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Data report: radiolarian abundances from IODP Holes U1431D, U1432C, and U1433A, Expedition 349¹



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Iván Hernández-Almeida^{2,3}

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Abstract

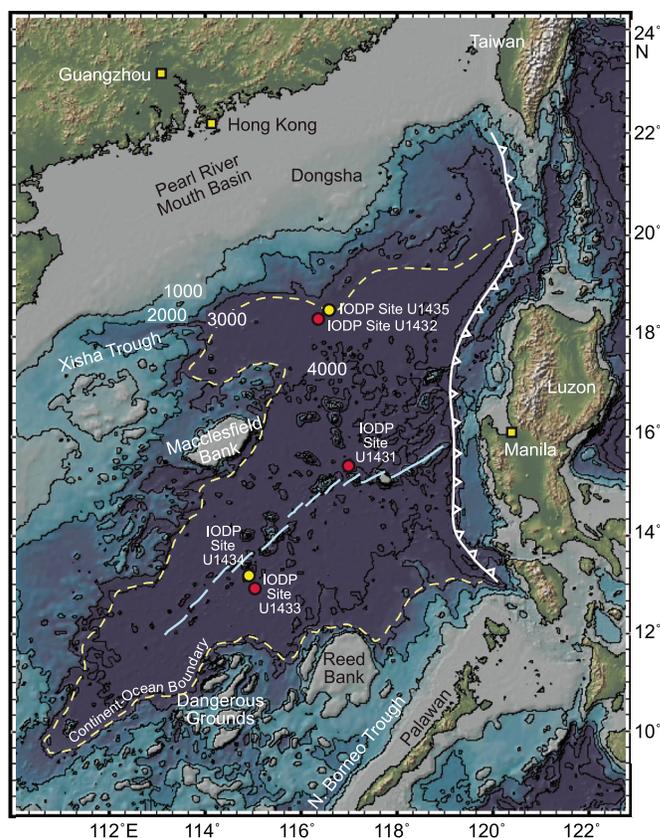
We studied radiolarian abundances in 303 samples from International Ocean Discovery Program Expedition 349 in the South China Sea (SCS), which cored five deep-sea sites. Three of them, Sites U1431, U1432, and U1433, are located along a latitudinal gradient. We analyzed, using a light microscope, the total radiolarian abundance (radiolarians per gram of dry sediment) for middle and upper Pleistocene sedimentary sequences from these three sites. Radiolarian abundances are higher uphole, in particular at Site U1432 (northern SCS). Site U1433 (southwestern SCS) contains the lowest numbers of radiolarians. In general, there are more barren samples in the older part of the section, with the upper Pleistocene having higher abundances and more consistent presence of radiolarians.

Introduction

International Ocean Discovery Program (IODP) Expedition 349 was conducted to investigate the tectonic history of the South China Sea (SCS). Five sites were drilled during this expedition, with the primary aim to document the timing of the opening of different subbasins of the SCS. A secondary objective was to use these records to better understand the East Asian tectonic, sedimentological, and paleoenvironmental evolution throughout the Neogene (see the [Expedition 349 summary](#) chapter [Li et al., 2015]).

Of the five sites drilled during this expedition, three sites (U1431, U1433, and U1434) were located in the central and southwestern subbasins and cored into oceanic basement, whereas two sites (U1432 and U1435) were drilled in the northern part of the eastern subbasin, proximal to the continent/ocean boundary on the Chinese continental margin (Figure F1). Although Expedition 349 focused on the tectonic history of the SCS, the recovered cores also

Figure F1. Expedition 349 site location map. This study includes samples from Sites U1431, U1432, and U1433 (red dots; yellow dots = the other two sites drilled during the expedition). Map modified from the Expedition 349 summary chapter (Li et al., 2015).



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² MARUM—Center for Marine Environmental Sciences, University of Bremen, Bremen, Germany.

³ Also at Department of Earth Sciences, ETH Zurich, 8092 Zurich, Switzerland. ivan.hernandez@erdw.ethz.ch
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provide a good opportunity to study paleoceanographic and paleoclimatic changes in the central SCS and their relationship to the tectonic evolution of this region. Sites U1431, U1432, and U1433 are of particular interest because they are located along a latitudinal transect in the deepest part of the SCS basin, which was not cored previously with conventional drilling.

Radiolarians are important components of the sediment record in this region. Variations in radiolarian abundance have been regarded as a good proxy of East Asian Monsoon upwelling (Chen et al., 2008a). Thus, study of radiolarian abundances across a latitudinal transect can provide information on East Asian Monsoon regimes that drive surface hydrography and past oceanographic productivity (Wang et al., 1999). There are studies on the abundance of radiolarians in modern surface (Chen and Tan, 1997) and Neogene (Chen et al., 2008a; Yang et al., 2002; Zhang et al., 2008) sediments of the SCS. However, there are no studies of fossil radiolarians in the deepest parts of the SCS (>3500 m water depth), even though these regions are characterized by higher abundances than other areas (Chen et al., 2008b). Hence, we chose 303 sediment samples from the three holes (U1431D, U1432C, and U1433A) to document the overall variability in total radiolarian abundance throughout the middle and upper Pleistocene.

Methods and materials

Geological settings

For this study, we prepared and analyzed 53 sediment samples from Hole U1431D, 131 from Hole U1432C, and 119 from Hole U1433A for their radiolarian content. Hole U1432C (18°21.0831'N; 116°23.4504'E) was drilled in 3829 m water depth just south of the northern continent/ocean boundary. Samples analyzed from between 0 and 35.75 m below seafloor (mbsf) are composed of dark greenish gray clay and clay with silt. Hole U1431D (15°22.5379'N; 117°00.0022'E) was drilled in 4240 m water depth near the relict spreading ridge. Samples analyzed from between 0 and 21.46 mbsf are characterized by a sequence of clay and silty clay with graded beds interpreted as turbidite sequences within the more silty layers and abundant thin volcanic ash layers. Hole U1433A (12°55.1380'N; 115°02.8345'E) was drilled in 4379 m water depth. This hole is located in the southwestern SCS basin, and samples from between 0 and 27.12 mbsf are composed of dark brownish to greenish clay layers, with abundant nannofossil ooze layers. Preliminary shipboard paleontological investigation indicates that the sections for this study are dated to the middle to upper Pleistocene, with average sedimentation rates of 12 cm/ky for Hole U1432C, 5 cm/ky for Hole U1431D, and 20 cm/ky for Hole U1433A (Li et al., 2015). Sampling resolution is mostly 40 cm for Hole U1431D and 20 cm for Holes U1433A and U1432C.

Radiolarian analysis

Prior to processing, samples (20 cm³) were freeze-dried overnight. Sediment samples (~1.5–5 g dry weight) were placed in a beaker on a hot plate with 20% H₂O₂ to disaggregate the sediment and remove the organic matter and 10% HCl to remove the calcareous components. The solution was then washed and sieved through a 63 µm mesh screen. Residue was placed in a 15 mL vial. Slides were prepared using a settling technique modified from Flores and Sierro (1997) and adapted to the study of radiolarians, which allowed us to obtain a random distribution of particles on the coverslip. A coverslip was placed on the bottom of a Petri dish and a mixture of distilled water and unflavored gelatin was added to reduce the surface

tension. Then, the vial was shaken, and a 1–5 mL aliquot was extracted with a micropipette and dropped into the Petri dishes. After 12–24 h, the water was withdrawn from the Petri dish using short strips of filter paper placed at the edges. Once dried, the coverslip was carefully transferred to a hot plate, where the coverslip was mounted onto a microscope slide using a few drops of Norland optical adhesive. Slides were analyzed under a Zeiss Axioskope light microscope at ×400 magnification.

Results

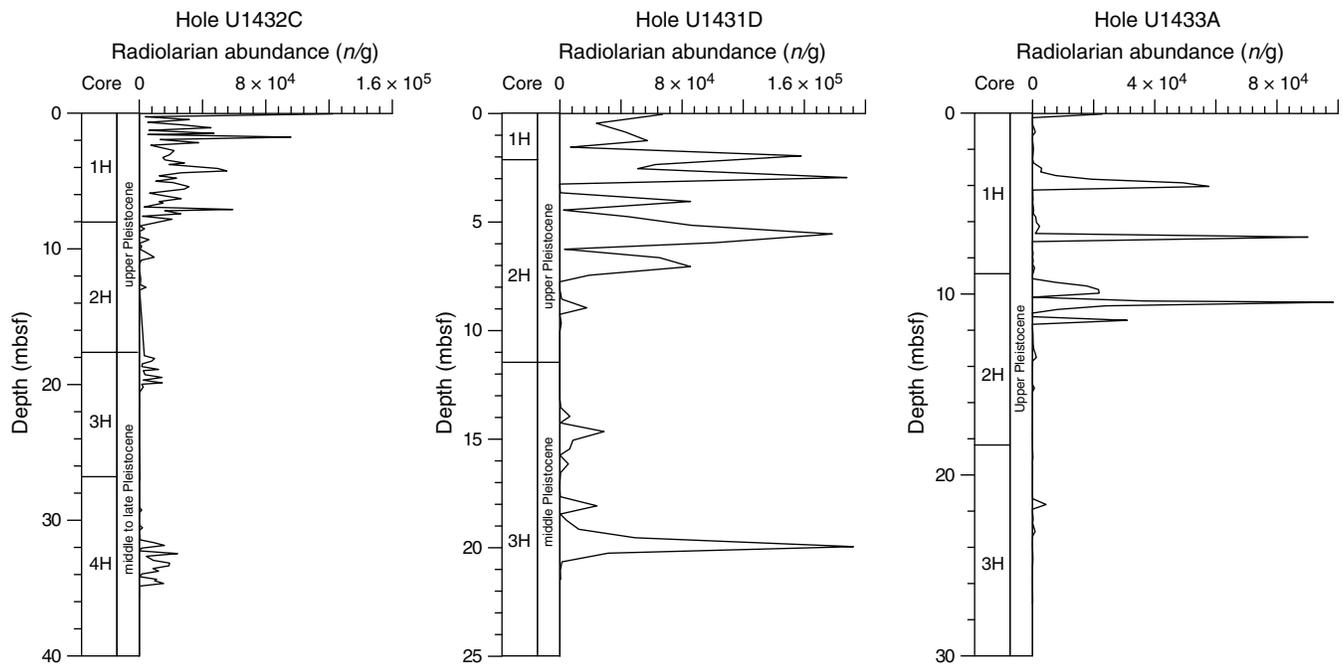
We analyzed the radiolarian abundance in 303 sediment samples from three Expedition 349 drill sites. Radiolarian abundances per gram of dry sediment (*n/g*) are given in RADCOUNTS in [Supplementary material](#). Figure F2 shows the downhole profile of radiolarian abundances together with the age based on the shipboard age models for the three holes. Radiolarian abundances are generally higher in the youngest part of the section at each site. There is a marked transition from lower abundances in the middle Pleistocene to higher abundances in the upper Pleistocene samples. Hole U1431D, located in the central SCS, shows the highest abundances (mean = 3.2×10^4 *n/g*), with $\sim 2 \times 10^5$ *n/g* at 19.95 and ~ 95 mbsf. Between 17.15 and 7.45 mbsf, the samples are almost barren of radiolarians. Hole U1432C, the northernmost site, shows the lowest mean abundances (4×10^3 *n/g*). The radiolarian abundances are high to moderate (mean = 8×10^3 *n/g*). Radiolarians are absent or very rare in the lower sections, with the exception of two short intervals with moderate abundances, between 17.85 and 19.65 and between 31.1 and 34.8 mbsf. Radiolarians are more common uphole and are without barren intervals in the upper 7.1 m. Two major peaks occur in this interval at 0.03 mbsf (1.2×10^5 *n/g*) and 1.74 mbsf (9.5×10^3 *n/g*). Hole U1433A, in the southwestern SCS, has intermediate abundances between the two previous sites (mean = 10×10^3 *n/g*). There are three short-lived increases in radiolarian abundance higher than 5×10^4 *n/g* at 10.45, 6.85, and 4.05 mbsf, whereas the rest of the samples are nearly barren of radiolarians.

Radiolarian species are very similar in the three holes, characterized by typical tropical–subtropical radiolarian assemblages as described in previous studies in this region (Chen and Tan, 1997; *Tetrapyle octacantha*/*Octopyle octospinosa* group, *Pterocorys herwigii* /*zancleus/minythorax* group, *Stylodictya tenuispina*, *Giraffospyris angulata*, *Didymocyrtis tetrathalamus tetrathalamus*, *Tholospyrus* sp., *Spongodiscus* spp., *Actinosphaera spinosa*, *Dictyocoryne profunda*, *Amphispyris reticulata*, *Pterocanium praetextum*, *Carpocanium* spp., *Lophospyris pentagona hyperborea*, *Larcopyle buetschlii*, and *Euchitonia furcata/elegans* group). Preservation ranges between bad and moderate downhole, where radiolarians are very scarce and often fragmented, and between moderate and good in the upper sections, where radiolarians are very abundant.

Acknowledgments

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Figure F2. Number of radiolarians per gram of sediment from Holes U1432C, U1431D, and U1433A sorted by latitudinal position from north to south.



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