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# Did opening of the South China Sea impact development of the Asian Monsoon? Results from Oligocene microfossils, IODP Site U1435, northern South China Sea

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Development of the Asian Monsoon is linked to uplift of the Himalayas and Tibetan Plateau in the Cenozoic, with good evidence for a strong monsoon system by the late Oligocene to early Miocene (e.g., Guo et al., 2002; Clift et al., 2008). However, Licht et al. (2014) suggested the presence of an Asian Monsoon in the late Eocene. Recent scientific ocean drilling in the Indian Ocean and surrounding marginal seas gives us the opportunity to test this hypothesis with newly recovered Paleogene sediment cores. International Ocean Discovery Program Expedition 349 to the South China Sea recovered a 30 m section of primarily lower Oligocene nannofossil-rich claystone at Site U1435, located near the northern continent/ocean boundary. A thick sandstone unit devoid of typical marine microfossils underlies the marine claystone. The sandstone is interpreted as a deltaic or restricted marine deposit and is dated to the Eocene based on the presence of organic-walled palynomorphs, suggesting that a hiatus of several million years likely separates the sandstone below from the Oligocene marine claystone. This hiatus is interpreted as the breakup unconformity, with paleodepths in the South China Sea increasing during the Oligocene. Thus, this claystone should record if opening of the South China Sea during the early Oligocene influenced development of the Asian Monsoon. Combined calcareous nannofossil and planktonic foraminifer biostratigraphy indicates that the 30 m section is primarily early Oligocene in age (~33.5–30 Ma) and was deposited on the middle slope, with paleodepths >500 m. Stable oxygen isotopes from planktonic foraminifers become heavier up-hole, suggestive of cooling/deepening in the region, whereas carbon isotopes record variable conditions with no distinct maxima or minima. Calcareous nannoplankton primarily live in the upper 50 m of the ocean and are sensitive to sea-surface temperature and nutrient conditions, thus making them useful recorders of paleoceanographic conditions. Warm-water indicators such as Discoaster and Sphenolithus are relatively common throughout the interval, with a small increase in abundance near the top of the section. On the other hand, species sensitive to nutrient and/or salinity conditions, such as Helicosphaera and Braarudosphaera, vary in abundance throughout the section. These variations may be linked to changes in rainfall intensity and runoff/nutrient input from the adjacent continent, reflecting variations in the monsoon. These records, together with other Oligocene records from the northern South China Sea, should help to shed light on variations in the Asian Monsoon during the transition from Greenhouse to Icehouse conditions in the Oligocene.

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