A MAGic approach to Phanerozoic seawater evolution

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We explore the Phanerozoic coevolution of ocean, atmosphere, and sediment composition using MAGic, a comprehensive numerical model of Earth system history, with a focus on the carbonic acid system. MAGic describes the coupled biogeochemical cycles involving major seawater components (Ca, Mg, Na, K, Cl, SO_4, HCO_3, CO_2, CO_3), as well as those central to net ecosystem productivity (O_2, Fe, P, C, S), and permits investigation of long-term feedbacks between the ocean, atmosphere, and continental and marine sediment and rock masses. As examples, we first discuss the sensitivity of primary productivity, weathering, reduced C and S burial, SO_4 reduction, and seawater-basalt exchange fluxes to global ocean ventilation. We show how this sensitivity can be evaluated using a simple mixing parameter [1], and discuss results suggesting a coupling between ventilation and complementary changes in seawater DIC and SO_4. Second, we discuss the timing of pelagic calcifier radiations and the relative importance of biogenic versus abiogenic carbonate in pelagic seafloor environments (Fig. 1), and reveal a possible trigger between Ca^{2+}/CO_3^{2-} ratios and the appearance of pelagic calcifiers [2]. Lastly, we discuss preliminary results involving the relationship between shallow marine versus epigenetic dolomite, and the potential for long-term mediation of seawater saturation state.

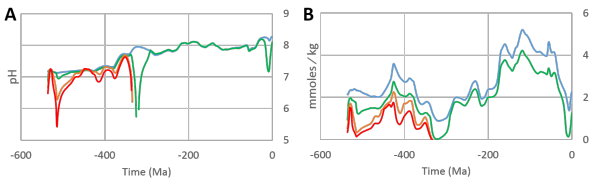

Fig. 1. The importance of carbonate uptake by submarine basalt to seawater pH (A) and DIC (B). Sufficient reduction in uptake depletes DIC (red curve) by –330 Ma [2].

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