Merrilite in NWA 6901 evidence for infiltration of a NWA 011-like melt.

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Introduction: Carbonaceous chondrites have a chemistry characterized by enrichment in refractory elements and depletion in moderately volatile elements. Typically their textures are of petrologic type 3 and lower. Recently a number of thermally metamorphosed carbonaceous chondrites of petrologic type 6 or beyond were identified. Some of these have O isotopes similar to CR chondrites and therefore were classified as CR metachondrites [1]. Based on chemistry, mineralogy and isotopic composition, Northwest Africa (NWA) 6901 has been linked to these CR metachondrites from Northwest Africa and potentially represents a paired meteorite [2, 3, 4, 5].

NWA 6901: NWA 6901 is almost identical to meteorites NWA 2994 and NWA 3250. Like the latter two, it has olivine and pyroxene compositions that are very FeO-rich (e.g., Fa~36). Furthermore, NWA 6901 has an equilibrated texture. Relict chondrules, mostly of BO type, are easily recognizable [4]. Merrilite is the only phosphate present and occurs in grains up to 300 µm in size. It is often associated with FeNi and poikilitically encloses rounded grains of olivine and low Ca-pyroxene.

In bulk chemistry, NWA 6901 differs in composition from CR chondrites [3]. Refractory elements (Al, Ca and Sc) and moderately volatile elements (K, Na, Ga, and Zn) are depleted relative to CR abundances. CI-normalized abundances of Th, U, and LREE are generally enriched over CI [3]. This bulk chemical abundance pattern is almost identical to that of individual merrilite grains [4].

Merrilite: The similarities of bulk and merrilite abundance patterns with respect to trace elements of REE and Th/U ratio show that merrilite is the carrier of these elements. Phosphates of basaltic achondrite NWA 011 have a similar REE abundance pattern suspected to be caused by terrestrial alteration [6]. Single phosphate grains in NWA 6901 were dated by U-Pb method and revealed no common Pb [4]. Therefore terrestrial alteration of phosphates is at most minor and unlikely to be the cause for the enrichment in LREE and subchondritic Th/U ratio. This is further supported by a bulk concentrations of K, an element that is typically enriched in desert finds, that is depleted relative to CI and CR.

Conclusion: Open system behavior and melt infiltration can explain the fractionated trace element abundance pattern. However, it is difficult explain major element composition of NWA 6901 if the parent body was of CR composition. Therefore, NWA 6901 may represent a fragment of a new type of carbonaceous chondrite parent body that gained a trace element rich partial melt with a chemical signature similar to that of phosphates in NWA 011. This argues for a relationship between these two meteorites in agreement with the O and ^{54}Cr isotopic record.

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