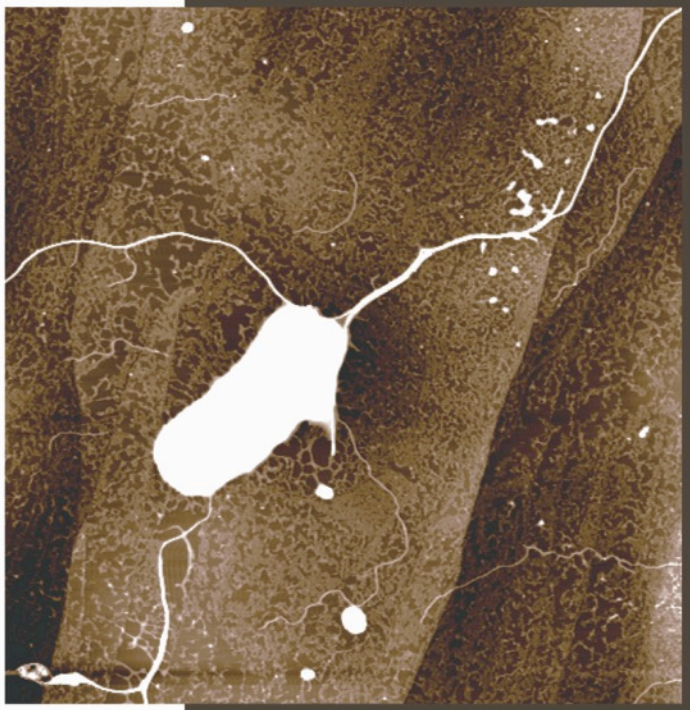
Life Underground



Professor Jan P. Amend
University of Southern California
Los Angeles, CA 90089

California Institute of Technology
Jet Propulsion Laboratory
Desert Research Institute

Investigators:

Jan Amend (USC)
Ken Nealson (USC)
Katrina Edwards (USC)
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Yuri Gorby (RPI)
Victoria Orphan (Caltech)
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Life Underground

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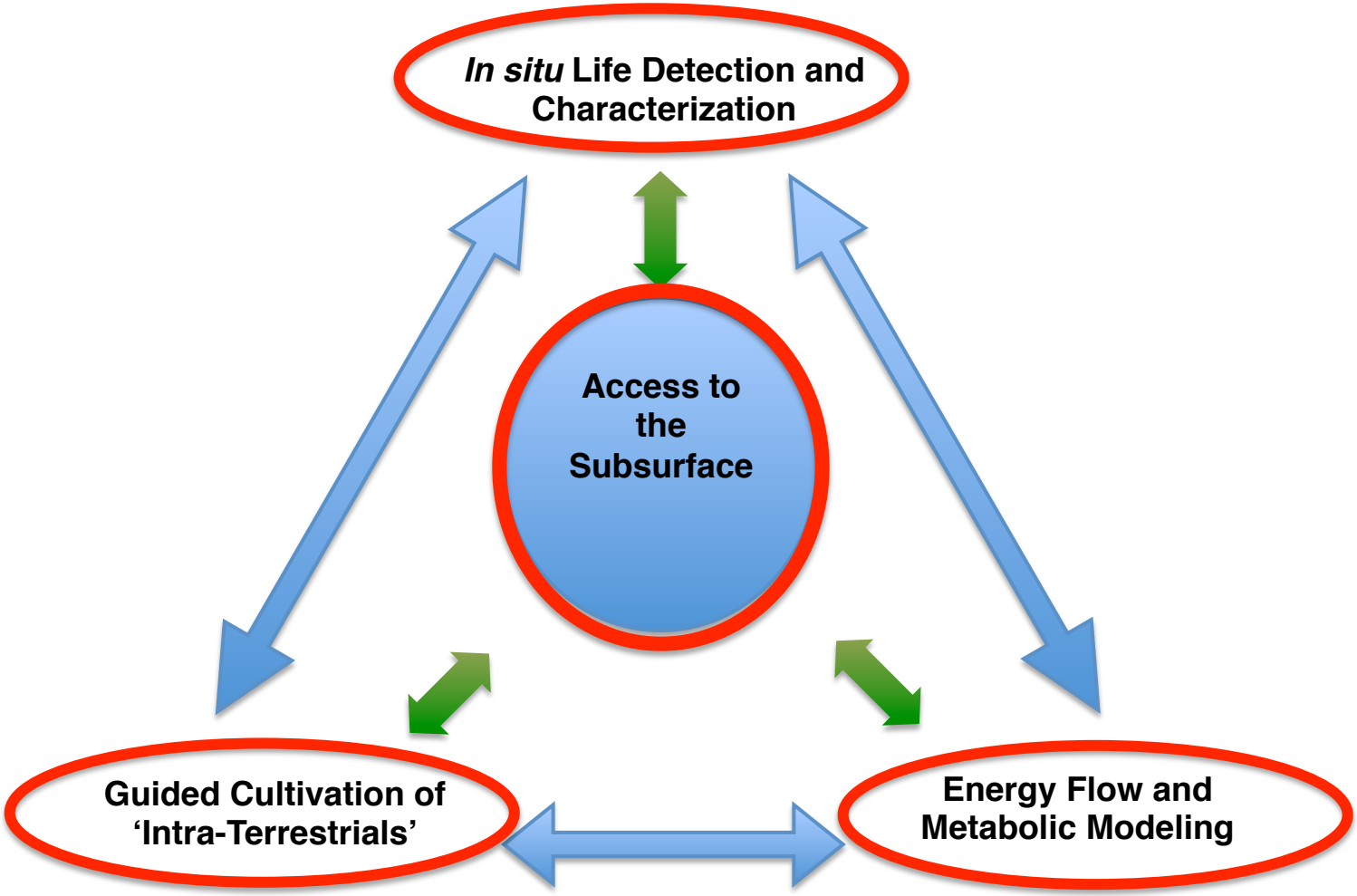
Overall Research Structure



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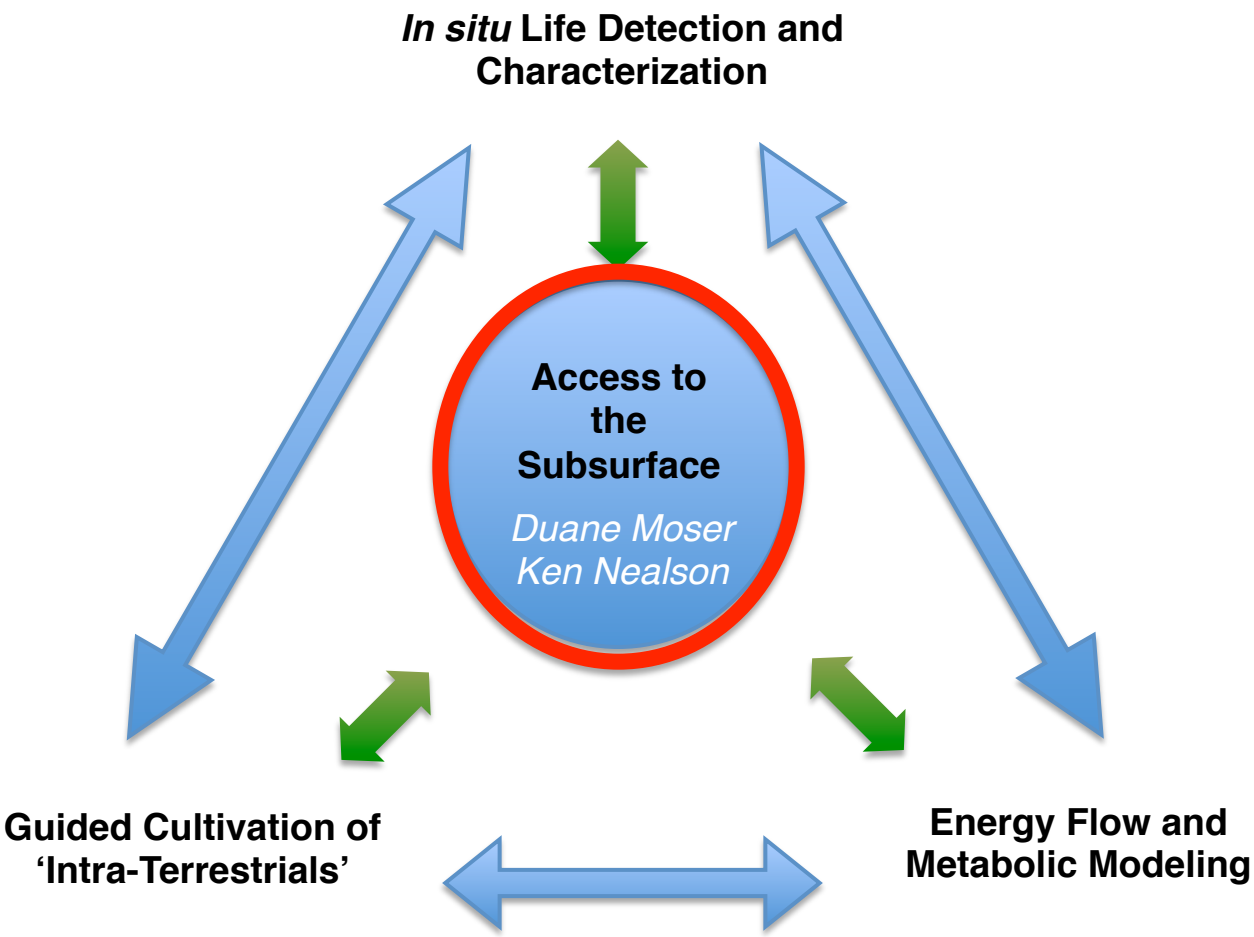
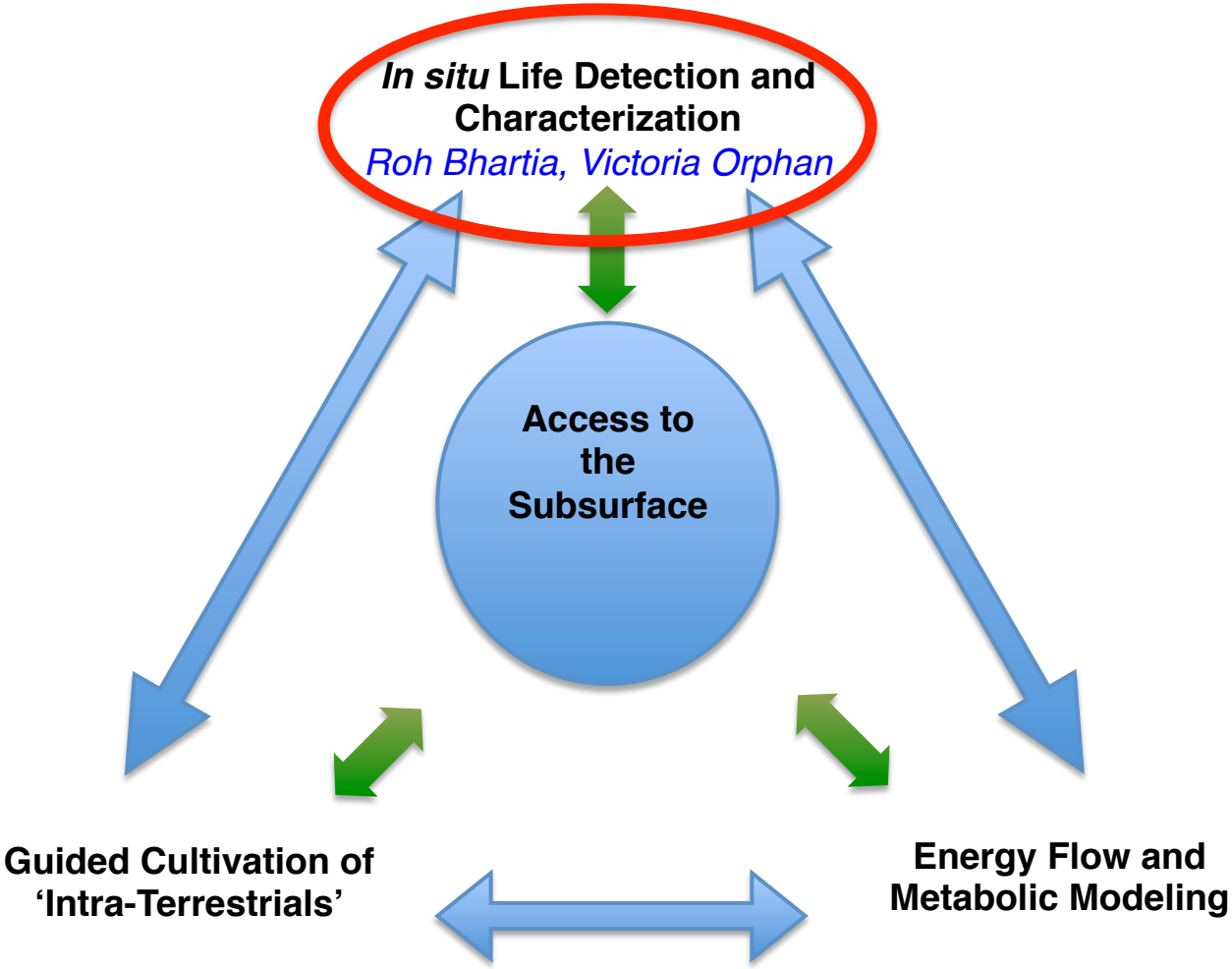


Access to the Subsurface

- Boreholes from surface (*Nevares, NNSS, ICDP*)
- Boreholes within mines (*SURF*)
- Deeply-sourced springs (*Cedars, Ash Meadows*)
- Marine subsurface (*Shimokita, C-DEBI sites*)
- Extraterrestrial sites (*Mars*)

NTS Photo Library

Overall Research Structure



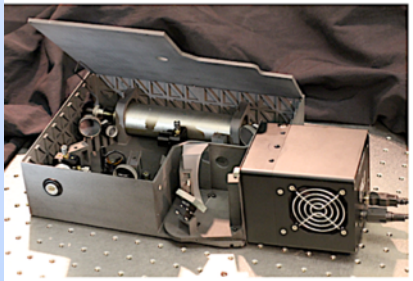
Instrument Arsenal

Detection

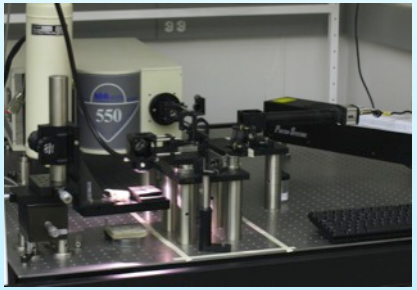
Acquisition

FLOCS
In-situ colonization devices

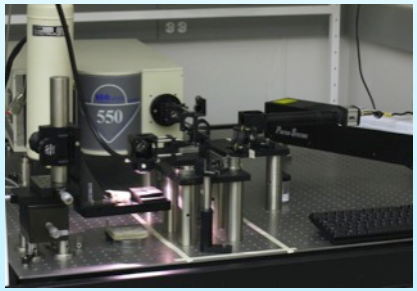
SHERLOC



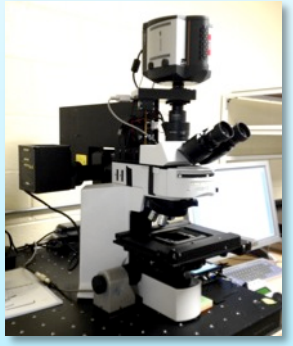
Lab Based: Microbial Distribution



MOBIUS

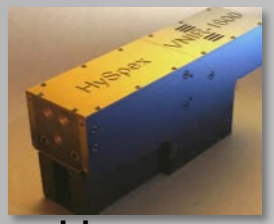


MOBIUS-NAI



DUV Scope

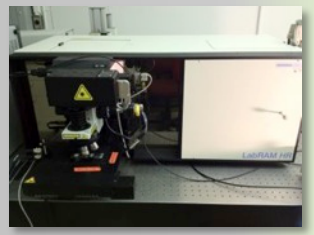
Mineralogy



Hyspex
(Near ir spectral imaging)

Microbe ID & Metabolic Potential

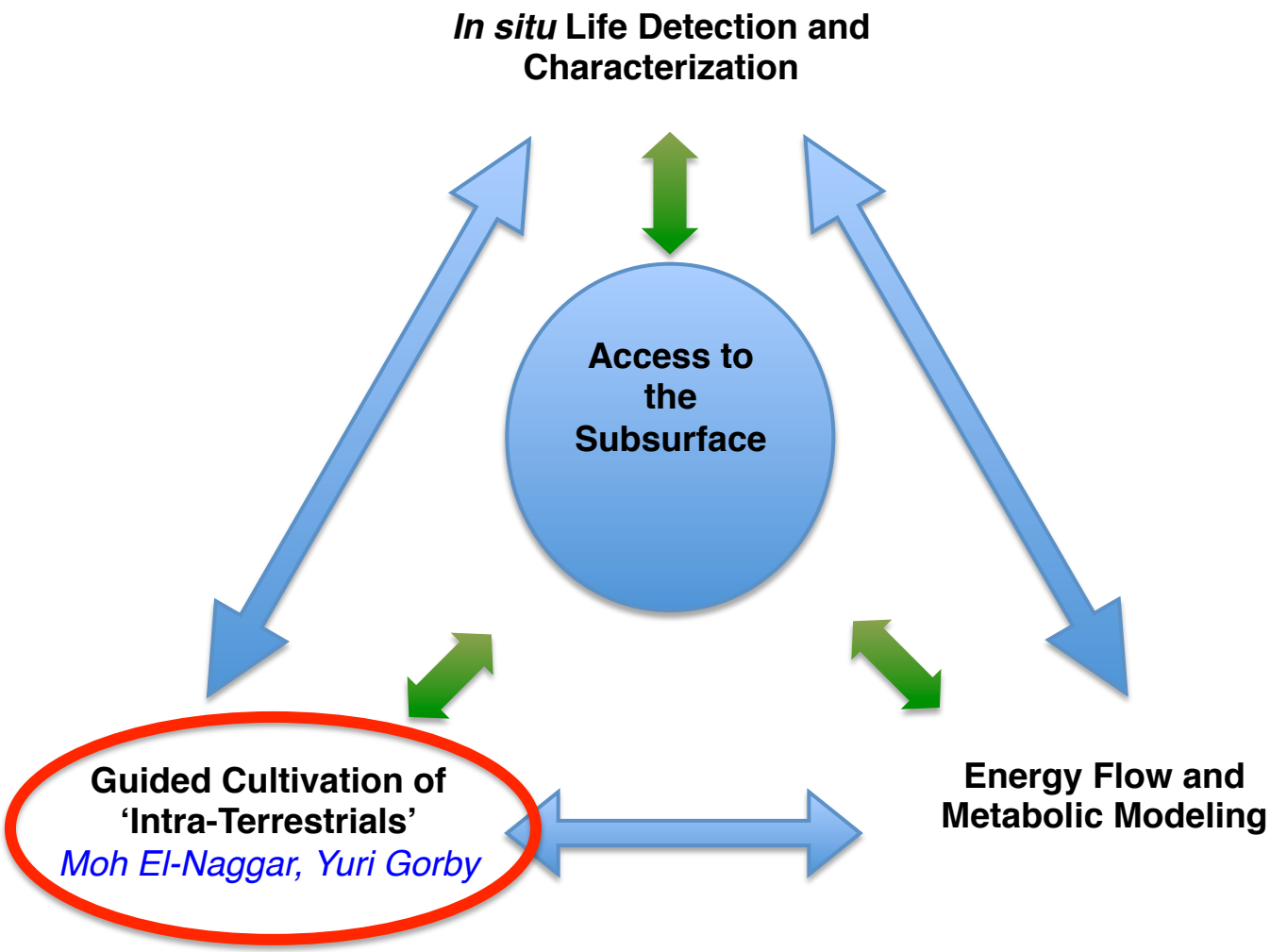
FISH+ single cell isotope analysis



Raman
(UV-NIR Raman Imager)

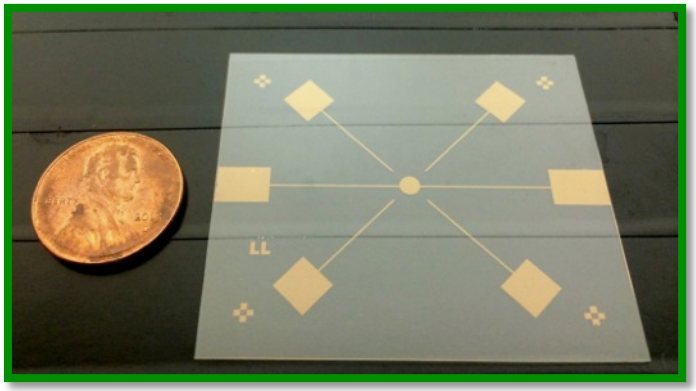
nanoSIMS
(Secondary Ion Mass Spec)

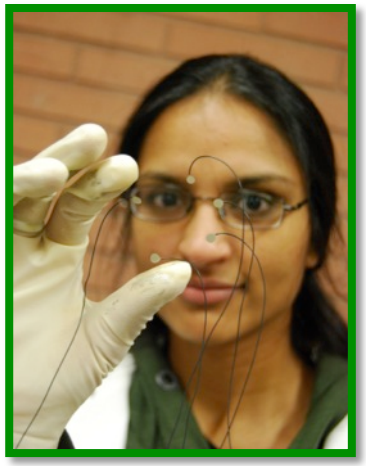
Overall Research Structure

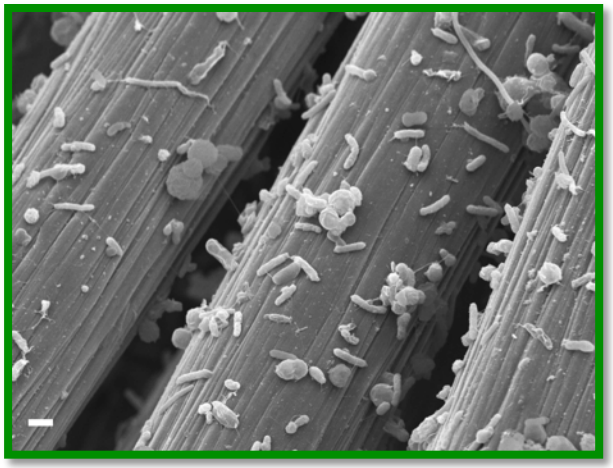


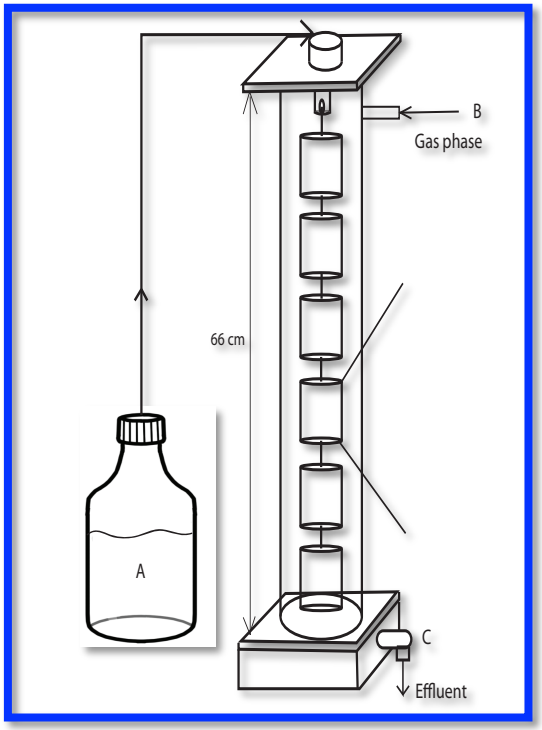
Culturing Approaches

Solid-state electrodes

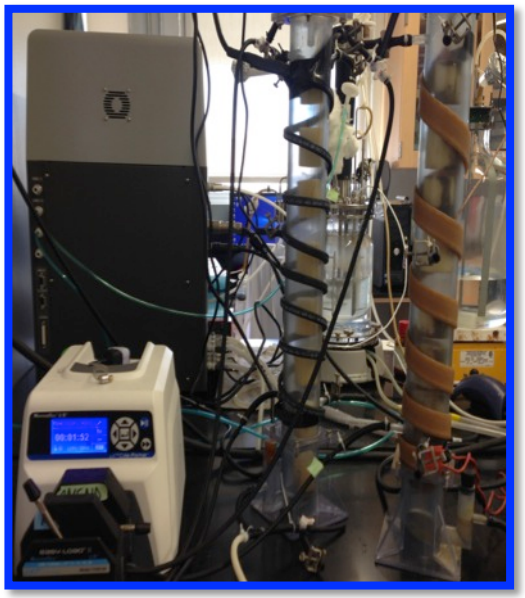






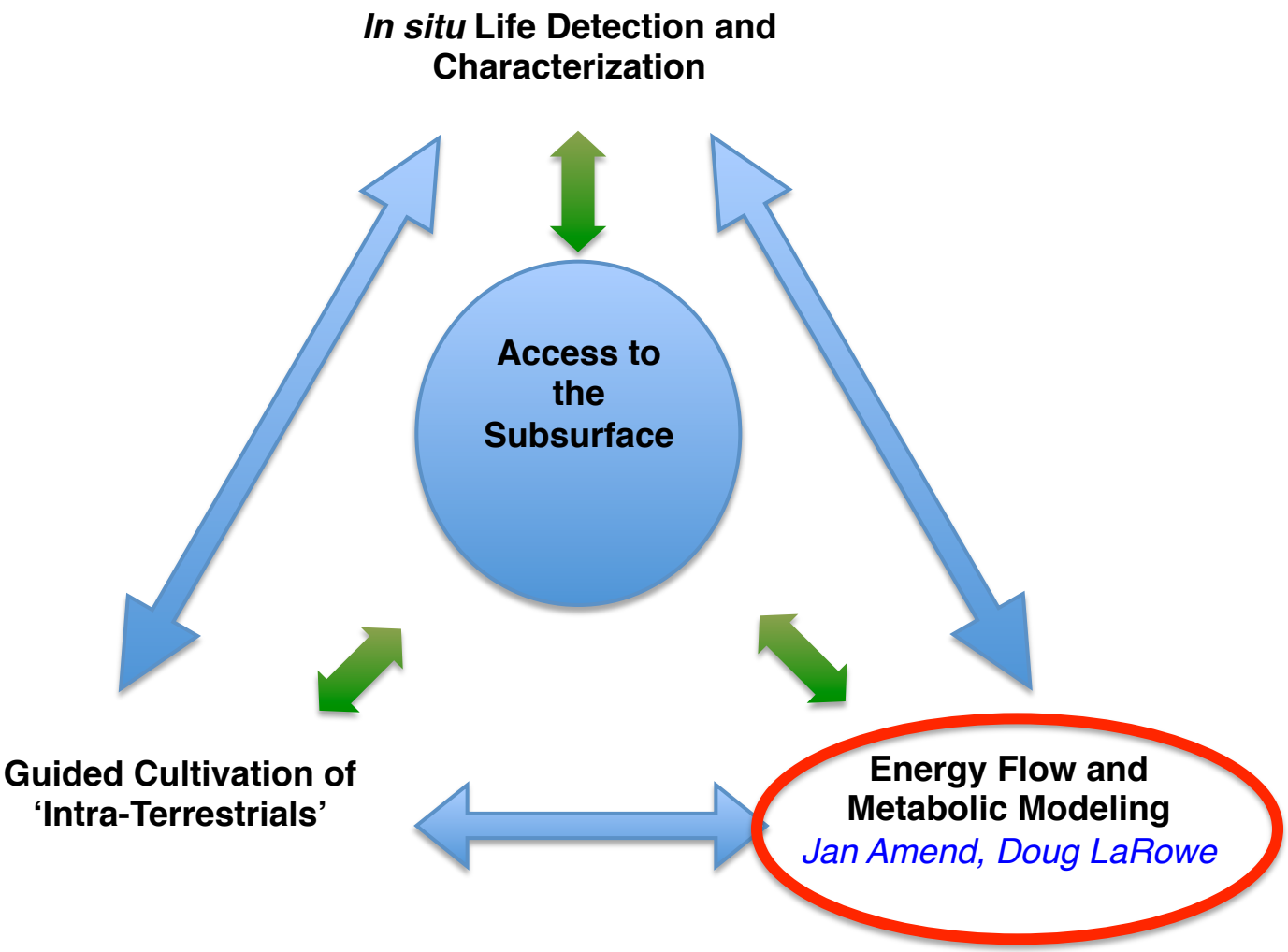


Down-flow hanging sponge reactors

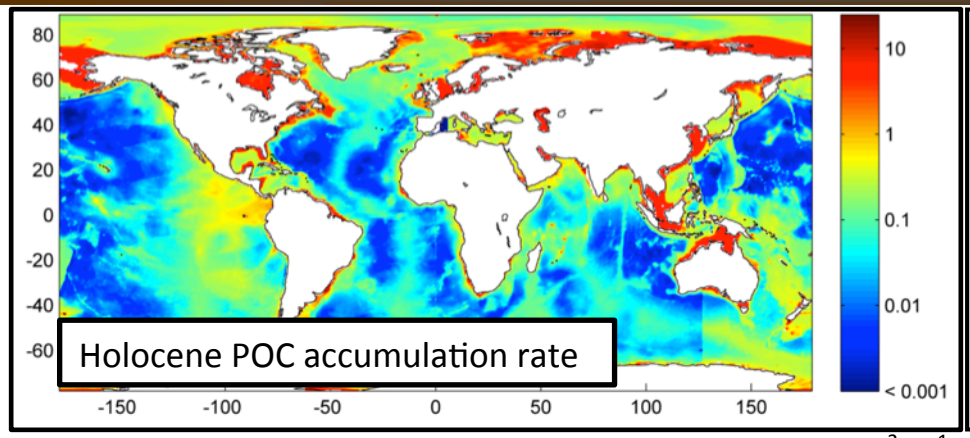


Instrumented chemostats

Overall Research Structure

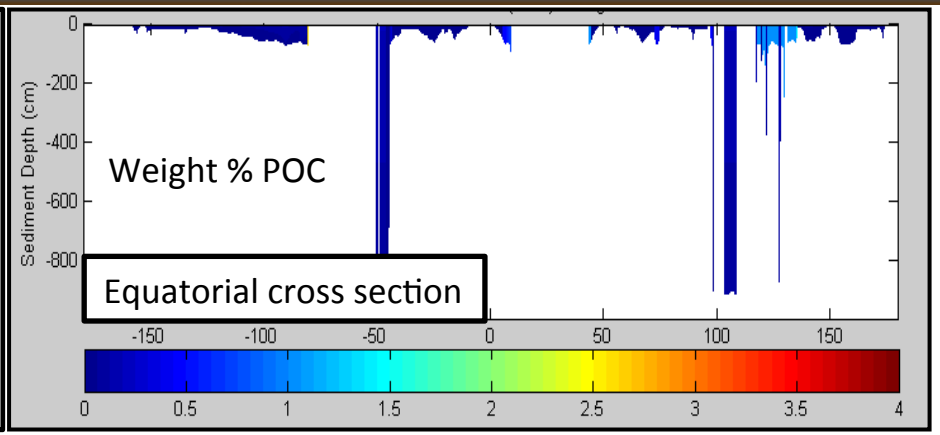


Global Sediment Bioenergetics



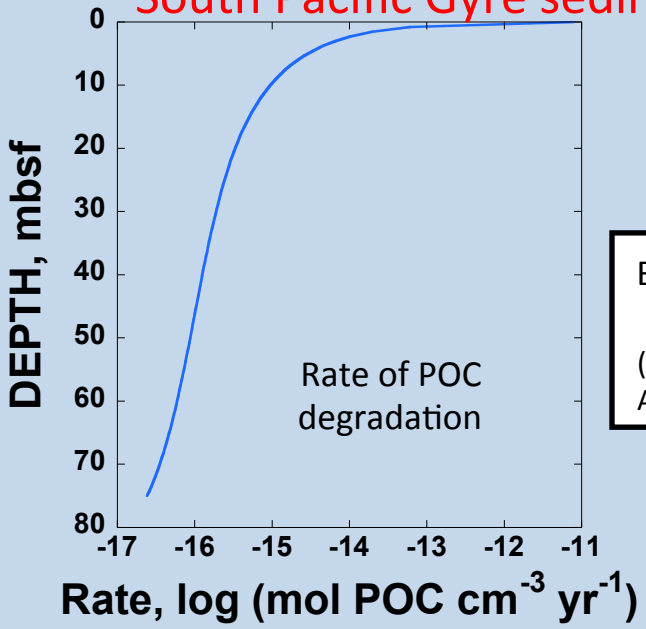
(Wallman et al., 2012)

g m^{-2} yr^{-1}



(LaRowe et al., in prep)

South Pacific Gyre sediments - IODP site U1365



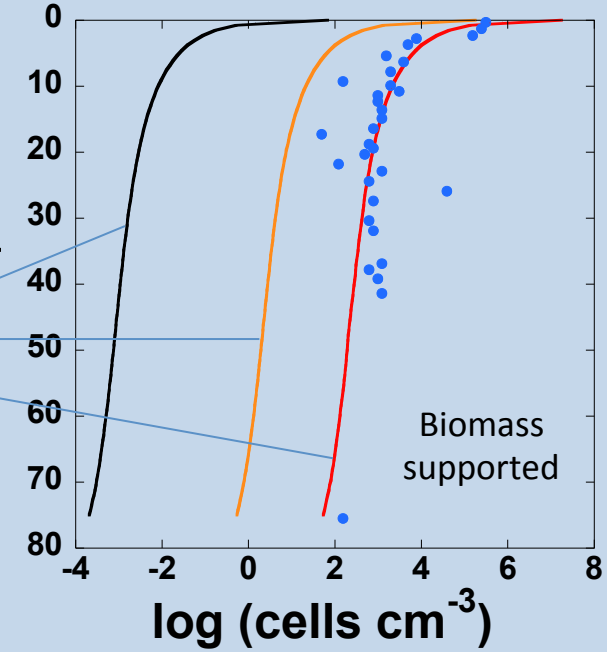
(LaRowe and Amend, in prep)

Bioenergetic Modeling

(LaRowe and Amend 2015)

Maintenance Powers

- O_2 + OM, lit.
- Lowest, lit.
- 2 orders of magnitude lower



(LaRowe and Amend, in prep)

Tomorrow morning

8:30 Life Underground: The Game
(*T. Fullerton*)

8:50 Culturing Continental 'Intraterrestrials'
(*L. Momper, Y. Jangir*)

9:10 SHERLOC, a Mars2020 Flight Instrument
(*R. Bhartia*)

9:30 Life in Ultrabasic Springs: The Cedars
(*K. Nealson*)

9:50 IODP x337: Shimokita Coal Bed
(*E. Trembath-Reichert*)

10:10 Life and Nanowires
(*M. El-Naggar*)

NTS Photo Library

Life Underground: The Game

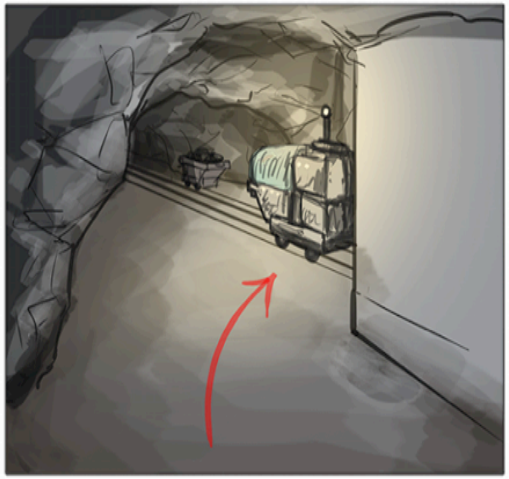
Tracy Fullerton (USC School of Cinematic Arts)

Start Time: Duration:

Long Descent

Start Time: Duration:

What are we doing here?

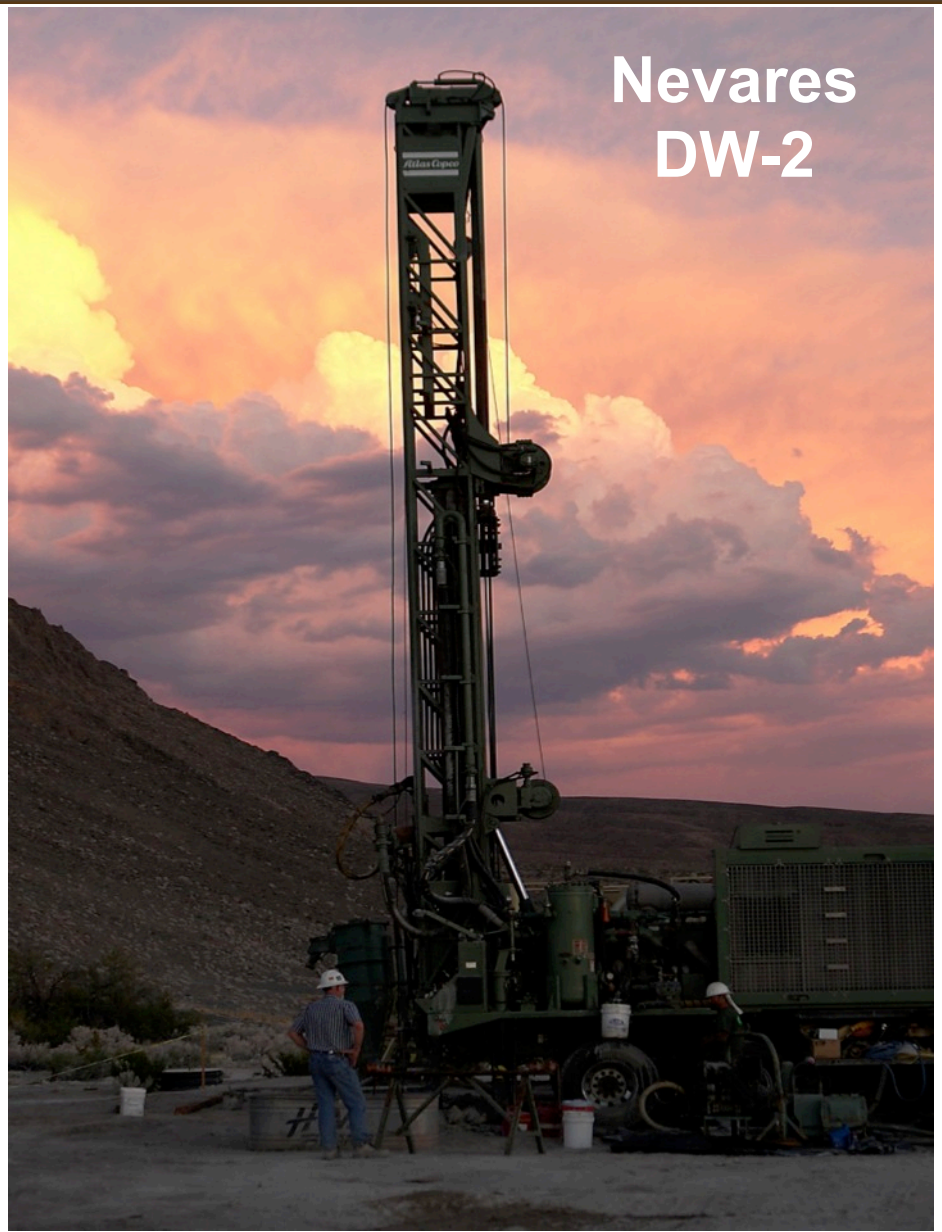


Start Time: Duration:

Main tunnel, intro to mine,

Culturing 'Intraterrestrials'

Lily Momper & Yamini Jangir (USC grad. students)

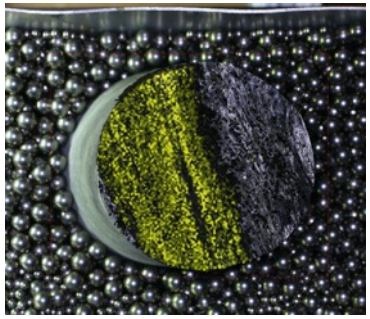


SHERLOC and Friends

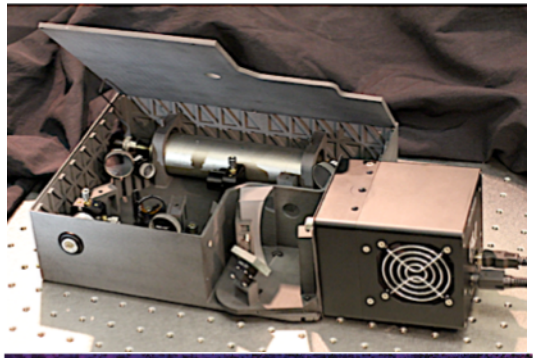
Rohit Bhartia (JPL)

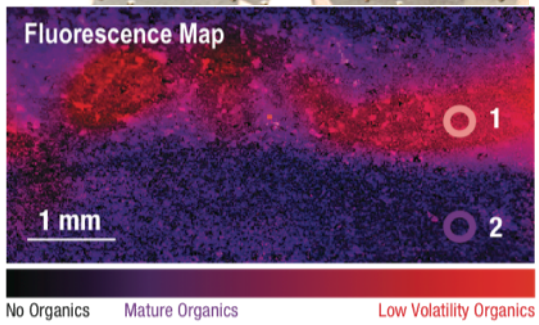
Bringing the instruments to the sample

Subsurface Analysis

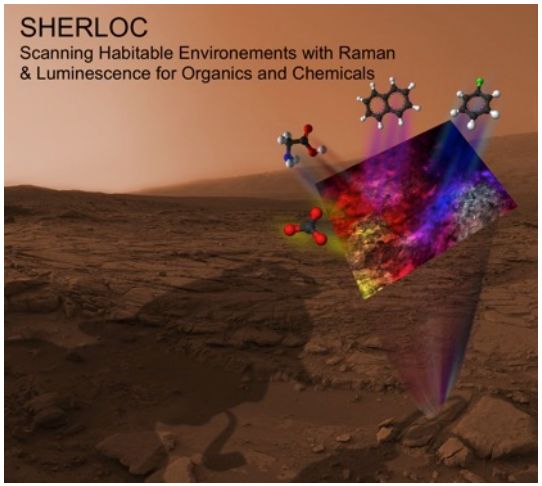


Infusion of Next Gen Field Inst.





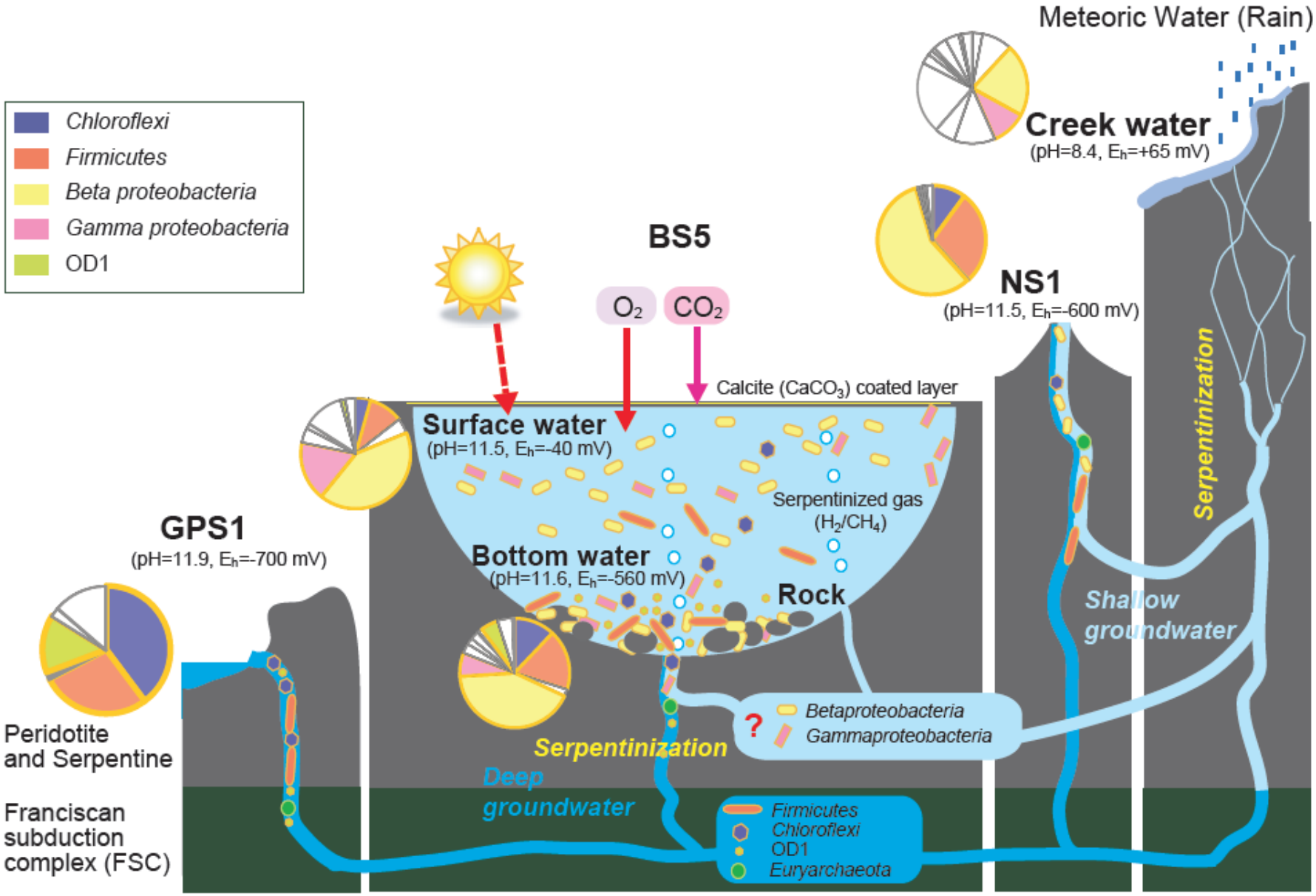
SHERLOC/Mars 2020



PI: Luther Beegle
Deputy PI: Rohit Bhartia
Co-I: Ken Nealson

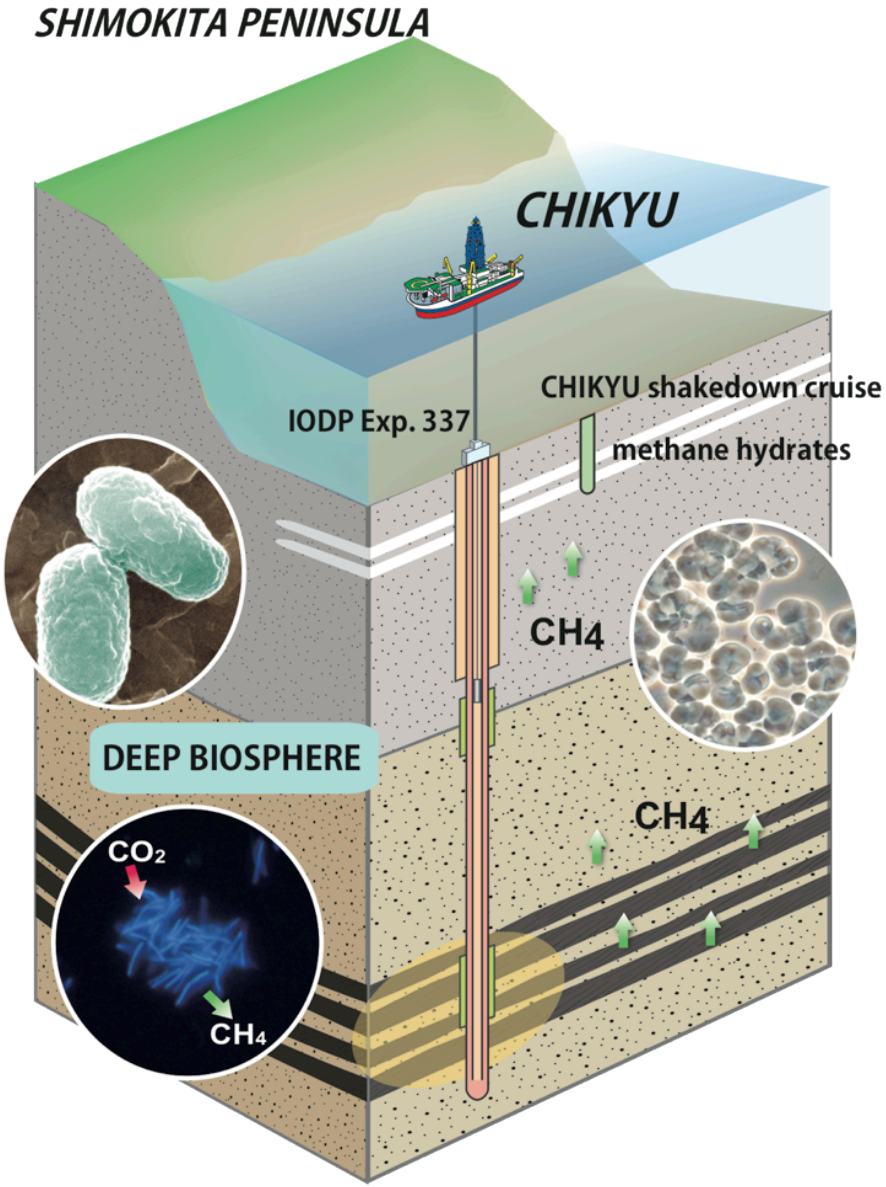
The Cedars

Ken Nealson (USC Earth Sciences)



Shimokita Coal Bed Biosphere

Elizabeth Trembath-Reichert (Caltech grad. student)



- **Study the interactions between 2-km deep coalbeds and subseafloor microbial life.**
- **Probe the deepest life ever accessed by scientific ocean drilling and constrain factors limiting life.**

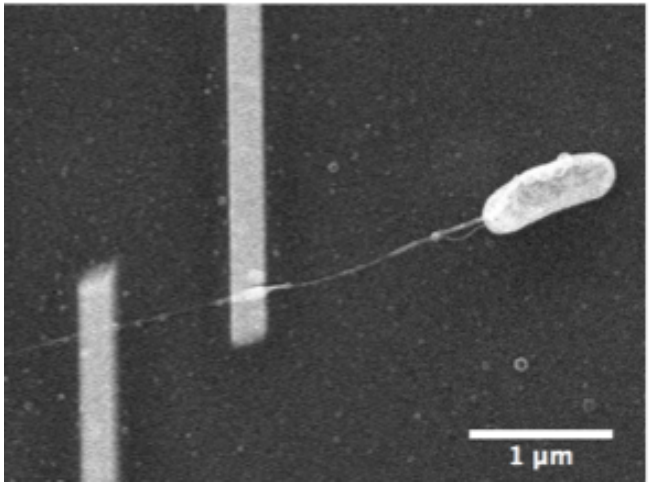
Inagaki, Hinrichs, and Kubo, IODP Sci. Pros., 2010

Life and Nanowires

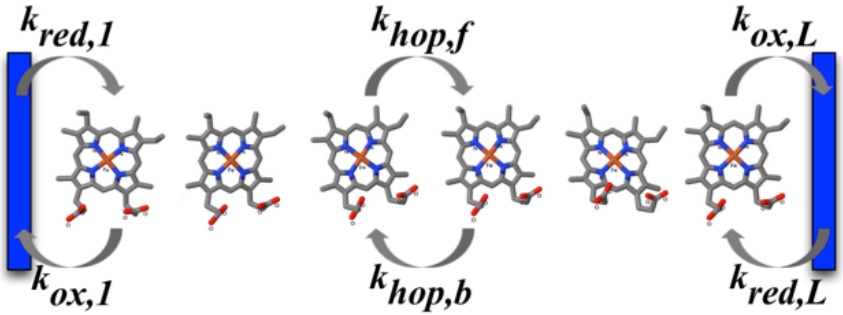
Moh El-Naggar (USC Physics)

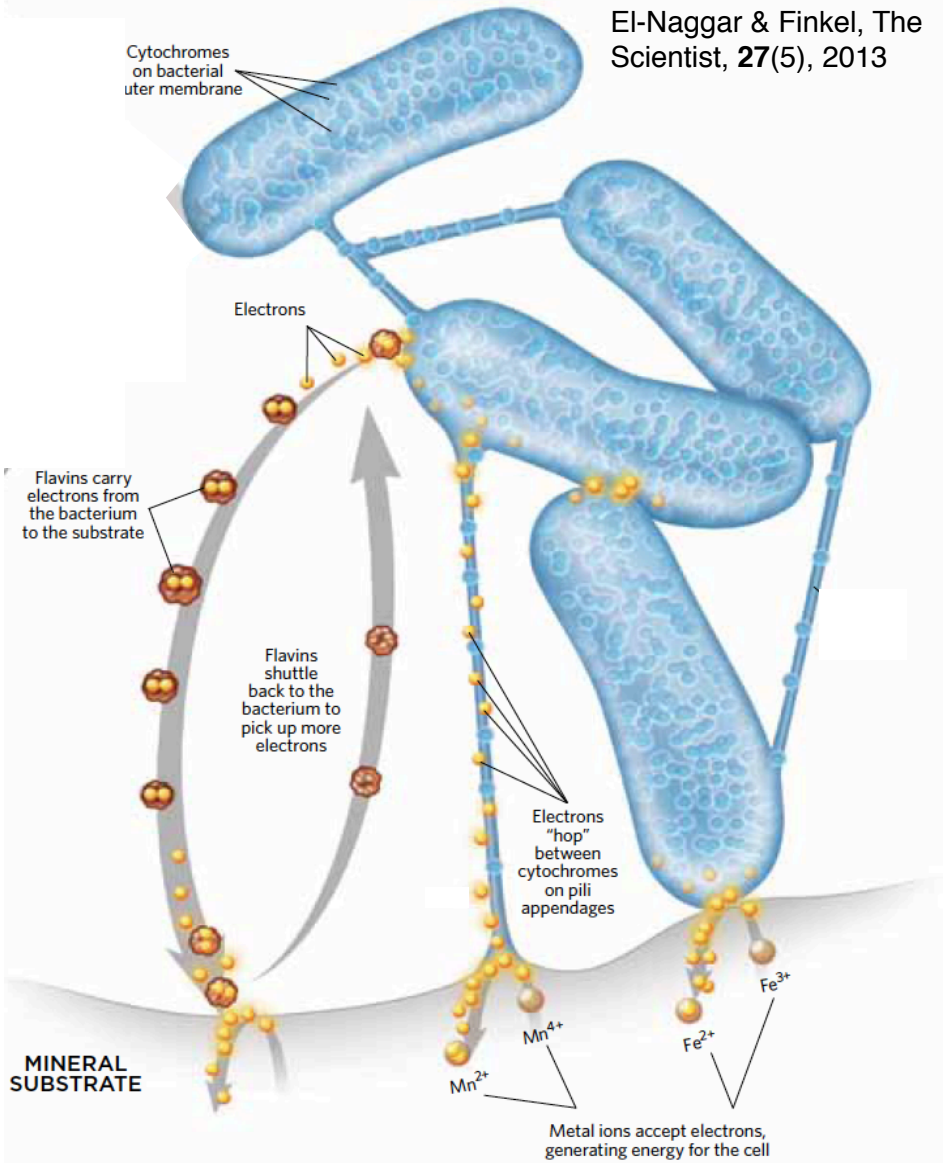
Focus on the biophysics of microbial electron transport

Experiments



Theory





El-Naggar & Finkel, The Scientist, **27**(5), 2013