Radioactivity Measurements: Some (Not-Always-So-Obvious) Things to Think About

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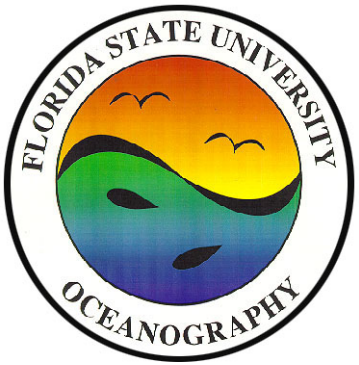
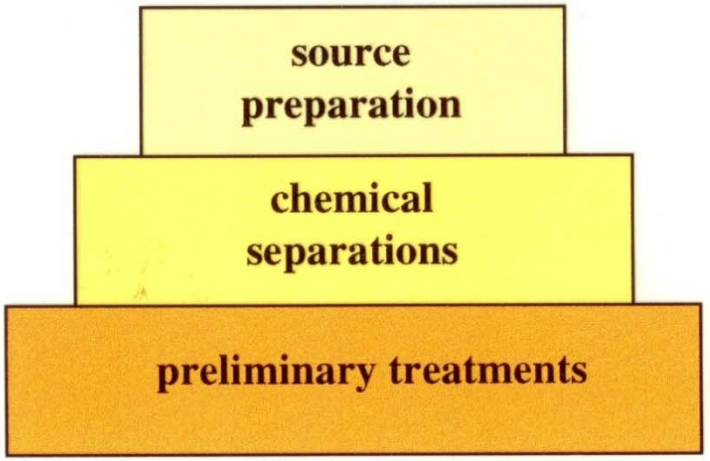


Sample Preparation Pyramid for Alpha Spectrometry

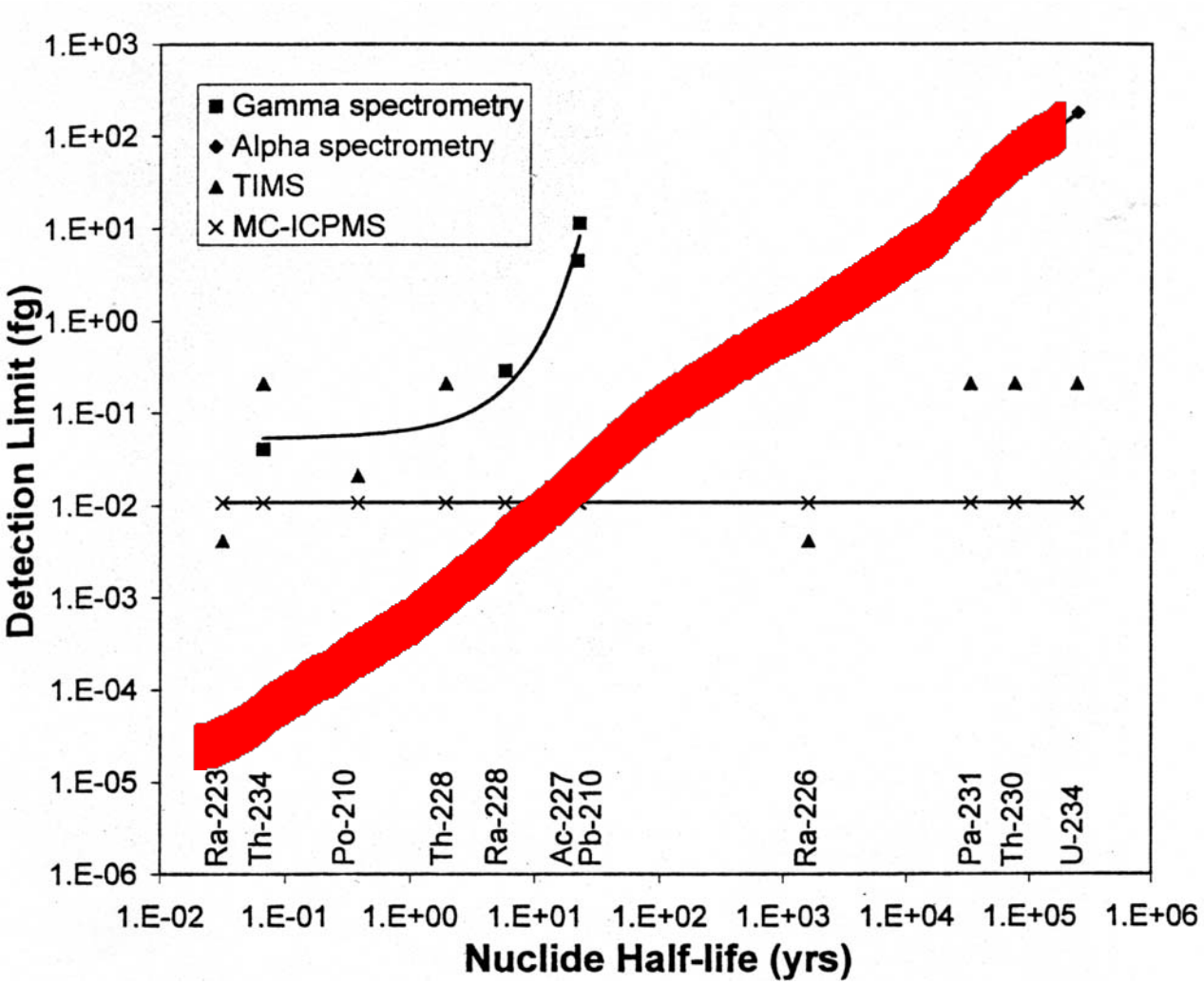


The various stages of sample preparation may be thought of as a pyramid of steps

α-spectrometry very sensitive for some radionuclides. Why?

Detection Limit Comparison

fg = femtogram = 10^{-15} grams



Assumptions for α-counting: 7-day count; 30% eff.,1 count/day background

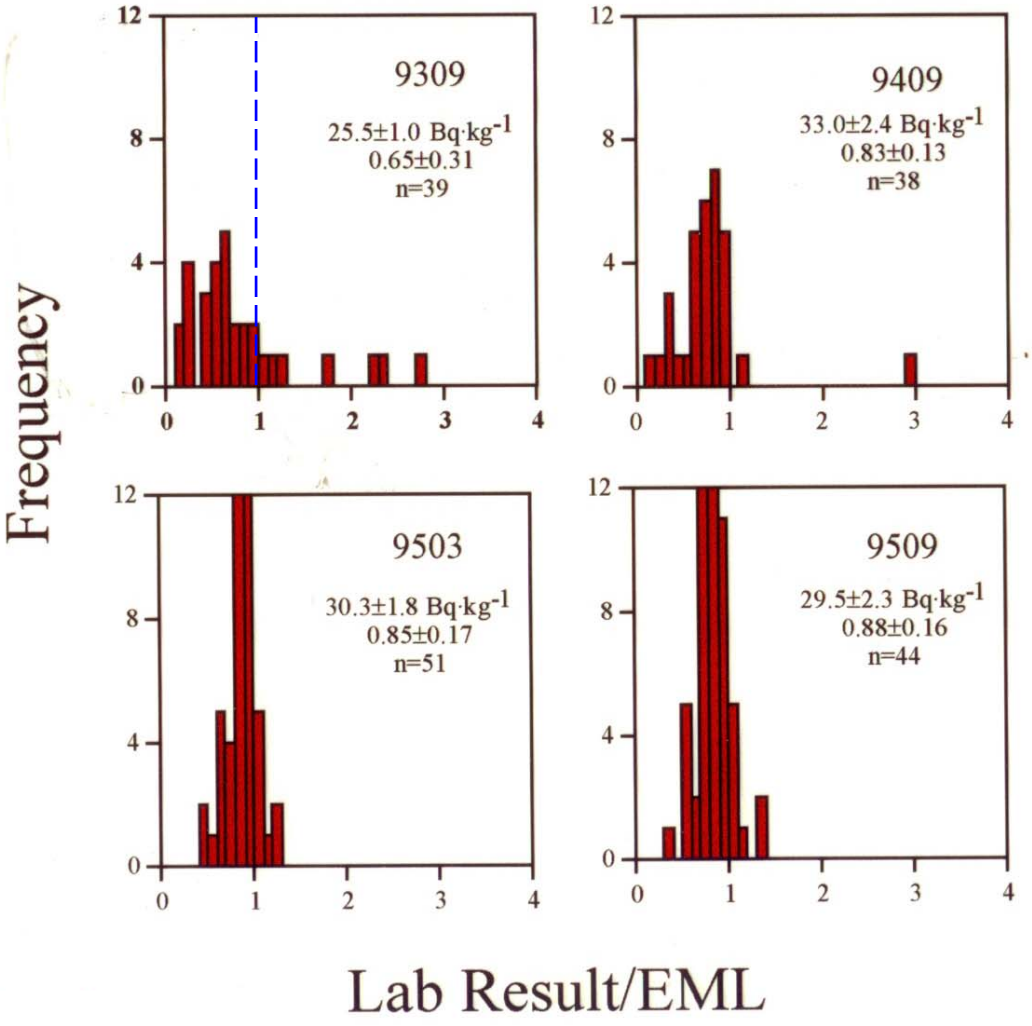
Why is the detection limit for α-counting on a sloping line?

Desirable Characteristics

- high yields (low MDA, etc.)
- clean separations with no interferences
- asap

Consider some basic sample prep techniques that may determine the success/failure of an analysis…

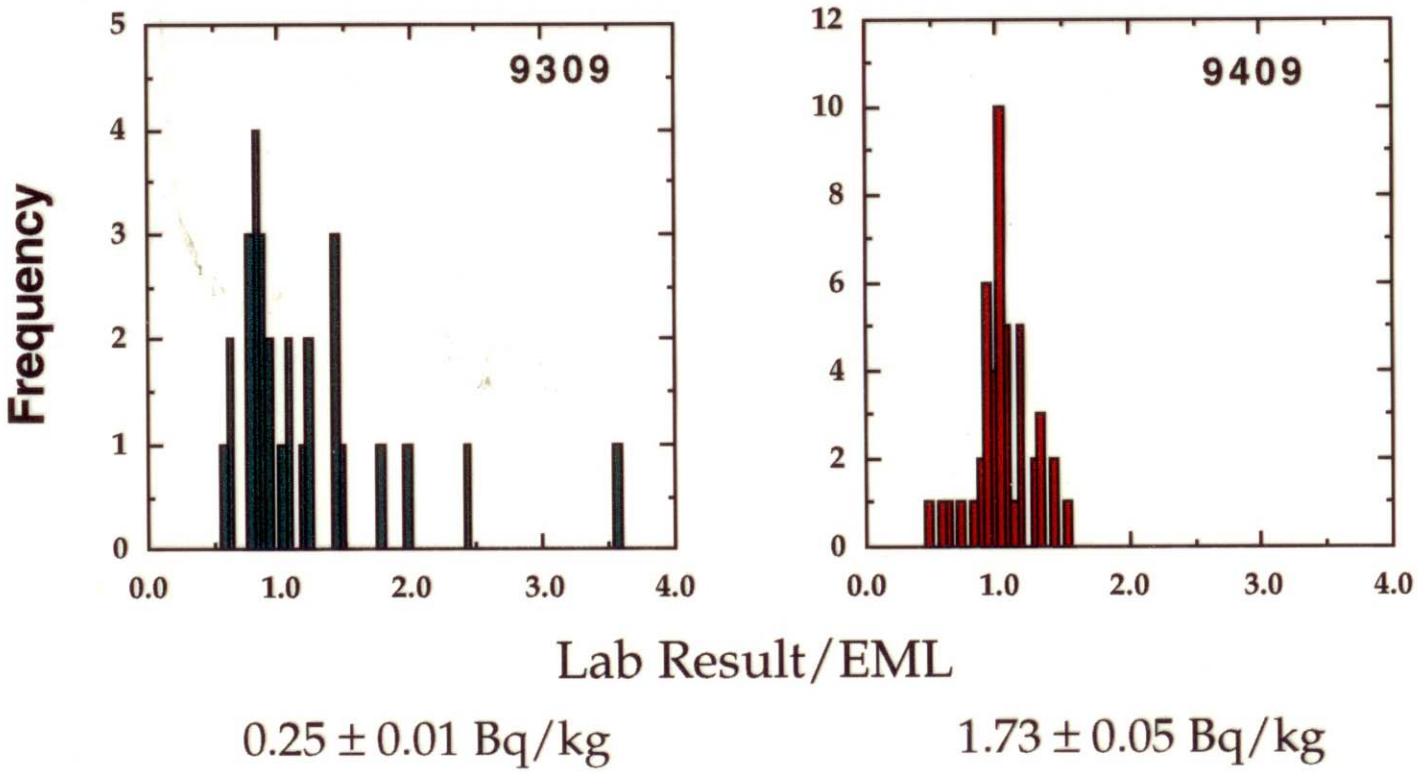
U in EML Soils



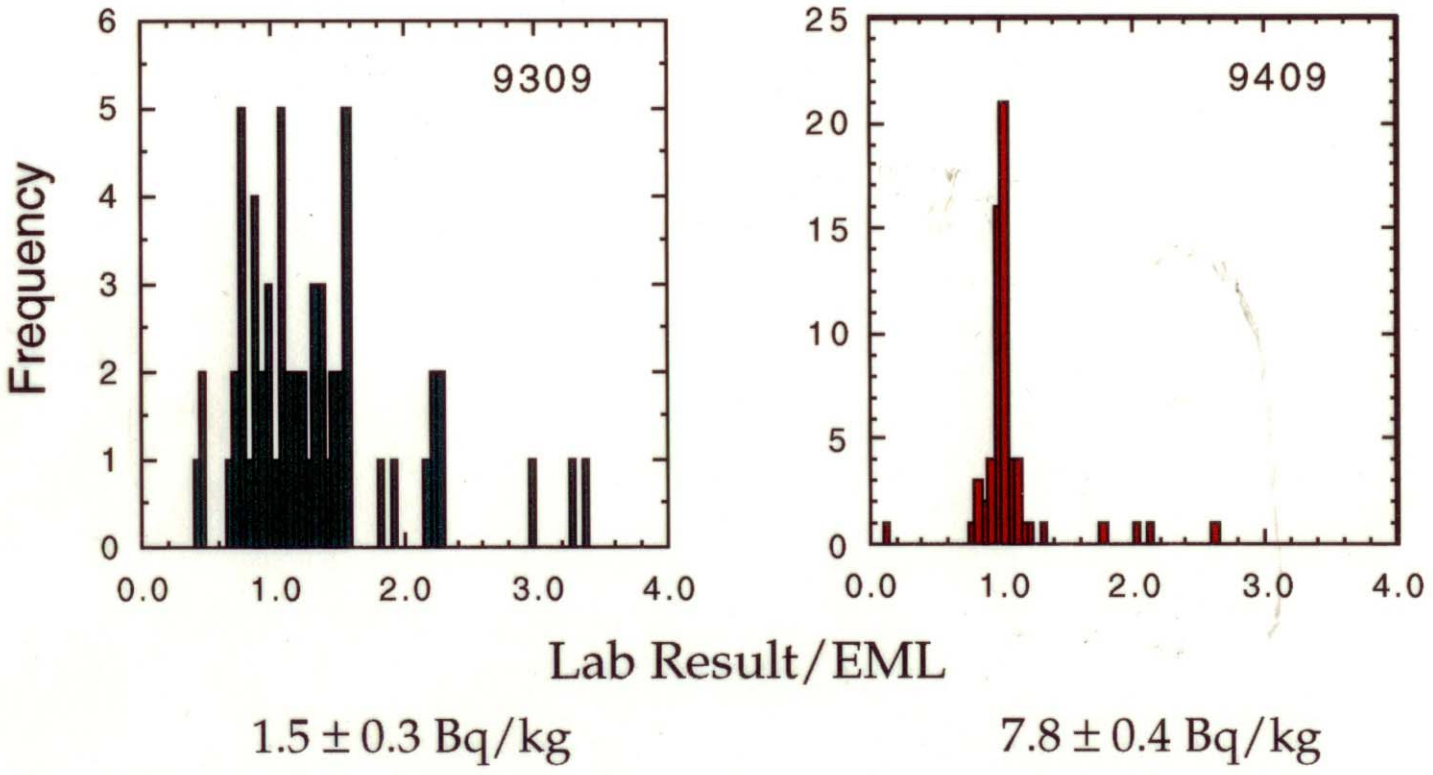
Thought Question #1

What is the most likely reason for the very poor (and low) performance on the U analyses for EML 9309?

EML Soils: Am



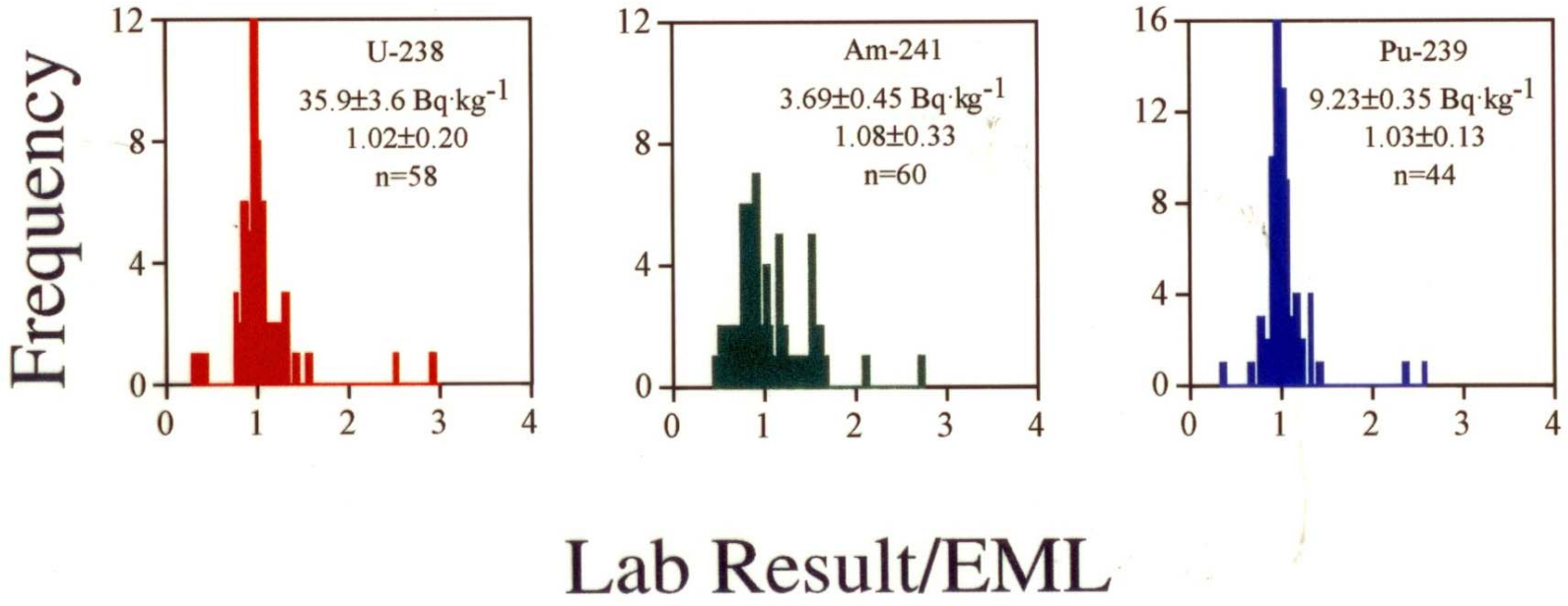
EML Soils: ^{239}Pu



Thought Question #2

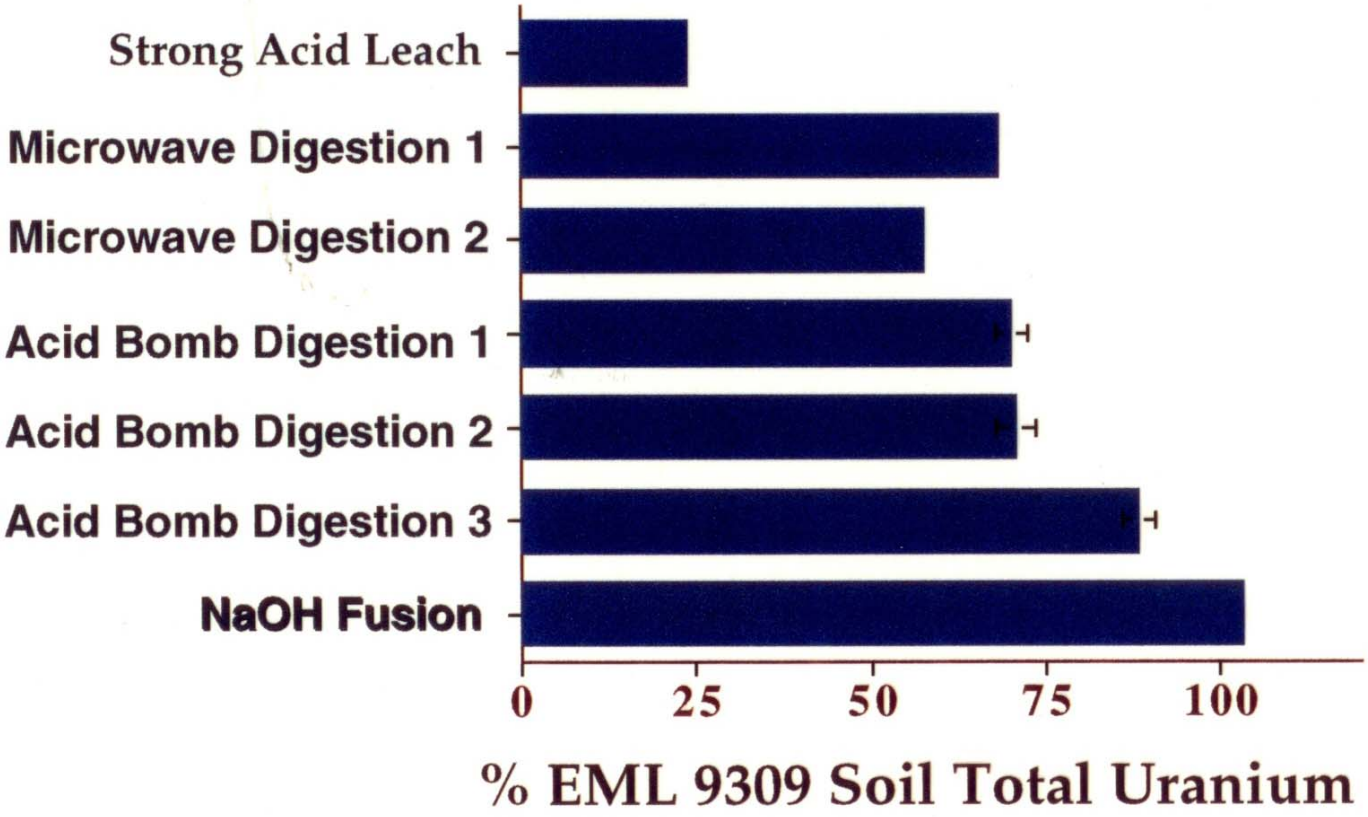
The Am and Pu results for EML 9309 were better than the U but there were still some very high results – why?

EML 9603 Results

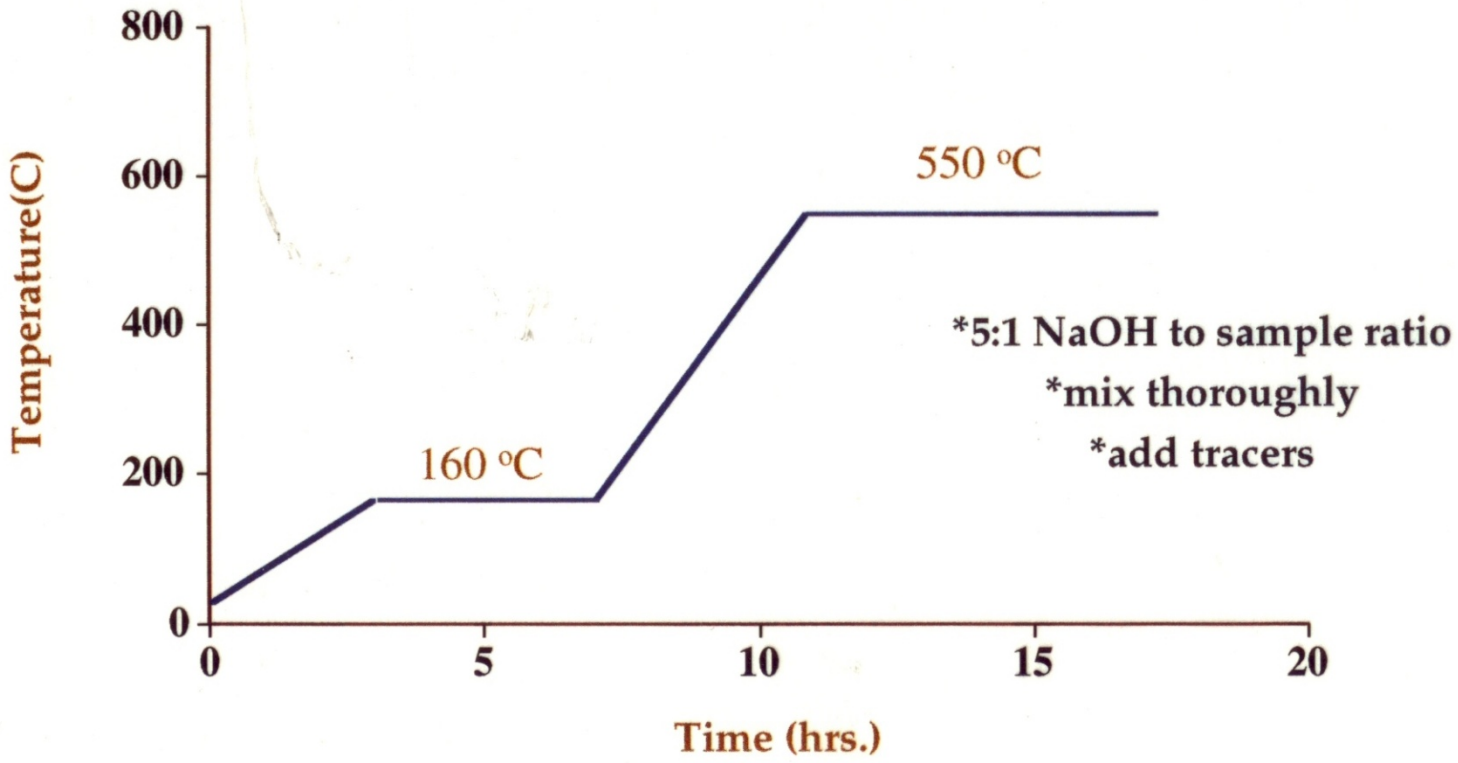


Some time later, the same laboratories were doing much better…

Soil Digestion Techniques



NaOH Fusion


800
600
400
200
0
Temperature(C)
550 °C
160 °C
0
5
10
15
20
Time (hrs.)
*5:1 NaOH to sample ratio
*mix thoroughly
*add tracers

Counting Uncertainties

Count Time Determination to Reach a Certain level of Uncertainty

$$S_{tot} = \frac{\sqrt{R \bullet t}}{R \bullet t} \times 100\%$$

S_{tot} = standard deviation
R = count rate
t = count time

Lower Limit of Detection

$$LLD(Bq/m^3) = \frac{2.71 + 4.66\sqrt{B \bullet T}}{E \bullet V \bullet Y \bullet T \bullet F \bullet I} \bullet \frac{1000}{60}$$

where:

B = background (cpm)
T = count time (min)
E = efficiency
V = volume (liters)
Y = yield
F = fractional intensity
I = ingrowth of radon

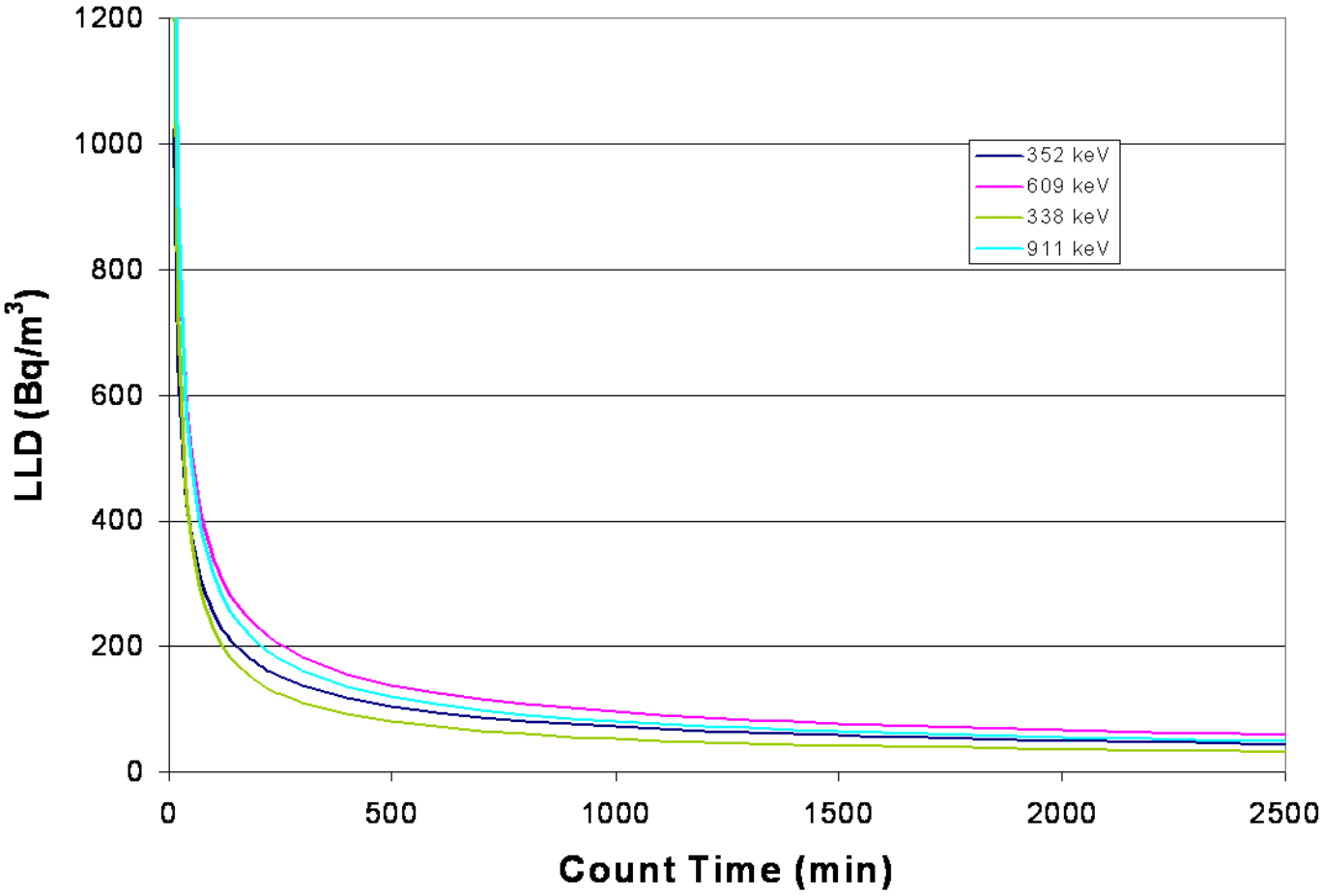
Which parameters can be controlled easily by the analyst?

LLD vs Time

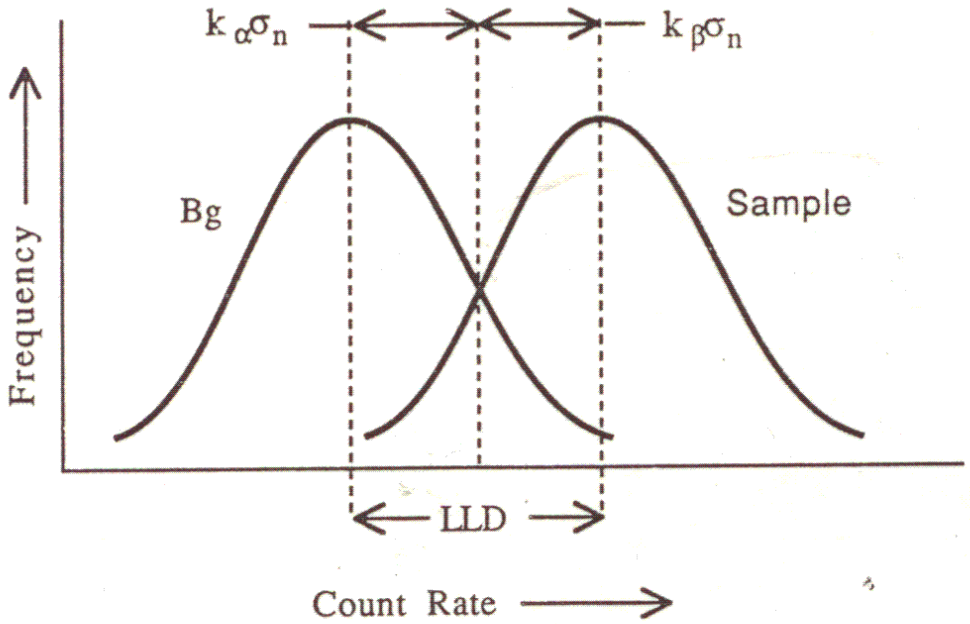
$$LLD(Bq/m^3) = \frac{2.71 + 4.66\sqrt{B \bullet T}}{E \bullet V \bullet Y \bullet T \bullet F \bullet I} \bullet \frac{1000}{60}$$

Assumptions:

- 95% yield
- 2-liter volume
- 88% ingrowth



LLD and Minimum Detectable Activity (MDA)



$$MDA\,(Bq/m^3) = \frac{2.71 + 4.66\sqrt{B \bullet T}}{E \bullet V \bullet Y \bullet T \bullet F \bullet I} \bullet \frac{1000}{60}$$

How does this differ from the LLD??

Other Benefits of Mathematical Embellishment