What is the Europa Deep Dive?

A series of workshops focused on Europa, which aims to:

• Create a unique platform to enable and encourage focused community discussion on specific aspects of Europa’s geology, ocean, interior, ice shell, composition, space environment, and astrobiological potential;

• Enable better understanding of existing spacecraft, ground-based telescopic, laboratory, theoretical, and modeling data;

• Highlight areas that would benefit from increased investment through, e.g., data analysis, laboratory, and technology development programs;

• Provide information for currently planned and potential future spacecraft missions to the Jovian system
Deep-Dive 1 objective:
Discussion-centered workshop centered around exchange processes within Europa’s ice shell, including (but not limited to) tectonism, diapirism, subduction, and impact processes, and their relation to the boundary layers above and below.

- How does material move through the shell?
- Is surface-ocean exchange likely, or is it difficult?
- What timescales are involved in these processes?
- What processes might operate across different shell thicknesses?

*Instrument/measurement technique abstracts were print only*
Agenda

Wednesday, November 1, 2017
8:30 a.m. Welcome and Introductory Talks
10:00 a.m. From Top to Bottom: Processes in Europa’s Ice Shell
11:45 a.m. Poster Lightning Talks
12:45 p.m. Poster Session
2:00 p.m. Breakout Session (2 groups)
   Sessions 1A and 1B: How are Energy and Material Incorporated into the Ice Shell?
3:45 p.m. Breakout Session (2 groups)
   Sessions 2A and 2B: What is the Surface Expression of Interior Exchange Processes?
5:15 p.m. Plenary
5:30 p.m. Networking Event

Thursday, November 2, 2017
8:30 a.m. Breakout 1 and 2 Recap
10:15 a.m. Breakout Session (3 groups)
   Sessions 3A, 3B, and 3C: What is the Age of the Ice at Europa’s Surface?
11:30 a.m. Breakout 3 Recap
1:00 p.m. Synthesis
Attendees

• 50 people attended the workshop

• Attendees included professional scientists at all career stages, postdocs, graduate students, and one artist/writer (Michael Carroll)

• Devon Burr and Josh Emery brought their entire Europa class
Oral presentations were a mixture of invited, submitted, and poster lightning talks.
The seven breakout sessions (2x2 + 1x3 groups) were each moderated by a different community member, who then reported back in a plenary session.
A formal poster session was held, plus an informal networking session in the poster area.
Plenary sessions were held for reporting out from the breakout sessions, as well as synthesis presentations toward the end of the workshop.
Outstanding Europa ice shell questions identified at the workshop
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Outstanding issues/questions

Ice Shell Structure (thermal and mechanical)
- Boundary between brittle/elastic cold ice layer (lithosphere) and viscous warm ice layer (asthenosphere) varies with time scale of deformation
- We might have a homogenous ice shell, but the thickness of the upper layer may not be homogeneous
- Mechanical (viscosity, Ra, Strength) and thermal properties and dependence on chemistry

Fluids in the ice shell
- Direct connection to ocean vs. no connection at all (“wet” vs. “dry” shell)
- Are surface features related to direct association with the ocean?
- Is there a sweet spot depth for fluids in the ice shell?
- Do surface materials have an ocean affinity signature (spectral)? (See next Deep Dive workshop!)
- Is there fracture connection to the ocean or not?

Heat Transport
- What is the nature of the heat transfer in the ice shell, is it a plume? Convection? Conduction?
- What are the rates of transport?
- Is transport vertical or lateral?

Surface Age and Recycling
- Crater based ages vs. actual ages of ice at surface
- Ability of surface processes to remove craters and reset derived age
- Wholesale recycling of outer cold ice later (plate tectonics/subduction) or very ancient ice?
Feedback on the workshop

• All participants rated the scientific content as excellent or very good

• The dialog and discussion were felt to be the most valuable aspects of the workshop

• Suggest changes for the next workshop
  • Longer meeting
  • Longer breaks for more discussion/networking
  • More overview talks
  • More time for questions/discussion
  • Develop breakout topics in real time ("choose your own adventure")
  • Glossary of agreed-upon terms

Grateful thanks to Curt Niebur/NASA for sponsorship of travel funds
Next Deep Dives

• Deep Dive 2: Composition of Europa
  • SOC: Gudipathi, Soderblom, others TBC
  • To be held in October, 2018, location TBD

• Deep Dive 3: Astrobiology of Europa
  • SOC: Cooper, Hand, others TBD
  • To be held in Barrow, Alaska, April 2019