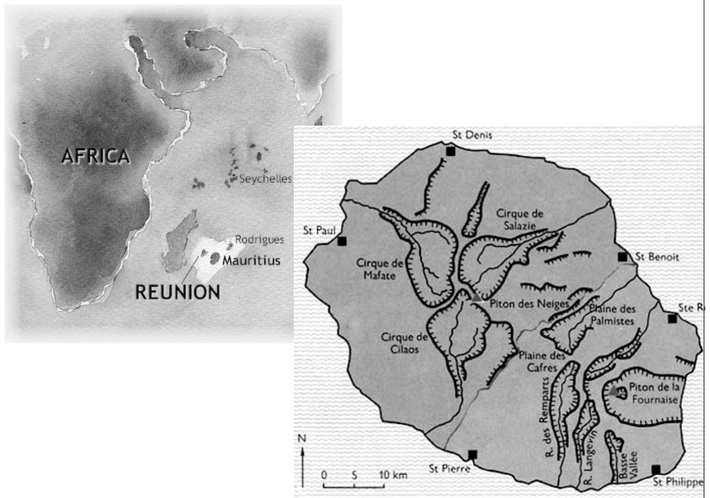
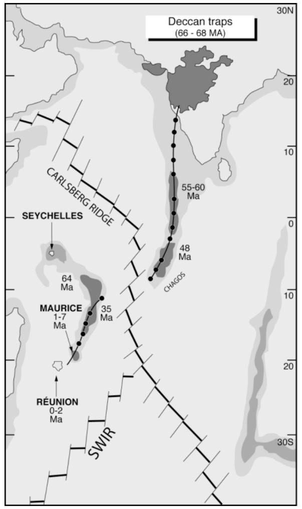
Cycles géochimiques

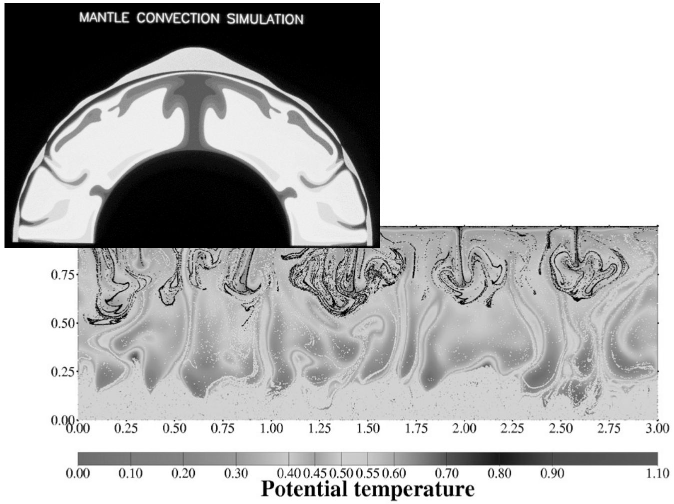


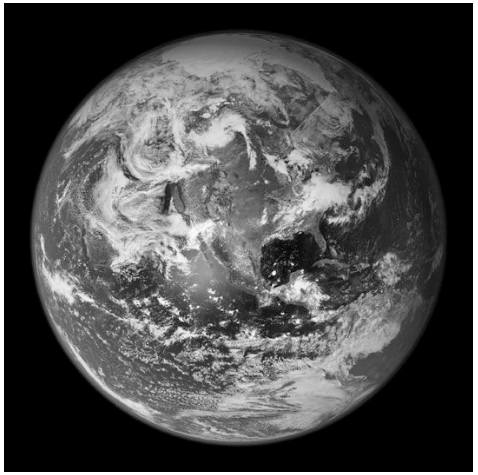
Éruption en cours
(photo 20 septembre 2006)

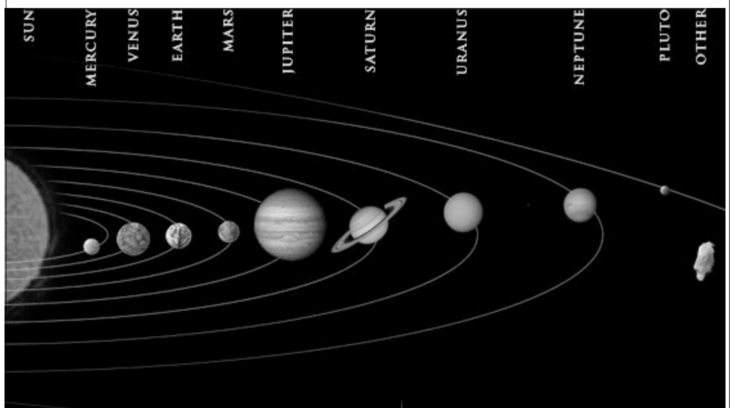
Questions

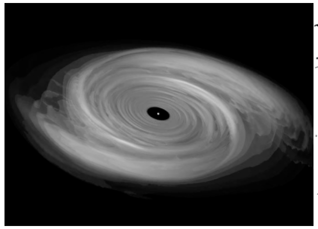
- Origine de la lave
- Structure du volcan
- Formation et évolution de ce volcan
- Origine profonde de la Réunion

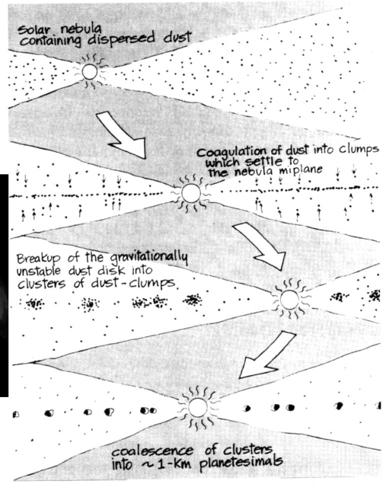

Deccan traps
(66 - 68 MA)
CARLSBERG RIDGE
SEYCHELLES
55-60
Ma
48
Ma
CHAGOS
64
Ma
MAURICE
1-7
Ma
35
Ma
RÉUNION
0-2
Ma
SWIR
30N
20
10
0
10
20
30S

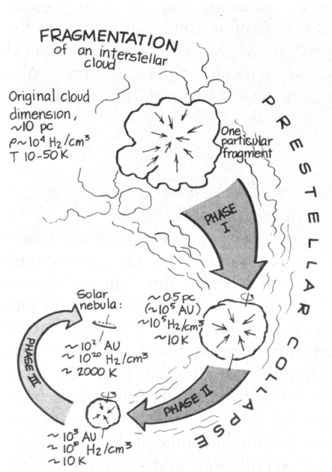

MANTLE CONVECTION SIMULATION
0.75
0.50
0.25
0.00
0.00 0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
0.00 0.10 0.20 0.30 0.40 0.45 0.50 0.55 0.60 0.70 0.80 0.90 1.10
Potential temperature




SUN
MERCURY
VENUS
EARTH
MARS
JUPITER
SATURN
URANUS
NEPTUNE
PLUTO
OTHER



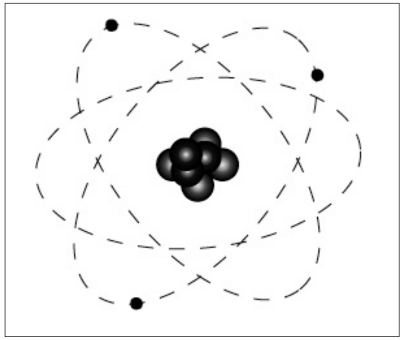




L'outil: la géochimie isotopique

1. Rappels: radioactivité

L’atome



Définitions:

$^{A}_{Z}X$ **A=Z+N**

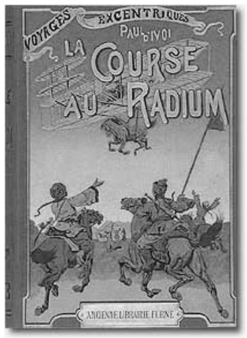
Ex: ^{20}Ne, ^{21}Ne, ^{22}Ne

Isotopes :
même nombre de protons,
mais nombre de neutrons différents

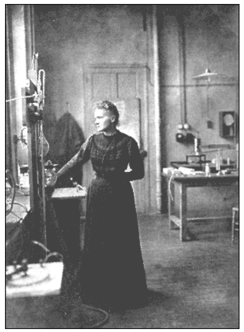
1896, **Henri Becquerel** range dans son armoire un sachet de sels d'uranium à coté d'une plaque photographique vierge.

Quelques jours plus tard, il développe la plaque. Il constate que la plaque photo est impressionnée sans avoir été exposée à la lumière.

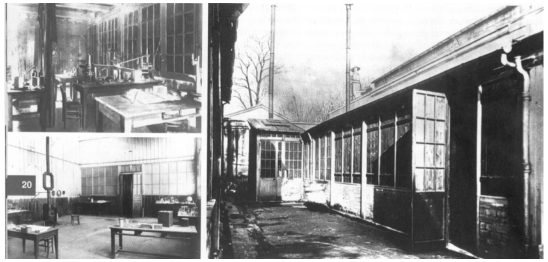
Après avoir renouvelé cette expérience, il en conclut que l'Uranium émet un rayonnement spontané qu'il nomme "rayons uraniques".



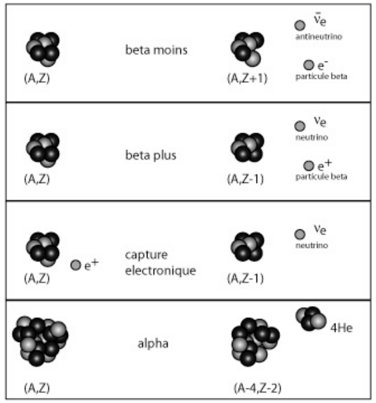
En 1898, **Marie Curie** découvre que la pechblende, un minerai d'uranium, émet davantage de rayonnements que l'uranium lui-même. Elle en déduit que ce minerai contient, en très petite quantité, un ou plusieurs éléments beaucoup plus actifs que l'uranium.



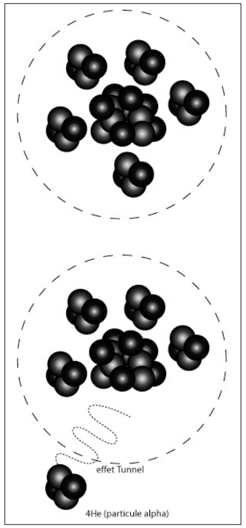
A l'aide de son mari Pierre Curie, et après deux ans d'effort, elle parvient à isoler deux nouveaux éléments: Le Polonium (baptisé ainsi en hommage à la patrie de Marie) et le Radium. A cette occasion, Marie Curie inventa le mot " **radioactivité** ".



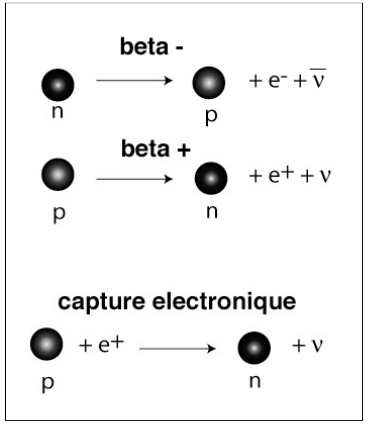
Les différentes radioactivités

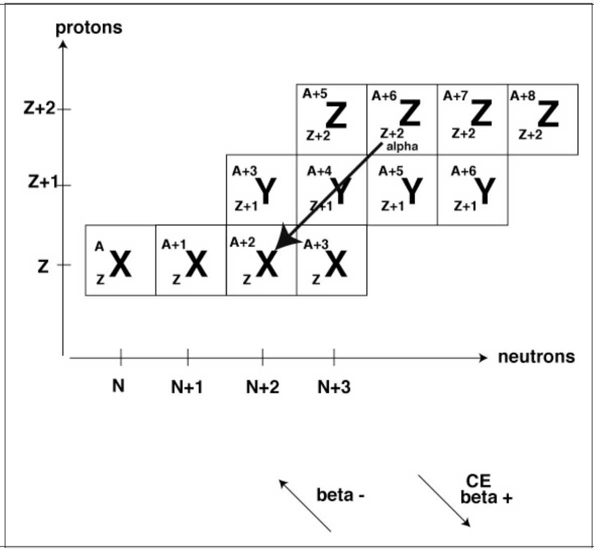


Alpha



beta

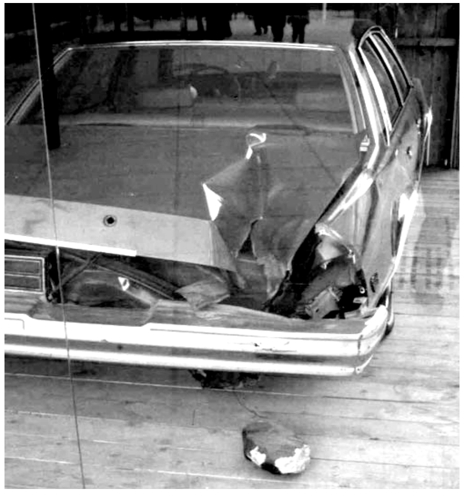




Définitions :

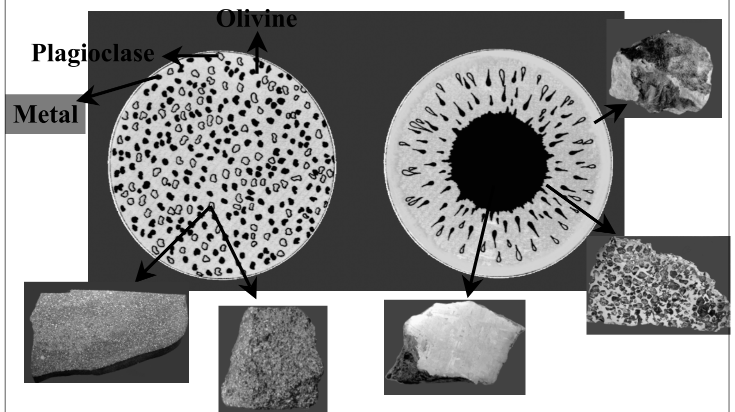
- Isotope radioactif
- Isotope radiogénique
- Isotope « stable »
- Rapport isotopique

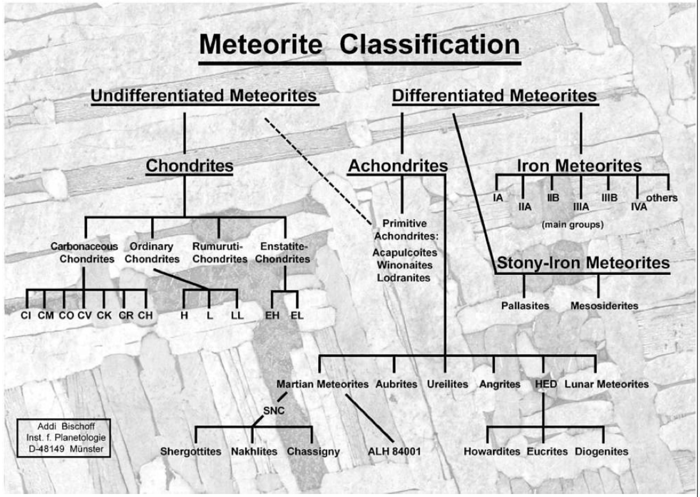
2. Météorites

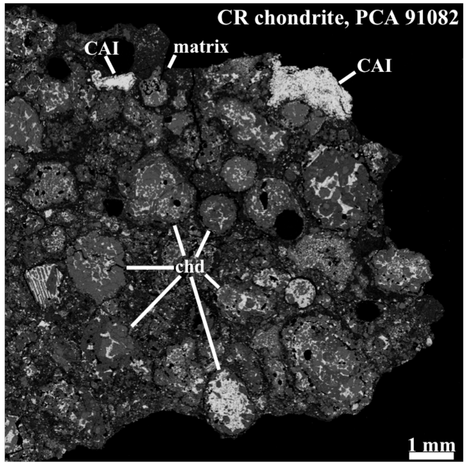


Chondrites

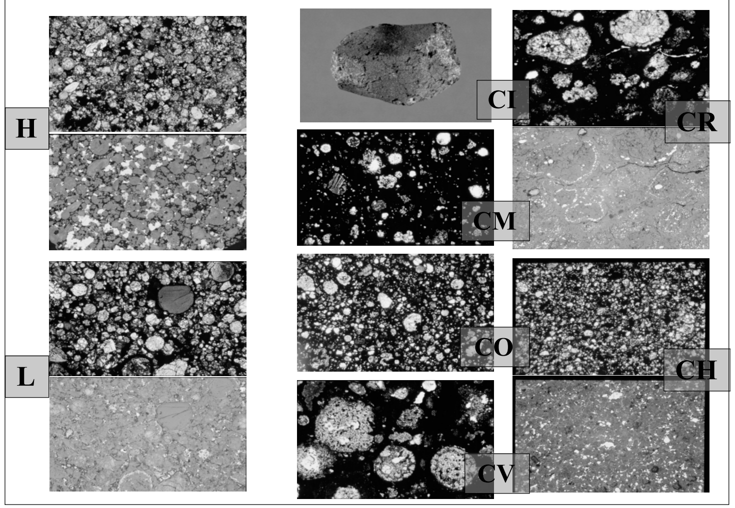
Meteorites différenciées







Chondrites ordinaires   Chondrites carbonées

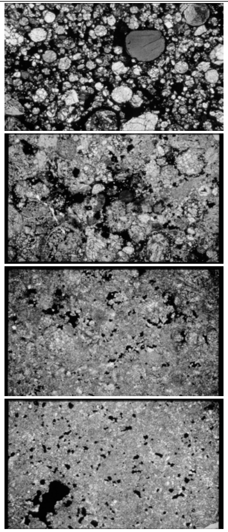


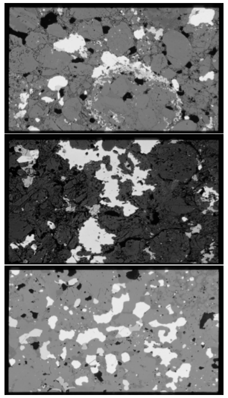
PETROGRAPHIC CHARACTERISTICS OF THE CHONDRITE GROUPS

	Chondrule abundance[1] (vol%)	Matrix abundance (vol%)	Refractory inclusion abundance[2] (vol%)	Metal abundance[3] (vol%)	Chondrule mean diameter (mm)
CI	<<1	>99	<<1	0	-
CM	20	70	5	0.1	0.3
CR	50-60	30-50	0.5	5-8	0.7
CO	48	34	13	1-5	0.15
CV	45	40	10	0-5	1.0
CK	15	75	4	<0.01	0.7
CH	?70	5	0.1	20	0.02
CB	3-10??	?	?	40?	
H	60-80	10-15	0.1-1?	10	0.3
L	60-80	10-15	0.1-1?	5	0.7
LL	60-80	10-15	0.1-1?	2	0.9
EH	60-80	<2-15	0.1-1?	8	0.2
EL	60-80	<2-15	0.1-1?	15	0.6
R	>40	36	0	0.1	0.4
K	27	73[4]	<0.1	0[4]	0.6

[1]Chondrule abundance includes mineral fragments.
[2]Refractory inclusion abundance includes CAI + AOI.
[3]Metal abundance is for metal outside chondrules.
[4]Matrix abundance includes metal.
Abundance sums of les than 100 vol% are because of significant sulphide component in most cases.
Sources: Scott et al. (1996) except for CO data (McSween, 1977a), K (Kakangari) chondrite data (Weisberg et al., 1996), and "CH" (ALH85085) chondrule mean diameter from Grossman e t al. (1988a) and Scott (1988).

Transformations métamorphiques dans les chondrites





Non-chondrites

Primitive

single asteroid? Acapulcoites
Lodranites
Winonaites
single asteroid? IAB silicate inclusions
IIICD silicate inclusions

Differentiated

Achondrites

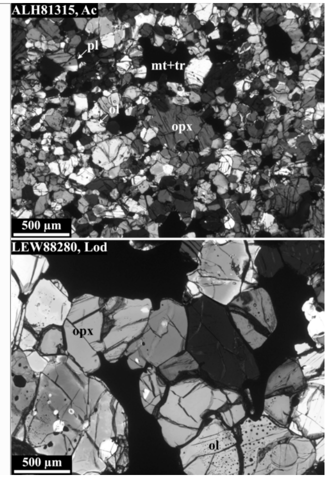
Angrites
Aubrites
Brachinites
Ureilites
HED
single asteroid (Vesta?) Howardites
Eucrites
Diogenites
Martian (SNC)
Shergottites
Mars Nakhlites
Chassignites
Orthopyroxenites
Moon Lunar

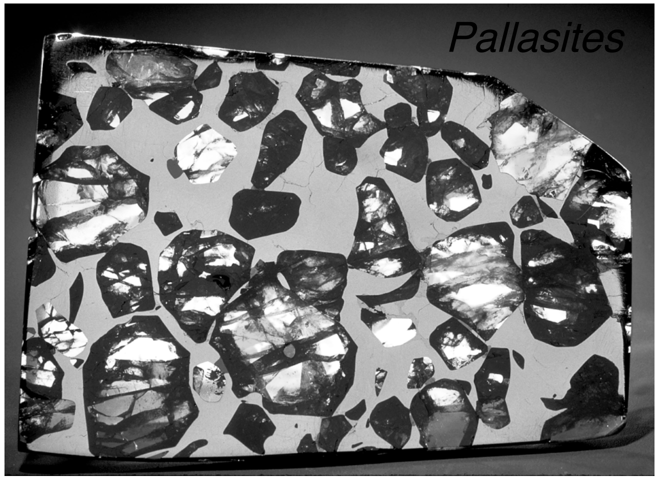
Stony-irons

Mesosiderites
Pallasites
main group
Eagle Station
pyroxene

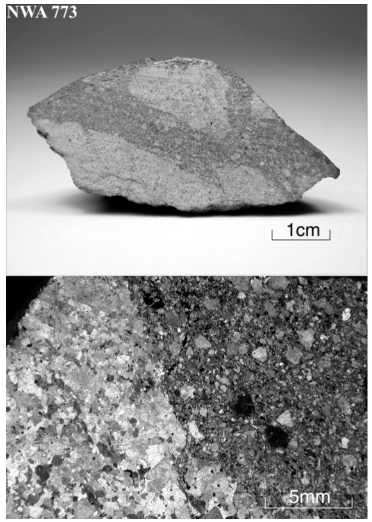
Irons

IAB*
IC
IIAB
IIC
IID
IIE*
IIIAB
IIICD*
IIIE
IIIF
IVA*
IVB

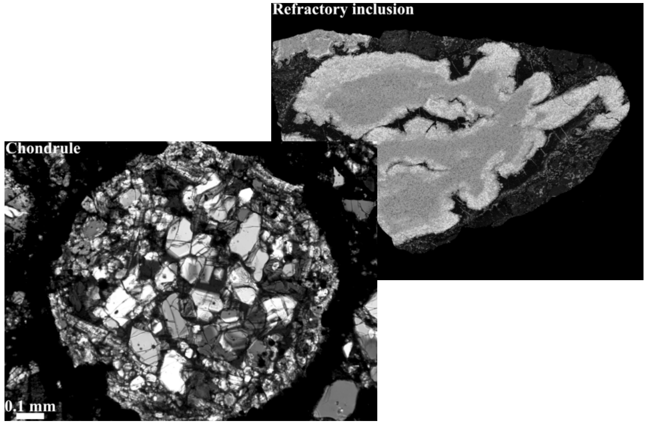




Meteorites Lunaires



CAI et chondres

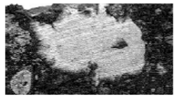


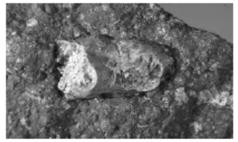
Calcium-Aluminum Inclusions

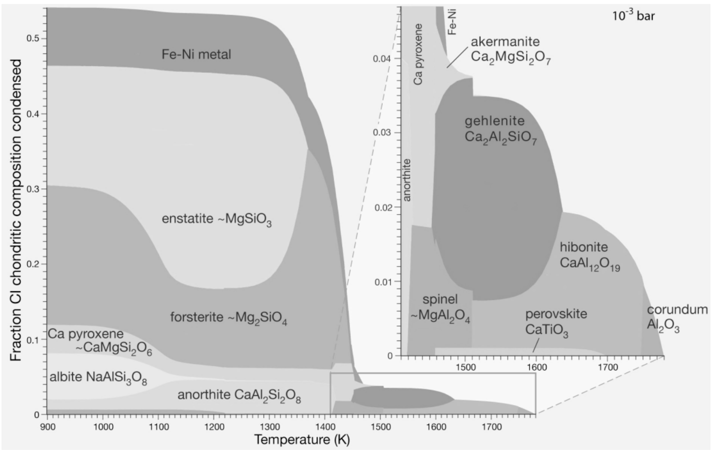
CAI- (also called refractory inclusions) are important because they are the first solar system solids!

Evidence:

- Mineralogy (condensation diagram)
- Age (more later)
- Nucleosynthetic anomalies







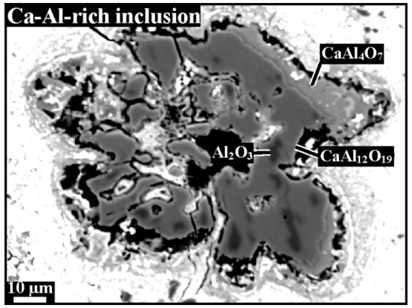
CAI

Mineralogy: Most CAIs are made of oxide and silicate minerals rich in Ca, Al, Ti, and Mg. These minerals tend to be rich in "refractory" trace elements as well.

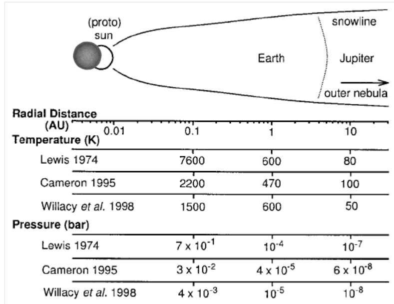
Mineral Name	Formula	
Corundum	Al_2O_3	
Perovskite	$CaTiO_3$	
Melilite (gehlenite)	$Ca_2Al_2SiO_7$	
Melilite (akermanite)	$Ca_2MgSi_2O_7$	
Spinel	$MgAl_2O_4$	
Hibonite	$CaAl_{12}O_{19}$	
Pyroxene (var. fassaite)	$CaMgSi_2O_6$ with abundant Al, Ti	
Metal Alloy	Fe + Platinum group metals, W, Re	
Anorthite	$CaAl_2Si_2O_8$	
grossite	$CaAl_4O_7$	
No glass or Fe-Mg silicates		

Calcium-aluminum-rich inclusions (CAIs)

- temperatures de condensation > 1400 K à une pression totale de 10^{-3} bar



Condensation dans les nébuleuses protostellaires



3. Ages des CAIs : méthodes Pb-Pb et U-Pb

4. Radioactivités de courte période et anomalies isotopiques