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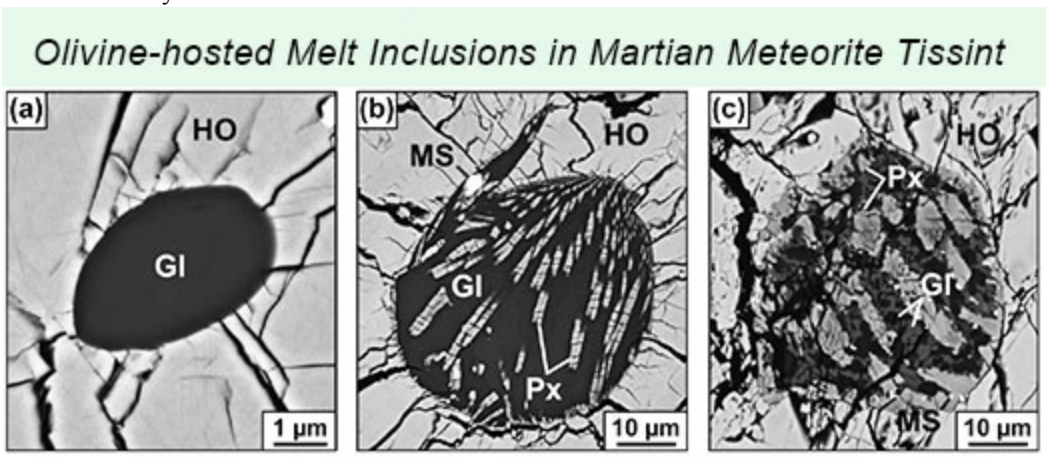
# *Probing Bulk Magma Compositions of Mars*

Melt trapped inside mineral crystals of igneous rocks can be examined to learn about the primary magma in which the crystals formed. The importance of these melt inclusions to understanding the origin and formation of igneous rocks in Mars has been borne out by meteorite studies. In these studies, size of the melt inclusions mattered. Cosmochemists typically analyzed melt inclusions >50 µm in diameter, thinking smaller inclusions would not likely entrap bulk (average composition) magma because of ***diffusional*** boundary layer effects at the surface of the melt with the host mineral crystals.




Backscatter electron images of olivine crystals with melt inclusions (black) in a Tissint sample analyzed by Sonzogni and Treiman. [LEFT] Small glass inclusion. [CENTER] Large partially crystallized inclusion with homogeneous glass. [RIGHT] Large partially crystallized inclusion with heterogeneous glass. HO = host olivine, GI = glass, Px = pyroxene, MS = metal/sulfide.

Yann Sonzogni and Allan Treiman (Lunar and Planetary Institute, TX) decided to look specifically at the usefulness of small melt inclusions (<15 µm in diameter) in the Tissint meteorite [***Data link*** from the Meteoritical Bulletin] to derive bulk magma composition. Theirs is the first account of Tissint melt-inclusion compositions. They studied 18 small glassy (mostly 5-10 µm in diameter) and 7 large, partially crystallized (mostly ~50 µm in diameter) ***olivine***-hosted melt inclusions using a field emission gun scanning electron microscope and electron microprobe. See images above. Both sizes can be present in a single olivine grain.

After determining the present bulk chemical compositions of the melt inclusions, Sonzogni and Treiman then reconstructed reasonable compositions of the melt trapped originally. The "now" and "then" melt compositions are not the same because as the trapped melt cooled it crystallized olivine onto the wall of the inclusion and chemically re-equilibrated. Therefore in the melt modeling scenario, olivine was added and the Fe/Mg ratio was adjusted as explained in their paper (this is a method well-established by cosmochemists). For the Tissint melt inclusions, Sonzogni and Treiman found no evidence of diffusional boundary layers affecting the compositions of small melt inclusions in their study. They determined that the small and large melt inclusions in Tissint olivines trapped the same original melt compositions—consistent with being chemical fractionates of a single parent magma.

See Reference:

· Sonzogni, Y. and Treiman, A. (2015) Small Melt Inclusions Can Record Bulk Magma Compositions: A Planetary Example from the Martian Basalt (Shergottite) Tissint, *Meteoritics & Planetary Science,* v. 50(11), p. 1880-1895, doi: 10.1111/maps.12516. [***abstract***]

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