

Fullerenes and the Flux of Extraterrestrial Helium He@C₆₀ to the Earth Over Geologic Time

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The discovery of fullerenes in deposits associated with two separate impact events involving a large bolide with the Earth suggests that these carbon (C) molecules may also be an indicator of extraterrestrial (ET) events over geologic time. Fullerenes were detected in carbon-rich breccias (Onaping Fm.) associated with the 1.85 byr Sudbury Crater (Becker *et al.*, *Science* **265**, 1994) and in clay sediments within the 65 myr old Cretaceous/Tertiary (K/T) boundary (Heymann *et al.*, *Science* **265**, 1994). To determine the origin of the Sudbury fullerenes, we searched for noble gases trapped inside the fullerene molecules (Saunders *et al.*, *Science* **259**, 1993). The Sudbury fullerenes contain trapped $^3\text{He}/^4\text{He}$ ratios ($\sim 5.5 \times 10^{-4}$) similar to those found in meteorites and some interplanetary dust particles (Becker *et al.*, *Science* **272**, 1996). Preliminary measurements of He in a continental K/T fullerene residue from Raton Basin (Colorado) revealed $^3\text{He}/^4\text{He}$ ratios some 100 times above air. A marine K/T residue from Stevns Klint, (Denmark) revealed $^3\text{He}/^4\text{He}$ ratios several thousand times above air in the high temperature fraction! We attribute the anomalously high $^3\text{He}/^4\text{He}$ ratios and high ^3He concentration in Stevns Klint to the abundance of higher fullerenes in the residue. The high $^3\text{He}/^4\text{He}$ ratio in the K/T fullerenes suggests that they were present in the bolide and somehow survived the impact event. Confirmation of these results could have broad implications concerning the importance of exogenous delivery in providing carbon, volatiles and perhaps other organics to the early Earth's crustal reservoir.