Co/Ni DOUBLE RATIOS IN MESOSIDERITE METAL AND THE UNREALISTICALLY LOW COOLING RATES

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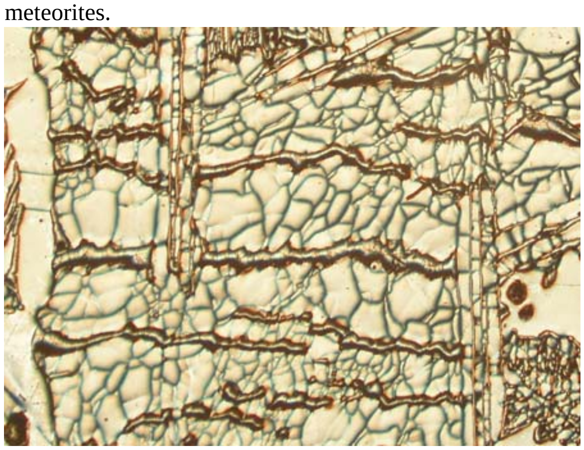
Published cooling-rate estimates for mesosiderites (Mes) are remarkably low, about 0.2 K/Ma [1], ~300× lower than the lowest values reported for magmatic groups of iron meteorites (e.g., 60 K/Ma in IIIAB) [2]. At these cooling rates the Mes have only cooled ~900 K during the last 4.5 Ga. To compound the discrepancy, the silicates in Mes are basalts which, because of their low melting temperatures and low densities, should be found near the asteroidal surface where high cooling rates are expected. To better assess the problem we applied our cooling-rate method [3] based on the ratio of $(Co/Ni)_\alpha/(Co/Ni)_\gamma$ (abbreviated to R$\alpha\gamma$) to examine cooling rates in two Mes samples previously studied by Goldstein and coworkers.

We [3] found R$\alpha\gamma$ values of 22 in IVA irons reported to have metallographic cooling rates differing by a factor of 25 and argued that the higher cooling rate reported for Bishop Canyon was in error. Recent R$\alpha\gamma$ data by Goldstein et al. [4] are lower but agree with trends for the IVA and IIIAB irons we studied.

Our R$\alpha\gamma$ values for two mesosiderites are much higher than those for the magmatic irons; our ratios are: Estherville (95.6 +-2.8) and Vaca Muerta (74.0±3.1). Goldstein et al. [4] report a still higher value for Estherville (122) but were unable to obtain Co data for the γ phase of Vaca Muerta. These high R$\alpha\gamma$ values imply low cooling rates and thus seem to support low metallographic cooling rates for mesosiderites. We suggest, however, that they are better interpreted as an indication that the cooling rate model (of kamacite nucleation and growth in a large single crystal of γ iron) is not applicable to these shocked and annealed meteorites.



As we [3] discussed, shock damage can produce diffusion paths that allow more rapid transport than body diffusion through massive γ iron. This image of Vaca Muerta shows recrystallized α and γ fields that were strongly annealed after heavy shock damage. There is no doubt that postshock annealing occurred. The R$\alpha\gamma$ values might be usable to calculate annealing periods and temperatures; they cannot be used to obtain cooling rates.

References: [1] Hopfe W. and Goldstein J. (2001) *MPS* **36**, 135. [2] Yang J and Goldstein J. (2006) GCA **70**, 3197. [3] Wasson J. and Hoppe P. (2012) *GCA* **84**, 508. [4] Goldstein J. et al. (2014) GCA doi: http://dx.doi.org/10.1016/j.gca.2014.05.025.