



INTERNATIONAL OCEAN DRILLING PROGRAMME

PROPOSAL 1109-PRE

Go Beyond the Limit (GBL) drilling: How, why,
and where does life become extinct, and what
lies beyond the limit?

IODP³ Proposal Cover Sheet

Proposal Title:

Go Beyond the Limit (GBL) drilling: How, why, and where does life become extinct, and what lies beyond the limit?

Broad Geographic Area of the Proposal

West Pacific ocean

Project Abstract

The "Go Beyond the Limit (GBL)" drilling project aims to define the environmental boundaries of Earth's biosphere by systematically exploring seafloor sediments in the Nankai Trough. Despite previous deep drilling expeditions revealing microbial life at high temperatures and depths, the precise termination point of the biosphere remains unknown. GBL will target sedimentary horizons exceeding 160°C—far beyond the known upper temperature limit for life—to identify where and how life ceases, and to characterize the physicochemical conditions of truly lifeless environments. Sedimentary environment entraps microbes in its fine structure and is the best target to explore the limits of life. The project will address three key objectives: (A) identifying the location and nature of biosphere termination and the factors controlling it, (B) elucidating structural and functional changes in microbial communities as they approach the biosphere's edge, and (C) distinguishing geochemical signatures of abiotic versus biotic realms. By leveraging state-of-the-art coring, contamination-minimizing sample handling, and advanced molecular and geochemical analyses, GBL will provide unprecedented insights into the limits of life on Earth, inform models of planetary habitability, and advance both deep biosphere science and astrobiology. The outcomes will also contribute to international frameworks for scientific drilling, aligning with the goals of IODP³.

Scientific Objectives

(A) Determination of Biosphere Termination: Identifying the precise location/mode of termination of the biosphere and deciphering the factors that govern the limits.

(B) Examining Microbial Communities Responses: Understanding the structural, functional, and activity changes that occur within microbial communities as they approach the biosphere's fringe.

(C) Exploring Lifeless Conditions: Understanding the physico-chemical conditions of environments that are devoid of life.

Science Communication Plain Language Summary

The "Go Beyond the Limit (GBL)" drilling project is an international scientific effort to find out where and why life stops existing deep beneath the ocean floor. While scientists have discovered tiny life forms living in very harsh conditions—such as high temperatures and great depths—nobody knows exactly how deep or hot life can survive underground.

To answer this question, we will drill deep into the seafloor in the Nankai Trough, off the coast of Japan, targeting areas where temperatures rise above 160°C—much hotter than any known life can survive. By collecting and studying these deep sediment samples, we hope to discover the true limit of life on Earth.

The project has three main goals:

- To pinpoint exactly where life ends beneath the seafloor and understand what causes it to stop.
- To study how the last surviving microbes adapt as conditions become more extreme.
- To examine what the environment looks like in places where life no longer exists.

This research will help us understand the boundaries of life on our planet, provide clues about where life might exist elsewhere in the universe, and improve our knowledge of how life survives in extreme environments.