Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.11005

# NITROGEN, MAGNESIUM AND OXYGEN MASS INDEPENDENT ISOTOPIC FRACTIONATION IN PLASMA CHEMISTRY

**FRANÇOIS ROBERT**[1], MARC CHAUSSIDON[2] AND SMAIL MOSTEFAOUI[3]

[1]CNRS/Museum National Histoire Naturelle
[2]Université de Paris, Institut de physique du globe de Paris, CNRS UMS 3454
[3]Museum National Histoire Naturelle - Sorbonne University
Presenting Author: francois.robert@mnhn.fr

Enrichment or depletion in $^{14}N$, $^{16}O$ and $^{24}Mg$ were observed in solids condensed from carbonaceous plasma composed of $N_2O$/Pentane for N, $CO_2$/Pentanol or $N_2O$/Pentanol for O and $MgCl_2$/Pentanol for Mg[(1)]. In NanoSims imaging, isotope effects appear as micrometer size hotspots embedded in a carbonaceous matrix. For Mg, these hotspots are localized in »200 nanometers carbonaceous grains having positive ($\delta^{25}Mg$ » $\delta^{26}Mg$ » up to +950‰) and negative ($\delta^{25}Mg$ » $\delta^{26}Mg$ » down to -450‰) isotopic compositions. These grains surround 5 mm size grains having a homogeneous and normal isotopic composition ($\delta^{25}Mg$ » $\delta^{26}Mg$ » 0±30‰). For O, the $CO_2$ yields positive $d^mO$ values ($\delta^{17}O$ » $\delta^{18}O$ » up to +1150‰) while $N_2O$ yields negative $\delta^mO$ values ($\delta^{17}O$ » $\delta^{18}O$ » down to -350‰). Although N has only 2 isotopes, several specific properties of the isotopic variations in N bearing grains suggest also a MIF effect.

If the activated complexes responsible for the isotopic exchange (N-$N_2O$, O-$CO_2$, Mg-$MgCl_2$) react with the radicals $CH_x^{\cdot}$ (resulting from the dissociation of Pentane or Pentanol) faster than their dissociation, the isotopic fractionation greatly exceeds the usual theoretical predictions and is not anymore governed by the ratio of the partition functions.

According to a theoretical model developed [(2)] to account for O MIF observed in ozone[(3)], the close agreement between the slopes of the linear correlations observed in the diagrams $\delta^{25Mg}$ *vs.* $\delta^{26}Mg$ and $\delta^{17}O$ *vs.* $\delta^{18}O$ and the slopes calculated using this theoretical model, attests to the ubiquity of this mechanism[(4)]. Although the chemical reactants used in the present experiments cannot be directly transposed to the protosolar nebula, a similar MIF mechanism may has taken place during the condensation of grains in the early solar system.

References: [1] F. Robert, M. Chaussidon, A. Gonzalez-Cano, S. Mostefaoui, *PNAS*, **118**, 52 (2021). [2] P. Reinhardt, F. Robert, *J. Chem. Phys.* **513**, 287–294 (2018). [3] M.H. Thiemens, J.E. Heidenreich, *Science*, **219**, 1073-1075 (1983).[4] F. Robert et al., *Nat. Astron*. **4**, 762–768 (2020).