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Iron isotopes as a powerful proxy to constrain high-velocity impact events that occurred throughout Earth's history

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High-velocity impact events are significant contributors to the geomorphological and geochemical modifications of the lithosphere throughout Earth's history. About 20 large impact events have been recorded on Earth [1]. However, many parameters related to these impacts remain unclear, including the nature and size of the impactors, the location of the impact structures in some cases, the magnitude of the impact and its effect on the lithosphere, as well as the chemical processes involved during cratering and ejection processes.

This study reports high-precision Fe isotope measurements of both proximal and distal impact spherules from the 66 Ma Cretaceous-Paleogene boundary, originating from the Chicxulub impact (Yucatán Peninsula, Mexico). A total of 47 impact spherules were investigated from various localities at different distances and directions from the source crater. Iron isotopic compositions were measured using a Thermo Scientific Neptune *Plus* MC-ICP-MS unit at Ghent University (Belgium), after anion exchange chemistry [2].Proximal impact spherules show a mean $d^{56}Fe$ of 0.041 ± 0.16 ‰ (2SD, n = 21), undistinguishable from the Earth's crust mean value [3] and comparable to the $d^{56}Fe$ composition of most distal impact spherules.

We show here that: 1) Despite the altered nature of the spherules, their Fe isotope compositions are predominantly pristine; 2) There is no resolvable Fe isotope fractionation in Chicxulub proximal and distal impact spherules, contrary to what is observed in the more recent Australasian impact spherules [4;5]. This lack of Fe isotope fractionation can be attributed to a slow cooling rate of the spherules within the larger impact plume [6], allowing the Fe isotopic system to re-equilibrate, and 3) The Fe isotopic system could be used to constrain high-velocity impact regimes and, consequently, the impact plume size of various ancient impact events.

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