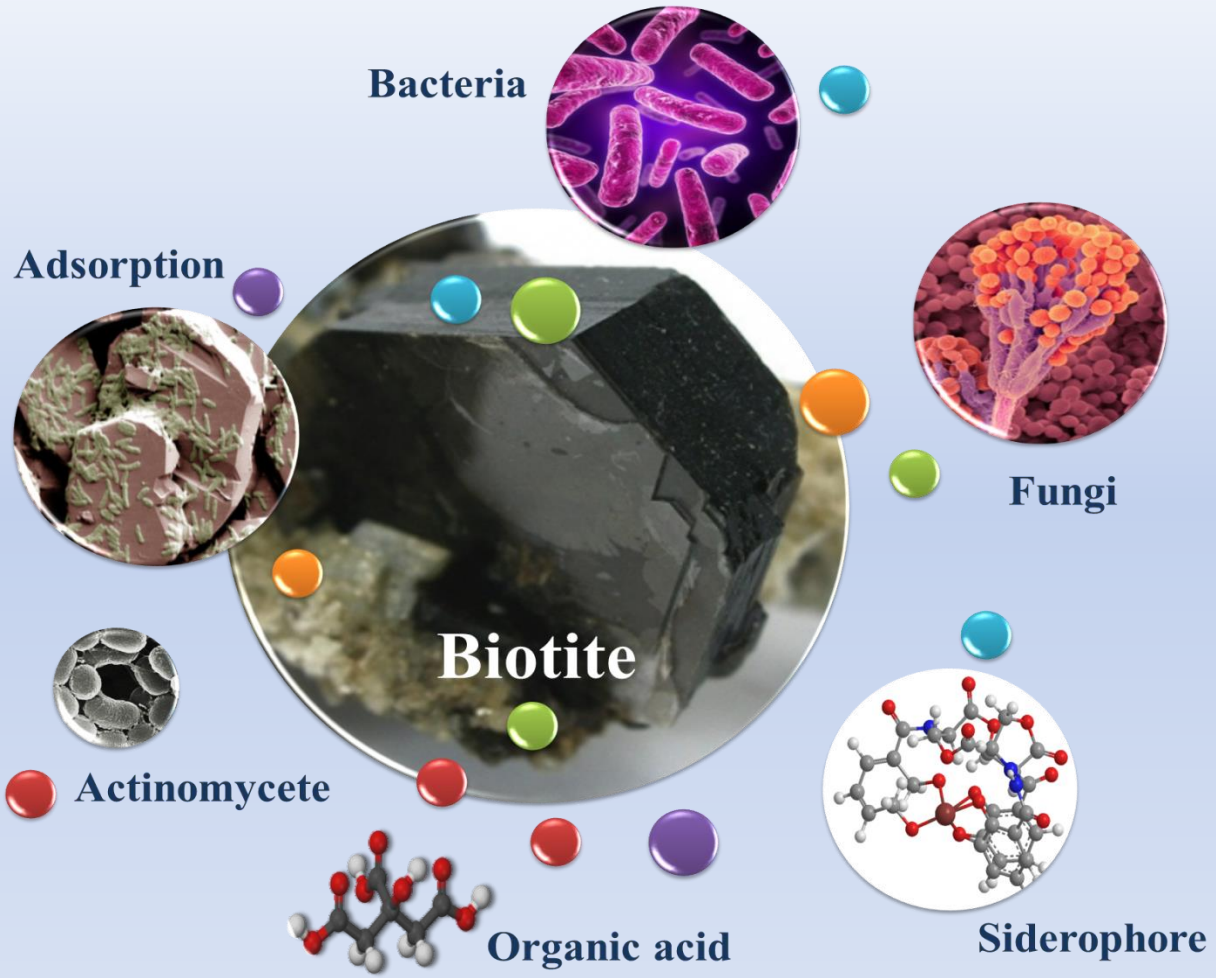
Stockholm University

Microbial Surface Attachment and Its Importance in Mineral Weathering

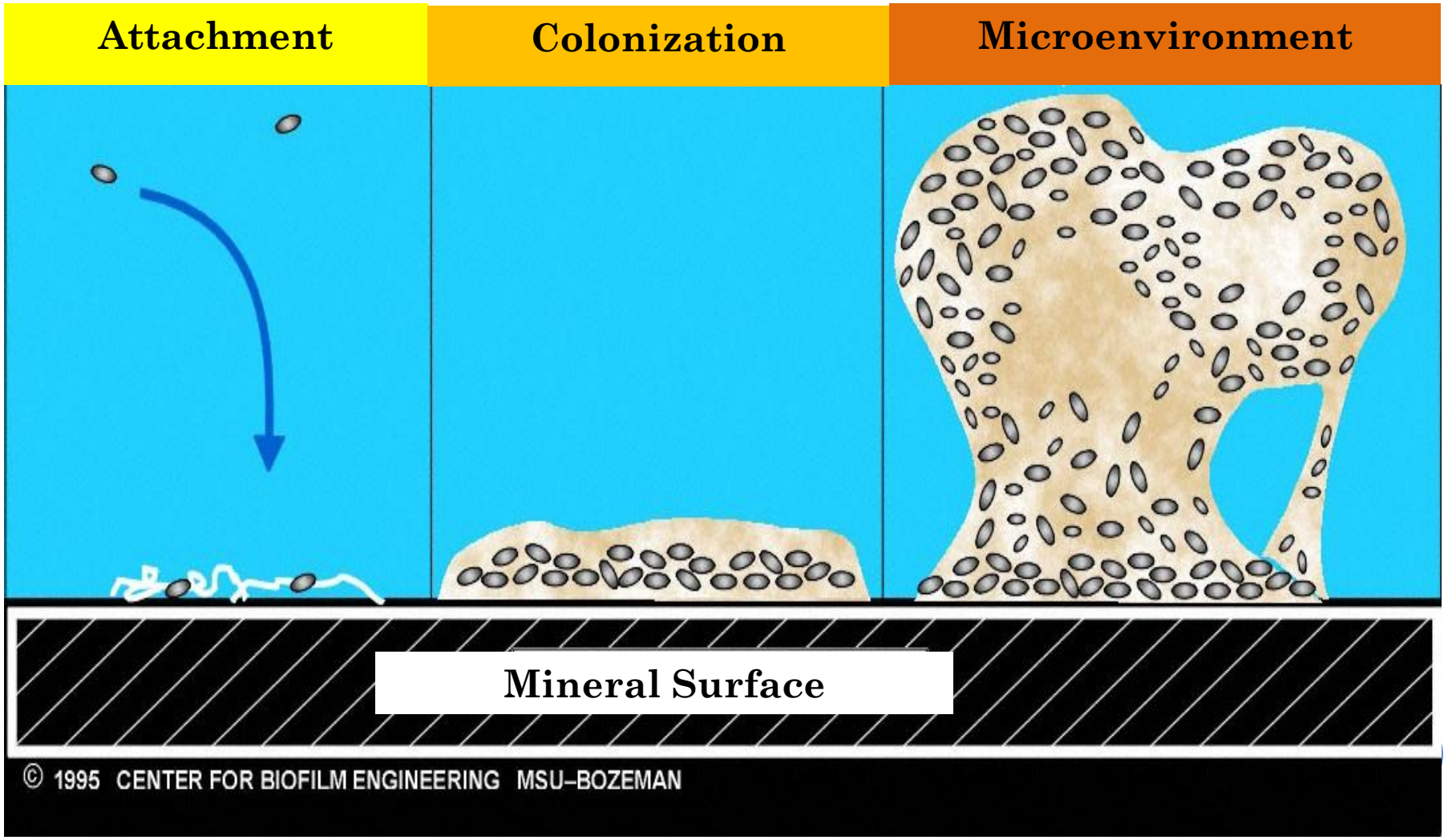


Engy Ahmed | 31st NGWM | 140110

The microbial life in soil

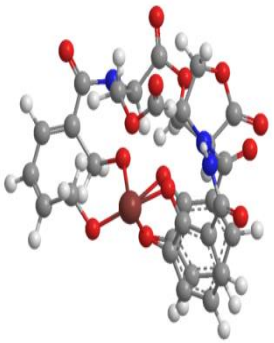
Attached form	Non-attached form
➢ 80 – 90% of soil microorganisms attached to soil minerals in the form of microenvironment. ➢ Provide localized concentrations of nutrients that can be recycled or moved from cell to cell by direct transfer. ➢ Alter the microsite environment surrounding the cell to optimize the growth conditions. ➢ Protected from the environmental stresses by the formation of EPS layer.	➢ 10 – 20% of soil microorganisms are free-living in soil solution. ➢ Their nutrients diluted in the soil solution. ➢ Suffer from environmental stresses. ➢ Can easily move from site to new site that may have additional nutrient supplies.

Formation of Microenvironment

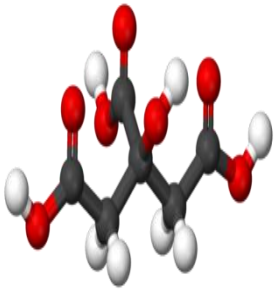


How do microorganism interact with minerals?

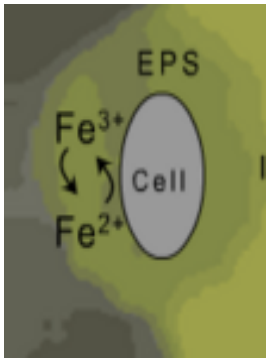
Attached microorganisms



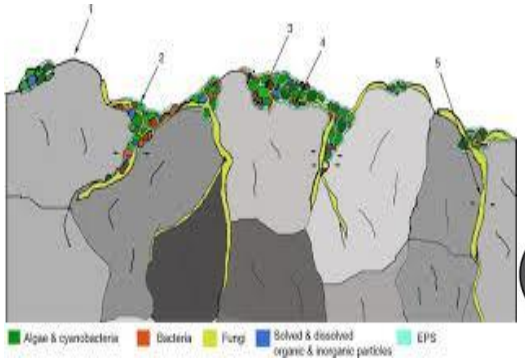
Siderophores



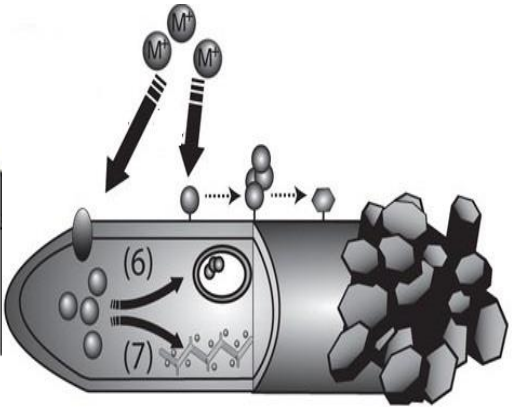
Organic acids



Oxid/Red



Physical forces

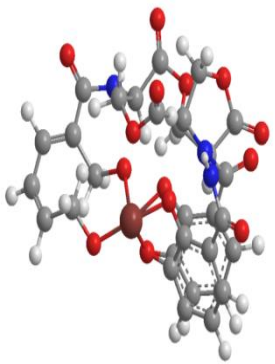


Direct accumulation

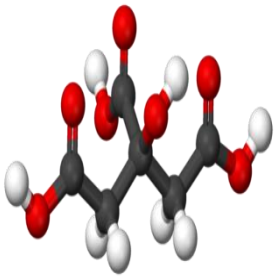
Mineral

How do microorganism interact with minerals?

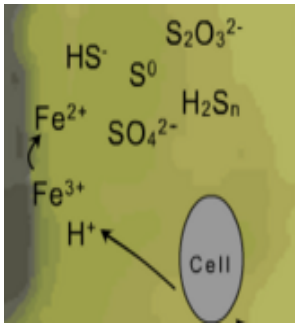
Non-attached microorganisms



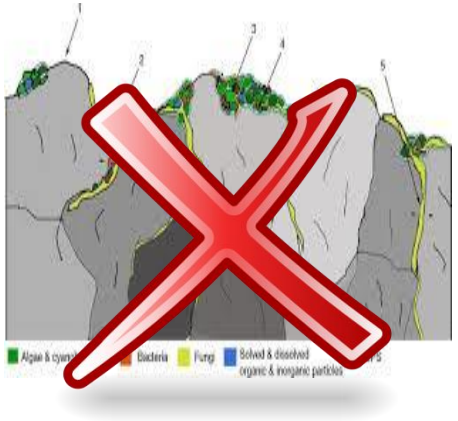
Siderophores



Organic acids



Oxid/Red



Physical forces

Direct accumulation

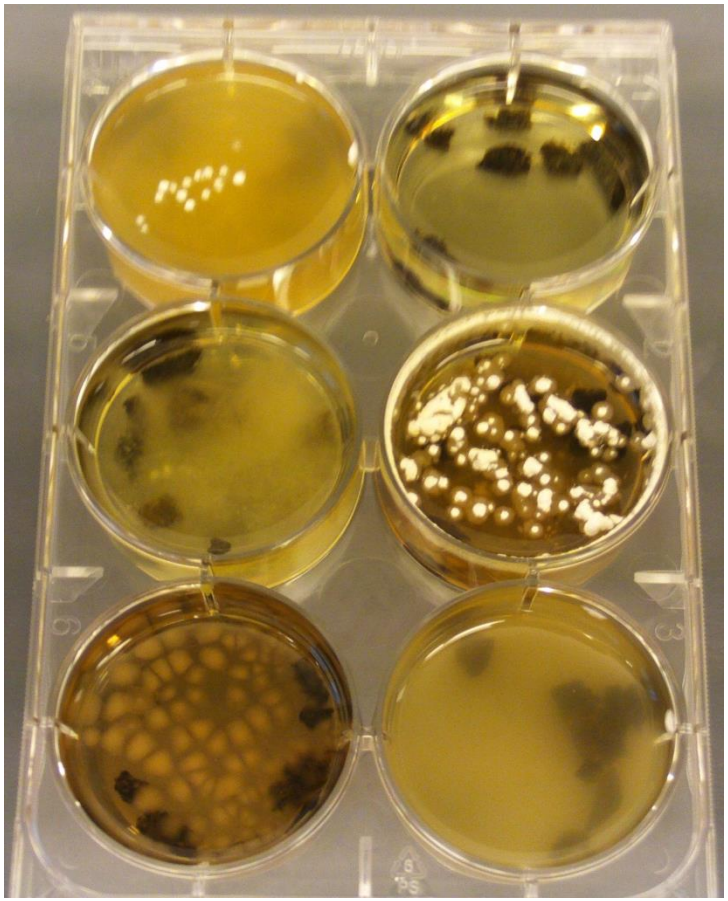
Mineral

The present study aims to…

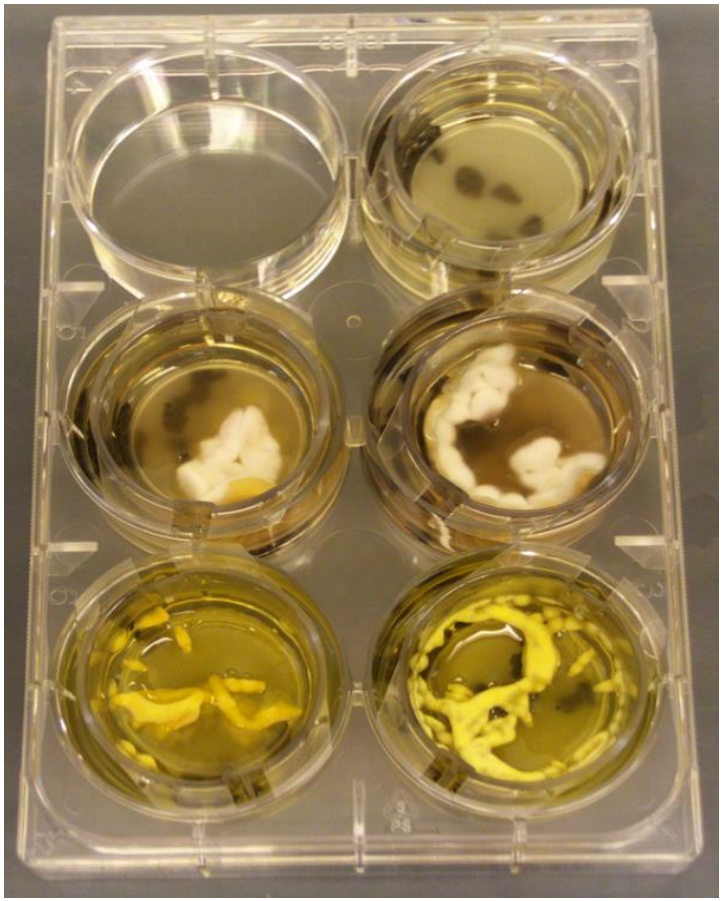
- Compare between the efficiency of attached and non-attached microbial forms on biotite dissolution.
- Differentiate between the behavior of fungal, bacterial and actinobacterial species in biotite weathering.

Experiment setup

Attached



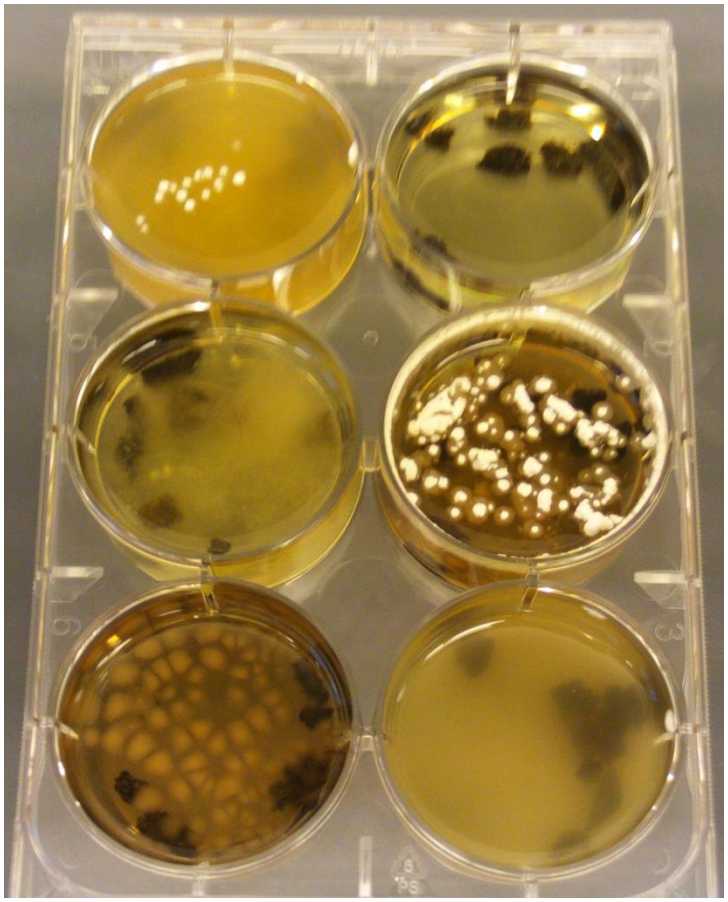
Non-attached



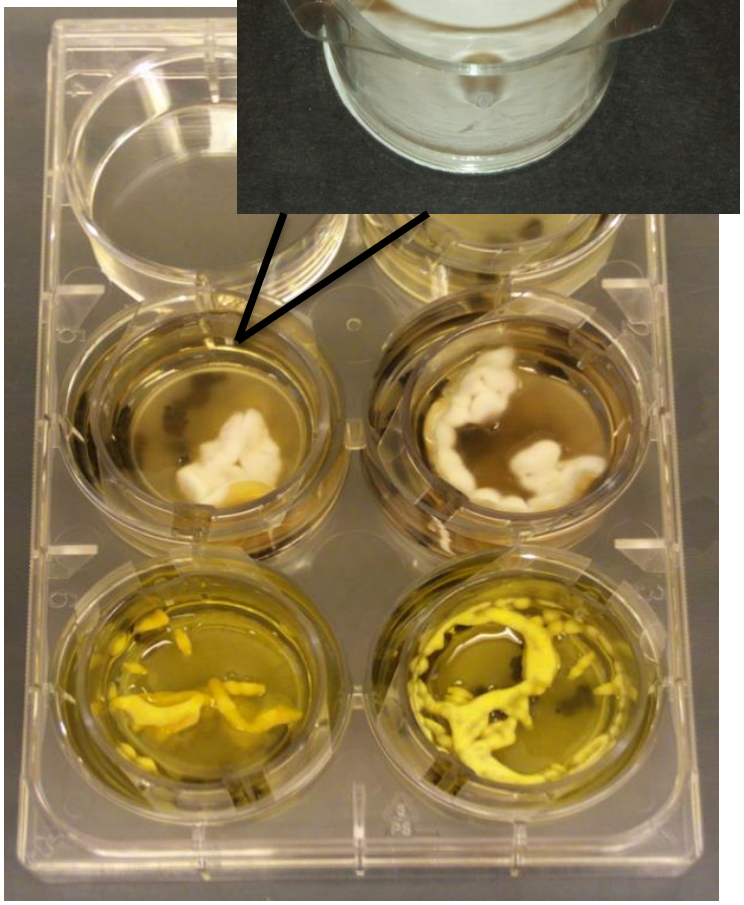
Experiment setup

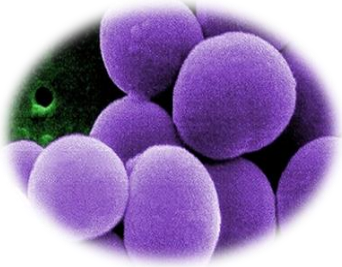
0.4 µm PET track-etched membrane

Attached



N





Klebsiella pneumoniae

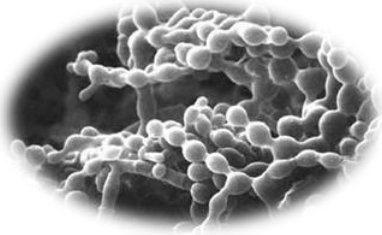
Erwinia amylovora

Pseudomonas mendocina

Pseudomonas stutzeri

Bacillus thuringiensis

Neurospora crassa



Streptomyces pilosus

Penicillium melinii

SIDEROPHORE PRODUCTION

Microorganisms	Ferrioxamines (nM)				Ferrichromes (nM)	Coprogens (nM)		
	FOX B	FOX G	FOX D	FOX E	FCH	Fe-DA	Neo-COP II	COP
Bacterial/Actinobacterial species								
Streptomyces pilosus	15	20	11	-	-	-	-	-
Erwinia amylovora	8	12	7	2	-	-	-	-
Pseudomonas stutzeri	9	2	1	1	-	-	-	-
Pseudomonas mendocina	-	3	15	11	-	-	-	-
Klebsiella pneumoniae	15	18	8	-	-	-	-	-
Bacillus thuringiensis	14	14	10	1	-	-	-	-
Fungal species								
Neurospora crassa	-	-	-	-	-	0.8	6	893
Penicillium melinii	-	-	-	-	0.6	-	-	540

Ferrioxamine B (FOX B), Ferrioxamine G (FOX G), Ferrioxamine D (FOX D), Ferrioxamine E (FOX E), Ferrichrome (FCH), Fe-dimerum acid (Fe-DA), Neocoprogen II (Neo-COP II), Coprogen (COP). Siderophores were measured by HPLC-ESI-MS.

SIDEROPHORE PRODUCTION

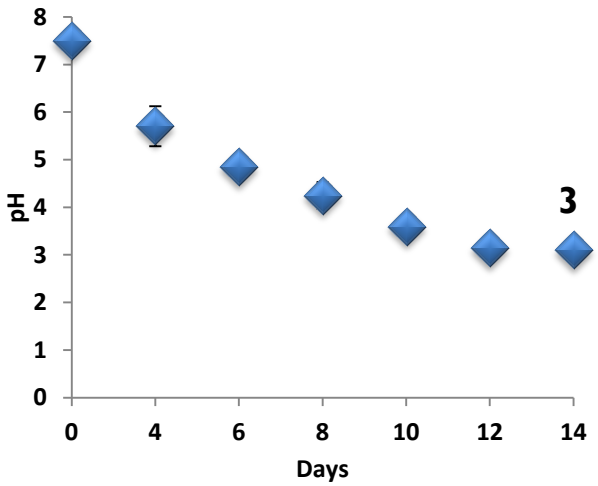
Microorganisms	Ferrioxamines (nM)				Ferrichromes (nM)	Coprogens (nM)		
	FOX B	FOX G	FOX D	FOX E	FCH	Fe-DA	Neo-COP II	COP
Bacterial/Actinobacterial species								
Streptomyces pilosus	15	20	11	-	-	-	-	-
Erwinia amylovora	8	12	7	2	-	-	-	-
Pseudomonas stutzeri	9	2	1	1	-	-	-	-
Pseudomonas mendocina	-	3	15	11	-	-	-	-
Klebsiella pneumoniae	15	18	8	-	-	-	-	-
Bacillus thuringiensis	14	14	10	1	-	-	-	-
Fungal species								
Neurospora crassa	-	-	-	-	-	0.8	6	893
Penicillium melinii	-	-	-	-	0.6	-	-	540

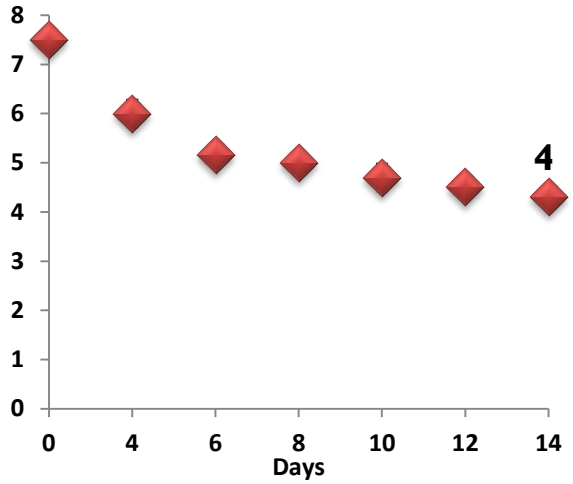
Ferrioxamine B (FOX B), Ferrioxamine G (FOX G), Ferrioxamine D (FOX D), Ferrioxamine E (FOX E), Ferrichrome (FCH), Fe-dimerum acid (Fe-DA), Neocoprogen II (Neo-COP II), Coprogen (COP). Siderophores were measured by HPLC-ESI-MS.

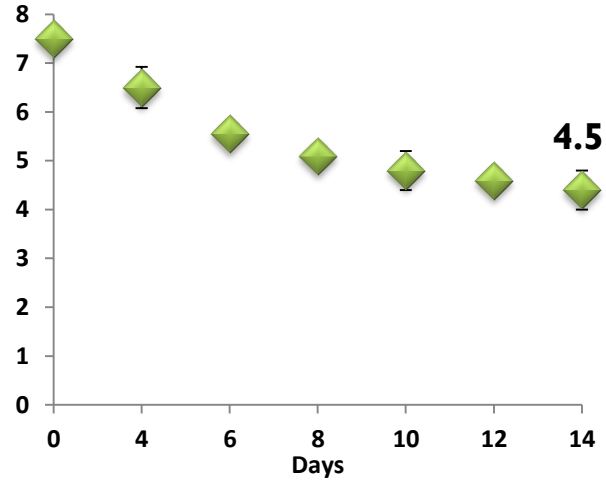
pH

Neurospora crassa | *Streptomyces pilosus* | *Pseudomonas mendocina*

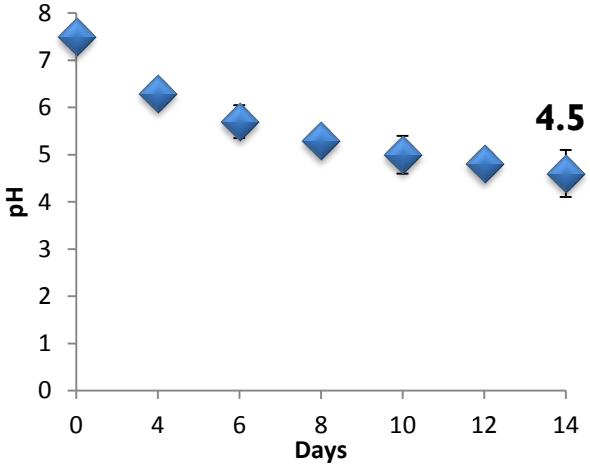
Attached

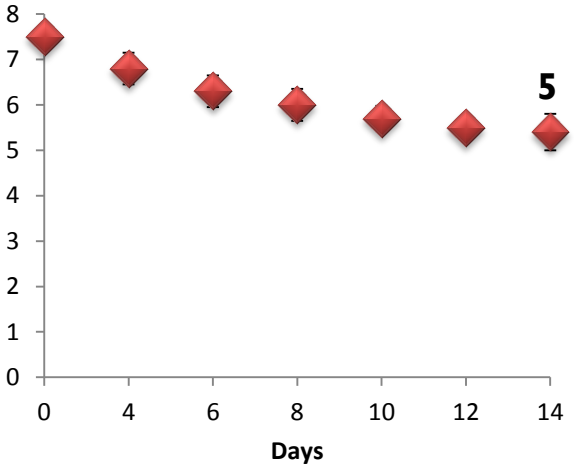


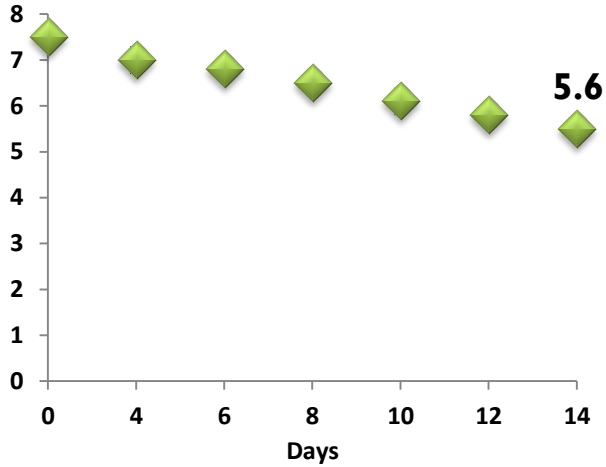




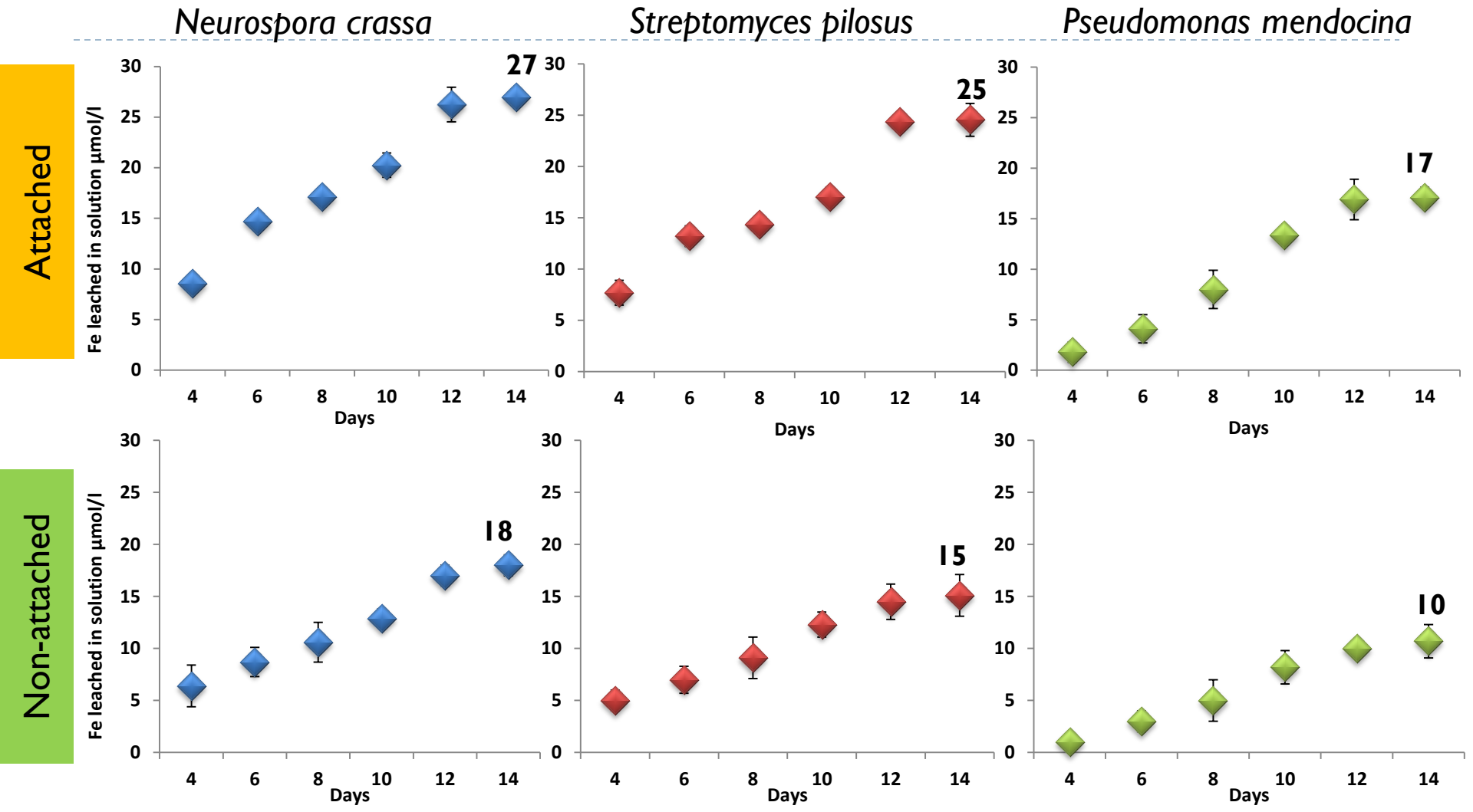
Non-attached



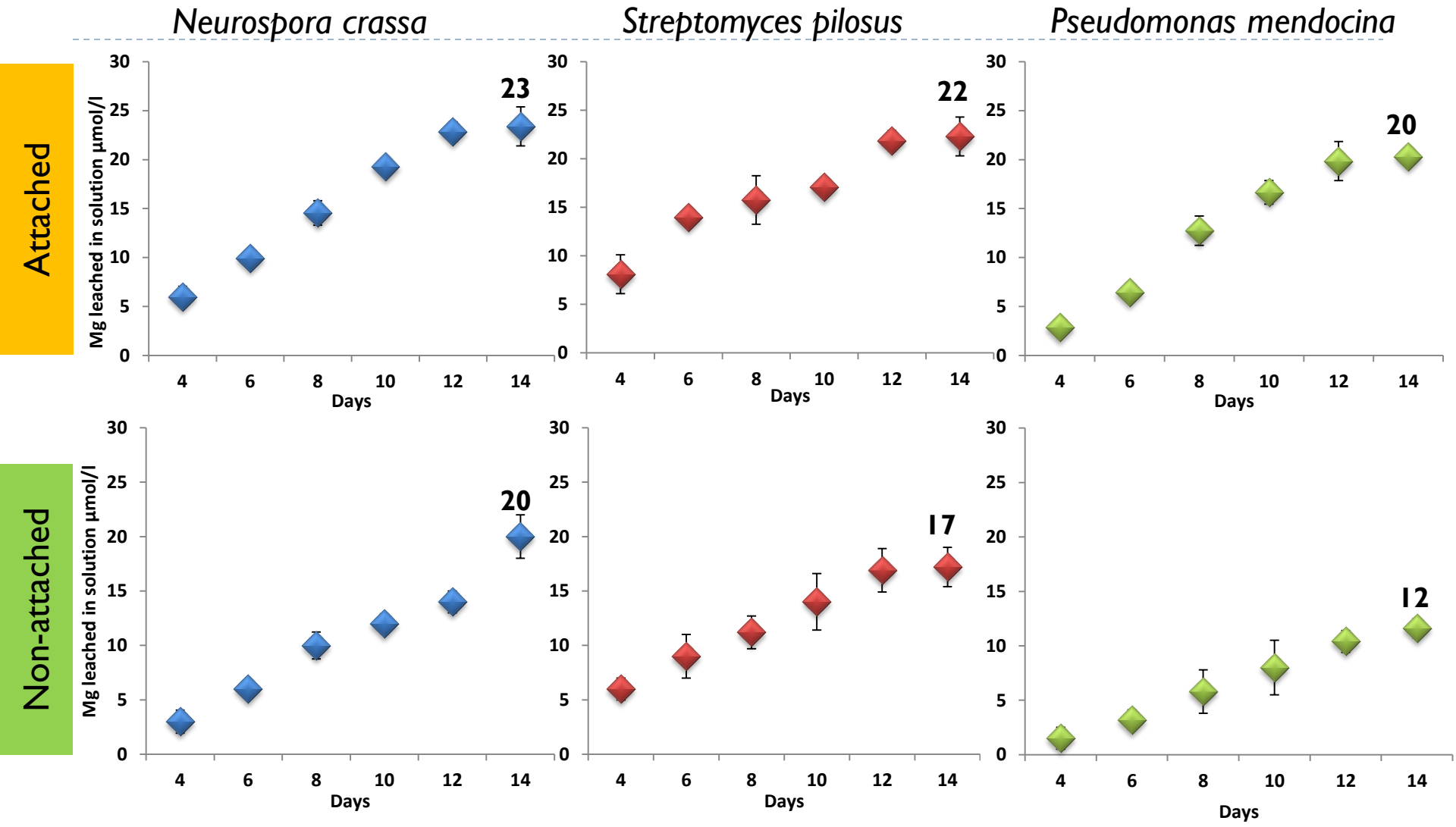




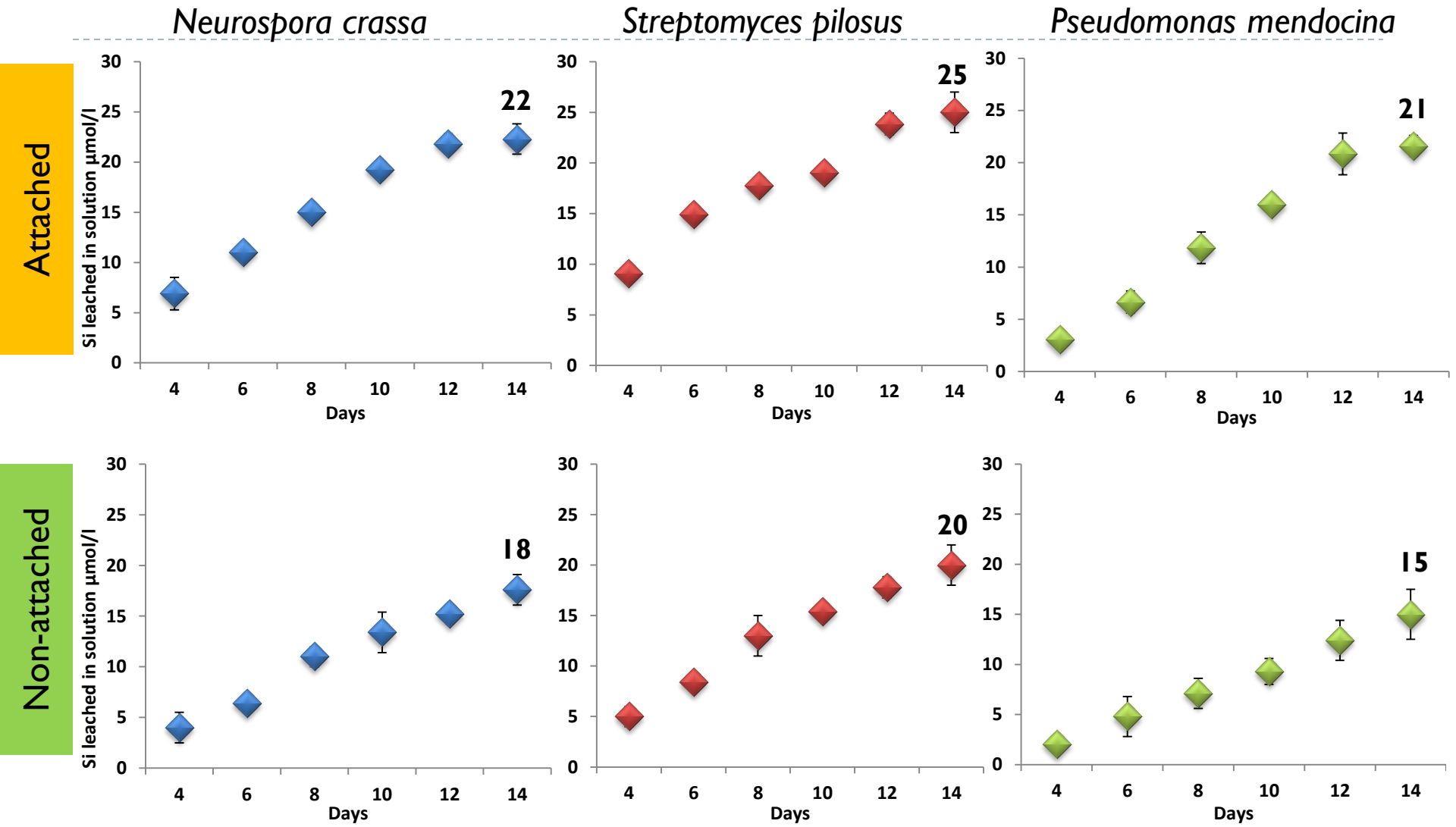
Iron dissolution



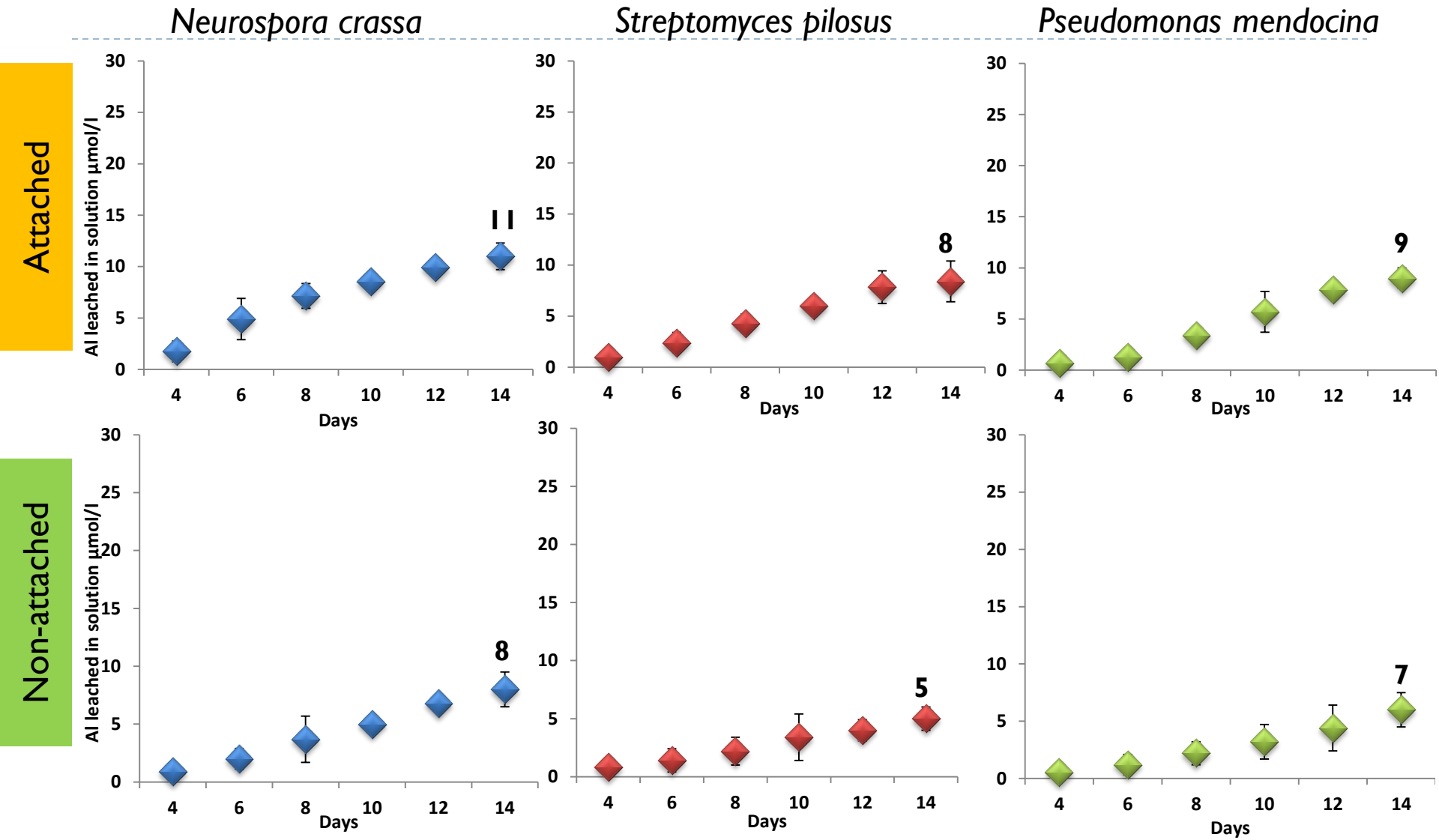
Magnesium dissolution



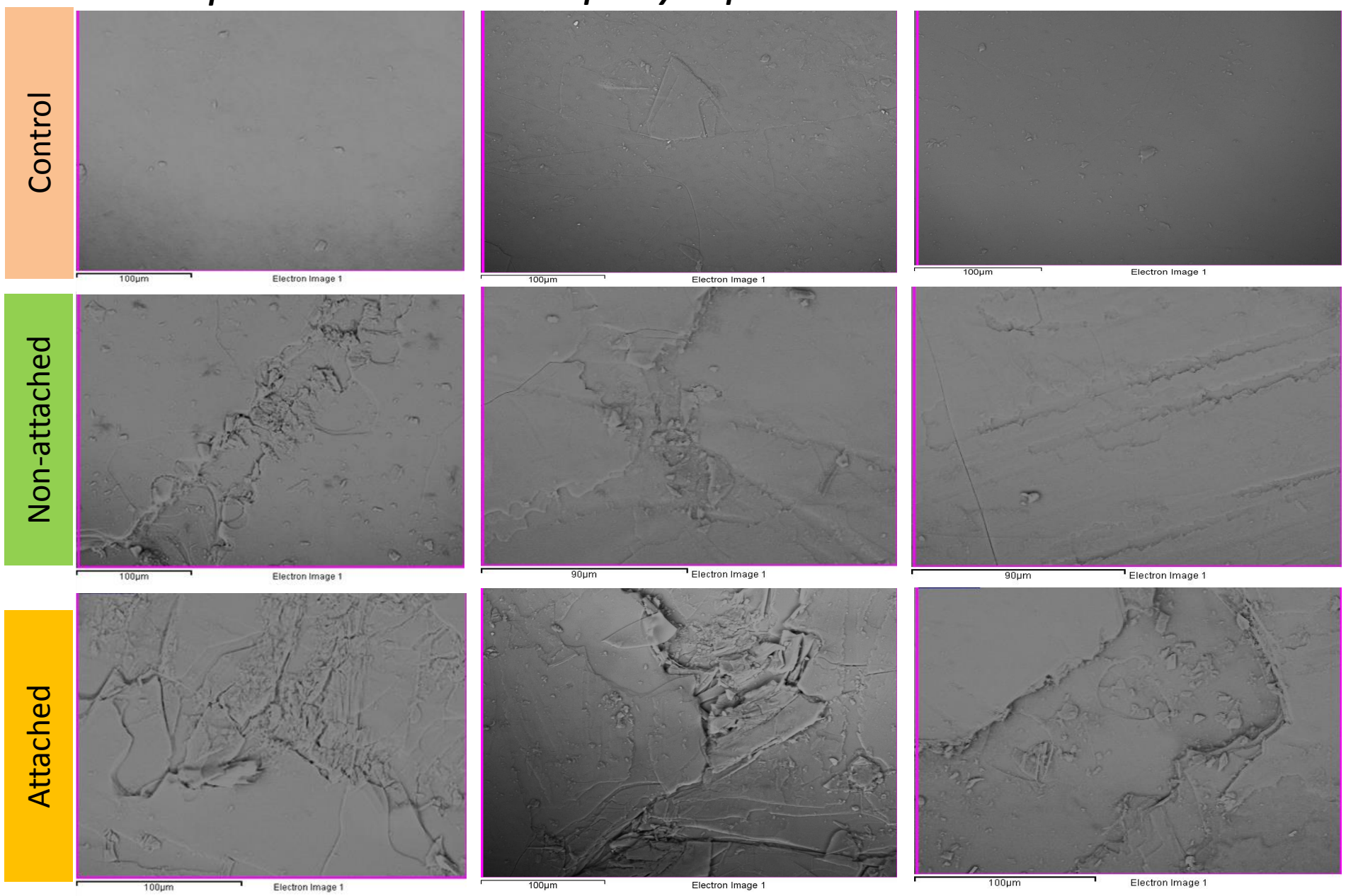
Silica dissolution



Aluminum dissolution



Surface analysis by ESEM



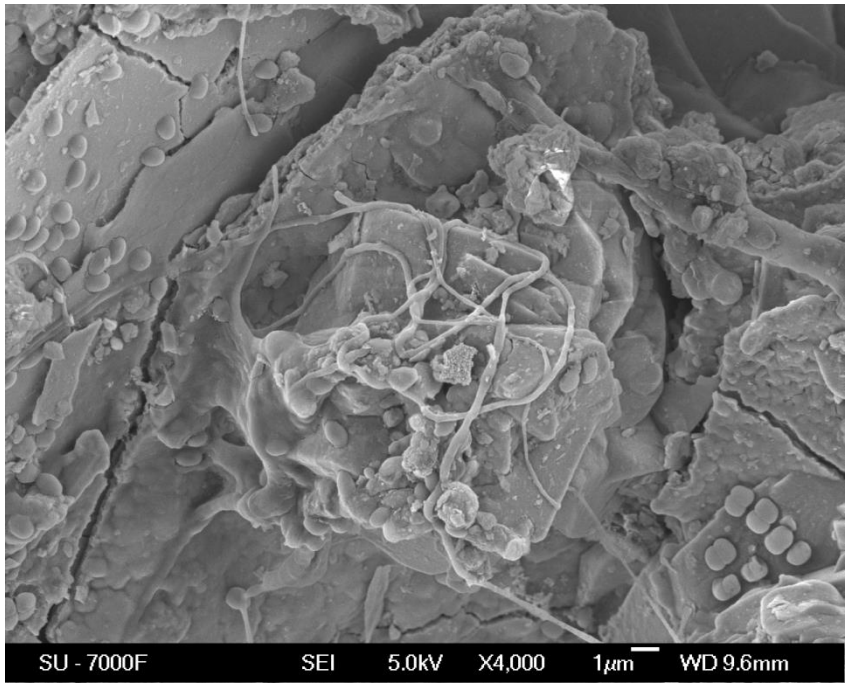
Conclusion

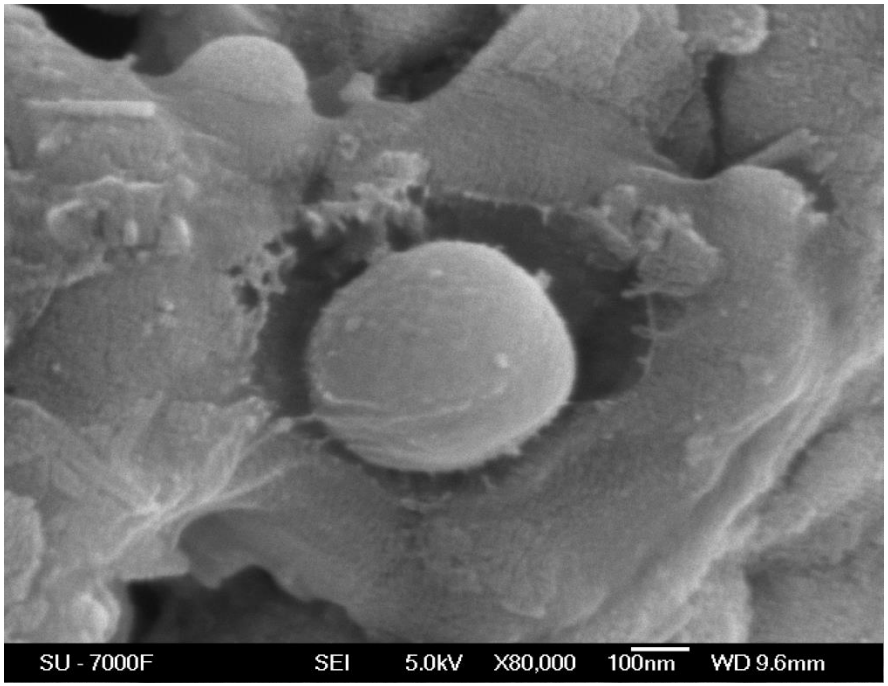
- The microbial communities that colonize mineral surfaces are more efficient in weathering than surrounding non-attached microorganisms, which is confirmed in the ESEM micrographs.

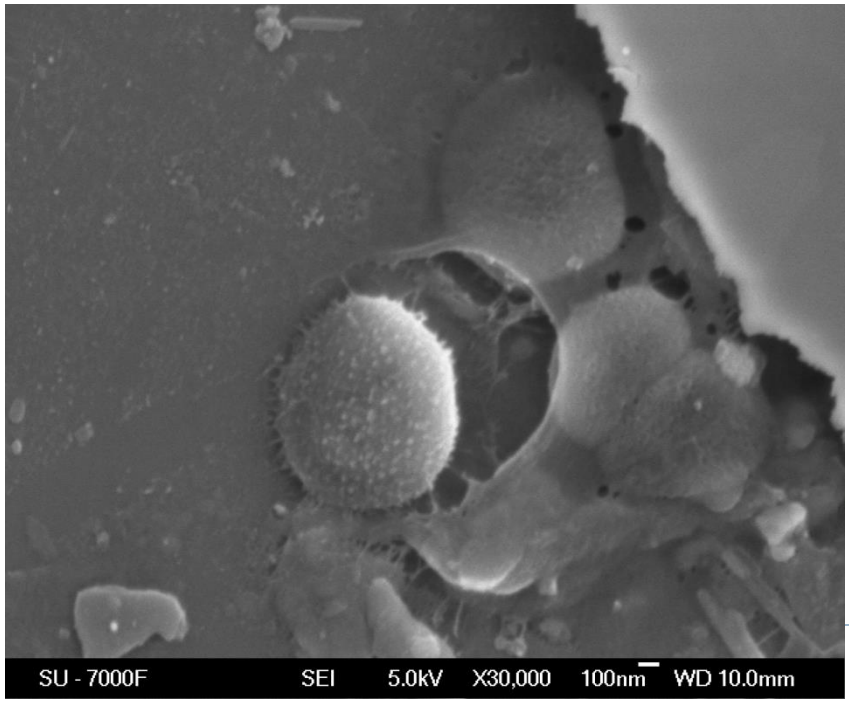
- The fungal species *Neurospora crassa* had a much higher ability to decrease the pH and to dissolve Fe, Mg, and Al from the biotite compared to the bacterial species *Pseudomonas mendocina,* which is a general trend for the fungal and bacterial species used in the study.

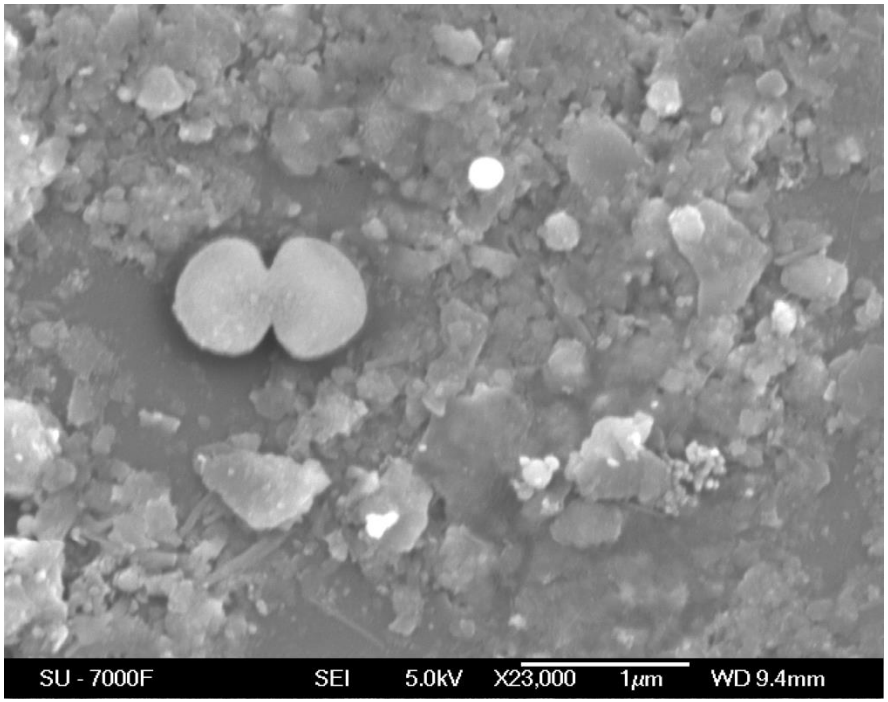
Acknowledgement

- Magnus Bergvall Foundation.
- Faculty of Science, Stockholm University, Sweden.


SU - 7000F SEI 5.0kV X4,000 1μm WD 9.6mm


SU - 7000F SEI 5.0kV X80,000 100nm WD 9.6mm

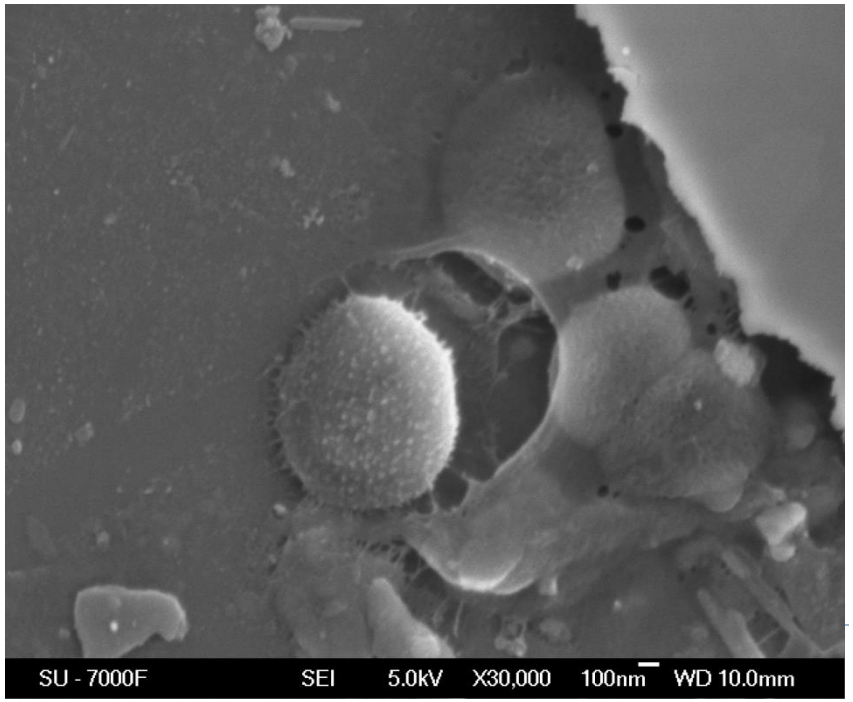

SU - 7000F SEI 5.0kV X30,000 100nm WD 10.0mm

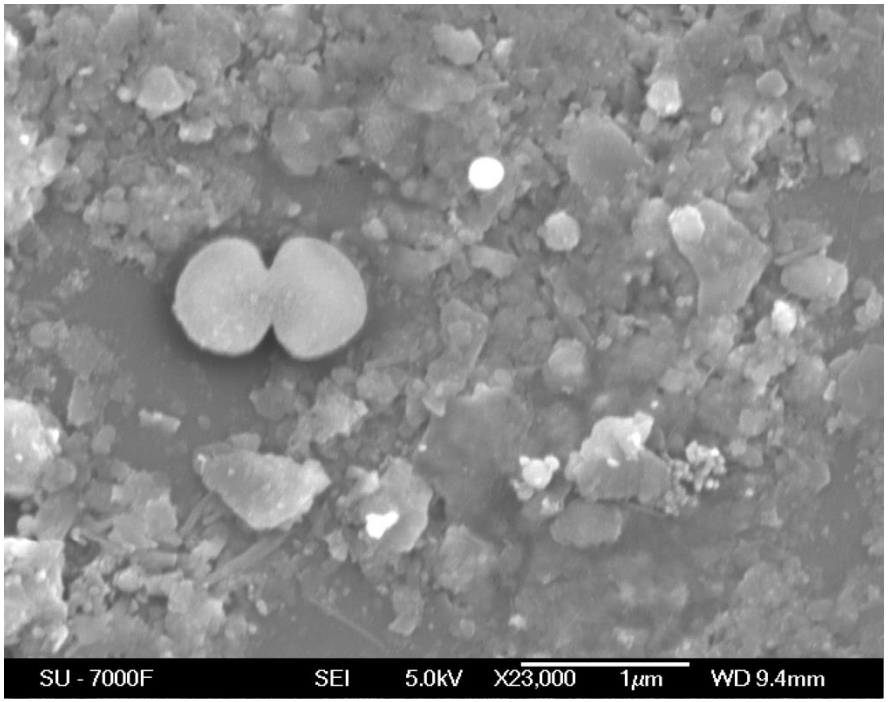

SU - 7000F SEI 5.0kV X23,000 1μm WD 9.4mm


SU - 7000F SEI 5.0kV X4,000 1μm WD 9.6mm

Thank you!!!


SU - 7000F SEI 5.0kV X80,000 100nm WD 9.6mm


SU - 7000F SEI 5.0kV X30,000 100nm WD 10.0mm


SU - 7000F SEI 5.0kV X23,000 1μm WD 9.4mm