The Ediacaran Acraman impact event: did it affect the long-term carbon cycle?

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The Acraman impact crater (c. 570 Ma) is one of the largest known [1], and the preservation of its ejecta in marine sediments (Dey Dey Mudstone) within a 500 km radius [2] provides a unique opportunity to test large impacts as major progenitors of biospheric change. The appearance of nearly 50 new taxa of acanthomorph acritarchs above the ejecta layer suggests a major evolutionary radiation of phytoplanktonic green algae [3].

Two drillcores from the Officer Basin (Munta-1 and OH-1) have been analysed and results show that the $^{13}C/^{12}C$ ratio of bulk kerogen (δ_{ker}) begins to decline 15 m above the ejecta layer in a smooth, point-to-point manner, culminating in a 7–8‰ decrease, from δ_{carb} (estimated) +11 to +4‰ in OH-1 and +10 to +2‰ in Munta-1. In 8 samples from Munta-1 acritarch (δ_{acr}) values are greater than δ_{ker} values by 2–4‰ and δ_{ker} is not heavier in samples with a higher concentration of intact acanthomorph acritarchs. So neither palynofacies change, diagenesis nor the overprint of water column stratification are responsible for the shift. We estimate the negative shift persisted for 2–3 million years (timescale of [4]). δ_{ker} then increases rapidly, 6–7 times faster than the negative shift, and stratigraphically above the first appearance of acanthomorph acritarchs. In Australia, post-impact Ediacaran δ_{carb} values never exceed pre-impact values.

We have demonstrated two biomarker anomalies: one in highly branched alkanes which virtually disappear over ~20 m of sediment in drillhole Munta-1, reappearing 5 m below the onset of the second anomaly, in steranes. A marked increase in ethylcholestane abundance in many sediment samples begins slightly below the first body fossil appearance of acanthomorphs and persists for ~20 million years [5]. The former is a prokaryotic signal and the latter is a eukaryotic biomarker anomaly.

Our results thus suggest that there was a change in the long-term regional carbon cycle at and immediately above the Acraman impact ejecta layer concomitant with profound changes in the evolution of acritarchs. However, further verification is required to eliminate other possibilities.

References

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