CK AND CV CARBONACEOUS CHONDRITES REFLECTANCE PROPERTIES COMPARED WITH THE Cg- ASTEROID CLASS

V Reunión de Ciencias Planetarias Y Exploración del Sistema Solar (CPESS5)

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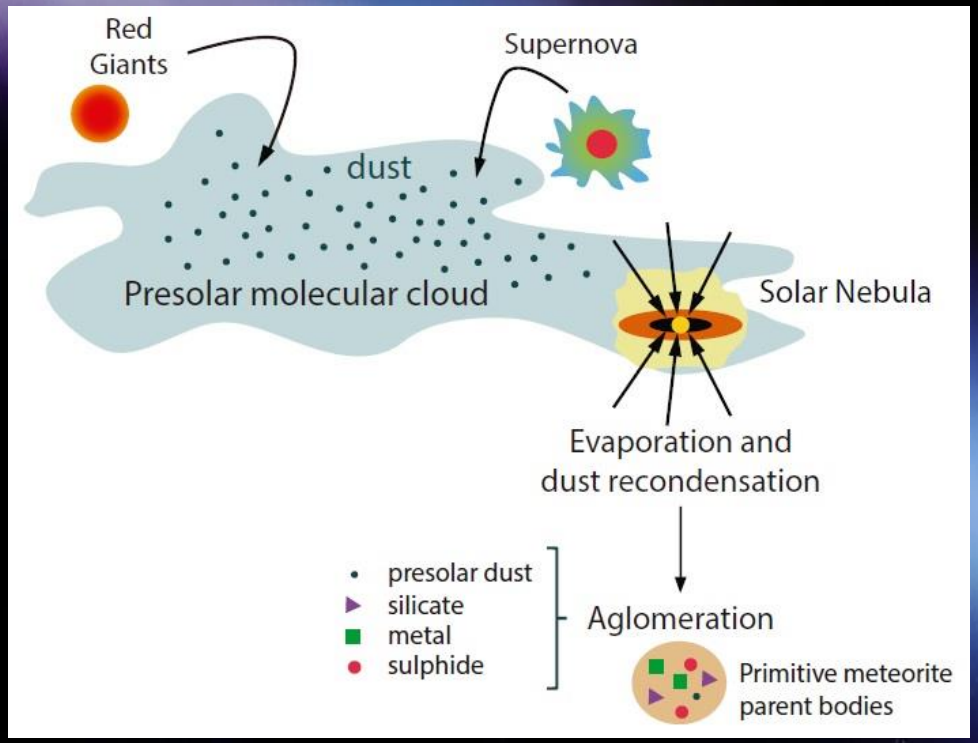
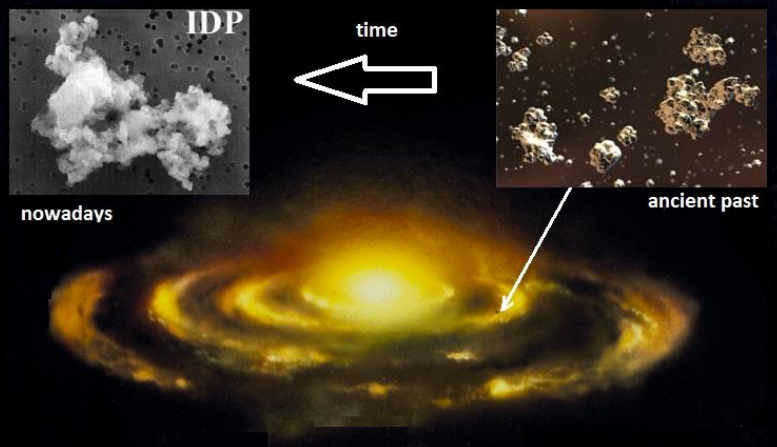
SOLAR SYSTEM FORMATION OVERVIEW

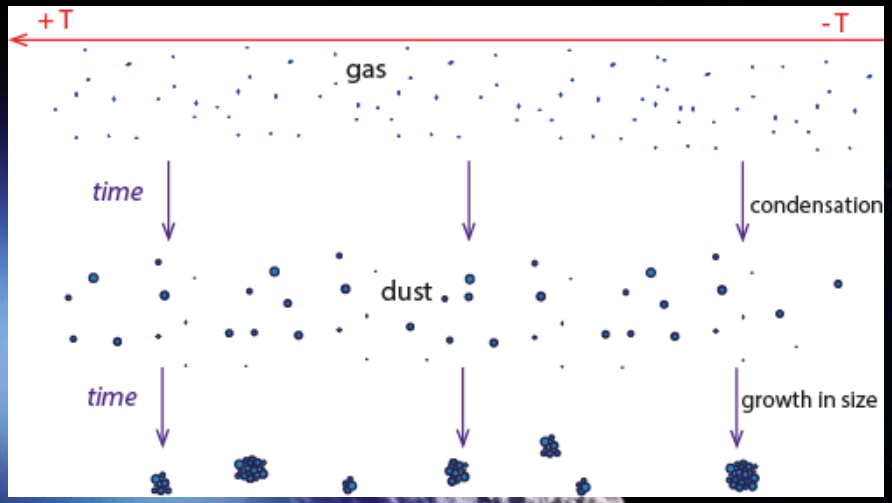




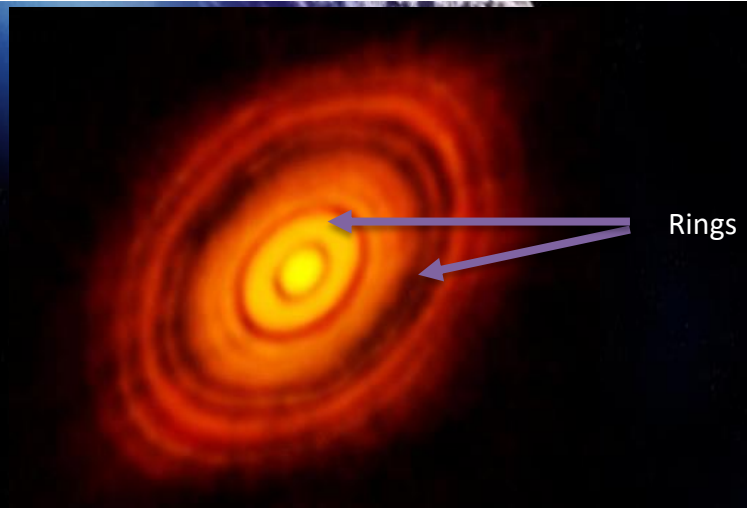
- Star formation takes place in cold, dense gas environments: molecular clouds
- The Sun and the protoplanetary disc inherited stellar products of nearby stars
- After collapse, and T-Tauri clean-up of gas the temperature decreased below 2000 K, allowing minerals to condense (Cameron, 1978)
- Stellar products were incorporated in the primeval rock-building aggregates
- Fragments concentrated in the mid-plane and formed fragile planetesimals Blum et al. (2006)

DECIPHERING SIZE-SORTING MECHANISMS IN THE PROTOPLANETARY DISC

- Chondrites are mixtures of different components: chondrules, metal and sulphide grains, refractory inclusions, etc…
- Chondrite components were sorted by dynamic processes.

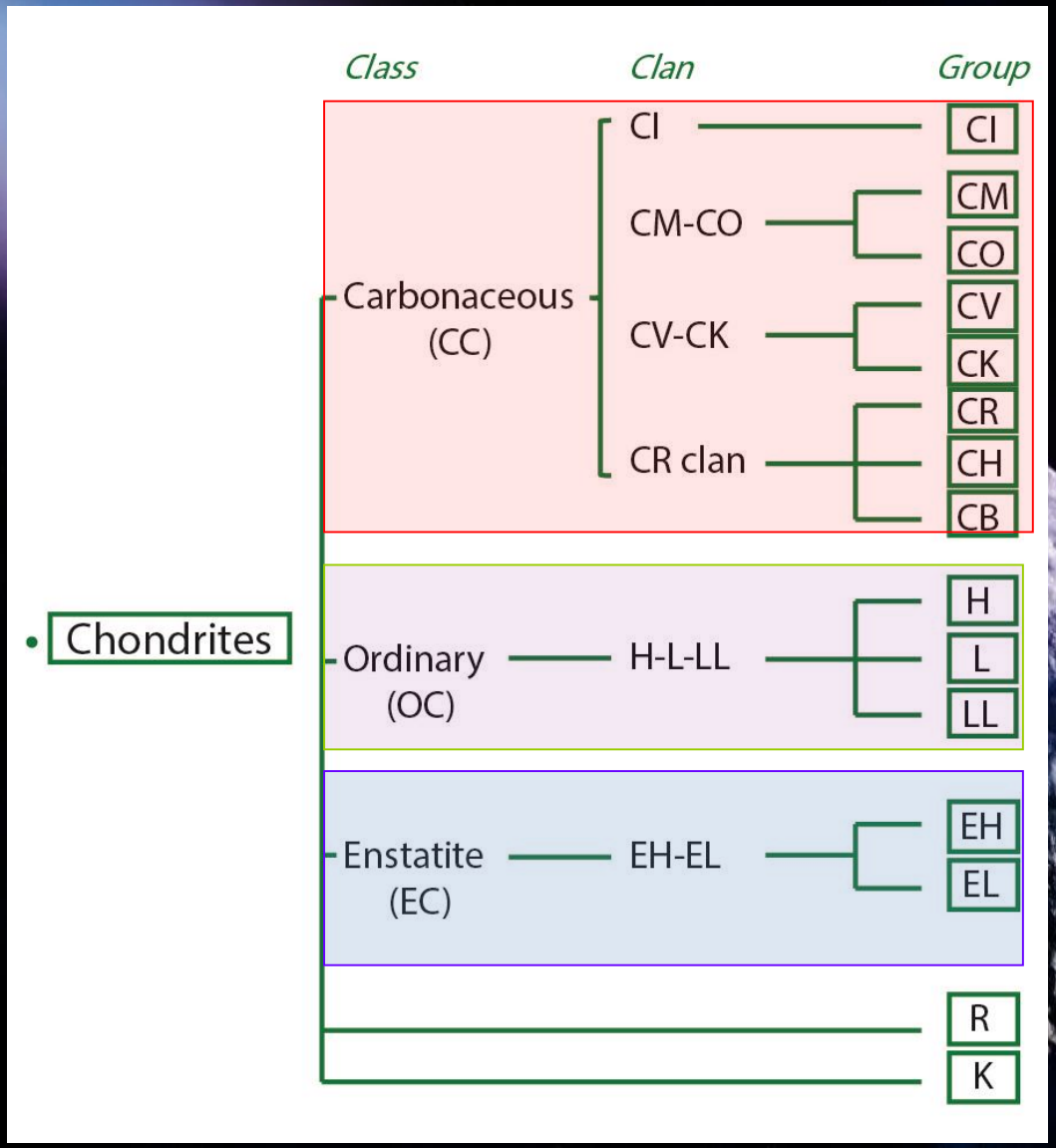


- Chondrites are characterized by heterogeneous compositions (Anders & Grevesse, 1989) and petrologic characteristics.
- Chondrite groups are coming from different reservoirs (rings?)



Protoplanetary disc surrounding the young star HL Tauri. Credit: ALMA (ESO/NAOJ/NRAO).

CHONDRITE GROUPS VS. DISTINCTIVE ORIGIN

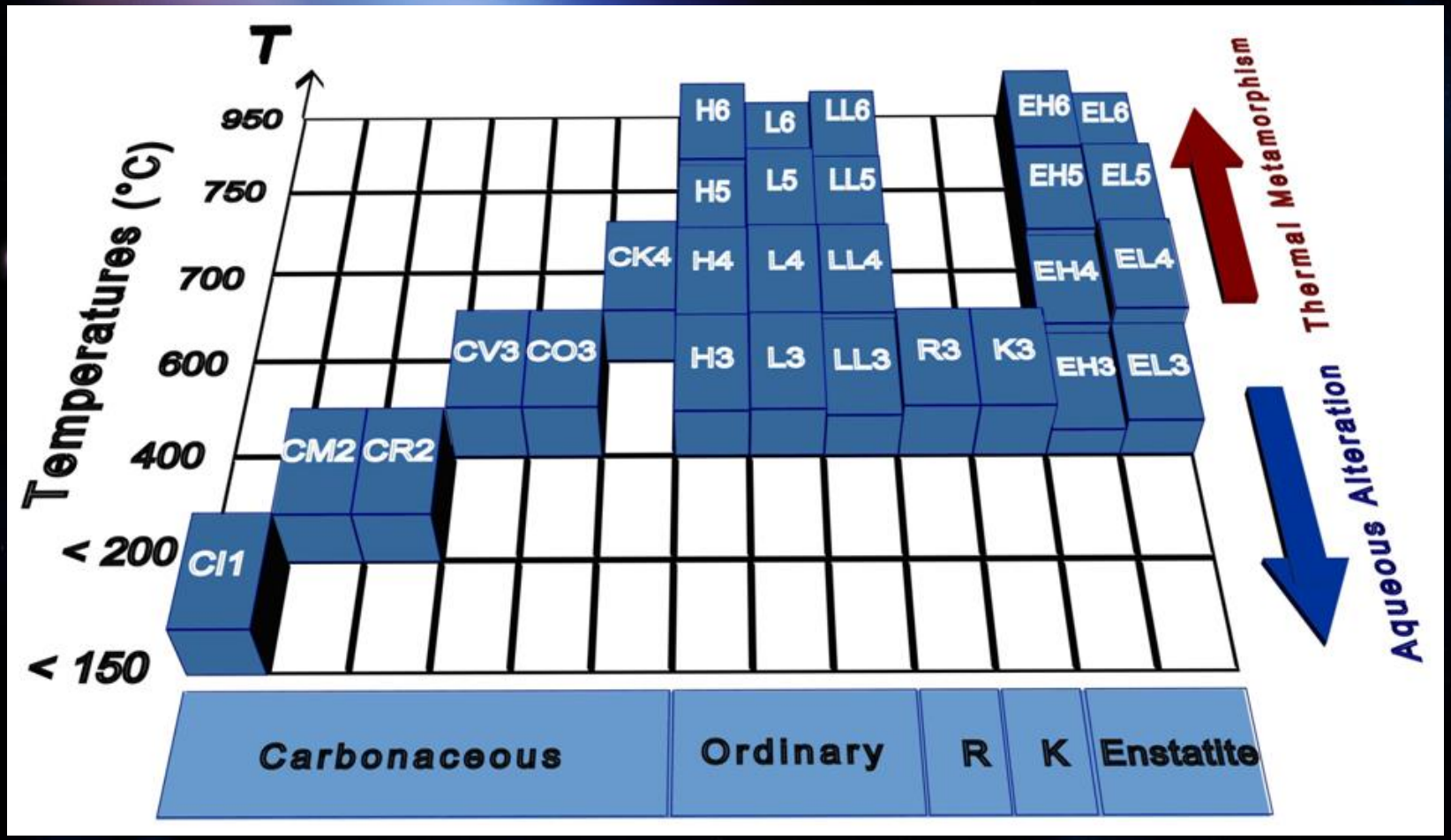


External regions

Inner regions

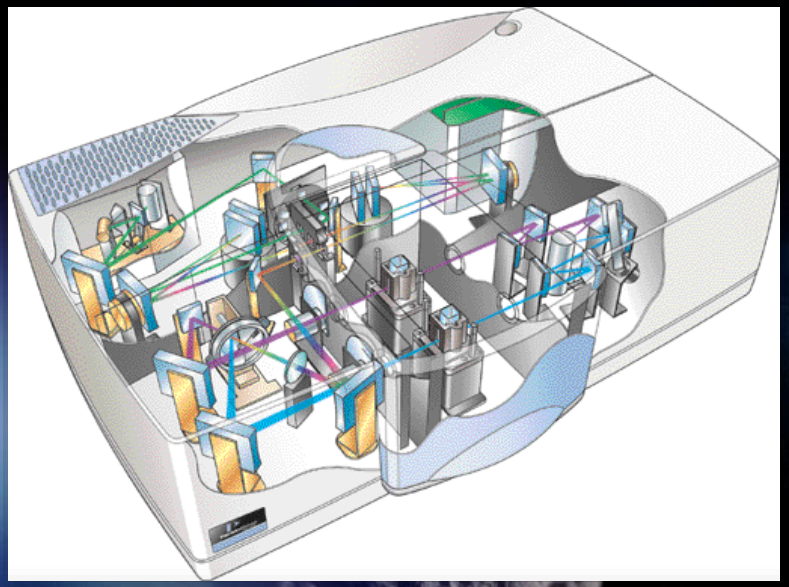
SECONDARY ALTERATION PROCESSES AND ORIGIN OF WATER

- Two main processes altered chemically the undifferentiated bodies
- Aqueous alteration produced by the release of primordial water
- Thermal metamorphism (radioactive and collisional)

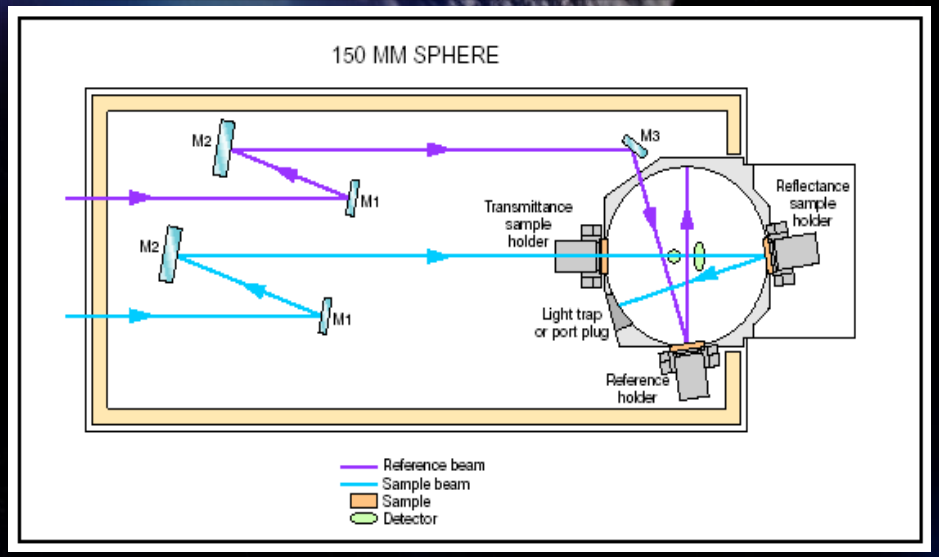


UV-vis-NIR SPECTROMETER

- The reflectance spectra are taken in the UPC Center for Research in Nano Engineering at Barcelona
- Model UV-3600 (Shimadzu)
- Spectral range: λ: 185-3,300 nm
- Deuterium and wolfram lamps as light sources in selected windows
- Reflectance measurements, performed at 8º of phase angle



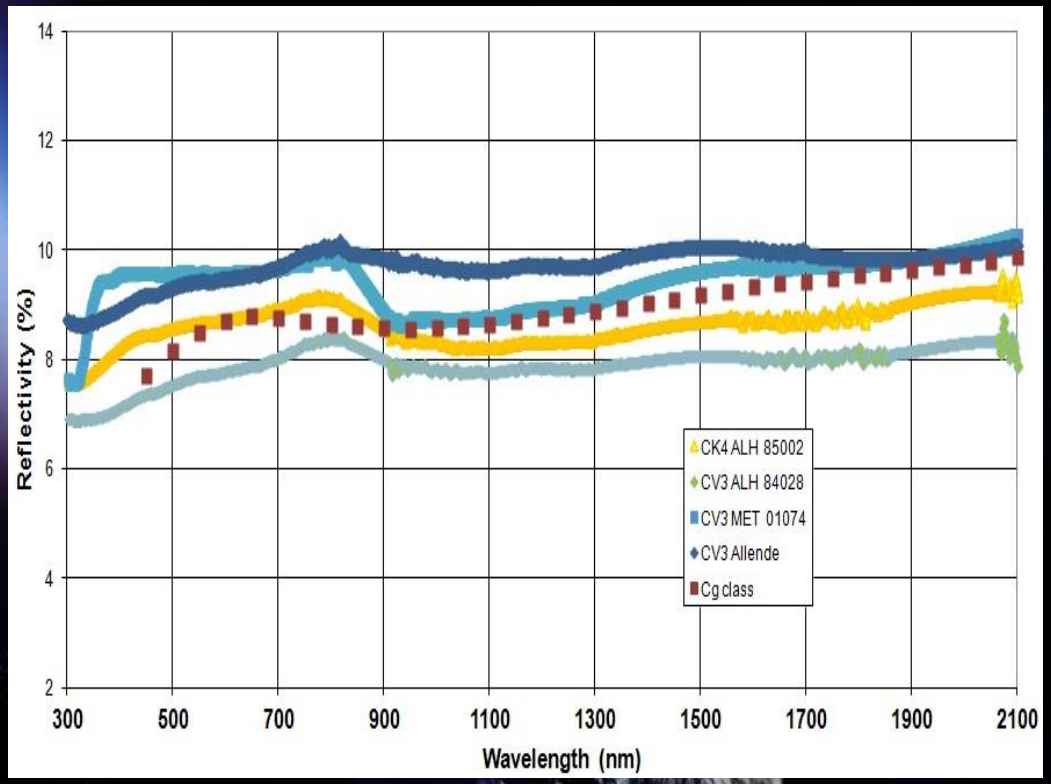
- The spectrometer consists of an integrating sphere with two separated beams, one going to the sample holder and the second one to the reference holder (BaS)
  - Reflectance spectra with a scattering lower of 1σ are obtained



Reflectante Spectra of CK-CV chondrites and asteroids spectra comparison

- We are starting to produce CV and CK reflectance spectra with our spectrometer
- Oxidized and reduced members have significant spectral differences due to distinctive mineralogy (Cloutis et al., 2012)
- The reduced CV subgroup may be the precursor to the CV oxidized one
- Magnetite modal abundance is variable, and when present, it produces a broad absorption band in the 1 micrometer region

- Fayalite absorption bands in MET 01074 is consequence of fayalite formation under thermal metamorphism (Trigo et al, 2000 LPSC).



CK chondrites in the ultraviolet to near-infrared range (or UV-NIR, 0.3 to 2.6 µm)

Mean CK petrologic types spectra:

- Mean CK4 includes CK4/5 and is the mean of 14 spectra of 5 different meteorites.
- Mean CK5 includes CK4/5 and CK5/6 and is the mean of 11 spectra of 6 different meteorites
- Mean CK6 includes CK5/6 and is the mean of 11 spectra of 2 different meteorites
- Mean CK5 is the mean of 11 spectra of 6 different meteorites.
- Mean CK6 is the mean of 11 spectra of 2 different meteorites.

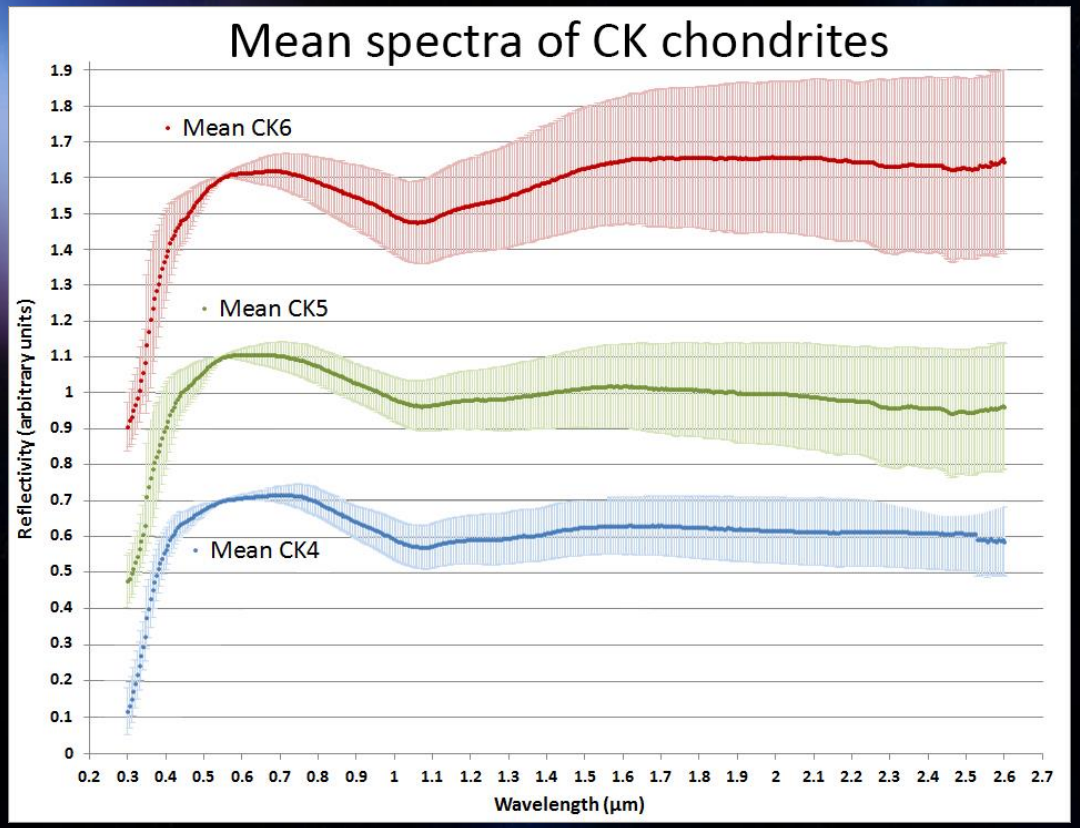


Image showing the progression between the different degrees of metamorphism on CK carbonaceous chondrites, using RELAB spectra.

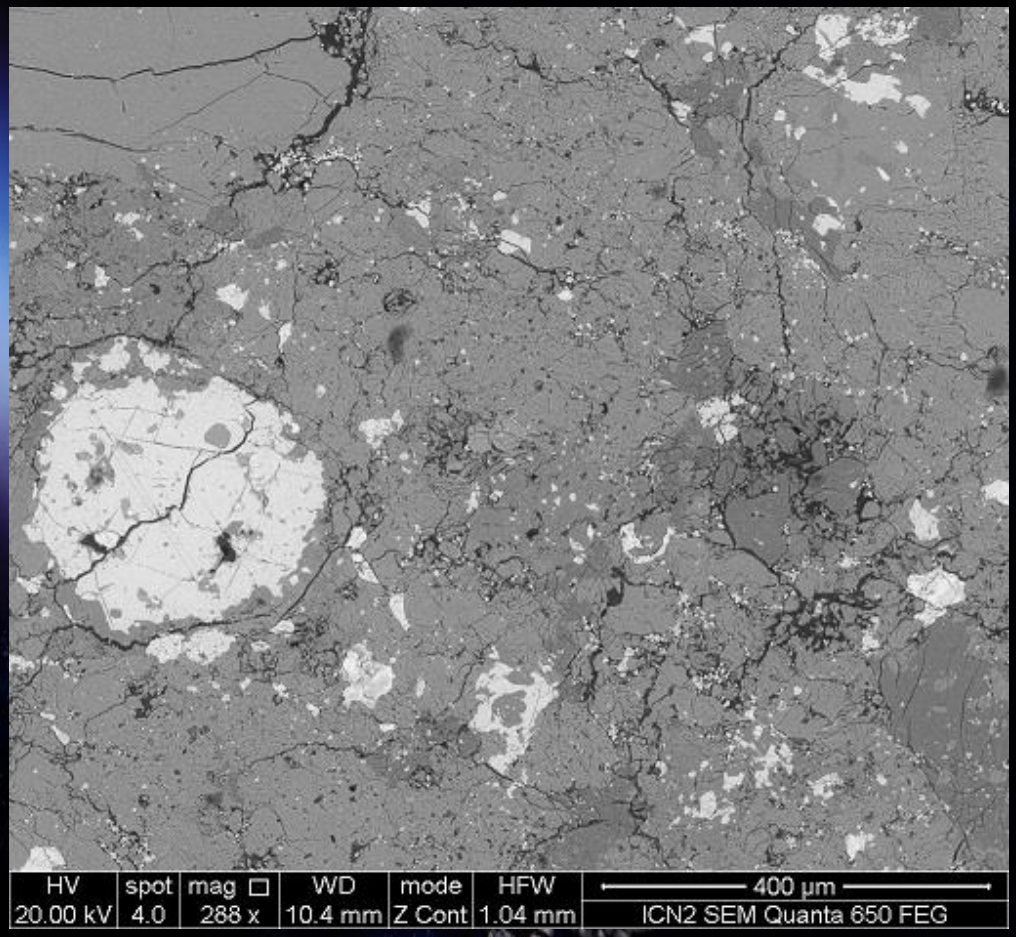
Different degrees of metamorphism in CKs

- CKs are highly oxidized meteorites, dominated by olivine, with a matrix similar in composition to CVs and COs, but being more metamorphosed than those groups.

- The CK chondrites are extremely oxidized; this is attributed to aqueous alteration on the parent asteroid.

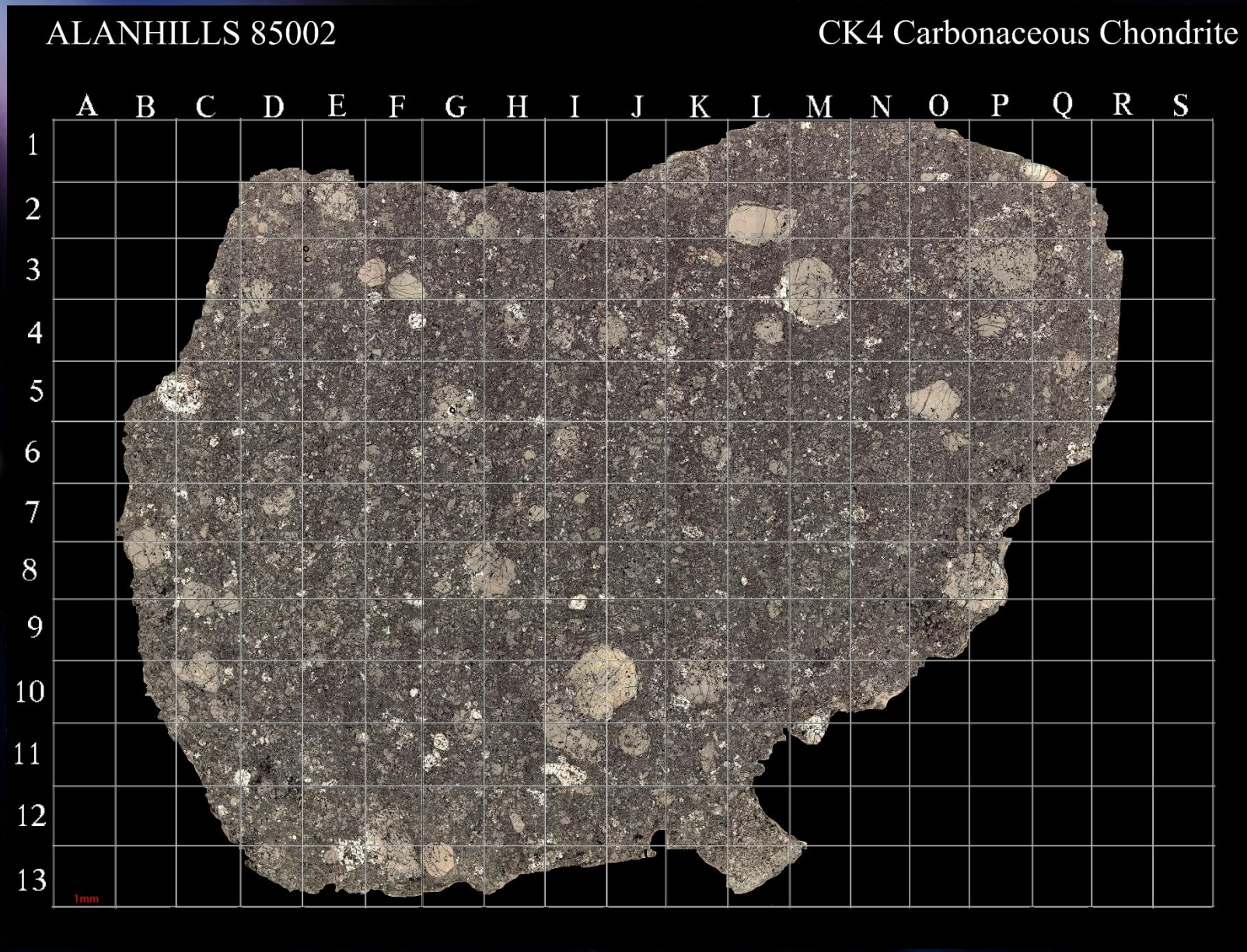
- Some CKs have experienced significant collisional processing, so they exhibit shock-transformed minerals

- The above cited processes have produced serious fractionations in the bulk elemental composition of CKs. (Rubin and Wasson, 2012)



Fractured chondrules and comminuted texture of ALH 85002

CK CARBONACEOUS CHONDRITES



Reflected light mosaic of the CK carbonaceous chondrite ALH 85002.

IMPLICATIONS FOR SAMPLE-RETURN

Variability of UV-NIR reflectance spectra of carbonaceous chondrites:

- Understanding the degree of shock in regions to recover samples in C-Type asteroids
- To develop new skills to interpret shock-induced metamorphism
- To get petrologic clues due to different burial depth (self gravity of parent asteroid)
- To decipher the possible effects of aqueous alteration
- Increase our capability to select regions for sample return: Hayabusa 2 and OSIRIS-REx

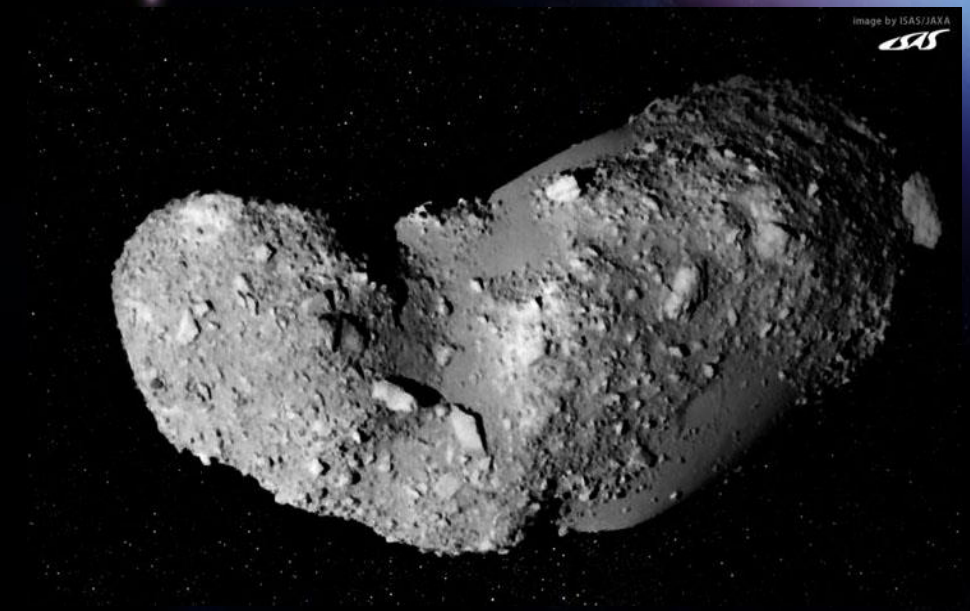
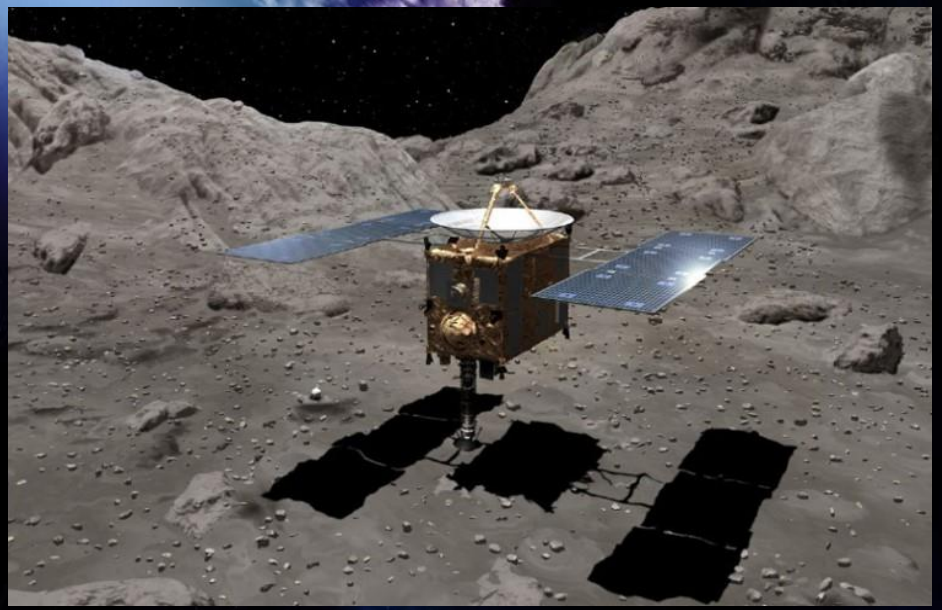


Image from the Itokawa asteroid (ISAS/JAXA)



Hayabusa at the surface of Itokawa (JAXA, left).

Results

- CK chondrites are gradationally metamorphosed CV chondrites that could explain the natural variation between Cg-type asteroids.
- In general, CKs are highly oxidized meteorites and more shocked comparatively with CVs, showing a higher degree of thermal metamorphism.
- We also found some consistency with Cg-type asteroids between 0.5 and 0.8 μm. Indeed, a mixture of K and Cg-type asteroids, after some processing, could be considered a good match for CK meteorites.
- The CKs have been tentatively related to asteroids before, but no definitive correlation exists yet.
- A deeper insight on the effect of impact darkening in carbonaceous chondrites could be of particular interest in the context of the Hayabusa 2 mission, which will return samples from the rare Cg-type asteroid (162173) 1999 JU3.