Redox conditions and carbon cycling of Mesoproterozoic Ocean: Clues from trace element and C-O-Sr isotope geochemistry of Carbonate rocks of the Bhima Group, Eastern Dharwar Craton, India

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The extreme low diversity of life and relative stasis of carbon cycle (uniform $\delta^{13}C$ ~0 ‰ in marine carbonate) in the Mesoproterozoic Era are thought to be related to low oxygen levels in the atmosphere and ocean. However, recent studies point towards a possible gap in data in understanding the Mesoproterozoic time period. We have carried out high-resolution C-O and Sr isotopic studies on drill-core carbonate samples of ~1.54 Ga Bhima Group. The low Mn/Sr ratios (~1.18) and Precambrian-like $\delta^{18}O$ values (avg. ~-7‰) of Bhima Carbonates (BC) suggest that secondary processes could not have altered the primary C-isotope signatures of the samples. Detailed geochemical modelling suggests little effect of diagenesis on $\delta^{13}C$ and $\delta^{18}O$ compositions of BC. They show well defined negative cerium anomalies with an average Ce/Ce* values of ~0.7 indicating well oxidised conditions. The prominent negative $\delta^{13}C$ excursions of ~5 ‰ in the basal part would be due to the oxidation of organic matter causing release of isotopically light carbon into the ambient waters. The $^{87}Sr/^{86}Sr$ ratios of BC are higher (0.7071 to 0.7120) in comparison to the contemporary ocean water (0.7048). This is attributed to the increased continental flux as supported by the corresponding depleted $\delta^{18}O$ signals. High frequency variation of $\delta^{13}C$ would require much higher level of atmospheric oxygen, and would suggest that oxygenation of atmosphere and biosphere happened much earlier than suggested.