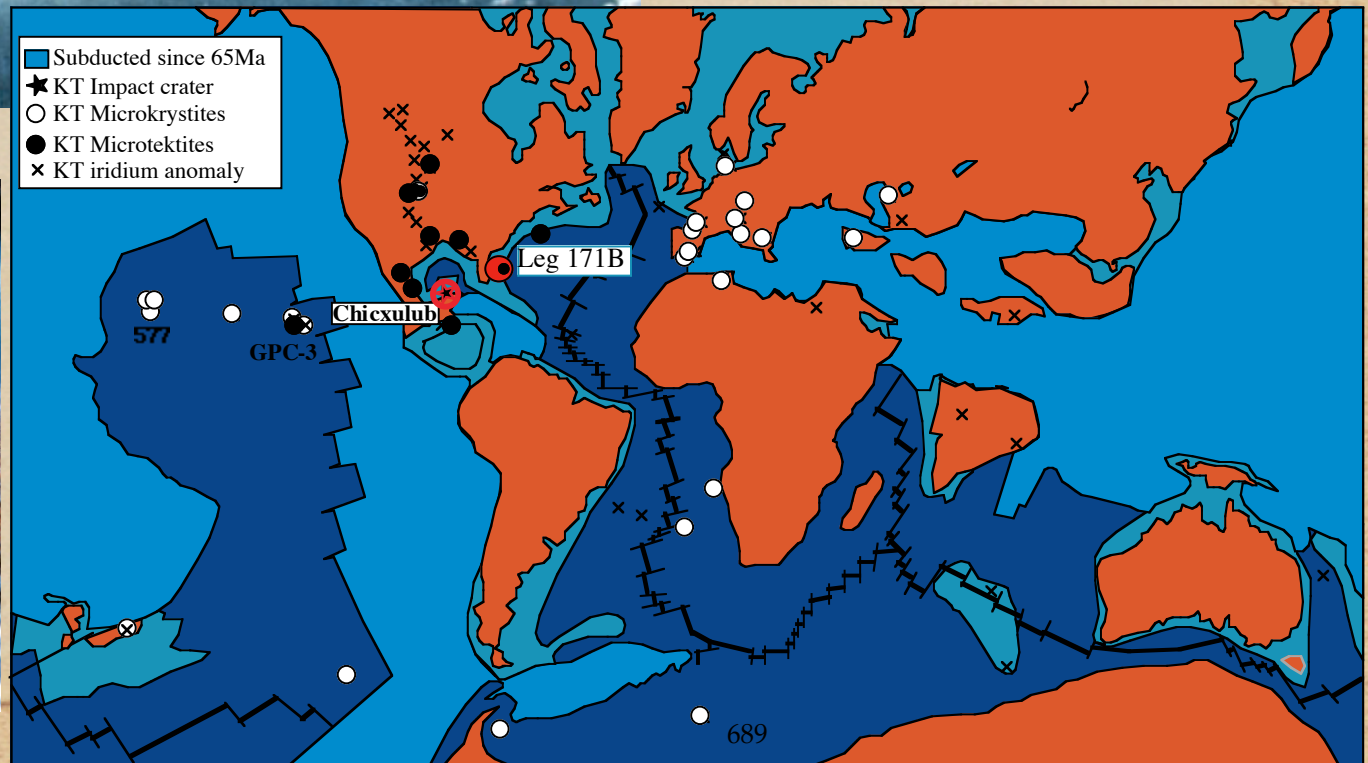
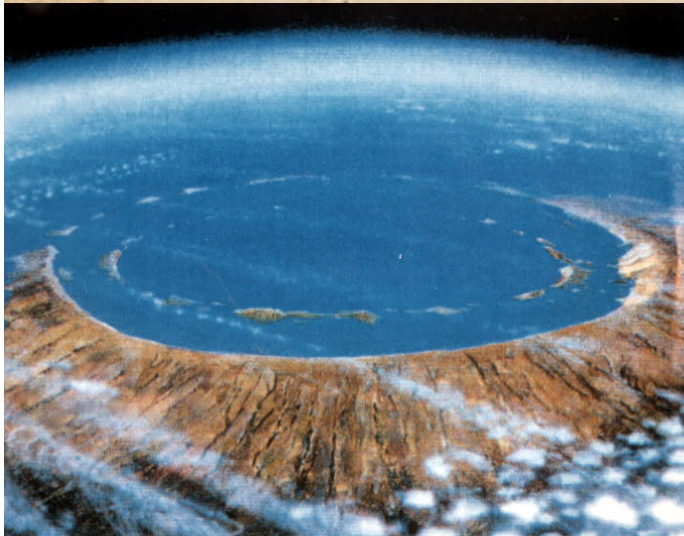


De Krijt-Tertiair grens: In en Uit de Chicxulub krater



Op 2000m diepte in de voormalige Tethys oceaan.....

Tertiary

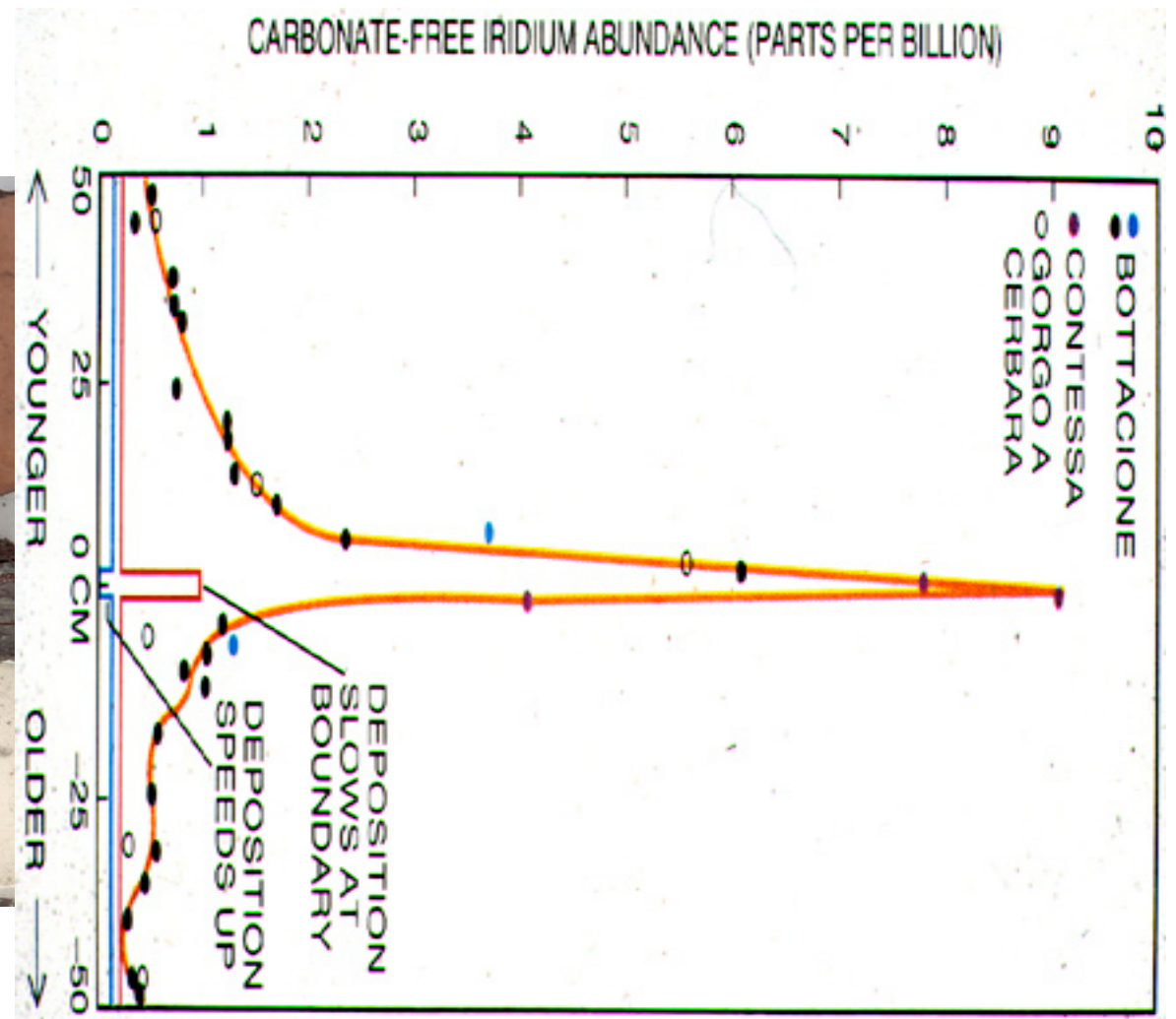
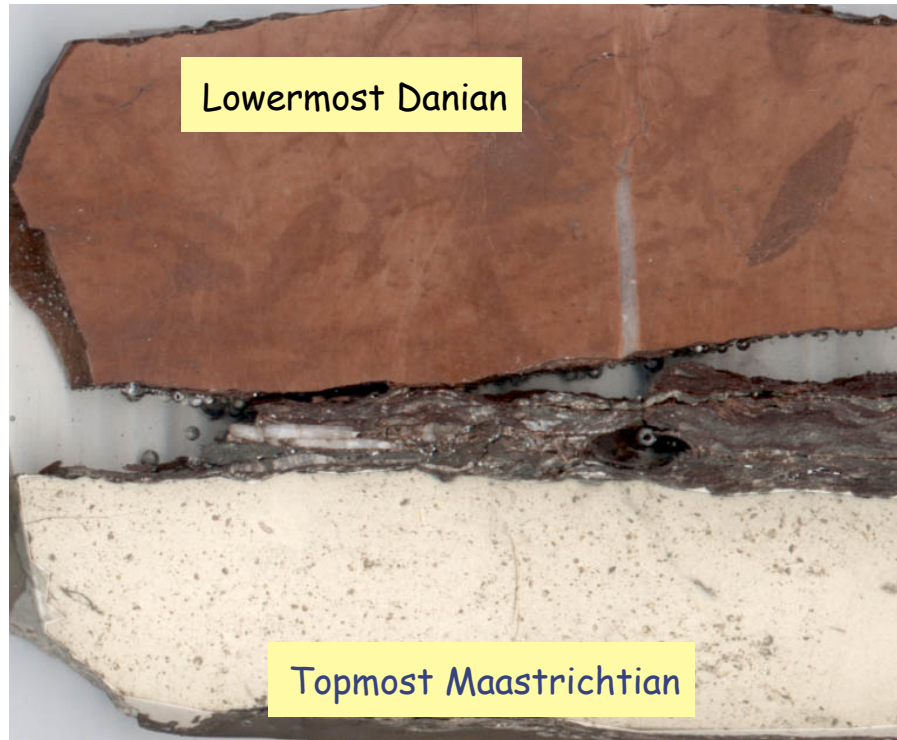
Cretaceous



Gola del Bottacione, near Gubbio, Italy

Wat gebeurde er op de Krijt-Tertiair grens in de Oceaan?

K/T grens in de Valle della Contessa near Gubbio



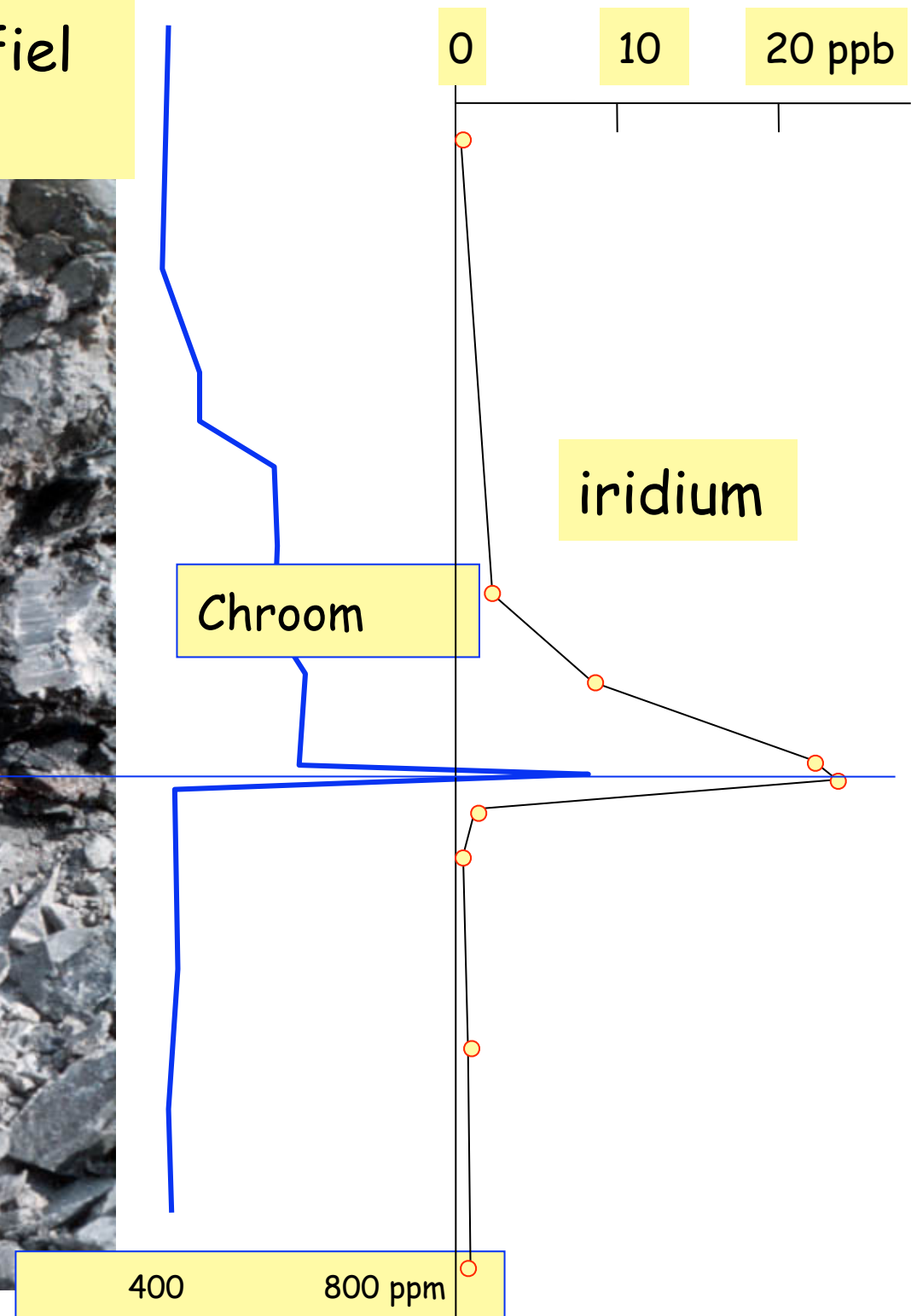
Iridium anomalie Gubbio, Italie

Agost en Caravaca, Spanje: veel meer detail



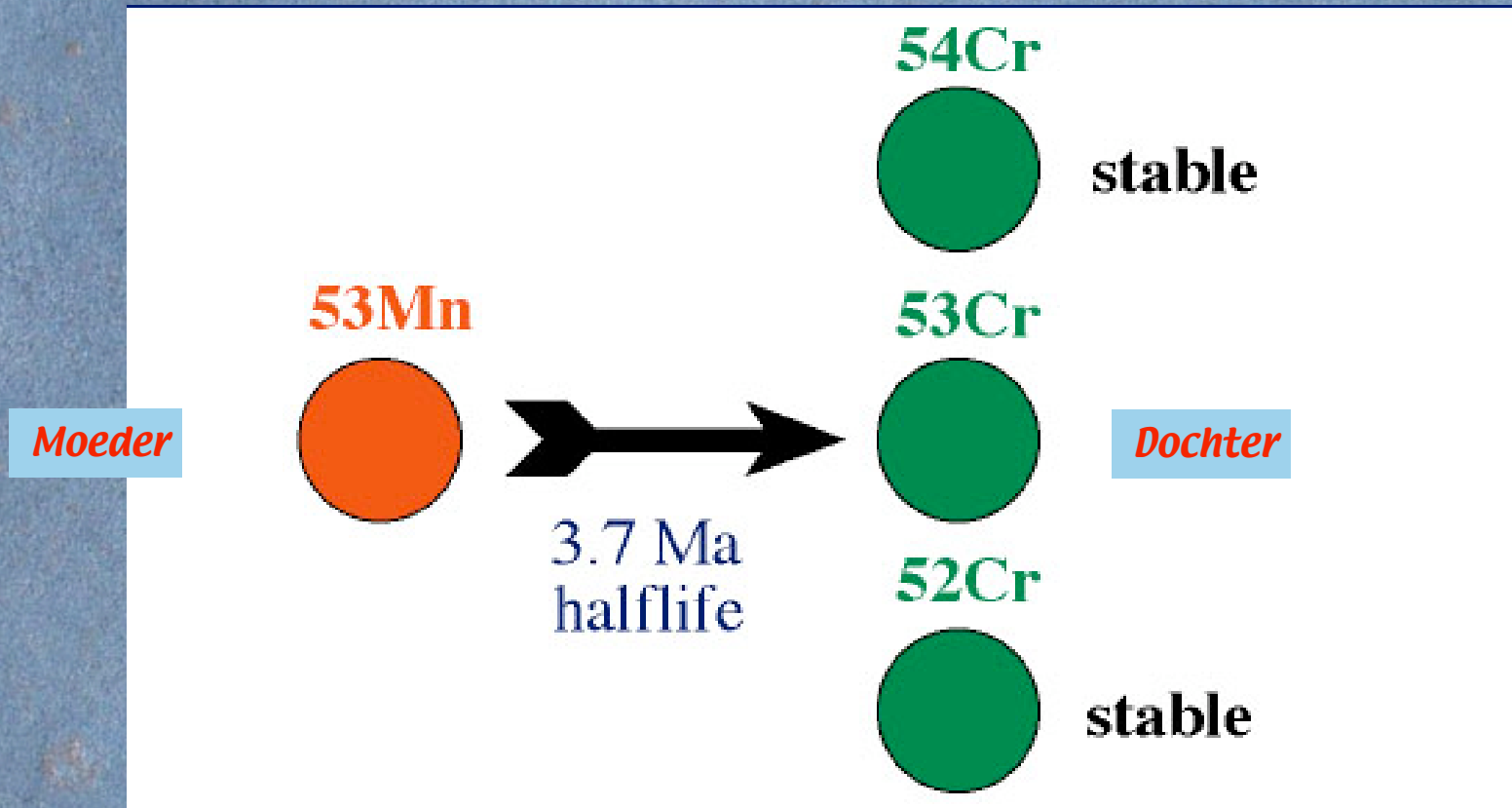
Caravaca, Spain Iridium profile

(J. Hertogen and F. Asaro, 1979)



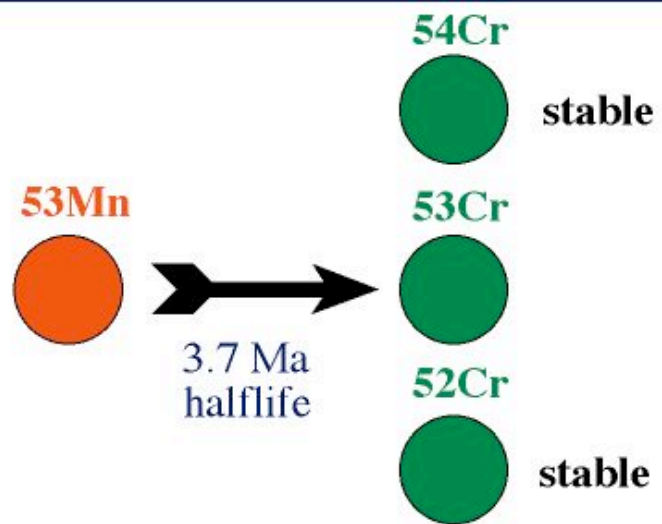
Chondrites (CM, CV, H, L, LL, E) 4.21 +/- 0.76 Ga
Carbonaceous chondrites 4.37 +/- 0.34 Ga
Eucrites (polymict) 4.53 +/- 0.19 Ga
Eucrites 4.44 +/- 0.30 Ga
Diogenites 4.45 +/- 0.18 Ga
Iron (plus iron from St. Severin) 4.57 +/- 0.21 Ga (=Giga annum of Miljard Jaar)

Chroom isotopen

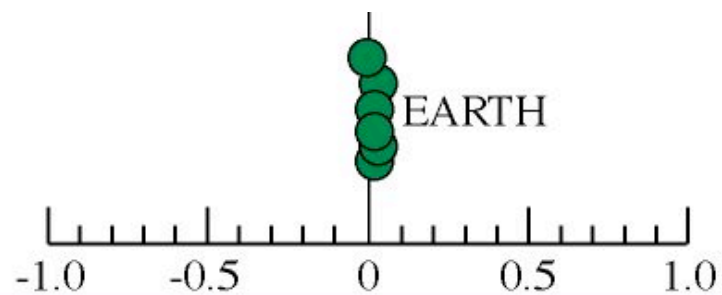


*Na 37 miljoen jaar is alle ^{53}Mn vervallen naar ^{53}Cr
D.W.Z dat (de aarde is 4550 miljoen jaar oud) 4515 miljoen jaar geleden
Alle ^{53}Mn verdwenen is.*

Chroom isotopen

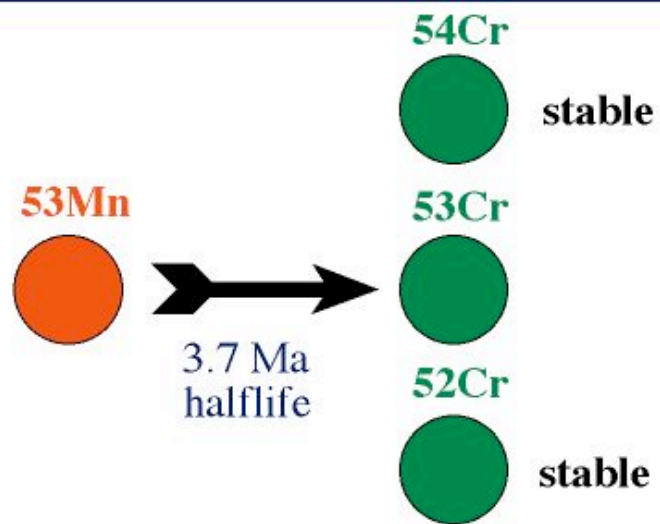


$\epsilon^{53}\text{Cr}$

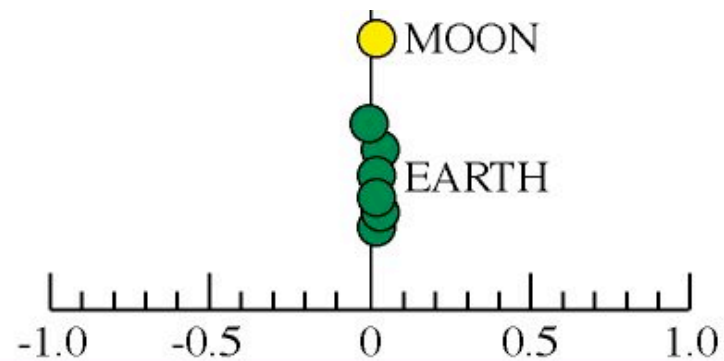


*Op de aarde is de chroom isotopen
Verhouding overal hetzelfde*

Chroom isotopen



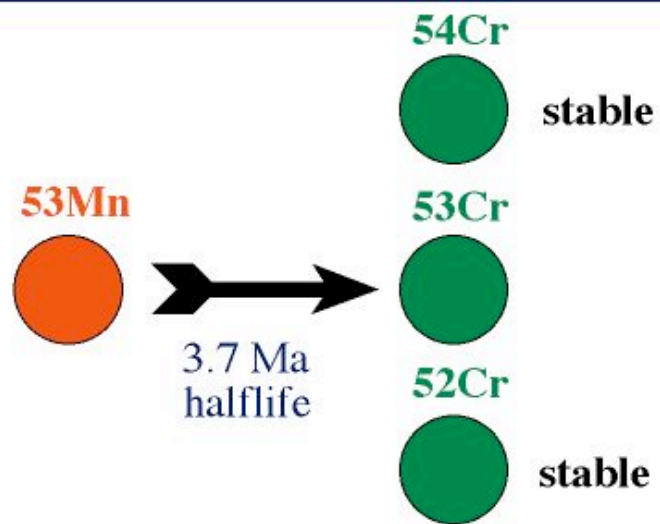
$\epsilon^{53}\text{Cr}$



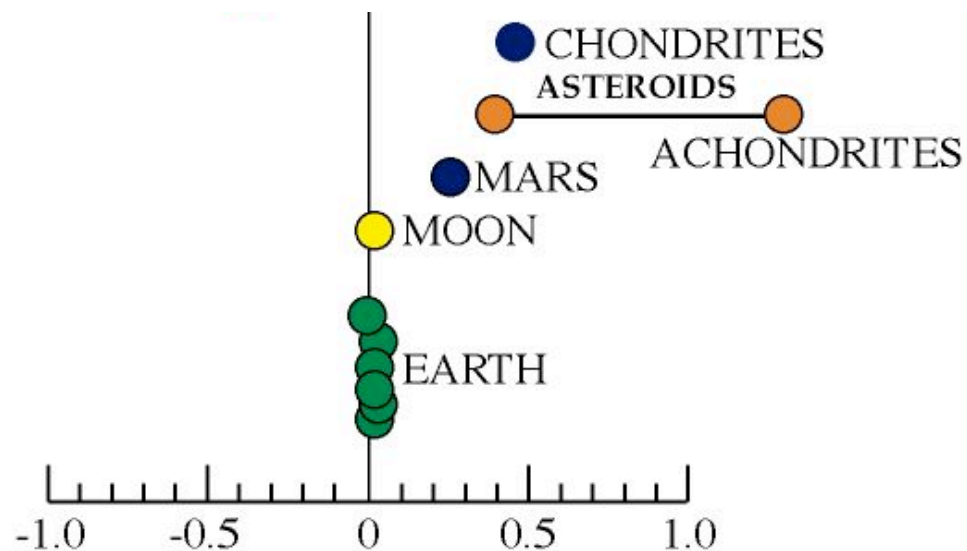
*De Maan heeft precies
dezelfde verhouding!*

*Op de aarde is de chroom isotopen
Verhouding overal hetzelfde*

Chroom isotopen



$\epsilon^{53}\text{Cr}$

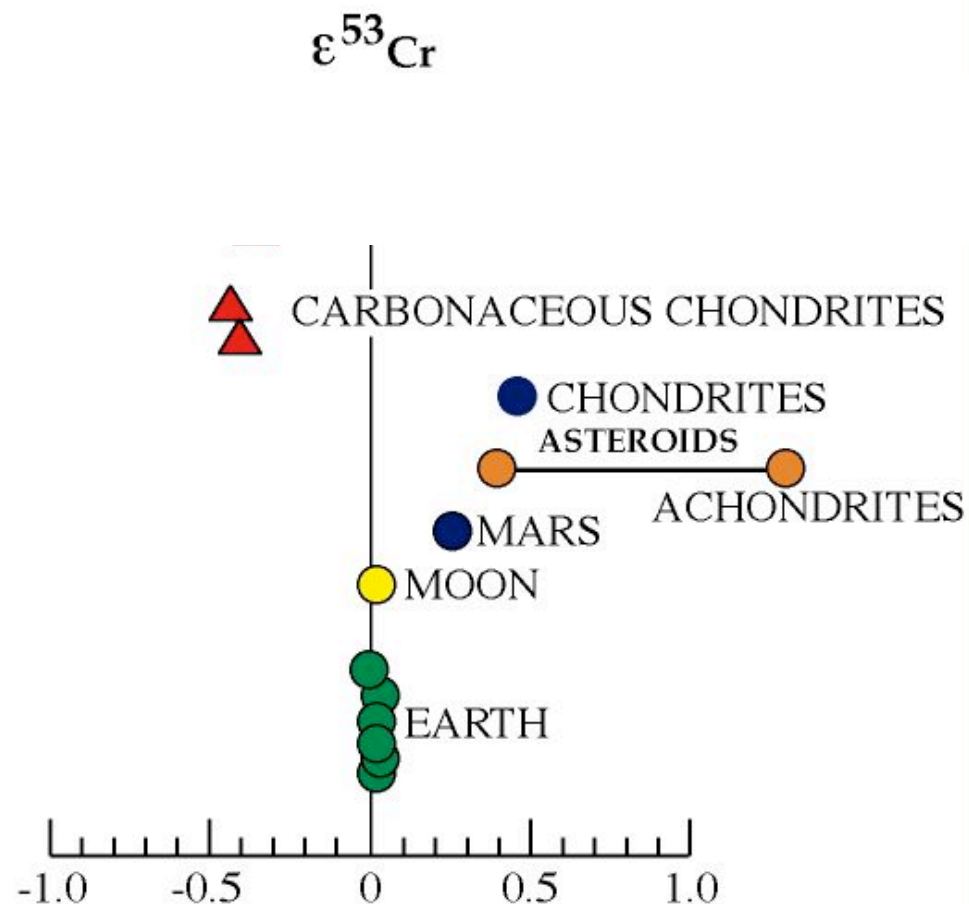
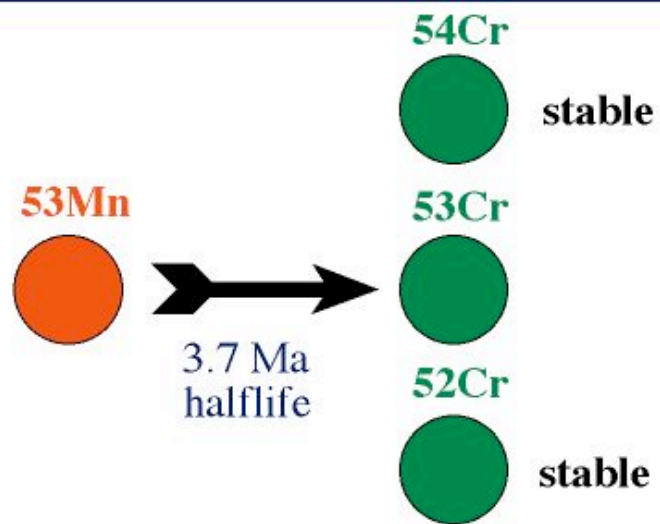


Op Mars en de asteroiden is de $\epsilon^{53}\text{Cr}$ Hoger

De Maan heeft precies dezelfde verhouding!

Op de aarde is de chroom isotopen Verhouding overal hetzelfde

Chroom isotopen



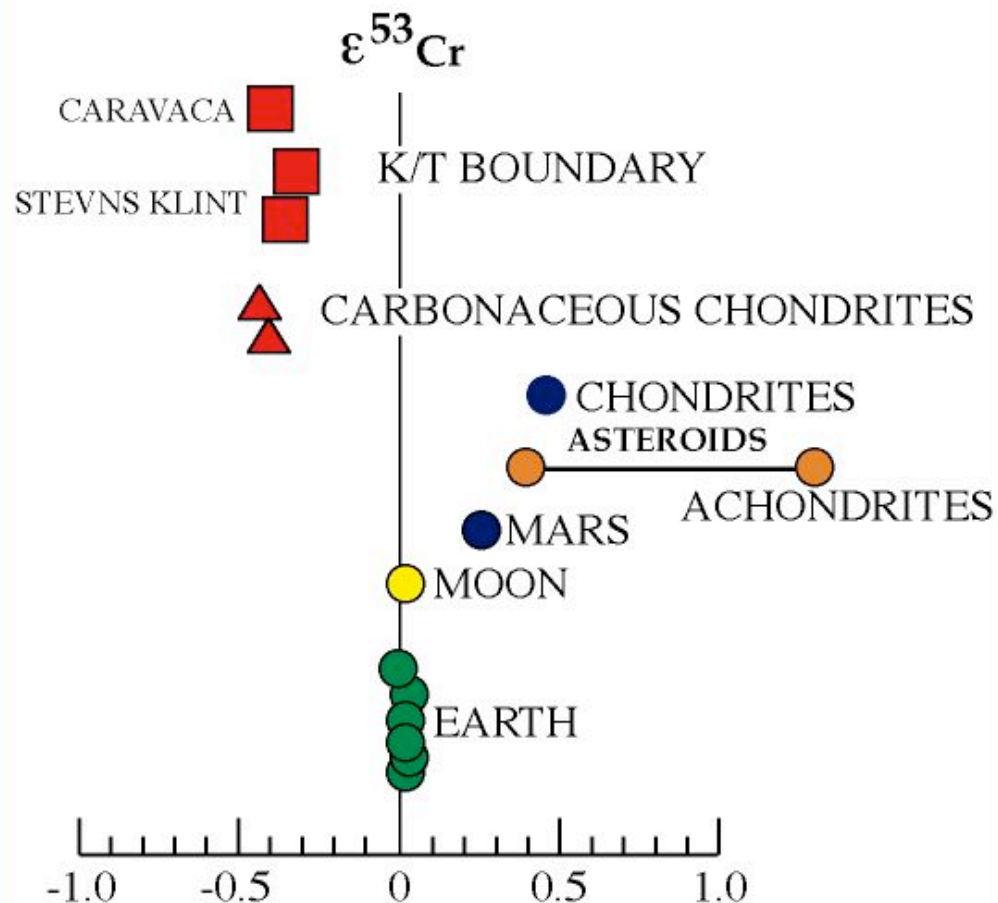
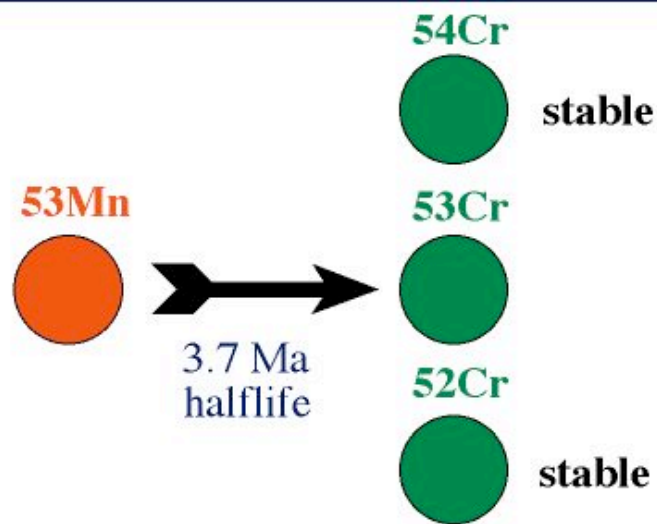
*Maar in Koolstof chondrieten
(=Verwant aan kometen) is de $\epsilon^{53}\text{Cr}$
Juist lager!*

*Op Mars en de asteroiden is de $\epsilon^{53}\text{Cr}$
Hoger*

*De Maan heeft precies
dezelfde verhouding!*

*Op de aarde is de chroom isotopen
Verhouding overal hetzelfde*

Chroom isotopen

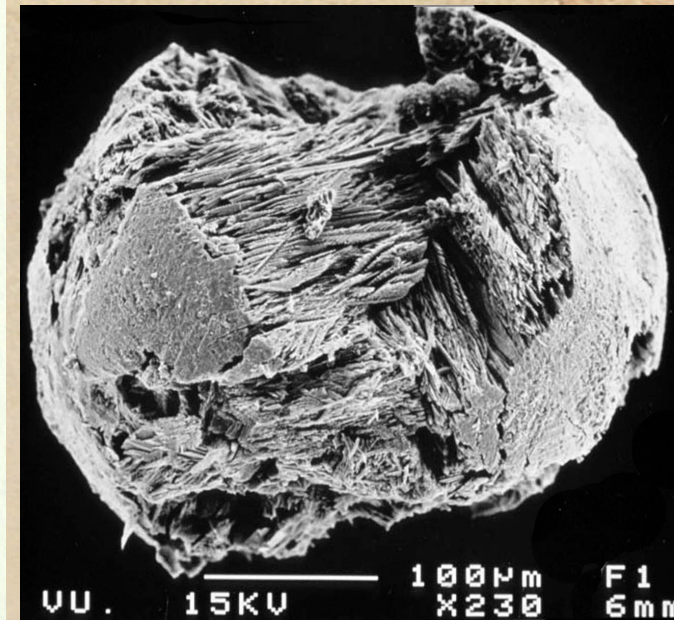
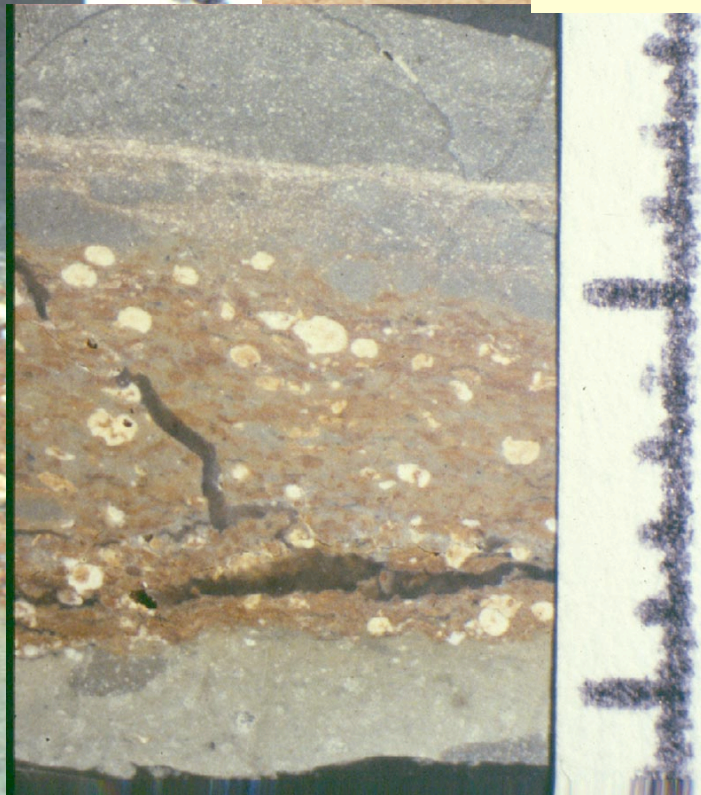
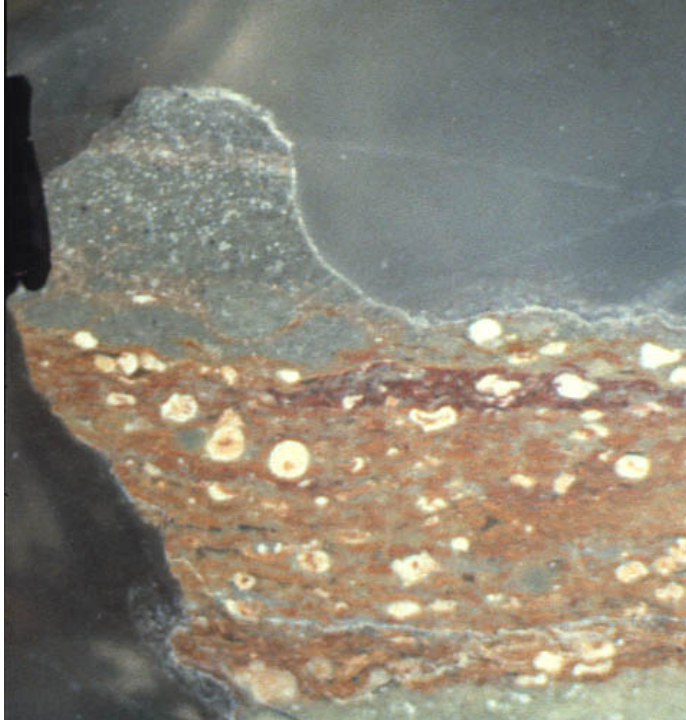


In de Krijt Tertiair ejectalaag is de $\epsilon^{53}\text{Cr}$ verhouding eveneens hoger

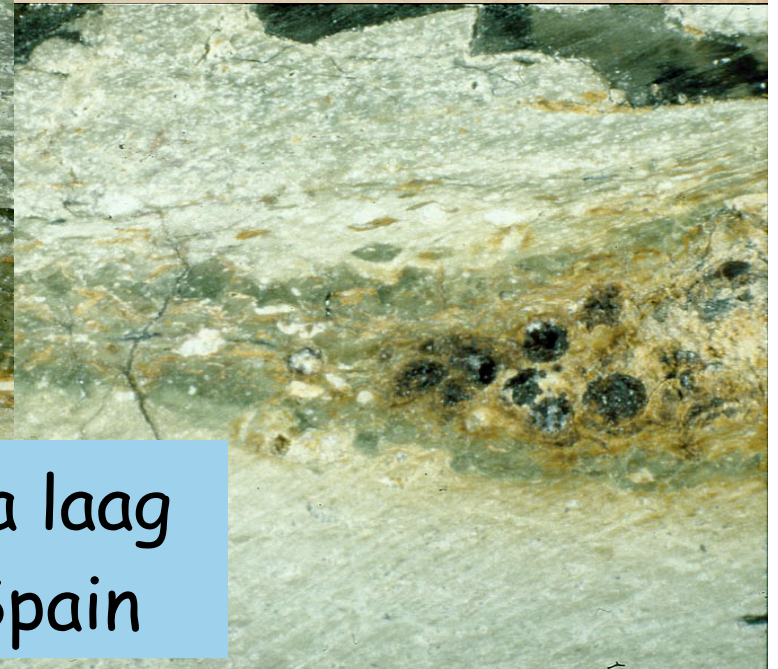
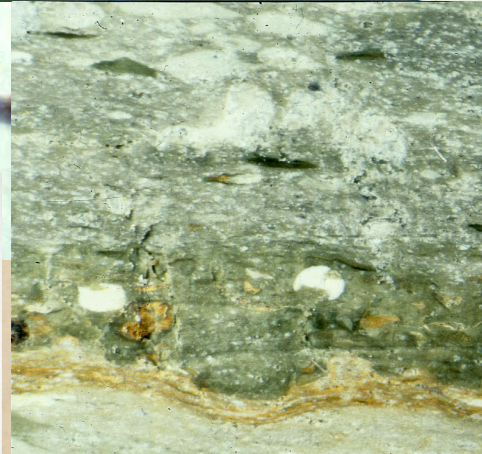
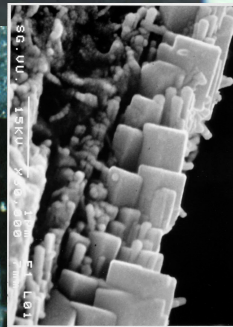
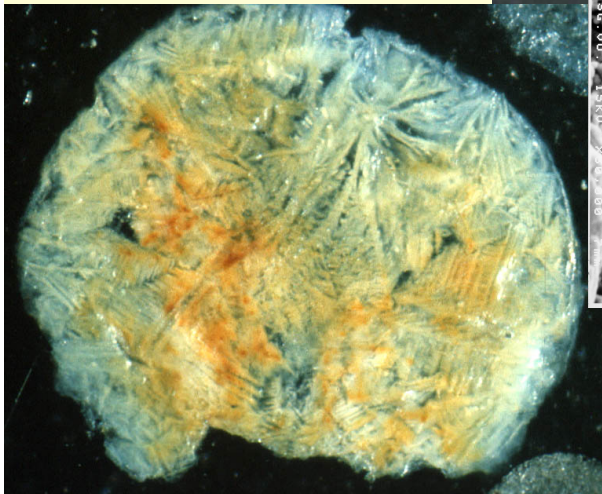
*Maar in Koolstof chondrieten (=Verwant aan kometen) is de $\epsilon^{53}\text{Cr}$ juist lager!
Op Mars en de asteroiden is de $\epsilon^{53}\text{Cr}$ Hoger*

De Maan heeft precies dezelfde verhouding!

Op de aarde is de chroom isotopen Verhouding overal hetzelfde



KT ejecta
laag
Caravaca,

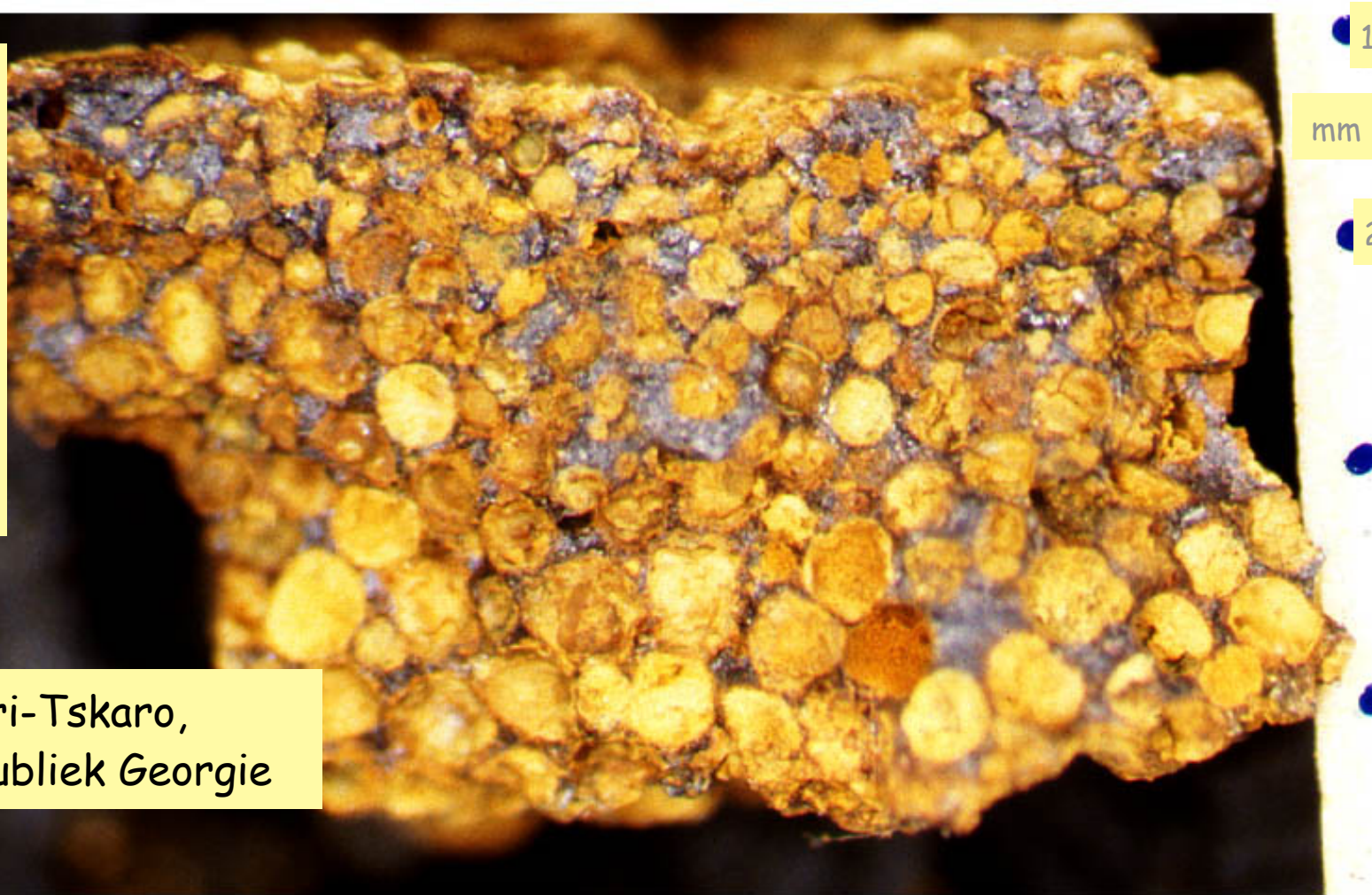


KT ejecta laag
Agost, Spain

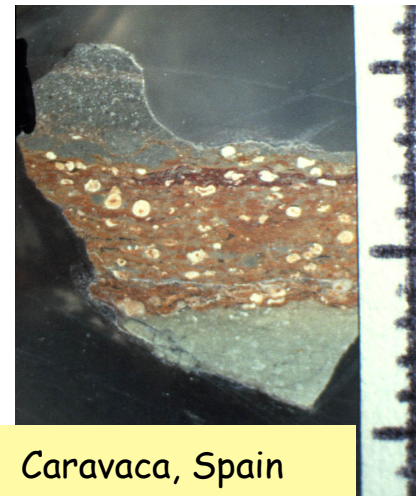
Microkrystieten:
(bolletjes)

verspreid over de
wereld:

4.59×10^{18} gr
(800km³)



Tetri-Tskaro,
Republiek Georgie

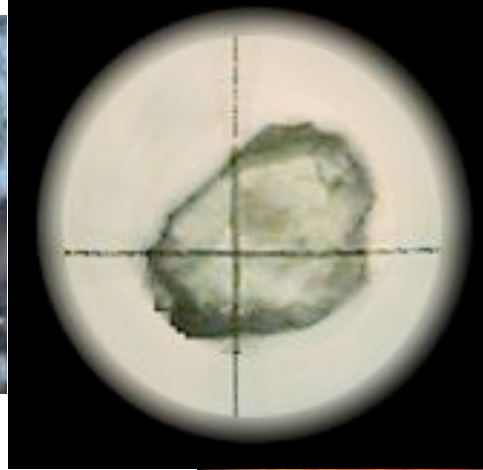
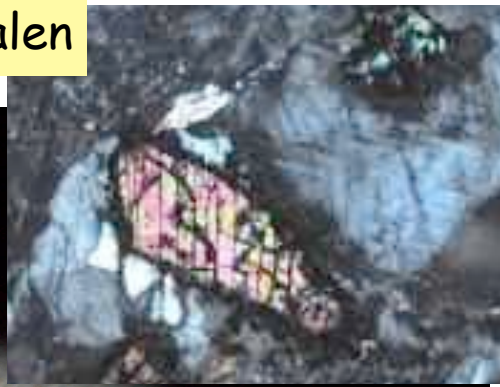


Caravaca, Spain



Zumaya, Spain

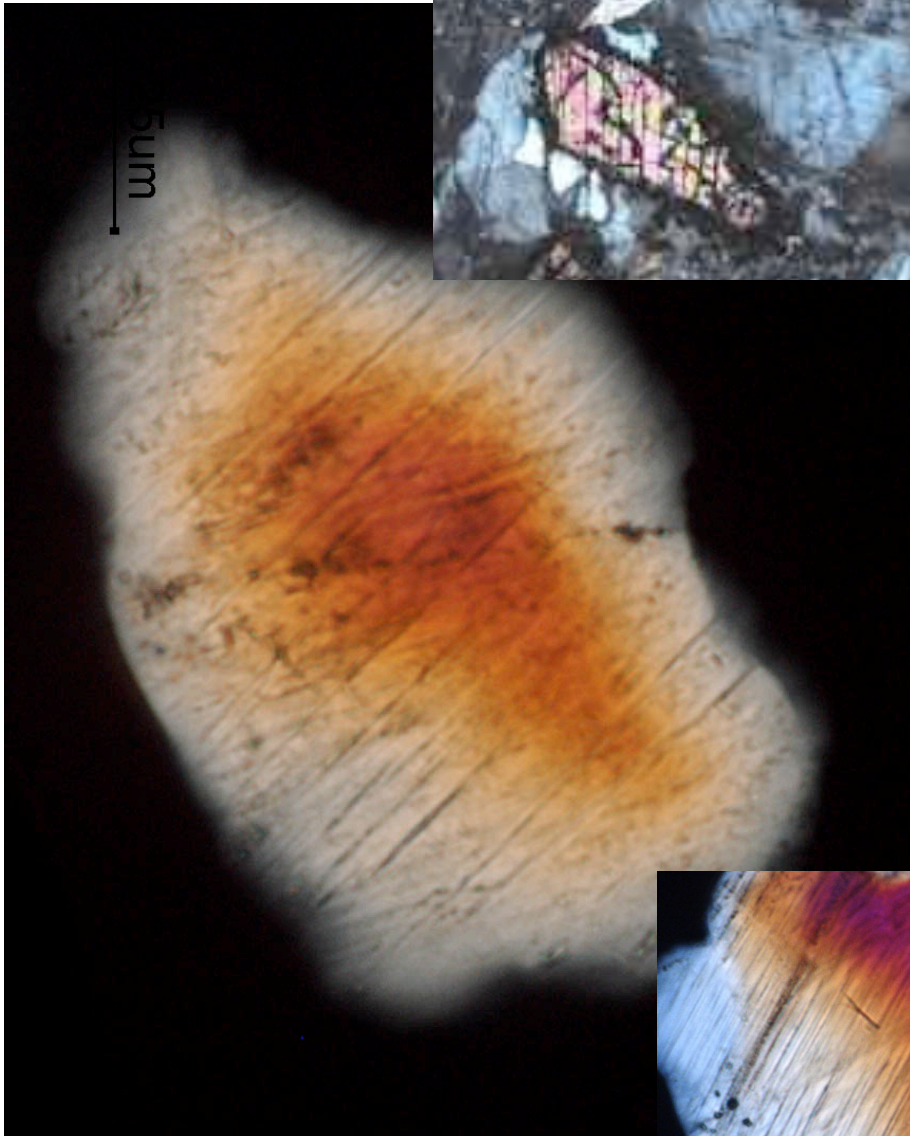
geschokte mineralen



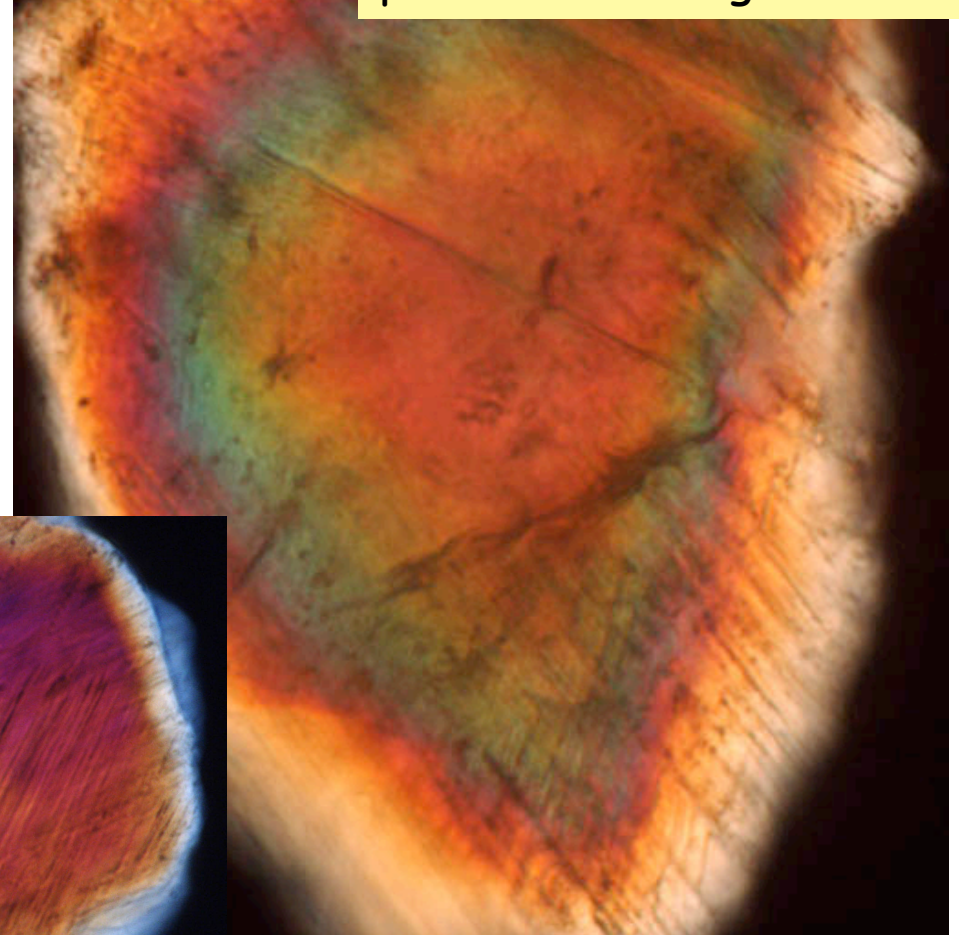
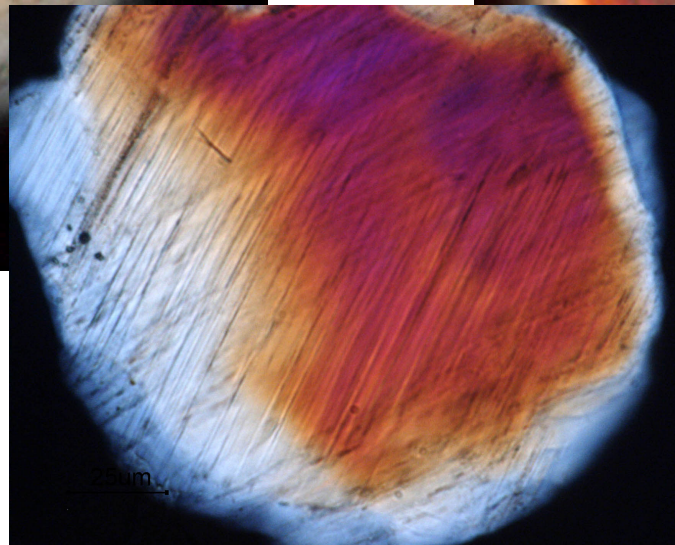
geschokte Zirconen
2 ouderdommen:

65Ma 'schok ouderdom'

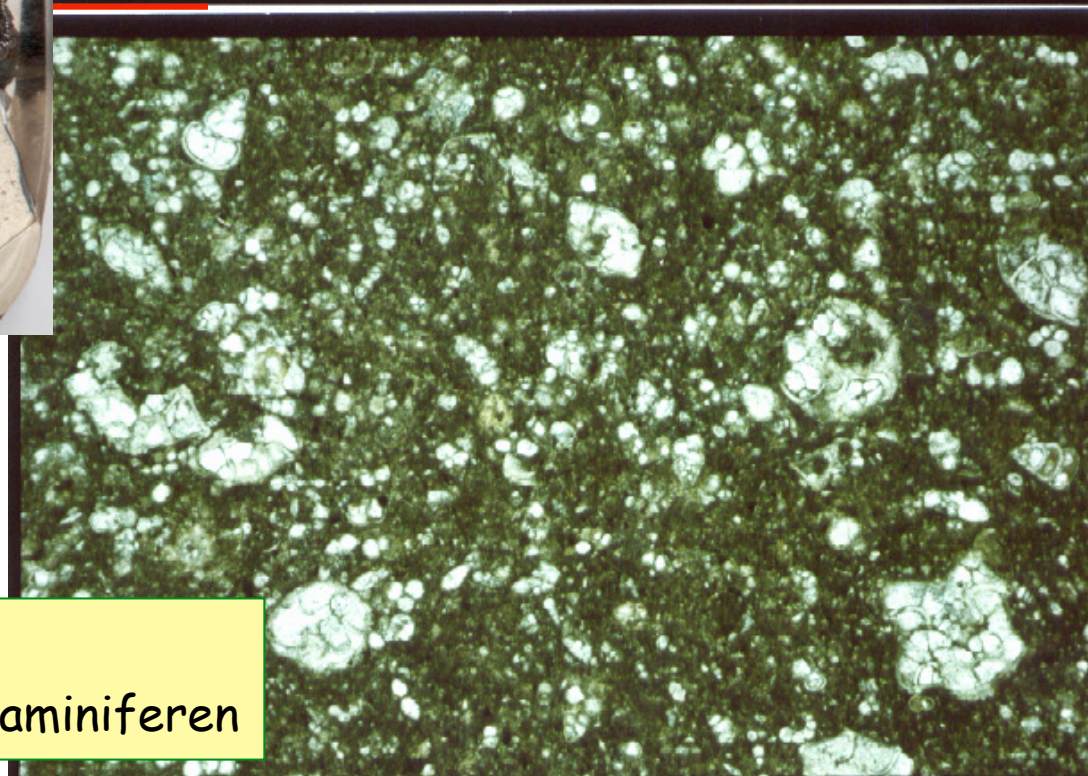
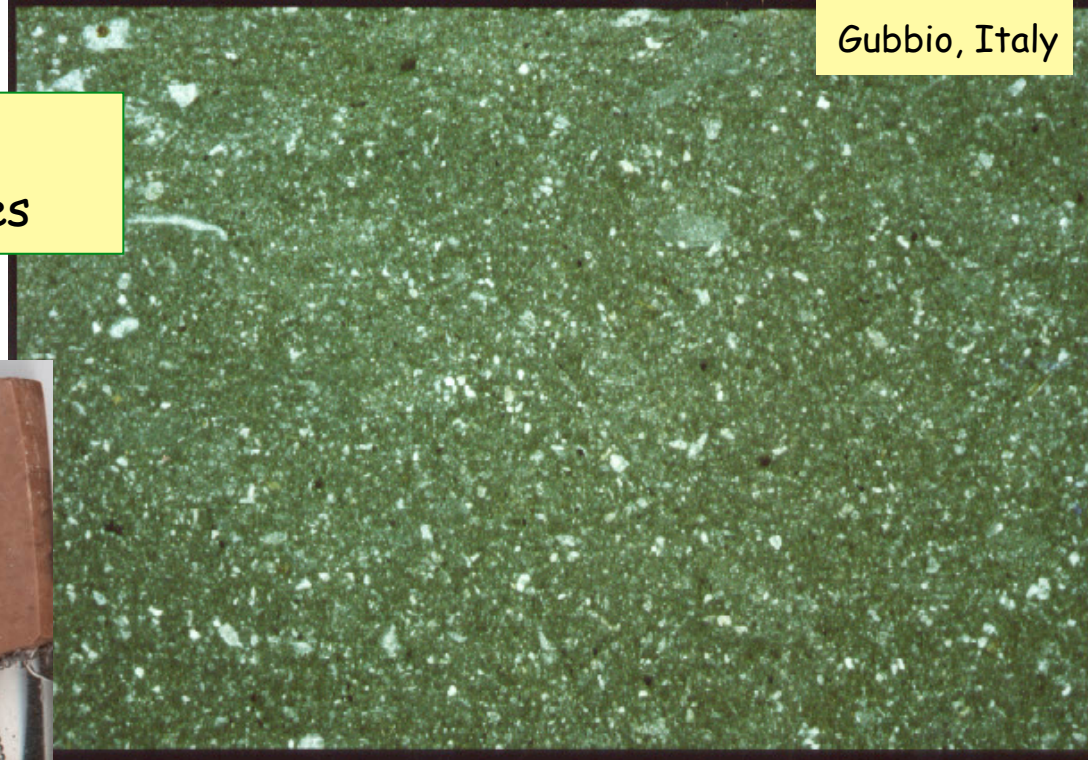
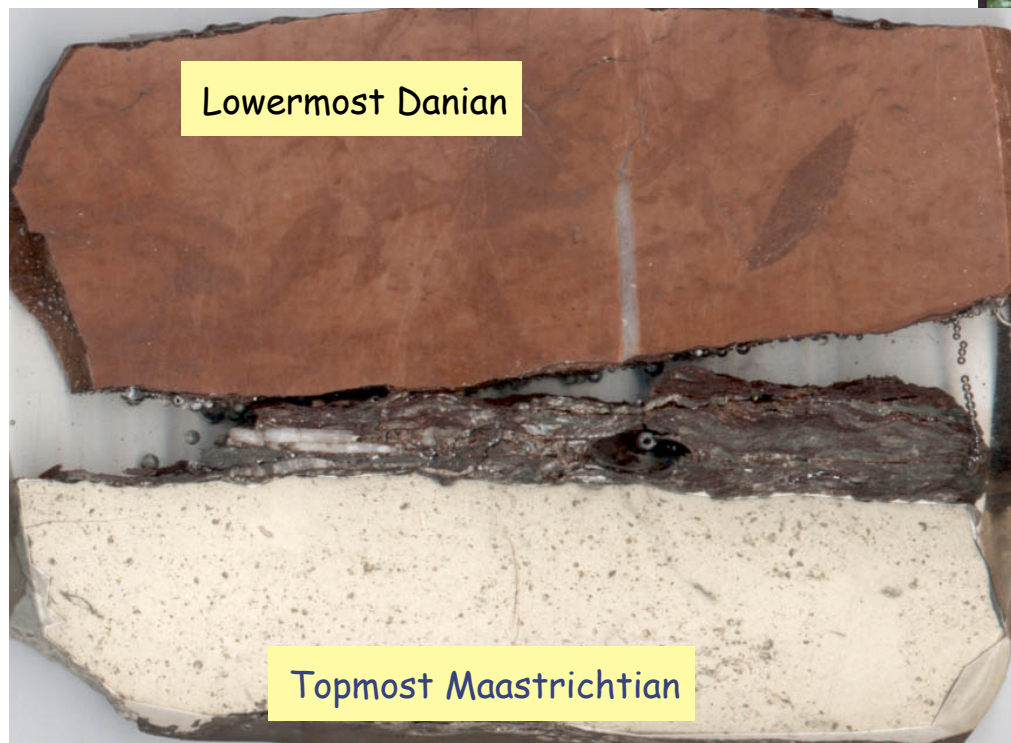
400Ma ouderdom van de
plaats van Inslag



Geschokte kwarts
(from Brownie Butte
Montana)

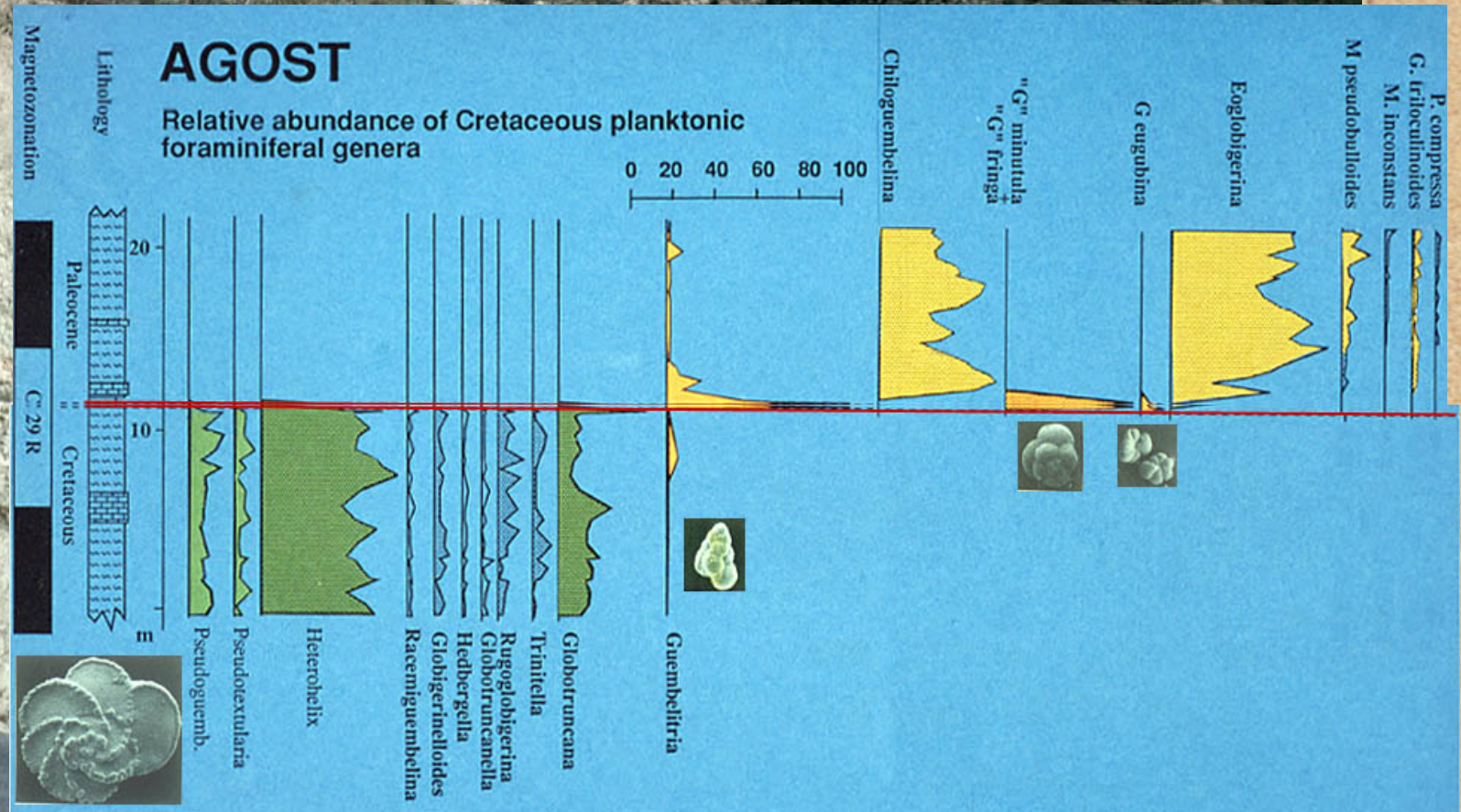


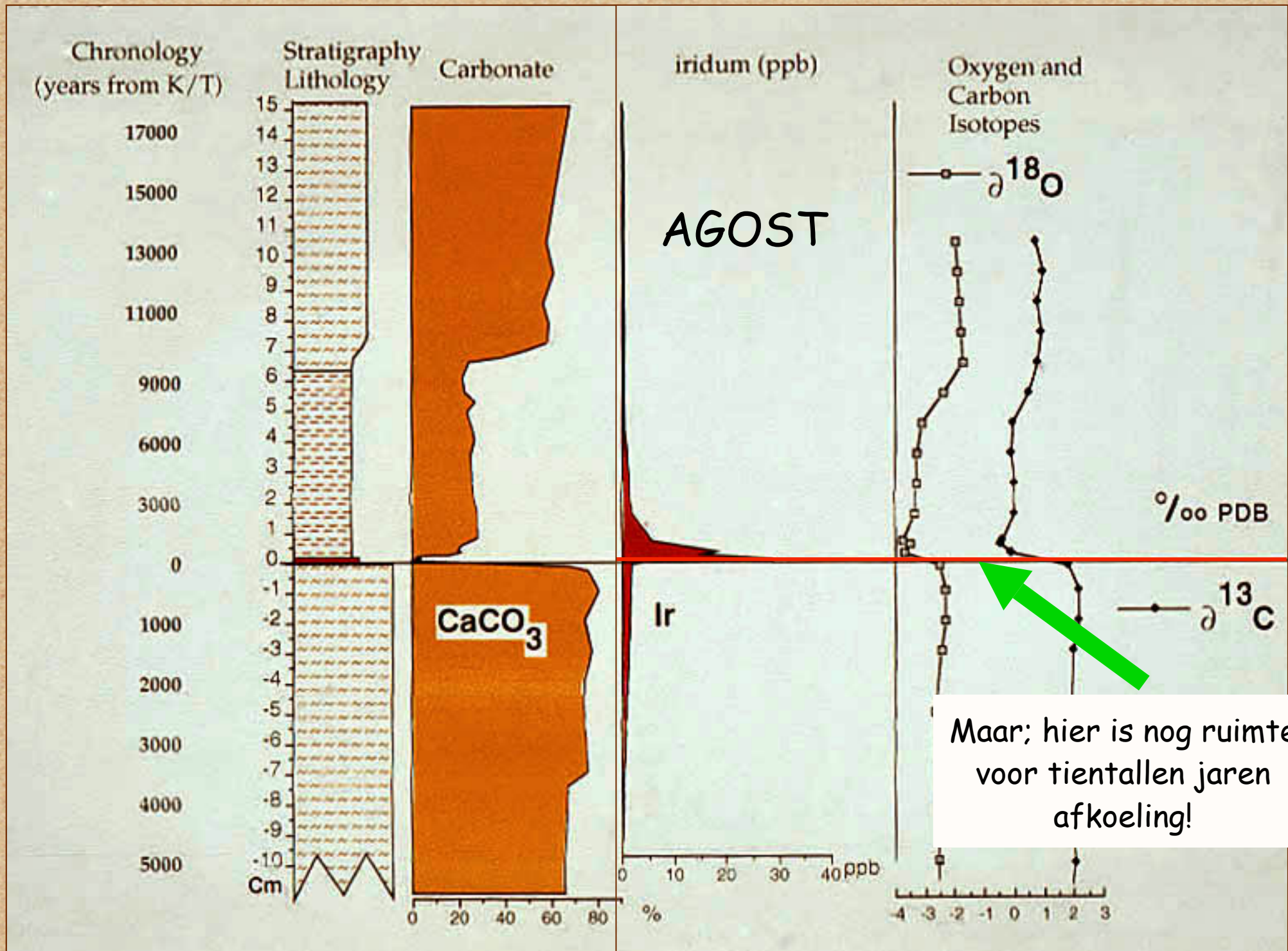
Onderste Tertiair:
slechts uiterst kleine foraminifeertjes



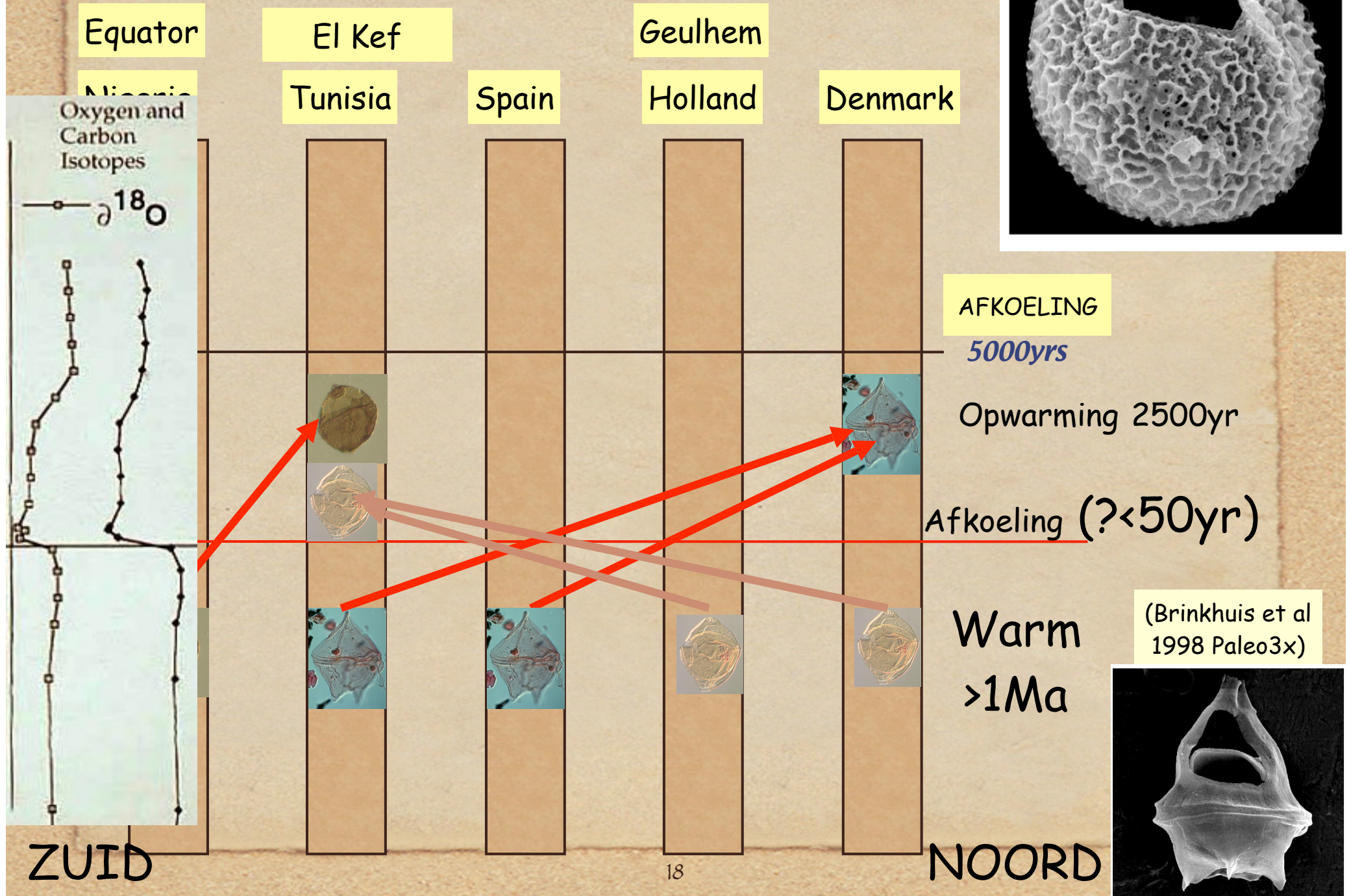
Bovenste Krijt:
Overvloedige grote gespecialiseerde foraminiferen

Agost Spain:
Uitsterven en
opnieuw evolueren
van
Foraminiferen



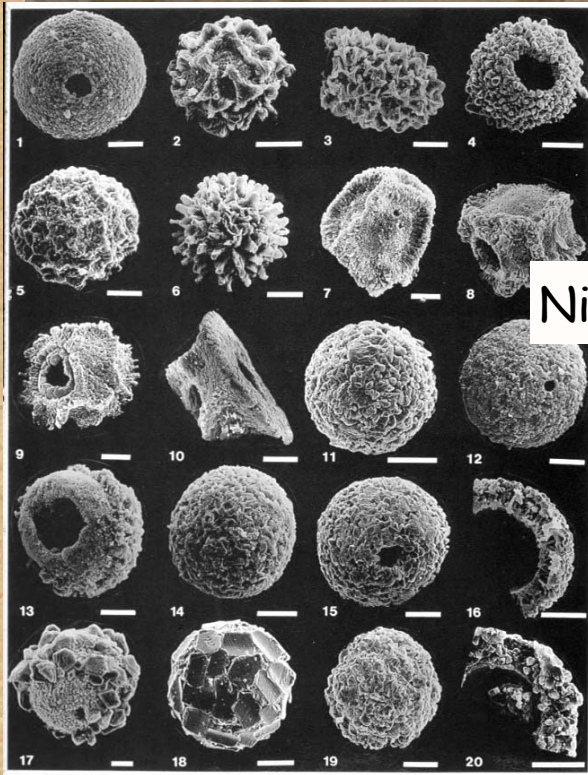


BEWIJS: DINOFLAGELLATEN MIGRATIES OVER THE KRIJGT TERTIAIR GRENS





Geulhemmerberg Grotten, Limburg



Nieuwe dinoflagellaten

Geulhemmerberg Grotten, Limburg

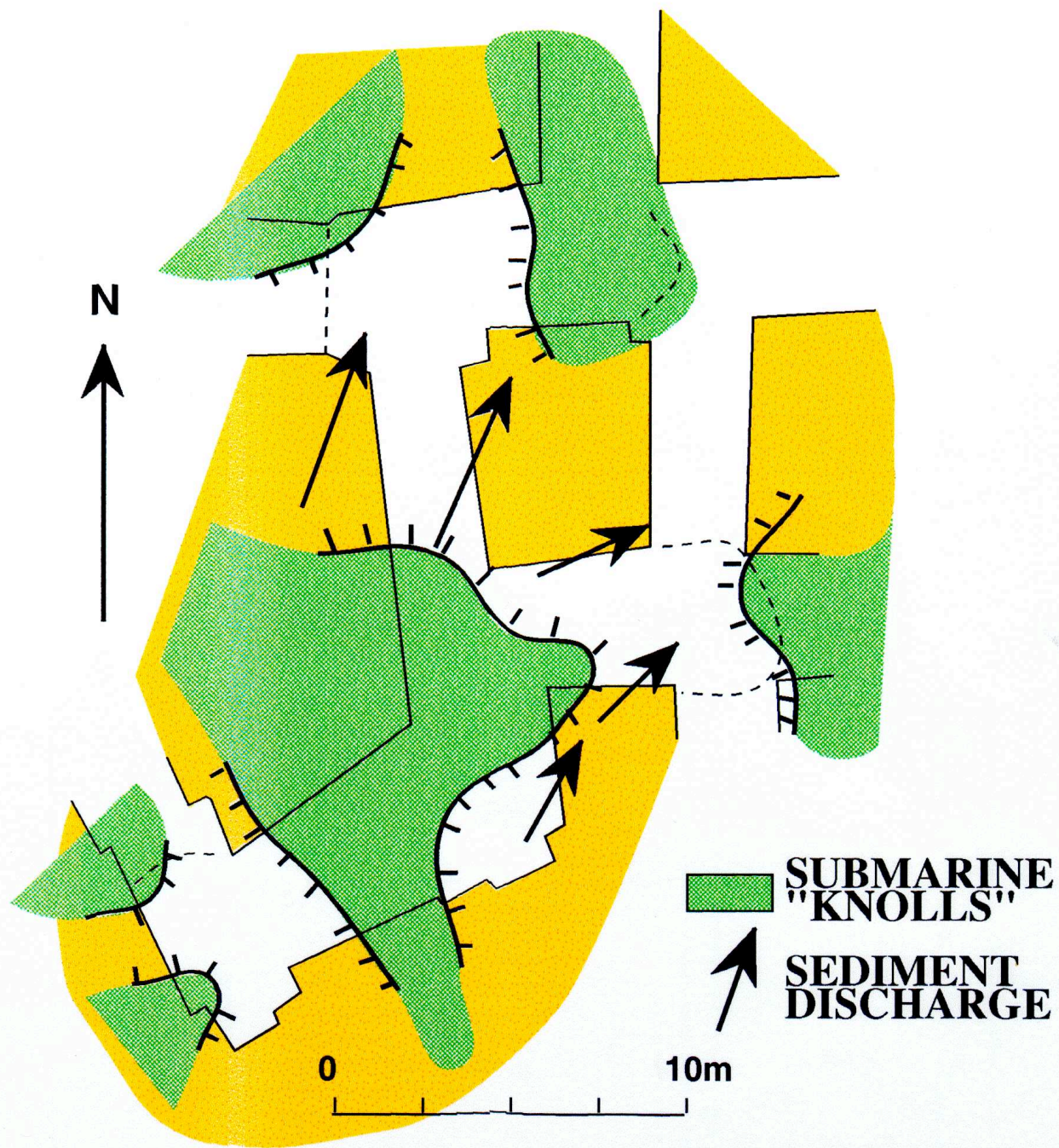
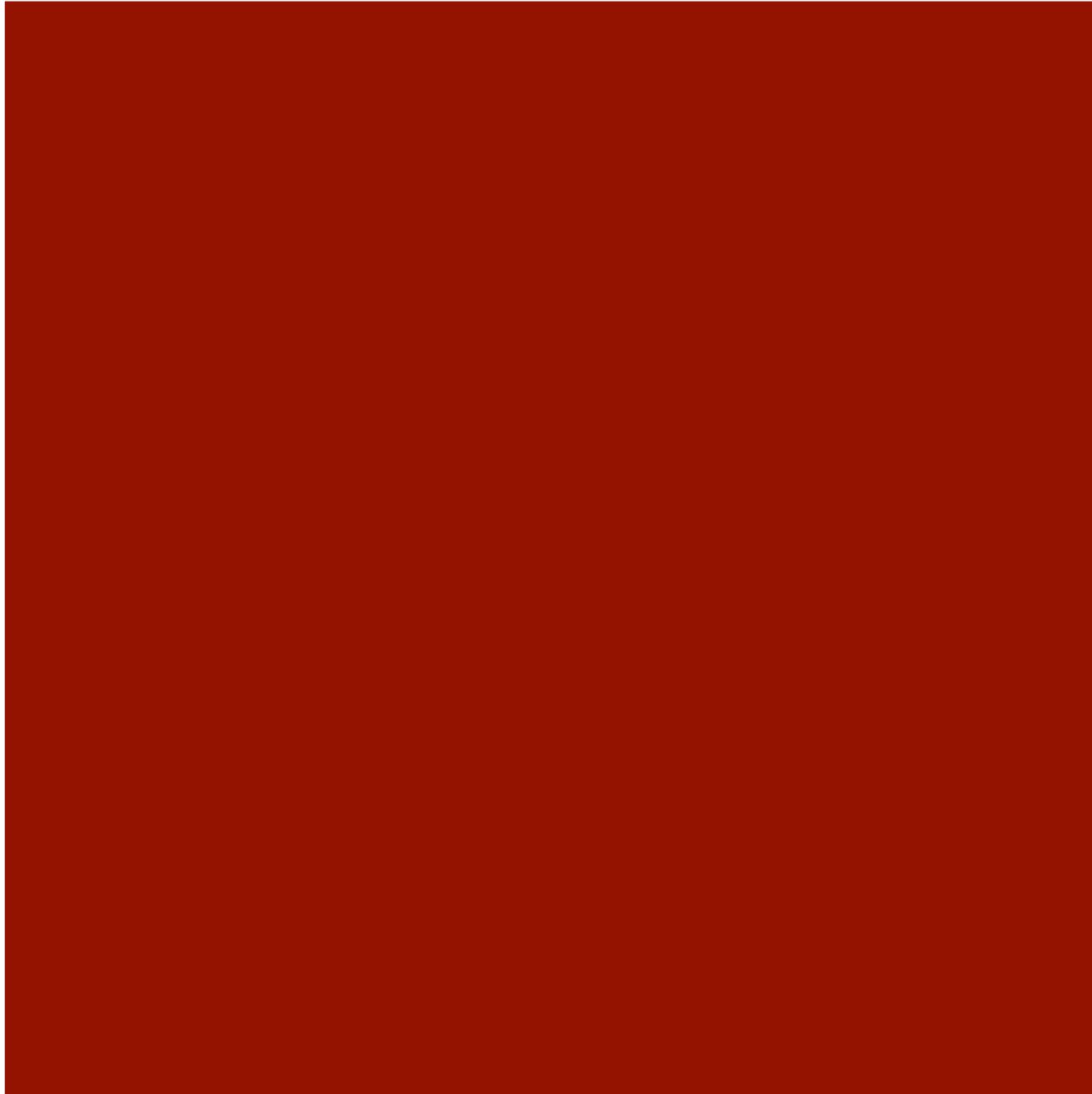


Fig. 12 (Roep&Smit)

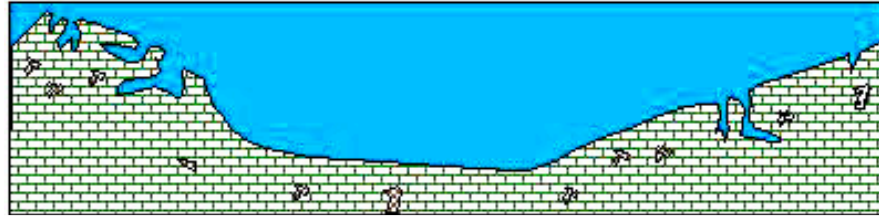


Latest Maastrichtian
Highstand tract deposits
Submarine relief,

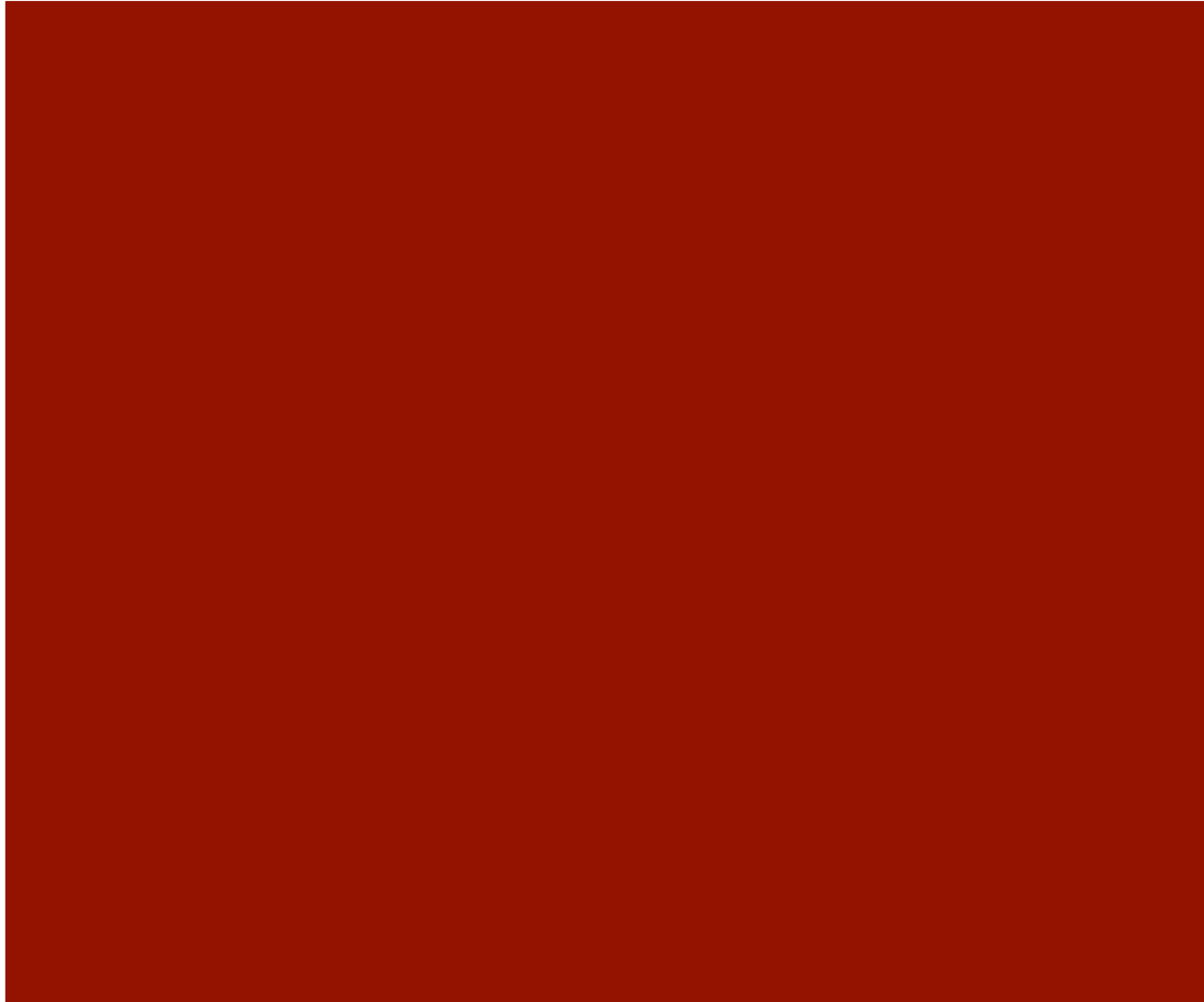




Latest Maastrichtian
Highstand tract deposits
Submarine relief,

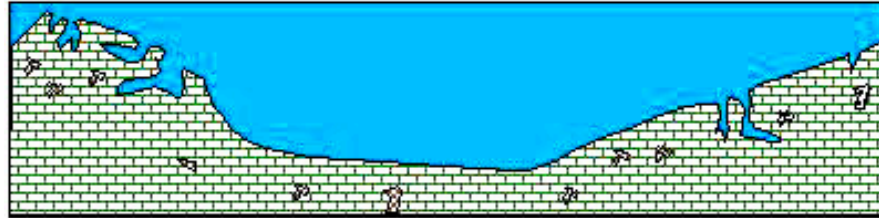


Impact
Hypercanes, removal of
sediment including ejecta
layer (iridium)
fermentation.
Cooling, followed by sealevel
drop. (1-10 years)

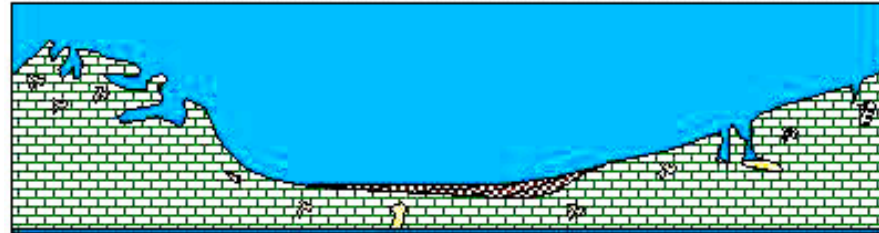




Latest Maastrichtian
 Highstand tract deposits
 Submarine relief,



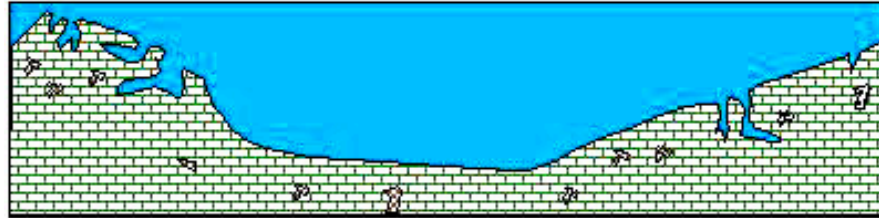
Impact
 Hypercanes, removal of
 sediment including ejecta
 layer (iridium)
 fermentation.
 Cooling, followed by sealevel
 drop, (1-10 years)



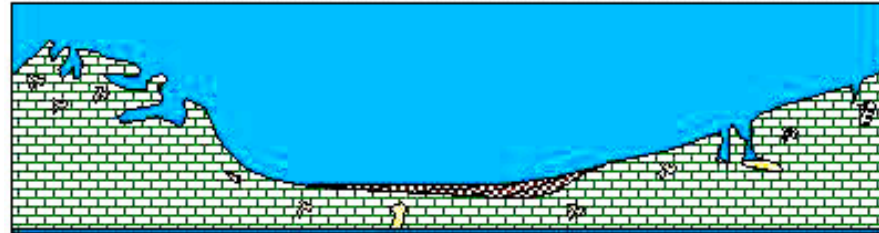
Lowermost Danian
 Sealevel rise, first coarse
 Hypercane deposits?
 rip currents
 (>10 years)



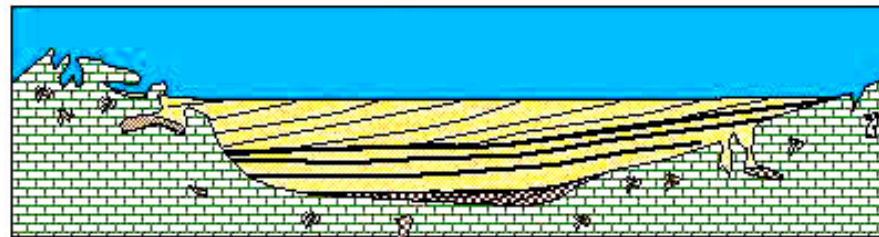
Latest Maastrichtian
Highstand tract deposits
Submarine relief,



Impact
Hypercanes, removal of
sediment including ejecta
layer (iridium)
fermentation.
Cooling, followed by sealevel
drop, (1-10 years)



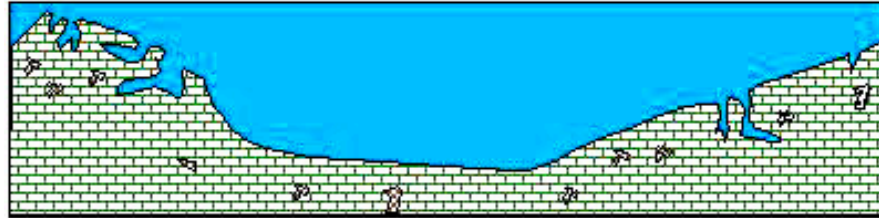
Lowermost Danian
Sealevel rise, first coarse
Hypercane deposits?
rip currents
(>10 years)



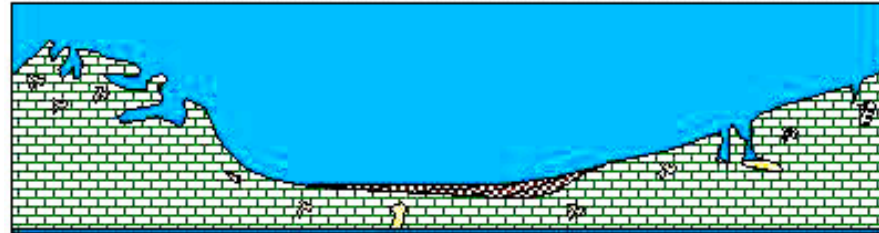
Episodic infilling:
Periods of deposition of coarse
material (storms) and fine
material clays, (quiescence)
(10-100yrs)



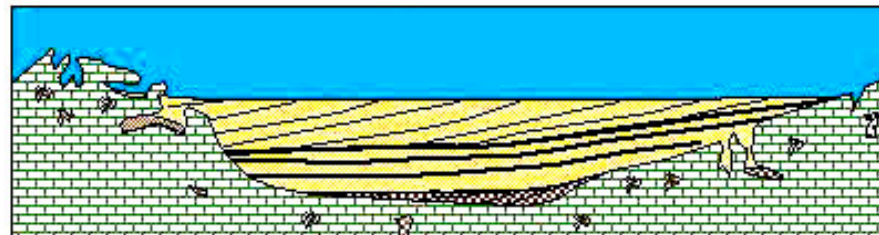
Latest Maastrichtian
Highstand tract deposits
Submarine relief,



Impact
Hypercanes, removal of
sediment including ejecta
layer (iridium)
fermentation.
Cooling, followed by sealevel
drop, (1-10 years)



Lowermost Danian
Sealevel rise, first coarse
hypercane deposits?
rip currents
(>10 years)



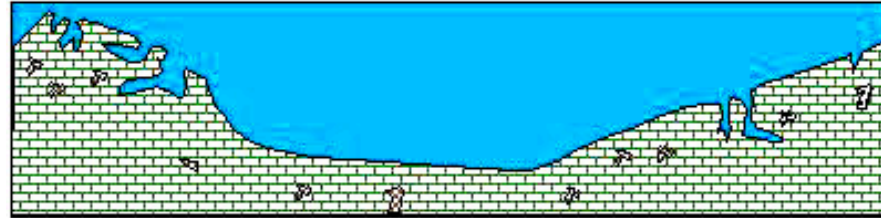
Episodic infilling:
Periods of deposition of coarse
material (storms) and fine
material clays, (quiescence)
(10-100yrs)



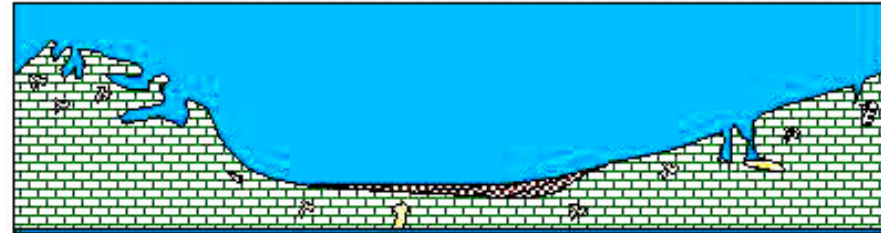
D + E clay infills
increasing water depth
to 20-40 m
(100yrs.)



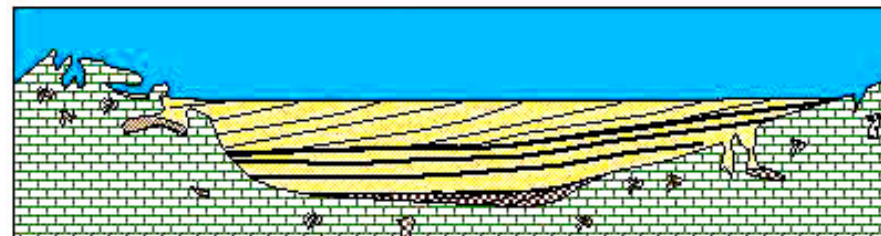
Latest Maastrichtian
Highstand tract deposits
Submarine relief,



Impact
Hypercanes, removal of
sediment including ejecta
layer (iridium)
fermentation.
Cooling, followed by sealevel
drop, (1-10 years)



Lowermost Danian
Sealevel rise, first coarse
hypercane deposits?
rip currents
(>10 years)



Episodic infilling:
Periods of deposition of coarse
material (storms) and fine
material clays, (quiescence)
(10-100yrs)



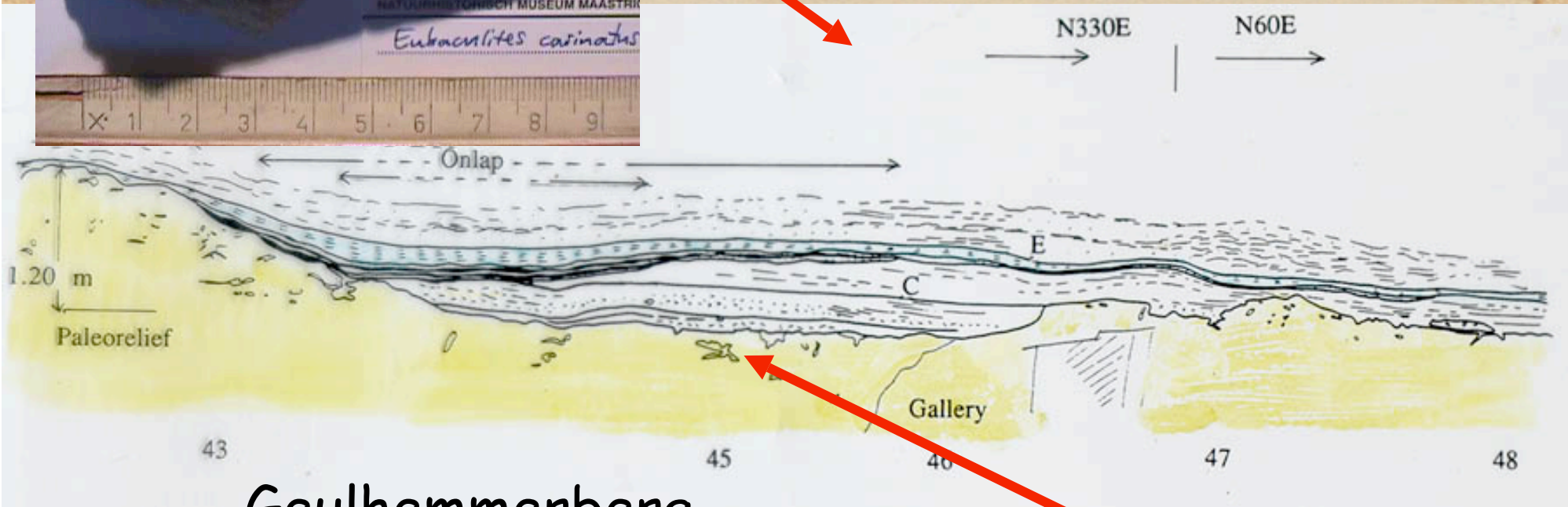
D + E clay infills
increasing water depth
to 20-40 m
(100yrs.)



← **Survivors? (>300 kyrs)**
← (Vroenhoven hard ground)

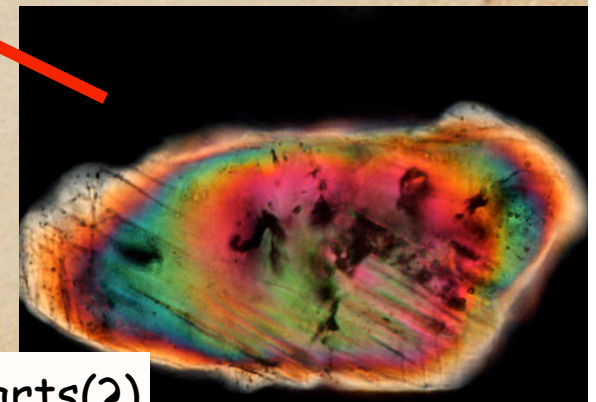
Smit & Brinkhuis Fig. 4

Ammoniet die het overleefd heeft



Geulhemmerberg.

Reconstructie van lokale depressie door Tom Roep



geschokte kwarts(?)

GEBEURTENISSEN OP DE K/T GRENS

Incoming
Paleocene
foraminifers

immigratie nieuw plankton

Boundary
clay

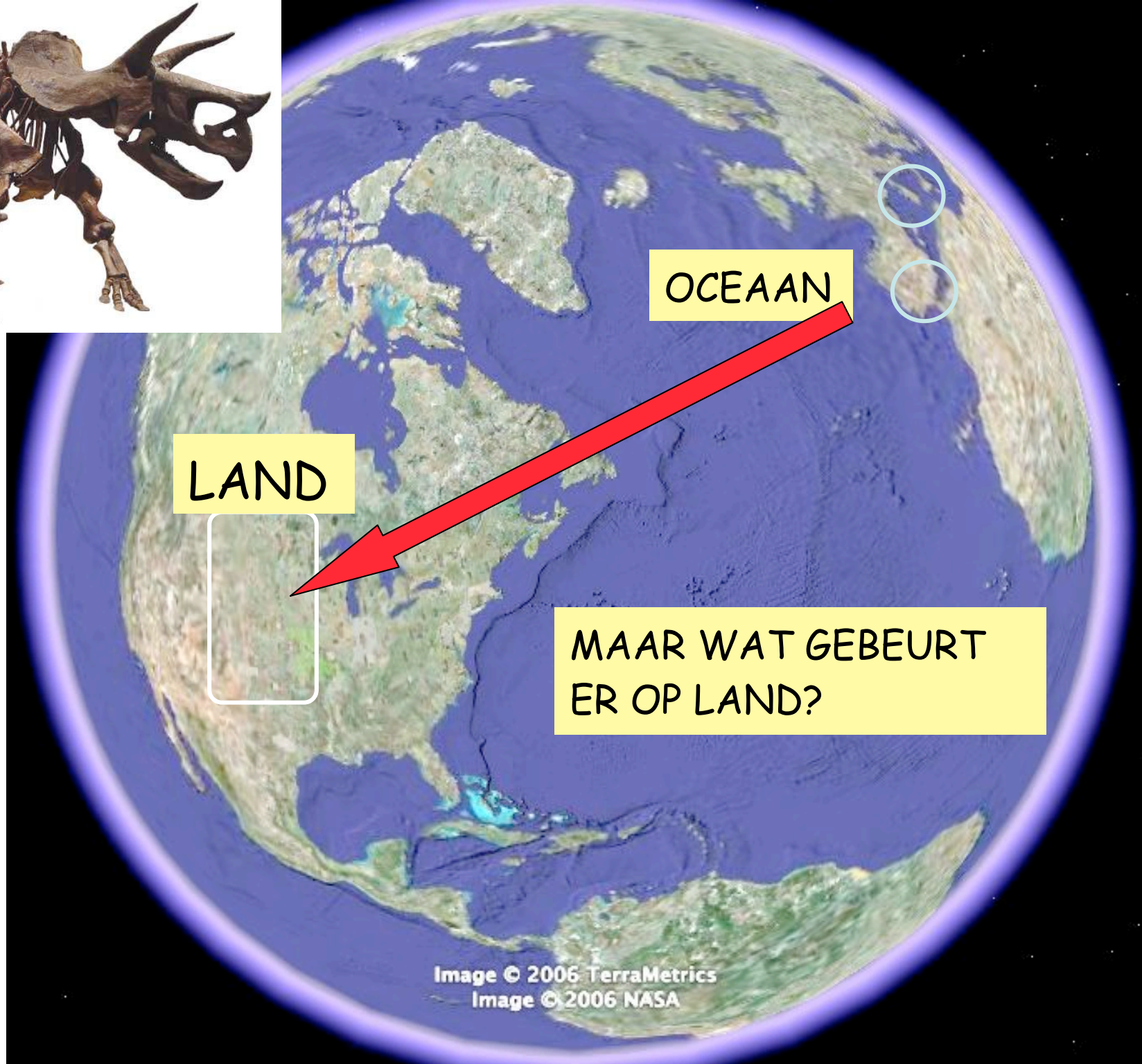
Donkere kleilaag "Strangelove ocean"
(minimale fotosynthese) gedurende
~5000 jaar

Ejecta
layer

Massa-extinctie van Krijt plankton

Ejecta laag

Boven Krijt sediment,
GREENHOUSE CLIMATE



OCEAAN

LAND

MAAR WAT GEBEURT
ER OP LAND?

Image © 2006 TerraMetrics
Image © 2006 NASA

Een ondiepe
zee met ● dinosaurus
vindplaatsen



Dinosauriers lopen bij de
kust van de Zee



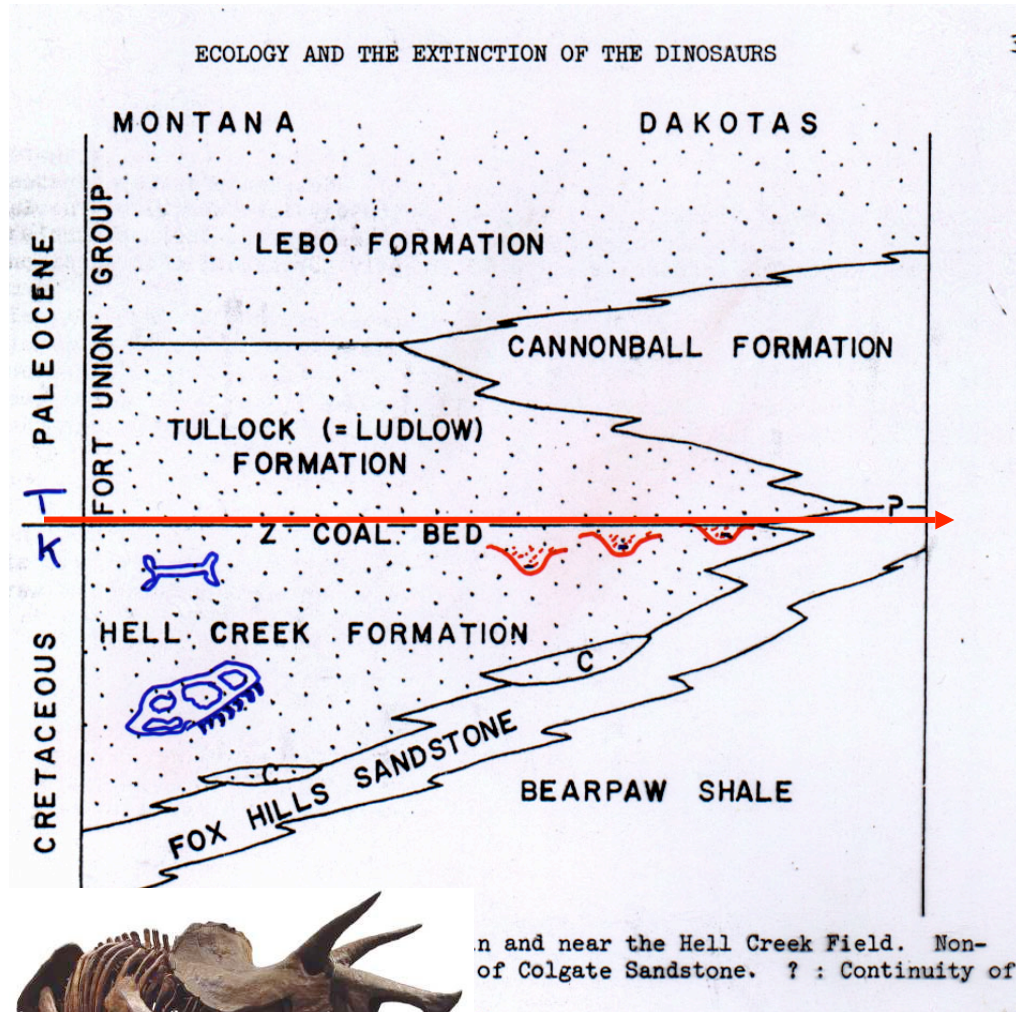
CHICXULUB
Krater



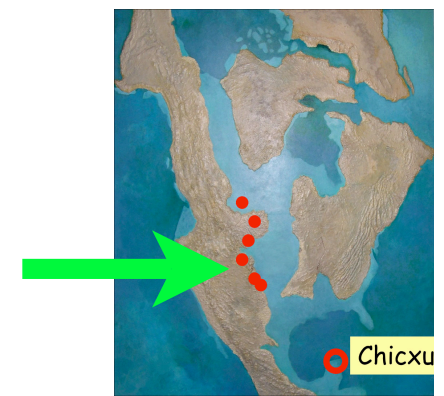
Raton Basin, New Mexico



De Zee stijgt en daalt in de loop van de tijd....
Dus moeten de dinosauriers meeverhuizen



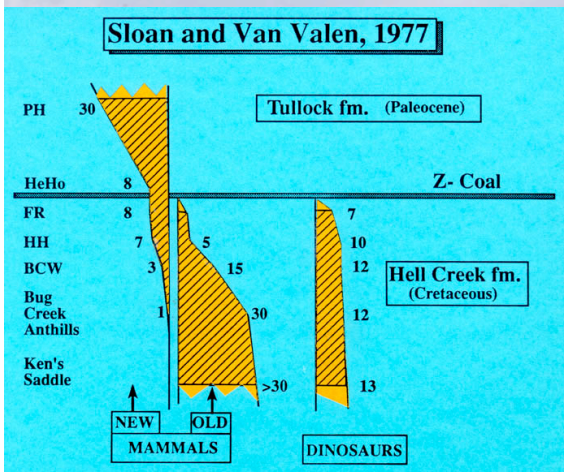
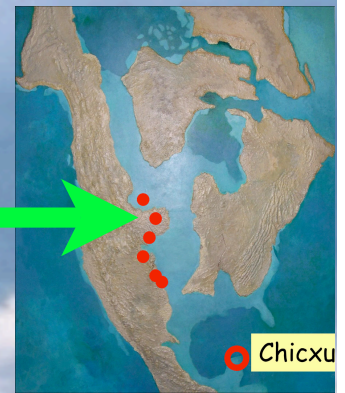
Overall is de ejectalaag terug te vinden, vooral in voormalige steenkoolmoerassen



Madrid Railroad Colorado

Het uitsterven van dinosauriers en de opkomst van
zoogdieren in de Badlands van Bug Creek, Montana

Missouri breaks, Montana

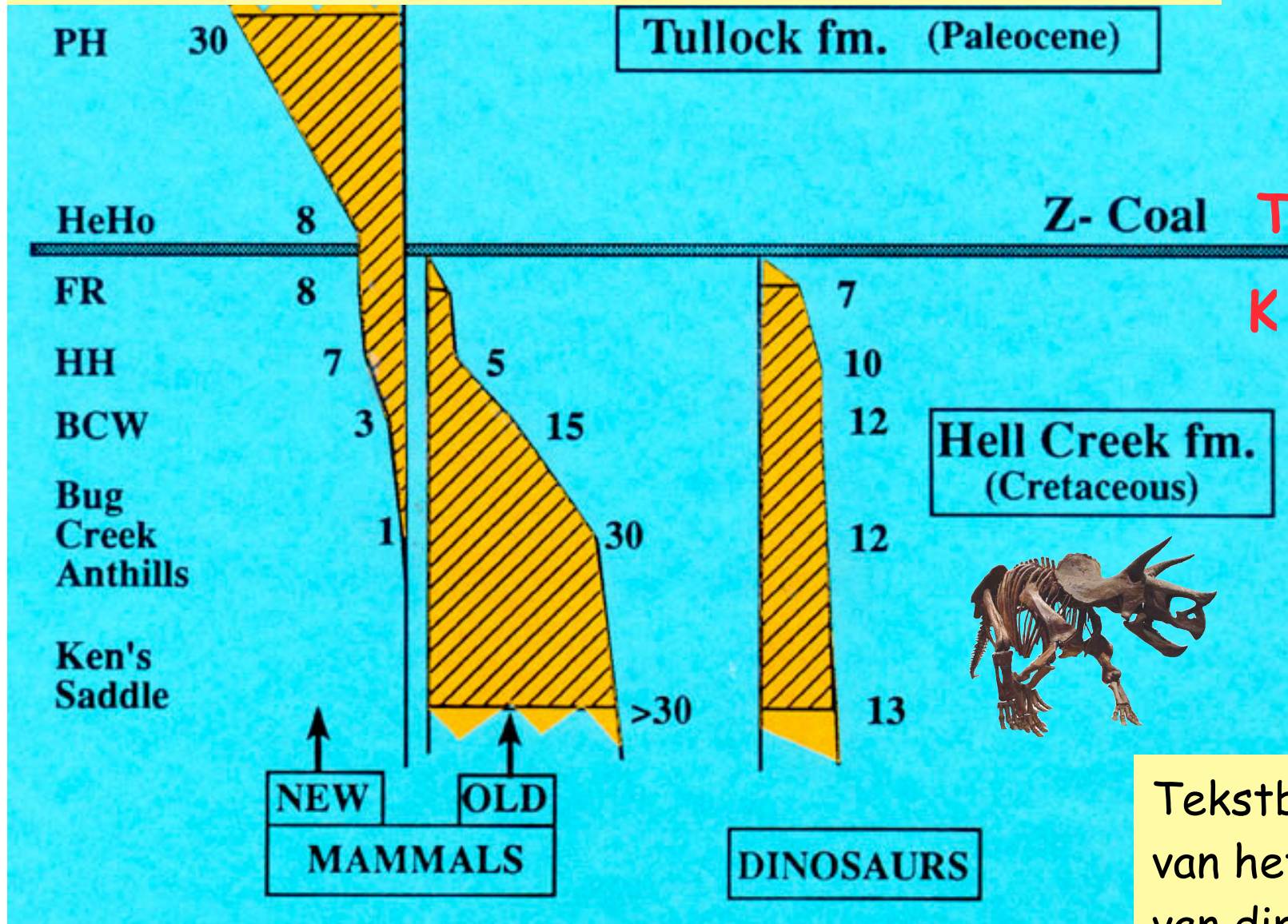


Z-coal

W-coal

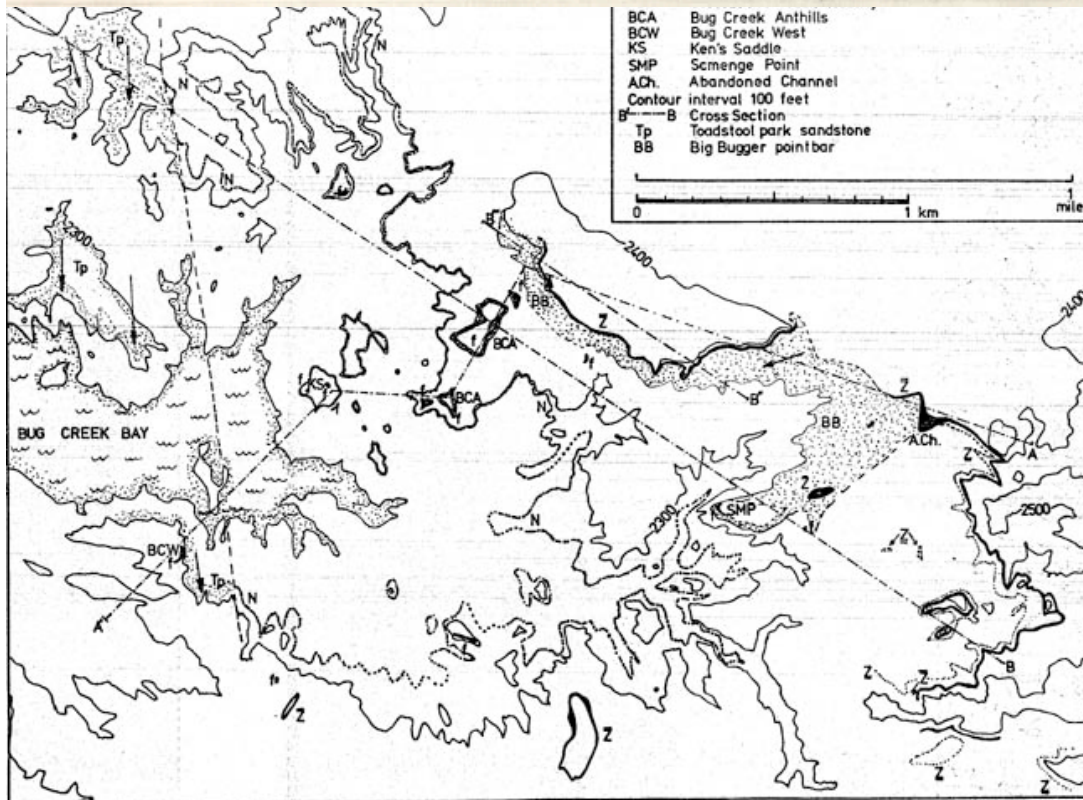
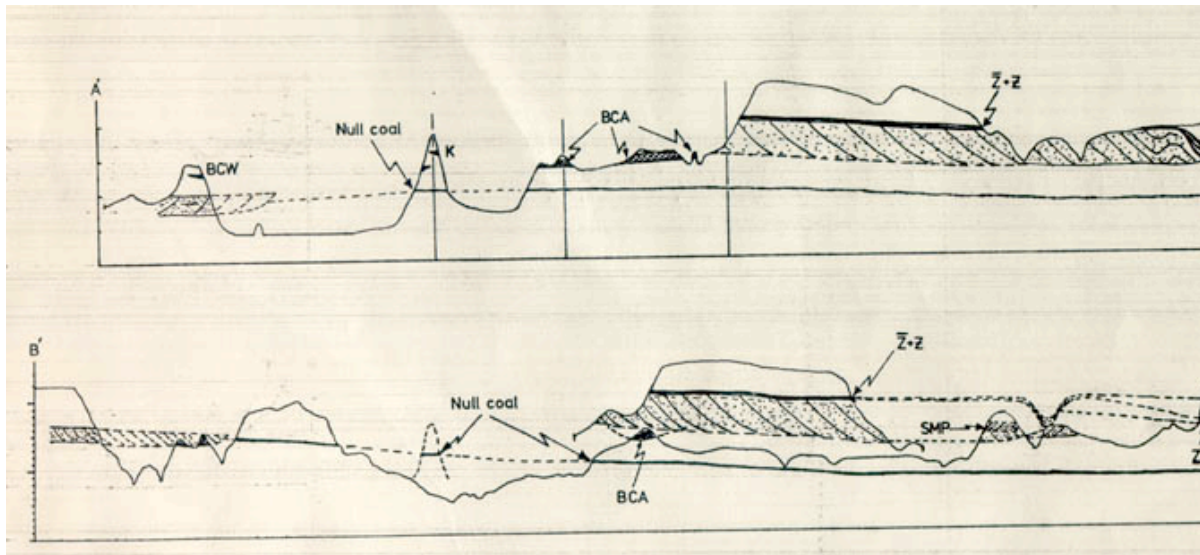


Nieuwe (placentalia) evolueren schijnbaar tegelijk met het verdwijnen van de dinosauriers, maar.....
Onder de K/T grens, en dus Vóór de inslag??

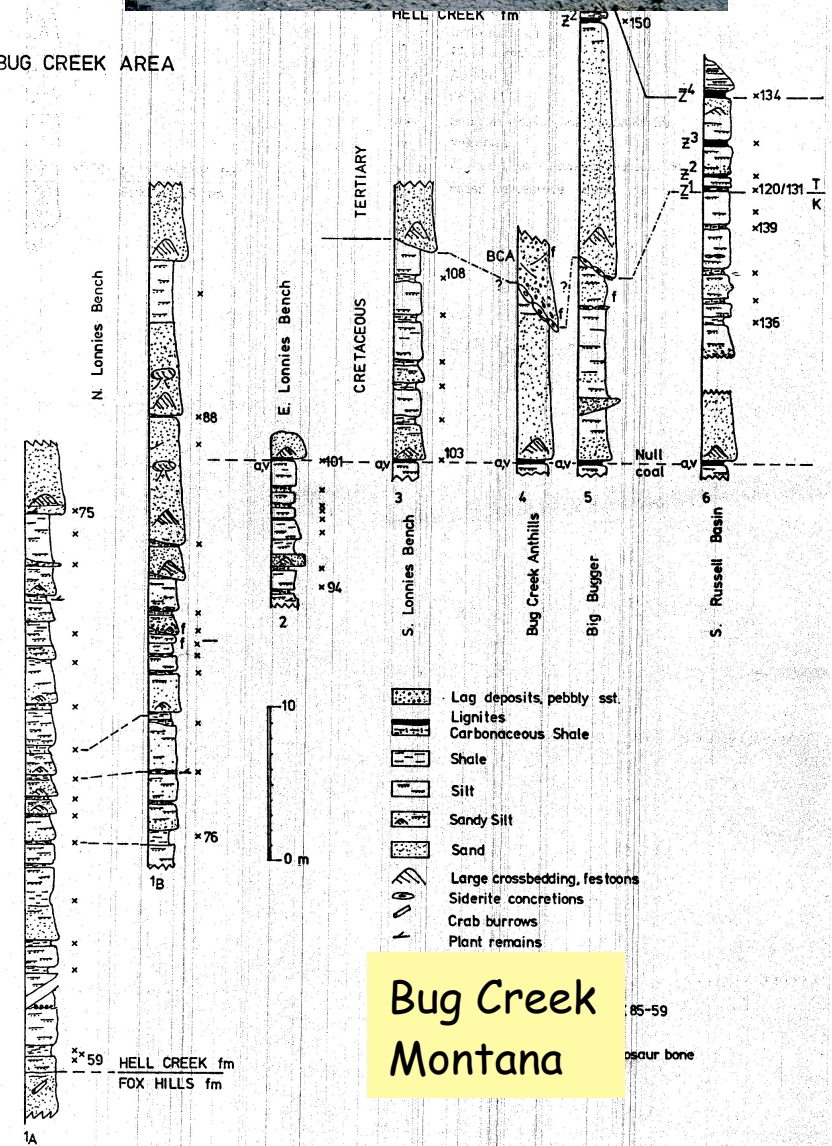


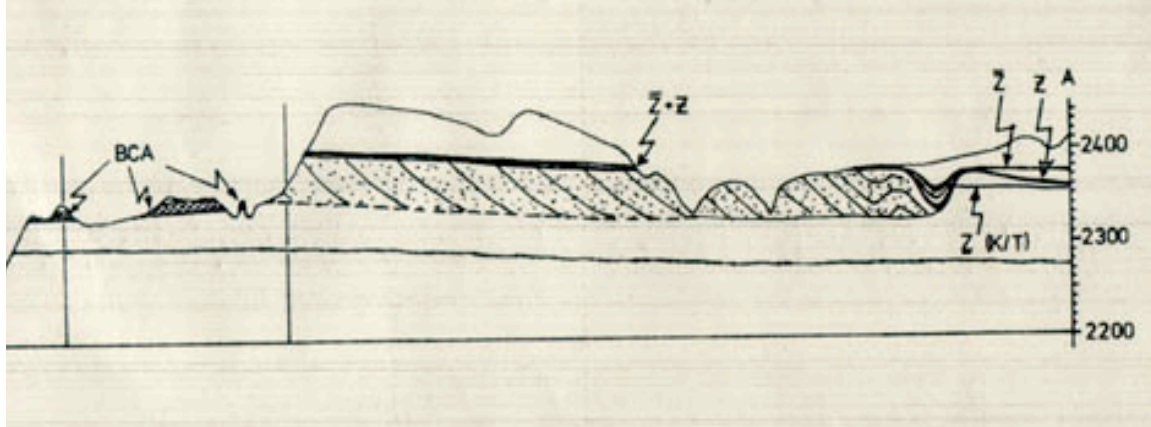
Tekstboek voorbeeld van het uitsterven van dino's en evolutie zoogdieren

Maar in het veld is niet alles simpel.....



BUG CREEK AREA





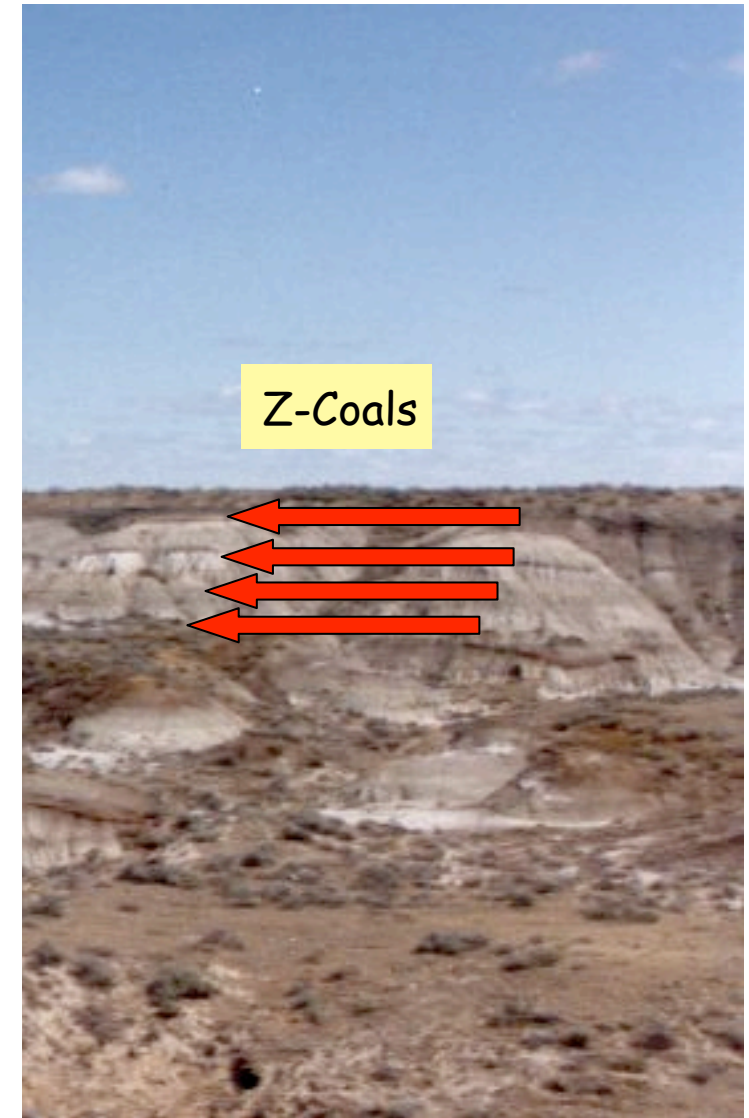
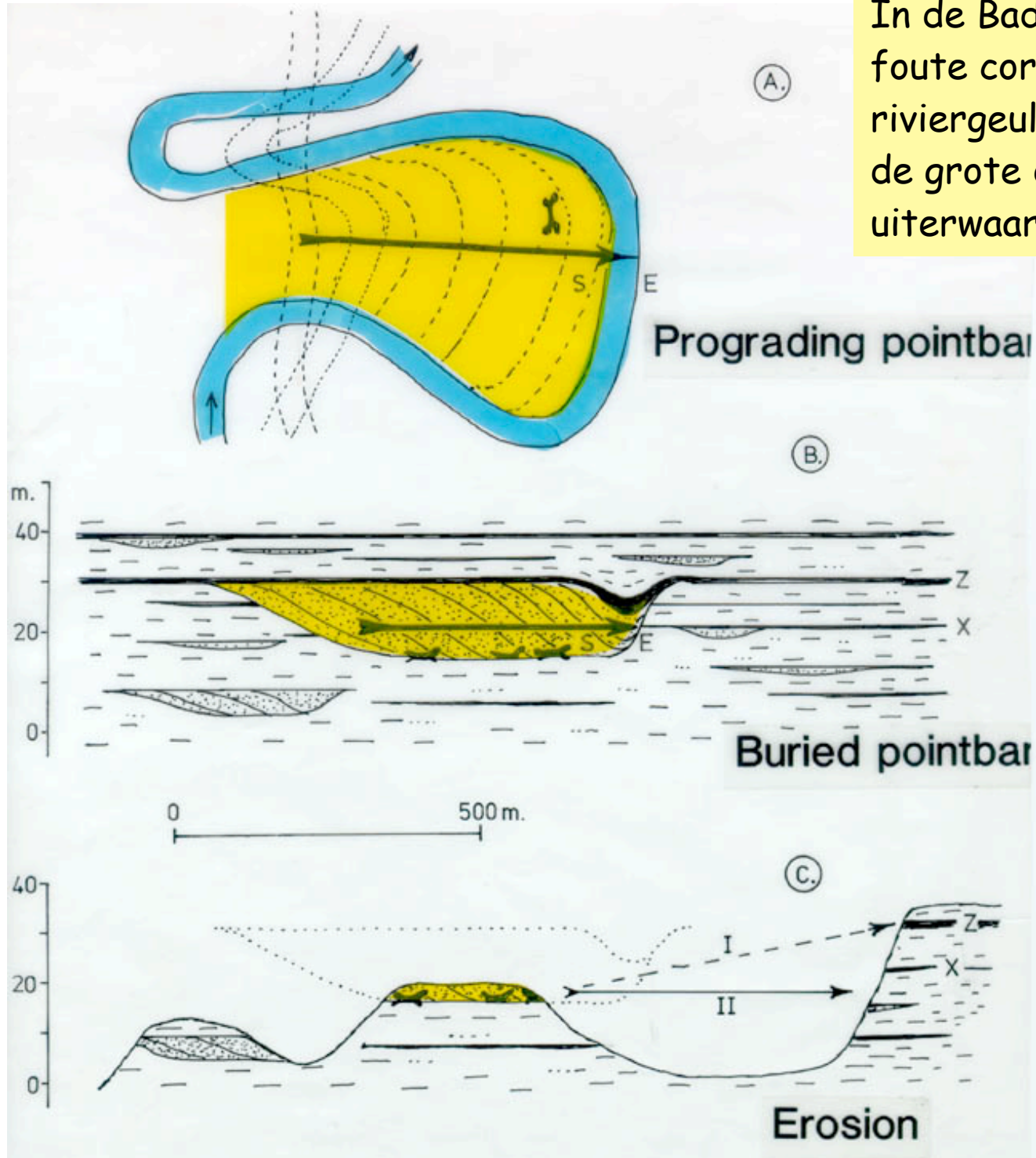
Bug Creek
Montana

A) Er blijken vier Z-coals te zijn

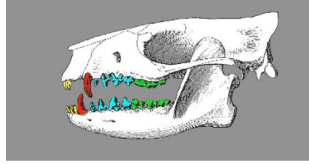
B) Die worden afgesneden door rivierarmen



In de Badlands kan je makkelijk een foute correlatie maken tussen de riviergeulen (met de zoogdiertanden) en de grote dinosaurierskeletten in de uiterwaarden



riviergeulen



Upper Z-coal

Tertiary

Ferguson ranch

Bug Creek Anthills

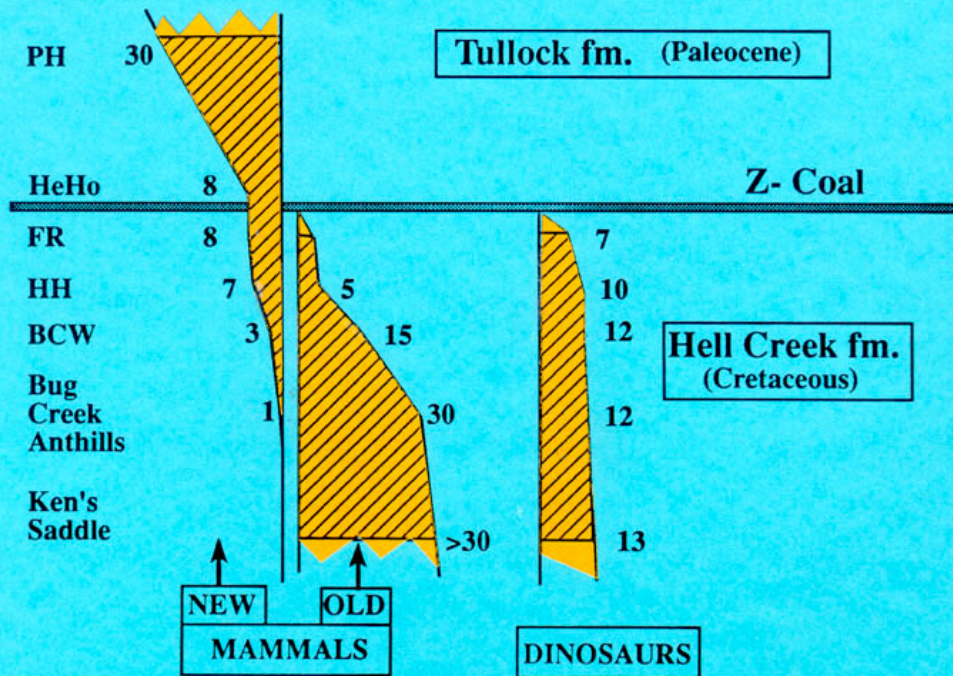
Bug Creek West

Cretaceous

Harbicht Hill

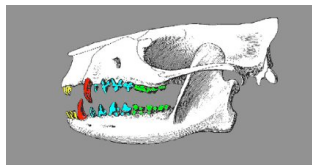


Sloan and Van Valen, 1977

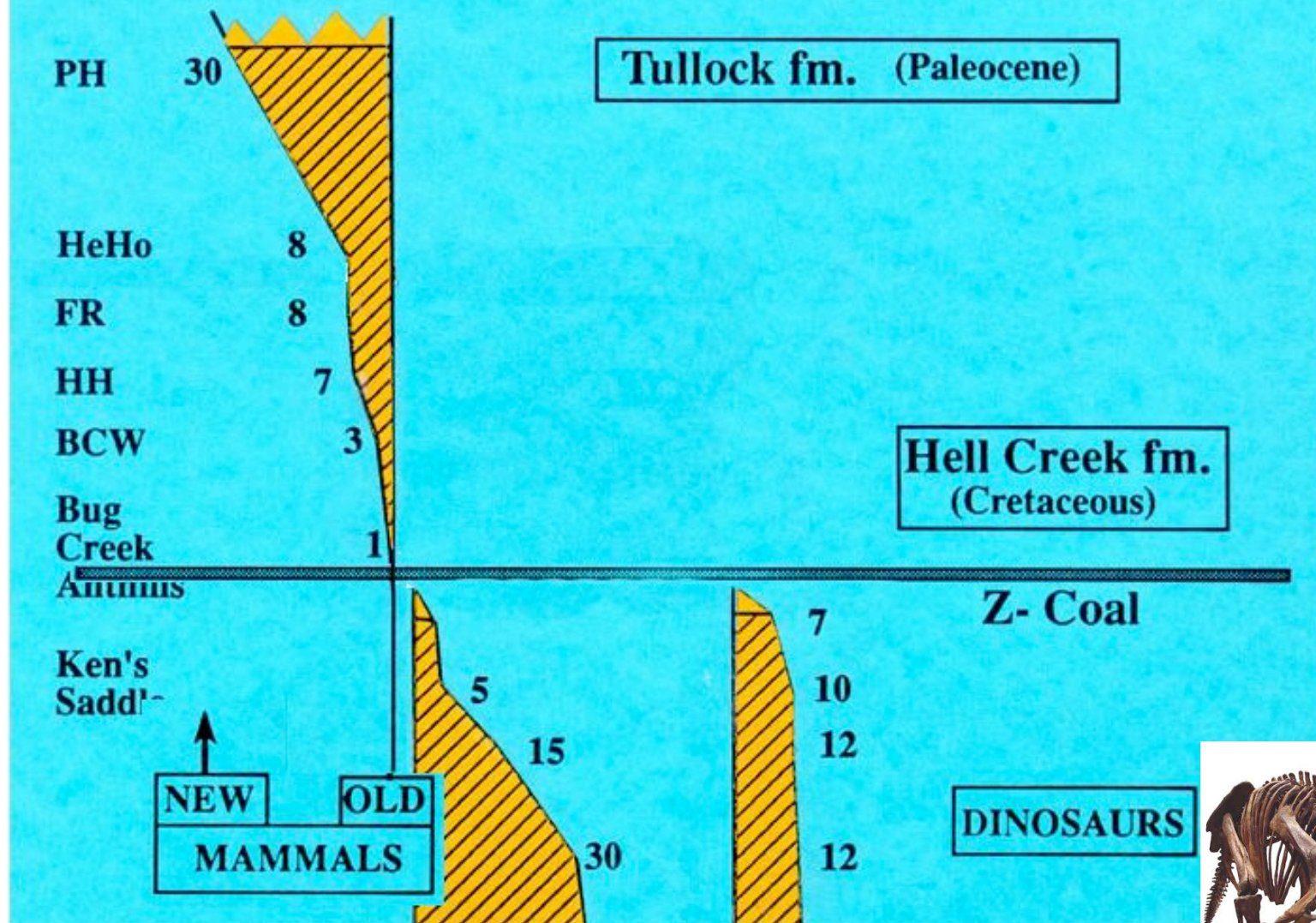


14 dinosaurus soorten op de uiterwaarden
In het Krijt





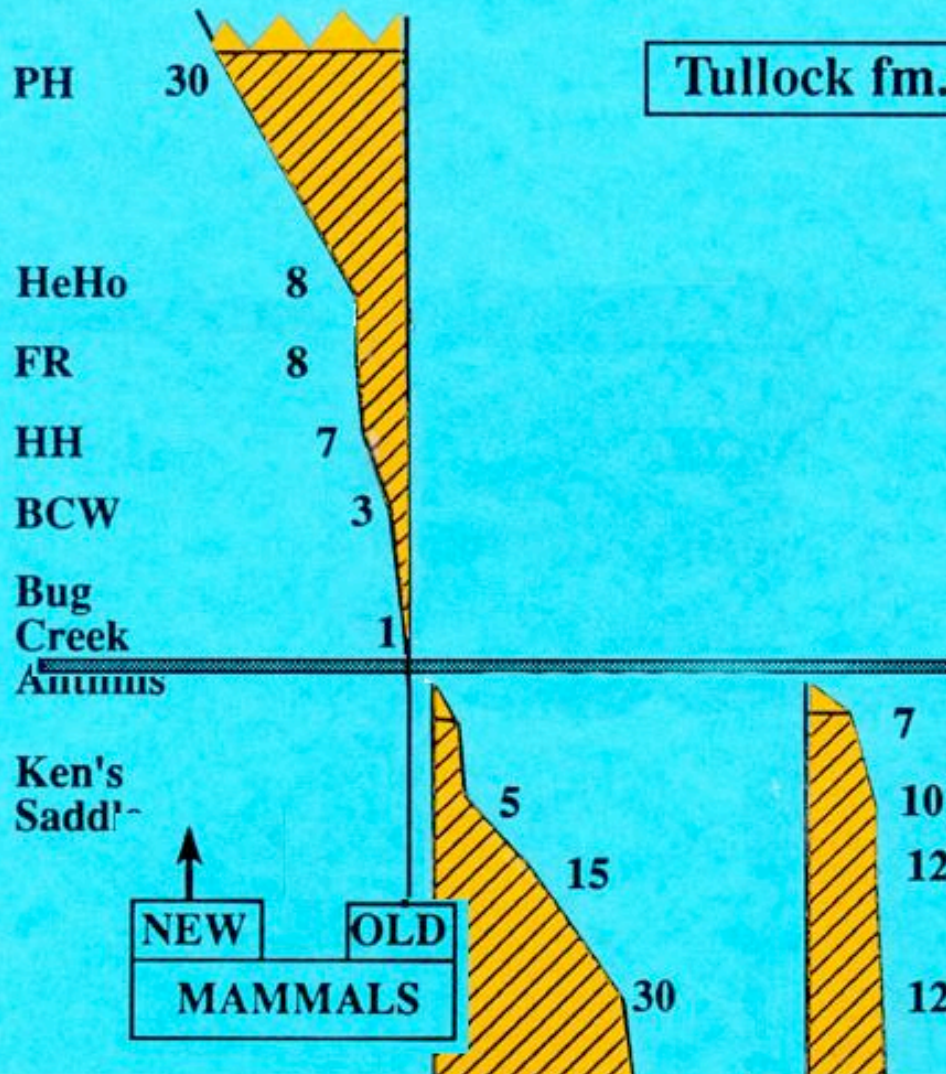
Sloan and Van Valen, 1977



En nu is de overgang op land en in de oceaan wél goed vergelijkbaar!

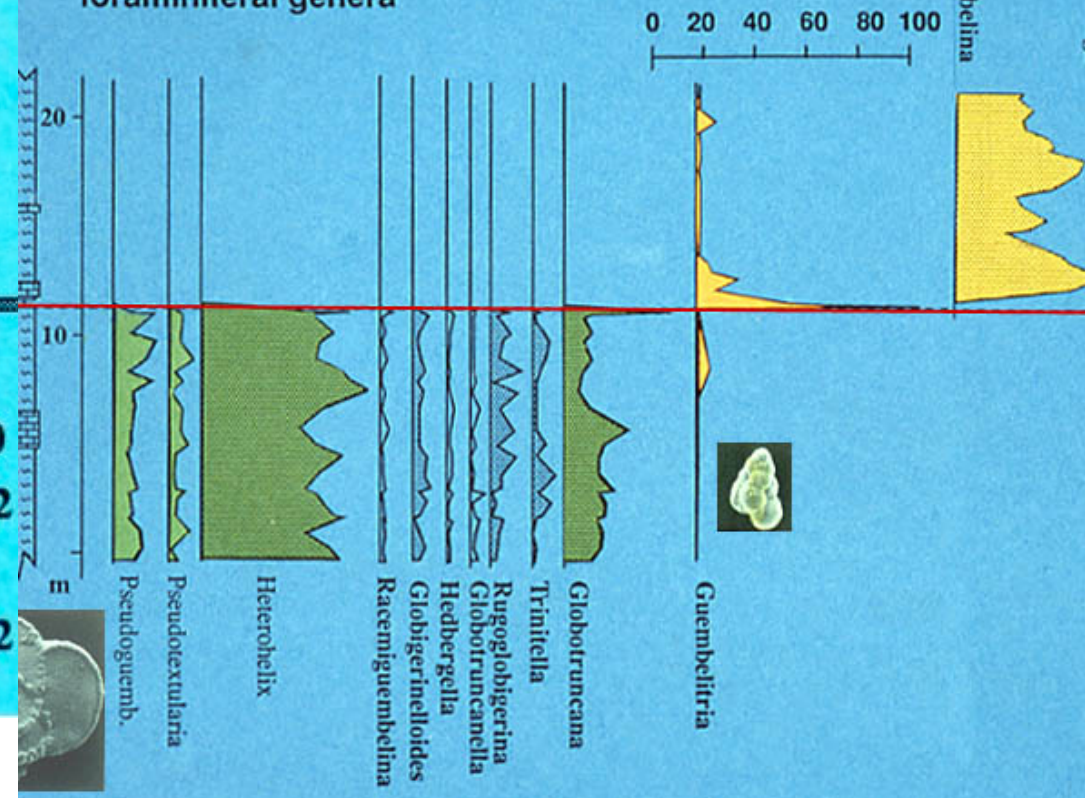
Sloan and Van Valen, 1977

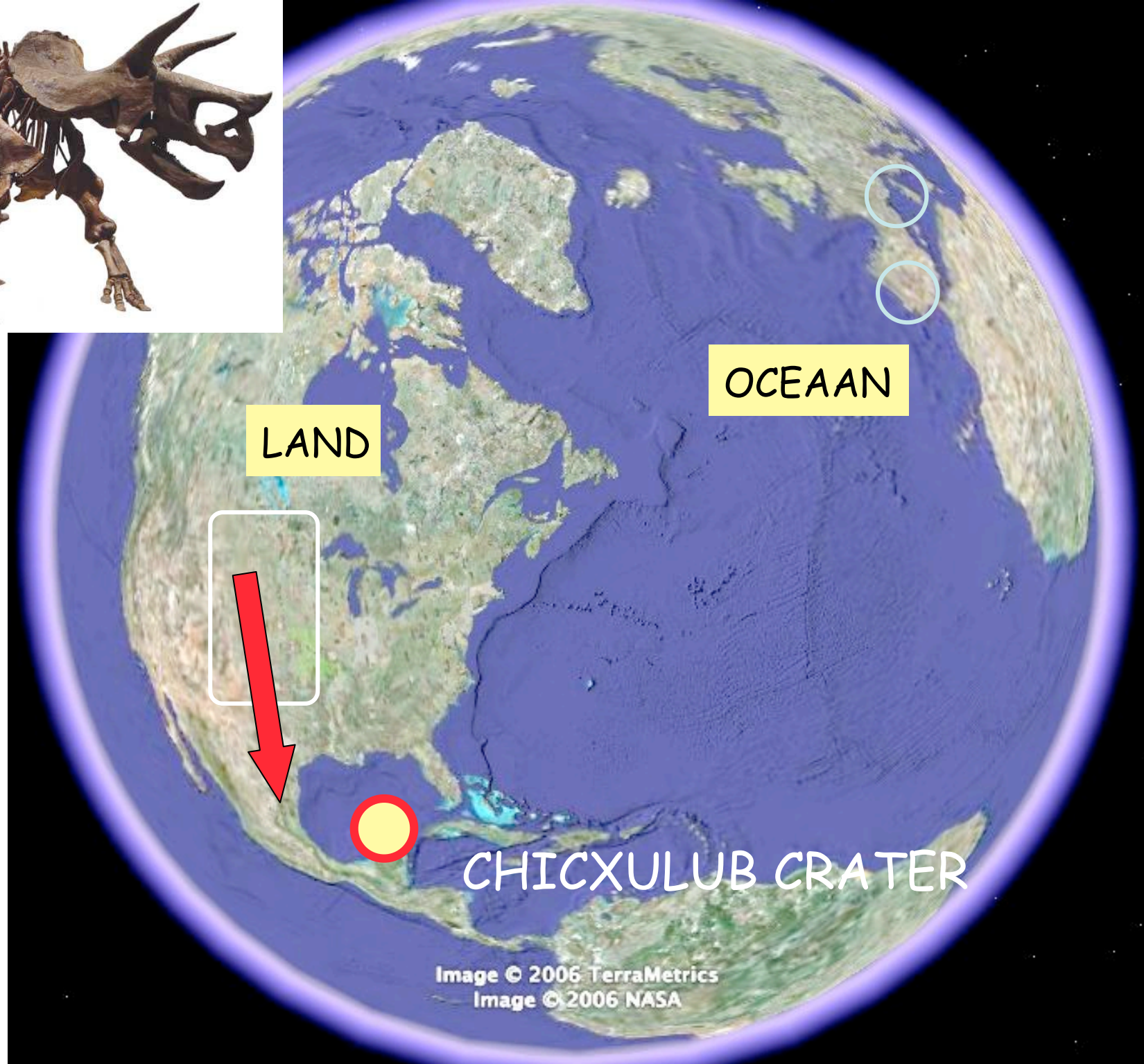
Tullock fm. (Paleocene)



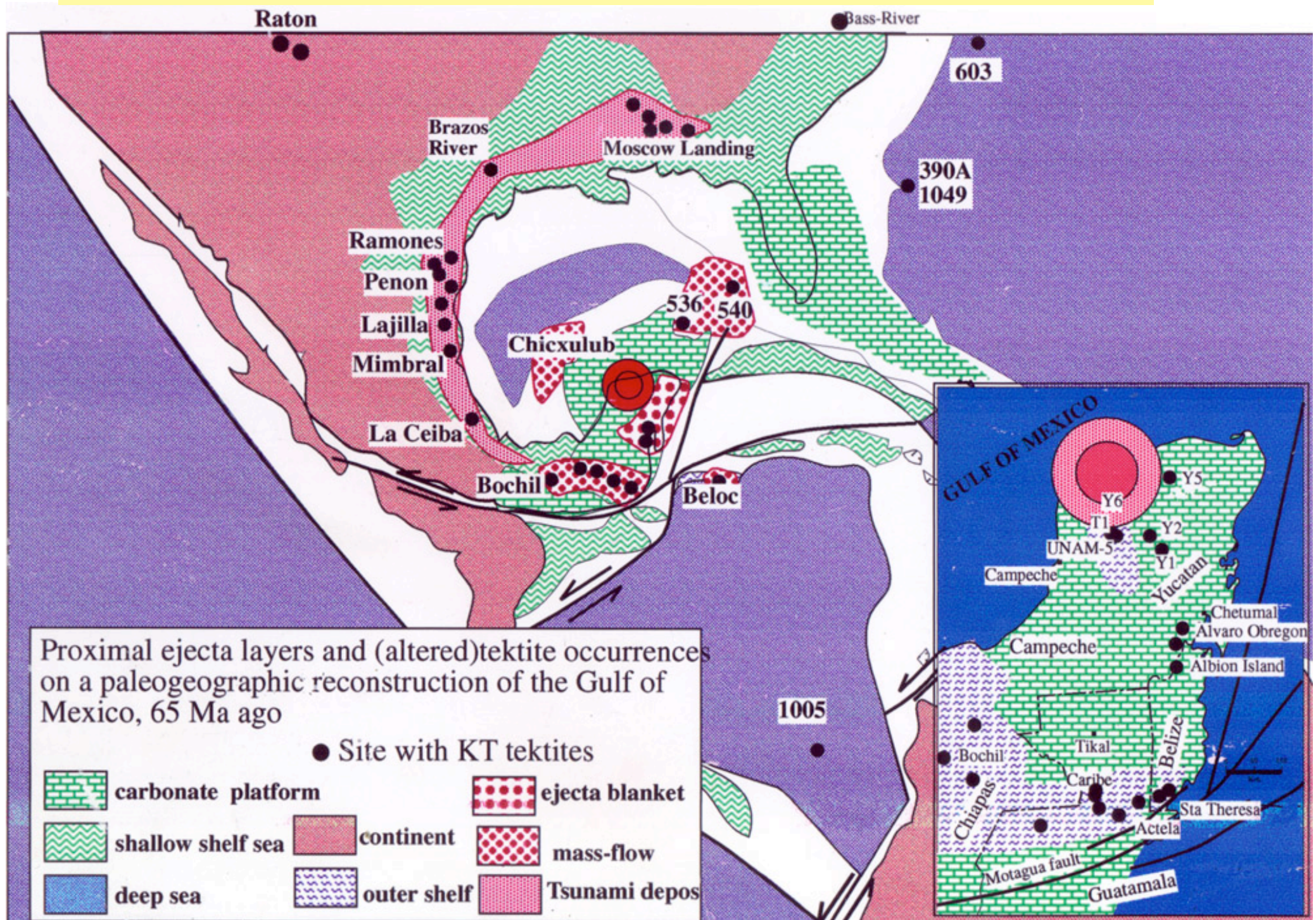
AGOST

Relative abundance of Cretaceous planktonic foraminiferal genera



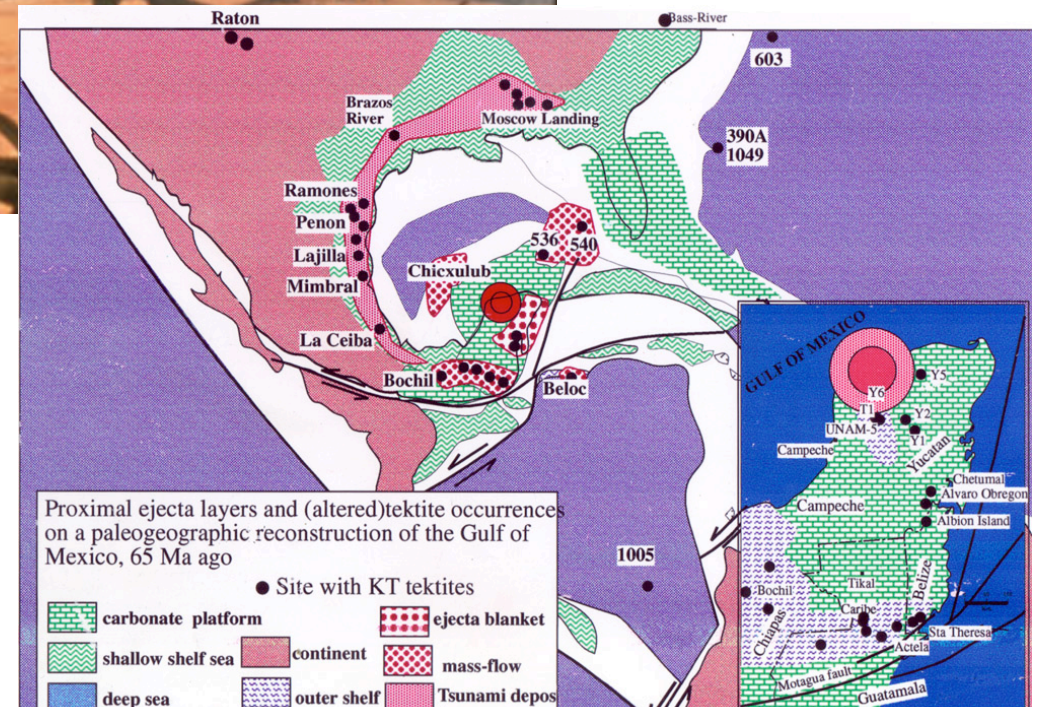


Kaartje zoals de Golf van Mexico er 65 Miljoen jaar geleden uitzag





Tsunami Golven in de Golf van Mexico
?fout plaatje?



TSUNAMI: Muur van water, sterke getijdestromingen



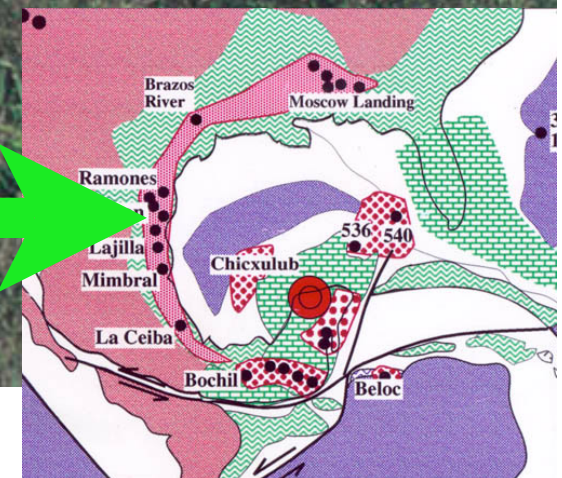
Een dikke zandsteenlaag in Mexico

El Mulato Tamaulipas Mexico

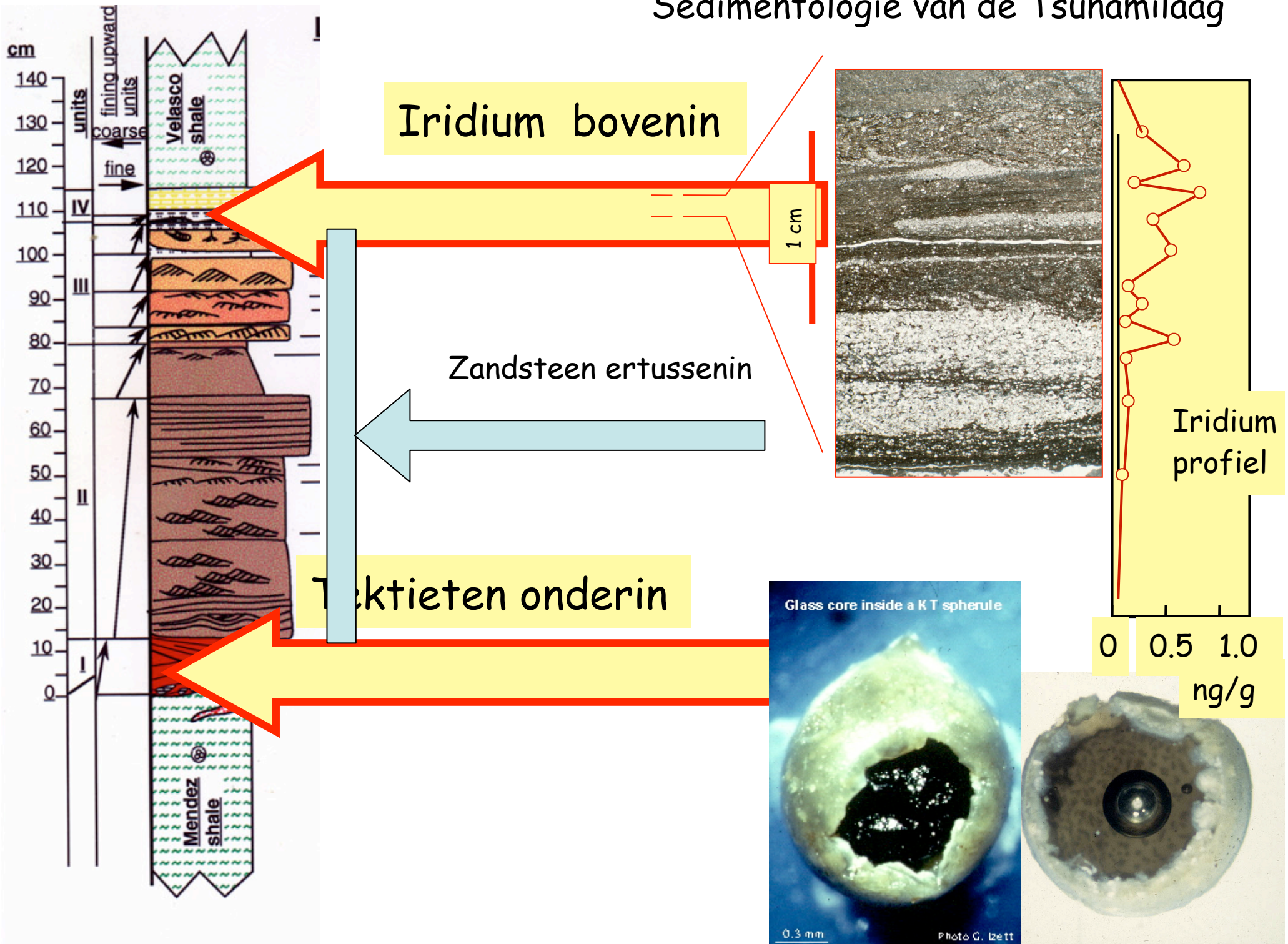
Paleocene

K/T boundary

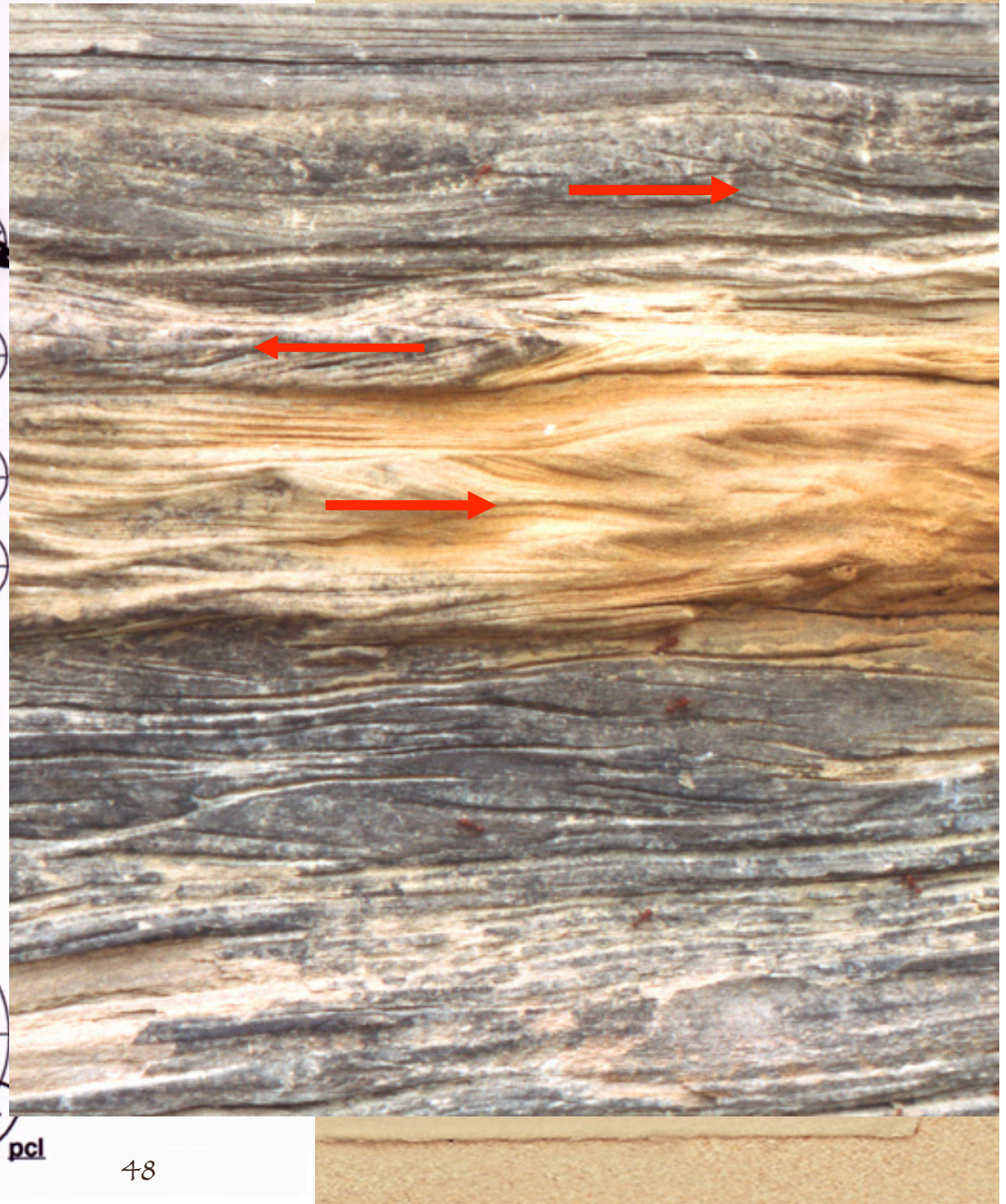
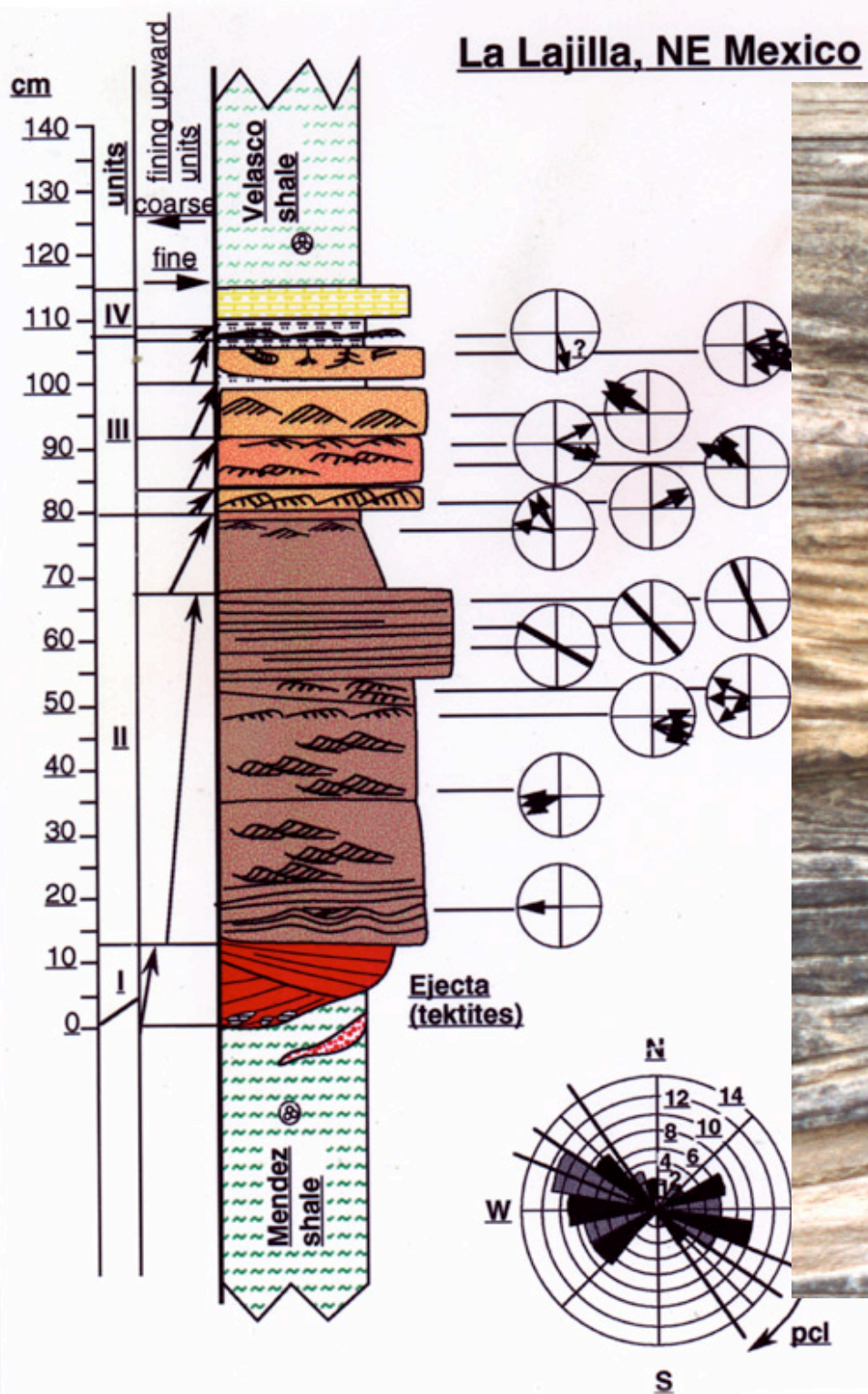
Maastrichtian



Sedimentologie van de Tsunamilaag



omkerende stroomrichtingen



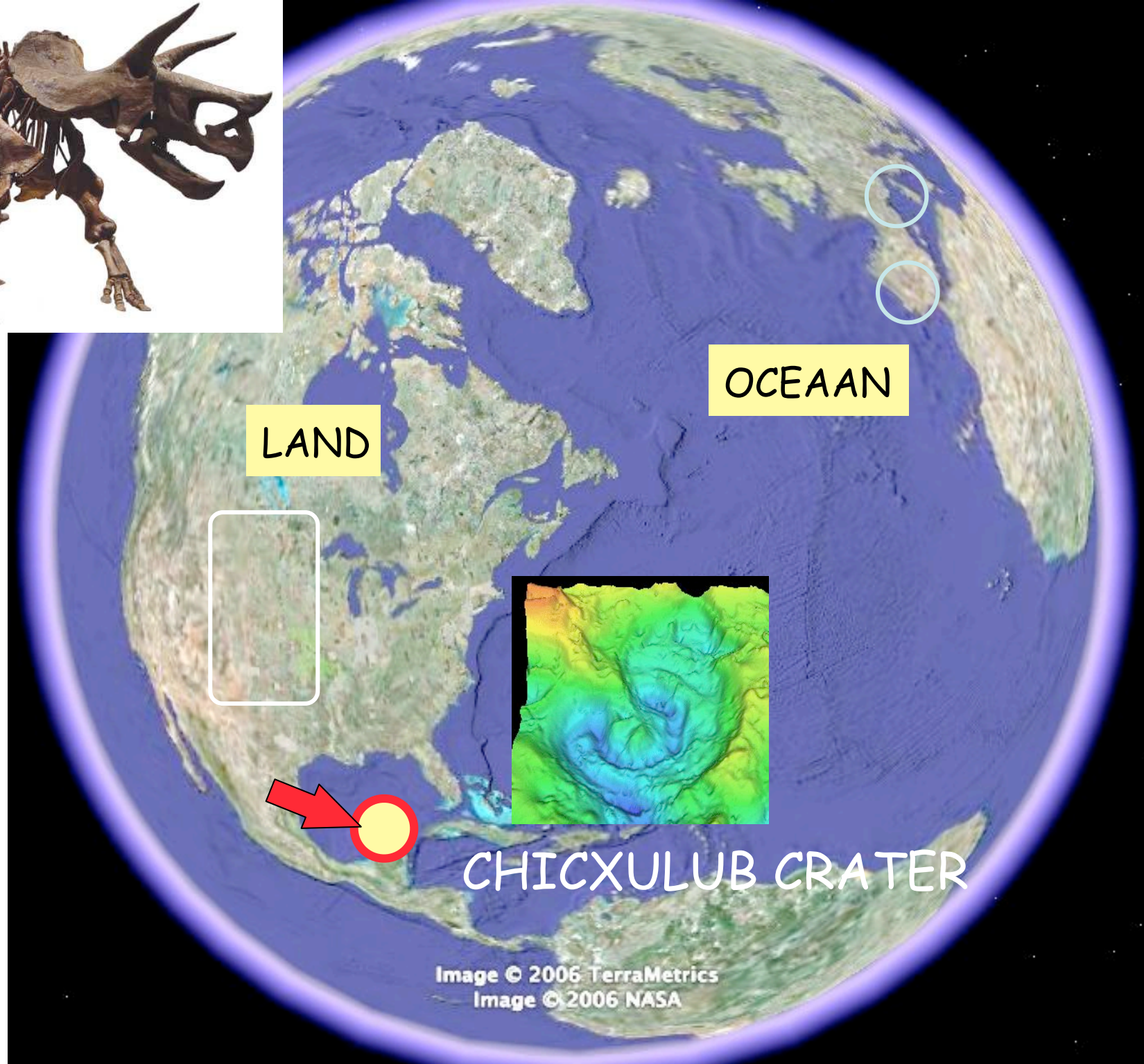


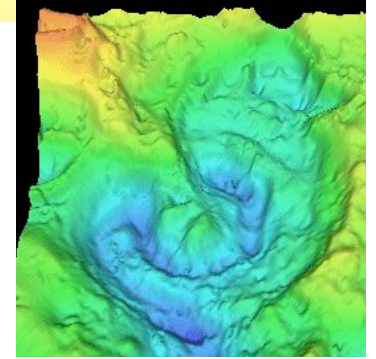
Image © 2006 TerraMetrics
Image © 2006 NASA

Diepboring in de Krater

Chicxulub
Scientific
Drilling
Project

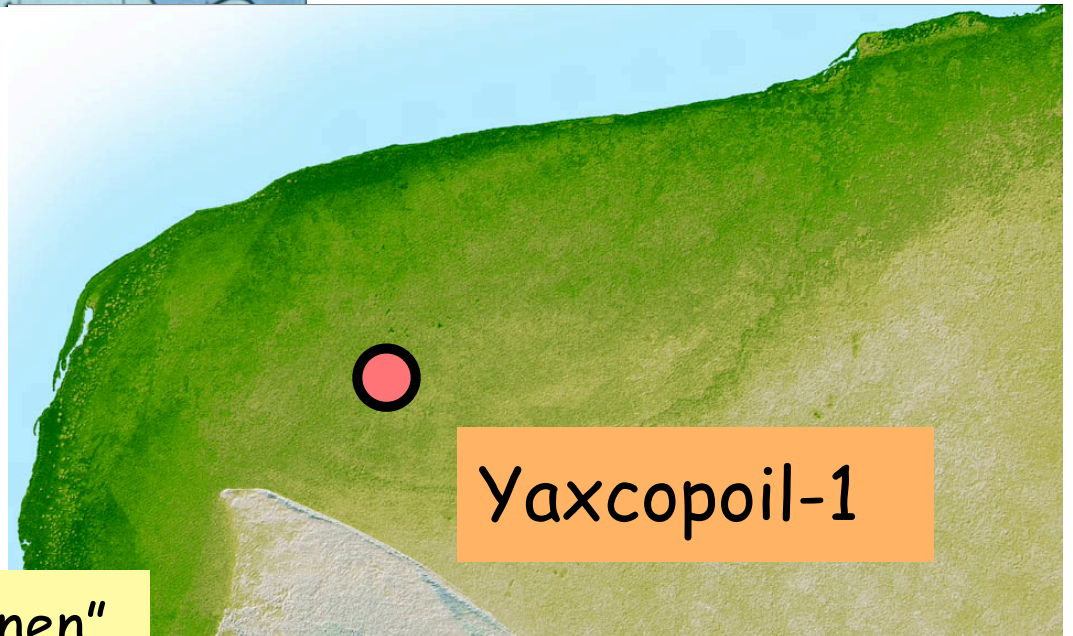
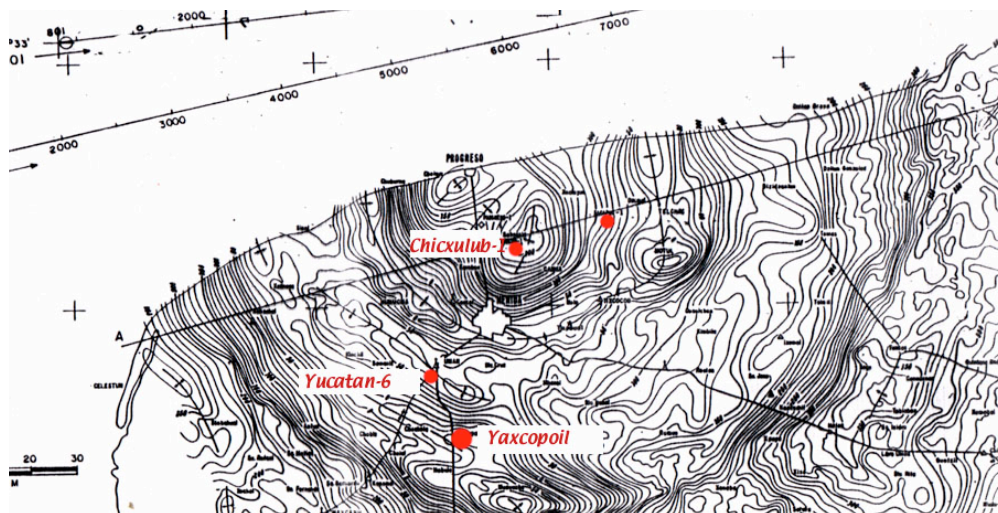
CSDP

Chicxulub crater



Magnetische afwijkingen
Isomilligal contours

Yaxcopoil-1

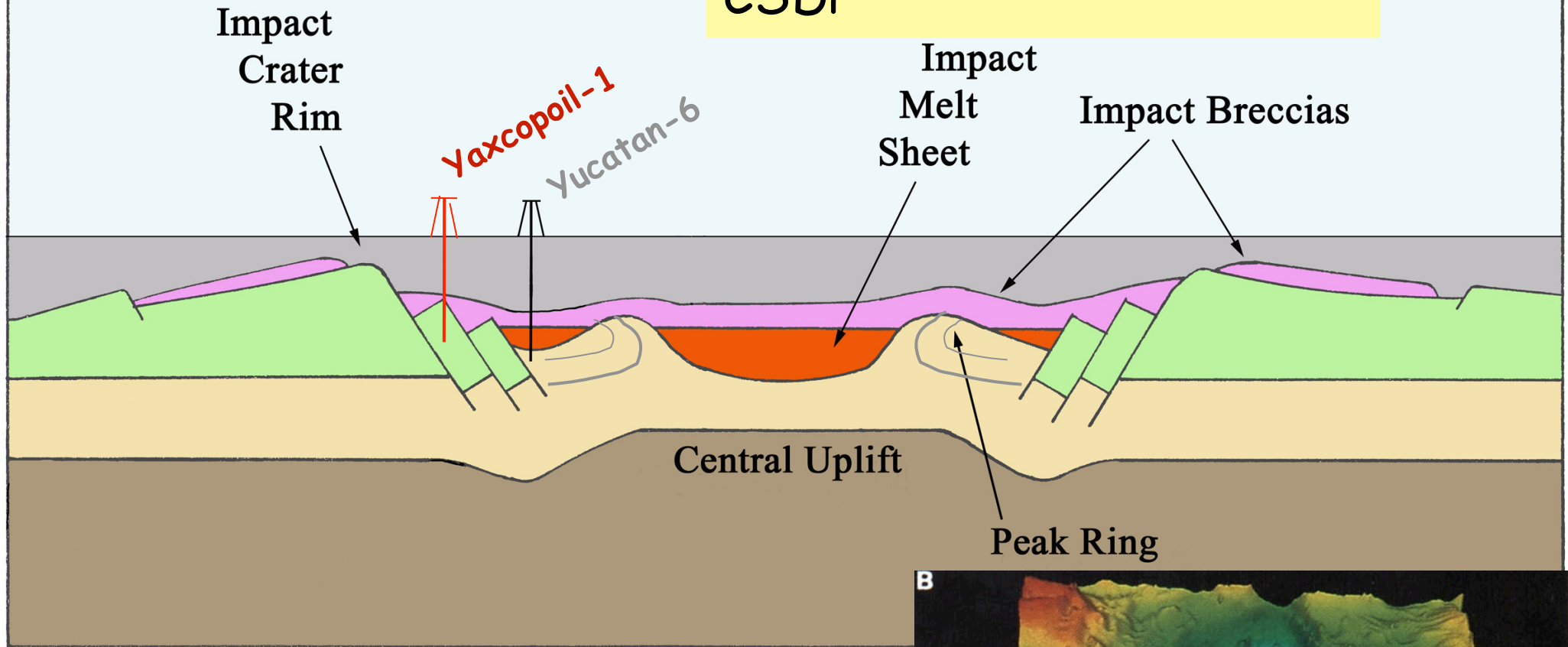


Yaxcopoil-1

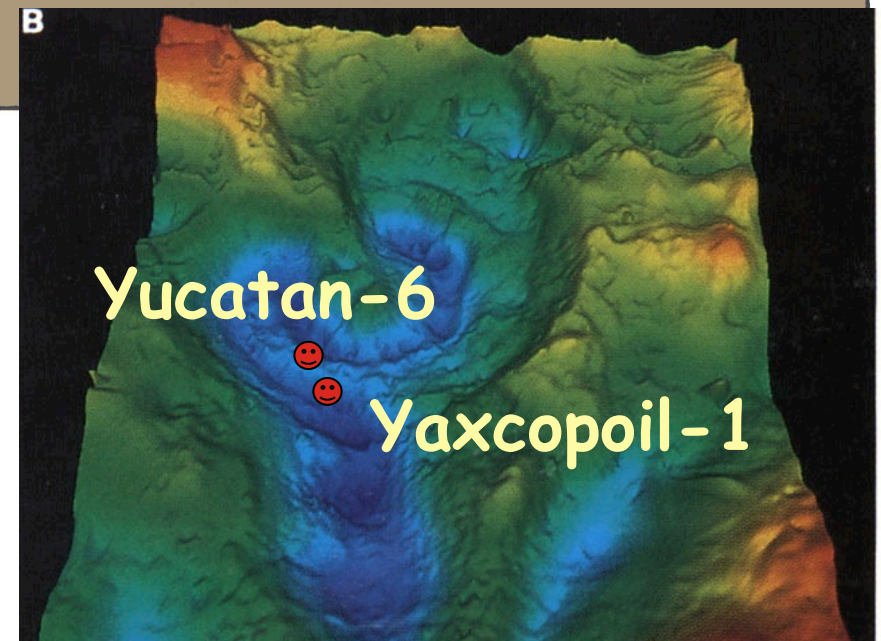
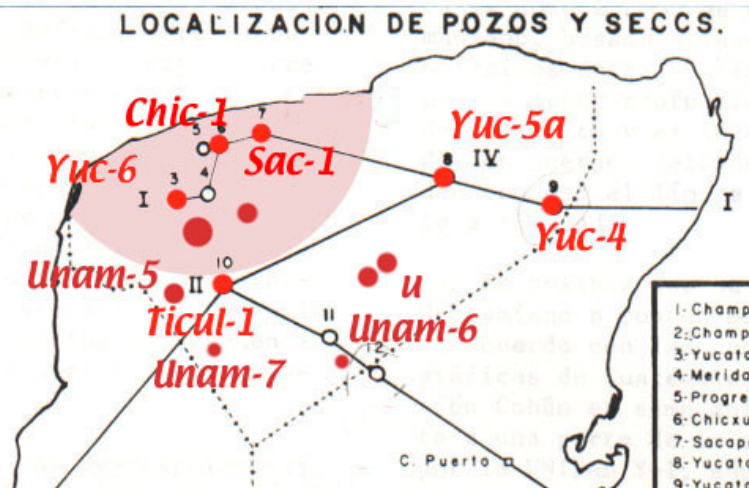
zwaartekrachtsafwijkingen "hoogtelijnen"

Chicxulub drilling project, CSDP

Yaxcopoil-1, where to drill?



David A. Kring, NASA/Univ. Arizona Space Imagery Center



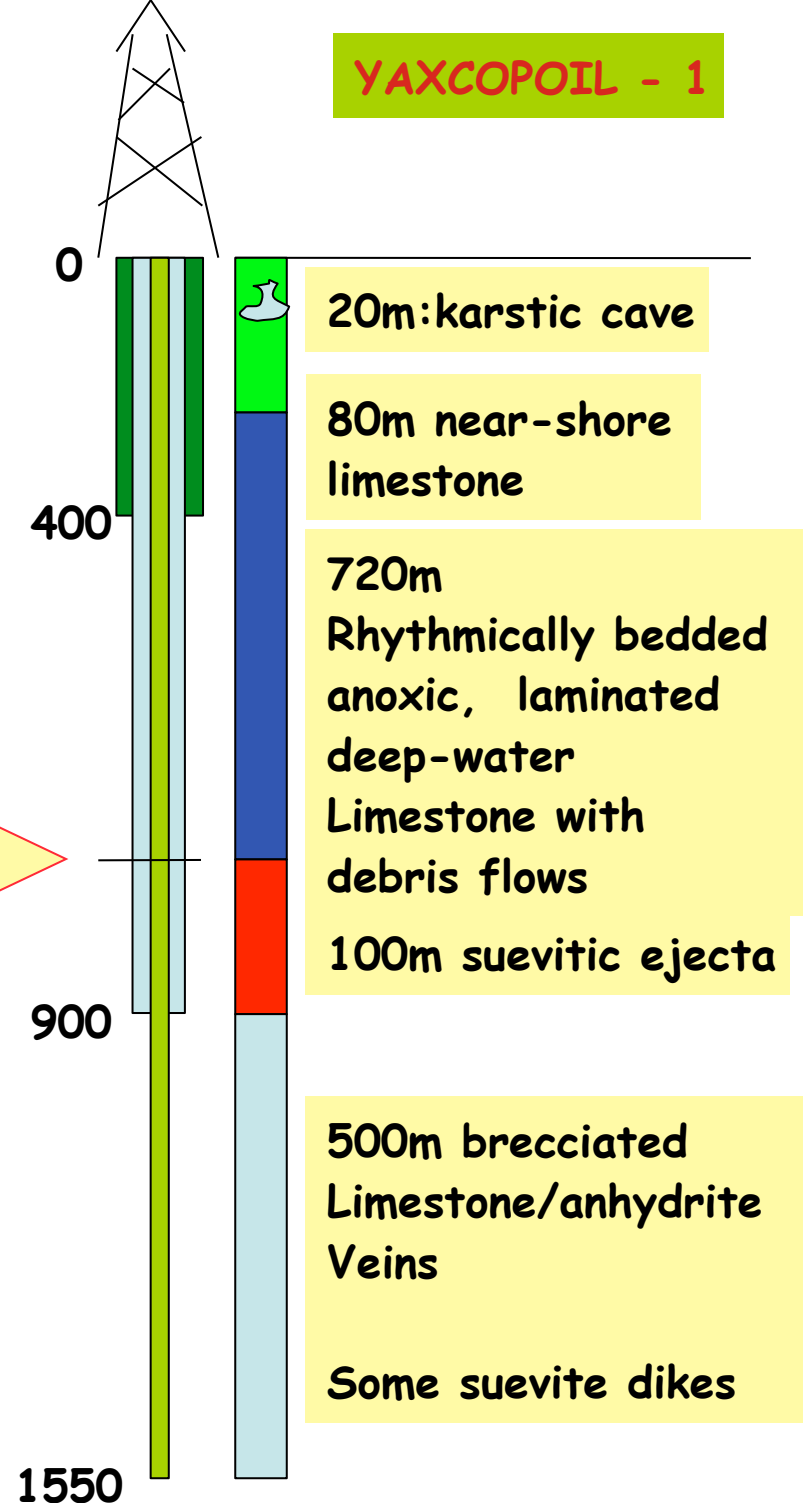


Chicxulub
Scientific
Drilling
Project

CSDP

YAXCOPOIL - 1

CRUCIAL CORE SEGMENT



CRUCIAL CORE SEGMENT

Base Paleocene

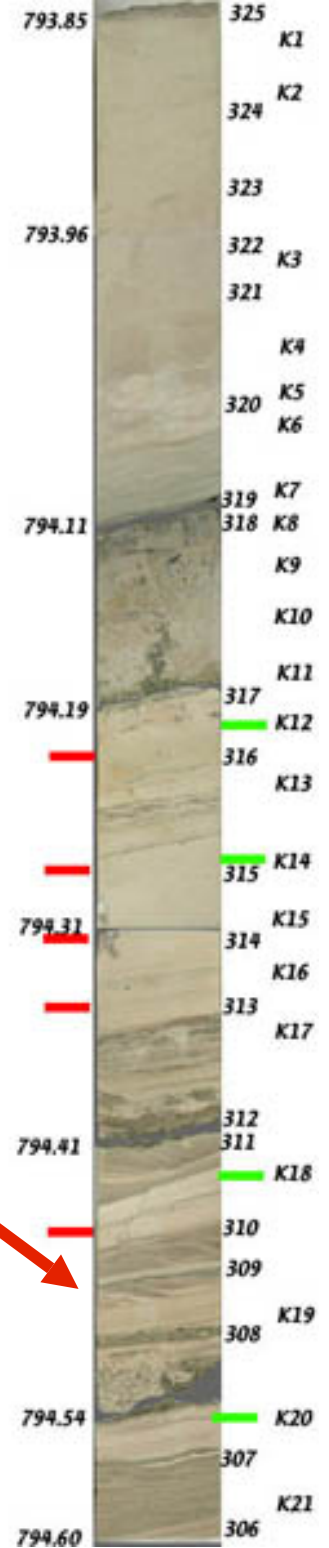
"K/T boundary clay layer"?

Hardground,
With burrows

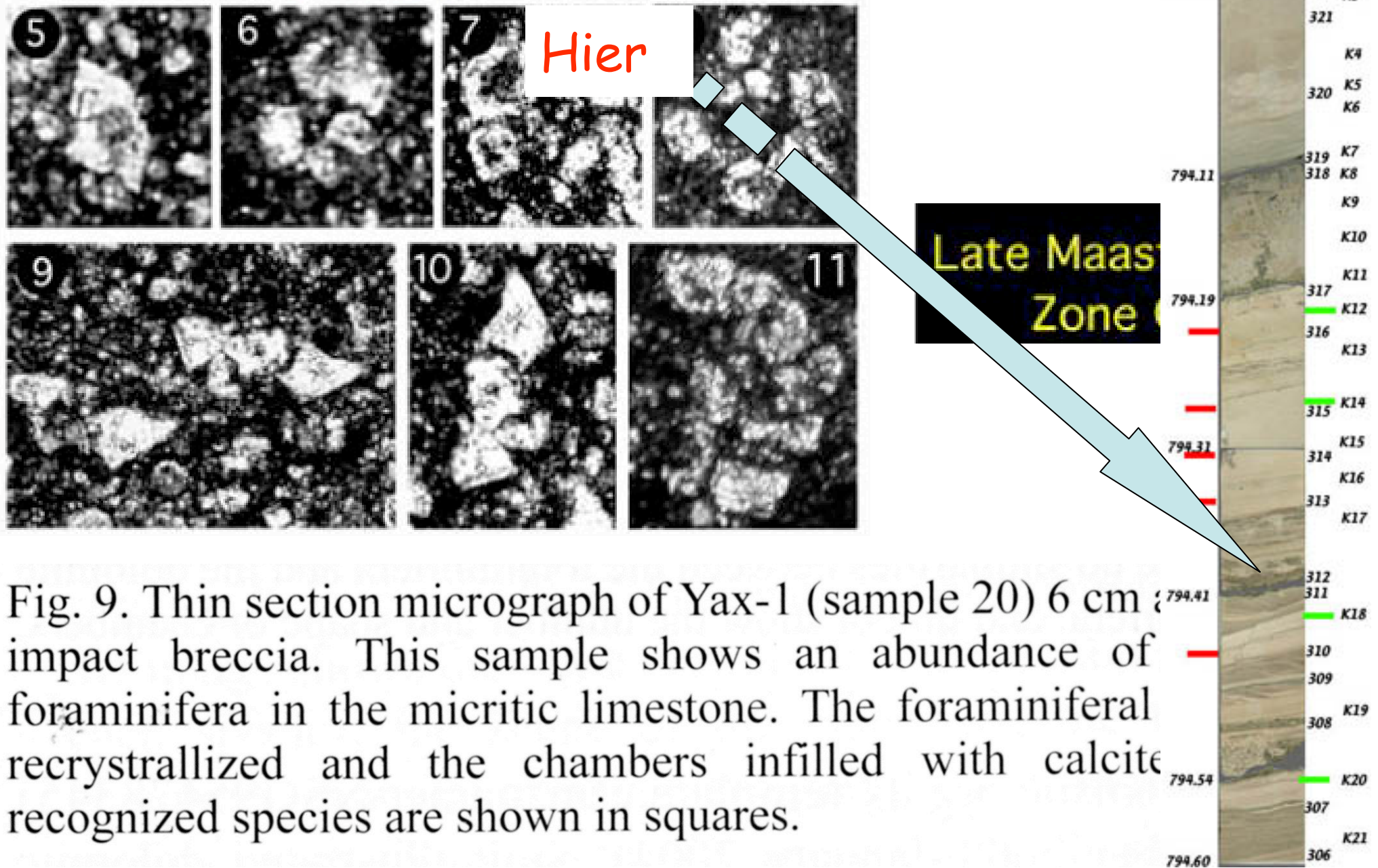
Crossbedded
Dolomitic sands

"rush-back
deposits"

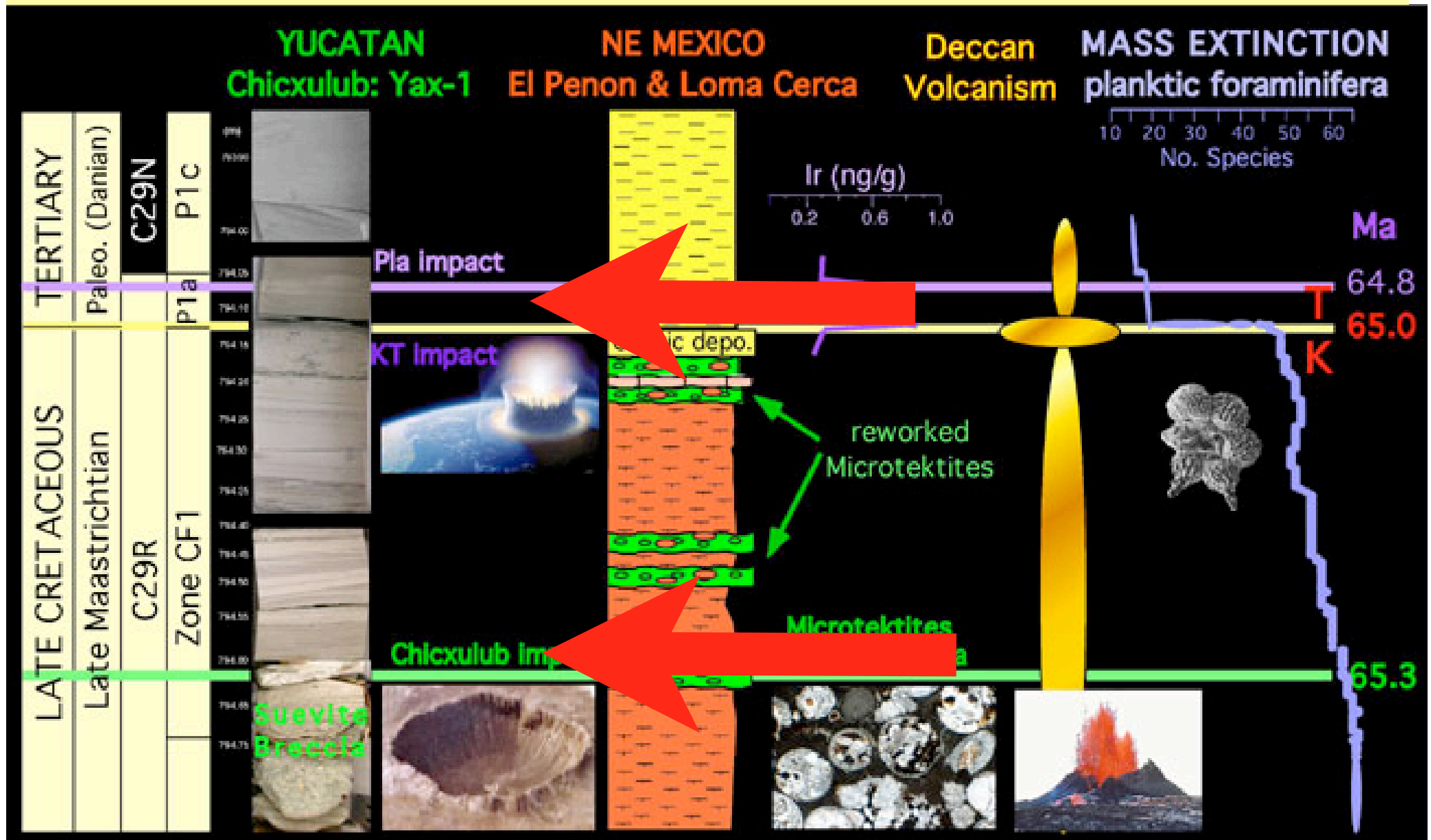
Overgang van impact naar post-impact gesteente



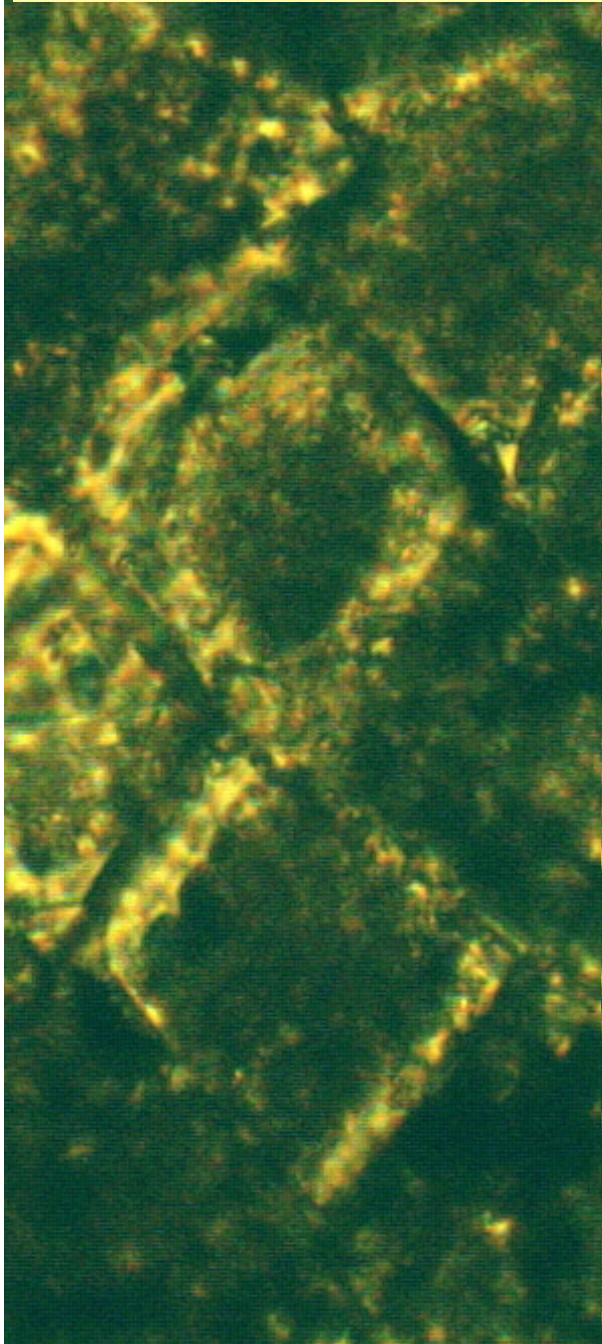
Maar tot onze verbazing denkt Gerta Keller **Hier**
Krijt foraminiferen gevonden te hebben!!



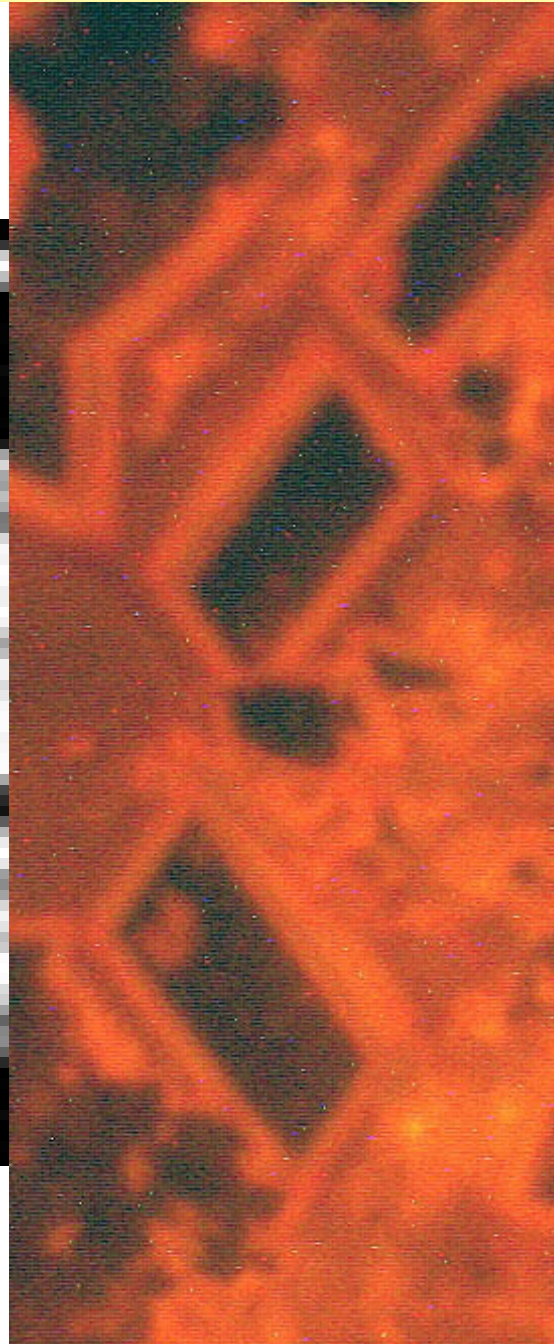
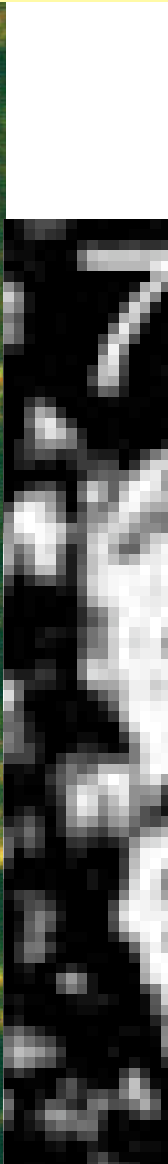
EN DAAROM DENKT KELLER DAT ER TWEE(drie) INSLAGEN HEBBEN
PLAATSGEVONDEN
EEN IN CHICXULUB, MEXICO EN EEN 300.000 JAAR LATER.....Ergens



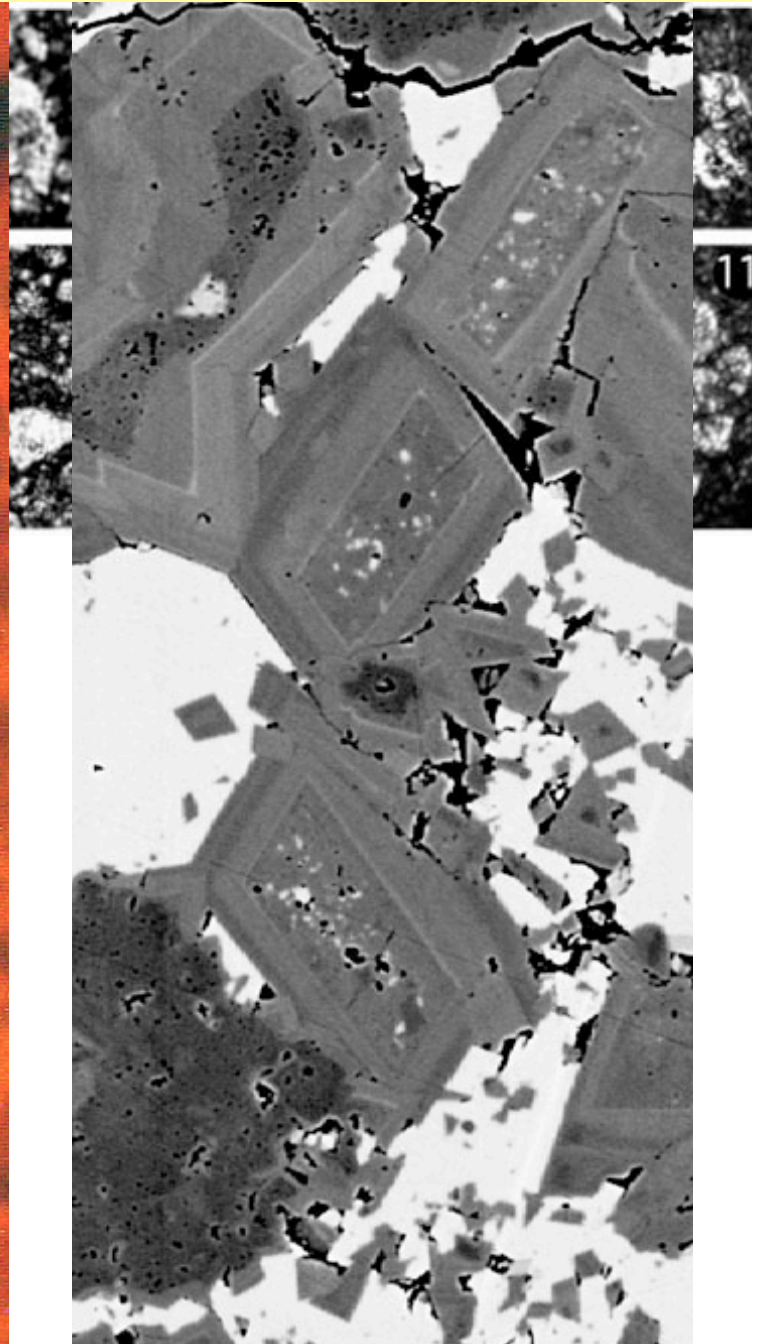
Maar zijn dit wel echte Foraminiferen?, of zijn het gewone dolomietkristallen?



Transmitted light



Cathode Luminescence



SEM backscatter

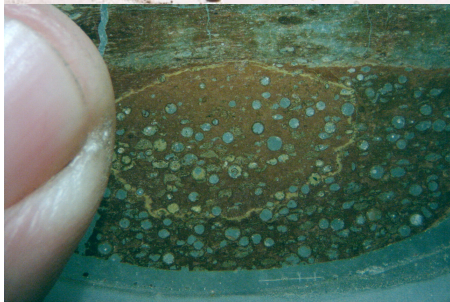
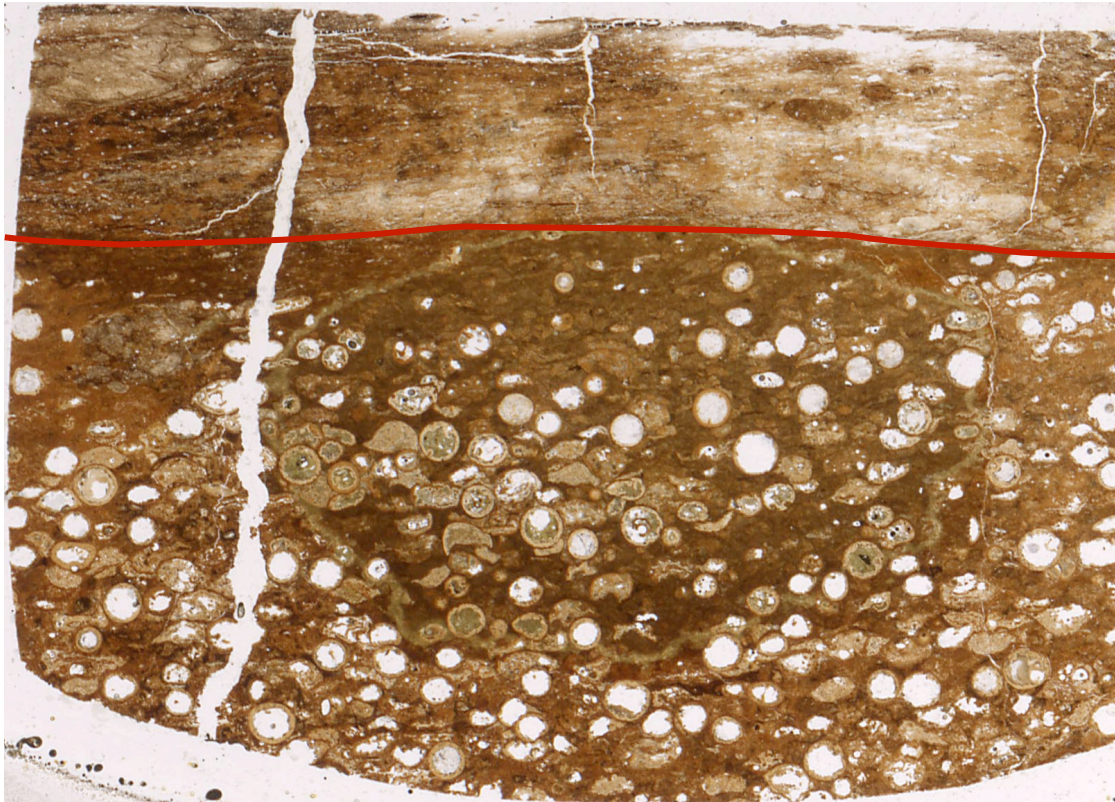
Het beste bewijs voor één inslag in plaats van drie komt uit de steenkoolmoerassen van de Montana tot New Mexico

Er is maar een ejectalaag bewaard gebleven

Raton Basin, New Mexico



Dogie Creek, Wyoming



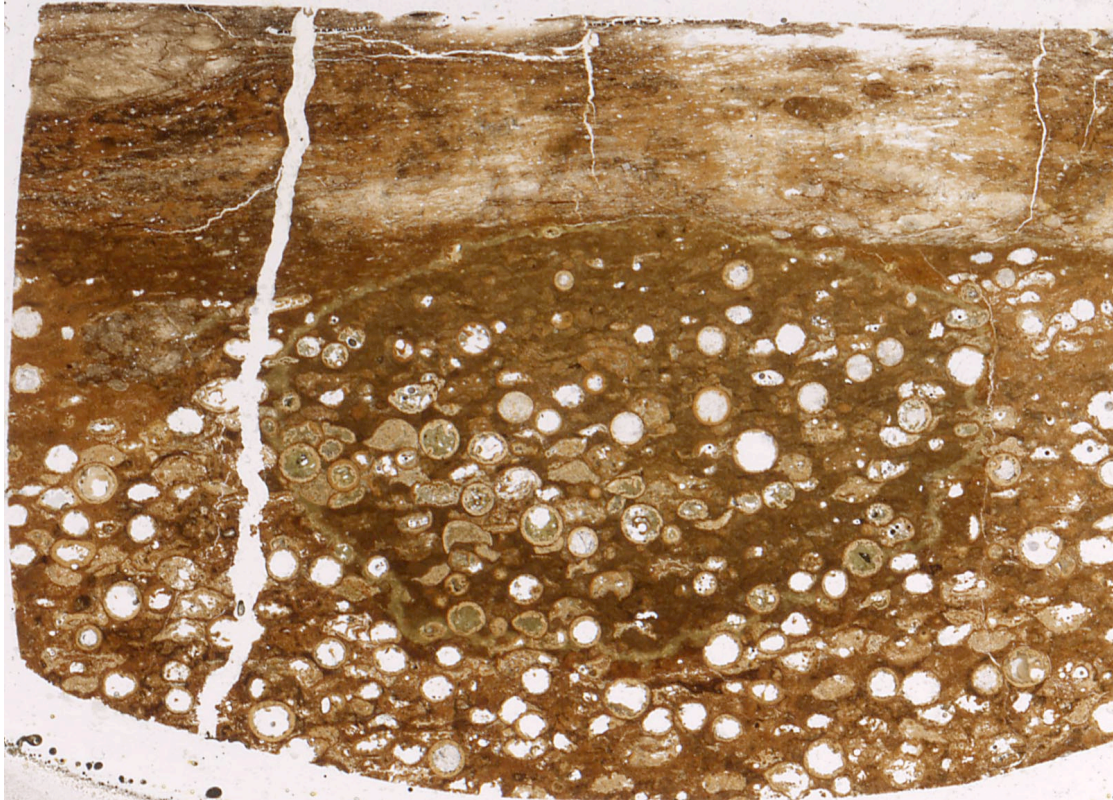
Brownie Butte, Montana



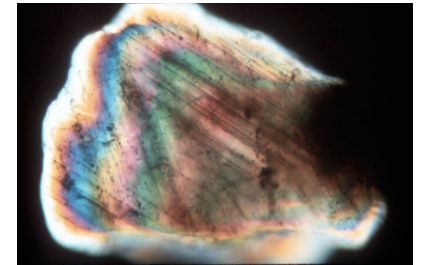
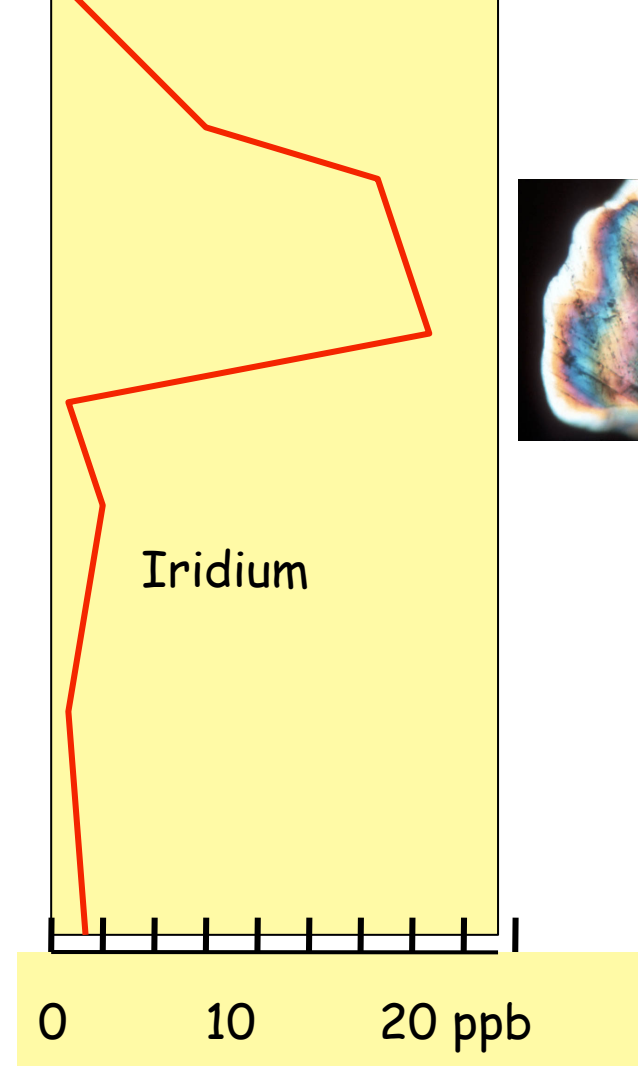
Van Noord naar Zuid is
deze ejectalaag overal
een "dubbele" laag



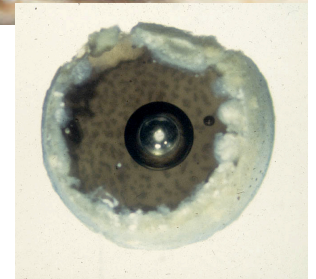
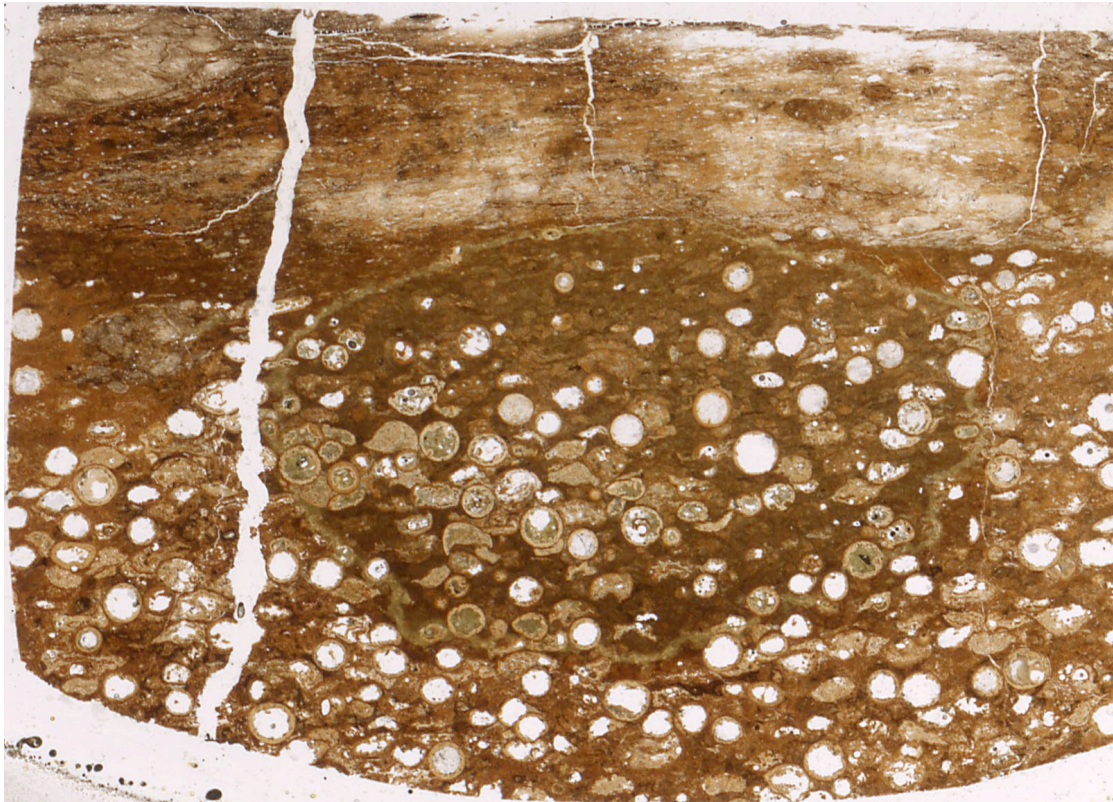
Dogie Creek, Wyoming



De bovenste laag is rijk aan iridium en geschokte kwarts.

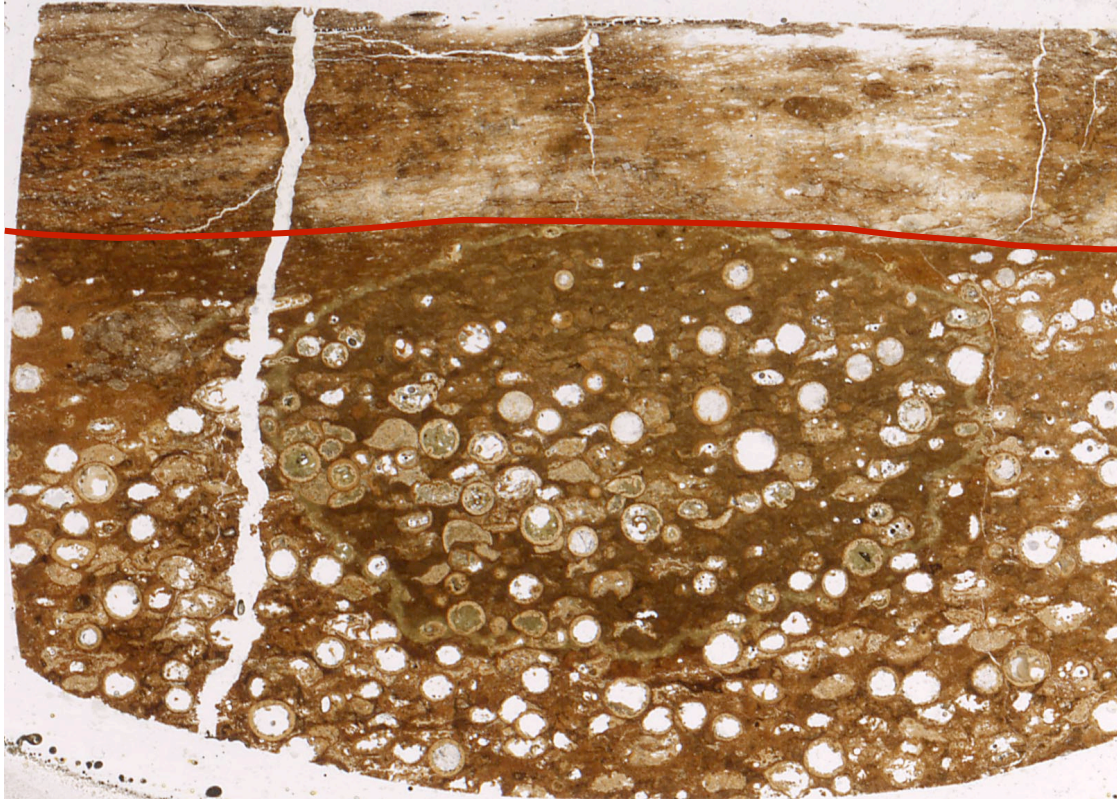


Dogie Creek, Wyoming

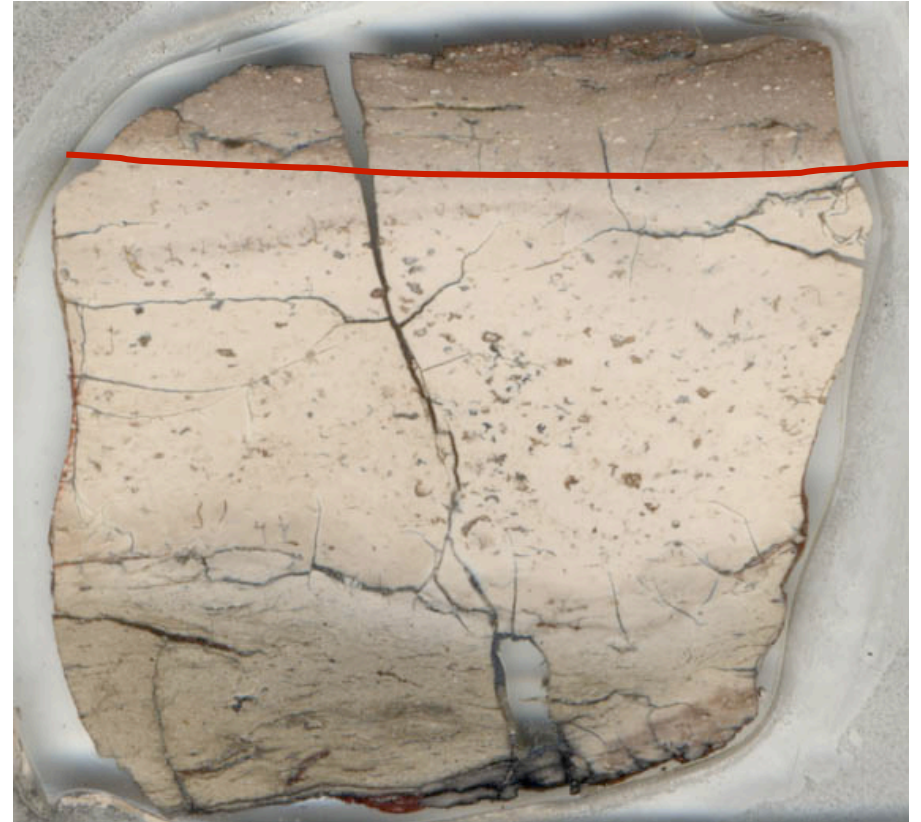


De onderste zit vol met omgezette tektieten

Er komt tussen de laagjes zelfs geen laagje van afgevalen bladeren voor



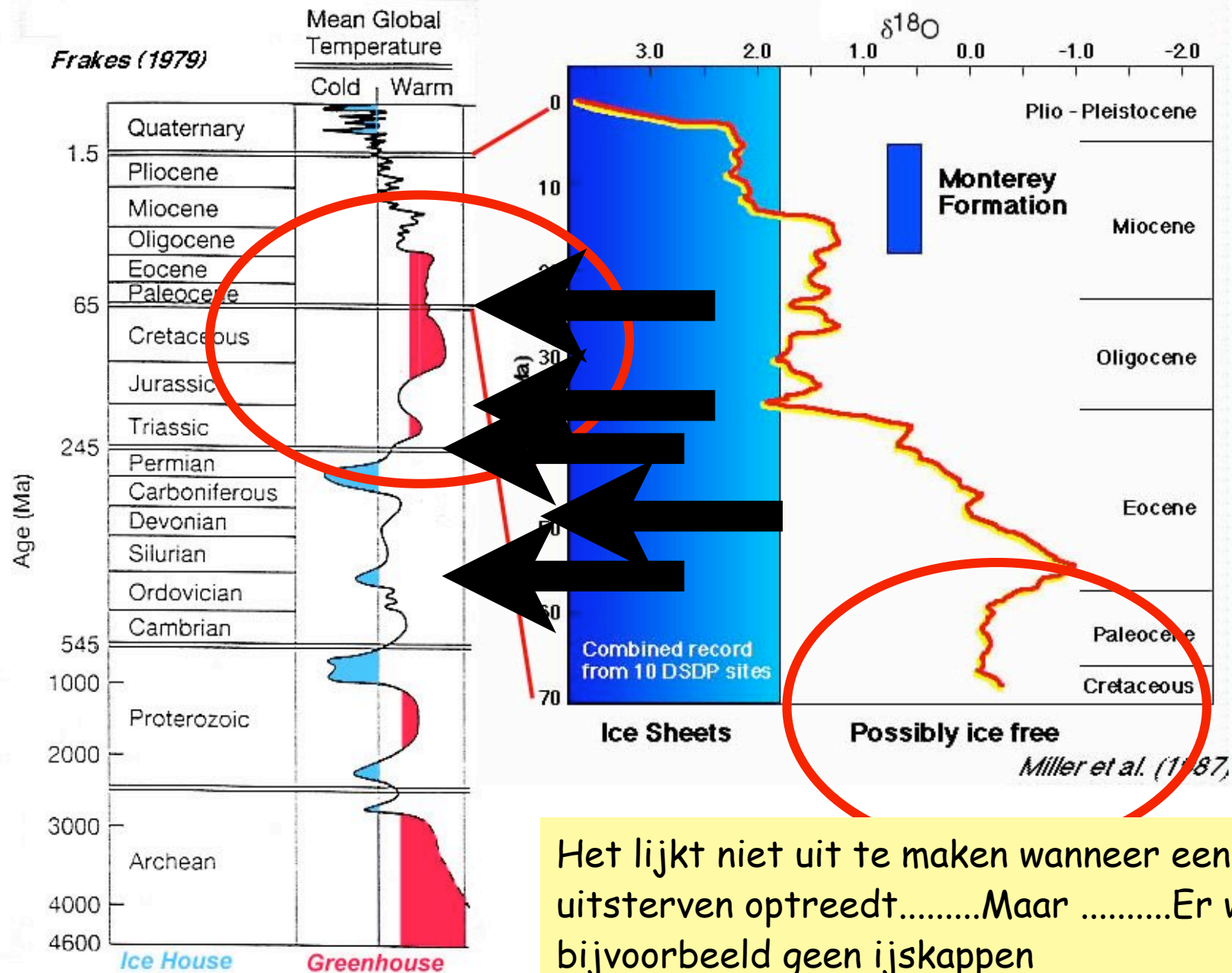
Dogie Creek, Wyoming



Brownie Butte Montana

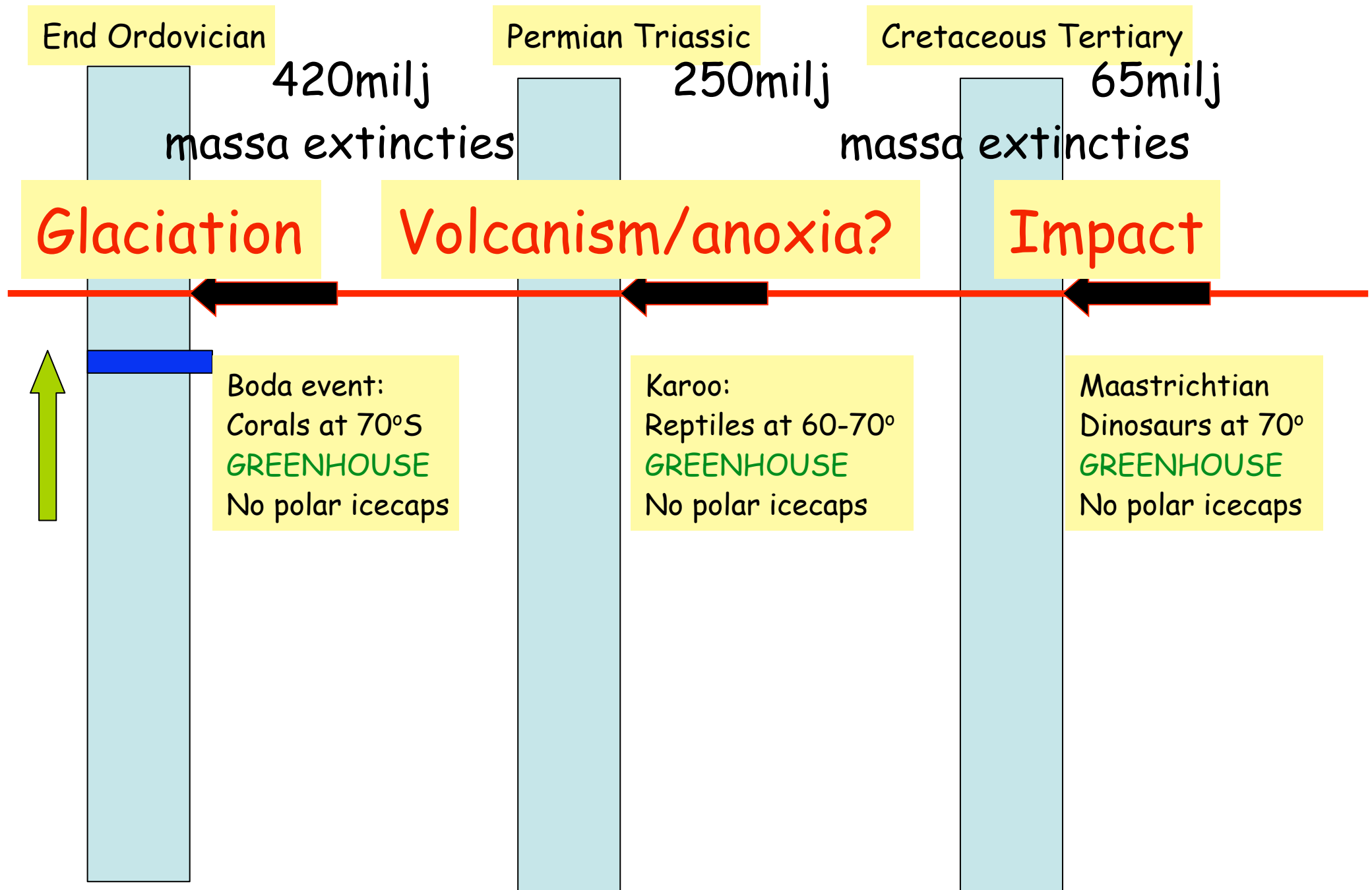
Laat staan 300.000 jaar.....

Maar is de inslag zaligmakend, of komt die wel op een heel ongelukkig moment??

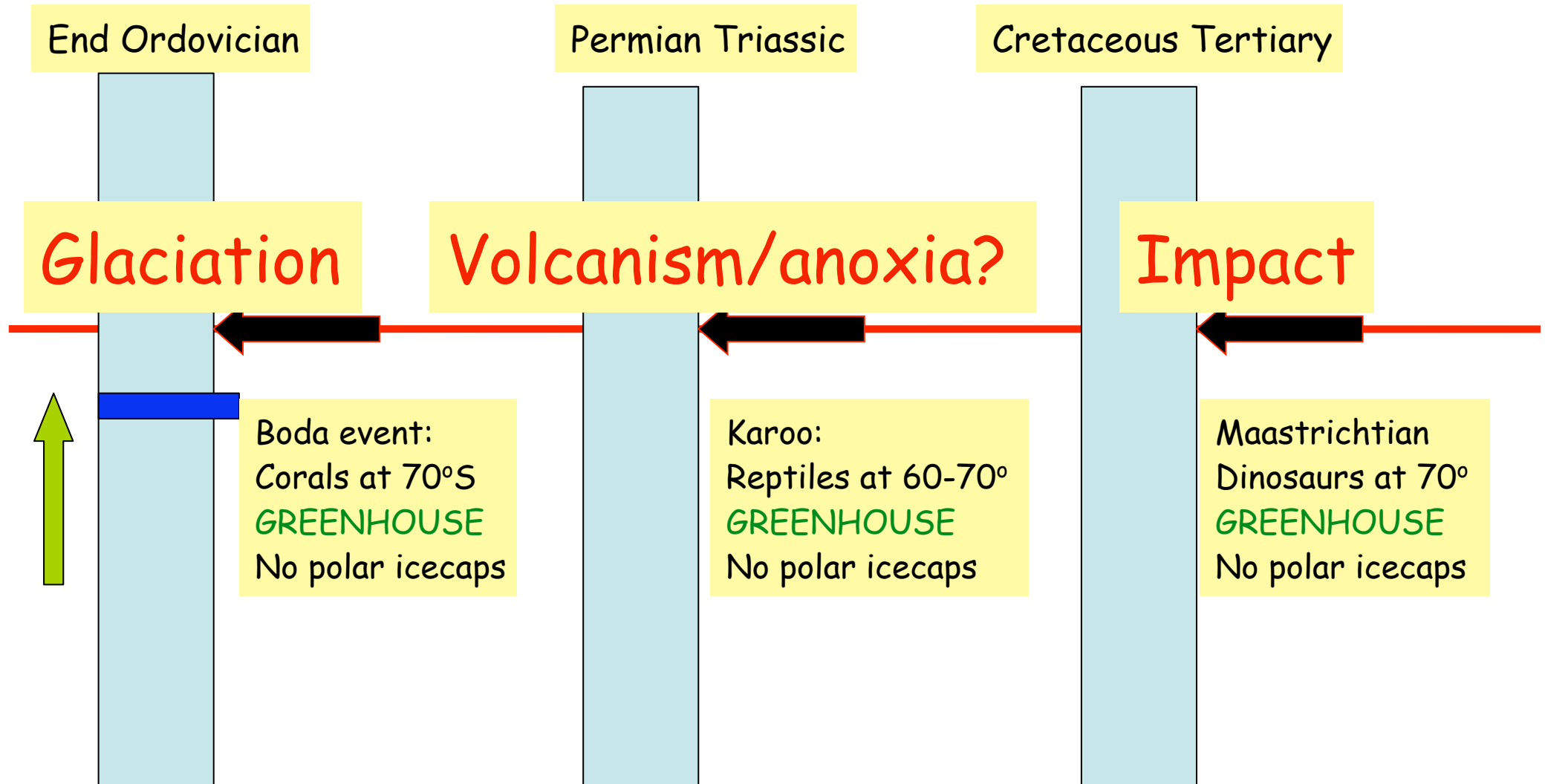


Het lijkt niet uit te maken wanneer een massaal uitsterven optreedt.....MaarEr waren bijvoorbeeld geen ijskappen

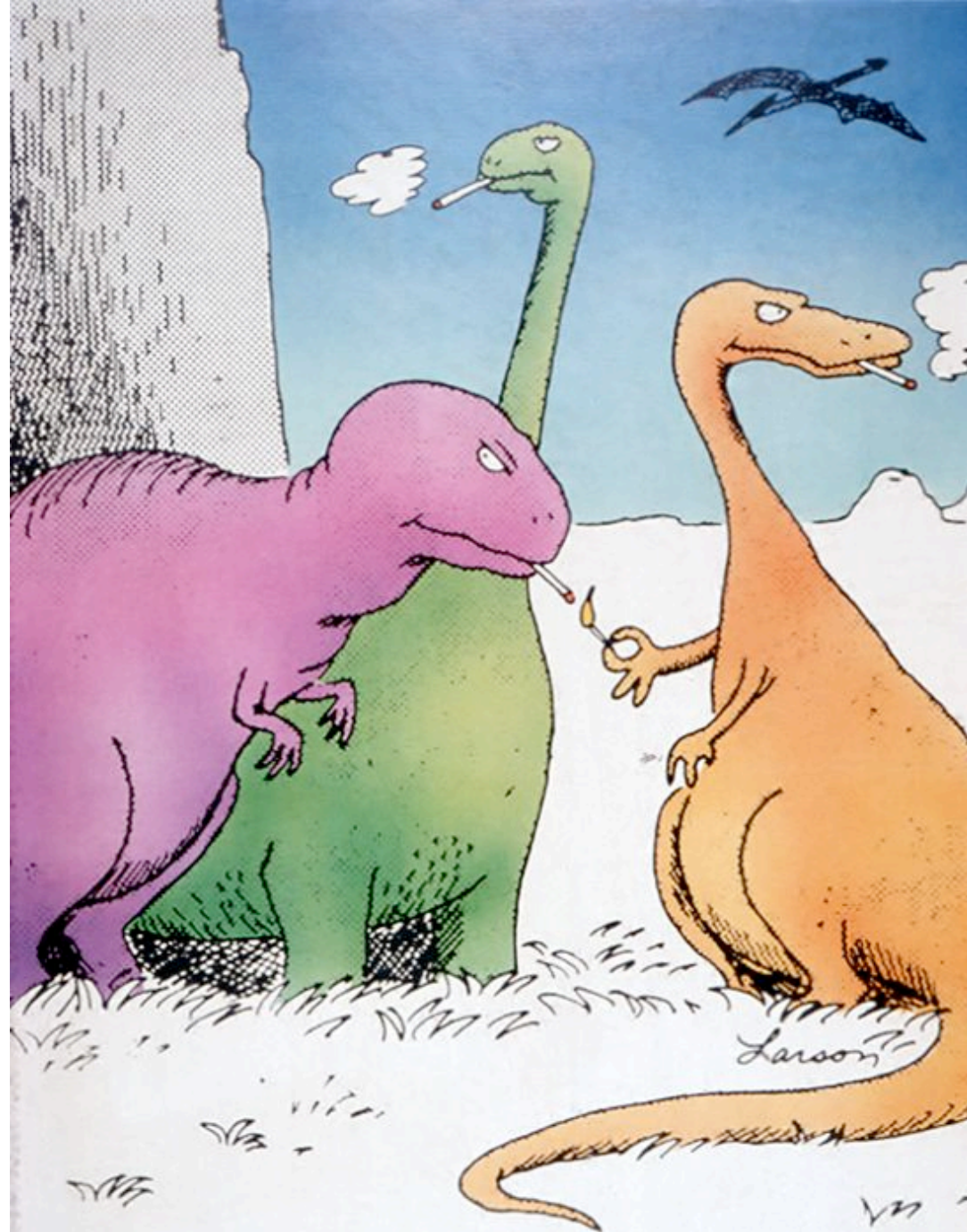
Dus wat is belangrijk bij Massa-extincties?



Dus wat is belangrijk voor Massa-extincties?



Misschien zijn levende wezens wel te veel gespecialiseerd en aangepast aan een warm, gelijkmatig klimaat, waardoor ze kwetsbaar worden voor plotselinge veranderingen??



The real reason dinosaurs became extinct.