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Advancing Water Content Measurements in Silicate glasses and Melt Inclusions through High-Temperature Raman Spectroscopy: Overcoming Nanolite and Fluorescence Challenges

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Water is the most abundant volatile species in magma, with concentrations up to 6–8 wt% in magmas from subduction zones and it represents to all effects the engine and the main driving force of a volcanic eruption. Hence, the characterization of water distribution in natural glasses is pivotal for a complete comprehension of the thermodynamic processes occurring before, during, and after a volcanic eruption. A precise method for measuring the water content in volcanic glasses is, thus, a prerequisite to investigate any petrological and/or volcanic processes. In the past years, a number of different techniques have been deployed to this purpose but to this day a non-destructive comprehensive protocol to quantify the water content of silicate glasses and/or melt inclusions in a wide compositional space has not been produced. In this work, we present a new methodology based on Raman spectroscopy for the determination of the dissolved water content in glasses and melt inclusions, that takes into account the chemistry of the samples, the presence of fluorescence, and/or nanolites.

Instead of developing a fitting procedure to account for the nanolite signal in the Raman spectra, we deployed a strategy to remove the nanolite signal and at the same time improving the overall quality of the spectrum by measuring the samples at high temperature. Analyses were performed both at ambient and high temperatures (up to 500 °C), using the Linkam TS1500-7/3 high-temperature cell in a series of synthetic glasses and natural melt inclusions from the Aira caldera-forming volcanic event (Kyushu, Japan).

HT measurements have allowed the complete removal of the contribution of nanolite features from the silicate band, with a progressive reduction and disappearance of the peak at 670-690 cm^{-1} with the increase in temperature. Moreover, HT measurements led to a significant enhancement of the spectral signal, by reducing the fluorescence and strongly improving the signal/noise ratio. The new method allowed us to perform a very precise calculation of water contents in the melt and to increase the resolution of Raman spectroscopy down to 0.10 wt%, with a very small uncertainty.