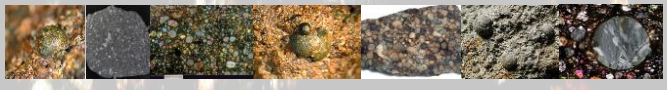

STUDY OF CHONDRULE FORMATION MECHANISMS IN CHONDITES FROM MELTS GENERATED EXPERIMENTALLY.

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CHONDRULES

Meteorites are samples of the earlier processes in the protoplanetary disk where the Solar System was formed. Chondrites have the oldest components of the Solar System. Chondrules are the main components of chondrites. They are compousd of olivine $(Mg,Fe)_2SiO_4$ and poor in Ca pyroxene $(Mg,Fe)SiO_3$. The range of chondrule formation is 1-3 Ma. They were formed under low pressure (~10^{-3} atm) and at temperatures in the range of 1200 – 1750 °C in the course of seconds and at most several minutes (Lofgren, 1996).

Unknowns in the formation of chondrules:

- The starting composition of the precursors.
- The physical conditions of their formation (pressure, temperature and time).
- The mechanisms that produce them (see Tab. 1).

The main aspects of chondrules:

1. Retention of volatile materials (S, Na and K), which had not survived heating and/or cooling for long periods of time.
2. The existence of grains and edges indicating different heating pulses, otherwise cooling monotonic event after a single heating.

Table 1.Constraints on chondrule thermal histories. Desch et al. (2012)

Constraint	X-wind	Lightning	Bow shocks	GI shocks
Ambient $T < 650$ K	X	✓	✓	✓
Heating duration < 10 min[a]	X	✓	✓	?
Peak $T \geq 2000$ K	X	?	✓	✓
Cooling rate from peak ~10^3–10^4 K h^{-1} [a]	X	?	✓	✓
Crystallization cooling rate ~10–10^3 K h^{-1} (porphyritic)	✓	X	?	✓
Crystallization cooling rate ~10^2–10^3 K h^{-1} (barred)	X	X	?	✓
Cooling rate correlates with chondrule density	X	X	?	✓

[a]These constraints may not apply, if high partial pressures of volatiles in the chondrule-forming region suppress evaporation of these volatiles from chondrules.

OBJECTIVES

* Determine what kind of heating conditions reproduce the features observed in chondrites that exist on Earth.

* Associating experimental results with solar nebula forming models, in order to determine the initial conditions of the disk that gave rise to the Solar System.

FIRST CHONDRULES

METHODOLOGY

> Simulate the formation of chondrules by melting olivine crystals at high vacuum conditions using a 50 W CO_2 laser emitting in the infrared at a wavelength of 10.6 µm.

> Measure the temperature during and after the melting. Each melt will have a thermal history recorded.

> Petrological, chemical, crystalographic and textural analysis of the melts.

MAIN ISSUES

The thermal histories provide the most relevant information in determining the processes that originated chondrules.

It is not known what is the precise mechanism of heating of chondrule precursors.

Conolly and Love (1998): the final petrological correlation between chondrule sizes and textures could be discriminatory key to validate the chondrule-forming mechanisms.

ACKNOWLEDGEMENTS

PAPIIT Project No. IA101312, CONACYT Project No. 128228, CONACYT master scholarship.

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