Geophysical Research Abstracts
Vol. 12, EGU2010-3728, 2010
EGU General Assembly 2010

Glacial CO2: Art thou as carbonate ion?

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The crucial parameter which dictates whether carbonate cycles influence the atmosphere is whether the cycles are associated with changes in the global deep ocean [CO32-]. An increase in whole ocean alkalinity and [CO32-] during glacial periods could account, in part, for the drawdown of atmospheric CO2 into the ocean. Such an increase may have been inevitable due to the near elimination of shelf area for the burial of coral reef alkalinity. Application of B/Ca which provides a quantitative proxy for [CO32-] (Yu and Elderfield 2007) to a core from the Weddell Sea suggests that there was a raised [CO32-], at this site, and therefore, the heterogeneity of the preservation histories in the different ocean basins reflects control of the carbonate chemistry of the deep glacial ocean in the Atlantic and Pacific by the changing ventilation and chemistry of Weddell Sea waters (Rickaby et al., 2010). These waters increase their flux to the deep Atlantic, and are more corrosive than interglacial northern sourced waters, but not as undersaturated as interglacial southern sourced waters. We shall provide a new record of B/Ca from TT013-PC72 in the deep Pacific which confirms that glacial periods are associated with a whole ocean increase in CO32-. Such an increase in whole ocean alkalinity, may be reconciled with reconstructions of glacial saturation horizon depth and the carbonate budget, if carbonate burial rates also increased above the saturation horizon as a result of enhanced pelagic calcification. From each of these records close to the saturation horizon, it appears that on the whole the [CO32-] changes hand in hand with %CaCO3 finally resolving that these cycles are largely preservation cycles. However there are some distinct departures from this relationship. Notably, in each record, some glacial terminations are associated with low [CO32-] coincident with maxima in %CaCO3 in the Atlantic and Pacific Oceans. Should the burial rate of alkalinity in the more alkaline glacial deepwaters outstrip the rate of alkalinity supply, then pelagic carbonate production by the coccolithophores, at the end of the glacial maximum could drive a decrease in ocean [CO32-] and catalyse the deglacial rise in pCO2. We will test quantitatively, the impact of this mechanism for the termination using the intermediate complexity GENIE model.