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Indonesian Gateway restriction between 4.0 and 2.8 Ma and its impact on Indian Ocean surface waters based on calcareous nannoplankton assemblages

Gerald Auer (1), David De Vleeschouwer (2), Kara Bogus (3), Jeroen Groeneveld (1), Jorijntje Henderiks (4), and Isla Castañeda (5)

(1) Department of Biogeochemistry, Japan Agency for Marine-Earth Science and Technology (JAMSTEC), 2-15 Natsushima-cho, Yokosuka, Kanagawa, 237-0061, Japan, (2) MARUM-Center for Marine and Environmental Sciences, University of Bremen, Klagenfurterstraße 2-4, Bremen, 28359, Germany, (3) International Ocean Discovery Program, Texas A&M University, College Station, 77845-9547, USA, (4) Department of Earth Sciences, Uppsala University, Uppsala, 75236, Sweden, (5) Department of Geosciences, University of Massachusetts at Amherst, Amherst, MA 01003, USA

The Early Pliocene is characterized by a fundamental reorganization of Earth's climate. In particular, the ongoing constriction of the Indonesian Gateway (IG) around 4.0 – 3.0 Ma is a commonly evoked cause for these climatic changes. The constriction of the IG, caused by the northward movement of Australia and related uplift of Indonesia, in particular had major effects on global climate and may have contributed to Northern Hemisphere cooling via complex atmospheric and oceanographic teleconnections. Untangling the exact timing of IG constriction are thus critical for resolving the mechanisms driving Earth's climatic evolution during the Pliocene.

Here we present high-resolution reconstructions of surface water conditions and IG connectivity using calcareous nannoplankton (CNP) assemblages between 4.0 and 2.8 Ma at Site U1463 (18°59'S, 117°37'E; IODP Expedition 356). Located on the Northwest Shelf (NWS) of Australia, the site lies directly in the path of the upper branch of the Leeuwin-Holloway current, making it an ideal location to study Pliocene IG dynamics and their influence on the eastern Indian Ocean.

Using modern analogue based interpretation of CNP assemblages, in combination with an independent orbitally tuned age model, shows a clear change in surface water conditions along the NWS ∼3.8 Ma recognizable by a decrease in tropical taxa like *Umbilicosphaera sibogae* and *Sphenolithus* spp. Subsequently, a shift from *Gephyrocapsa* sp. to *Reticulofenestra* sp. dominated CNP assemblages and the increase of mesotrophic CNP taxa (e.g. *Umbilicosphaera jafari*; *Helicosphaera* spp.), suggests that warm, stratified, oligotrophic (i.e. tropical) waters were replaced by cooler, more turbulent, and less saline waters by ∼3.8 – 3.6 Ma. We relate this switch in dominant water masses to changes in IG geometry delivering relatively cooler and fresher waters from northern Pacific sources to the NWS. A subsequent shift in the assemblage composition between 3.4 – 3.2 Ma straddles the marine isotope stage (MIS) M2 glacial event (∼3.3 Ma), which suggests sea-level driven changes in IG connectivity are reflected by CNP assemblages during this major glacial event.

Combined with existing records and new proxy data reflecting the Australian climate during the Pliocene, our data suggest that initial tectonic IG constriction occurred ∼ 3.8 – 3.75 Ma while also reflecting the response of the tropical Indian Ocean to cooling in the southern high latitudes during the M2 glacial event.