A dry origin of 4-Vesta estimated by the water content in pyroxenes from the HED

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The HED meteorites provide a uniquely detailed record of differentiation processes that occurred on the early-formed basaltic 4-Vesta asteroid. We used pyroxenes from eucrites (Juvinas, Serra de Magè, Stannern), howardite (Luotolax, Kapoeta) and one diogenite (Shalka) as proxy to estimate the water content of 4-Vesta. Pigeonite and orthopyroxene were extracted from the HED meteorites and measured by FTIR spectroscopy in the region 6000-2000 cm-[1]. The integrated area of OH bands is used to estimate the water content of pyroxene and then to calculate the primitive magma water content. However, no specific opx OH bands could be observed.

Since H diffusion coupled to redox exchange with Fe is very fast (10-13 cm^2/sec at 1100°C) in pyroxene, hydrogen can be lost during late stage(s) of magmatic evolution. In pyroxene H is incorporated associated to point defects that are retained in the structure during the H loss processes. By experimentally reversing the redox reaction under reducing conditions at 700-800°C, the original H content of pyroxene can be recovered.

After FTIR measurements on untreated HED pyroxenes, we performed several annealing experiments under hydrogen atmosphere at 1 Atm and 700-800°C and hydrothermal experiments at 0.2 GPa and 700°C to assess the H uptake that corresponds to previous H loss. FTIR spectra were recorded after each heating step but none of the HED pyroxenes showed OH band signal (detection limit is 4-5 ppm H_2O).

We thus conclude that the "dry" condition of 4-Vesta magmas is primary and that no H loss occurred in pyroxene during the evolution of the asteroid.

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