American Mineralogist, Volume 93, pages 676–684, 2008

Maskelynite-hosted apatite in the Chassigny meteorite: Insights into late-stage magmatic volatile evolution in martian magmas

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Abstract

Apatite-hosting maskelynite and alkali maskelynite within regions interstitial to cumulus olivine differ compositionally from that found within melt inclusions in the Chassigny martian meteorite. Feldspar glass compositions within the interstitial regions evolve along a high-temperature crystallization path. Within the melt inclusions, feldspar glass shows evolution to low temperatures, extending into the subsolidus regime. Coupled with these differences in maskelynite compositions are differences in volatile abundance in apatite included within the maskelynite. Apatite found within the large olivine-hosted polyphase melt inclusions is uniformly fluorapatite, whereas that interstitial to cumulus olivine is chlor-fluorapatite.

We propose that the differences in maskelynite and apatite compositions within the melt inclusion and interstitial regions arose primarily from different crystallization conditions. Melt-inclusion maskelynite and apatite are consistent with nearly closed-system buildup of magmatic volatiles during crystallization within the melt inclusions, exsolution of a Cl-bearing fluid phase, and retention of this fluid phase within the melt inclusions into the hydrothermal regime. For the interstitial regions, however, the higher solidus temperatures of the interstitial melts, the early crystallization of feldspar with significant ternary component, and the Cl-rich nature of the apatite, all suggest open-system fluid migration through the cumulus pile, ingress of Cl-rich, H_2O-poor brine from a hotter, less evolved portion of the magma plumbing system, and interaction of this Cl-rich fluid with melt prior to the crystallization of feldspar. Such processes of fluid migration through a cumulus pile have been suggested on Earth in layered intrusions, and apatite is the primary recorder of this process.

Keywords: Magmatic volatiles, chlorine, water, fluorine, Chassigny, Mars, SNC meteorite, apatite