DIFFUSION KINETICS OF K IN MELILITE AND DIOPSIDE: CONSTRAINTS ON THE ACCRETION TIME SCALE AND THERMAL HISTORY OF CAI PARENT BODY. M. Ito and J. Ganguly, Department of Geosciences, University of Arizona (Tucson, AZ 85721, motoo@geo.arizona.edu, ganguly@geo.arizona.edu)

Important constraints on the time scales of events in the early history of the solar system can be derived from the presence and absence of the decay products of the short lived radionuclides, such as ^{26}Al (half-life, $t_{1/2}$: 0.72 Myr), which decays to ^{26}Mg, ^{41}Ca ($t_{1/2}$: 0.15 Myr), which decays to ^{41}K, etc. in the CAI minerals, which represent the earliest formed crystals in the solar system. Among these minerals, ^{26}Mg was detected in anorthite [1]. On the other hand, we have failed to detect any ^{41}K in melilite and fassaite grains in CAI [2]. However, in an earlier study [3], ^{41}K was detected in fassaites in CAI, but not in melilite.

It was suggested that the CAI had experienced a peak temperature (T_P) of ≤ 650˚C in a parent body of ≤ 15 km radius, or were preferentially stored in the outer part of larger parent body, in order that the radiogenic ^{26}Mg could be retained in anorthite [4]. In this work, we report the results of our on-going project on the K diffusivity in melilte and fassaite, and apply these data to further constrain the T_P, and from that the accretion time of the CAI parent body after CAI formation. Because of the difficulty in finding fassaite crystals of appropriate size and quality for diffusion kinetic studies, we have measured K diffusion in diopside, which should closely approximate the diffusion property of fassaite.

We have determined the diffusion coefficients of K in oriented grains of melilite and diopside as function of temperature by tracer diffusion experiments at 1 bar. The diffusion profiles were measured by depth profiling in SIMS and modeled to retrieve the diffusion coefficients. These diffusion data, together with that for Mg diffusion in anorthite [4], were applied to calculate the closure temperature (T_c) of K diffusion in fassaite and melilite and of Mg diffusion in anorthite as function of T_P, grain size and cooling rate, according to the method of Dodson-Ganguly-Tirone [5, 6]. Using the appropriate grain size for the CAI minerals, and T_P = 650˚C, these calculations yield T_c(fassaite) ~ 650˚C, irrespective of the cooling rate, and depending on it, T_c (melilite) ≥ 600˚C and T_c (anorthite) ≥ 460˚C. Thus, the CAI parent body must have been heated above 600˚C in order for the melilite to loose ^{41}K, but not above 650˚C, since, otherwise, ^{26}Mg would not be significantly retained in anorthite [4]. This tight constraint on the peak temperature requires that the CAI parent body must have accreted ~ 1.7 Myr after CAI formation so that there was just enough ^{26}Al to cause heating of the parent body to 600-650˚C by the heat release through its decay to ^{46}Mg. The formation of CAIs after neucleosynthesis must have taken place within a time interval that is comparable to the half-life of the short lived radionuclides, such as ^{41}Ca ($t_{1/2}$: 0.15 Myr), in order that these radionuclides were incorporated in the CAI minerals in significant quantities.

References: [1] Lee T. *et al.,* (1976) *Astrophys. J. 211*, L107-110. [2] Ito M. *et al.,* (2000) *LPSC XXXI*, CD-ROM#1600. [3] Srinivasan G. *et al.*, (1996) *GCA 60*, 1823-1835. [4] LaTourrette T. and Wasserburg G. J. (1998) *EPSL 158*, 91-108. [5] Ganguly J. and Tirone M. (1999) *EPSL, 170*, 131-140. [6] Ganguly J. and Tirone M. (1999) *Meteorit. Planet. Sci. 36*, 167-175.