# SILICATE AND CARBONACEOUS MINERALS IN METEORITIC MINERAL ENVIROMENTS I . THE ALLENDE C-CHONDRITE.

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**Introduction:**
Primitive meteorites contain, among others, silicates, carbonaceous and carbon-based mineral compounds, which had been formed before the formation of the Solar System [1]. The highly anomalous isotopic composition of the presolar grains refers to on the stellar origin and the study of them can provide information on stellar nucleosynthesis, physical and chemical properties of the stellar atmospheres and the galactic chemical evolution, respectively [2].
Primitive meteorites contain presolar grains (silicates, oxides, nanodiamonds, graphite, silicon nitride and silicon carbide). The Allende meteorite is a CV3-type carbonaceous chondrite (CC), with characteristic carbonaceous chondrite mineral compounds of olivine and Ca-Fe-rich pyroxene (they can predominantly be in chondrules and the matrix), fine-grained matrix of minerals, Ca-Al-rich inclusions (CAI), amobeoid olivine aggregates (AOA), coarse-grained matrix olivine, fayalitic olivine rims around forsterite grains [3] and it contains a small amount of carbon (mostly graphite and diamond), respectively. The elemental abundance of C is estimated to be 0.27 ± 0.03 wt% [4] in the Allende c-chondrite and it contains smaller amount of silicon carbide than the Murchison CM2 chondrite. (The majority of silicon carbide grains have been originated from the AGB stars and in a smaller ratio SiC is derived from supernovae and novae.)
The Allende contains relatively large Ca-Al-rich inclusions and the bulk composition of Allende matrix was Fe-rich obtained by Inoue et al. [5]. The average age of Allende chondrule formation is determined as 4566.6 ± 1.0 Ma based on the age examination of eight chondrule fractions performed by Amelin and Krot (2007) [6]. The Allende can be belonged to the oxidized subgroup of CV3 chondrites, which are enriched in alkalies, chlorine, and ferric iron. These are present in mineral phases of Ca, Al-rich inclusions (CAIs), chondrules, dark inclusions including nepheline ($NaAlSiO_4$), sodalite ($Na_8[AlSiO_4]_6C_{l2}$), wadalite ($Ca_6Al_5Si_2O_{16}C_{l3}$), magnetite ($Fe^{2+}Fe^{3+}{}_2O_4$), and andradite ($Ca_3Fe_3+ 2Si_3O_{12}$) [7].
Interestinghly, new minerals have also been discovered during a nanomineralogy investigation of the Allende meteorite. Among these, the allendeite ($Sc_4Zr_3O_{12}$) is a new Sc- and Zr-rich oxide [8]. Moreover, fullerenes ($C_{60}$ and $C_{70}$) and higher fullerenes ($C_{100}$ to $C_{400}$) have also been found among the aromatic carbon-rich molecules in the Allende [9].
**Measurement procedure for identification of silicate- and carbonaceous minerals:** In order to provide some information from the bulk mineral composition of the matrix of the Allende CV3 meteorite, one piece of the chondrite was examined applying the Raman-spectroscopy method. The mineral analyses was performed by Raman-spectroscope+optical microscope with X-50 Olympos lens in the range of wave numbers between 0-3500 1cm$^{-1}$. The spectroscope operated at 20 mW with a beam-size of ~5 μm (detection limit).
Furthermore, approximate Mg/Fe ratios are calculated from the measured data of Inoue et al. [5] to obtain a short comparative result from the abundance ratio of magnesium silicates and the presolar silicon carbide in the matrix mineral composition.
**Results and Discussion:** Raman spectral properties of the carbonaceous matrix of the Allende meteorite show a major area, as follows: Carbonaceous material with olivine (Fe, Mg ($SiO_4$)) (Fig. 1). It shows three spectral regions, which are centered at 835-847 (stretching SiO4 tetrahedral vibration of olivine), 1344 (D-line) and 1602 (G-line) cm$^{-1}$. Relatively narrow peaks and the ID/IG ratio indicates that this part of the mateorites has a well-ordered crystallinity. Consequently, the matrix in the whole texture is thought to have been composed of silicate, and carbonaceous/carbon based compounds (with a small amount of carbon) in the fine-grained structure.

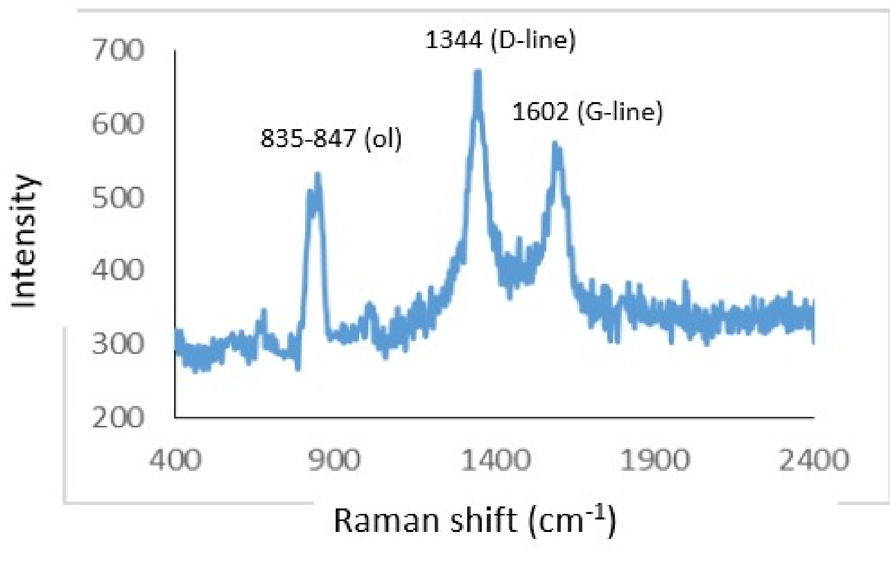


Figure 1. Raman spectral properties of the carbonaceous matrix with olivine.

The moderately low Mg/Fe ratio (~$Mg_{0.29}Fe_{0.71}$) shows excellently the Fe enriched matrix material in the Allende c-chondrite (Table 1). The abundance of magnesium silicates is roughly half the total chemical composition of the matrix.
The one of the main differences between the c-chondrite groups is the matrix-normalized abundance (ppm) of presolar silicon carbide. The differences may reach more orders of magnitude. The abundance of SiC in CV-type chondrites (Allende) might be smaller with four orders of magnitude than for the case of CM chondrites (Table 2). It varies from 0.006 to 35 ppm. Accordingly, I note that the ratio of the magnesium silicates in the matrix of carbonaceous chondrites is higher with a minimum four orders of magnitude than that of the abundance of silicon carbide.

| Examined sample | FeO(wt%) | MgO(wt%) | Mg/Fe |
|---|---|---|---|
| B1 | 37.01 | 19.17 | $Mg_{0.29}Fe_{0.71}$ |
| B2 | 34.55 | 18.03 | $Mg_{0.288}Fe_{0.712}$ |

Table 1. The FeO and the MgO abundances in the bulk chemical composition of the matrix of the Allende (CV3) chondrite. The Mg/Fe ratio is calculated from the basic data that are taken from Inoue et al. [5].

| C-chondrite group | CV | CM |
|---|---|---|
| SiC abundance | 0.006-0.2[1] | 14[2] |
| Chondrite-type | CV oxidized | Murchison (CM2) |
| SiC abundance | 5[2] | 35[2] |
| Chondrite-type | RBT04133 (CV3 reduced) | Bells (CM2) |

Table 2. Estimated abundances (ppm by mass) of presolar SiC in different carbonaceous chondrites. The data are taken from previous studies: 1 :Huss and Lewis (1995) [10], Huss et al. [11]; 2 : Davidson et al.[12].

**Summary:** The detailed study of the composition of primitive meteorites is very useful in respect of the better understanding the stellar nucleosynthesis, the dust formation and the Galactic chemical evolution.

**References:**

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