Petrological insight into the formation of the mesosiderite parent body

ANA PAGU[1], CONALL MAC NIOCAILL[2], JAMES F. J. BRYSON[3]

[1]Department of Earth Sciences, University of Oxford, Oxford, UK (ana.pagu@earth.ox.ac.uk)
[2]Department of Earth Sciences, University of Oxford, Oxford, UK (conall.macniocaill@earth.ox.ac.uk)
[3]Department of Earth Sciences, University of Oxford, Oxford, UK (james.bryson@earth.ox.ac.uk)

The study of early Solar System dynamos can provide a wealth of information on the formation and internal dynamics of a planetesimal. Mesosiderites are a meteorite group whose magnetic mineralogy has not been extensively studied. Electron microscopy methods applied to the mesosiderite Estherville have revealed chromite-tridymite symplectites and nanometric metal and sulfide inclusions trapped in coarse enstatite crystals. Such symplectites have been reported before in HED meteorites and they were caused by reduction of orthopyroxene with formation of excess silica [1]. We propose that the reduction in this case was caused by mixing of pre-existing silicates with reduced metal in the mesosiderite-forming impact and that the inclusions were trapped during crystal growth caused by thermal metamorphism.

Some of the metal inclusions are made of nanometric tetrataenite (ordered FeNi), which has been proved to be a very reliable palaeomagnetic recorder [2]. Given the slow cooling rate of mesosiderites [3] and the low ordering temperature of tetrataenite [2], a significant length of time is necessary for the meteorite to reach low enough temperatures to record a magnetisation. Therefore, a planetary magnetic field recorded by these inclusions would be a long-lived dynamo, which has implications for planetesimal differentiation and the timing of the mesosiderite - forming impact.

Future work includes a comprehensive nanopalaeomagnetic analysis using SQUID microscopy and Quantum Diamond Microscopy, to determine the origin of the magnetic signal recorded by the tetrataenite inclusions, and use it to inform a formation scenario for the mesosiderite parent body.

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