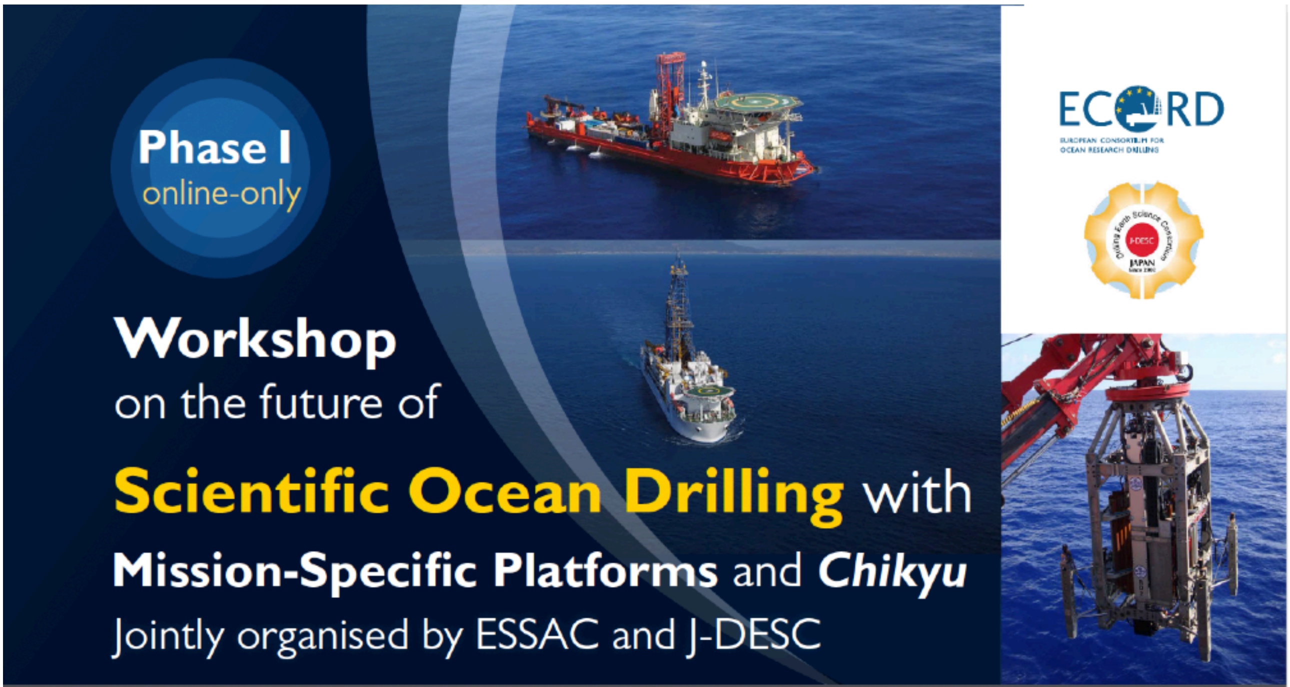

Day-2. 2023/1/19		
09:30 – 09:35	**Plenary: Introduction**	**Co-chairs**
09:35–10:00	**Plenary: Operational options for offshore drilling**	**Dave McInroy**, ESO Science Manager, British Geological Survey, Edinburgh **Nobu Eguchi**, Director, Science Services Department Institute (MarE3), Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Japan
10:00–11:30	**BREAK OUT SESSIONS**	
	Climate Change and Ocean Health	Co-Coveners **Helen Coxall**, Stockholm University **Junichiro Kuroda**, The University of Tokyo
	Deep Earth	Co-Coveners **Esther Schwarzenbach**, University of Fribourg **Tomo Morishita**, Kanazawa University
	Geohazards	Co-Coveners **Becky Bell**, Imperial College London **Kohtaro Ujiie**, University of Tsukuba
	Deep Life	Co-Coveners **Vanni Aloisi**, Institut du Physique du Globe de Paris IPGP **Yuki Morono**, Japan Agency for Marine-Earth Science and Technology (JAMSTEC)
11:30–12:00	**Plenary: Outcome from each Thematic Group**	Co-conveners of each break out session
12:00-12:30	**Plenary session: Synergy for the successful proposals/program**	Co-chairs

Abstract Title

Probing Deep Earth from the Oceanic Plate

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Active backarc basins are unique tectonic features which divide the margin of continents, generate complex subduction geometries, and host a large number of hydrothermal systems that harbour unique mineralization and diverse biological communities. The mechanisms controlling the initiation and evolution of backarc basins has been a long-standing question in global tectonics. The Wilson cycle, which describes the life cycle of a plate, does not cover the backarc basin, which occupies about 5% of the Earth's surface. Therefore, the backarc basin is one of the keys to understanding plate tectonics. The Okinawa Trough is a ~1500-km long continental rift in the East China Sea parallel to and behind the Ryukyu Arc. The Okinawa Trough, together with Bransfield Strait which is in a challenging Antarctic environment and therefore we do not think it is prospective target for a scientific drilling, is the only active and accessible continental backarc basin on earth which has not produced oceanic crust via seafloor spreading yet. As a driving force for progressive backarc rifting processes, we have a working hypothesis that fluids and/or heat-induced weakening enhance strain localization in the rift axis. To demonstrate the hypothesis, we propose coring the rift axis in the southern part of the Okinawa Trough (Yaeyama Rift) by the Chikyu. Our strategy includes >100 m coring at the sites. The coring aims to recover sediments and pore fluids and measure ground temperatures. The objectives of the piston coring program are three-fold. (1) Investigate the source of the trough-filling sediments by studying the variation of lithology and grain size in the depth direction. (2) Document and analyze the hydrogeological and geochemical properties of the trough-fill sediments to determine the upwelling of deep fluids derived from the mantle. (3) Measure the temperature in the trough-filling sediments to understand the true thermal structure of the trough axis. Results from our studies directly address Strategic Objective 2 “The Oceanic Life Cycle of Tectonic Plates” and contribute to Strategic Objective 7 “Natural Hazards Impacting Society” of the 2050 Science Framework: Exploring Earth by Scientific Ocean Drilling. This proposal is the first milestone of our future drilling project which ultimately aims to core and monitor in both of the seismogenic rifts zone in the Okinawa Trough.

Inception, growth and decay of the British-Irish Ice Sheet - a new IODP proposal for Irish and UK margins

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One of the key uncertainties in the projections of future sea-level rise comes from an imperfect understanding of ice sheet processes and their internal variability in response to climate and ocean forcing, especially for marine-terminating ice sheets such as the West Antarctic and Greenland Ice sheets. Improving such understanding for palaeo-ice sheets has important implications for modelling and forecasting of future changes in modern ice sheets. The British-Irish Ice Sheet (BIIS), that extended over the UK and Ireland during the Quaternary, was marine-terminating, drained by large ice streams, and was particularly sensitive to oceanographic and climatic changes due to its geographical position bordering the North Atlantic. This makes it an excellent analogue to gain further insight into the dynamics of modern marine-terminating ice sheets. However, surprisingly little is known about BIIS inception and older glaciations prior to the last glacial period. We aim to fill this scientific gap by identifying specific drilling sites along the UK and Irish continental margin for the submission of an IODP proposal on the reconstruction of the inception, and cycles of growth and decay of the BIIS during the Cenozoic.

The demise of a salt giant: climatic-environmental transition during the terminal Messinian Salinity Crisis

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Proposal 857C aims to drill the Messinian evaporites/salt in the Eastern Mediterranean and was submitted in 2021 to the IODP Joides Resolution scientific drilling program. The proposal is presently within the JRFB, but not scheduled for the current program. We aim to explore future drilling opportunities involving either MSPs or the Chikyu, with the possibility of modifying the drilling locations to suit both scientific targets and technical constraints of the new MSP vessels. The original proposal aims to address fundamental questions related to the evolution of evaporites basins by addressing the mechanisms responsible for the dramatic salinity fluctuations experienced by the Mediterranean Basin during the terminal stages of the Messinian Salinity Crisis (MSC) ~6 to 5 million years ago. The processes by which this large water mass underwent a rapid hypersaline-brackish-normal seawater evolution in ca. 600ky are still widely unknown: this refers in particular to the influence of monsoons via large African and Arabian river systems, and of the Paratethys, on the hydrological cycle and its evolution in the MSC. Just after the emplacement of up to 3-4 km of salt in the deepest part of the Mediterranean basin, short-lived and dramatic environmental perturbations led to the formation of brackish-water Lago-Mare deposits. These environmentally enigmatic accumulations may serve as a record to better understand diagenetic mechanisms responsible for dolomitization. Based on results of previous DSDP drilling (Leg 42, site 374), the Lago-Mare related dolomite deposit could hold the key for understanding the little known processes that lead to microbially-mediated, low-temperature formation of this geologically relevant carbonate mineral. The central and eastern Mediterranean MSC deposits are ideally located for understanding 1) the hydrological connectivity among all sub-basins and with the Paratethys, 2) the response of major circum-Mediterranean rivers to the demise of the Messinian salt giant and 3) the link between evaporite formation, microbial activity and dolomitization. Therefore, we propose to sample and analyse in these basins the record of the last stages of the MSC, including Lago Mare facies and the upper part of the evaporite/clastic series, which were not fully cored in previous scientific drilling campaigns (DSDP/ODP Legs 13, 42, 160). We propose to drill four sites, two in the Ionian Basin and two in the Levant Basin, which would penetrate (in descending order): open-marine Pliocene siliciclastic deposits hosting the hypothesized active dolomitization front; lacustrine Lago-Mare sulphate evaporites, carbonates, marls, and siliciclastic accumulations; and Upper Messinian salts. These sequences are accessible to riserless drilling; the depth below mudline ranges from ca. 600m to 1000m and TD is located within the top of the halite, without approaching the base of the main salt unit. The wider scientific objectives on the mechanisms of the MSC termination and probable biosphere modulated dolomitization processes are in line with the strategy of the 857-MDP2 Umbrella proposal ‘Uncovering a Salt Giant’, and complementary to the pre-proposal P857B ‘Deep Sea Records of the Messinian Salinity Crisis (DREAM).

The last Million years…..

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The Mid-Pleistocene Transition (MPT) in global climate is evident from a shift in the frequency and characteristics of glacial-interglacial cycles, from small amplitude symmetrical 41 kyr cycles to large amplitude asymmetrical 100 kyr cycles starting around 1.2 Ma. The MPT was originally studied using oxygen isotopes from benthic foraminifera from deep sea marine sediment cores and using this information to show the change in frequency and amplitude of the glacial cycles. There are several hypotheses for this transition including (and not mutually exclusive); insolation changes, enhanced CO2 removal from the atmosphere; coeval timing of ice sheet expanse in the northern and southern hemisphere, deep ocean cooling and reduced ventilation in the Southern Ocean; and intensification of the tropical Pacific Ocean/atmosphere circulation. There are currently several initiatives to drill longer ice cores in Antarctica (Beyond EPICA Oldest Ice Core (BEOIC) 2019-2026 and Australian Million Year Ice Core (MYIC) – 2021 to 2027) to measure the atmospheric CO2 and climate changes across the MPT.

While there is evidence from deep marine records which show that these changes in the length and amplitude of the glacial cycles had a major impact on the earth's climate including larger ice sheets, larger amplitude sea level cycles, but also changes in atmospheric dust, ocean circulation changes, marine productivity etc… there are still many outstanding questions around how our coastal regions and terrestrial environments responded to these changes in the climate across the MPT and evolved into the modern climate and ecosystems. One example is the relatively recent evolution of the Great Barrier Reef, which appears to have only initiated around 700 ka.

I would like to propose a focus on collecting MSP/ICDP cores to understand the last million years of climate change, to link with the significant efforts going in to drilling the long Antarctic ice cores, and to understand the evolution of our modern climate and ecosystems.

Postglacial Atlantic sea-level reconstruction through drilling the Belize Barrier Reef (submitted pre-proposal)

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In contrast to the Indo-Pacific, where postglacial sedimentary successions of coral reefs including relative sea-level data were obtained from outcrops and coring, e.g., in Vanuatu as well as in Tahiti and the Great Barrier Reef (IODP drilling), there is only one such record in the Atlantic (Barbados, eastern Caribbean). The Barbados core data are extremely valuable, however, there are also limitations and challenges. The cores were not rigorously investigated with regard to sedimentology, paleoecology, and taphonomy, and there are apparent differences to more recent, IODP-based data, e.g., the evidence of meltwater pulse (MWP) 1B, the timing and height of sea level during the last glacial maximum (LGM), the apparent lack of microbialites, as well as mismatches with Holocene sea-level curves. Therefore, it is planned to obtain glacial-postglacial reef sections by coring in the western Caribbean, which would provide valuable comparisons with the existing eastern Caribbean (Barbados) and the Indo Pacific records. The barrier and atoll reef system offshore Belize is the largest modern tropical reef complex in the Atlantic Ocean, and well-suited for this purpose. It also represents a mixed carbonate-siliciclastic sedimentary system. Late Quaternary reefs were deposited largely during sea-level highstands, like those of the Holocene and marine isotope stage 5, which are well studied, unlike the reef deposits from lower highstands and lowstands of sea level. The latter deposits, including those from the last postglacial, can be recovered by drilling in fore-reef areas of the 250 km-long barrier reef of Belize. Based on a recent site survey, which obtained highly resolved bathymetric and shallow seismic data from the area, and based on discussions during an international workshop, three drill areas have been identified. These include two transects of four drillholes each, oriented perpendicular to the modern reef crest. Drillholes will be situated on linear ridges running along the fore-reef slope. One of these transects will be located off Carrie Bow Cay where shallow coring in the fore-reef area has been performed by previous studies. A third transect of four drillholes will be located on a southward shoaling ridge, running more or less parallel to the modern reef crest south of the mouth of English Cay Channel. In addition to these 12 drillholes, one site is planned in deep water east of the barrier reef and one on the delta of the English Cay Channel in order to obtain off-reef reference records with both limited and strong siliciclastic input, respectively.

New Caledonia Ophiolite Land-to-Sea Drilling Project (NCDP): a need for future riserless Scientific Ocean Drilling

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Drilling the center of the K-Pg Chicxulub impact structure

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In 2016, the International Ocean Discovery Program-International Continental Scientific Drilling Program Site M0077 drilled into the peak ring of Chicxulub during Expedition 364. Key goals of this project were to answer the following questions: 1) What rocks comprise and how are peak rings formed? 2) How are rocks weakened during large impacts to collapse and form relatively wide, flat craters? 3) What caused the environmental changes that led to a mass extinction and what insights arise from biologic recovery in the Paleogene?, and 4) Can impacts generate habitats for chemosynthetic life? Exp. 364 Site M0077 drilled into a depression in the top of the peak ring in the northwestern portion of the impact structure where it was observed to have the highest relief (hence shallowest drilling target) and clearly imaged early Cenozoic sequence including the Cretaceous-Paleogene (K-Pg) boundary on seismic reflection data. Coring started at 506 meters below seafloor (mbsf) and completed at 1335 mbsf exhibiting a stratigraphy that included 100 m of Eocene and 10 m of Paleocene carbonates overlying ~225 m of K-Pg boundary impactites and ~600 m of granitic basement rocks intercalated with impact melt and pre-impact dikes. These cores, associated downhole geophysical logs, laboratory analyses, and related modeling efforts have resulted in >50 peer-reviewed publications of which we highlight key examples that provided insights into the expedition questions. The Chicxulub peak ring proved to be Carboniferous volcanic arc granitoids uplifted from ~10 km depth and emplaced along an ~80 m thick melt-rich shear zone. Modeling and structural analyses together support the process of acoustic fluidization as critical in the impact crater modification stage implying, in the case of Chicxulub, 10s of km rebound in the transient cavity, followed by gravitational collapse of the central uplift wherein target materials regain coherency through a process of increasing effective block size culminating in macroscale fault-transported blocks 100s of m in scale forming the peak ring. Physical properties of the peak ring emphasize generation of porosity through shock, lowering velocity and density by ~25%. Comparison of pre-impact to K-Pg boundary stratigraphy and geochemical analyses imply the ejecta curtain and impact plume contained carbonate dust, sulfur/sulfate aerosols, and soot which generated global cooling as a key driver of the mass extinction. The K-Pg boundary sequence within Chicxulub includes melt rock, unsorted suevite generated by melt-water interactions and ground-hugging flows, sorted suevite consisting of proximal ejecta returned to the impact via ocean resurge and settling throughout the basin, seiche deposits, a returning rim-wave tsunami deposit, and a transition layer the deposited over 10-20 years post impact capped by an Iridium-rich layer that corresponds to the global K-Pg boundary clay layer. Yet, life was present within the water column overlying the marine Chicxulub impact crater and within the sediments within years of the impact with algae playing a key role in productivity. Hydrothermal minerals, geothermochronometry, and seismic evidence of upflow zones in the central impact basin give evidence for an impact hydrothermal system that persisted for millions of years. Modern elevated active cell counts and DNA extraction demonstrate that thermophilic bacteria continue to reside within the crater lending credence for impact generated chemosynthetic ecosystems. While each of these results yield insights into impact cratering processes and effects on the biosphere, these findings suggest additional lines of inquiry. What are the timing and controls on regaining strength of the acoustically fluidized target materials under different impact and planetary conditions? What controls the transition from peak ring to multi-ring impact basins? Is sulfur, dust, or sort the dominant driver of extinction and what is the duration of global cooling? What is the role of the ocean in colonization of impact basins? Where are the different habitats within an impact basins and what processes affect temperature and fluid flow through time? What is the evolution of an impact melt sheet and how is it different in a marine versus terrestrial impact? Do impact melt sheets differentiate? What changes occur in a chemosynthetic ecosystem as impact craters cool? These questions have major implications for each planetary crust formation on Earth and other worlds, provide insights into habitats for the origin of life, and require great fidelity to assess impact processes, K-Pg extinction drivers, and recovery of life in the early Cenozoic. We propose to launch a new scientific drilling expedition to tackle these questions by drilling into the center of the Chicxulub impact structure as part of the 2050 Science Framework and as a mission specific drilling expedition.

Future options for IODP Proposal 871 "Lord Howe Rise Continental Ribbon"

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Proposal 871 presents a case for riser drilling using D/V Chikyu on the Lord Howe Rise, an extended and submerged continental ribbon that forms the core of northern Zealandia. The objectives of this proposal are: 1) To define the role and importance of elongate strips of continental crustal ribbons in plate tectonic cycles and continental evolution; 2) To recover new high-latitude data to better constrain the timing and nature of Cretaceous paleoclimate and linked changes in ocean biogeochemistry; and 3) To test fundamental evolutionary concepts of sub-seafloor microbial life over a 100-million-year timeframe. These objectives align directly with the IODP 2013-2023 Science Plan and also with Strategic Objectives and Flagship Initiatives of the 2050 Science Framework.

This innovative proposal for riser drilling is currently with the Chikyu IODP Board for implementation. However, as a high-cost Complementary Project Proposal involving riser drilling to ~2.5 km below the seafloor at a site ~800 km from the nearest major port, implementation requires considerable additional non-IODP funding. This funding has been sought but, to date, has yet to be secured.

Whilst funding for Proposal 871 remains uncertain and the proposal requires updating to incorporate advances in understanding the Lord Howe Rise and northern Zealandia since 2017, the scientific merits of the proposal remain valid. In addition, extensive site survey data – including novel datasets such as high-resolution ocean-bottom seismometer data around the proposed riser drill site – mean that Proposal 871 can readily be revised to accommodate riserless drilling whilst allowing the main scientific objectives to be met. For example, existing and new riserless sites should allow characterisation of Zealandia basement as well as sampling of Cretaceous ocean anoxic events and inferred coaly strata that possibly harbours ancient microbial life.

INDIAN-SOUTHERN OCEAN LATITUDINAL TRANSECT (ISOLAT): A PROPOSAL FOR THE RECOVERY OF HIGH-RESOLUTION SEDIMENTARY RECORDS IN THE WESTERN INDIAN OCEAN SECTOR OF THE SOUTHERN OCEAN

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Quantifying oceanic variability at timescales of oceanic, atmospheric, and cryospheric processes are the fundamental Scientific Ocean Drilling. In this context the Southern Ocean plays a leading role in that it is involved, through its influence on global ocean circulation and carbon budget, with the development and maintenance of the Earth's climate system. The seas surrounding Antarctica contain the world's only zonal circum-global current system that entrains water masses from the three main ocean basins, and maintains the thermal isolation of Antarctica from warmer surface waters to the north. Furthermore, the Southern Ocean is a major site of bottom and intermediate water formation and thus actively impacts the global thermohaline circulation. The primary aim of this proposal is to determine millennial- to sub-centennial scale variability of the ACC and the ensuing Atlantic-Indian water transports, including surface transports and deep-water flow. We will focus on periods of rapid ocean and climate change and assess the role of the Southern Ocean in these changes, both in terms of its thermohaline circulation and biogeochemical inventories. We would propose a suite of sites (GPC) that form a latitudinal transect across the ACC in the westernmost Indian Ocean sector of the Southern Ocean. The transect is designed to allow the reconstruction of ACC variability across a range of latitudes in conjunction with meridional shifts of the surface ocean fronts. The northernmost reaches of the transect extend into the Agulhas Current and its retroflection system which is a key component of the THC warm water return flow to the Atlantic. The principal topics are: (i) the response of the ACC to climate variability; (ii) the history of the Southern Ocean surface ocean fronts during periods of rapid climate change; (iii) the history of North Atlantic Deep Water export to the deep South Indian Ocean; (iv) the variability of Southern Ocean biogeochemical fluxes and their influence on Circumpolar Deep Water carbon inventories and atmospheric chemistry; and (v) the variability of surface ocean fronts and the Indian-Atlantic surface ocean density flux. To achieve these objectives we will generate fine-scale records of palaeoceanographic proxies that are linked to a variety of climatically relevant ocean parameters. Temporal resolution of the records, depending on sedimentation rates, will range from millennial to sub-centennial time scales. Highest sedimentation rates are expected at coring sites located on current-controlled sediment drifts, whereas dense sampling of cores with moderate sedimentation rates will enable at least millennial-scale events to be resolved.

Drilling and monitoring in Hyuga-Nada

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Shallow slow earthquakes, which last minutes to years, are important indicators of subduction megathrust slip behavior and future seismic and tsunami potential. Subducting plate roughness and seamounts have been proposed to promote slow earthquakes by inducing local hydrologic and geomechanical heterogeneity. The Hyuga-Nada region offshore Kyushu, Japan is an outstanding locale for drilling and observatory experiments to investigate these effects. Drilling, logging, and coring will provide key constraints on the stress state, hydrologic processes, and sediment physical properties in the region above the ridge

The effect of decollement geometry on heterogeneous distributions of stress, strain and physical properties of upper plate in subduction zones

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Variations of slips from slow to fast earthquakes has been observed in subduction zones (e.g., Obara and Kato, 2020). Heterogeneity of rheology is one of models to explain the variation of slips (Ando et al., 2010). The cause of the heterogeneity, however, has not been well understood. Some previous studies have suggested heterogeneity of lithology such as mélange texture including competent blocks surrounded by incompetent matrices (Barns et al., 2020). Another candidate is the heterogeneity of stress and strain which also can control the rheology of rocks. Geometry or roughness of plate interface can modulate the stress and strain in upper plate in subduction zone as modeled by Sun et al., (2020). Slow earthquakes actually distribute in specific places related to the subducting seamounts in Hyuganada, Japan (Yokota and Ishikawa, 2020) and in Hukurangi, New Zealand (Todd et al., 2018). Hashimoto et al. (2022) suggests that the geometry of the plate interface modulate the stress distribution heterogeneously and it is the primary control on shallow very low frequency earthquakes due to the modulated stress distribution.

Hyuga-Nada Drilling Project aims to examine the modulation of upper plate due to a subducting seamount and to monitor the change in the conditions by long-term observatories, which could provide a nature for slow earthquakes. The proposal was already evaluated in IODP SEP as excellent and successfully sent to CIB. In the new ECORD-Japan Program, the Hyuga-Nada project will be one of the most likely candidates to be operated.

I also would like to discuss the effect of geometry of plate interface on the modulation in upper plate to make heterogeneous distributions of stress, strain, physical properties, and fluid pressure. 3D seismic profiles shown in Nankai Trough or Hikurangi are significant to discuss about the effect as natural examples. The roughness analysis, distribution of slip tendency, velocity anomaly on the plate interface would provide the relationship among geometry, stress and physical properties, which also give us the idea where we need to drill and monitor.

Silicate alteration from land to ocean and its role in Earth system functioning

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Silicate alteration from land to ocean and its role in Earth system functioning

Dissolution of terrestrial silicate minerals as a result of acidic CO_2-containing rain water is one of the few processes that regulates global atmospheric CO_2 level over the Earth's long history1,2. This process not only sequestrates atmospheric CO_2 as carbonate rocks, it also returns silicon back to ocean as silica, which is essential to the silicifying organisms, such as diatom, and their O_2-producing ability. Recent studies advocate a similar process in the marine environments that petrifies CO_2 (from organic matter degradation) through dissolving disseminated silicate minerals that are buried in marine sediments3,4. Besides the resulting carbonate mineral authigenesis as a result of elevated alkalinity from silicate dissolution, this process also promotes clay mineral formation that serves as an important sink for many cations in the ocean4. While the overall marine silicate alteration, including silicate dissolution and clay formation, potentially could be important for global matter cycling over the Earth's history, its connection to the terrestrial counterpart and the resulting climatic feedback are essentially unknown. Specifically, marine silicate alteration could be a continuation of terrestrial silicate alteration, and thus the marine rates depends primarily on the reactiveness of unreacted terrestrial silicates that are transported to the oceans. Under such a circumstance, marine silicate alteration should be dictated by the terrestrial physical weathering (physically dismantle rocks), erosion (transport of rock fragments downstream) and chemical weathering (actual CO_2 sequestration). Alternatively, the competing hypothesis is, a different set of silicate minerals is altered in marine environments and the process is thus only weakly-coupled to the silicate alteration occurs terrestrially. The inference of this hypothesis is that, marine silicate alteration should be regarded as a stand-alone pathway, in addition to the alteration of terrestrial silicates and freshly produced ultramafic rocks along mid-ocean ridges5.

To examine the two competing hypotheses, scientific drilling along land-shallow sea-deep sea (or source-to-sink) transects from key locations where different modes of silicate weathering/erosion/alteration from land to the ocean is absolutely essential. To this aim, drilling capability from Mission Specific Platforms are crucial for successful drilling in shallow waters. New technology to recover sand-rich sediments is also essential to the proposed drilling strategy. I propose two geographic regions for such a drilling strategy. The first target will be a drilling transect in southern Ulleung Basin (Japan Sea) from river mouth (e.g., Nakdong river from Southern Korean) to continental shelf is proposed. The northern and middle part of Japan Sea (Yamato and Japan Basin, respectively) was drilled during several DSDP and ODP expeditions for the tectonic history of basin evaluation6. The southern basin of Japan Sea, the Ulleung Basin, was drilled twice in 2007 and 2010 (UBGH1&2, up to 250 mbsf) by the Korean government due to the high potential of gas hydrates in this region7. Exceptionally high alkalinity as a result of marine silicate weathering has been documented based on the inorganic geochemistry data produced from these various drilling campaigns8,9. This location thus serves as an ideal location to reconcile the competing hypotheses proposed. Sediment samples and information from the delta and continental shelf regions of the southern Ulleung Basin, where terrestrial sediments in the basin were sourced from10, could be compared with the results from previous scientific drillings to track the progression of silicate alteration from land to ocean.

The second drilling target will be from the river mouth, delta, and continental shelf regions off the central western India where the Krishna and Godavari rivers, the forth and second largest Indian rivers, respectively, meet the ocean. The Krishna and Godavari Basin (K-G Basin) that receives the sediment load from these two rivers happens to be the largest natural gas reserve of India that was discovered in 2003. The high potential in gas hydrate attracted more scientific drilling campaigns funded by the Indian government in 2006 and 201511,12. Similar to the finding from Ulleung Basin, the inorganic geochemistry results suggest marine silicate weathering13, even though the process is less active as compared to that in Ulleung Basin. Drilling from the delta and costal ocean regions will again help elucidate how silicate minerals were transported and altered from land to deep ocean.

This proposition of drilling campaign aligns with the following Strategic Objectives (SO):

SO4-Feedbacks in the Earth system/SO5-Tipping points in Earth's history: While terrestrial silicate weathering is traditionally regarded as an important feedback for atmospheric CO_2 concentration, disseminated marine silicates were thought to passively deposit on the seafloor and have no effect on the long-term climatic system2. Such a view is however being challenged3,4. Alteration of marine silicates provide additional buffering power for the oceanic pCO_2. In addition, the initiation of marine silicate alteration is pH-dependent and thus could be activated during prevailing hypoxia events when fast organic matter burial and degradation occurred4. Such responses provide negative feedbacks to ocean pH and pCO_2 level and could change Earth system behaviors when approaching climatic tipping points. For example, making Earth system components more resilient to abrupt changes or accelerating recovery after catastrophic events. It is thus crucial to understand how silicate alteration is coupled between land and ocean in a more systematic way.

SO6-Global cycles of energy and matter/SO1-Habitability and life on Earth: Alteration of silicate minerals is

Links between organic-mineral interaction and the climate/tectonic evolution: the role of clay transformation under the microbial forcing

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The conversion of smectite to illite (S-Ireaction) in the deep sediments has been of great interest for more than four decades. This reaction is closely linked to a number of processes including the burial of organiccarbon with global climate change, the generation of crude oil and natural gas, modification of sediment physical properties and alteration of fault friction properties. Moreover, it is also suggested that microbial activity in the deep earth sediment play an important role in enhancing the transformation of clay minerals. Therefore, the organic-mineral interaction in the deep earth sediment could be a key process to better understand the climate change and deep earth stability from various timescales. We would like to join this Ecord-Japan workshop and the future Scientific Ocean Drilling activities if possible through our cooperators from Kochi Core Center, JAMSTEC (e.g., Prof. Minoru Ikehara and other related scientists). We hope to select thesenew and previous sediment columns with distinct depth intervals in terms of clay mineralogy through *Chikyu*platformsfrom the northwesternPacifictarget areato study the links between organic-mineral interaction and the climate/tectonic evolutionunder a multidisciplinaryscientific concern.

Title Plio-Pleistocene Southern Ocean Paleoceanography: Latitudinal drilling in the Southwestern Indian sector of the Southern Ocean (IODP 918-Pre)

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Riser-less drilling through the petit-spot pipe to recover oceanic mantle -New idea for Mohole using the deep sea drilling vessel (D/V) CHIKYU-

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Riser-less drilling through the petit-spot pipe to recover oceanic mantle -New idea for Mohole using the deep sea drilling vessel (D/V) CHIKYU- ISHII Teruaki1, KANEKO Makoto2, HIRANO Naoto3, MACHIDA Shiki4, AKIZAWA Norikatsu5 1Shizuoka University, 2Fukada Geological Institute, 3Tohoku University, 4Chiba Institute of Technology, 5The University of Tokyo On the bases of review on the 60 year's scientific Ocean Drilling, we propose new mantle drilling. A: Alkaline basaltic magma of petit spot volcano is generated in the oceanic plate asnosphere (approximately 60 km below the seafloor), and passes through the Moho discontinuity (approximately 6km below the seafloor), and rises, and erupts as sills, lavas, and volcanic breccia (density is about 1.4) on the deep seafloor in the off Tohoku, Japan. B: Among petit spot volcanoes, there is a volcanic edifice showing an ultra-deep seafloor Maar Crater, at about 5500m deep, suggesting the existence of the Petit Spot Pipe, or a deep structure similar to the Kimberlite Pipe. C: Petit Spot Pipe, which is volcanic vent, may have formed a nearly vertical tunnel with a natural casing down to the mantle, as a result of gaining regional stress relief and of getting robust walls due to ascent of magmas. D: We propose riser-less mantle drilling (and utilization of core barrels that can drill upwards) on the petit-spot pipe filled with volcanic breccia, which is easy to drill, using a 12,000m drill pipe of the deep-sea drilling vessel Chikyu. Sampling will be carried out by lateral drilling, later. E: The borehole will be used as geophysical observation station for disaster prevention and reduction.

Recurrence cycle of plate boundary earthquakes off the coast of Hokkaido, north Japan

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Giant earthquakes on the Pacific coast, off Hokkaido, North Japan has considered having occurred in multi-segments since Nanayama et al. (2003) revealed the distribution of Tsunami deposits which suggests giant earthquake occurrences at intervals of several hundred years (Ioki and Tanioka, 2016). In particular, a giant earthquake (with an earthquake magnitude of about Mw 8.8) is now thought to have occurred in the 17th century. Documented record of past earthquakes is very limited in Hokkaido, only several earthquakes since the 19th century are available (e.g. Hatori, 1984). So it is difficult to understand the variation of rupture zone and recurrence interval within the available historical record. For elucidating those past earthquake properties, we propose to collect the deep-sea sediment containing seismo-turbidite in the area close to the expected rupture zones off Hokkaido through a new IODP program. The conventional piston coring is difficult to enough long record due to less penetration into the turbidite sequence. Hydraulic Piston Coring System of scientific drill vessel (e.g. JR or Chikyu) or giant piston coring system is necessary to obtain a continuous record to unravel the earthquake recurrence pattern in a long term.

A new proposal for re-drilling in the East China Sea to understand the millennial-scale variability of the Asian monsoon during the Quaternary

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The East Asian summer monsoon (EASM) is a crucial component of the climate and hydrological systems, which determines rainfall variability in East Asia. The Early–Middle Pleistocene transition (EMPT) spanning ~ 1.4–0.4 Ma and following the Mid-Brunhes Transition (MBT) are the critical periods to understand the 100 ky-cycle worlds during the Pleistocene. How the EASM has responded to such global climate change gives an insight into future climate change. Geological evidence suggests that the MBT was not a critical turning point for the EASM in North China, but rainfall variability in South China remains an issue of intense debate. Such spatial heterogeneity over North and South China is a fundamental characteristic of the EASM but is barely understood on a longer geological time scale. The East China Sea (ECS) is a marginal basin located on the rim of the western North Pacific, receiving massive runoff from the Yangtze (Changjiang) River; the discharge accounts for ~90% of the total river discharge to the ECS, making surface salinity well-correlated with basin-wide summer precipitation in southern China. IODP Expedition 346 was held in 2013 to understand the long-term millennial-scale variability of the East Asian monsoon during the Quaternary. During this expedition, we drilled the proposed sites to ~200 mbsf at Site U1429 in the northern ECS. We recovered a continuous record of hemipelagic sediments for the last 400 ky with a high sedimentation rate of 30–70 cm/ky at Site U1429. The advantage of using the marine core is the oxygen isotope (δ18O) of calcite from planktic foraminifers preserved in nearshore marine sediments can be quantitatively partitioned into sea surface temperature and δ18O of seawater (δ18Ow), a function of sea surface salinity (a proxy of the monsoonal rainfall), using well-established methods of paired Mg/Ca and δ18O. Results from Site U1429 show that the δ18Ow marks the detectable millennial-scale variability, which correlates to the Chinese speleothem δ18O for the last 400 ky. The remarkable correlation between the ECS and the Chinese speleothem demonstrates that the ECS is a great candidate for a benchmark for the Asian monsoon record, especially for older than 600 ka. To understand the rainfall variability in South China, we propose to drill the northern East China Sea (ECS) to obtain a sediment record spanning the past 1 Ma, primarily focusing on a continuous high-resolution sediment record older than 400 ka. As we expect a high sedimentation rate at a potential site, we anticipate that millennial-scale variability will be fully resolved.

An idea of a drilling campaign on simplified KUROKO-cultivation at artificial vents by shallow multiple drilling

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Beneath the active hydrothermal venting area, a certain volume of reservoir of high temperature fluid should be occurred (e.g. Hamada et al., 2015), which firstly inferred by commencement of vigorous discharging from artificial vents opened by IODP expedition 331 (Takai et al., 2012). At the vents, rapid growth of the chimney structures also immediately commenced (Kawagucci et al., 2013). According to this phenomenon, a patent on the Kuroko-cultivation system had been claimed (Takai et al, 2016). Several cultivation apparatuses have been made and retrieved to date (e.g. Kinoshita et al., 2022). Besides those carefully designed apparatus, even within the casing tubes just penetrated into the reservoir, also hosting metal sulfides (Nozaki et al, 2020). Further, the sulfides precipitated in the tube just cooled down by conductive cooling from the wall of the tube itself unless mixing with seawater, little sulfate contained unlike to the natural chimney. Contrasting to the state-of-art apparatus proposed by Takai et al. (2016), it is also expected that venting fluids guided into just a metal tube will precipitate pure sulfides inside the tubes. Here, thus we propose a drilling campaign, 1) a swarm of the holes drill in and near an active hydrothermal venting field, then 2) just tubes extend from the casings penetrated into the deep, and 3) once the tube is blocked by scale composed of sulfides replace the tube into new one and “practically pure” sulfides could be retrieved.

Earth's Extremes -warm/anoxic ocean and evaporated basins

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Scientific Ocean Drilling has contributed significantly to the deciphering of Earth's history. In particular, understanding the amplitude of the changes that the Earth's climate system can undergo is essential to understanding the behavior of the Earth system and its climate sensitivity. Over the past 100 million years, the Earth has experienced a number of extreme conditions. Earth’s system witnessed a super-greenhouse climate and anoxic events in the oceans during Cretaceous, that could have significantly impacted on marine ecosystem and resulted in mass extinctions. In recent years, lines of geochemical evidence suggest that massive igneous activity associated with the formation of large igneous provinces contributed significantly to these events. On some plateaus or seamounts in the Pacific Ocean (e.g., Magellan Rise), more than 100 million years of paleoclimate archives are buried in-situ as seafloor sediments. Scientific ocean drilling can only provide an opportunity to access these continuous, long-term archives. The Mediterranean Sea experienced another extreme environment that is massive evaporite precipitation in the end of Miocene, known as Messinian Salinity Crisis. This event is also A group of international scientific team has developed an umbrella proposal “DREAM” to obtain the deep-basin record of the Mediterranean salt giant, and elucidate the full extent of the salinity crisis. Deep buried salt and sulfate may sustain unique biogeochemical cycles in the present deep biosphere. This is an important scientific target not only for understanding the marine environment change and its significance on marine life and regional climate, but also for understanding the linkage of the Mediterranean Sea with Solid Earth processes such as basin tectonic evolution. Deep penetration with riser-type drilling equipment is necessary to achieve this dream.

Construction history of intermediate-spreading oceanic crust

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I would like to propose topographic survey and sampling of Cretaceous oceanic crust and volcanic chains and ridges at the northeast Hawaiian Arch area. Northeast Hawaiian Arch area have a 951-full proposal of drill through upper oceanic crust as a pilot hole of project Mohole, and interesting place to considering off-ridge volcanism occurred after the mid-ocean ridge spreading. Occurrence of many off-ridge volcanoes and volcanic chains can correlate with the basement spreading rate at East Pacific Rise, but the formation history and cause are still unknown. Developing history of plenty of cretaceous volcanoes dispersed in northeast Hawaii should be essential for understanding formation process of upper oceanic crust in this region, and they will give some information for why large volume of off-ridge volcanoes formed on an intermediate-spreading oceanic crust. At this moment, high-resolution topographic map and volcanic rock samples are indispensable to understand regional history of on- and off-ridge magmatism. This theme will expand a result of ocean drilling at northeast Hawaiian Arch in the future and can be corroborated with studies targeting overlying sediment and ecosystem.

Bridging Continents and Oceans (NICA-BRIDGE): An ICDP/IODP initiative to drilling the large Nicaraguan Lakes and their oceanic continuation

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An international, multi-disciplinary research group is proposing the "NICA-BRIDGE" Drilling Project, within the framework of the International Continental Scientific Drilling Program (ICDP) and a future ocean drilling program. The project goal is to conduct scientific drilling in Lakes Nicaragua and Managua (Nicaragua, Central America) as well as the marine Sandino basin to obtain long marin and lacustrine sediment records to: (a) extend the Neotropical paleoclimate record back to the Pliocene, making it one of the longest continental tropical climate archives in the world, and (b) provide geological data on the long-term complex interplay among tectonics, volcanism, sea-level dynamics, climate change and biosphere. The lakes are the two largest in Central America and they are located in a trench-parallel half graben that hosts the volcanic front, which developed during or prior to the Pliocene, as a consequence of subduction-related tectonic activity. The lakes are uniquely suited for multidisciplinary scientific investigation because their long, continuous sediment records (several Ma) will facilitate the study of: 1) terrestrial and marine basin development at the southern Central American margin, 2) alternating lacustrine and marine environments in response to tectonic and climatic changes, 3) the longest record of tropical climate proxies, 4) the evolution of, and transition between, the Miocene to Pliocene/Pleistocene and Pleistocene to present volcanic arcs, which were separated by slab rollback, 5) the significance of the lakes as hot spots for endemism, and 5) the great American biotic interchange at this strategic location, i.e., the N-S and reverse migration of fauna after the land bridge between the Americas was established. The planned ICDP project offers an opportunity to explore these topics through continent-based seismological, volcanological, paleoclimatological, paleoecological, and paleoenvironmental studies, combined with an IODP drill project to explore its oceanic continuation. In Phase I, with ICDP support, we will obtain sediment cores ~100 m long, which will allow us to investigate many of the scientific questions. Based on the data from those drill cores, coring locations will be identified for a future Phase II, which we envisage as a combined ICDP/IODP project to collect deep drill cores in the lakes and the offshore Sandino Basin in order to extend Phase I results to much deeper time. The Sandino Basin is the oceanic continuation of the depression in which the studied lakes are located and complementary marine drilling, possibly with MSP, will improve the understanding of the evolution of this complex margin.

Title Pelagic deep-sea sedimentation in relation to radiolarian evolution (provisional)

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Radiolarians are planktonic organisms that are regarded as one of the most important proxies in ocean environment and paleo-environment. They are alive in oceans worldwide and their shells are recorded in Cambrian rocks. It is known that radiolarian shells have become smaller and thinner through their long evolutionary history. Radiolarian-shell rich pelagic sediments (cherts) were common in most of ocean floors in the Mesozoic and Late Paleozoic times. This recognition comes from research largely on pelagic sediments embedded in accretionary complexes in the circum-Pacific orogenic belt including the Japanese Islands. On the other hand, radiolarian ooze are found only on limited ocean floors below high-productivity waters in the present day. Pelagic clays are more common sediments below low-productivity waters typified in the oceanic gyre. The transition from chert to pelagic clay in sedimentary succession is recognized at several sites in the northwestern Pacific. For investigating the transition from a Mesozoic chert-rich ocean to a Cenozoic chert-poor ocean, it is critical to confirm the lithological change from the chert/silica-rich sediments to the clayey/silica-poor sediments and to elucidate factors that caused the lithological change. This can enhance our understanding of silica budget in the Earth. The deep sea floor in the central and northern Pacific is suitable for this examination.

Evolution of the meridional gradient in the North Pacific Ocean under varying Neogene climate conditions

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Today Earth's climate is recording a spectacular warming with a 1.25°C temperature increase between 1960 and 2020, and this warming can even reach 2°C in 2100. The high latitudes of the northern hemisphere are the most sensitive area to the global warming with a +2°C warming in the past 50 years. Consequently, meridional temperature gradient reduction and atmospheric system disturbance, including the complex Indo-Asian Monsoon system will impact the lives of 1/3 of world population. Therefore, the understanding of Earth's climate system under a highly variable meridional gradient is of high importance.
Recent studies suggested that 2100 climate may be close to those during the middle Miocene Climatic Optimum (MMCO) (~15 Ma). Indeed, since the MMCO, Earth's climate underwent a series of cooling event establishing modern meridional gradient, climate, and ecological systems. Among, the Late Miocene Global Cooling (LMGC, 7.5-5.5 Ma), the Northern Hemisphere Glaciation (NHG, 3.0-2.7 Ma) and the Mid Pleistocene Transition (MPT, 1.2-0.8 Ma) are the three main cooling events defining the outlines of our modern climate.
In this context, a longitudinal transect in the North Pacific from the tropics to the polar regions would be of very high interest for monitoring the variability of the North Pacific Meridional gradient during late Neogene key cooling events as the LMGC, NHG and the MPT. This would allow to understand: 1) how was the meridional gradient in past warmer climate phase than today, 2) monitor the impact of each cooling event on the meridional gradient and the atmosphere and 3) understand cooling/warming events affected life on Earth.
There, relying on future of Scientific Ocean Drilling project post 2024, we propose to conduct a meridional transect in the North Pacific covering the tropics to the subarctic areas at least. Because of numerous concerns about future politics and budgets issues, we propose an expedition relying on Giant Piston Core (GPC) using or JAMSTEC Kamei R/V GPC system. This may be also a good opportunity to strengthen JDESC-ECORD drilling collaboration by using the French Marion Dufresne GPC system. However, GPC coring system can only recover approximately 40 to 50 m of sediments. Thus, we propose to focus on abyssal plain of the Northeast Pacific, where the sedimentation rates are the lowest. However, abyssal plain have the disadvantage to be poor in calcareous microfossils, thus for conduct temperature estimates and reconstruct atmospheric changes, we will have to focus on siliceous microfossils (radiolarians and diatoms), biomarkers (sterol, alkenone and TEX86,), clay minerals assemblages, inorganic geochemistry mainly.
However, exact sedimentation rates are not well documented yet. We need to perform one or several site survey expeditions to conduct sites seismic profile analysis and to retrieves some 6-10 m long piston core for determine sedimentation rates to assess the feasibility of the project. If the sedimentation rates are from 1 to 0.5 cm/kyr, with a 50 m piston coring we can expect to have sediment recovering the LMGC fully and thus it is enough to complete the proposed science. For conduct the preliminary site survey, although there are several possibilities, we may rely in AORI, The University of Tokyo funded Hakuho R/V expedition.

Probing the Deep Earth toward the uppermost mantle

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J-DESC emphasizes the importance of the deep mantle drilling through collaboration with international communities. The mantle drilling attempts to constrain the architecture of oceanic crust and mantle in diverse tectonic settings and spreading rates, in order to characterize processes and extent of hydration in the oceanic plate and links to biogeochemical processes, to perform monitoring of active lithosphere processes and conditions, and to install in-situ laboratories. The (Moho-to-Mantle) M2M project, submitted to IODP in 2012, addressed the reachable goals of sampling the in situ upper mantle peridotite and investigating the nature of the Mohorovičić seismic discontinuity (Moho) with the drilling vessel Chikyu. Fore Arc M2M project has been submitted to IODP in April 2016 for sample relatively young oceanic mantle. The target site of Fore Arc M2M is the fore-arc mantle/crust section exposed on the landward slope of the Bonin Trench, near the drill sites for the recently completed IODP Expedition 352 and will sample the fresh lower igneous crust and the uppermost mantle peridotite, including the intervening boundary layer, that were accreted during the tectonism and magmatism associated with initiation of subduction at ~52–48 Ma.

Recent progress in Hard-rock drilling (Tentative)

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Bend-Fault Hydrology in the Old Incoming Plate (H-ODIN)

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The oceanic plate has played a key role in Earth's surface and deep water circulation. In the last two decades, it has become generally accepted that hydration due to plate bending-induced normal faults (bend-faults) occurs in the region between trench and outer rise (outer-rise). Nonetheless, little is certain about the degree and style of hydration in the oceanic plate at outer-rises. Bend-fault hydration processes depend on thermal conditions, conditions for water circulation, reaction rates, and stress state. Investigating several subduction zones with various subducting plate conditions will be crucial to expand our knowledge of bend-fault hydration processes. The northwest Pacific (NW Pacific) region is one of the world oldest, thus coldest, and most studied oceanic plates, and is therefore a high priority region to study bend-fault hydration. Water circulation (deep penetration and deep upwelling) and hydration through bend-faults in the NW Pacific region is supported by results from extensive recent geophysical surveys. Here: (1) Horst and graben structures formed by bend-faulting are the best developed in the world, (2) Large bend-fault earthquakes (M>7) have repeatedly occurred and been well recorded, (3) Detailed Vp/Vs variations within the incoming plate have been determined (only known here), and (4) Anomalously high heat flow implies active heat transport by water circulation. The 2011 off the Pacific coast of Tohoku Earthquake may also have an important influence since (5) the local stress state is likely to have changed significantly after the 2011 Tohoku Earthquake, and (6) there is now an increased risk of intraplate normal-faulting earthquake in the outer-rise region that might cause tsunamis based on the historical records related to the mega-Earthquakes. We are now likely be in a the short-lived phase between a giant megathrust event and its potential outer-rise doublet. It is imperative to understand the nature of this type of outer-rise normal-fault earthquake to better assess global tsunami hazards. In order to address (a) geophysical, chemical and structural properties of the bend-faults, (b) hydration processes and their extents along bend-faults, (c) the processes by which the bend-faults developed and are linked to the developments of horst-graben structures, and (d) the chemosynthetic habitability of oceanic crust from mid-ocean ridge to plate subduction, we will analyze in-situ physical properties and litho/biofacies that are best obtained by ocean drilling in the NW Pacific region.

Where to go drilling for microbiology exploration?

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This is not quite a drilling proposal at specific site, but a discussion proposal to define the best target sites for microbiology exploration. Our understanding of the distribution of microbial life on Earth has expanded continuously as research activities focused on the discovery of life in new environments have progressed. In recent decades, numerous studies have been conducted on subseafloor environments, leading the estimates of the global microbial biomass in the subseafloor biosphere, which considered to account for 12–45% of the total microbial biomass on Earth. In current IODP Science Plan, deep biosphere has three challenges namely, "What are the limits of life in the subseafloor?", "What are the origin, composition, and global significance of subseafloor communities?", "How sensitive are ecosystems and biodiversity to environmental change?". They are challenging targets that still remain to be fully addressed and passed to newly formulated "2050 Science Framework: Exploring Earth by Scientific Ocean Drilling science framework". To address the remaining challenges, fine tuning of target sites is necessary. For example, although the high temperature zones have been challenged several times, reaching temperature not clearly exceeding 122ºC, which is current high temperature limit for known life. Where is appropriate to drill will be more important to successfully obtain samples beyond the current limit. The other questions are also necessary to have intensive discussions to achieve appropriate goals. In the discussion time, I'd like to hear the attendees' feedback and build plan for future drilling.

Drilling of Kikai caldera volcano for elucidation of magma plumbing system and flow-deposition processes of large ignimbrite

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Caldera volcanoes universally exist in volcanic regions with continental crust and their activities are characterized by catastrophic caldera-forming eruptions (CCFEs) that discharge more than 40 km3 of silicic magma as pyroclastics. The CCFEs are rare but extremely hazardous events. Mechanisms of magma generation and eruption in the caldera volcanoes are important to understand igneous processes in continental crust and mitigate volcanic hazard. Kikai caldera volcano in the southwest Japan arc repeated CCFEs in the past (140 ka, 95 ka, and 7.3 ka), has a caldera formed by the latest 7.3-ka CCFE, and is active at the present. So far, we have reported a giant lava dome inside the caldera that was formed at the post caldera stage and accurate volume estimation of the latest CCFE. We have been comprehensively researching it to know all about it with surveys of geology, bathymetry, seismic reflection, geomagnetic field, and resistivity structure and analyses of volcanic products in the Kikai caldera region. Our purposes are to clarify the current situation of magma beneath the volcano, mechanisms and evolution of the magma plumbing system, and transportation and deposition processes of submarine pyroclastics. In our project on Kikai caldera volcano, drilling, coring, and dredge are conducted for the last two purposes. Some volcanics samples by coring and dredge in Kikai sea area were obtained from 2019 to 2022. These samples with the previously obtained samples clearly show temporal change of petrological features of the Kikai magmas in whole-rock composition. The cored samples were obtained down to the second CCFE deposit (95 ka) and show different occurrence of the submarine pyroclastic deposits from the subaerial ones. In order to advance understanding of evolution of the Kikai magmas and sedimentological processes of the submarine pyroclastics, further drilling at a proximal subaerial area of Kikai caldera volcano is needed, because Kikai caldera volcano which is a submarine volcano gives us only limited exposure of its ejecta and is not fully understood in terms of its detailed history and occurrence of pyroclastic ejecta. Collecting volcanics samples throughout the activity of Kikai caldera volcano allow us to elucidate magmatic evolution in petrological and geochemical characteristics. Comparison between the submarine and subaerial pyroclastic deposits in the same eruption clearly shows key processes of pyroclastic transportation and deposition in submarine condition; volcanic fields that have both the submarine and subaerial deposits from the same eruption source are rare and precious. We propose new drilling of 300 m depth at two sites in Takeshima island which is a subaerial area of Kikai caldera volcano to proceed with the investigations mentioned above. The two sites are near the outcrops of the first and second CCFEs (140 ka and 95 ka, respectively). We plan to clarify eruption sequences of the older two CCFEs which are much less understood and activity of the volcano at the early stage, and analyze petrographical and geochemical characterization of the samples with many analyses such as major/trace elements composition, isotope composition, volatile content for whole-rock, volcanic glass, and phenocryst. On the basis of these results, we attack to reveal mechanisms of magma processes for caldera volcanoes. We plan to analyze sedimentary structure, grain size, and component for the submarine and subaerial pyroclastic deposits, compare the sedimentological characteristics between them, and reconstruct traveling and sedimentation of pyroclastic clasts produced by submarine eruptions.

Into the Nadir: a new Cretaceous-Paleogene impact structure?

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This proposal has already been submitted as an APL proposal for the Joides Resolution. Depending on the future of JR operations (and non-US participation) this proposal may be suitable to be extended and modified as an MSP expedition. The proposal is to drill a candidate K-Pg age impact structure offshore Guinea, West Africa. The crater is situated at 900 m water depth and ~300 m below seabed, and could potentially be drilled with a geotechnical vessel. This proposal also has a number of additional objectives, including drilling an extended Albian-Paleocene low-latitude stratigraphic sequence for palaeoclimate archives, including the PETM and Late Cretaceous OAEs.

The nature of the Philippine Sea backarc basin lower crust and upper mantle at the Mado Megamullion

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Oceanic core complexes (OCCs) or megamullions are domal bathymetric highs with axis-normal corrugations, showing exposure of serpentinized peridotite and gabbroic rocks and interpreted as exhumed footwalls of low-angle detachment faults. OCCs are the ideal places at which the petrological oceanic crust/mantle boundary can be drilled in-situ with current technology. It is commonly accepted that water from the subducting slab plays a major role in tectono-magmatism in backarc basins, leading to a different crustal accretion process than at that of normal mid-ocean ridges. Understanding of the architecture and composition of backarc basins therefore represents an important milestone in understanding the global oceanic crustal accretion process. Here, we propose to drill the Mado Megamullion, an OCC located in a backarc setting, in the Shikoku Basin in the Philippine Sea. It is characterized by a ~20 km square corrugated surface, comparable in areal size to typical OCCs in the Mid-Atlantic Ridge, such as Atlantis Massif and Kane Megamullion. The Mado Megamullion thus represents an ideal case study to make comparison with well-known OCCs exposed at the slow-spreading Mid-Atlantic Ridge. This will provide useful information to understand the fundamental differences of the lithospheric characteristics between the two major oceanic settings. We propose to use either DV Chikyu or any other research vessels with a seabed drilling system as drilling platform, depending on the availability of the platform and on the scientific objectives which will be identified in future discussions among the hard-rock community.

Cold axis or Hot axis? Investigating the geothermal structure of a pre-break-up backarc basin, Okinawa Trough

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Active backarc basins are unique tectonic features which divide the margin of continents, generate complex subduction geometries, and host a large number of hydrothermal systems that harbour unique mineralization and diverse biological communities. The mechanisms controlling the initiation and evolution of backarc basins has been a long-standing question in global tectonics. The Wilson cycle, which describes the life cycle of a plate, does not cover the backarc basin, which occupies about 5% of the Earth's surface. Therefore, the backarc basin is one of the keys to understanding plate tectonics. The Okinawa Trough is a ~1500-km long continental rift in the East China Sea parallel to and behind the Ryukyu Arc. The Okinawa Trough, together with Bransfield Strait which is in a challenging Antarctic environment and therefore we do not think it is prospective target for a scientific drilling, is the only active and accessible continental backarc basin on earth which has not produced oceanic crust via seafloor spreading yet. As a driving force for progressive backarc rifting processes, we have a working hypothesis that fluids and/or heat-induced weakening enhance strain localization in the rift axis. To demonstrate the hypothesis, we propose coring the rift axis in the southern part of the Okinawa Trough (Yaeyama Rift) by the Chikyu. Our strategy includes >100 m coring at the sites. The coring aims to recover sediments and pore fluids and measure ground temperatures. The objectives of the piston coring program are three-fold. (1) Investigate the source of the trough-filling sediments by studying the variation of lithology and grain size in the depth direction. (2) Document and analyze the hydrogeological and geochemical properties of the trough-fill sediments to determine the upwelling of deep fluids derived from the mantle. (3) Measure the temperature in the trough-filling sediments to understand the true thermal structure of the trough axis. Results from our studies directly address Strategic Objective 2 “The Oceanic Life Cycle of Tectonic Plates” and contribute to Strategic Objective 7 “Natural Hazards Impacting Society” of the 2050 Science Framework: Exploring Earth by Scientific Ocean Drilling. This proposal is the first milestone of our future drilling project which ultimately aims to core and monitor in both of the seismogenic rifts zone in the Okinawa Trough.

Northeast Greenland: Unlocking records from sea to land

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The projections of future scenarios under the current trend of global climate change demand a better understanding of the long-term ice-ocean-tectonic interactions, and in particular the potential meltwater contributions from modern ice sheets. The sensitivity of the Greenland Ice Sheet to polar amplification, changes in ocean heat transport and deteriorating perennial sea ice conditions makes the Northeast Greenland margin one of the most critical locations to understand the impact of future climate change on ice sheet instability and associated sea level rise. The development of oceanic gateways controlling the long-term water mass exchanges between the Arctic and Atlantic oceans, notably the Fram Strait and the Greenland-Scotland Ridge, have played a pivotal role for the Cenozoic evolution of the Northeast Greenland regions. In Northeast Greenland, ice-ocean-tectonic interactions and coupling between the ice sheet, ocean and sea ice are readily observable today, but geological records that can illuminate long-term trends are lacking. Consequently, NorthGreen MagellanPlus workshop was organised at the Geological Survey of Denmark and Greenland in collaboration with Aarhus (Denmark) and Stockholm (Sweden) universities in November 2022 as an international effort to develop Mission Specific Platform (MSP) proposals on Northeast Greenland margins under the umbrella of the European Consortium for Ocean Research Drilling (ECORD). For three days, seventy-one participants (56 in person + 15 online) discussed the key scientific questions and primary targets for scientific drilling in Northeast Greenland. Three pre-proposals have been initiated during the workshop targeting Morris Jesup Rise, Northeast Greenland continental shelf and Denmark Straight.

Do Calabrian Arc diapirs return lower plate mantle from the oldest ocean on Earth?

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Do Calabrian Arc diapirs return lower plate mantle from the oldest ocean on Earth? Polonia A., Gasperini L., Asioli A., National Research Council, Institute of Marine Sciences, Bologna, Italy Bonatti E., Lamont-Doherty Earth Observatory of Columbia University, Palisades, NY 10964, USA Hensen C., GEOMAR Helmholtz Centre for Ocean Research, Kiel, Germany Morgan J. P., Department of Ocean Science and Engineering, SUSTech, China Ruffine L., Unité des Géosciences Marines, IFREMER- Centre de Bretagne, Plouzané, France Vannucchi P., Department of Earth Sciences, University of Florence, Italy Geologic processes at subduction zones affect geochemical cycling and fluxes, seismicity, crustal and mantle evolution, in addition to the microbiological activity nurtured by fluid circulation. Slab-derived fluids and materials may ascend to the seafloor, which leads to the formation of serpentinite mud volcanoes. This usually occurs above mantle wedges, for example in the Mariana Arc. The only site where serpentinite diapirs are observed to intrude the accretionary wedge directly from the lower plate mantle is at the Calabrian Arc. Here, deep serpentine diapirism is linked to lithospheric faults produced by arc-orthogonal margin segmentation. The presence of serpentinite in these diapirs has been inferred by indirect methods, such as seismic reflection images, quantitative modelling of potential field data, and the observation of high Vp/Vs values in these regions. All mapped diapirs terminate too deep within the sediments of the overlying accretionary prism to be sampled with conventional piston-coring. This is the leading scientific motivation for a drilling project. A MagellanPlus workshop held in September 2022 at ISMAR-CNR in Bologna, was designed to discuss the rationale to submit an IODP proposal to drill and core the serpentinite diapirs intruding the Calabrian Arc subduction system. The workshop involved a broad scientific community, ranging from sedimentologists, geophysicists, geochemists, seismologists to microbiologists. The workshop program was conceived to discuss among a multidisciplinary community the questions and concerns raised by SEP on the 968_Pre SCYLLA proposal (submitted Oct. 2019). The workshop successfully identified main synergic research lines and strategies that will be developed as a Mission Specific Platform (MSP) proposal to be submitted in the near future. Understanding mantle serpentinization is critical to reconstruct the dynamics of plate tectonics. The Calabrian Arc is a unique place on Earth where drilling will make it possible to reconstruct the entire lifecycle of sub-continental peridotites: from rifted continental margins, to subduction zones, to eventual mountain building at the close of a Wilson Cycle. Subducting slab may be pervasively hydrated in the plate-bending region near the oceanic trench. However, the depth extent of hydration is not yet well constrained and most studies investigate young incoming plates, leaving subduction-zone water budgets for old subducting plates uncertain. SCYLLA will address hydration state of the incoming plate where destructive historical earthquakes caused about hundreds of thousands of victims during the last centuries.

Mantle Remelting and hydrothermal chemical EXchange at Knipovich Ultraslow Spreading ridge

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The oceanic lithosphere is the fundamental zone for thermal and mass exchange between Earth's deep interior and its surface. “MAREXKUS” (MAntle Remelting and hydrothermal chemical EXchange at Knipovich Ultraslow Spreading ridge) is a MagellanPlus workshop aimed at gathering specialists from multiple disciplines (tectonics, geophysics, petrology, sedimentology, biogeochemistry) willing to develop an MSP-type scientific drilling proposal targeting the oceanic mantle, lower crust and overlaying sediments at Knipovich Ridge. The workshop will be held in Rome, on March 1-3, 2023. Knipovich is an almost 500 km-long ultraslow Arctic spreading ridge (14-17 mm/yr full spreading) characterized by a high obliquity (35°-50° between spreading direction and ridge axis) and consisting of a series of pull apart basins with sparse magmatic activity (Okino et al, 2002). This long transform-free ridge is bound to the north by the Molloy transform fault and to the south bends into the Mohns Ridge. Basalts, recovered from volcanic centres, have distinctly high Hf isotope ratios, not mirrored by comparatively high Nd and low Sr and Pb isotope ratios (Blichert-Toft et al., 2005; Sanfilippo et al., 2021). This suggests anomalously high proportions of ancient, highly depleted mantle formed either by multiple melting events in an asymmetric melting region or by the occurrence of subcontinental mantle stripes. Notably, ridge morphology, magnetic and gravity data (Okino et al., 2002) indicate that these volcanic centres are separated by 60–110 km long amagmatic segments characterized by aseismic deformation (Meier et al., 2021). Mantle and lower crustal rocks have been recovered at oceanic core complexes identified at the connection between Knipovich and Mohns Ridge (Pedersen et al., 2007; Bruvoll et al., 2009), whereas the origin of the basement in the amagmatic segments remain unresolved (Kvarven et al., 2014). Another unique aspect of Knipovich Ridge is its vicinity to the Norwegian continental margin. The proximity of the ridge to a glacial margin with high sedimentation rates causes a high sediment discharge into the rift axis. Hence, the element exchange at Knipovich is controlled to some extent by the presence of sediments, but this process is poorly understood. In summary, Knipovich Ridge provides a unique opportunity to study the interplay between mantle alteration, volcanism and sedimentation. This makes it a compelling target for a drilling proposal that integrates several aspects of the 2050 Science Framework, including the formation of the oceanic lithosphere, mantle alteration and global geochemical cycles. We therefore believe that a MSP-type drilling proposal would capture the interest of a large part of the IODP community.
References: Blichert-Toft J. et al., 2005, Geochem. Geophys. Geosyst.6, Q01E19.; Sanfilippo A. et al., 2021, Earth Planet. Sci. Lett 566; Okino K. et al., 2002. Earth Planet. Sci. Lett.202, 275–288.; Meier M. et al., 2021. Geochem. Geophys. Geosyst. 22, e2020GC009375; Bruvoll, V. et al., 2009, Tectonics 28; Kvarven et al., 2014. Mar. Geophys. Res.35, 89–103.
Specific_Interests petrology of Mid Ocean Ridges, oceanic accretion, neotectonics of ocean basins, chemical exchange between oceanic basement and ocean

Testing the Ontong Java Nui hypothesis

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Testing the Ontong Java Nui hypothesis Takashi Sano1, Maria Luisa G. Tejada2, Jörg Geldmacher3, and IODP 967-Full2 Scientists 1 Department of Geology and Paleontology, National Museum of Nature and Science, Japan 2 Volcanoes and Earth's Interior Research Center (VERC), Research Institute for Marine Geodynamics (IMG), Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Yokosuka, Kanagawa 237-0061, Japan 3 GEOMAR Helmholtz Centre for Ocean Research Kiel, Germany Abstract The following IODP 967 Full2 has been recommended to forward to JRFB by SEP in July 2021, but the proposal was not considered for scheduling on the JOIDES Resolution due to its geographic location relative to the current ship track. We would like to submit similar proposal in future Scientific Ocean Drilling with Mission-Specific Platforms and Chikyu. Large Igneous Provinces (LIPs) such as the Ontong Java Plateau (OJP) in the western equatorial Pacific provide information on mantle processes and composition, and their formation may have had global environmental consequences. The OJP is the largest oceanic plateau and is probably the most voluminous igneous edifice on Earth. Despite its importance, the size, volume, and formation rate of the OJP are not yet well constrained. The maximum extent of OJP-related volcanism may be even greater than currently estimated, because volcanological studies indicate that long lava flows (or sills) from the OJP may have reached the adjacent Nauru, East Mariana, and possibly Pigafetta basins. Moreover, the similarity in age and geochemistry of lavas from the Ontong Java, Hikurangi, and Manihiki plateaus suggests that they may have formed together as a single LIP (Ontong Java Nui, OJN). If true, OJN's magma source would have involved a major part of Earth's upper mantle (16-48 % of mid-Cretaceous asthenosphere!), presumably lower mantle, and possibly some core material. The lack of detailed knowledge of the size, age, and composition of the OJP has given rise to various models such as a surfacing mantle plume head, bolide impact, and fusible mantle melting, but no model satisfies all observational data and no consensus has been reached on its origin. Likewise, geodynamic effects, evolution, and hydrothermal alteration of the OJP have not been clarified yet. The OJP is divided into the High Plateau to the west and the Eastern Salient to the east. Basaltic basement of the OJP has been cored at seven Deep Sea Drilling Project (Site 289) and Ocean Drilling Program (Sites 803, 807, 1183, 1185, 1186, and 1187) sites – but these are exclusively located on the High Plateau. Assuming that the proposed OJN reconstruction is correct, the approximate center would be the Eastern Salient, the crust and lithosphere of which may have been thinned by rifting and breakup of the various plateaus. Therefore, the Eastern Salient is the best area to test the OJN hypothesis. In order to examine the true extent of the OJP (i.e., whether the flows in the Nauru, East Mariana, and Pigafetta basins, as well as the Manihiki, and Hikurangi plateaus are parts of the OJN), we propose drilling five sites on the Eastern Salient and adjacent basins to recover sediment and igneous basement samples with variable compositions

Drilling for lavas from two types of oceanic crust will reveal the origin of the Moho beneath fast-spreading centers

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Hypotheses to be tested: • Where the Moho can be detected clearly in the Pacific Plate, the overlying oceanic crust is systematically thicker and water depth shallower. • A clear Moho is caused by a dunitic residue produced by the hydrous melting of mantle peridotite triggered by seawater reaching the base of the crust. • The hydrous melting, in addition to the normal decompression melting, increases the thickness of the oceanic crust by enhancing magma production. • Thus, lavas from the oceanic crust having clear Moho reflections have a boninites component derived from the hydrous mantle melting, in addition to a normal MORB component.
Abstract It is common knowledge that the Moho is the boundary between the crust and the Earth's mantle. Here we show along several seismic profiles through the Pacific Plate that a correlation exists between the strength of Moho reflections, crustal thickness, and water depth. Where the Moho can be detected clearly, the overlying oceanic crust is systematically thicker and the water depths are shallower. We suggest that two end-members of oceanic crust exist in fast spreading environments: one thick, underlain by a clear Moho; the other thinner, without a Moho; with all intermediate situations. In the Oman ophiolite, the best-preserved on-land analogue of fossil oceanic lithosphere created by fast-spreading, the boundary between the mantle peridotites and the lower crustal gabbros mainly consists of a dunitic transition zone (DTZ) ranging from a few meters to a few hundred meters in thickness. A sudden influx of seawater down to the base of the crust at the mid-ocean ridge (MOR) results in the hydrous (re-)melting of mantle peridotites, producing a dunitic residue at the crust-mantle boundary that represents the most reflective Moho. At the same time, the hydrous melting, in addition to the normal decompression melting, beneath the MOR, increases the thickness of the oceanic crust by enhancing magma production. In the absence of hydrous melting, the DTZ is thin or absent at the crust-mantle boundary, and instead the uppermost mantle harzburgite is intruded by gabbros, and/or the overlying crustal gabbro is intruded by numerous wehrlite bodies, which will be seismically gradational.

The Renaissance of the oldest Pacific sediments: Trans-Pacific records of co-evolution of geochemistry, marine ecosystem, and sediment lithology in the pelagic realm

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The Renaissance of the oldest Pacific sediments: Trans-Pacific records of co-evolution of geochemistry, marine ecosystem, and sediment lithology in the pelagic realm

I Abstract
The Pacific Ocean has been the largest ocean during the Mesozoic and Cenozoic and contains various types of sediments on the seafloor. Previous studies focused mainly on carbonate-bearing sediments to discuss the oceanic, biological, and geochemical evolution. However, chert and pelagic clay also have comparable, or complementary, information to that of carbonate. Radiolarian shells in chert were the main component of the pelagic siliceous sediments during the Mesozoic, and their diversity should have reflected local to global environmental changes. Recent studies on pelagic clay discovered that transient increase of the fish debris (teeth/bones) accumulation occurred repeatedly in the Pacific Ocean. For the complete understanding of the oceanic and biological evolution since the Mesozoic, it is essential to utilize the chert and pelagic clay as well as carbonate.
This proposal aims to recover the latest Jurassic to Cenozoic sediments on the Pacific abyssal plain and around Shatsky Rise. Our primary objectives are (1) to elucidate the changes in marine biota across the Jurassic-Cretaceous boundary (JKB), (2) to understand the long-term transition from a Mesozoic chert-rich ocean to a Cenozoic chert-poor ocean including a change in diversity of radiolarians, and (3) to decipher the environmental change recorded as an enrichment of fish remains, and rare-earth elements, in the pelagic clay during the Late Cretaceous and Cenozoic.
To study the turnovers of marine biota at pelagic sites in the Pacific Ocean across the JKB, both siliceous and calcareous fossils are required to be preserved. A promising sediment succession across the JKB could exist underneath the seafloor at
the middle flank of Shatsky Rise (Site SR-01A/SR-03A; nearby ODP Site 1213). For investigating the transition from a Mesozoic chert-rich ocean to a Cenozoic chert-poor ocean, it is critical to confirm the lithological change from the chert/silica-rich sediments to the clayey/silica-poor sediments and to elucidate factors (e.g., environmental changes and/or physicochemical processes during early diagenesis) that caused the lithological change. Drilling at DSDP Site 198, north of Minamitorishima Island, can recover this transition. To verify the relationship among the enrichment of fish remains (or rareearth
elements), paleoceanographic conditions, and geochemical cycles, a complete set of pelagic clay of the Cretaceous to Paleogene is required. For these purposes, we propose drilling of sediments in the southern foot (Site SR-02A/SR-04A) of Shatsky Rise, and north of Minamirtorishima (Site MM-01A/MM-02A).

Investigating East Gondwana rifting to breakup processes at Naturaliste Plateau and Mentelle Basin, offshore SW Australia

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The unique tectonic and paleoceanographic setting of the Naturaliste Plateau (NP) and Mentelle Basin (MB) offers an outstanding opportunity to investigate a range of scientific issues of global importance, with particular relevance to advancing understanding of extensional tectonic systems and exploring interactions between the atmosphere, hydrosphere, biosphere, lithosphere, and deep mantle through all stages of extension - from incipient continental rifting through breakup and formation of rifted continental margins and finally to formation and evolution of seafloor spreading systems. Late Jurassic through Early Cretaceous rifting between Australia-Antarctica and Greater-India culminated in the breakup of the supercontinent Gondwana and opening of the Indian Ocean. Seafloor spreading was established at 132-133 Ma on the Perth Abyssal Plain, adjacent to the central part of the southwestern Australian continental rifted margin, and at 126-124 Ma to the west of the Naturaliste Plateau, on the southwestern part of the margin. Extension between the NP and continental shelf formed the deep-water Mentelle Basin (MB) during this interval. Breakup on the southwestern Australian margin was accompanied by eruption of the Bunbury Basalt in the Perth Basin beneath the continental shelf from 137-130 Ma. Volcanism on NP is indicated by similar age basalts dredged (132-129 Ma) and drilled at only one IODP Expedition 369 Site U1513 (135-128 Ma), where the eastern NP is onlapped by syn-rift strata of the western MB. Based on more detailed study of seismic sections, the drilled volcanic unit may form part of a laterally extensive (up to 20 km) flows interbedded within the volcaniclastic unit (age 134-126 Ma) overlaying the basalts at Site U1513 (Harry and Guerzon, AGU FM 2021). It is inferred that the NP, MB, and southern Perth Basin hosted a broad eruptive complex during the final stages of breakup associated with the Grater Kerguelen Large Igneous Province spread across modern-day India, Australia and Antarctica. We propose a drilling transect across the NP from the Perth Abyssal plain/north margin of the NP, on the NP, then finally on Diamantina zone using the D/V Chikyu. The transect can trace the various stages of rifting, breakup, and ocean development and their associated modes of melting over different mantle temperatures. Defining the extent and evolution of magmatic processes in response to rifting in the NP, MB and southern Perth Basin needs to be tested by new drilling initiatives since such large-scale volcanism may have had an impact on the Early to Mid-Cretaceous atmosphere and biosphere through changes in paleoclimatic conditions.

Activity, response, and impact of Earth's gas hydrate system during environmental changes

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Gas hydrate has occurred naturally in high-pressure and low-temperature environments with high hydrocarbons (predominantly methane) concentrations, such as the sediments in continental margins, permafrost regions, and inland lakes. The formation of gas hydrate accumulates a vast amount of methane and solidifies the sediment structure in the higher-pressure/lower-temperature term. That probably stabilizes the environments including gas hydrate. However, the gas hydrate dissolves due to the pressure-drop/temperature-increase. That liberates a vast amount of methane into the surrounding environments and destabilizes the sediment package, possibly resulting in anoxia and landslide at various spatial/time scales. Therefore the formation/dissolution of gas hydrate might have been induced by environmental changes and have caused environmental impacts during the Earth's history. A number of geological signals indicating the linkage to methane activities have been reported, such as carbonate, microfossils, topography, stratigraphy, seismic records, etc. However, it is still unclear how the gas hydrate stability subsequently responded to the environmental change, e.g., did it enhance or reduce the environmental impacts? In addition, the gas hydrate fields often accompany methane seepage (high methane flux), reflecting an active migration of deep-thermogenic/biogenic materials to the Earth's surface. Because the subseafloor biosphere is associated more or less with thermal degradation compounds, the change of the gas hydrate system might have also affected the deep ecosystem. This proposal primarily aims to compare the responses of gas hydrate deposits to global environmental changes by integrating the results from different gas hydrate fields in marine-permafrost-lake conditions (in various latitudes, water depths, gas hydrate occurrences, etc.). This comparative land-to-ocean research quantifies the scale, timing, and impact of gas hydrate activity during the Earth's history

Origin of the Pacific plate: Bridging from the past into the future - the impact of Earth's largest oceanic seafloor province on climate and habitability of life

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We propose a drilling campaign in the western Pacific to understand the origin of the Pacific plate. The Pacific plate is the Earth's largest seafloor province, covering the 1/3 of Earth's surface today. The Pacific plate has evolved over time while impacting climate and plate tectonic activity through interactions with the atmosphere, hydrosphere, lithosphere, asthenosphere and biosphere. The birth of the Pacific Plate coincides with the breakup of the last supercontinent Pangea and signals the beginning of the current Wilson cycle. Processes in Earth systems that enabled the initial formation of the Pacific plate has been unknown, except for geological evidences suggesting that the plate eventually expanded over time by three fast-spreading mid-ocean ridges. A series of recent near-source marine magnetic studies in the western Pacific have successfully narrowed down a seafloor region bounded by M42-M44 age, encompassing the geographical origin of the Pacific plate within. By obtaining samples from the basement of this region (cf. ODP Site 801), we will be able to address source, distribution and time-series of magmatic processes that were responsible for the initiation of the Pacific seafloor formation. Geochemistry and geomagnetic record acquired from cored samples will manifest connection between outer-core/lower-mantle to upper mantle activities at the onset of this tectonic cycle. Obtained core materials from such deep environment in time (~ 170Ma or older) and space (~ 6000m water depth) will ultimately provide insights on deep biosphere as well as heat, fluid and chemical cycle through oceanic lithosphere impacting Earth's climate system since the inception of the Pacific plate formation to date. Numerical prediction using overall results from this drilling/coring effort will shed new light on planetary magmatism, volcanism, plate tectonics, and habitability of life in extra-terrestrial environments.

Drilling Mature Oceanic Crust on North Arch off Hawaii

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We propose to drill using Chikyu on the North Arch off Hawaii, a complete section down to cumulate gabbros of mature (~80 Ma) upper ocean crust formed at a half spreading rate of ~3.5 cm/a. This region is one of the three candidate sites of the MoHole to Mantle (M2M) project. Mantle drilling is one of the flagship initiatives of 2050 Science Framework. Our overarching goal is to drill a pilot hole to inform the design of a future MoHole and gain experience in deep hard rock drilling with Chikyu. The formation of new ocean crust at mid-ocean ridges, its subsequent aging over million years leading to subduction, arc volcanism, and recycling of some components into the mantle comprises the dominant cycle of matter and energy on Earth. The average age of the Earth's ocean crust is ~63 Ma and the average age of ocean crust being subducted is ~79 Ma. Although, there are some drillholes in old (>110 Ma) and young (100 m) into mature intact average age ocean crust that records the full history of seawater-basalt exchange. With the proposed drilling we will investigate the physical, chemical, and biological architecture and evolution of the ocean crust to test three major hypotheses, that: (1) the North Arch crust spread at an intermediate rate will comprise an intact 740–820 m-thick extrusive sequence with 50:50 pillow and sheet flows, overlying a thick (1,770–880 m) sheeted dike complex (Challenges 8, 9); (2) hydrothermal exchanges between the ocean crust and seawater are episodic and the extent of fluid-rock exchange does not just reflect the age of the crust but external factors that enhance fluid flow and reaction (Challenges 10, 13, 14); (3) in ocean crust cooler than the thermal limit to life, water-rock interactions sustain microbial life as deeply as seawater-derived fluid penetrates (Challenges 5, 6). Drilling will provide additional insights into the North Arch volcanism and the hazardous giant landslides from the Hawaiian volcanoes (Challenges 8, 12). The drilling operation will be conducted in three stages: Stage 1 coring sediment to below the sediment-basalt interface (Hole A), drilling and coring basement to 1,130 mbsf and setting casing (Hole B); Stage 2 (Hole B) coring and setting casing to 1,730 mbsf; and Stage 3 coring to 2,500 mbsf and penetrating through the Layer 2-3 transition and into the uppermost cumulate gabbros without casing.