EVIDENCE FOR A CERES-SIZED, WATER-RICH, CARBONACEOUS CHONDRITE PARENT ASTEROID: A MISSING LINK FOUND IN THE ALMAHATA SITTA METEORITE

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We have discovered abundant (~10 vol.%) tremolite amphibole in a carbonaceous chondrite (CC) fragment (202, C-ung) from the Almahata Sitta (AhS, Ur-anom) meteorite. Terrestrially, tremolite is a fairly common hydrous mineral that forms under greenschist facies conditions (300-500° C and ~2-8 kbar). Amphibole has been identified in two R chondrites at similar abundances, but it is virtually unknown in CC, having been identified only in Allende ($CV3_{oxA}$) at trace to minor (likely <<1 vol.%) abundances. Thus, AhS 202 provides evidence of a previously unrecognized CC parent body that must have been of sufficient size (~500-1400 km diameter) to support prolonged, fluid-assisted metamorphism at intermediate pressures and temperatures.

The previous detection of amphibole in a CC, even at very low abundances, is noteworthy as it indicates that conditions for that mineral's formation existed in the early solar system, no matter how briefly or how localized. However, our detection of abundant amphibole in a second CC that implicates a second, large parent body suggests that moderately elevated, hydrous P/T conditions may have been more widespread than previously thought based on meteorites. The apparent absence of amphibole in most carbonaceous chondrites may reflect bias in our meteorite collections and/or failure to identify it in other samples. Finally, samples like AhS 202 provide important missing links if spaceflight missions such as Hayabusa2 and OSIRIS-REx return samples that differ from what exists in meteorite collections.