Lead isotopes in marine barite: An intermediate water mass tracer

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Changes in the chemistry of intermediate water provides insight into formation and movement of this water mass. These intermediate water dynamics are attributed to the redistribution of heat and freshwater, making it an important driver and archive of climate change. This study investigates the utility of lead isotopic ratios incorporated into marine barite to address changes in intermediate water provenance.

Lead and its isotopes are introduced into the ocean primarily through the weathering of continental rock. These rocks may have distinct isotopic signatures, depending on the age of the eroded material. As a result, the source regions of a water mass and climate related weathering processes can be reconstructed [1].

Marine barite is known to precipitate directly from seawater in micro-environments containing decaying organic mater. It has been shown to record seawater chemistry for a variety of trace elements. Marine barite forms predominantly at intermediate water depths and does not exchange with seawater or porewater after formation.

This work reports the first application of stable lead isotopes in marine barite. To determine the integrity of the method, marine barite was precipitated in seawater with varying concentrations and ratios of lead isotopes. These experiments show a linear relationship between lead concentration in the marine barite and seawater. In addition, the lead incorporated into the barite crystal faithfully recorded the seawater isotopic composition.

Marine barite from core top sediments demonstrate a near contemporaneous regional record consistent with expected intermediate water signatures.

Down core records show large scale shifts in the lead isotopic signature. These changes generally correspond to global glaciation events, potentially reflecting changes in ocean circulation and source waters during these times. The trends exhibited in this marine barite lead record are consistent with records from iron-manganese nodules, though the magnitude of the shifts are greatly increased. Potential water source regions and their implications for global circulation will be discussed.

[1] Foster & Vance (2006) *Nature* **444**, 918–921.

Distal transport (>650 km) of detrital shocked zircon in a cratonic fluvial system: The Vaal River, South Africa

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No evidence of meteorite impacts has been recognized from the Hadean. A new approach to discover the early impact history is through identification of detrital shocked minerals. Shocked minerals eroded from an impact crater express unique microstructures. The 2.02 Ga Vredefort Dome is the largest and oldest identified impact structure on Earth. The Vredefort structure is 90 km wide and is the remnant of the central uplift of a 300 km wide multi-ring basin. The Vaal River cross cuts the Vredefort Dome and flows 750 km further to its confluence with the Orange River.

Cavosie *et al.* [1] identified detrital shocked zircons from sediments in the channel of the Vaal River and its tributaries within the Vredefort Dome, including grains with multiple sets of Planar Fractures (PFs). We have extended the occurrence of shocked zircons in the Vaal River in channel sediments ~675km downstream from the Vredefort Dome. Zircons were analyzed by SEM in sediments from several localities. Shocked zircons were identified in 5 of 6 samples, including the furthest downriver sample near Sydney-on-Vaal, approximately, 675 km from Parys, a location on the Vaal River chosen to represent the center of the Vredefort Dome. PFs were recognized in euhedral, subhedral and rounded zircons that show severe sedimentary abrasion. Multiple grains with PFs have been identified, with 90% of the identified shocked zircons exhibiting at least two sets of PFs and 45% displaying 3 sets.

This study demonstrates that shocked zircons survive sedimentary transport to distal locations (~700 km of fluvial transport) and are therefore a robust record of eroded impact structures. Shocked zircons will likely remain within detrital systems long after erosion and tectonics has destroyed the original impact structure. An impact record from the early Earth may therefore exist as shocked zircons in Archean siliciclastic deposits containing Hadean detritus.

[1] Cavosie *et al.* (2010) *GSA Bulletin*, in press.