

**MagellanPlus workshop: Investigating the Oceanic Life Cycle of
Tectonic Plates with Mission-Specific Drilling
University of Plymouth + Online**

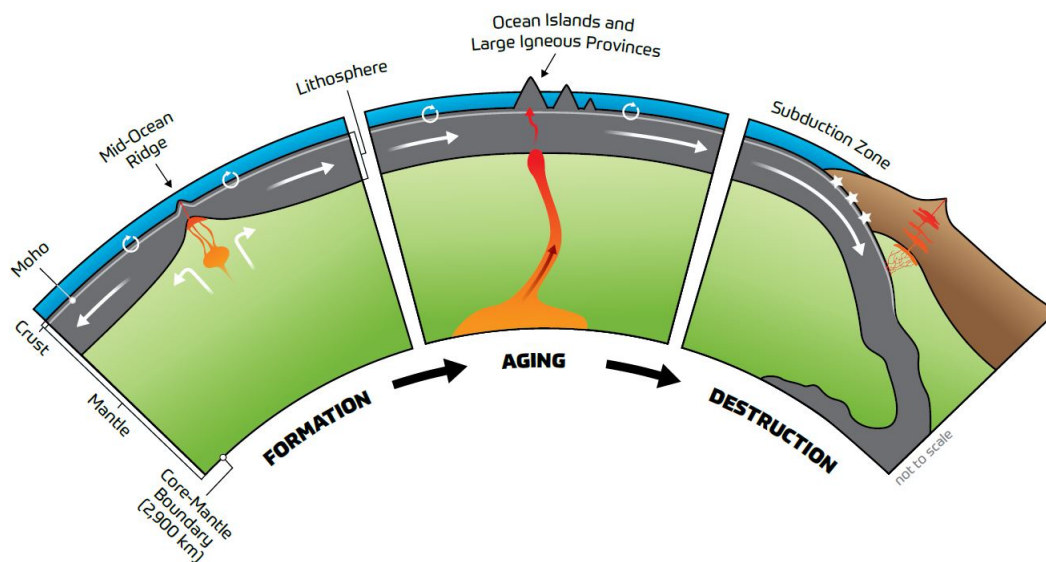


Figure 1: Overview of the oceanic life cycle of tectonic plates. Source 2050 Science Framework

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As we look to the future of IODP and the delivery of the 2050 Science Framework, we were tasked with developing a MagellanPlus workshop to explore how Strategic Objective 2 ‘The Oceanic Life Cycle of Tectonic Plates’ could be addressed with Mission Specific Drilling (MSP). The workshop comprised two parts, an online information event, followed seven weeks later by a two-day, hybrid in person/online workshop. Originally planned to take place in Vienna prior to EGU, the two-day event was moved to the University of Plymouth when EGU moved dates.

Online Information Event 11th February 2022 – highlights

The purpose of the information event was to help the community better understand the potential of Mission Specific Drilling, and to start the discussions on how MSPs could help us deliver on Strategic Objective 2 science. This builds on ECORD Headline #18 that emphasises the intention of ECORD to further develop the MSP concept with the use of a broader range of drilling and coring technologies.

51 participants attended this meeting, with scientists from ECORD countries and beyond and from a wide range of career stages.

The event began with an introduction to MSPs by David McInroy from BGS. David highlighted past examples of MSPs, both in terms of drilling techniques and the types of vessels used, and also introduced the current range of drilling technologies that could be used for future MSPs. There were two key messages from David: first, that as a community, we should focus on the science questions we want to answer; and second, that MSPs are incredibly flexible by design and that we are not necessarily bound to the technologies and approaches that have been used so far.

Next up we heard from the two previous IODP MSP expeditions that sampled 'hard rocks':

- IODP Expedition 357 Atlantis Massif Serpentinisation and Life, by Gretchen Fruh-Green. This was the first IODP Expedition to use seabed rock drills (the BGS RD2 and Marum MeBO). Although penetration was lower than expected, these drills did manage to successfully core and recover some very fragile and highly heterogeneous lithologies.
- IODP Expedition 364 Chicxulub: Drilling the K-Pg Impact Crater, by Joanna Morgan. This expedition was able to use a typical mining style diamond drill rig off of a fixed platform. This expedition has the exceptional core recovery that comes with diamond coring.

Both of these expeditions demonstrated that we don't need riser-drilling with the JOIDES Resolution to get good 'hard rock', and, along with the presentation from David, certainly gave us all food for thought for the next workshop.

Two-day workshop 4th-5th April (University of Plymouth and online) – highlights

The aim of this main part of the workshop was to stimulate discussions for new MSP-focused IODP projects that would address Strategic Objective 2. In total, we had 41 participants, with 20 attending the workshop in person (Figure 2). All parts of the workshop were offered in hybrid format, and we thank the University of Plymouth Events team for supporting this workshop and especially for establishing an effective hybrid setup. Prior to the workshop, we asked each participant which parts of the life cycle of an oceanic plate they were interested in (Figure 3), and it is clear that there is interest throughout the life cycle and each area has strong community interest.

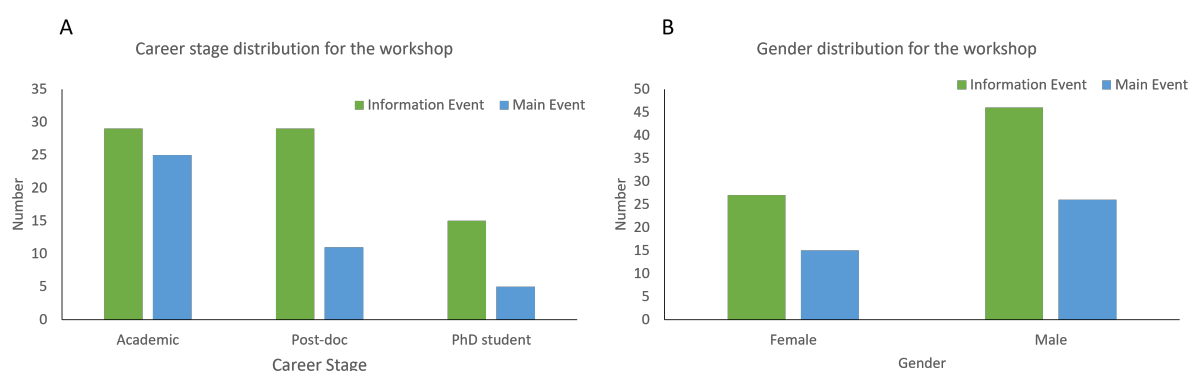


Figure 2: Distribution of the workshop participants for each part of the workshop for (A) career stage and (B) gender.

EXAMINING THE PLATE TECTONIC LIFE CYCLE

CONTINENTAL BREAKUP AND NEW OCEAN BASINS

THE GENESIS OF OCEANIC CRUST

OCEANIC CRUST MATURATION

SERPENTINIZATION PROCESSES

HOTSPOT VOLCANISM AND LARGE IGNEOUS PROVINCES

PLATE DESTRUCTION IN SUBDUCTION ZONES

SUBDUCTION INITIATION

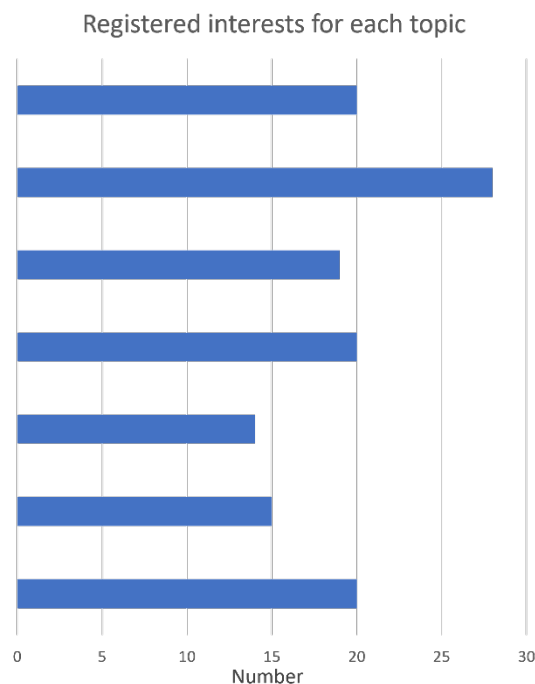


Figure 3: Interests in strategic objective 2 by theme registered by all workshop participants.

Day 1 focused on delving more into the science questions and future opportunities within Strategic Objective 2, and we had 5 keynote talks that covered the life cycle of a tectonic plate. These talks also brought into focus some of the unifying themes that cover the life cycle of tectonic plate. Our keynotes covered:

- Back-arc systems (*Yasuhiko Ohara*)
- Ocean–continent transition and rift systems (*Gianreto Manatschal*)
- Oceanic lithosphere (*Damon Teagle*)
- Ocean islands (*William Sager*)
- Arc volcanic systems (*Maryjo Brounce*)

We also had a live link up with ProjectULTRA from Chris MacLeod, who was at sea in the mid-Atlantic and using seabed rock drills to sample massive sulphide deposits. A recurring point throughout the talks and follow up discussions was the need for better recovery of hard rock samples: for too long has our science been biased by poor recovery using rotary coring.

Following the keynote talks, the floor was open for anyone to share targets or questions that they wanted to explore with drilling by a potential MSP. These discussions continued into the start of day 2, and following these discussions, the group divided into 3 breakout groups:

- Group 1: Drilling zero age basalt
- Group 2: Mantle processes in the context of continental break-up and subduction initiation
- Group 3: Mantle processes in the context of mid-ocean ridges

Each breakout group discussed the science questions in these settings and started to come up with ideas for where they might be addressed with future MSP drilling. Each group then presented back to the whole group. Some highlights of each group:

Group 1: Drilling zero age basalt

- The general theme of this group centred around the early evolution of key properties of the ocean crust, these include the establishment of physical properties such as seismic structure and seafloor magnetics, and the development of hydrothermal systems that rapidly modify the composition of the ocean crust. To date, scientific ocean drilling has sampled older ocean crust where these early processes are overprinted by the aging of the seafloor, drilling very young seafloor would enable us to really understand the complexity of processes happening at mid-ocean ridges.
- Recognising this has been attempted in the past, there is a need to explore the technical options for drilling very young (unsedimented) igneous basement. With a range of commercial drilling options now available, in collaboration with ESO, testing these systems will be explored as a precursor to future zero-age drilling proposals. Several future targets for zero-age drilling were identified.

Group 2: Mantle processes in the context of continental break-up and subduction initiation

- The general theme of this group was what happens to the mantle and what is the role of serpentinization at ocean-continent transitions both at the start and end of the plate tectonic cycle. A range of themes were discussed, fluid-rock interaction, melt-rock interaction, mantle heterogeneity and rheology, deformation and strain localisation to name a few.
- The group framed their discussions around the contrasting styles at play in the Atlantic and Pacific oceans and identified the need for both systems to be studied and sampled in order to really understand the role of serpentinites in Earth system processes.

Group 3: Mantle processes in the context of ridges

- The general theme of this group was what happens to the mantle and the role of serpentinization at mid-ocean ridges. The group developed four main topics to explore further: (1) the role of serpentinisation in transform faults; (2) understanding the scale and magnitude of mantle heterogeneity; (3) understanding the Moho transition zone and the lower oceanic crust; and (4) fluid flow and mineralisation.
- A range of potential targets were identified and sampling serpentinised mantle in a range of places will help address this broad range of processes that are fundamental to understanding the plate tectonic cycle and the interactions between the geosphere, hydrosphere and biosphere.

Overall the workshop was very informative and productive, and it was great to have dedicated time to discuss new science with both old and new faces. The community is in a strong position to go forward with the development of new IODP proposals that address strategic objective 2 using mission specific platforms. Watch this space for follow up workshops and exciting science!

The organising committee gratefully acknowledge the financial support provided by the MagellanPlus Workshop Series Programme that supported 18 participants to attend in person. We would also like to thank all our speakers across the entire workshop and all our participants for an excellent workshop.



Figure 4: Workshop participants at the end of a long two days of science discussions. Photo Credit: Katie Rhodes, University of Plymouth.