OXYGEN ISOTOPIC COMPOSITIONS OF AN PLAGIOCLASE–OLIVINE INCLUSION FROM NINGQIANG CARBONACEOUS CHONDRITES

D. DAI[1], X. LIU[1,2] and C. ZHOU[1,2], [1]Institute of Geology, Hunan University of Science and Technology, ddqygf@163.com, [2]Institute of Geochemistry, Chinese Academy of Sciences, 1364049229@qq.com.

Introduction: Plagioclase–olivine inclusions (POIs) are characteristic inclusions in carbonaceous chondrites, and mainly consists of plagioclase, olivine, pyroxene and spinel. POIs are distinguished in mineralogy, chemistry and isotopic compositions from the other types of inclusions and Al–rich chondrules, and they probably represent intermediate assemblages between more refractory inclusions and chondrules [1]. The refractory inclusions are composed of such refractory minerals as spinel, melilite and Al–Ti–rich diopside, are enriched in refractory elements and generally show an ^{16}O–rich oxygen isotopic composition (δ^{17}, ^{18}O ~ –50‰) [2]. However, in comparison with the other types of refractory inclusions, there are only few reported studies of POIs [3]. In this paper, we will report the oxygen isotopic compositions of an POI from Ningqiang chondrites.

Samples and Experiments: The POI is labeled as C#1 from Ningqiang an anomalous carbonaceous chondrites. The petrography, mineral chemistry and aluminum–magnesium istopic compositions of the POI have been studied [1,3,4]. The Cameca NanoSIMS 50L at the Institute of Geology and Geophysics, Chinese Academy of Sciences was used to measure the oxygen isotope ratios of C#1in this study. All analyses were normalised to a mineral standard matched for elemental composition to provide appropriate corrections for instrumental mass fractionation (IMF). Oxygen isotopes results are reported as δ^{17}O and δ^{18}O, representing permil deviations from SMOW.

Results and discussion: Inclusion C#l (2.5 × 3.0 mm) contains 59 vol% plagioclase, 14 vol% spinel, 14 vol% olivine, 7 vol% Ca–rich pyroxene, 5 vol% Ca–poor pyroxene, 1 vol% Ti–rich oxides and the other accessory phases [3]. Plagioclase is euhedral and coarse–grained (up to 380 μm in size), spinel (euhedral and <20 μm in size) occurs as inclusions in plagioclase and olivine in the whole inclusion but predominantly in the central area. Most of the olivine is coarse–grained (50–240 μm in size) and subhedral to euhedral in form. C#l is the presence of a pyroxene layer (100–150 μm in width), partially surrounding host of the inclusion. The pyroxene layer is predominantly composed of Ca–poor and Ca–rich pyroxenes (64 and 36 vol%, respectively). All core and Ca–poor and Ca–rich pyroxenes rim (W–L rim) oxygen isotope measurements for the inclusion C#l plot within error of the Carbonaceous Chondrite Anhydrous Minerals (CCAM) [5]. This indicates that the inclusion has not been significantly affected by mass-dependent fractionation processes. The spinels are ^{16}O–rich (Δ^{17}O= –5.8 to –20.9). The oxygen isotopic compositions of the olivines, plagioclase and W–L rim (Ca–poor and Ca–rich pyroxenes) are relatively ^{16}O–poor compared with that of the spinel and are moderately ^{16}O–rich with a weighted mean Δ^{17}O value of –2.3 to –8.4, –0.9 to –7.1 and –2.6 to –4.9, respectively.

The petrographical and mineralogical evidence suggests that C#1POI was once melted [3]. The C#1 appears to have undergone at least two high–temperature events in the solar nebula prior to incorporation into the Ningqiang parent body. The first high–temperature event was the formation of the inclusion precursor of the C#1. The CAI precursor was formed by fractional condensation from an ^{16}O–rich nebular gas. The second high–temperature event caused the mixing of the inclusion and the chondrule materials. The inclusion precursor melted, assimilated the chondrule materials, crystallized the interior portion and formed the core and Ca–poor and Ca–rich pyroxenes rim of the inclusion in the same environment. The environment of the nebular gas where this event took place was relatively ^{16}O–poor and chondritic–dust–rich [6], and it is consistent with olivine–rich in C#1 inclusion. This environment is different from that of the first high–temperature event and suggests that the two high–temperature events are spatially and/or temporally separated.

Acknowledgements: This work was supported by the Natural Science Foundation of China (Grant No. 41103032) and Scientific Research Fund of Hunan Provincial Education Department (Grant No.15B080).

References: [1]Sheng Y. et al. 1991. *Geochimica et Cosmochimica Acta* 55: 581–599. [2] Wakaki S. et al. 2013. *Geochimica et Cosmochimica Acta* 102: 261–279. [3] Lin Y. and Kimura M. 1997. *Antarctic Meteorite Research*, 10: 227–248. [4] Hsu W. et al. 2003. *Meteoritics & Planetary Science* 38: 35–48. [5] Dai D. et al. 2016. *Acta Petrologica Sinica* 32: 64–70. [6] Itoh S. and Yurimoto H. 2003. *Nature* 423: 728–731.