Ca and Mg isotope variations of Paleoproterozoic (~2 Ga) carbonates: Implications for positive $\delta^{13}C$ event

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We report Ca and Mg isotope compositions of Paleoproterozoic (~2.0 Ga) dolostones that accumulated along the SE Fennoscandian Shield [1] and recorded the first major positive excursion in marine $\delta^{13}C$ record, i.e. the Lomagundi-Jatuli event [2,3]. Selected drill core samples of stoichiometric dolomites with low Mn/Sr ratios (0.5 to 6) are considered to be primary or synsedimentary precipitates. Analyzed samples cover a wide range of depositional settings, from marine intertidal to supratidal and fluvial. The $\delta^{44/40}Ca$ (NIST) of dolostones is strongly dependent on the depositional environment, which in turn changes with stratigraphic depth. All intertidal dolomites with abundant evaporite relics (after $CaSO_4$) yielded extremely heavy $\delta^{44/40}Ca$ of +1.5 to 1.7‰ (±0.15, 2sd), which can be explained by Rayleigh fractionation of Ca isotopes in progressively evaporated seawater due to ongoing precipitation of $CaSO_4$ [4], in addition to $CaCO_3$. These Ca-bearing minerals preferentially take in light Ca isotopes, leaving the remaining seawater (brine), and the dolomite formed from it, isotopically heavy. In contrast, sabkha/playa dolomites from the supratidal zone show much lighter $\delta^{44/40}Ca$ of 0.7 to 1.3‰, likely reflecting a contribution of light Ca from continental runoff with estimated $\delta^{44/40}Ca$ of ~0.9±0.2‰ [5]. This scenario is supported by more radiogenic $^{87}Sr/^{86}Sr$ found in the supratidal samples [6]. The average $\delta^{26}Mg$ (DSM3) of dolostones equals -1.0±0.3‰ and show no resolvable trend with stratigraphic depth, but dolostones collected in the vicinity of a major magnesite layer [1] show slight ^{26}Mg-enrichment ($\delta^{26}Mg$ of -0.7±0.17‰). In conclusion, our results support the hypothesis that the studied dolomites formed from evolved seawater brines in a partially restricted evaporative environment. This implies that their isotope composition, affected by local conditions, might not directly reflect the global seawater $\delta^{13}C$ signal.

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Major events in the recent history of the solar system recorded by ^{3}He in deep-sea sediments

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Cosmic dust is extraordinarily enriched in ^{3}He compared to terrestrial sediments, making it a sensitive tracer of the flux of fine-grained extraterrestrial matter to earth. Analyses of marine sediments demonstrate that this helium is preserved for at least several hundred million years, though it remains unclear what phase(s) are responsible for this preservation. Using ^{3}He concentrations in sedimentary rocks my many collaborators and I have produced and attempted to interpret a record of the cosmic dust flux spanning the last ~100 Myr. The record reveals several multi-Myr episodes of enhanced flux, most prominently at 36 and 8 Myr. These episodes document the occurrence of important events in the history of the solar system. The timing and temporal evolution of the 8 Myr event are consistent with the collisional destruction of a 140 km diameter asteroid to produce the Veritas asteroid family. The enhanced ^{3}He flux is maintained for ~1.5 Myr by a collisional cascade among resulting fragments. In contrast there is no known collision corresponding to the 36 Myr peak. The temporal evolution of the enhanced dust flux and the occurrence of several major terrestrial impacts at the peak of the event are more consistent with a comet shower produced by a close stellar encounter. However, other workers have presented geochemical evidence from the impacts themselves that may argue against such an origin. One postulated alternative is the occurrence of an asteroid shower, with dust derived from lunar impacts. We are continuing to push deeper into the past searching for additional events, and hope to reach at least 150 Myr of continuous record.