Changes in carbonate sedimentation and the ocean's calcium inventory during the Paleocene-Eocene Thermal Maximum

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Abstract

A simple model of the total carbon inventory, alkalinity and calcium concentrations of the ocean during the PETM (Paleocene-Eocene Thermal Maximum; ~55Ma ago) was developed. The main purpose of the research was to determine the magnitude of change in calcium ion of the deep sea as result of carbon perturbation and increased weathering fluxes. Additionally, we investigate possible implications that such a change would have on boron/calcium and magnesium/calcium ratios, which are used as a proxy for deep water carbonate saturation state and temperature, respectively. It has been observed in sediment cores that during the PETM recovery stage there was enhanced carbonate deposition on the seafloor as a consequence of ocean oversaturation. During the recovery interval, weight percent $CaCO_3$ values were higher than the pre-PETM values, which represents an "overshoot" before the system moved back to steady state. The model includes a weathering feedback in order to simulate the overshoot in carbonate deposition during the PETM recovery phase. We investigated the calcite compensation depth recovery time and calcite saturation state during the recovery phase as well as global ocean bottom water carbonate ion concentration. It was found that under the most plausible scenario the calcium ion concentration change ($\Delta[Ca^{2+}]$) was less than 1.4 % and thus it was concluded that the perturbation that took place during the PETM would not jeopardize the validity of the two above mentioned proxies. The significance of understanding the chemistry and processes that took place in the ocean during the PETM lies in the fact that the amount of CO_2 that was released into the atmosphere-ocean

system during the PETM may be similar to the amount of carbon that humans could potentially emit to the atmosphere in the next several centuries. Thus, comprehension of the processes that occurred during the PETM is important since it provides the opportunity to better predict the future states of the ocean and impacts of anthropogenic CO_2 emissions on ocean chemistry.