EPSC Abstracts
Vol. 5, EPSC2010-500, 2010
European Planetary Science Congress 2010

A Zr,Y,Sc,Ti,Hf-bearing phase in a composite CAI from the North West Africa 3118 CV chondrite

M. Ivanova (1,2), C. Lorenz (1), A. Krot (3), and G. MacPherson (2)
(1) Vernadsky Institute of Geochemistry, Moscow, Russia, meteorite2000@mail.ru, (2) National Museum of Natural History, Smithsonian Institution, Washington DC, USA, (3) University of Hawaii at Manoa, Honolulu HI, USA.

Abstract

A unique Zr,Y,Sc,Ti,Hf-bearing mineral phase (named ZYS) was found in one of the composite CAI from NWA 3118 CV chondrite. This mineral phase may represent a carrier of HREE in which CAIs having a Group II REE pattern are depleted.

1. Introduction

Important information on the rare earth elements (REE) fractionation, or gas/dust separation, at very high temperatures could be received from the "ultra-refractory (UR) components" found in several CAIs [1,2]. UR component is enriched in heavy REE (HREE) in comparison with CAIs having Group II REE pattern which were condensated from a fractionated gas and they demonstrate enrichment in light REE (LREE) and depletion in HREE [3]. We report here the first discovery of unusual Zr,Y,Sc,Ti,Hf-bearing mineral phase from a refractory CAI #3N in NWA 3118 (CV3) chondrite. Its trace element pattern is so unusual that it may give important evidence about refractory trace element condensation. Although there is no direct evidence that this CAI actually has an UR component, we expect that the ZYS phase may be such a carrier of HREE. Measurements of REEs will be conducted in future.

2. Analytical procedure

Polished section of CAI# 3N were studied using an FEI Nova NanoSEM 600 scanning electron microscope, equipped with a Thermo Electron energy dispersive X-ray spectrometer. Minerals were analyzed using a JEOL JXA-8900R electron microprobe at the Smithsonian and a Cameca-SX100 at the Vernadsky Institute.

3. Results and discussion

CAI #3N is a complex refractory inclusion, 1.7 ×1.7 cm in size, composed of 26 individual CAIs or their fragments of different types (Fig. 1).

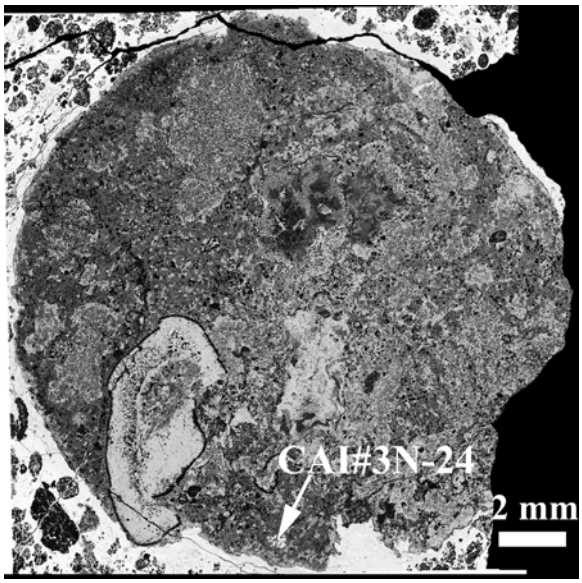

Figure 1: BSE image of CAI#3N.

One of the CAIs, #3N-24, ~0.5 mm in diameter, consists mainly of Al,Ti-diopside and spinel, with minor anorthite and secondary sulfide. It also contains a Zr,Y,Sc,Ti,Hf-bearing mineral phase (ZYS) (Fig. 2). The texture and round shape of the CAI indicates it was melted.
The chemical composition of the ZYS phase and bulk chemical composition of the CAI#3N-24 are listed in Table 1. The best fit structural formula of the ZYS phase calculated on 18 oxygens is $(Ca,Zr)(Y,Sc,Ti)_3(Zr,Hf)_6O_{18}$.

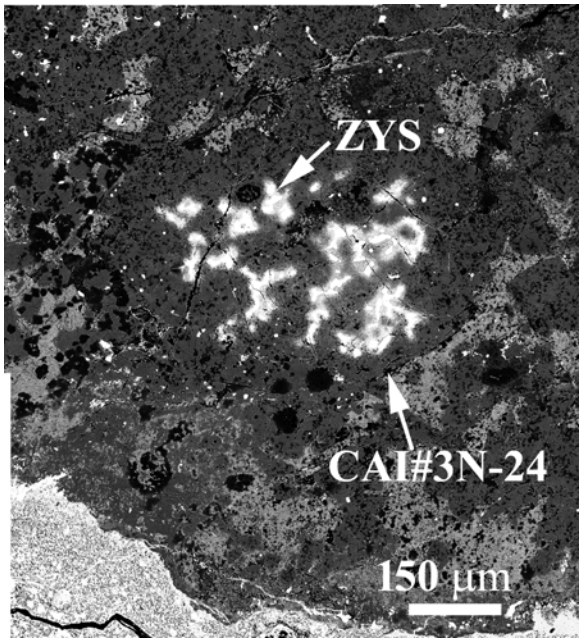

Figure 2: BSE image of CAI #3N-24

Table 1: Average chemical composition of the ZYS phase (1) and bulk composition of the host CAI #3N-24 (2).

	1	2
MgO		13.18
FeO		1.25
Al_2O_3		19.82
SiO_2		32.8
Cr_2O_3		0.06
La_2O_3	0.16	
Ce_2O_3	0.13	
Ta_2O_5	0.20	
HfO_2	1.88	0.58
CaO	4.16	21.33
Sc_2O_3	7.92	0.75
TiO_2	6.07	3.33
Y_2O_3	11.11	0.51
ZrO_2	68.12	5.33
Total	99.64	99.04

The bulk composition of the CAI #3N-24 is highly enriched in Zr, Hf, Y, Sc, Ti, Al and Ca (Table 1, Fig. 3) and depleted in moderate volatile elements relative to CI. The bulk enrichment of CAI #3N-24 in Zr, due to the presence of the ZYS phase, reflects a large degree of fractionation of its precursor material in Zr relative to other refractory elements: Zr/Y (9.9), Zr/Sc (8), and Zr/Hf (8) are all super-chondritic. Ca/Al ratio of the inclusion is 1.45, higher than chondritic.

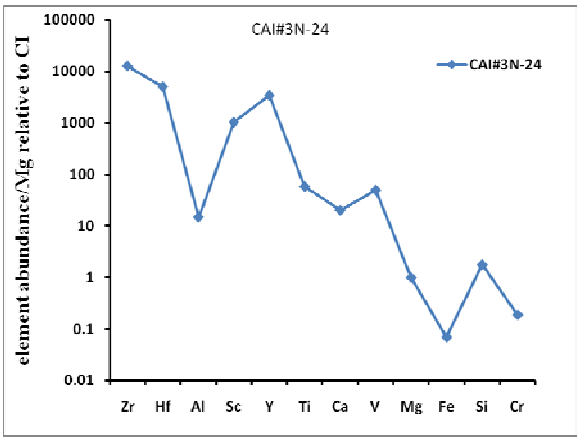

Figure 3: Bulk composition of CAI #3N-24 normalized to Mg and CI chondritic abundance.

4. Conclusion

CAIs like #3N-24 recorded an unusual kind of refractory elemental fractionation. It is not yet known if this CAI has an ultrarefractory rare earth element pattern that would indicate it to be among the very highest-temperature condensing materials from the solar nebula; this analysis is planned. Alternatively, this CAI may contain relict presolar grains. It is clear in any cases, that this CAI and others like it provides important information about elemental fractionation processes during the birth of our solar system.

References

[1] El Goresy, A., Zinner, E., Matsunami, S., Palme, H., Spettel, B., Lin, Y., and nazarov, M.: Efremovka 101.1: A CAI with ultrarefractory REE patterns and enormous enrichments of Sc, Zr and Y in fassaite and perovskite, Geochimica et Cosmochimica Acta, Vol. 66, pp. 1459-1491, 2002.

[2] Hiyagon, H., Hashimoto, A., Kimura, M., and Ushikubo, T: First discovery of an ultra-refractory nodule in an Allende fine-grained inclusion, Abstract#1552, 34th Lunar Planetary Science Conference.

[3] Huss, G., MacPherson, G., Davis, A., Krot, A., and Ulianov, A.: Microdistribution of REE in fine-grained group II CAIs in Efremovka, Meteoritics & Planetary Science, Vol. 37, p. A68, 2002.