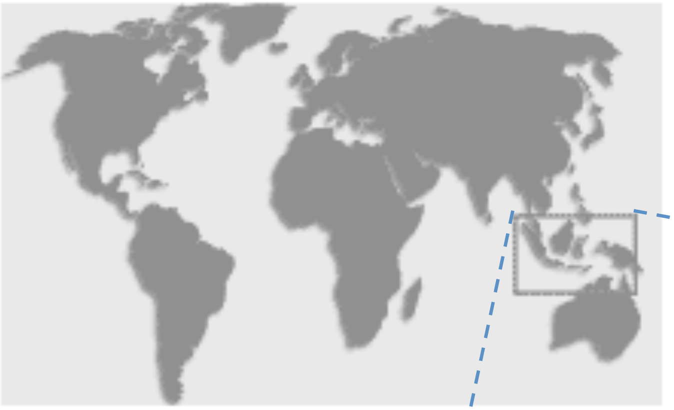
Meeting at Utrecht University,
Tuesday 4th October 2011:

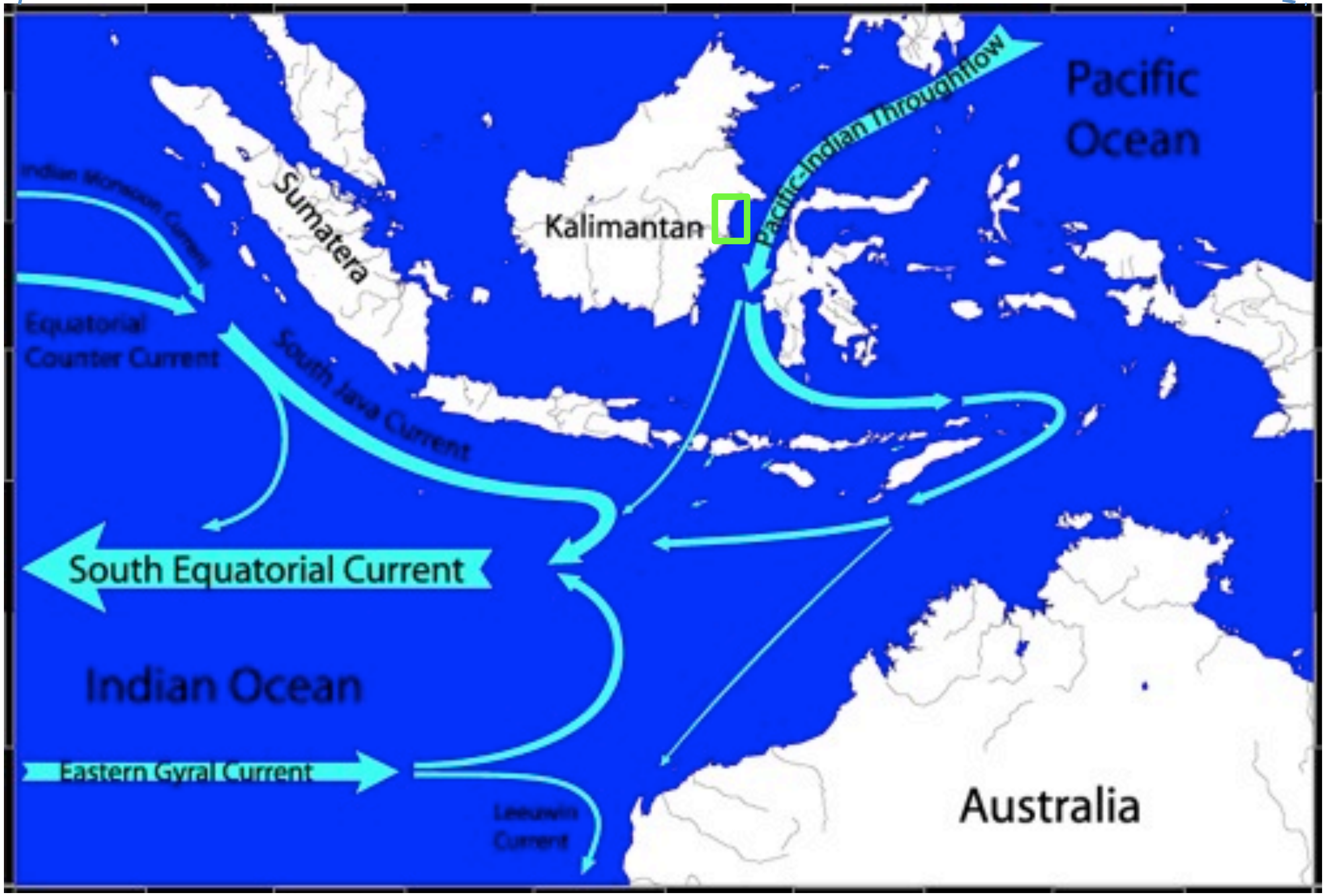
Origins of the South East Asian Marine Biodiversity Maximum

Preliminary results of $^{87}Sr/^{86}Sr$ analysis from corals and molluscs, East Kalimantan, Indonesia:

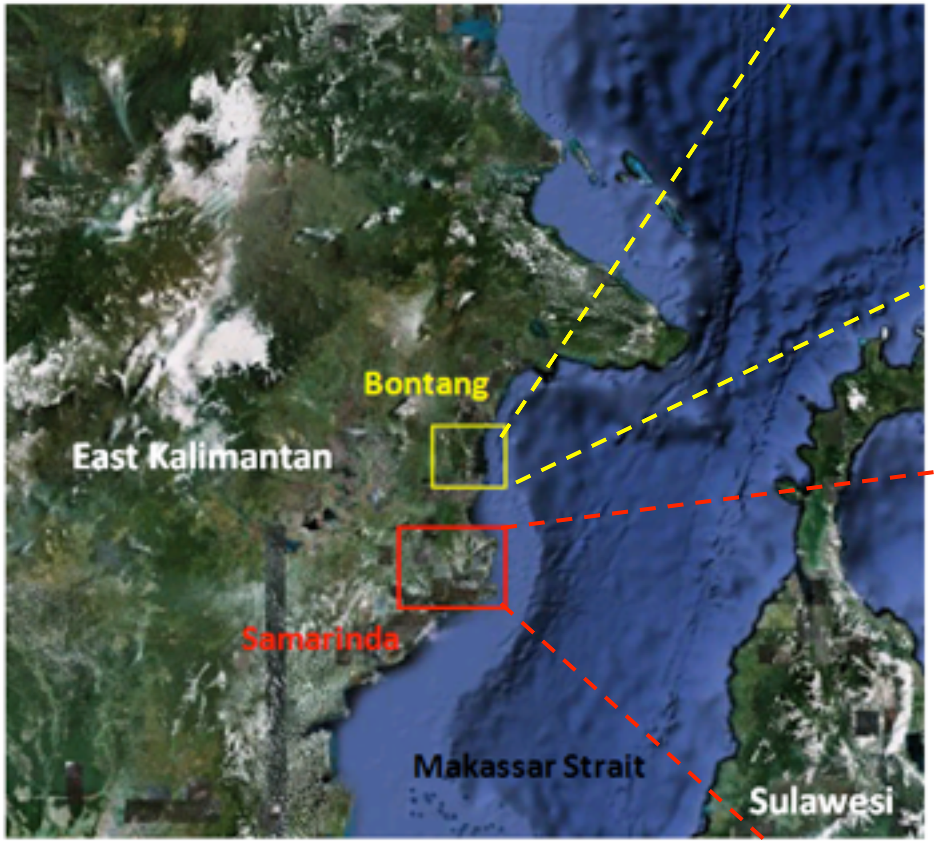
Implications for Chronostratigraphy

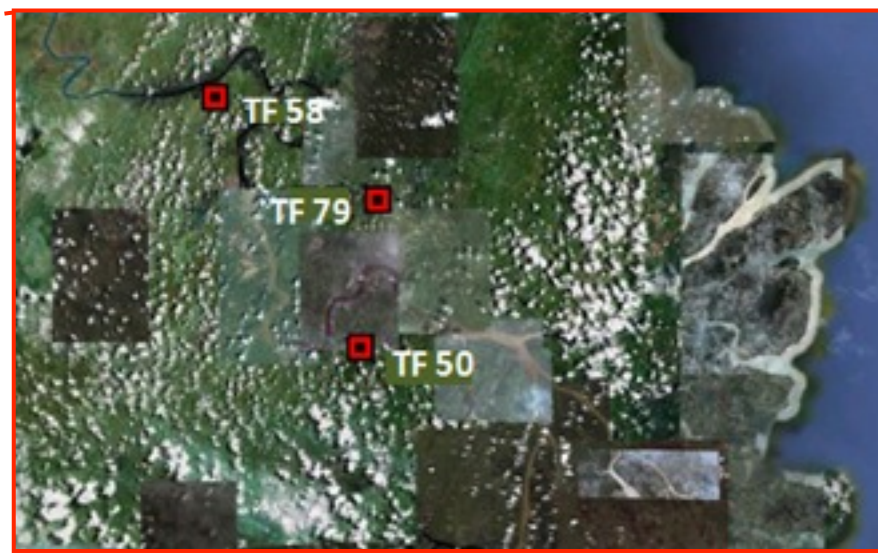
Research Area





Sample Location (NTA 2)



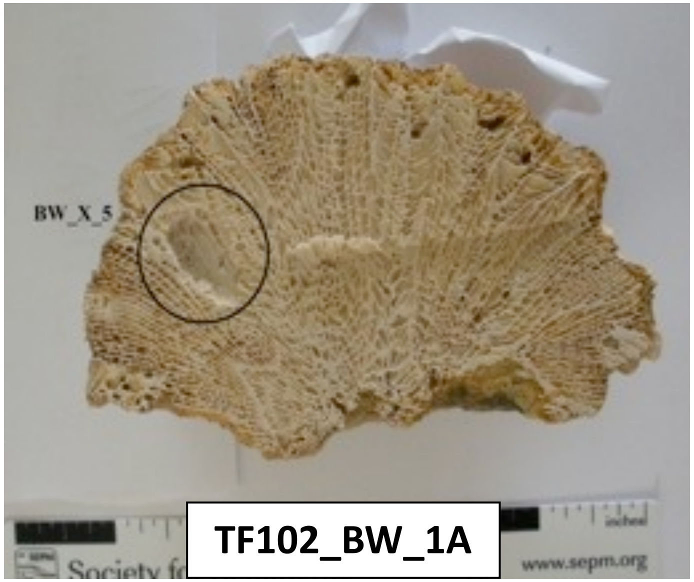


THROUGHFLOW

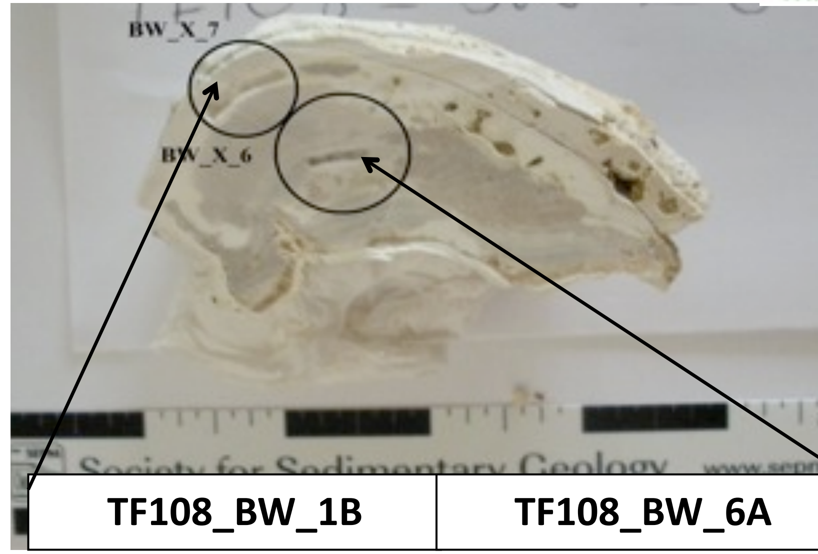
THROUGHFLOW

Analysed samples from Bontang and Samarinda

Samples from Bontang (NTA 2)

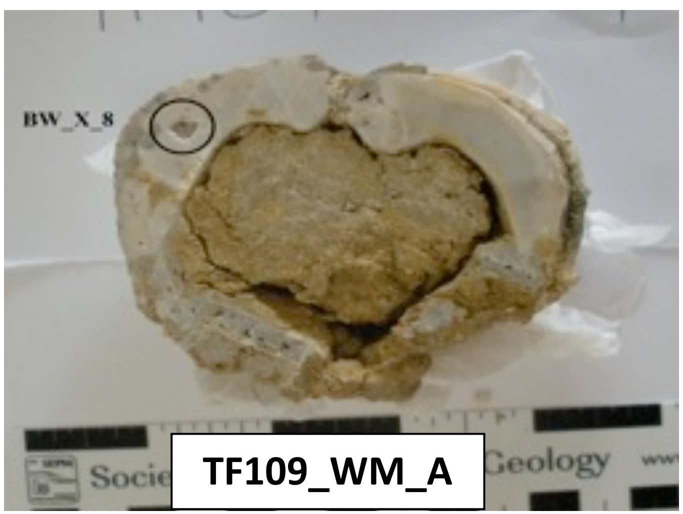


TF102_BW_1A



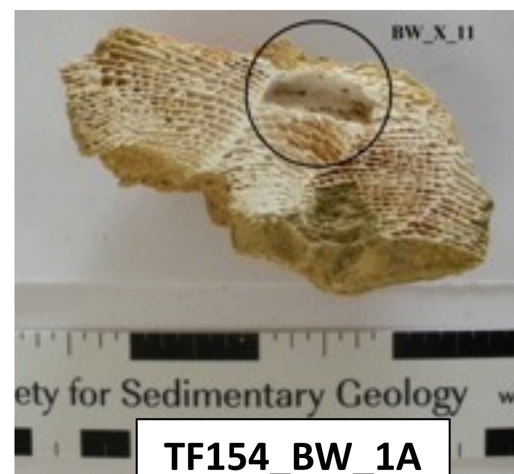
TF108_BW_1B

TF108_BW_6A



TF109_WM_A

TF110_BW_3



TF154_BW_1A

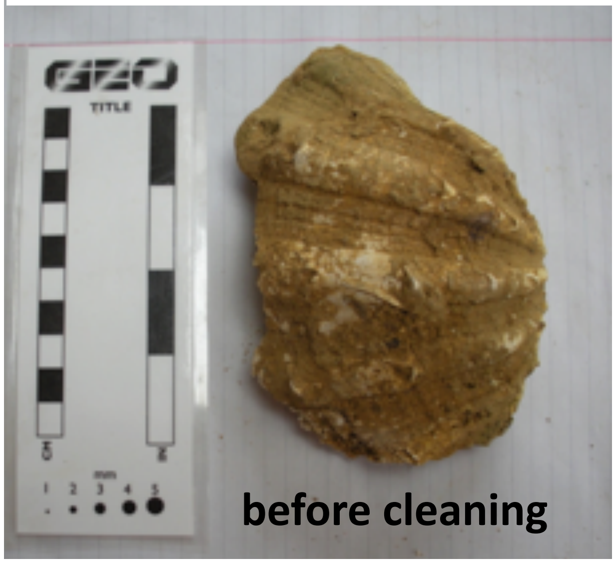
TF102_BW_1: Complete Brain Coral, Bontang, Garden Hotel

before cleaning

after cleaning

THROUGHFLOW

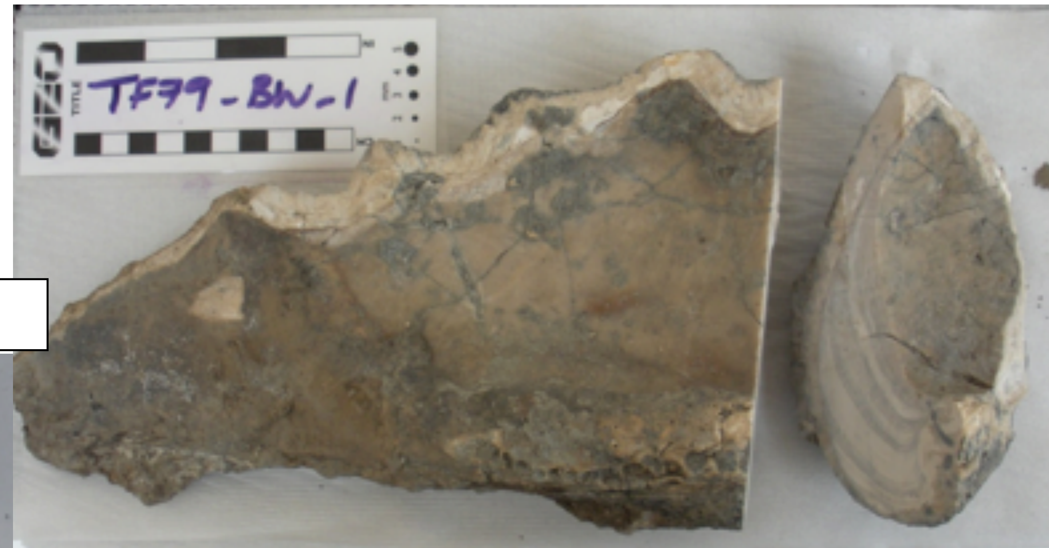
TF108_BW_6A: Tridacna, Bontang, Garden Hotel, Tridacna Gully



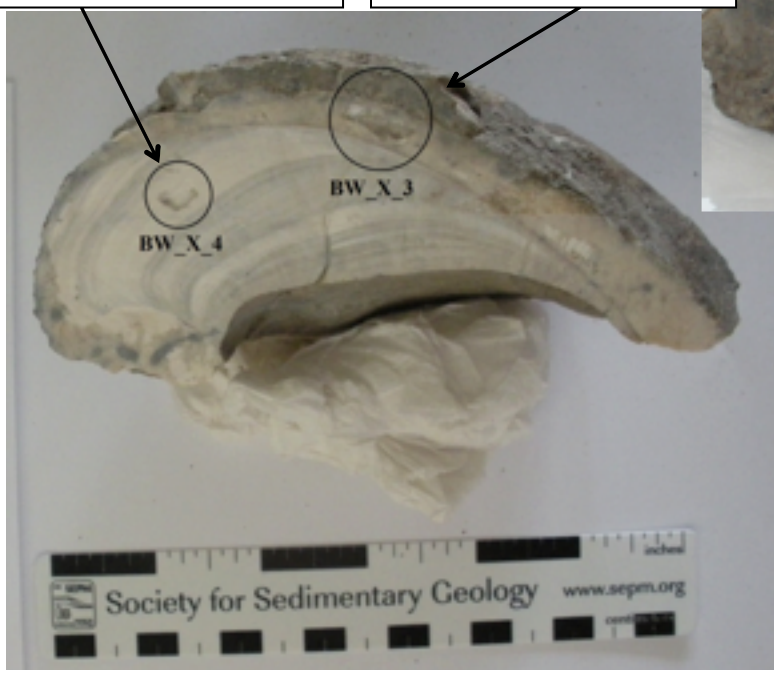
TF109_WM_A: Bivalved Tridacna, Bontang, Garden Hotel

Samples from Samarinda (NTA 2)

TF79_BW_1 : Fragments of a large Tridacna, Samarinda, Batu Putih, Batu Cermen (Tridacna Site)



TF79_BW_1B **TF79_BW_1A**

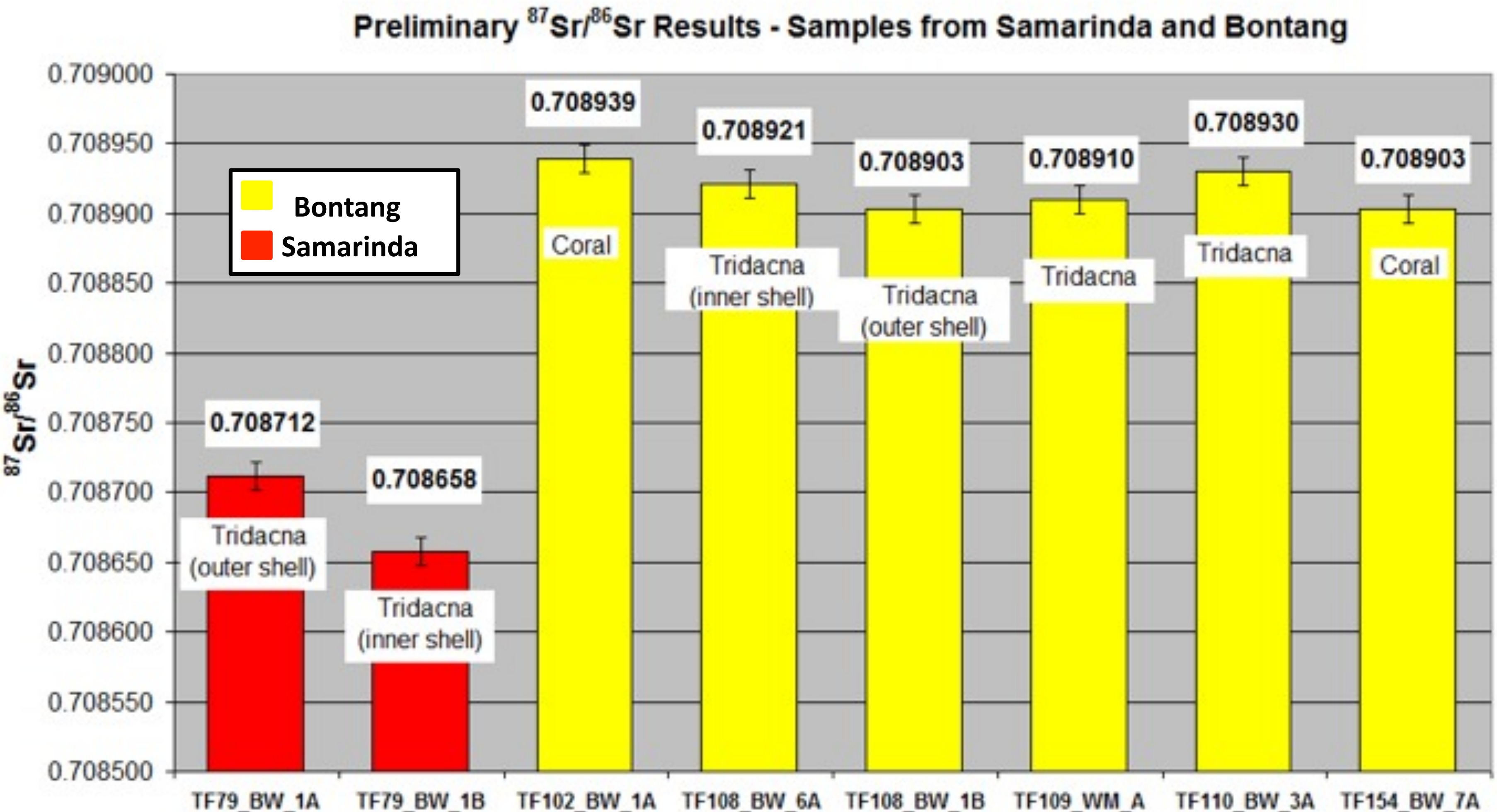


TF50_SR_0172: Oyster, Samarinda, Stadion Palaran

TF58_BW_1: Oyster, Samarinda, Badak

Results of Strontium Isotope Analyses

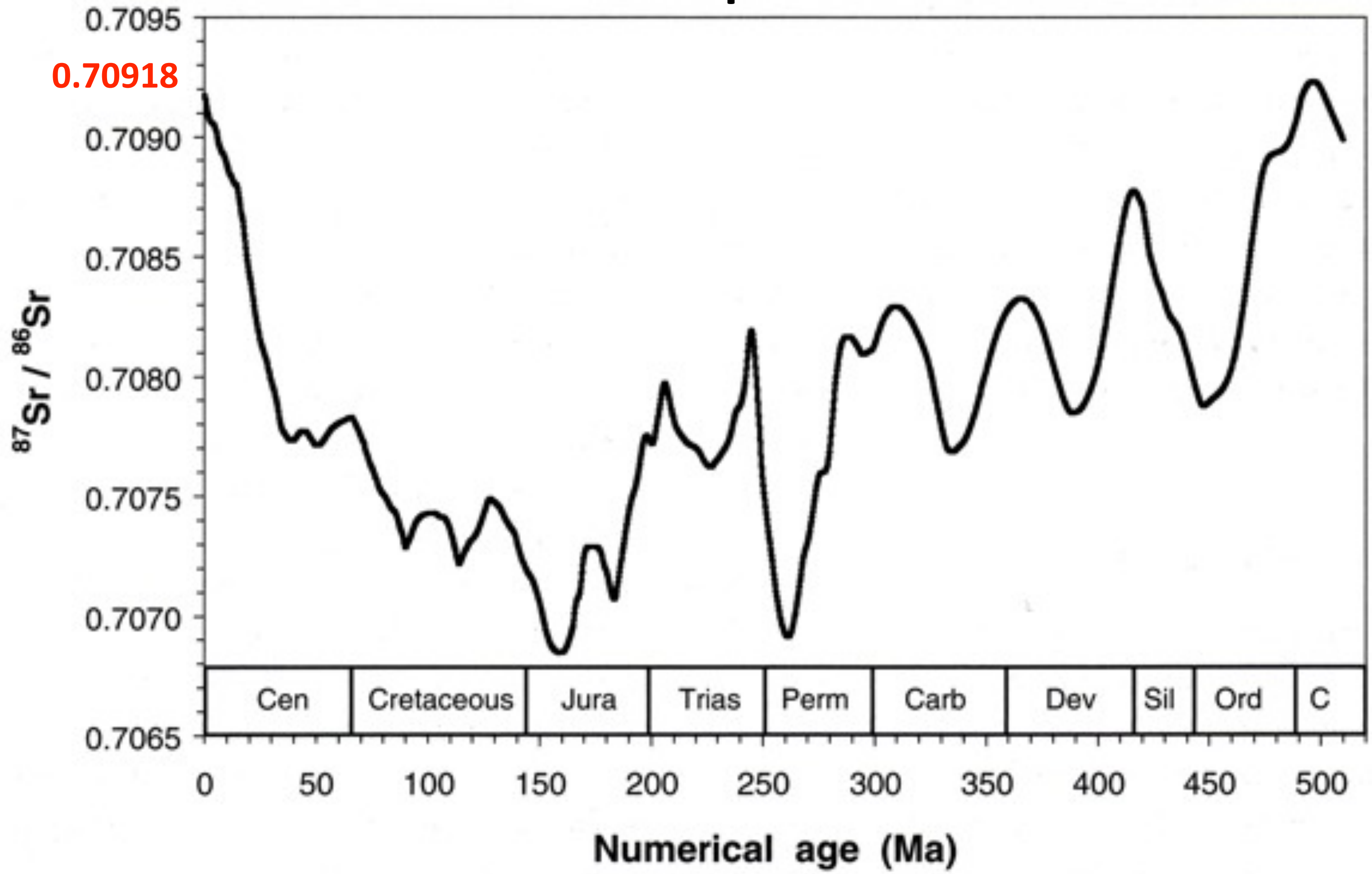
Preliminary Strontium Isotope Results



How can we obtain ages from these data?

Strontium Isotope Stratigraphy (SIS)

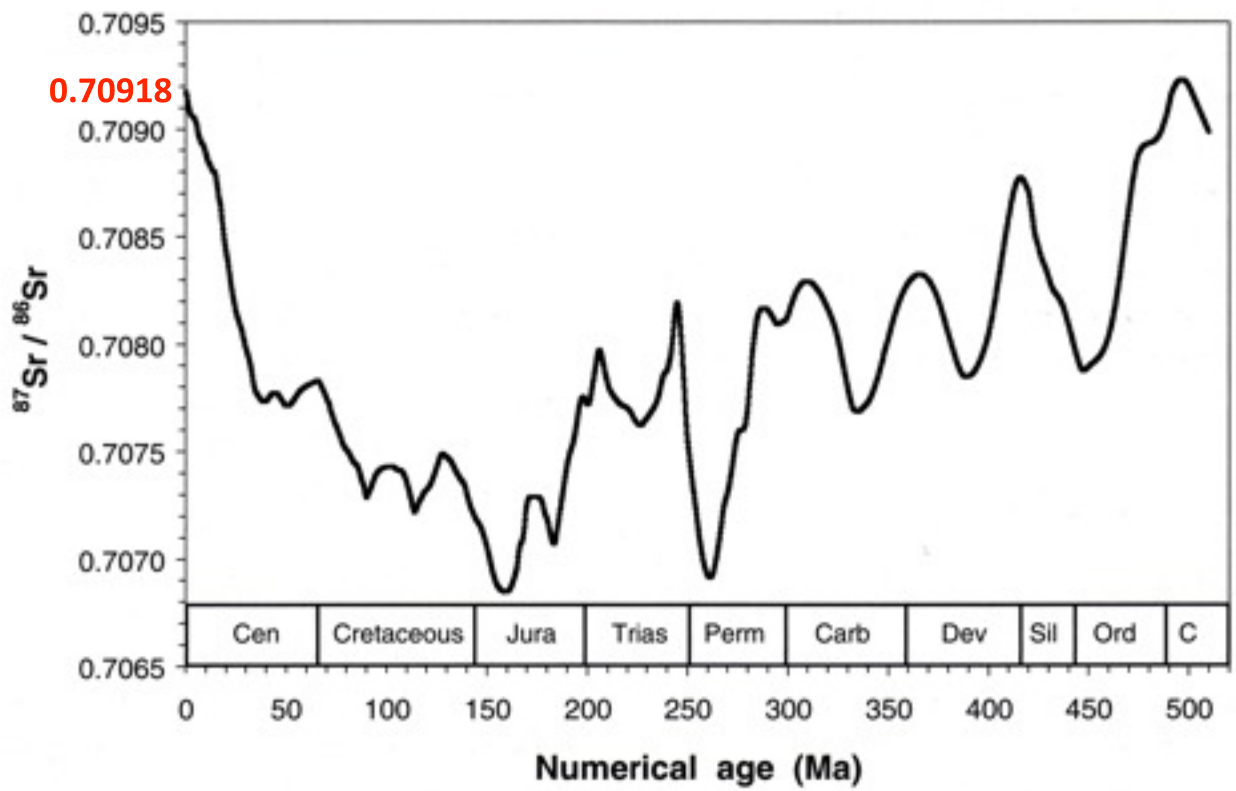
Strontium Isotope Seawater Curve



Variation of $^{87}Sr/^{86}Sr$ through the Phanerozoic time after Mc. Arthur and Howarth (2004).

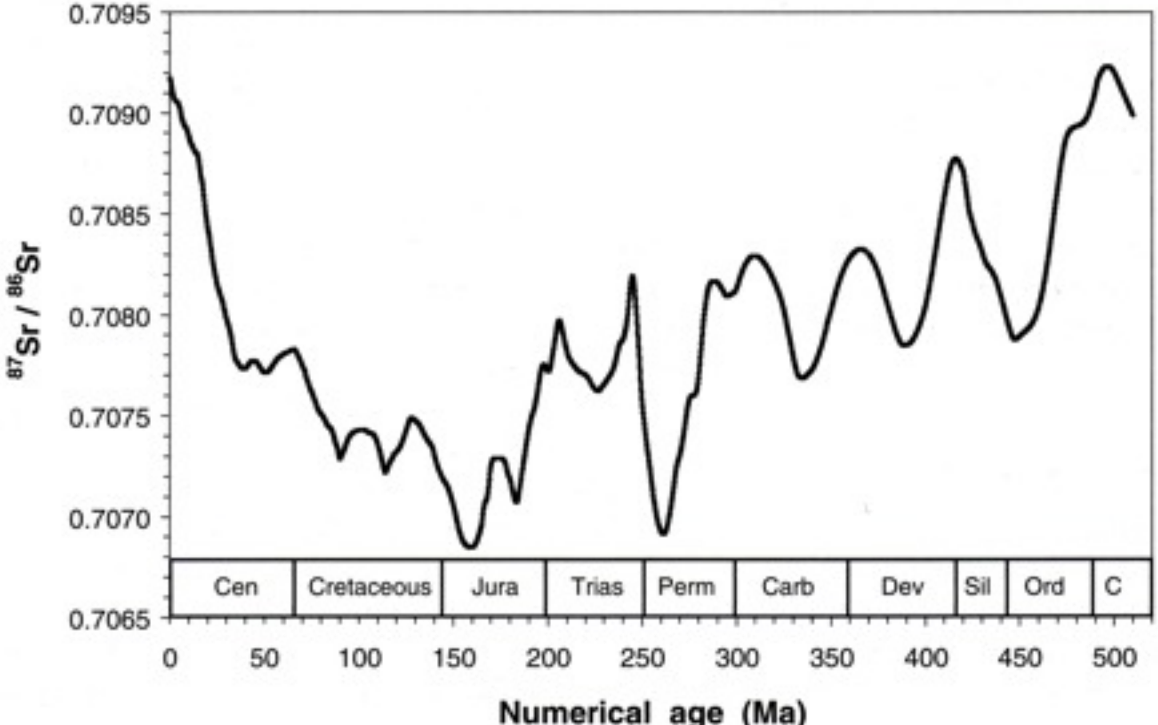
Strontium Isotope Seawater Curve

During their formation marine minerals incorporate and presereve the actual Sr isotope of the ambient seawater at the time of their formation



Variation of 87Sr/86Sr through the Phanerozoic time after Mc. Arthur and Howarth (2004).

Strontium Isotope Stratigraphy (SIS)



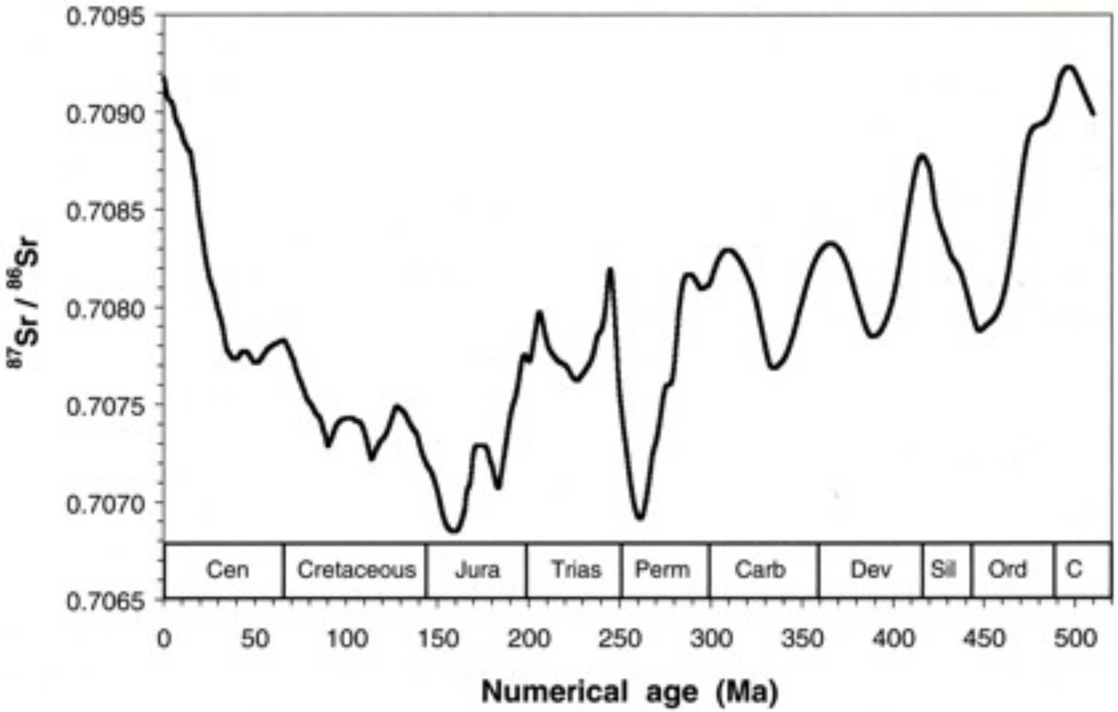
Variation of $^{87}Sr/^{86}Sr$ through the Phanerozoic time after Mc. Arthur and Howarth (2004).

Time-dependent variations of $^{87}Sr/^{86}Sr$ ratio of seawater throughout the Phanerozoic, but

Strontium ratio of seawater measured at any given time is considered to be globally uniform stable –

(Sr-residence time: 10^6 a; Sr-mixing time 10^3 a)

Strontium Isotope Stratigraphy (SIS)



Variation of $^{87}Sr/^{86}Sr$ through the Phanerozoic time after Mc. Arthur and Howarth (2004).

Change in the Sr isotope ratio of the seawater - Response to geological changes

Why does the Sr-isotope ratio of sea water vary at all?

Isotopic evolution of strontium in the oceans is a record of the geological activity of the earth on a global scale

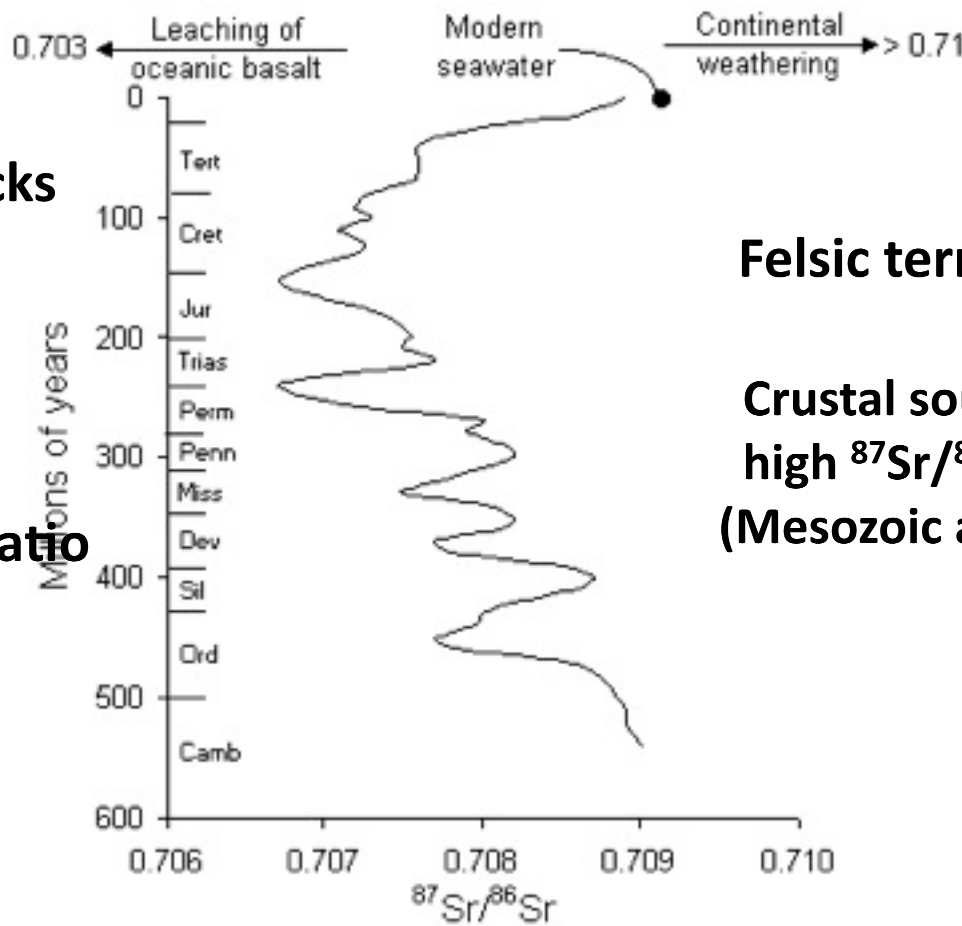
Strontium Isotope Stratigraphy (SIS)

The Sr isotope signature of seawater is derived from the contribution of the

2 different Strontium isotope sources:

Mafic volcanic rocks

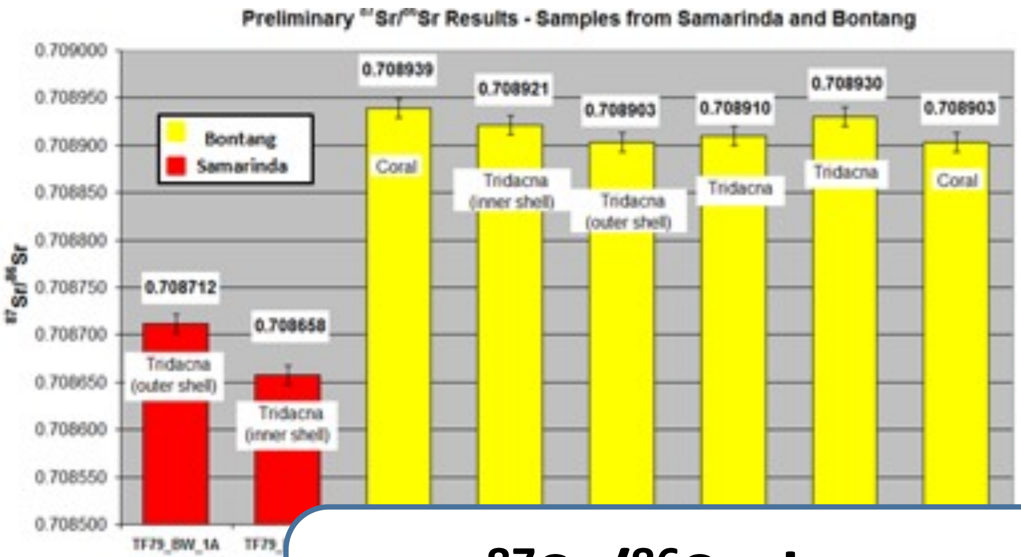
Earth mantle source and therefore low $^{87}Sr/^{86}Sr$-ratio ~ 0.704 (Precamrian age)



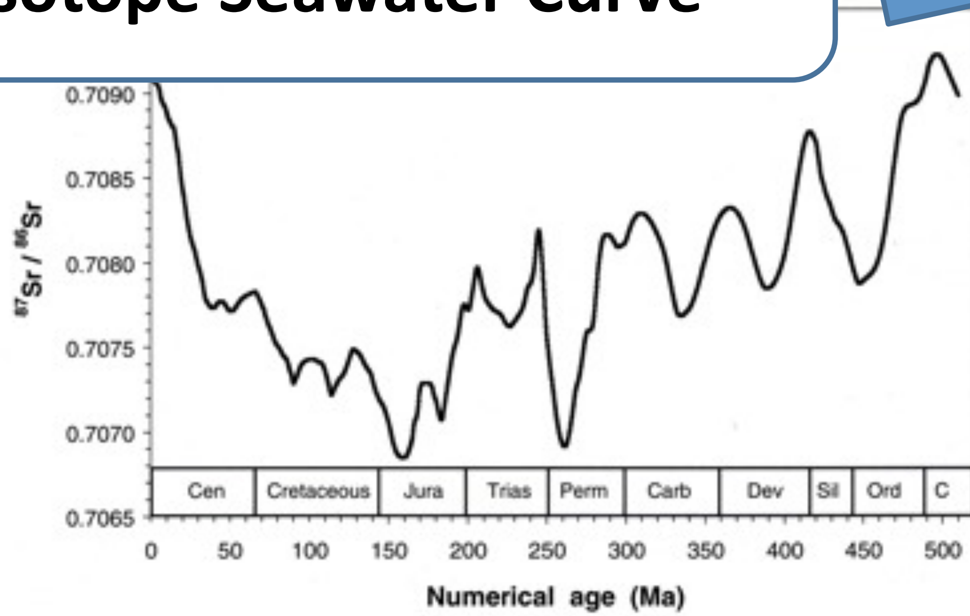
Strontium isotopes in sedimentary rocks throughout Phanerozoic time (modified from Veizer (1989).

Felsic terrigenous rocks

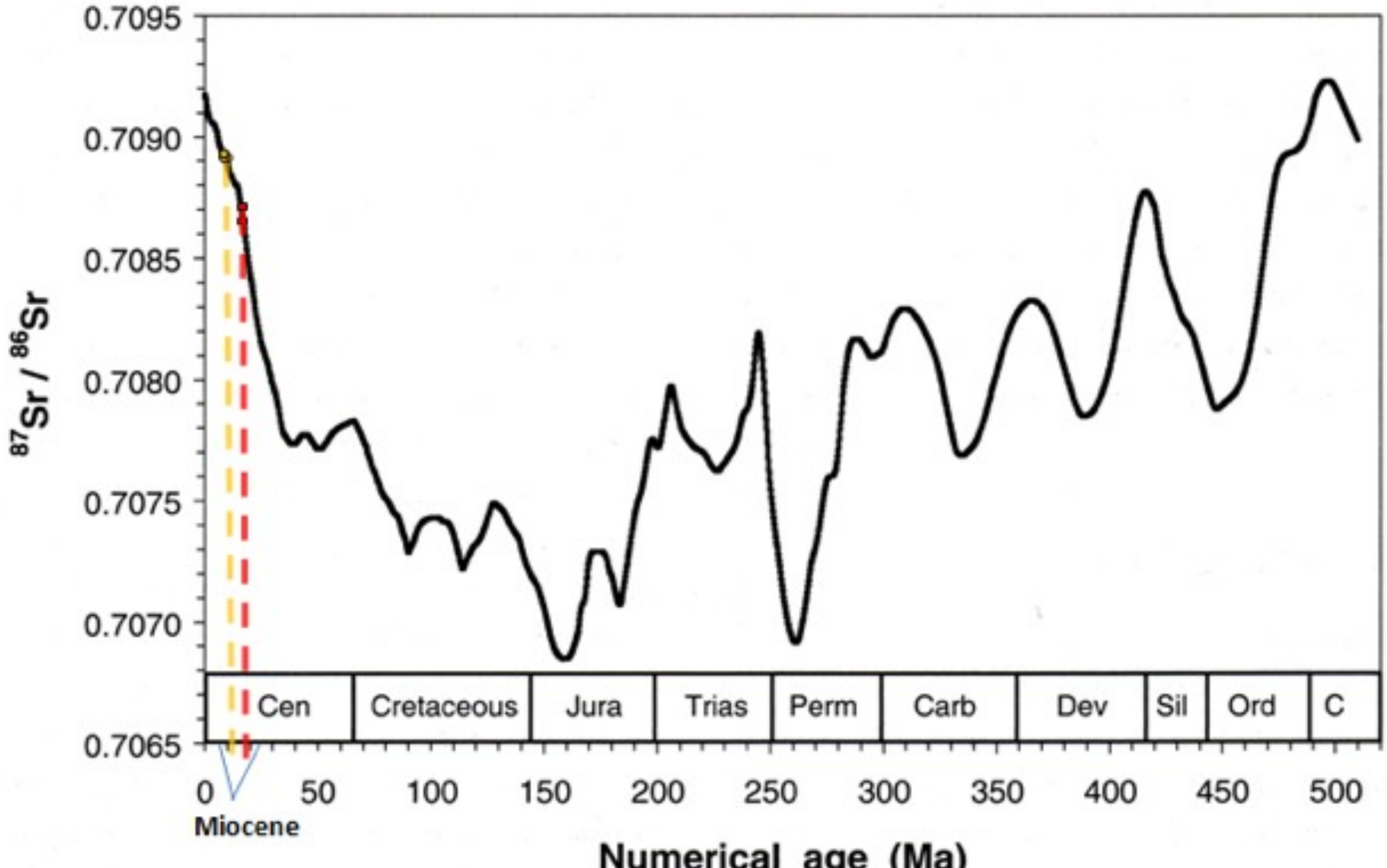
Crustal source and therefore high $^{87}Sr/^{86}Sr$-ratio $>$ 0.710 (Mesozoic and Cenozoic ages)



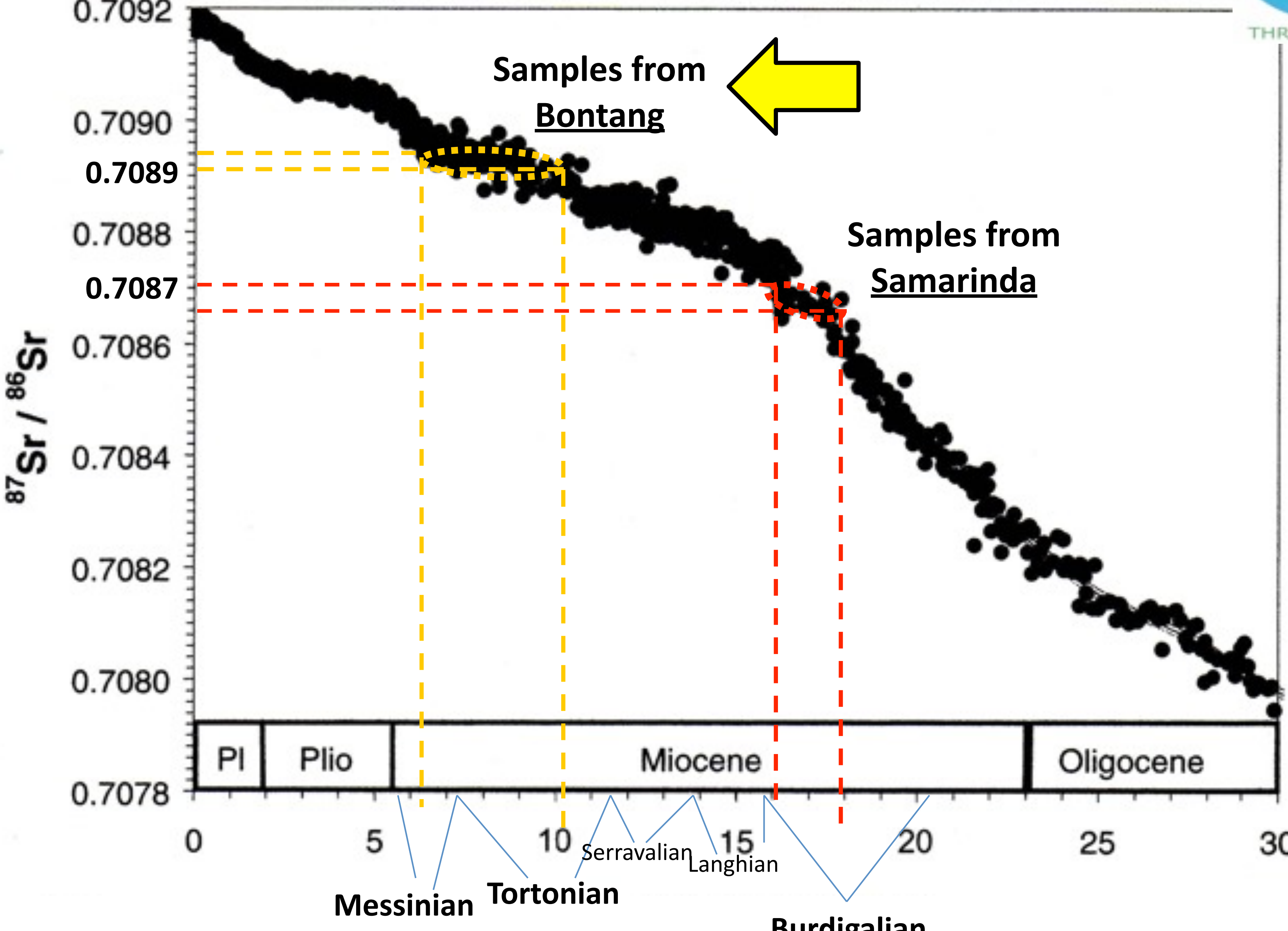
$^{87}Sr/^{86}Sr$ data transferred to Strontium Isotope Seawater Curve



Strontium Isotope Stratigraphy (SIS)

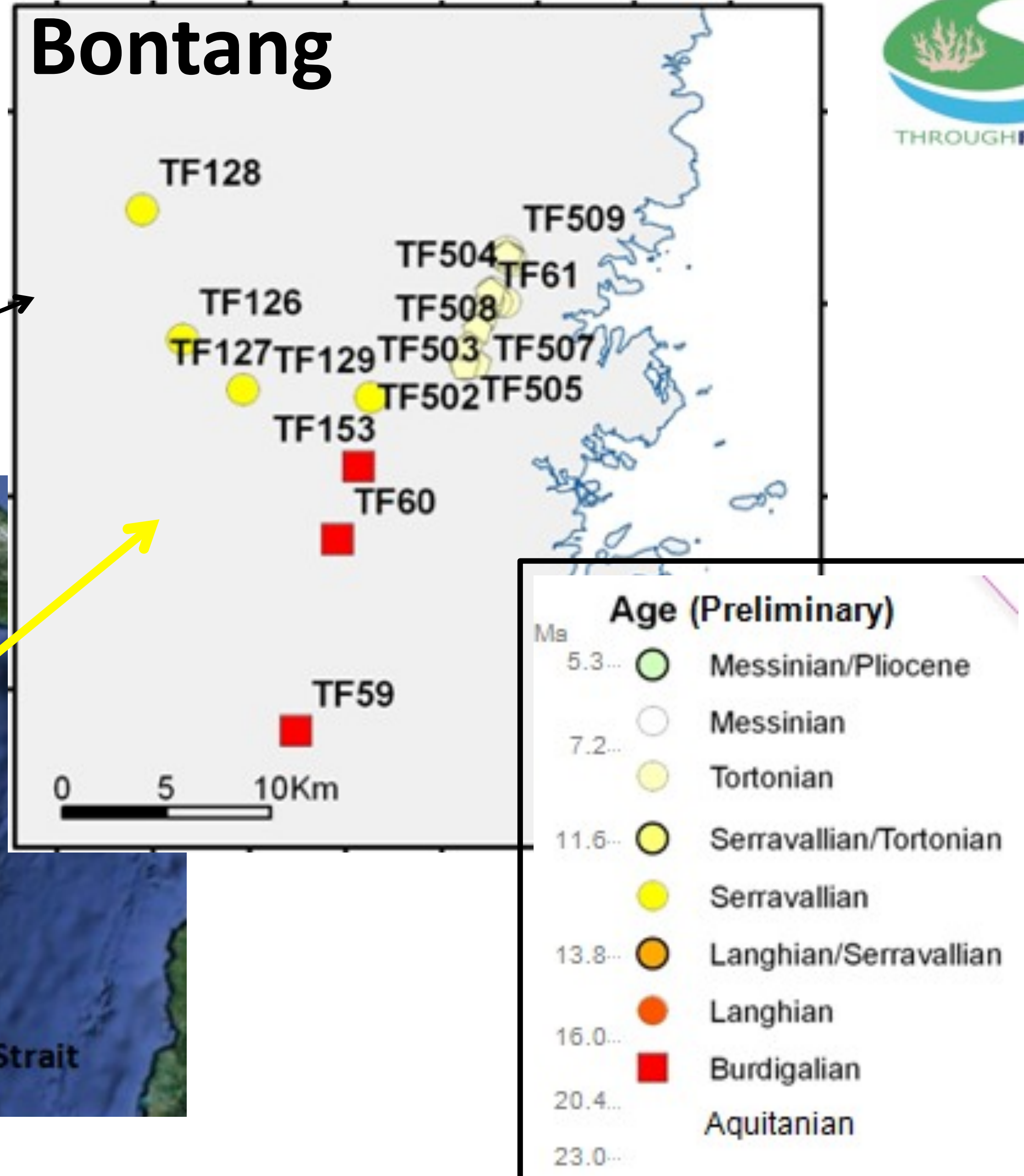


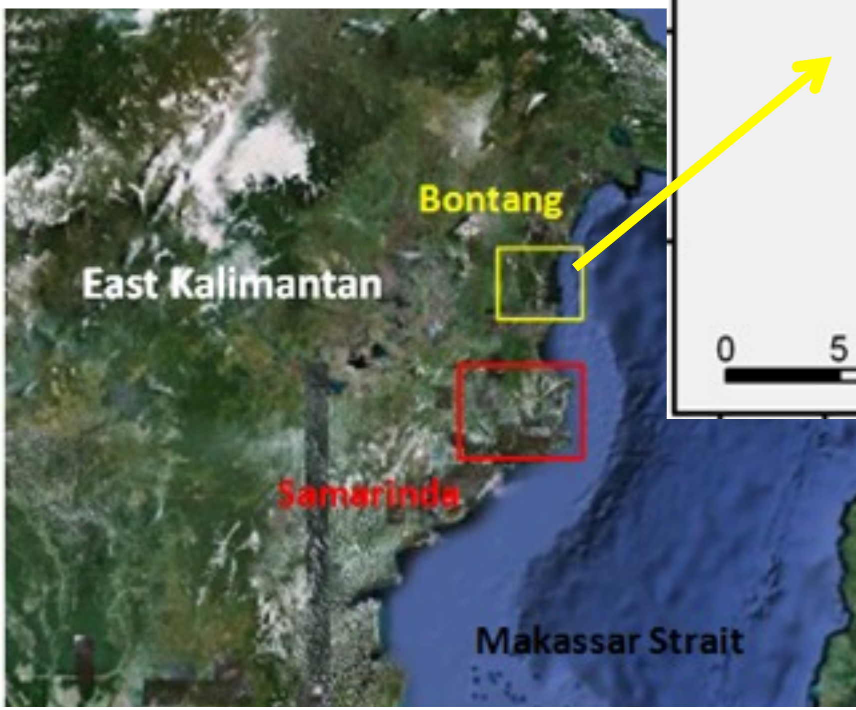
Strontium Isotope Stratigraphy (SIS)



Comparison with estimated ages obtained from Biostratigraphy

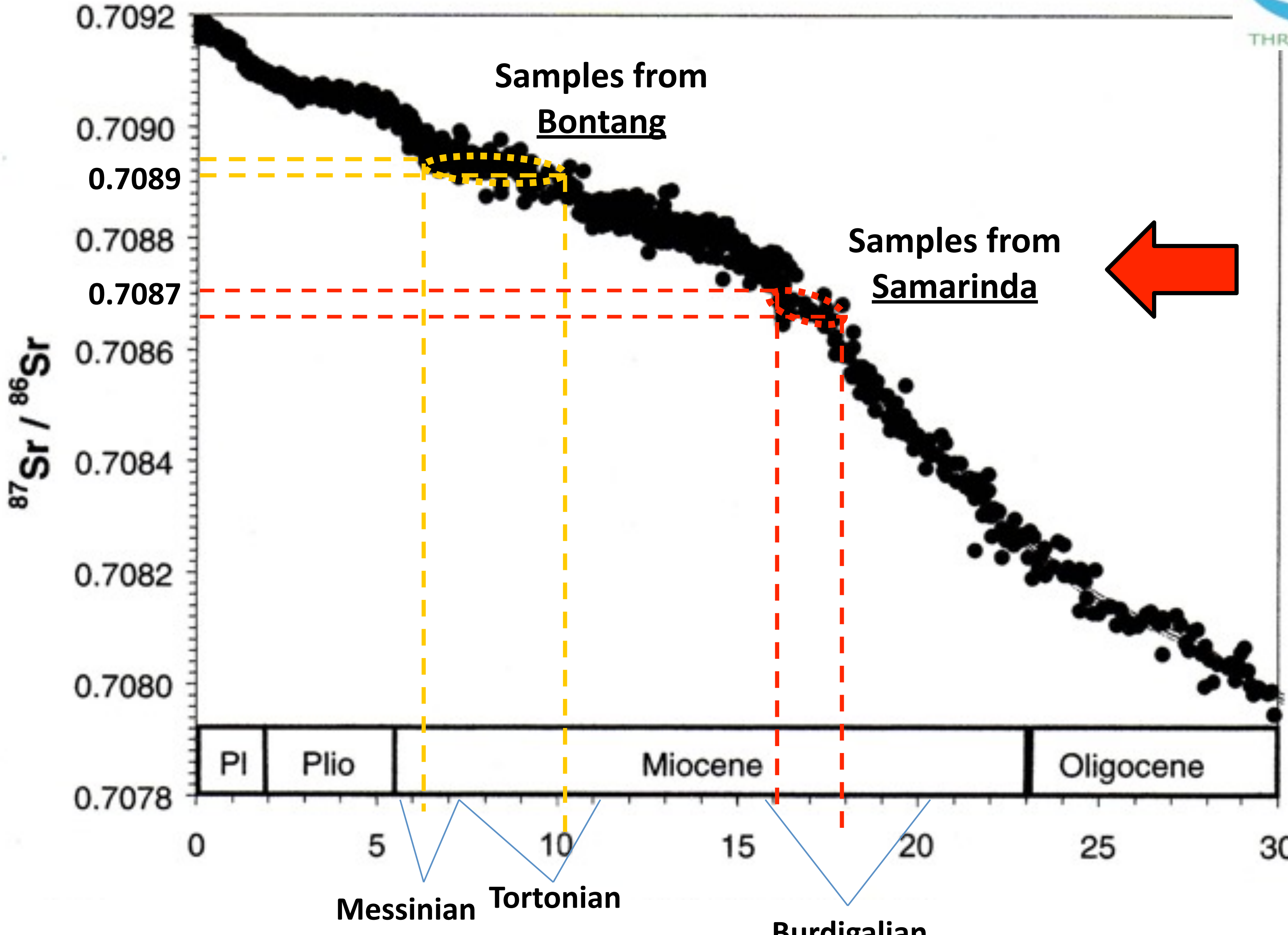
Estimated Ages from W. Renema based on field observations of LBF



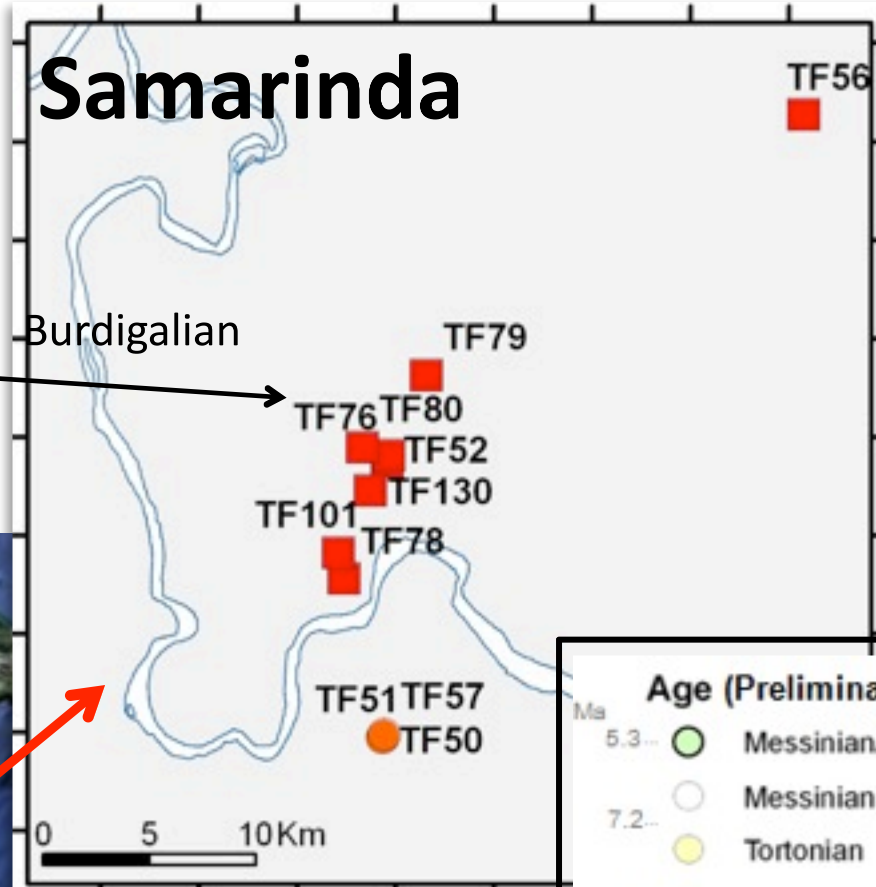


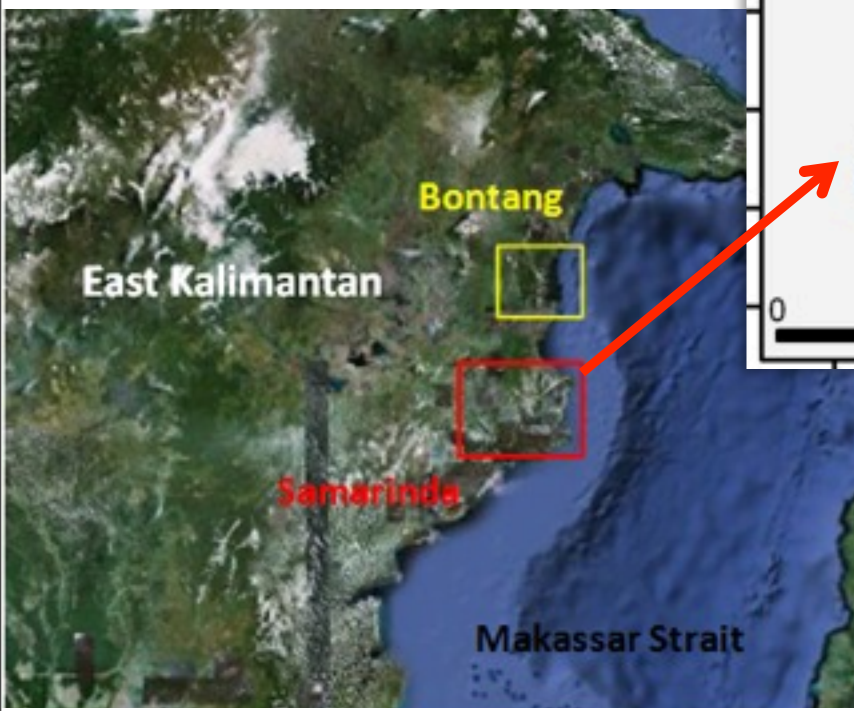
Ages SIS: Messinian - Tortonian

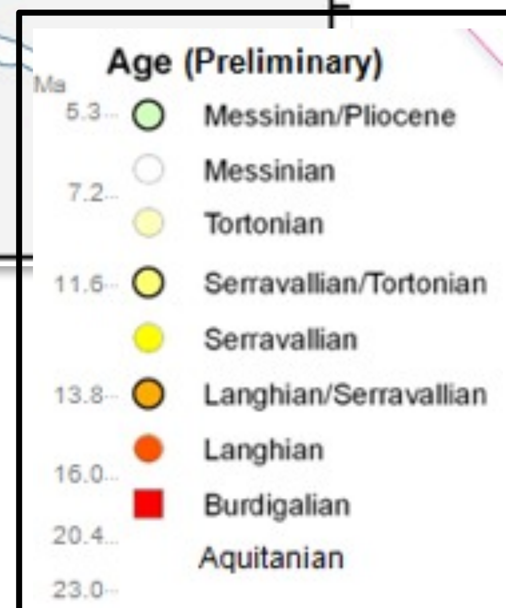
Strontium Isotope Stratigraphy (SIS)



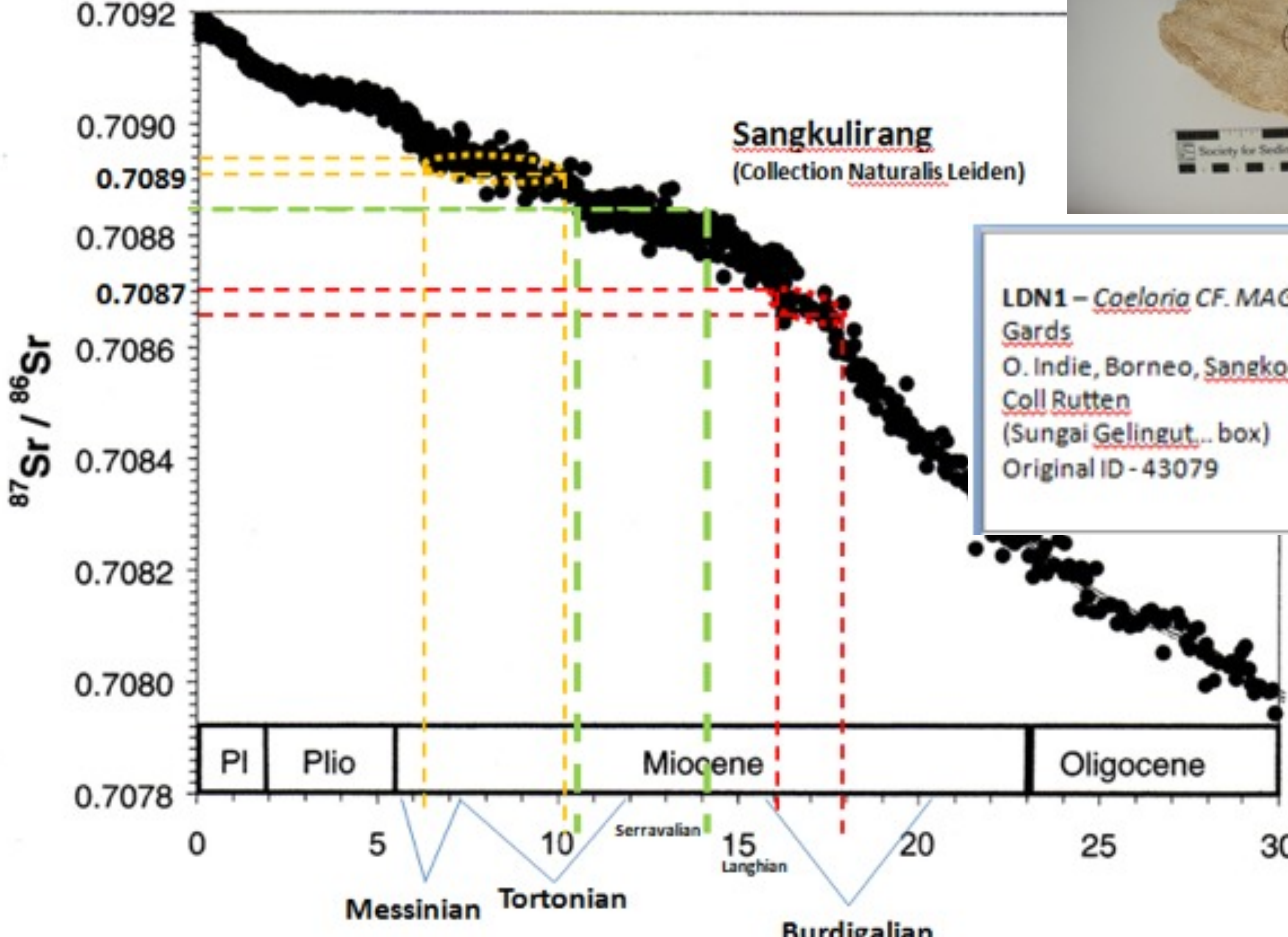
Estimated Ages from W. Renema based on field observations of LBF







Ages SIS: Burdigalian

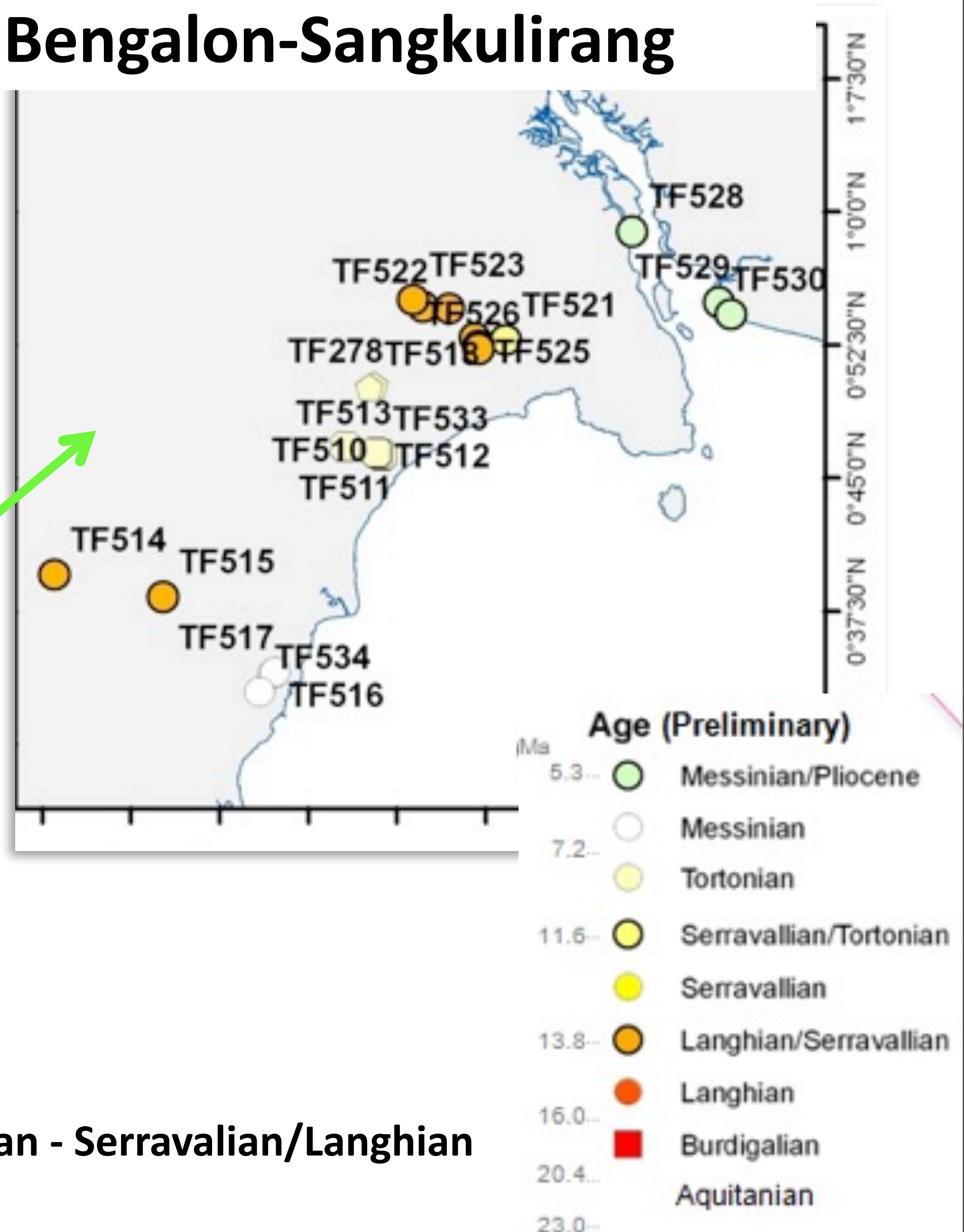


LDN1 – *Coeloria CF. MAGNA*
Gards
O. Indie, Borneo, Sangkoelirang Baai
Coll Rutten
(Sungai Gelingut… box)
Original ID - 43079

THROUGHFLOW

Bengalon-Sangkulirang

Estimated Ages from W. Renema based on field observations of LBF



Ages SIS: Tortonian –Tortonian/Serravalian - Serravalian/Langhian

Good agreement with between ages based on field observations of LBF and SIS

Further close collaboration between (Magneto)-Biostratigraphy and Geochemistry is required.

How reliable are our ages obtained via SIS?

Limitations of the SIS - 1

$^{87}Sr/^{86}Sr$ ratio of the samples must be unaffected by

Diagenetic Alteration

because

Diagenetic processes (e.g. recrystallization of aragonite to calcite / secondary aragonite precipitation)

Change/Overprint of the original geochemistry

resulting generally in unreliable pelaeoenvironmental reconstructions

effect also the Sr isotpe ratio stored in the carbonate minerals

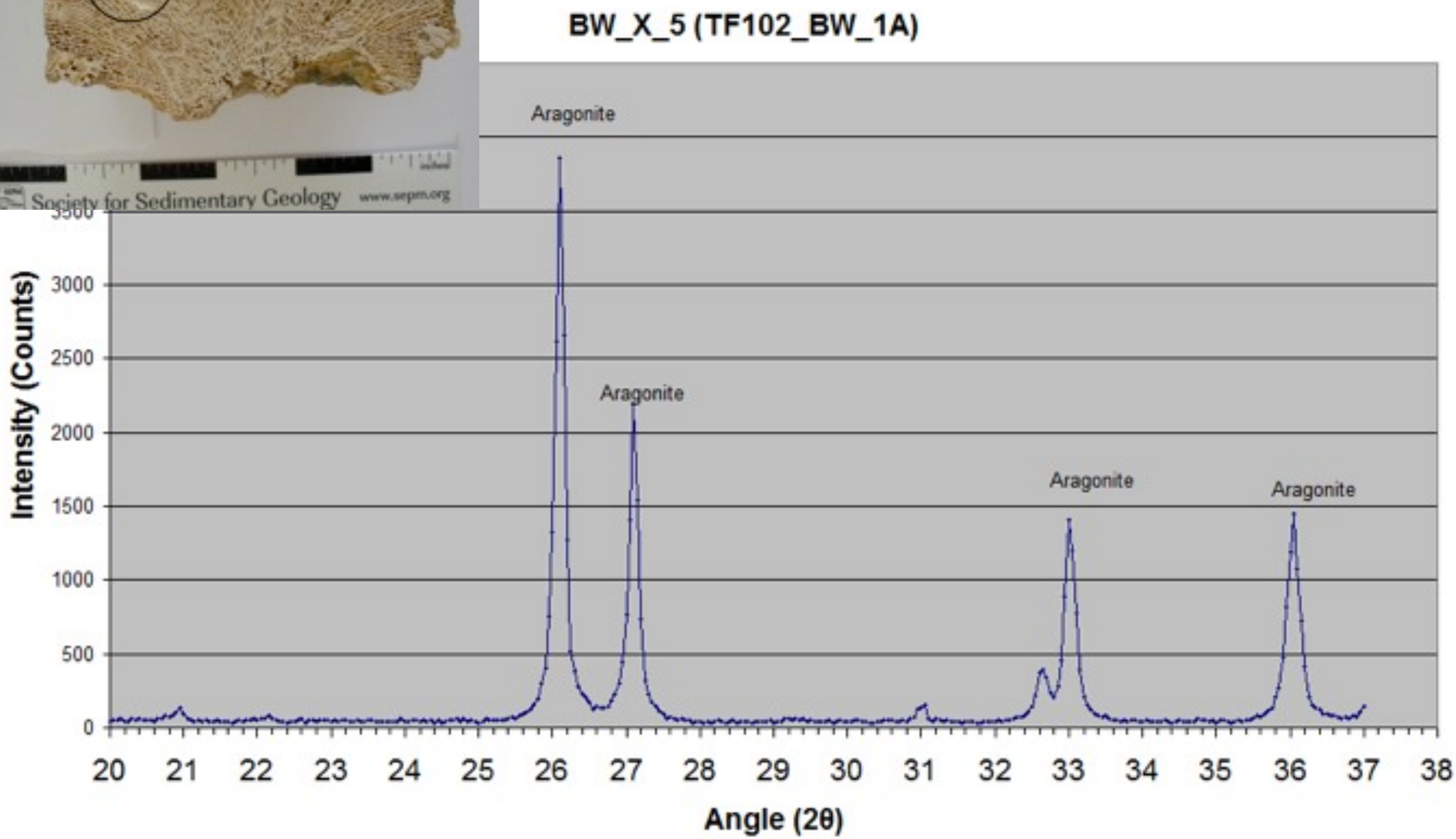
How can we recover material effected by alteration/ diagenesis?

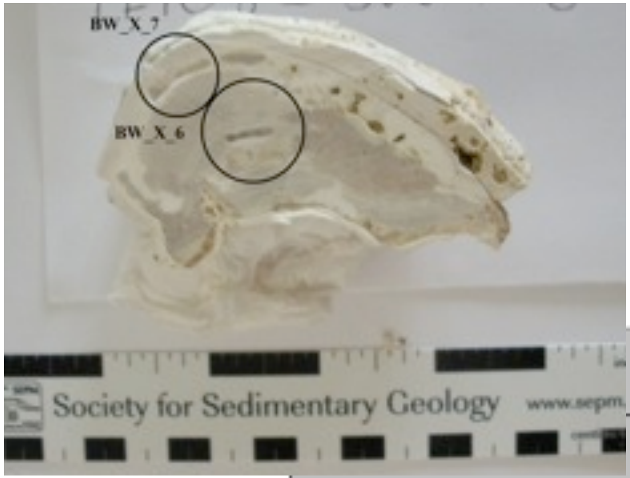
X- ray diffraction analysis (XRD)

analyses for quantification of aragonite and calcite concentration

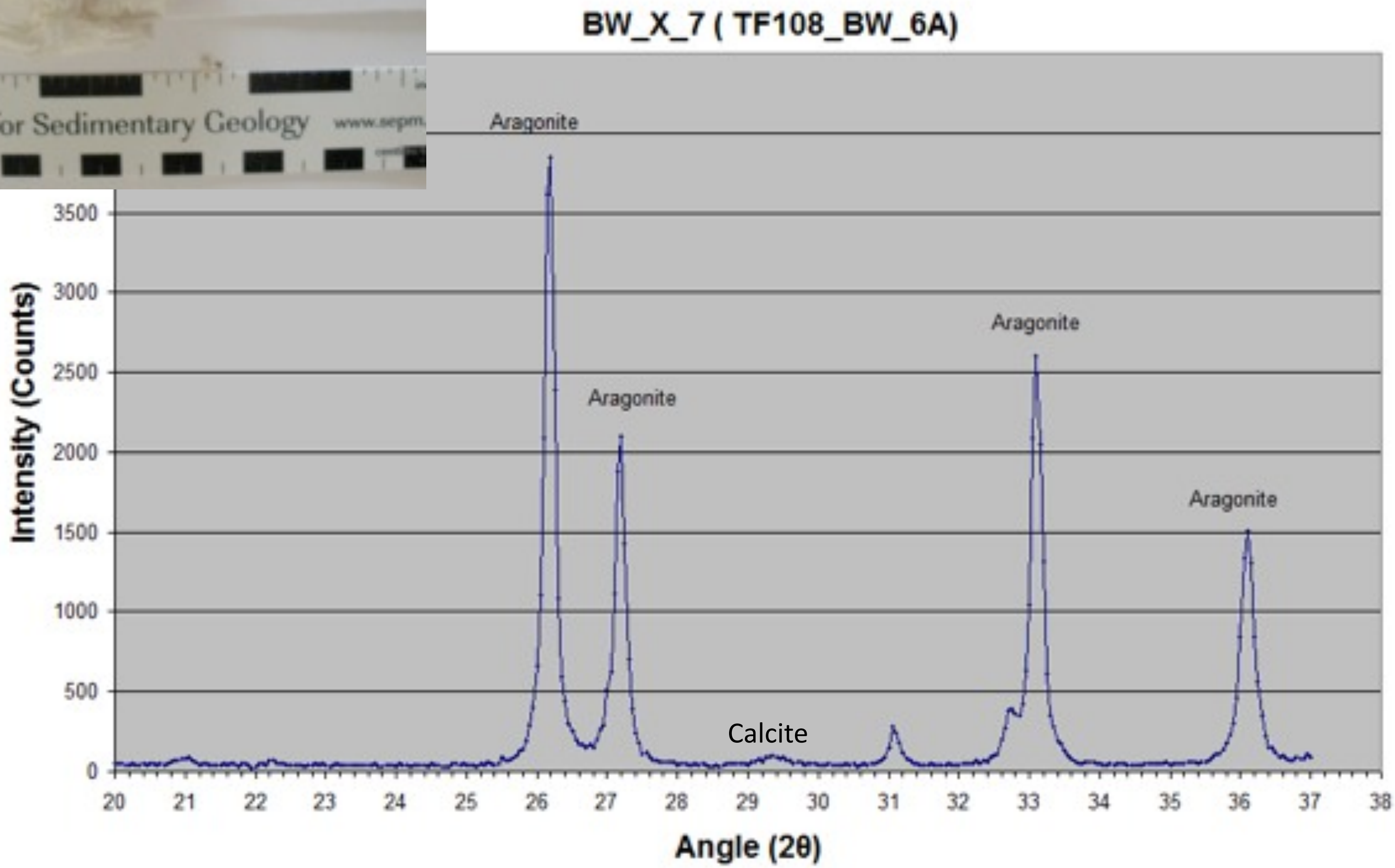
Results of
X-ray diffraction analysis (XRD)

X-ray diffraction analysis (XRD)
of sample **TF102_BW_1A**

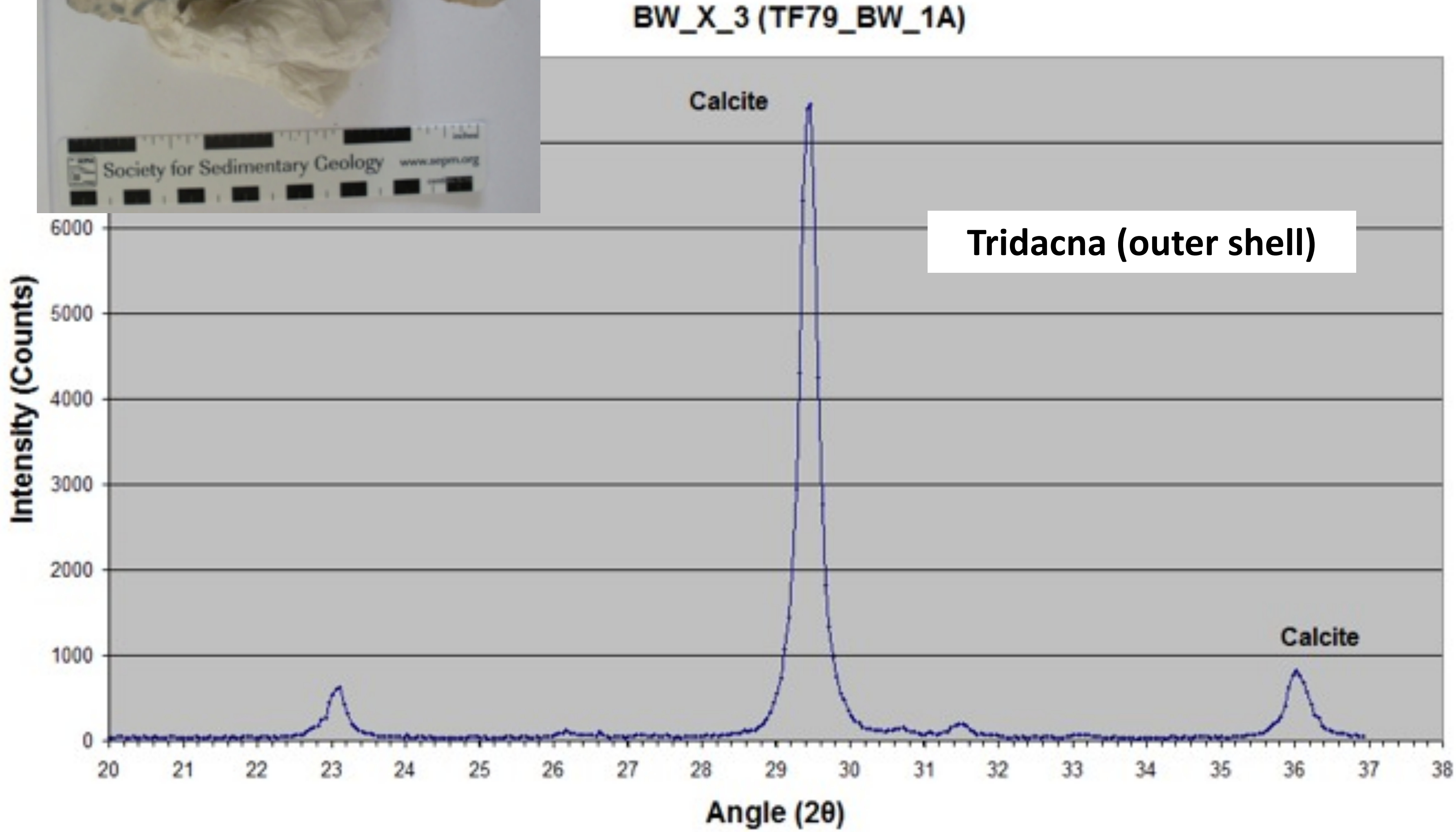




X-ray diffraction analysis (XRD)
of sample **TF108_BW_6A**

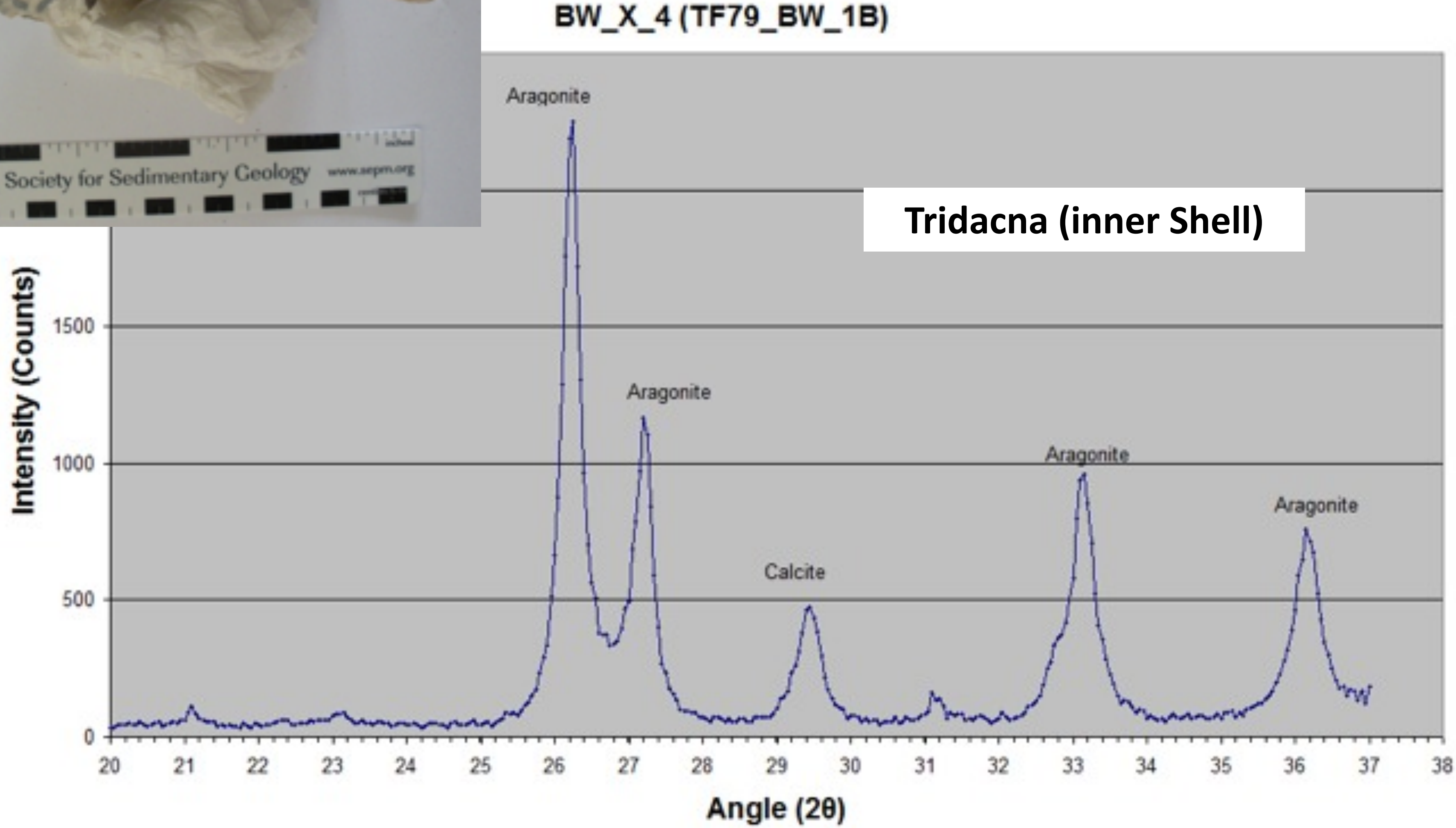


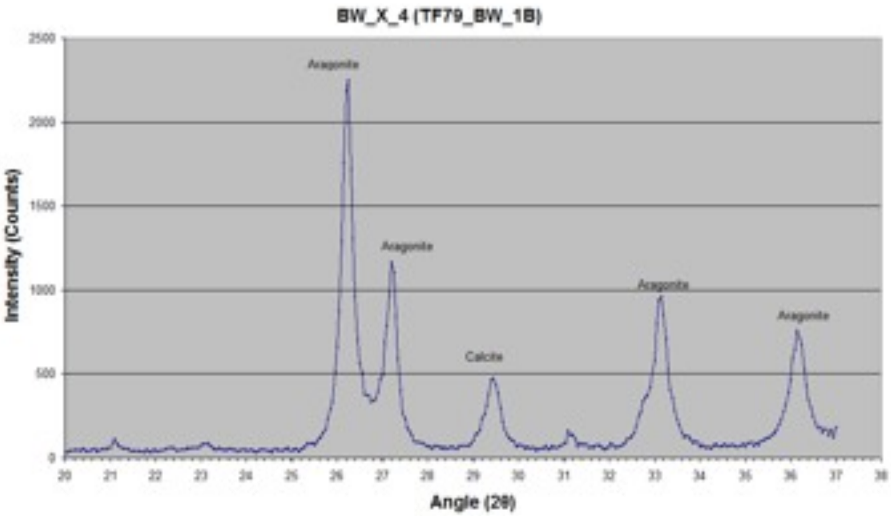
X-ray diffraction analysis (XRD)
of sample **TF79_BW_1A**



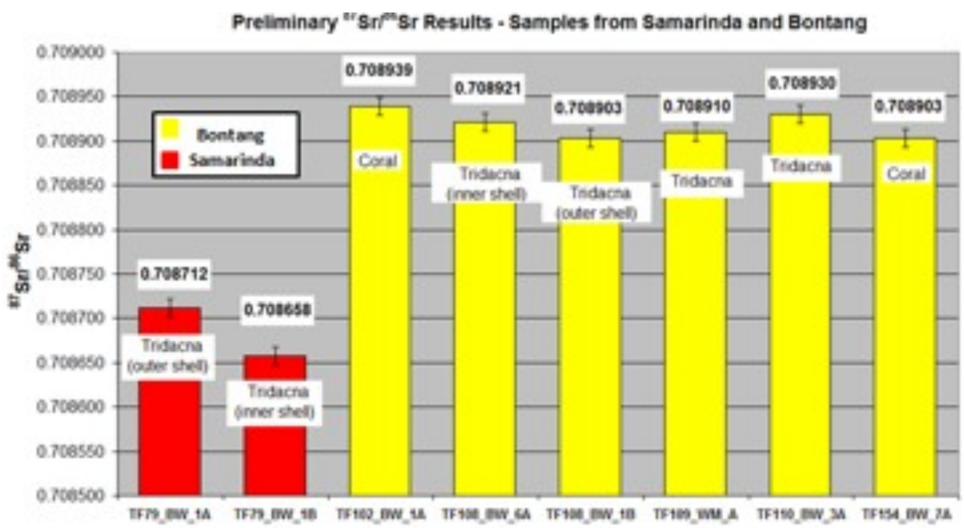
Tridacna (outer shell)

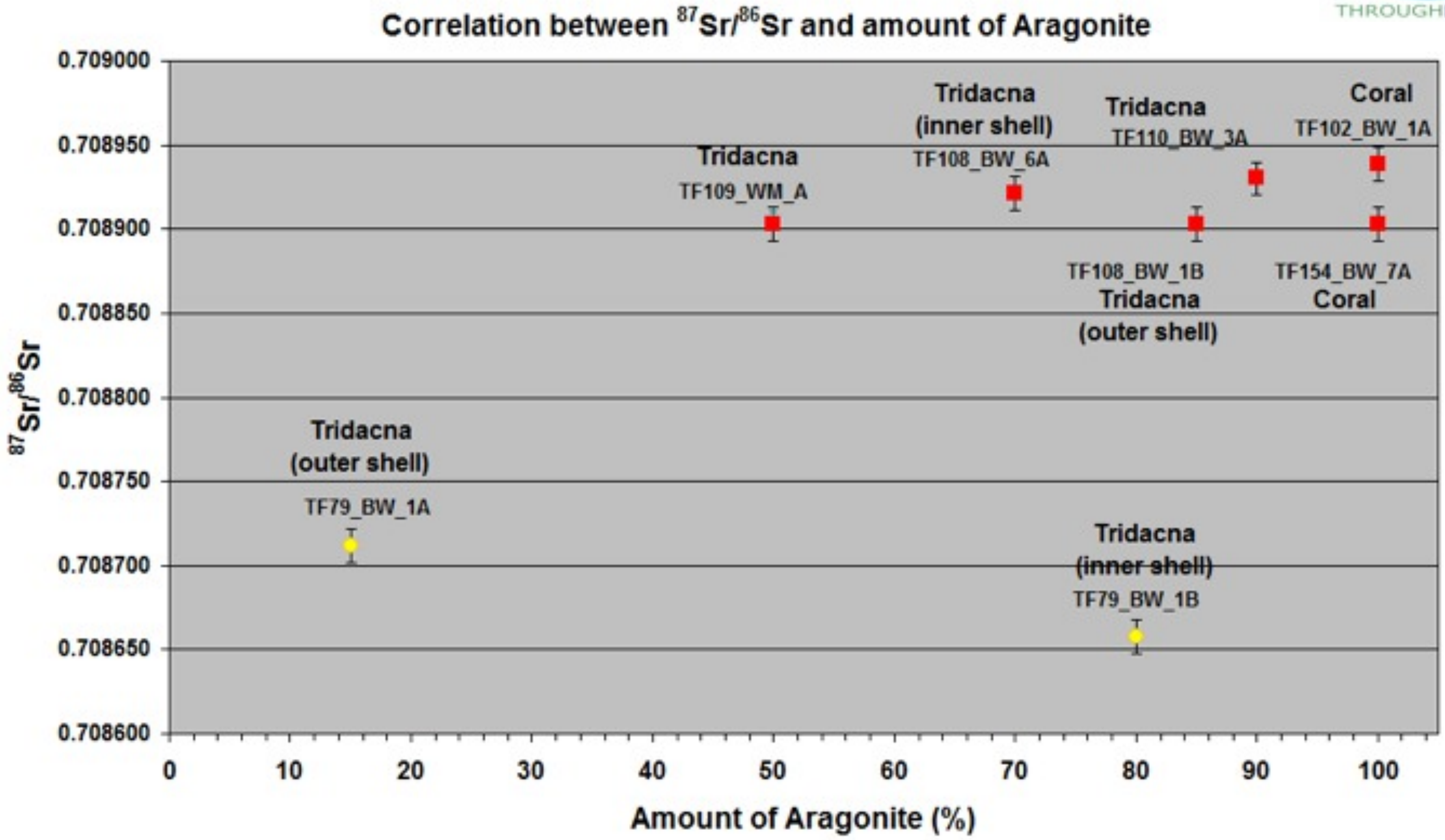
X-ray diffraction analysis (XRD)
of sample **TF79_BW_1B**





Existing relation between diagenesis/ recrystallisation and Sr isotope results?





- **No immediate link detectable , but also very small sample volume**
- **More analysis required**

To obtain reliable ages

Thorough pre-analytical determinations are essential for obtaining reliable data

These includes:

- **X-ray diffraction analysis (XRD)** - Quantitative estimates of aragonite and calcite concentration (only suitable to differ between aragonite and Calcite), **but not to suitable differ between primary aragonite and secondary aragonite**

- **Polarised Light Microscopy (PLM) combined with Scanning Electron Microscopy (SEM**) – to recover secondary formed araogonite

Recovering (micro)areas in a sample which are the most suitable for analyses – areas of excellent preservation my also exist in a strongly altered sample!

Limitations of the SIS - 2

SIS works only for marine carbontates
(e.g. biogenenic carbontes)
produced under open marine conditions

No reliable results from biogenic carbonates in **estuarine milieu**

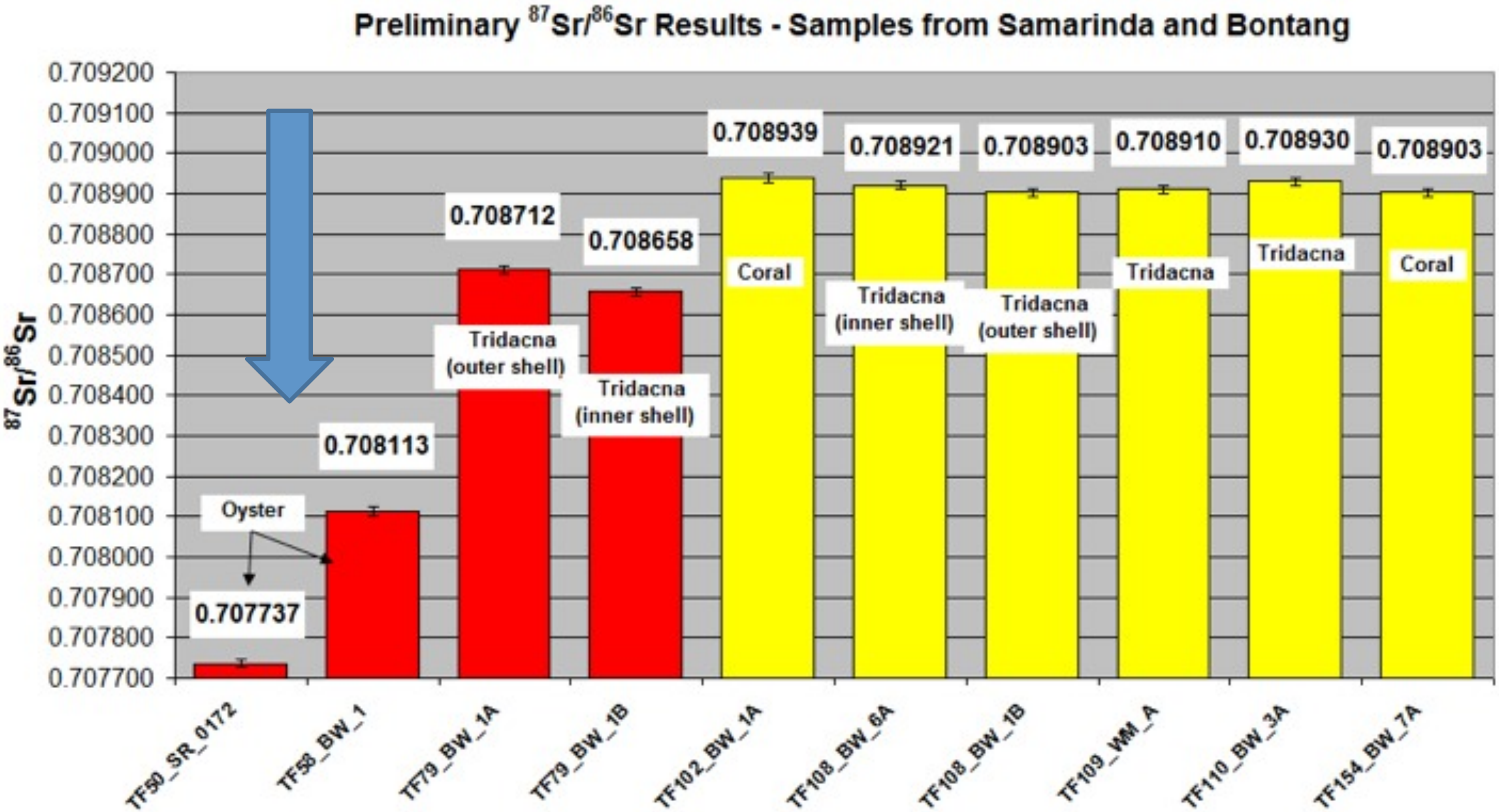
↓

freshwater Input

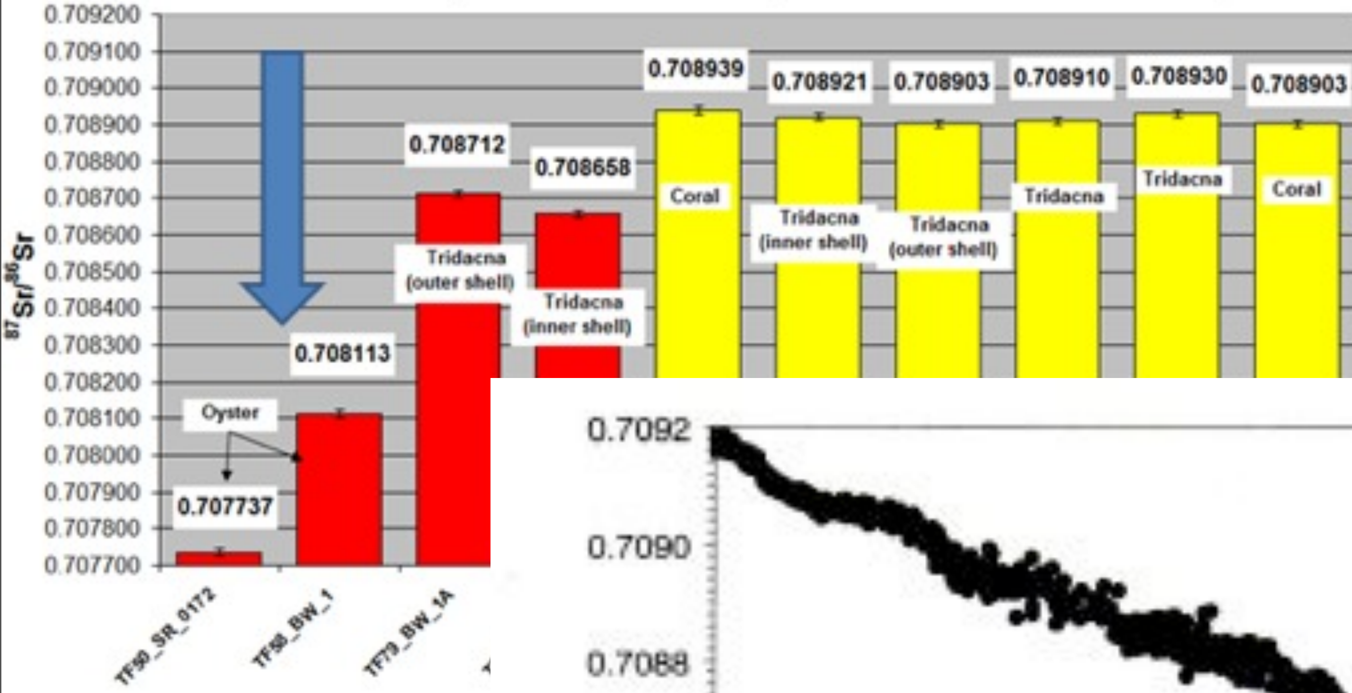
↓

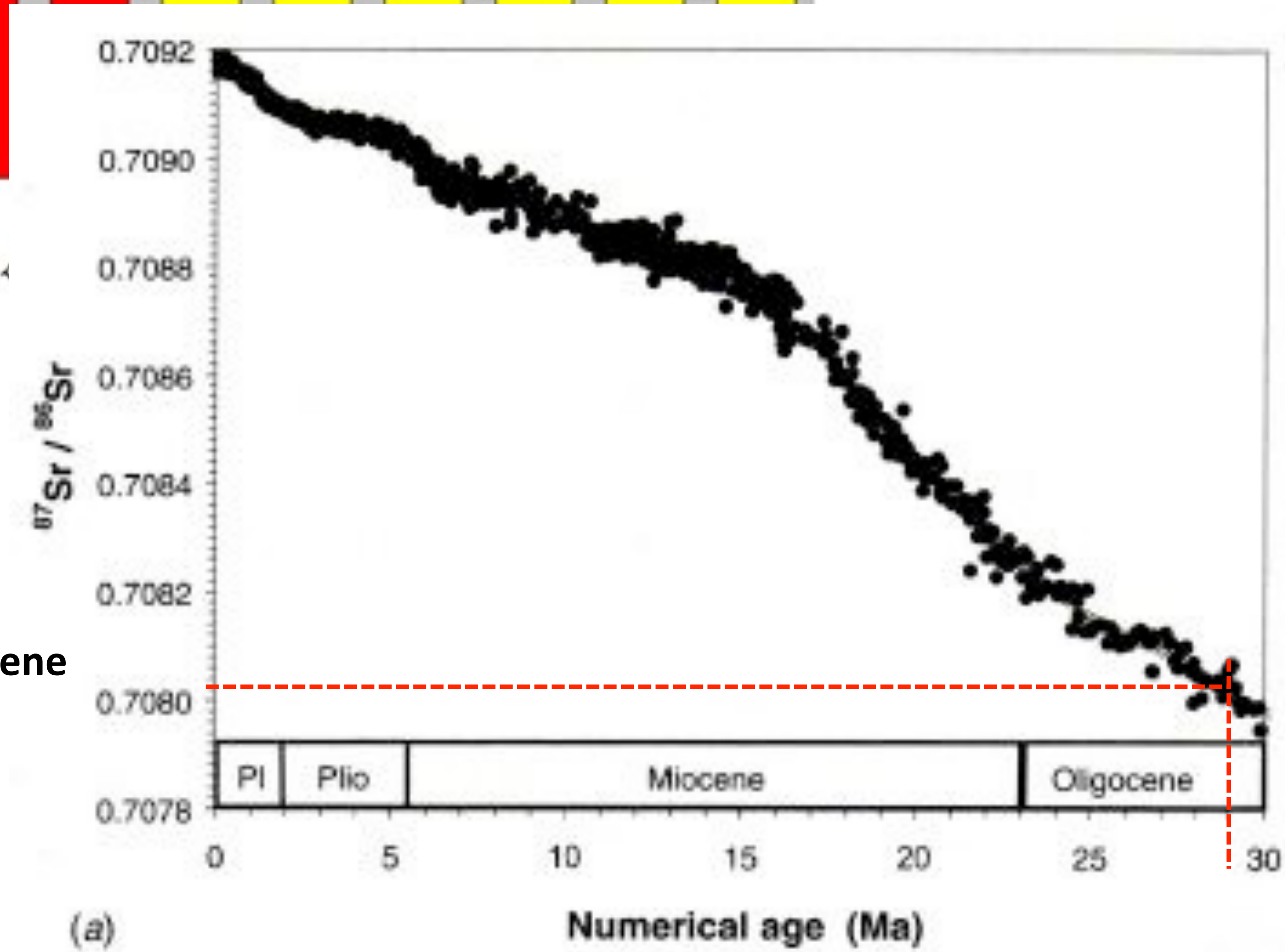
Overprint strontium isotope ratio of seawater

Example Oysters from Samarinda →



Preliminary 87Sr/86Sr Results - Samples from Samarinda and Bontang
87Sr/86Sr
0.709200
0.709100
0.709000
0.708900
0.708800
0.708700
0.708600
0.708500
0.708400
0.708300
0.708200
0.708100
0.708000
0.707900
0.707800
0.707700
Oyster
0.707737
0.708113
0.708712
Tridacna (outer shell)
0.708658
Tridacna (inner shell)
0.708939
Coral
0.708921
Tridacna (inner shell)
0.708903
Tridacna (outer shell)
0.708910
Tridacna
0.708930
Tridacna
0.708903
Coral
TF50_SR_0172
TF58_BW_1
TF79_BW_1A
TF79_BW_1B
TF102_BW_1A
TF108_BW_6A
TF108_BW_1B
TF109_WM_A
TF110_BW_3A
TF154_BW_7A

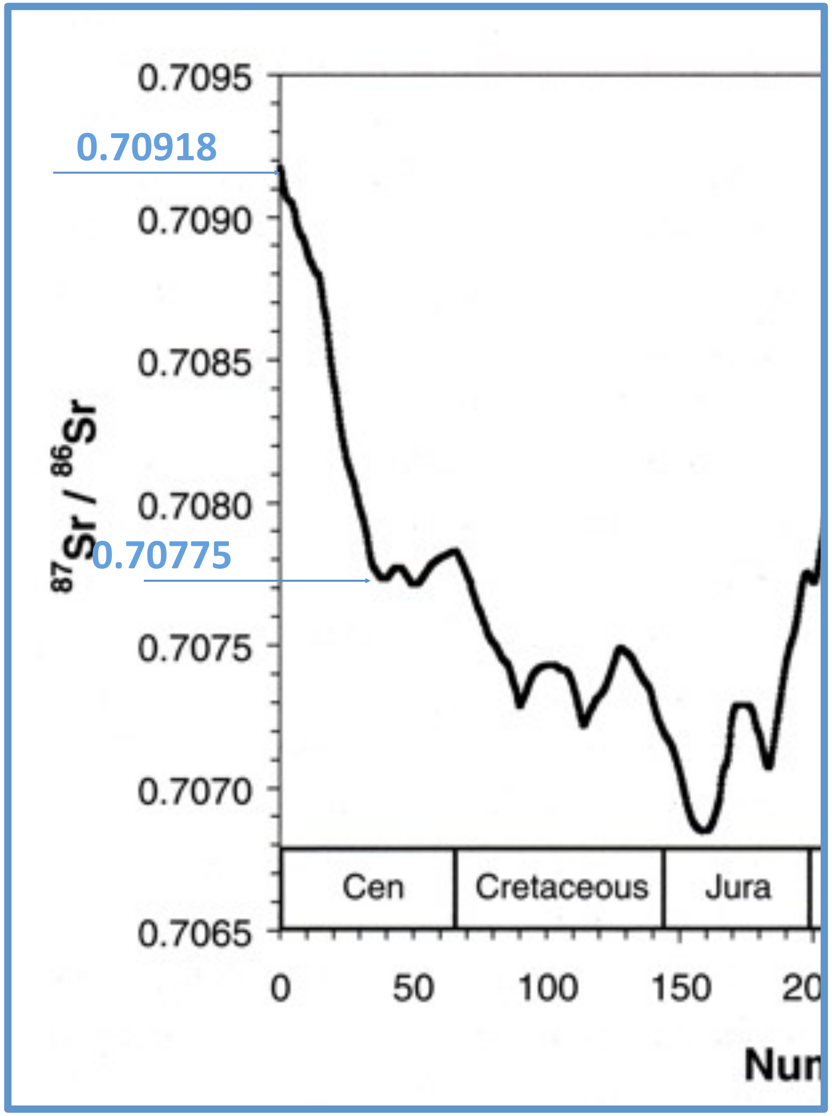




SIS-Results

TF 50: older than Oligocene
TF 58: ca. 29 Ma

Unreliable Results



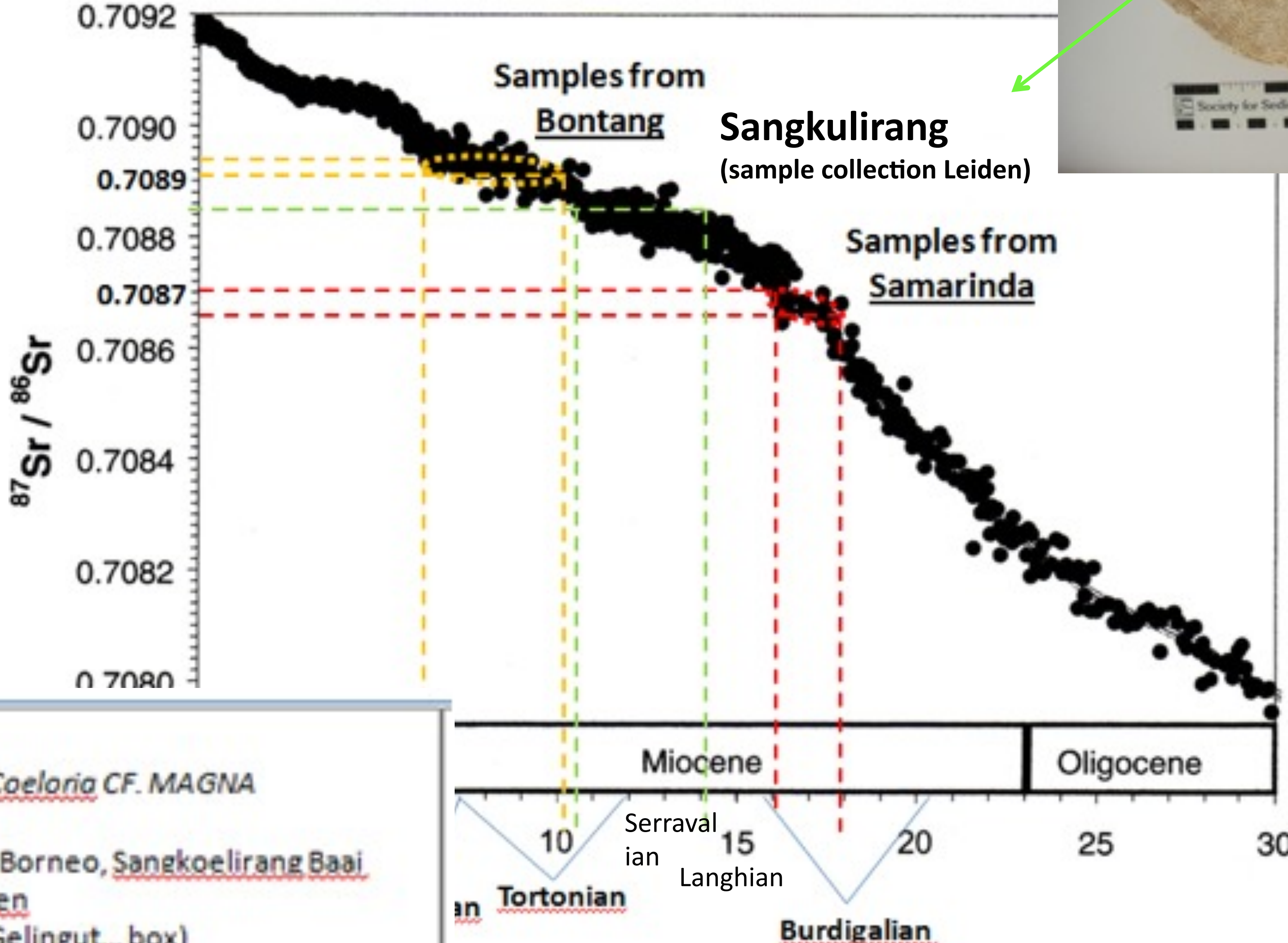
$^{87}Sr/^{86}Sr$ **studies of well preserved Miocene coral and molluscs promising tool for age determinations**

High precision chronostratigraphic determination are possible,

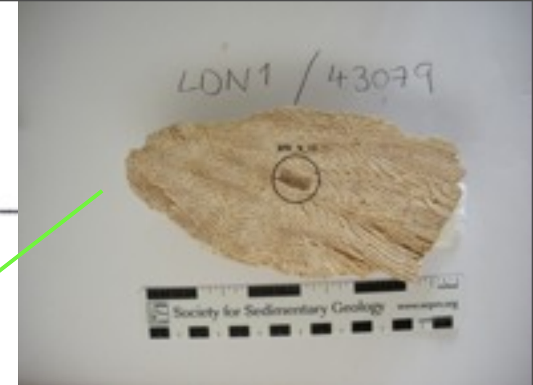
as

most favourable conditions exist for samples of post Eocene age (<55-33Ma)

THANK YOU



Sangkulirang
(sample collection Leiden)



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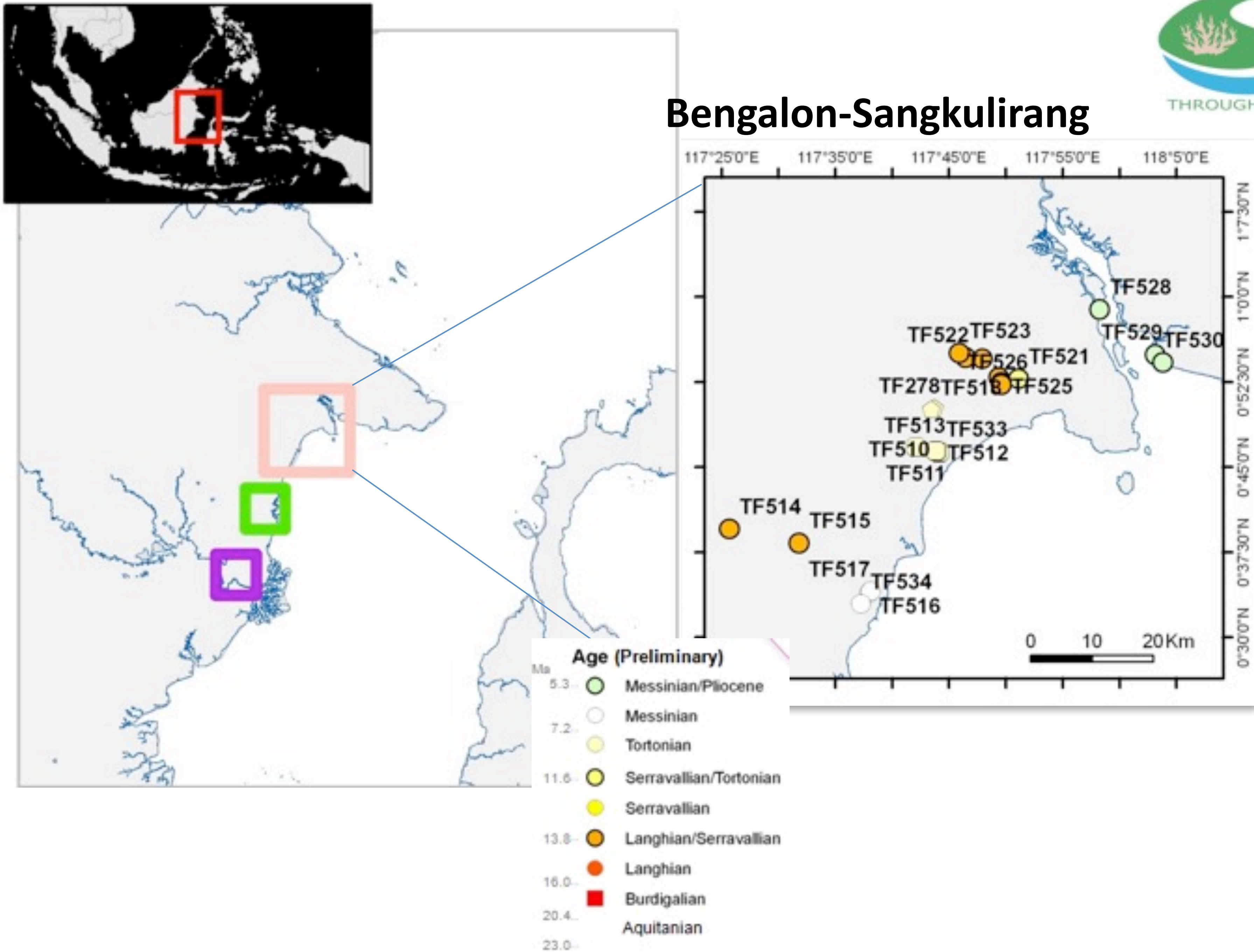

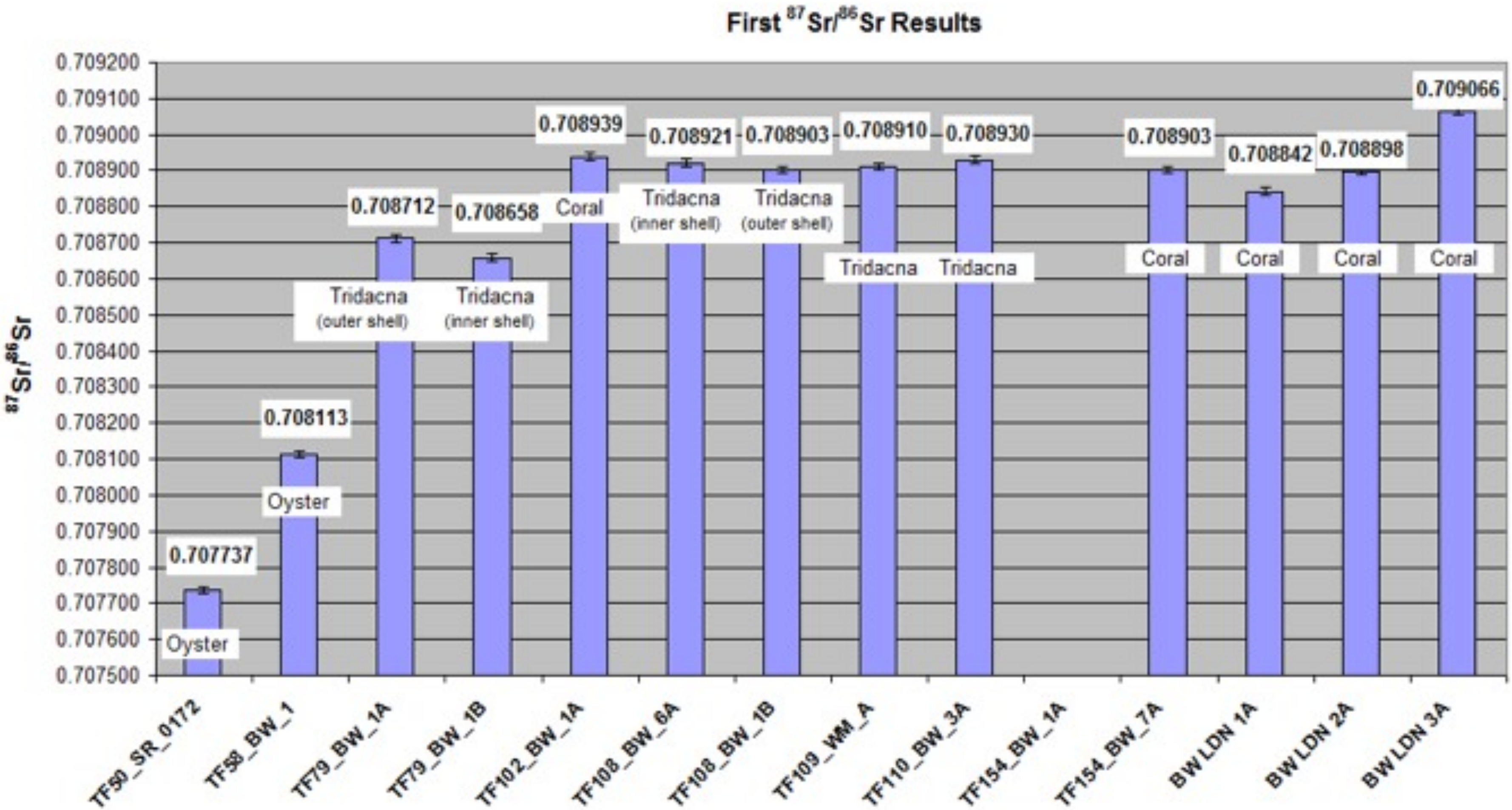
First $^{87}Sr/^{86}Sr$ Results
$^{87}Sr/^{86}Sr$
0.709200
0.709100
0.709000
0.708900
0.708800
0.708700
0.708600
0.708500
0.708400
0.708300
0.708200
0.708100
0.708000
0.707900
0.707800
0.707700
0.707600
0.707500
0.707737
Oyster
0.708113
Oyster
0.708712
Tridacna (outer shell)
0.708658
Tridacna (inner shell)
0.708939
Coral
0.708921
Tridacna (inner shell)
0.708903
Tridacna (outer shell)
0.708910
Tridacna
0.708930
Tridacna
0.708903
Coral
0.708842
Coral
0.708898
Coral
0.709066
Coral
TF50_SR_0172
TF58_BW_1
TF79_BW_1A
TF79_BW_1B
TF102_BW_1A
TF108_BW_6A
TF108_BW_1B
TF109_WM_A
TF110_BW_3A
TF154_BW_1A
TF154_BW_7A
BW LDN 1A
BW LDN 2A
BW LDN 3A

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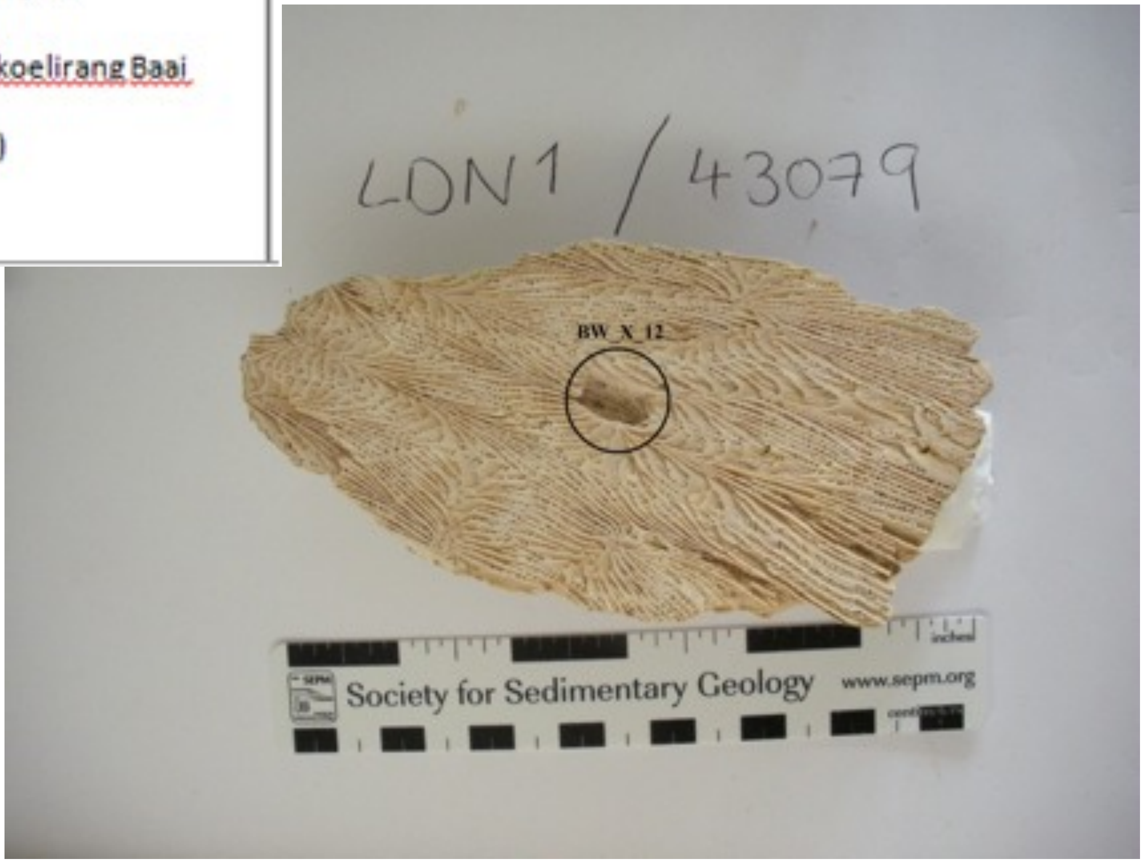
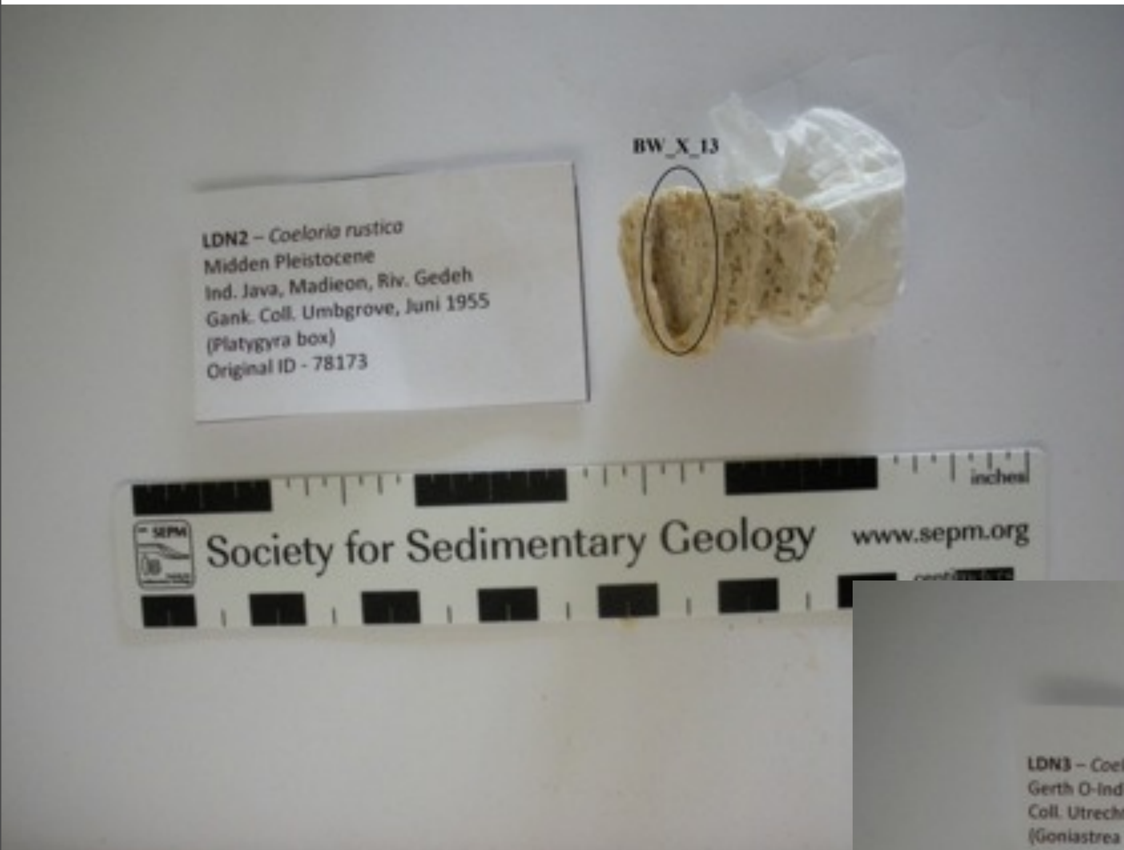
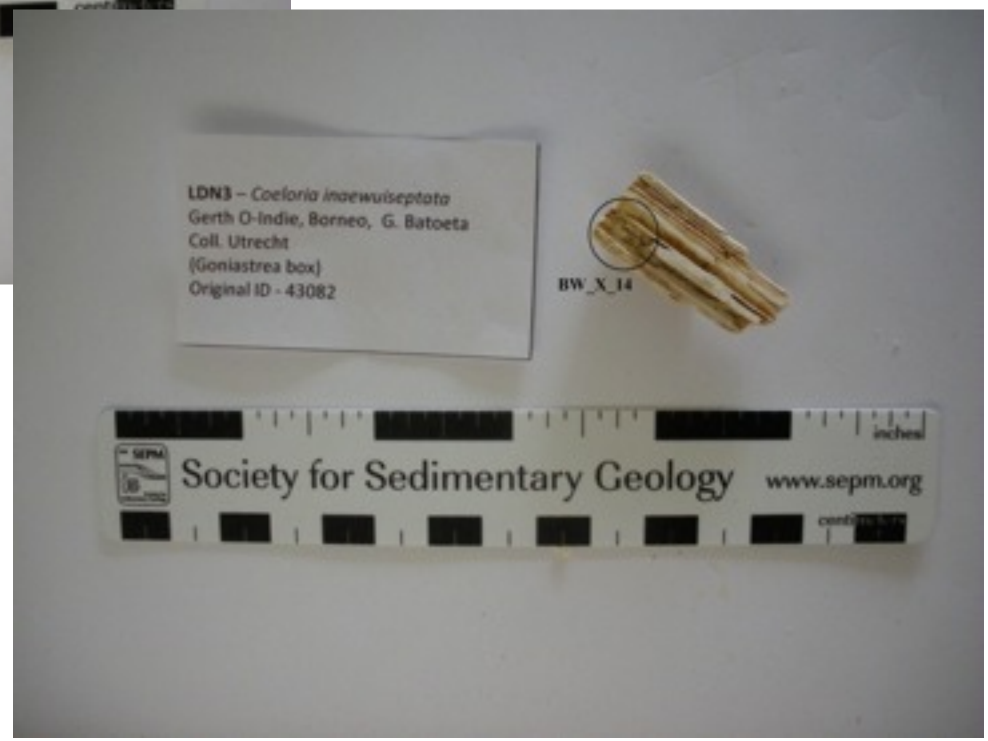
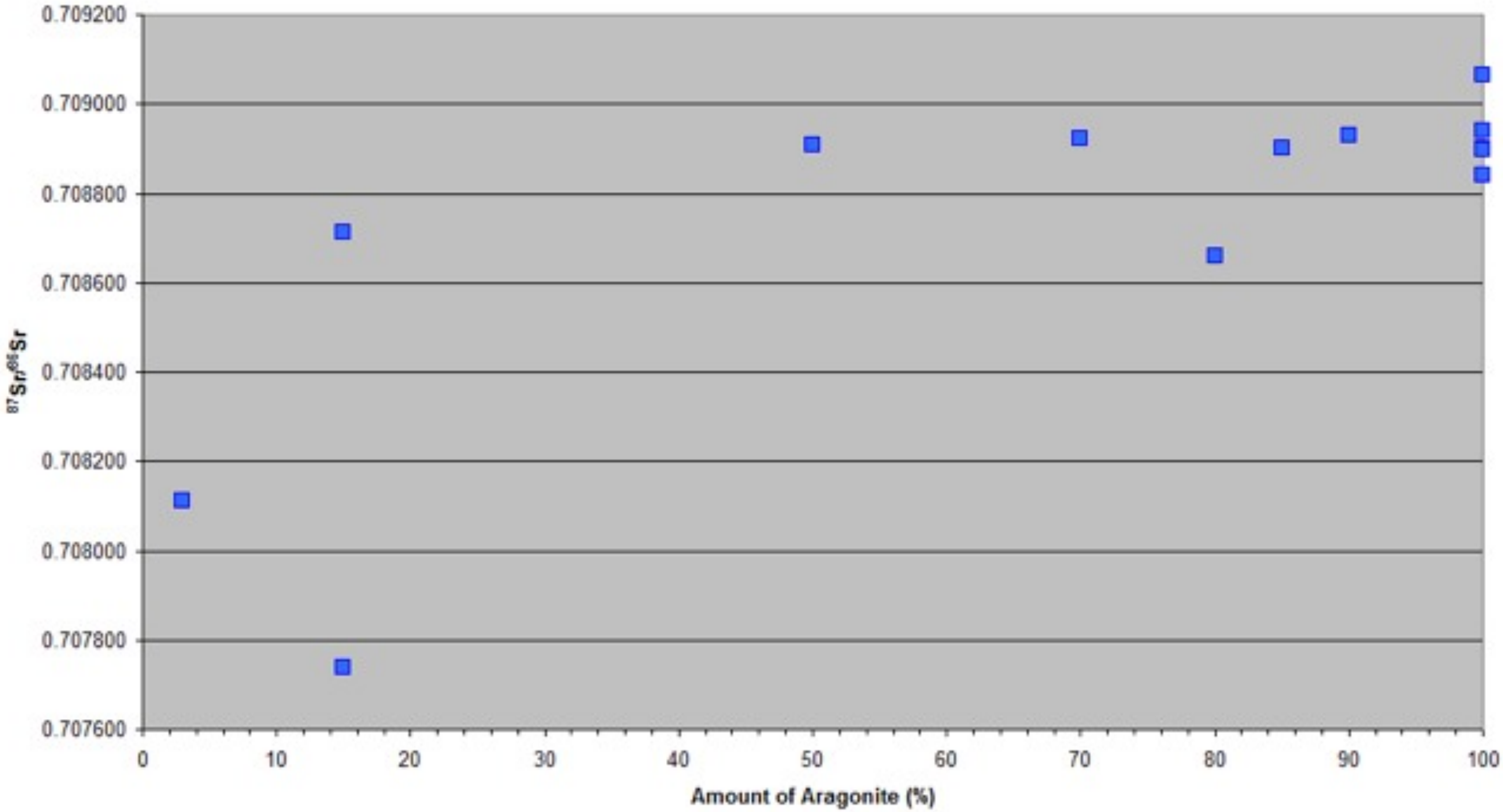


THROUGHFLOW

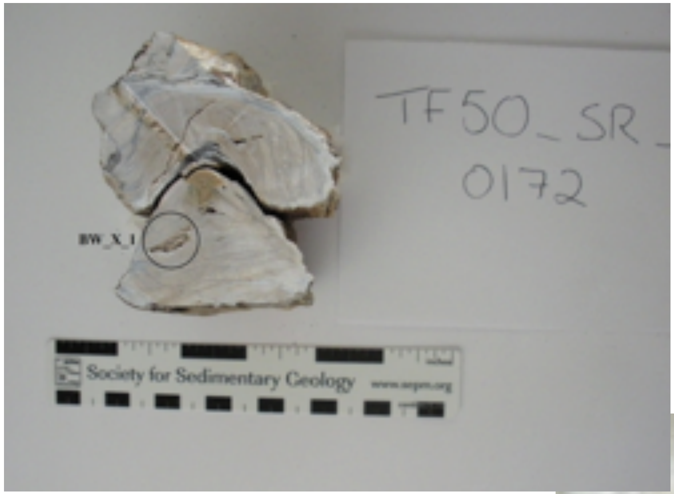




Correlation between Sr Isotope Ratio and Amount of Aragonite



THROUGHFLOW




TF58_BW_1
Society for Sedimentary Geology
www.sepm.org


Calcite cements : warm temperature anomalies
(smaller Sr/Ca ratios