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Meteorite Just One Piece of an Unknown Celestial Body

Scientists from all over the world are taking a second, more expansive, look at the car-sized asteroid that exploded over Sudan's Nubian Desert in 2008. Initial research was focused on classifying the meteorite fragments that were collected two to five months after they were strewn across the desert and tracked by NASA's Near Earth Object astronomical network. Now in a series of 20 papers for a special double issue of the journal Meteoritics and Planetary Science, published on December 15, researchers have expanded their work to demonstrate the diversity of these fragments, with major implications for the meteorite's origin.

In the first round of research, Carnegie Geophysical scientist Doug Rumble, in collaboration with Muawia Shaddad of the University of Khartoum, examined one fragment of the asteroid, called 2008 TC3, and determined that it fell into a very rare category of meteorite called ureilites". Ureilites have a very different composition from most other meteorites. It has been suggested that all members of this meteoric family might have originated from the same source, called the ureilite parent body, which could have been a proto-planet.

Now Rumble has expanded his work to examine 11 meteorite fragments, focusing on the presence of oxygen isotopes. Isotopes are atoms of the same element that have extra neutrons in their nuclei.

Rumble explains: "Oxygen isotopes can be used to identify the meteorite's parent body and determine whether all the fragments indeed came from the same source. Each parent body of meteorites in the Solar System, including the Moon, Mars, and the large asteroid Vesta, has a distinctive signature of oxygen isotopes that can be recognized even when other factors, such as chemical composition and type of rock, are different."

Rumble and his team prepped tiny crumbs of these 11 meteorite fragments and loaded them into a reaction chamber, where they were heated with a laser and underwent chemical reactions to release oxygen and then used another device, called a mass spectrometer, to measure the concentrations of these oxygen isotopes. Results showed that the full range of oxygen isotopes

known to be present in ureilites were also present in the studied fragments.

"It was already known that the fragments in the Nubian Desert came from the same asteroid. Taking that into account, these new results demonstrate that the asteroid's source, the ureilite parent body, also had a diversity of oxygen isotopes," says Rumble.

The diversity of oxygen isotopes found in ureilites probably arises from the circumstances of the parent body's formation. Rumble theorizes that the rock components of this parent body were heated to the point of melting and then cooled into crystals so quickly that the oxygen isotopes present could not come to an equilibrium distribution throughout.

Together the collection of 20 papers published in Meteoritics and Planetary Science offer enormous insight about the formation and composition of ureilites and their hypothesized parent body.

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Liping Qin, Douglas Rumble, Conel M. O'D. Alexander, Richard W. Carlson, Peter Jenniskens, Muawia H. Shaddad. The chromium isotopic composition of Almahata Sitta. Meteoritics & Planetary Science, 2010; DOI:10.1111/j.1945-5100.2010.01109.x