

Advanced Technologies of CHIKYU to Challenge the Deep Earth's Interior

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JAMSTEC developed the deep sea scientific drilling vessel *Chikyu* to drill the sea floor, recover core samples, and analyze these on board to obtain important scientific information targeted by International Ocean Discovery Program (IODP, in previous, Integrated Ocean Drilling Program), which includes the studies of deep biosphere, environmental change, and solid earth dynamics. *Chikyu* was delivered to JAMSTEC in July 2005 and the shakedown, training, System Integration Tests (SITs) were initiated shortly thereafter. Then, JAMSTEC started the scientific drilling operation for IODP beginning in September 2007. *Chikyu* already conducted such major scientific projects as 1) Nankai Trough Seismogenic Zone Experiment (NanTroSEIZE), 2) Deep Hot Biosphere, 3) Japan Trench Fast Drilling (JFAST), 4) Deep Coalbed Biosphere off Shimokita, and so on. Any of these expeditions could satisfyingly contribute to understanding of the earth system. However, in order to successfully achieve these brilliant scientific results, we challenges many technical difficulties related to strong current, high wave, rough sea, deep water, deep penetration, which have not been experienced even in the oil industries nor the previous ocean drilling programs.

For example, the NanTroSEIZE C0002 deep riser hole site is located in a water depth of approximately 2,000 m and persistently experiences the Kuroshio Current, which is a strong/deep current with mean surface currents of 3.5 knots, and a 1-yr extreme current of approximately 7.0 knots. When drill pipe is placed in a strong current, an alternating Karman vortex forms on the downstream side. Vibration occurs when two of these vortices alternately pull at one another, known as VIV, which potentially cause serious damage on riser pipe, drill pipe, and the instruments attached along. The NanTroSEIZE site also experiences intense typhoons during the summer and autumn. Thus all operational phases should need to be analyzed thoroughly for high currents and potential typhoons; evacuation criteria are developed for each operational condition. Considering the major operational concerns, we developed the VIV reduction countermeasures for riser/drill pipe, real-time riser VIV monitoring system to estimate the fatigue, to successfully conduct riser drilling operation and riserless borehole observatory deployment at the NanTroSEIZE sites.

To realize the JFAST operation which was a challenging drilling program (water Depth: 6,897.5 m, penetration depth: 854.81 mbsf), thorough investigation of the strength of drill pipe was conducted, and operation criteria was determined based on the strength evaluation by considering such combined forces as the drill pipe weight in water, dynamic load caused by heaving motion, over pull force caused by hole condition, and bending force caused by ship motion and current.

As the other developments, we are developing the Turbine Driven Coring System (TDCS) to improve core quality and recovery especially for hard rock, the new material riser pipe such as the Carbon Fiber Reinforced Plastic (CFRP), the precise dynamic analysis for deep water drill pipes, the Long Term Borehole Monitoring System (LTBMS) for riser hole and so on.

IODP will start afresh in the new era from 2013 to implement the Mohole project which is long-cherished dream for scientific drilling communities. *Chikyu* continues to evolve furthermore toward this great challenge of unexplored scientific mission.

Keywords: Scientific drilling, Deep water, Deep penetration, NanTroSEIZE, JFAST