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A new approach combining diffusion chronometry & thermal modeling to determine the peak temperatures of parent body metamorphism

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Carbonaceous chondrites are a unique archive of the early history for the solar system and are affected to different degrees by metamorphism on their parent body. We developed a strategy to distinguish if certain element and isotope signatures in minerals were formed before or after accretion into the parent body and applied it to the CO3 chondrite Kainsaz. We analyzed the chemical zoning in chromites and fayalitic olivines in type II chondrules using EMPA and simulated the profiles using the integrated diffusion coefficient over time as fitting parameter. This approach allows us to quantify the compositional change of the initial profiles by diffusion processes, which is directly related to the thermal history of the mineral. The combination of the diffusion modeling with numerical modeling of the thermal evolution of the parent body provides an independent estimate of the peak temperature of parent body metamorphism of 480°C identical to temperature estimates by Raman spectroscopy of carbonaceous matter [1].

[1]: Bonal et al. (2007), Geochim. Cosmochim. Acta 71, 1605-1623.

Cite abstract as:
Schwinger, S., Dohmen, R., Schertl, H.-P. (2013) A new approach combining diffusion chronometry & thermal modeling to determine the peak temperatures of parent body metamorphism. Paneth Kolloquium, Nördlingen (Germany), abstract URL: http://www.paneth.eu/PanethKolloquium/2013/0056.pdf (abstract #0056).