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Oxygen isotope exchange between chondrule melt and water vapor: an experimental study

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We report on the results of time- and fO_2 -dependent oxygen isotope exchange experiments between a chondrule analogue melt and H_2O -rich gas phase, conducted to address the question of whether the oxygen isotope heterogeneity of chondrules derives from the continuous exchange of a crystallising melt with surrounding gas. The experiments were performed at the temperature of 1500 °C and different fO_2 in a vertical gas mixing furnace equipped with an H_2 - H_2O - N_2 gas mixing system using the loop technique. Equilibration of Fe-loop with silicate melt was used to check the oxygen fugacity. Our results reveal that at IW-1 and -2 about the 75% of oxygen exchange is reached in the first 10 minutes while it took more than 200 minutes at IW-3 and -4. However, despite the decrease in the exchange rate with the increase of H_2/H_2O ratios, the calculated diffusion coefficients agree well with literature values determined for basalts and diopside melt at similar temperature, suggesting that the dominant process controlling the isotopic exchange is volume diffusion through the melt and independent on the partial pressure of water even at very reducing conditions.

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