

**TWO GENERATIONS OF HEXAGONAL  $\text{CaAl}_2\text{Si}_2\text{O}_8$  (DMISTEINBERGITE) IN THE TYPE B2 FUN CAI STP-1.**

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**Introduction:** Dmisteinbergite (*dmist*) is a metastable hexagonal form of  $\text{CaAl}_2\text{Si}_2\text{O}_8$ , with space group of  $P6_3/mcm$ ,  $a = 5.10\text{\AA}$  and  $c = 14.72\text{\AA}$  [1]. First occurrence of meteoritic *dmist* has been reported in the Allende Type B2 FUN CAI STP-1 [2], where it appears to have crystallized from a <sup>16</sup>O-rich ( $\Delta^{17}\text{O} \sim -25\text{‰}$ ) silicate melt via rapid cooling [3]. Here we report on another textural occurrence of *dmist* in STP-1 – <sup>16</sup>O-poor ( $\Delta^{17}\text{O} \sim -2\text{‰}$ ) fine-grained crystals in alteration zone of the inclusion.

The mineralogy and mineral chemistry of STP-1 were studied with the UH field-emission JEOL JXA-8500F electron microprobe and JEOL JSM-5900LV equipped with electron back-scattered diffraction detector HKLNordlys. Oxygen isotopes were measured *in situ* with the UH Cameca ims-1280 ion microprobe using primary Cs<sup>+</sup> ion beam with  $\sim 2\ \mu\text{m}$  beam size.

**Results and Discussion:** STP-1 is a Type B2 CAI composed of melilite, Al,Ti-diopside, spinel, *dmist*, and minor hibonite. Melilite in the CAI periphery is partly replaced by secondary nepheline, sodalite, grossular, Al-diopside, hexagonal *dmist*, and triclinic anorthite. Secondary *dmist* occurs as acicular crystals whereas secondary anorthite forms anhedral massive grains. Secondary *dmist* and anorthite contain up to 1 wt% of Na<sub>2</sub>O, whereas primary *dmist* is Na-free. On a three-oxygen isotope diagram, secondary *dmist* and anorthite plot along slope-1 line have <sup>16</sup>O-poor compositions ( $\Delta^{17}\text{O} \sim -2\text{‰}$ ); one *dmist* grain is <sup>16</sup>O-enriched ( $\Delta^{17}\text{O} \sim -10\text{‰}$ ). In contrast, O-isotope compositions of coarse-grained igneous *dmist* plot along  $\sim$ slope-0.5 line with  $\Delta^{17}\text{O} \sim -25\text{‰}$ . Experimental studies show that in supercooled melts *dmist* crystallizes prior to anorthite at temperatures below metastable liquidus (1400°C) [e.g., 4]. These observations and the fractionated O-isotope compositions of coarse-grained igneous *dmist* in STP-1 suggest that it crystallized from a supercooled melt that experienced evaporation, possibly at low total pressure ( $<10^{-6}$  bar) [5]. On the contrary, fine-grained *dmist* coexisting with secondary minerals is likely to have formed by hydrothermal alteration on the CV parent asteroid, which is consistent with its <sup>16</sup>O-depleted composition and elevated Na<sub>2</sub>O content. Experimental studies suggest during hydrothermal alteration at 200–250°C, reaction of gehlenitic melilite with SiO<sub>2</sub> dissolved in an aqueous solution/fluid may result in formation of hydrogrossular [6]. Subsequent heating may transform hydrogrossular into *dmist* that is stable up to 1000°C [7]. We infer that STP-1 contains two generations of *dmist* – igneous and hydrothermal. Crystallization of igneous *dmist* from a Type B2 FUN CAI melt indicates that the melt experienced supercooling at the final stages of crystallization. Subsequently, STP-1, like many typical CV CAIs, experienced hydrothermal alteration on the CV parent asteroid.

**References:** [1] Takeuchi & Donnay (1959) *Acta Crystallogr.* 12, 465–470. [2] Ma et al. (2013) *Amer. Mineral.*:in press. [3] Holst et al. (2013) *PNAS*:in press. [4] Abe & Sunagawa (1995) *Mineral. J.* 17:257–281. [5] Mendybaev et al. (2013) *GCA*:in press. [6] Nomura & Miyamoto (1998) *GCA* 62:3575–3588. [7] Borglum et al. (1993) *J. Am. Ceram. Soc.* 76:1354–1356.