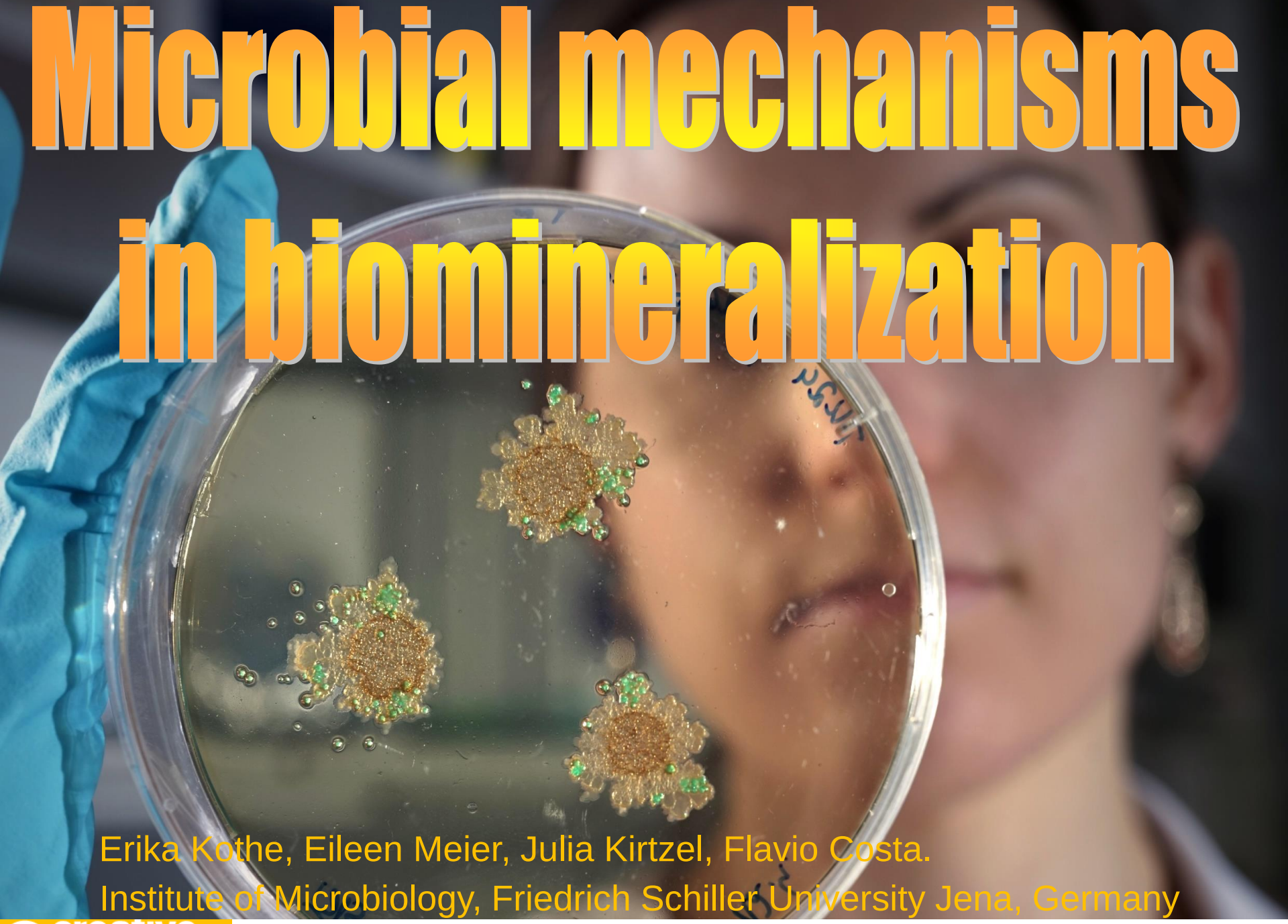
Microbial mechanisms in biomineralization



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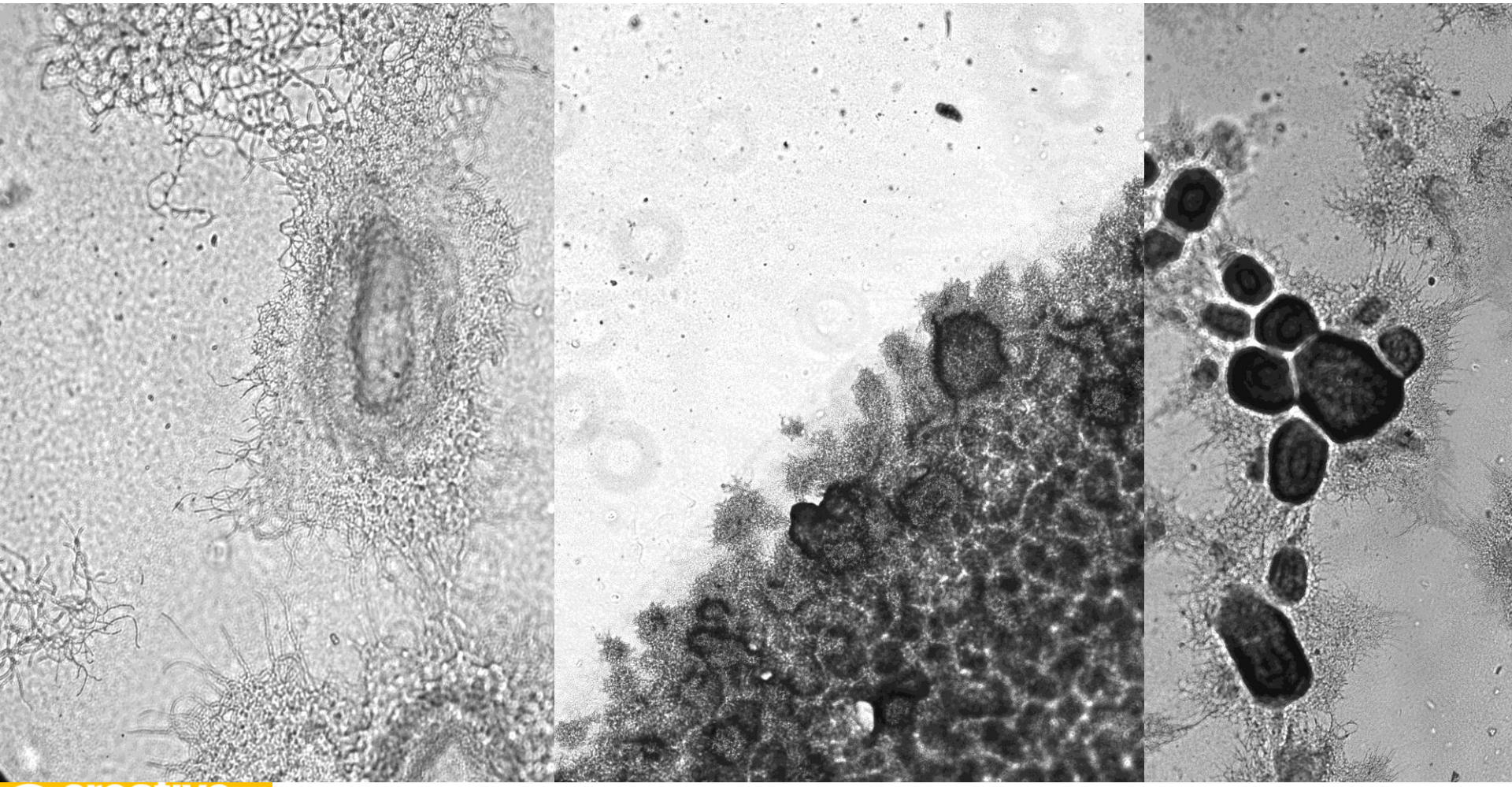
The concept of biomineralization distinguishes **microbially controlled** and **microbially induced** formation;
both may be intracellular or extracellular

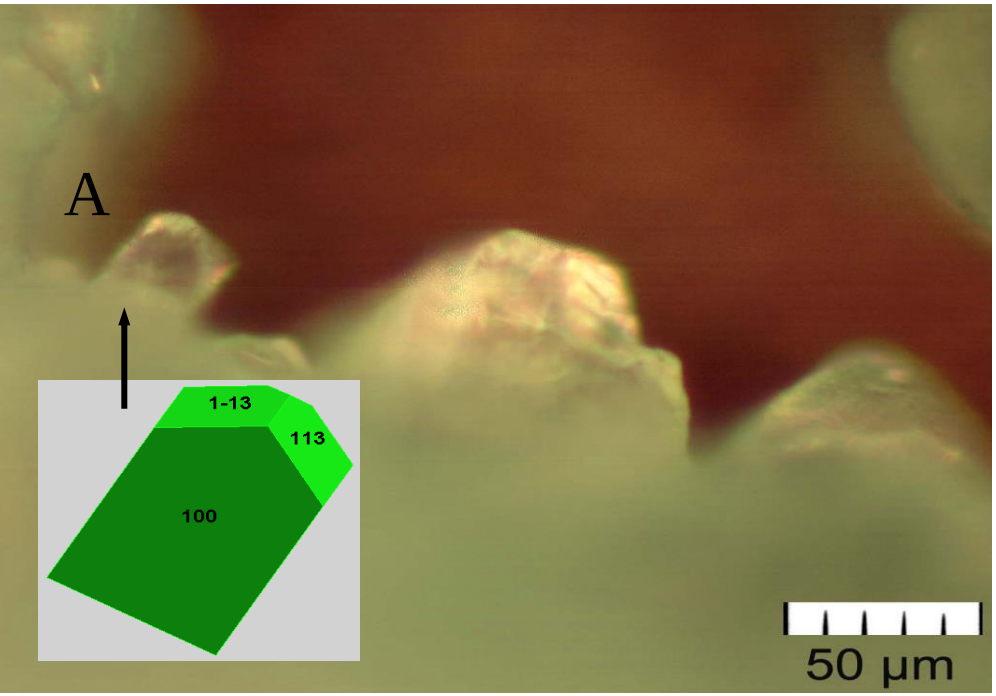
Our research on heavy metal resistance mechanisms in bacteria and fungi led us to consider a more microbiological distinction based rather on **metabolic active** or **passive** processes

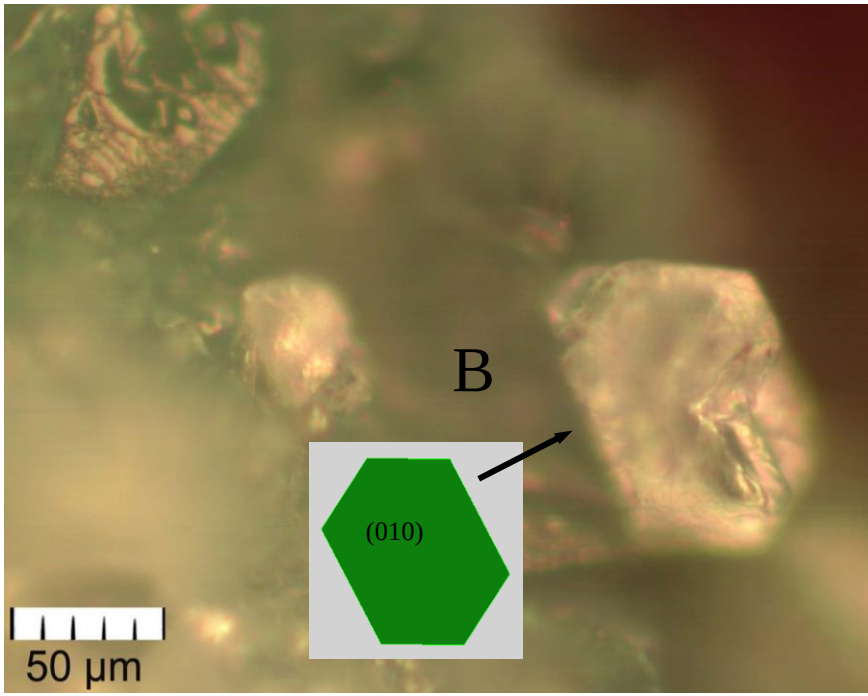
Crystal formation is dependent on living biomass

Streptmyces acidiscabies forms nickel struvite crystals surrounded by the bacterial mycelium. Autoclaved biomass does not lead to crystal formation



Different strains form different crystals



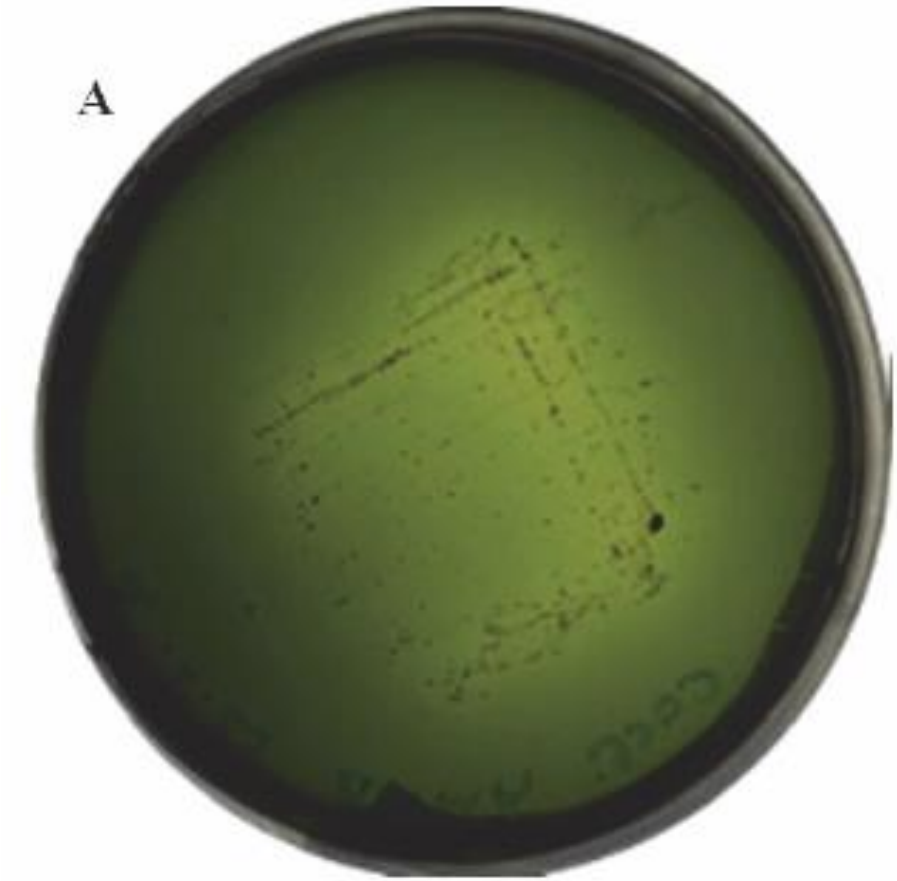


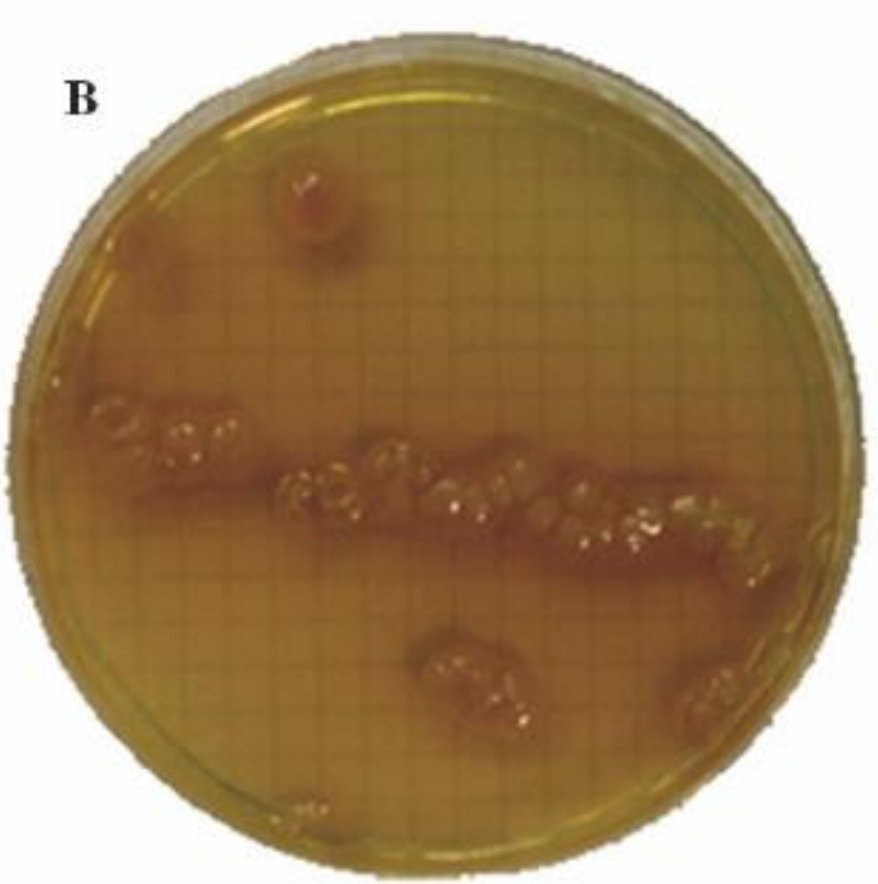
Habit of single crystals of $Ni(NH_4)(PO_4)\cdot 6H_2O$
A) possible habit formed by {00-1}, {100}, {010}, {113} and {001} faces
B) view direction parallel to [010] of an idealized struvite crystal formed by {010}, {100},{103} and {10-3} faces

Active pH control leads to different minerals formed

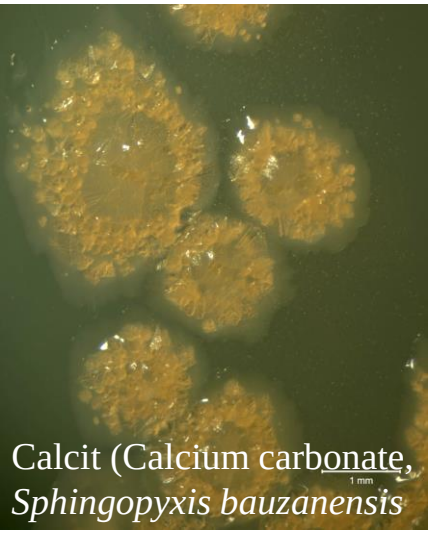
Streptmyces lividans TK 23 acidifies the medium

Streptmyces naganishii P9A-1 leads to alkalinization (without urea in the medium!)

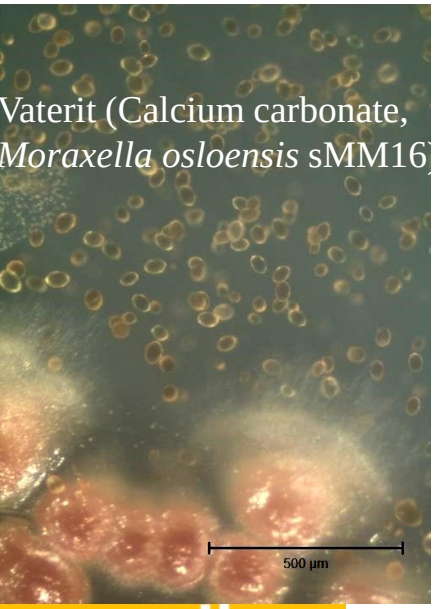




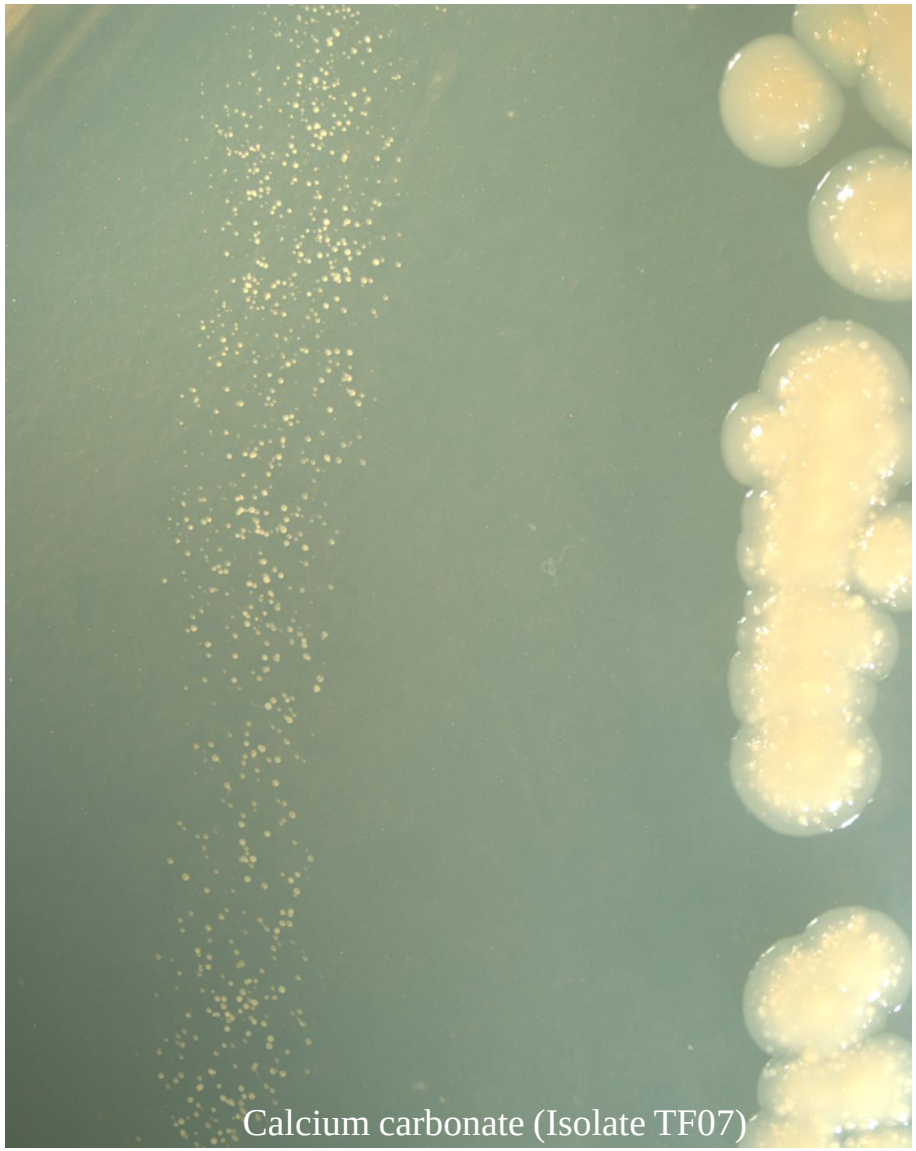
Minerals at different distance to the colony



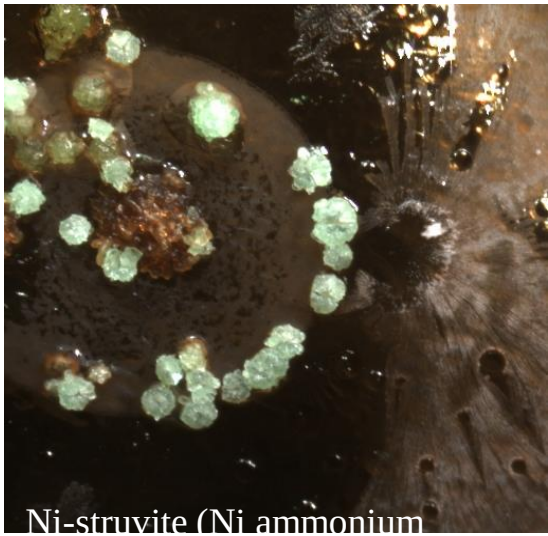
Calcit (Calcium carbonate, *Sphingopyxis bauzanensis*



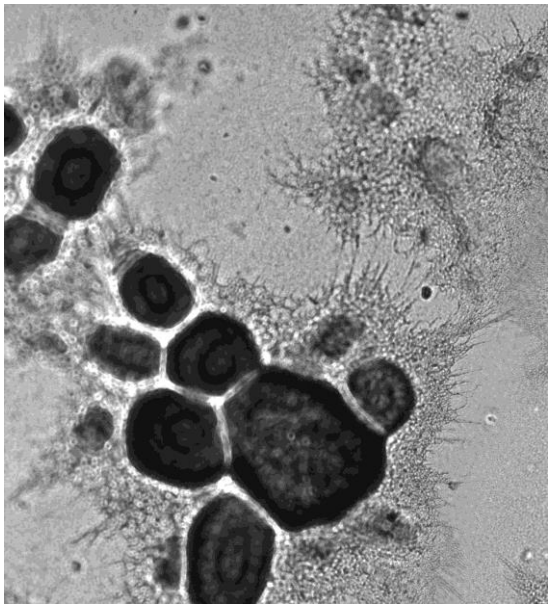
Vaterit (Calcium carbonate, *Moraxella osloensis* sMM16)



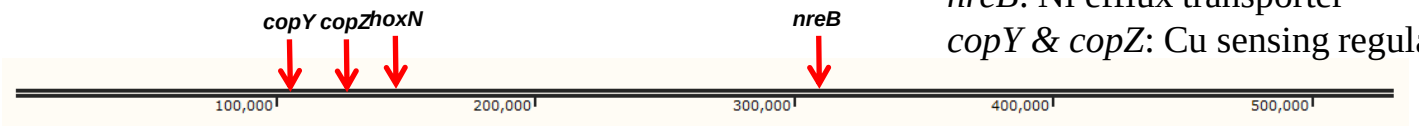
Calcium carbonate (Isolate TF07)



Ni-struvite (Ni ammonium



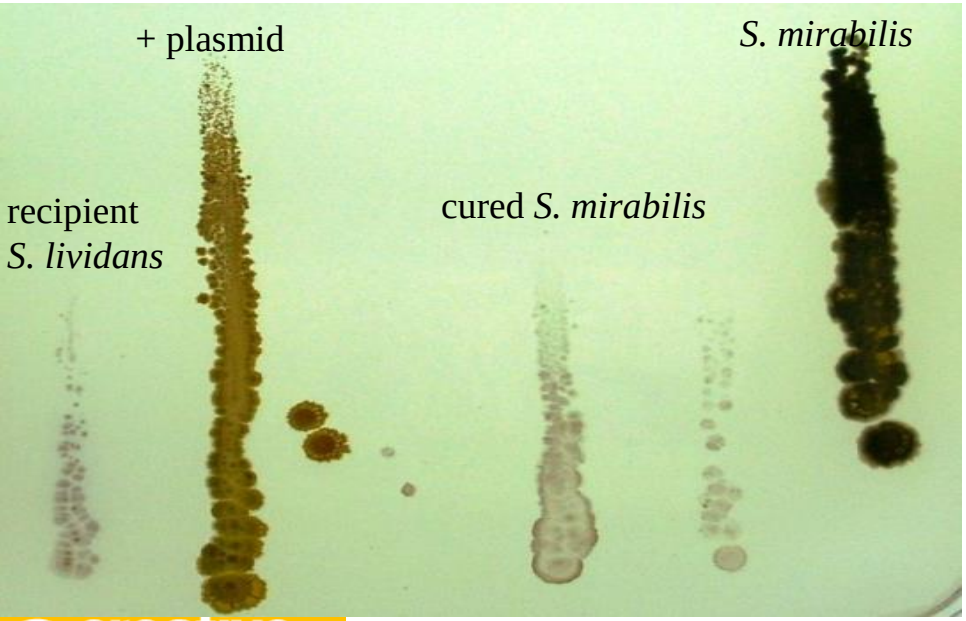
Genetic determinants

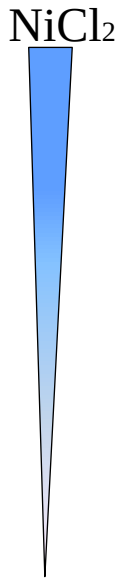


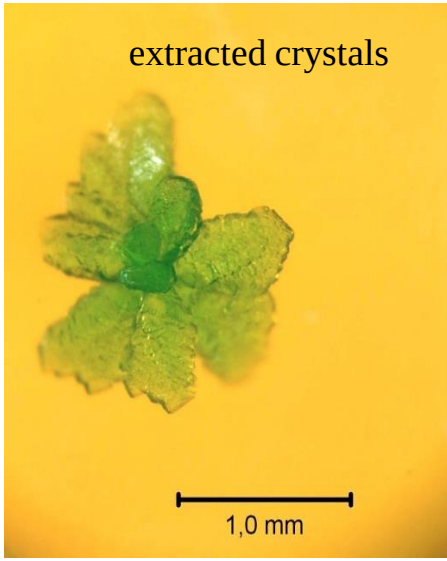
hoxN: Ni/Co permease
nreB: Ni efflux transporter
copY & *copZ*: Cu sensing regulation system

A megaplasmid of *Streptomyces mirabilis* P16-B1 with several metal resistance genes leads to enhanced biomineral formation if transferred to a metal sensitive *S. lividans*.

The plasmid is naturally transferable in soil microcosms

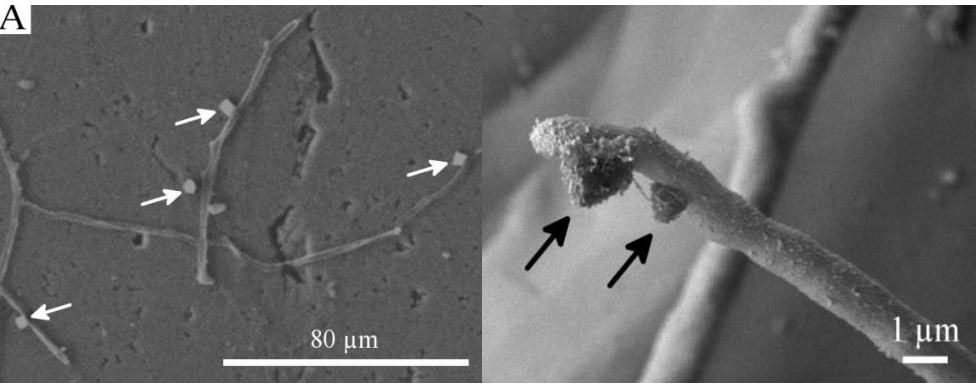




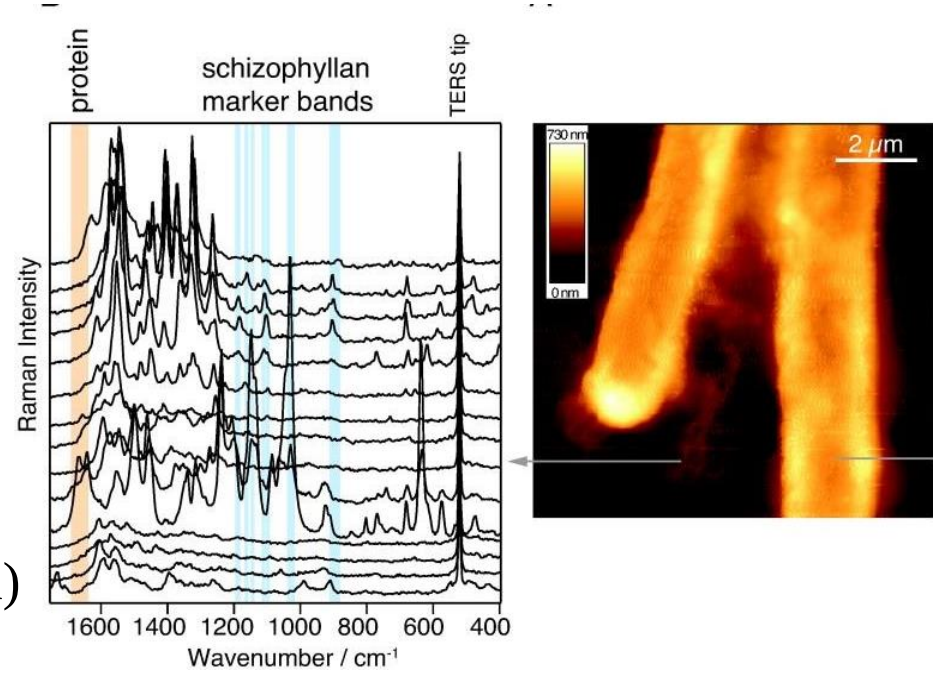


Bioweathering and biomineralization are connected

The basidiomycete fungus *Schizophyllum commune* can degrade shale (by laccase involvement)
This releases metals which induce metal resistance gene (as shown with transcriptome and proteome studies



Oxalates are formed, likely connected to extracellular matrix
(the glucan schizophyllan could be shown)



JSMC Jena School for Microbial Communication

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