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The proportion of high-temperature crystalline particles in Wild-2 cometary dust.

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Examination of cometary dust recovered from comet Wild-2 by the Stardust mission revealed that the dust contains chondrule-like and CAI-like particles that experienced high temperatures as well as primitive fluffy particles with low densities and high porosities. It has been generally considered that these high-temperature crystalline particles were once formed in an inner region of the protoplanetary disk in the early stage of the solar system formation and moved to an outer region of comet formation by X-wind [1] or outflow in the disk [4].
Our research group examined the three-dimensional structures of impact tracks that were formed in silica aerogel collector during the capture of the cometary dust by the Stardust spacecraft and estimated the densities of individual dust particles responsible for individual impact tracks (0.83-5. 88 g/cc) [5]. Based on the average density (1.01 g/cc), we also estimated the proportion of high-temperature crystalline particles of roughly 5 vol.%. In the density estimation, we assumed the volume of track cavity is proportional to the kinetic energy of impacted dust particles (note that the impact velocity was constant of 6.1 km/s in the Stardust mission). We made impact experiments in space plasma laboratory of JAXA to try to verify the assumption and calibrate the estimated density values.
We consider that the value of the proportion of high-temperature crystalline particles is roughly correct in its order irrespective of some possible errors of the density estimation because the proportion value was estimated from relative values of the densities. In this case, the following possibilities are suggested from the proportion (roughly 5 vol.%); (1) the proportion corresponds to that of crystalline particles moved from an inner region of the disk to the outer region, (2) the proportion on the comet surface became very large due to selective release of fluffy dust than crystalline particle-bearing dust, (3) the proportion was overestimated due to selective capture of crystalline particle-bearing dust than fluffy dust in the Stardust spacecraft, and (4) interplanetary dust fell onto the comet surface during the revolution around the sun and the crystalline particles found in the Stardust sample originate from crystalline interplanetary dust.
The validity of the dust density and the crystalline particle proportion estimations and implication of the proportion will be discussed.
[1] Brownlee et al. (2006) Science, 314:1711-1716. [2] Zolensky et al. (2006) Science, 314:1735-1 739. [3] Nakamura et al. (2008) Science, 321:1664-1667. [4] Ciesla et al. (2007) Science, 318: 613 -615. [5] Iida et al. (2009) JGU meeting and submitted to MAPS.

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