Assessing the classification of presolar silicon carbide grains using cluster analysis

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Presolar grains are minerals formed prior to the formation of our Solar System. Their stellar origin is implied by their highly unusual isotopic compositions. Among these presolar grains, silicon carbides (SiC) are the most studied, and their isotopic compositions are key to understanding stellar evolution, nucleosynthesis, and Galactic chemical evolution. These isotopic compositions are usually coupled with astrophysical observations and models to define populations of grains formed in the same type of environment, such as AGB stars and supernovae. In the present study, we used a machine learning technique, cluster analysis, to statistically assess and refine their classification.

We used isotopic compositions of presolar SiC grains compiled in the presolar database (PDB) hosted by Washinton University in St Louis [1–2]. We employed a clustering approach that is based on the asumption that the data distribution is a Gaussian finite mixture, using the *mclust* R package. Cluster analysis was applied to datasets that inlude combinations of isotopic compositions of C, N, Al, and Ti. In addition, we investigated how the clustering changes with the addition of data every year over the last 10 years, to evaluate the completeness of the dataset. Overall, derived clusters are in agreement with previously defined grain types but also highlight new divisions and a few discrepancies between our model output and previous manual classification.

[1] Hynes K. M. and Gyngard F. (2009) *Lunar Planet. Sci. 40,* #1198. [2] Stephan T. et al. (2020) *Lunar Planet. Sci. 51,* #2140.