Summary for Tutorial 6

QL
(Dated: December 4, 2008)

I. URANIUM THORIUM DATING

The decay chain:
$^{238}U \rightarrow^{234} Th \rightarrow^{234} Pa \rightarrow^{234} U \rightarrow^{230} Th$

The age of the sample is related to the number of ^{238}U, ^{234}U and ^{230}Th, and is given by:

$$\frac{^{230}Th}{^{238}U} = (1-e^{-\lambda_{230}\cdot t})+\frac{\lambda_{230}}{\lambda_{230}-\lambda_{234}}(\frac{^{234}U}{^{238}U}-1)(1-e^{-(\lambda_{230}-\lambda_{234})\cdot t}) \quad (1)$$

II. THERMOLUMINESCENCE DATING

$$Age = \frac{paleodose}{annual\ dose} \quad (2)$$

How to determine the paleodose?
Suppose the paleodose is N. After β radiation, the dose is N+N_β, then the ratio R is

$$R = \frac{N}{N+N_\beta} \quad (3)$$

Thus the paleodose N is:

$$N = \frac{N_\beta}{R^{-1}-1} \quad (4)$$

How to determine the annual dose?

$$D = D'_\alpha + D_\beta + D_\gamma \quad (5)$$

If the environment is wet, we have to correct for that:

$$k^w_\alpha = \frac{k^d_\alpha}{1+1.5\times f\times w} \quad (6)$$

$$k^w_\beta = \frac{k^d_\beta}{1+1.25\times f\times w} \quad (7)$$

$$k^w_\gamma = \frac{k^d_\gamma}{1+1.14\times f\times w} \quad (8)$$

With k^w/k^d the coefficients in the wet/dry environment. Then the annual dose is:

$$D = k^w_\alpha D'_\alpha + k^w_\beta D_\beta + k^w_\gamma D_\gamma \quad (9)$$

The sunlight will decrease the paleodose in the antique. After being exposed for time t, the paleodose is:

$$TL(t) = TL(0)\times e^{-\kappa\cdot t} \quad (10)$$

with κ the material coefficient, t in unit of [hour].

OK, finally, let's make some forgery! (Oh, just for fun, don't sell it.)

$$FakeAge = \frac{N+N_\gamma}{annual\ dose} \quad (11)$$

$$N_\gamma = \frac{E}{m} \quad (12)$$