

RUTHENIUM-DOMINATED PHASES IN THE HETEROGENEOUS REFRACTORY METAL NUGGETS IN CALCIUM-ALUMINIUM INCLUSIONS IN THE CV3R CHONDRITE NORTHWEST AFRICA 12590.

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Introduction: Refractory metal nuggets (RMNs) are sub-micron alloys that contain siderophile elements such as PGE, Mo, and W. The previous observations of the crystal structures showed that RMNs are cubic or hexagonal [1-5]. Hexamolybdenum ($P6_3/mmc$) was described in refractory inclusions of CV3 chondrite Allende [5].

RMNs were discovered in calcium-aluminium inclusions (CAI) in the CV3r chondrite Northwest Africa 12590. We reported morphological and chemical features of some RMNs in these CAIs previously [6]. Here we report new data on the crystal structures of Ru-dominated phases in RMNs.

Sample and methods: One plate of CV3R chondrite Northwest Africa 12590 with B-type CAIs was chemically polished by silica gel during 3 hours. The RMNs were analyzed by JEOL JSM-IT500 with EDS and electron backscattered diffraction (EBSD) detectors. The Kikuchi patterns were interpreted using Aztec software.

Results: Two RMNs from B-type CAIs have been included into clinopyroxene and spinel grains. All RMNs mainly consist of Fe-Ni alloys with inclusions of Mo and platinum group elements (PGE) bearing phases (Fig. 1). The RMN #1 contained two phases: awaruite (Ni_3Fe with space group $Fm\bar{3}m$) and ruthenium-dominated phase with empirical formula $Ru_{0.42}Mo_{0.23}Ir_{0.11}Os_{0.11}Ni_{0.11}Fe_{0.03}$ and space group $Fm\bar{3}m$. The RMN #2 has a nearly spherical shape. It consists of Fe-Ni phase with cubic crystal structure (space group $Pm\bar{3}m$) and Ru-dominated phase with the orthorhombic crystal structure (space group $Pmma$) and empirical formula $Ru_{0.46}Mo_{0.25}Ir_{0.11}Fe_{0.08}Os_{0.07}Ni_{0.04}$.

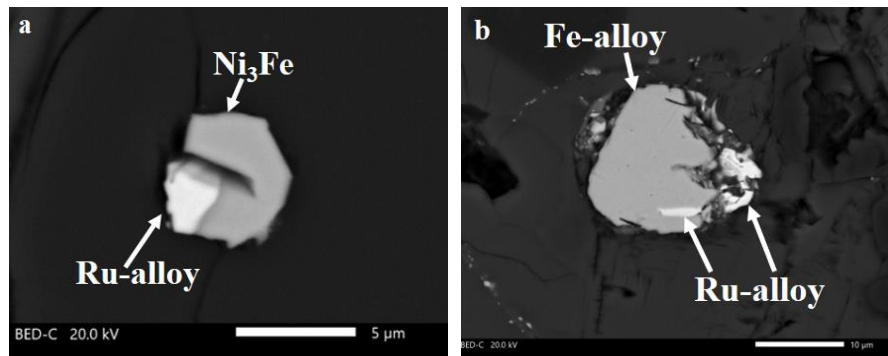


Fig. 1. BSE images of RMN #1 (a) and RMN #2 (b) in B-type CAIs from CV3R chondrite NWA 12590

Conclusions: A cubic system is common for Fe-Ni alloys but still unknown for Ru-dominant RMNs. Also, an orthorhombic system is described for the first time for the Ru-dominant phase. Orthorhombic iron was experimentally synthesized at very high pressure (>50 GPa). We suppose that the orthorhombic Ru-dominant phase may also reflect elevated pressure during CAI formation. Thus, we expect wider diversity of crystal structures among phases in refractory metal nuggets in CAI inclusions of primitive carbonaceous chondrites.

References: [1] Eisenhour, D., & Buseck, P. (1992) *Meteoritics*, 27: 217–218. [2] Harries D/ et al., 2012. *Meteoritics & Planetary Science* 47:2148–2159. [3] Croat T.K. et al., 2013. *Meteoritics & Planetary Science* 48:686–699. [4] Daly L. et al., 2017. *Geochimica et Cosmochimica Acta* 216:42–60. [5] Ma C. et al., 2014 *American Mineralogist*, 99(4):654–666. [6] Konovalova K.A. et al., (2021) *LPS LII*, Abstract #1961.