

OXYGEN ISOTOPIC COMPOSITIONS OF FAYALITE IN THE CV CHONDRITE KABA

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Introduction: Among primitive meteorites, CV carbonaceous chondrites are of primary importance as they are composed of mm-sized chondrules and abundant refractory inclusions [1]. They are also the only group to contain large, once-molten, refractory inclusions that bring invaluable information on the conditions that prevailed in the Solar protoplanetary disk. CV3 carbonaceous chondrite parent body accreted relatively small amount of water ice grains and experienced fluid alteration that resulted in formation of diverse secondary minerals, including fayalite in the oxidized Bali-like group (CV3OxB) [2]. Although it is commonly accepted that CV chondrites experienced fluid alteration, the conditions under which it took place remains under debate [3, 4]. I will present new results on the oxygen isotopic compositions of Fayalite in the CV3 Kaba and discuss the isotopic evolution of the CV parent body.

Material and methods: Two thin sections of Kaba (N4075 and O229; National History Museum, Vienna, Austria) were surveyed in order to find fayalite large-enough to be chemically and isotopically characterized. Scanning electron microscope observations and Energy Dispersive X-ray spectral analyses were performed at CRPG using a JEOL JSM-6510. Quantitative analyses of fayalite were made with a CAMECA SX-100 electron microprobe (CAMECA, Paris, France) using a 10 nA focused beam accelerated to 15 kV. *In situ* oxygen isotopic compositions were measured with a CAMECA ims 1280 at CRPG. ¹⁶O⁻, ¹⁷O⁻, and ¹⁸O⁻ ions produced by a Cs⁺ primary ion beam (~ 5 nA) were measured in multicollecion mode with three Faraday cups. Four terrestrial standard materials (San Carlos olivine, magnetite, diopside, and fayalite) were used to (i) define the mass fractionation line and (ii) correct the matrix effect on instrumental mass fractionation (IMF) for fayalite.

Results: Fayalite grains were observed in the two sections of Kaba. They mainly occurs in peripheral portions of type I chondrules, in fine-grained chondrule rims, and in matrix. Fayalite forms large subhedral-to-anhedral grains that are sometimes associated with magnetite and sulfide grains. However, sulfide- and magnetite-free fayalite grains are also commonly observed in the matrix. These fayalite grains show homogeneous compositions in the range Fa₉₇ to Fa₉₉. The O-isotopic composition fall above the Terrestrial Fractionation Line (TFL) with $\Delta^{17}\text{O}$ ranging from 0.8 to 2.6 ‰.

Discussion: It is commonly accepted that the bulk O-isotopic compositions of CV chondrites plot along the Carbonaceous Chondrite Anhydrous Mineral (CCAM) line with a slope ≈ 1 [2]. In detail, it rather appears that bulk and matrix of CV chondrites define a trend with $\delta^{17}\text{O} = 0.84 \times \delta^{18}\text{O} - 4.25$ ($r^2 = 0.99$, [5]), which likely corresponds to the fingerprints left by secondary alteration processes. The O-isotopic compositions of fayalite grains reported here do not fall on the TFL but show $\Delta^{17}\text{O} > 0$ ‰. Interestingly, when plotted with the bulk and matrix O-isotopic compositions of CV chondrites, the Kaba fayalite grains define a continuous trend with $\delta^{17}\text{O} = (0.84 \pm 0.03) \times \delta^{18}\text{O} - (4.25 \pm 0.1)$ (2σ , $r^2 = 0.99$) This trend is in good agreement with the O-isotopic compositions of fayalite grains reported in the CV3 chondrite A-881317 [2]. The comparison with other studies is difficult due to the large uncertainties associated to the O-isotope measurements (e.g., 4.4 ‰ and 2.3 ‰ on $\delta^{18}\text{O}$ and $\delta^{17}\text{O}$ (2σ), respectively, [6]). The continuous trend defines by bulk CV chondrites and fayalite grains implies that the main process that controls the O-isotopic composition of the CV chondrite parent body is related to isotopic equilibrium between ¹⁶O-rich anhydrous silicates and ^{17,18}O-rich fluid. Such a process is similar to that recently reported in CM chondrites [7]. Taking into account the low isotopic fractionation factor α at the temperature range estimated for fayalite formation (i.e., $1000 \ln \alpha_{\text{Fa-water}} = 0.6$ ‰ at 100°C and -1.1 ‰ at 200°C, [8]), it thus appears that the fayalite O-isotopic compositions represent a direct proxy to estimate the origin of water accreted by CV chondrites. This suggests that most water ice grains accreted by CV chondrites had a dominantly local origin inherited from the inner Solar System [9].

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