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Impacts of results from IODP Expedition 324 (Shatsky Rise) on solid-earth science and Cretaceous paleoceanography

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IODP Expedition 324 to Shatsky Rise was primarily aimed at elucidating the processes of the formation and evolution of oceanic plateaus based on the integrated analysis of the basement basaltic rocks by means of petrology, geochemistry, volcanology, radiometric geochronology, etc., with a special emphasis on testing the two competing hypotheses for the mechanism of oceanic plateau emplacement (mantle plume vs. peculiar plate tectonics). In terms of solid-earth science, several important new findings have already been made, including a large variety of magma chemistry, magma evolution at shallow magma chambers, and the deep origin for primary magma. On the other hand, this expedition was initially deemed to be unsuitable for the study of sediments/sedimentary rocks because of various restrictions from the drilling strategy, and actually the cored sedimentary materials were rather limited in quantity. Unexpectedly, postcruise study has brought about important new insights into Cretaceous paleoceanography, the outline of which is presented herein.

Through the drilling at Site U1348 on the northern summit of Tamu Massif, the presence of unconsolidated Cretaceous pelagic sediment cover was revealed, and paleoceanographically important intervals were captured, though poor in recovery. Of these, a short 1.4 m-thick interval of calcareous ooze in Site U1348-Core 2 has been accurately dated to be the Santonian-Campanian (S-C) transition, based on shore-based integrated stratigraphy of planktonic foraminifera, Sr isotopes and paleomagnetism. This finding is significant, because a major obstacle in Late Cretaceous paleoceanography has long been the lack of deep-sea sedimentary records across the S/C boundary resulting from the spatiotemporally extensive hiatus. The ooze lithology allows the acquisition of stable isotope data from very well-preserved, taxon-specific separates of foraminifera for the first time for the deep-sea S-C transition. The detailed benthic foraminiferal oxygen isotope data predict a sustained supergreenhouse condition until the end of the Santonian and a subsequent relatively rapid cooling (+1.0 per mil shift) within the early Campanian, opposing the preconceived view for a gradual cooling trend during this period.

In Site U1348-Core 10, another short interval (22 cm-thick) of calcareous ooze was recovered and dated onboard to be the early Aptian in age, thus representing the oldest known record of unconsolidated pelagic sediments recovered through the history of scientific deep-sea drilling. Detailed shore-based chronological assessments by means of planktonic foraminifera, carbon isotopes and Sr isotopes have been successful in placing the rigorous age constraints upon this interval at around the early/late Aptian boundary. Accordingly, it is certain that the deposition took place just after Oceanic Anoxic Event (OAE) 1a, and that the extension of the global stable isotopic compilation of deep-sea benthic foraminifera is possible to as old as ~120 Ma. It is noteworthy that seismic interpretation indicates that the expanded, older pelagic sedimentary strata are present just to the south of Site U1348. Consequently, northern Tamu Massif of Shatsky Rise, where pelagic sediments are unconsolidated, thick and potentially dating back to the earliest Cretaceous (spanning the OAE1a interval), would be the ideal target area for future paleoceanographic IODP expedition.

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