IODP³ INTERNATIONAL OCEAN DRILLING PROGRAMME

PROPOSAL 1103-FULL

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

IODP^3 Proposal Cover Sheet

Proposal Title:

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

Broad Geographic Area of the Proposal

Shatsky Rise, North of Minamitorishima (Marcus) Island

Project 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 rare earth 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).

Scientific Objectives

Our primary objectives are:
(1) We elucidate the changes in marine biota across the Jurassic-Cretaceous boundary (JKB). The decision of the Global Boundary Stratotype Section and Point (GSSP) of the JKB is an urgent task because the JKB is the last system boundary without stratotype in the Phanerozoic. The pelagic records can critically constrain the evaluation of GSSP sites. Our project provides a unique opportunity for scientific ocean drilling to make a profound contribution to the selection of the primary and secondary markers for the first time in the history of stratigraphy.
(2) We understand the long-term transition from a Mesozoic chert-rich ocean to a Cenozoic chert-poor ocean including a change in diversity of radiolarians. During the Mesozoic Era, thick beds of chert were widely deposited on the seafloor of the Pacific Ocean. The biogenic silica producers in the pelagic Pacific have changed dramatically from Mesozoic thick-walled radiolarians to Cenozoic thin-walled radiolarians and diatoms. The proposed drilling will reconstruct the longest history of the biological evolution and lithological change since the Mesozoic to the present ocean.
(3) We decipher the environmental change recorded as an enrichment of fish-remains in the pelagic clay during the Late Cretaceous and Cenozoic. Recently, multiple layers that extremely concentrate fossilized fish remains, and rare-earth elements, were reported. Characterization of the hitherto overlooked variability of pelagic clay, which could be one of the largest reservoirs of rare-earth elements in the Earth’s surficial system, should shed new light on the evolution of global geochemical cycles.

Science Communication Plain Language Summary

The Shatsky Rise, a massive underwater plateau in the northwest Pacific Ocean, holds valuable clues about Earth's ancient oceans and climate. This research proposal aims to drill into the ocean floor to uncover 150 million years of history, helping us understand changes in marine environments, ocean circulation, and global climate.
Most previous deep-sea drilling studies have focused on carbonate sediments, which form from marine calcareous plankton. However, this project will also explore lesser-studied materials such as chert (silica-rich

rock) and pelagic clay, which could reveal new insights into how Earth's oceans and ecosystems evolved over time.

One key goal is to study the Jurassic-Cretaceous Boundary, a period of major environmental change that remains poorly understood. By comparing sequences from the Pacific with those from the Tethys Ocean, we hope to better define this critical boundary in Earth's history. Another objective is to investigate why the Pacific Ocean shifted from being rich in chert during the Mesozoic Era to being dominated by pelagic clay in the Cenozoic Era. This shift may be linked to the evolution of microscopic marine life and changes in global ocean chemistry. The project will also examine the accumulation of fish remains in deep-sea sediments, which could help us understand long-term changes in ocean productivity and marine life. These fish remains are important because they act as natural markers of past ocean conditions and even help store rare earth elements, which are crucial for modern technology.

To achieve these goals, the research team plans to drill at multiple locations on and around Shatsky Rise, creating depth and latitudinal transects to compare past ocean conditions. We will use advanced techniques such as isotope analysis and X-ray imaging to reconstruct ancient marine environments and geochemical cycles.

This study has broad implications for understanding climate change, ocean circulation, and the long-term stability of Earth's ecosystems. The findings could help predict how modern oceans may respond to environmental changes in the future. Additionally, the project aligns with global scientific initiatives, contributing to a better understanding of Earth's climate system, ocean biodiversity, and material cycles.

By exploring deep-sea sediments in a previously under-studied region, this research will provide a clearer picture of how Earth’s oceans have changed over millions of years, helping us better prepare for the challenges of a changing climate.