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A new calcium-aluminate from a refractory inclusion in the Leoville carbonaceous chondrite

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The first meteoritic occurrence of CaAl_4O_7 is described from a Ca-Al-rich inclusion (CAI) in the Leoville carbonaceous chondrite. This CAI consists mainly of gehlenitic melilite, spinel, perovskite, and hibonite. CaAl_4O_7 is a minor component and occurs within melilite preferentially in portions rich in perovskite.

The CAI is enveloped by a succession of three rims (from inside out): (a) hibonite + melilite + spinel + perovskite, (b) diopside, and (c) olivine.

On the basis of mineral associations found and from the presence of moderately volatile elements (Fe and Cr) we conclude that the CaAl_4O_7 -bearing CAI from Leoville is of residual nature. CaAl_4O_7 is apparently stable in the very Mg- and Si-poor environment of this CAI and is probably of igneous origin.

The rims are interpreted as products of partial evaporation (rim (a)) and associated re-condensation (rims (b) and (c)).

1. Introduction

Carbonaceous chondrites of types CV, CO, and CM [1] abundantly contain highly refractory "inclusions" generally known as Ca-Al-rich inclusions (CAI). Bulk compositions of these inclusions vary over a wide range but generally are dominated by high (15- to 10^4 -fold) enrichments of refractory elements as compared to bulk carbonaceous chondrite matter [2–5]. The CAI's are primarily composed of Al_2O_3 , CaO, MgO, SiO_2 , and TiO_2 but also have variable but low contents of more volatile elements. Accordingly, their mineralogy is rather simple (except for rims and alterations): major minerals are melilite, spinel, and perovskite in the type A inclusions [6] and melilite, fassaite, spinel, anorthite, and perovskite in type B inclusions. Depending upon the bulk composition some type A inclusions also contain minor or major amounts of a crystalline Al_2O_3 phase [7] and hibonite, $\text{CaAl}_{12}\text{O}_{19}$ [8]. Al_2O_3 apparently is rather rare but hibonite is quite common. In cases where

a crystallization sequence can be established from textural relationships, hibonite is apparently followed by either spinel or melilite or both. Other Ca-Al phases such as CaAl_4O_7 and CaAl_2O_4 which should appear after hibonite in Mg- and Si-poor systems [9–11], have not been found so far. We report here on the first meteoritic occurrence of CaAl_4O_7 from a coarse-grained CAI in the Leoville carbonaceous chondrite.

2. Occurrence

Within a thin section of the carbonaceous chondrite Leoville, in the possession of the Laboratoire de Minéralogie-Cristallographie, Université Pierre et Marie Curie, Paris, there is exposed a large (6 mm longest dimension) coarse-grained CAI which we labelled L2. Its shape is highly irregular amoeboid (Fig. 1) and it is outlined by delicate rims. The main mass shows granular intergrowth of gehlenite, spinel, perovskite,