Ocean Drilling Legacy Asset Projects (LEAPs): A New Approach to Collaborative Research in Ocean Drilling Science

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Ocean Drilling Legacy Asset Projects (LEAPs)

- **What are LEAPs?** A new opportunity for a portfolio of stand-alone research endeavors without new drilling
  - each LEAP larger than conventional single or multi-investigator project
    - with objectives that maximize the scientific return on legacy assets of scientific ocean drilling while addressing at least one aspect of the 2050 Science Framework
    - developed based on Enduring Principles of scientific ocean drilling (2050 Science Framework)
      - bottom-up proposal submissions and peer review
      - open access to samples and data
      - collaborative and inclusive international approaches
      - enhancing diversity
    - open to participation by the community
    - with outcomes that strengthen the impact of ocean drilling science writ large
  - mirroring, as closely as possible, the collaborative and focused nature of shipboard experience (research, collaboration, mentoring, and professional development)

Ocean Drilling Legacy Asset Projects (LEAPs)

- **Foundation** for the LEAPs concept
  - community interest and informal to semi-formal discussions during the past 5+ years
  - aka “Virtual Expeditions”
  - “Fourth Platform” concept in US NEXT report (2019)
  - “Big Data Analytics” Enabling Element in 2050 Science Framework
  - JOIDES Resolution Facility Board action item (2022) to explore this concept and associated implementation issues

Ocean Drilling Legacy Asset Projects (LEAPs)

What assets are available?

- Core: ~150 km of core from all drilling programs in each of 3 repositories (Gulf Coast, Bremen, Kochi)
    - But material appropriate for highest priority science is much less than ~450 km
- Microbiology samples: ~1300 samples; frozen, which affects their usability
- Data: average ~1,000,000 measurements per IODP expedition + ~700 core images & ~700 x-ray images per km of core. Downhole logging data in addition to this
- Open/instrumented boreholes -- ~90 with reentry cones. ~50 with observatories, but very few monitored real-time.

JRFB Working Group on Legacy Asset Projects (LEAPs)

- Agreement that definition should be broad and inclusive
- Recommend calling these activities Ocean Drilling Legacy Asset Projects (**LEAPs**), since "virtual expedition" has been used by different people to mean different things
- LEAPs do not preclude conventional single PI or multi-PI projects
- Review & endorsement of LEAPs by body to-be-determined. Perhaps collaboration of program(s) with active drilling platforms & partners supporting work on legacy materials?
- Review & endorsement of a LEAP does not take the place of review by a funding entity, unless the funding entity chooses to do so

JRFB Working Group on Legacy Asset Projects (LEAPs)

- WG recommends that a LEAP should
  - be a standalone research activity that addresses at least one component of 2050 SF;
  - have objectives that maximize the return on the legacy assets of past scientific ocean drilling programs (i.e., cores, samples, data, open drillholes, downhole observatories) without new drilling;
  - be of duration, level of focus, and approaches appropriate for addressing the objective(s), as described in a Project Management Plan;
  - provide an opportunity for members of the broader community to participate, thereby promoting a diverse international and interdisciplinary science party (without recommending a prescribed approach to be used by all LEAPs)
  - be formally reviewed and endorsed, with ongoing communication with the endorsing body during implementation
  - be implemented in a way that reflects the community-driven approach of the scientific ocean drilling programs so that LEAPs and their outcomes fit inclusively within that overall structure and history (e.g., Report as described in Project Management Plan)

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Why LEAP?

- opportunity for focused multidisciplinary integration across legacy assets (e.g., multiple expeditions or multiple boreholes)
    - What might a LEAP look like?
        - Synthesis of results + new data across a region (e.g., deepwater circulation history of the Atlantic for the past 40 million years)
        - Synthesis of results + new data focused on a short interval of time (e.g., the global climate system during warm intervals of the Pliocene (cf. USGS PRISM & PlioMIP projects))
- encourage open involvement and participation from the community, leading to diverse science parties
- opportunity to mentor early career scientists
- programmatic endorsement may open some funding sources and other resources (e.g., supercomputer time)
- enhanced visibility of project outcomes in programmatic publication collection
- enhanced integration of project and its outcomes into the overall structure and contributions of scientific ocean drilling

Ocean Drilling Legacy Asset Projects (LEAPs)

Next Steps

- working toward piloting this process with the existing IODP Science Evaluation Panel. LEAP proposal guidelines presently being developed, with eye on 1 November 2023 submission deadline for January 2024 SEP review.
- LEAP process will be reviewed/revised on basis of this pilot run.
- Japan is piloting their ReCORD program, which is proscriptive in approach but might qualify as LEAPs if they choose to propose them. This year's pilot project is a regional synthesis with additional data from cores and samples.

To Move Forward in the U.S.

- coordinate with others on LEAP evaluation panel beyond September 2024 (perhaps US involvement managed through a USSSP-type office, with overall panel and proposals managed through a Science Support-type office)
- My opinion -- incentivize US participants with funds available through OCE-Ocean Drilling, committed to supporting LEAPs via standard NSF review and award process

Ocean Drilling Legacy Asset Projects (LEAPs)

A reality check on what assets are available

- Core: ~150 km of core from all drilling programs in each of 3 repositories (Gulf Coast, Bremen, Kochi)
  - ≥ 90% are sediments/sedimentary rocks; ≤10% are igneous/metamorphic rocks
  - Difficult rock types and difficult operational areas significantly underrepresented
- Microbiology samples: ~1300 frozen samples from 23 legs/expeditions
- Data: average ~1,000,000 measurements per IODP expedition + ~700 core images & ~700 x-ray images per km of core. Downhole logging data in addition to this
- Open/instrumented boreholes -- ~90 with reentry cones. ~50 with observatories, but very few monitored real-time.

Can the science done with these assets match the science done with new material and data?

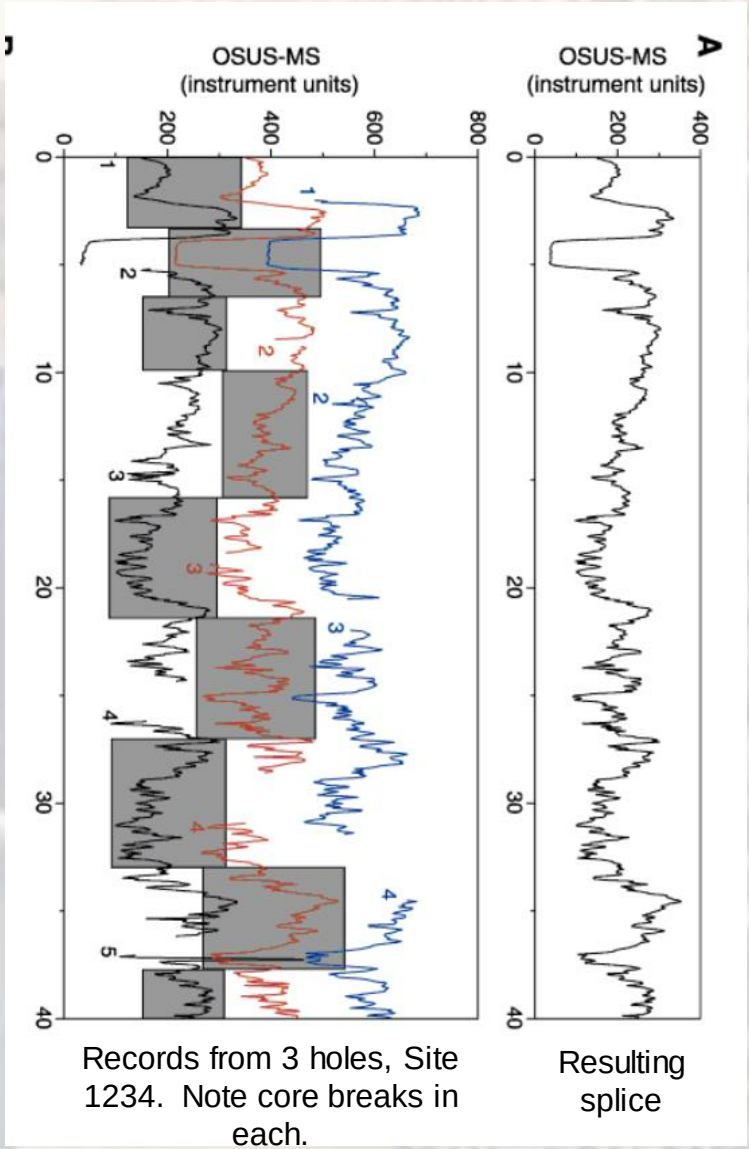
No.

Ocean Drilling Legacy Asset Projects (LEAPs)

A few comments about cores as legacy assets:

- For high-resolution paleoceanographic studies, a “splice” must be constructed to give a continuous record. Uses at least 2 full penetrations of the interval of interest, with proper offsets in core depths between holes.
- If heavy sampling is anticipated, enough holes drilled at a site to construct multiple splices.
  - => For high resolution studies, prime material is ≤ half of total recovery.

Material outside the splice can be used for other types of studies.



Records from 3 holes, Site 1234. Note core breaks in each.

Resulting splice

Ocean Drilling Legacy Asset Projects (LEAPs)

A few comments about cores as legacy assets:

- Some sediment intervals of high scientific value are very thin, but deeper than accessible even by long piston corers.
  - e.g., Paleocene-Eocene Thermal Maximum (very high CO_2 world)
  - Much core recovered, but interval of primary interest is a small portion of that
- Recovery of igneous and metamorphic rocks and other challenging rock types (e.g., in fault zones) generally low, so very limited material to sample, especially from intervals of high scientific value.
- During International phase, > 1M samples have been taken. $\geq$ 30% of those have been taken from 15 sites
- Essential takeaway point – cores are finite resources. Intervals of high scientific and societal interest (responses to high CO_2 world, ocean acidification, biodiversity stressors and natural experiments in changing productivity/oxygenation/nutrient supply, natural experiments of CO_2 storage, fault zones, etc.) are a small portion of the total core holdings or have been poorly recovered in existing cores.

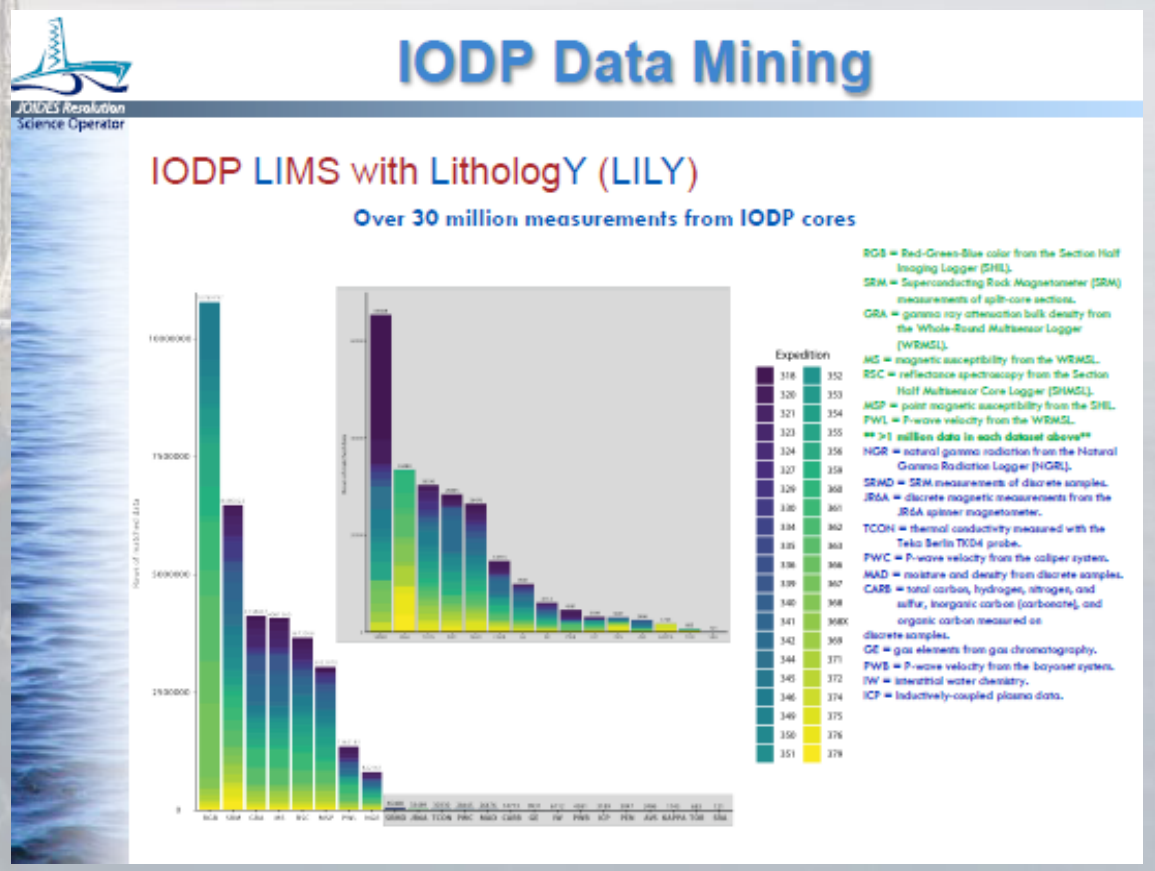
~40 cm interval of PETM at Site 1215, Leg 199, 1000 km NE of Hawaii. Interval is ~55 m into the seafloor

Ocean Drilling Legacy Asset Projects (LEAPs)

- **Microbiology samples**: ~1300 frozen samples from 23 legs/expeditions
  - suitable for gene surveys and possible metagenomics. What microbes are present?
  - not suitable for addressing what the microbes are doing, or at what rates, so can't contribute to understanding global elemental cycles

Ocean Drilling Legacy Asset Projects (LEAPs)

- **Data** -- some data mining projects already underway (e.g., Li et al., 2023, Neogene burial of organic carbon in the global ocean, Nature 613, 90-95).
- Another example -- links between lithology and measured properties (Childress et al., 2023, AGU abstract submitted)
- Issues with data quality, calibrations, consistency, etc., especially when combining across programs or with qualitative/semiquantitative data



Ocean Drilling Legacy Asset Projects (LEAPs)

Closing Thoughts

- LEAPs are a new and flexible mechanism for large multidisciplinary community-driven research efforts that maximize the return on legacy assets of past scientific ocean drilling and strengthen the scientific and societal impacts of ocean drilling-based research.
- Although promising on several levels, the science that can be done with LEAPs is not a replacement for the science that can be done with new materials and data
- Challenges to successfully implementing the LEAPs concept in the U.S. include
  - the nature and composition of the LEAPs evaluation panel (perhaps US involvement managed through a USSSP-type office?)
  - funding – perhaps incentivize US participants with funds available through OCE-Ocean Drilling, committed to supporting LEAPs via standard NSF review and award process
  - nature of the legacy assets available

JRFB Working Group on Legacy Asset Projects (LEAPs; originally "Virtual Expeditions")

- **Motivation -** Build on prior discussions within the community, to develop and embed more formal process and outcomes within future structure of ocean drilling

- **JRFB WG on Virtual Expeditions Statement of Task**
  - To define the minimum requirements for a research effort to be considered a virtual expedition (now LEAP)
  - To develop recommendations for procedures related to the evaluation, endorsement, and scientific outcomes/scientific legacy of a virtual expedition (now LEAP)

- **Members**
  - Larry Krissek (Chair), Daniel Babin (LDEO), Amelia Shevenell (USF), Laurel Childress (JRSO), Hugh Daigle (UT), Susan Humphris (WHOI)
  - Ex officio – Beth Christensen (Rowan), Gail Christeson (NSF), Sarah Kachovich (ANZIC), Charna Meth (SSO), Angela Slagle (USSSP), Junichiro Kuroda (Japan), Angelo Camerlenghi (ECORD), Yangyang Li (China), Dhananjai Pandey (India)

JRFB Working Group on Legacy Asset Projects (LEAPs; originally "Virtual Expeditions")

- **Process –** met ~every 2 weeks September 2022 – April 2023. First ~4 meetings spent learning about applicable activities underway or planned across the IODP partners

- **Report** – has been finalized and distributed to the JRFB. It is posted at iodp.org

- **Initial Response** – broadly positive. "LEAPs" term now being used in the U.S. and by our international partners. Discussions about implementation are taking place.