Stardust and Hayabusa Missions

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150 km from nucleus
ΔV = 6.1 km/s

January 2, 2004
A Jupiter family comet captured into present orbit in 1973 after a 0.006 AU Jupiter encounter
**Track shape - unbiased insight into particle structure**

**Type A** (Burchell et al 2008)
- Cohesive - solid rocks
- Only minor fragmentation
- All short tracks & most made by
- <5µm particles are type A

**Type B** (Burchell et al 2008)
- Weakly bound
- Severe fragmentation
- ~50% of tracks made by >10µm particles are type B

**Implication**
- Much/Most Wild 2 dust is an aggregation of solid > 1µm components!
- **Not** submicron components!

**Type A**
- Carrot shaped

**Type B**
- Bulbous
Requires T~1300°C

spinel, Al-diopside, anorthite, gehlenite
Fe-sulfides in glass
void
Ti-oxide
compressed aerogel

Ti
V
Requires T~1300°C

Titanium-L$_{2,3}$ edges
Vanadium-L$_{2,3}$ edges
Hogen-K edge

134/134/150 54 72

LLNL Group
The particle experienced partial melting at temperature higher than 1800 °C, prior to the formation of the comet.
Gozen-sama oxygen isotopes

Nakamura et al LPSC 2008

OI-A $^{16}$O-rich
OI-B $^{16}$O-poor
LPx intermediate

A product of incomplete melting of $^{16}$O-rich and $^{16}$O-poor precursors
Large scale radial transport processes?

either
Above disk
or
In disk plane

Several authors had predicted large-scale radial transport
Shu et al X-Wind theory

predicted that comets would contain CAIs
That formed a few radii from the T Tauri Sun
Ballistic mechanisms above disk
X-Wind- Shu et al. 2001

In-disk or near disk mechanisms
Bockelee-Morvan et al. 2002
Cuzzi et al. 2003
Ciesla 2007
Boss 2008
Mousis et al 2008
The large scale radial transport of particles to the Kuiper belt can be considered to be the

Grand Radial Express (GRE)
Huge $^{17}\text{O}$-enrichment:

$^{17}\text{O}/^{16}\text{O} = (1.01 \pm 0.10) \times 10^{-3}$

$^{18}\text{O}/^{16}\text{O} = (1.77 \pm 0.12) \times 10^{-3}$

does not have a clear origin in Red Giant
or AGB star

Stadermann, Messenger, et al.
Concentration of presolar grains appears to be low

~17ppm
This could be low due to measurement bias

This is 5-10 times lower than primitive chondrites and IDPs
Speculation

There might be two types of comets

a) Those formed while the GRE was in operation
b) Those that formed before or afterwards

Are Wild 2 solids typical for Kuiper Belt Comets?
Probably when GRE operated - it sprinkled particles all bodies
The majority of Wild 2 solids formed at moderate to extreme temperatures

They appear to be products of the inner solar nebula. Most are similar to meteoritic components.

The Wild components are highly unequilibrated mineral compositions not modified during storage.

The silicates are at least as primitive as those in most primitive meteorites.

There is no evidence for modification inside Wild 2.
Conclusions

It is an extraordinary diverse mix of unequilibrated materials

Its similarity to any meteorite or IDP group is unclear
It may be a sampling of the entire nebular disk

Cometary rocks, ices and perhaps organics formed in disparate local environments

Some comets accreted after CAI & chondrule formation
First Track / Keystone removed from the Interstellar Tray of Stardust

The first track / keystone was successfully removed from the Stardust Interstellar Tray on Wednesday, February 13, 2008. This the first track-containing keystone removed and is named I1017,2. The track is a high-angle track, with a rather large terminal grain (arrowed) that is either an IDP or a secondary grain from an impact onto a solar panel (that then splashed onto the tray). In the next few days we will be harvesting several of these high-angle tracks. After a short pause in the action we plan to begin harvesting actual interstellar track candidates.
Sept 2005
Preliminary Landing Ellipse (Courtesy: T. Yamada)

Landing Dispersion: DR \times CR = 168 \text{ km} \times 16 \text{ km} (4-\sigma)
Capsule Main Component Transportation: Segment-1 (1/3)

- 23:20LT > The capsule enters the atmosphere at 200 km altitude
- 23:26 > The capsule beacon signal (T4) starts at 10 km altitude
- 23:40 > Resumed landing of the capsule
- Direct Finding Stations (DFS) narrow down lat./long. (down to 2~5 km or so across) at the landing point
- Initial estimate of the landing coordinates by HQ
- 24:00~02:00 > The helicopter seeks beacons and visuals to bookmark the GPS position.
こちらより失へば、箱を脱いで。箱箱（下段）に収め、上段に置い
である上تمき（スリッパ・サンダ
ル）に鍵き替えてください。

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Clean Rooms and Equipment in the Curation Facility

- Hallway
  - Information Room
  - Monitor Room
  - Clean Chambers
  - Planetary Sample Treating Room (class 100 - 1,000)
  - Electron Microscope Room (class 1,000)
  - Sample Preparation Room (class ?)
- Clean draft chamber and clean evaporator
- Received capsule will be checked and cleaned here.

**Clean chambers (CCs) for planetary sample handling**

**SEM and Multipurpose glove box**

**Clean draft chamber and clean evaporator**
Visible and Near-infrared Spectroscopy

Analyze samples with visible and near-Infrared (from 300nm to 3200nm) spectroscopy for their initial descriptions.

Two optic fibers for both incident radiation and reflection, which can move along the tube.

Quartz tube chamber

Powder sample

Quartz dish

Optic fiber for incident radiation

Light sources and detectors
Now we are practicing sample handling for sub-sub gram sized samples.