The Martin Curve

Paraphrasing Tom Trull from the VERTIGO website…*it's the Law, but is it a good Idea?*

$$F_z = F_{100}\left(\frac{z}{100}\right)^{-b}$$

Does it fit the data any better than other functional forms, for instance that proposed by **Lutz et al. (2002)**:

$$F_z = F_{labile}e^{-\left(\frac{D}{W}\right)z} + F_{refrac}$$

If flux attenuation is completely due to in-situ remineralization, then degradation rates of unpoisoned material can be used to estimate sinking rates through comparison of remineralization length (time/space) scales…

define remineralization length scale as e-folding scale (time or depth over which flux changes by 1/e):

The Martin Attenuation Curve is matched with exponential decay to zero, while Lutz Attenuation Curve is matched with exponential decay to a constant.

$$\frac{1}{e} = \frac{F_{100}\left(\frac{z_2}{100}\right)^{-b}}{F_{100}\left(\frac{z_1}{100}\right)^{-b}} = \left(\frac{z_2}{z_1}\right)^{-b}$$

Lutz Curve matches the data better (esp. if you include deep trap data)…but Martin Curve appears to require increasing bulk sinking rates, which is consistent with increasing importance of ballasting biomineral phases.

$$\therefore \frac{z_2}{z_1} = e^{-b}$$

Is Reality somewhere in between?

$$L_{Martin}^{depth} = z_2 - z_1 = z_1\left(e^{-b} - 1\right)$$

$$F = F_{t=0}e^{-kt}$$

$$F_{labile}e^{-kt} + F_{refrac} = F_{labile}e^{-\left(\frac{D}{W}\right)z} + F_{refrac}$$

$$L_{Martin}^{time} = \frac{1}{k}$$

$$\therefore kt = \left(\frac{D}{W}\right)z$$

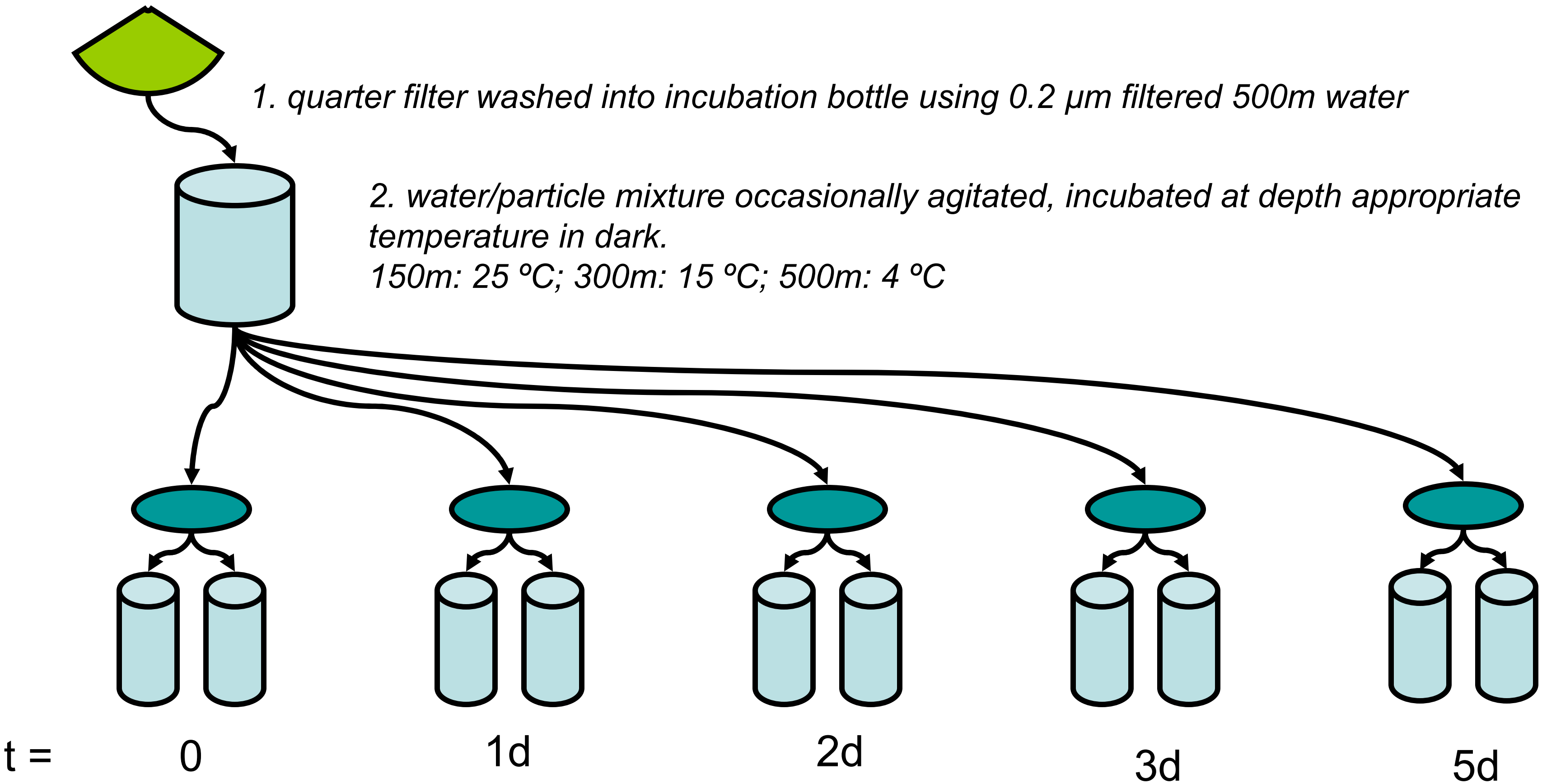
$$S_{Martin} = z_1 k\left(e^{-b} - 1\right)$$

sinking rate accelerates with depth!

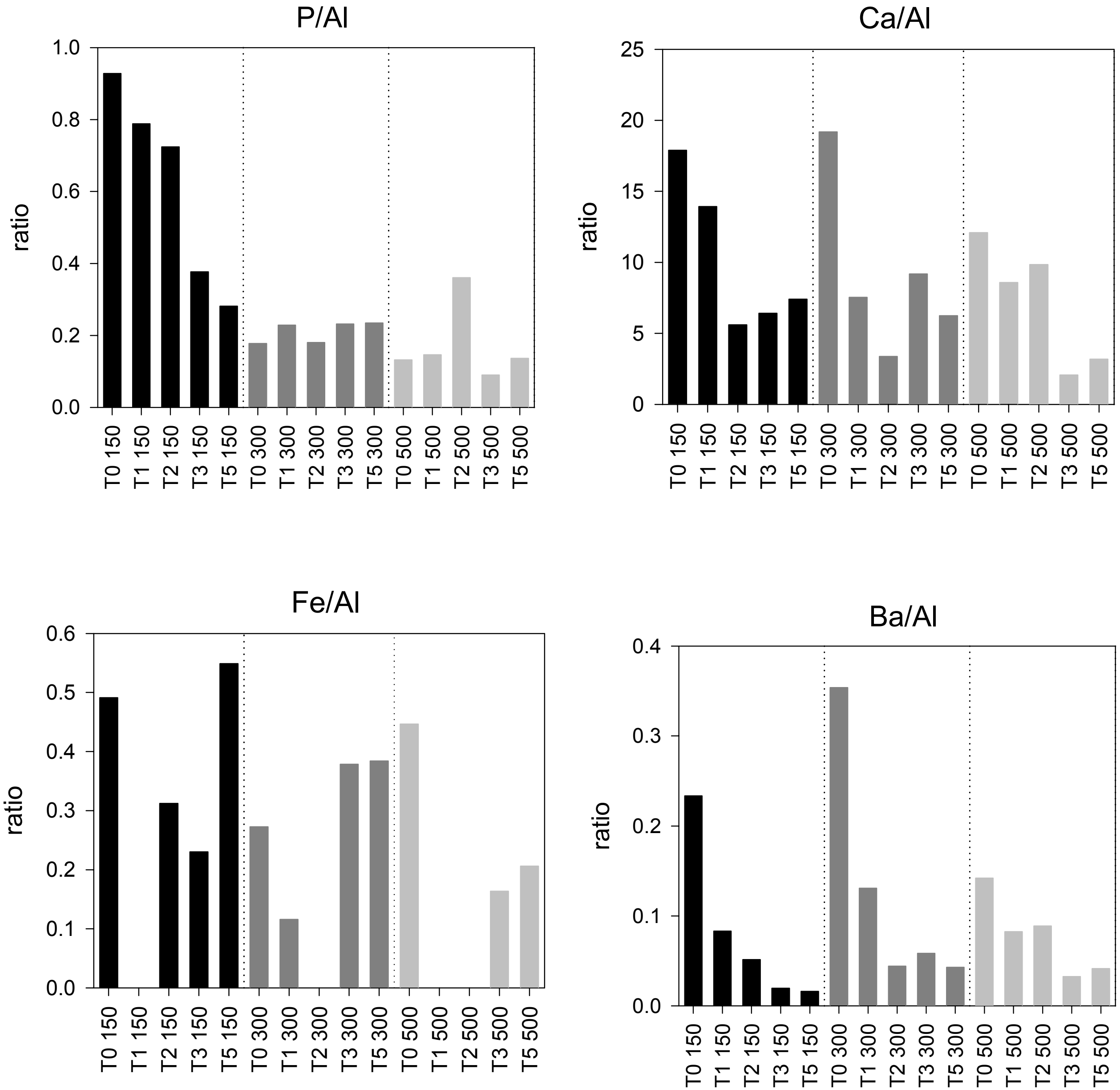
$$S_{Lutz} = \frac{z}{t} = \frac{kW}{D}$$

sinking rate is constant in relation to remineralization

VERTIGO Unpoisoned Particulate Degradation Experiments

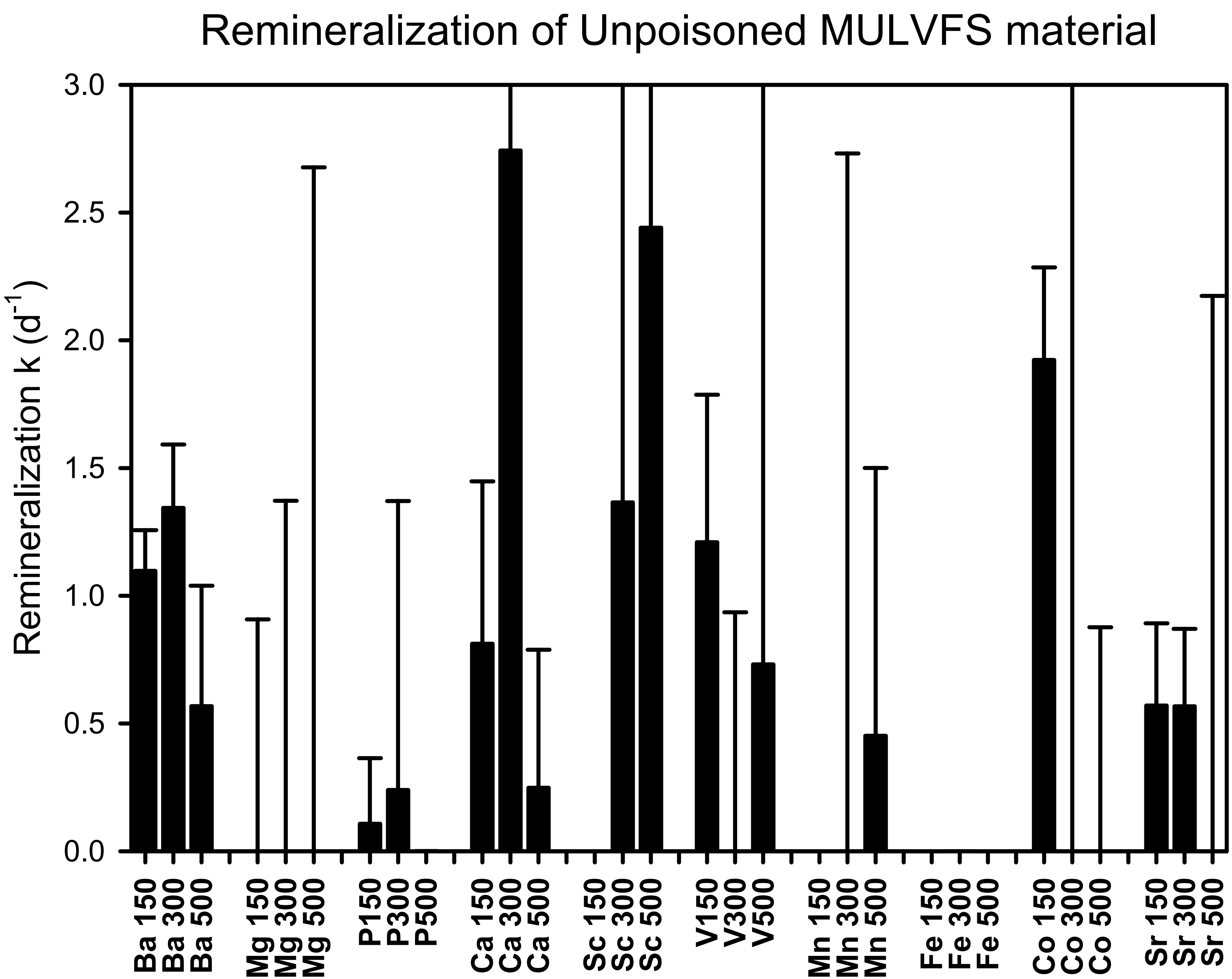


3. at particular times, incubation bottle agitated and aliquot removed by clean syringe. mixture is filtered on 0.2 µm PC, with liquid subsamples going for nitrification experiments ($^{15}NH_4^+$), ICPMS and DOC. filters rinsed and dried for ICPMS. half PC filter washed onto Ag filter for POC.



Unpoisoned Remineralization Rates

More elements showed remineralization in these experiments than in the poisoned experiment, but not all…


Remineralization of Unpoisoned MULVFS material
Remineralization k (d-1)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Ba 150
Ba 300
Ba 500
Mg 150
Mg 300
Mg 500
P150
P300
P500
Ca 150
Ca 300
Ca 500
Sc 150
Sc 300
Sc 500
V150
V300
V500
Mn 150
Mn 300
Mn 500
Fe 150
Fe 300
Fe 500
Co 150
Co 300
Co 500
Sr 150
Sr 300
Sr 500

Sinking Rates for Comparison of Remineralization Rates and Attenuation Lengths (deployment 1)

Element	Apparent sinking Rate (m d^{-1})
Ba	114 - 233
Mg	slow - 294
Al	undefined
P	14 - 43
Ca	51- fast
Sc	fast
Mn	slow
Fe	fast
Co	Slow - 107
Ni	undefined - slow
Sr	77 - 219

For elements where attenuation and remineralization both seen, the analysis suggests sinking rates comparable to those observed directly…remineralization can explain the vertical profiles!

For the others, analysis suggests constrained fast or slow rates…either approach is breaking down or perhaps other factor important (particle type, grazing)

slow=attenuation in flux profile seen, but little remineralization on 5 day timescale.

fast=vertical profile doesn't show much attenuation, but some remineralization seen.

Martin, Lutz give comparable results.