In the Land of Black and White, Microbial Deposition of Ferromanganese on the Walls of Snowy River, Ft Stanton Cave , NM

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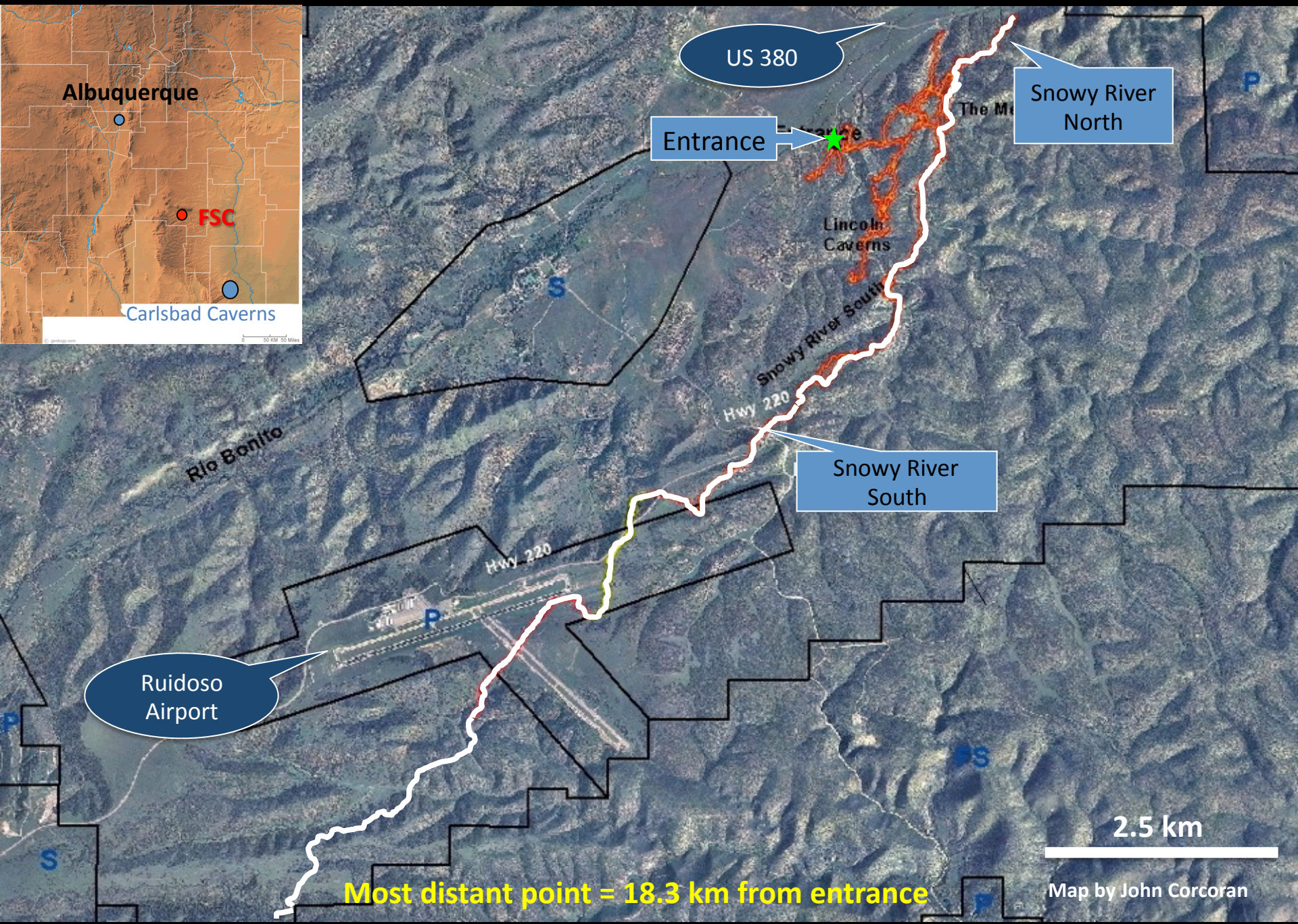
Victor Polyak Photo

Fort Stanton Cave

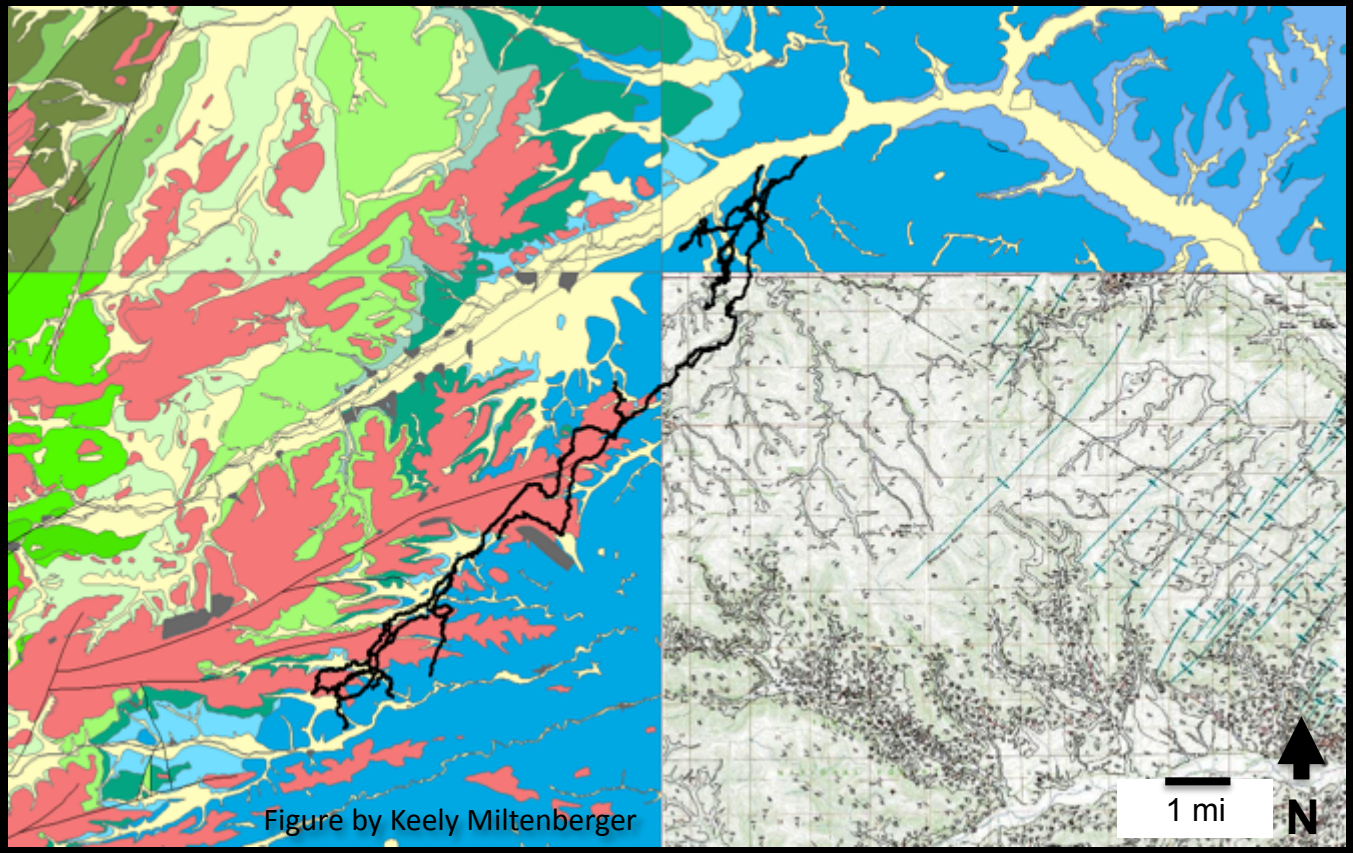


The Snowy River Passage

Ft Stanton Cave: 50+ km of surveyed passage (14th longest in US)
Snowy River: 19.1 km long and still going!

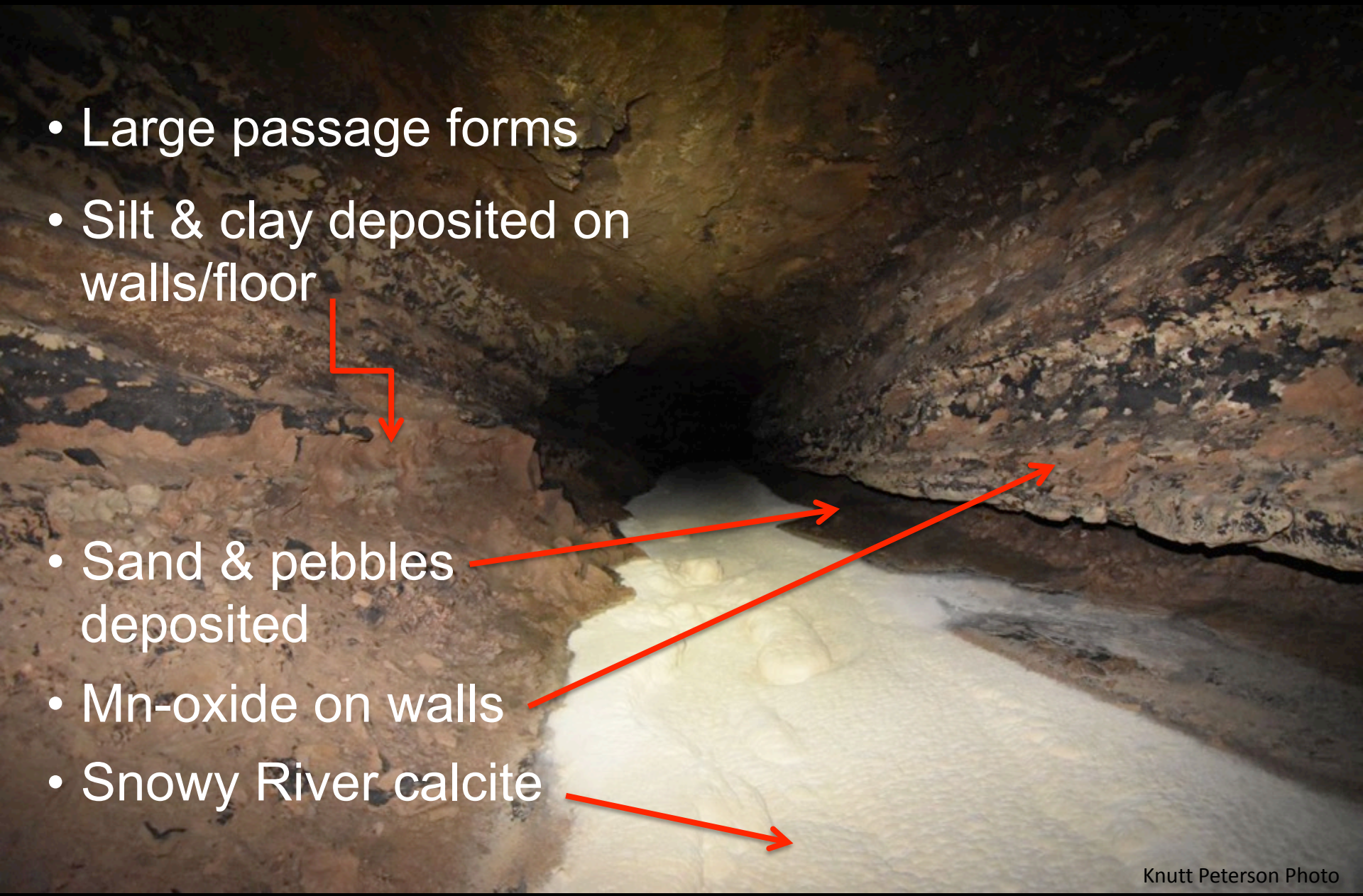
John Ganter Photo

Geology of Ft Stanton Cave

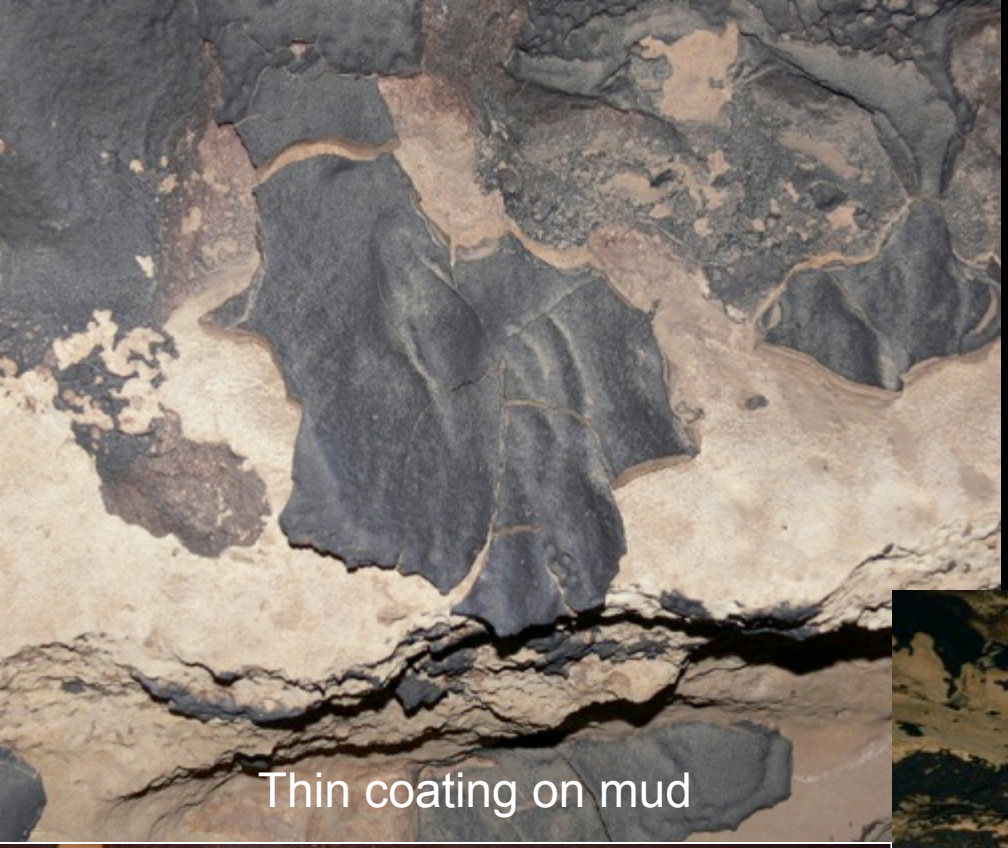


- Cave is hosted in Permian San Andres Limestone
  - Soils above the cave developed in mainly limestone and Tertiary gravels (stay tuned for the next talk!)
  - Likely source of water in Snowy River is 6 km to SW

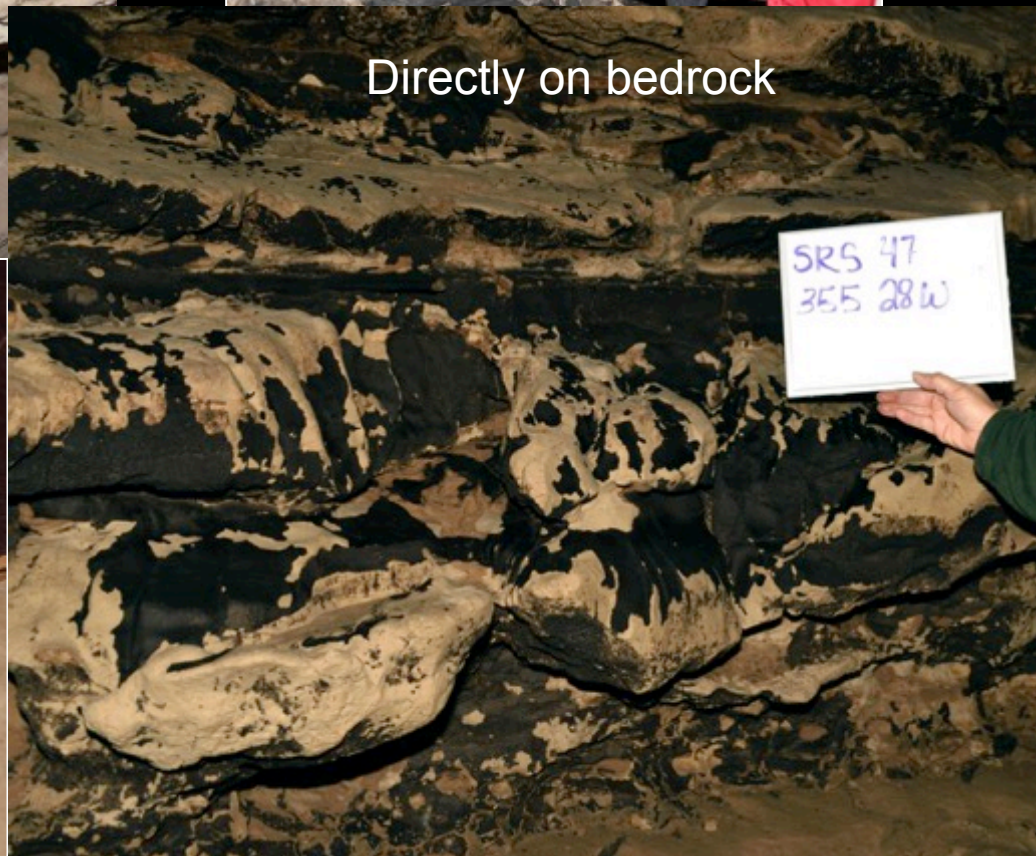
Natural History of Snow River Passage



Ferromanganese



Thin coating on mud



Directly on bedrock

Evidence of multiple episodes of growth

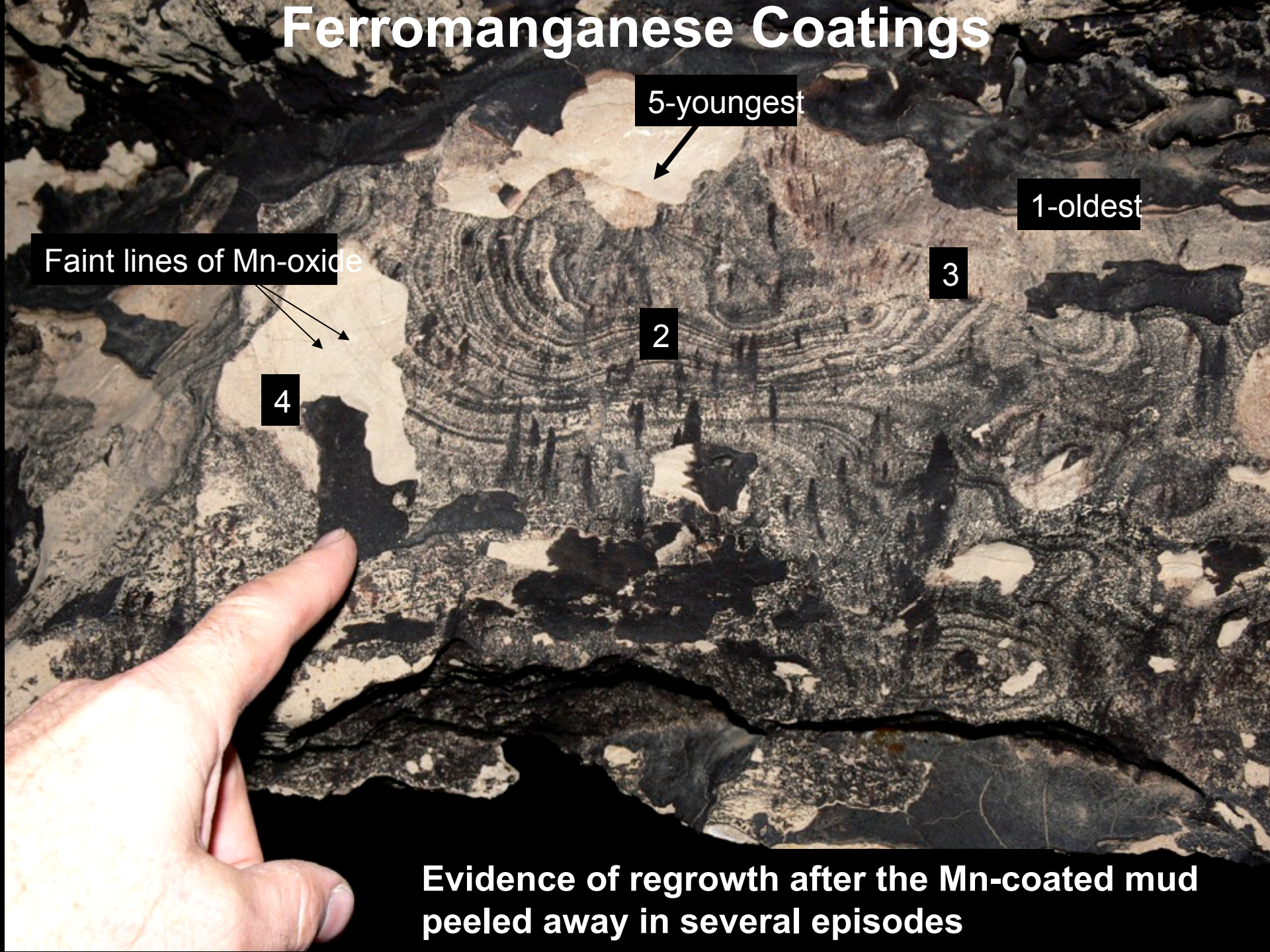
Ferromanganese Coatings

May be patchy and discontinuous

Or cover nearly every surface

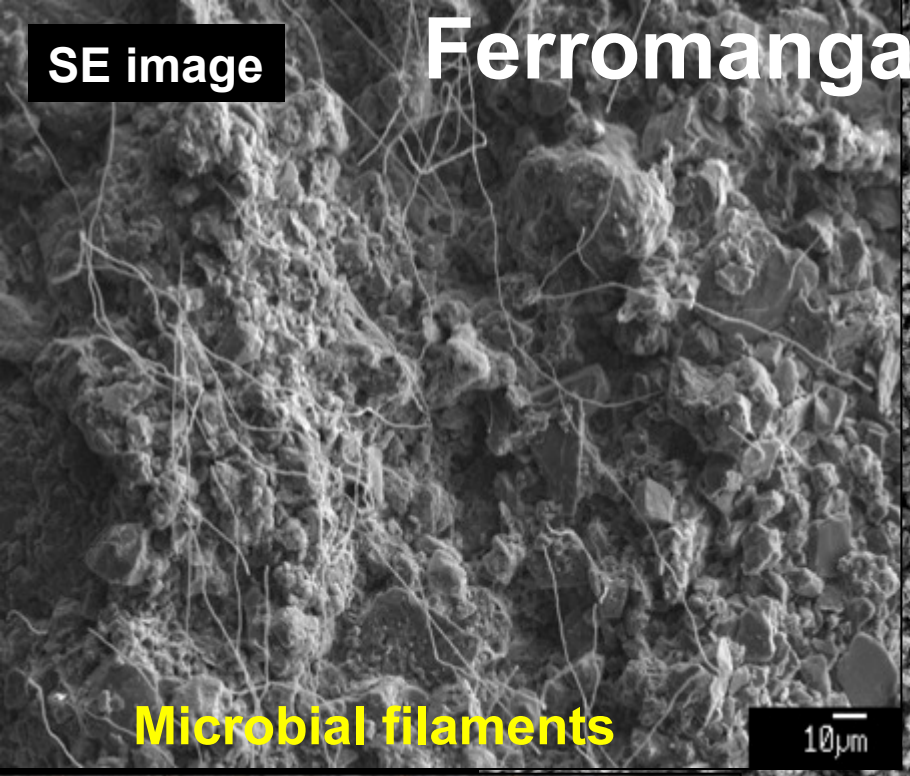
Victor Polyak Photos

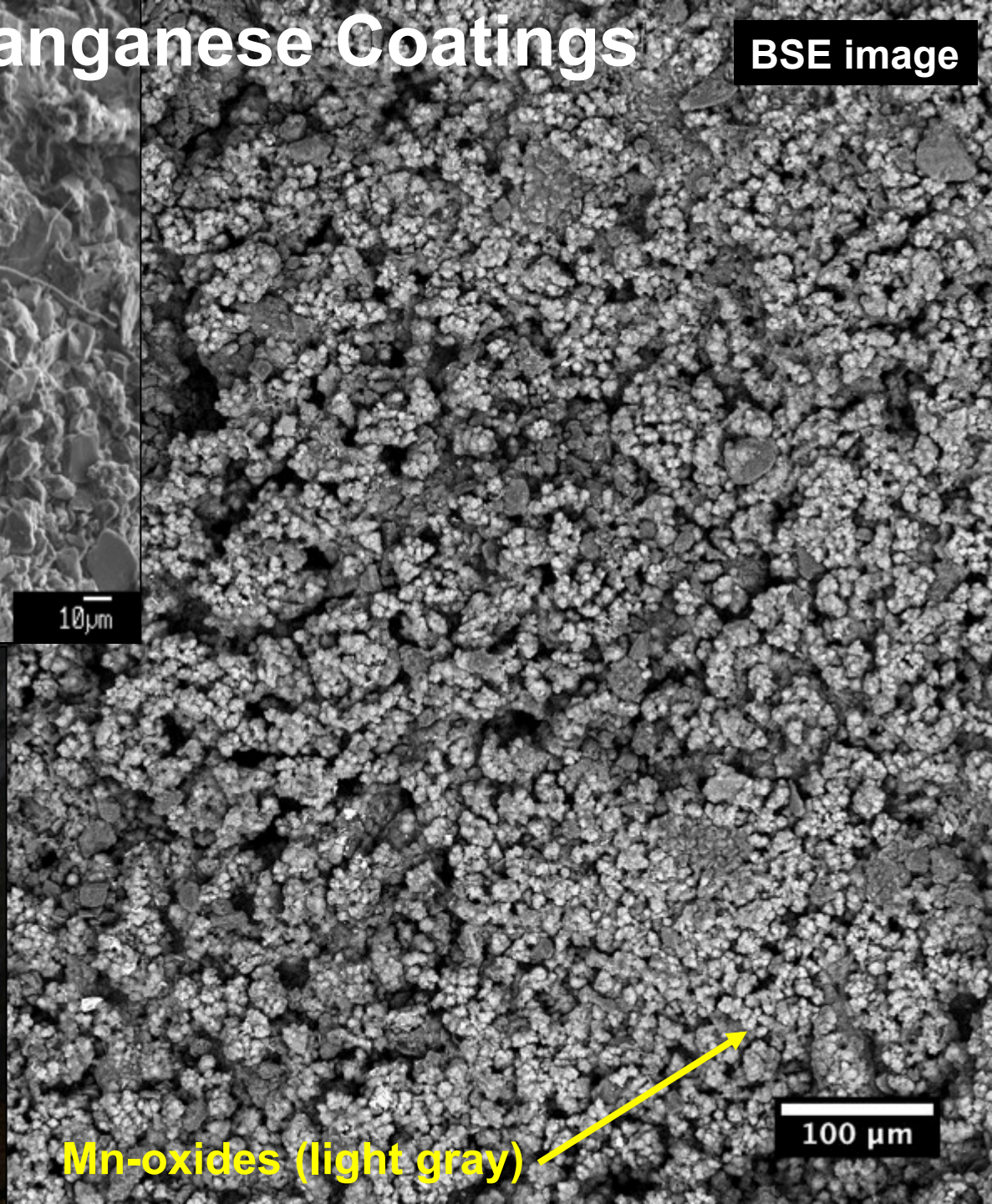
Ferromanganese Coatings



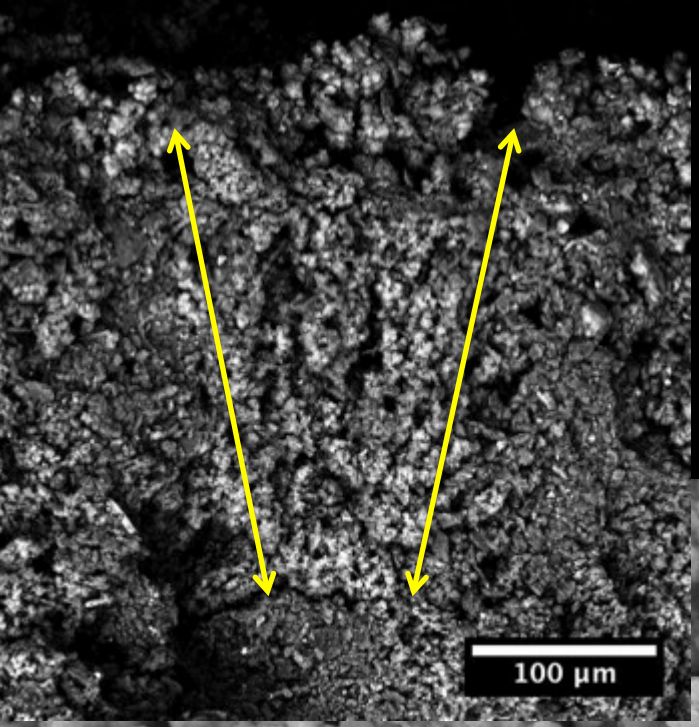
Evidence of regrowth after the Mn-coated mud peeled away in several episodes

Ferromanganese Coatings

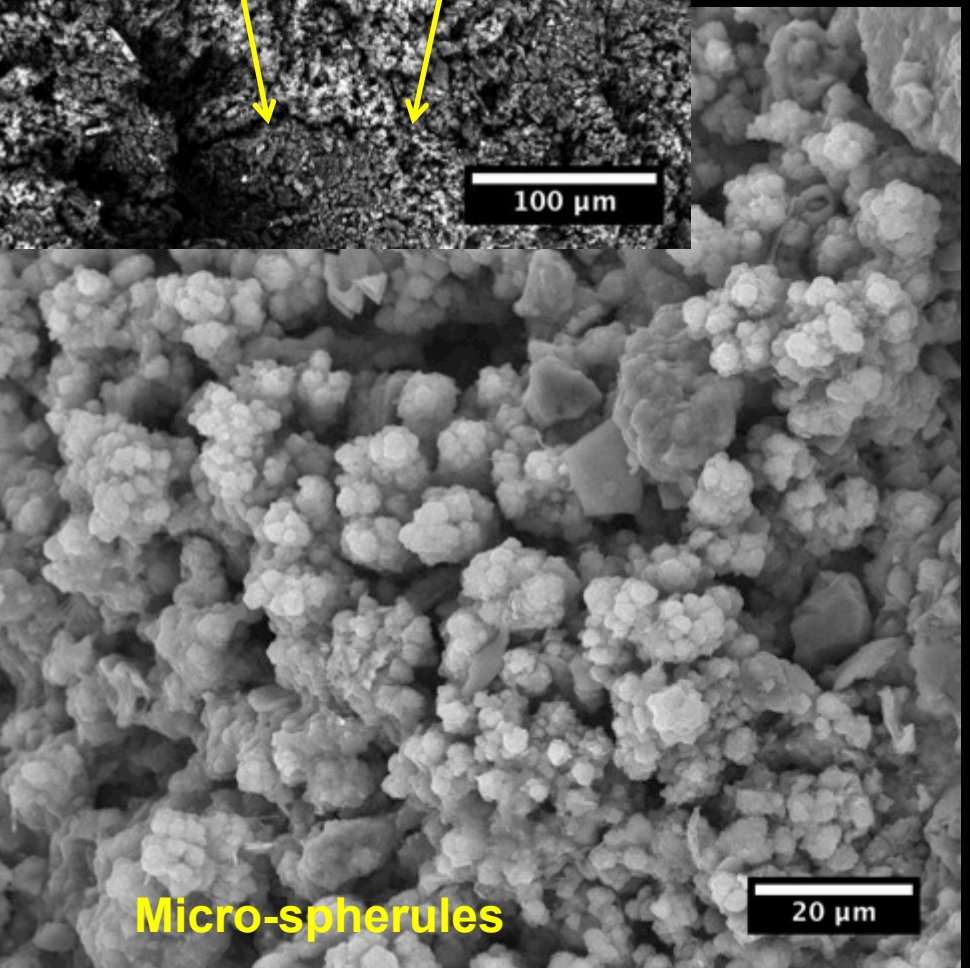




FMD Coatings in the SEM

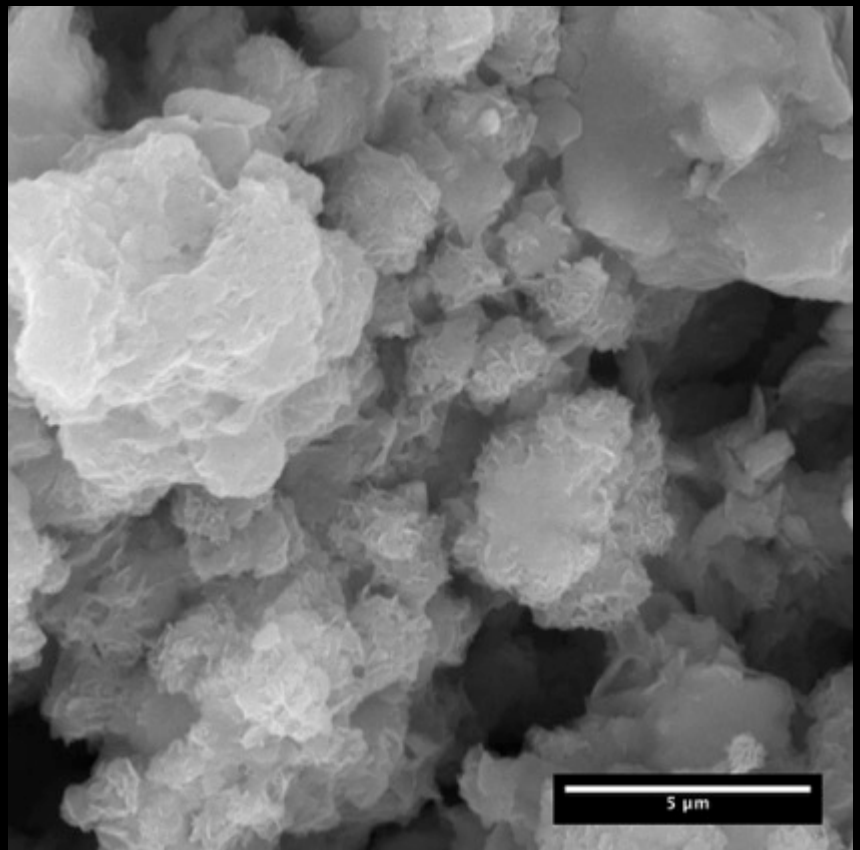


Root-like structures



Micro-spherules

Wispy Mn-oxide sheets



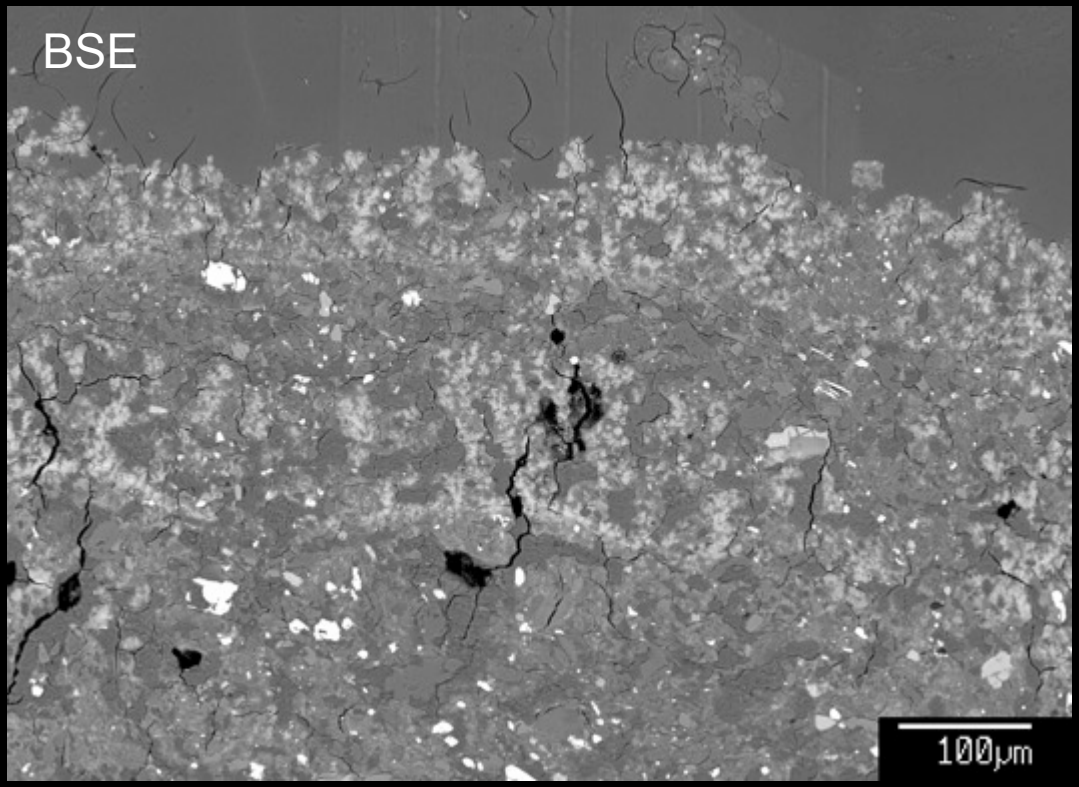
EPMA Analysis of FMD

- Polished section prepared without carbon-based epoxy
  - Section of Mn-oxide crust on mud collected from cave
  - Sample vacuum impregnated with Na-silicate solution
  - Evaporated copper used for conductive coating instead of carbon for electron probe analysis

	CO_2	Na_2O	MgO	Al_2O_3	SiO_2	K_2O	CaO	MnO_2	Fe_2O_3
Mn-oxide	5.00	7.91	2.06	5.13	20.48	0.59	1.70	42.06	4.67
Mn-oxide	3.54	8.52	1.52	6.25	15.54	0.50	1.86	48.18	4.17
Clay	0.61	2.74	1.10	14.24	66.40	1.96	0.90	2.57	5.24

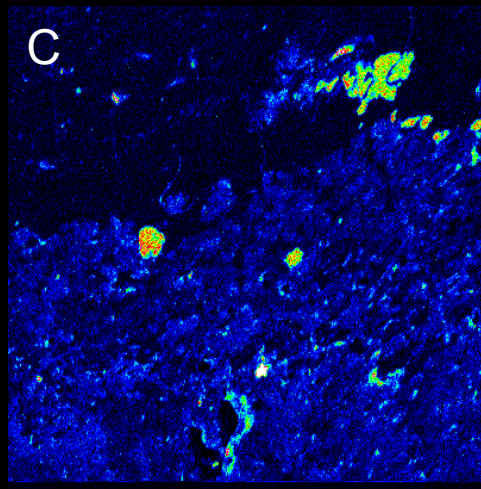
EPMA Mapping of FMD

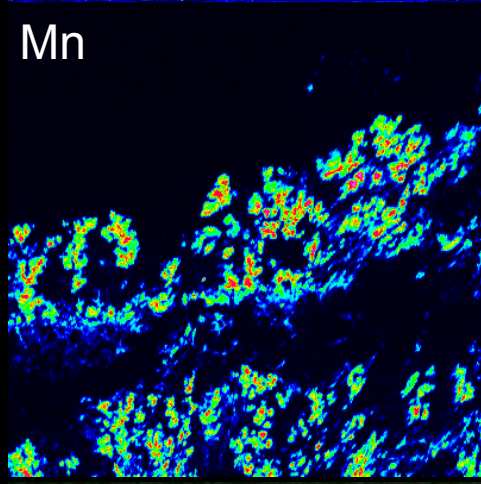
- X-ray maps on polished section
  - Higher carbon associated with FMD
  - Maps show 2 layers of FMD crust
  - Crust inundated with mud then regrowth

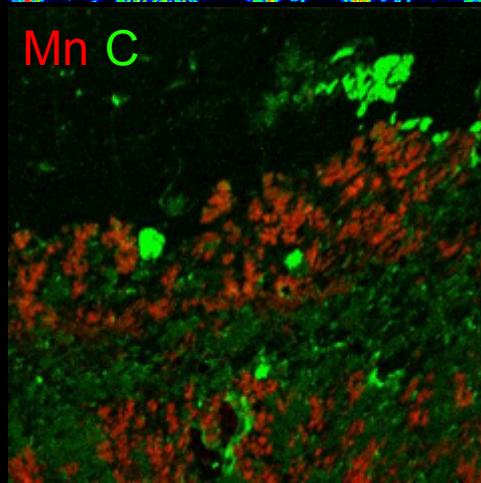


} Surface layer

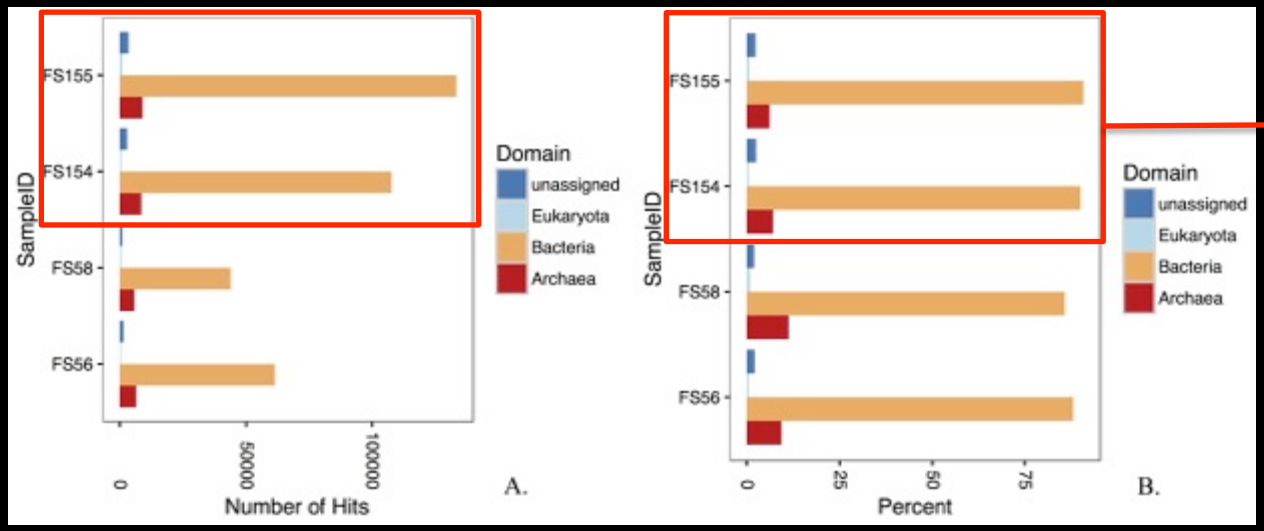
} Buried layer





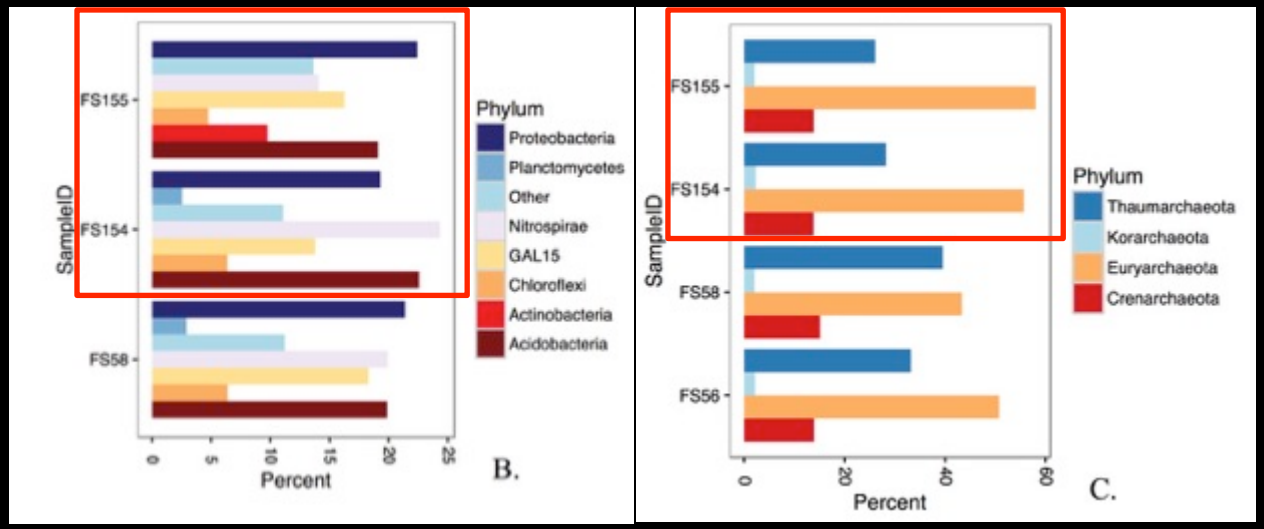


Metagenomic Dataset from FMD



Number of hits for each domain

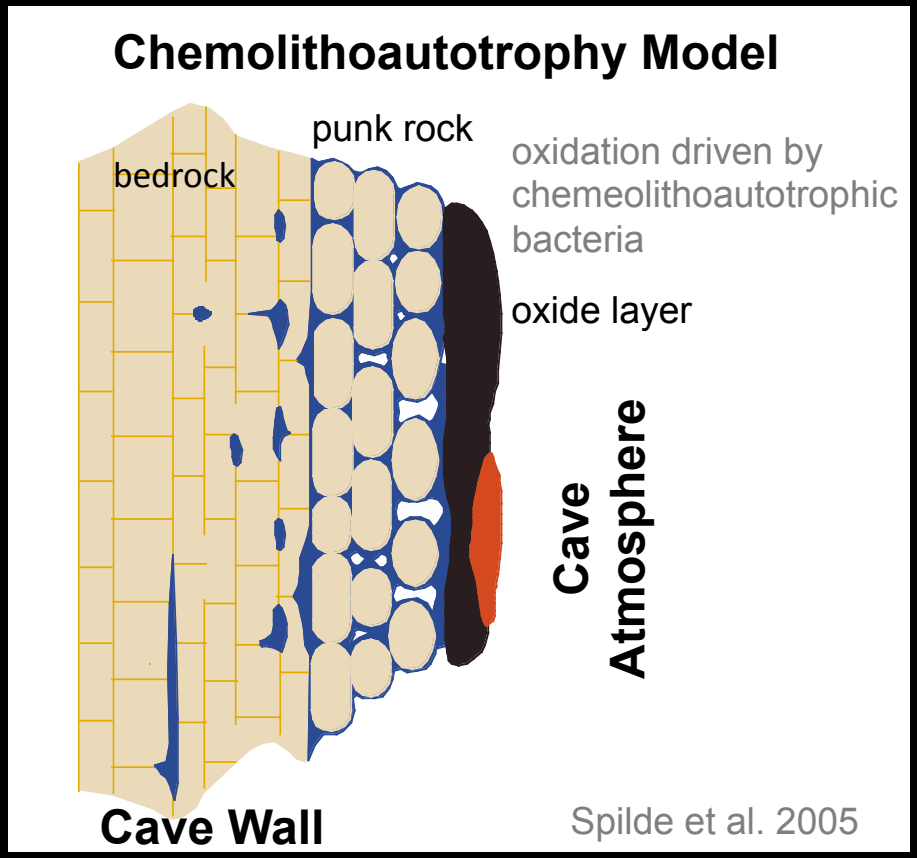
By percent of each domain

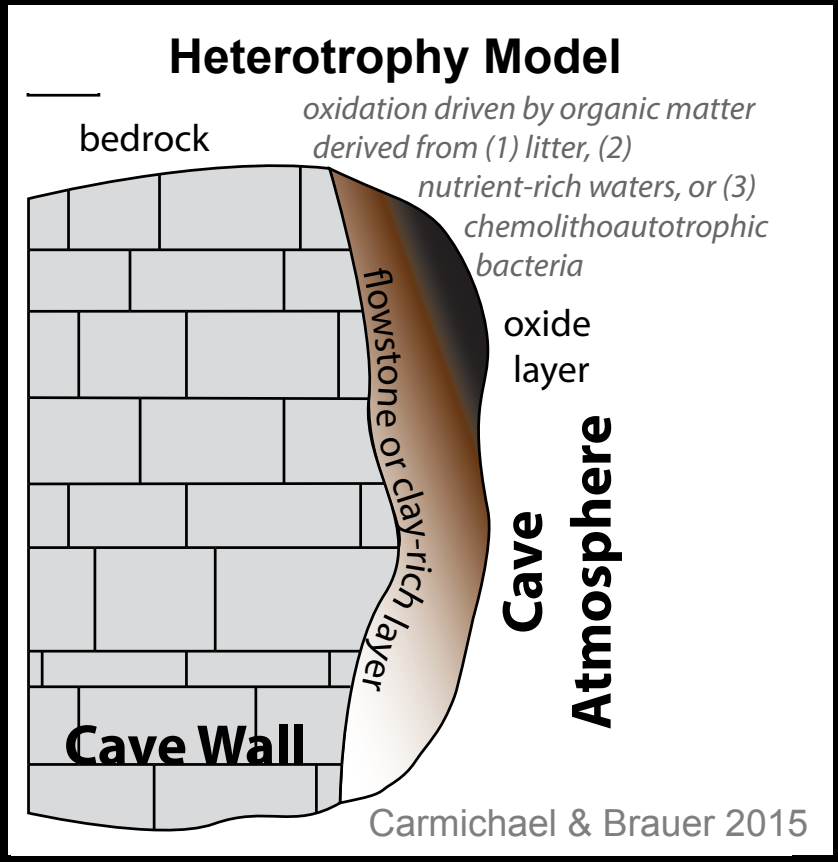


Top six bacterial phyla

Top archaeal phyla

Mn Oxidation in Oligotrophic Cave Systems





Mn oxidation driven by chemolithoautotrophic bacterial breakdown of bedrock (hypogene caves)

Mn oxidation driven by nutrient input from exogenous carbon in water, clay, etc. (epigene caves)

Conclusions

- Careful preparation of samples allows EPMA analysis of carbon
- FMD is associated with higher carbon, likely the result of microbial activity
- Microbial community in FMD is dominated by heterotrophic bacteria, chemolithoautotrophs rare
- Nutrients/metals supplied by water & detrital material
- FMD deposition has continued over time and is still active in the cave

Acknowledgements

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