PROPERTIES OF A NEW GROUPLET OF G METAL-RICH CHONDRITES

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Introduction: The metal-rich (MR) chondrites (>20 vol% of Fe,Ni-metal) have attracted a lot of attention recently. MR chondrites include Carbonaceous (C) chondrites (CHs, CBs [e.g., 1-4], CH/CBb chondrite Isheyevo [5], G chondrites (GC), Northwest Africa (NWA) 5492, and Grosvenor Mountains (GRO) 95551 [6] and new ungrouped chondrites, Northwest Africa (NWA) 12379/12273 [7,8]. Here we discuss the main properties of a new grouplet of MR GCs and discuss possible origin of their components based on our comprehensive study of the Sierra Gorda (SG) 009 ungrouped MR chondrite.

Results and Discussion*:* SG 009 (S1, W2), a new MR chondrite, consists of FeNi-metal (22 -25 vol%), chondrules and their fragments; matrix is absent. Chondrules, up to 2 mm, are PP (predominant), BO, POP, SiO_2-bearing and Al-rich with clear boundaries. The meteorite also contains large (up to 1 cm) chondrule-like clasts. The main minerals of SG 009 are pyroxene, Fe,Ni-metal, and olivine. Accessories are sulfides (troilite and daubreelite), schreibersite, silica, Mg-chromite, anorthite, spinel, and PGE-metal nuggets. Olivine is Fa0.47±0.10, pyroxene is represented by Opx (Fs1.42, Wo0.88, Fe/Mn -2.83), and diopside (Fs1.34, Wo47.32). FeO-rich Opx occurs in some chondrules (Fs9.33-32.48, Wo0.23-4.74). Plagioclase varies in composition: An32.28-95.04. Mesostasis in chondrules is enriched in K_2O (up to 9.18 wt%) and TiO_2 (up to 6.53 wt%); kamacite contains 5.07 wt% of Ni, 0.43 wt% of Co, Co/Ni - 0.09, Si and Cr are below detection limit (<0.03 wt%); taenite has Ni - 32.3 wt%, Co - 0.25 wt%; troilite is enriched in Cr (up to 2.4 wt%); MgO-chromite is almost pure MgO-end member. The average metal composition of SG 009 is a good match to that of the metal in NWA 5492 [6]. However, there are important differences – SG 009 metal shows a wide range of compatible element abundances (Re,Os, Ir, Pt, Ru) which implies that the metal underwent some igneous fractionation . Volatile elements that are not fractionated by igneous processes, Ga and Ge, completely overlap between these two chondrites. The Cu abundances slightly differ, but the average Sn abundances and Ni/Co ratio are identical between the two chondrites. REEs in chondrules show positive anomalies in Ce and Yb which might be cosmochemical in origin and recorded volatilization in a gas rapidly changing its fO_2. Other evidence for a highly reducing environment is provided by subchondritic Nb/Ta ratios in the silicates. We analyzed 6 sulfide grains and found strong enrichment of V, Cr and Nb, confirming that Nb has acted like a chalcophile element and corroborating the evidence of Nb depletion in the silicates due to reduction. We also observed fractionation of the Th/Sc ratio possibly indicating igneous processing in the chondrule precursors [9]. Using the metal, olivine, and orthopyroxene compositions, and assuming a temperature of 1273 K, we calculated $\log fO_2$ = -18.2, which relative to the IW buffer is -3.29, indicating highly reduced formation conditions of this material [10]. Oxygen isotopic compositions of SG 009 silicates are between OCs and ECs ($\delta^{17}O$ 3.763, 3.736; $\delta^{18}O$ 6.263, 6.169; $\Delta^{17}O$ 0.506, 0.528 ‰,) similar to other G-chondrites [7]. Average $\delta^{13}C$ (+1.6 ‰) and $\delta^{15}N$ (+14.4 ‰) are in the range of ECs and OCs, respectively [11]; ^{20}Ne and ^{36}Ar contents are 53.6 and 18.2 ($\times 10^{-7}$ cm^3 STP/g), respectively.

Conclusions: The MR-chondrites are a unique phenomenon among chondrites. SG 009 has affinity to two GCs described by [6]. The GC grouplet is characterized by abundant metal, very reduced silicates (like ECs), absence of matrix (like CH-CBs), lack of Si in the metal, and oxygen isotopic compositions between OCs and ECs. However, the metal geochemistry of SG 009 [9] demonstrates igneous origin, and various silicate chondrules and fragments might have igneous precursors unlike for other GCs, but similar to the CBb chondrite Gujba [10]. GCs differ from NWA 12379 and 12273 [7,8], possessing OCs (L/LL) affinities and geochemically and isotopically different from CB and GCs. However, it is still unclear whether the major components of GCs grouplet originate from the same cosmochemical reservoir in the early solar system or formed separately and were mixed together afterwards.

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