Elettra Sincrotrone Trieste

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IN SUPREMÆ DIGNITATIS 1343
DIPARTIMENTO DI SCIENZE DELLA TERRA
UNIVERSITÀ DI PISA

MNA

Non-equilibrium melting of partially differentiated asteroids: insights from HP-HT experiments on DAV01001 L6 chondrite

Iannini Lelarge S.[1], Masotta M.[1,2], Folco L.[1,2], Mancini L.[3], Pittarello L.[4]

1 Dipartimento di Scienze della Terra, Università di Pisa, Via Santa Maria 53, Pisa, Italy

2CISUP, Centro per l'Integrazione della Strumentazione Universita' di Pisa, Lungarno Pacinotti 43 Pisa, Italy

3 Elettra-Sincrotrone Trieste S.C.p.A., S.S. 14-km 163,5 Area Science Park, 34149 Basovizza, Trieste, Italy

4 Natural History Museum Vienna, Burgring 7, Vienna 1010, Austria

EGU General Assembly 2022

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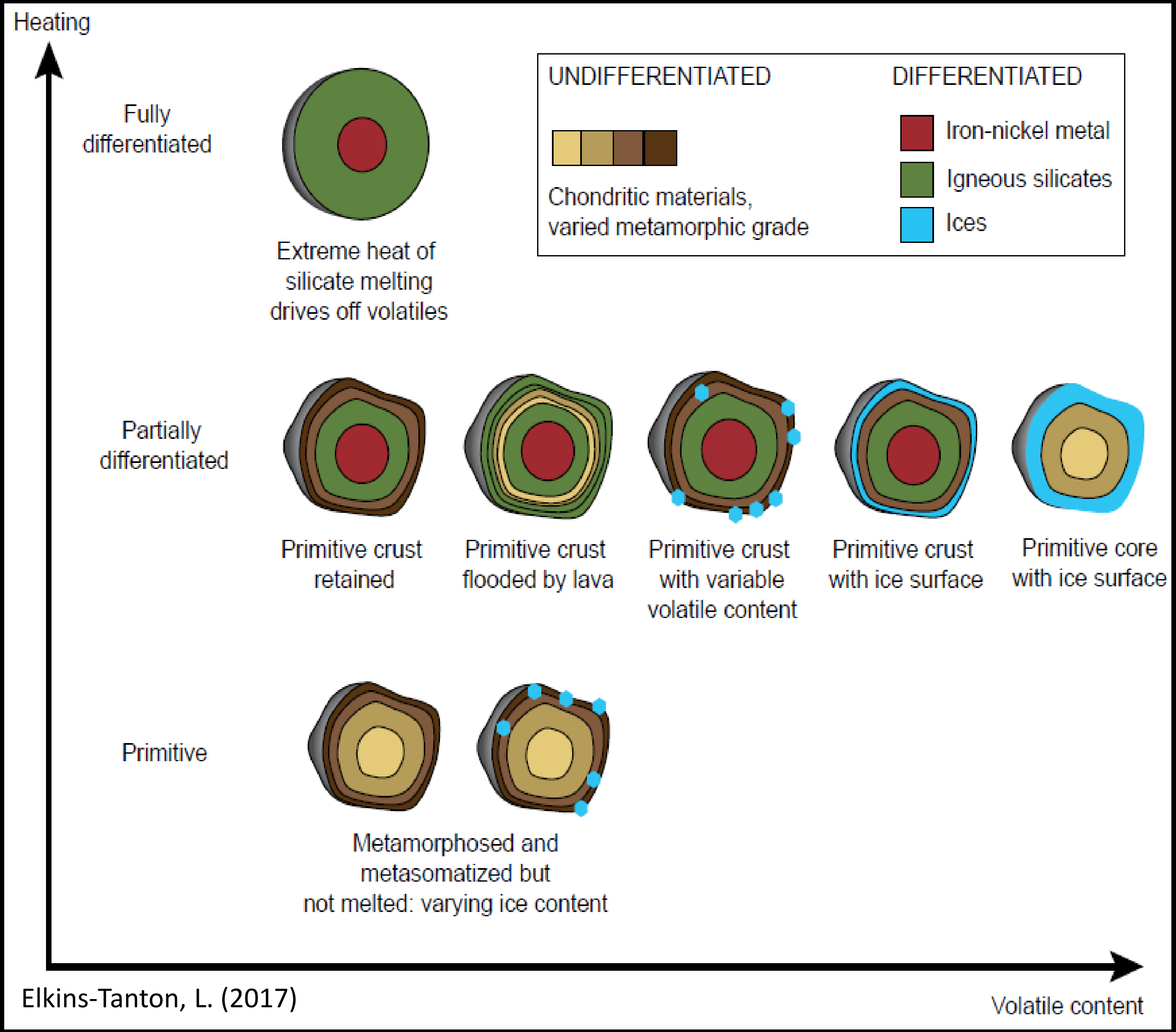
23 May 2022

Planetary accretion and differentiation →

several partial end-states of differentiation and accretion each characterized by low degrees of partial melting and melt segregation

Partially differentiated planetesimals



High-pressure partial melting experiments on natural chondrites

P

1 GPa

Deep processes
Planetary differentiation

T

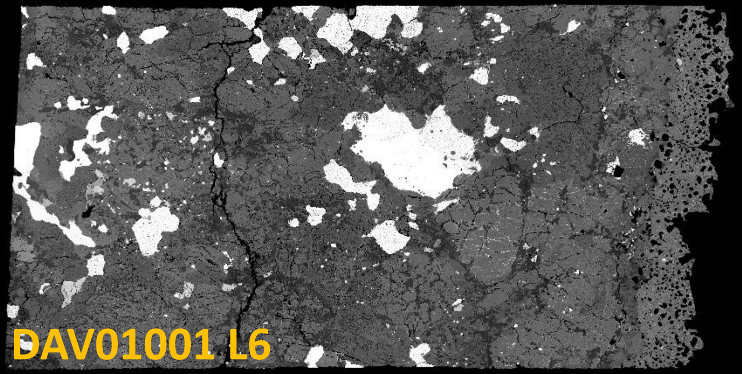
1100 °C to 1400°C
(1 to 24 hours)

Impact heating
Non-equilibrium melting

X_i

ordinary chondrite
L6 DAV01001

Petrological control



Experimental methods

Type = Non End-Load PC

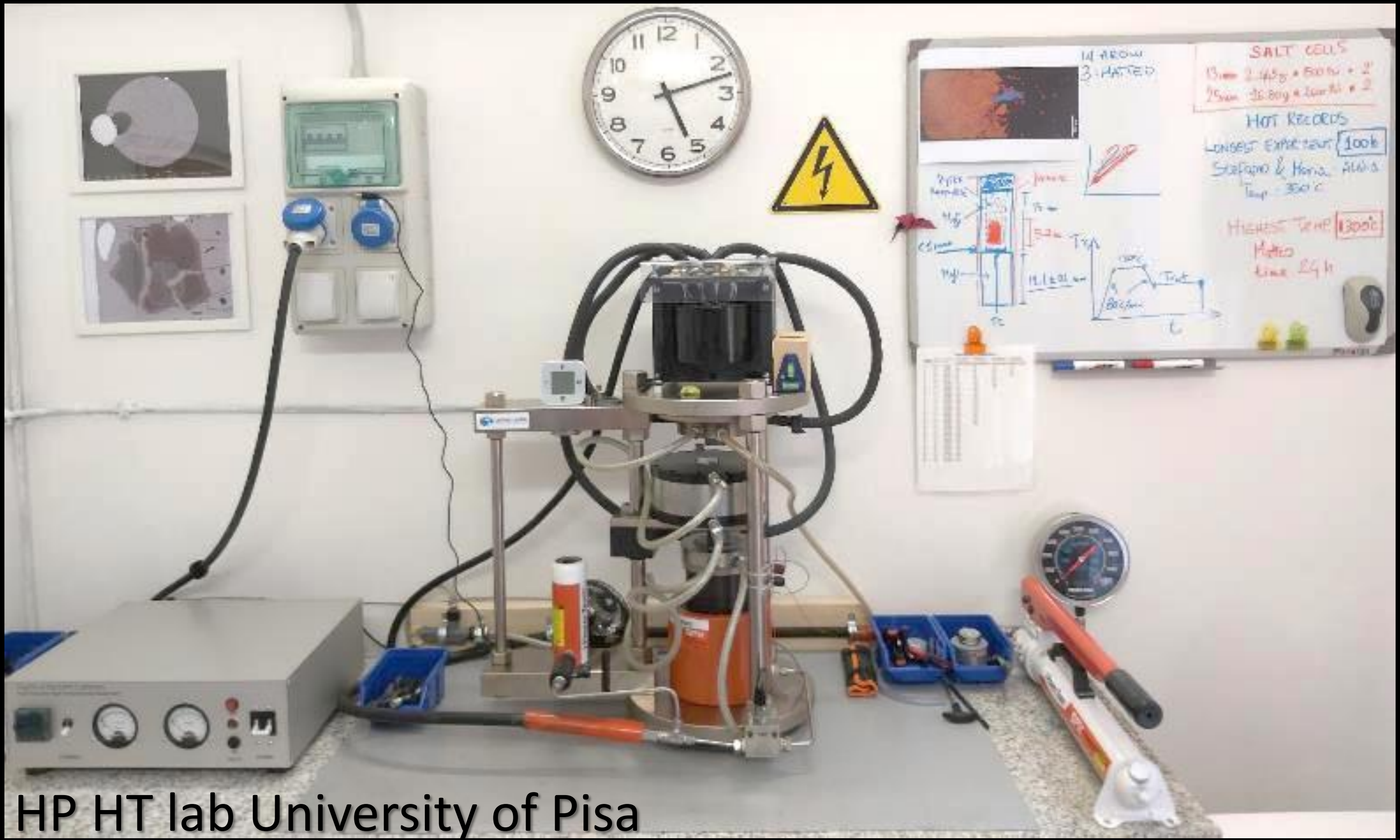
Material = WC

Max Temp. = 2000 °C

Max Pres. = 2.5 GPa

Pres. Med. = Solid

Intrinsic fO_2 = NNO+1

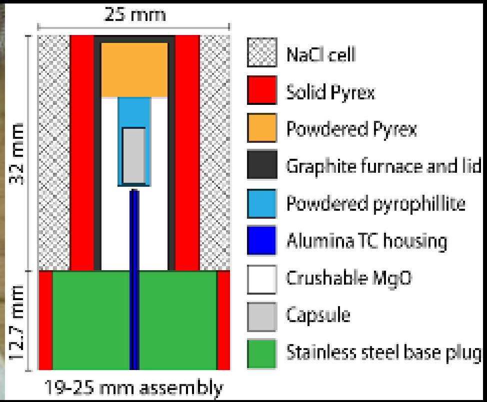


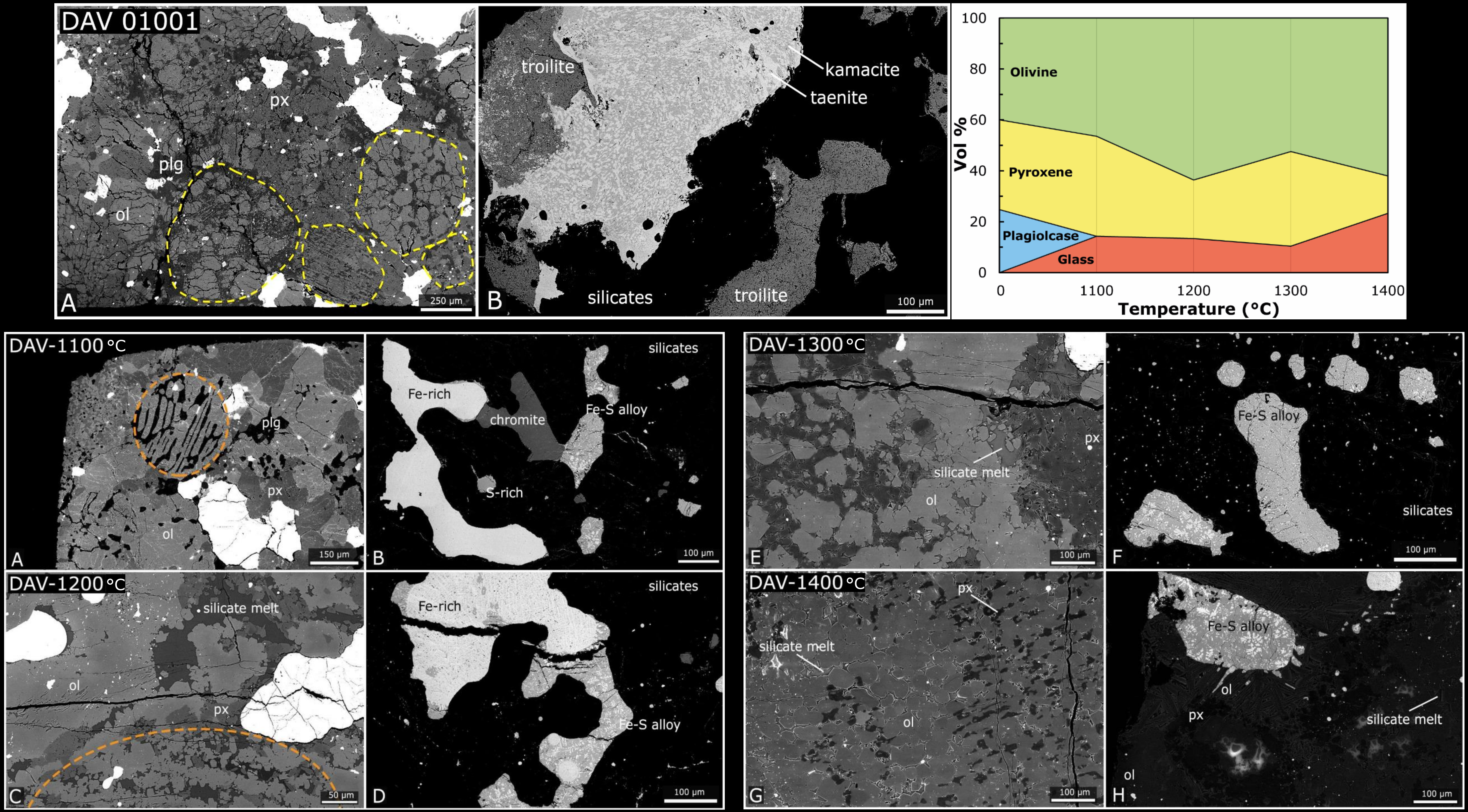
HP HT lab University of Pisa

Graphite capsules →

fO_2 ~ 0 to -1.3 log units below IW buffer

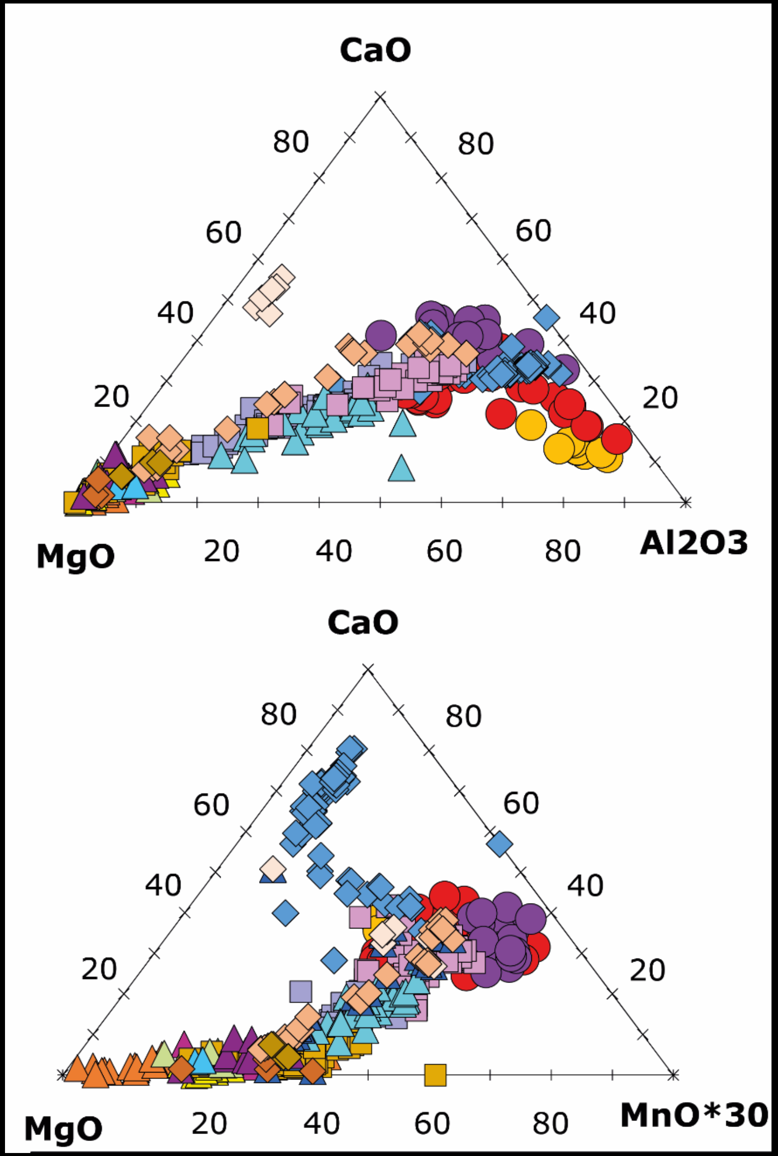
Meteorites fO_2 range between -7 &+8 log units below IW

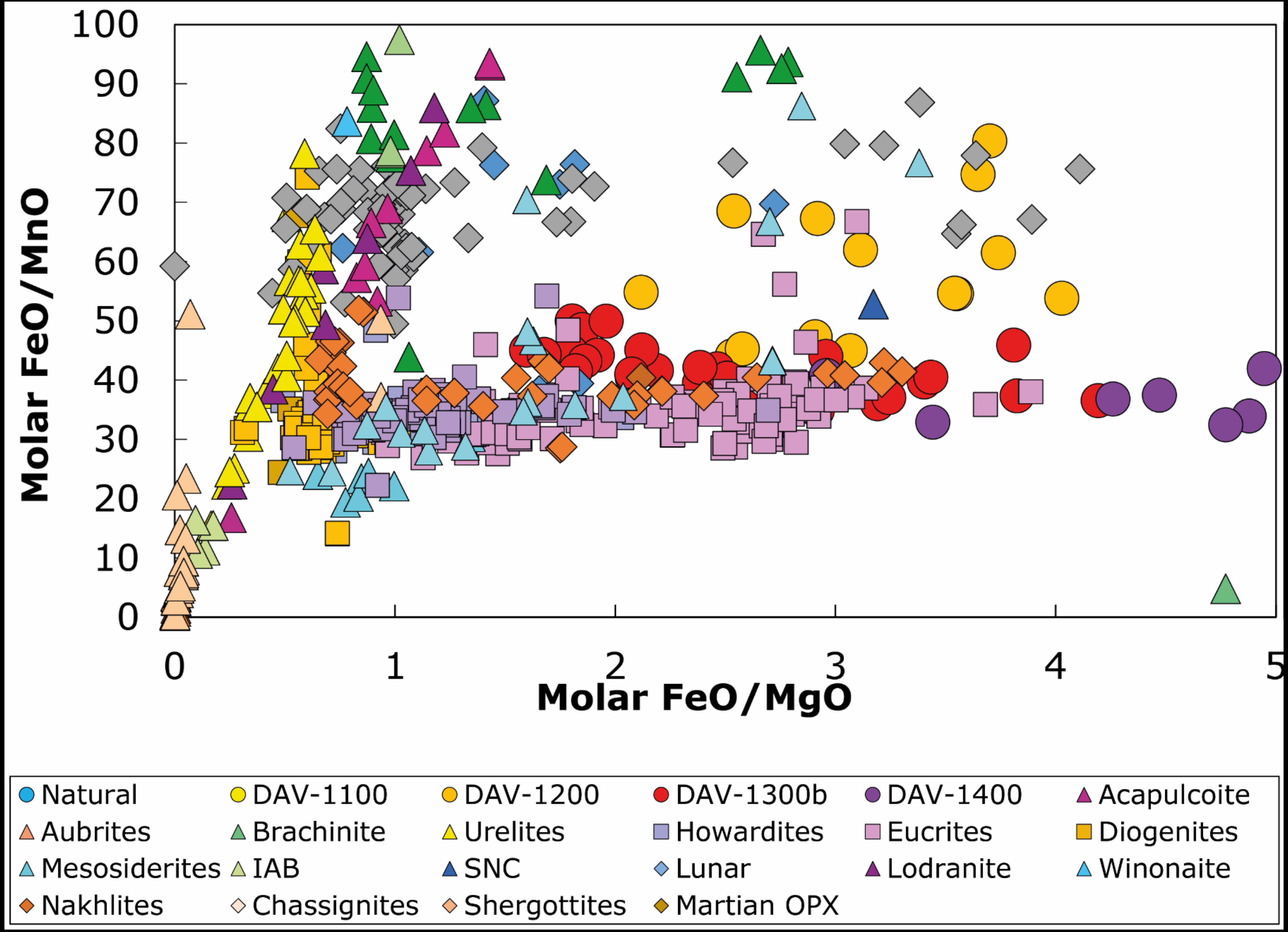



DAV 01001
px
plg
ol
A
250 μm
troilite
kamacite
taenite
B
silicates
troilite
100 μm
100
80
60
40
20
0
Vol %
Olivine
Pyroxene
Plagiolcase
Glass
0
1100
1200
1300
1400
Temperature (°C)
DAV-1100 °C
plg
px
ol
A
150 μm
Fe-rich
chromite
Fe-S alloy
S-rich
silicates
B
100 μm
DAV-1200 °C
silicate melt
ol
px
C
50 μm
Fe-rich
silicates
Fe-S alloy
D
100 μm
DAV-1300 °C
px
silicate melt
ol
E
100 μm
Fe-S alloy
silicates
F
100 μm
DAV-1400 °C
px
silicate melt
ol
G
100 μm
Fe-S alloy
ol
px
silicate melt
ol
H
100 μm

silicate melts vs bulk achondrites

newly grown phases vs phases in achondrites

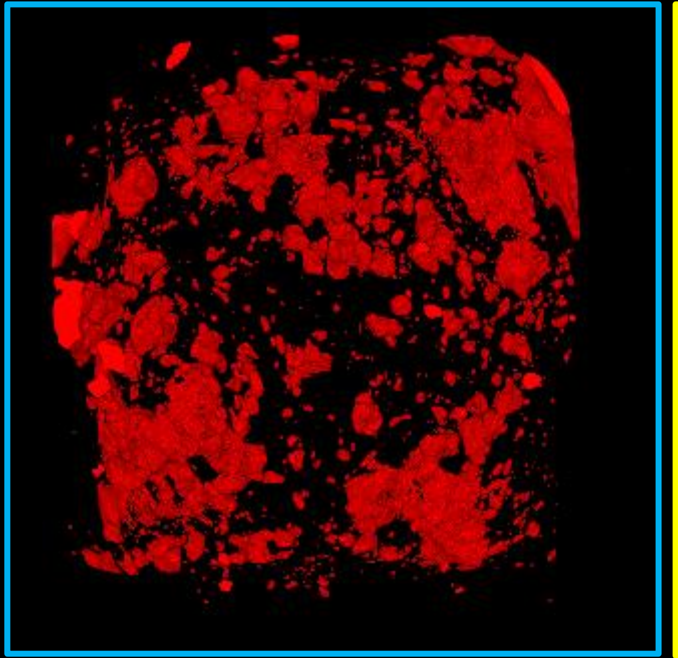




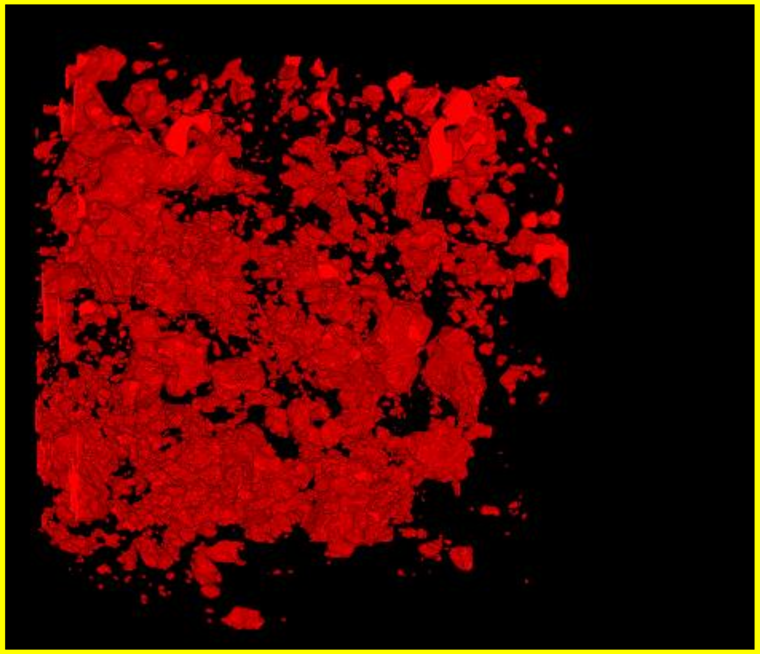
DAV01001 L6

Temperature change at 1GPa for 24h

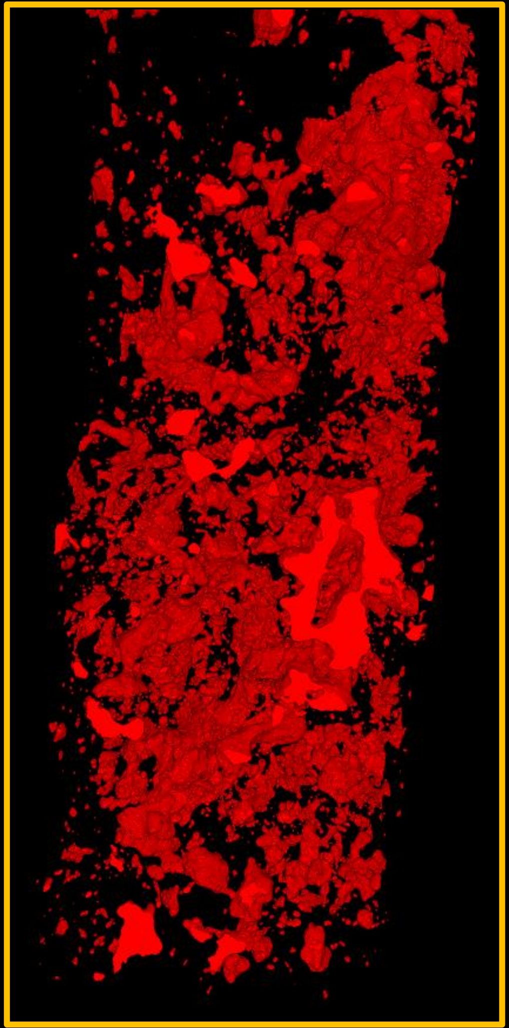
Starting material



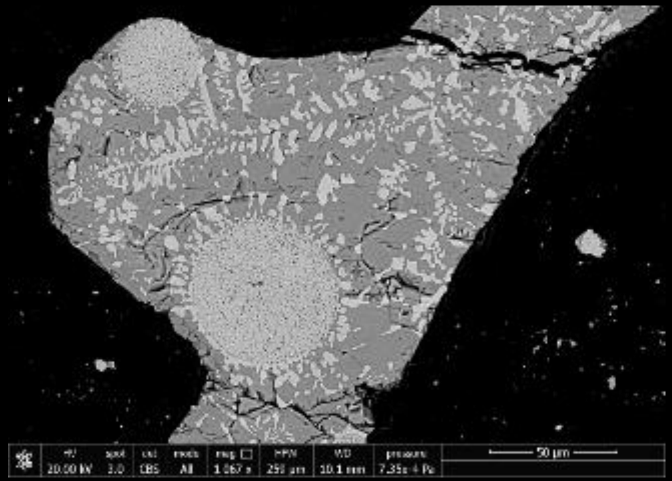
1100°C

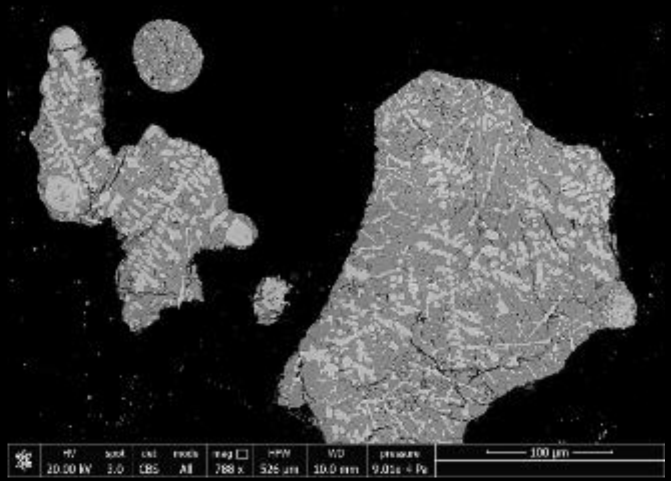


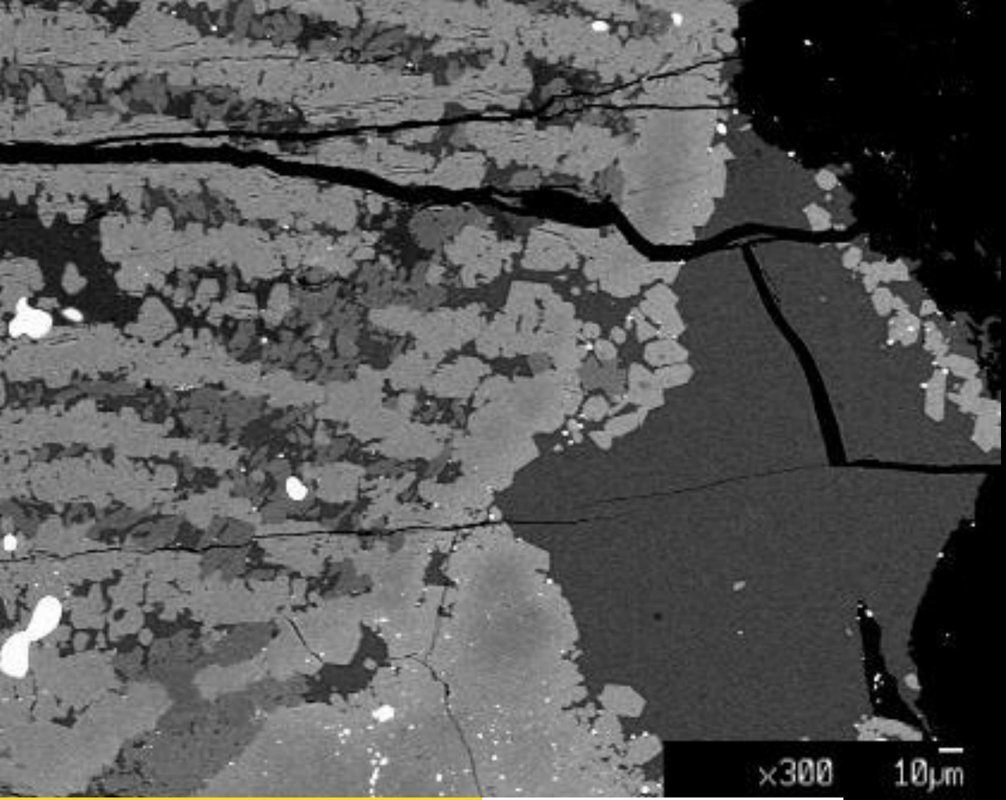
1200°C



1300°C







Summary

- **Non-modal melting** coupled with significant **crystallization of new grown phases**
- **Silicate liquids** similar to basaltic achondrites bulk composition
- **New grown phases** similar to basaltic achondrites
- **Lack of metal segregation** even in presence of a silicate liquid (~10%vol)

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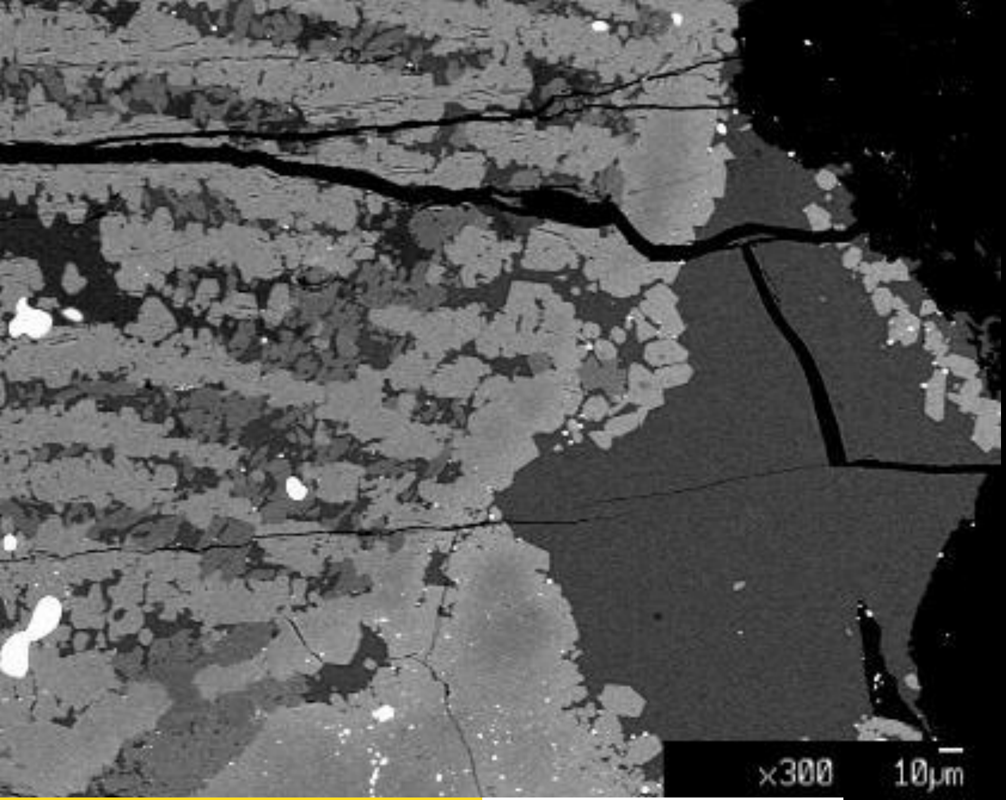

Conclusions

- The **achondritic interiors of partially differentiated planetesimals** have an **affinity** with **basaltic achondrites**
- **Basaltic achondrites-like lithologies** (such as eucrite-like) can be produced by **small degrees of partial melting of chondrites**
- The **coalescence of the metal and sulphur phases does not occur spontaneously** in these bodies and **other forces** such as **rotational spin** or **deformation** are needed to **segregate metal** under these conditions

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