

THERMAL HISTORY OF VIG1623-5 FUN CAI: EXPERIMENTAL MODELLING.

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Introduction: Vig 1623-5 is a FUN CAI composed mainly of 30-170 μm grains of forsterite (Fo) enclosed within pyroxene (Px) and/or $\text{\AA}k_{89}$ melilite (Mel) and surrounded by incomplete gehlenitic ($\text{\AA}k_{16-60}$) melilite mantle [1]. The inclusion is characterized by extremely large mass-dependent fractionations of magnesium, silicon and oxygen isotopes [1, 2]. Earlier we showed [3] that isothermal evaporation of FUN1 melt (Mg_2SiO_4 plus several wt% of CaO and Al_2O_3) at 1900°C results in residues with chemical and isotopic compositions of Mg, Si and O close to those in Vig1623-5. In this paper we present results of cooling experiments aimed at reproducing the texture of 1623-5.

Experiments: Most experiments have been conducted in a vacuum furnace using FUN1 and FUN2 melt compositions; the latter is a product of evaporation of FUN1 and has a composition close to 1623-5 (see [3] and references therein). A one-atmosphere furnace was used in experiments when FUN2 melt was cooled from temperatures below 1600°C in H_2 .

Results: Cooling FUN1 from 1850°C in vacuum at 30-120°C/hr results in residues composed of Fo and Px. Contrary to the crystallization in a closed system, fast cooling ($\sim 120^\circ\text{C/hr}$) leads in formation of massive Fo (up to 1 mm in size) while slow cooling ($\sim 30^\circ\text{C/hr}$) results in “quench-like” textures. This is due to the fact that as Mg and Si evaporate, the liquidus of the melt decreases, but when the evaporation rate becomes sufficiently slow, instant nucleation and crystallization of Fo begins. These experiments show that although evaporation of Mg and Si from FUN1 melt results in residues appropriately enriched in heavy Mg and Si isotopes [3], the texture and mineral compositions of the residues are distinctly different from that of Vig1623-5.

Cooling of FUN2 melt in vacuum from $\sim 1650^\circ\text{C}$ at 30-60°C/hr results in Fo (up to 200-300 μm) embedded in Px and Mel. Small Sp grains and some An are also observed in the residues. The compositions of forsterite (up to 1.5 wt% CaO) and the Ca-, Al-rich pyroxene in the residues are close to that of Vig1623-5 [1]. Melilite from these experiments, however, is more gehlenitic ($\sim \text{\AA}k_{75}$) than the $\text{\AA}k_{89}$ found in the main mass of Vig1623-5.

We showed that when Type B melt is exposed to H_2 melilite mantle forms [4]. Similar experiments are underway using FUN2 melt. Run products from the vacuum experiments described above were reheated into one atm H_2 and cooled from $T \leq 1600^\circ\text{C}$. We have not yet succeed in forming a melilite mantle, but cooling from 1425°C at 10 and 25°C/hr results in 10-50 μm thick forsterite-free mantle (5-10 μm Sp grains are enclosed into Mel and Px). The expectation based on the phase diagram is that slower cooling (or slightly higher starting temperatures) will evaporate sufficient Mg and Si so that Px would convert into Mel followed by dissolution of Sp in the gehlenitic Mel. The last step in this process was observed in evaporation experiments with Type B-like compositions [4].

Conclusions: Formation of texture similar to Vig1623-5 FUN CAI seems to require multiple heating and cooling events.

References: [1] Davis et al. 1991. *Geochimica Cosmochimica Acta* 55:621-637. [2] Marin-Carbonne et al. 2011. 74th Met. Soc. Meeting. [3] Mendybaev et al. 2010. Abstract #2725. 41st Lunar Planet. Sci. Conf. [4] Mendybaev et al. 2006. *Geochimica Cosmochimica Acta* 70:2622-2642.