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The Aguas Zarcas breccia - similarities to surface features of asteroids Ryugu and Bennu

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At 21:07 local time on 23rd April 2019, a meteorite fall occurred in Aguas Zarcas, Costa Rica. The rapid recovery of this brecciated carbonaceous chondrite after its fall provides an opportunity to investigate a freshly-fallen, relatively uncontaminated and highly-brecciated meteorite for comparison to the samples returned from C-group asteroids by the Hayabusa2 and OSIRIS-REx spacecraft.

The study includes several pre-rain fragments. Our X-ray Computed Tomography results show many different lithologies. In this study we describe the petrography and mineralogy of five different lithologies of the Aguas Zarcas meteorite. We also present bulk oxygen isotope data of some lithologies and results concerning the organic matter. We describe all the fragments in detail and attempt a classification of each lithology in order to understand the origin and the history of formation of the Aguas Zarcas' parent body.

Our results show some lithologies of Aguas Zarcas similar to those in CM chondrites, but others are unique. The different lithologies [1] represent different levels of hydration and heating as well, which are good analogues for the types of materials returned from asteroids Bennu and Ryugu.

Spectroscopic observations of the Ryugu and Bennu asteroids compared to laboratory measurements of meteorites suggest that the asteroids show some similarities to heated CM, heated CI or, CI chondrites [2-5]. Both asteroids are regarded to consist of materials altered by aqueous alteration (e.g.,[5]) and formed by re-accretion after impact destruction and brecciation (e.g., [6-7]). Considering the various different lithologies in Aguas Zarcas [2] and other CM chondrites [8-9] these types of carbonaceous chondrites may be regarded as good analogues for samples from the Ryugu and Bennu asteroids. The presence of unique and rare lithologies in the Aguas Zarcas, that are distinct from typical CM chondrite lithologies, indicates a complex mixing of various materials in a highly dynamic environment.

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