DISCOVERY OF METEORITIC LAKARGIITE (CaZrO₃), A NEW ULTRA-REFRECTORY MINERAL FROM THE ACFER 094 CARBONACEOUS CHONDRITE

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Introduction: During a nano-mineralogy investigation of the Acfer 094 carbonaceous chondrite, lakargiite (CaZrO₃) was identified as sub-micrometer inclusions in an isolated hibonite grain in section USNM 7233-1. The hibonite grain was described in [1]. Lakargiite is a recently found perovskite-group mineral from high-temperature skarns in ignimbrites of the Upper-Chegem volcanic structure, the North Caucasus, Russia [2]. Reported here is the first extraterrestrial occurrence of lakargiite, as a new ultra-refractory mineral in a primitive meteorite, among the first solids formed in the solar system. Field-emission SEM with EDS and electron back-scatter diffraction (EBSD) was used to characterize its composition and structure and associated phases.

Occurrence, Chemistry, and Crystallography: Lakargiite $[Ca_{0.95}(Zr_{0.87}Ti_{0.16})O_3]$ occurs along with tazheranite $[(Zr_{0.52}Ti_{0.18}Ca_{0.16}Y_{0.06}Fe_{0.05}Sc_{0.03})O_{1.75}], \quad Zr\text{-bearing} \quad perovskite$ $[Ca_{0.94}(Ti_{0.98}Zr_{0.06})O_3]$ and Os-W-alloy $[Os_{0.81}W_{0.13}Fe_{0.06}]$ as fineinclusions scattered in the central area of the hibonite $[Ca(Al_{11.70}Ti_{0.14}Fe_{0.10}Mg_{0.06})O_{19}] \ \ grain \ \ (Fig. \ 1). \ \ Lakargiite \ \ ap$ pears as irregular or subhedral lath-shaped grains, 300 nm - 900 nm in size, sometimes in contact with Os-W or perovskite. Associated tazheranite is a Ca-stabilized cubic zirconia (CSZ), likely being the first reported meteoritic CSZ. EBSD analysis revealed that the lakargiite has a perovskite Pbnm structure, identical to that of synthetic CaZrO₃ [3], showing a = 5.591 Å, b = 5.762 Å, $c = 8.017 \text{ Å}, V = 258.3 \text{ Å}^3, Z=4.$

Origin and Significance: Lakargiite is a new Zr-dominant ultra-refractory mineral, joining the Zr-rich refractory minerals allendeite ($Sc_4Zr_3O_{12}$) [4], tazheranite (Sc- or Y- stabilized cubic zirconia) [4,5] and panguite [6]. Texturally, lakargiite, tazheranite, Zr-bearing perovskite and Os-W formed before host hibonite. Lakargiite is likely an early condensate. Further work is under way to determine its place in the nebula.

References: [1] Simon S.B. and Grossman L. 2011. *MAPS* (in press). [2] Galuskin E.V. et al. 2008. *Am. Min.* 93:1903-1910. [3] Koopmanns H.J.A. et al. 1983. *Acta Cryst. Sec. C* 39:1323-1325. [4] Ma C. et al. 2009. 40^{th} *LPSC*, Abstr. #1402. [5] Ma C. and Rossman G.R. 2008. *GCA* 72:12S, A577. [6] Ma C. et al. 2011. 42^{nd} *LPSC*, Abstr. #1276.

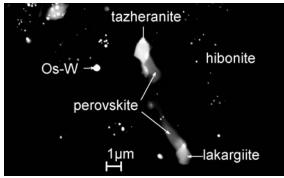


Fig 1. BSE image showing lakargiite in Acfer 094.