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Xenon in Bennu, Ryugu, and Winchcombe

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Carbonaceous chondrites sample some of the most primitive materials from our Solar System and are implicated in the delivery of water, organics and volatile species to Earth [1]. However, exposure to the terrestrial atmosphere can lead to alteration or loss of information about their composition and history [2]. Returned samples, such as those collected from asteroids Ryugu and Bennu by JAXA's Hayabusa2 [3] and NASA's OSIRIS-REx [4] missions, respectively, are protected from the terrestrial atmosphere, allowing more accurate interpretation. Careful curation of the Winchcombe (CM2) carbonaceous chondrite [5,6] has provided a near-pristine meteorite to compare with returned samples.

Xenon is particularly useful among the noble gases for tracing Solar System evolution. Nine isotopes are sufficient to unambiguously identify multiple sources contributing to the observed composition: different reservoirs, radioactive decay of ^{244}Pu and ^{238}U, spallation and secondary neutron capture reactions of samples containing Ba and light REE, and artificial neutron irradiation of samples containing ^{127}I, ^{130}Ba, ^{130}Te and ^{235}U, all produce characteristic xenon isotopic signatures. The I-Xe chronometer [7,8] provides a high-resolution means to investigate the timing and sequence of events in the first ~70 Myr of Solar System history. Here we report and compare xenon isotopic analyses of Ryugu, Bennu and Winchcombe, conducted using the RELAX mass spectrometer [9,10]. The high sensitivity of RELAX enables us to separate different components and observe small isotopic excesses which may not be resolved using a conventional noble gas mass spectrometer.

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