THE PRESOLAR GRAIN DATABASE RELOADED—SILICON CARBIDE. T. Stephan[1,2], M. Bose[3], A. Boujibar[4], A. M. Davis[1,2,5], C. J. Dory[6], F. Gyngard[7], P. Hoppe[8], K. M. Hynes[9], N. Liu[9], L. R. Nittler[4], R. C. Ogliore[9], and R. Trappitsch[6], [1]Department of the Geophysical Sciences, The University of Chicago, Chicago, IL, USA, [2]Chicago Center for Cosmochemistry, [3]Center for Isotope Analysis, School of Earth and Space Exploration, Arizona State University, Tempe, AZ, USA, [4]Carnegie Institution of Washington, Washington DC, USA, [5]Enrico Fermi Institute, The University of Chicago, Chicago, IL, USA, [6]Nuclear and Chemical Sciences Division, Lawrence Livermore National Laboratory, Livermore, CA, USA, [7]Center for NanoImaging, Harvard Medical School, Cambridge, MA, USA, [8]Max Planck Institute for Chemistry, Mainz, Germany, [9]Department of Physics, Washington University in St. Louis, St. Louis, MO, USA. (tstephan@uchicago.edu)

Introduction: Since presolar grains were first isolated from meteorites about three decades ago, many thousands of individual grains have been analyzed for their isotopic composition, often in an automated way to facilitate the search for rare and exotic grains.

The Presolar Grain Database (PGD), a collection of spreadsheets containing the vast majority of isotope data (published and unpublished) on presolar grains, was first released in 2009 [1]. The PGD was initially compiled by students at Washington University and occasionally updated and corrected over the years, but it has become apparent that accumulated errors have compromised major parts of the PGD.

At the Presolar Grains Workshop in Chicago in 2019, the future of the PGD was discussed. Since the PGD has been used as a helpful tool by many researchers in cosmochemistry and astrophysics, we decided to rebuild the PGD from the ground up by: (1) eliminating known errors; (2) searching for inconsistencies by comparing with publications, original data files, and/or personal compilations; and (3) updating and adding data that have been reevaluated and/or published. We found that many grains had multiple entries in the database, often due to the fact that they had been analyzed in various measurement sessions, sometimes in different laboratories, and often using inconsistent grain labels. Our initial effort focused on silicon carbide (SiC) grains.

The new Presolar Grain Database: With isotopic data for exactly 16,000 presolar SiC grains, the new PGD continues to be hosted at: https://presolar.physics.wustl.edu/presolar-grain-database/.

A new feature of the PGD is that each individual grain now has a specific ID, which is not meant to replace a grain label defined by the original author, but to prevent confusion from inconsistent nomenclatures used. The PGD ID (e.g., SiC-2001-AMA-000001) consists of four sections separated by hyphens. The first section denotes the phase (e.g., SiC). The second part is the year the data appeared in a publication (0000 for data not related to any publication). In the third section, the first three letters of the first author's surname are given (e.g., AMA here stands for Amari). The final part is a six-digit number denoting the individual grain. If a first author has published more than one paper with grain data in one year, we skip numbers to the next 100,000 (e.g., SiC-2001-AMA-100001 denotes the first grain of a series described by Amari et al. in a second paper from 2001). A specific ID will only be assigned once. If it turns out that one grain has more than one ID, the data will be consolidated and obsolete IDs will be retired. A list of such obsolete PGD IDs will be provided, and all changes to the PGD will be documented.

SiC grains have been classified into many subgroups, or types [e.g., 2]. In addition to the grain type initially assigned, we also provide a so-called PGD type, which is meant as an attempt to correct misclassifications from the original authors and to unify the various definitions of grain types used over time.

We provide a reference for each grain if the data has been published or at least could be related to any publication. If data is provided in more than one publication, we provide this information together with other notes about an individual grain or an entire data set. We also provide information if all data have been fully published or only in part or not at all. During our search, we found some typographical errors in the published literature, and mentioned those in the PGD.

Names of the meteorites the grains came from, the techniques used to produce the data, and the institutions where the measurements were performed are given.

Isotopic data are provided either as ratios (e.g., $^{12}C/^{13}C$) or as δ-values (e.g., $\delta(^{29}Si/^{28}Si) = \delta^{29}Si_{28} = [(^{29}Si/^{28}Si)_{grain}/(^{29}Si/^{28}Si)_{std} - 1] \times 1000$, giving the deviation of an isotope ratio ($^{29}Si/^{28}Si$) measured in a grain relative to that in a terrestrial standard (std) in parts per thousand (‰). 1σ uncertainties are given, which for some isotope ratios are asymmetric. For some silicon and molybdenum data, error correlation coefficients are also provided, which were often not published.

The database version (which should be cited) is the date it was created, e.g., PGD_SiC_2020-01-03 is the current version. The PGD is provided in both Microsoft Excel and comma-separated ASCII file formats.

First Results: Nitrogen versus carbon isotope ratios and silicon 3-isotope plots for SiC grains from the PGD are shown in Fig. 1. The nomenclature for grain types

follows the typical scheme as described, e.g., by [2]. However, we slightly modified the separation between mainstream and AB grains and used $^{12}C/^{13}C < 12$, which seems to reflect the minimum in a bimodal $^{12}C/^{13}C$ distribution, as an upper limit for AB grains (Fig. 1a). Further dividing AB grains into AB1 and AB2 subgroups based on nitrogen isotopes has been proposed [3, 4], but this is not currently adopted in the PGD. We also have not subdivided type X grains into X0, X1, and X2 grains as suggested by [5], although most X grains clearly plot around a line through the origin with slope 2/3 (Fig. 1c), as expected for the most common X1 subtype.

Outlook: We will continue our work on the PGD in the upcoming years. Major tasks will be to add more SiC data and to rebuild the PGD for other kinds of grains: graphite, oxide, silicate, and rarer phases. Also in progress is a reassessment of the PGD types, especially the discrimination between mainstream and types Y and Z grains.

We strongly encourage users of the PGD to give proper credit to the authors by also referencing the original papers.

References: [1] Hynes K. M. and Gyngard F. (2009) *LPS, 40*, Abstract #1198. [2] Zinner E. K. (2014) *Treatise on Geochemistry*, Vol. 1, 2nd ed., Elsevier, 181–213. [3] Liu N. et al. (2017) *ApJL, 844*, L12. [4] Liu N. et al. (2018) *ApJ, 855*, 144. [5] Lin Y. et al. (2010) *ApJ, 709*, 1157–1173.

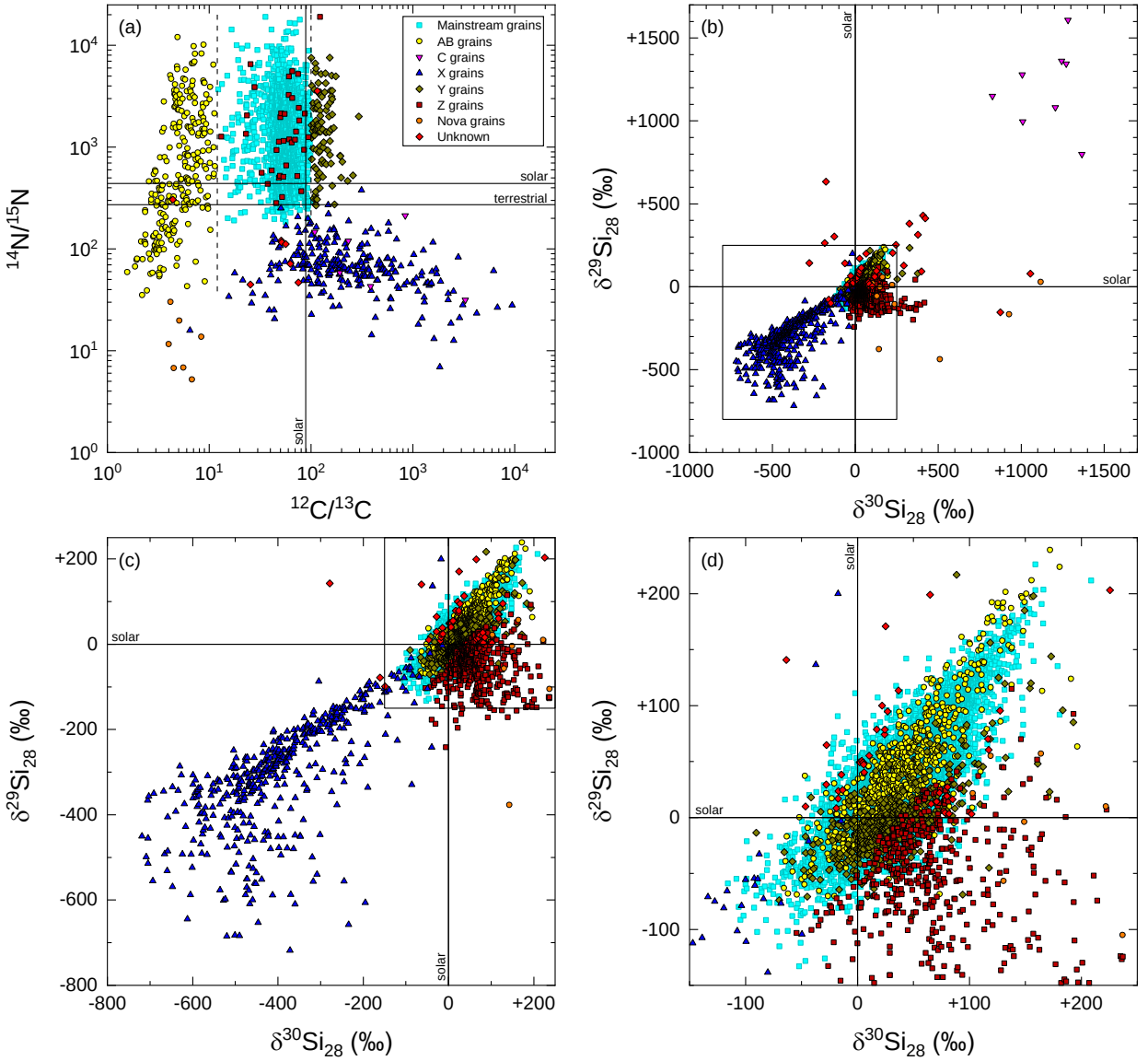

Fig. 1: (a) Nitrogen versus carbon and (b–d) silicon isotope data for SiC grains from the PGD. AB and Y grains are separated from mainstream grains by their carbon isotope ratios ($^{12}C/^{13}C$ for mainstream grains assumed to be 12–100) as shown by the vertical dashed lines in panel (a). For clarity, we omitted data for mainstream, AB, X, Y, and Z grains that have uncertainties >30 ‰ in at least one of the silicon isotope ratios (b–d).