

Identification of hydroandradite in CM carbonaceous chondrites: A product of calc-silicate alteration on C-complex asteroids

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ABSTRACT

A hydrous Ca-Fe-rich silicate identified as hydroandradite was observed in the “Mighei-type” carbonaceous (CM) chondrite falls, Shidian and Kolang. This is the first report of hydroandradite occurring within meteorites. Hydroandradite forms through aqueous calc-silicate alteration under specific fluid conditions. Its presence within Shidian and Kolang has implications for interpreting alteration processes within the C-complex asteroid parent bodies of the CM chondrites. To better understand its occurrence, the meteoritic hydroandradite was studied with scanning electron microscopy, electron probe microanalysis, transmission electron microscopy, and Raman spectroscopy. It occurs in four petrographic contexts: layered, perovskite-associated, sulfide-associated, and spheroidal. Kolang has all four morphologies, while only the sulfide-associated occurs in Shidian. In Kolang, hydroandradite was likely produced by replacement of kamacite, Ti-bearing clinopyroxene in calcium- and aluminum-rich inclusions, and secondary magnetite in three distinct alteration events. The formation temperature of meteoritic hydroandradite was estimated to be 100–245 °C, based on the mineralogy of the lithologies within which it occurs as well as on its degree of hydration relative to synthetic and terrestrial hydroandradites. Because Kolang and Shidian are the only reported meteorites with hydroandradite to date, they may be from the same parent body.

Keywords: Meteorites, hydrogarnets, aqueous alteration