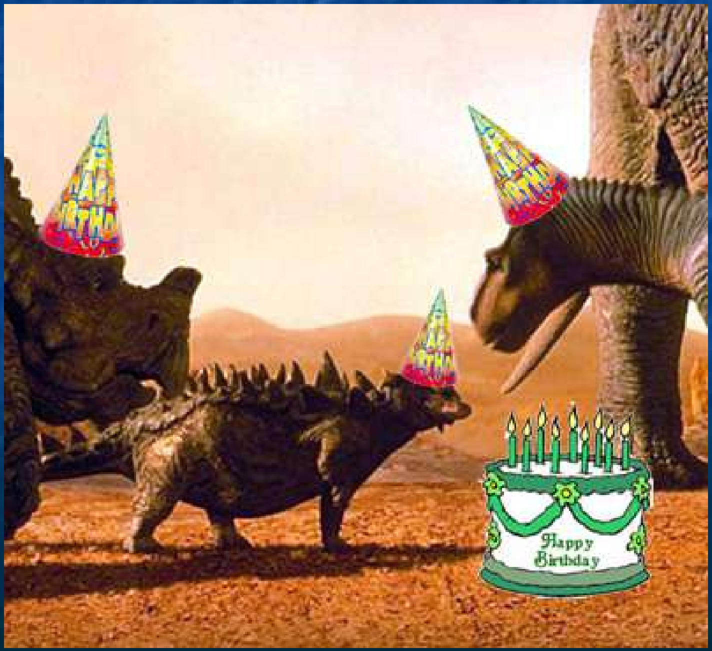
Rock Dating

Think About It . . .

How old is Earth?

What are some tools or methods that scientists could use to figure out the age of Earth?



There are two types of time dating

- Geologists use **relative dating** to figure out if a rock is older or younger than another rock.

• In rock that is not disturbed (moved around by tectonic forces)

•The older rocks are on bottom.

• The younger rocks are on top.

(law of superposition)

•Just like laundry in a laundry basket

Index fossil can also be used to show the approximate ages of rock. Fossils in different rock layers can be compared to determine one rock layers age in relation to another's

Problems…

- Rock layers are not undisturbed. Earthquakes, faults, flooding, erosion, volcanic activity all change the landscape (some quickly and some slowly)
- **Unconformity**: a gap in the rock sequence that happens because
  - agents of erosion (water, wind, glaciers) move layers or parts of layers away

    or

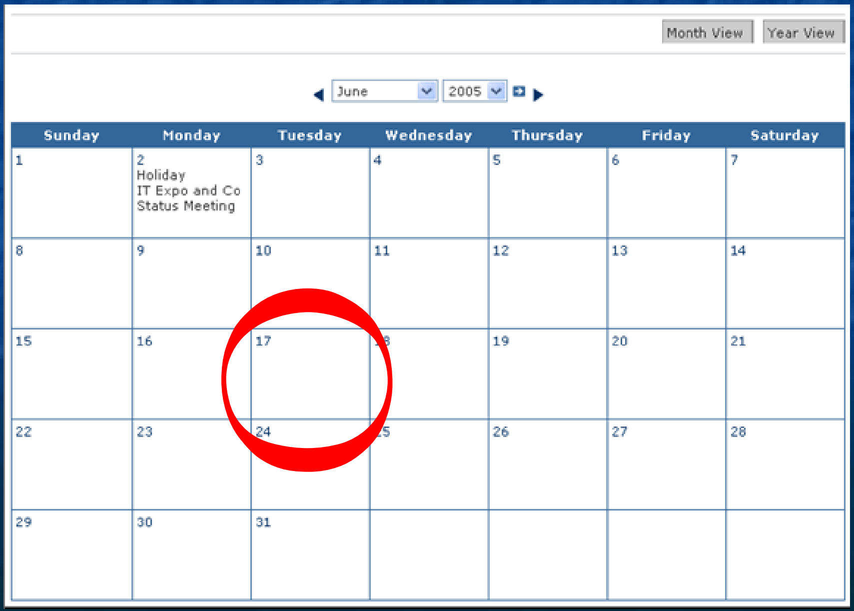
  - because no deposition occurs in that area.
    - Deposition does not evenly distribute sediments (higher areas may not get as much as lower etc..)

    or

  - Earthquakes/plate movement has caused ground to be uplifted

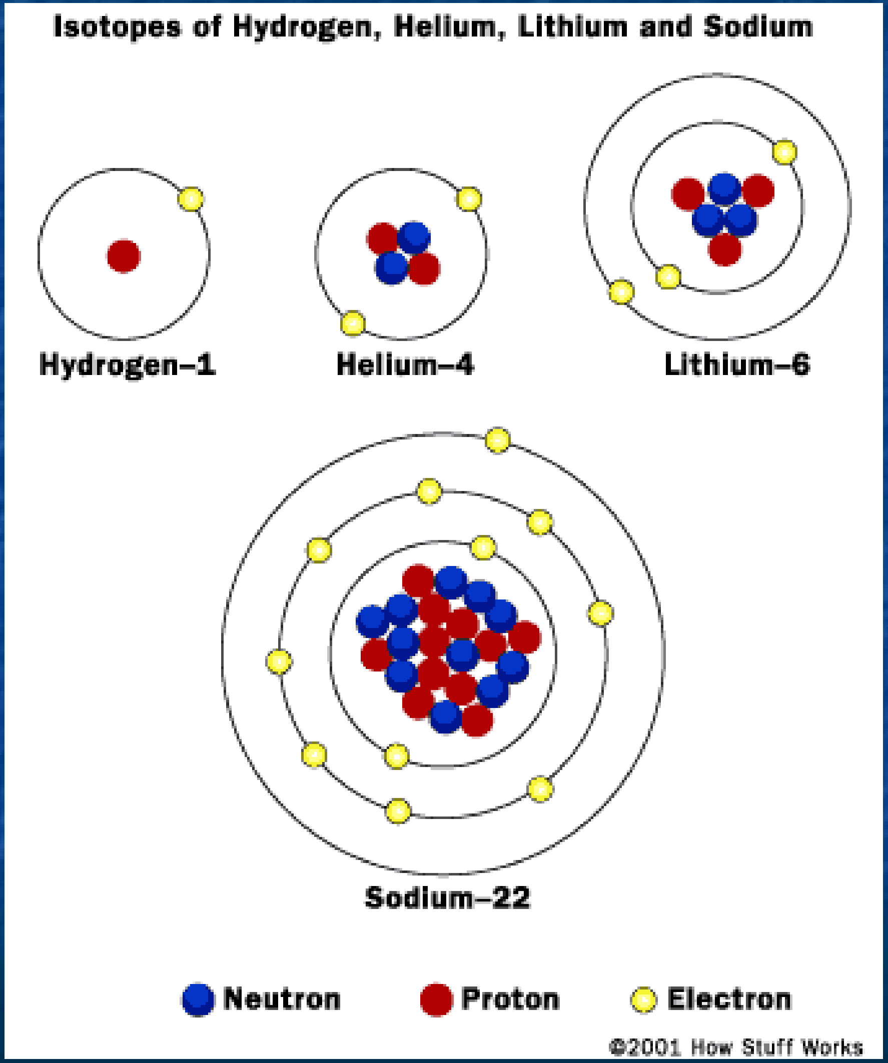
But What If You Want to Know the Exact Age?

- Geologists often also need to know the **exact age** of a rock or fossil.
- Finding the exact age of an object is called **absolute dating**.
- Remember "absolute" means **exact** or **definite**.



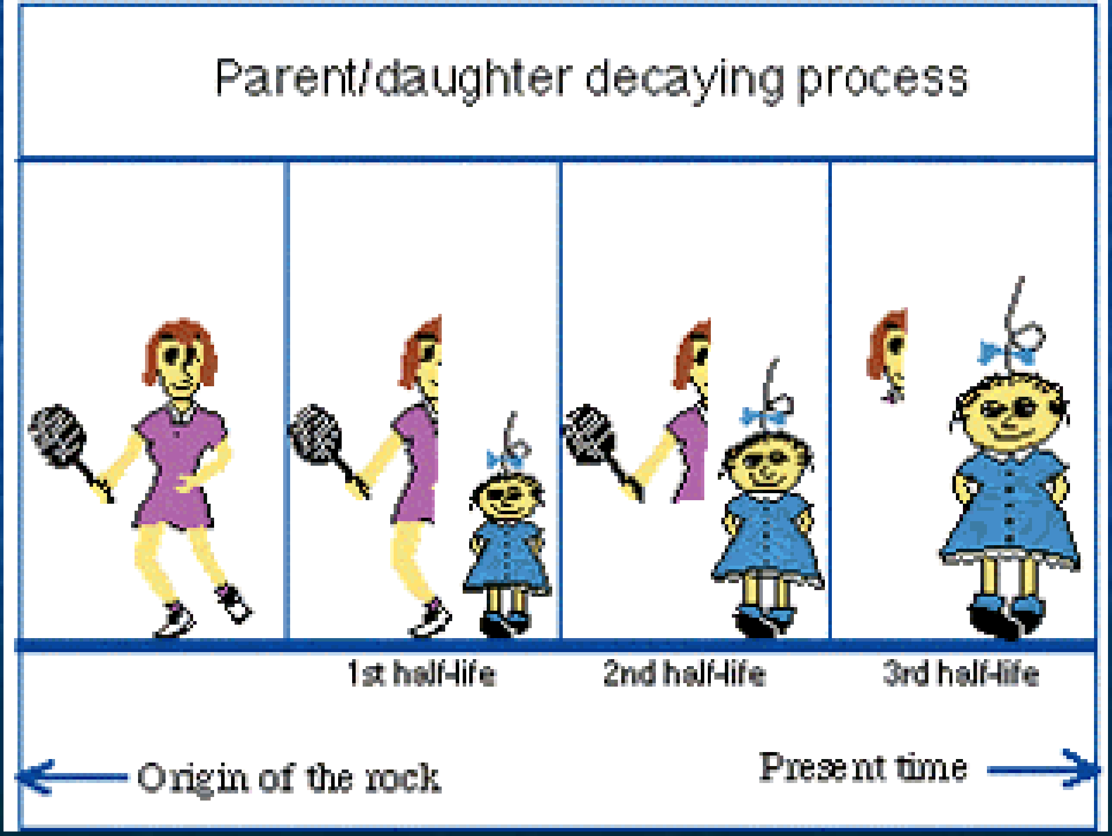
Atoms

- Everything is made of **atoms**.
- The defining characteristic of an atom is the number of protons.
- The number of neutrons can vary from one carbon atom to another or from one hydrogen atom to another. These are called isotopes.
- Over time, some of these atoms may **change** into a <u>different</u> type of atom.
- The original atom is called the "**parent**."
- The new form of the atom is called the "**daughter**."



Parents and Daughters

- **Half** of the **parent** atoms turn into **daughter** atoms once the object has reached a certain age.
- Like how every year on your b-day you turn a different age.

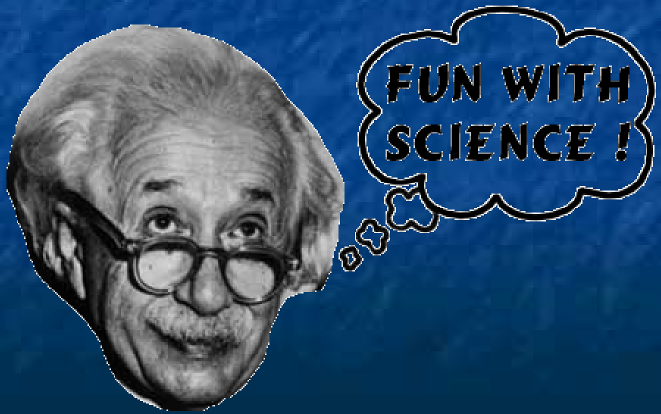


Parents and Daughters

- Scientists can learn the age of a rock by counting the number of **parent** and **daughter** atoms.

Half-Life

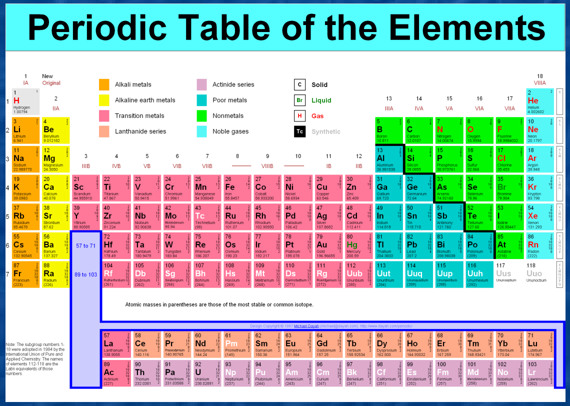
- A **half-life** is the time needed for one-half of the **parent** atoms to turn into **daughter** atoms.
- Different atoms have **different** half-lives.
- Some have half-lives are more than 4 billion years; others have half-lives of only 6,000 years.
- Scientists figure out which atom would be best to use to determine the exact age of a rock.



Half-Lives of Two Atoms

- Potassium-40 has a half-life of **1.3 billion** years. It can be used to date rocks older than 100,000 years.
- Uranium-238 has a half life of **4.5 billion** years. It can be used to date rocks older than 10 million years.

•The half-life of carbon-14 is known to be 5720 years. Why do you think it is a good element to use to date fossils and some rock?



Shorter half life means more accurate age

Radiometric dating

- Radiometric dating uses the half-life of atoms to figure out the age of the rock layers the atoms are in.
  - Determines Absolute Age

Age of Earth

- Scientists have used **absolute dating** to figure out the **age of the earth**.
- By counting the **parent** and **daughter** atoms in some very old rocks, scientists say that the solar system (including Earth) is about **4.6 billion years old**!
- (4,600,000,000 years old!)
- That's a lot of birthdays!
- Before this method was invented, people believed Earth was only **6,000** yrs old.

Example

- A scientist knows that **half** of the **parent** atoms will turn into **daughter** atoms every 10,000 years.
- Originally, there is **16mg** of parent atoms
- 10,000 years go by . . .
- **Half** of the **16mg** of parent atoms turn into daughter atoms.
- **16 ÷ 2 = 8**
- So there are **8mg** of daughter atoms <u>now</u>
- And there are **8mg** of parent atoms <u>left</u>.
- Check your math: **8 + 8 = 16 mg**

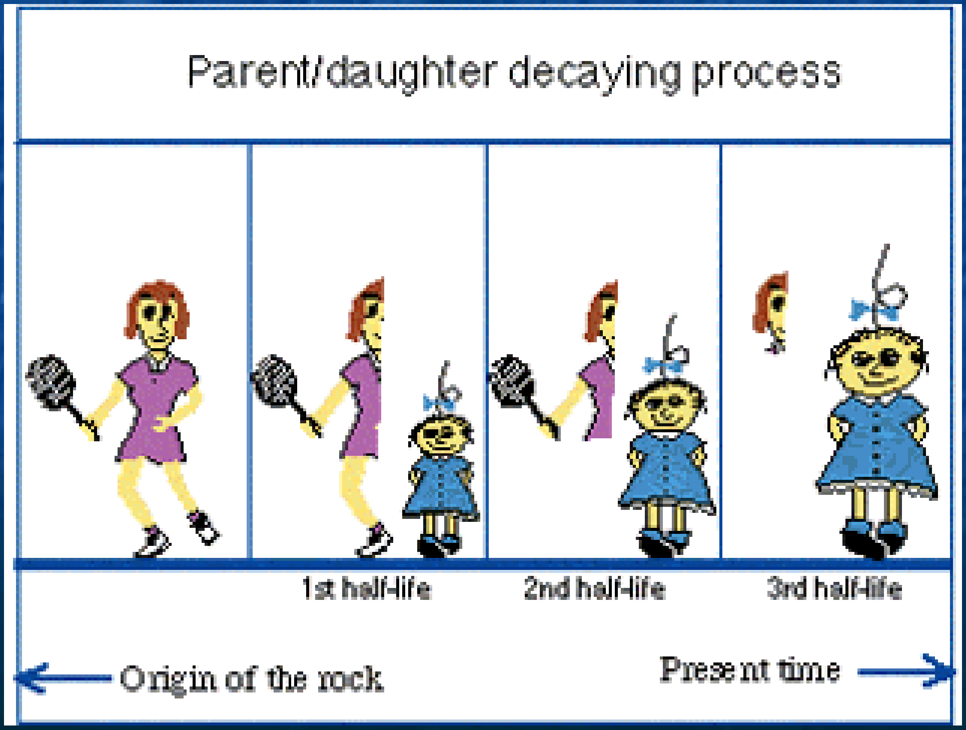
Parent: 16 → 8
Daughter: 0 → 8

- Then another 10,000 years go by . . .
- **Half** of the **8mg** of parent atoms turn into daughter atoms.
- **8 ÷ 2 = 4**
- Now there are **4mg** more daughter atoms.
- Add this to the **8mg** that has already formed
- **8 + 4 = 12 mg** of daughter atoms
- And there are only **4mg** of parent atoms left.
- Check your math: **12 + 4 = 16 mg**

Parent: 16 → 8 → 4
Daughter: 0 → 8 → 12

- Then another 10,000 years go by . . .
- **Half** of the **4mg** of parent atoms turn into daughter atoms.
- **4** ÷ **2** = **2**
- Now there are **2mg** more daughter atoms.
- Add this to the **12mg** that has already formed
- **12** + **2** = **14 mg** of daughter atoms
- And there are only **2mg** of parent atoms left.
- Check your math: **14** + **2** = **16 mg**

- Scientists compare the number of **parent** atoms to the number of **daughter** atoms.
- The more **daughter** atoms there are, the older the rock is.
- This tells them how many times half the **parent** atoms turned into **daughter** atoms.

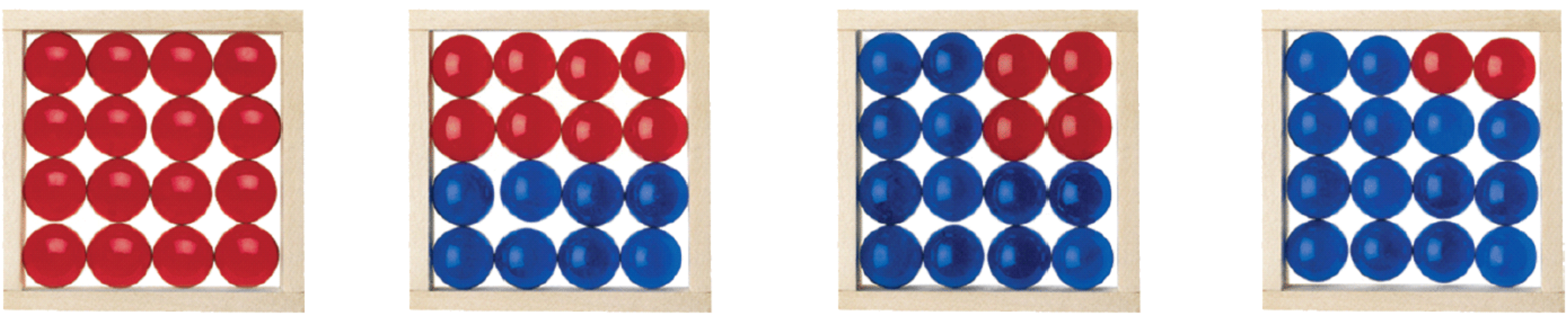


Parent: 16 → 8 → 4 → 2
Daughter: 0 → 8 → 12 → 14

- In this example, each time this happened, **10,000 years** had gone by.
- So if it happened **3 times**, then the object is:

3 x 10,000 = 30,000 yrs old

Radioactive Decay: Parent and Daughter Isotopes



0 years	10,000 years	20,000 years	30,000 years
Parent isotope = 16 mg	Parent isotope = 8 mg	Parent isotope = 4 mg	Parent isotope = 2 mg
Daughter isotope = 0 mg	Daughter isotope = 8 mg	Daughter isotope = 12 mg	Daughter isotope = 14 mg

Pop Quiz

1) What method is used to figure out if a rock is **older or younger** than other rocks?

RELATIVE DATING

2) What methods has helped scientists determine the **exact age** of Earth?

ABSOLUTE DATING

3) Fill in this **table**:

Isotope Ratios		
	Parent isotope (mg)	Daughter isotope (mg)
Rock forms	20	0
20,000 years	10	10
40,000 years	**5**	**15**

Rock interpretation

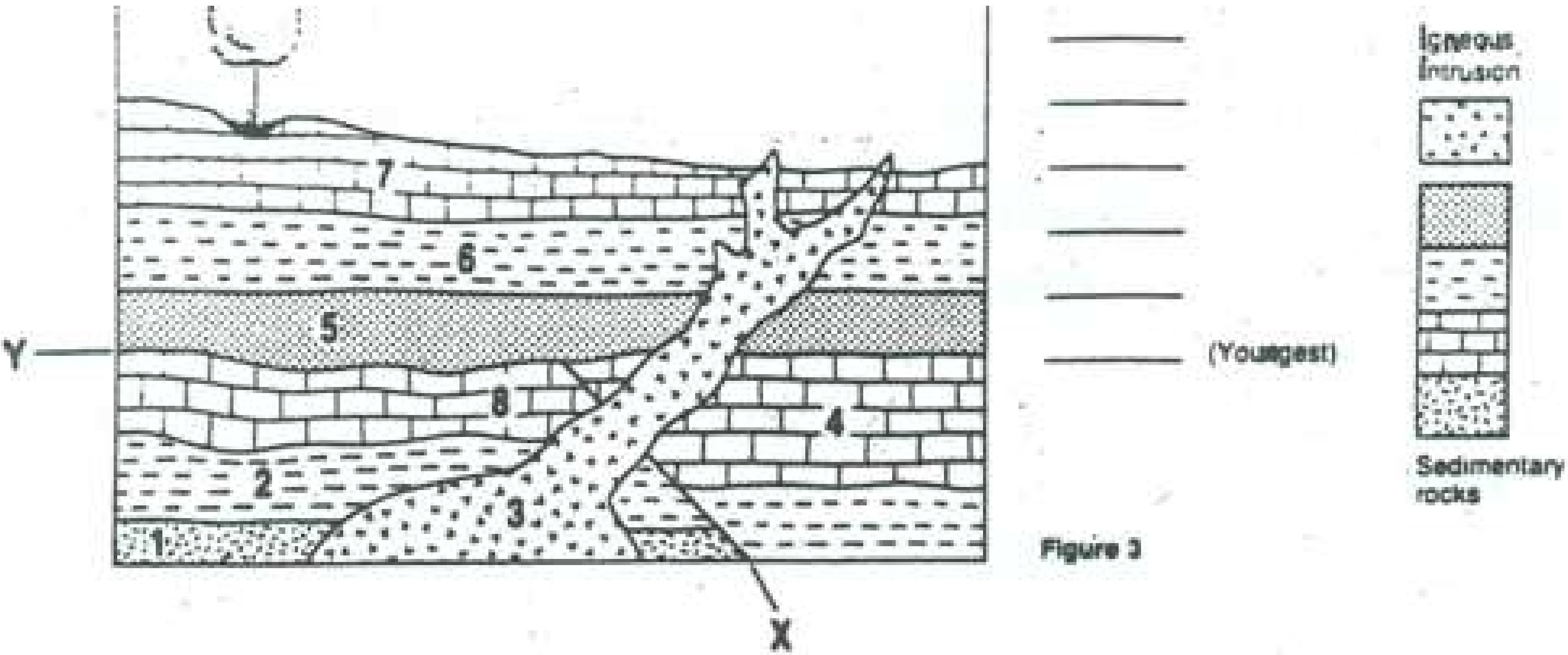
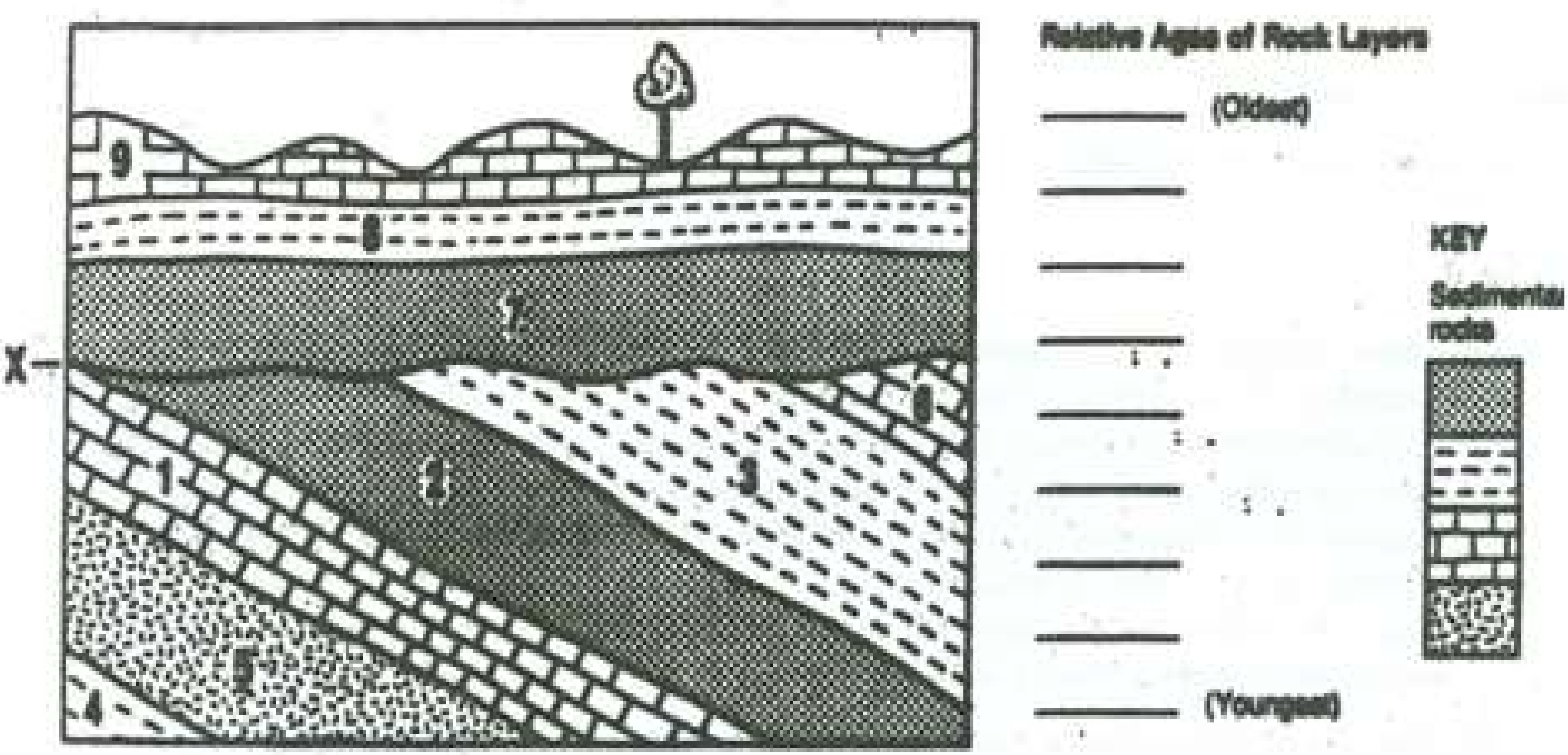
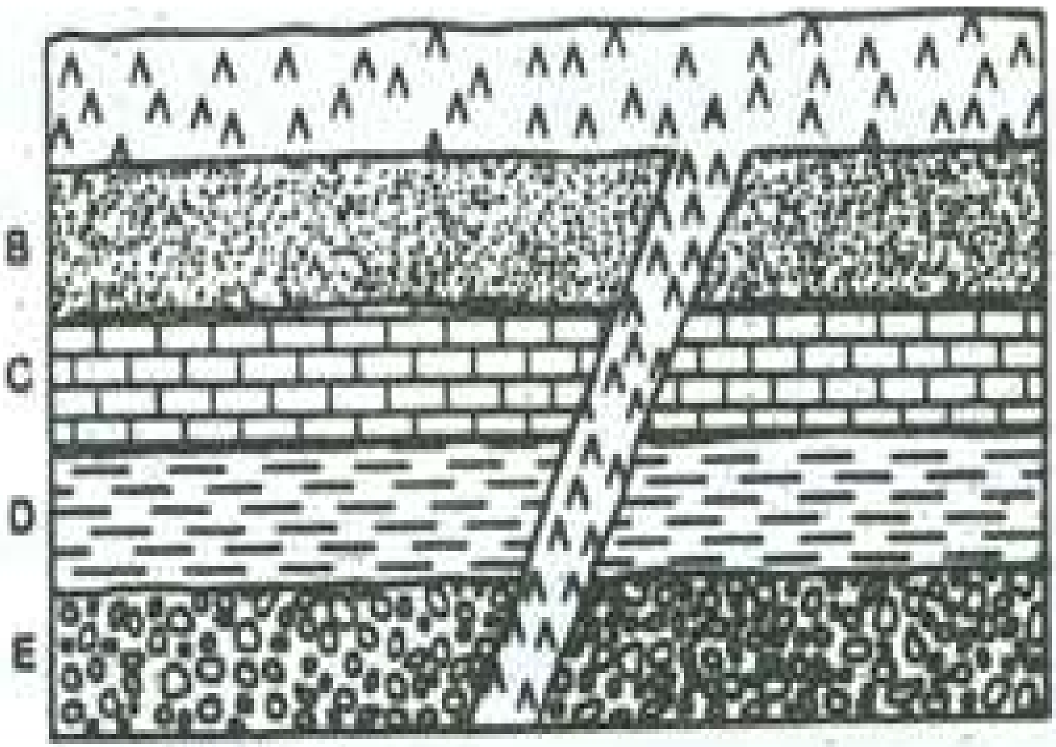


Figure 3

Rock interpretation



Rock Interpretation



Cross Section 1

ORDER OF FORMATION

Cross Section 1

1st _______

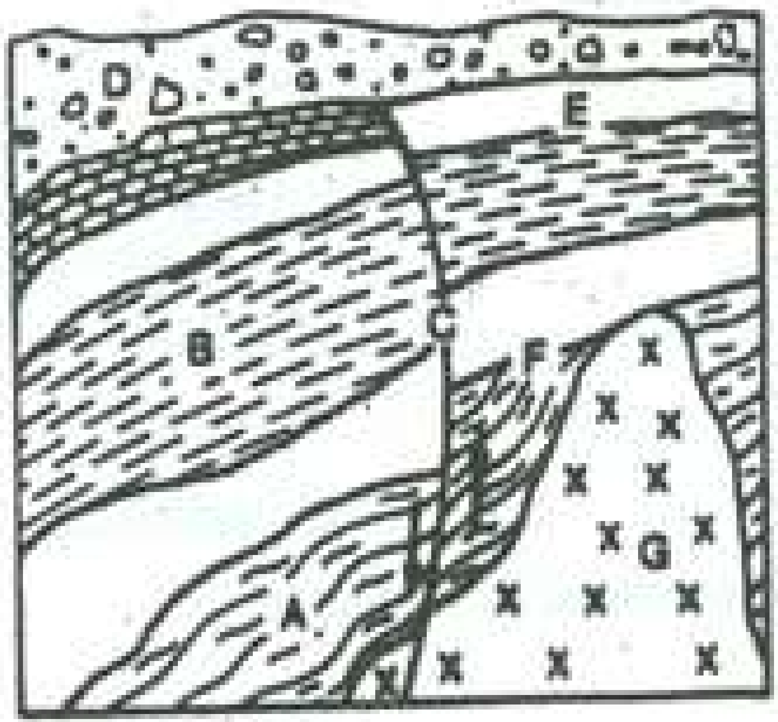
2nd _______

3rd _______

4th _______

5th _______

Rock interpretation



Cross Section 2

ORDER OF FORMATION

Cross Section 2

1st ______

2nd ______

3rd ______

4th ______

5th ______

6th ______

7th ______