Case studies at different depths

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Today ..nothing really new…from the point of view of theory

but I wanted to get a better feeling for the different mechanisms via some case studies

We have shown previously that the method of interest for us for dating is the **min/max method**

The min/max method
in two lines without formulae

The **min** is given assuming **no postburial production** on the quarz grain

The **max** is given by assuming **maximum postburial production** on the quarz grain

The **min method** in a couple of more words and still without formulae

The **minimum** is given by assuming **no postburial production** on the quarz grain

Why?

Post burial production will increase the Al/Be ratio making the sample look younger than it is and if we don't correct for post burial we get the youngest possible age, thus minimum age.

To relate the measured Al/ Be ratio to a burial age we then need to know the Al/Be inherited ratio thus the ratio before burial.

Thus the min age is basically determined by the production rate at the surface which is completely dominated by the production initiated by cosmic neutrons

The min is given by the neutron spectra at the surface

The **max method** in a couple of more words and without formulae

Postburial production increases the Al/Be ratio on the quarz grain and makes it look younger than it is.

We measure the post burial production by measuring the μ -flux in the cavern.

However we don't know if the overburden has been the same since burial.

The over burden might have been bigger at burial and eroded after burial which thus would have given less post burial production since burial relative the assumption of constant overburden

Thus by assuming no erosion after burial we get max postburial production which corresponds to the maximum age.

The max is thus given by measuring the muon flux in the cave and at the surface

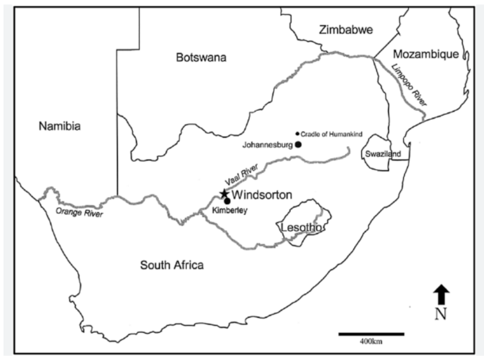
Today I want to illustrate the min/max method with a couple of case studies at different depths

Three examples with different depths

Carstic dolomite

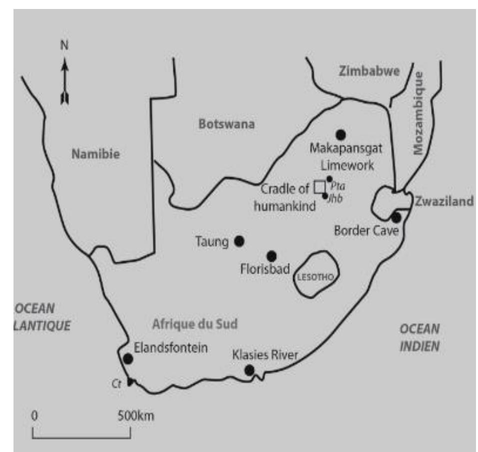
Vertical overburden about 6 m
and using density 2.1 g/cm3
Thus we assume 1260g/cm2
of overburden

1) Rising Star 105 Amphi theather shallow
Nominal depth 6 m or ***1260 g/cm2***
Input data: Tebogo



2) Windsorton pit 5
Nominal depth 15 m or ***2850 g/cm2***
Input data: granger 2014 table 4 and 5

ρ=1.9 g/cm3



3) Rising Star 105 deep
Nominal depth 30 m or ***6300g/cm2***
Input data:Tebogo

I start with Windsorton pit 5 and here below the relevant data for Windsorton pit 5

Table 4 Cosmogenic nuclide data and minimum burial age for Windsorton Pit 5

Sample	$[^{10}Be]^a$ ($\times 10^6$ at g^{-1})	$[^{26}Al]$ ($\times 10^6$ at g^{-1})	N^*_{10} ($\times 10^{-3}$)	N^*_{26} ($\times 10^{-3}$)	*Minimum age (Ma)*
Pit 5	0.364 ± 0.015	1.26 ± 0.11	21.5 ± 0.9	21.3 ± 1.9	1.35 ± 0.21

Adjusted for local production rates of 8.45 and 57.4 at g^{-1} $year^{-1}$.
[a]Normalized against standard 07KNSTD.

Table 5 Postburial production and maximum burial age for Windsorton Pit 5

Sample	*Depth (m)*	$P_{26,\ pb}$ (at g^{-1} $year^{-1}$)	$P_{10,\ pb}$ (at g^{-1} $year^{-1}$)	$N_{26,\ pb}$ ($\times 10^6$ at g^{-1})	$N_{10,\ pb}$ ($\times 10^6$ at g^{-1})	*Maximum age (Ma)*
Pit 5	15	0.150	0.022	0.117	0.017	1.46 ± 0.21

Assuming overburden density 1.9 g cm^{-3}.

These values are the same as I get with my program based on the different equations from Granger 2014

min 1.35 Ma
max 1.46 Ma
Δ=0.011 Ma or 7.5 % of the max value

Rising Star 105 Amphi theather shallow

Sediment from cave insitu samples								Simple Burial	
Sample ID	True samp	N10	σN10	N26	σN26	26Al/10Be	σ26Al/10Be	Age (Ma)	+/- (Ma)
TM-5	AEW4C	7.12E+05	1.86E+04	3.99E+06	2.31E+05	5.60	0.06	0.33	0.05
TM-14	AEW2C1	7.88E+05	2.09E+04	2.09E+06	2.64E+05	2.65	0.13	1.74	0.34
TM-16	AEW2C1	7.84E+05	1.99E+04	1.69E+06	1.40E+05	2.16	0.09	2.13	0.36
TM-18	AEW5C	8.88E+05	2.41E+04	3.50E+06	1.74E+05	3.94	0.06	0.98	0.15

I use the sample TM-14 and I get

min 1.62 Ma
max 1.70 Ma

Δ=0.08 Ma or 4.7 % of the max value

Also note importance of p-values used in the calculation. Here I have used the values of Be from Granger 2014 and multiplied with 6.8 to get p-values for Al

Tebogo use another set of p-values and get Min =1.74 Ma and the result of min is outside the range above….

A good reason for us to measure…….

Rising Star 105 Deep

Sediment from blocks prepared for fossil recovery							
Sample ID	True sample nam	N10	σN10	N26	σN26	26Al/10Be	σ26Al/10Be
TM-4	UW105B008	6.39E+05	1.76E+04	1.72E+06	1.28E+05	2.69	0.08
TM-11	UW105B005	5.81E+05	1.41E+04	8.81E+05	1.26E+05	1.52	0.14
TM-13	UW105B002	5.20E+05	1.71E+04	3.95E+05	9.81E+04	0.76	0.25
TM-15	UW105B007	6.40E+05	2.14E+04	1.01E+06	1.97E+05	1.58	0.20
TM-17	UW105B004	5.52E+05	1.52E+04	1.03E+06	1.10E+05	1.87	0.11

I use the sample TM-4 and I get

min 1.65 Ma
max 1.67Ma

Δ=0.02 Ma or 1.2 % of the max value

..to be consistent…

I want to see how the difference max- min vary with depth…

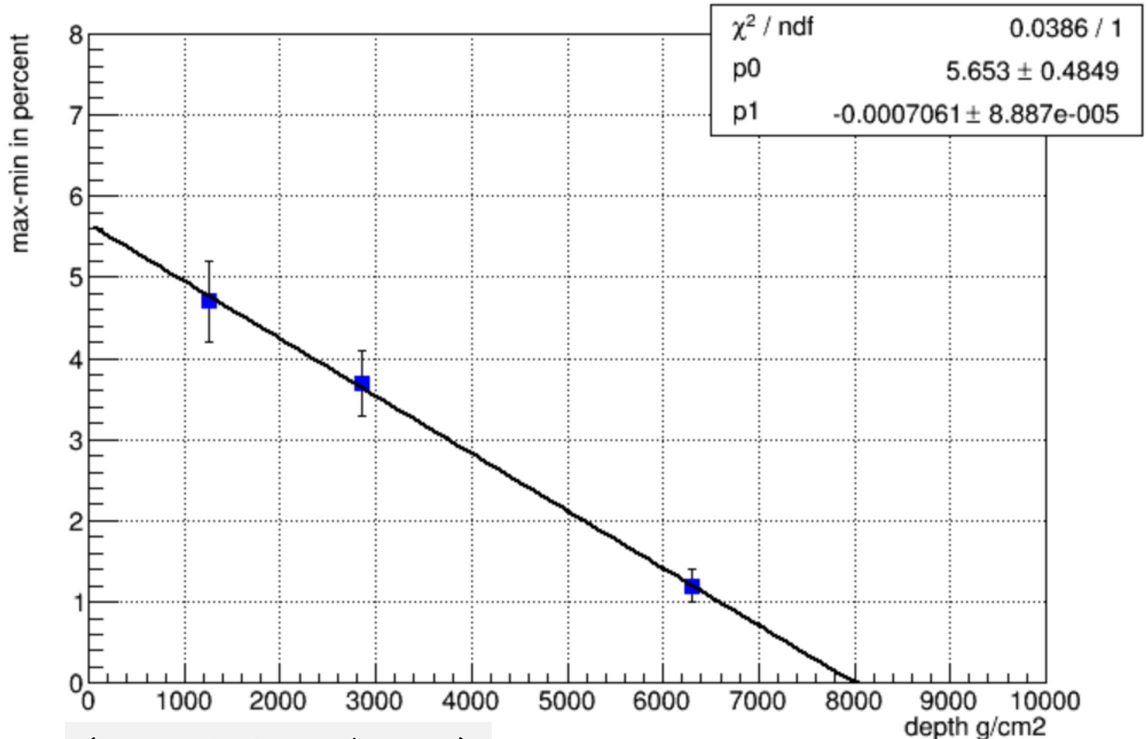
To get a coherent picture I need to use the same p-values for all three cases…instead of the recommended values

Instead of using the recommended p-value for Windsorton pit 5
I use the p-values I have used for Rising star 105 also for Windsorton.
to get a coherent picture

min 1.35 Ma becomes 1.29 Ma
max 1.46 Ma becomes 1.34Ma

Δ=0.05 Ma or 3.7% of the max value

Putting the three together and plotting….



(uncertainties ..arbitrary)

Conclusion 1

The deeper the cave is …the smaller is the difference between the min and the max….this is of course due to the fact the post burial production diminish with depth

At a depth of about 8000 g/cm2 i.e. about 38 m for carstic dolomite there is no difference between min and max

…but not the whole story….

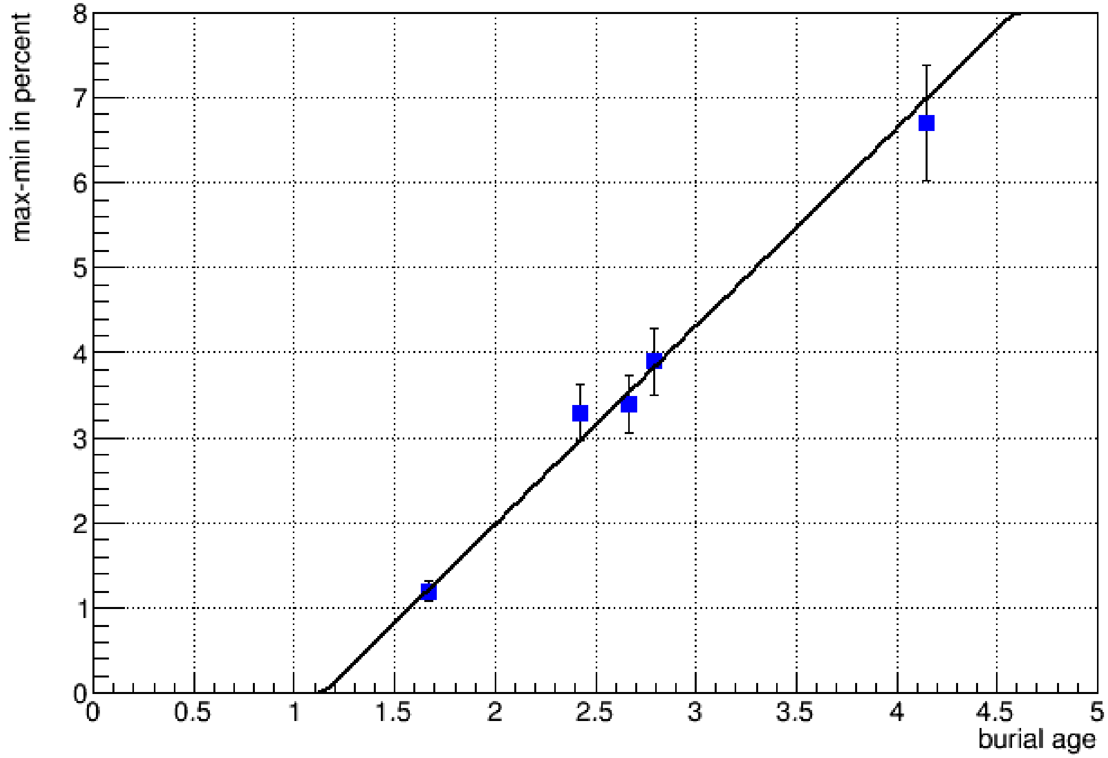
what happens for a given depth with samples of different age ?

take Rising Star 105 Deep as an example

Sediment from blocks prepared for fossil recovery							
Sample ID	True sample nam	N10	σN10	N26	σN26	26Al/10Be	σ26Al/10Be
TM-4	UW105B008	6.39E+05	1.76E+04	1.72E+06	1.28E+05	2.69	0.08
TM-11	UW105B005	5.81E+05	1.41E+04	8.81E+05	1.26E+05	1.52	0.14
TM-13	UW105B002	5.20E+05	1.71E+04	3.95E+05	9.81E+04	0.76	0.25
TM-15	UW105B007	6.40E+05	2.14E+04	1.01E+06	1.97E+05	1.58	0.20
TM-17	UW105B004	5.52E+05	1.52E+04	1.03E+06	1.10E+05	1.87	0.11

Sample	Max-min MA	Max burial age MA	max-min in % of max
TM-4	0.02	1.67	1.2
TM-11	0.11	2.79	3.9
TM-13	0.28	4.15	6.7
TM-15	0.09	2.67	3.4
TM-17	0.08	2.42	3.3

...and plotting



I think this reflect the fact at with greater burial age there is more post-burial production

Conclusion 2

The difference between max and min is not only determined by the depth but also on the age of the buried sample

Conclusion

No real conclusion

I just wanted to play with the formulae and see how things work at different depths and for different samples

Back up