近期完成的 ODP 航次科学目标概述

编者按 1994 年 7 月～1996 年 2 月，ODP 在大西洋和地中海完成了 157～165 航次(Legs 157-165)。这些最新航次的钻探资料和科研成果出版后传到国内还需要很长一段时间。这里根据 ODP 总部提供的资料，摘要编录 ODP 最近一年半的时间内的钻探活动和科学目标，以飨读者。

LEG 165

DIAMOND CORING SYSTEM: VEMA FRACTURE ZONE A BRIEF ENGINEERING AND OPERATIONS PROSPECTUS

165 航次
Vema 破碎带金刚石钻头取芯系统检测
——工程检测和作业计划简介

ABSTRACT

The Vema Fracture Zone has been proposed as the next engineering test site for the Diamond Coring System (Phase II), scheduled for Leg 165 in January-February, 1996. The area is characterized by relatively thin sediments overlying limestone formations, deposited on up thrust blocks of crust. The limestone is anticipated to be on the order of 400-m thick in some areas. Water depths range from a few hundred meters to over 2 000m.

Only two out of the three previous deployments of the Diamond Coring System can be considered successful. A failure of the secondary heave compensation system during Leg 142 precluded successful coring with the system.

Changes made to the Phase II system during 1992-1993 will be tested at sea for the first time during Leg 165, the most significant of these changes being the modifications made to the secondary heave compensation system. The development, testing, and proving of the secondary heave compensation is critical to the future of the Diamond Coring System, as it is impossible to slimhole core offshore without effectively removing heave motion at the core bit.

A secondary objective of the Leg 165 engineering test will be an assessment of new hardware, in particular the diamond retractable bit which has the potential to significantly improve the operational efficiency of the Diamond Coring System by greatly decreasing the time required for coring bit trips.

LEG 164

GAS HYDRATE SAMPLING ON THE BLAKE RIDGE AND CAROLINA RISE

164 航次
Blake 海岭和 Carolina 隆起气水化合物钻探采样

ABSTRACT

Gas hydrates are a solid phase composed of water and low molecular weight gases (predominantly methane) which form under conditions of low temperature, high pressure, and gas saturation; conditions that are common in the upper few hundred meters of rapidly accumulated marine sediments (Claypool and Kaplan, 1974; Sloan, 1989. Although gas hydrates may be a common phase in the shallow geobiosphere, they are unstable under normal surface conditions, and thus surprisingly little is known about them.

The in situ characteristics of gas-hydrated sediments can best be studied by drilling where gas hydrates are as extensive as possible and their influence on sediment properties are largest. The Blake Ridge-Carolina Rise gas hydrate field is an excellent area for a gas hydrate drilling program because it is associated with sediments that have especially high interval velocities and distinct reflection characteristics, is well surveyed, contains one of the worlds most laterally extensive gas hydrate fields including a well developed BSR (bottom-simulating-reflector), and lacks tectonic influences that complicate hydrate distribution and fluid circulation in accretionary prisms.

Drilling in the Blake Ridge-Carolina Rise area will 1) determine the amounts of gas trapped in extensively hydrated sediments, 2) contribute to an understanding of the lateral variability in the extent of gas hydrate development, 3) investigate the distribution and fabric of gas hydrates within sediments, 4) establish the physical property changes associated with gas hydrate formation and decomposition in continental margin sediments, 5) assess whether the gas captured in gas hydrates is produced locally or has migrated in from elsewhere, 6) measure changes in the porosity (and permeability?) structure associated with gas hydrate cemented sediments, and 7) determine the role of gas hydrates in stimulating or modifying fluid circulation.

LEG 163

NORTH ATLANTIC-ARCTIC GATEWAYS II (NAAG)

163 航次
北大西洋——北极水道(NAAG)钻探

ABSTRACT

The Arctic and sub-Arctic areas exert major influences on global climate and ocean systems. Understanding the causes and consequences of global climatic and environmental change is an important challenge for humanity. The high northern latitude oceans are of great relevance for this task since they directly influence the global environment through the formation of permanent and seasonal ice-cover, transfer of sensible and latent heat to the atmosphere, deep-water formation and deep-ocean ventilation which control or influence both oceanic and atmospheric chemistry. Thus, any serious attempt to model and understand the Cenozoic variability of global climate must take into account these paleoenvironmentally oriented topics.

Leg 163 represents the second in a two-legs program to investigate four major geographic locations (the Northern Gateway Region, the East Greenland Margin, the Greenland-Norway Transect (Iceland Plateau), and the Southern Gateway Region) with the aim of reconstructing the temporal and spatial variability of the oceanic heat budget and the record of variability in the chemical composition of the ocean. ODP Leg 151, the first leg in this program, successfully completed operations at five sites within the Northern Gateway region, one site in the East Greenland Margin region, and one site within the Greenland-Norway Transect. Together, the Leg 151 and Leg 163 program undertakes a study of circulation patterns in a warm ocean, and the mechanisms of climatic change in a predominantly ice-free climatic system and will provide a collection of sequences containing records of biogenic fluxes ($CaCO_3$, opal, and organic carbon) and stable-isotopic carbon and oxygen records which will address aspects of facies evolution and depositional environments and the carbon cycle and productivity. The drilling approach focuses on high-resolution, Milankovitch-scale paleoclimatic analysis of rapidly-deposited sediment sequences. The proposed sites are either 1) arrayed as broad north-south and east-west transects to monitor spatial paleoclimatic variability or closely spaced suites of cores across depth ranges to monitor vertical variability, 2) deep drilling targets to constrain the time of opening of Fram Strait, or 3) placed to monitor downstream sedimentological effects of deep flow through narrow gateway constrictions.

LEG 162

MEDITERRANEAN SEA II-THE WESTERN MEDITERRANEAN

162 航次
地中海 II——西地中海钻探

ABSTRACT

Leg 162 represents the second in a two-leg program to investigate the tectonic and paleoceanographic history of the Mediterranean Sea and focuses upon the evolution of the Alboran Sea, a typical "Mediterranean backarc basin", and the origin of sapropels, laminated organic-rich layers deposited in the eastern Mediterranean Basin. The cause of the extension in basins such as the Alboran Sea Basin, and the rapid evolution of a collisional zone into superimposed regions of extension and adjacent contraction, has not yet been adequately explained and the Alboran Basin presents an ideal situation to investigate the competing hypothesis. The Neogene extensional basin beneath the Alboran Sea developed behind an arc-shaped mountain belt and is located on the site of Late Cretaceous/Paleogene orogen generated from collisional stacking. The region straddles the boundary between the European and African plates which converged during the Neogene; the basin thus formed in an overall environment of plate convergence. During the Miocene, the migration of the arcuate mountain front may have been nearly coeval with extension in the inner part of the arc that resulted in crustal attenuation and basinal spreading on the Alboran Domain. The basin formed from early Miocene onwards, whereas, outside the arc, the thrusting processes continued.

In order to determine the influence of the various factors on sapropel formation, we must obtain multi-proxy records along an east-west transect across the entire Mediterranean and synoptically map the hydrographic and climatic conditions throughout the Mediterranean both at the sites of sapropel formation in the eastern basin and at sites in the western basin where no sapropels formed. During Leg 161, drilling will be conducted at the easternmost sites (proposed sites MedSap 2B, 3, and 4) and Leg 162 will concentrate on sampling the westernmost occurrence of sapropels and areas in the western part of the basin where no sapropels formed (proposed sites MedSap 5,6, and 7). Only this Mediterranean-wide data base will allow us to determine the driving force behind sapropel formation at different times, and how the Mediterranean's physical circulation and chemical cycling preconditioned the eastern basin towards sapropel formation.

LEG 161

MEDITERRANEAN SEA I-THE EASTERN MEDITERRANEAN

161 航次
地中海 I——东地中海钻探

ABSTRACT

Leg 161 represents the first in a two-leg program to investigate the tectonic and paleoceanographic history of the Mediterranean Sea and focuses upon the processes associated with accretion at incipient continental collision on a salt-bearing accretionary complex, and the origin of sapropels, laminated organic-rich layers deposited in the eastern Mediterranean Basin. To achieve the tectonic objectives of identifying the incoming sediment, rates of outward growth and uplift of the deformation front, and the influence of the Messinian evaporites on the interstitial fluid circulation, drilling will be conducted in zones of terminal subduction at near-orthogonal and low-angle plate convergence, and of initial continental collision where the deformed sediments of the Mediterranean Ridge override the African continental slope. Drilling on the Napoli mud volcano on the crest of the ridge will provide insight into diapiric processes while a transect of sites from the top of the Eratosthenes Seamount to the Cyprus Margin will identify the tectonic phases that led to the present structure of the seamount.

Sapropels are deposited in a rhythmic fashion unrelated to global glacial-interglacial cycles but driven by distinctive changes in physical circulation and biogeochemical cycling possibly related to precession-induced fluctuations of monsoonal atmospheric circulation. One hypothesis for their origin postulates that the deeper water column went anoxic during their formation, fostering preservation of organic carbon at the sea floor. A second hypothesis favors increased primary productivity as the ultimate stimulus through increased rates of carbon flux to the sea floor. Variations in sediment texture, dilution, and the settling flux of carbon exert a dominant control on the carbon contents of sediments and water column redox conditions may play only a secondary role (Pedersen and Calvert, 1990). Recent evidence that the early-Holocene sapropel found in the Black Sea, the "type" euxinic basin in the stagnation/anoxia hypothesis, has accumulted under well-ventilated conditions, appears to underscore the importance of productivity over anoxia.

LEG 160

THE COTE D'IVOIRE-GHANA TRANSFORM MARGIN (EASTERN EQUATORIAL ATLANTIC)

160 航次

Cote D'Ivoire-Ghana 转换边缘(东赤道大西洋)钻探

ABSTRACT

Proposals for scientific drilling of transform continental margins have recently received increased attention for two main reasons. Firstly, transform faults represent the third category of major plate boundaries, but are still less understood than the two other major plate boundaries, divergent and convergent. Among transform faults, transform continental margins are still poorly known, and have never been investigated by the potentialities of scientific drilling. Secondly, drilling at a transform margin can constrain the structure and evolution of the ocean-continent transform boundary, particularly deformational history, vertical movements and its effects on the sedimentary records.

The Cote d'Ivoire-Ghana (ICG) Margin in the eastern equatorial Atlantic is considered as one of the best known examples of a transform boundary between continental and oceanic crust. The margin has been created by major transform motion between plate boundaries. This motion is still active today along the Romanche Fracture Zone. Since its creation, the ICG Margin has not experienced any major regional tectonic disruption, and its present day sedimentary and tectonic features are directly inherited from its Cretaceous transform margin history. Drilling on the ICG Margin will document 1) the relationship between deformation and sedimentation and the development of the transform margin, 2) the nature, structure and deformation history of this transform boundary, and 3) the history of the oceanic gateways between the Central and South Atlantic during the opening of the Equatorial Atlantic, particularly in Cretaceous times.

LEG 159

RETURN TO HOLE 735B

159 航次
735B 钻孔重测

ABSTRACT

Hole 735B was previously drilled during ODP Leg 118 on the Southwest Indian Ridge and Leg 159 represents the first leg in a proposed multi-leg program to deepen Hole 735B to a nominal depth of 2 km sub-basement, drill a suite of complementary shorter 500 m holes along a lithospheric flow line at 800 m intervals, and conduct downhole and logging experiments. This program takes advantage of the unique outcrop of the lower crust exposed along a 15-km-long wave-cut terrace 18 km east of the Atlantis II Transform Fault to drill the first systematic transect of the lower ocean crust to directly test the widely hypothesized episodic and discontinuous nature of magmatic, hydrothermal, and tectonic processes in the lower ocean crust at a slow-spreading ocean ridge. A spacing of 800 m along the flow line corresponds to 100 000-year increments and each penetration would overlap the paleo-horizontal with several other holes. The proposed suite of holes thus spans a 400 000-year interval of crustal generation at varying depths, which should reflect many magmatic and amagmatic cycles if current models are correct.

The principle objective of Leg 159 is to explore the lateral and temporal variability of lower crust generated at a slow-spreading ocean ridge. The proposed drilling may reach the petrologic Moho, the boundary between rocks which are the residues of the processes by which magmas form and migrate to the crust and rocks produced by the crystallization of those magmas as they rise out and pool above the upwelling mantle peridotite; however, reaching the petrologic Moho is not a requirement to achieve our objectives as the recovery of a truly representative section of plutonic crust would, by itself, be a major breakthrough in understanding the geologic processes occurring beneath ocean ridges. By deepening Hole 735B and drilling an offset section of holes along a lithospheric flow we will obtain a representative section of the lower ocean crust at one of the two critical ends of the spreading spectrum which, together with seafloor mapping, will permit a true three-dimensional view of the ocean crust and provide a natural laboratory where hole to hole magnetotelluric and permeability experiments can be conducted and the nature of layer 3 may be directly tested.

LEG 158

DRILLING AN ACTIVE HYDROTHERMAL SYSTEM ON A SLOW-SPREADING RIDGE: MAR 26°N (TAG)

158 航次
缓慢扩张脊(26°N 大西洋中脊)活动热水体系的钻探

ABSTRACT

The overall scientific objectives of Leg 158 are to investigate the fluid flow, geochemical fluxes and associated alteration and mineralization, and the subsurface nature of an active hydrothermal system on a slow-spreading ridge. The TAG active mound is a large, mature deposit of varying mineralogy with emanating fluids displaying a wide range of temperatures and distinct chemistries. The large size and age argue for a reasonably large and altered crustal root zone suitable for good drill penetration and recovery with conventional drill bits. Studies of this feature will give insight into fluid flow, structure, and "zone-refining" in active hydrothermal systems, and clarify how large deposits, similar in size to those mined on land today, are formed on the modern seafloor.

A transect of three holes, one penetrating into the stockwork zone, is proposed to investigate the nature of fluids, deposits, and altered crust in the near-surface part of the hydrothermal system and in the stockwork and root zone underlying the surface deposit. Although it is anticipated that these objectives can be achieved with the currently available technology in this hostile environment, the nearby inactive MIR mound is proposed as a back-up drilling site. The size and primary sulfide features of the MIR mound are similar to that of TAG, but the MIR mound has undergone extensive recrystallization, being entirely indurated by late-stage fluids that have replaced anhydrite and filled all voids with silica.

Drilling at TAG will directly address the processes occurring during hydrothermal circulation. Understanding these processes, and the implications for energy transfer, geochemical fluxes, and the formation of ore deposits is of fundamental importance to our knowledge of crustal accretion.

LEG 157

DRILLING INTO THE CLASTIC APRON OF GRAN CANARIA AND THE MADEIRA ABYSSAL PLAIN

157 航次

Gran Canaria 火山岛和 Madeira Abyssal 海底平原碎屑裙的钻探

ABSTRACT

The Volcanic Island Clastic Apron Project (VICAP) entails a case history study of a coupled system, "oceanic island-volcaniclastic apron". The source area has a long-term record of chemically distinct rocks/deposits with physically datable mineral phases, so that the submarine and subaerial growth and destruction is reflected in sufficient detail in the volcaniclastic apron. The seamount/island evolution as deduced from deep drilling into the apron can then be compared to the volcanic evolution reconstructed from the study of products exposed on land. Gran Canaria, one of the best studied oceanic volcanic islands, is the most suitable candidate for such a case history study.

The Madeira Abyssal Plain Project (MAP) is aimed at testing the hypothesis that ocean basin sedimentation is controlled by sealevel changes which affect the stability of sediments on continental margins including those on the flanks of volcanic islands. The products of mass wasting events accumulate on the continental slope and on the abyssal plains, but the abyssal plain is the only place where a complete record can be obtained in one drillisite. The combined VICAP-MAP project will study the development of the Canary Basin in terms of the history of volcanic activity in the Canary hotspot, the detailed evolution of the large volcanic oceanic islands of Gran Canaria and Tenerife (Canary Islands), and the filling of the Madeira Abyssal Plain.