# NanoSIMS isotopic analysis of small presolar dust grains: implications for stellar nucleosynthesis

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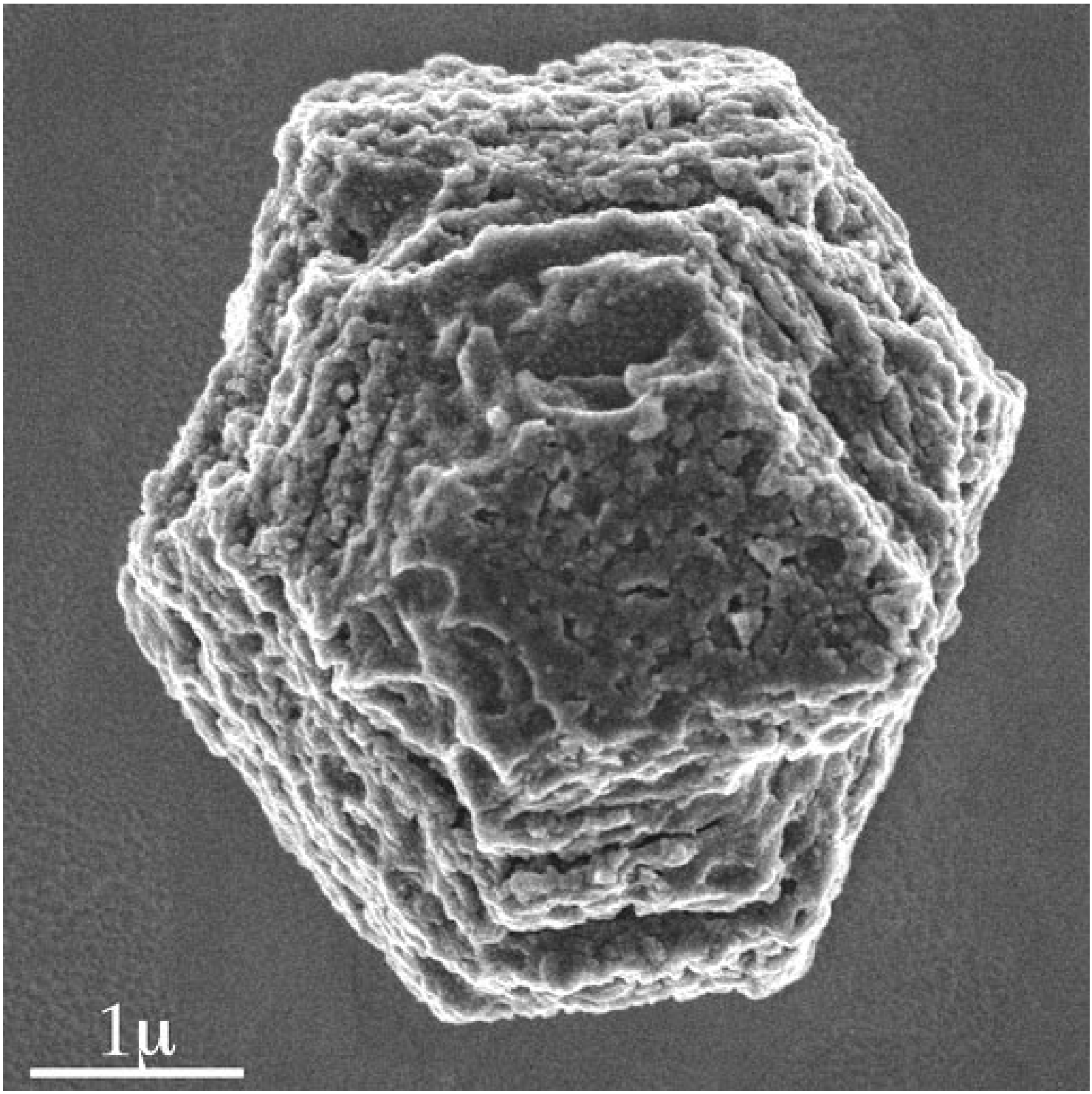
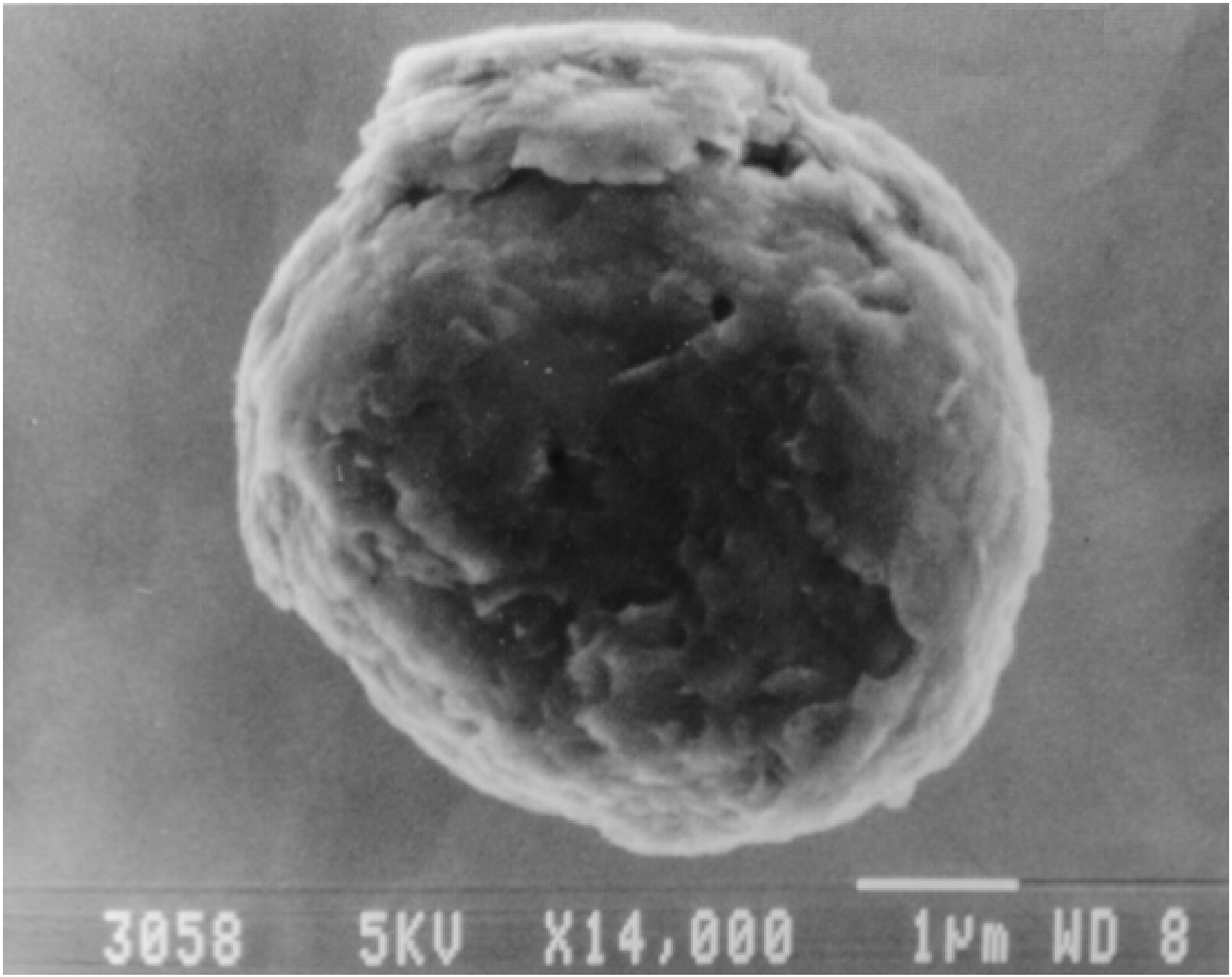
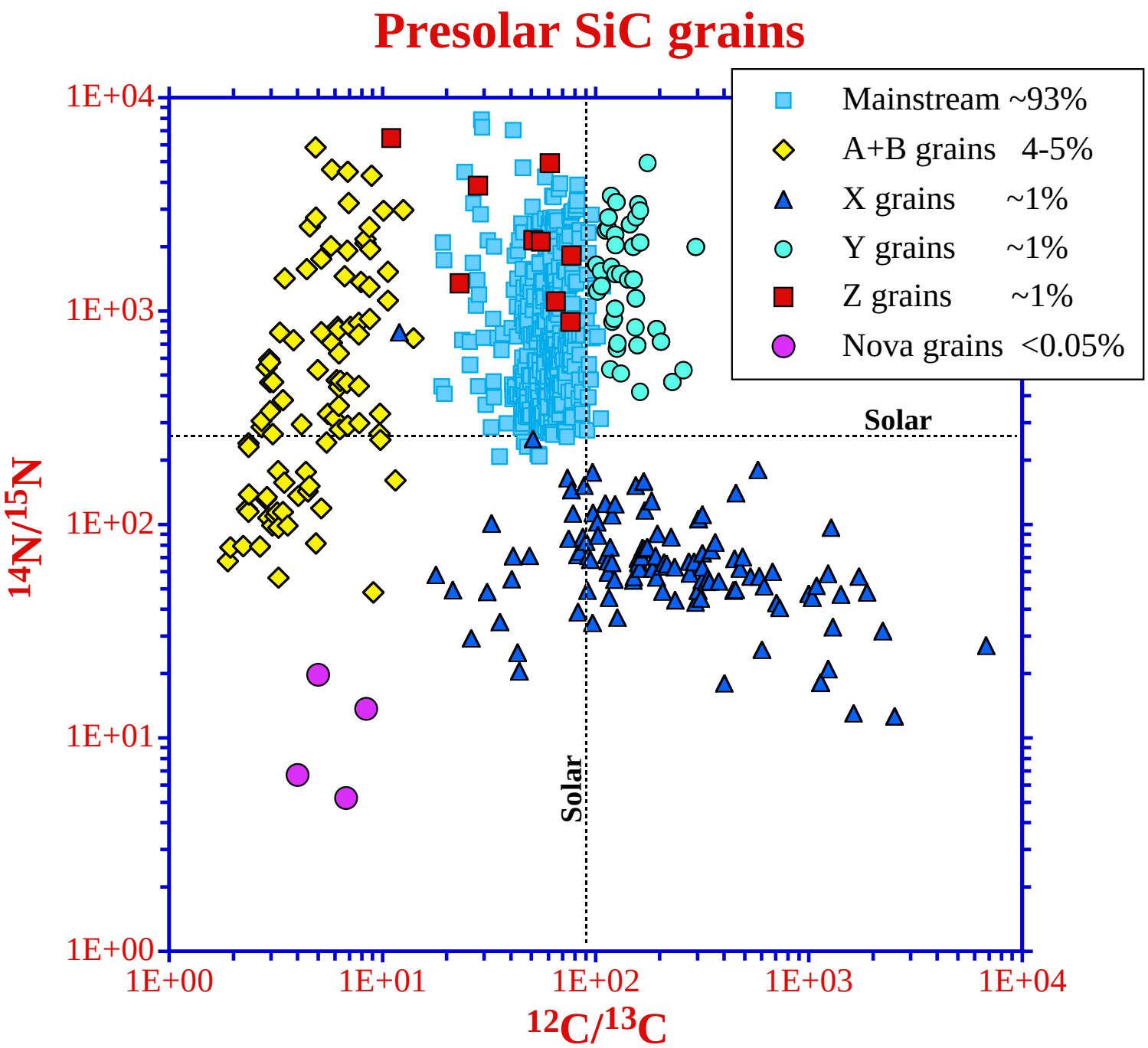
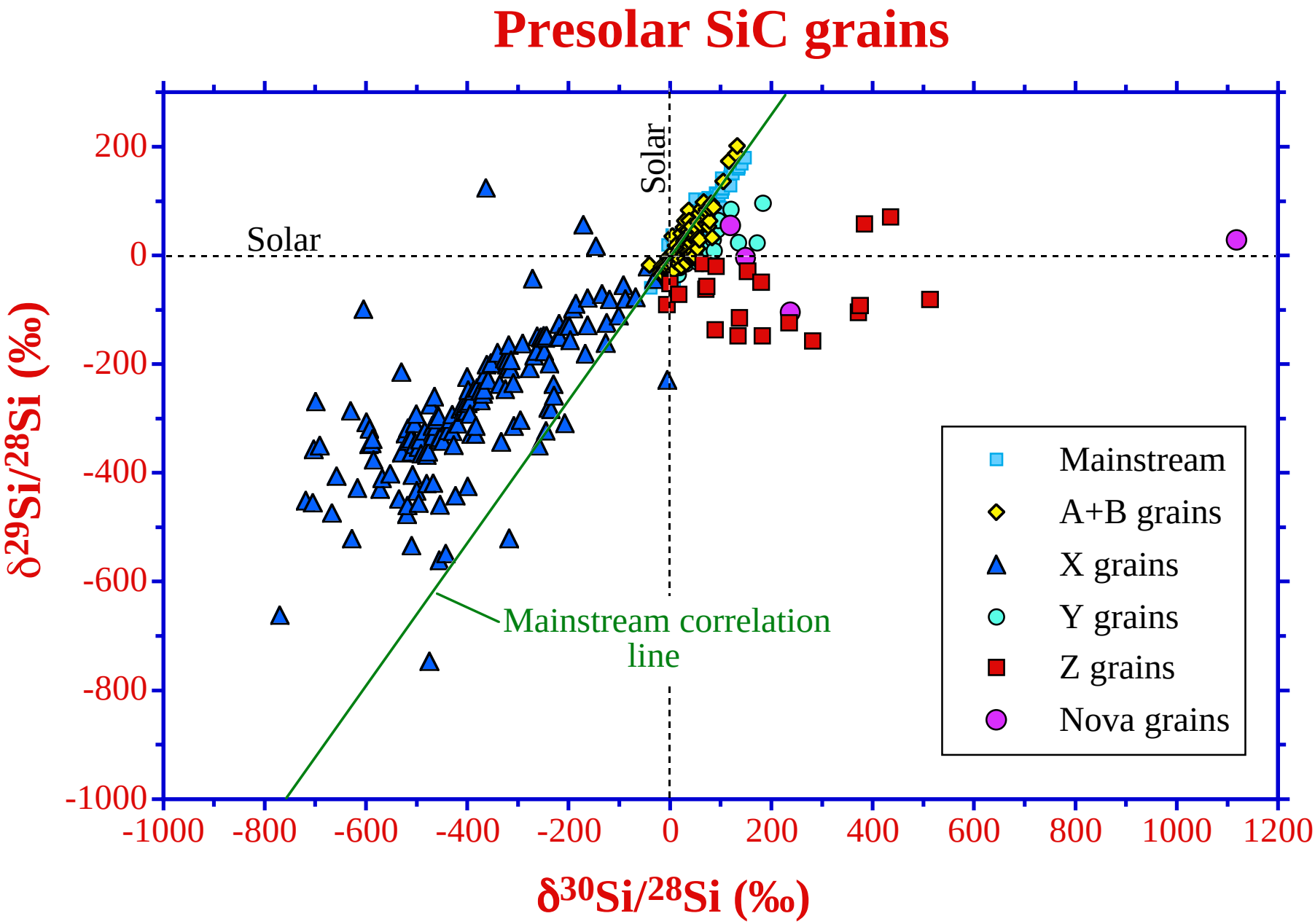
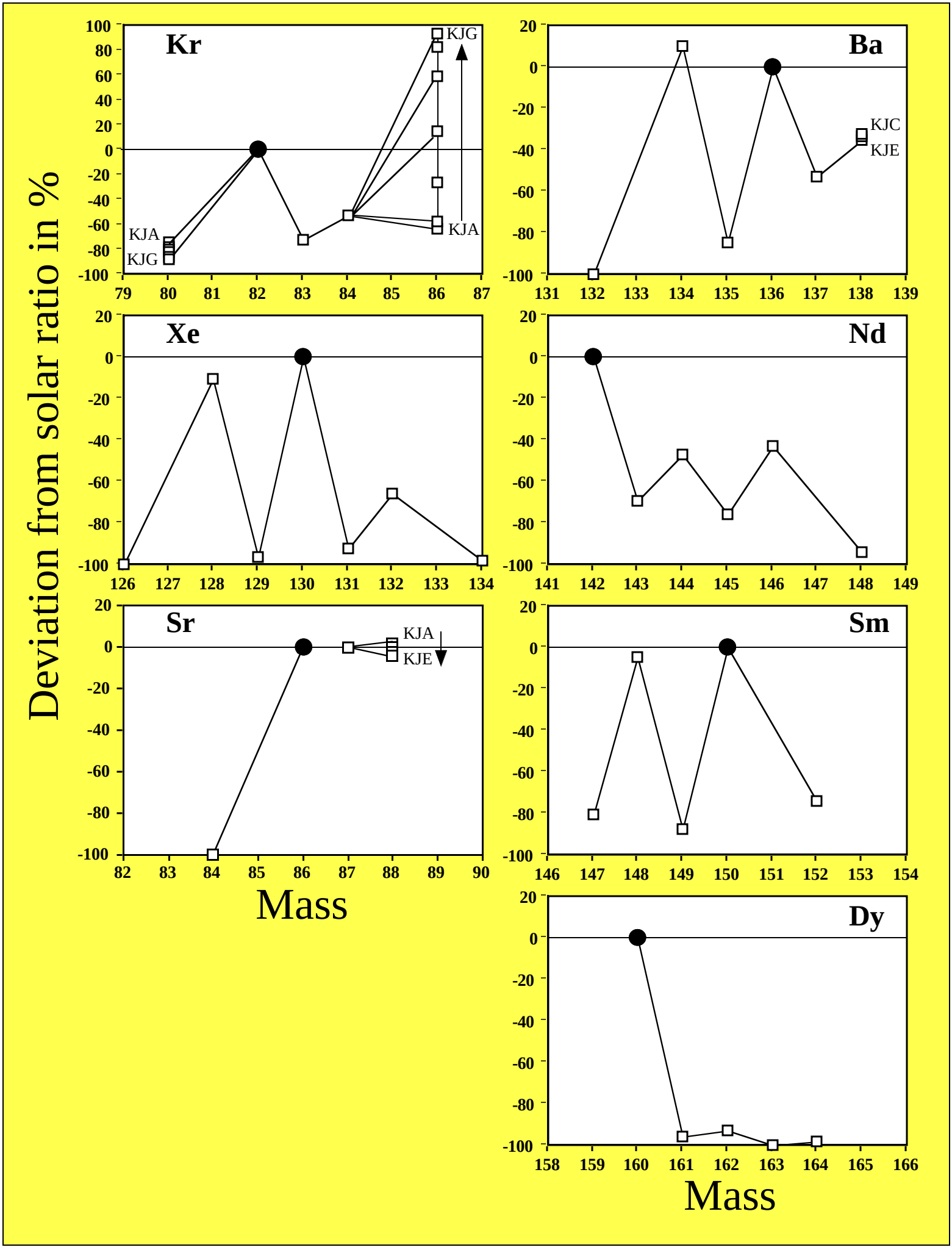
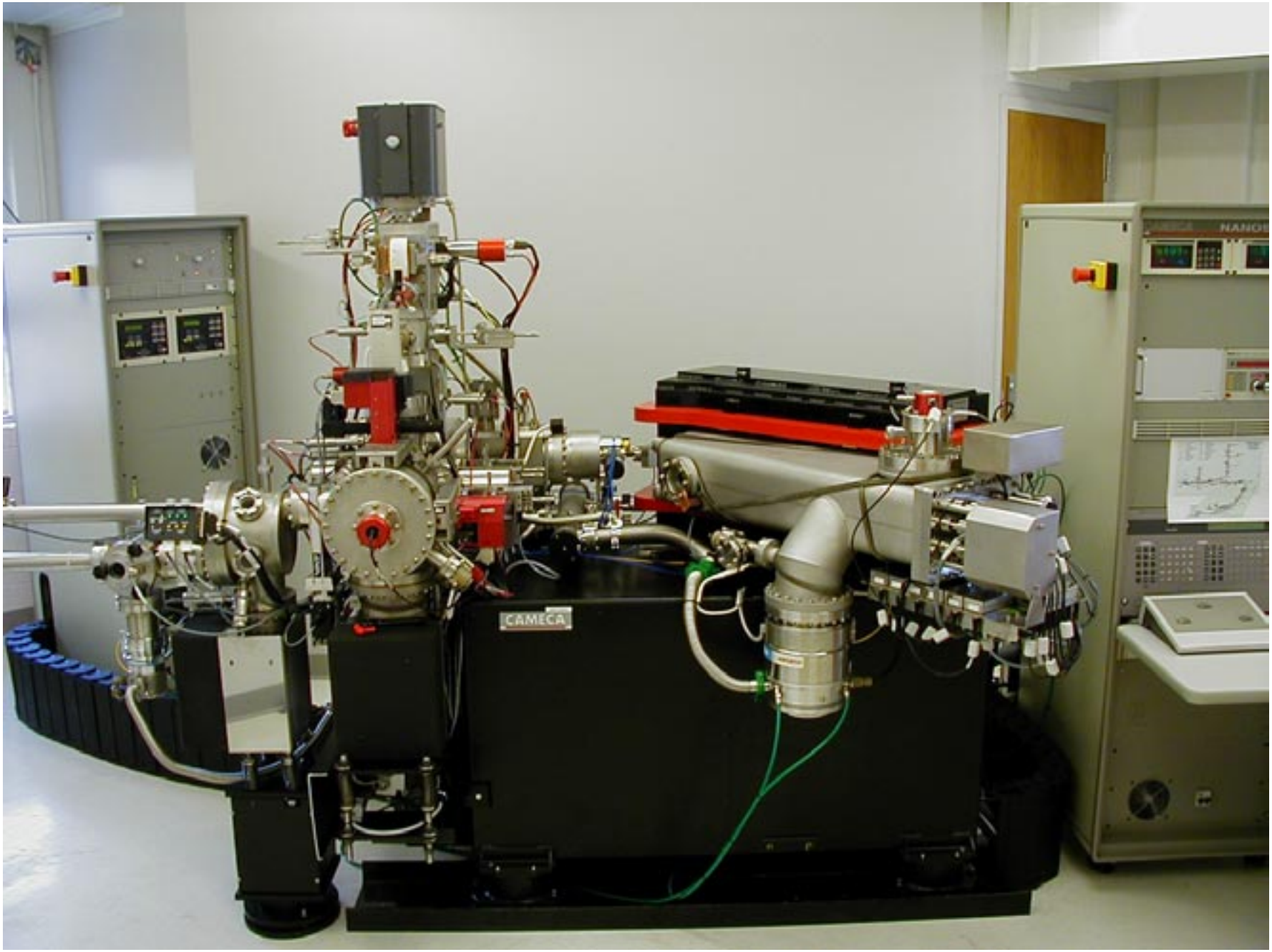

1μ

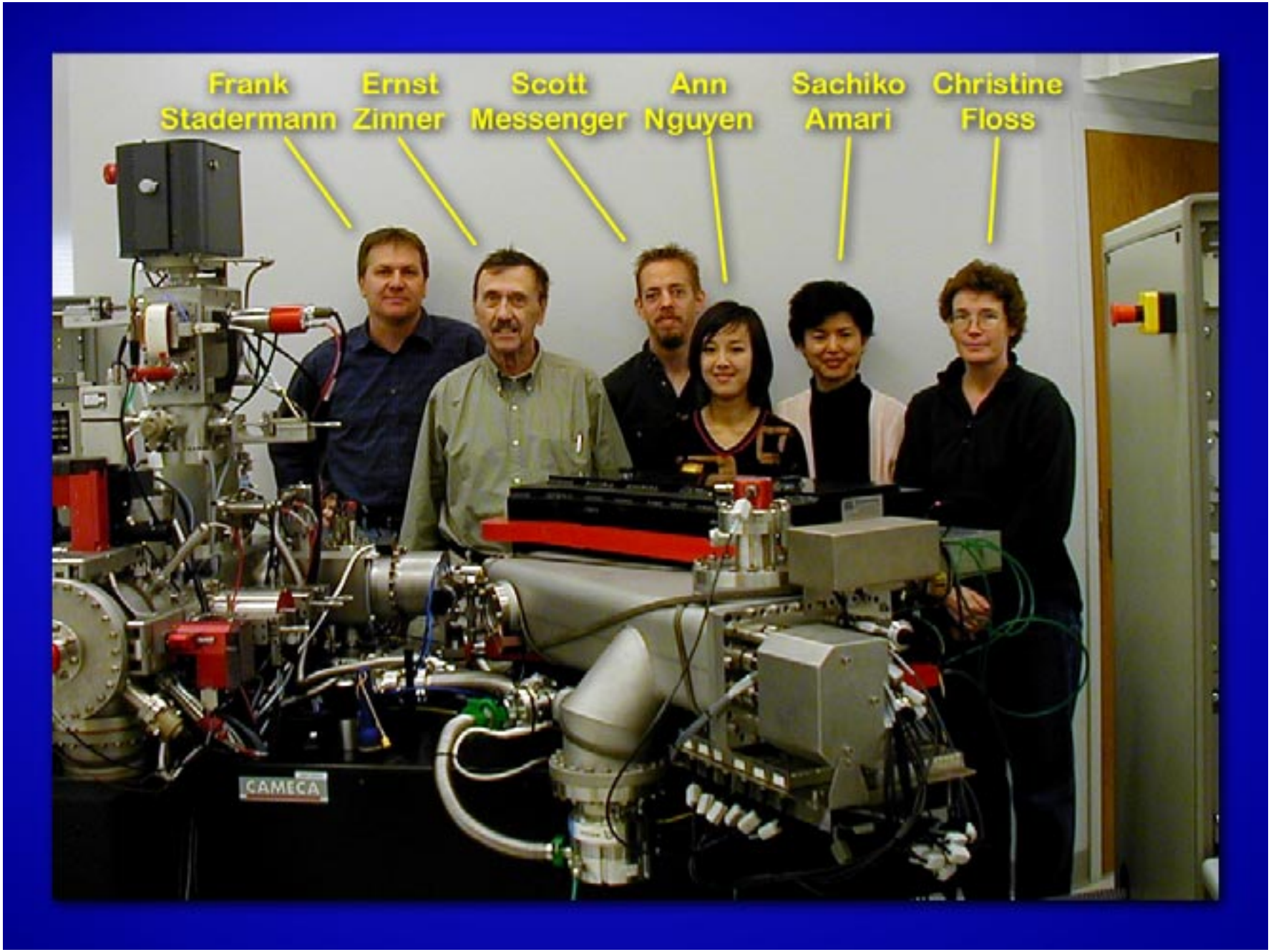

3058 5KV X14,000 1µm WD 8

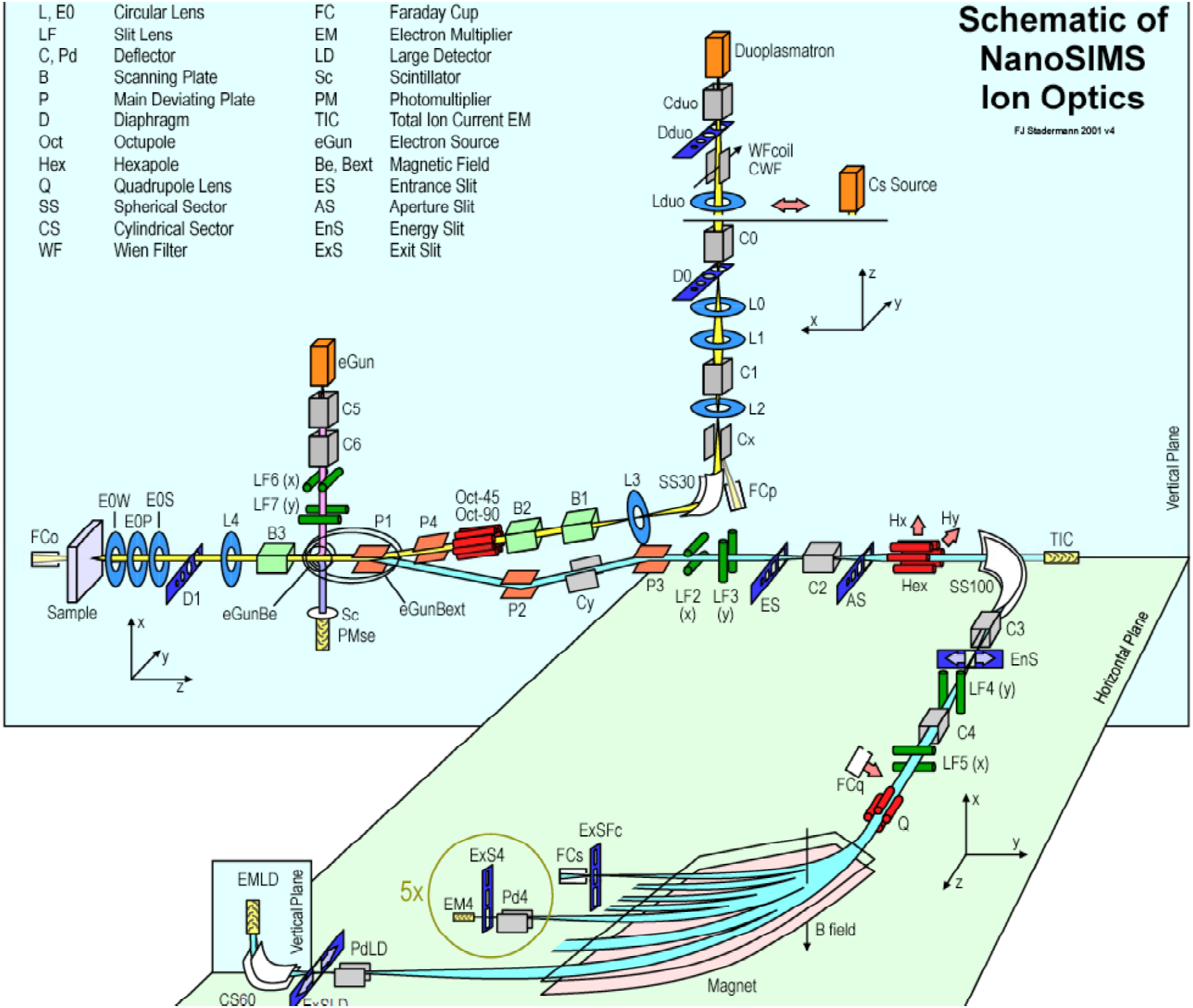

Presolar SiC grains
Mainstream ~93%
A+B grains 4-5%
X grains ~1%
Y grains ~1%
Z grains ~1%
Nova grains <0.05%
Solar
Solar
1E+04
1E+03
1E+02
1E+01
1E+00
1E+00
1E+01
1E+02
1E+03
1E+04
14N/15N
12C/13C

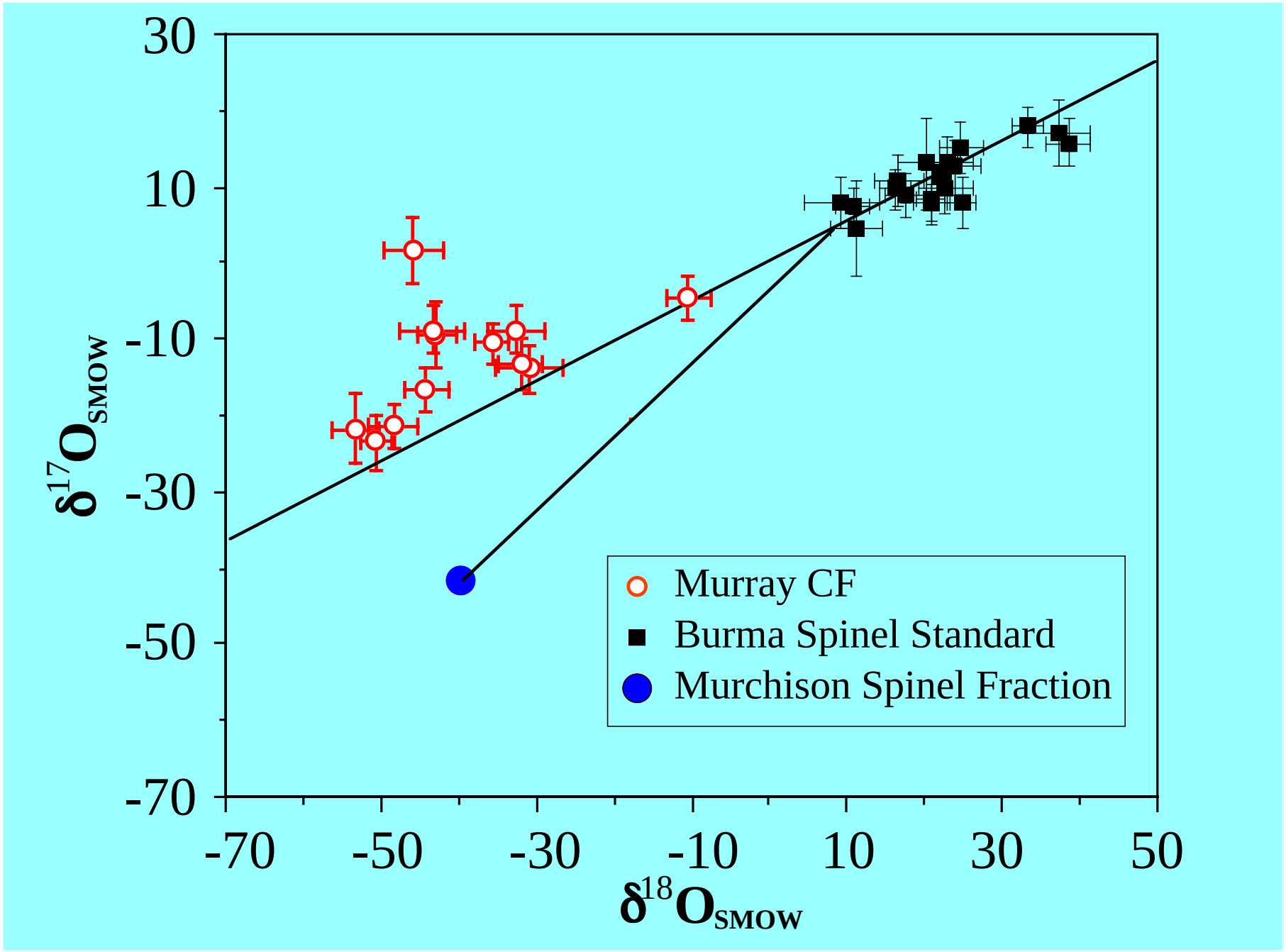

Presolar SiC grains
Solar
Solar
Mainstream correlation line
Mainstream
A+B grains
X grains
Y grains
Z grains
Nova grains
δ29Si/28Si (‰)
δ30Si/28Si (‰)
200
0
-200
-400
-600
-800
-1000
-1000
-800
-600
-400
-200
0
200
400
600
800
1000
1200

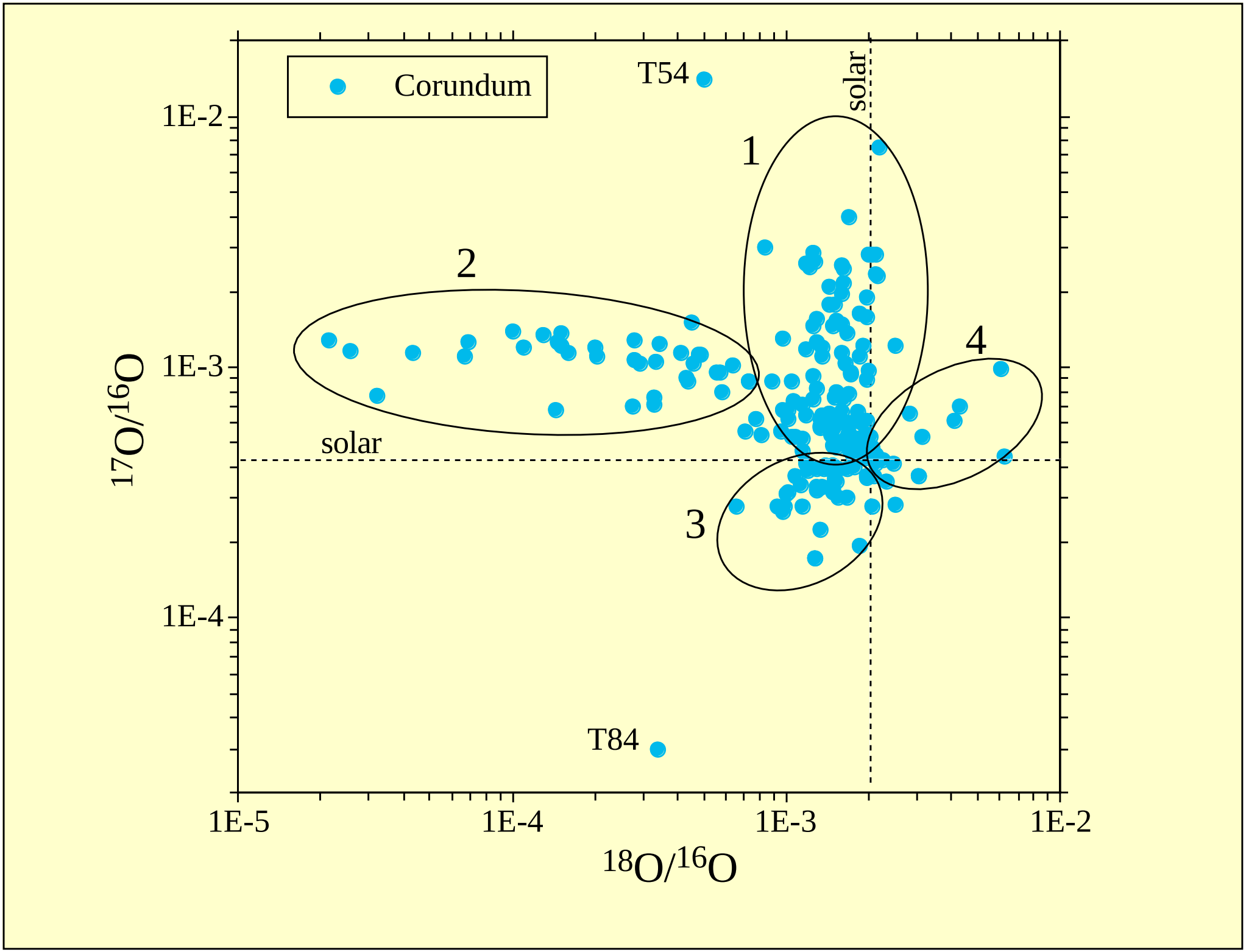

Deviation from solar ratio in %
Kr
KJG
KJA
KJG
KJA
Ba
KJC
KJE
Xe
Nd
Sr
KJA
KJE
Sm
Dy
Mass
Mass


CAMECA


Frank Stadermann
Ernst Zinner
Scott Messenger
Ann Nguyen
Sachiko Amari
Christine Floss
CAMECA


Schematic of NanoSIMS Ion Optics
FJ Stadermann 2001 v4
L, E0 Circular Lens
LF Slit Lens
C, Pd Deflector
B Scanning Plate
P Main Deviating Plate
D Diaphragm
Oct Octupole
Hex Hexapole
Q Quadrupole Lens
SS Spherical Sector
CS Cylindrical Sector
WF Wien Filter
FC Faraday Cup
EM Electron Multiplier
LD Large Detector
Sc Scintillator
PM Photomultiplier
TIC Total Ion Current EM
eGun Electron Source
Be, Bext Magnetic Field
ES Entrance Slit
AS Aperture Slit
EnS Energy Slit
ExS Exit Slit
Duoplasmatron
Cduo
Dduo
WFcoil CWF
Cs Source
Lduo
C0
D0
L0
L1
C1
L2
Cx
FCp
SS30
L3
B1
B2
Oct-45 Oct-90
P4
P1
LF6 (x)
LF7 (y)
C5
C6
eGun
E0W
E0S
E0P
FCo
Sample
D1
L4
B3
eGunBe
Sc
PMse
eGunBext
P2
Cy
P3
LF2 (x)
LF3 (y)
ES
C2
AS
Hx
Hy
Hex
SS100
TIC
C3
EnS
LF4 (y)
C4
LF5 (x)
FCq
Q
ExSFc
FCs
ExS4
5x
EM4
Pd4
EMLD
Vertical Plane
PdLD
CS60
B field
Magnet
Horizontal Plane
Vertical Plane

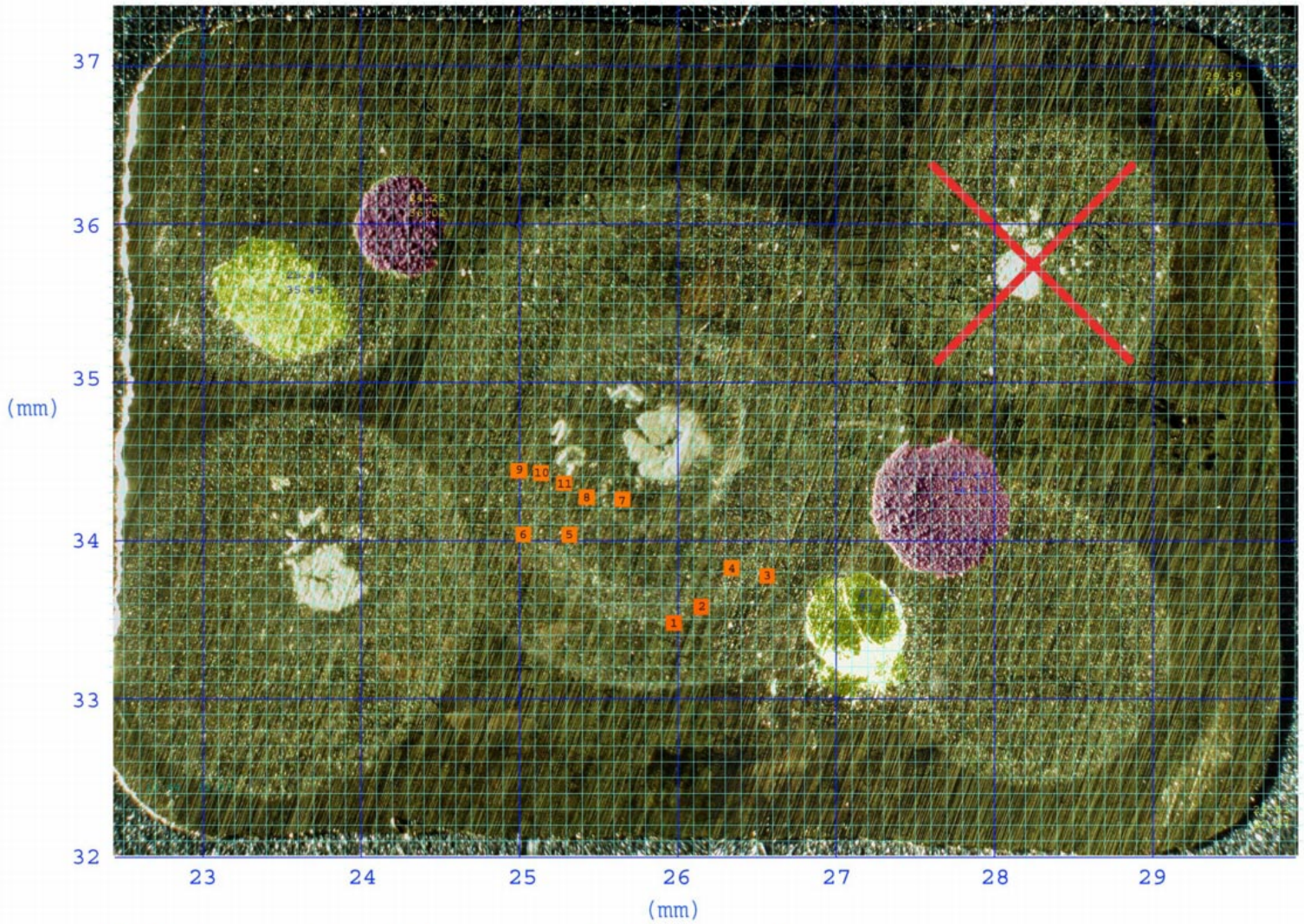

30
10
-10
-30
-50
-70
-70
-50
-30
-10
10
30
50
δ17OSMOW
δ18OSMOW
Murray CF
Burma Spinel Standard
Murchison Spinel Fraction


Corundum
T54
T84
solar
solar
1
2
3
4
1E-2
1E-3
1E-4
1E-5
1E-4
1E-3
1E-2
$^{17}O/^{16}O$
$^{18}O/^{16}O$

A2 mount: Murray CG

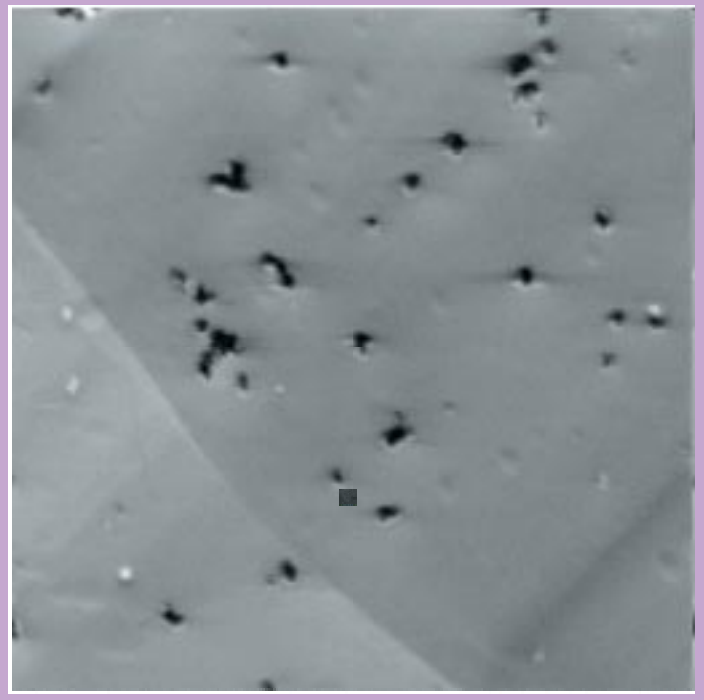
# Regions marked for analysis

♦ Murchison Matrix ♦ Corundum Standard

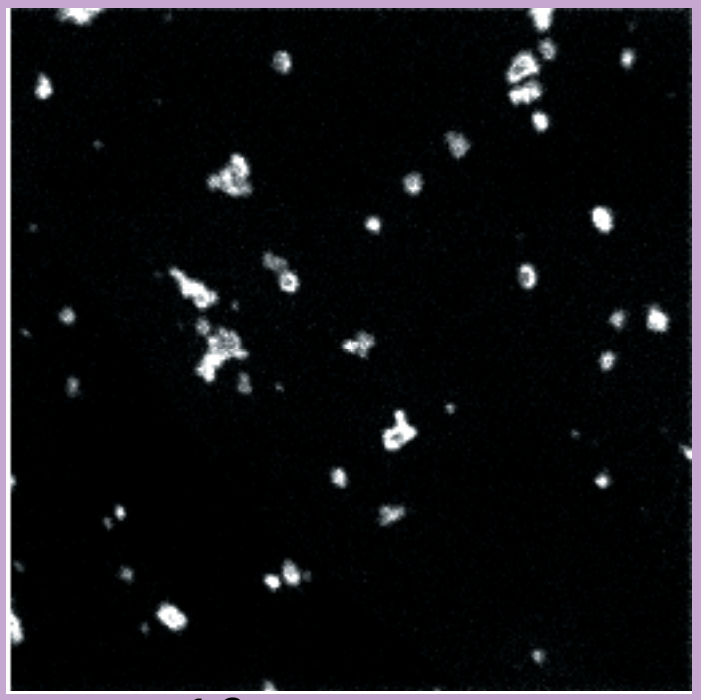



X Region accidentally sprayed with corundum

26 February 2002



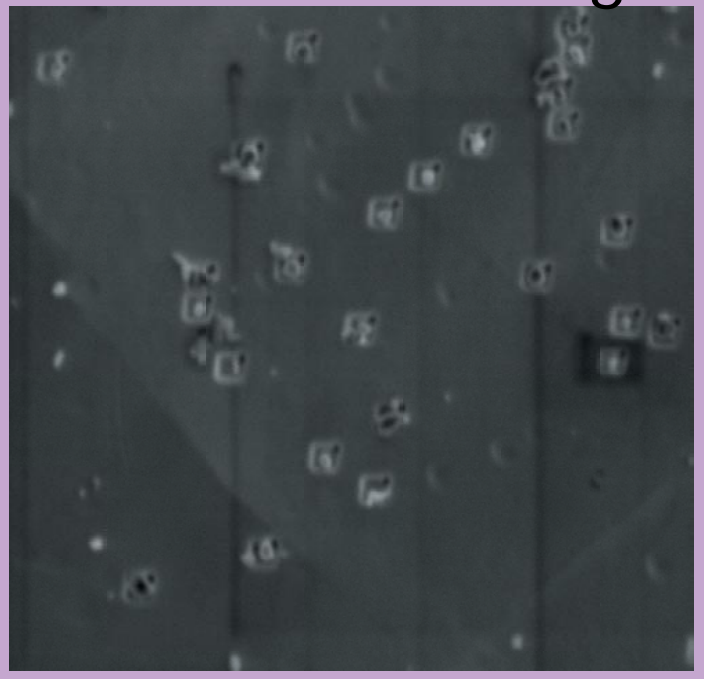
Sec. electron image



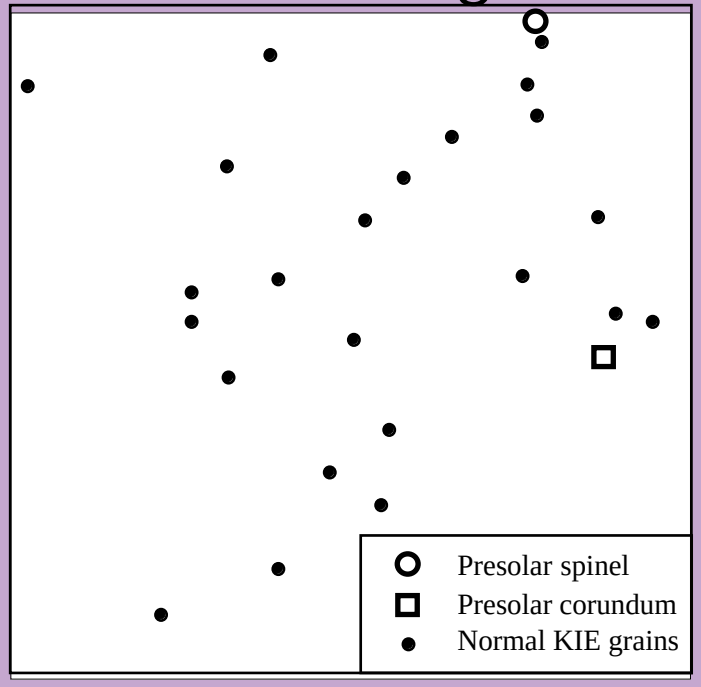
$^{16}O^-$ image

# Murchison KIE grains

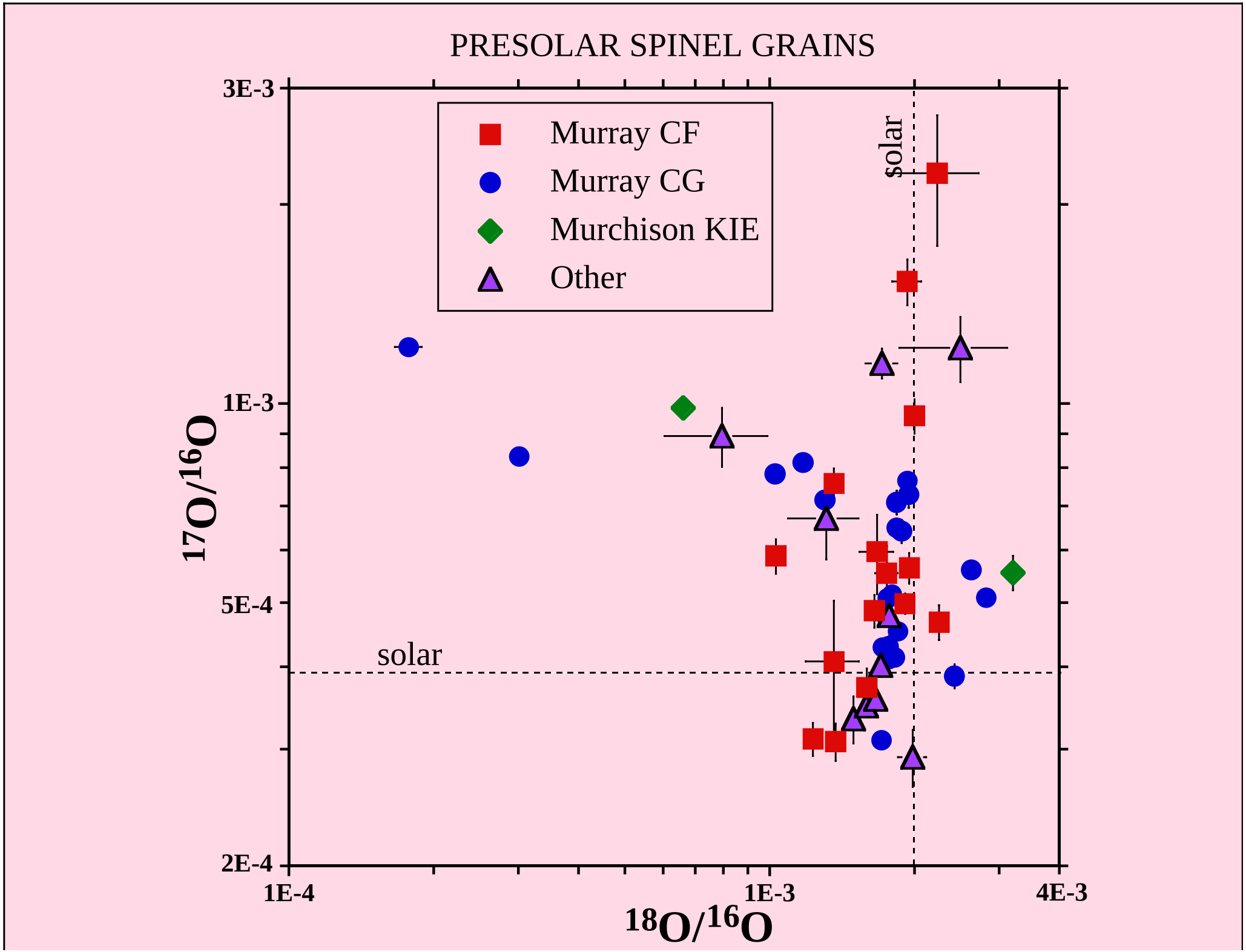
20x20 $\mu m^2$



SEM image after



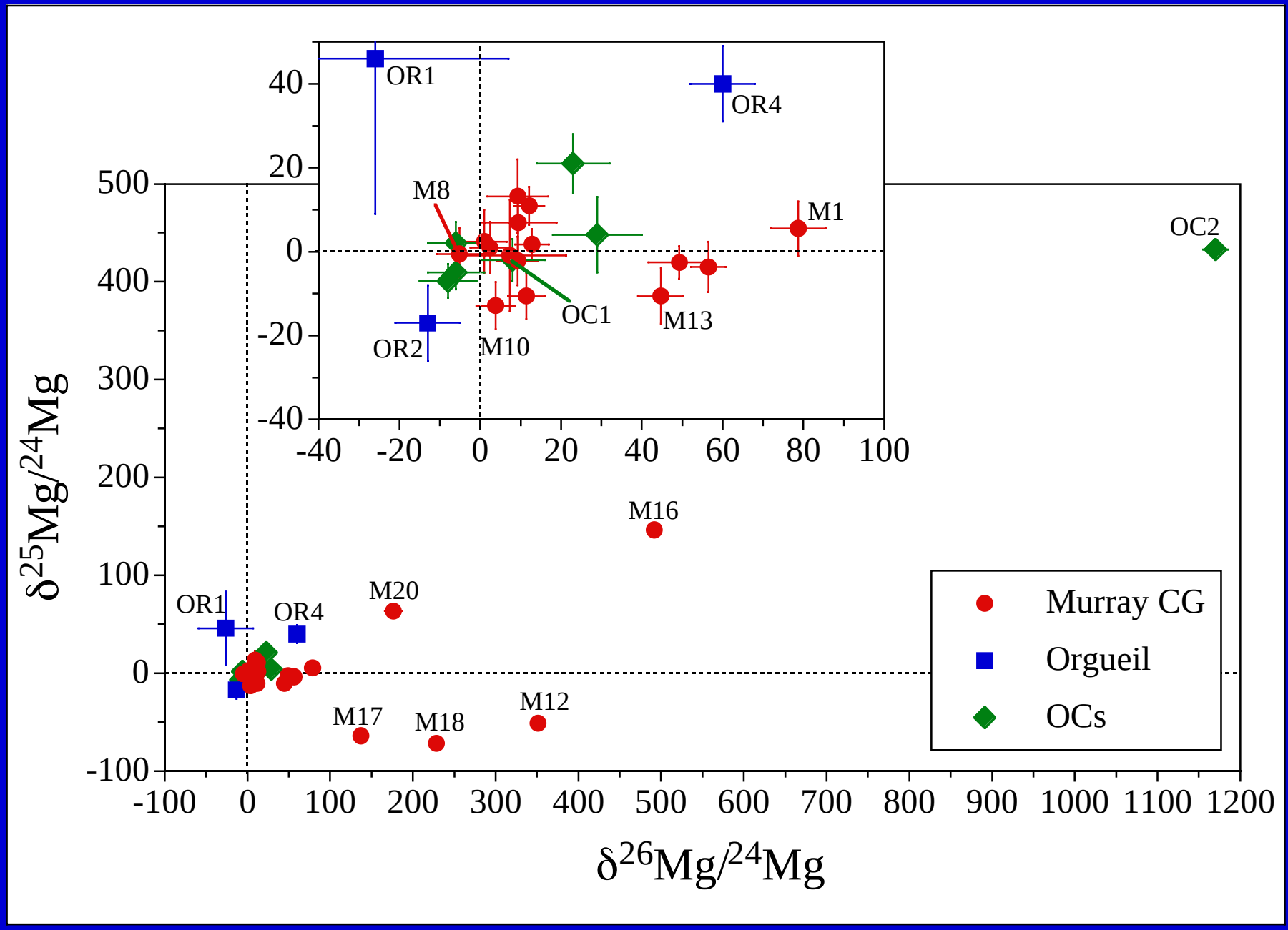

Analyzed grains

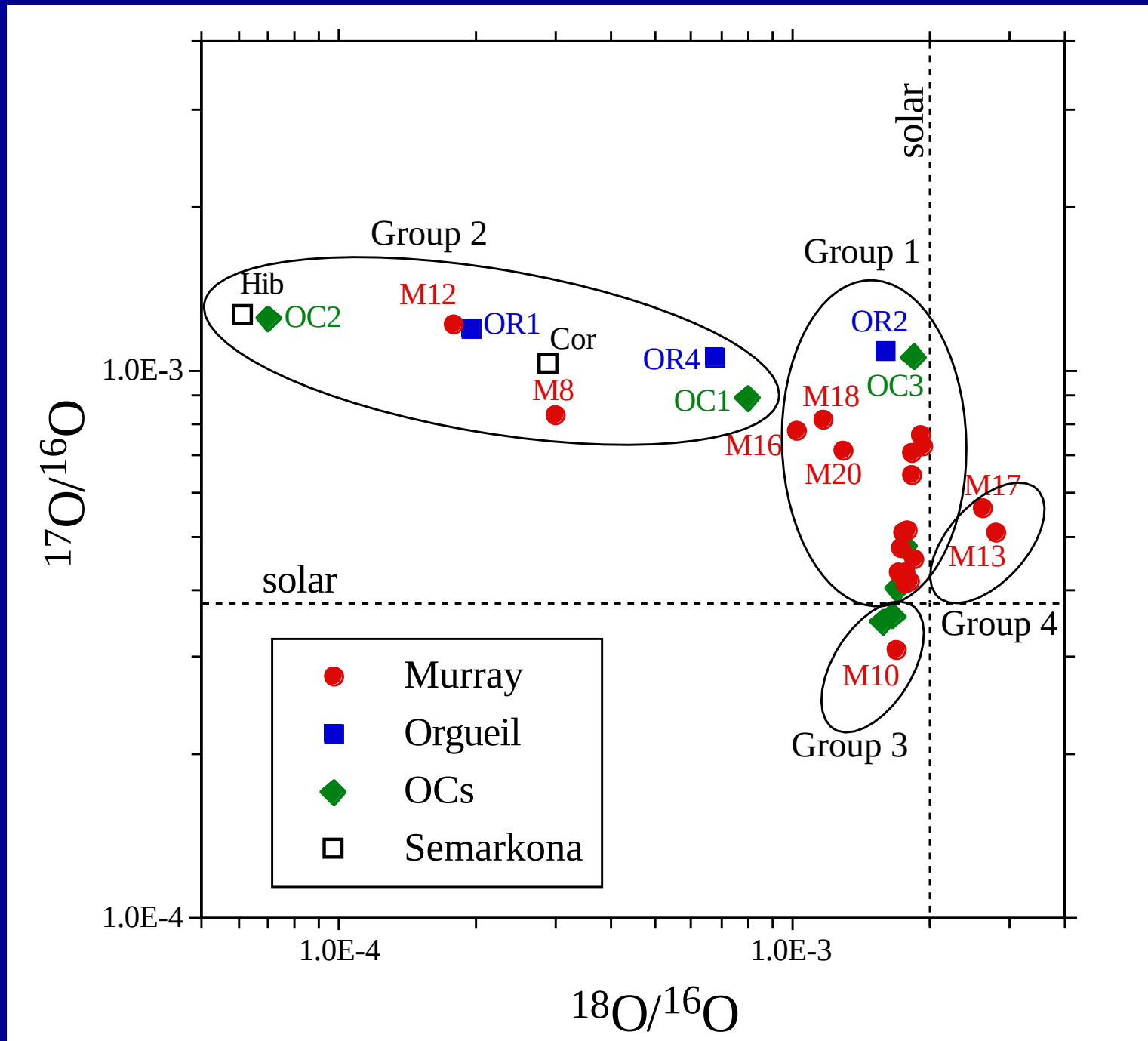

PRESOLAR SPINEL GRAINS
Murray CF
Murray CG
Murchison KIE
Other
solar
solar
3E-3
1E-3
5E-4
2E-4
1E-4
1E-3
4E-3
17O/16O
18O/16O

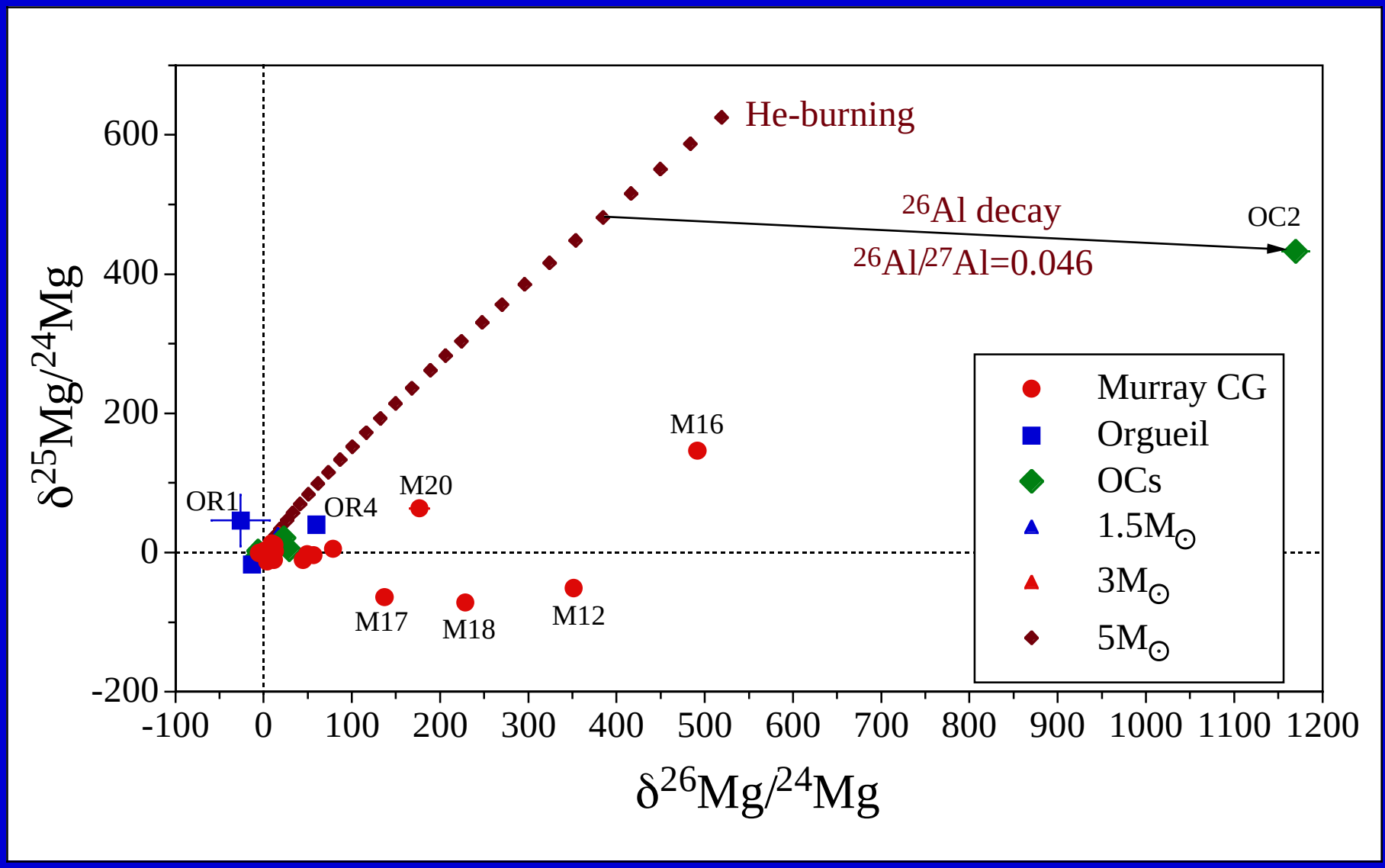
## FRACTIONS OF PRESOLAR OXIDE GRAINS

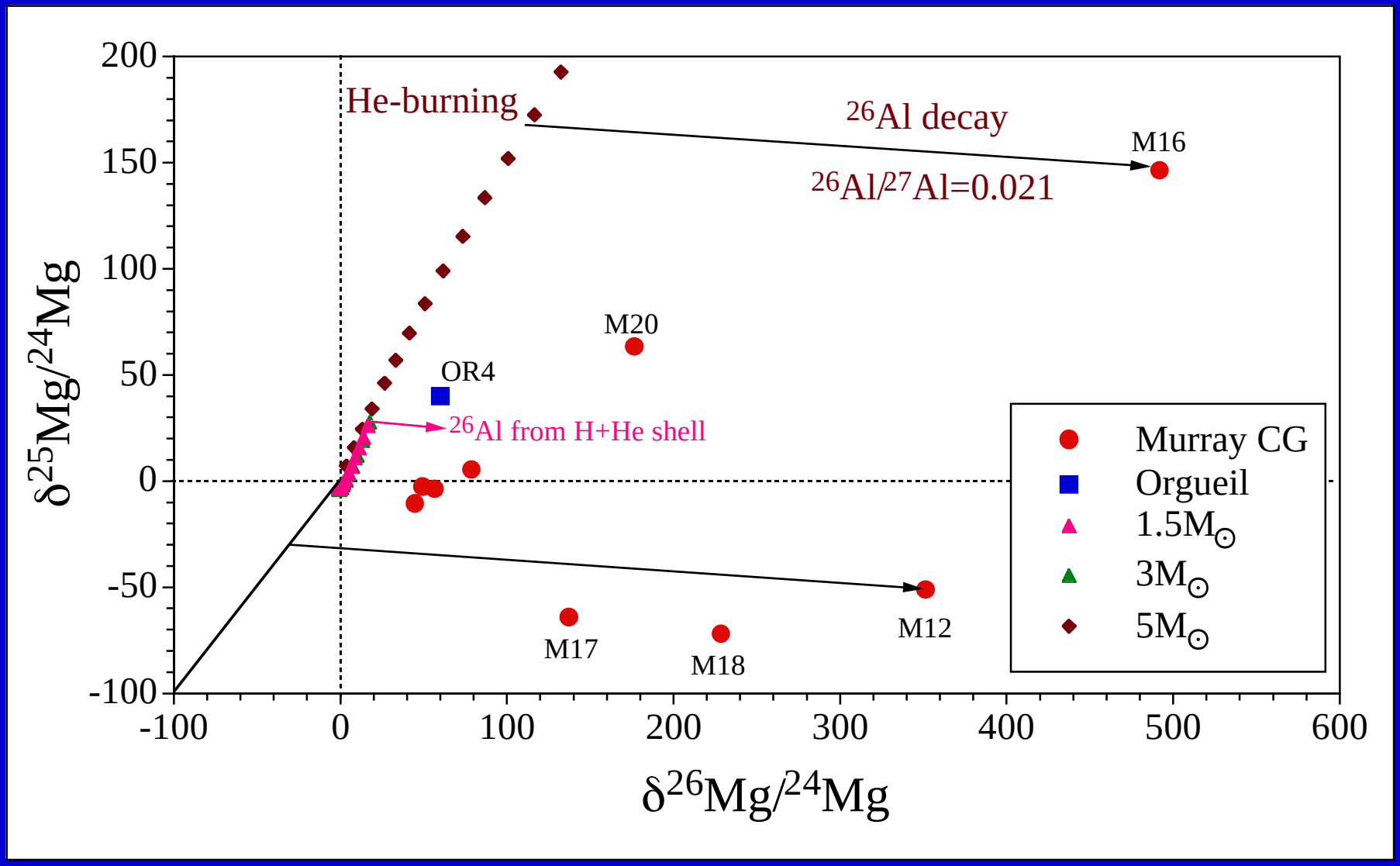
| Meteorite/residue | Spinel/res | Corundum/res |
|---|---|---|
| Murray CF (0.15 µm) | 15/628 (2.4%) | 3/628 (0.5%) |
| Murray CG (0.45 µm) | 21/1253 (1.7%) | 1/1253 (0.1%) |
| Murray CH (0.7-2 µm) | 0/1000 (<0.1%) | 0/1000 (<0.1%) |
| | **Spinel/Murray** | **Cor./Murray** |
| CF | **670 ppb** | **25-130 ppb** |
| CG | **765 ppb** | **45-130 ppb** |
| Total | **~1.4 ppm** | **70-260 ppb** |

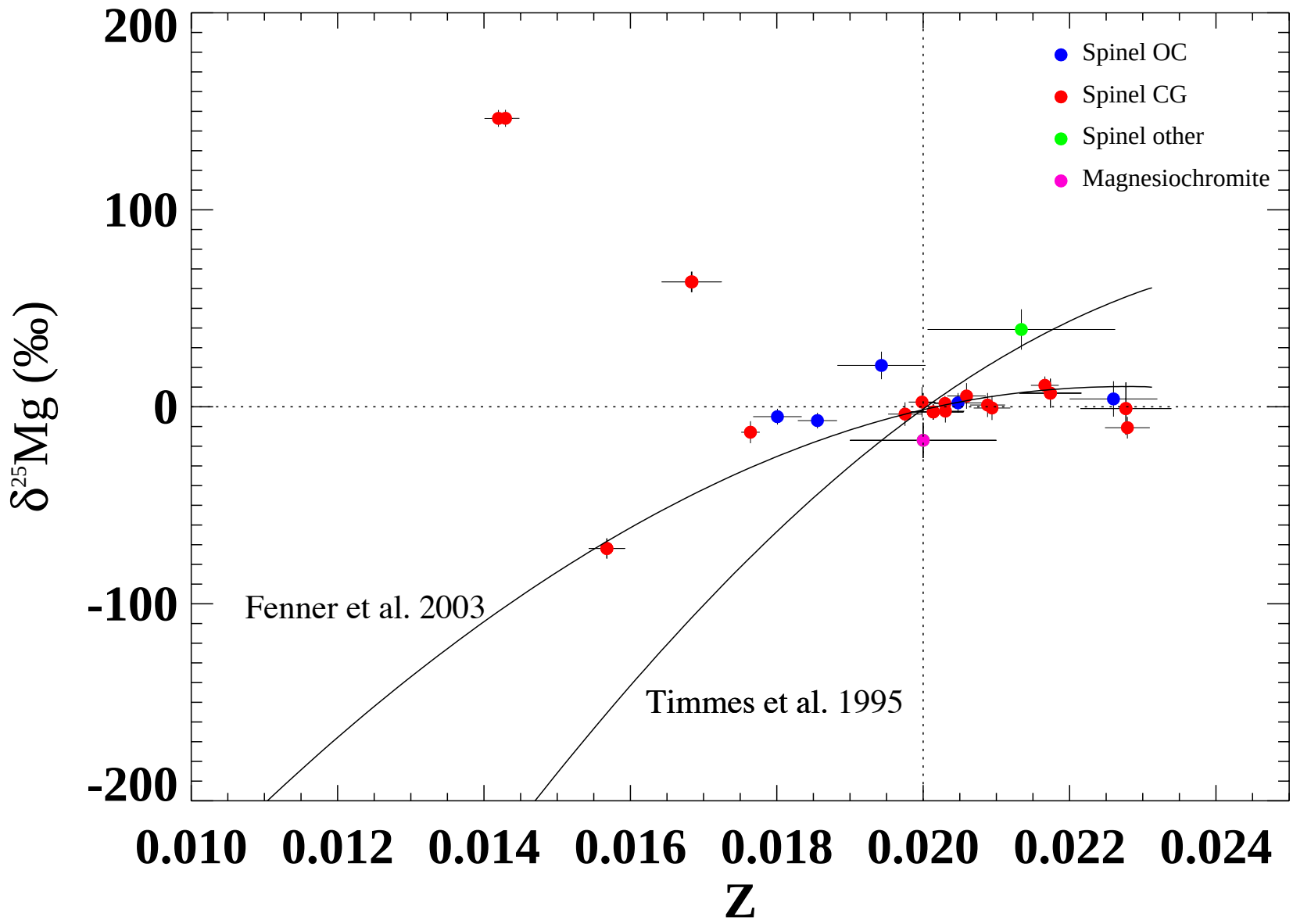
April-21-3
x=30.101 y=37.842
38
24
4
10µm
1µm
Pixel Size = 27.94 nm
Mag = 7.10 K X
EHT = 5.00 kV Extractor I = 144.90 µA Signal A = SE2
WD = 9 mm
Mix Signal = 0.00e+000
Date :15 Jul 2003 Time :11:46
© J. Huth MPICH_Mainz

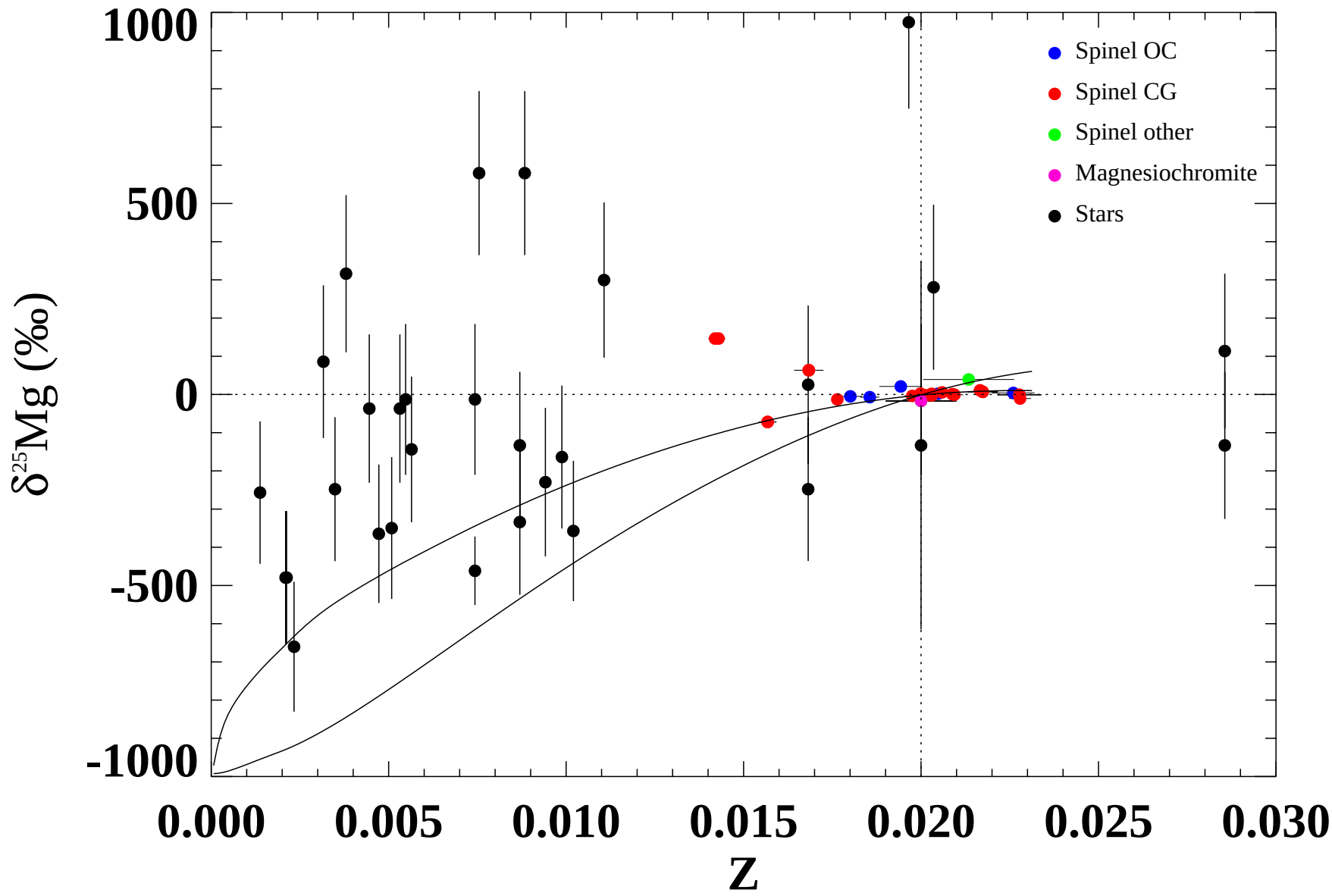

δ25Mg/24Mg
δ26Mg/24Mg
OR1
OR4
M8
M1
OC2
OC1
M13
OR2
M10
M16
M20
M17
M18
M12
Murray CG
Orgueil
OCs

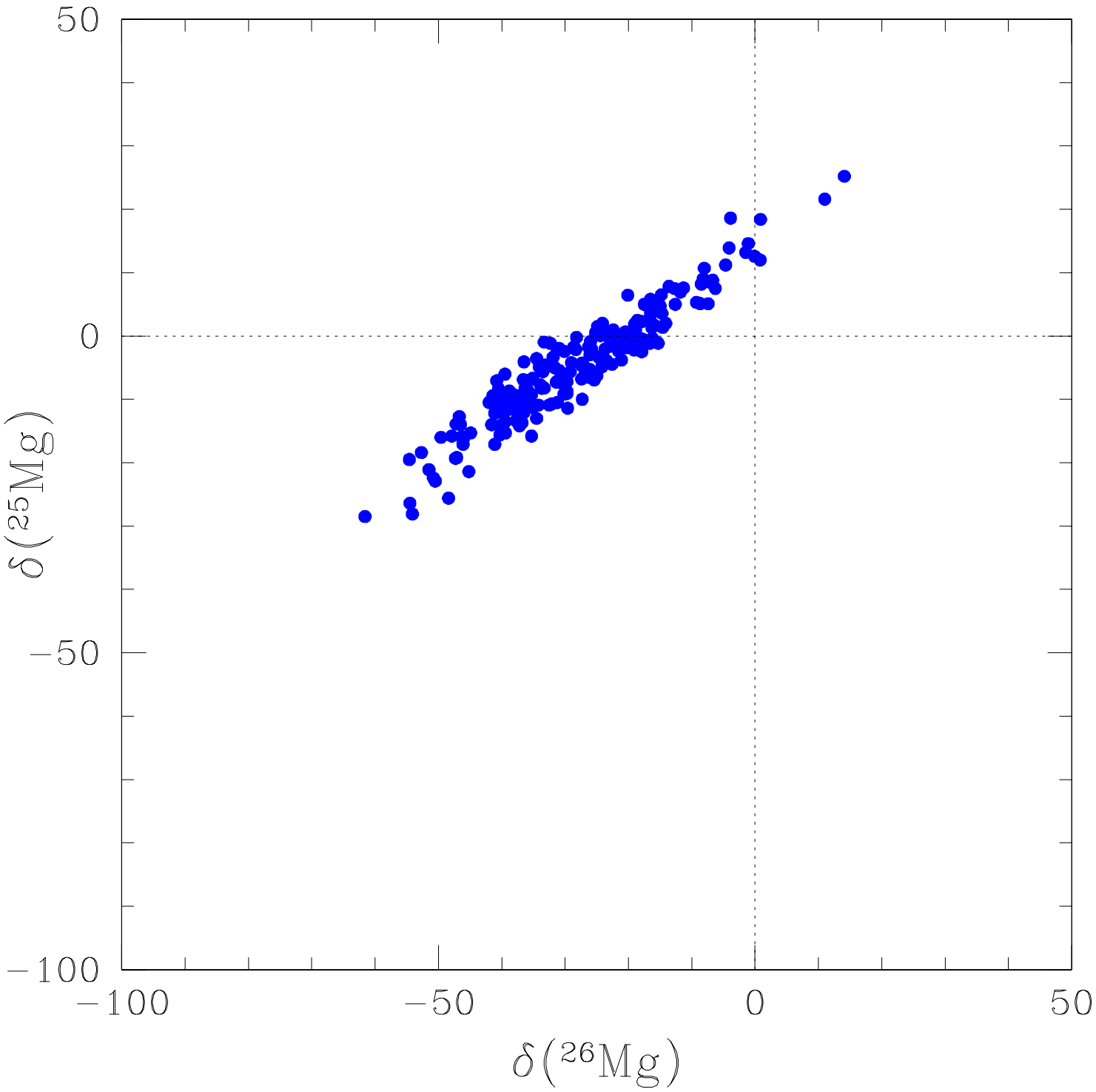

solar
Group 2
Group 1
Hib
OC2
M12
OR1
Cor
OR4
M8
OC1
OR2
OC3
M18
M16
M20
M17
M13
solar
Group 4
M10
Group 3
Murray
Orgueil
OCs
Semarkona
1.0E-3
1.0E-4
1.0E-4
1.0E-3
17O/16O
18O/16O


He-burning
$^{26}$Al decay
$^{26}$Al/$^{27}$Al=0.046
OC2
M16
M20
OR1
OR4
M17
M18
M12
Murray CG
Orgueil
OCs
1.5M$_\odot$
3M$_\odot$
5M$_\odot$
600
400
200
0
-200
-100
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
$\delta^{25}$Mg/$^{24}$Mg
$\delta^{26}$Mg/$^{24}$Mg


He-burning
26Al decay
26Al/27Al=0.021
M16
M20
OR4
26Al from H+He shell
M12
M17
M18
Murray CG
Orgueil
1.5M⊙
3M⊙
5M⊙
δ25Mg/24Mg
δ26Mg/24Mg
200
150
100
50
0
-50
-100
-100
0
100
200
300
400
500
600

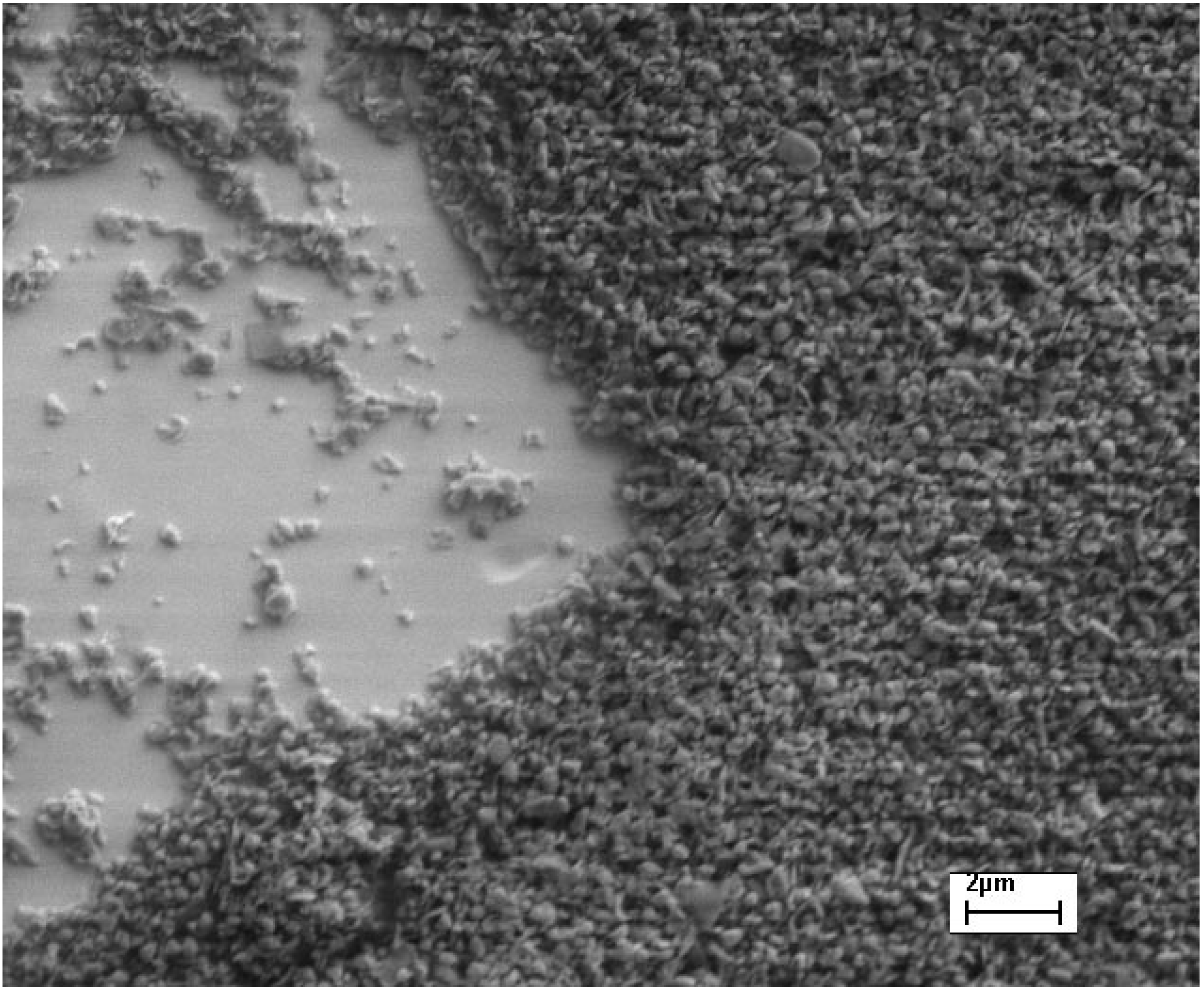

200
100
0
-100
-200
δ25Mg (‰)
0.010
0.012
0.014
0.016
0.018
0.020
0.022
0.024
Z
Spinel OC
Spinel CG
Spinel other
Magnesiochromite
Fenner et al. 2003
Timmes et al. 1995


1000
500
0
-500
-1000
δ25Mg (‰)
0.000
0.005
0.010
0.015
0.020
0.025
0.030
Z
Spinel OC
Spinel CG
Spinel other
Magnesiochromite
Stars



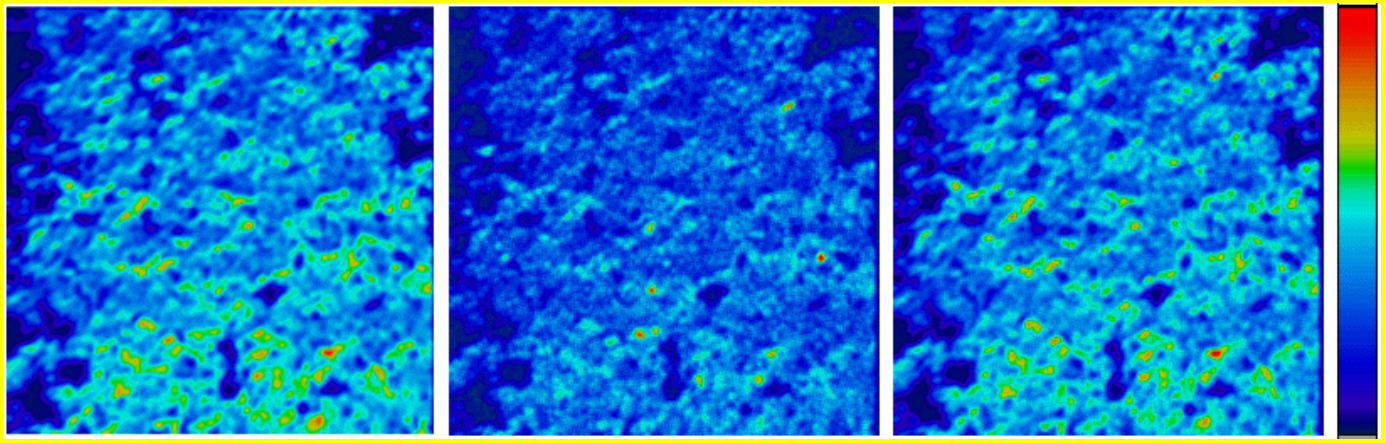

Monte Carlo model of Galactic heterogeneity

by Maria Lugaro

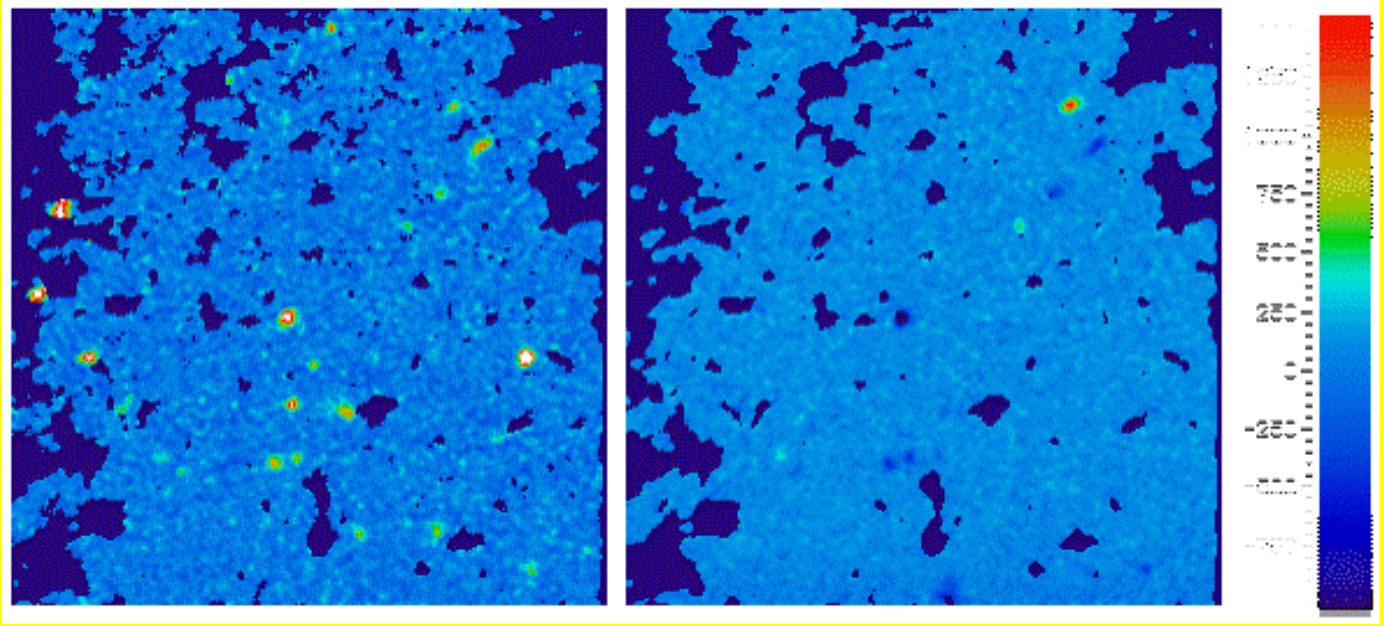

2µm

# Murray CG residue

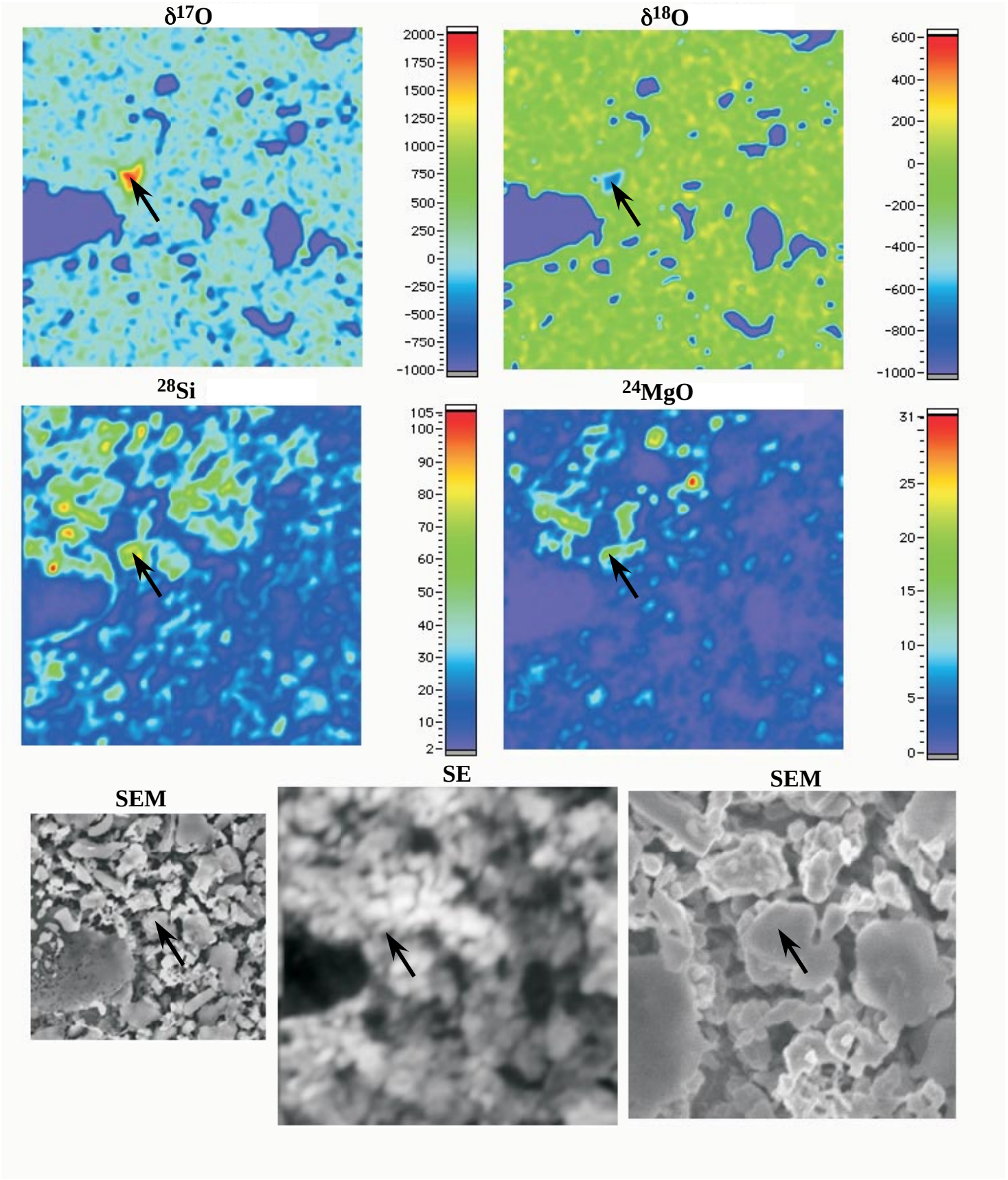
$^{16}O^-$ $^{17}O^-$ $^{18}O^-$

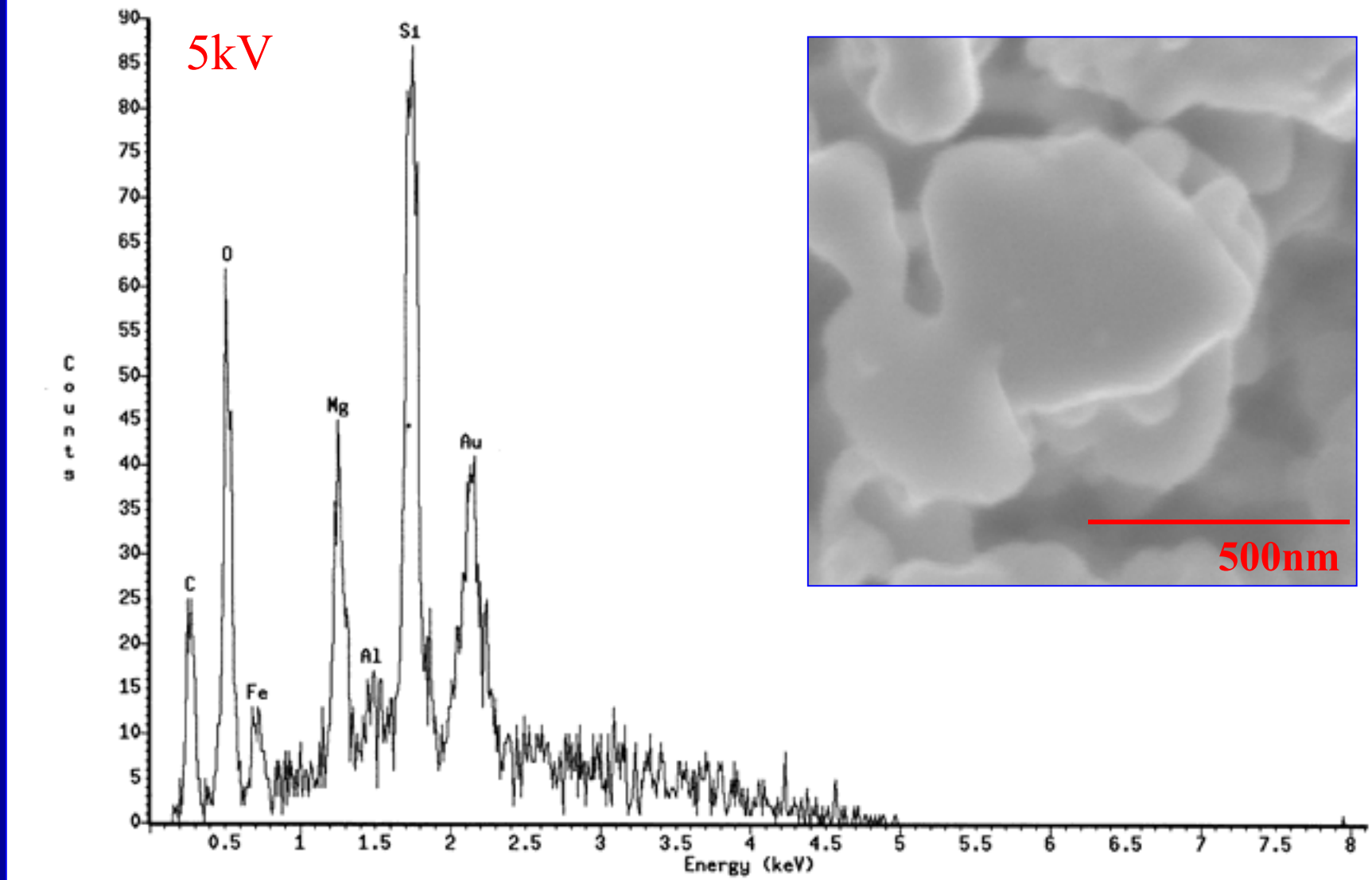


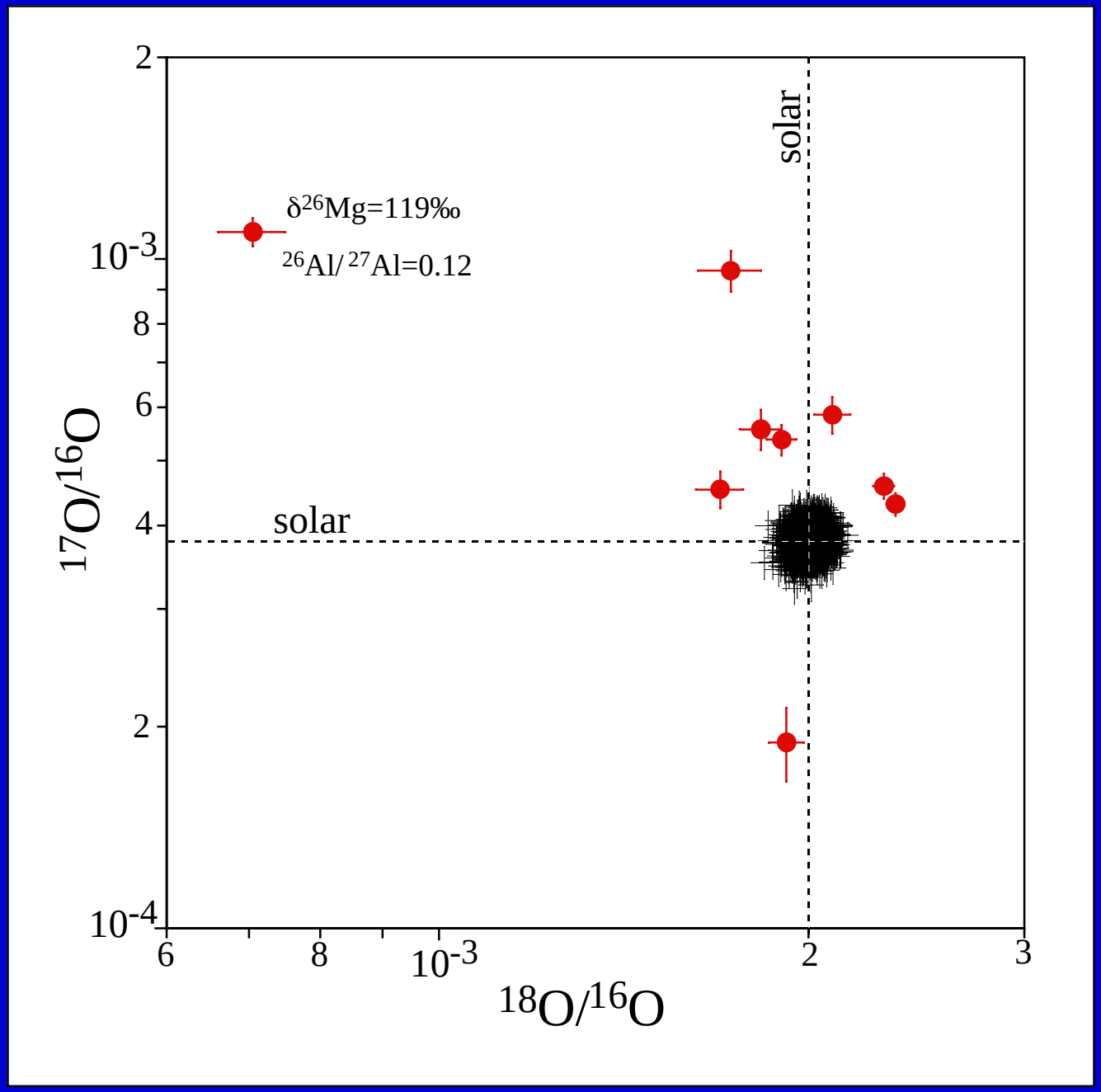
$^{17}O/^{16}O$ $^{18}O/^{16}O$

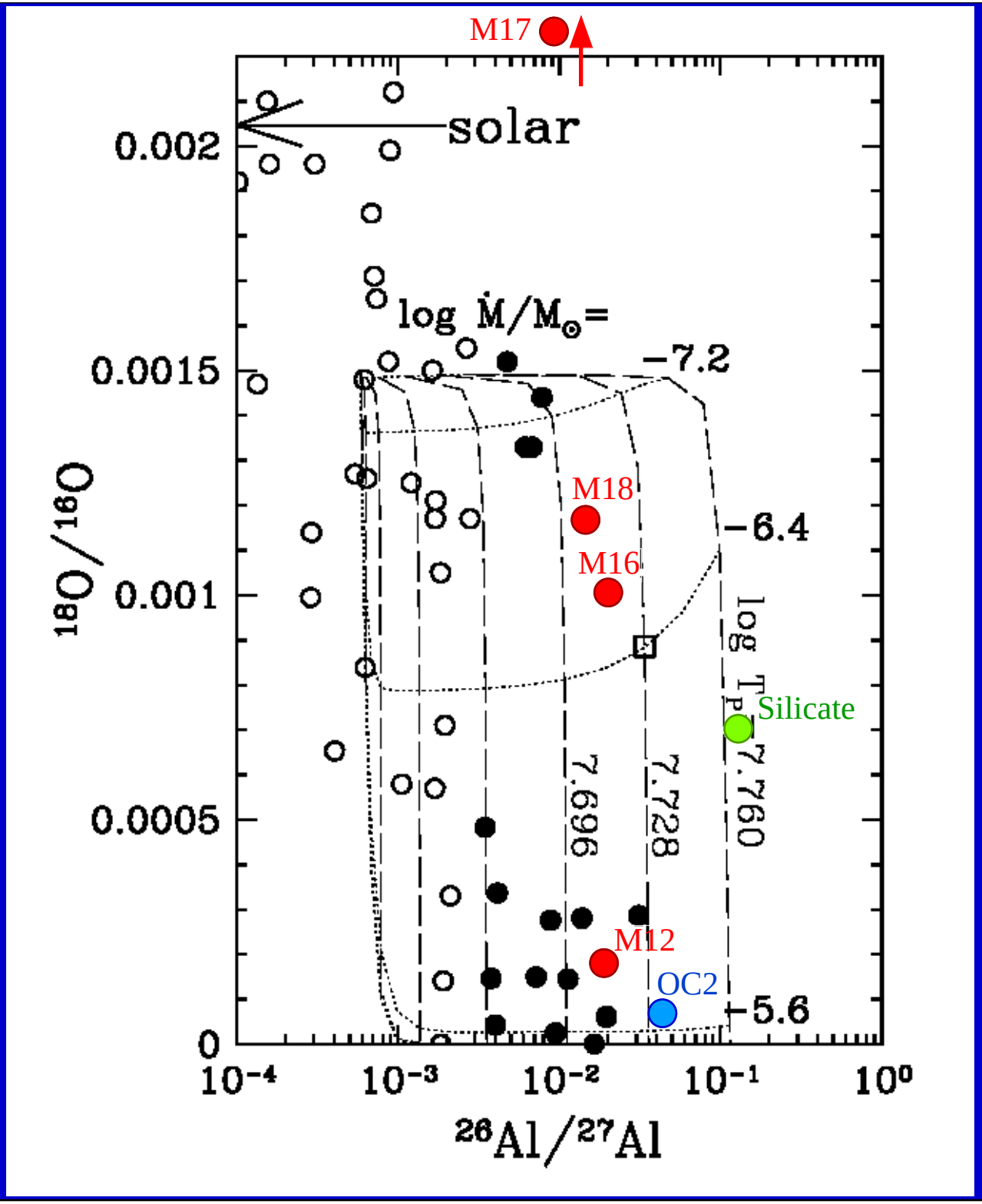


# Discovery of presolar silicate in a primitive meteorite

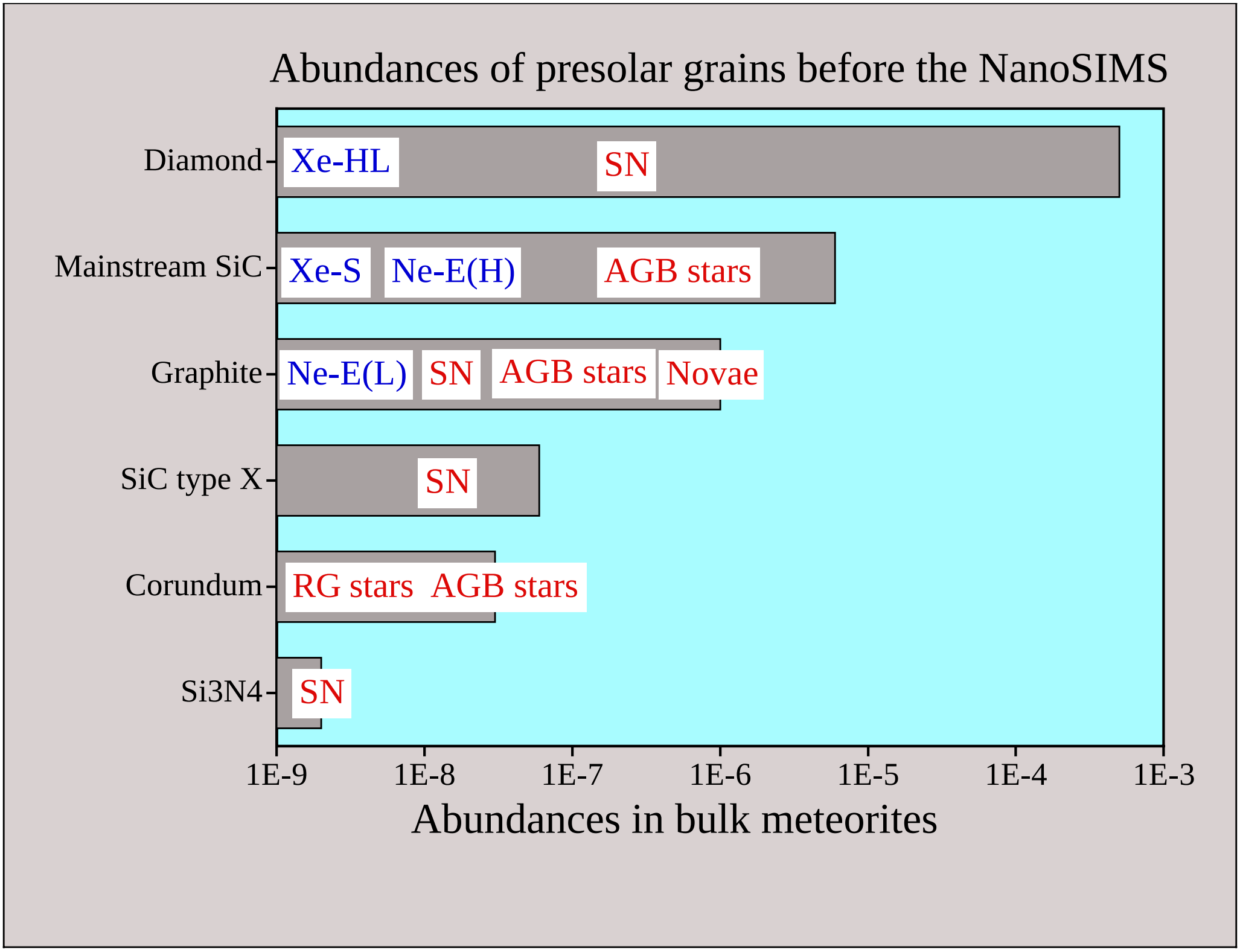


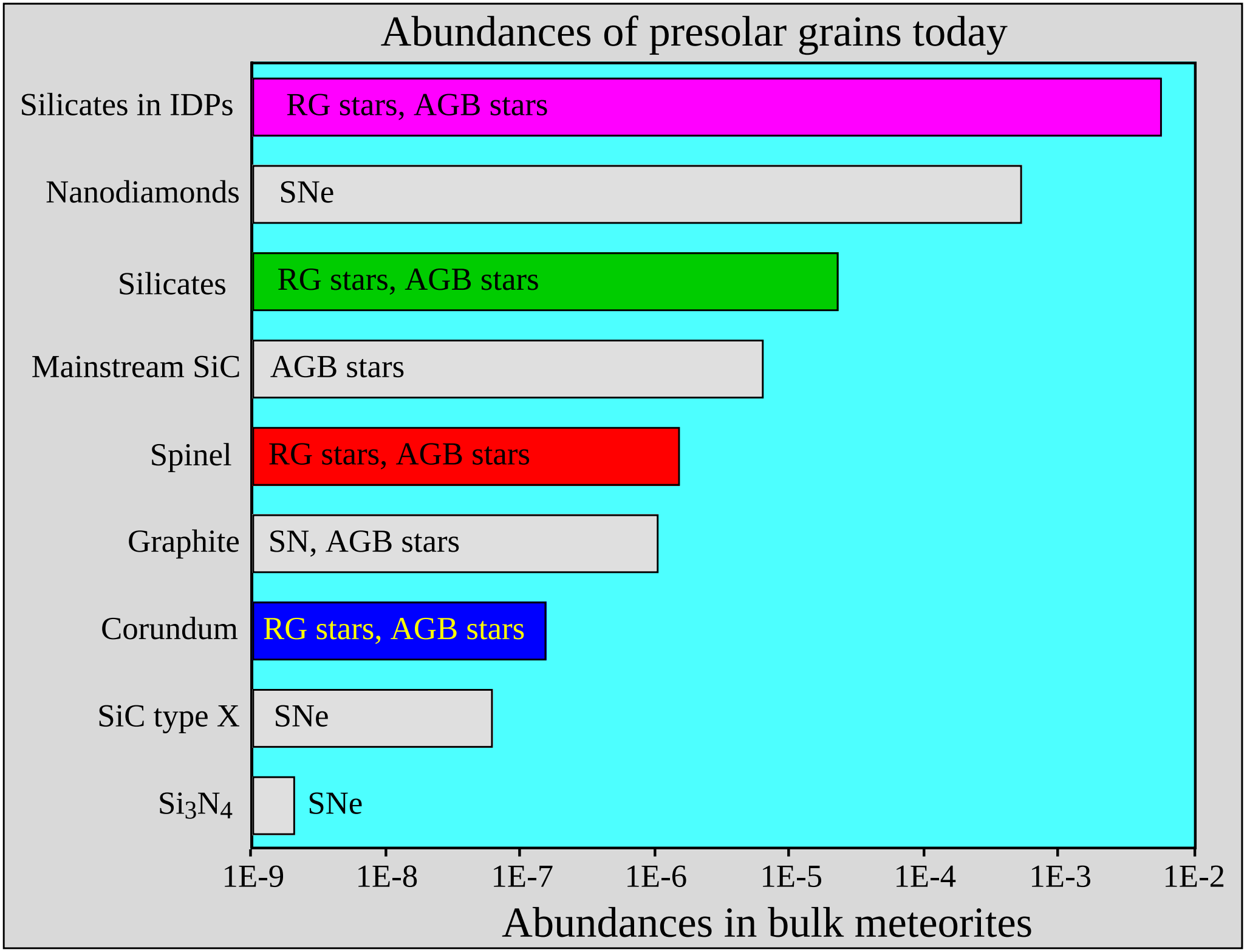

5kV
Si
O
Mg
Au
C
Fe
Al
Counts
Energy (keV)
500nm


2
10-3
8
6
4
2
10-4
6
8
10-3
2
3
17O/16O
18O/16O
solar
solar
δ26Mg=119‰
26Al/27Al=0.12




**Nollet et al. 2003**


Abundances of presolar grains before the NanoSIMS
Diamond
Xe-HL
SN
Mainstream SiC
Xe-S
Ne-E(H)
AGB stars
Graphite
Ne-E(L)
SN
AGB stars
Novae
SiC type X
SN
Corundum
RG stars
AGB stars
Si3N4
SN
1E-9
1E-8
1E-7
1E-6
1E-5
1E-4
1E-3
Abundances in bulk meteorites


Abundances of presolar grains today
Silicates in IDPs
RG stars, AGB stars
Nanodiamonds
SNe
Silicates
RG stars, AGB stars
Mainstream SiC
AGB stars
Spinel
RG stars, AGB stars
Graphite
SN, AGB stars
Corundum
RG stars, AGB stars
SiC type X
SNe
Si3N4
SNe
1E-9
1E-8
1E-7
1E-6
1E-5
1E-4
1E-3
1E-2
Abundances in bulk meteorites