APLACON CONFERENCE - ALTERNATE PLATFORMS AS PART OF THE INTEGRATED OCEAN DRILLING PROGRAM (IODP)

May 10-12, 2001, Lisbon, Portugal

EXECUTIVE SUMMARY

PREAMBLE

The APLACON meeting was the logical continuation of a series of international meetings to prepare IODP: the CONCORD meeting which established the case for the Japanese Deep Ocean Riser Vessel, and the COMPLEX meeting which established the continued case for non-rise drilling. APLACON addressed the science themes which require technologies other than those provided by the Japanese vessel and the JOIDES Resolution replacement already proposed as part of IODP. The key objective of the meeting was to define a science programme in Polar regions, in shallow water sedimentary environments, and in deep-water, where specialised drilling technology may result in more effective core recovery, thereby demonstrating the necessity for a third core capability of “Mission Specific Platforms” (MSP) in IODP. An important additional aim of this meeting was to incorporate projects involving these MSP in earth science initiatives (e.g. InterMARGINS, Images, InterRidge, Nansen Arctic Drilling, ICDP etc.) which in many cases require drilling with multiple and diverse drilling platforms.

The meeting was sponsored by the ESF, ESCOD, JEODI and the ICCTI, Portugal. It was attended by more than 100 people and involved discussion of approximately 50 drilling proposals. It was organised following a workshop format with four groups (Extreme climates in Earth history; Rapid climate change; Sedimentary basin formation and processes; Solid earth processes) writing position papers. The full report from the meeting will be published in Autumn 2001, along with a partner document “*Technological requirements for Alternate Drilling Platforms* » which presents the results of a meeting hosted by the EC and the ESF in December 2000.

SCIENCE THEMES

A) Extreme Climates in Earth History

I) The Polar Oceans

The Arctic Ocean seabed remains completely unsampled by any scientific drilling program beyond one meter penetration and will be one of the major scientific and technological challenges of IODP. The Antarctic has been drilled by ODP but the scientific results have been hampered by inadequate sediment recovery in diamict on the continental shelf and slope.

Key scientific areas of research to be addressed by dedicated Arctic scientific drilling include:

- History and evolution of Arctic sea ice cover
- Variations in the physical and chemical characteristics of the water masses in an evolving Arctic deep ocean basin, and the oceanographic response to opening of gateways
- Processes of methane release associated with gas hydrate accumulations
- The permafrost record as a proxy for high latitude climate
- The response of the Arctic and Antarctic during periods of extreme polar warmth
- The relative roles of the Arctic and Antarctic as triggers of events in climate history
- History of marine polar biota and fertility
- Tectonic history of the Arctic Ocean and its link to global climate systems

To achieve the scientific objectives in the ice covered polar environments IODP requires an ice-going drilling platform with minimum capabilities equivalent to Polar Class 1. Whilst drilling on the circum-Antarctic continental margin can (in most cases) be carried out as a single ship operation, the thicker and relatively fast moving ice in the Arctic Ocean will require ice management by one or several support icebreakers in all cases.

The necessary data base for definition of optimum drill sites in ice covered water is, with very few exceptions, limited or non-existent, particularly in the Arctic Ocean. A broad multi-national effort with dedicated cruises is needed to collect regional seismic data for identification of target regions. These areas must in turn be subject to follow-up surveys in order to satisfy the site requirements for drillable locations.

II) Abyssal plain-to-shelf transects to reconstruct Cretaceous-Palaeogene hydrography

In order to obtain high-resolution (Milankovitch frequencies or higher) records of Cretaceous-Palaeogene climatic change, it is necessary to sample the most stratigraphically expanded sections. Such sections, in both pelagic and hemipelagic facies, are typically located along continental margins, at a range of water depths. Such studies utilising well-preserved microfossils will yield high-quality geochemical data (^{18}O, $^{13}C_{carb}$, Cd/Ca, Mg/Ca, Ba/Ca) as will investigations of organic matter ($^{13}C_{org}$, ^{15}N), individual biomarkers and clay mineralogy.

Drilling of palaeodepth transects will facilitate reconstruction of the hydrographic structure (temperature, dissolved oxygen, nutrients, etc.) of the Cretaceous-Palaeogene. The nature of these transects necessitates the use of a multi-platform drilling strategy: e.g., a JOIDES Resolution-type vessel for the greater water depths and alternate platforms for shallower water depths. Possible examples of transects include north-eastern Atlantic from the present Porcupine Abyssal Plain over the Goban Spur and the Celtic Sea to chalk sections situated in eastern England; the Exmouth Plateau, Carnarvon and Canning Basins, situated off western Australia; and the Great Australian Bight.

B) Rapid Climate Change

The ability to investigate climate variability at ultra-high resolution permits new questions to be posed concerning the dynamics of rapid climate change. Palaeoclimate data are required to study non-equilibrium climate forcing and feed-backs and to develop and test conceptual and numerical models. Four scientific themes can be specifically addressed through the use of MSP:

- Climatic dynamics – especially those climate issues associated with temporal and spatial variability on the global scale and their linkages to the ocean-atmospheric dynamics of greenhouse gases;
- Sea-level dynamics – rates, amplitudes and the frequency of sea-level change at the highest possible resolution;
- Biotic, sediment and geochemical responses and feed-backs – especially those associated with marine biota and their structures, sediment budgets and fluxes, and geochemical budgets and nutrient fluxes;
- Geochronology – development of chronostratigraphic records with the highest possible resolution (e.g., annual to centennial scale for the period 0 to 500 ka.).

The scientific themes listed above may be addressed at three different time streams: 0–1 ka, 0 to 500 ka and >500 ka (especially at specific time intervals associated with large climate perturbations induced by tectonic, external forcing, and impact events).

On the global scale MSP are required to retrieve the samples needed to understand the dynamics of the climate and sea-level processes recorded in the shallow and deep ocean in order to generate multi-site and 3-dimensional distribution pattern of the target area, and to provide ample and continuous sample volumes sufficient for multi-proxy studies on a cost and time efficient basis. Such a programme of sampling would involve integration of a JOIDES Resolution type vessel with a strategy involving multiple 50 –100 m piston cores.

Flexible drilling and coring approaches, adaptable to specific research objectives, are also needed in reef environments and on well characterised continental margins inn order to extend high-resolution sea-level change signals back in time and unravel the complex interplay of eustacy and glacio-isostacy.

C) Sedimentary basin formation and processes

MSP will play a major role in providing the technology to core in shallow-margin environments (oceans and inland seas) and to enhance recovery in sand-dominated systems. These platforms will be used in conjunction with continental drilling and deep-sea drilling for land to sea transects that will allow:

- Development of models of stratal architecture based on drilling transects on continental margins and modern epeiric seas;
- Understanding of the shelves (carbonate dominated, non-glacial detrital, glacial detrital) as buffers of chemical and biological cycles by studying the fate of terrestrial input in the margin and deep-ocean.

The principal interfaces are: (i) shorelines, where terrestrial/fluvial processes change to marine; (ii) the shelf edge, where the processes change from shallow- to deep-water (along-slope, down-slope vertical fluxes);

- Study of fluid-flow and transport of mass and heat in complete sedimentary basin systems. Also to study the relationship of the present and past hydrogeological regimes of sedimentary basins to: the deep biosphere; diagenesis; gas hydrate formation; and deformation processes (tectonics and slope instability);
- Models of palaeohydrogeology of continental shelves and coastal seas in relation to sea-level change, in particular the occurrence and genesis of large brackish water bodies (e.g. North Sea, Surinam, Java Sea) and brines (Great Australian Bight);
- Definition of the rates, timing and duration of rifting, and the nature of the continent-ocean transition zone.

In addition to the possibility of working on a routine basis in shallow water, using MSP will help overcome some of the political issues connected with drilling in marginal seas where access is restricted due to safety problems due to possible hydrocarbon accumulations and political considerations. Platforms that cause minimum disturbance to the seabed and cored sediment are required. Jack-up platforms are stable and can be used for directional drilling, emplacement of sensors and they provide set-up for frequent re-entry of probes for data recovery in instrumental boreholes. Most projects on sedimented margins will require either dense 2D or true 3D seismic survey grids.

D) Solid Earth Processes

Although in general most of the deep-ocean solid earth processes are best studied using a JOIDES Resolution-type vessel, or from a deep hole drilled using the Japanese riser vessel, the addition of MSP will allow greater understanding of many environments.

(II) Ridge axis observatories

There is a need for three dimensional characterisation of ridge systems involves the development of ridge observatories requiring multiple drill-holes and monitoring systems. The principal objectives require coring along and across ridge axes to document variations and links in magmatic and tectonic activity, the hydrology of oceanic crust, and fluctuations in activity at hydrothermal vent sites, as well as to sample and monitor the deep biosphere. All objectives will require integrated MSP approaches, involving:

- Drilling involving grids of shallow boreholes (20 meters or more);
- Shallow-deep (50 – 500m) boreholes drilling using diamond coring systems to sample along and across ridge axes (ported from the dynamically positioned vessels);
- Multiple logging re-entry in drill-holes.

(II) Large Igneous Provinces and volcanic islands

Other environments in which shallow-water jack-up platforms may provide an effective drilling alternative include:

- Oceanic volcanic island flanks for studies of magmatic chronology, mass wasting, and hydrothermal activity;
- Large Igneous Provinces for their subaerial to deep-water evolution.

(III) Drilling the K-T impact crater

The Chicxulub structure in Mexico is widely thought to be the site of the Cretaceous-Tertiary (K-T) impact which was, at least in part, responsible or a major global extinction event. About 50% of the crater lies offshore in ~35m water-depths. An integrated project including ICDP drilling is due to commence in 2001. IODP drilling should complete the image of this structure. This combined drilling project aims to identify the lithological and structural form of the Chicxulub Crater and to understand the tectonic and environmental effects of these large-scale impact features.

CONCLUDING STATEMENT

The Arctic remains the principal unexplored frontier on Earth and obtaining cores in this hostile region can only be achieved through an expensive strategy involving vessels with ice-breaker capability. Europe along with other partners, such as Canada and Russia, has an important role to play in opening this frontier to oceanic drilling. The APLACON meeting demonstrated the need for Mission Specific Platforms to achieve many of the objectives outlined in the IODP Initial Science Plan. These platforms must be used in conjunction with the other two coring facilities of IODP in integrated drilling programmes that involve land to sea transects, sea-floor observatories and would, for example, provide the global coverage required in high-resolution climate-change studies.