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Titanium and chromium nucleosynthetic isotope variation in samples from the Almahata Sitta strewnfield

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Mixing processes in the protosolar disk can be traced through studies of nucleosynthetic isotope compositions of planetary materials. These compositions are unique for each body in our solar system with a few exceptions (e.g., Earth and Moon). They can be related to a heterogeneous distribution of presolar dust in the disk [1] and are powerful tracers for genetic relationships between different planetary bodies. The impact of asteroid 2008 TC_3 revealed a rubble-pile body [2]. Petrological characterisation showed that it mainly consisted of various types of chondritic (mainly enstatite chondrites) and ureilitic fragments, including four ureilite-related trachyandesites, with a mean mass of 29 g [3]. The diversity of meteorite types found among the Almahata Sitta samples indicates that asteroid 2008 TC_3 may have been a product of secondary accretion [3,4]. The compositions of these fragments can be further constrained by Ti and Cr isotope analyses, providing evidence of their origin. Titanium and Cr isotope data for eleven Almahata Sitta fragments were measured on a Neptune Plus multi-collector ICP-MS at ETH Zürich. The results show that fragments of CB-, R-, and enstatite chondrite-like composition, previously identified through petrological classification, display Ti and Cr isotope compositions characteristic for the respective groups. This new Ti and Cr isotope data confirm the presence of non-carbonaceous (NC) and carbonaceous chondrite (CC) fragments within the same rubble-pile asteroid 2008 TC_3. This indicates mixing between the NC and CC reservoirs after the dissipation of the protoplanetary disk. Ureilitic fragments show a clear ureilitic Ti and Cr isotope composition, suggesting that the studied ureilitic fragments contain insignificant amounts of small CC clasts. Ureilite-related trachyandesites included the sample ALM-A and yield Ti and Cr isotope data, which falls within the ureilitic field. Therefore, these trachyandesites are likely genetically related to the ureilite parent body (UPB), and sample the UPB crust.

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