Distinctive carbonate ion variations in the deep Southern Ocean since the Last Glacial Maximum

YUHAO DAI[1]*, JIMIN YU[1], BRAD OPDYKE[1] AND ZHANGDONG JIN[2]

[1]The Research School of Earth Sciences, The Australian National University, Canberra, ACT 0200, Australia (*yuhao.dai@anu.edu.au)

[2]State Key Laboratory of Loess and Quaternary Geology, Institute of Earth Environment, Chinese Academy of Sciences, Xi'an, 710075, China.

Past changes in deep water carbonate ion concentration ($[CO_3^{2-}]$) have important implications for the oceanic carbon cycle and thus atmospheric CO_2 fluctuations.. We present new $[CO_3^{2-}]$ records derived from B/Ca in benthic foraminifer for the deep Atlantic and Pacific sectors of the Southern Ocean over the last ~30 ka.

In the deep South Atlantic (3.2 -4.2 km), $[CO_3^{2-}]$ is higher during the Holocene than during the Last Glacial Maximum (LGM), and show a similar pattern to benthic $\delta^{13}C$ and $\%CaCO_3$ ("the Atlantic-type"). These changes indicate a strong circulation influence on $[CO_3^{2-}]$ in the deep South Atlantic.

In constrast, $[CO_3^{2-}]$ at 3.3-4.0 km water depth of the Southwestern Pacific displays similar values during the LGM and late Holocene, with a peak centered at the early Holocene ("the Pacific-type"). Considering the roughly stable benthic $\delta^{13}C$, the $[CO_3^{2-}]$ decline since ~10 ka is likely caused by a change in deep water alkalinity that is associated with the deep-sea carbonate compensation. It's worth noting that, unlike the deep Indian Ocean core [1], changes in the pattern of deep water $[CO_3^{2-}]$ is not reflected by sediment $\%CaCO_3$ highlighting complications of using $\%CaCO_3$ to infer past deep water $[CO_3^{2-}]$.

Our results demonstrate that $[CO_3^{2-}]$ of different sectors of the Southern Ocean is controlled by various processes. While $[CO_3^{2-}]$ in the more saturated Atlantic seemed to be sensitive to ocean circulation changes, alkalinity variations associated with the $CaCO_3$ burial imposed a strong influence on $[CO_3^{2-}]$ of the unsaturated deep southwestern Pacific. During the last deglacial, the coherent $[CO_3^{2-}]$ increases, observed in all records, are consistent with degassing of CO_2 from the deep Southern Ocean for driving up atmospheric CO_2.

[1] Yu *et al*., *Science*, **330**, 1084-87 (2010).