Mass-dependent and radiogenic isotope variation of Sr in the Neoproterozoic Doushantuo Formation

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We measured both mass-dependent isotope fractionation of $d^{88}Sr$ ($^{88}Sr/^{86}Sr$) and radiogenic isotopic variation of Sr ($^{87}Sr/^{86}Sr$) for the Neoproterozoic Doushantuo Formation that deposited as a cap carbonate immediately above the Marinoan-related Nantuo Tillite. The $d^{88}Sr$ and $^{87}Sr/^{86}Sr$ compositions showed three remarkable characteristics: (1) high radiogenic $^{87}Sr/^{86}Sr$ values and gradual decrease in the $^{87}Sr/^{86}Sr$ ratios, (2) anomalously low $d^{88}Sr$ values at the lower part cap carbonate, and (3) a clear correlation between $^{87}Sr/^{86}Sr$ and $d^{88}Sr$ values. These isotopic signatures can be explained by assuming an extreme greenhouse condition after the Marinoan glaciation. Surface seawater, mixed with a large amount of freshwater from continental crusts with high $^{87}Sr/^{86}Sr$ and lighter $d^{88}Sr$ ratios, was formed during the extreme global warming after the glacial event. High atmospheric CO2 content caused sudden precipitation of cap carbonate from the surface seawater with high $^{87}Sr/^{86}Sr$ and lighter $d^{88}Sr$ ratios. Subsequently, the mixing of the underlying seawater, with unradiogenic Sr isotope compositions and normal $d^{88}Sr$ ratios, probably caused gradual decrease of the $^{87}Sr/^{86}Sr$ ratios of the seawater and deposition of carbonate with normal $d^{88}Sr$ ratios. The combination of $^{87}Sr/^{86}Sr$ and $d^{88}Sr$ isotope systematics gives us new insights on the surface evolution after the Snowball Earth.