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Geochemical and Geophysical Evidence for Late Miocene Onset of Tasman Leakage

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The recent documentation of the southern hemisphere “supergyre”, the coupled subtropical southern hemisphere gyres spanning the 3 ocean basins, leads to questions about its impact on Indian Ocean circulation. The Indonesian Throughflow (ITF) acts as a switchboard directing warm surface waters towards the Agulhas Current (AC) and return flow to the North Atlantic, but Tasman Leakage (TL) is another source of return flow, however, at intermediate water depths. Fed by a complex mixture of South Pacific (SP) western boundary current surface and intermediate waters, and Antarctic Intermediate Water (AAIW), today the topography forces it to flow in a westerly direction. The TL flows over the Broken Ridge towards Madagascar, joining the AC and ultimately Atlantic Meridional Circulation (AMOC).

Stable isotope data from 4 DSPD/ ODP Indian Ocean sites define the history of TL and constrain the timing of its onset to ~7 Ma. A simple nannofossil- biostratigraphy age model applied to previously published benthic foraminiferal carbon isotope data ensures the 4 time-series (~11 – 2 Ma) are consistent. All 4 records (Sites 752 Broken Ridge, 590 Tasman Sea, 757 90 East Ridge, 751 Kerguelen Plateau) are similar from ~11 Ma to ~7 Ma, indicating the Tasman Sea intermediate water was sourced from the Southern Ocean (SO). A coeval shift at ~7 Ma at Sites 590 and 752 signals a SP contribution and the onset of TL. We do not observe TL at Sites 757 and 751 and so interpret the post-7 Ma divergence between the TL pair and the KP / 90E Ridge sites as a reflection of different intermediate water masses. The KP / 90E Ridge sites record a more fully SO signal, and these waters are constrained to the region west of the 90 East ridge.

The isotopic record of TL onset suggests important tectonic changes ~ 7 Ma: 1) opening of the Tasman Sea to the north and 2) Australia’s northward motion allowing westward flow around Tasmania. The former is supported by a change in sedimentation style on the Marion Plateau (ODP Site 1197). The latter is supported by unconformities on the South Australian Bight margin (Leg 182 Sites 1126 (784 m), 1134 (701 m), 1130 (488m) and coeval decreases in mud- sized sediments at the Broken Ridge sites, indicating winnowing associated with the onset of the TL. A divergence is also apparent between Broken Ridge and Mascarene Plateau Site 707 records at this time. These events, coupled with the temporal relationship between the onset of the TL and a change in the character of deposition in the Maldives indicate enhanced Indian Ocean circulation

at intermediate depths coincident with the late Miocene global cooling. Combined, these observations suggest the Indian Ocean in general plays a larger role in the global ocean system than previously recognized, and intermediate waters in particular are a critical yet poorly understood component of AMOC.

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