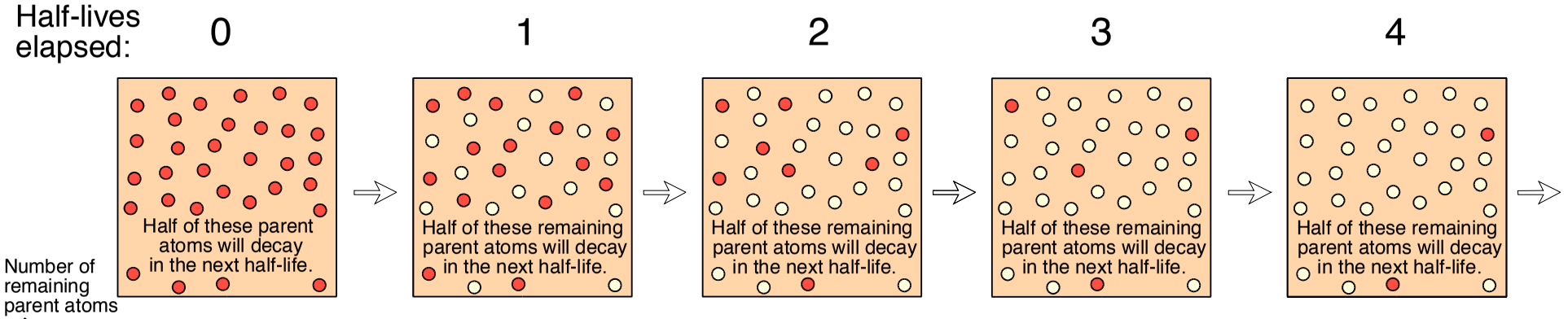
Half-lives of radioactive atoms and measurement of age

If one considers a population of humans, one can't predict which individuals will die when, but actuarial study can predict when some proportion of the population will have died. If we consider a group of radioactive atoms, we likewise can't predict when any one atom will decay, but we can determine the time in which half of the population will have decayed. This is the concept of half-lives.

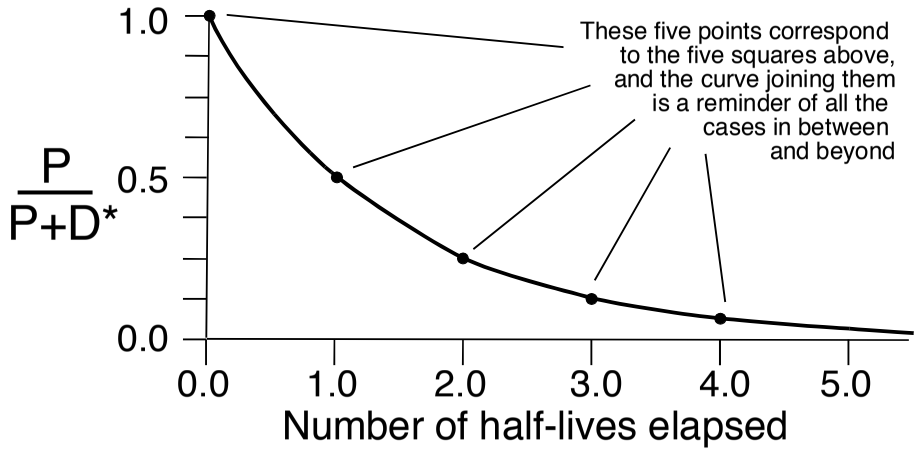
Half-life: with regard to a population of atoms of one radioactive isotope, the time in which half of those atoms will decay from parent to daughter.

In the sketches below, the square boxes will represent and enclose an evolving population of atoms of one radioactive isotope (perhaps ^{238}U or ^{40}K). For a geologist, the square boxes typically represent time-series views of a crystal in which radioactive atoms are present.



Thus, after *n* half-lives,

$$\frac{P}{P+D^*} = \left(\frac{1}{2}\right)^n$$



The relationship at left is what lets us use radioactive decay as a clock to measure the age of a material. That material (perhaps a crystal of a mineral in a rock) must be one into or from which neither parent nor daughter atoms have been added or lost – it must have have been a closed system during the time that we will call its age.