

Exploring multi-spheres interactions through scientific ocean drilling: A perspective from the deep biosphere

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Over the past decades, scientific ocean drilling has explored seafloor environments at various oceanographic and geological settings, which resulted in numerous discoveries on Earth's planetary sub-systems—the atmosphere, hydrosphere, geosphere, and biosphere. The dynamism fostering the co-evolution of life and the Earth system is principally constrained by extra- and intra-terrestrial energy sources. The lithosphere consisting of sediments, crusts and upper mantle plays a significant role as an interface between the Earth's asthenosphere and the overlying hydrosphere and atmosphere. Drilling deep into the Earth's lithosphere has significantly expanded our understanding of Earth's sub-systems and will continue to do so in the future. To date, only little is known about how Earth's various spheres interact, despite the awareness that such spheres connect and interact with each other. Building this knowledge will provide useful insights at various levels into the past, present and future of our Earth and human society.

With respect to the deep biosphere, accumulating evidence from ocean margin sites indicates that remarkable numbers of anaerobic microbial cells are present at least down to at least ~2.5 km below the ocean floor¹. In open ocean sites, the occurrence of microbial communities and oxygen was observed in the entire sediment column of the ultra-oligotrophic South Pacific Gyre, qualifying up to ~37% of the global oceanic sediment as aerobic biosphere². These recent findings through scientific ocean drilling have characterized the deep biosphere as one of the important Earth's sub-systems, where microbial life inhabiting the vast oceanic lithosphere influences whether several important elements are sequestered for millions of years or returned to the ocean as active agents with an impact on life and climate³.

Only a better understanding of the Earth's multi-spheres interactions through scientific ocean drilling will enable informed conclusions regarding the origins and evolution of life, oceans and Earth—the characterization and monitoring of multi-spheres boundaries, including the limits to the deep biosphere, will highlight the organization and interactions of Earth's sub-systems and provide critical information enabling the discovery and utilization of new functions of Earth's multi-spheres deep beneath the ocean.

References

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