

# Organic matter of Ultracarbonaceous Antarctic Micrometeorites (UCAMMs). Comparison with Rosetta/COSIMA analyses

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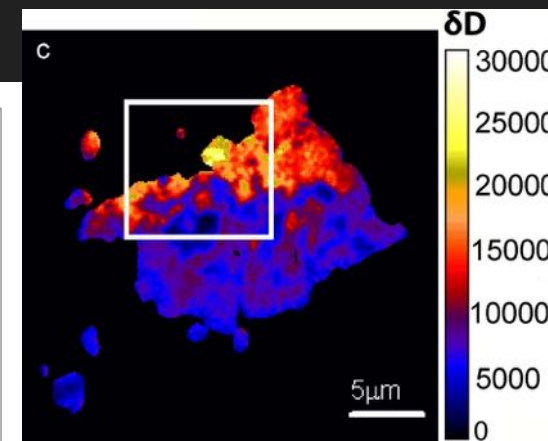
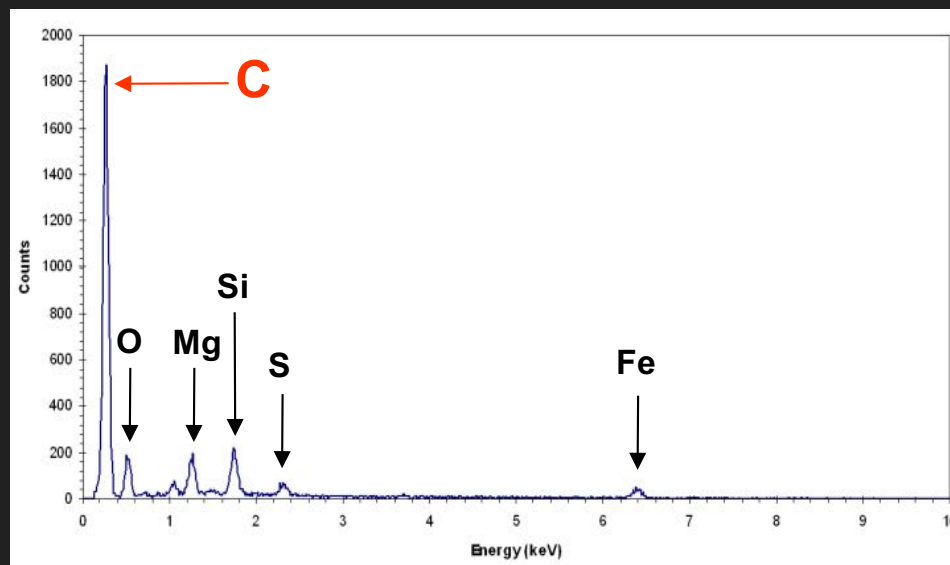
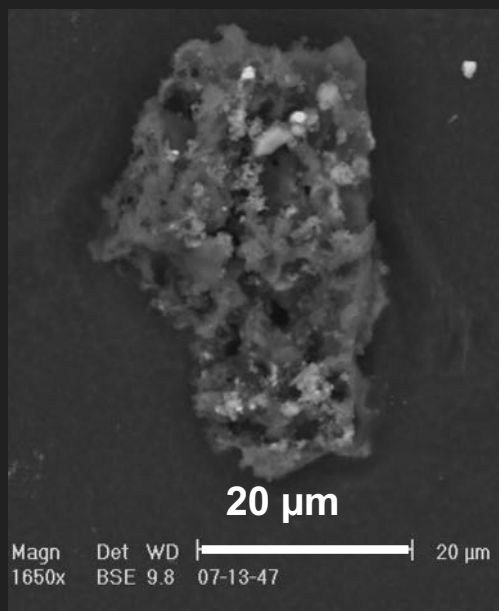
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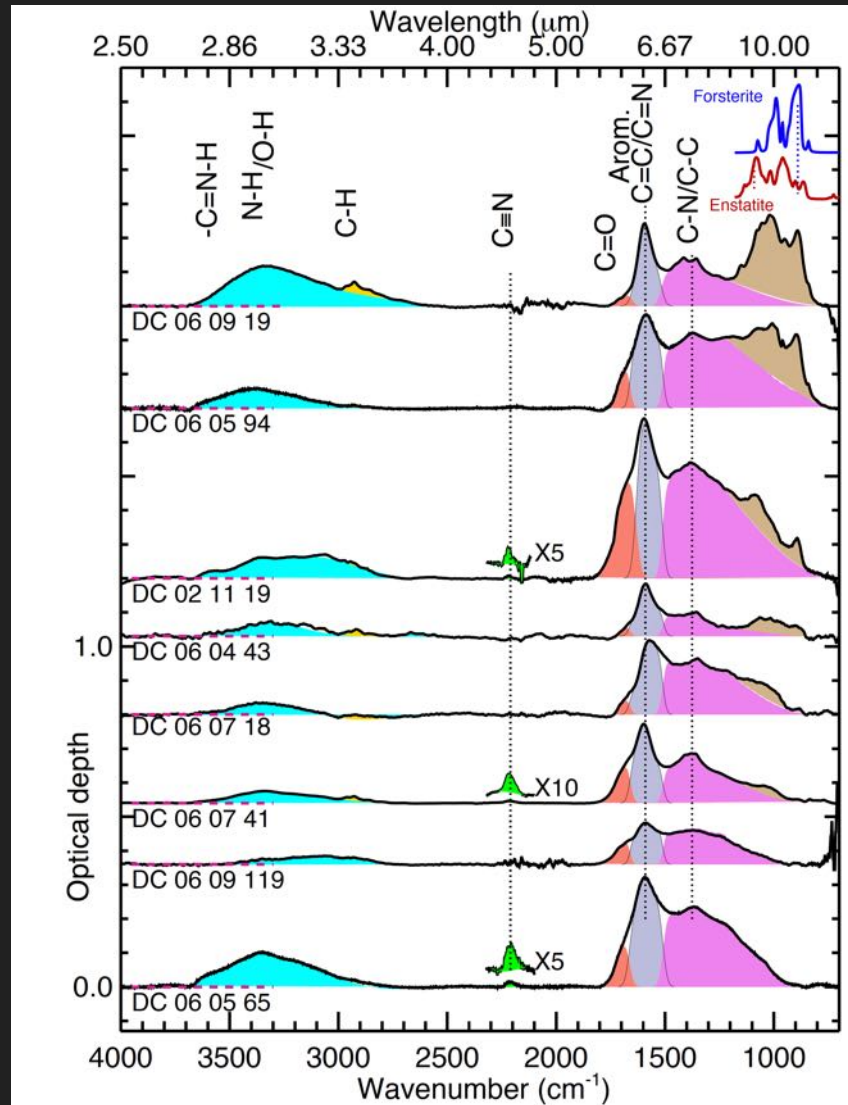
# Ultracarbonaceous Antarctic Micrometeorites (UCAMMs)



Nakamura+2005,  
Duprat+2010, Dobrica+  
2011, 2012, Dartois+2013,  
2018

- Found in J and F collections (and IDPs)
- Particles dominated by OM + minor mineral component
- Extreme D/H ratios (low T formation – outer regions)

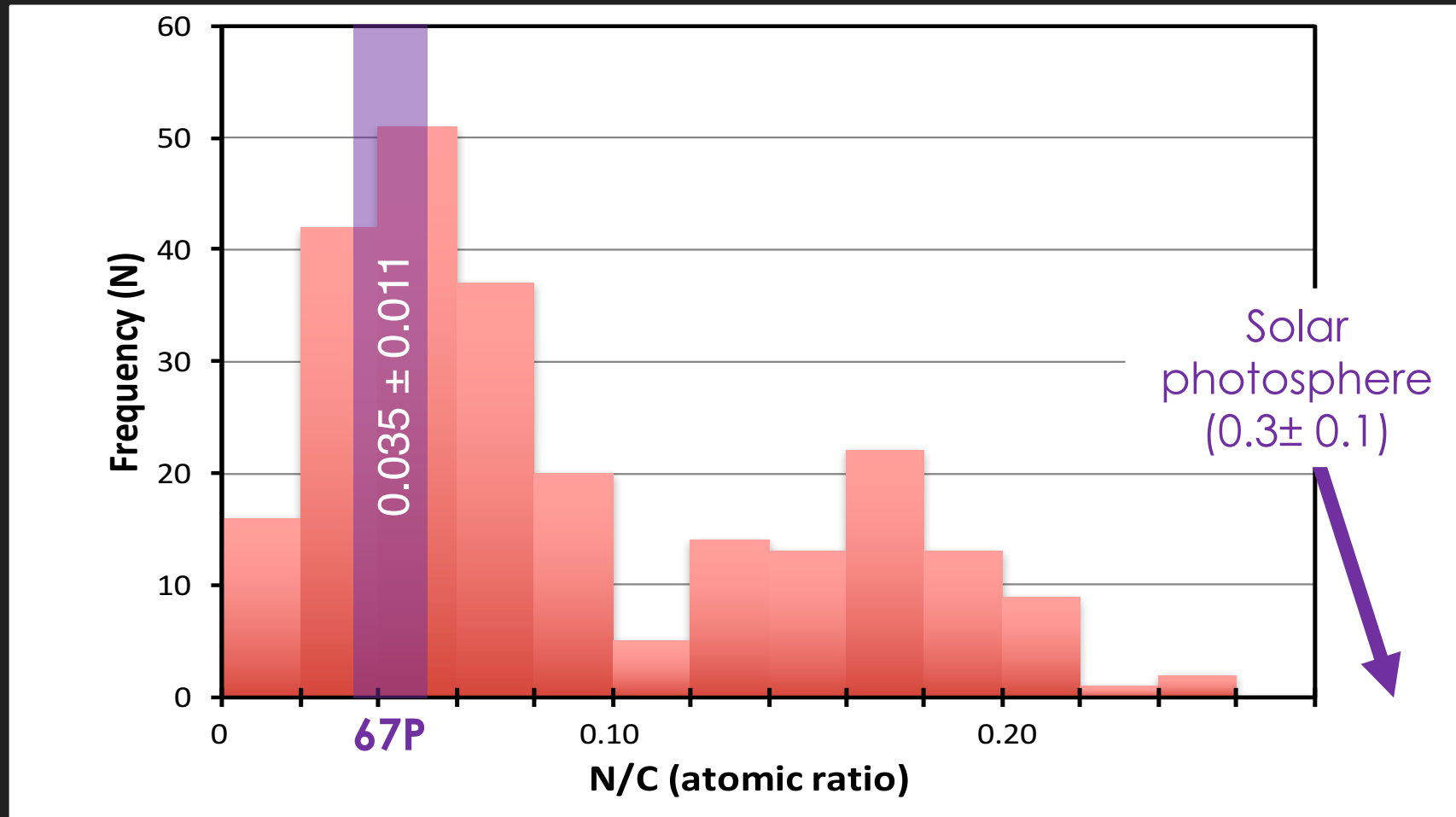
# FTIR spectroscopy of UCAMMs



Dartois+2018

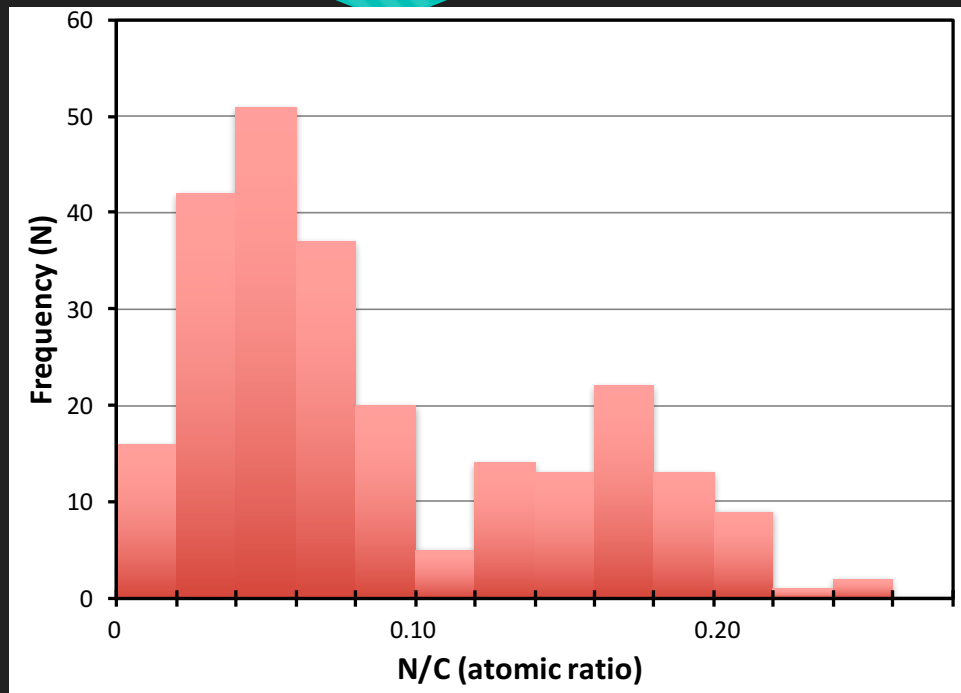
- Polyaromatic organic matter (OM)
- Bulk N-rich OM, variable mineral contents

# N/C atomic ratios of UCAMMs

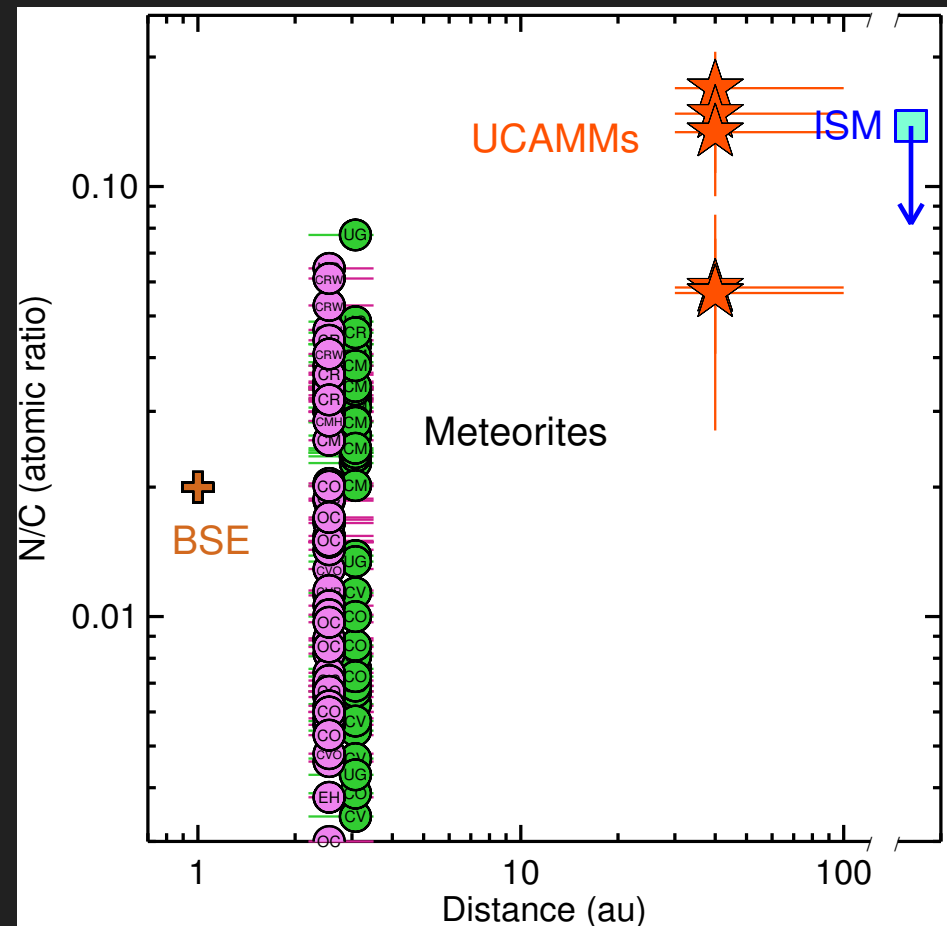


- Individual random point analyses: atomic N/C from 0.05 to ~ 0.2
- Diverse proportions of the 3 organic phases in UCAMMs

# N/C ratios in UCAMMs



Engrand+LPSC2018

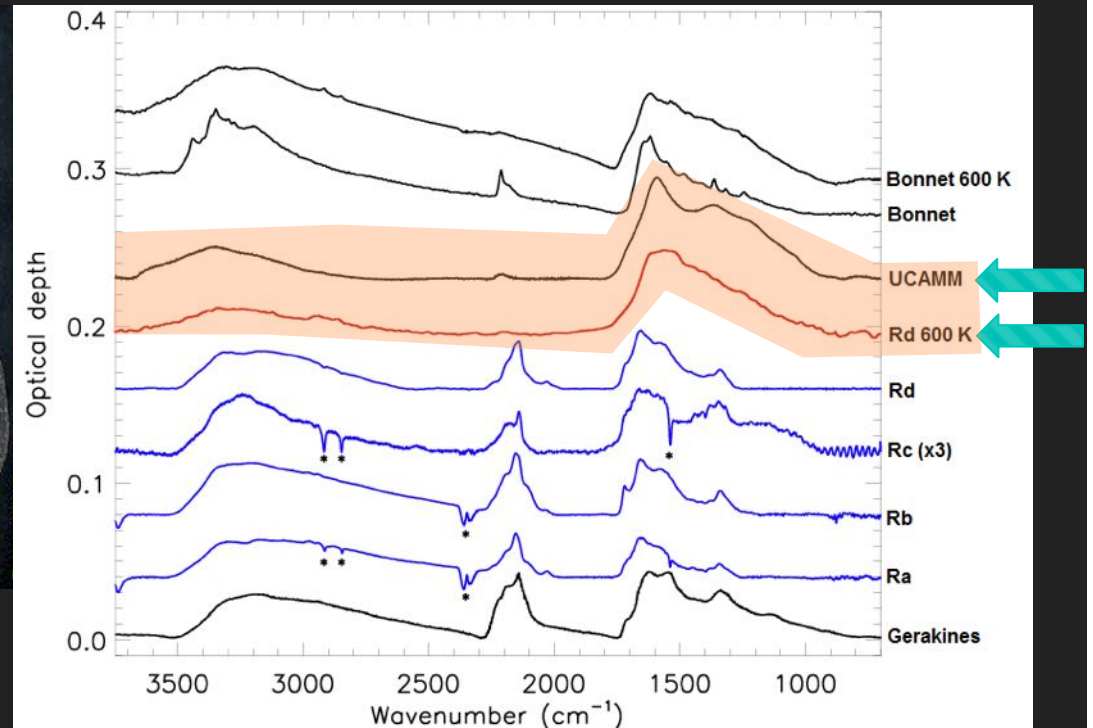
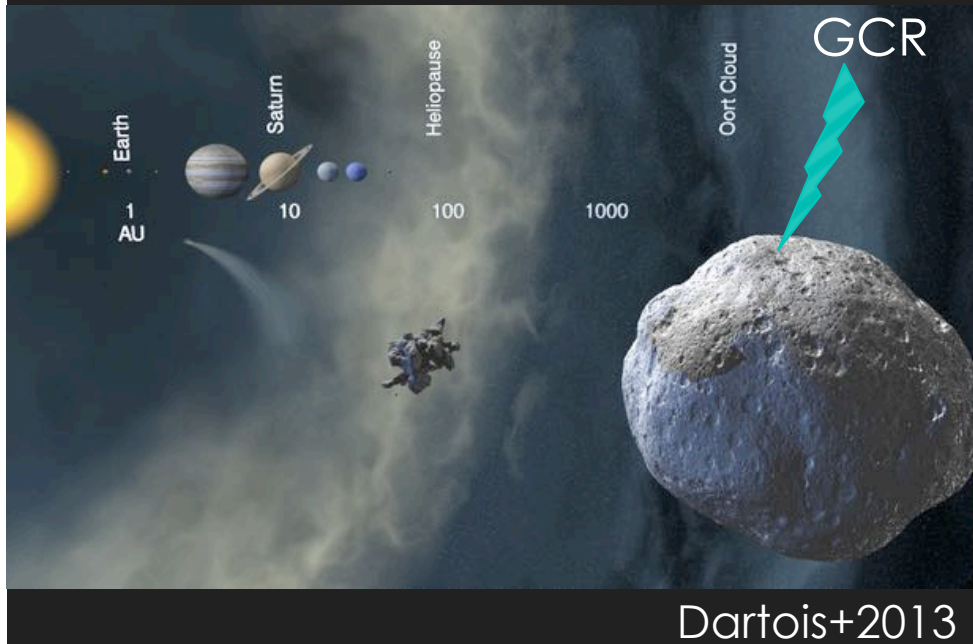


Dartois+2018

- Some UCAMMs N/C compatible with meteorites
- Some N/C UCAMMs > N/C ISM
- Local process to enrich UCAMMs in Nitrogen

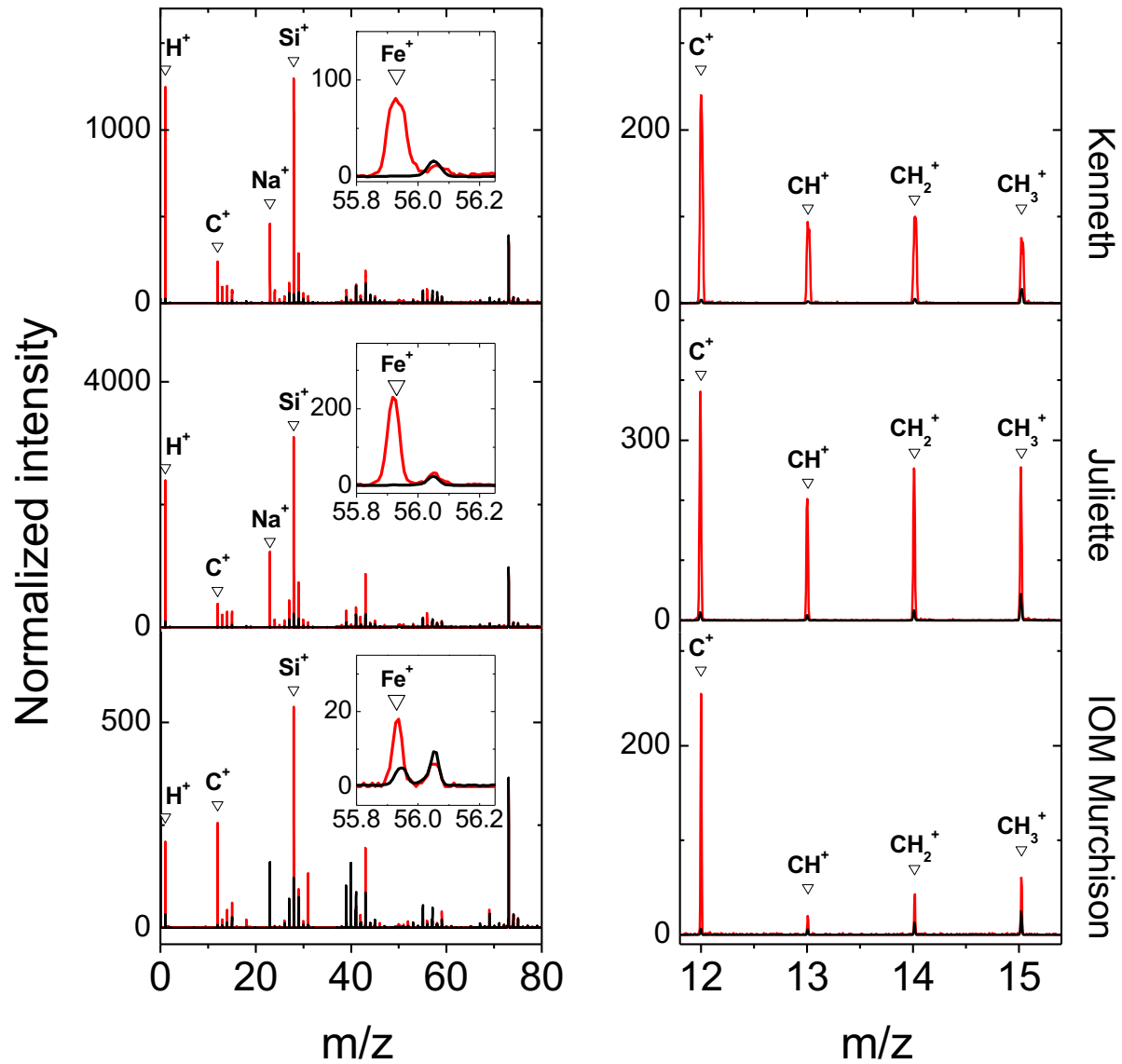


# Formation of N-rich OM by irradiation?



- UCAMMs : material from beyond the nitrogen snow-line
- Formation of N-rich OM by GCR irradiation at surface of a Kuiper belt or Oort cloud icy objet ?
- Demonstration of feasibility by ion irradiation of  $\text{N}_2\text{-CH}_4$  ices (Augé et al. 2016)

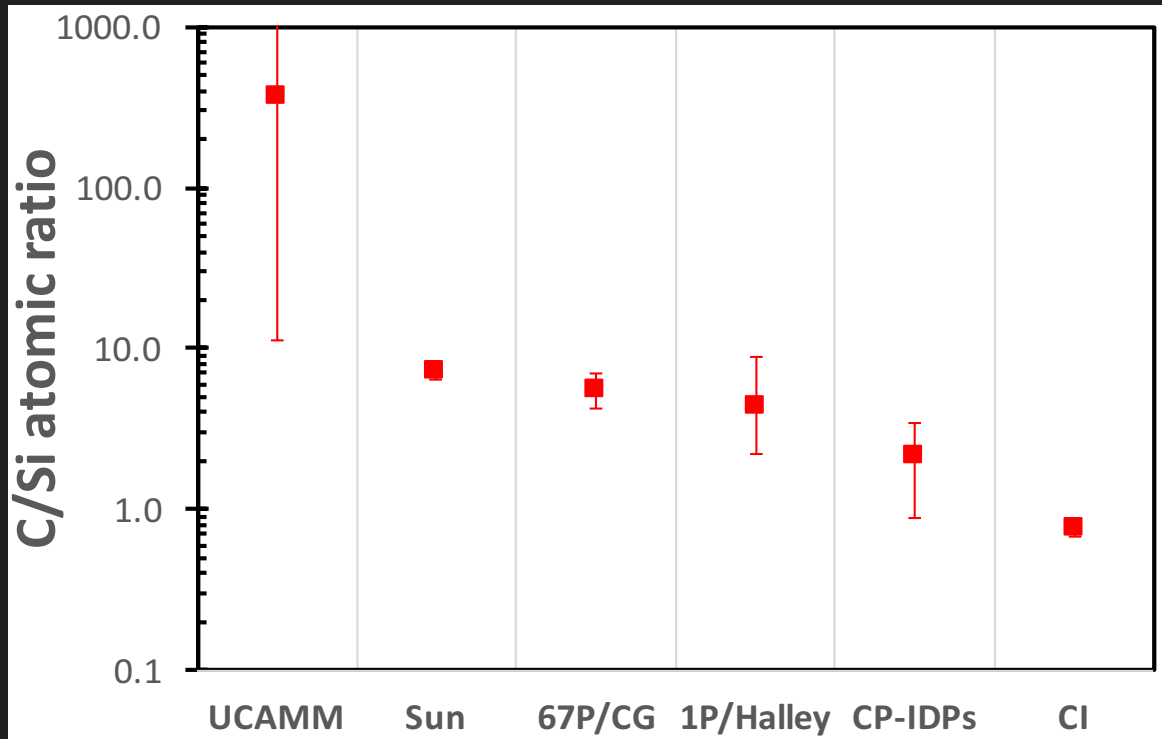
# 67P dust : Cometary « Insoluble Organic Matter »



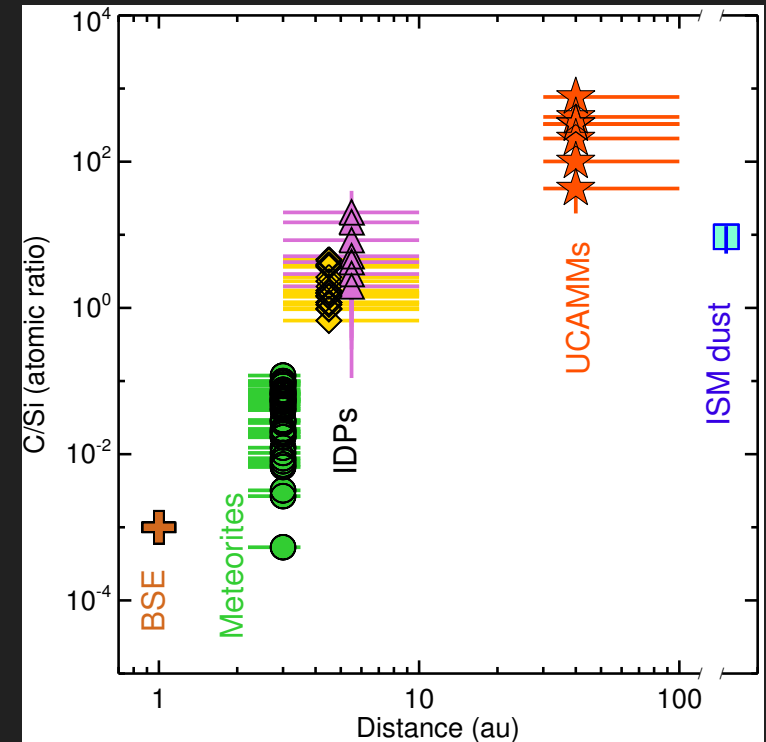
Fray+ Nature 2016

- Best analogues: IOM extracted from CCs
  - ⇒ high-molecular-weight organic matter in the particles of 67P
- CH<sub>x</sub><sup>+</sup> / C<sup>+</sup> ratio higher in 67P than in IOM samples
  - ⇒ H/C higher in cometary refractory organic matter than IOM?

# C/Si in the Solar System



Bardin+2018, Engrand+2018



Dartois+2018

- Preservation of C/Si in comets 67P and Halley
- Local OM accumulation process in UCAMMs
- C/Si gradient with heliocentric distance?



# UCAMMs : summary and open questions

- UCAMMs formed in the outer regions of the solar system (high D/H ratio, high C content)
  - Have to be delivered to Earth by comets
- 3 kinds of organic matter in UCAMMs:
  - N-rich with no crystalline minerals (GEMS possible)
  - N-poor (IOM-like) with minerals (crystalline and amorphous)
  - « Dusty patches » in the N-poor organic matter
- N/C, C/Si and O/Si can be different in UCAMMs and 67P or Halley (Wild 2 comparison not possible)
  - Local accumulation process of (N-rich) organic matter for UCAMMs - Formation by irradiation of N<sub>2</sub>-CH<sub>4</sub> ices? (feasibility demonstrated)
  - Better preservation of the inner solar nebula O abundance in UCAMMs (minerals)
- Formation of N-poor OM? (like meteoritic IOM?)
- UCAMMs minerals : originate from the inner solar nebula + transport to outer regions of the protoplanetary disk
- Mixing processes of these OM – and minerals?