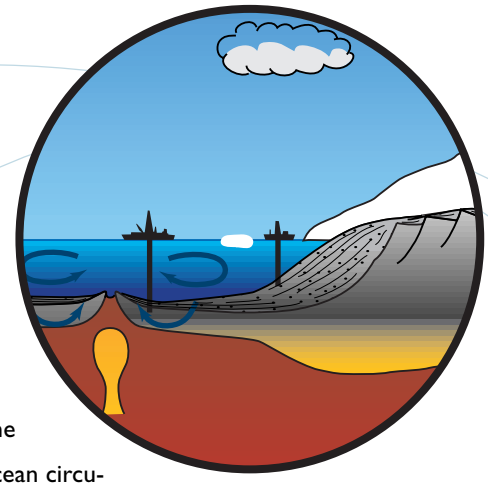
A Vision for Scientific Ocean Drilling

Executive Summary



Earth's surface veneer of seafloor sediment and extrusive volcanic rock represents the most recent snapshot of geologic time. Beneath that veneer, buried in sedimentary sections and the underlying crust, is a rich history of the waxing and waning of glaciers, the creation and aging of oceanic lithosphere, the evolution and extinction of microorganisms and the building and erosion of continents. More than thirty years of scientific ocean drilling have explored this history in increasing detail, revealing the complexity of the processes that control crustal formation, earthquake generation, ocean circulation and chemistry, and global climate change. Drilling has also revealed that deep within marine sediments, rock pore spaces and rock fractures is an active environment where ocean water circulates, microbes thrive and natural resources accumulate.

The Integrated Ocean Drilling Program, planned to begin October 1, 2003, envisions an ambitious expansion of exploration beneath the oceans, made possible by increasing drilling capability, from the single-ship operation currently in use, to the multiple-drilling platform operation of the future. The centerpiece of IODP's deep-water efforts will be a brand new riser-equipped, dynamically positioned drillship, to be provided and operated by JAMSTEC (Japan Marine Science and Technology Center). This vessel will be partnered with a modern, non-riser, dynamically positioned drillship, a successor to the Ocean Drilling Program's *JOIDES Resolution*, to be supplied and operated by the US National Science Foundation. These drillships will be supplemented with additional drilling platforms as needed (e.g., drilling barges, jack-up rigs and seafloor drilling systems). European and circum-Pacific nations are establishing initiatives to provide some of these "mission-specific" drilling technologies. Enhanced downhole measurement devices and long-term seafloor observatories complete the suite of sophisticated, state-of-the art tools planned for the new program. This new technology and multiple-platform approach will allow scientists to conduct experiments and collect samples in environments and at depths never before attempted.

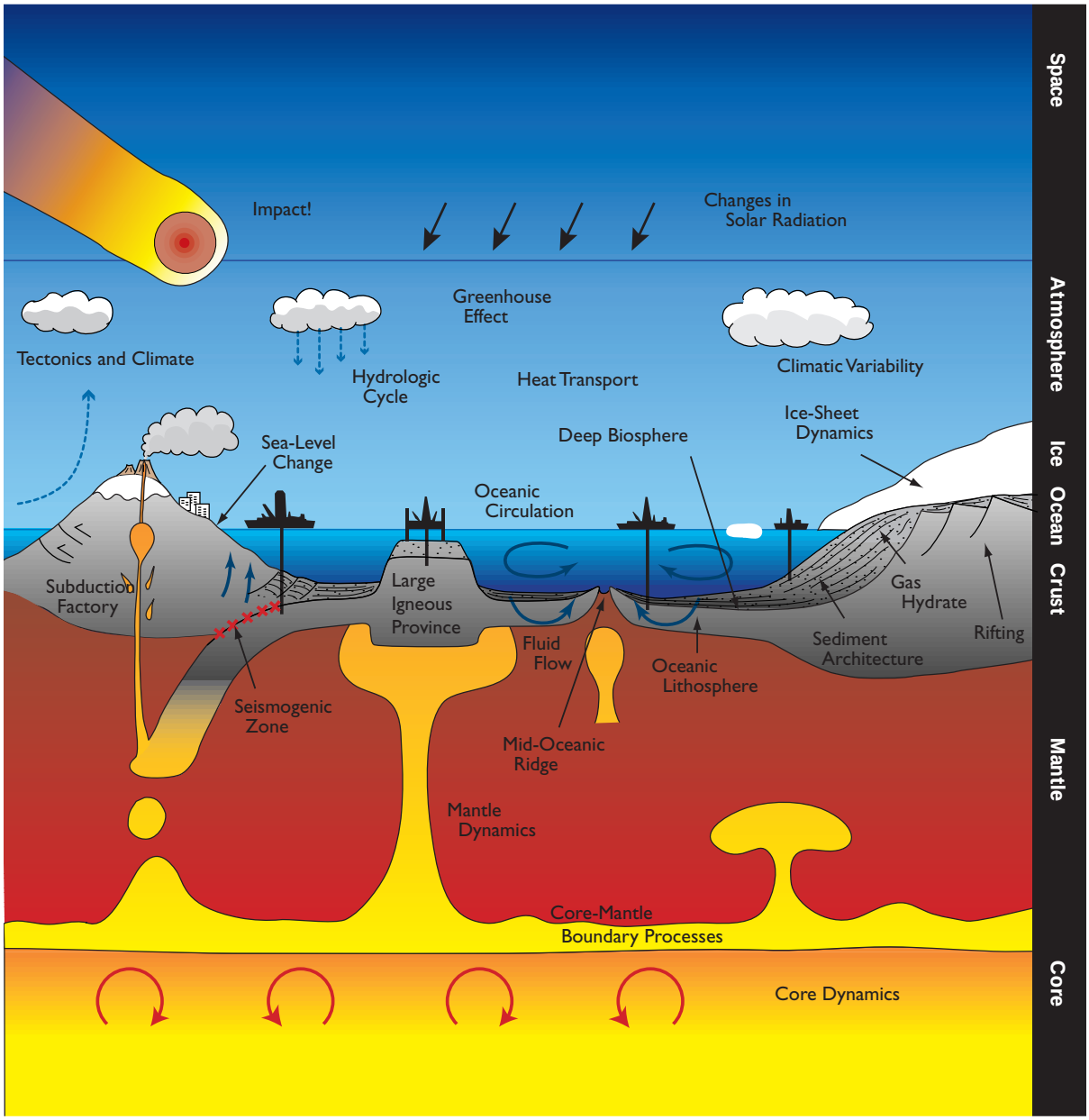


Figure 1. Earth system components, processes, and phenomena. Figure courtesy of Asahiko Taira, University of Tokyo.

The international community of ocean drilling scientists has devised a bold new strategy for investigating the Earth system that takes full advantage of these new drilling, sampling and observing capabilities. The IODP Initial Science Plan organizes scientific study by major Earth processes, encouraging specialists to broaden their proposals to include cooperative work with colleagues in related disciplines. Using the new multiple-platform approach to scientific ocean drilling and a new process-oriented approach to research, IODP will focus on three broad scientific themes:

- **The deep biosphere and the subseafloor ocean.** New evidence suggests that vast microbial populations may live within a broad range of temperatures and pressures, where sediment and rock appear to provide life-sustaining resources. Microbes that characterize these extreme environments are now broadly considered a potential source of new bio-materials and are the basis of ideas for new biotechnical applications, such as water treatment and microbially enhanced oil recovery. Little is known about the architecture and dynamics of the vast subseafloor plumbing system, where flowing water alters rock, influences the chemical composition of the ocean, lubricates seismically active faults, concentrates economic mineral deposits and may teem with life. IODP will probe this environment globally, providing the first comprehensive characterization of this ocean below the seafloor.

- **Environmental change, processes and effects.** Ocean sediments provide a unique record of Earth's climate fluctuations and permit detection of climate signals on four time scales: tectonic (longer than about 0.5 m.y.); orbital (20 kyr to 400 kyr); oceanic (hundreds to a few thousand years); and anthropogenic (seasonal to millennial). Studies of drill cores indicate that the pace of climate change has varied over time, from gradual to abrupt. What needs to be fully explored, however, is what initiates these changes, how they are propagated, what circumstances amplify or reduce the climatic effects of large and small events and what processes bring about change in Earth's environment. IODP will recover cores from as yet poorly sampled environments, such as the Arctic Ocean basin, atolls, reefs, carbonate platforms, continental shelves beneath very shallow waters and settings where sediments accumulate very rapidly (especially anoxic basins). Combined with drilling results from a global array of sites, these new sediment samples will allow a more sophisticated analysis of the causes, rates, sequencing and severity of change in Earth's climate system over all time scales. They also permit a more thorough investigation of the relationship among climate extremes, climate change and major pulses in biological evolution.

- **Solid earth cycles and geodynamics.** The vast amount of energy stored within the Earth is regularly brought to our attention by transient and often destructive events such as earthquakes, volcanic eruptions and tsunamis. These punctuating events are part of the solid Earth cycle, which involves the creation and aging of oceanic crust, its recycling at subduction zones and the formation and evolution of continents. The rates of mass and energy transfer from the mantle to the crust and back again are not constant through time. The causes of these variations and their influences on the global environment are poorly understood. Using new IODP technologies, some pioneered by DSDP and ODP, researchers will sample and monitor regions of the seafloor that currently have the greatest mass and energy transfers, as well as regions where these transfers were largest millions of years ago. IODP will also drill deeper into Earth's crust than ever before, providing new insight into—and perhaps answers