MULTIPLE HEATING EVENTS AND CRYSTALLIZATION OF MELILITE. R. A. Mendybaev[1,2] [1]Department of the Geophysical Sciences, [2]Chicago Center for Cosmochemistry, University of Chicago, Chicago, IL, 60637 (ramendyb@uchicago.edu).

Introduction: Melilite is one of the major components of Type B Ca-Al-rich inclusions (CAIs). Equilibrium crystallization experiments showed that melilite from liquids close to CAI-composition crystallizes at 1300º to 1450ºC depending on melt composition (e.g. [1] and references therein). However, it is also well established [1, 2] that heating such melts above the liquidus for extended period of time destroys melilite nucleation sites so that melilite may not crystallize at all or crystallize at significantly (>100ºC) lower temperatures than one would expect at equilibrium crystallization. Such overcooling results in a dendritic texture observed in some experimental run products [2]. The fact that melilite in Type B CAIs usually appear as euhedral crystals and that dendritic melilite has never been observed in the natural CAIs is usually considered as an indicator that the maximum temperatures experienced by Type B CAIs were on the order of 1400ºC, and that their cooling rates were in the range of 2 to 50°C/hr [2].

The natural CAIs most likely experienced multiple heating/cooling events since they have been formed in a solar nebula. Here we present new experimental results on crystallization of melilite from CMAS liquids during two episodes of heating and cooling.

Experimental: Two types of materials have been used in the experiments : 1) melt from åkermanite-gehlenite binary system [3] with compositions of ÅK35 and Åk65; and 2) CAI-like melts of two compositions slightly enriched in MgO (CAI1 - 15 wt.%, and CAI2 - 20 wt.% MgO) compared to the average Type B CAI melts used in [1] and [2]. ÅK35 and Åk65 were heated in air at 1600ºC for several hours and than cooled down to 1400ºC at 10ºC/hr (ÅK35) or from 1450º to 1400ºC at 5ºC/hr (ÅK65). Most of the samples were then annealed at 1300ºC for several hours, reheated to about 20ºC above liquidus and immediately cooled to the solidus temperatures at 5-10ºC/hr. In experiments with CAI-like melts the samples were melted in vacuum at 1700ºC for 4 hours, cooled to 1450ºC at 100ºC/hr followed by cooling to ~1250ºC at 25ºC/hr. Several sets of samples were then annealed at 1250ºC for 10 hours, reheated to 1450ºC and finally cooled at 25ºC/hr to 1250ºC.

Texture, mineral and chemical compositions of the experimental run products were studied using SEM equipped with X-ray microanalysis system.

Results and Discussion: When droplets of CMAS liquids were cooled after several hours of heating above liquidus, melilite was never observed in the run products regardless of the composition of the melts used. This is in agreement with the earlier experiments indicating that overheating destroys melilite nucleation sites. However, extended heating at subsolidus temperatures transforms optically clear glasses produced after the first heating and cooling episode to a milky opaque material due to the formation of an abundant very fine grained melilite crystals. When such material was reheated to ~1450ºC followed by slow cooling, relatively large melilite crystals were observed in the experimental charges. Fig. 1 is a backscattered electron image of a fragment of CAI2 heated from 1250ºC to 1450ºC (just slightly above melilite crystallization temperature) and cooled back to 1250ºC at 25ºC/hr. Melilite (white) appears mostly as elongated crystals 30-50µm wide along with 10-50 µm size spinel (dark) and the residual melt (grey). The fact that melilite forms abundant but smaller than in the natural CAIs melilite crystals suggest that large number of the melilite nucleation sites survived the reheating. Slightly higher reheating temperatures and/or lower cooling rates would destroy the majority of the nucleation sites and therefore result in fewer but larger crystals of melilite making the textures closer to those observed in the natural Type B CAIs.

The texture of Type B CAIs allows to restore the conditions of crystallization of minerals from the melt produced during the last heating event. The chemical and isotopic characteristics of CAIs could have been established in the previous heating episodes.

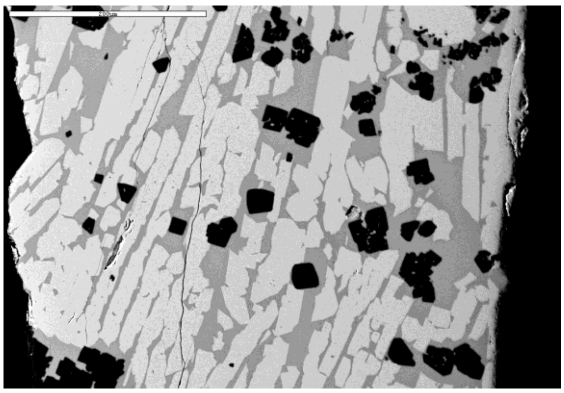

Fig. 1. Backscattered electron image of the experimental charge produced by evaporation and multiple heating of CAI2 melt (scale bar is 200 microns).

References: [1] Mendybaev R. A. et al. (2006) *GCA*, *70*, 2622-2642. [2] Stolper E. And Paque J. M. (1986) *GCA*, *50*, 1785-1806. [3] Mendybaev R. A. et al. (2006) *LPS XXXVII*, Abstract #2268.