

Determination of Thickness

Understanding that x ray attenuation is an exponential function of thickness and elemental mass

A narrow beam of mono energetic photons with an incident intensity I_0 , penetrating a layer of material with mass thickness x and density emerges with intensity I given by the exponential attenuation law

$$I/I_0 = e^{-(\mu/\rho)x}$$

Note that the mass thickness is defined as the mass per unit area, and is obtained by multiplying the thickness t by the density i.e., $x = \rho t$

Mass attenuation coefficients

<u>material</u>	<u>Density</u>	6 keV	7 keV	8 keV	9 keV	10 keV	15 keV	22 keV
aluminium	2.70E+00	1.15E+02	8.03E+01	5.03E+01	3.90E+01	2.62E+01	7.96E+00	2.98E+00
silicon	2.33E+00	1.47E+02	1.05E+02	6.47E+01	4.80E+01	3.39E+01	1.03E+01	1.98E+00
cobalt	8.90E+00	9.37E+01	7.00E+01	3.25E+02	2.72E+02	1.84E+02	6.20E+01	2.42E+01
iron	7.87E+00	8.48E+01	5.32E+01	3.06E+02	2.60E+02	1.71E+02	5.71E+01	2.22E+01
nickel	8.90E+00	1.09E+02	7.50E+01	4.95E+01	1.90E+02	2.09E+02	7.08E+01	2.78E+01
copper	8.90E+00	1.16E+02	7.50E+01	5.26E+01	2.78E+02	2.16E+02	7.41E+01	2.92E+01

<http://www.nist.gov/pml/data/xraycoef/index.cfm>

$$I/I_0 = e^{[-(\mu/\rho)x]}$$

I_0 is the value of the area without the overlaying foil

I is the value of the area with the overlaying foil

Choose the density and the attenuation coefficient for the material of foil you have chosen for the energy of the x ray that is being attenuated.

Solve the attenuation equation for x and then use the equation relating x and t and solve for the thickness t

t = thickness of material attenuating x rays (cm)

$$t = -\text{Ln}(I/I_0)/(\mu/\rho)\rho$$

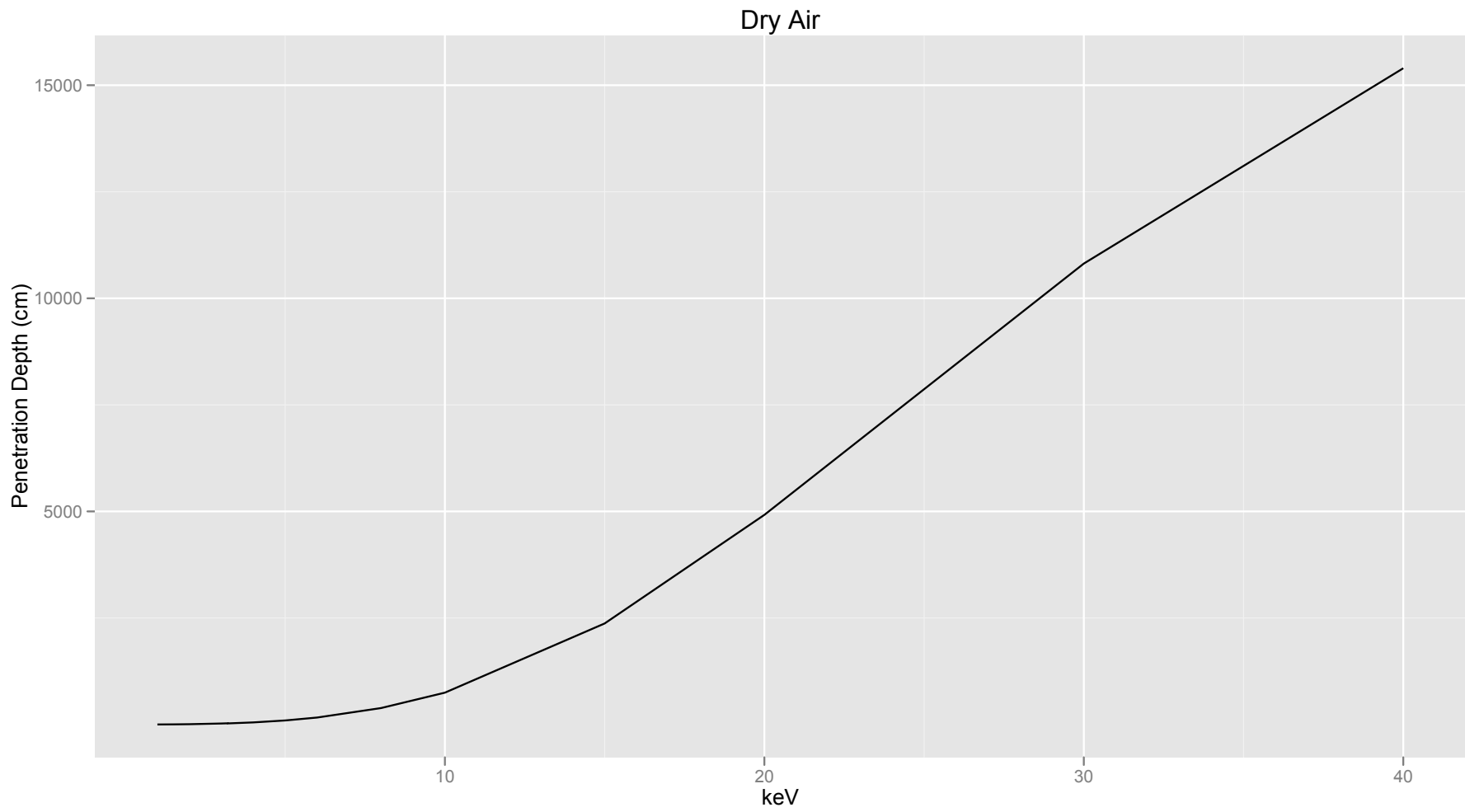
(μ/ρ) = Mass attenuation coefficient read off the chart for a given material and a given x ray energy

ρ = density of the material that the x ray are going through

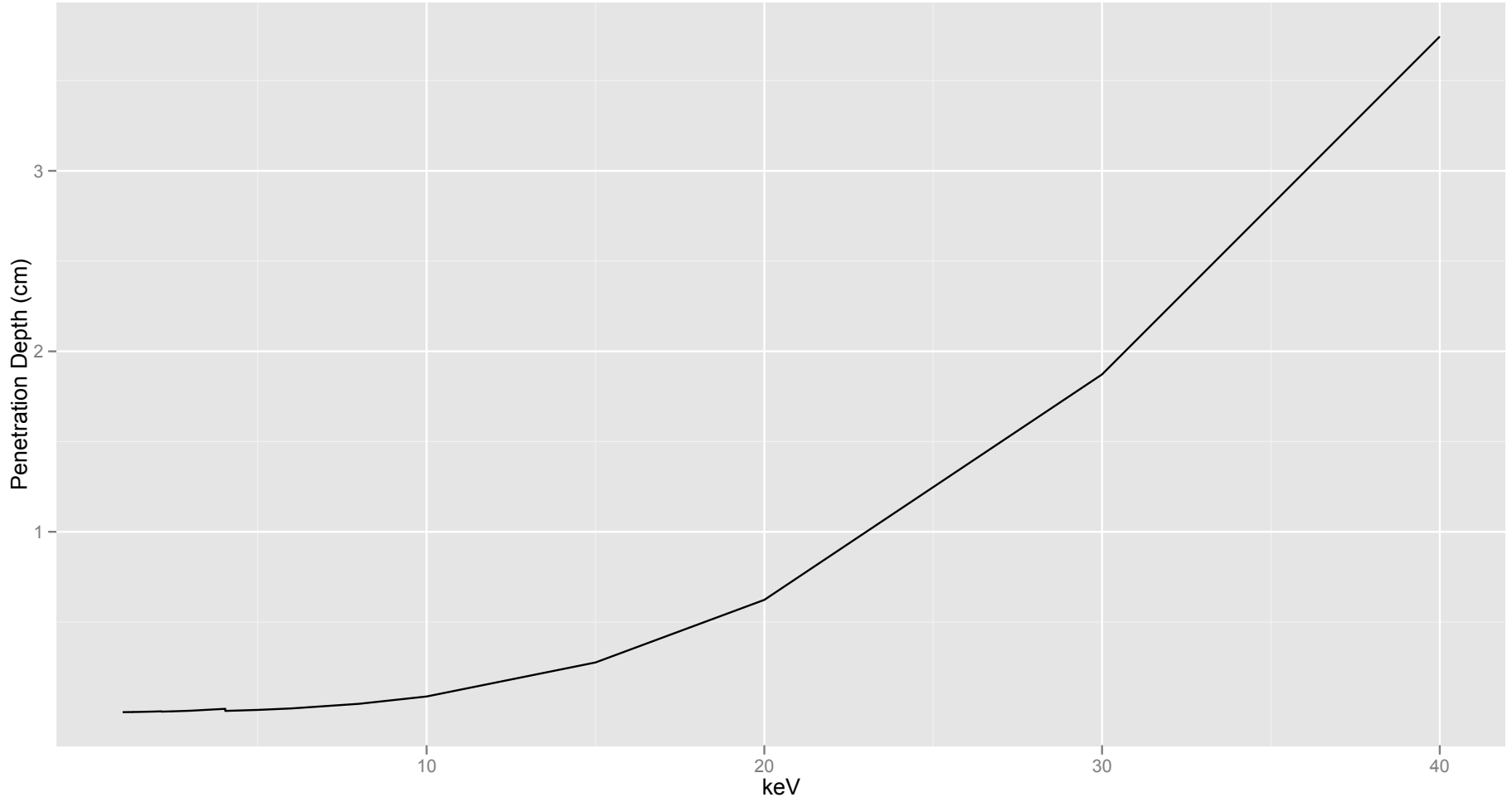
I = Beam intensity with attenuation

I_0 = Beam intensity without attenuation

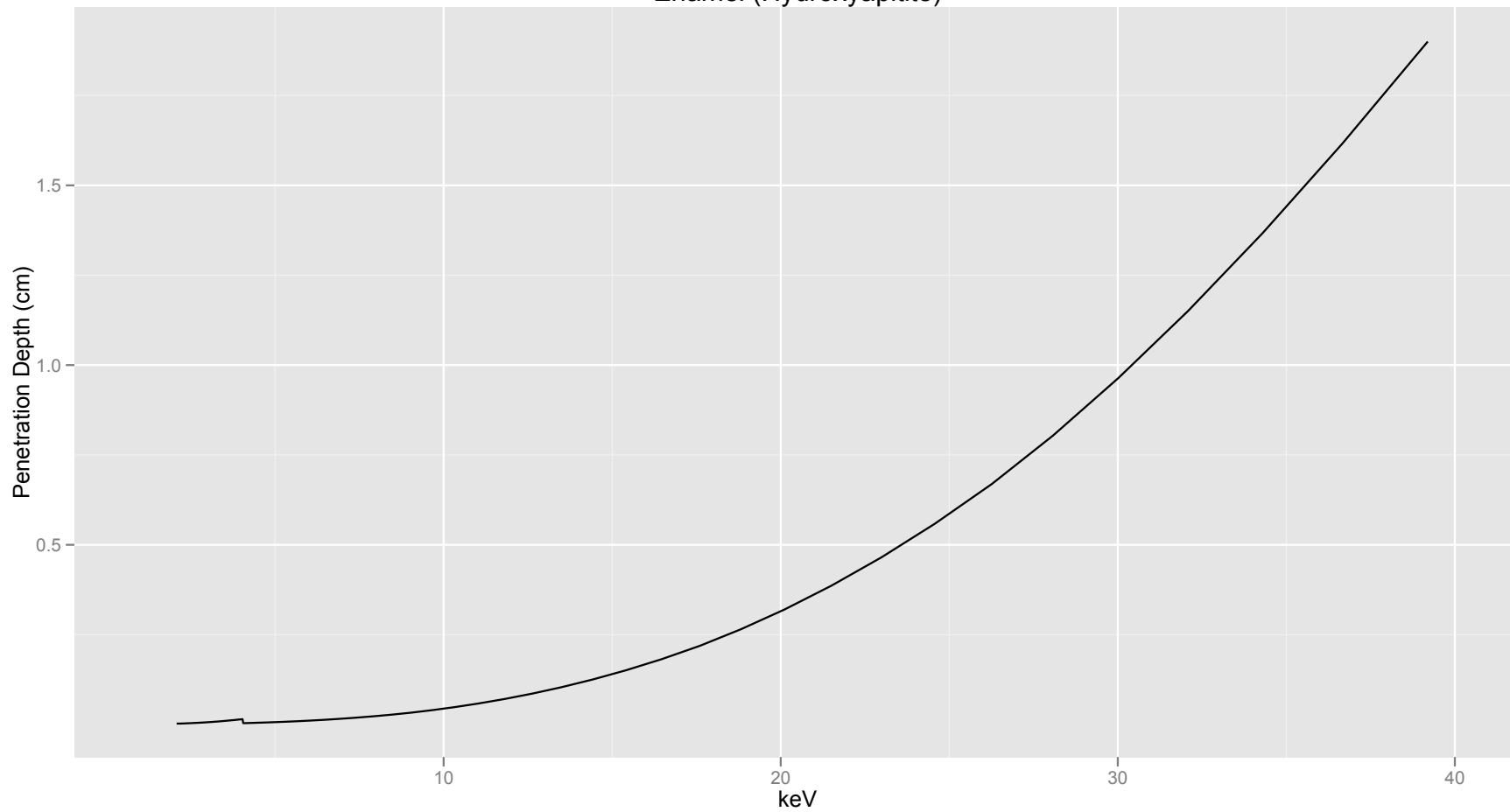
$$t = 4.63/(\mu/\rho)\rho$$



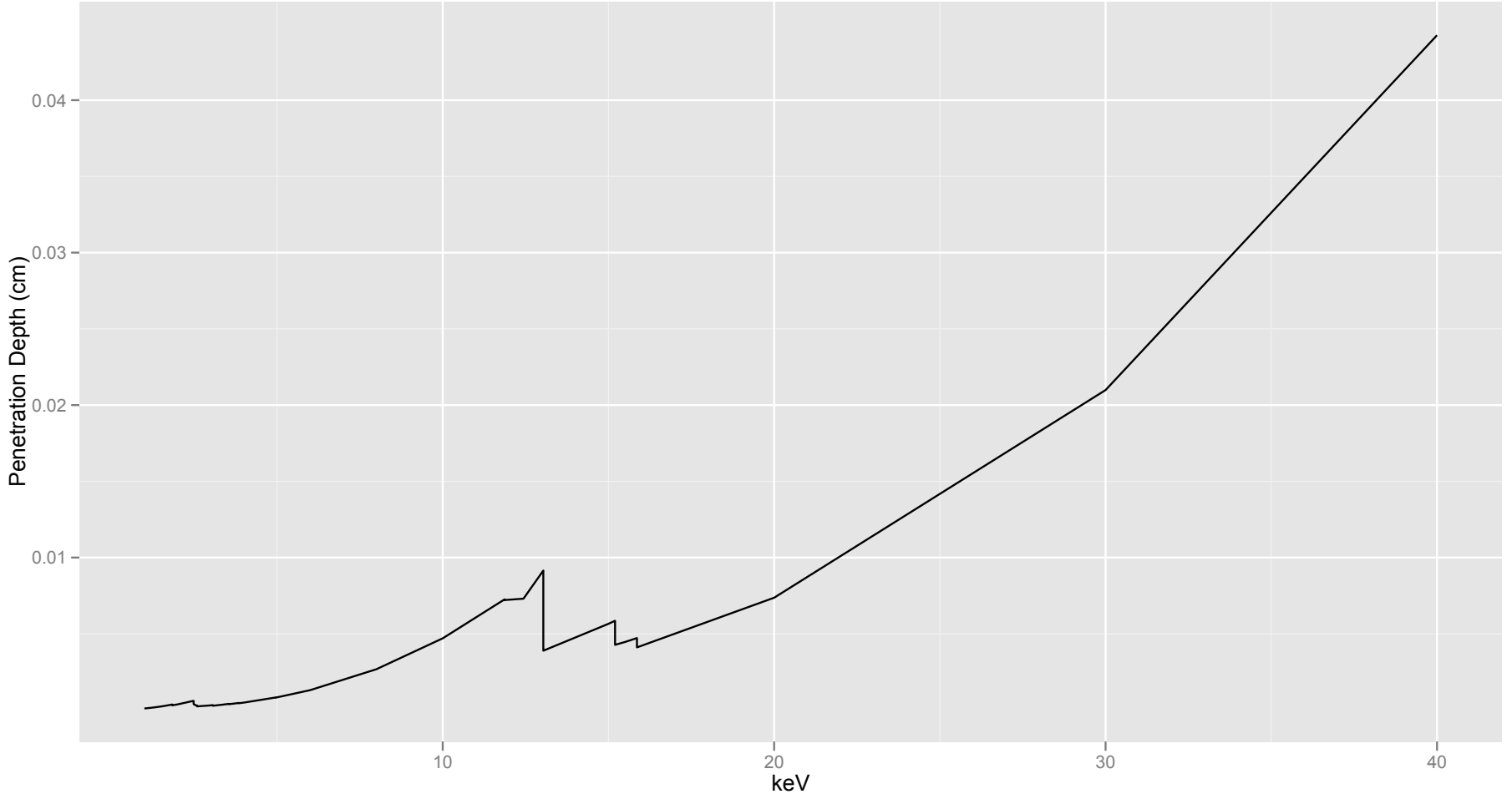
Cortical Bone



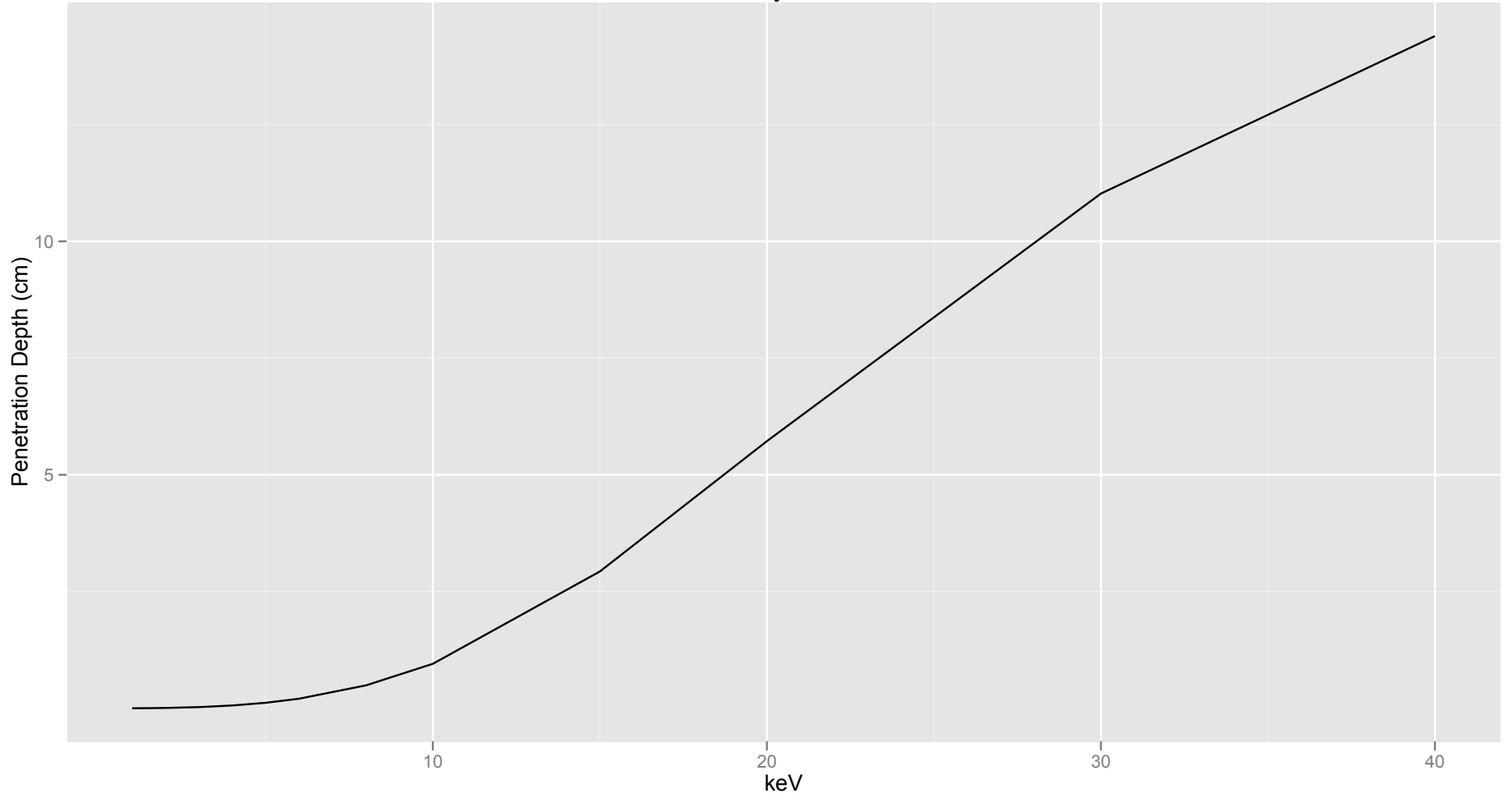
Enamel (Hydroxyapatite)



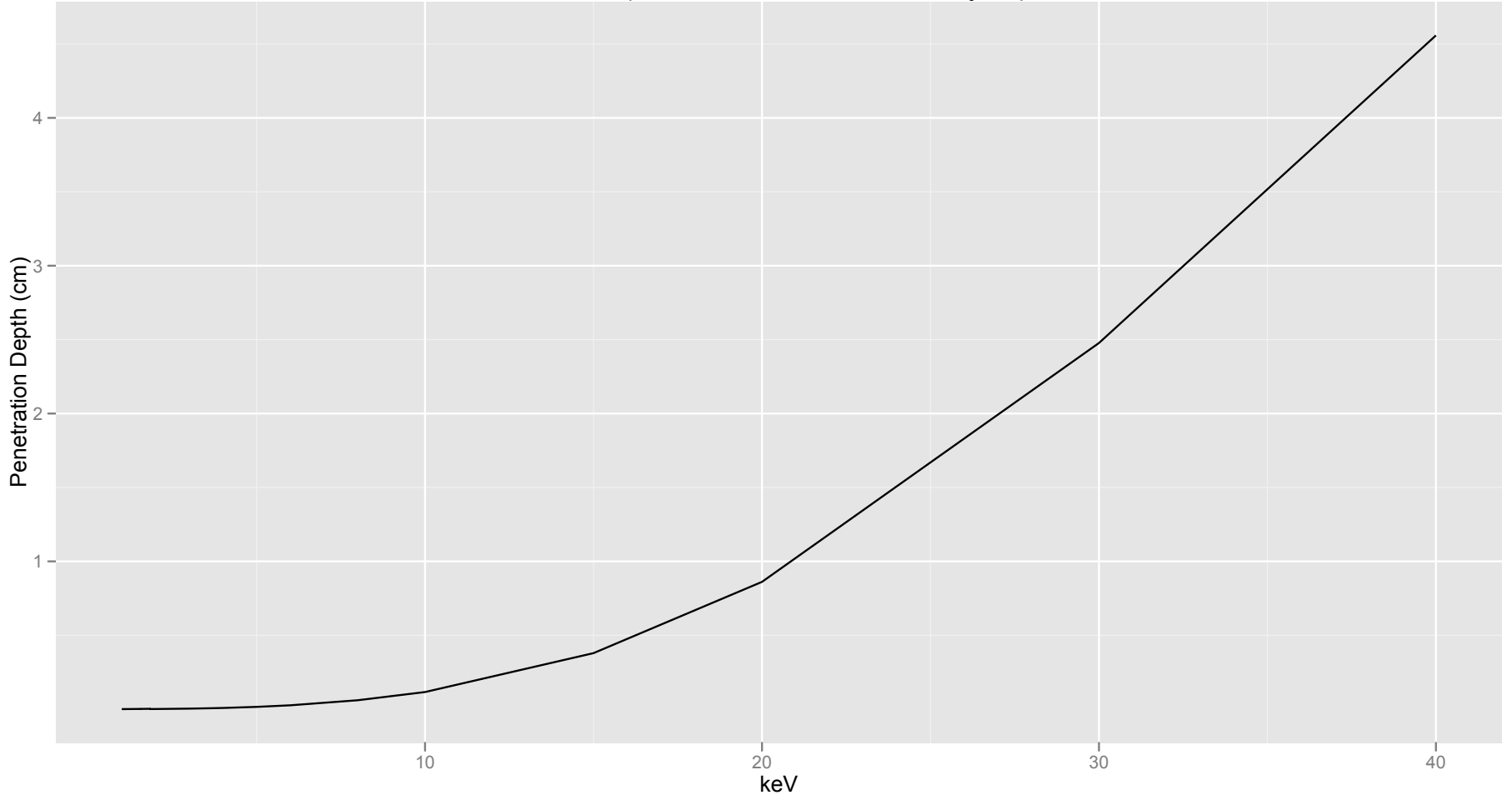
Lead Glass



Mylar



Silicate (Glass, Ceramic, Obsidian, Pyrex)



Water

