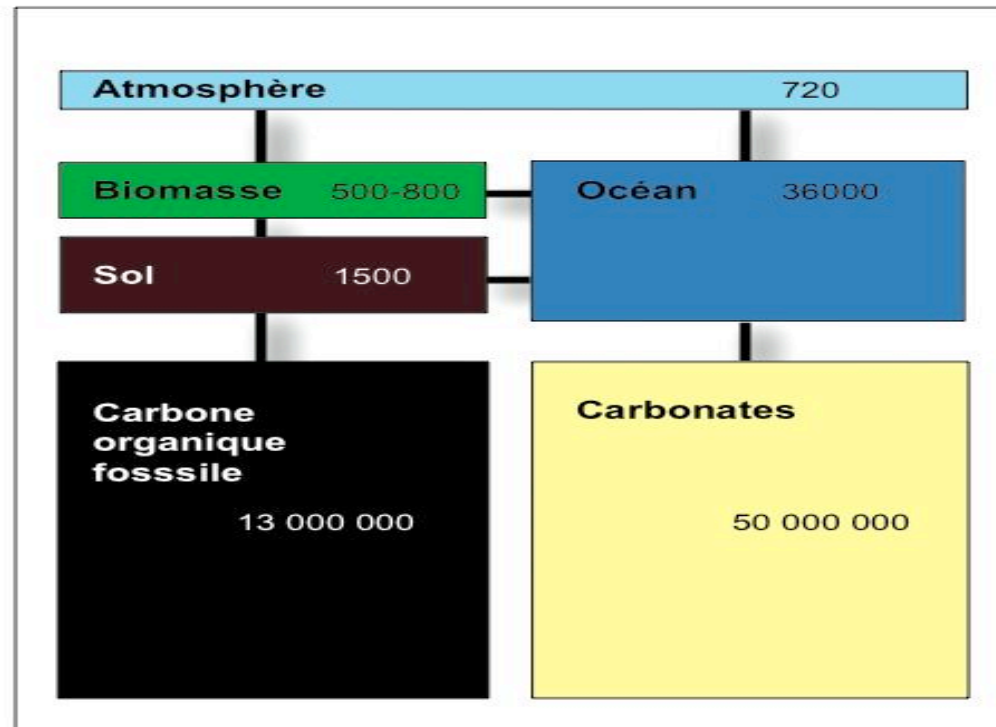


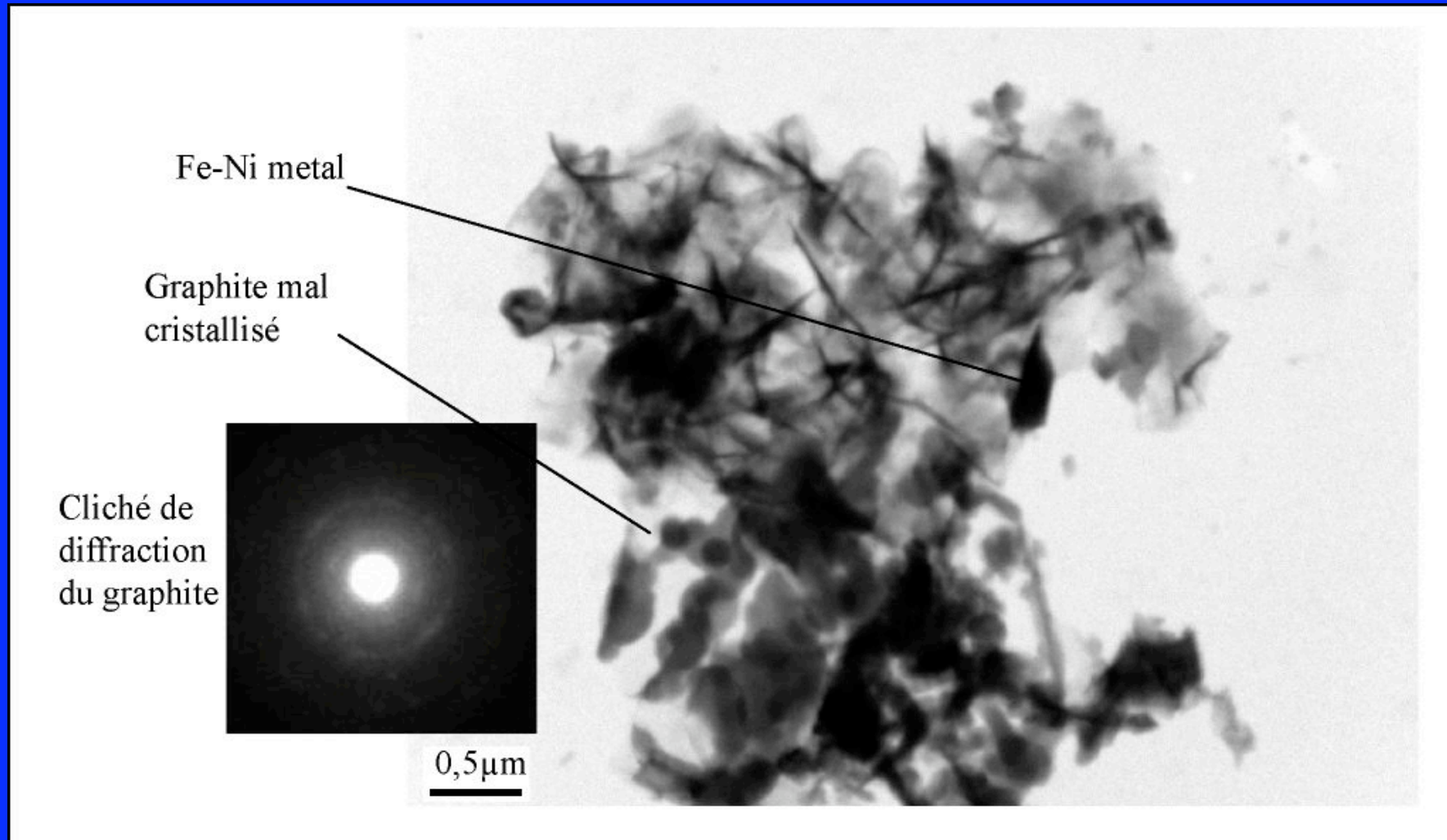
New scientific questions regarding CO₂ geological storage

- CO₂ --> supercritical CO₂
- CO₂ --> dissolution H₂CO₃
- CO₂ --> dissolution/neutralization HCO₃⁻
- CO₂ --> solid carbonates MCO₃
- CO₂ --> Reduction « organic » carbon

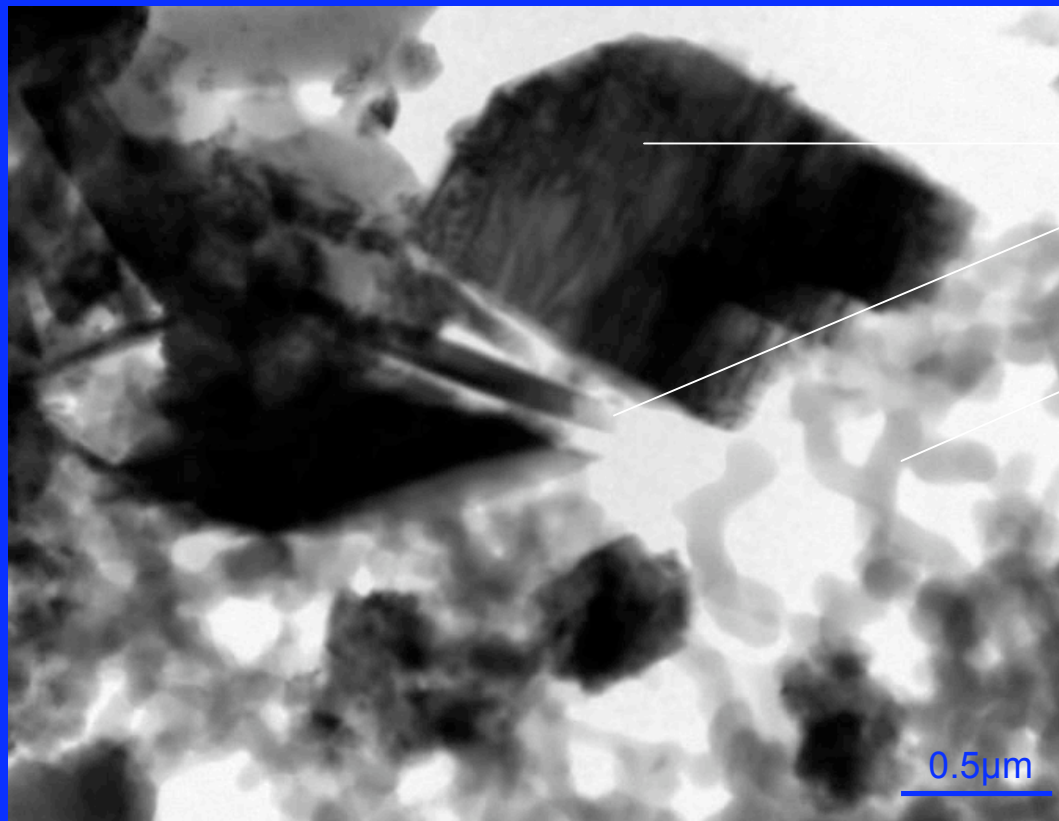
Natural CO₂ storage



Reduction of CO₂ into graphite (400°C)

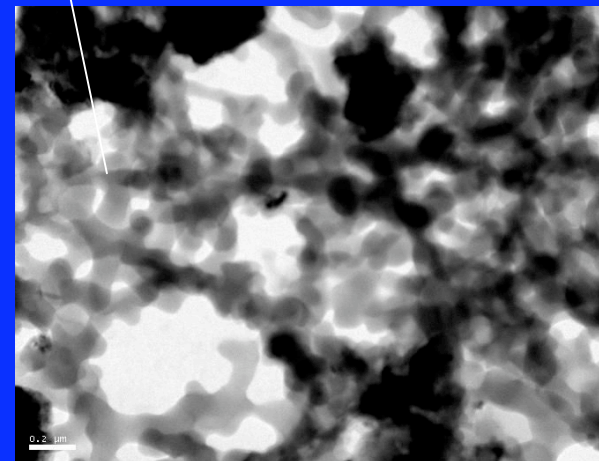


Reduction of CO₂ at much lower T (90°C) Catalysis?



MgCO₃
magnesite

Amorphous
reduced carbon
phase



Reduction of CO₂ at much lower T Biology?

DEEP BIOSPHERE

Global carbon content in plant and prokaryotic biomass

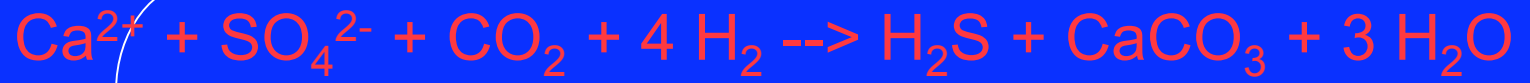
Ecosystem	Carbon content, 10 ¹² kg of C		
	plant	soil and aquatic prokaryotes	intraterrestrial prokaryotes
Continental	560	26	22–215
Oceanic	1.8	2.2	303
Total	561.8	28.2	325–518

Whitman, 1998, PNAS

Possible mechanism :



5.00 μm



Sulfate reducing bacteria (SRB)

Acétate

SO_4^{2-}

Acetogenic bacteria

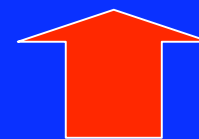
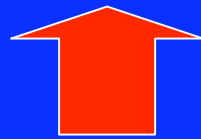
H_2

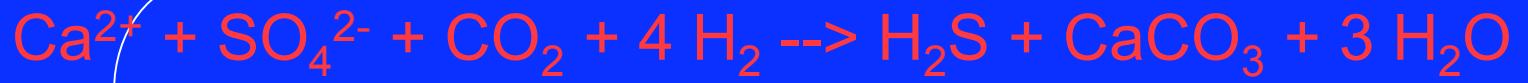
CO_2

CaCO_3



Dupraz, Menez, Magot, Guyot, 2007





Sulfate reducing bacteria (SRB)

Methane

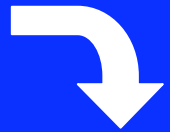
SO_4^{2-}

Methanogenic bacteria

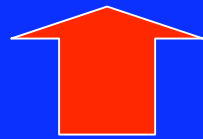
H_2

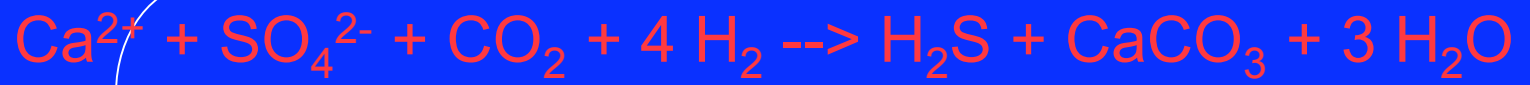
CO_2

CaCO_3

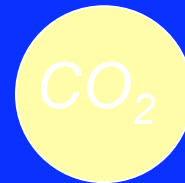
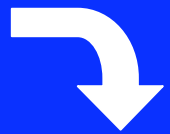


Dupraz, Menez, Magot, Guyot, 2007



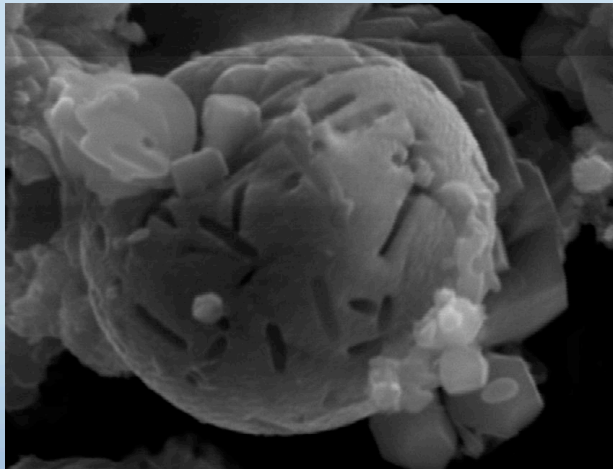


Autotrophic Sulfate reducing bacteria



Dupraz, Menez, Magot, Guyot, 2007

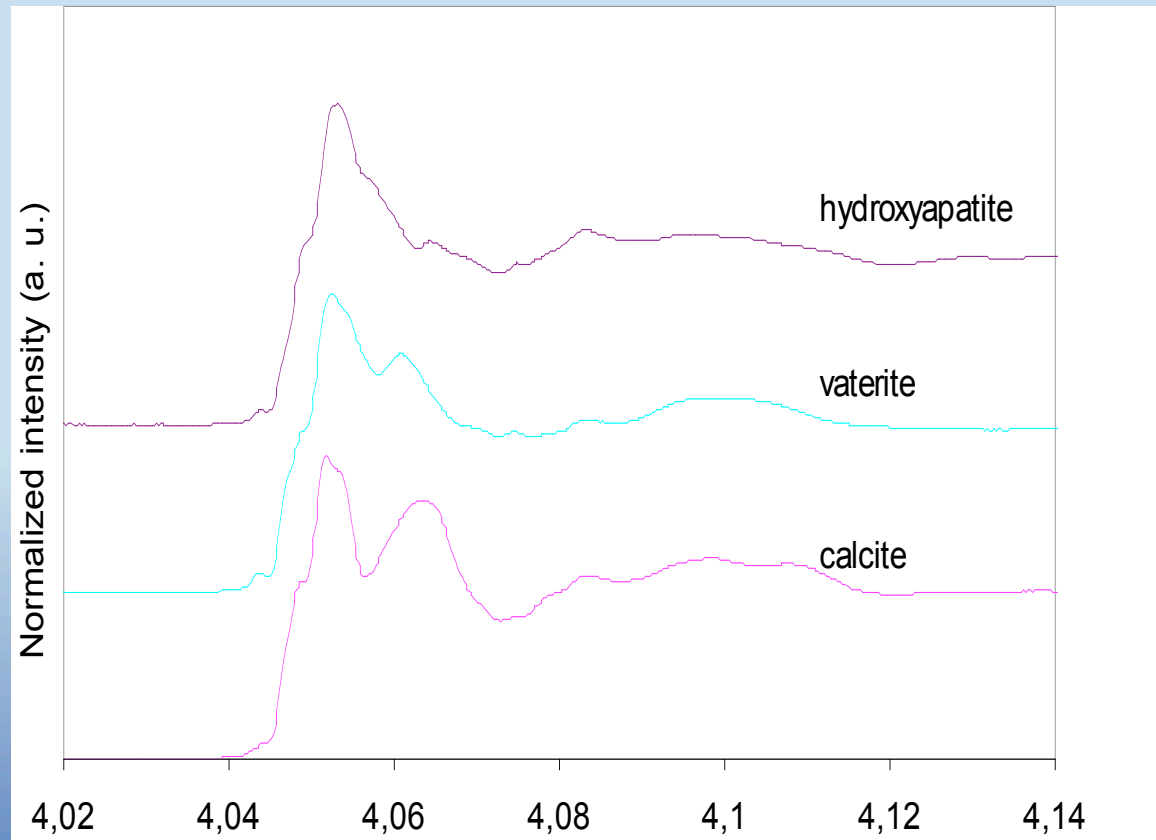
Biomineralization of carbonates in the sub-surface



Biocarbonate. B. Pasteurii

Menez, Dupraz, Guyot, 2007

**Thèse Sébastien Dupraz IPGP
ADEME, Total, Schlumberger**



Déterminer la présence et les métabolismes des micro-organismes des roches

Fluorescently labeled rRNA-targeted
nucleic acid probes



➤ détermination des abondances, localisation et activité de
cellules microbiennes ou de biofilms

➤ fortes limitations en environnements minéralisés

- *autofluorescence*

- *non-détermination des minéraux associés*

In-situ hybridization. Coupling with nanoparticles

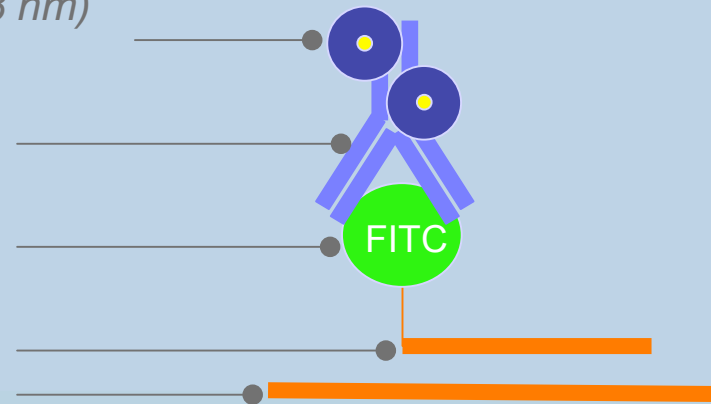
*Gold nanoparticles (0.8 nm)
& Silver enhancement*

Antibodies

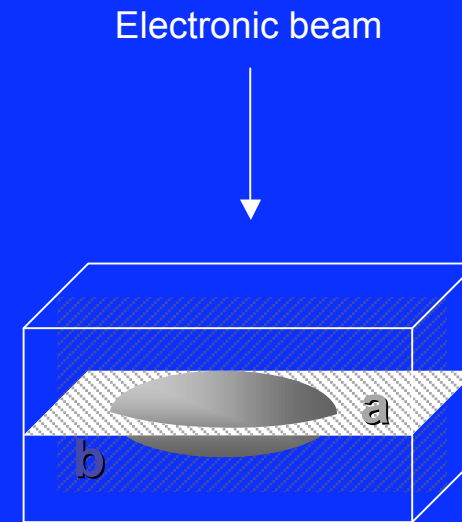
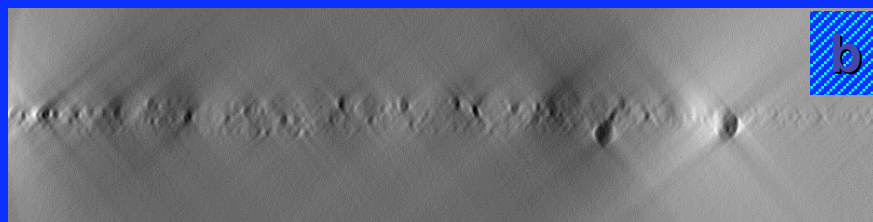
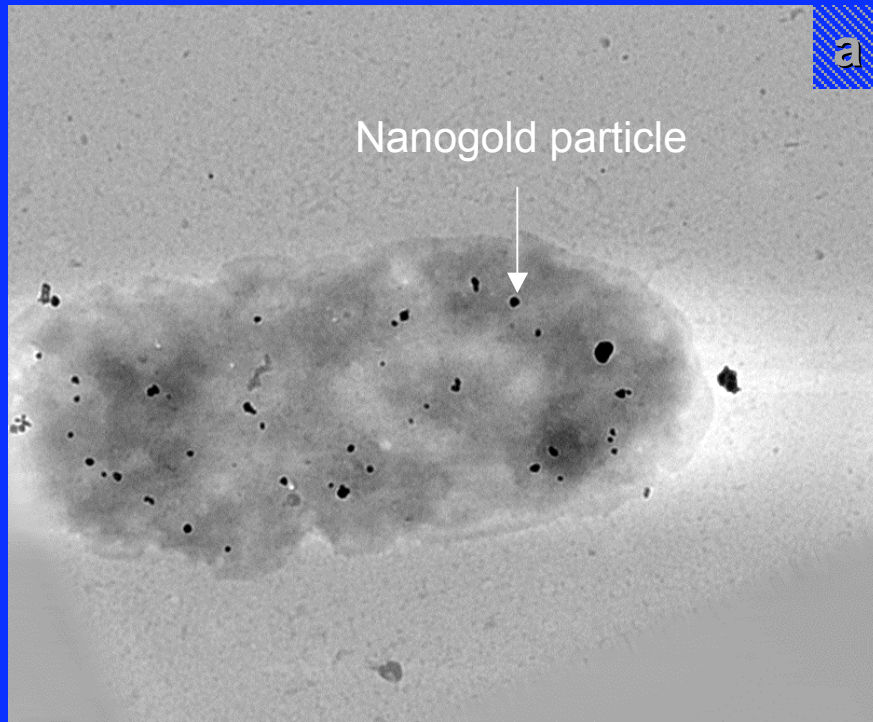
Fluorescein

Oligonucleotides

Targeted DNA/RNA



➔ Visualisation par microscopies électroniques ou X



3D electron tomographic reconstruction of silver-enhanced ultra small immunogold particles in *E. coli* cell hybridised with fluorescein-labeled probe GAM42A.

(

Détection et identification de cellules procaryotes sur minéraux par microscopie RX au synchrotron

