4.1.41

Sea level, sediments, and the composition of Phanerozoic seawater

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The composition of seawater during the Phanerozoic is well correlated with changes in sea level and the flooding of the continents. Spencer and Hardie proposed that this correlation is due to changes in the rate of seafloor spreading and accompanying changes in the rate of seawater cycling through mid-ocean ridges. Two observations now make this explanation unlikely: 1) the concentration of K^+ in seawater changed very little during the Phanerozoic; 2) the rate of seafloor spreading has apparently changed very little during the past 180 Ma.

These observations suggest that processes other than changes in the cycling of seawater through MORs were responsible for the observed changes in the composition of Phanerozoic seawater. The major shift in $CaCO_3$ deposition from the shallow to the deeper parts of the oceans during the Cenozoic resulted in a decrease in the rate of dolomite and gypsum-anhydrite deposition. A semiquantitative model of the response of seawater composition to these changes does justice to all of the available data.

The flooding of the continents during the warm Mesozoic probably increased the rate of dolomite and gypsum/anhydrite deposition. The effect of these changes can explain the observed evolution of seawater composition without requiring variations in the rate of seawater cycling through MORs.

The low stand of sea level during the Permian was accompanied by a seawater composition close to that of the present day and by a considerably greater degree of supersaturation with respect to $CaCO_3$**.** These observations are consistent with a decrease in the size of the continental shelves and by an increase in the physical transport of shallow water carbonates into deeper waters, where dolomitization was minor.

There is little information regarding the rate of seafloor spreading during the Paleozoic. However, the similarity of the correlation between sea level and the composition of seawater during the first and second of the Phanerozoic supercycles suggests that the controls on seawater composition have remained the same or very similar during the entire Phanerozoic.

4.1.42

A remained sulfidic ocean in Early Cambrian of S. China: Evidence from organic carbon isotope

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Total 60 samples from the Lower Precambrian black shale of NW Hunan, China (541±16Ma)[1] for isotopic compositions of organic and carbonate carbon were analyzed. The δ^{13}Corg values vary from –29.7 to –34.2‰ with average -31.5‰, and the reliable $\delta^{13}C_{carb}$ values are between -2.1 to -4.1‰ with average -2.3‰ only from 7 samples of them because of very low carbonate content in black shale. The $\delta^{13}C_{org}$ of the black shale show obvious ^{13}C-depletion compared with those of the pre-Devonian ($\delta^{13}C_{org} \geq -30‰$) from the other place in the world[2,3]. The isotopic difference, $\varepsilon_{TOC} \approx \delta_{carb} - \delta_{org}$,, between TOC and sedimentary carbonates in the samples is from 29.9 to 31‰ with average 30.1%. Parameter ε_{TOC} represents the combined effects [2, Fig.5] from the fractionations of dissolved CO_2 fixed by primary producers (ε_p), precipitated into carbonates via dissolved inorganic carbon (Δ_{carb}), various secondary biological processes ($_{\Delta 2}$) and sea-surface temperature. The CO_2 concentration in the atmosphere of the Early Cambrian would be about 20 times higher than today (Crowley et al., 2002) and generally associated with warm period. Calculations according to the relationship $\varepsilon_{TOC} - \Delta_{carb} = \varepsilon_p - \Delta_2$ (Hayes et al., 1999, Eq.10) show that given 20ºC as sea-surface temperature of that time, the values of $\varepsilon_p - \Delta_2$ all fall in a range from 19.3 to 23‰, obviously higher than the values of ε_p in the modern ocean (8□18‰). It means that if sedimentary environment of the Lower Cambrian black shale was similar to modern ocean, the Δ_2 values must be negative and thus indicative of chemoautotrophic inputs and there was sulfide-oxidizing bacteria flourish in the water column. It is consistent with evidence from the sulfur isotopic data of pyrite in the Lower Cambrian black shale of NW Hunan, China and related paleo-atmosphere and -ocean model (Ma et al., 2003).

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