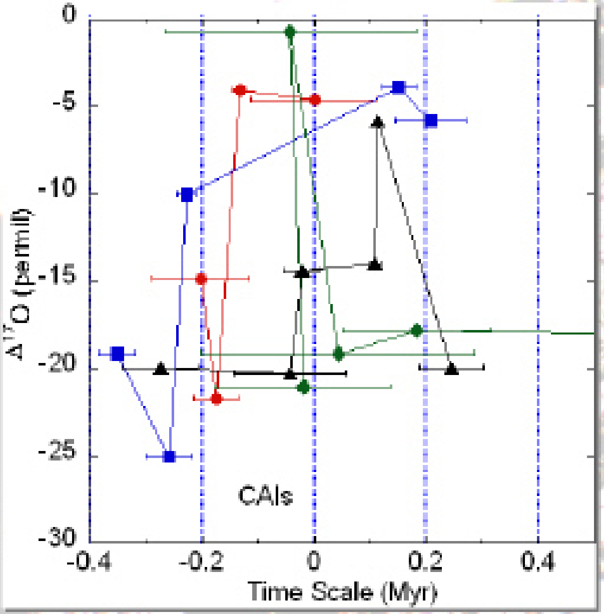
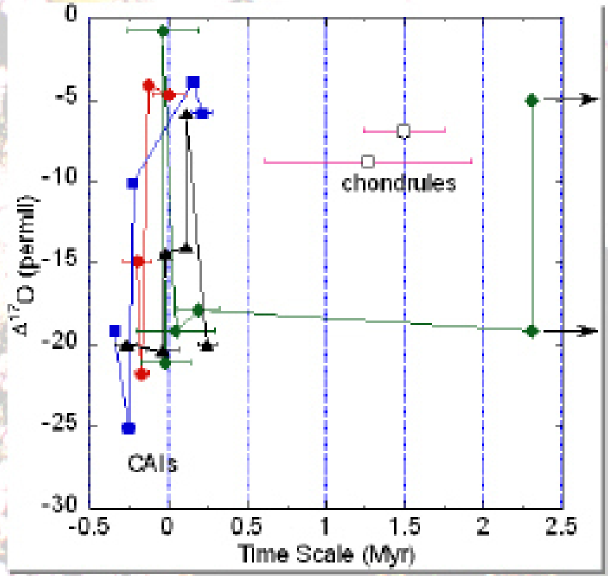
原始太陽系円盤ガスの酸素同位体変動

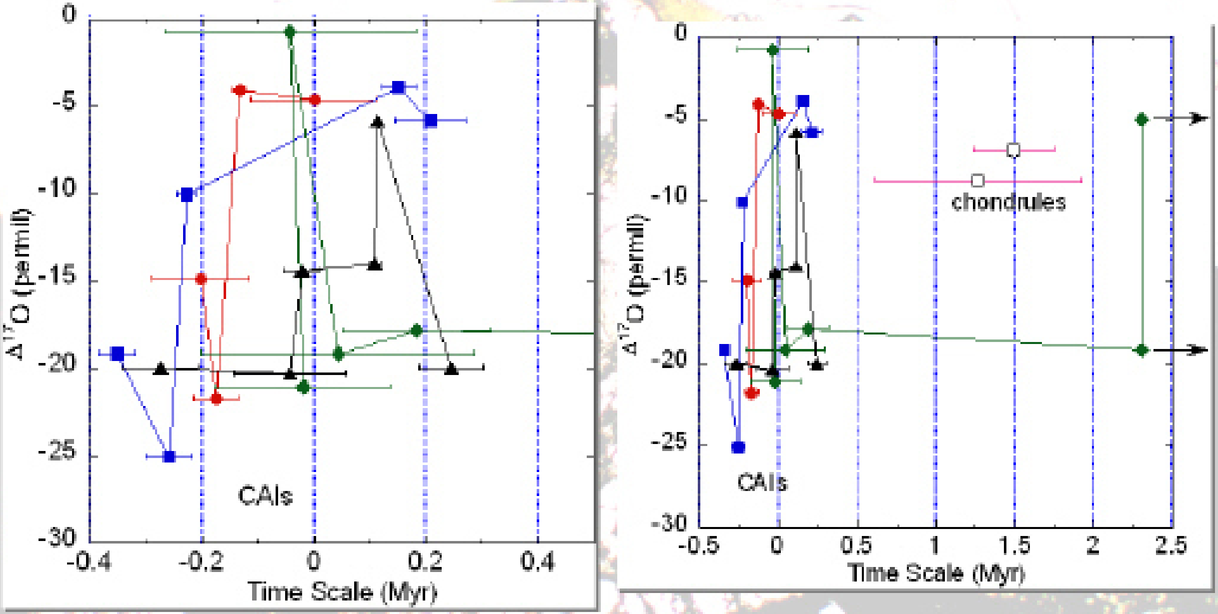




- １個のCAIの形成期間（一瞬〜数百万年）
- １個のCAI周辺の円盤ガスは10万年より短い間に異なる酸素同位体比をもつものに切り替わる。
- 酸素同位体比の切り替わり現象は数百万年間起きている。

原始太陽系円盤ガスの酸素同位体変動

巻出健太郎，吉武美和，伊藤正一



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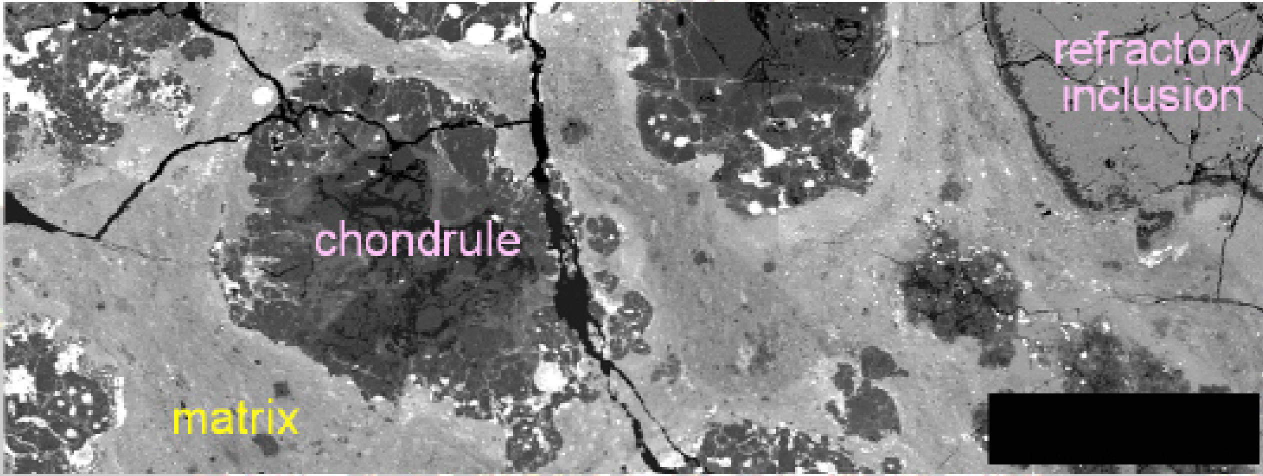
Mineralogy of matrix



- Disequilibrium mixtures
  - silicates, oxides, metals, sulfides, carbonates, phyllosilicates, hydrous silicates, amorphous materials
- Grain size: 10 nm–10 µm

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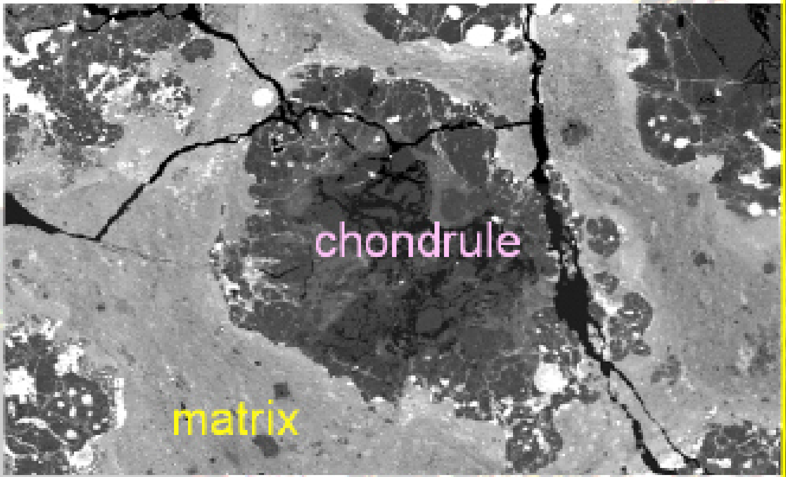

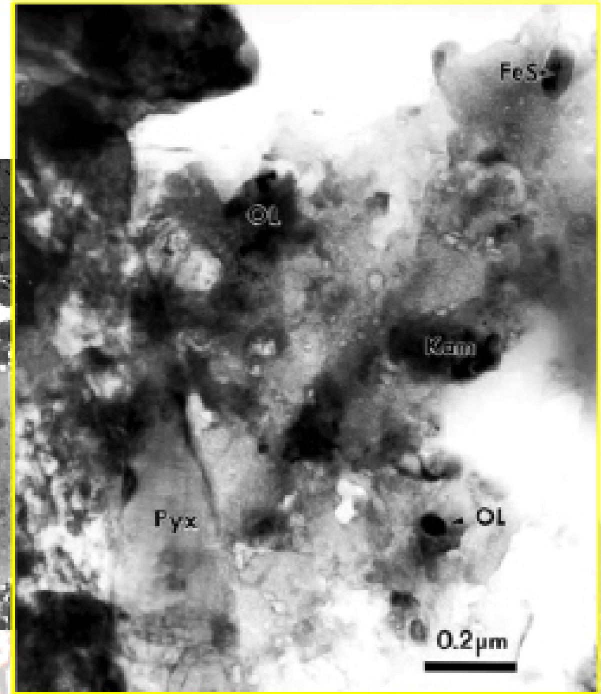

ALHA 77307 (Brearley 1993)

- Disequilibrium mixtures
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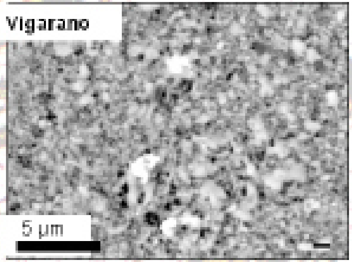
Controversial origin of matrix material

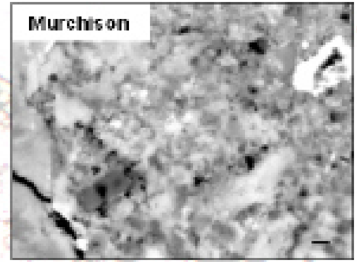
- Prior to the solar system
    - presolar materials (eg. Zinner 2003)
- In the solar system
    - nebular origin
        - condensates
        - chondrule/refractory inclusion related dusts
    - chondrite parent-body origin
        - accreted material is aqueously altered (eg. Brearley 2003)
- O-isotopes are a useful parameter for understanding genesis of matrix materials

Alteration on chondrite parent-body

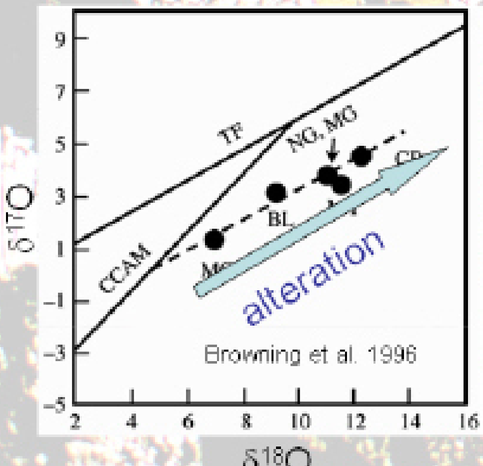
- Presence of phyllosilicates indicates aqueous alteration (Brearley 2003)



slightly altered
- minor phyllosilicates

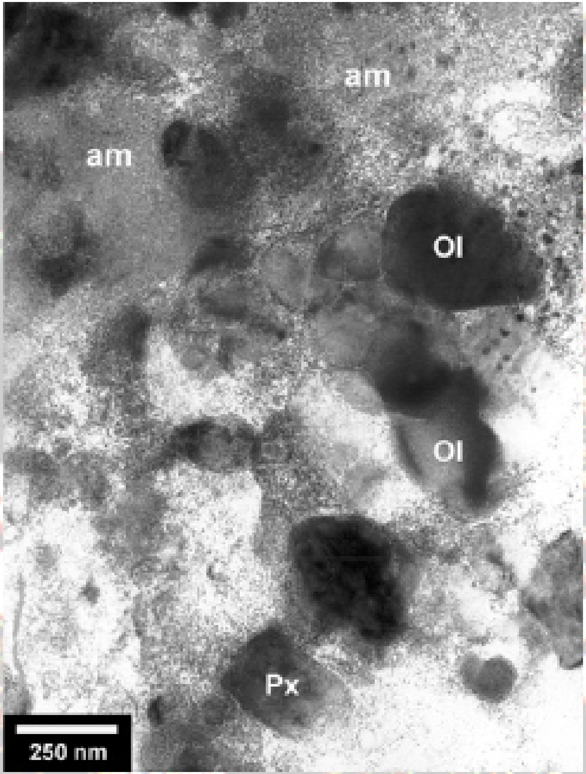


pervasive alteration
- abundant phyllosilicates



- Correlation between O-isotopes and degree of alteration (Browning et al. 1996)
- Unaltered matrix should be examined to see O-isotope of nebular features

Matrix of primitive meteorites



Acfer 094 (Greshake et al. 2004)

component	abundance in matrix
amorphous silicates	~40 vol%
crystalline silicates	~50 vol%
sulfides	~ 5 vol%

Greshake et al. 1997

- lack of phyllosilicates
- origin of amorphous silicates
  - condensation / irradiation
  - unlikely to be produced or reprocessed on parent body
- minimal alteration and metamorphism on parent body

Phases in the matrix

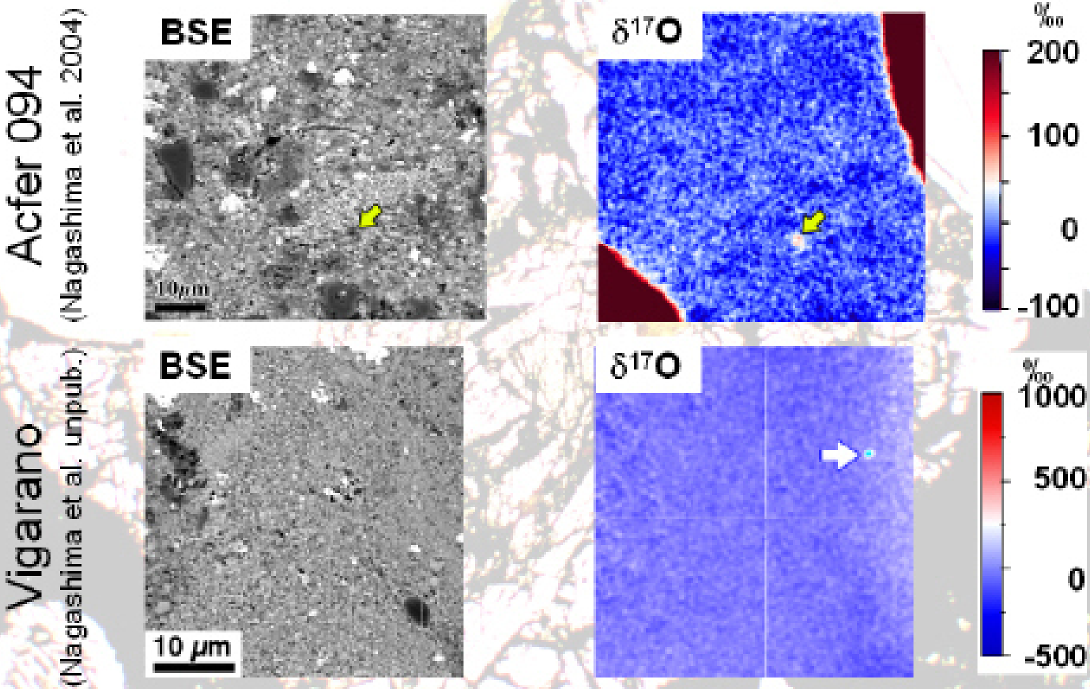
chondrite	matrix phases
CI	serpentine, saponite, ferrihydrite, magnetite, Ca–Mg carbonate, pyrrhotite
CM	serpentine, tochilinite, pyrrhotite, amorphous phase, calcite
CR2	ol, serpentine, saponite, FeS, pentlandite, pyrrhotite, calcite
CV3 oxidized	fayalitic ol, Ca–Fe px, nepheline, pentlandite
CO >3.1	fayalitic ol, phyllosilicates, ferric oxide
CV3 reduced	fayalitic ol, low-Ca px, low-Ni metal, FeS
CO 3.0	amorphous silicate, Fo_{30-98}, low-Ca px, Fe,Ni metal, magnetite, sulfides
Acfer 094	amorphous silicate, forsterite, en, pyrrhotite, ferrihydrite
Adelaide	amorphous silicate, fayalitic ol, en, pentlandite, magnetite

Scott and Krot 2003

Recent studies of matrix

- New techniques allow isotope mapping
- Analyses of primitive matrix
  - Acfer 094 (Nagashima et al., 2004; Mostefaoui and Hoppe, 2004; Stadermann et al., 2005; Bland et al., 2005)
  - ALHA77307 (Kobayashi et al., 2005; Nguyen et al., 2005)
  - Vigarano (Kunihiro et al., 2005; Nagashima et al., in prep.)
  - Semarkona, Bishunpur (Mostefaoui et al., 2004)

Presolar silicates in matrix

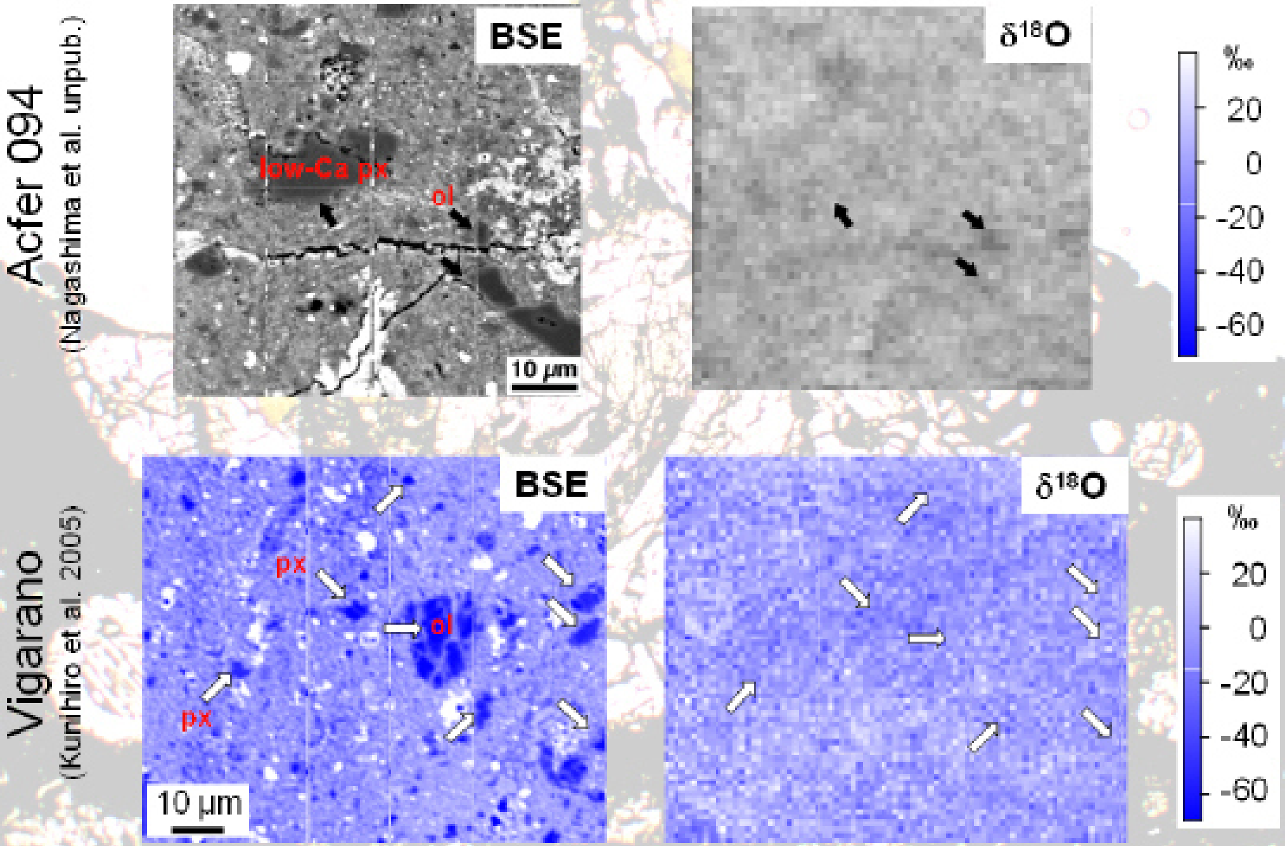


- Presolar silicates found in matrix (10-100 ppm)
- Grain size: < 1 μm

Preservation of sub-micron presolar silicates in matrices

- Aqueous alteration on these meteorites did not equilibrate O-isotopes of sub-micron grains
- Matrices of primitive meteorites retain O-isotope distribution of the nebular dust

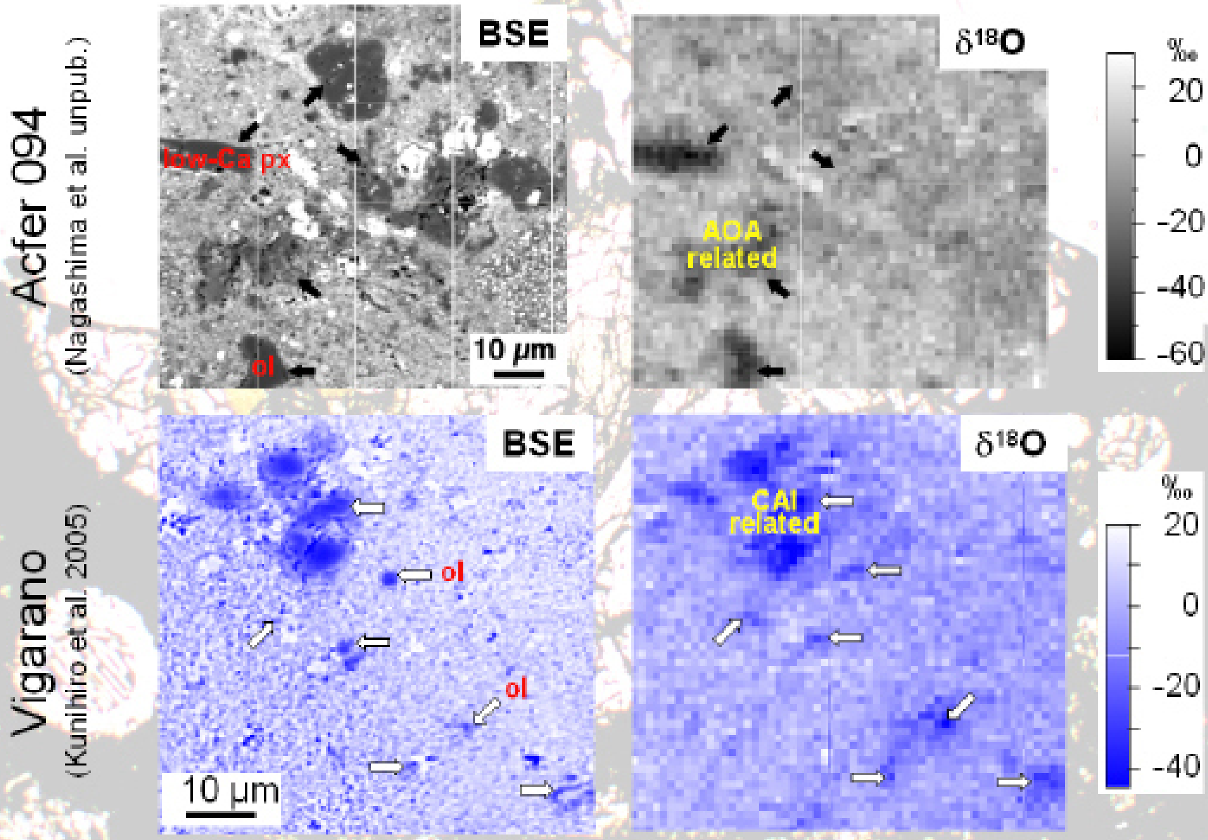
Homogeneity in matrix



Origin of the homogeneity

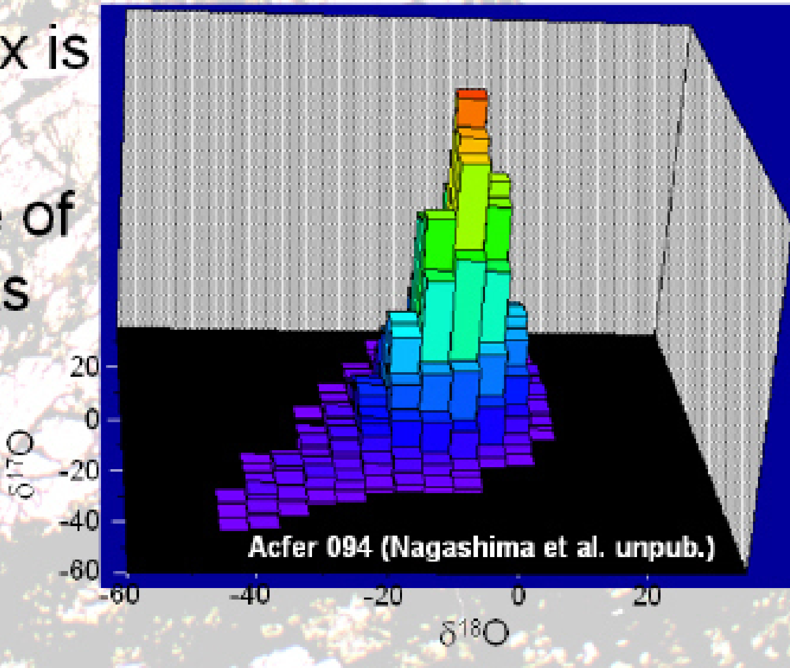
- Vast majority of matrix is:
  - ^{16}O-poor
  - homogeneous (± 5‰)
- Most of the matrix is <u>not</u> of presolar origin
- Matrix inherited its O-isotope homogeneity from the solar nebula

Matrix with refractory components



Quantification of matrix components

- Distribution is consistent with other CC components
- Only 1–5% of matrix is enriched in ^{16}O
- Mechanical mixture of nebular components



Nebular dust

- Constituents of nebular dust

presolar dust	**> 100 ppm**
^{16}O-rich solar dust	**1-5 vol. %**
^{16}O-poor solar dust	**> 90 vol. %**

- Nebula mechanisms reprocessed most presolar dust generating solar O-isotope characteristics
- Most solar dust is ^{16}O-poor

Origin of ^{16}O-poor dust

- O-isotopic equilibration with ^{16}O-poor gas
- The equilibration was completed before parent-body accretion
  - gas-solid equilibration in the nebula
  - condensation from ^{16}O-poor gas
- Chondrule-forming region is a possible place to provide both heat source and ^{16}O-poor reservoir

Summary

- O-isotopes of primitive matrix
  - heterogeneity
    - presolar silicates
    - refractory-inclusion related
  - most of matrix is ^{16}O-poor and homogeneous (± 5‰)
- Most of nebular dusts seem to be equilibrated with ^{16}O-poor gas
- Nebular dust is a mixture of grains from:
  - presolar origin
  - refractory-inclusion-forming region
  - chondrule-forming region