

ATLANTA, GA, USA



15-20 MAY 2022

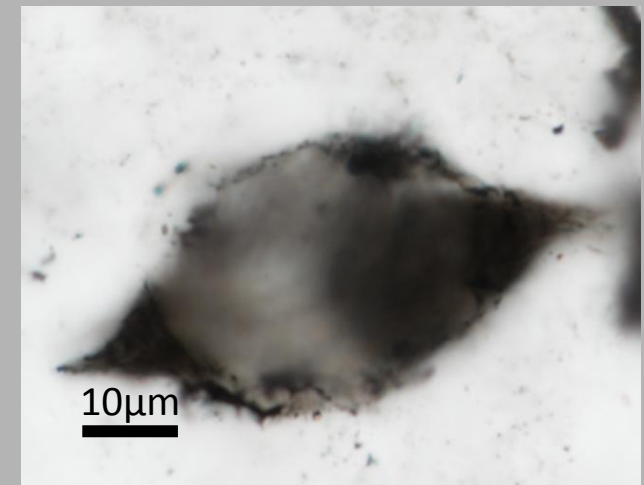
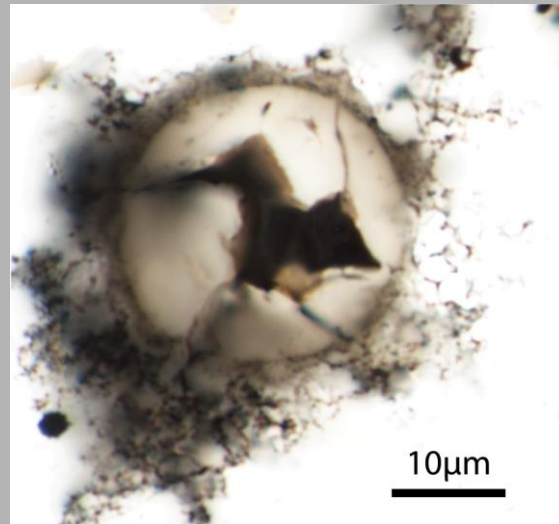


Université
de Lille



225 : Recent Advances, Development and
New Challenges in Understanding Early Life

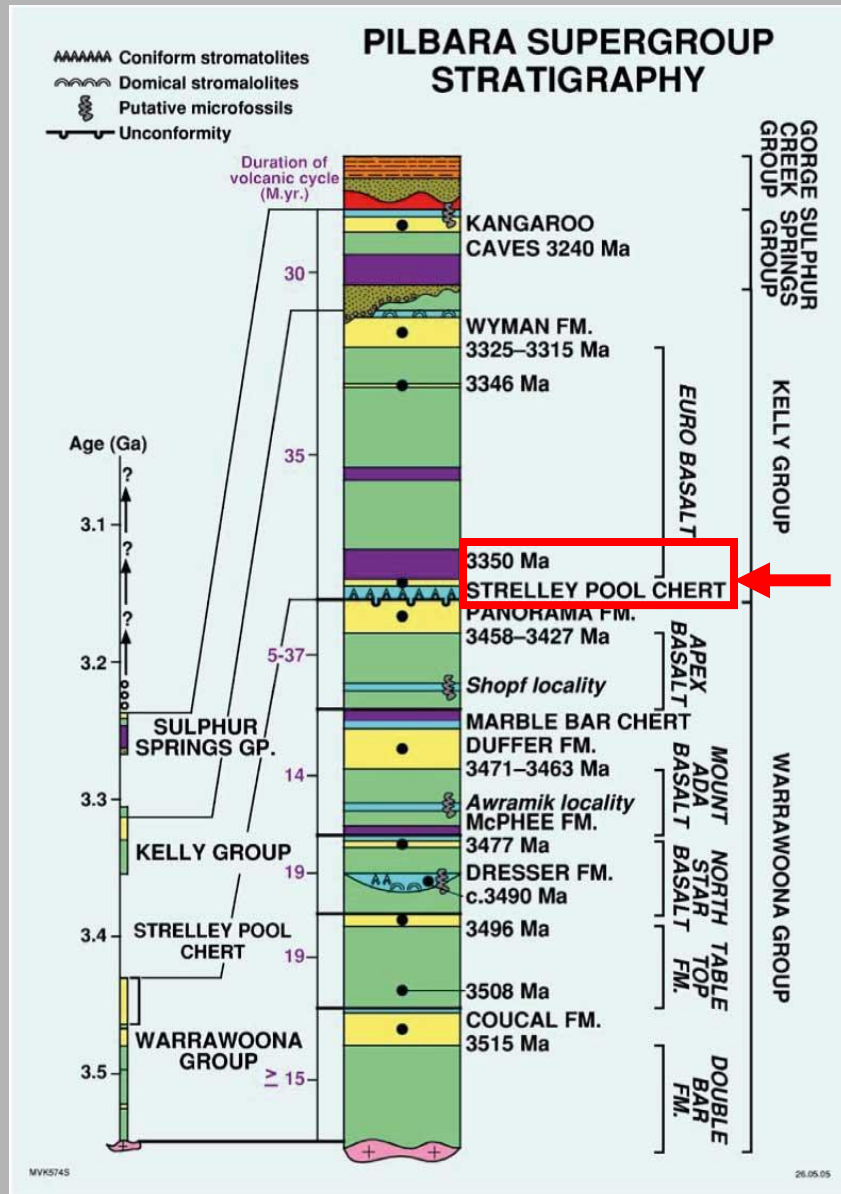
Nanoscale petrographic insights into the morphogenesis of carbonaceous microstructures from the ca. 3.4 Ga Strelley Pool Formation



Maxime Coutant*, Lepot K., Fadel A., Addad A., Richard E., Troadec D., Ventalon S., Sugitani K., Javaux E. J.

*Corresponding author: maxime.coutant@uliege.be

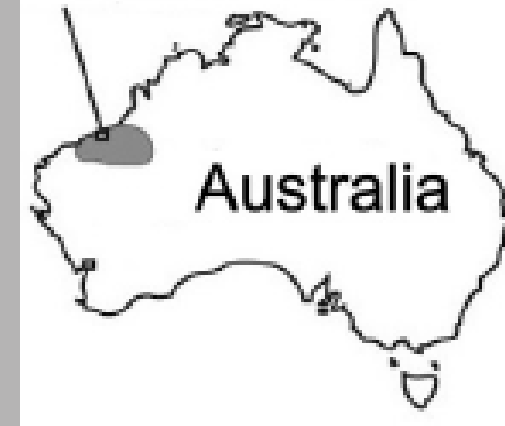
Strelley Pool Chert



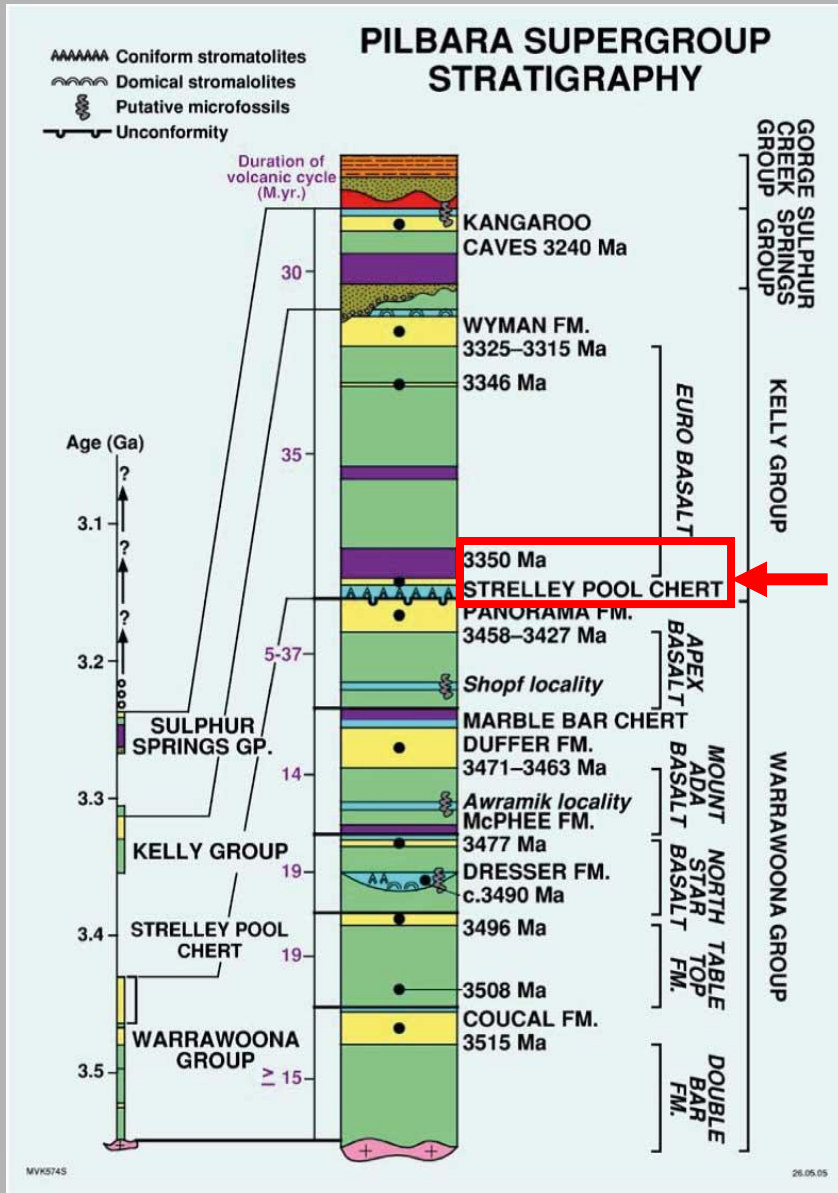
Allwood et al., 2006

Time constrained ~3.4 Ga

Pilbara Craton



Strelley Pool Chert



Van Kranendonk, 2006



Sugitani et al. 2015b

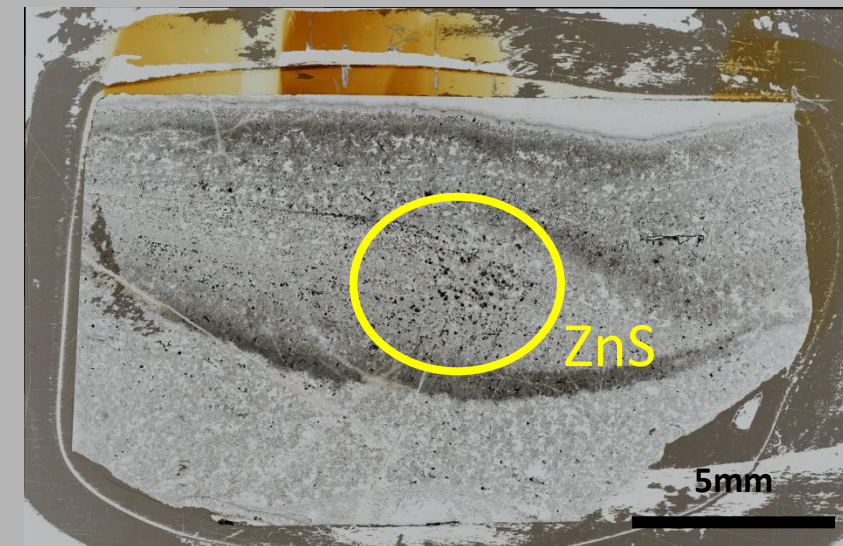


Time constrained ~3.4 Ga

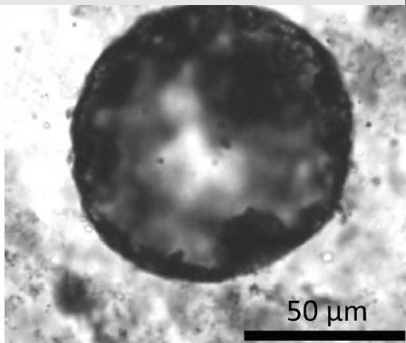

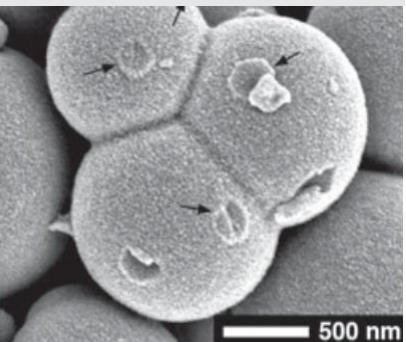
Siliceous rocks

Hydrothermal input
+ Diagenesis

Petrographical thin section



Coutant et al., accepted

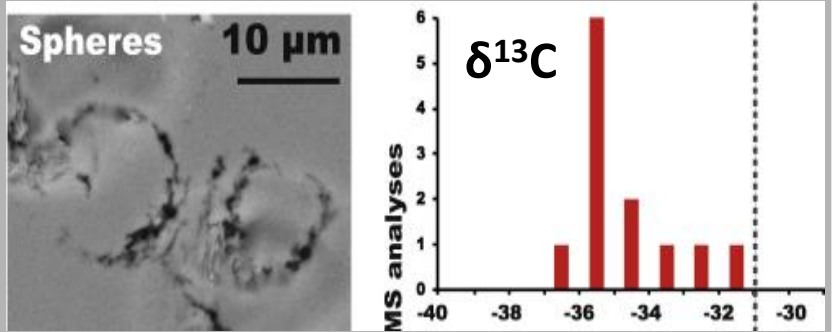
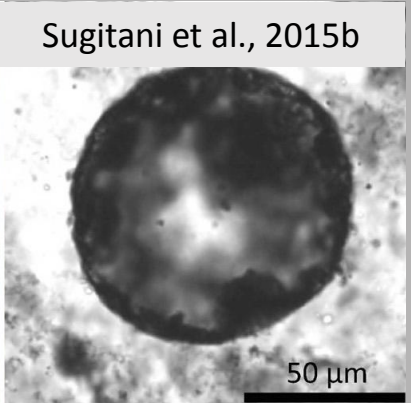
	Paleontological approach (morphologies)	Geochemical approach (isotopes)	Petrographical approach (organo-minerals)
SPF	<p>Sugitani et al., 2015b</p> 		
Fossil	<p>Wacey et al., 2012</p> 		
Abiotic process	<p>Jones & Renaud 2007</p> 		

**Paleontological approach
(morphologies)**

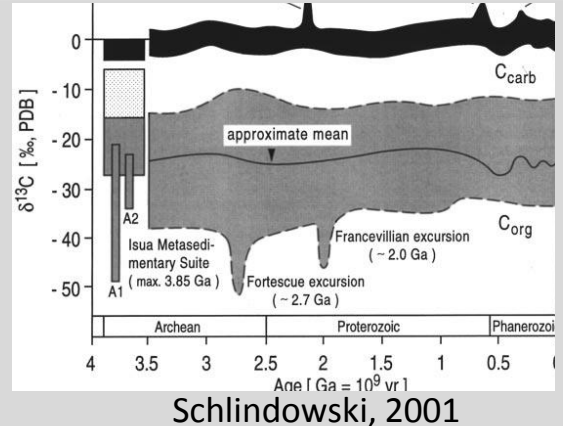
**Geochemical approach
(isotopes)**

**Petrographical approach
(organo-minerals)**

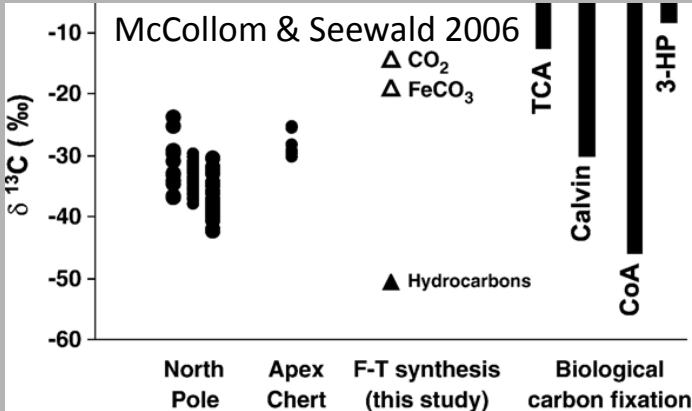
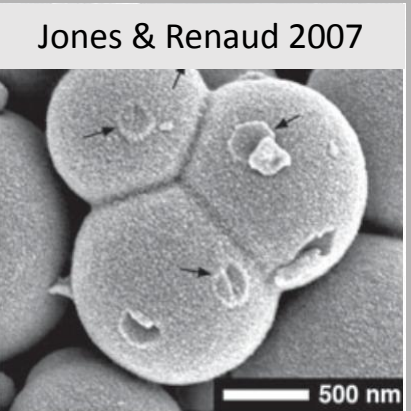
SPF



Fossil



Abiotic process

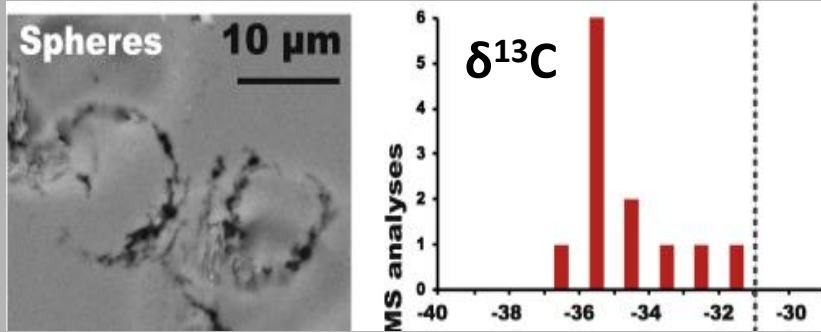
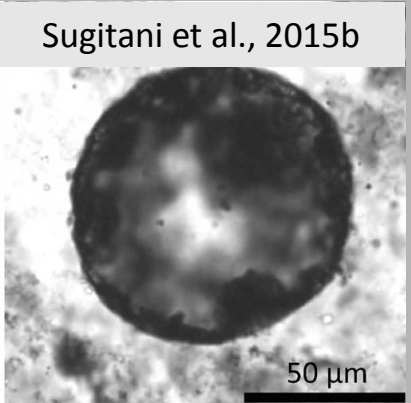


**Paleontological approach
(morphologies)**

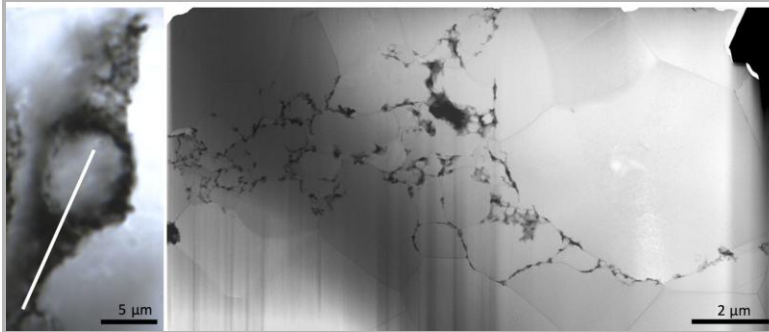
**Geochemical approach
(isotopes)**

**Petrographical approach
(organo-minerals)**

SPF

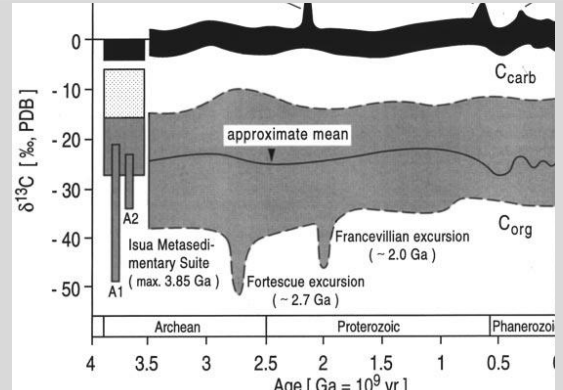


Lepot et al., 2013 – Nano-SIMS

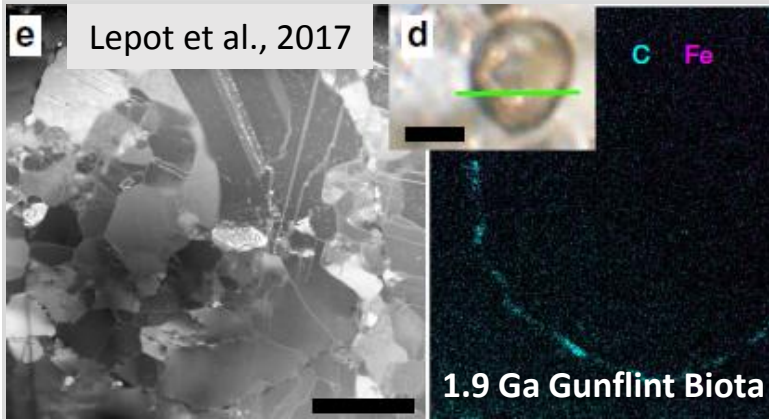


Sugitani et al., 2015a – FIB-TEM

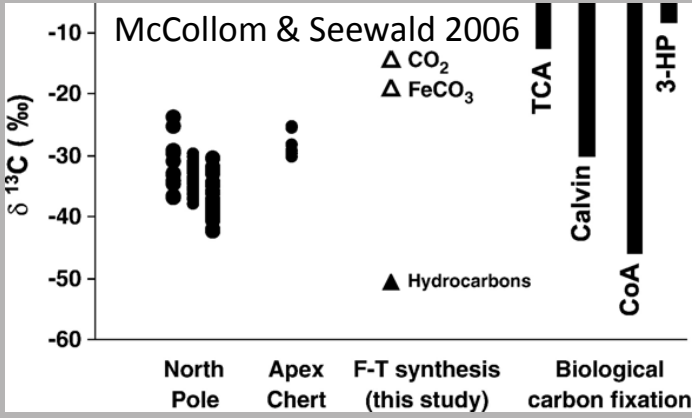
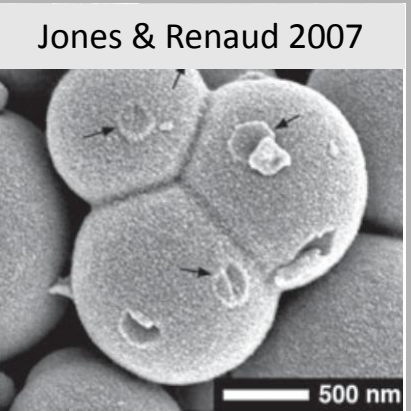
Fossil



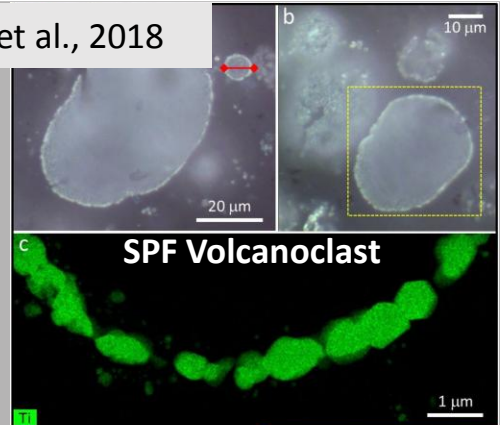
Schlindowski, 2001

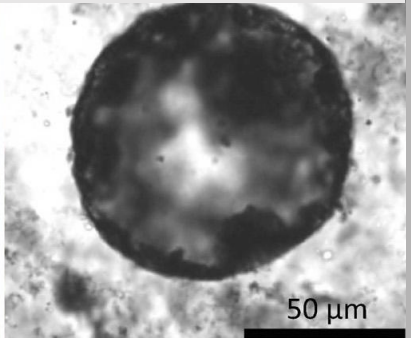
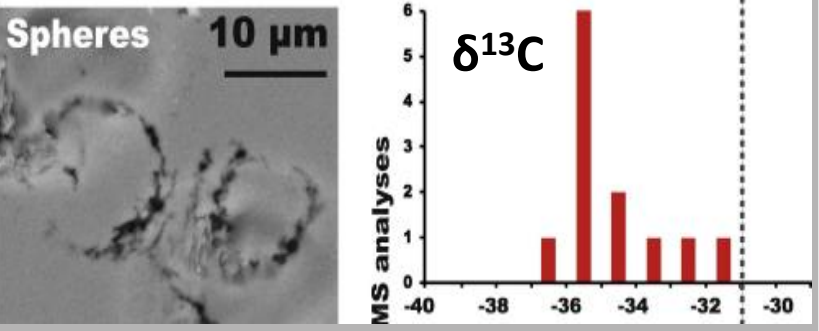
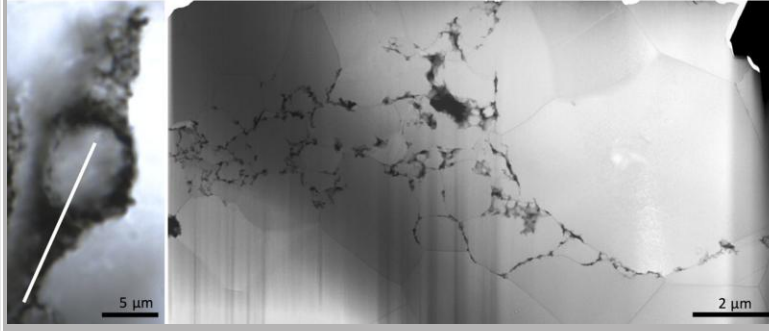


Abiotic process

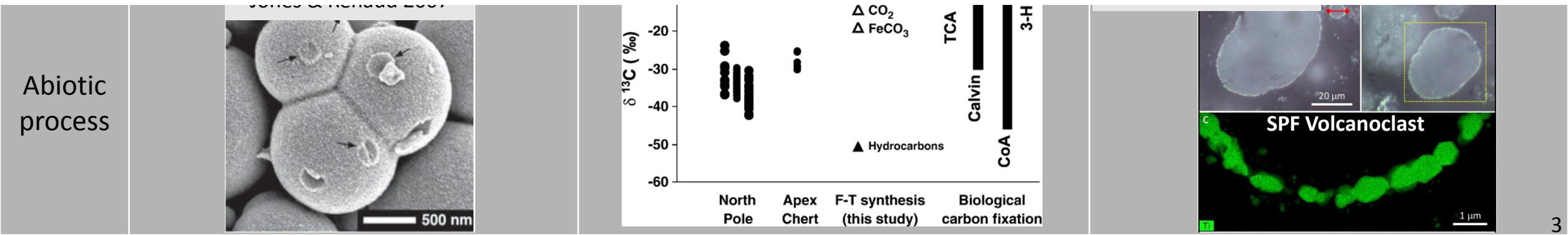


Wacey et al., 2018



	Paleontological approach (morphologies)	Geochemical approach (isotopes)	Petrographical approach (organo-minerals)
SPF	<p>Sugitani et al., 2015b</p> 	<p>Spheres 10 μm</p>  <p>Lepot et al., 2013 – Nano-SIMS</p>	 <p>Sugitani et al., 2015a – FIB-TEM</p>

Non unambiguous answers → need new tools

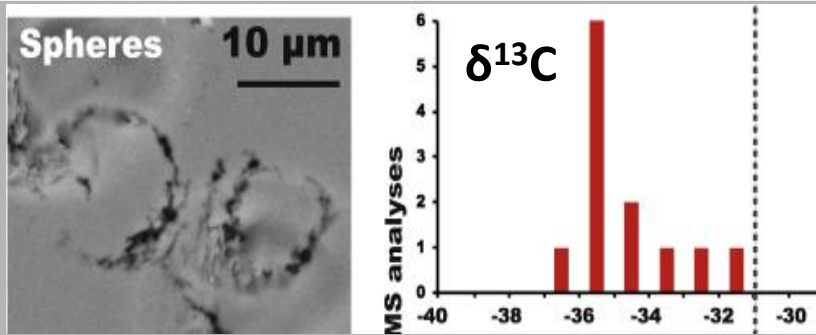
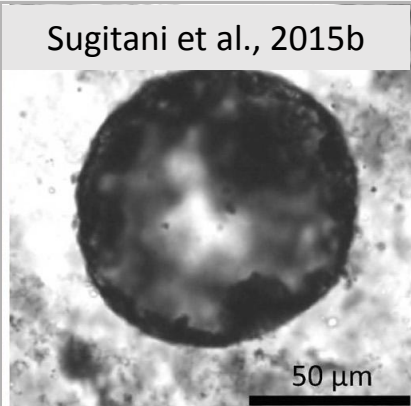


**Paleontological approach
(morphologies)**

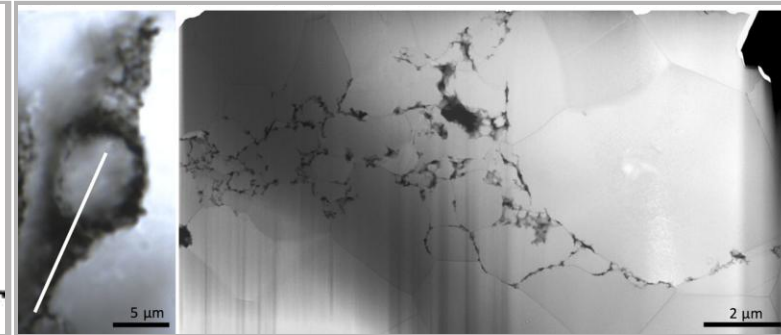
**Geochemical approach
(isotopes)**

**Petrographical approach
(organo-minerals)**

SPF

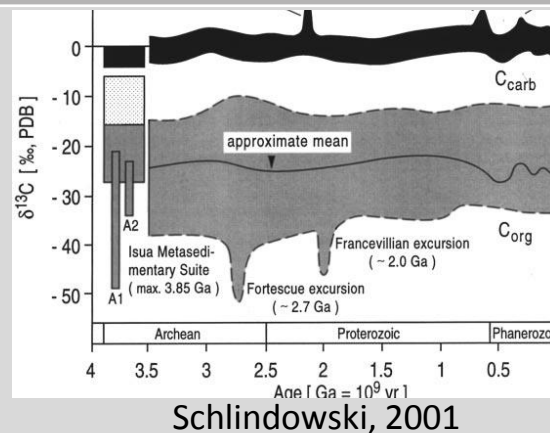


Lepot et al., 2013 – Nano-SIMS

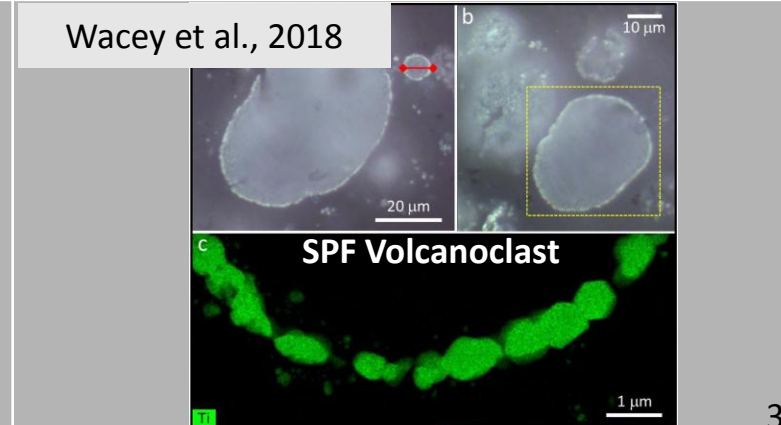
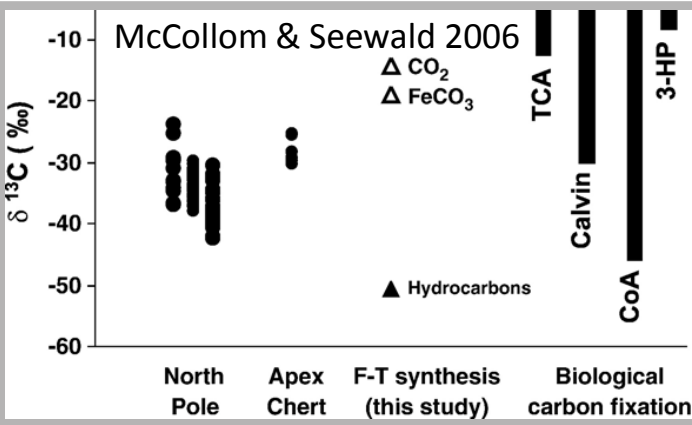
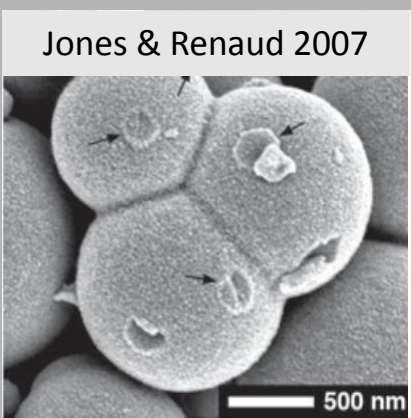


Sugitani et al., 2015a – FIB-TEM

Fossil



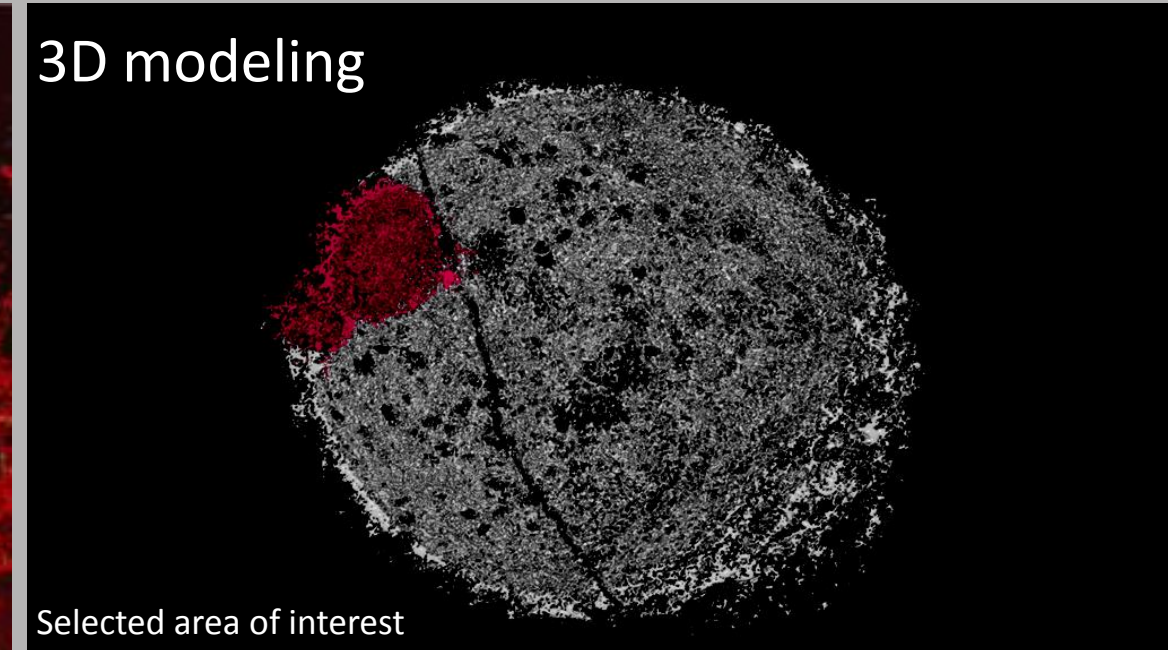
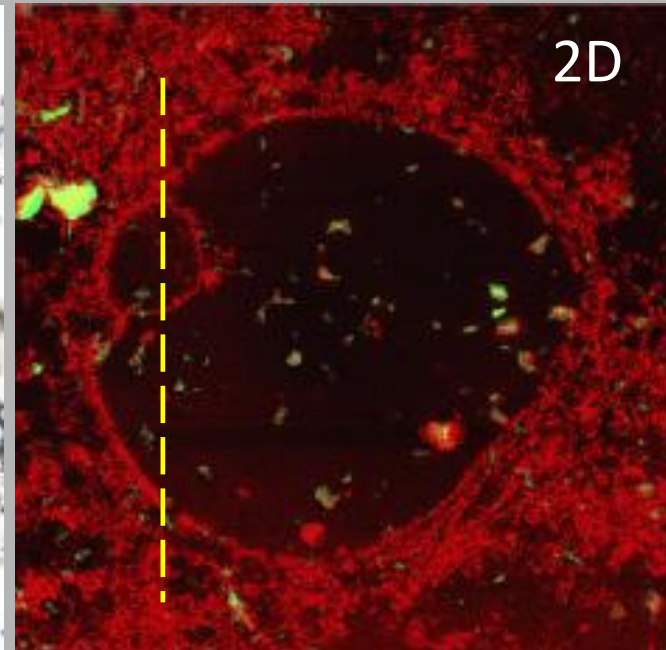
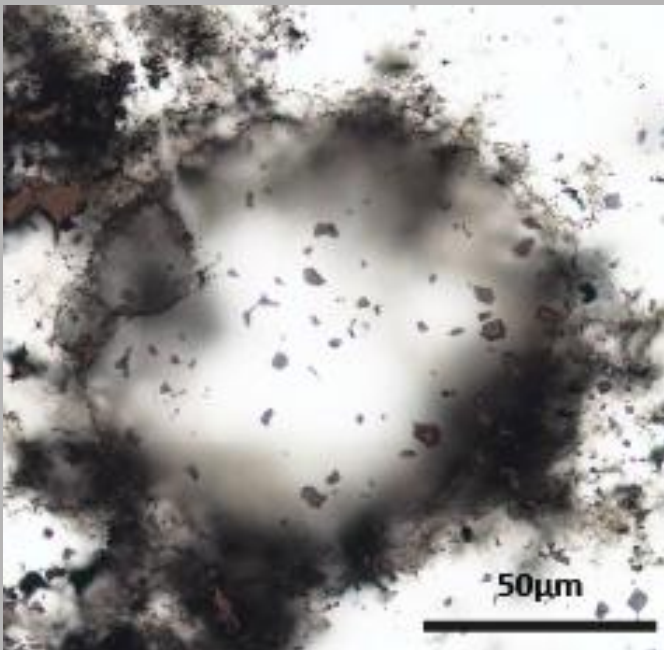
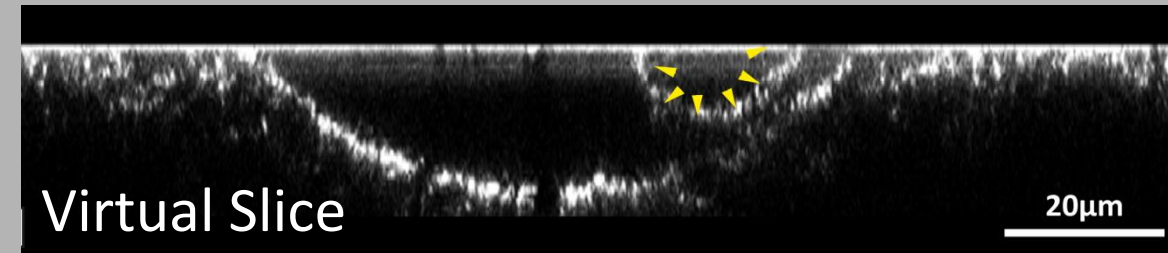
Abiotic process



New approach to assess morphogenesis

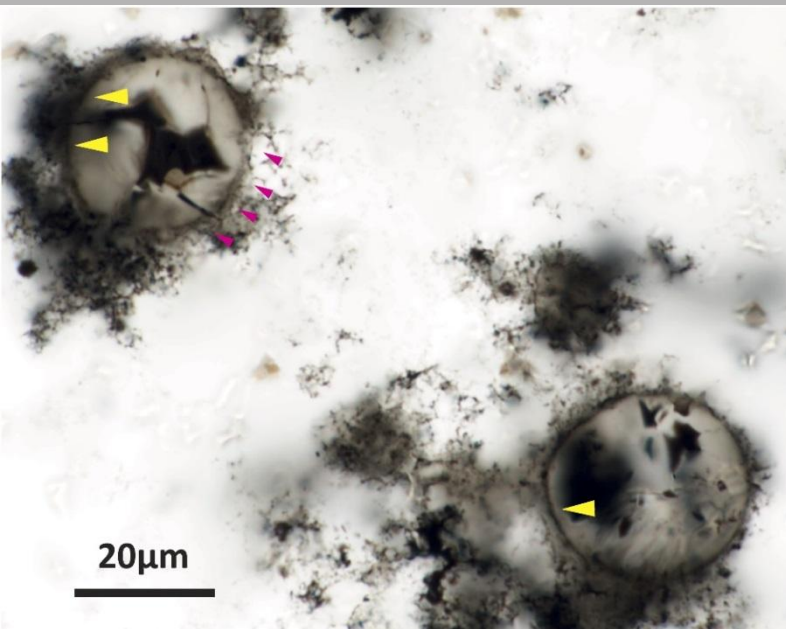
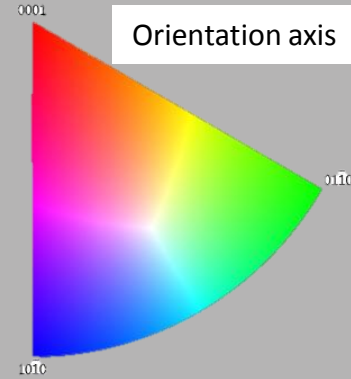
- Paleontological approach : CLSM
- UltraHigh resolution morphology
- 2 & 3D images – view X, Y, Z axis

Coutant et al., accepted

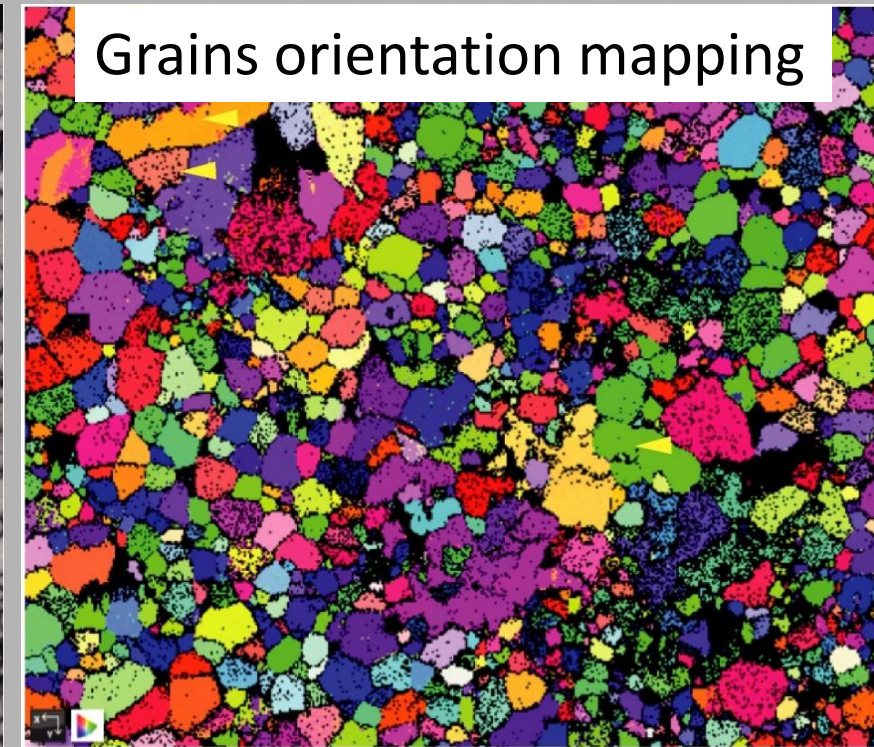
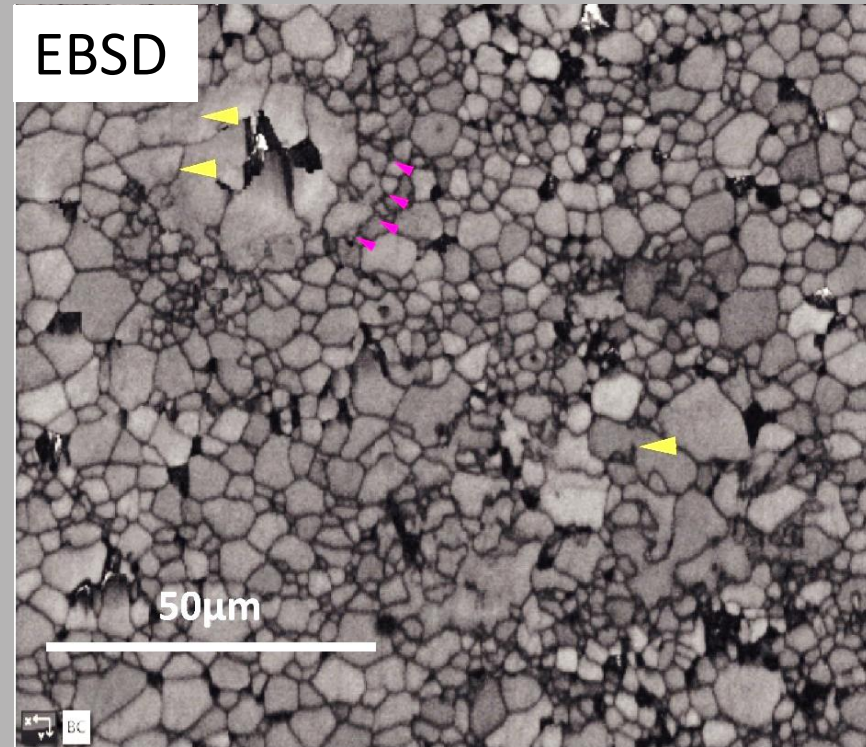


New approach to assess morphogenesis

- Petrographical approach : SEM-EBSD
- Grain size and shape – matrix texture



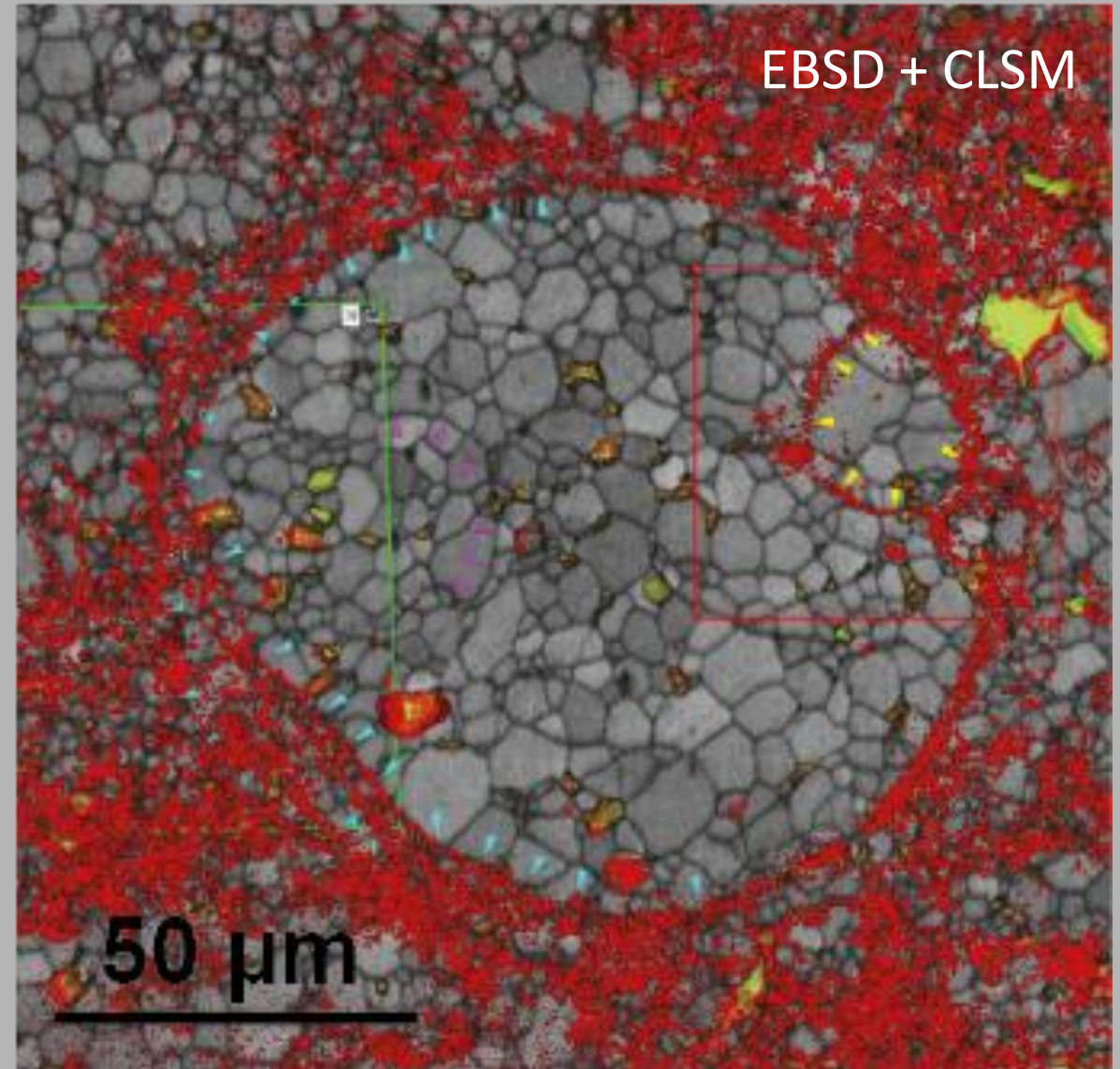
Coutant et al., accepted



New approach to assess morphogenesis

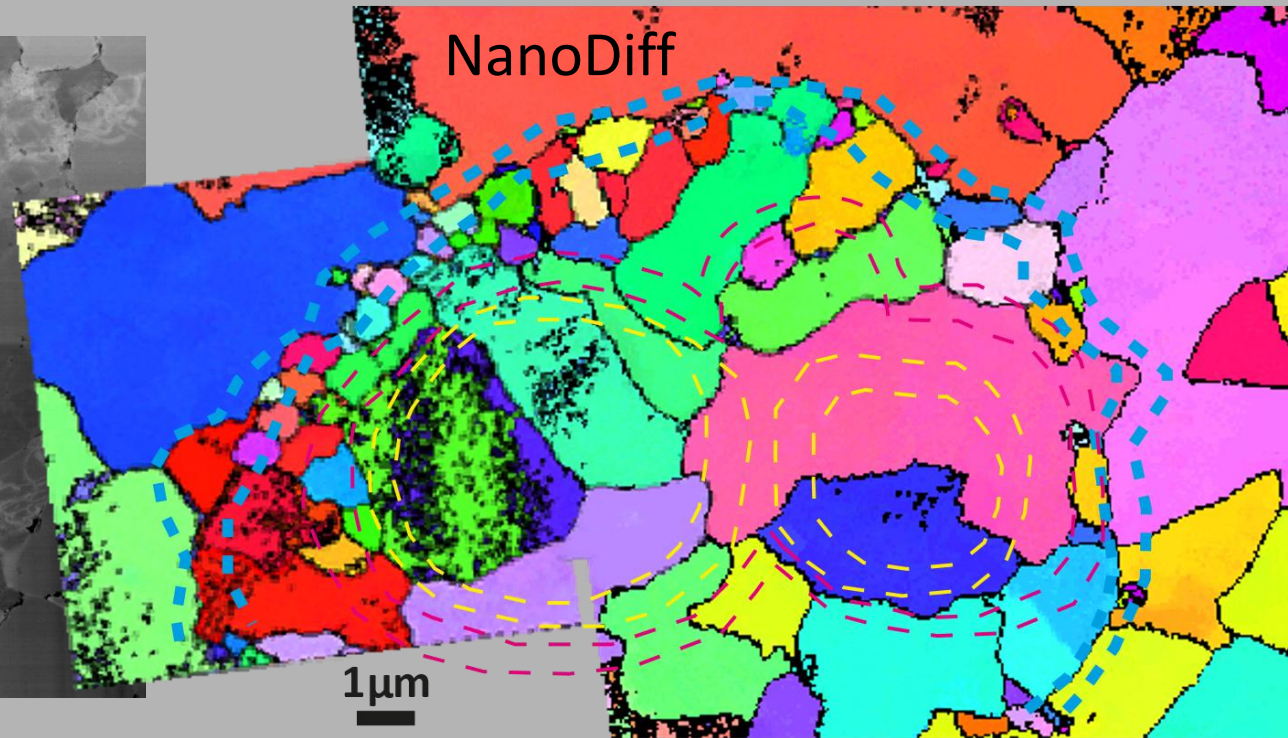
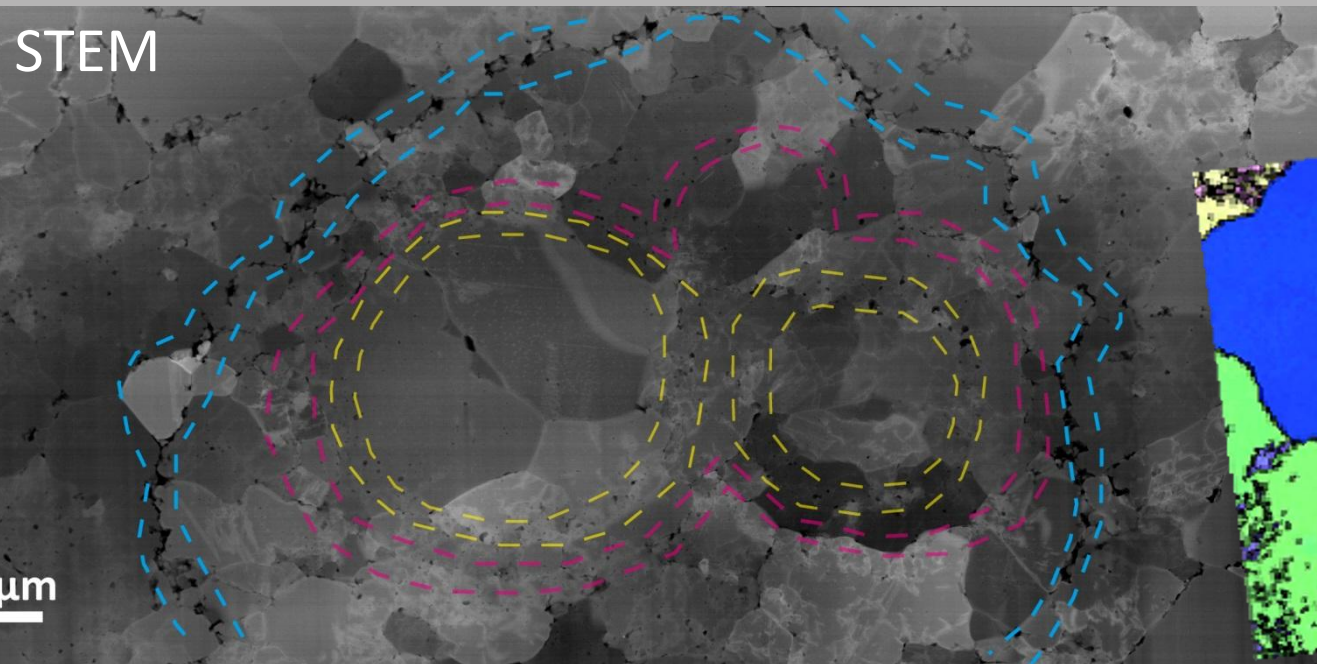
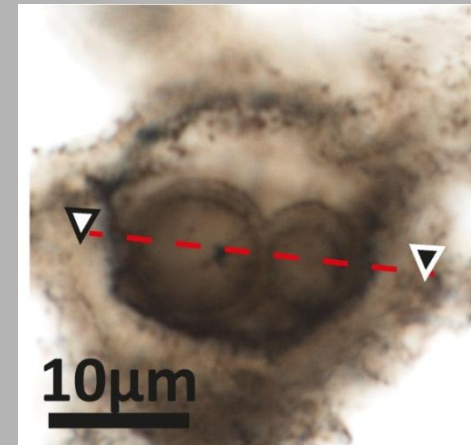
Coutant et al., accepted

- Morphologies integrate **petrographical** analyses :
- Coupling CLSM-EBSD
- OM at grain-boundaries/within grains
- Crystallization affected OM shapes

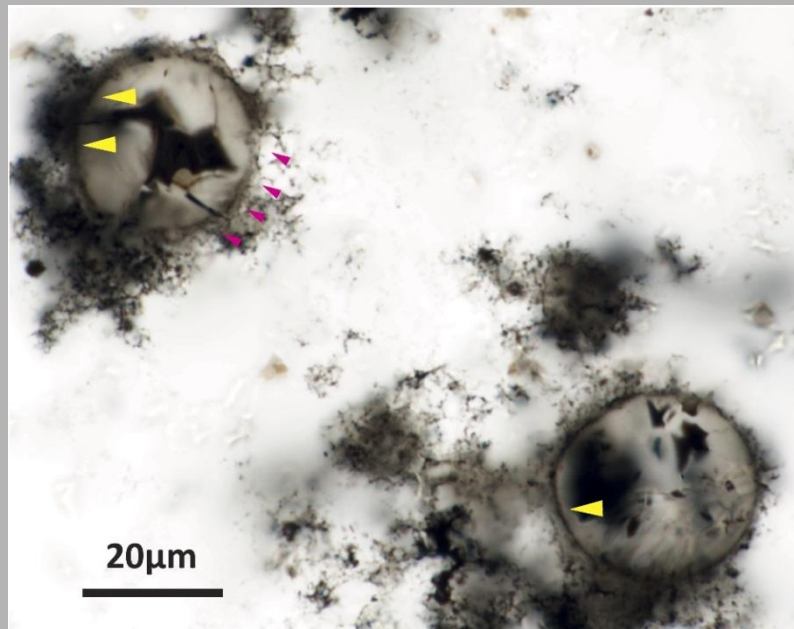


New approach to assess morphogenesis

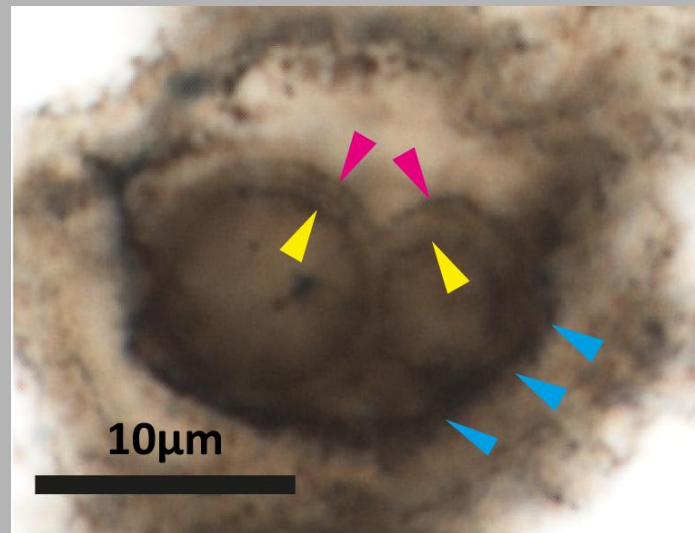
- **Petrographical approach** : FIB-STEM NanoDiff
- STEM → CLSM + NanoDiff → EBSD



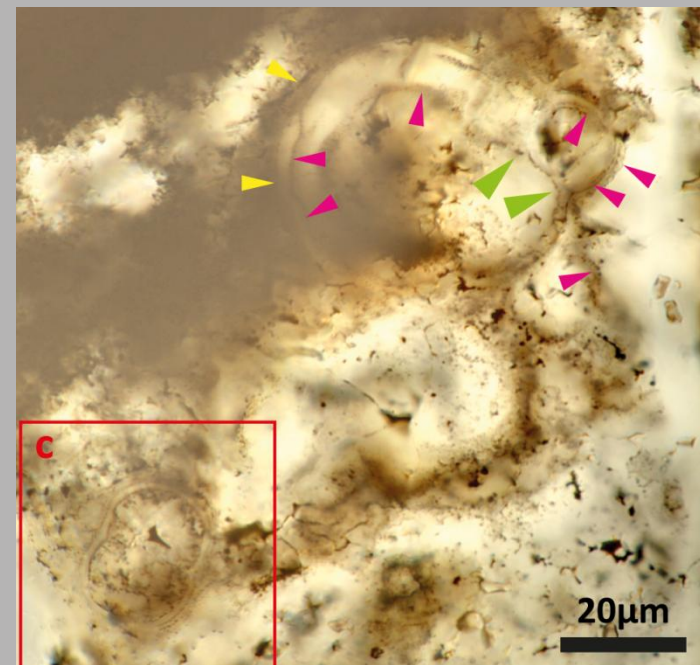
Type- 1



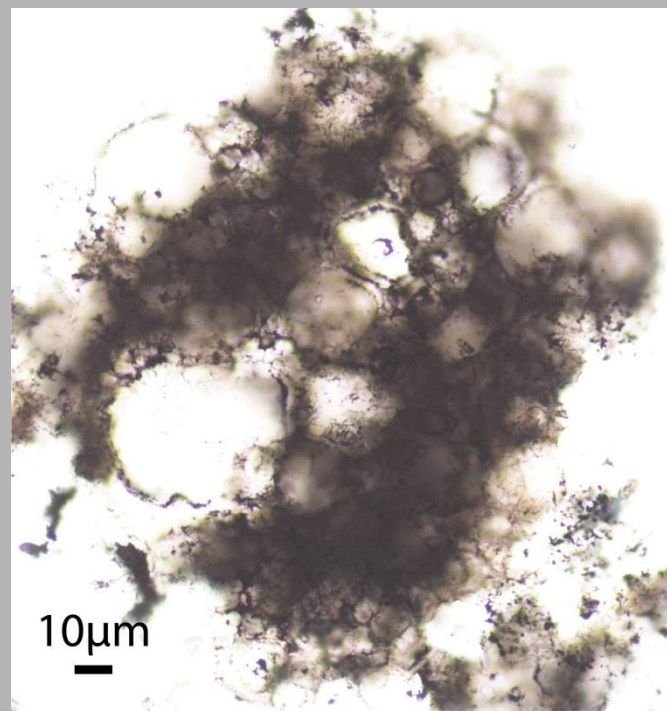
Type- 2



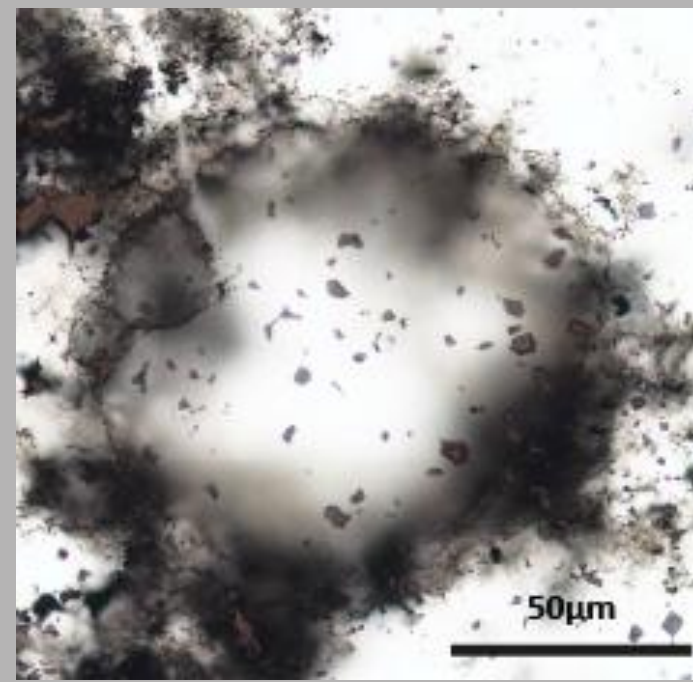
Type- 3



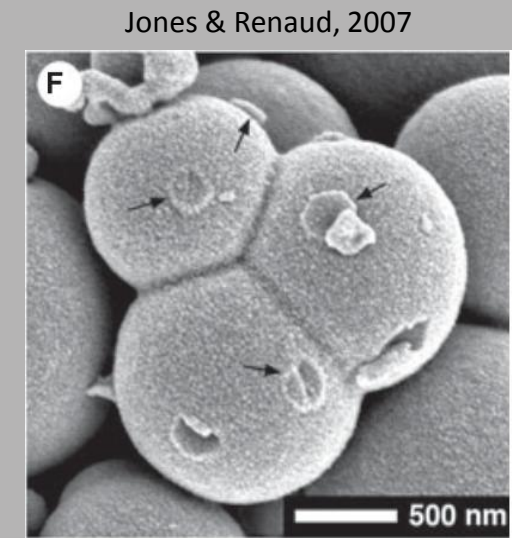
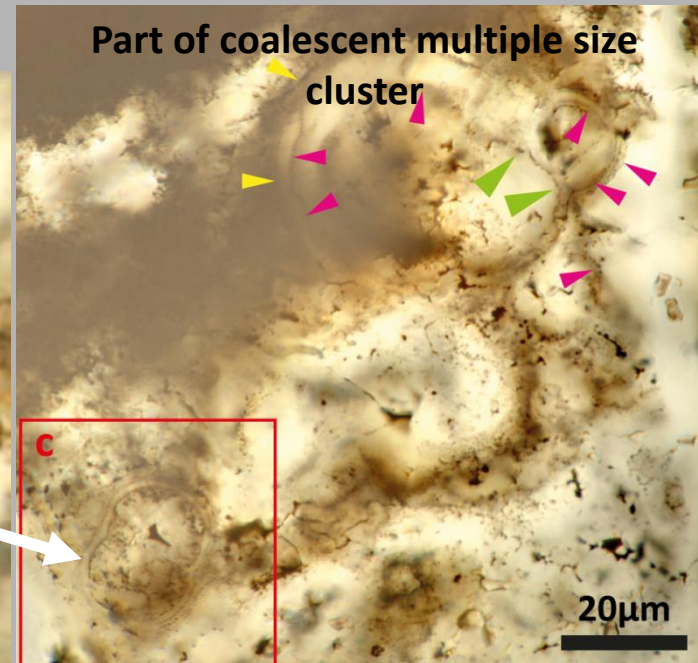
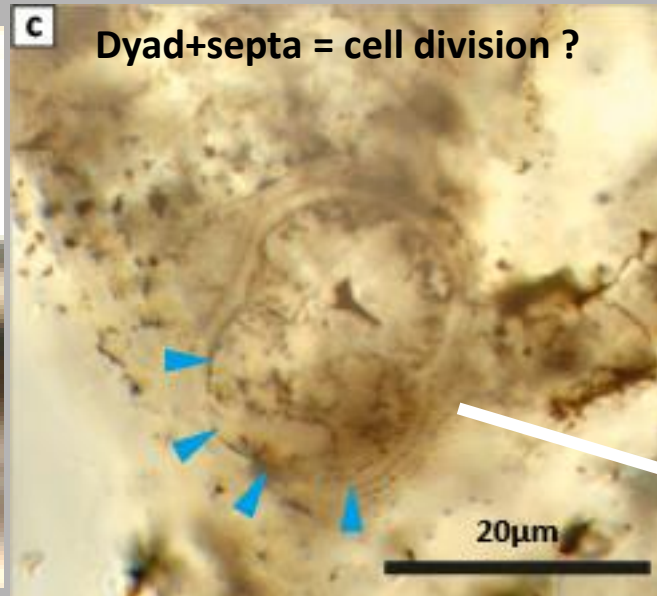
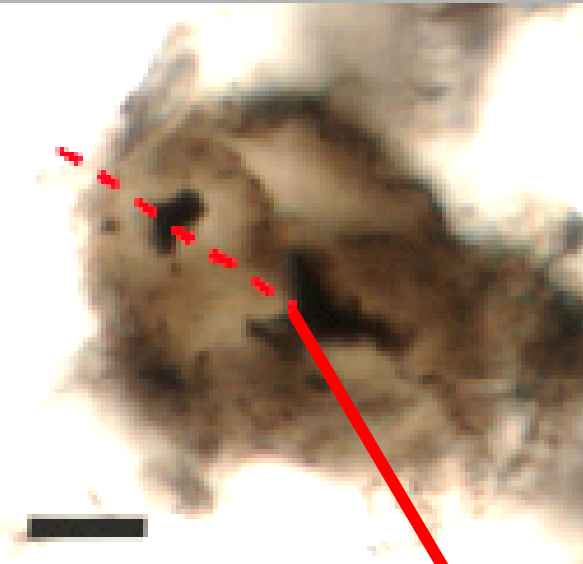
Type- 4



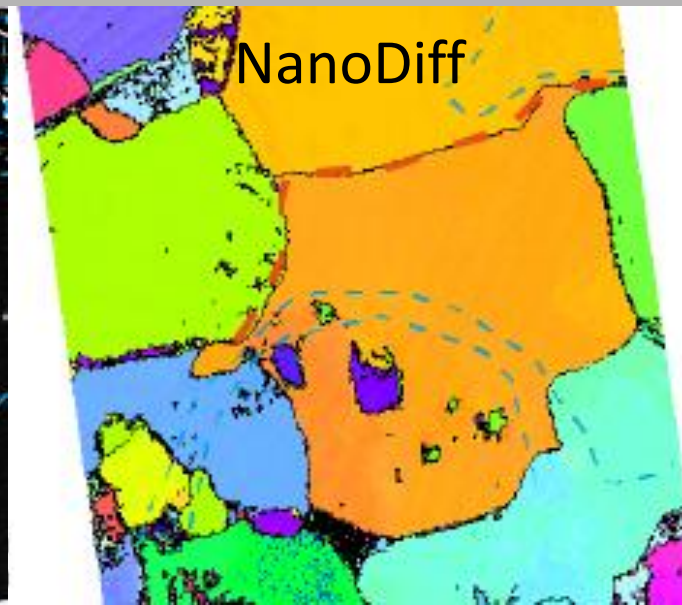
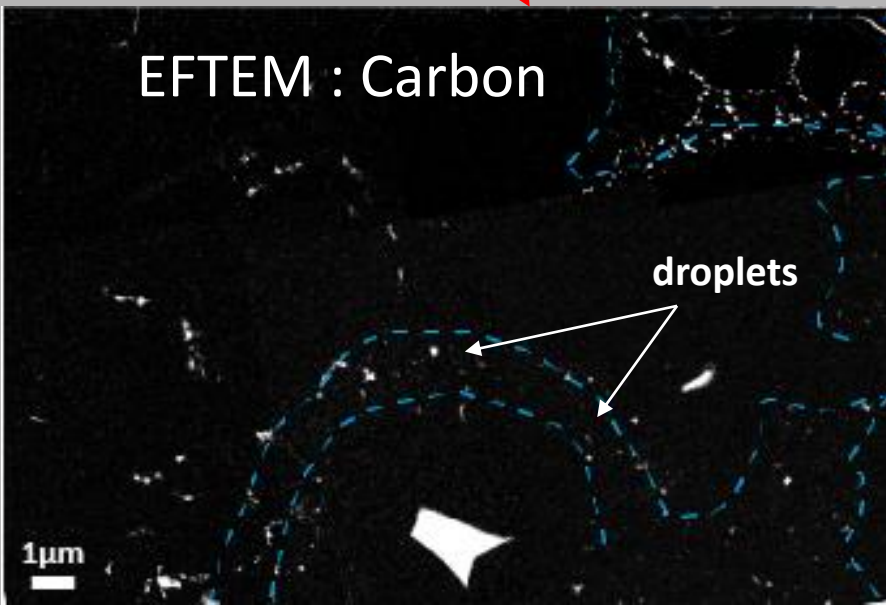
Type- 5



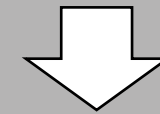
Type- 1 & Type- 3



Coutant et al., accepted

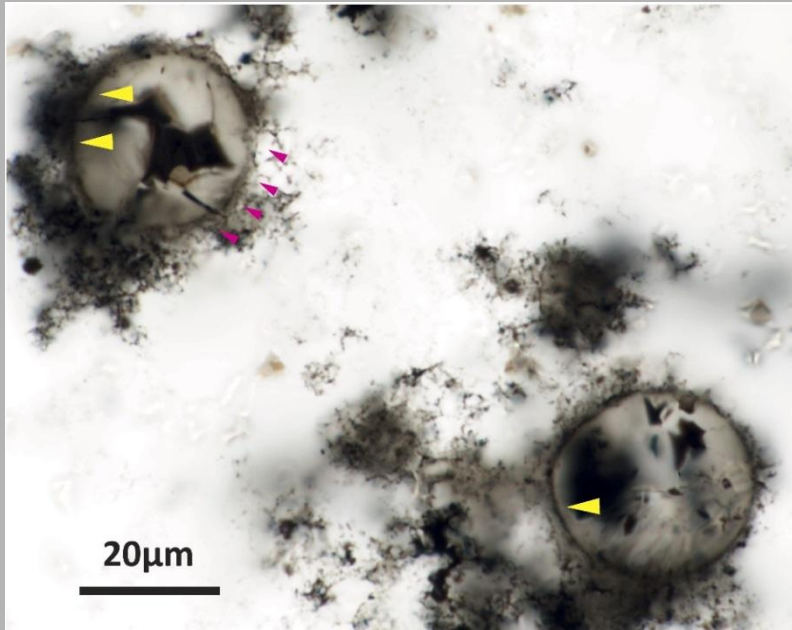


- Coalescence → botryoids opal/chalcedony (eg. Liesegang rings)



- Nanoparticles → organic diffusion, migration

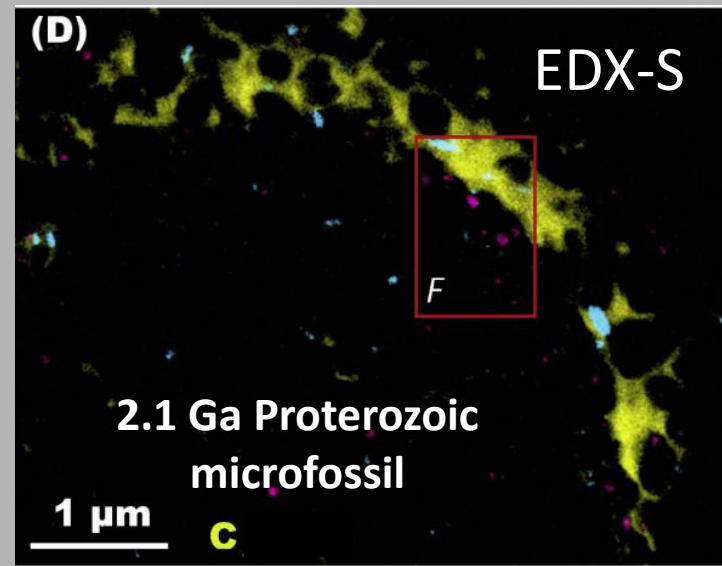
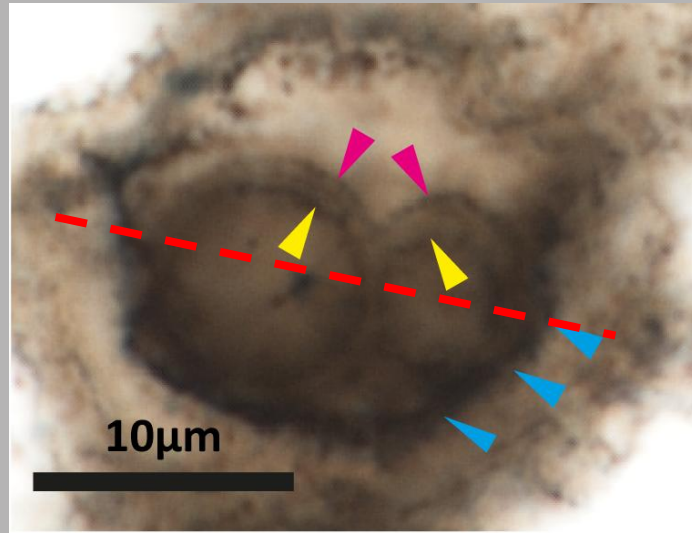
Type- 1 & Type- 3



- Coalescence + Nanoparticulate aspects of the walls

Abiotic morphogenesis

Type- 2

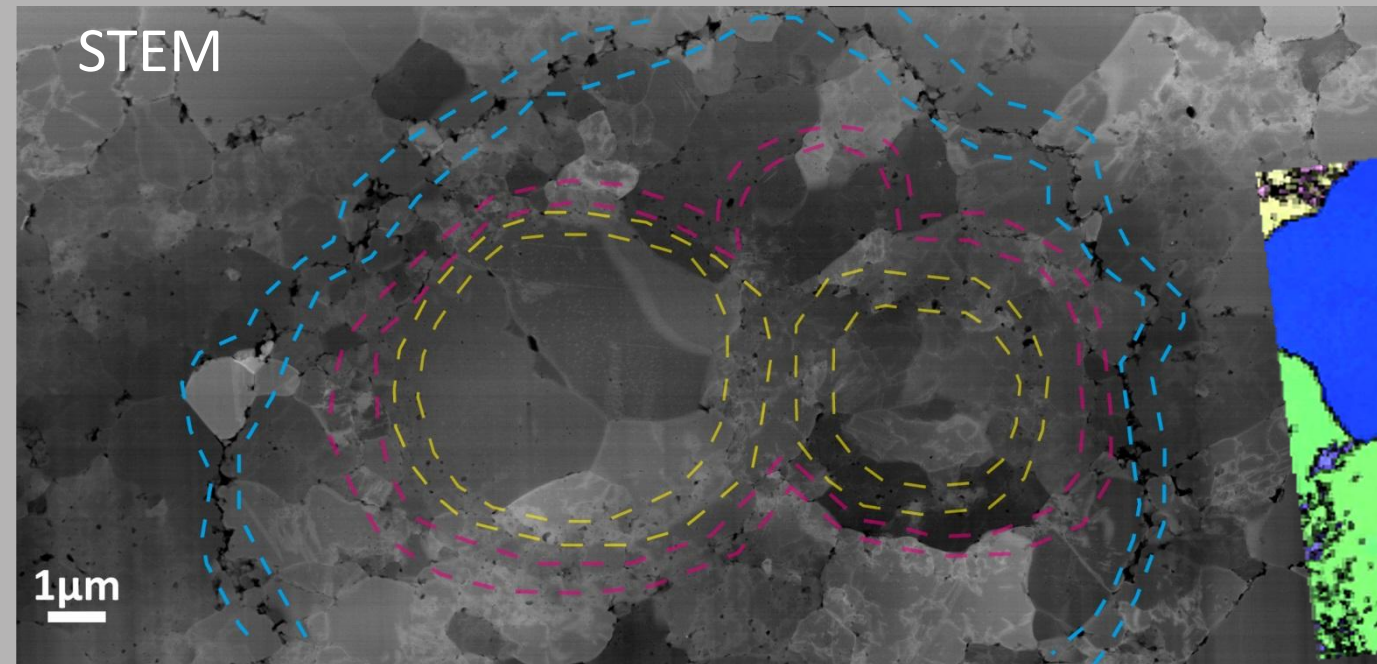


Lekele-Baghekema *et al.*, 2017

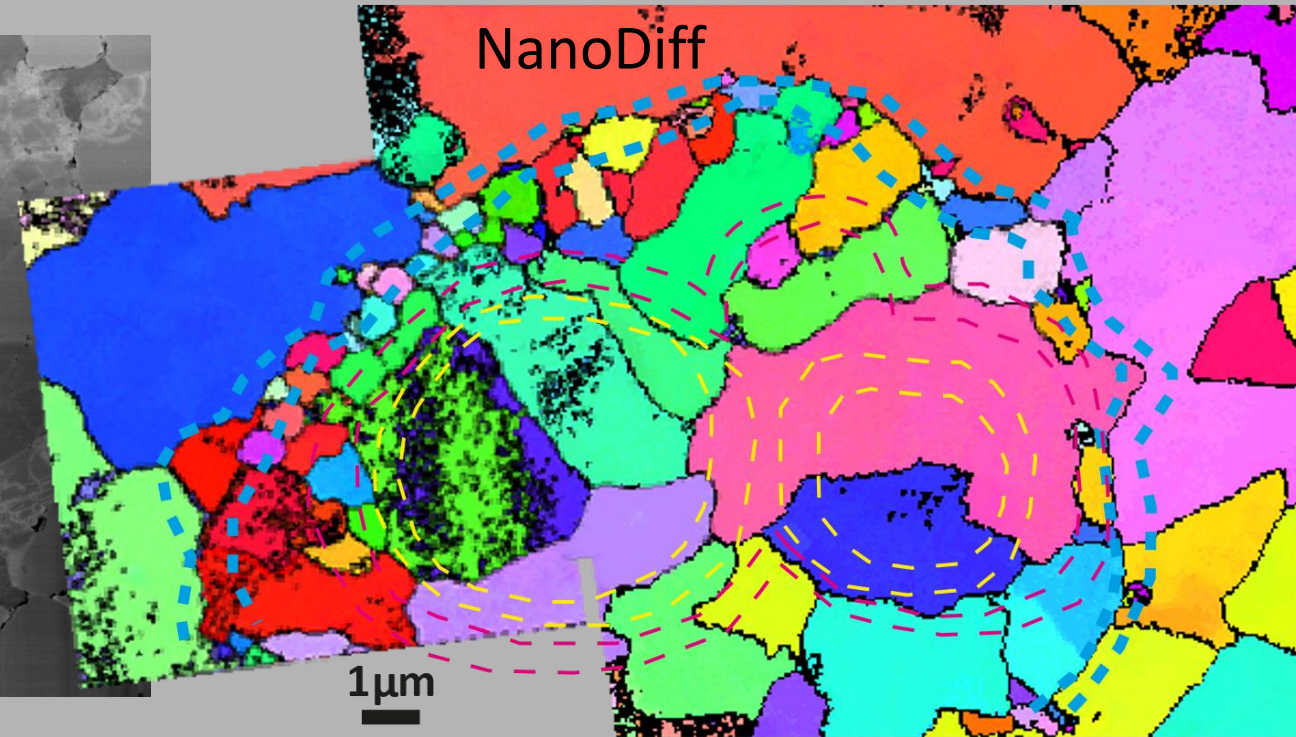
- Thick outerwall at grain boundaries
- Coalescent discontinuous inner vesicles

Coutant *et al.*, accepted

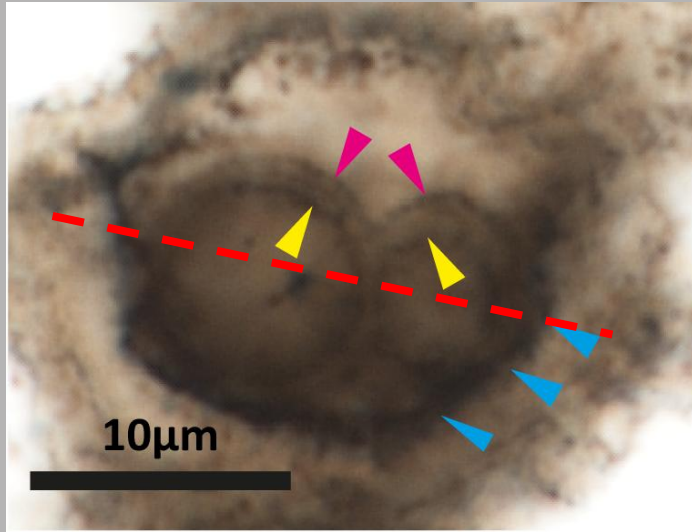
STEM



NanoDiff



Type- 2

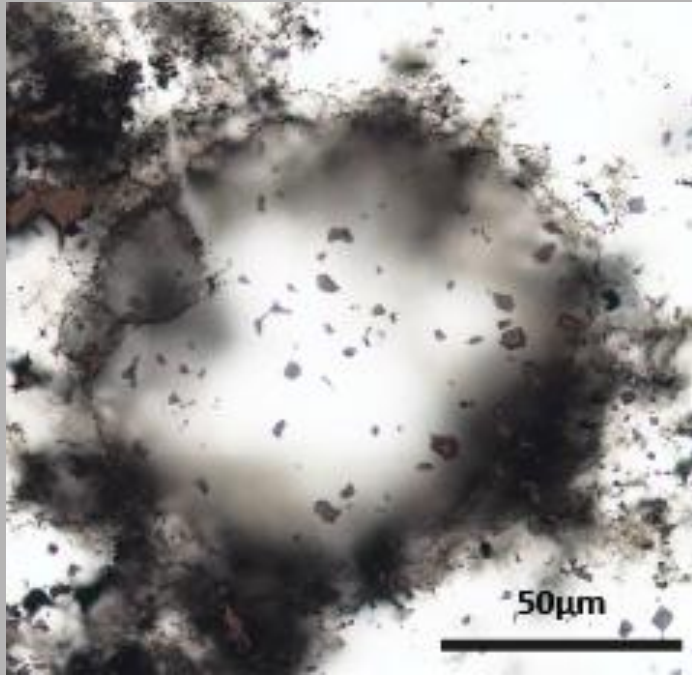


Coutant et al., accepted

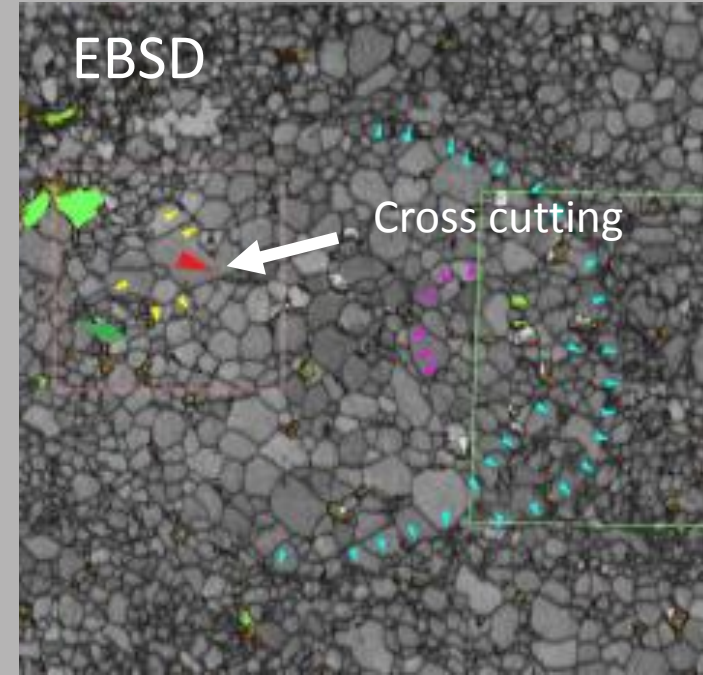
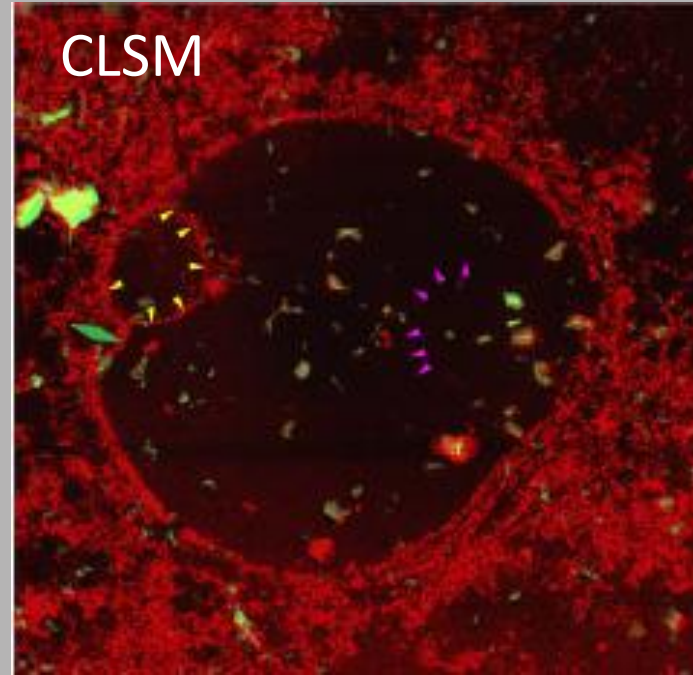
- Thick outerwall at grain boundaries = **bio?**
- Coalescent discontinuous inner vesicles = **abio?**

Dubiofossil

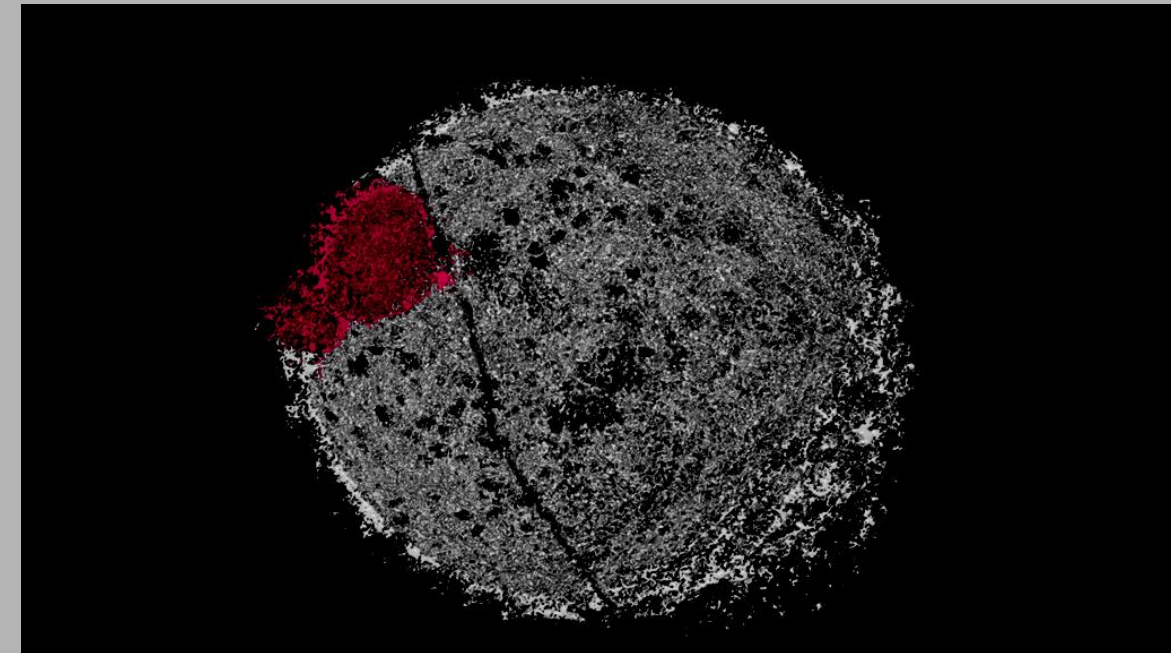
Type- 5



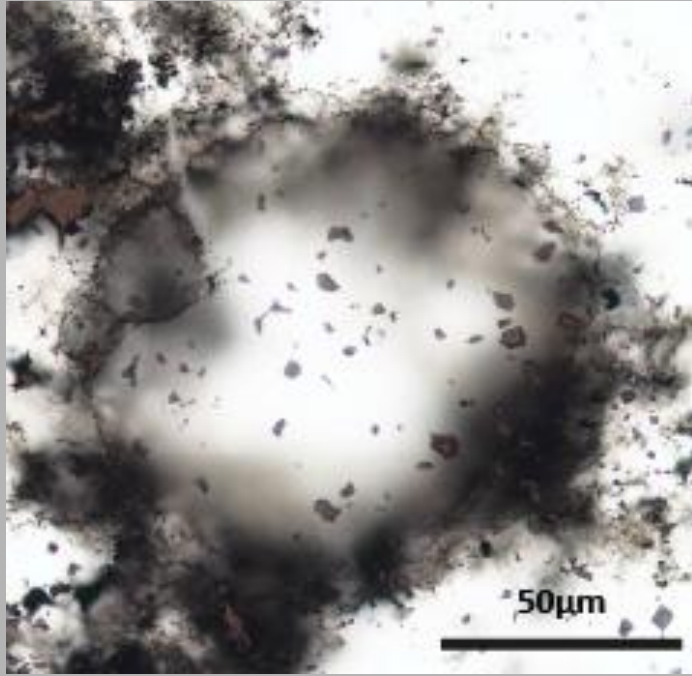
Coutant et al., accepted



- Unique large specimen
- Continuous wall with crystals disrupting wall integrity
- Pustule of different thickness (inside-outside)



Type- 5



Coutant et al., accepted

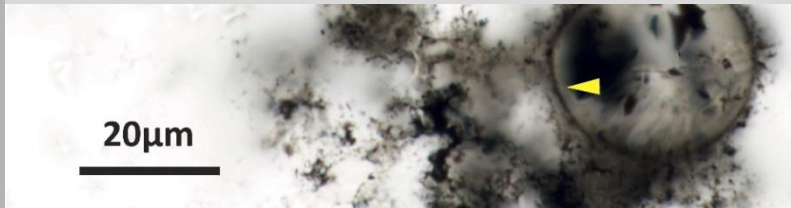
Dubiofossil

- Unique large specimen
- Continuous wall with crystals disrupting wall integrity = **bio** ?
- Pustule of different thickness (inside-outside) = **abio** ?

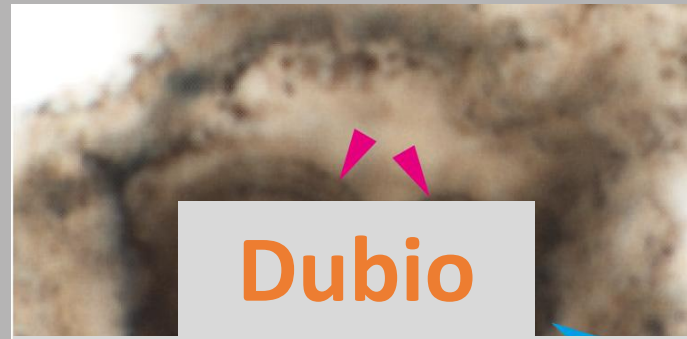
Type- 1



Coalescence + nanoparticles



Type- 2



Thick outer wall + vesicles

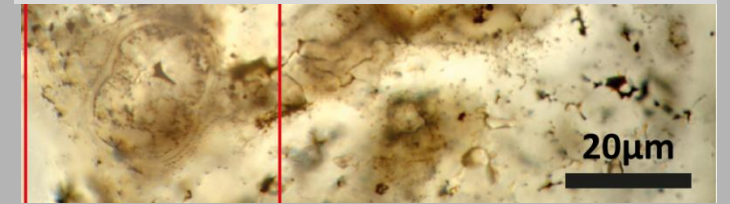


Coutant et al., accepted

Type- 3



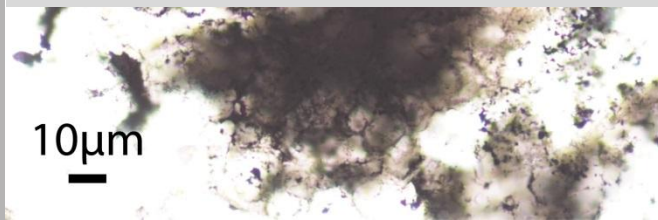
Coalescence + nanoparticles



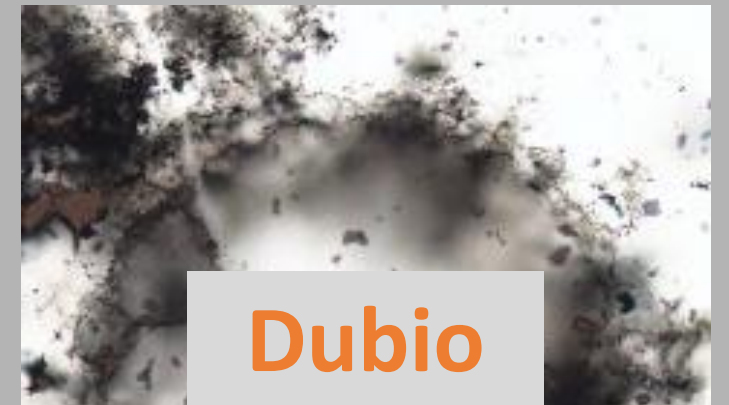
Type- 4



Thick outer wall + heterogeneous



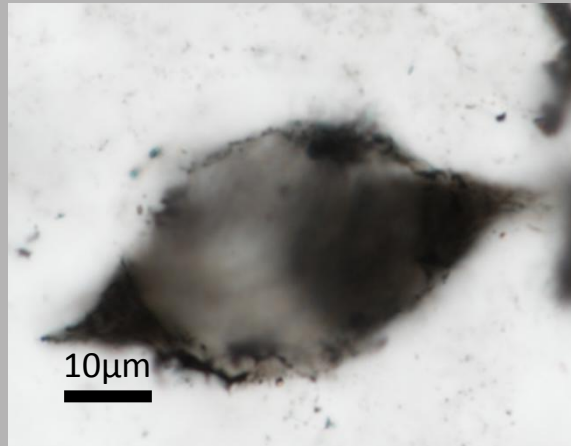
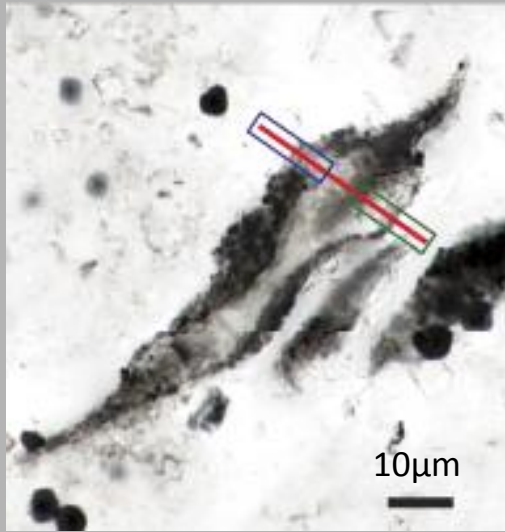
Type- 5



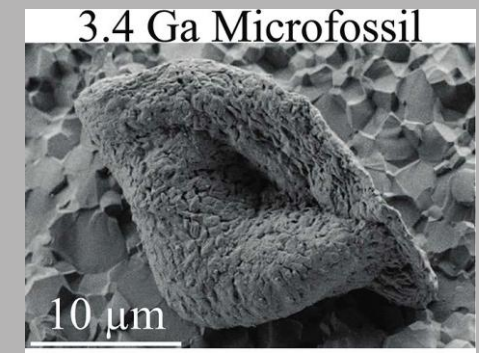
Thick outer wall + pustule (unique)



Ongoing research : Lenses

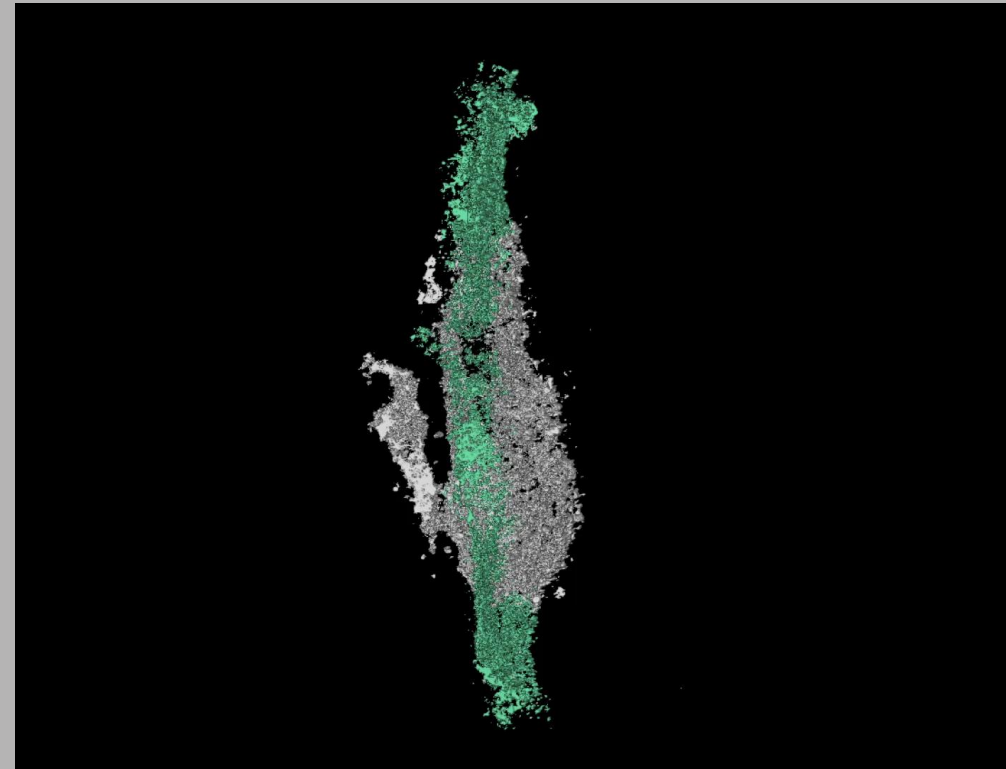
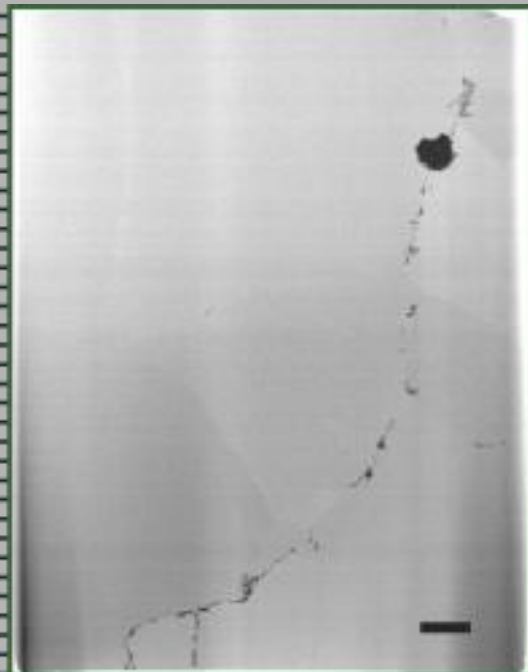
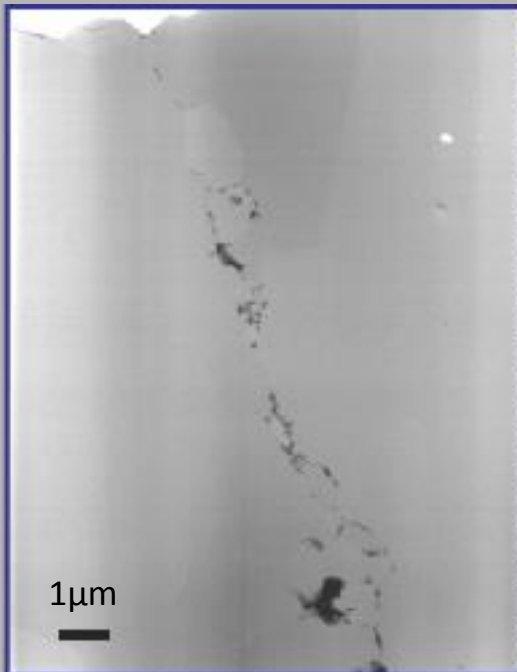


Coutant et al., in prep



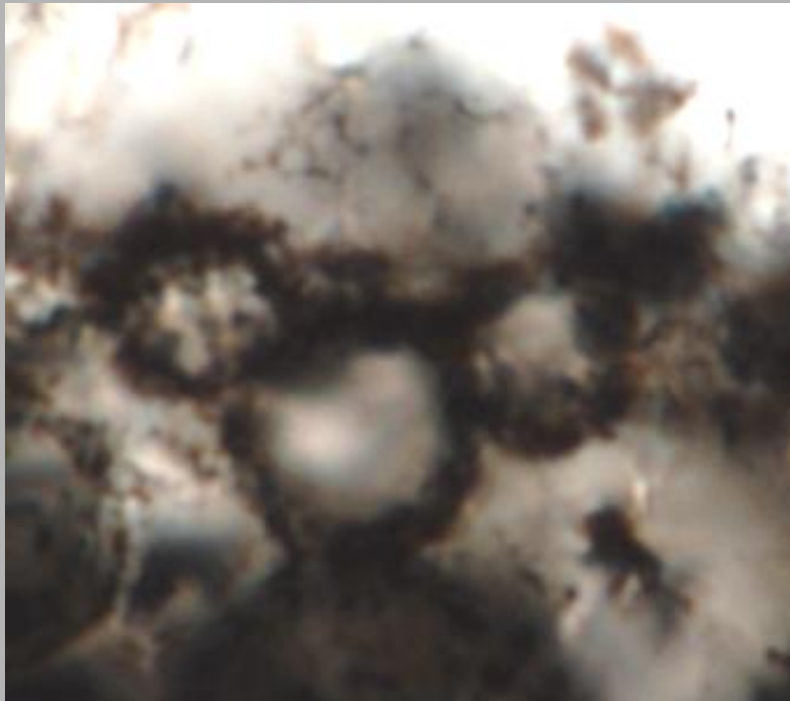
Alleon et al., 2018

- Unique morphology = flange
- Different from spheres in petrography & ultrastructures



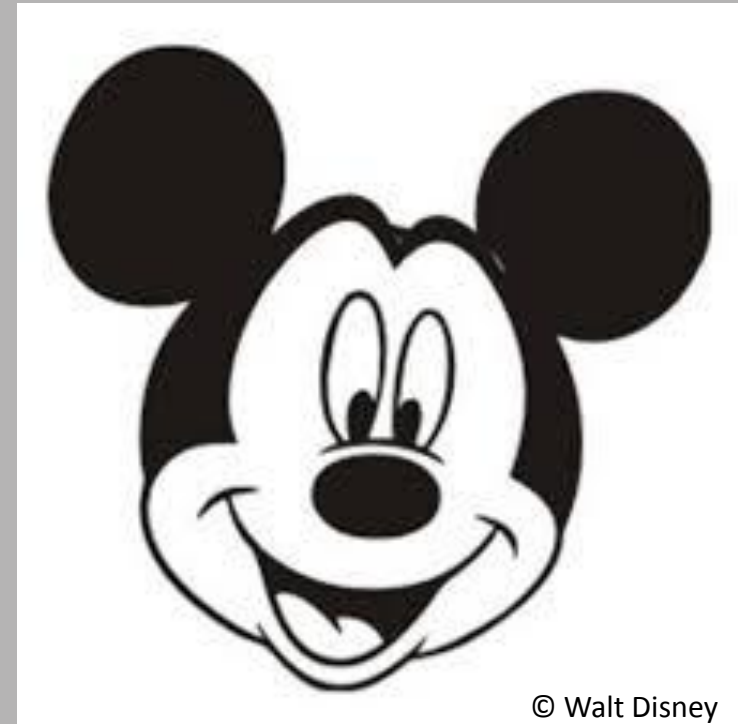
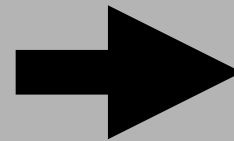
Thanks for your attention

K. Lepot E. J. Javaux +Collaborators



Coutant personal obs.

???



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