Granddad was superstitious about books. He thought that if you had enough of them around, education leaked out, like radioactivity.

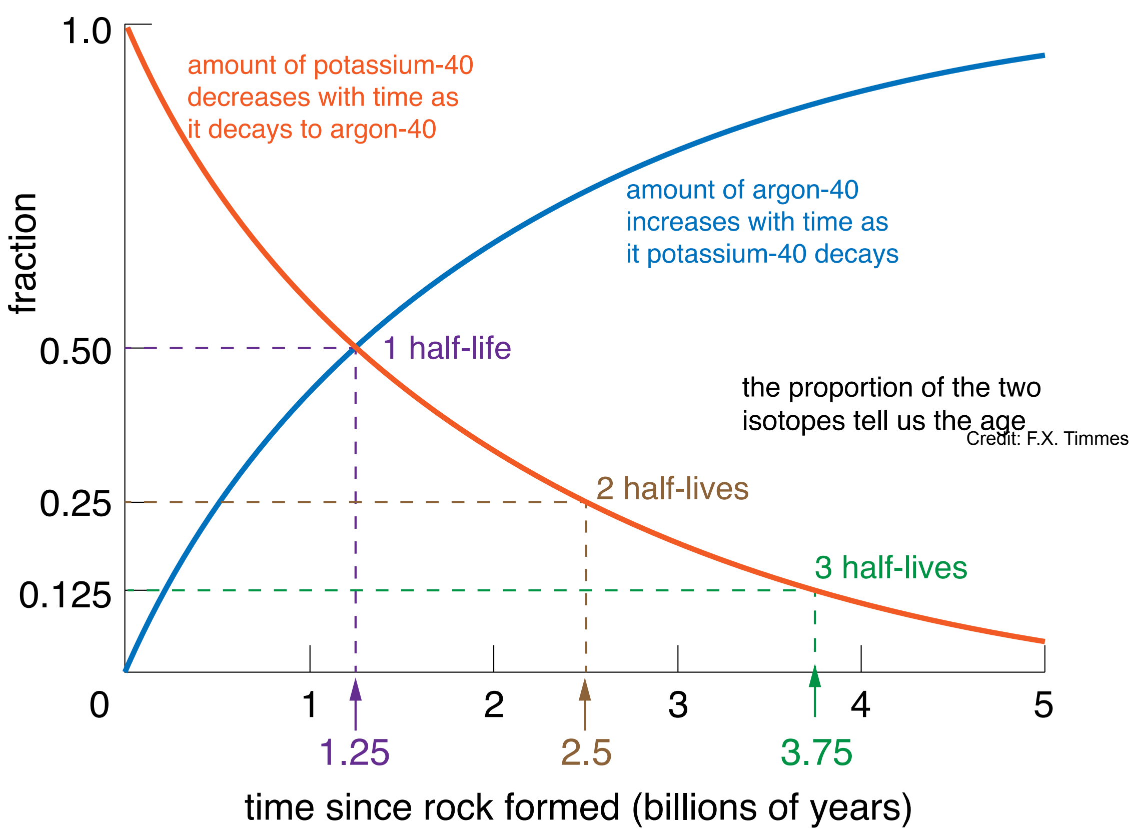
Terry Pratchett

Dates with Rocks

We're here! In this module we'll explore dates with rocks and what they tell us about the age of the solar system.

In radioactive decay an atom with one type of nucleus transforms into an atom with a nucleus containing a different number of protons and neutrons, or in some cases the same nucleus but in a different state. We'll be most interested in the first case.

So radiometric dating, founded upon radioactive decay, is based on measuring the abundance of a radioactive isotope and its decay products. These abundances change with time in a predictable manner and provide a high-quality measurement age - the age of rocks in our case.



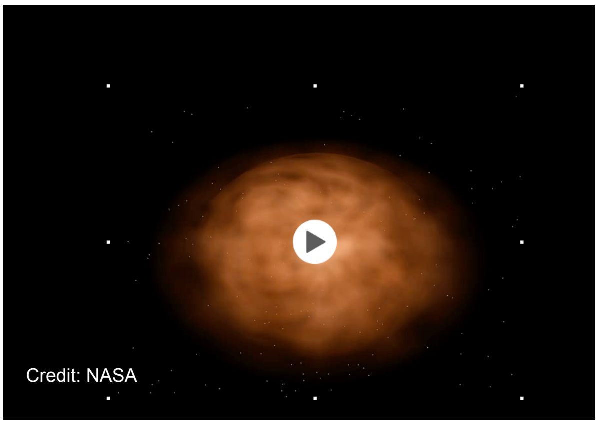
An isotope. As a refresher, an elements is defined by just the number of protons in it. Then the number of neutrons determines the isotope of an element. You're probably a little bit familiar with this from carbon-14 dating. You measure the amount of carbon-14 and the amount of its decay product, nitrogen-14. From this information you can tell the age of the tree. We basically do the same thing with rocks, except we don't use carbon-14. We need things with longer half-lives since the solar system is much, much older than any tree.

The plot above shows how the abundance of a radioactive isotope changes with time. This is in particular for the potassium-argon radioactive pair. As potassium-40 goes down, the red curve, the amount of argon-40, blue curve, goes up. Since there's a very well defined half-life of potassium-40, the time it takes for half of any sample of potassium-40 to decay, the ratio between the parent, potassium-40, and the daughter, argon-40, tells you the age of the rock. The image below shows a sample of Sylvite from new Mexico. Sylvite is rich in potassium-40.

Parent	**Daughter**	**Half-life (years)**
Rubidium-87	**Strontium-87**	**50 billion**
Uranium-238	**Lead-206**	**4.5 billion**
Potassium-40	**Argon-40**	**1.3 billion**
Uranium-235	**Lead-207**	**700 million**
Uranium-234	**Thorium-230**	**80 thousand**
Carbon-14	**Nitrogen-14**	**5700**

Different radioactive isotopes have different half-lives. Ones that have common usage in geology are given in the table above. You use several isotope pairs to get a handle on how old a rock is. You use several pairs because they serve as a cross-check on each other. You'd like the different isotope pairs to give a consistent answer. And they generally do.

It's from the dating of Earth rocks and meteorite rocks with these radioactive isotopes that we know the solar system is about 4.5 billion years old. That's how old the Earth is. That's how old the Sun is. That's how old the planetary system is. 4.5 billion years.



The still image is from an animation that covers 4.5 billion years and shows the primordial cloud, the solar nebula, on down to a disc -- the flattening, the formation of the planets, the clearing out of the solar disc as the sun turns on, the period of bombardment, until you have the eight planets, which hopefully, on one of them, life can arise.

Radioactivity is much more important that "just" dating rocks. As we will see, its one of the main drivers for keeping Earth's interior warm!

Rock on! Bye bye.