THE CASE FOR MELTING IN PLAGIOCLASE-POIK MESOSIDERITES, Roger H. Hewins and Theresa A. Harriott, Dept. of Geological Sciences, Rutgers University, New Brunswick, N.J. 08903

Introduction The major uncertainty about mesosiderites is whether they originated by metal-silicate mixing resulting from impact processes or from internal processes. The mineral compositions and textural relationships of mesosiderites are still not completely documented or perfectly understood, despite the fact that such data may yield criteria for distinguishing between different possible models of origin. In particular, the plagioclase-POIK mesosiderites, Bondoc, Budulan and Mincy, were recognized only recently (4) as subgroup 3B and they have not been thoroughly studied. This paper suggests that they contain a poikilitic matrix crystallized from a melt, which requires more extensive heating in mesosiderites than previously recognized.

POIK Textures The 3B POIK texture, with large grains of plagioclase enclosing small equant orthopyroxene crystals, has been described as poikiloblastic (4,5). However, poikiloblastic plagioclase is not commonly found in metamorphic mafic rocks. The texture resembles that of poikilitic igneous rocks, in particular, the olivine zone in the Palisades sill, and leads us to compare these rocks to mesosiderites known to contain a significant melted fraction. The subgroup 4 mesosiderites have a melt-rock matrix containing plagioclase laths as well as plagioclase clasts (6) but in the coarsest-grained member Pinnaroo some of the plagioclase is poikilitic to pyroxene, as originally reported by (6). Local patches of matrix in Pinnaroo closely resemble the plagioclase-POIK mesosiderites and differ mainly by having smaller more lathy plagioclase. Lathy plagioclase is, however, present locally in Bondoc (associated with metal) and Mincy (associated with pigeonite).

Olivine Reactions Olivine in melt-rock mesosiderites shows embayed grain boundaries consistent with resorbtion, whereas in most other mesosiderites olivine grains are surrounded by coronas as a result of solid state reactions (4-7). In Mincy, olivine grains show lobate, embayed margins suggestive of resorbtion by a melt. Vermicular chromite is found along parts of the olivine grain boundaries, although generally not extending far outwards from the grain, and they have therefore been described as having a Stage I corona (7). However, the surrounding pyroxene is granular rather than acicular as expected, and POIK plagioclase is also in contact with the olivine grains. The pyroxene-rich zones around embayed olivine are interpreted as the result of crystallization of Mg-enriched melt, similar to orthopyroxene-rich shells over peridotite xenoliths in Sudbury sublayer.

Pyroxene Relationships Orthopyroxene occurs as clasts, both large single crystal clasts and "pyroxenite" formed by recrystallization of shock-deformed material, and also as small equant crystals enclosed by plagioclase (chadacrysts). Their distribution near "pyroxenite" clasts suggests that orthopyroxene chadacrysts need not be entirely the products of melt crystallization, but some could have been small clasts on which later overgrowth occurred. Inverted pigeonite also has two modes of occurrence. It occurs as borders or overgrowths on large orthopyroxene clasts (the characteristic mesosiderite pyroxene relationship) and as grains interstitial to plagioclase. Aggregates of "interstitial" inverted pigeonite could possibly represent clasts of intermediate composition but most pigeonite would be better explained as the product of melt crystallization. In particular, local patches in Mincy have a distinct subophitic texture with lathy plagioclase embedded in inverted pigeonite. The different distribution of the two pyroxenes in the POIK matrix, with pigeonite surrounding plagioclase which

encloses orthopyroxene, would be very hard to explain by metamorphic recrystallization of the matrix, but it would be entirely consistent with fractional crystallization of a melt, in which orthopyroxene preceeded pigeonite.

Discussion Assuming a melt matrix for the plagioclase-POIK mesosiderites, the different texture from subgroup 4 impact melt mesosiderites needs to be explained. The larger plagioclase grain size in the POIK rocks, i.e. smaller number of crystals, could reflect a smaller number of nucleii available. Plagioclase nucleii would be associated with relict unmelted plagioclase grains and such plagioclase clasts are absent in plagioclase-POIK mesosiderites, but preserved in impact-melt mesosiderites. What makes this relationship particularly plausible is that Pinnaroo, the coarsest of the melt-rocks with a sub-poikilitic to intergranular texture, has very little relict plagioclase (6).

It is significant that, if the present interpretation is sustained, half the mesosiderites show evidence of melting. Impact melt textures were observed in Simondium, Hainholz, Pinnaroo and Estherville, in clasts in Patwar and Crab Orchard (4) and also locally in West Point (this study). Evidence of a melt in Emery was also reported but an origin by partial melting (anatexis) was suggested (5). Adding the plagioclase-POIK mesosiderites (including the related subgroup 2B Veramin) makes a total of 12 out of 21 well characterized mesosiderites (8) with evidence of melting, surely a much larger fraction than is found in most suites of fragmental breccias, e.g. howardites. Some models of mesosiderite origins (2,3) involve mixing liquid metal with crustal regolith which might involve more silicate melting than impact processes. The plagioclase-POIKs do not appear to have any features, such as checkerboard melting, unequivocally requiring that the melting be caused by impact. However, subgroup 4 is best explained by impact melting (6,1) and because of the apparent gradation of textures to those of subgroup 4, with Pinnaroo having a transitional texture, an impact-melt origin seems the simplest interpretation.

Conclusion The poikilitic (to subophitic) textures, the crystallization sequence (orthopyroxene, plagioclase, pigeonite) and the embayed margins of olivine grains all suggest that the matrix of plagioclase-POIK mesosiderites crystallized from a melt. If this interpretation is confirmed, the Floran classification (4) can be revised by calling these rocks subgroup 4b. About half of all mesosiderites show evidence of melting.

References

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