Slow cooling rate of silicate in mesosiderite inferred from exsolution lamellae in pyroxene

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Mesosiderites are breccias consisting of a mixture of metal, chemically similar to IIIAB iron meteorites, and silicates, which resemble HED achondrites [1] [2]. From microscale metallographic textures and geochemistry, the cooling of the metal fraction from about 550°C appears to be uniquely slow (cooling rate of 0.25-0.5°C/My [3]) despite some debate about systematic error in these determinations [4]. On the other hand, the silicate are believed to have cooled quite quickly (e.g., [5]). The mesosiderite A 09545 [6] contains large grains of pyroxene exhibiting two generations of exsolution lamellae, which have been here investigated with electron microscopy (SEM, TEM, and EPMA) and used for constraining the thermal evolution of the silicate fraction in the sample.

The host pyroxene is clino-enstatite (Monoclinic, $P2_1/c$) with composition $Wo_3En_{59}Fs_{38}$ and contains thick (up to 25 μm) lamellae of augite (Monoclinic, C2/c, $Wo_{42}En_{41}Fs_{17}$) along cleavage. A second generation of exsolution lamellae occurs within the augite lamellae, with thin (ca. 300 nm) lamellae, apparently parallel to [001], and composition $Wo_1En_{56}Fs_{43}$. Geothermobarometry calculation [7] [8], lattice parameters [9], lamellae orientation [10], and the inversion of ortho- to clinopyroxene [11] have suggested a slow cooling rate of the pyroxene from the crystallization of pigeonite (ca. 1150°C) to the inversion into clinoenstatite (ca. 570°C), followed by the slow cooling recorded in the metal (e.g., [3]).

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