Geophysical Research Abstracts
Vol. 14, EGU2012-7604-1, 2012
EGU General Assembly 2012

Changes in carbonate ion concentrations of deep and intermediate Southern Ocean waters over the past 25 kyrs

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The Southern Ocean is a key area for water mass exchange between all world oceans. The importance of this region with respect to the carbon cycle is demonstrated by a high correlation between Antarctic temperature and atmospheric CO_2 concentrations that is documented for the past 800.000 years (Wolff et al. 2005, Lüthi et al. 2008).
B/Ca-reconstructed carbonate ion concentrations ($CO_3{}^{2}-$) for the past $\sim$ 25 kyrs will be presented for sediments that were retrieved from the slope of Chatham Rise (East of New Zealand), from Antarctic Intermediate Water (AAIW) and Circumpolar Deep Water (CPDW) depths (cores PS75/103-1, 1390m and PS75/100-4, 2498m). $CO_3{}^{2-}$ in both cores show similar values in the Last Glacial and the recent Holocene (core-top). For PS75/100-4, $CO_3{}^{2}-$ are 33.5 $\pm$ 8 μmol/kg and 28.4 $\pm$ 6.6 μmol/kg, while $CO_3{}^{2}-$ reconstructed for PS75/103-1 are 25.5 $\pm$ 7.6 μmol/kg and 23.7 $\pm$ 7.2 μmol/kg for the Last Glacial and recent Holocene respectively.
In the CPDW-core several transient $CO_3{}^{2}-$ peaks occur between 25 and 19 kyrs BP. These excursions likely reflect internal mechanisms, such as deep-sea $CaCO_3$ dissolution events, seeing that atmospheric CO_2 concentrations stayed constant throughout this time interval. After each maximum, $CO_3{}^{2}-$ -concentrations decrease towards a steady state that remains stable for a few kyrs, which is likely a result of calcite compensation. Around 20 kyrs BP a drop in $CO_3{}^{2}-$ is observed in PS75/103-1, which is roughly coeval with a positive $CO_3{}^{2}-$ peak in PS75/100-4. When the deglacial atmospheric CO_2 rise begins around 17 kyrs BP, $CO_3{}^{2}-$ in the deep water core remains in a steady state until $\sim$ 15.5 kyrs BP, when it shows an initial increase. Conversely, $CO_3{}^{2}-$ reconstructed from the AAIW core rises until $\sim$17 kyrs BP, when a transient decrease is observed. The observed differences in response times to the CO_2 degassing might be due to distinct ventilation histories of AAIW and CPDW. It has been argued that the deep Southern Ocean was less well ventilated during the Last Glacial (e.g.: Hodell et al. 2003), effectively impeding exchange between the ocean and the atmosphere as is currently a topic of debate. Hence, the results of this study (including newly obtained δ13C data) provide new insights into this area of research.

Hodell et al., G-cubed, doi:10.1029/ 2002GC000367 (2003)
Lüthi et al., Nature 453, 379–382 (2008)
Wolff et al., EOS 86, 341-345 (2005)