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In-situ spectroscopic investigations of volatiles speciation in hydrous melts and magmatic fluids

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Magmatic degassing is an important geological process, not only directly affecting the populations leaving close to volcanoes, but playing a key role in the formation of different type of ore deposits and, on a larger and longer scale, mitigating chemical exchanges between the solid Earth and its atmosphere.

Depending on the conditions of degassing, magmatic fluids will develop very diverse compositions that spans from supercritical fluids containing thousands of ppm to few wt% of S and Cl to CO2 and SO2-rich high-temperature gases or Cl-rich brines. The properties of these 'magmatic volatile phases' (MVPs), including their volatile composition from source to surface and capacity to carry trace elements or metals, however remain elusive. This lack of knowledge is mostly due to the fact that the only samples available are either the volcanic gases released to the surface or fluid inclusions trapped under varying but often poorly known P-T-fO2 conditions. MVPs are also hardly quenchable and thus difficult to investigate via the experimental approach.

A way to overcome quench-related issues in experimental studies (e.g., fast chemical exchange, destabilization of species that are only stable under particular P-T conditions), is to use so called 'in-situ' devices that are equipped with high P-T windows transparent to different spectroscopic technics, such as diamond anvil-cells or silica capillaries. Up to now, working conditions of these devices have however been limited either to low-temperature (T< 500C) or extreme pressure conditions (P> 1GPa) that are not relevant for the study of magmatic degassing. Here, we present a new IHPV that enables in-situ Raman and X-ray absorption (XAS) spectroscopy measurements to typical degassing conditions (600-1200°C and 1-2kbar). To illustrate the capacities of this novel experimental device to study the distribution and speciation of volatiles during degassing, we present preliminary studies investigating S and Se speciation in MVPs, as well as Br fluid-melt partitioning in granitic systems.