PRESOLAR SILICATE ABUNDANCES IN THE UNEQUILIBRATED ORDINARY CHONDRITES METEORITE HILLS 00526 AND QUEEN ALEXANDRA RANGE 97008.

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Introduction: Presolar silicate grains are highly labile and are only found in extraterrestrial materials that have experienced minimal secondary processing. Among meteorite groups, the highest abundances have been found in primitive carbonaceous chondrites, particularly samples from the CR and CO groups [1]. However, presolar silicates were recently reported from an unequilibrated ordinary chondrite (UOC), MET 00526 [2], the first non-carbonaceous chondrite with presolar silicate abundances comparable to those of the most primitive carbonaceous chondrites studied to date. Here we report on our search for presolar grains in another UOC, QUE 97008.

Experimental: We carried out NanoSIMS C and O ion imaging measurements in fine-grained matrix areas of QUE 97008, following routine procedures [3]. Presolar grains were identified from ratio images processed using L'Image. The total area measured in QUE 97008 was 22,500 μm^2, comparable to that measured in MET 00526 [2].

Results: As in MET 00526, we identified both O-rich and C-rich presolar grains in QUE 97008. We found 23 O-rich presolar grains. Most of the grains belong to Group 1 [e.g., 4], with enrichments in ^{17}O and close-to-solar $^{18}O/^{16}O$ ratios, but we also found one ^{18}O-depleted Group 2 grain and a ^{17}O- and ^{18}O-depleted Group 3 grain. We also identified 16 presolar SiC grains. Most are mainstream grains of AGB star origin, with $^{12}C/^{13}C$ ratios between 22 and 64. However, three grains have $^{12}C/^{13}C$ ratios of less than 20 and may be AB grains, while one grain is strongly enriched in ^{12}C ($^{12}C/^{13}C = 267 \pm 5$) and could be either an X grain of supernova origin, or a Y grain from a low-metallicity AGB star [5]; additional isotopic data are required to distinguish between these possibilities.

The abundance of O-rich presolar grains in QUE 97008 is 145 ± 30 ppm. This is comparable to the presolar silicate abundances in many primitive carbonaceous chondrites [1], but is significantly lower than the abundance of 275 ± 50 ppm that we observed in MET 00526 [2]. In both meteorites the presolar silicate abundances are considerably higher than those determined for other UOCs; in particular, they are more than an order of magnitude higher than the abundance of O-rich presolar grains in Semarkona (~4–8 ppm [6,7]). For SiC, we found twice as many grains in QUE 97008 as we did in MET 00526: 16 vs. 7 (125 ±30 ppm vs. 65 ± 25 ppm). As for presolar silicates, the abundance of SiC (~10–30 ppm [8,9]) is lower in Semarkona than in MET 00526 and QUE 97008.

Discussion: The most commonly used scheme for determining the petrologic type of UOCs is based on the distribution of Cr in Fe-rich olivine [10]. According to this scheme, MET 00526 and QUE 97008 are both of petrologic type 3.05. Only Semarkona is considered to be less equilibrated, and is classified as a type 3.00, suggesting that its presolar silicate abundance should be comparable to (or higher than) those of MET 00526 and QUE 97008. However, while these meteorites all experienced minimal thermal metamorphism, they do differ in the degree of aqueous alteration they have experienced. In Semarkona fine-grained and chondrule rims are dominated by smectite and sulfide phases show ubiquitous evidence of alteration [11]. In contrast, a transmission electron microsopy study of MET 00526 and QUE 97008 [12] indicates that, although these meteorites also show signs of aqueous alteration, the effects are minimal compared to Semarkona. Matrix material consists of a mixture of amorphous silicates and unequilibrated crystalline phases, much like that found in other meteorites with high presolar silicate abundances. Phyllosilicates, when present, are more fine-grained than in Semarkona, and are poorly crystallized and heterogeneously distributed [12].

This difference in the degree of aqueous alteration likely accounts for the large difference in abundance of O-rich presolar grains between Semarkona and MET 00526 / QUE 97008. Our study demonstrates that chondrites of similar petrologic type can have vastly different presolar grain abundances and emphasizes the difficulty of establishing consistent criteria for classifying meteorites according to petrographic type.

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