FLUORINE ABUNDANCES AND ZONATION PATTERNS IN MARTIAN PYROXENES

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Introduction: Volatiles can play a significant role in the evolutionary history of planetary bodies. However, determining the water content of the martian magmas (as represented by the martian meteorites) has proven difficult [1, 2] and therefore previous workers have attempted to use other indirect means of estimating it [3-8]. Dreibus and Wanke [9] first argued that halogens may be used to estimate the water content of the martian mantle. Additionally, it has been suggested that halogens may greatly affect magmatic phase equilibria [10]. Therefore, we have conducted an investigation of the F contents of pyroxenes in several martian meteorites.

Analytical Procedures: Fluorine abundances were measured on pyroxenes in polished thin sections of two shergottites (Shergotty and Zagami) and a nakhlite (Yamato 000593) using a Cameca IMS-6f ion microprobe at ASU using methods similar to those described previously [11]. Absolute abundances were calculated assuming NIST 610 contains 250 ppm F. TiO_2 contents were additionally measured close to the ion microprobe analysis spots using the JEOL 8600 electron microprobe at ASU.

Results and Discussion: Fluorine abundances in augite cores of Yamato 000593 are relatively constant (~100 ppm), while higher values (up to ~300 ppm) were obtained within the thin, more ferroan rims. These rim F contents are consistent with simple closed-system fractional crystallization of the nakhlite parent melt; however, the constant F abundances within the larger core regions may have resulted from diffusive re-equilibration of the cores prior to rim crystallization.

Pigeonites in the shergottites (Shergotty and Zagami) are characterized by relatively low F abundances (<50 ppm). Shergotty pigeonites show a flat trend for F contents from core to rim with abundances ranging between 8 and 29 ppm. Fluorine contents in Zagami pigeonites decrease slightly from ~37 ppm in the cores to ~9 ppm in the rims. These trends suggest that the primary magmatic signature of F zonation in shergottite pigeonites has been disturbed, mostly likely by post-crystallization diffusive re-equilibration.

Using relevant crystal-melt partition coefficients from [11], the F contents for martian meteorite parental melts can be calculated. Inverted core compositions of pyroxenes measured in this study yield estimates of ~910 and ~220 ppm for the F contents of the parental melts of the nakhlites and shergottites, respectively.

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