

# Meeting Reports– Focus on Enceladus

Enceladus Focus Group, 8-9 June, Berkeley CA

Enceladus and the Icy Moons of Saturn Conference  
26-29 July, Boulder CO

Ocean Worlds 2, 25-26 Aug, Woods Hole MA

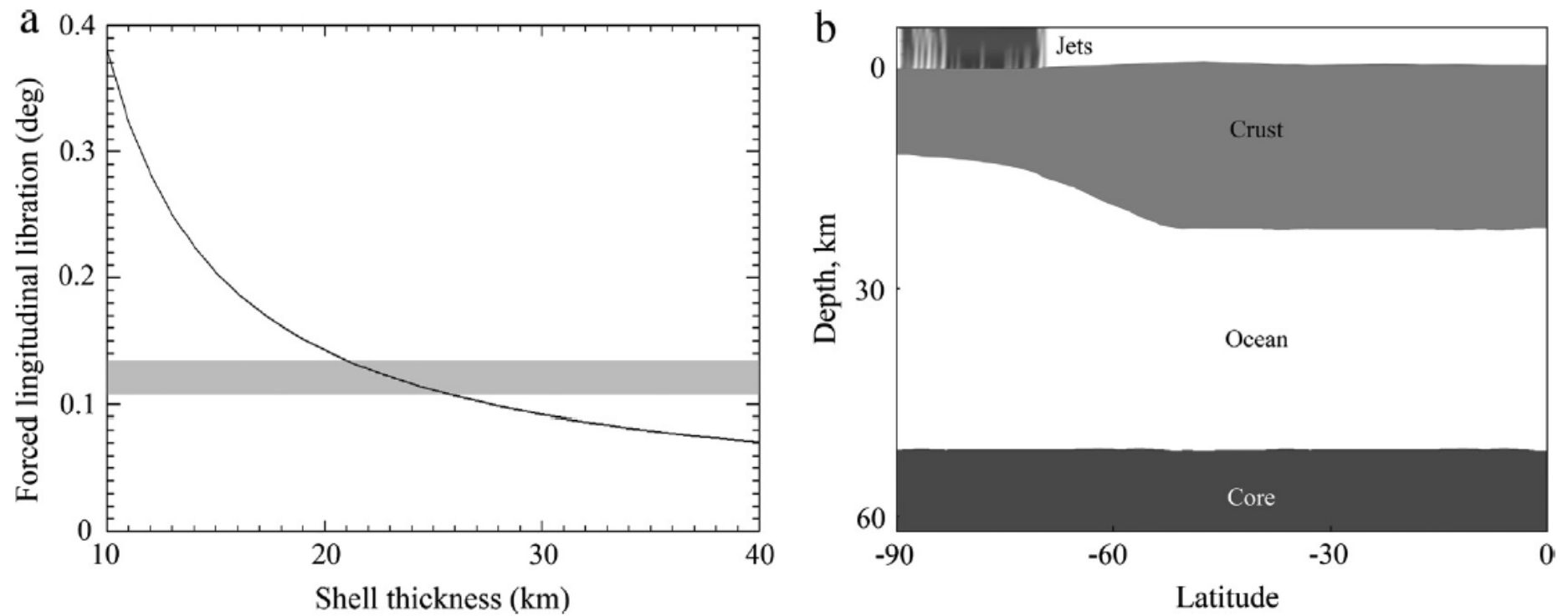
William B McKinnon, Washington Univ in St Louis  
w/input from Christophe Sotin

CAPS, 14 Sept 2016, Irvine CA

# Enceladus Focus Group, 8-9 June, Berkeley CA

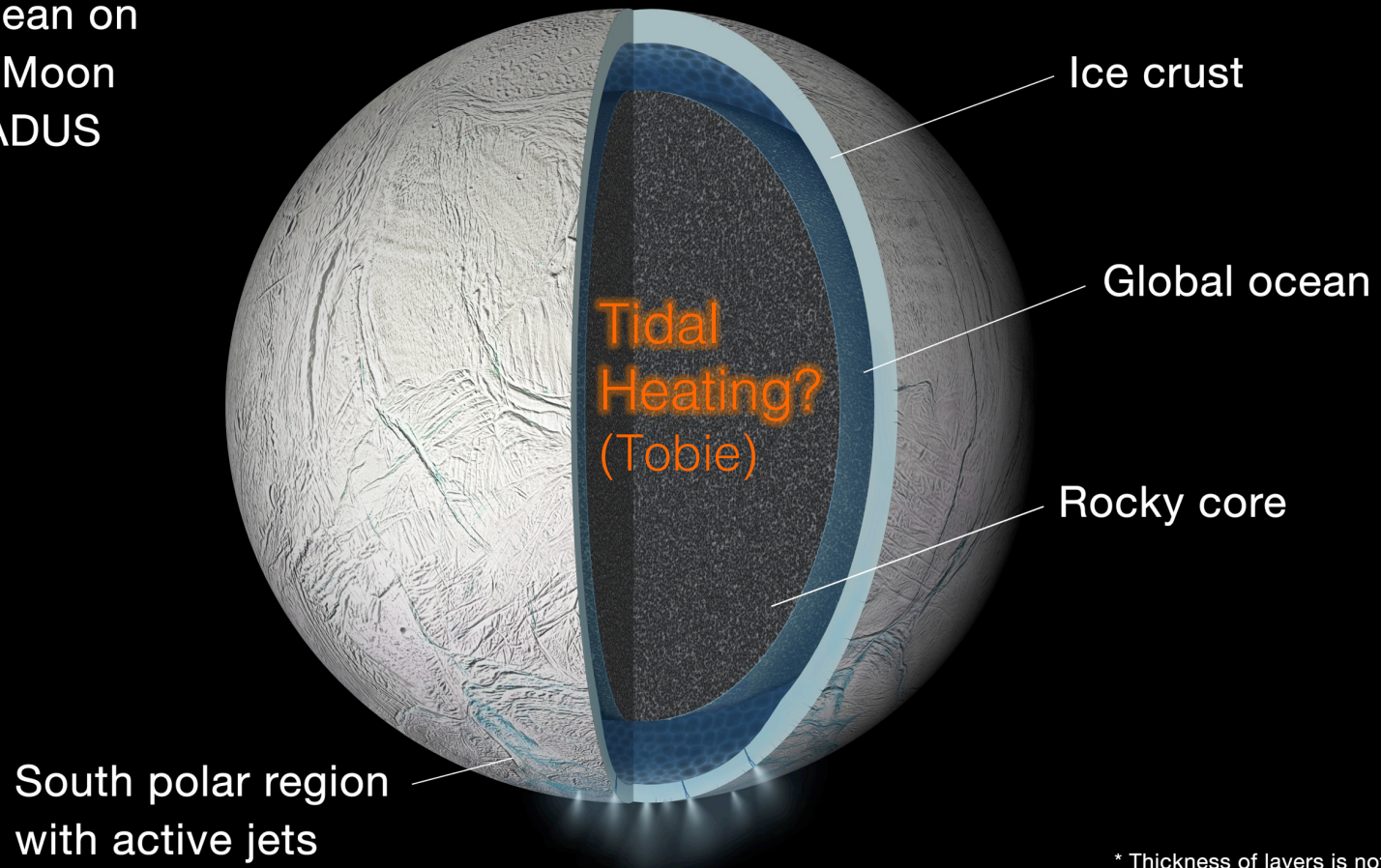
C Porco & C McKay, organizers

Enceladus Focus Group Workshop					
June 8/9, 2016					
131 Campbell Hall, UC Berkeley					
JUNE 8, 2016	SPEAKER	TOPIC	TALK	DISCUSSION	CUMULATIVE
7:45:00 AM	Breakfast				
8:30:00 AM	Opening Remarks		15	15	30
9:00:00 AM	Jing Luan	Orbital Evolution of Enceladus	15	15	60
9:30:00 AM	Carolyn Porco	Thoughts on Looking for Life	15	15	90
10:00:00 AM	Amanda Hendrix	Recent Cassini UVIS Results	15	15	120
10:30:00 AM	Miki Nakajima	Modeling of Plume Eruptions	15	15	150
11:00:00 AM	Matt Hedman	Cassini VIMS: Constraints on Eruptions	15	15	180
11:30:00 AM	David Goldstein	DCMS Plume Simulations	15	15	210
12:00:00 PM	Ben Teolis	Plume Structure/Variation from INMS & UVIS	15	15	240
12:30:00 PM	Bill McKinnon	Enc Shape/Gravity Update	5	0	245
12:35:00 PM	Paolo Tortora	Gravity Measurements of the Future	5	0	250
12:40:00 PM	LUNCH		90		340
2:10:00 PM	Francis Nimmo	Enc Plume Variability from ISS	10	10	360
2:30:00 PM	Edwin Kite	Turbulent Dissipation w/in TS Fractures	15	15	390
3:00:00 PM	Marie Behoukova	Improved Tidal Deformation Models	15	15	420
3:30:00 PM	Christophe Sotin	Hydration of Enceladus' Silicate Core	15	15	450
4:00:00 PM	Gabriel Tobie	Tidal Dissipation/Heat Transfer in Core	15	15	480
4:30:00 PM	Emily Martin	Tectonic History of Enceladus	15	15	510
5:00:00 PM	An Yin	Structural Evoltn of Enceladus Terrains	15	15	540
5:30:00 PM	ADJOURN				
NOTE: 5 min presentations are poster advertisements					



**Evidence from Physical Libration for a Global Ocean**  
Shell thickness ~20–25 km

Global Ocean on  
Saturn's Moon  
ENCELADUS



\* Thickness of layers is not to scale



# Enceladus Focus Group, 8-9 June, Berkeley CA

## Day 2

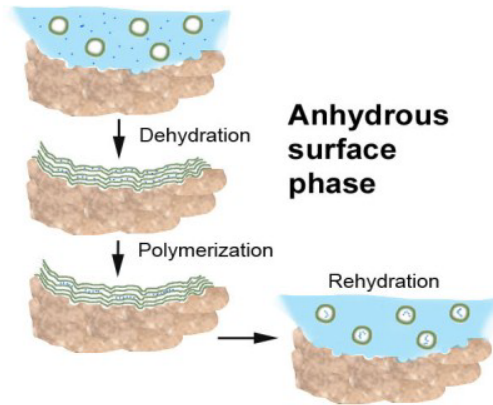
JUNE 9, 2016	SPEAKER	TOPIC	TALK	DISCUSSION	CUMULATIVE
7:45:00 AM	Breakfast				
8:30:00 AM	Frank Postberg	Recent Cassini Dust Analyzer Results	15	15	30
9:00:00 AM	Hunter Waite	Recent Cassini INMS Results	15	15	60
9:30:00 AM	Chris Glein	Enceladus' Ocean Chemistry	15	15	90
10:00:00 AM	Bryan Travis	Modeling of Convection on Enceladus	15	15	120
10:30:00 AM	Ron Oremland	Detecting acetylene-Eating Bacteria?	15	15	150
11:00:00 AM	Chris German	Ice Vents, Water/Rock Interactions, Etc			180
11:30:00 AM	Laura Barge	Life Began at Hydrothermal Zones			210
12:00:00 PM	Bruce Damer	Life Began at Hydrothermal Fields	15	15	240
12:30:00 PM	Jay Bishop	Robotic Ocean Profilers	5	0	245
12:35:00 PM	Amanda Stockton	Organics Detection from Ice Impactors	5	0	250
12:40:00 PM	LUNCH		90		340
2:10:00 PM	Karthik Anantharaman	The New Tree of Life	15	15	370
2:40:00 PM	Jay Nadeau	A Microimager for Enceladus	15	15	400
3:10:00 PM	Steve Benner	Comments on Chemical Signatures	10	10	420
3:30:00 PM	Rich Mathies	Microfluidics to Detect Bioorganics&Chirality	15	15	450
4:00:00 PM	Chris McKay	An Approach to Detecting Enceladus Life	15	15	480
4:30:00 PM	Marc Neveu	Sample Return Mission	15	15	510
5:00:00 PM	Margaret Race	Planetary Protection	15	15	540
5:30:00 PM	Closing Remarks/ADOURN				

Not deep sea!

## Inland hydrothermal site subject to cycling

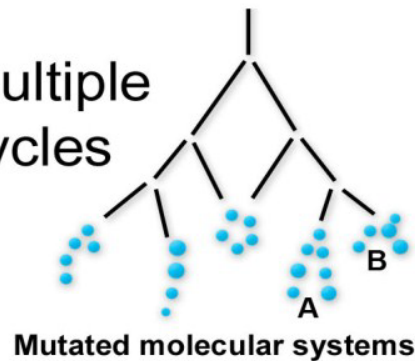


Dehydration and deposition of protocell contents into surface matrix

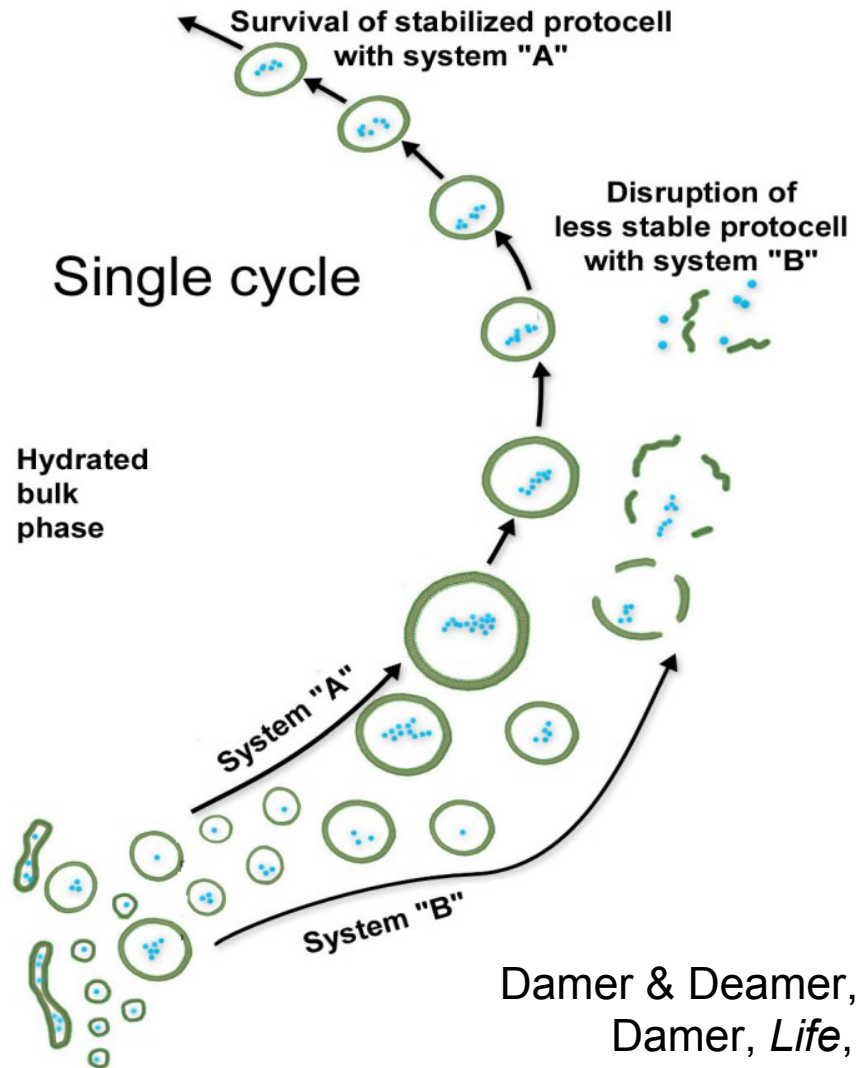


Stepwise evolution of systems of functional polymers


Multiple cycles



Single cycle



Damer & Deamer, *Life*, 2015;  
Damer, *Life*, 2016



## Enceladus and the Icy Moons of Saturn

July 26–29, 2016

Boulder, Colorado

<http://www.hou.usra.edu/meetings/enceladus2016/>

### **FINAL ANNOUNCEMENT**

#### **MEETING LOCATION AND DATE**

The conference on Enceladus and the Icy Moons of Saturn will be held July 26–29, 2016, at the [Hotel Boulderado](#) in Boulder, Colorado.

#### **PURPOSE AND SCOPE**

The planetary community is invited to the first major international conference devoted specifically to Enceladus and the Icy Moons of Saturn. Through its array of instruments and global mapping opportunities, the Cassini mission has revolutionized our understanding of the Saturn system, and the surprisingly complex icy moons are no exception. The active jets of Enceladus are chief among the new discoveries. Others include color/thermal anomalies, equatorial ridges, satellite-derived rings, resurfacing and thermal relaxation, librations, and global fracture network surprises, to name just a few.

The conference will be open to all scientific aspects of Enceladus and its neighboring moons. Topics include (but are not limited to) geology, geophysics, geochemistry and mineralogy, active jets and their properties and origins, formation and evolution, astrobiology, and future investigations of these bodies. Comparative planetology is encouraged! A major focus will be the new results from the 2015 Cassini encounters with Enceladus and the other icy moons. Contributions from Cassini, Voyager, and groundbased studies are welcome, as are suggestions for additional topics.

The conference, in planning for almost two years, will feature invited speakers, contributed talks, and contributed posters; major reviews of key topics will also be presented. The conference will also lead to the production of a printed volume summarizing the findings of the conference, and encompassing the state of the art in our knowledge and wisdom concerning these amazing icy worlds.



# Enceladus and the Icy Moons of Saturn

July 26–29, 2016 • Boulder, Colorado

## Institutional Support

Universities Space Research Association (USRA)  
Lunar and Planetary Institute (LPI)

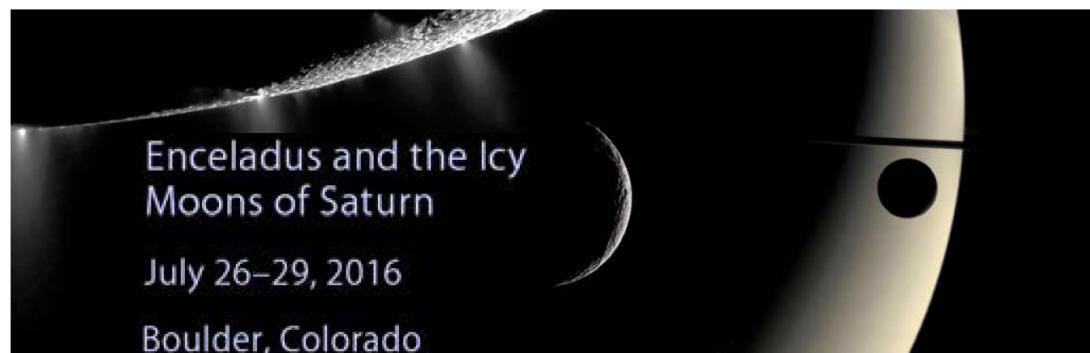
## Local Organizing Committee

Larry Esposito, *University of Colorado*  
Carly Howett, *Southwest Research Institute*  
Laura Bloom, *University of Colorado*

## Science Organizing Committee

Paul Schenk, *Lunar and Planetary Institute*  
Bonnie Buratti, *Jet Propulsion Laboratory*  
Roger Clark, *Planetary Science Institute*  
Tilman Denk, *Freie Universität Berlin*  
Athena Coustenis, *Observatoire de Meudon*  
Dale Cruikshank, *NASA Ames Research Center*  
Candice Hansen, *Planetary Science Institute*  
Matthew Hedman, *University of Idaho*  
Amanda Hendrix, *Planetary Science Institute*  
Carly Howett, *Southwest Research Institute*  
Simon Kattenhorn, *ConocoPhillips Petroleum*  
Sascha Kempf, *University of Colorado*  
Luciano Iess, *University of Rome*

William McKinnon, *Washington University*  
Jeffrey Moore, *NASA Ames Research Center*  
Francis Nimmo, *University of California at Santa Cruz*  
Robert Pappalardo, *Jet Propulsion Laboratory*  
Wesley Patterson, *Applied Physics Laboratory*  
Laurence Soderblom, *U.S. Geological Survey, Flagstaff*  
John Spencer, *Southwest Research Institute*  
Federico Tosi, *Istituto Nazionale di Astrofisica*  
Anne Verbiscer, *University of Virginia*  
J. Hunter Waite, *Southwest Research Institute*  
Robert West, *Jet Propulsion Laboratory*



To access the abstracts, use the hand tool of your Acrobat Reader to click on the name of any session.

After the full program listing for that session appears, click on the title of a presentation to view the abstract for that presentation.

### **Tuesday, July 26, 2016**

8:30 a.m.	Boulderado Ballroom	<a href="#">Origins and Evolution: Past and Future</a>
10:45 a.m.	Boulderado Ballroom	<a href="#">Interiors and Geophysics</a>
1:30 p.m.	Boulderado Ballroom	<a href="#">Geology and Tectonics 101</a>
3:40 p.m.	Boulderado Ballroom	<a href="#">Geology and Tectonics 102</a>

### **Wednesday, July 27, 2016**

9:00 a.m.	Boulderado Ballroom	<a href="#">Ages and Cratering</a>
10:20 a.m.	Boulderado Ballroom	<a href="#">Surface Composition and Properties</a>
1:30 p.m.	Boulderado Ballroom	<a href="#">Plumes 101: Plumbing and Dynamics</a>
4:45 p.m.	Boulderado Ballroom	<a href="#">Posters</a>

### **Thursday, July 28, 2016**

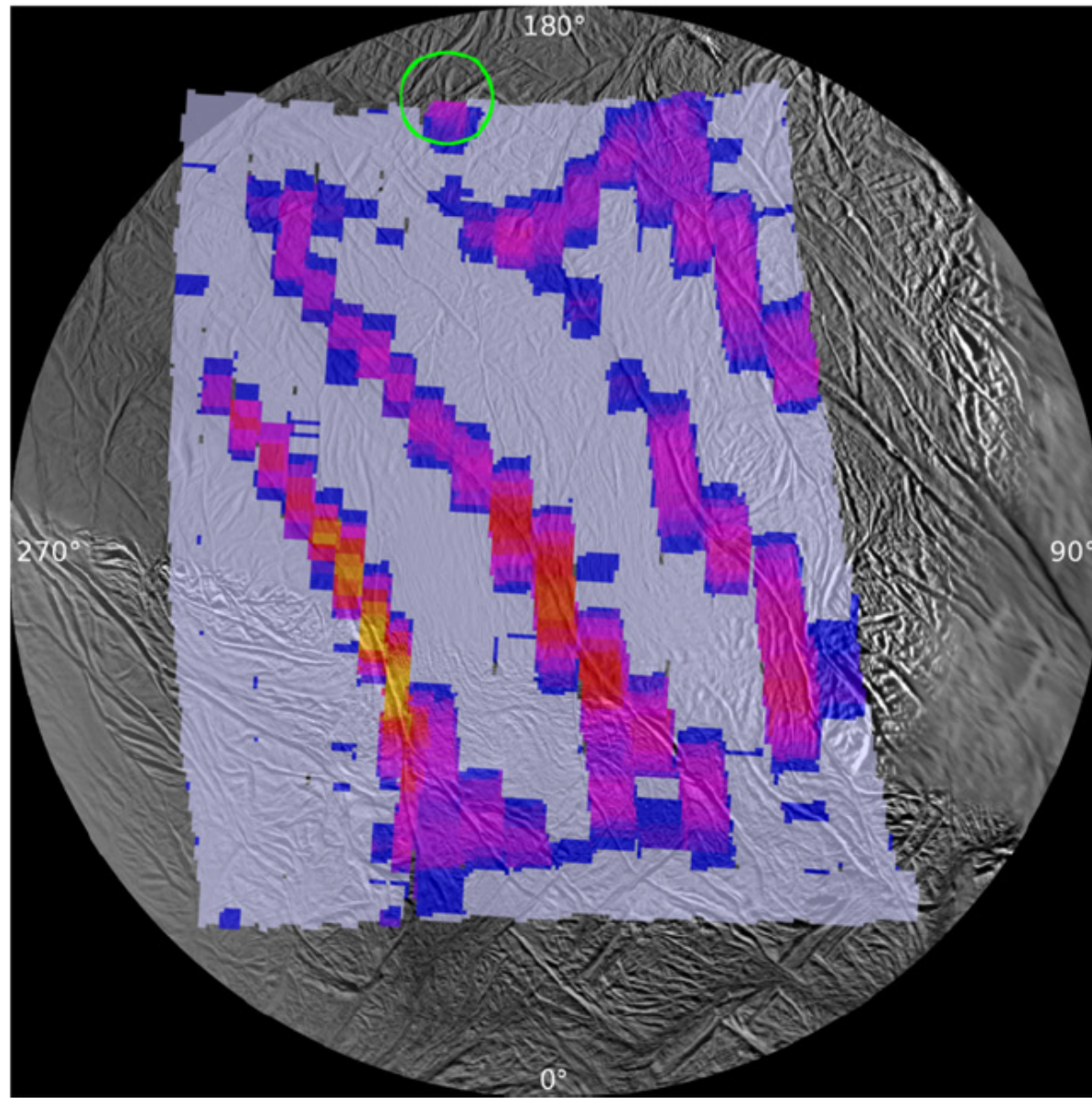
9:00 a.m.	Boulderado Ballroom	<a href="#">Plumes 102: Variability in Space and Time</a>
2:00 p.m.	Boulderado Ballroom	<a href="#">Interactions: Moon-Moon-Rings-Saturn</a>
4:35 p.m.	Boulderado Ballroom	<a href="#">Small Fry in the Saturn System</a>

### **Friday, July 29, 2016**

9:00 a.m.	Boulderado Ballroom	<a href="#">Astrobiology and the Future</a>
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# CIRS Heat Flow Map of the Enceladus SPT (Howett et al. 2011)



Spencer reported max temps of 200 K in tiger stripes (high resolution observations);

Plus high heat flows in between stripes (polar night observations)

**Friday, July 29, 2016**  
**ASTROBIOLOGY AND THE FUTURE**  
**9:00 a.m. Boulderado Ballroom**

**Chairs:**    **Christopher Glein**  
              **Amanda Stockton**

- 9:00 a.m.    McKay C. \*  
                  *Astrobiology of Enceladus*
- 9:20 a.m.    Duca Z.    Tan G.    Cantrell T.    Van Enige M.    Dorn M.    Cato M.    Putman P.    Kim J.  
                  Mathies R. A.    Stockton A. \*  
                  [Development of an Extraterrestrial Organic Analyzer \(EOA\) for Highly Sensitive Organic Detection on a Kinetic Penetrator](#) [#3087]  
                  We show the development of an EOA for future planetary impact penetrator missions. EOA can survive a 50,000 g impact, making it the only current optical instrument with this capability.
- 9:35 a.m.    Fujishima K. \*    Dziomba S.    Takahagi W.    Shibuya T.    Takano Y.    Guerrouache M.  
                  Carbonnier B.    Takai K.    Rothschild L.    Yano H.  
                  [A Fly-Through Mission Strategy Targeting Peptide as a Signature of Chemical Evolution and Possible Life in Enceladus Plumes](#) [#3085]  
                  We present a combination of two latest and unpublished experiments that enable us to realize in situ life signature detection and chemical evolution for deep habitats of the “Ocean World.”.
- 9:50 a.m.    Kowalski J. \*    Schüller K.    Zimmermann A.  
                  [Towards Simulation-Based Mission Support for Subsurface Exploration of the Icy Moons](#) [#3077]  
                  Advanced subsurface mission scenarios for the icy moons suggest to deploy a robotic probe. In our contribution, we will present an integrated computational model for a probe migrating through ice, as well as its ambient cryospheric state.
- 10:05 a.m.    Break
- 10:20 a.m.    Baader F. \*    Dachwald B.    Espe C.    Feldmann M.    Francke G.    Förstner R.  
                  [Testing of a Miniaturized Subsurface Icecraft for an Enceladus Lander Mission Under Enceladus-Like Conditions](#) [#3029]  
                  The German project “Enceladus Explorer - Environmental Experimental Testing” is conducting research to evaluate technology for an Enceladus lander mission. The concept of an advanced melting probe will be evaluated in simulated Enceladus environment.
- 10:35 a.m.    Dachwald B. \*    Kowalski J.    Baader F.    Espe C.    Feldmann M.    Francke G.    Plescher E.  
                  [Enceladus Explorer: Next Steps in the Development and Testing of a Steerable Subsurface Ice Probe for Autonomous Operation](#) [#3031]  
                  Within Enceladus Explorer, the technology for a lander is developed and tested. The steerable subsurface ice probe was used in 2013 in Antarctica to get a clean subglacial sample and is now redesigned for testing in a more Enceladus-like environment.
- 10:50 a.m.    Laine P. E. \*  
                  [Life on Icy Worlds? Emergence vs. Panspermia](#) [#3017]  
                  The icy moons present some of the promising examples of extended habitable locations in our solar system. How do they fit in to our knowledge about the origin of life? Where are the challenges for models for the origin life on the icy moons?
- 11:05 a.m.    ASTROBIOLOGY DISCUSSION
- 11:35 a.m.    ENCELADUS ROUND TABLE

# Enceladus Round Table/Debate

Chris McKay, NASA Ames, moderator

*Enceladus as an important target for astrobiology*

Chris Glein, SwRI San Antonio

*Possibility of a habitable but uninhabited body*

Alfonso Davila, SETI Institute

*Origin of life – second genesis – life not like Earth life*

Amanda Stockton, Georgia Tech

*Instrumental approaches for detecting life (as we know it)*

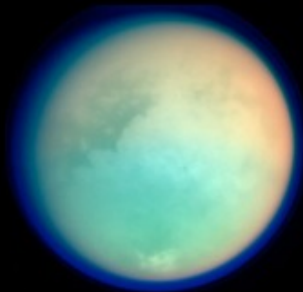
● Enceladus



Europa



Callisto



Titan

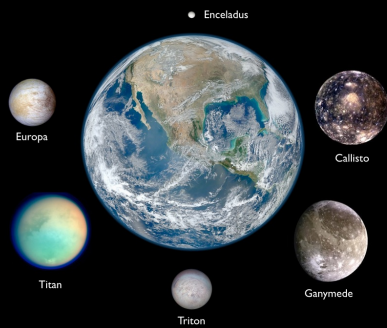


Triton



Ganymede

*Shown to scale*



Shown to scale

# Purpose and scope

Woods Hole Oceanographic Institute  
August 25-26, 2016

INSTITUTIONAL SUPPORT  
Woods Hole  
Oceanographic Institute,  
WHOI

Jet Propulsion Laboratory,  
California Institute of  
Technology, JPL-Caltech

National Aeronautics and  
Space Administration,  
NASA

CONVENERS  
Chris German (WHOI)  
Christophe Sotin (JPL)  
Jim Bellingham (WHOI),  
Kevin Hand (JPL)  
Gretchen McManamin  
Gregg Vane  
Bobby Braun,  
Jonathan Lunine  
.....

## MEETING LOCATION AND DATE

The second annual ocean worlds meeting will be held August 25-26, 2016, at take place at the Woods Hole Oceanographic Institute ...

## PURPOSE AND SCOPE

Foster cooperation between the oceanographic community and the planetary science community for the exploration of ocean worlds and test ideas and models for the emergence of life.

Ocean worlds are possibly the best place to search for extant (living) life and a second, independent origin. We are on the brink of revolutionizing biology. Comparative oceanography (Earth, Europa, Enceladus, Titan) will spark new discoveries and insights regardless of habitability

## MEETING FORMAT

The two-day meeting will consist of oral presentations invited from submitted abstracts, followed by an evening poster discussion session. Due to limitation of the venue (60-90 people), the organizing committee may have to establish a waiting list





# Scientific & Technical Motivation and Framework for Ocean Worlds

Exploration of Ocean Worlds is an interdisciplinary endeavor: biology, chemistry, physics, geology, oceanography, and planetary science. Each discipline has its own language and there is a need to understand each other's language.

Learn about

- the diversity of fluid/rock interaction settings on the terrestrial sea-floor
- the conditions that prevail at the ocean/rocky core interface on extraterrestrial ocean worlds

Investigate how what we know on Earth can apply to extraterrestrial ocean worlds

What technology already developed for terrestrial oceanography could apply to extraterrestrial exploration

What measurements and technology demonstration are needed



# Program

Key scientific aspects of Oceans on Earth

Key scientific aspects of Oceans beyond Earth

System-wide Approaches to Ocean Exploration on Earth

Ocean Worlds Technologies: Core components

Key technologies for Ocean Exploration beyond Earth







***Europa Ocean Conference, San Juan Capistrano, CA, 12-14 Nov 1996***

Ocean Worlds "0"



## OCEAN WORLDS 2: AGENDA

Thursday, August 25<sup>th</sup>, 2016

8:00 – 9:00	<b>Breakfast</b>
9:00 – 9:15	<b>Welcome &amp; Introductions</b> <i>Ellen Stofan (NASA)</i> <i>Mark Abbott (WHOI)</i>
9:15 – 9:30	<b>Scientific &amp; Technical Motivation and Framework for Ocean Worlds</b> <i>Christophe Sotin (JPL) &amp; Jim Bellingham (WHOI)</i>
9:30 – 9:45	<b>Goals for the Meeting and the Year Ahead</b> <i>Chris German (WHOI) &amp; Kevin Hand (JPL)</i>
9:45 – 10:00	Q&A Session
10:00 – 10:50	<b>Key scientific aspects of Oceans on Earth (1)</b> <i>(Chair: Chris German)</i> <i>3 talks (12 min + 4 min Q&amp;A = 48 min)</i> <ul style="list-style-type: none"><li>• Paul Falkowski Biogeochemical Evolution of a Life-Sustaining Planet</li><li>• Julie Huber Life in the Extreme: Seafloor Fluid Flow and Chemosynthesis</li><li>• Mark Skidmore Life in the Extreme: Microbiology at the Ice-Water Interface</li></ul>
10:50 – 11:10	Coffee break
11:10 – 12:00	<b>Key scientific aspects of Oceans beyond Earth (1)</b> <i>(Chair: Christophe Sotin)</i> <i>3 talks (12 min + 4 min Q&amp;A = 48 min)</i> <ul style="list-style-type: none"><li>• Carolyn Porco The Geysering World of Enceladus</li><li>• Bill McKinnon Geophysics of Ocean Worlds</li><li>• Krista Soderlund Ocean Circulation Beyond Earth</li></ul>
12:00 – 13:15	<b>Lunch</b>
13:15 – 14:20	<b>Ocean Worlds Technologies: Core components</b> <i>(Chair: Heidi Perry)</i> <i>4 talks (12 min + 4 min Q&amp;A = 64 min)</i> <ul style="list-style-type: none"><li>• Pete Girguis Sensors for Investigating the Oceans <i>In Situ</i></li><li>• Henrik Schmidt Acoustics for Interrogating the Oceans Remotely</li><li>• Dana Yoerger Robotics for Ocean Exploration</li><li>• Bob Pappalardo Mission to Europa</li></ul>



14:20 – 15:10	<b>Key Scientific Aspects of Oceans on Earth (2)</b> <i>(Chair: Julie Huber)</i> <i>3 talks (12 min + 4 min Q&amp;A = 48 min)</i>
• Everett Shock	Energetics to Drive Chemosynthesis
• Beth Orcutt	Life <i>Beneath</i> the Seafloor
• John Priscu	Subglacial Lake Investigations
15:00 – 15:10	Coffee Break
15:10 – 16:00	<b>Key Scientific Aspects of Oceans beyond Earth (2)</b> <i>(Chair: Sarah Horst)</i> <i>3 talks (12 min + 4 min Q&amp;A = 48 min)</i>
• Wes Patterson	Tectonics on Icy Moons
• Jason Goodman	Ocean Circulation Effects on Europa
• Chris Glein	Geochemical Modelling for Enceladus's ocean
16:00 – 17:00	<b>Day 1 Discussion</b>
17:00 – 17:15	<b>Break</b>
17:15 – 18:45	<b>Happy Hour &amp; Ocean Worlds “Karaoke”</b> 1 slide per person, 60 seconds to present.
19:00	<b>Conference Dinner</b>

**Friday August 26<sup>th</sup>, 2016**

8:00 – 9:00	<b>Breakfast</b>
9:00 – 9:10	Day 1 Comments/Recap: Chris German & Kevin Hand
9:10 – 10:30	<b>System-wide Approaches to Ocean Exploration on Earth</b> (Chair: Kevin Hand) 4 talks (15 min + 5 min Q&A = 80 min) <ul style="list-style-type: none"><li>• Chris German Nested Exploration Strategies for Seafloor Fluid-Flow</li><li>• Jim Bellingham Coordinated Use of Multi-Platform Systems</li><li>• Heidi Perry Latest Updates on Unmanned Underwater Systems</li><li>• John Delaney Ocean Observatories &amp; exploring Ocean Worlds</li></ul>
10:30 – 10:40	<b>Break</b>
10:40 – 12:00	<b>Key technologies for Ocean Exploration beyond Earth</b> (Chair: Gregg Vane) 4 talks (15 min + 5 min Q&A = 80 min) <ul style="list-style-type: none"><li>• Tom Cwik What Constrains Payload/Power/Accessing Ocean Worlds?</li><li>• Ralph Lorenz Sensor Suites for Ocean World Exploration: Huygens</li><li>• Kevin Hand Planetary Sampling</li><li>• Bill Stone Accessing Oceans Beneath Ice</li></ul>
12:00 – 13:15	<b>Lunch</b>
13:15 – 14:00	<b>Discussion/Synthesis</b> (Chair: Jonathan Lunine)
14:00 - 15:30	<b>Choice of Tours at WHOI</b>

*Option 1: Ocean Observatories & Telepresence*

*Option 2: Ocean Robotics Laboratories & Research Docks*

# The Ocean Worlds

_____	Gravity	Induced $\vec{B}$ $\vec{E}$		Libration	Obliquity	Geology	Plumes
Europa	✓	✓			TBD	Active	?
Ganymede	✓	✓			TBD	Dormant	
Callisto	✓	✓				Dead	
Titan	✓		✓			“not dead yet”	
Enceladus	✓			✓		Hyperactive	✓✓
Triton						Active	✓



# Prelim Findings - Technology

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- What technologies for what scale
  - Time, space & mass?
- Instrumentation
  - Which tools are cross purpose?
  - What are the science drivers? E.g., GCMS
- How useful has remote sensing been for Ocean Exploration?
  - What if the oceans were transparent?
  - Radio wavelengths: Titan's sea are transparent – seafloor maps can be acquired from orbit or airborne platform
- Clipper payload – earth ocean community thoughts on selected payload. Making the most of the datasets that we will generating.
- Experiments that can be done in the lab will be better informed once this community better understand the payload.
- Getting people less involved in the PS community into the field



# Prelim Findings - Technology

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- Lander goals – input from this community would be useful.
- Lander: productivity, what's the right trade in autonomy versus GITL so as to optimize sample selection. Seismometry
- Replace specialized sensors with additional computation – is that a way to optimized limited resources? Event detection.
- What are the technology taboos? E.g., nuclear systems. Reintroduce these kinds of ideas/technology.
- EO: Limitations on imaging – data rates; storing and then forwarding
- Analog research has intrinsic 'offsets' whereas vents may well be more 'authentic' than what we are used to.
- Boots (wheels) on the ground experience has benefited the Mars community greatly.
- Antarctica is low hanging fruit and moving too slowly – collaborative effort across agencies could be helpful.
- Remote, electro-optically linked, natural laboratory centered on an active mid-ocean ridge volcanic center, could be a powerful test-bed for developing robust, exportable undersea AI-based sensor-robotic platforms designed (and tested) for exploration of thermally active sea floor systems on other ocean worlds.



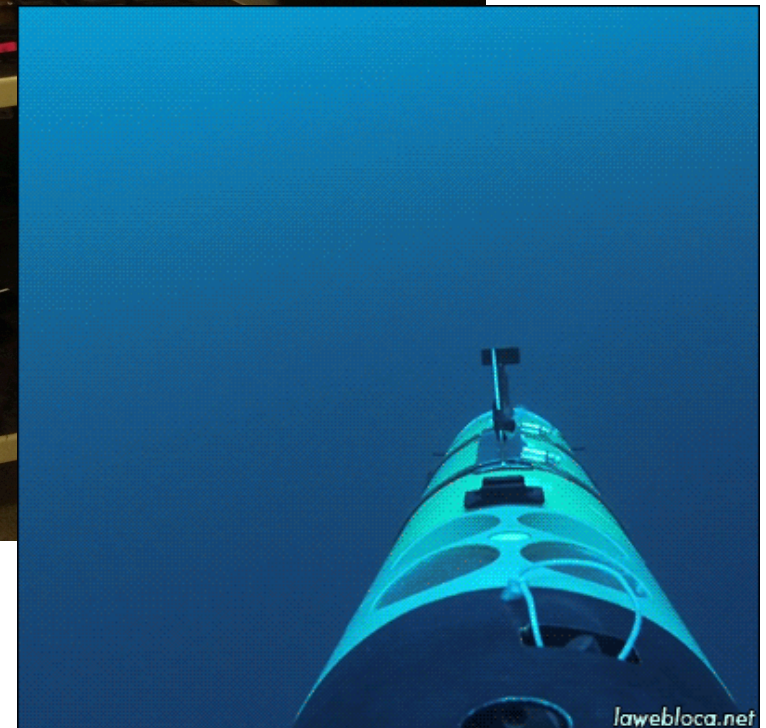


Remote Environmental  
Monitoring Units (REMUS)

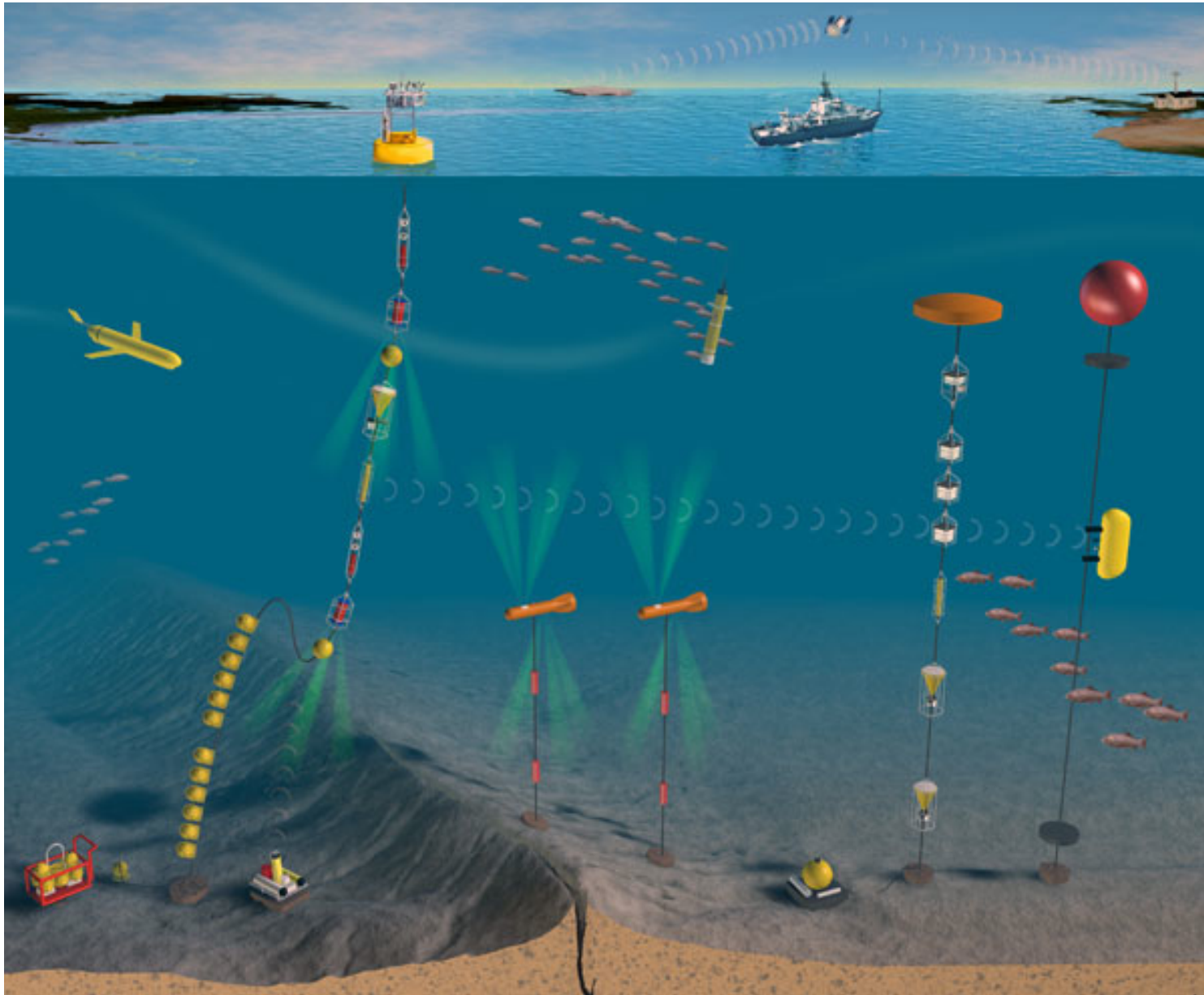




Remote Environmental  
Monitoring Units (REMUS)







Ocean Observatory Initiative: Instrument arrays that combine surface and sub-surface bouys, moorings, gliders, drifters, and shipboard measurements that can monitor many complementary ocean processes



# Prelim Findings - Science

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- Habitability & Chemical Disequilibrium vs Chemical Equilibrium and Biosignatures: What is the energetic biosignature of an inhabited system. Has it been 'Shocked' (in the Everett sense)?
  - New vents, new chemistries: Abiotic organics versus biological materials, e.g., Lost City, FT synthesis
  - Abiotic methane is a key link between ocean worlds
  - Mineral evolution and diversity; higher mineral diversity on earth is linked to life; Roughly half of earth's minerals
- Ocean modeling/circulation – what experiments are needed to advance the models?
- Humans use the same sensors for navigation/autonomy as we do for 'science'; i.e., exploration payload = science payload.
- Advances in Earth ocean capabilities are making the idea of getting into Europa's ocean seem more feasible than even just 10 years ago.
- Methane and molecular hydrogen are cross 'signatures'
- Do we debate or think that biochemistry is the same across our solar system?





# Big Picture

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- Two relatively unconnected fields in the late 1990's — Deep Sea Research on Earth and Outer Solar System Exploration — now have increasingly common ground (...seas)
- General excitement of the Ocean Worlds Meeting at WHOI was evident to all who attended. Organizers deserve much credit for putting together a stimulating ensemble of proponents for the long-term study of oceans in our solar system. It is a tremendously exciting field that has the potential to galvanize many young people across the world, with bold, long-range visions that will outlive all of us.
- A 3<sup>rd</sup> Ocean Worlds Meeting could occur next year. A possible focus could be the synergy between technologies and methodologies for exploring the Earth's ocean and the extraterrestrial oceans.



<https://vimeo.com/177182335>