Radiolarian biostratigraphy from Deep Sea Drilling Project Site 213, eastern Indian Ocean

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Biostratigraphy divides strata into biozones defined based on the contained fossils, which enables stratigraphic correlation between geographically-distant localities. Calcareous nannofossils, radiolarians, foraminifers, and diatoms are the representative microfossils to construct biostratigraphy. Radiolarians are zooplankton with biogenic opal or strontium sulfate skeletons. Radiolarians distribute in the world ocean from surface to deep water. Because of their high evolution rates, radiolarians are valid for constructing biostratigraphy. Radiolarian ooze is a deep-sea pelagic sediment occupying 5% of the Indian Ocean. Sediment core samples used in this study were drilled to the basement at Site 213 (10˚12.71’ S, 93˚ 53.77’ E, water depth 5609 m, 172.5 m penetration) in the eastern tropical Indian Ocean during Leg 22, Deep Sea Drilling Project (DSDP) in 1972. Core samples at Site 213 compose of radiolarian and diatom ooze from late Miocene to Quaternary for the upper 75 m (Core 1R-8R), pelagic clay in middle Miocene for 75-135 m (Core 8R-15R), calcareous ooze from early Eocene to late Paleocene for 135-145 m (Core 15R-16R), and ferromanganese oxide and weathered basalt for 147-172 m (Core 16R-19R). Johnson (1974) constructed radiolarian biostratigraphy of Site 213 at low time resolution and has not been updated for 50 years. In addition, Site 213 core sediments were rotated and transformed during the drilling using a rotary core barrel, which hampered constructing of paleomagnetic stratigraphy at Site 213. The objective of this study is to update radiolarian biostratigraphy since the late Miocene at Site 213. Site 213 samples from the upper 0-75 m (Core 1R-8R) were used because of their good core recoveries and abundant radiolarian occurrences. The discrete sediment samples were treated with 10% hydrogen peroxide to remove organic matter and sieved with a stainless screen with a 63-micrometer mesh, mounted with Norland optical adhesive 61. A total of 47 slides from Core 1R to 8R were prepared for light microscopic observation. We have mainly focused on the late Miocene to Pliocene samples (Core 4R-8R). We identified the radiolarian specimens encountered during the microscopic observation and have selected radiolarian age markers. Radiolarian biozones at Site 213 were determined following the tropical Neogene radiolarian biostratigraphy (Sanfilippo and Nigrini, 1998). We have determined the following boundaries of radiolarian biozones at Site 123: *Pterocanium prismatium* Zone/ *Lychnodictyum audax* Zone, *Lychnodictyum audax* Zone / *Phormostichoartus doliolum* Zone and *Phormostichoartus doliolum* Zone/ *Stichocorys peregrina* Zone. The identified boundaries of radiolarian biozones were calibrated to the latest geomagnetic reversal ages in Geologic Time Scale 2020. The boundary ages of *P. prisamtium* Zone and *L. audax* Zone, *L. audax* Zone and *P. doliolum* Zone, and *P. doliolum* Zone and *S. peregrina* Zone were 2.60 –2.76 Ma, 3.73 –3.78 Ma, and 4.19 Ma, respectively. A total of 263 *Stichocorys peregrina* specimens from six samples at Site 213 (5R-1W 25.0-27.0 cm, 6R-3W 28-30 cm, 7R-6W 79.0-81.0 cm, 8R-3W 125.0-127.0 cm, 8R-4W 79.0-81.0 cm, and 8R-5W 125.0-127.0cm) were taken pictures to investigate the temporal morphological variations, but not found distinct changes. In addition, Scanning Electron Microscope (SEM) observation has been conducted for the selected *S. peregrina* specimens. We have confirmed that *S. peregrina* has no pore on the cephalis.

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