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# Helium Isotopes in Norian-Rhaetian Shales from Black Bear Ridge: Evidence for the Manicouagan Impact Origin of a Late Triassic Biotic Crisis?

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A major positive C and N isotope excursion has been recorded in the Late Triassic (Norian-Rhaetian) black shales at Black Bear Ridge, British Columbia that precedes the end-Triassic mass extinction but begins coincident with the demise of the monotid bivalves. The isotope excursion is attributed to the development of widespread oceanic stagnation that favoured deposition of organic-rich shales (Sephton et al. 2002, Geology, 30, 1119-1122). The duration of this major oceanic event is unknown owing to the lack of layers amenable to radiometric dating. One approach to improve our understanding is to use the flux of interplanetary dust-borne extraterrestrial $^3$He ($^3\mathrm{He}_{et}$) which is fairly constant and can be used to determine the accumulation rate of oceanic sediments. Caution is required around the time of asteroid/comet impact when the flux is enhanced dramatically. We have measured helium isotopes in 29 Late Triassic Black Bear Ridge sedimentary rocks in order to assess the duration or possible impact origin of the C-N isotope excursion. A 10- to 100-fold increase in $^3\mathrm{He}_{et}$ starts abruptly in the late Norian, approximately 5 m below the first evidence of the Rhaetian high $\delta^{13}\mathrm{C}_{org}$ excursion. The period of high $^3\mathrm{He}_{et}$ continues into rocks younger than the excursion and an eventual return to background values coincides with the Triassic-Jurassic extinction (199.6 Ma) which is stratigraphically much higher than the demise of the monotid bivalves. If interpreted as a reduction in sedimentation rate the period of high $^3\mathrm{He}_{et}$ requires $\sim$30 Myr and the sample interval would be a zone of condensation with a major hiatus spanning much of the Rhaetian Stage. Although evidence for condensation exists, $\sim$30 Myr is difficult to reconcile with existing chronology

and the amount of time reflected in these sedimentary rocks is likely to be at least half this value. In addition, the absence of other indications of decreasing mass accumulation rate (4He and non-carbonate fraction) supports an origin for the elevated $^3He_{et}$ in an increase in the extraterrestrial dust flux associated with the bolide impact that generated the Manicouagan impact crater in Quebec at 214$\pm$1 Ma. The positive $\delta^{13}C_{org}$ excursion may be the consequence of post-impact gas flux to the atmosphere, associated warming and oceanic torpor.