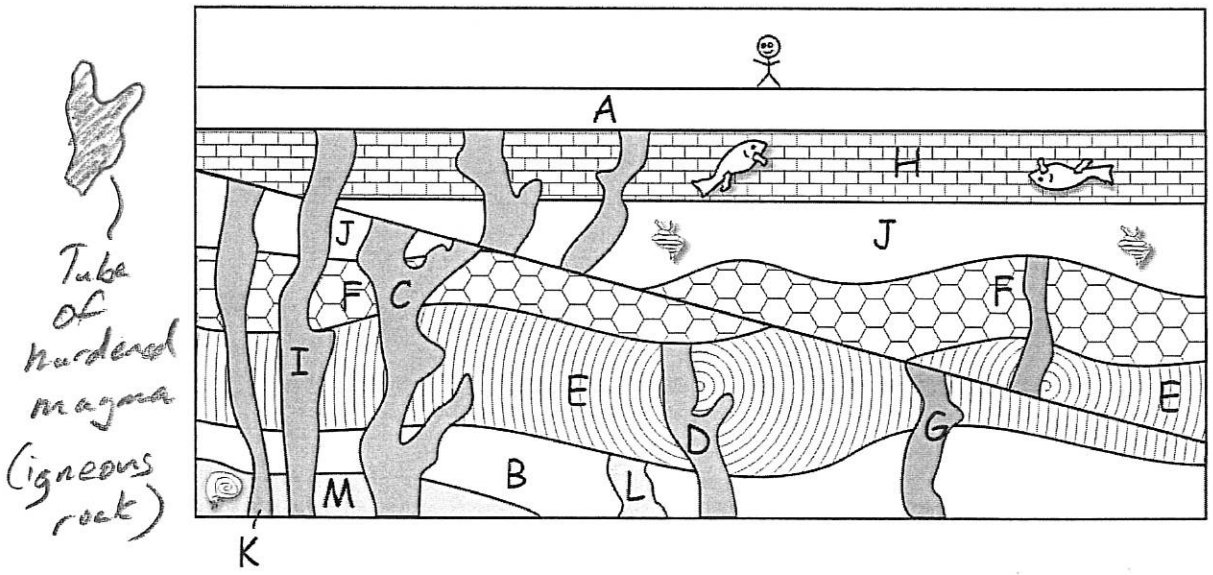
The Rock Record

Earth Science Notes
Relative Dating

Name: _____

1. The diagram below shows a cross-section of a portion of the Earth's crust. Most of the rocks in the picture are sedimentary, which means that they were created by sediment settling onto the ground in layers. At various times in the past, this area has been covered by water. Some of the rock layers in the picture have been folded. Other layers have been cracked. In some places, tubes of magma have burned, melted, and pushed their way to the surface. By looking at the diagram, you can determine which rocks are older and which are younger. Try to rank the rocks from oldest to youngest.

Oldest												Newest



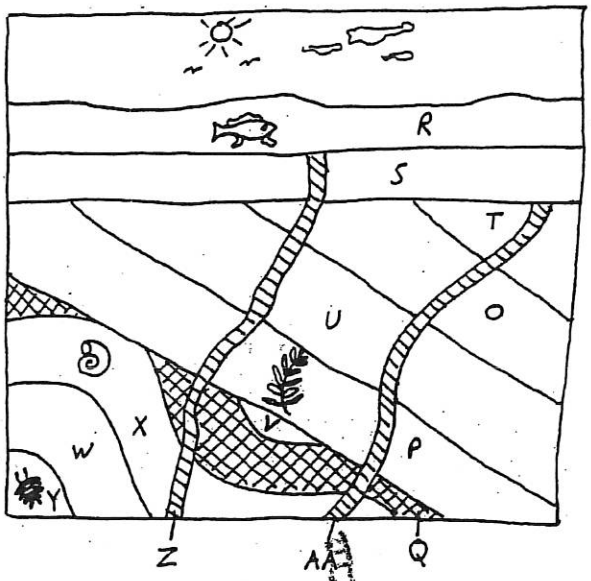
Definitions/Information:
Principle of Original Horizontality: Rock layers are horizontal when they are deposited.
Relative Dating: Comparing or ranking the ages of rocks without actually determining their actual ages. For example, with relative dating we might say that rock A is older than rock B, but we don't know the actual age of either rock.
Absolute Dating: Determining (or approximating) the exact age of a rock.
Principle of Superposition: The closer a rock layer is to the surface of the Earth, the younger it is.
Principle of Cross-Cutting Relationships: If a layer of rock is found cutting through another layer of rock, the layer which is cutting through must be younger.
Principle of Faunal Succession: In the history of the Earth, many species of living things have come and gone. Some animals and plants are not alive today, but their fossils are evidene that they lived in the past. Layers of rokcs with similar types of fossils are probably of similar ages.

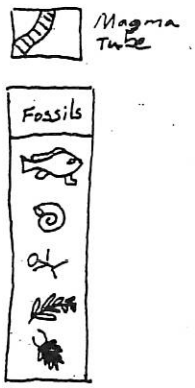
HINTS: Questions to ask yourself when you are trying to determine which of two rock layers is older:
1. Which layer reaches highest?
2. Which layer cuts through the other layer?
3. Which layer was broken by the earthquake?

2. Rank the rocks in diagram A, below, from oldest to youngest.

Oldest												Youngest

Diagram A

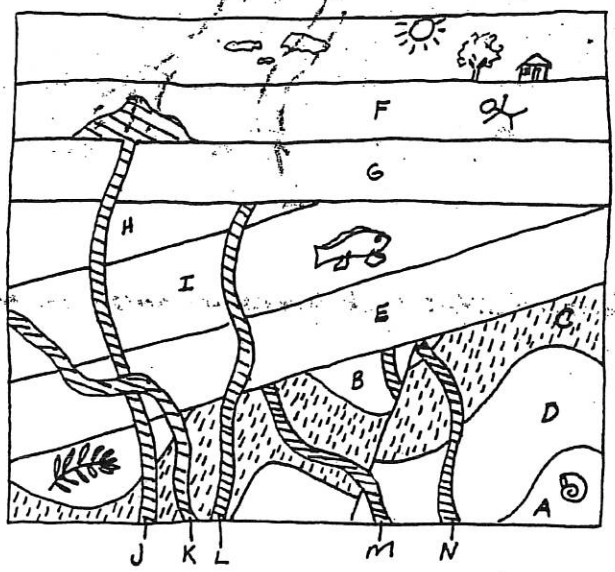




3. Rank the rocks in diagram B, below, from oldest to youngest.

Oldest												Youngest

Diagram B



3.5. which layers cannot be ranked with certainty?

4. a. Which rock layer is probably older, Layer S (diagram A) or Layer H (diagram B)?
   b. How did you decide?
5. Which of the two diagrams (A or B) probably contains the very oldest rock layer?
6. Which of the two diagrams (A or B) probably contains the very youngest rock layer?

ESS200

Earth Science Notes
RADIOMETRIC DATING

Name: _____

PURPOSE: to be able to determine the age of a rock by measuring the number of radioactive atoms in it.

Helpful Information: Isotope [2 "isotopes" are the same element, but different masses.]

Radioactive Element: An element whose atoms turn into other types of atoms over time. As these atoms turn into other atoms, they lose mass. That lost mass turns into a form of energy called radiation. [Example: Uranium-238 is a radioactive element which gives off energy when it turns into Lead-206, a smaller element.]

Radioactive Decay: The process of large radioactive atoms losing mass and becoming smaller atoms.

Half-life: The amount of time it takes for half of something to die or to turn into something else. [Example: If you have 50 U-238 atoms, one half-life is the amount of time it takes for 25 of those atoms to turn into Pb-206 (Pb is the symbol for lead.)]

Parent Atom: A larger atom which can turn into a smaller atom by radioactive decay.

Daughter Atom: What the parent atom turns into when it decays.

How to tell if a rock is old: If there are many daughter atoms and few parent atoms, the parent atoms have been decaying for a long time, so the rock is old. If there are many parent atoms and few daughter atoms, the parent atoms have not been decaying for very long, so the rock is new.

Resetting the Clock: When lava hardens and becomes rock, parent atoms and daughter atoms become separated. They form different types of minerals. When rock is melted, its atoms are re-set.

Sedimentary Rock Cannot Be Dated: Its atoms are not "re-set" by melting.

HALF-LIVES OF COMMONLY USED RADIOACTIVE ELEMENTS		
Parent Element	**Daughter Element**	**Approximate Half-life**
Uranium-238 (U-238)	Lead-206 (Pb-206)	4.5 Billion Years
Potassium-40 (K-40)	Argon-40 (Ar-40)	1.5 Billion Years
Carbon-14 (C-14)	Nitrogen-14 (N-14)	6,000 Years

AN EXAMPLE OF THE DECAY OF **U-238** ATOMS					
Number Of Half-lives Which Have Passed	0	1	2	3	4
Age Of The Rock In Years					
Number Of Parent Atoms In Rock	400				
Number Of Daughter Atoms In Rock					
Total Number Of Atoms In Rock					
What % Of The Atoms Are Parent Atoms?					

AN EXAMPLE OF THE DECAY OF **K-40** ATOMS					
Number Of Half-lives Which Have Passed	0	1	2	3	4
Age Of The Rock In Years					
Number Of Parent Atoms In Rock	64				
Number Of Daughter Atoms In Rock					
Total Number Of Atoms In Rock					
What % Of The Atoms Are Parent Atoms?					

AN EXAMPLE OF THE DECAY OF **C-14** ATOMS					
Number Of Half-lives Which Have Passed	0	1	2	3	4
Age Of The Rock In Years					
Number Of Parent Atoms In Rock	240				
Number Of Daughter Atoms In Rock					
Total Number Of Atoms In Rock					
What % Of The Atoms Are Parent Atoms?					

Use the data from the charts above to complete the graphs which are provided on a separate sheet.

Rock Dating Questions:

1. As a rock gets older, does the number of parent atoms in a rock increase, decrease, or stay the same?
2. As a rock gets older, does the total number of parent and daughter atoms in the rock change?
3. a) 10 years ago there were 80 atoms of mercurium in a rock. Now there are only 40. What is the half-life of mercurium?
   b) How many atoms of mercurium will remain 10 years from now?
4. a) A rock started out with 48 atoms of C-14. Now it contains 24 atoms of C-14 and 24 atoms of N-14. b) How many half-lives have passed?
   c) How old is the rock?
   d) How old will the same rock be when it contains 6 atoms of C-14?
5. a) A rock started out with 100 atoms of U-238. Now it has 50 atoms of U-238. How old is the rock?
   b) How many atoms of Pb-206 does it contain?
   c) How many U-238 atoms will the rock has when it contains 75 Pb-206 atoms?
   d) How old will the rock be when it contains 75 atoms of Pb-206?
6. a) A rock contains 64 Ar-40 atoms and 64 K-40 atoms. When the rock was new, how many K-40 atoms were there in the rock?
   b) How old is the rock now?
7. A rock contains 5 atoms of C-14 and 35 atoms of N-14. How old is the rock?

Use the formula below to answer these questions. A calculator would be helpful.

8. A rock contains 8 Ar-40 atoms and 17 K-40 atoms. What percentage of the atoms in the rock are parent atoms?
9. A rock contains 24 C-14 atoms and 47 N-14 atoms. What percentage of the atoms in the rock are parent atoms?
10. A rock contains 43 U-238 atoms and 35 Pb-206 atoms. What percentage of the atoms in the rock are parent atoms?

How to determine the percentage (%) of atoms in a rock which are parent atoms:
USE THIS FORMULA.
% Which Are Parent Atoms = Number Of Parent Atoms Remaining ÷ Total Number Of Atoms In Rock
*****You will need to move the decimal point in your answer 2 places to the right.*****

Example Question: A rock contains 14 U-238 atoms and 9 Pb-206 atoms. What percentage of the atoms in this rock are parent atoms?

#of Parent Atoms = 14
Total # of Atoms = 14 + 9 = 23
(% which are parent atoms) = 14 ÷ 23

14 ÷ 23 = 23 ⟌ 14.0 = .608

13 8
200
184
16

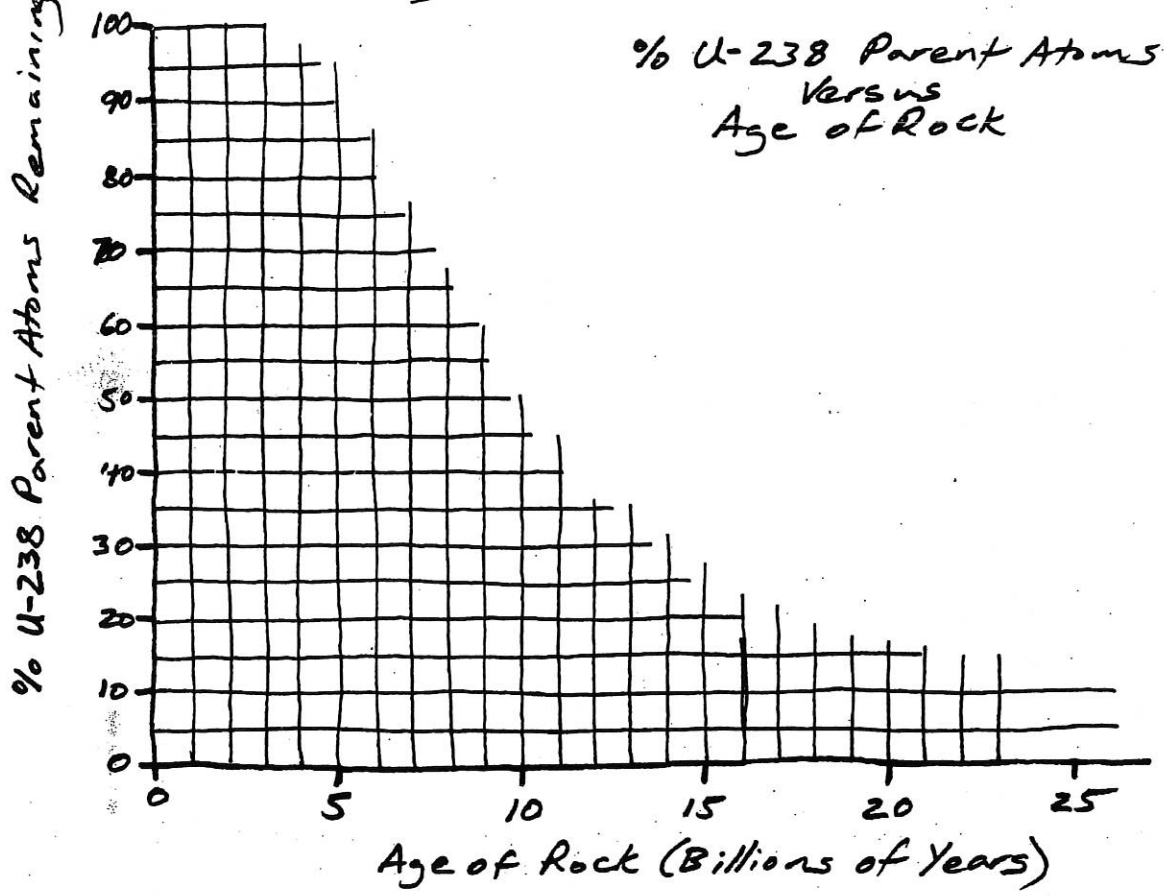
⇒ .608 Move decimal two spaces to get 60.8%

Use your graphs to answer the following questions.

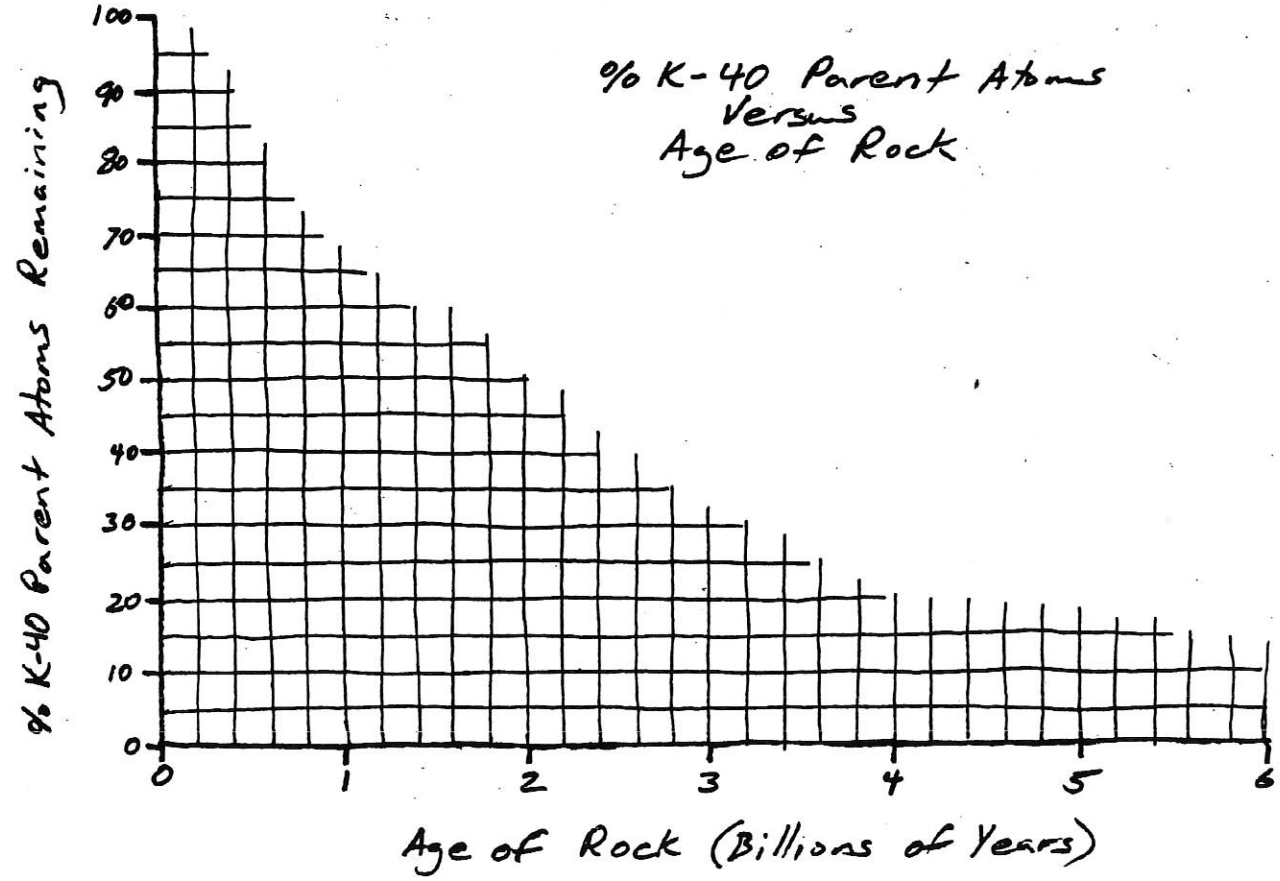
11. If a rock containing U-238 and Pb-206 contains 80% parent atoms, how old is the rock?
12. If a rock containing C-14 and N-14 contains 25% parent atoms, how old is the rock?
13. If a rock containing K-40 and Ar-40 contains 65% parent atoms, how old is the rock?
14. How old was the rock in question number 8?
15. How old was the rock in question number 9?
16. How old was the rock in question number 10?
17. A rock contains 90 atoms of U-238 and 7 atoms of Pb-206. How old is it?
18. A rock contains 17 atoms of K-40 and 3 atoms of Ar-40. How old is it?

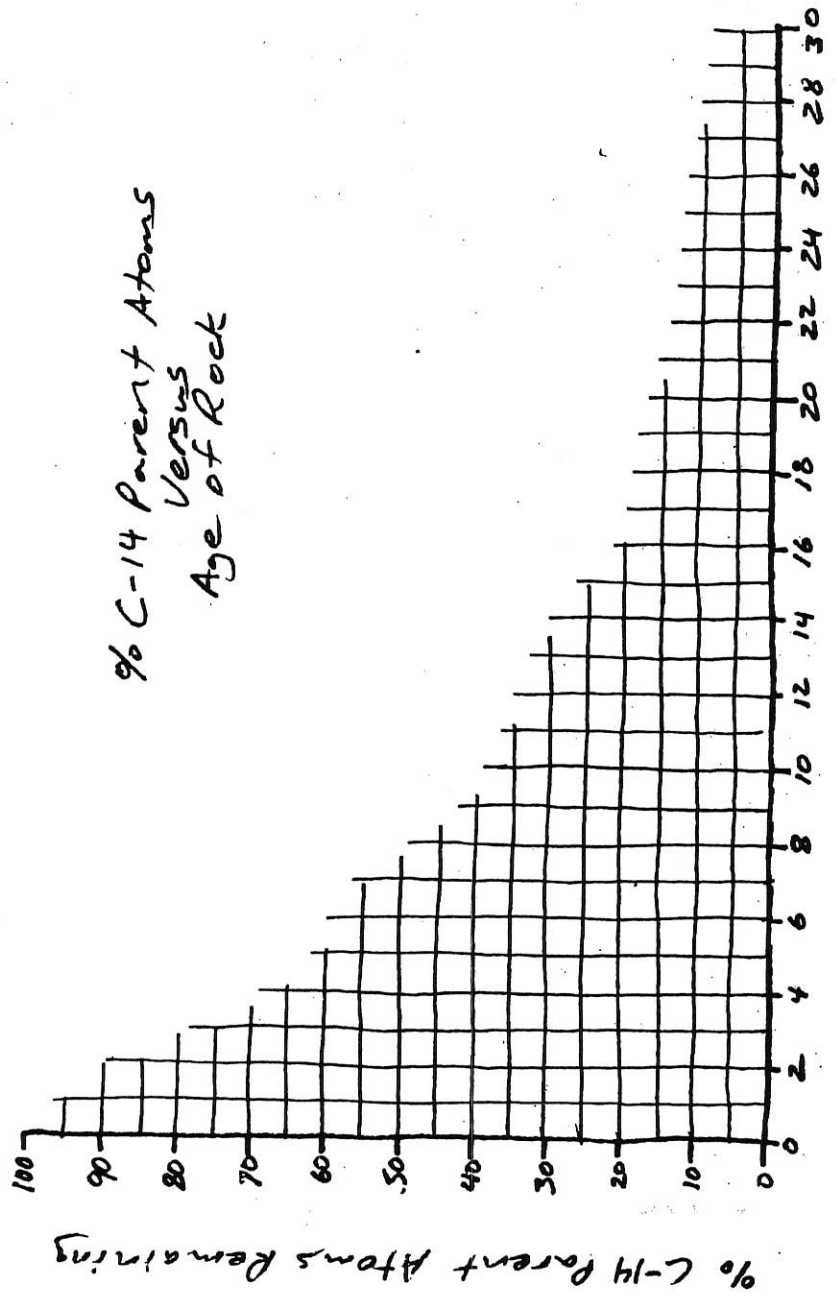
Rock Dating Notes Science

% U-238 Parent Atoms
Versus
Age of Rock



% K-40 Parent Atoms
Versus
Age of Rock



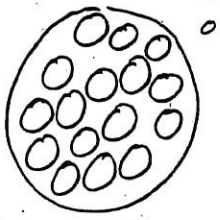


Assume here that 1 Half-Life =

_____

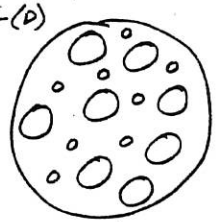
O = Parent Atom (P)

o = Daughter (D) Atom



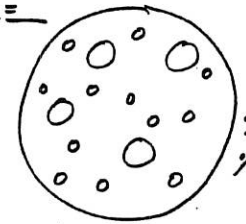
%P = ___ Half-lives = ___

%D = ___ Age = ___



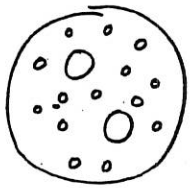
% Par. = ___ Half-lives = ___

% D. = ___ Age = ___



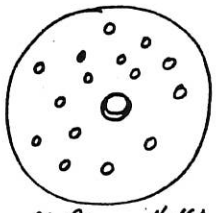
% Parent = ___ Half-Lives = ___

% Daughter = ___ Age = ___



% P = ___ Half-lives = ___

% D = ___ Age = ___

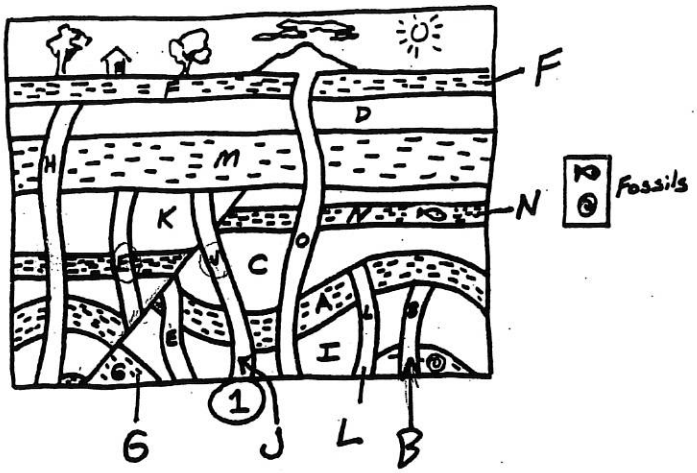


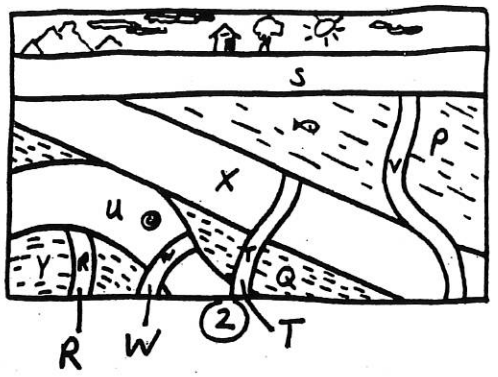
% P = ___ Half-lives = ___

% D = ___ Age = ___

Earth Science
Rock Dating Review

Name: _____





Use Diagram 1 to answer questions 1-10.

1. Which rock layer is barely younger than I? _____.
2. Which layer is barely older than I? _____
3. Which rock layer is barely younger than A? _____.
4. Which layer is barely older than A? _____
5. Which rock layer is barely younger than N? _____.
6. Which layer is barely older than N? _____
7. Which rock layer is barely younger than F? _____.
8. Which layer is barely older than F? _____
9. Which rock layer is barely younger than J? _____.
10. Which layer is barely older than J? _____

The samples below contain atoms of a radioactive element which has a half-life of 4 million years. Use the graph on the back to determine the age of each sample. **DARKEN** the correct choice for each sample.

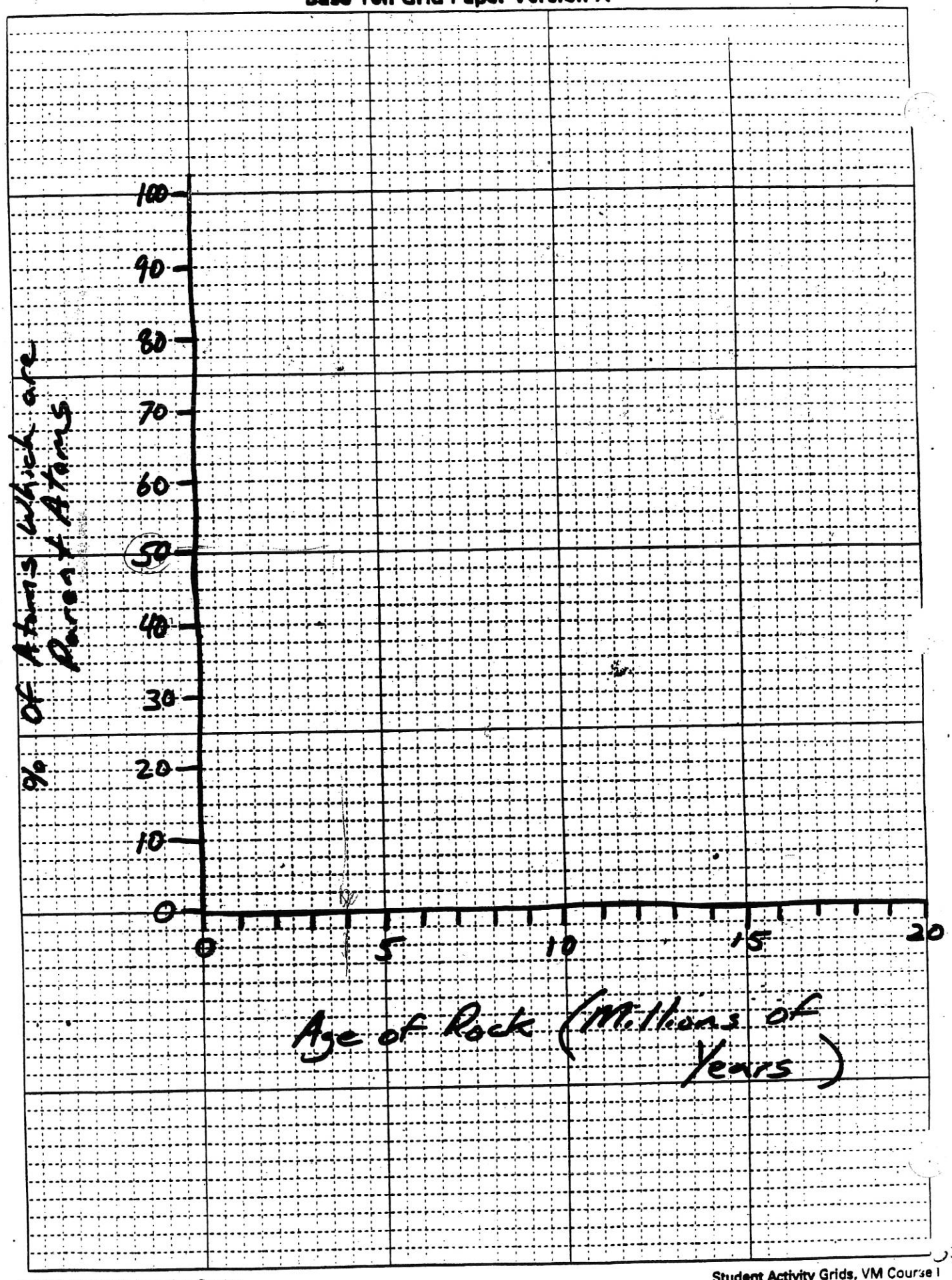
Example: (a) 5-6 (b) 6-7 (c) 7-8 ● 8-9 (e) 9-10

Sample	# of Parent Atoms	# of Daughter Atoms	% Which Are Parent Atoms	Age of Sample (Millions of years) **CHOOSE ONE OF THESE**
B	14	37		(a) 5-6 (b) 6-7 (c) 7-8 (d) 8-9 (e) 9-10
L	10	21		(a) 5-6 (b) 6-7 (c) 7-8 (d) 8-9 (e) 9-10
E	12	10		(a) 0-1 (b) 1-2 (c) 2-3 (d) 3-4 (e) 4-5
W	7	24		(a) 5-6 (b) 6-7 (c) 7-8 (d) 8-9 (e) 9-10
O	35	4		(a) 0-1 (b) 1-2 (c) 2-3 (d) 3-4 (e) 4-5
V	25	29		(a) 0-1 (b) 1-2 (c) 2-3 (d) 3-4 (e) 4-5
R	8	33		(a) 5-6 (b) 6-7 (c) 7-8 (d) 8-9 (e) 9-10
H	12	4		(a) 0-1 (b) 1-2 (c) 2-3 (d) 3-4 (e) 4-5
J	32	18		(a) 0-1 (b) 1-2 (c) 2-3 (d) 3-4 (e) 4-5
T	23	36		(a) 5-6 (b) 6-7 (c) 7-8 (d) 8-9 (e) 9-10

Use your answers to the previous questions, and the diagram above, to determine the ages of the rock layers and the earthquake below. Circle the correct answers.

Rock Layer or Event	Age (Millions of Years) **CHOOSE ONE OF THESE**
F	(a) 0-3 (b) 3-5 (c) 5-7 (d) 7-10
G	(a) 0-2 (b) 2-4 (c) 4-6 (d) 6-8 (e) 8-10
N	(a) 0-2 (b) 2-4 (c) 4-6 (d) 6-8 (e) 8-10
A	(a) 0-2 (b) 2-4 (c) 4-6 (d) 6-8 (e) 8-10
EARTHQUAKE	(a) 0-2 (b) 2-4 (c) 4-6 (d) 6-8 (e) 8-10

Base Ten Grid Paper Version A



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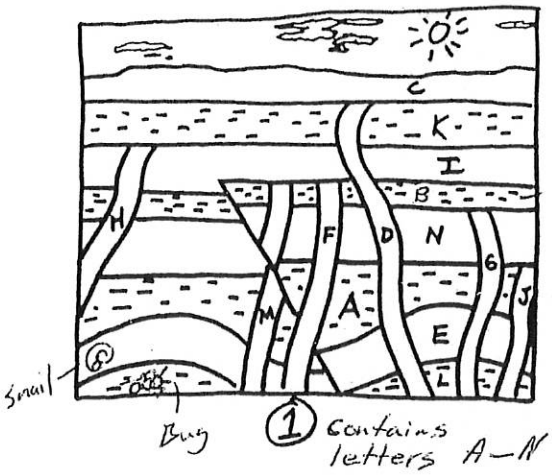
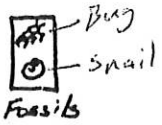
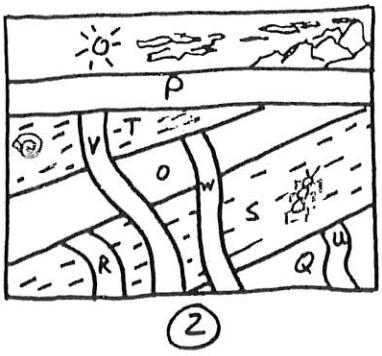
EPS 200 (Stapleton)
Rock Dating Test, Version 2

Name: _____







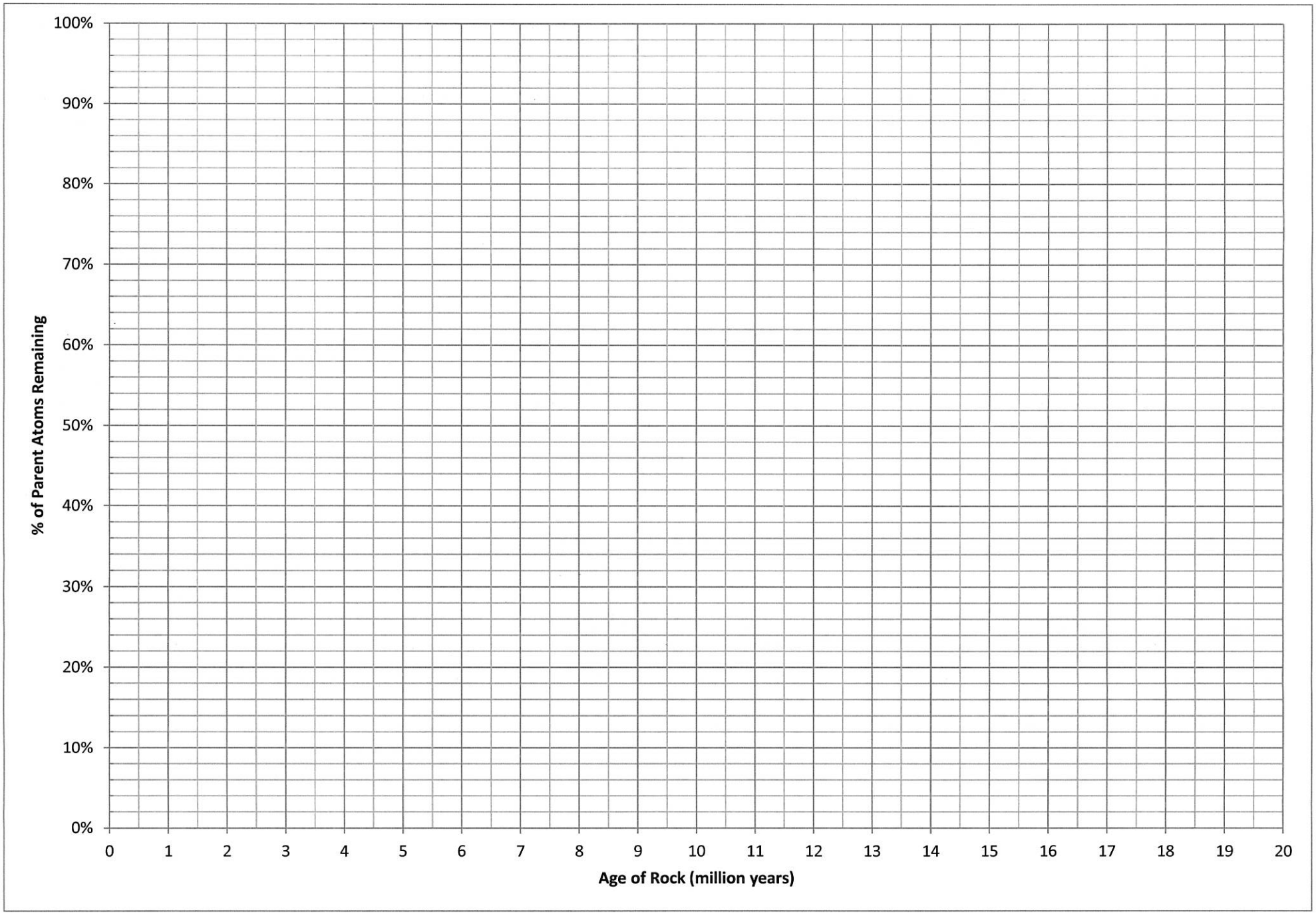
Use the diagram on the top left to answer questions 1-10

1. Which sample is barely older than **M**? _____
2. Which sample is barely older than **E**? _____
3. Which sample is barely older than **D**? _____
4. Which sample is barely older than **I**? _____
5. Which sample is barely older than **N**? _____
6. Which sample is barely younger than **M**? _____
7. Which sample is barely younger than **E**? _____
8. Which sample is barely younger than **D**? _____
9. Which sample is barely younger than **I**? _____
10. Which sample is barely younger than **N**? _____

Use the information below and the graph on the back to choose the correct rock ages. In order to complete the graph, you need to know that the half life of the radioactive parent atoms is **5 million years**.

Sample	Parent Atoms	Daughter Atoms	% of Parents remaining	Age of rock in Millions of years
W	20	138		0-2 2-4 4-6 6-8 8-10 10-12 12-14 14-16 16-18 18-20
V	13	66		0-2 2-4 4-6 6-8 8-10 10-12 12-14 14-16 16-18 18-20
G	25	62		0-2 2-4 4-6 6-8 8-10 10-12 12-14 14-16 16-18 18-20
H	25	13		0-2 2-4 4-6 6-8 8-10 10-12 12-14 14-16 16-18 18-20
D	80	12		0-2 2-4 4-6 6-8 8-10 10-12 12-14 14-16 16-18 18-20
F	36	37		0-2 2-4 4-6 6-8 8-10 10-12 12-14 14-16 16-18 18-20
R	16	114		0-2 2-4 4-6 6-8 8-10 10-12 12-14 14-16 16-18 18-20
M	15	25		0-2 2-4 4-6 6-8 8-10 10-12 12-14 14-16 16-18 18-20
U	14	134		0-2 2-4 4-6 6-8 8-10 10-12 12-14 14-16 16-18 18-20
J	32	113		0-2 2-4 4-6 6-8 8-10 10-12 12-14 14-16 16-18 18-20

Sample or Event	Age of rock in Millions of years
N	0-4 2-6 4-8 6-10 8-12 10-14 12-16 14-18 16-20
L	0-4 2-6 4-8 6-10 8-12 10-14 12-16 14-18 16-20
Appearance of fault in diagram 1 (left diagram)	0-4 2-6 4-8 6-10 8-12 10-14 12-16 14-18 16-20
K	0-4 2-6 4-8 6-10 8-12 10-14 12-16 14-18 16-20
E	0-4 2-6 4-8 6-10 8-12 10-14 12-16 14-18 16-20


100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
% of Parent Atoms Remaining
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Age of Rock (million years)