Absolute Age Dating

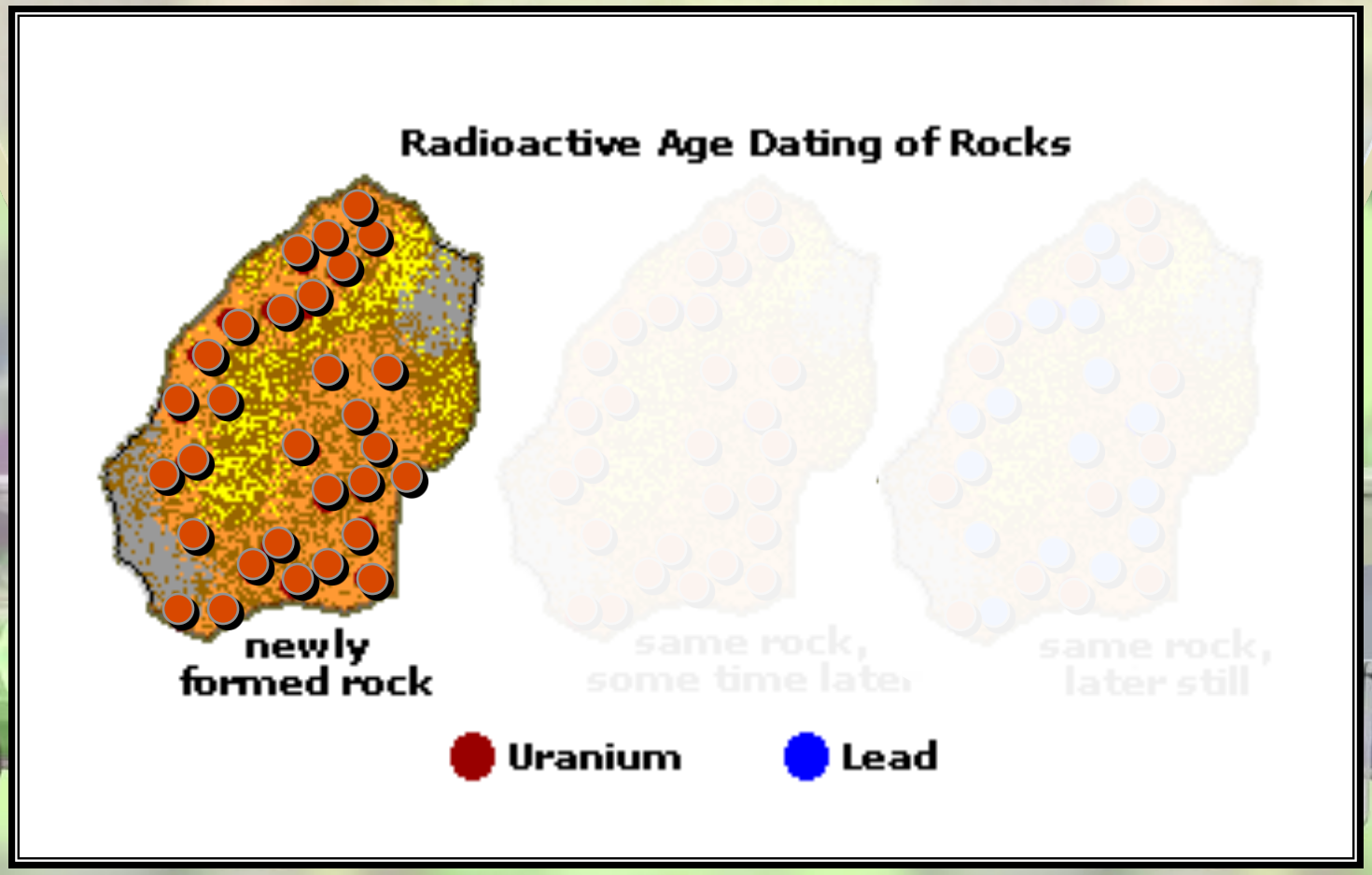
Absolute Ages

Radiometric Dating

- Radioactive isotopes
- Radioactive decay
- Half-life

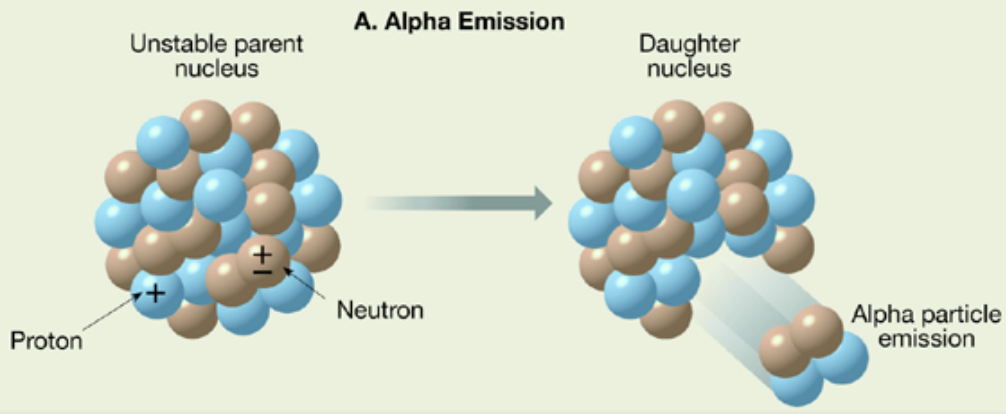
Radiometric Dating

Absolute dating using radioactive decay data



http://www.cotf.edu/ete/modules/msese/earthsysflr/geotime.html

Alpha Emission

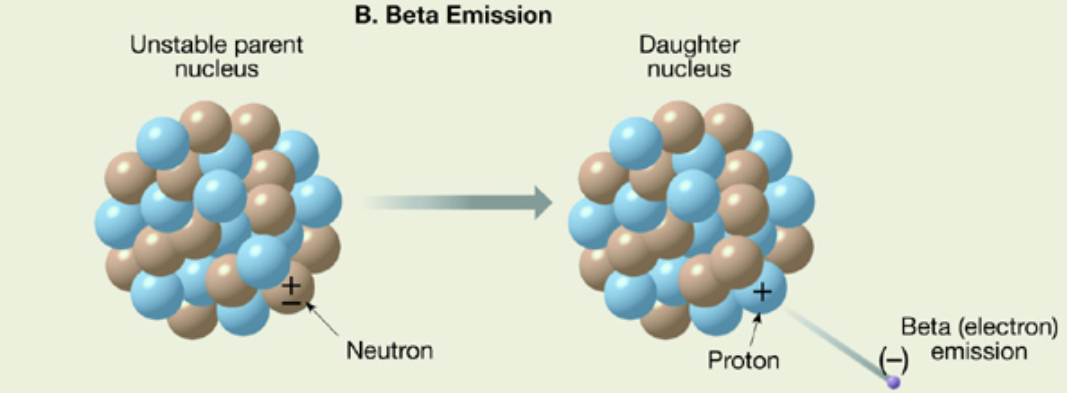


Daughter nucleus-

Atomic number: 2 fewer

Atomic mass: 4 fewer

Beta Emission

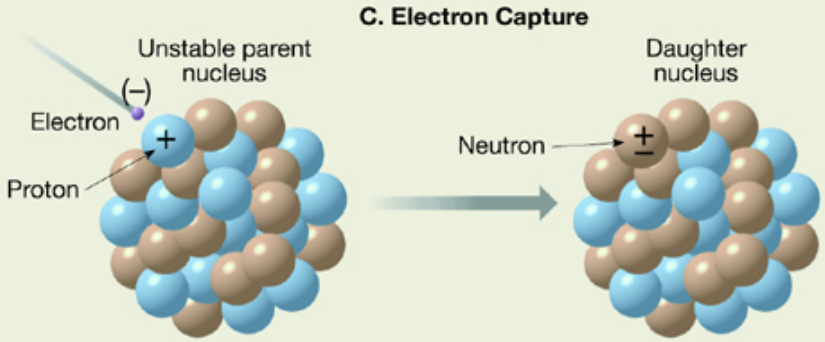


Daughter nucleus-

Atomic number: 1 more

Atomic mass: no change

Electron Capture



Daughter nucleus-

Atomic number: 1 fewer

Atomic mass: no change

General Decay Rules

Atomic mass number

- No change
- Decrease

Atomic number

- Decrease
- Increase

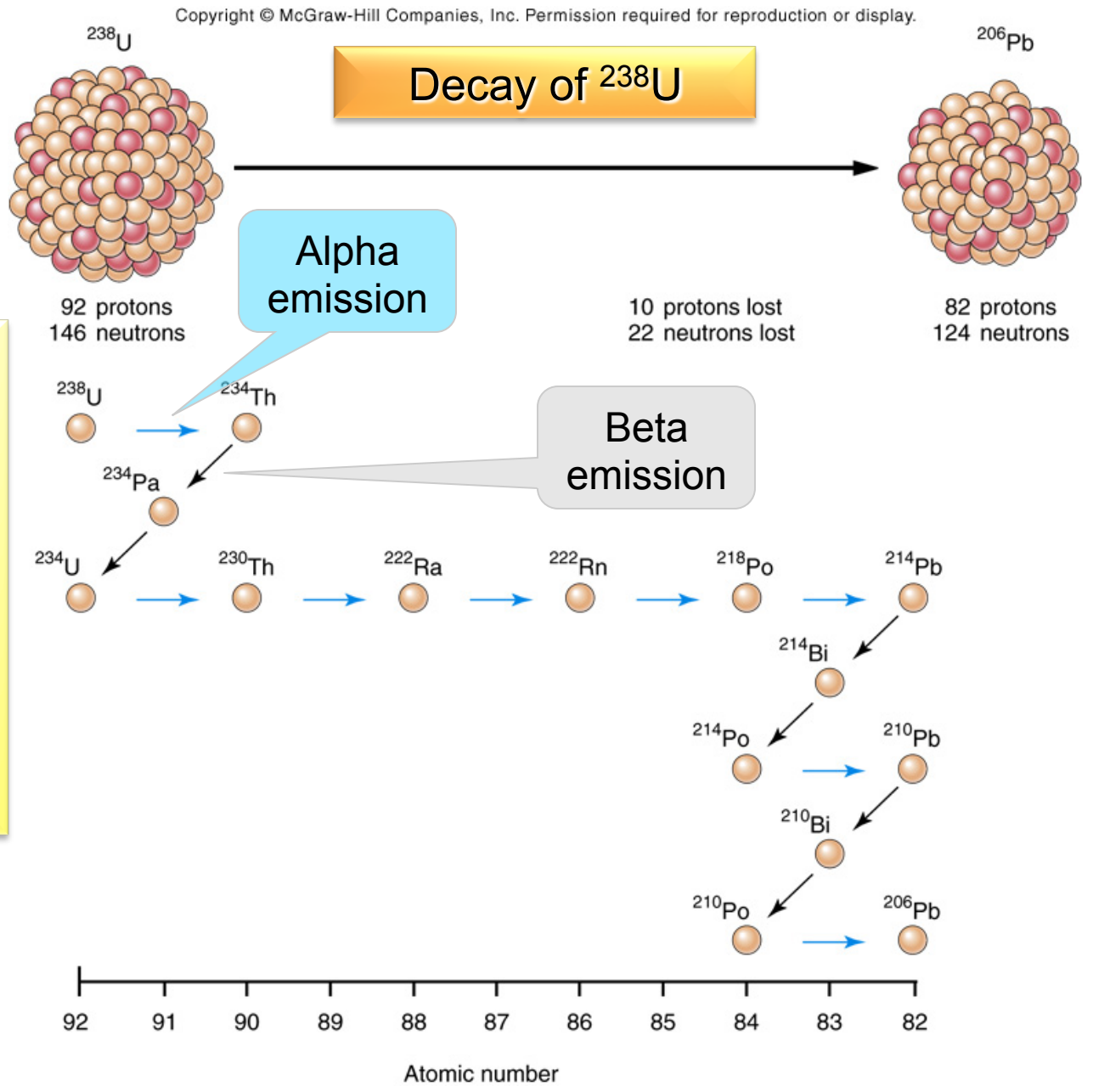
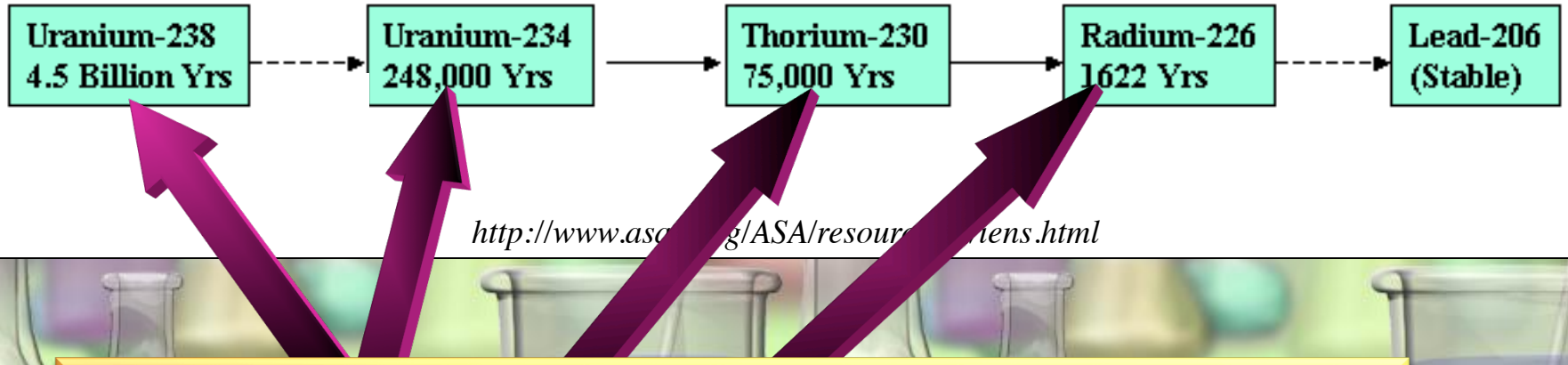


Fig. 08.23

Decay sequence for Uranium-238



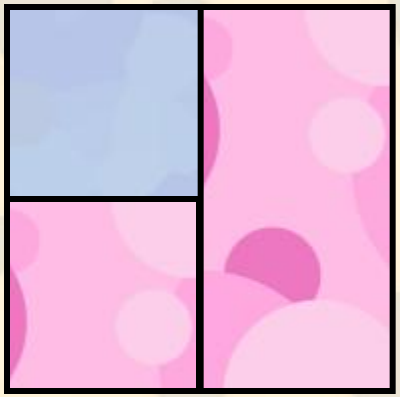
http://www.asc g/ASA/resour tens.html

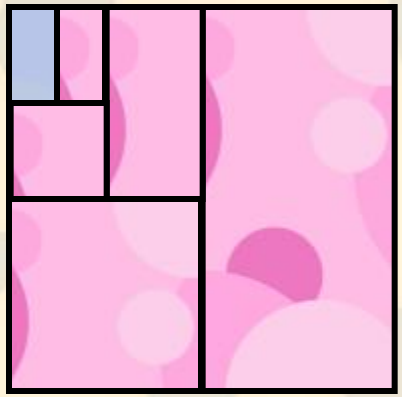
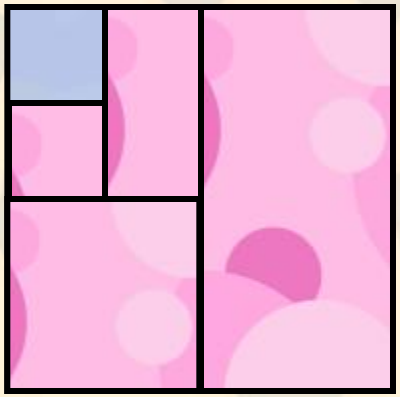
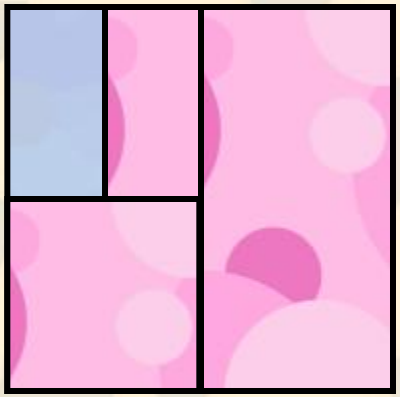
Half life – the time it takes for half of the original element to decay to the new element.

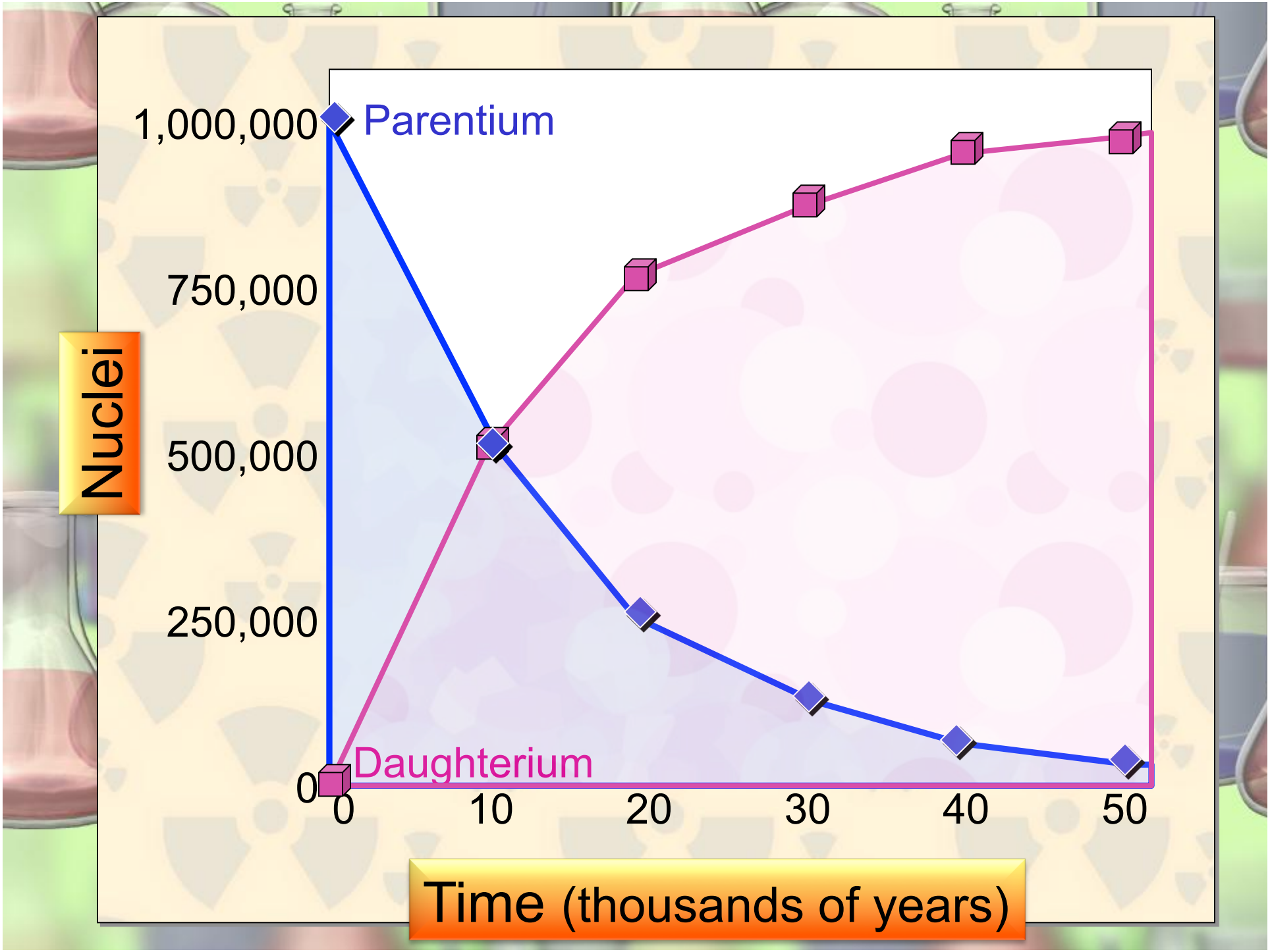
Hypothetical Element Parentium

Half Life = 10,000 yrs
Decays to Daughterium

Starting with 1,000,0000 nuclei of Parentium

Time		Parentium	Daughterium
+20,000		250,000	750,000
+10,000		500,000	500,000
0		1,000,000	0

Time		Parentium	Daughterium
+50,000		31,250	968,750
+40,000		62,500	937,500
+30,000		125,000	825,000


1,000,000
750,000
500,000
250,000
0
Parentium
Daughterium
Nuclei
0
10
20
30
40
50
Time (thousands of years)

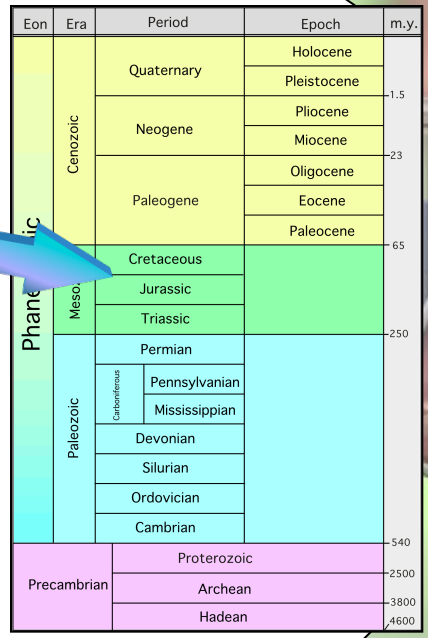
Geologically Useful Radioactive Isotopes

Parent → Daughter	Half-life (yrs)	Useful Range (yrs)
$^{40}K \rightarrow {}^{40}Ar$	1,250,000,000	100,000 - formation of Earth
$^{238}U \rightarrow {}^{206}Pb$	4,500,000,000	10,000,000 - formation of Earth
$^{235}U \rightarrow {}^{207}Pb$	713,000,000	10,000,000 - formation of Earth
$^{87}Rb \rightarrow {}^{87}Sr$	49,000,000,000	10,000,000 - formation of Earth

Geologist collects samples of rock

Geochemist finds radiometric age

Geologist interprets the geologic history of area during the time that the rock was being formed



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$^{87}Rb \rightarrow {}^{87}Sr$	49,000,000,000	10,000,000 - formation of Earth

An analysis of a feldspar crystal in a rock reveals that it contains 75% ^{40}Ar and 25% ^{40}K.

How many half-lives have passed since the formation of the feldspar?

Assuming the feldspar and rock formed at the same time, how old is the rock?

Parent → Daughter	Half-life (yrs)	Useful Range (yrs)
$^{238}U \rightarrow {}^{206}Pb$	4,500,000,000	10,000,000 - formation of Earth
$^{235}U \rightarrow {}^{207}Pb$	713,000,000	10,000,000 - formation of Earth

An analysis of a zircon crystal in a rock reveals that it contains:

50.0% ^{238}U and 50.0% ^{206}Pb
1.6% ^{235}U and 98.4% ^{207}Pb

How many half-lives of ^{238}U have passed since the formation of the zircon?

How many half-lives of ^{235}U have passed since the formation of the zircon?

What is the age of the zircon?