Excess silica in plagioclase in some mesosiderites

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Introduction: Excess silica in plagioclase has been reported in lunar rocks [1] and chondrules [2]. It is absent in terrestrial plagioclase and the presence of the excess is considered as evidence against metamorphism and/or slow cooling at temperatures where cations could move around. Here we report excess silica in plagioclase in some mesosiderites (Dong Ujimqin Qi (B1), NWA1878 (B0), NWA2924, NWA4747, Bondoc (B4)), and absence of the excess in Estherville(A3/4).

Instrumental: Plagioclase compositions were measured by SEM-EDS. The measurements were made without standards and normalized to 100%. Since excess silica is produced by vacancies [1] this is problematic, but until measurements with EPMA are made we have to abide this ambiguity. The differences in apparent excesses in mesosideritic plagioclase and those in other plagioclase (terrestrial and achondrites) at the same anorthite number (An#) are considered as true excess silica.

Results: Similar to lunar plagioclase, silica excesses in mesosideritic plagioclase increase with decreasing anorthite number [1]. The excess silica evaluated at the same An# varies considerably among the mesosiderites. It decreases in the order of, NWA1878 > Dong Ujimqin Qi > Bondoc > NWA2924 > NWA4747> Estherville. The excess is practically nil in Estherville, within the error (standard deviation) of the measurement (about +/- 1% which is not significantly larger than those reported for lunar rocks). A typical excess in NWA1878 is ~4.5 % at An90, which is significantly higher than those in lunar rocks [1].

Discussion: In the case of lunar rocks, the excess silica is explained as a result of a high silica activity during crystallization of increasingly Na-rich plagioclase from a melt. Most mesosiderites experienced brief reheating to near-solidus temperatures after the mixing of metal. Also, the silica activities in most mesosiderites were high during reheating as a result of phosphate formation reactions. (Note that this requires reheating after the formation of phosphates.) Therefore, the excess silica in mesosideritic plagioclase may be understood to have been produced by a mechanism similar to that in lunar rocks. The variation in the excess among mesosiderites could be due to difference in the thermal histories (cooling rate or multiple reheating). The higher excesses in mesosideritic plagioclase than those in lunar rocks may be due to difference in the thermal histories. Dissecting the mesosiderite data in detail, however, it is found that the vacancy corresponding to the silica excess seems to be mostly created by Na deficiency. Merrillite in mesosiderites is known to be deficient in Na [3]. Therefore, both merrillite and plagioclase competed for limited supply of Na. This may have contributed to the high excess silica in mesosideritic plagioclase. A peculiar feature of mesosideritic plagioclase with high excess silica is the presence of fine silica particles. This is observed in NWA1878, Dong Ujimqin Qi and Bondoc. (A caveat on the reported excesses in these mesosiderites is that they could be due to hidden silica particles. Some of the data are likely to be affected by such hidden silica particles, but we believe many of the excesses are authentic.) Investigations of excess silica, exsolved silica particles, and the compositional relationship between plagioclase and merrillite would clarify the reheating history of mesosiderites.

References:

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