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Ocean Drilling: Successes, Opportunities and Challenges

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Preface

The Ocean Drilling Program (ODP, 1985-2003) and its predecessor, the Deep Sea Drilling Project (DSDP, 1968-1983), together are widely regarded as the most successful international earth science program ever conducted. Outstanding scientific achievements over the past 33 years include validation of the theory of plate tectonics; advances in our understanding of the formation, structure and composition of ocean crust; quantitative studies of past climate change; the birth of paleoceanography; and recognition that the Earth's biosphere extends deep under the seafloor, to name but a few. Canada joined ODP in 1985 and has been an active participant ever since. Many Canadian scientists have participated in this international program by proposing holes to be drilled in the world's ocean basins, participating in scientific studies aboard the *Glomar Challenger* and the JOIDES *Resolution*, and using ODP data in their research and teaching. The Ocean Drilling Program ends in September 2003, to be replaced by a new, larger, more ambitious project, the Integrated Ocean Drilling Program (IODP), involving the use of a riser-equipped ship (risers are steel pipes extending down from the drillship to the seafloor to control drilling fluids and hydrocarbons), an improved non-riser vessel, and alternate platforms for drilling in shallow water and the Arctic.

To highlight accomplishments of the current program and outline the evolving IODP program, a technical session titled "ODP's 100 Greatest Hits" was held during the GeoCanada 2000 Millennium Conference in Calgary 1 June 2000, sponsored by six Canadian scientific and technical societies[1]. The technical session, sponsored by the Canadian Society of Exploration Geophysicists and the Geological Association of Canada, included eight oral and two poster presentations. This issue of *Geoscience Canada* contains overview papers from three of the GeoCanada 2000 presentations, and three additional overview papers not given at GeoCanada 2000. These six papers provide examples of the range of topics addressed in ODP studies by Canadian scientists, and the remarkable accomplishments achieved.

Despite much progress, many problems remain unanswered which will require further ocean floor sampling, often in more difficult and unusual environments than those sampled previously: this will be the focus of the new IODP program. Kathryn Gillis notes that, although we have learned much about ocean crust origin, we understand neither the diversity of its composition and structure, nor the fluxes and rates of matter and energy transfer in the ocean/oceanic crust and their importance to global geochemical and climatic cycles. To address this we need to drill, sample and monitor the oceanic lithosphere at greater depths. Progress so far is impressive in quantitative measurement of fluid flow and geochemistry from long term observatories installed in drilled holes as discussed by Earl Davis and Keir Becker. Fluid circulation seems to prevail at great depths and may have introduced microbes deep into the oceanic crust. Newly developed sampling/monitoring devices already in use will provide the ability in IODP to remotely monitor and sample the dynamic oceanic environment of changing pressures, temperatures, and fluid compositions, also crustal seismicity and tectonic strain (see cover, this issue). There are enormous accumulations of gas hydrates — essentially methane in ice "cages" — present on continental margins as discussed by George Spence and Roy Hyndman. How stable are these accumulations; can they be tapped as energy sources; and what is their role in changing climate, especially in Arctic regions where sealevel changes easily perturb shallow-depth gas hydrates? These questions will be central to the IODP program. When lithospheric plates rift apart, their conjugate boundaries thin and are either intruded by magmas or cut by listric faults, exposing deeper levels of the crust and mantle as discussed by Keith Louden and Helen Lau. Yet it is not known what causes these differences in rifting, partly because drilling has had to be restricted to regions of thin sediment cover over basement highs. We need to sample continental margin basins to greater depths and along long transects to understand the rifting process, another IODP objective.

ODP drilling in fiords has provided high-resolution 10,000+ year records of climatically related biological, geochemical, and sediment changes as discussed by Louis Hobson, Melissa McQuoid, and Verena Tunnicliffe. Continued high-resolution sampling of more of these natural environmental libraries is a high priority in the IODP program. The shapes of continental shelves have been profoundly influenced by glacial cycles, as outlined by Nicole Januszczak and Nicholas Eyles for the Antarctic continental margin. High-latitude climatic changes and their role in influencing global climate remain poorly known because of the difficulty of drilling in these regions, especially in the Arctic. Arctic drilling is one of the high priorities in the IODP program.

Answers to these challenging questions will come from drilling through thick, sometimes hydrocarbon-rich sediments, in the IODP program. New, state-of-the-art technology will be required; planned co-operation with the oil industry is essential. A more detailed account of these and other topics to be pursued in this unique new program is given in the Initial Science Plan of IODP (www.iodp.org).

We are grateful to all contributors to this issue and to their reviewers, as well as *Geoscience Canada* Editor Roger Macqueen for his help in putting together this remarkable group of papers.

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[1] Canadian Geophysical Union (CGU), Canadian Society of Exploration Geophysicists (CSEG), Canadian Society of Petroleum Geologists (CSPG), Canadian Well Logging Society (CWLS), Geological Association of Canada (GAC), and the Mineralogical Association of Canada (MAC).