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Links between silicate-carbonate weathering, climate and the origin of Neoproterozoic cap carbonates: New constraints from stable and radiogenic Sr isotope records (δ88/86Sr and 87Sr/86Sr) from the Amadeus Basin, Australia

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One of the most extreme environmental and climatic changes in the Earth's geological history occurred during the Neoproterozoic, specifically the Cryogenian period (~720 to ~635 Ma) when our planet experienced two major worldwide glaciations, i.e. the Sturtian and Marinoan 'Snowball Earth' events. The aftermath of these glaciations is characterized by the deposition of globally distributed post-glacial cap carbonates, whose origin is controversial but likely related to a purported massive deglaciation weathering flux from the continents (i.e. the post-Snowball meltdown), proposed to be the main source of alkalinity and Ca and Mg cations for the formation of cap carbonates. The issue with the above scenario is that traditional isotope tracers for continental weathering, such as the 87Sr/86Sr proxy, have not yet provided convincing evidence for the above massive increase in the weathering flux to the oceans, and thus alternative explanations have been put forward recently (cf. Gernon et al., 2016). The latter study proposed that the main source of cations and alkalinity for the formation of cap carbonates originated from the submarine alteration/weathering of newly formed volcanic materials by seawater, i.e. the 'shallow ridge hypothesis', which is thus decoupled from the continental weathering fluxes.

To reconcile this controversy, and test the above hypotheses, we applied here a coupled stable and radiogenic Sr isotope proxies (d88/86Sr and 87Sr/86Sr), which were analyzed in a set of Neoproterozoic carbonates collected in the Amadeus Basin, Central Australia, including: pre-Marinoan carbonates (i.e. Bitter Spring Gr. and Ringwood Mb. from Aralka Fm.) and post-Marinoan cap carbonates (i.e. post-glacial Olympic Fm.). We hypothesized that a scenario involving enhanced 'continental weathering' would be reflected as shifts to more radiogenic 87Sr/86Sr and lower d88/86Sr in cap carbonates, the latter due to increased input of light Sr from carbonate weathering (cf., Krabbenhoeft et al. 2014). In contrast, the 'shallow ridge hypothesis' is expected to be manifested by less radiogenic 87Sr/86Sr and relatively higher d88/86Sr.

Importantly, our results confirmed that the stable and radiogenic Sr isotope records of Neoproterozoic carbonates from the Amadeus Basin are more consistent with the 'continental weathering' hypothesis, as the post-glacial cap carbonates yielded systematically lower d88/86Sr and more radiogenic 87Sr/86Sr, relative to the studied pre-Snowball carbonates. Implications of the acquired Sr isotope data for temporal changes in the weathering regime, carbonate burial, and/or links to Neoproterozoic climate will be discussed and evaluated.

REFERENCES

Gernon et al. (2016), Nature Geoscience, Vol. 9, 242-248.
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